KINGS BAY VEGETATION EVALUATION

SWFWMD

CONTRACT NUMBER 04CON000081 – PROJECT W457

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SURFACE WATER IMPROVEMENT AND MANAGEMENT PROGRAM
RESOURCE MANAGEMENT
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
7601 HIGHWAY 301 NORTH
TAMPA, FLORIDA 33637-6759

DECEMBER 2007

EXECUTIVE SUMMARY

Submersed aquatic vegetation (SAV) represents a critical element of the Kings Bay ecosystem because it promotes water clarity, provides habitat for refuge and foraging, and supplies food to grazers. Vegetation in the bay appears to have changed. The native *Vallisneria americana* has become less prevalent and non-native species (*Hydrilla verticillata* and *Myriophyllum spicatum*) and nuisance filamentous algae (including *Lyngbya* spp.) have expanded. Managers remain concerned about the effects of these changes on water quality and other aspects of the Kings Bay ecosystem.

This study provides a critical, multi-year baseline for SAV in Kings Bay. Sampling was conducted at 71 stations in February, May, July and October of 2004, 2005 and 2006. The occurrence, percentage cover and biomass of filamentous algae (including *Lyngbya* spp.), *Ceratophyllum demersum*, *Chara* spp., *Hydrilla verticillata*, *Myriophyllum spicatum*, *Najas guadalupensis*, *Potamogeton pectinatus*, *Potamogeton pusillus*, *Ruppia maritima*, *Vallisneria americana*, and *Zannichellia palustris* were recorded. In addition, data were pooled in appropriate combinations to yield total SAV, angiosperms, macroalgae, native taxa and non-native taxa. Additional data related to potential influences on submersed aquatic vegetation were obtained from the literature (sediment depth from Belanger et al. 2005 and salinity pulses from hurricanes from Frazer et al. 2006), the Southwest Florida Water Management District (water quality), Citrus County Aquatic Services Division (management of aquatic vegetation) and the Chassahowtizka National Wildlife Refuge (numbers of manatees frequenting Kings Bay). Data were analyzed with multivariate ordinations and analyses of variance. Interpolations were employed to estimate percentage cover and biomass between stations.

Over the three years of sampling, vegetation in Kings Bay exhibited a persistent spatial pattern. Vegetation was more diverse at one group of stations in the southern and western portions of the bay. Filamentous algae (including *Lyngbya* spp.) and *Hydrilla verticillata* characterized the other group of stations. This spatial pattern was not correlated with sediment depth or management of aquatic vegetation. It was correlated with water quality. Filamentous algae and *H. verticillata* tended to occur at stations near springs.

Submersed aquatic vegetation at many stations in Kings Bay also exhibited two temporal patterns. Neither temporal pattern was related to management of aquatic vegetation. Overall, it appeared that management actions were not undertaken at stations sampled in this study. A one-off decrease in percentage cover and biomass of most plants and algae was recorded in October 2004. Apparently, most taxa did not cope with stress caused when high salinity water was forced into Kings Bay by three hurricanes that passed nearby in September 2004. *Vallisneria americana* and filamentous algae (including *Lyngbya* spp.) were two important exceptions. The native plant, *V. americana*, appeared to tolerate the pulses of high salinity water, and it may have benefited from reduced competition after non-native taxa became less prevalent. Filamentous algae at the stations near springs also appeared to cope with the salinity pulses, perhaps because of greater freshwater input. Repeated decreases in the percentage cover and biomass of many plants and algae were recorded in February sampling periods. It appeared that manatees sheltering and grazing in the bay led to these changes. An important exception to this pattern was filamentous algae (including *Lyngbya* spp.), which did not appear to be grazed where it was dominant.

Several key conclusions arise from this study. Firstly, the impacts of storms and manatees need to be considered as part of plans to restore submersed aquatic vegetation in Kings Bay. Established vegetation is more likely to cope with storms and grazing. Therefore, restoration should be timed to avoid hurricane season, and manatees may need to be excluded from restoration sites until plants become established. Secondly, diagnostic studies that disentangle potential influences, such as conductivity, concentrations of nitrate-nitrite and water clarity, could explain the persistent spatial pattern in submersed aquatic vegetation in Kings Bay. Lastly, other diagnostic studies that compare and contrast coastal systems should help explain the persistence of submersed aquatic vegetation in Kings Bay while other coastal systems exhibit significant declines. Overall, this baseline study provides managers with some key insights into the spatial and temporal variation in submersed aquatic vegetation in Kings Bay.

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BACKGROUND AND RATIONALE

Establishing a favorable submersed plant assemblage in Kings Bay remains a primary objective for the Southwest Florida Water Management District because such an assemblage should improve water clarity and wildlife habitat. According to recent research, the submersed plant assemblage in Kings Bay has changed. The coverage of native macrophytes, particularly *Vallisneria americana*, has decreased, and invasive or undesirable plants and algae, such as *Myriophyllum spicatum* and *Lyngbya* spp., have become more prevalent (Frazer and Hale 2001; Hauxwell et al. 2004a). In addition, research has implicated decreased coverage of rooted, aquatic macrophytes as a cause of diminished water clarity in the bay (Hoyer et al. 2001). Plans to establish a favorable plant assemblage in Kings Bay will benefit from an improved understanding of the form and causes of spatial and temporal variations in the distribution and abundance of submersed aquatic vegetation (SAV).

Spatial and temporal patterns in the distribution and abundance of SAV reflect an integration of i) physical, chemical and biological influences; ii) related ecological processes; and iii) management actions. For example, the SAV assemblage in the bay may respond to both acute variations in salinity resulting from tropical storms and longer-term fluctuations in salinity driven by droughts or increased rainfall (Terrell and Canfield 1996; Mataraza et al. 1999; Frazer et al. 2001; Frazer et al. 2006a). Furthermore, the SAV assemblage can be affected by increased availability of nutrients through increased abundance of phytoplankton, decreased water clarity, and reduced transmission of light. In fact, recent research suggested feedback between the abundance of submersed vegetation and changes in water clarity due to interactions among increased concentrations of nutrients in the water column, increased abundance of phytoplankton and increased resuspension of particles driven by wind and wave disturbance (Bachmann et al. 2001; Hoyer et al. 2001). In addition, poorly understood pressures on native plants arise from the introduction of non-native plants, such as *Hydrilla verticillata* and *Myriophyllum spicatum*, and from grazing by manatees that use the bay as a winter refuge (Hauxwell et al. 2004a, b).

Quantifying spatial and temporal patterns in the distribution and abundance of SAV represents an important step in understanding the dynamics of the vegetative assemblage in Kings Bay. Moreover, if management of the bay is to be improved, it is imperative that this information be coupled with data related to key natural and anthropogenic influences, such as those noted above. For example, agents of the United States Fish and Wildlife Service have been surveying the abundance of manatees, and the Southwest Florida Water Management District initiated baseline measurements of salinity and other aspects of water quality. ***The objective of this project is to establish a spatiotemporal baseline for vegetation in Kings Bay that complements other activities and data.***

METHODS

Study system

Kings Bay is a tidally influenced, spring-fed system located adjacent to the City of Crystal River in Citrus County on the west coast of peninsular Florida (approximate coordinates 28° 53.3' N and -82° 35.9' W). The bay has a surface area of approximately 1.75 km^2 and water from 1 m to 3 m deep (Haller et al. 1983; Hammett et al. 1996; Bachmann et al. 2001). Numerous springs supply groundwater to the bay, with the total discharge averaging 27.6 $m^3 s^{-1}$ (Yobbi and Knochenmus 1989). Kings Bay forms the headwaters of the Crystal River, which flows westward for approximately 10 km to the Gulf of Mexico.

Recreational divers, wildlife enthusiasts, boaters and anglers use the bay. The opportunity to SCUBA dive and observe West Indian manatees (*Trichechus manatus*) represents one of the principal attractions (Buckingham 1989). Manatees use the bay primarily as a thermal refuge in the winter, but they also feed on submersed aquatic vegetation (Hauxwell et al. 2004a, b).

Field sampling and laboratory processing

Sampling in 2004, 2005 and 2006 was conducted during February, May, July and October at 71 stations (Frazer and Hale 2001; Figure 1; Appendix A). During each sampling period, divers sampled three, haphazardly placed, replicate quadrats at each station. In each quadrat, they visually estimated total percent cover of all plants and percent cover for different taxa. Thus far, data have been collected for eleven types of vegetation: filamentous algae (including *Lyngbya* spp.)[1], *Ceratophyllum demersum*, *Chara* spp., *Hydrilla verticillata*, *Myriophyllum spicatum*, *Najas guadalupensis*, *Potamogeton pectinatus*, *Potamogeton pusillus*, *Ruppia maritima*, *Vallisneria americana*, and *Zannichellia palustris*. After making these estimates, the divers removed all aboveground plant biomass and placed it into a uniquely labeled plastic bag. Bags were transported to the University of Florida for processing.

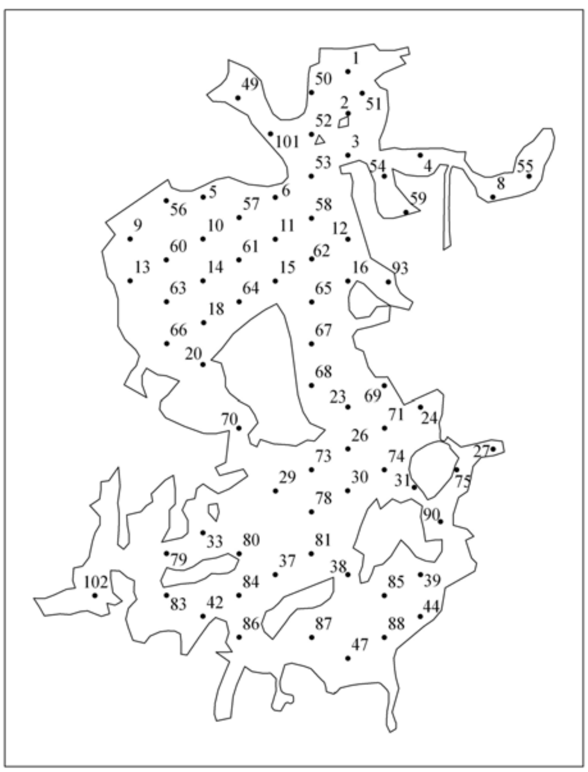


Figure 1. Kings Bay with 71 sampling stations.

In the laboratory, samples from each quadrat were rinsed in fresh water and sorted into taxonomic categories. Samples for each category were dried at 70 °C to a constant weight. These dry weights, recorded to the nearest 0.001 g, represented a quantitative measure of biomass.[2]

Analyses and production of maps

Three measures provided complementary views of submersed aquatic vegetation. Frequency of occurrence assessed distribution as presence or absence, and it was expressed as the percent of quadrats in which a taxon or category was present. Percent cover data also elucidated the distribution of plants and algae, and these data provided a quantitative measure of abundance based on the amount of “space” occupied. Space was considered three-dimensional because quadrats typically contained multiple layers of plants and algae. Due to layering, the coverage of plants, algae, and bare substratum (the area without vegetation) often summed to more than 100%. Percent cover data were standardized to sum to 100% before analyses (Figure 2). Biomass, expressed as kilograms dry weight per square meter (kg DW m^{-2}), provided additional data on the distribution of plants and algae and yielded a quantitative measure of abundance as standing crop, which indicated the amount of carbon, nutrients and other resources “tied up” in plants and algae.

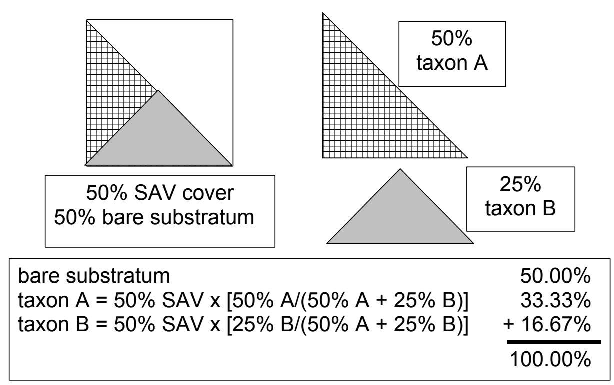


Figure 2. Example of standardization for percent cover.

[1] Filamentous algae often appeared to be entangled mats of a single species, but detailed examination of samples collected in February 2004 revealed multiple species (Notestein et al. 2005). Therefore, only attached macroalgae in the genus *Chara* were identified separately. *Lyngbya* spp. consistently comprised a major component of filamentous algae.

[2] Dry weights can be converted to wet weights using ratios for each taxon that were determined in 2004 (Appendix B).

For some analyses, data for one or more of the eleven types of vegetation were combined. For example, total submersed aquatic vegetation represented a combination of data for all angiosperms and macroalgae. Angiosperms comprised data for all flowering, vascular plants, and macroalgae included data for attached and filamentous forms. Data for any taxon known to be native to Florida were pooled to form a native plant and algae category. Data for plants introduced to Florida were combined to create a non-native plant category. Data for filamentous algae were not included in the native or non-native categories due to their uncertain origins.

Spatial patterns in percent cover, biomass and environmental parameters across stations were explored with multivariate ordinations (Belbin 1989). Ordinations were based on Bray–Curtis association measures. The proximity of stations in graphs derived from ordinations indicated the degree of similarity among samples. Stress values below 0.2000 were taken to indicate suitable representations of the relationships among samples. Environmental parameters included depth and measures characterizing water quality. To balance the influence of absolute values spanning several orders of magnitude, these parameters were range standardized before ordination [range standardized value = (value – minimum value)/range of values]

Frequencies of occurrence, relative contributions to mean percent cover and mean biomass, and deviations from mean values of environmental parameters were used to evaluate the results of ordinations. Frequencies of occurrence were generated by converting the numbers of quadrats containing *Ceratophyllum demersum*, *Chara* spp., *Hydrilla verticillata*, *Myriophyllum spicatum*, *Najas guadalupensis*, *Potamogeton pectinatus*, *Potamogeton pusillus*, *Ruppia maritima*, *Vallisneria americana*, *Zannichellia palustris*, bare substratum, angiosperms, macroalgae, native taxa, and non-native taxa to percentages of the total numbers of quadrats sampled. Relative contributions to percent cover and biomass were calculated using means for each combination of taxon or category, station, and sampling period [relative contribution = (mean/sum of means) x 100]. Deviations from mean values for environmental data were calculated by subtracting the mean for a given sampling period from the raw data recorded at each station during the same sampling period.

Analyses of variance (ANOVAs) were used to test for statistically significant variations in percent cover and biomass among years, sampling periods within years, and stations. Percent cover data were arcsine-transformed and biomass data were $\log_{10}$-transformed to improve normality and homogeneity of variances. ANOVAs were considered significant at probabilities less than or equal to 0.05. Back-transformed means were used to illustrate spatial and temporal patterns. ANOVAs were performed using percent cover and biomass data for common taxa, bare substratum, angiosperms, macroalgae, native taxa, and non-native taxa.

Interpolated maps of percent cover and biomass were created in ArcGIS 9.2 (ESRI 2005) using Transverse Mercator projection and the North American 1983 HARN Geographic Coordinate System (see Appendix E for GIS metadata). To be consistent with Frazer and Hale (2001), interpolations were based on Inverse Distance Weighting (IDW) and percentage cover values were not standardized to sum to 100%. Interpolations for composite categories and taxa were based on means of data from each of the 71 sampling stations for each of the four sampling periods and each of the three years.

Estimated values were interpolated into a grid using the ESRI ArcMap v.9.x IDW algorithm (Geostatistical Wizard). Key parameters were:

- power = 3
- neighborhood search or neighbors to be included = 5 (include at least 5 neighboring values)
- searching ellipse angle = 0
- radii of semimajor and semiminor axes = 400
- sector mode = 0

The resulting grid was converted to a shapefile containing polygons. Each polygon represented either:

i) one of five Braun–Blanquet percent cover classes (< 5%, 5–25%, 25–50%, 50–75% or > 75%; Braun–Blanquet 1965)

ii) one of five biomass classes (0.000–0.001, 0.001–0.010, 0.010–0.100, 0.100–1.000 or 1.000–10.000 kg DW m^{-2})

RESULTS AND DISCUSSION

Effort in each year yielded 852 SAV samples. In combination, samples from 2004, 2005 and 2006 yielded 2,556 values for analyses.

Bay-wide spatial pattern – variation in the assemblage

Bray–Curtis association measures were calculated from percent cover or biomass data averaged for three quadrats at each station (Figure 3). Both ordinations involved data for eleven categories recorded in the field. Bare substratum was added to ordinations based on percent cover measurements.

Three-dimensional ordinations based on mean values for percent cover and biomass from each station in each sampling period during 2004–2006 indicated two groups of stations (Figure 4). Ordinations based on both types of data split the 71 stations into groups containing 39 stations and 32 stations. The groups from the two ordinations shared 35 and 28 stations (Table 1). Four stations grouped with the 39 stations in the ordination based on percent cover, and four different stations grouped with the 39 stations in the ordination based on biomass. In subsequent analyses, these eight stations were considered intermediate, and data from them were included in both groups, yielding a group of 43 stations and a group of 36 stations.

Station (71 total)	Mean percent cover (144 total) or Mean biomass (132 total)						
	February 2004			…	October 2006		
	Ceratophyllum demersum	…	***Zannichellia palustris***	…	***Ceratophyllum demersum***	…	***Zannichellia palustris***
1		…		…		…	
2		…		…		…	
…		…		…		…	
102		…		…		…	

Figure 3. Format of data used in ordinations.

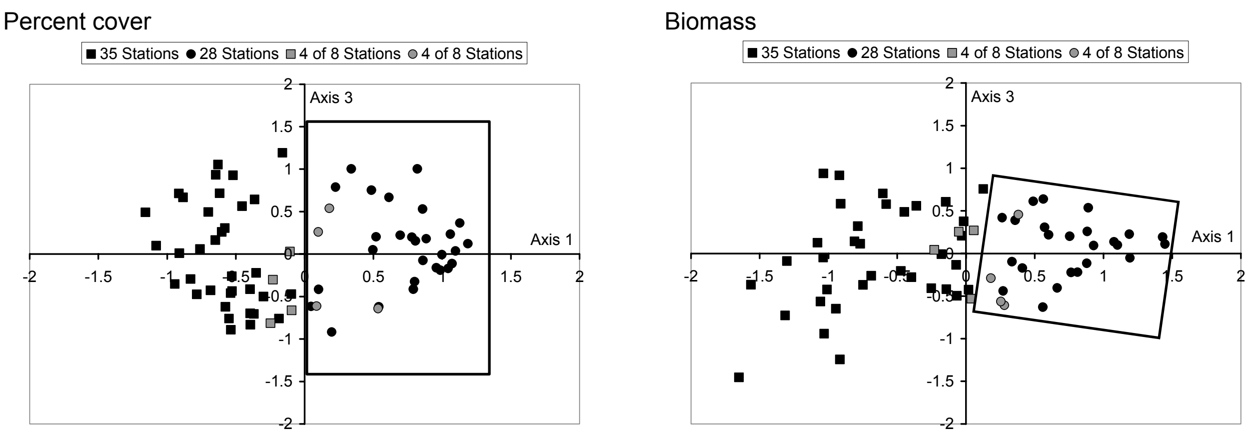


Figure 4. Ordinations based on mean percent cover and mean biomass (n = 3 replicate 0.25-m^2 quadrats). For clarity, only two of the three dimensions are shown. stress values: percent cover = 0.1667, biomass = 0.1383

Table 1. Groups of stations from ordinations.

Group of 35 stations for cover & biomass													
5	9	13	14	15	18	20	23	24	26	29	30	33	37
42	60	61	63	64	66	67	68	69	70	71	73	78	79
80	81	83	84	85	86	87							
Group of 28 stations for cover & biomass													
1	2	3	4	6	8	10	12	16	27	31	39	44	49
50	51	52	53	54	55	56	57	59	62	75	90	93	101
Group of 4 intermediate stations for cover													
11	38	65	74										
Group of 4 intermediate stations for biomass													
47	58	88	102										

The group of 43 stations, which includes the 8 intermediate stations, were located primarily in the southern and western portions of the bay (Figure 5). Stations 47, 88 and 102 were three intermediate stations nearest the shoreline.

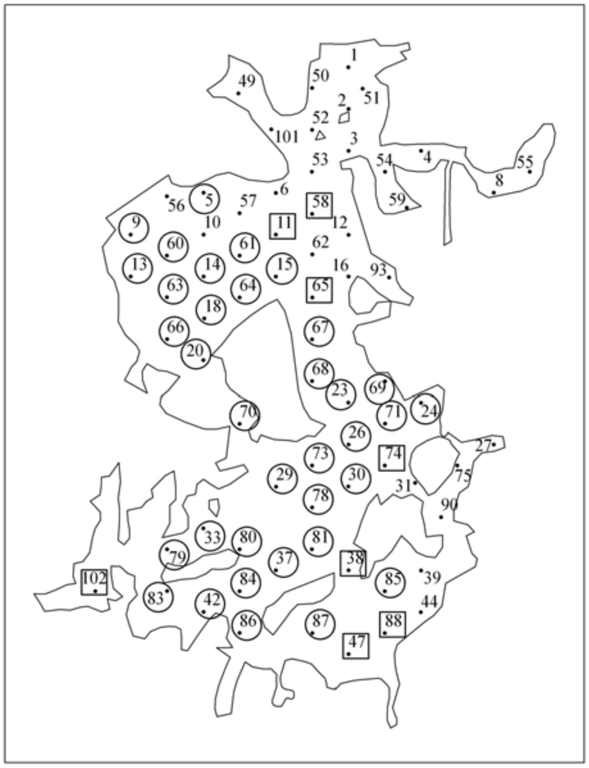


Figure 5. Groups of stations identified by ordinations. circles = 35 stations, squares = 8 intermediate stations

Bay-wide spatial pattern – variation in submersed aquatic vegetation

Submersed aquatic vegetation (SAV) of some type was found in a similar number of quadrats across all stations and years of sampling (Figure 6). In the three years of sampling, SAV occurred in an average of 87% of the quadrats sampled in the group of 43 stations and 94% of the quadrats sampled in the group of 36 stations. In contrast, bare substratum appeared in an average of 69% of quadrats across the group of 43 stations and 49% of quadrats across the group of 36 stations. On average, 13% of quadrats sampled in the group of 43 stations and 6% of quadrats sampled in the group of 36 stations did not contain SAV of any type. In other words, the substratum at stations in the group of 36 was more uniformly covered by SAV.

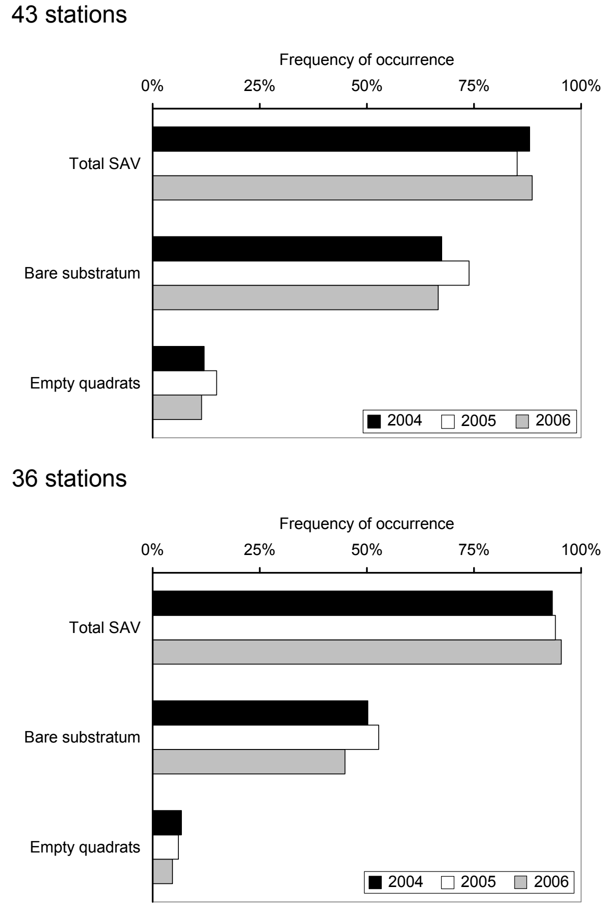


Figure 6. Frequency of occurrence for total submersed aquatic vegetation (SAV), bare substratum and quadrats without any SAV.

Analyses of variance indicated that percent cover of total submersed aquatic vegetation (SAV) and percent cover of bare space varied significantly among combinations of sampling periods within years and stations (Figures 7, 8). In general, stations in the group of 36 consistently had more coverage of SAV and less bare substratum. At some stations in both groups, percentage cover of SAV decreased in October 2004 to levels that were not typical of October 2005 and 2006. Across most stations in the group of 43 and some stations in the group of 36, back-transformed mean percent cover of SAV was relatively low in all February sampling periods. As expected, back-transformed mean percent cover of bare substratum was higher at these times.

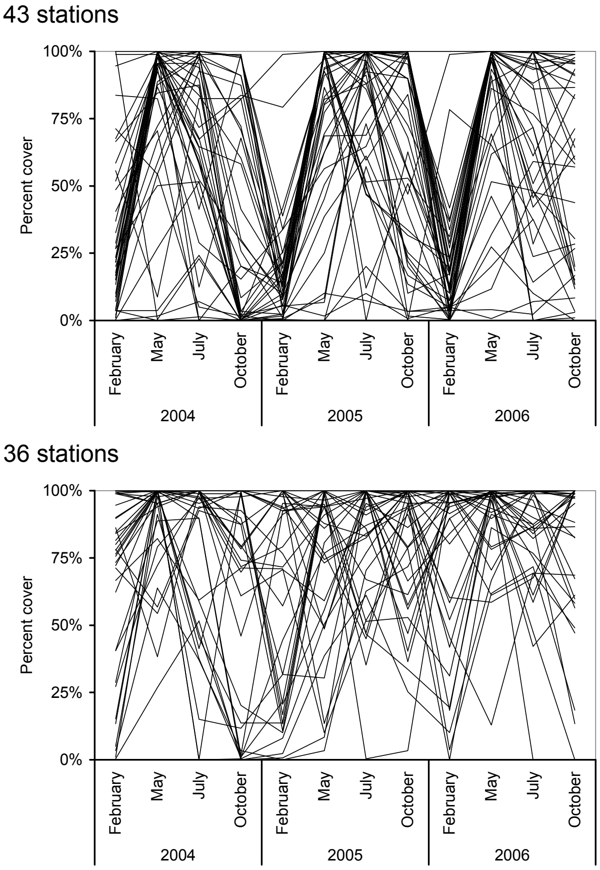


Figure 7. Back-transformed mean percent cover for SAV.

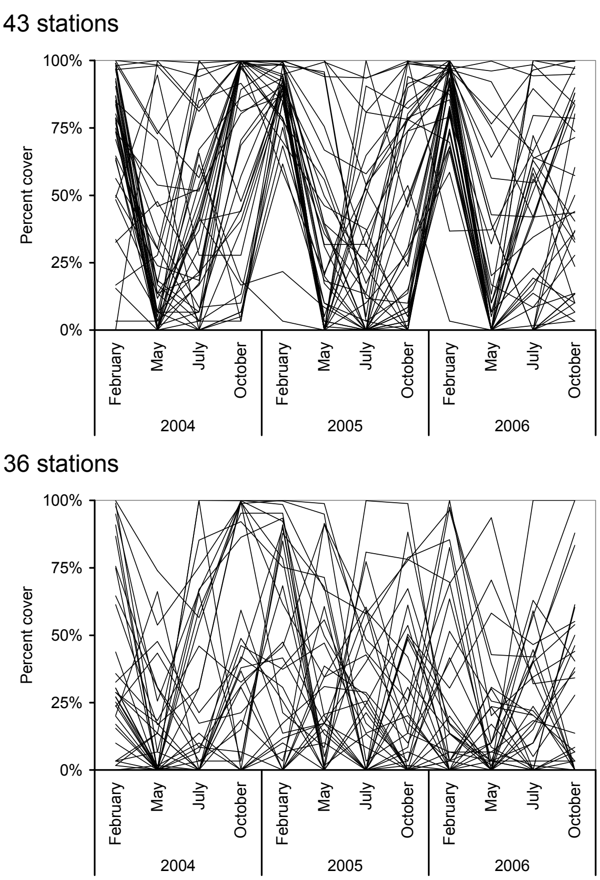


Figure 8. Back-transformed mean percent cover for bare substratum.

Analysis of variance indicated that biomass of total submersed aquatic vegetation (SAV) varied significantly among combinations of sampling periods within years and stations (Figure 9). In general, biomass of SAV was higher at stations in the group of 36. In October 2004, biomass at some stations in both groups decreased to levels that were not typical of October 2005 and 2006. Across most stations in the group of 43 and some stations in the group of 36, back-transformed mean biomass of SAV was relatively low in all February sampling periods.

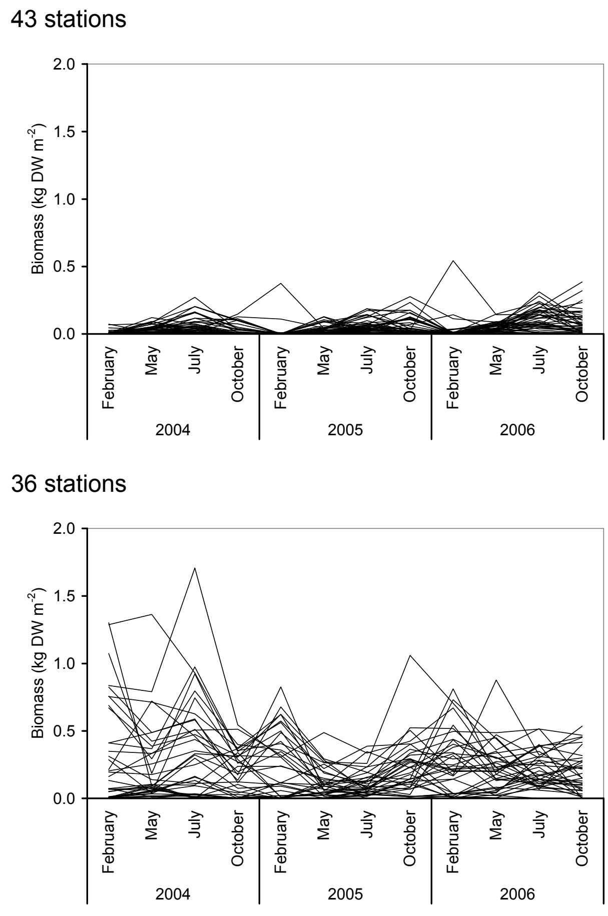
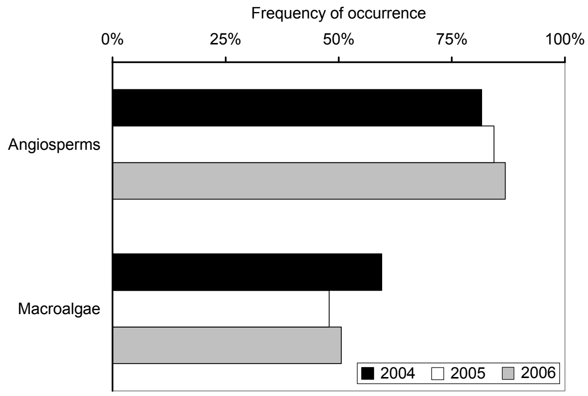


Figure 9. Back-transformed mean biomass for SAV.

Bay-wide spatial pattern – variation in angiosperms and macroalgae

Angiosperms and macroalgae occurred in different percentages of the quadrats sampled at the two groups of stations (Figure 10). Across all years, quadrats sampled at stations in the group of 43 contained angiosperms about 1.2 times as often as quadrats sampled at stations in the group of 36. In contrast, quadrats sampled at stations in the group of 36 contained macroalgae, including filamentous forms, about 1.7 times as often.

43 stations



36 stations

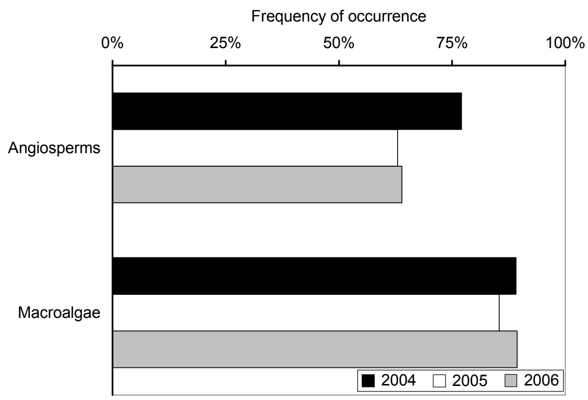
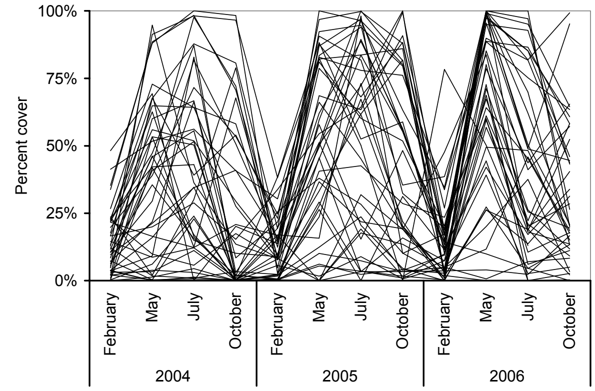


Figure 10. Frequency of occurrence for angiosperms and macroalgae.

Analyses of variance indicated that percent cover of angiosperms and macroalgae varied significantly among combinations of sampling periods within years and stations (Figures 11, 12). Back-transformed mean percent cover of angiosperms tended to be higher at stations in the group of 43, and coverage of macroalgae tended to be higher at stations in the group of 36. Across both groups of stations, back-transformed mean percent cover for angiosperms tended to exhibit low values in February sampling periods, although there were exceptions to this trend. In addition, coverage of angiosperms across some stations in both groups decreased more in October 2004 than in either October 2005 or 2006. Coverage of macroalgae at some stations in the group of 43 also decreased in October 2004, but this pattern was not as evident at stations in the group of 36.

43 stations



36 stations

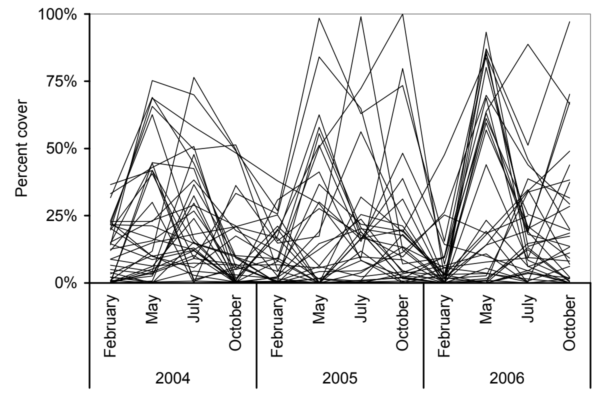
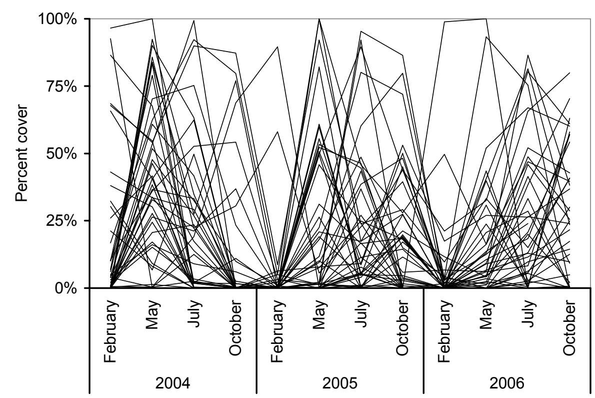


Figure 11. Back-transformed mean percent cover for angiosperms.

43 stations



36 stations

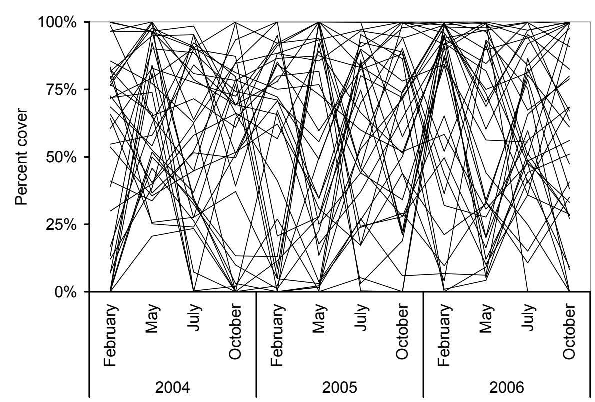


Figure 12. Back-transformed mean percent cover for macroalgae.

Analyses of variance indicated that biomass of angiosperms and macroalgae varied significantly among combinations of sampling periods within years and stations (Figures 13, 14). Biomass of angiosperms tended to be higher at stations in the group of 43, and biomass of macroalgae tended to be higher at stations in the group of 36. At most stations in both groups, back-transformed mean biomass for angiosperms tended to exhibit low values in February sampling periods. In addition, back-transformed mean biomass of angiosperms across some stations in both groups and mean biomass of macroalgae across some stations in the group of 43 decreased more in October 2004 than in October 2005 or 2006. In contrast, back-transformed mean biomass of macroalgae did not vary as consistently among sampling periods at stations in the group of 36.

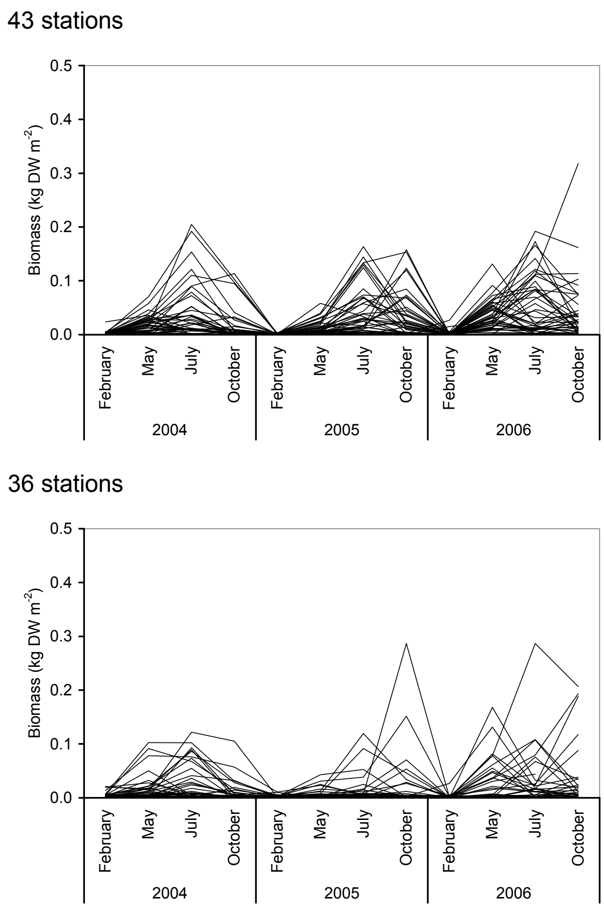


Figure 13. Back-transformed mean biomass for angiosperms.

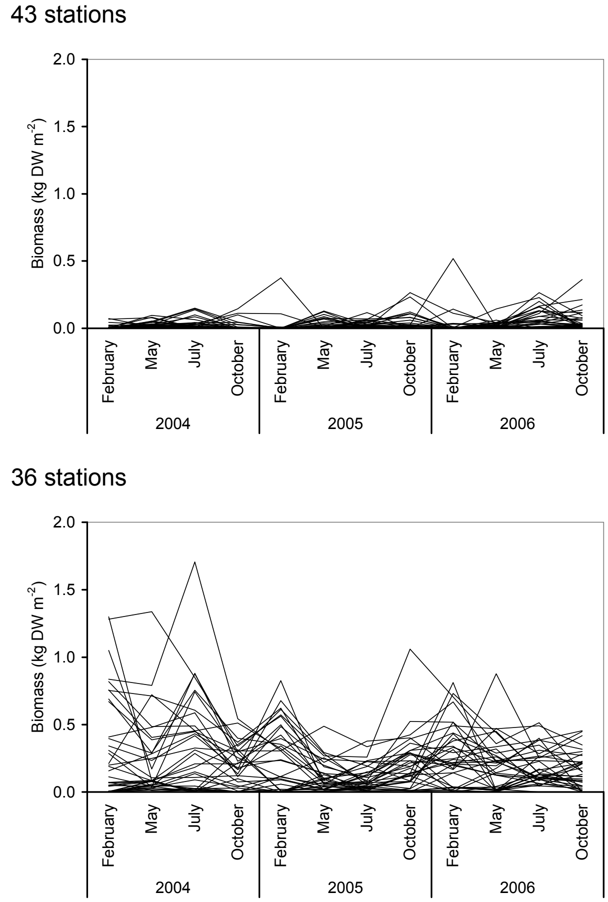


Figure 14. Back-transformed mean biomass for macroalgae.

Bay-wide spatial pattern – variation in native plants and algae, non-native plants and filamentous algae

Submersed aquatic vegetation in Kings Bay includes native and non-native taxa. Two species of angiosperms, *Hydrilla verticillata* and *Myriophyllum spicatum*, were classed as non-native. Native taxa comprised one genus of attached macroalgae, *Chara* spp., and seven species of angiosperms, *Ceratophyllum demersum*, *Najas guadalupensis*, *Potamogeton pectinatus*, *Potamogeton pusillus*, *Ruppia maritima*, *Vallisneria americana*, and *Zannichellia palustris*. Filamentous algae were not classed as native or non-native due to their uncertain origin, but they were included in analyses because they are considered a nuisance.

Native plants and algae, non-native plants, and filamentous algae occurred in different percentages of the quadrats sampled at the two groups of stations (Figure 15). Quadrats at stations in the group of 43 contained natives about 1.6 times as often and non-natives about 1.2 times as often as quadrats at stations in the group of 36. In contrast, quadrats at stations in the group of 36 contained filamentous algae about 2.0 times as often as quadrats at stations in the group of 43.

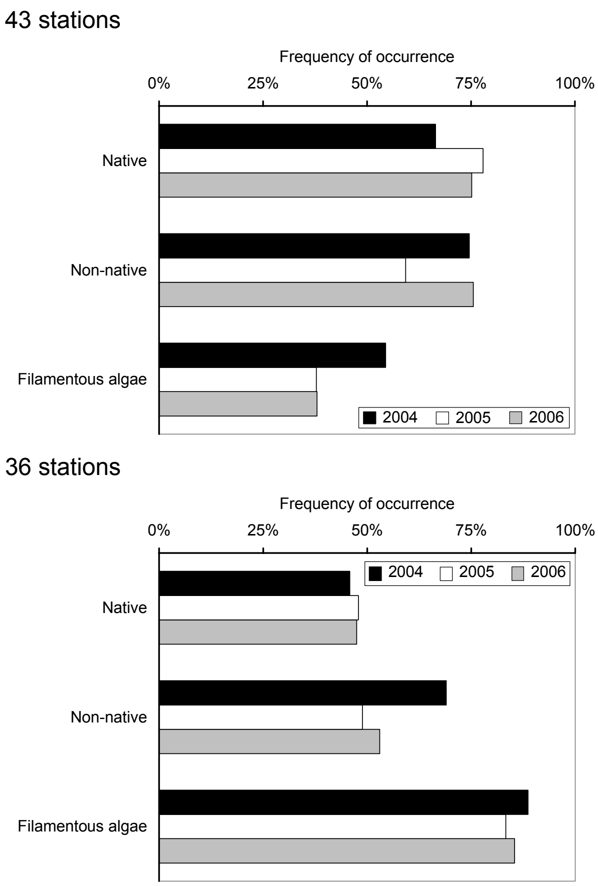


Figure 15. Frequency of occurrence for filamentous algae and native and non-native plants and algae.

Analyses of variance indicated that percent cover of natives, non-natives and filamentous algae varied significantly among combinations of sampling periods within years and stations (Figures 16–18). Natives covered more area at stations in the group of 43, and coverage tended to be lower in February sampling periods and October 2004 at some stations. Variations in coverage of non-native plants were more consistent, with decreases in February sampling periods and October 2004. Filamentous algae consistently covered more area at stations in the group of 36, and decreases in February sampling periods and October 2004 were more evident at stations in the group of 43.

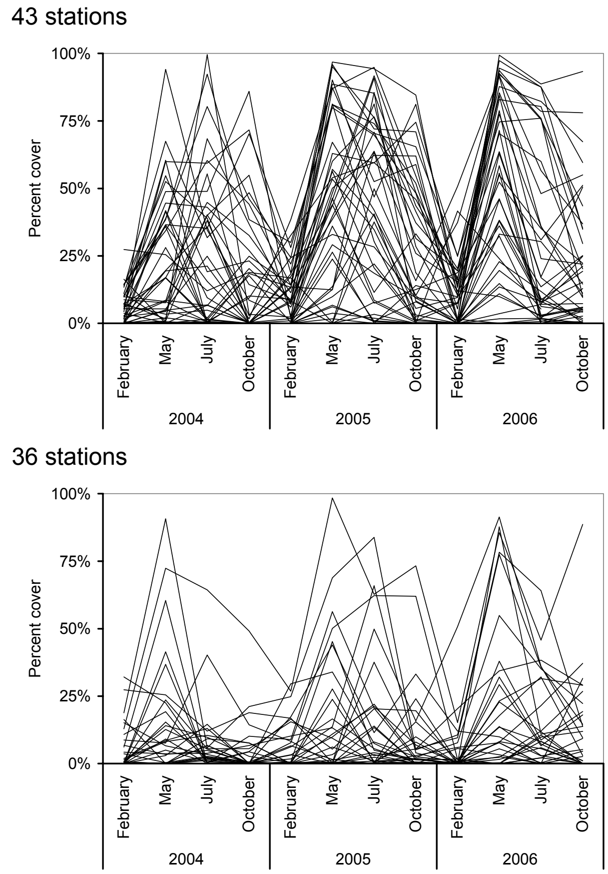


Figure 16. Back-transformed mean percent cover for natives.

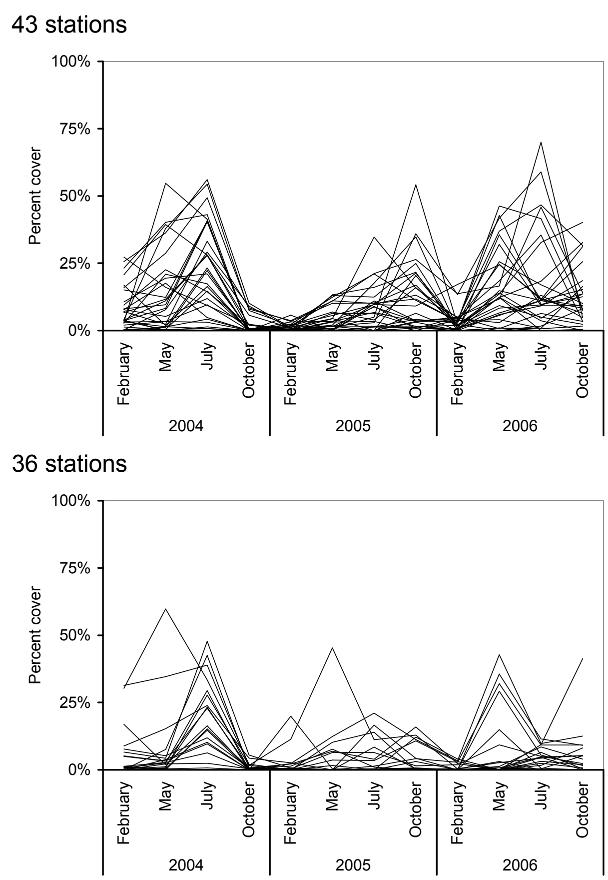


Figure 17. Back-transformed mean percent cover for non-natives.

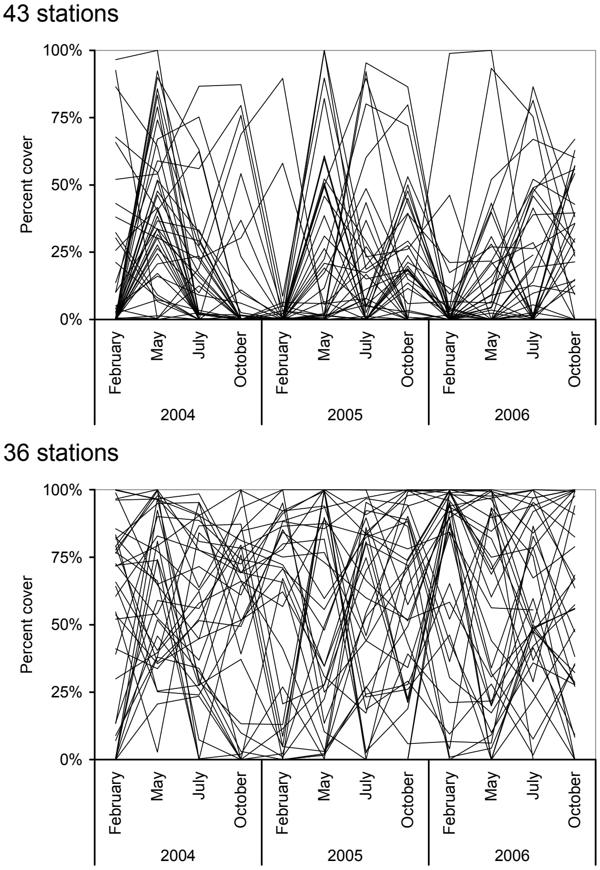


Figure 18. Back-transformed mean percent cover for filamentous algae.

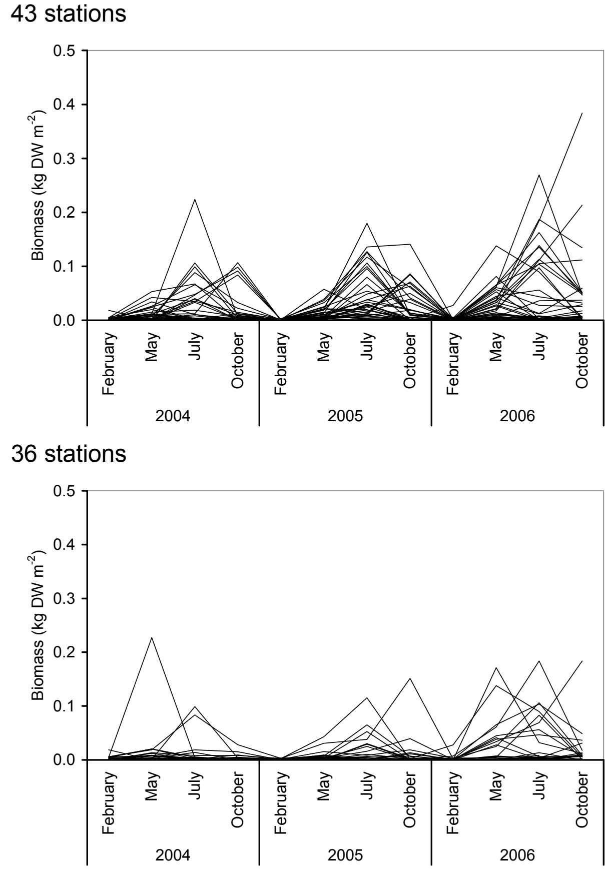


Figure 19. Back-transformed mean biomass for natives.

Analyses of variance indicated that biomass of natives, non-natives and filamentous algae varied significantly among combinations of sampling periods within years and stations (Figures 19–21). Biomass of natives tended to be higher and more consistent at stations in the group of 43. Biomass of non-natives did not differ as clearly between the two groups of stations, and biomass of filamentous algae tended to be higher at stations in the group of 36. Biomass of natives decreased in February sampling periods and in October 2004 at some stations. Biomass of non-natives reached its lowest values in February sampling periods and decreased in October 2004, with fewer exceptions across both groups of stations. Similar patterns appeared for biomass of filamentous algae at stations in the group of 43, but biomass of filamentous algae did not vary as consistently across the group of 36 stations.

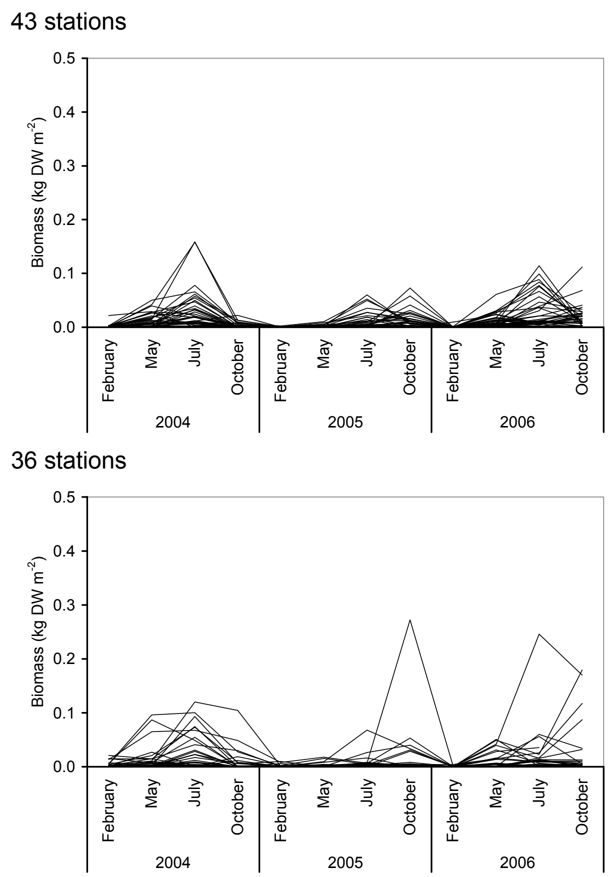


Figure 20. Back-transformed mean biomass for non-natives.

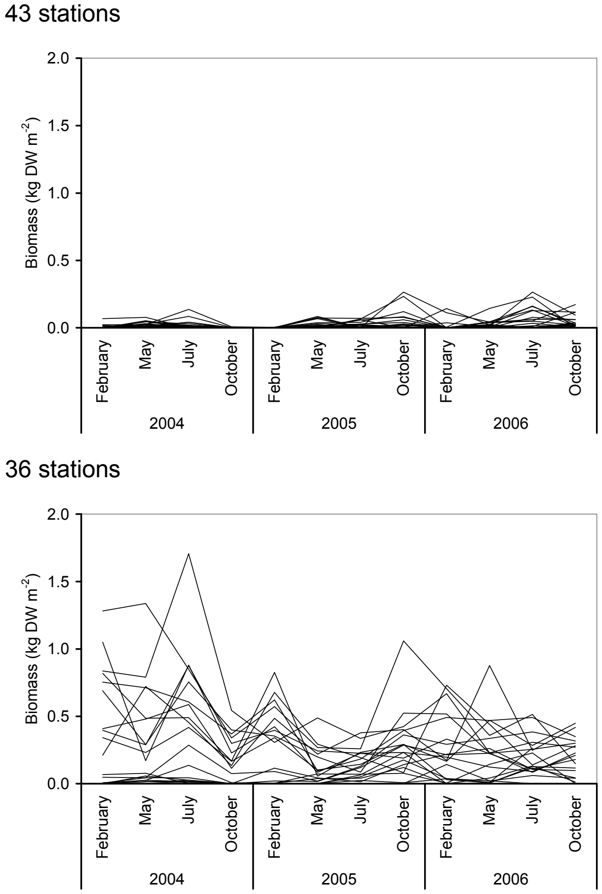


Figure 21. Back-transformed mean biomass for filamentous algae.

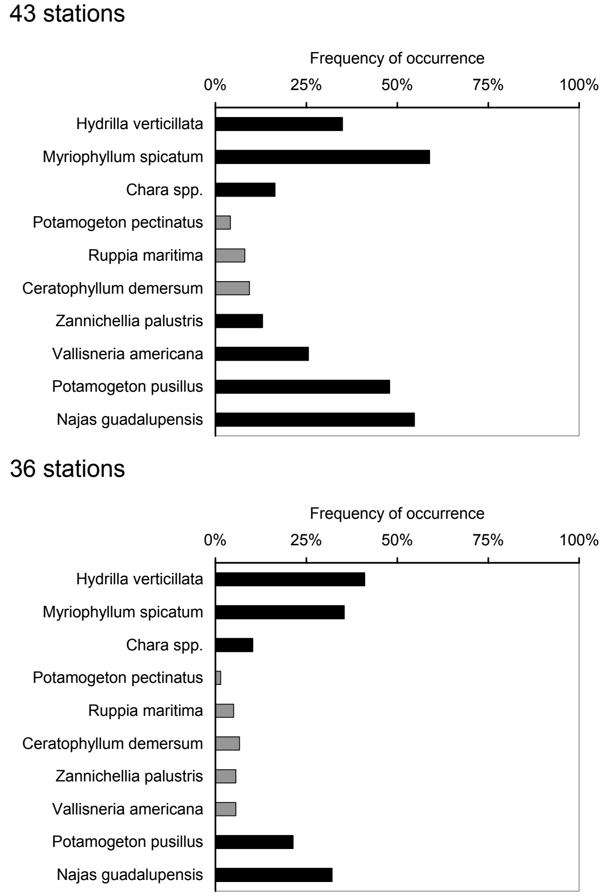


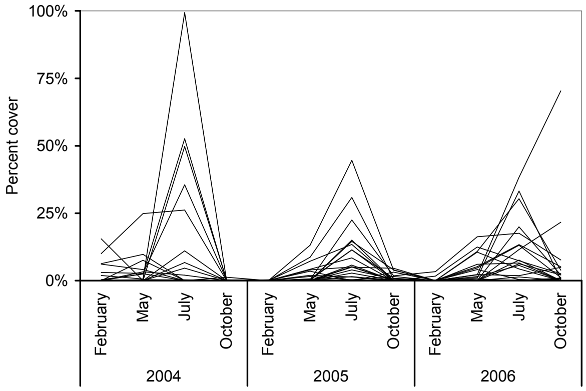
Figure 22. Mean frequency of occurrence in quadrats separated by groups of stations. black bars = taxa that occurred in an average of at least 10% of all quadrats, gray bars = taxa that occurred in an average of less than 10% of all quadrats

Bay-wide spatial pattern – variation in common taxa

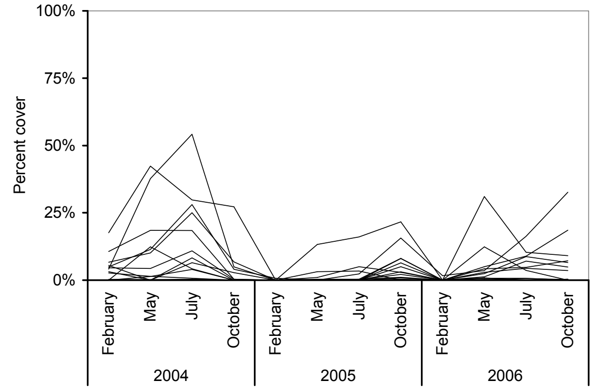
Analyses of variance were conducted with data from taxa that occurred in an average of 10% or more of the quadrats sampled at stations in either group (Figure 22). Based on this criterion, common taxa comprised a genus of attached macroalgae (*Chara* spp.), four species of native angiosperms *(Najas guadalupensis*, *Potamogeton pusillus*, *Vallisneria americana*, and *Zannichellia palustris*), and two species of non-native angiosperms (*Hydrilla verticillata* and *Myriophyllum spicatum*). Other than *H. verticillata*, all of these taxa occurred in 1.4–5.4 times as many quadrats across the group of 43 stations. *Chara* spp., *N. guadalupensis*, *P. pusillus*, *V. americana*, *Z. palustris*, *H. verticillata* and *M. spicatum* occurred at a total of 49, 67, 68, 31, 46, 69, and 71 stations, respectively.

Analyses of variance indicated that percent cover and biomass of all taxa varied significantly among combinations of sampling periods within years and stations (Figures 23, 24). Coverage and biomass of taxa other than *Hydrilla verticillata* tended to be higher at stations in the group of 43. In addition, coverage and biomass of all taxa except *Zannichellia palustris* tended to be lowest in February sampling periods, with this pattern being clearer for biomass data. At most stations, coverage and biomass of *Chara* spp., *Myriophyllum spicatum*, *Najas guadalupensis*, and *Potamogeton pusillus* were lower during October 2004 than during October 2005 or 2006. A similar pattern was visible for coverage of *H. verticillata* across the group of 43 stations and biomass data across both groups of stations. In contrast, *Vallisneria americana* coverage and biomass did not decrease consistently in October 2004, and *Z. palustris* coverage and biomass peaked in May and decreased to low levels in July after it appeared in February 2005.

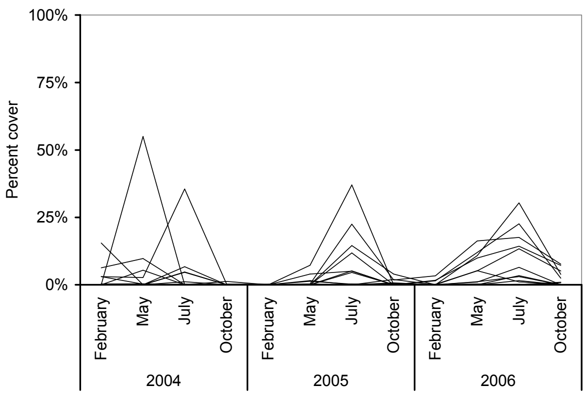
Chara spp. at 29 of 43 stations



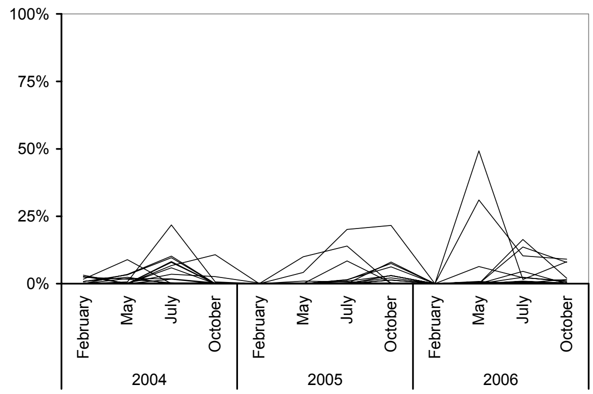
Myriophyllum spicatum at 43 of 43 stations



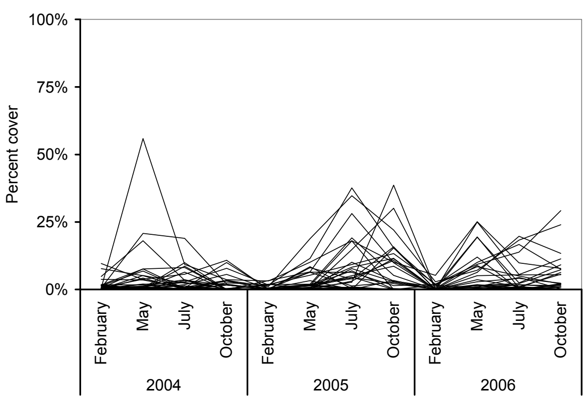
Chara spp. at 25 of 36 stations



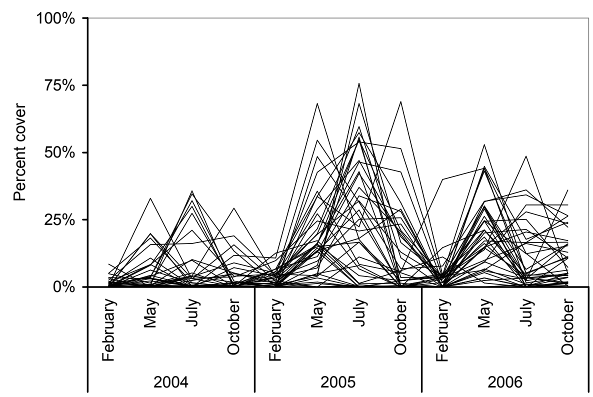
Myriophyllum spicatum at 36 of 36 stations



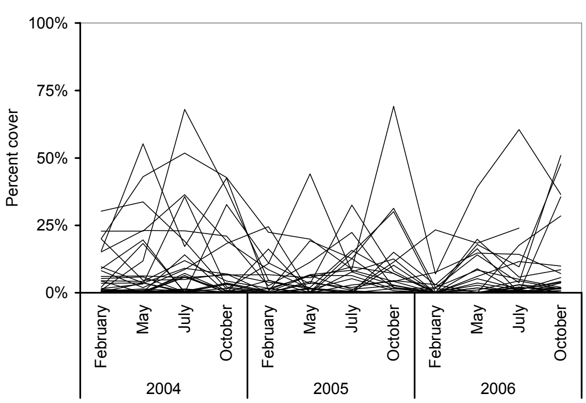
Hydrilla verticillata at 41 of 43 stations



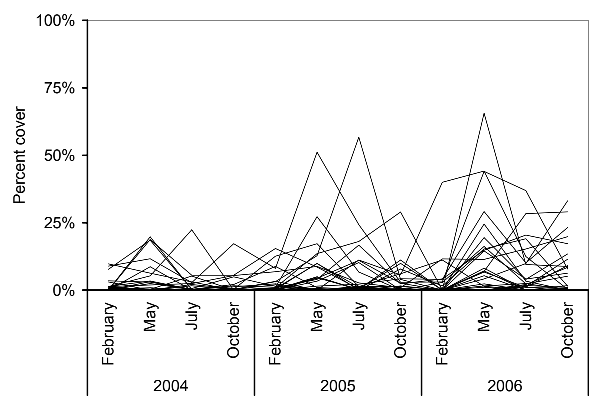
Najas guadalupensis at 42 of 43 stations



Hydrilla verticillata at 36 of 36 stations



Najas guadalupensis at 33 of 36 stations



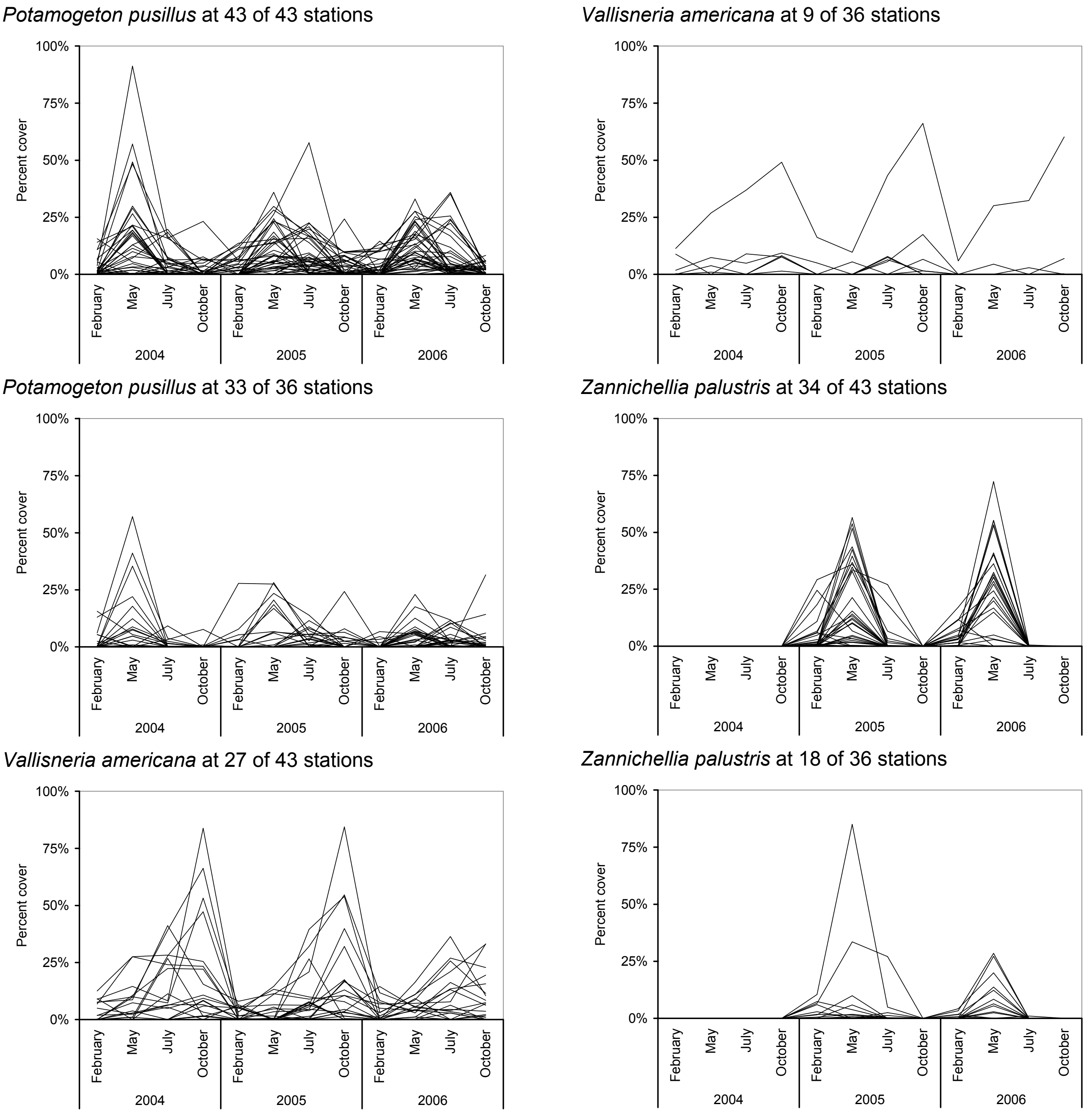
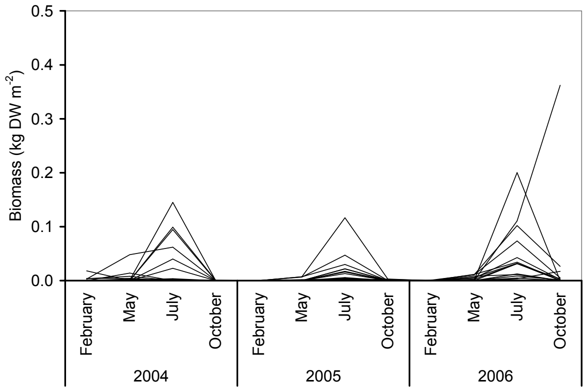
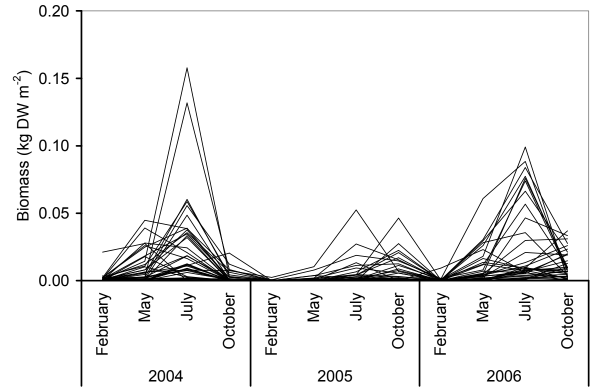


Figure 23. Back-transformed mean percent cover for common taxa at stations where they occurred.

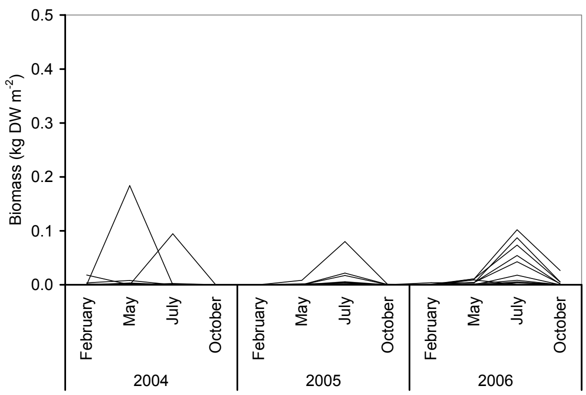
Chara spp. at 29 of 43 stations



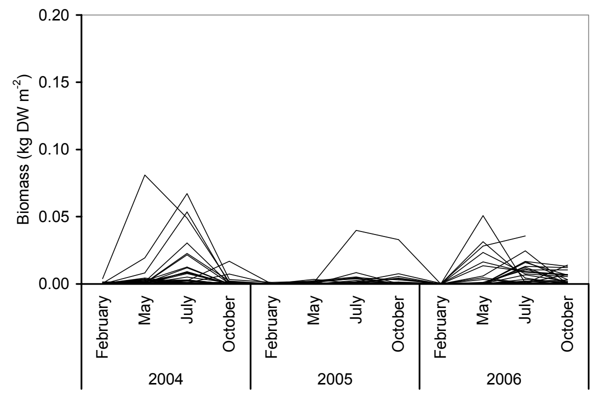
Myriophyllum spicatum at 43 of 43 stations



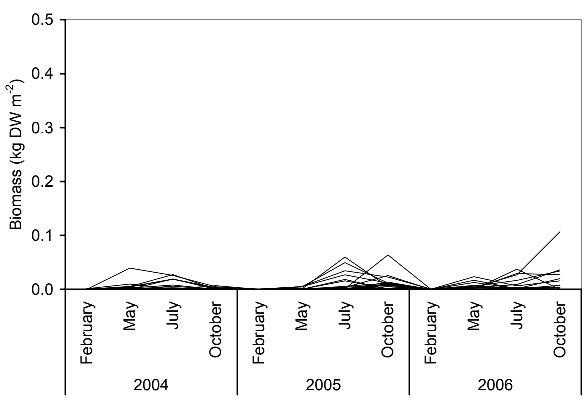
Chara spp. at 25 of 36 stations



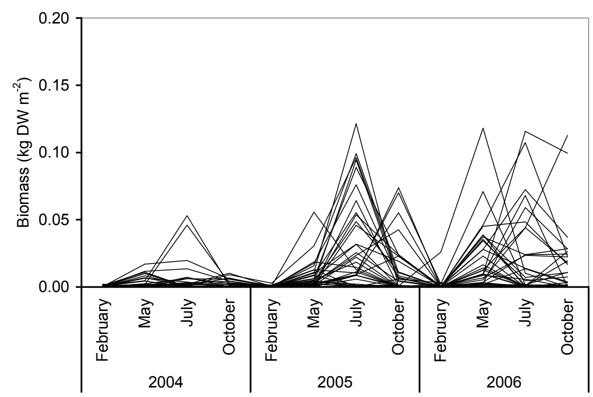
Myriophyllum spicatum at 36 of 36 stations



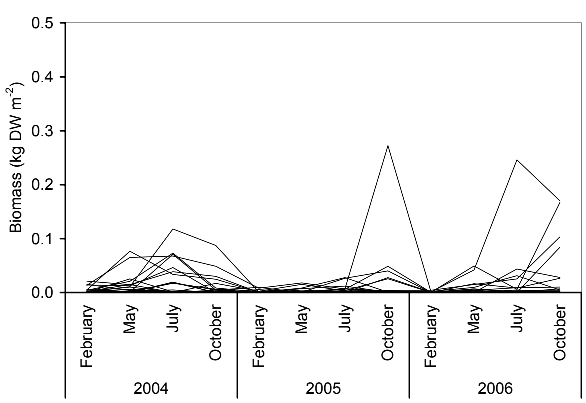
Hydrilla verticillata at 41 of 43 stations



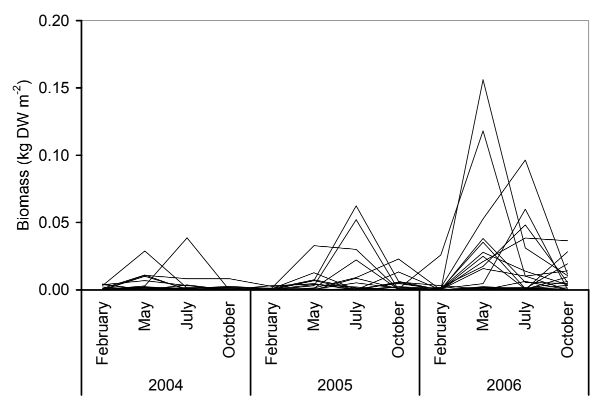
Najas guadalupensis at 42 of 43 stations



Hydrilla verticillata at 36 of 36 stations



Najas guadalupensis at 33 of 36 stations



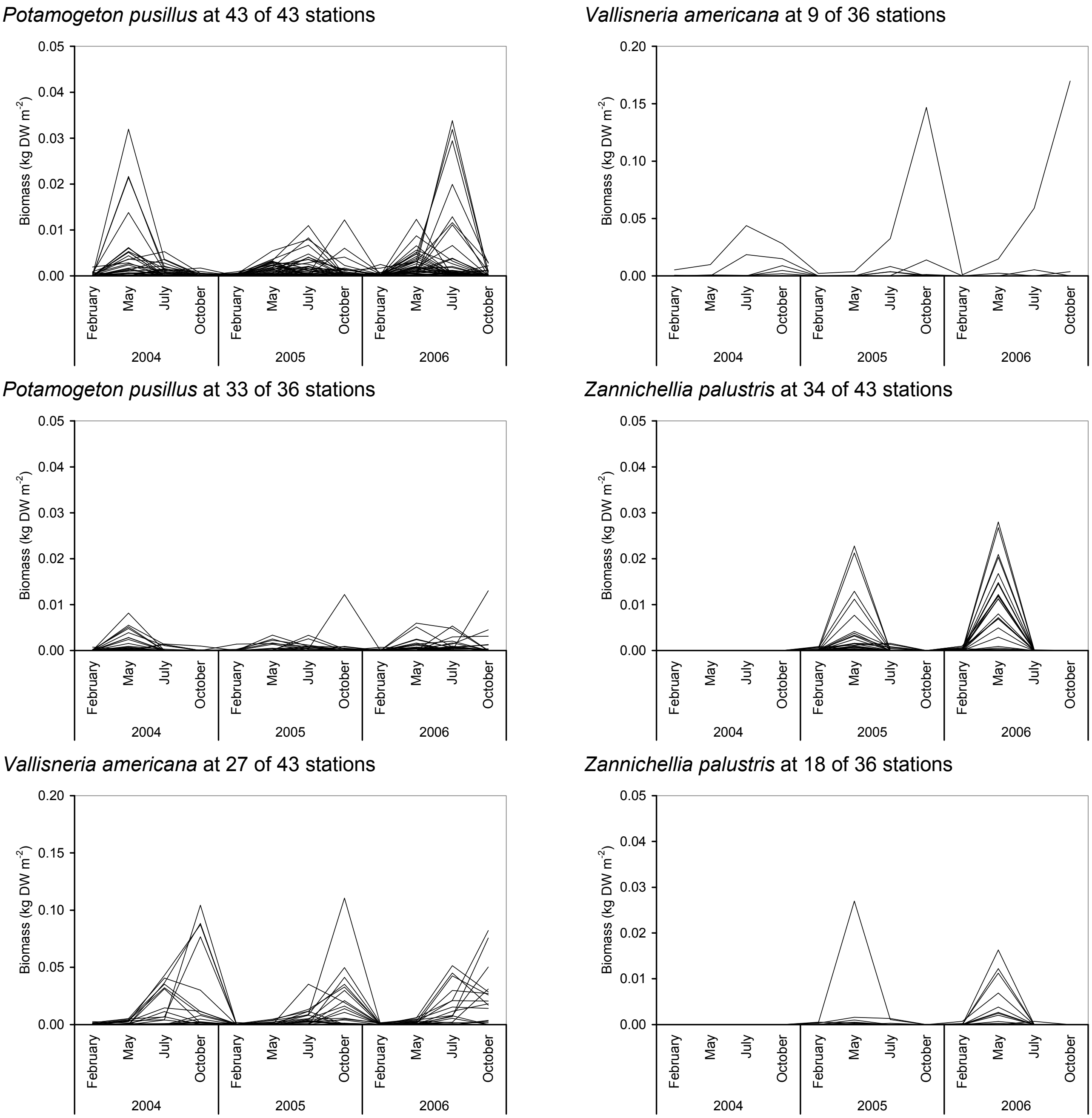


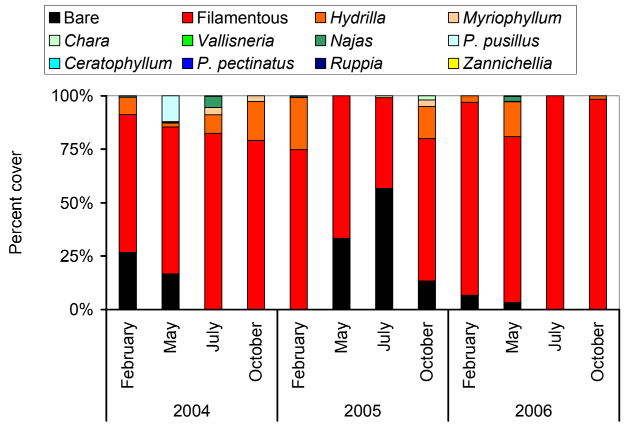
Figure 24. Back-transformed mean biomass for common taxa at stations where they occurred.

Bay-wide spatial pattern – variation in relative percent cover and biomass

Relative contributions to mean percent cover and mean biomass revealed patterns underpinning the ordinations (Figures 25–30). Contributions for bare substratum, filamentous algae, *Hydrilla verticillata*, *Myriophyllum spicatum*, *Chara* spp., *Vallisneria americana*, *Najas guadalupensis*, *Potamogeton pusillus* (*P. pusillus*), *Potamogeton pectinatus* (*P. pectinatus*), *Ruppia maritima*, and *Zannichellia palustris* varied among groups of stations.

Across all sampling periods, filamentous algae and *Hydrilla verticillata* represented relatively consistent percentages of the vegetative cover and biomass found at stations in the group of 28. In contrast, a greater diversity of vegetation and bare substratum often were found at stations in the group of 35. Stations in the group of 8 exhibited intermediate values. Interpolations based on mean coverage and biomass values supported this interpretation (Appendices C and D).

Station 1



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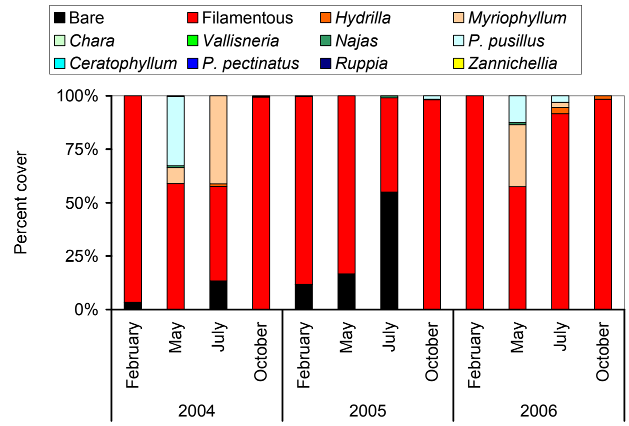

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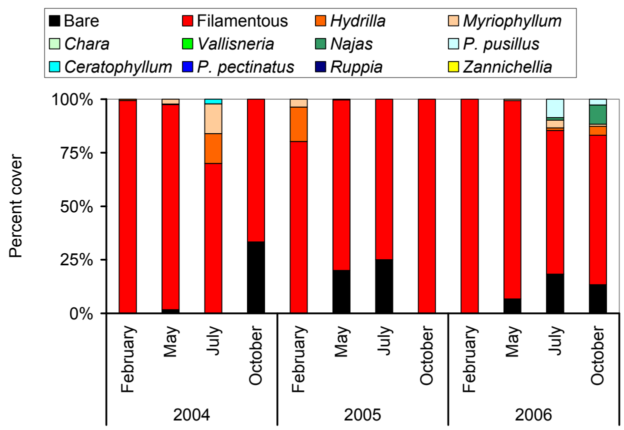

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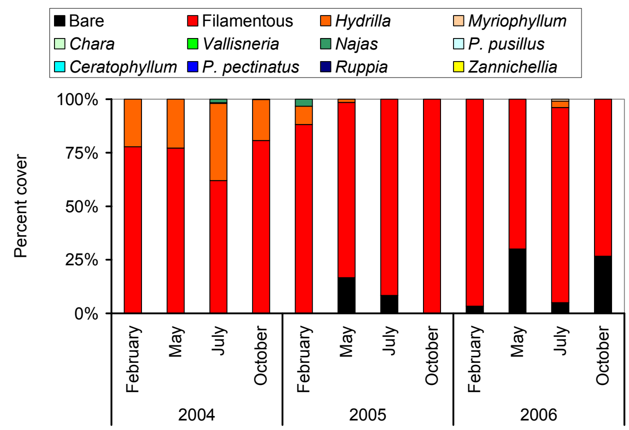

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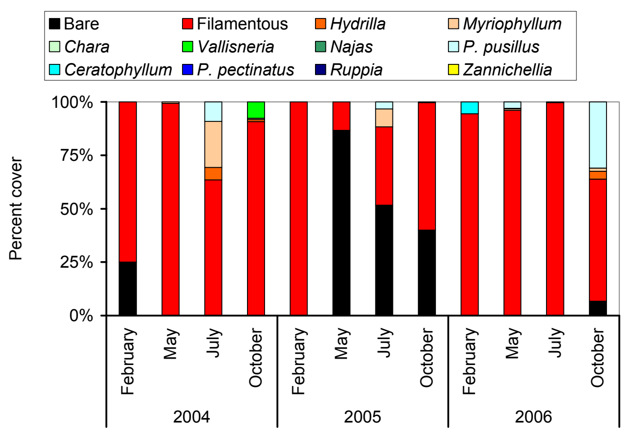

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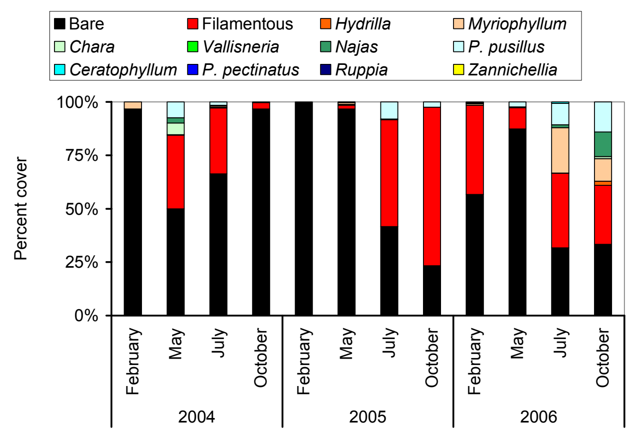

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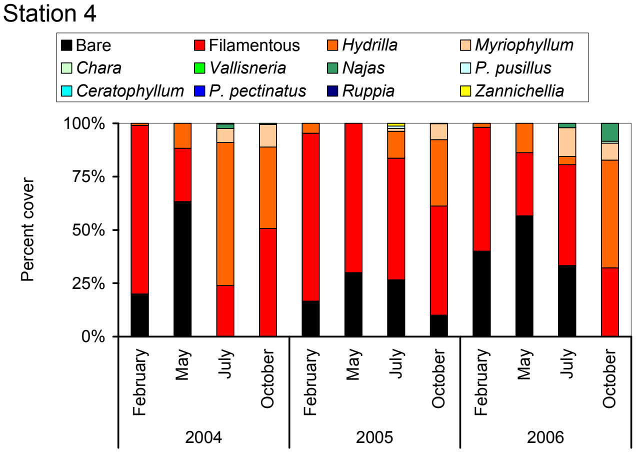

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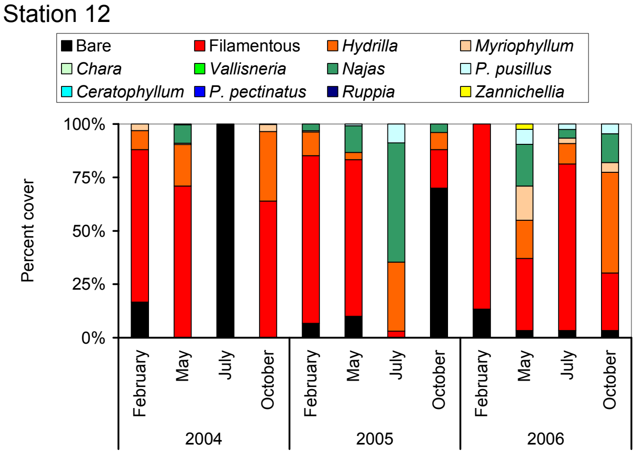

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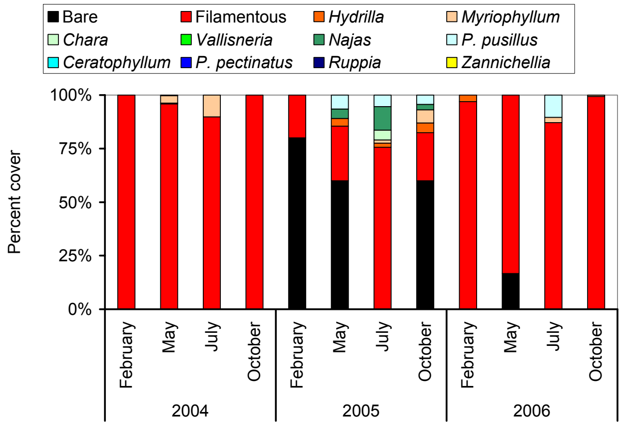

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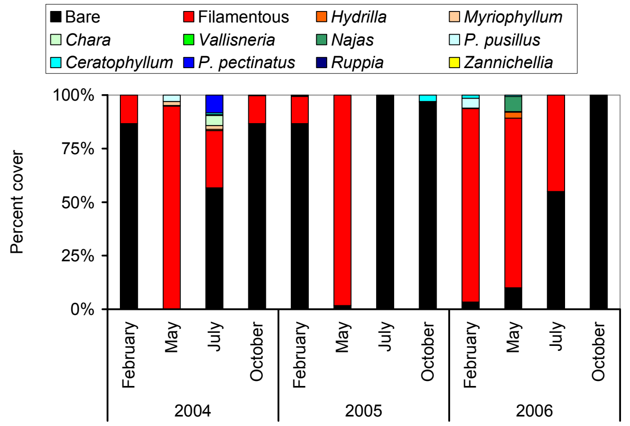

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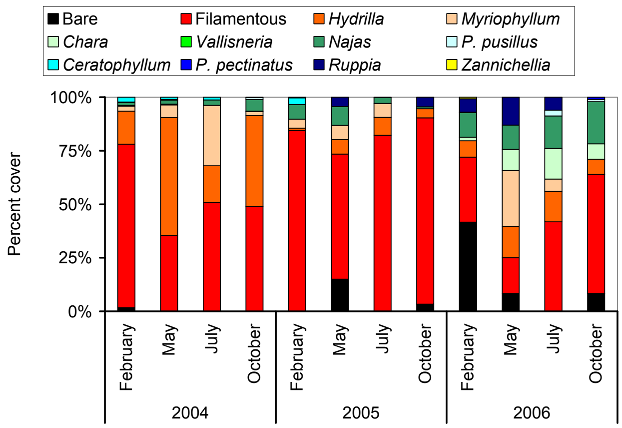

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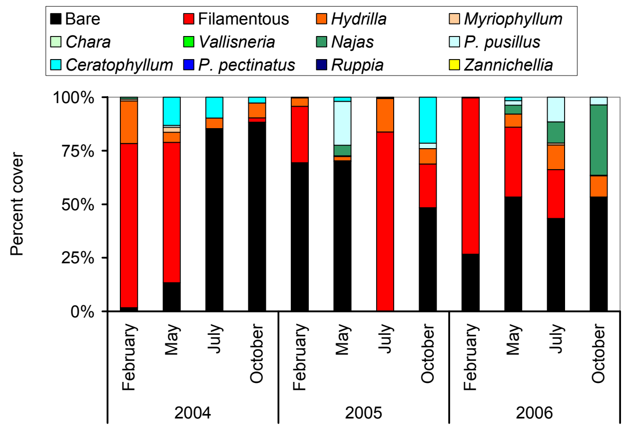

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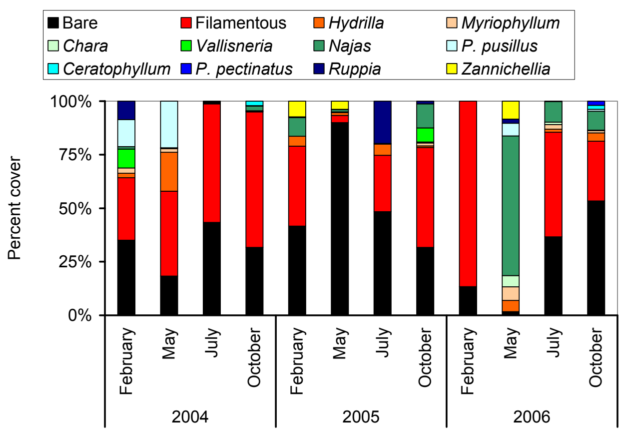

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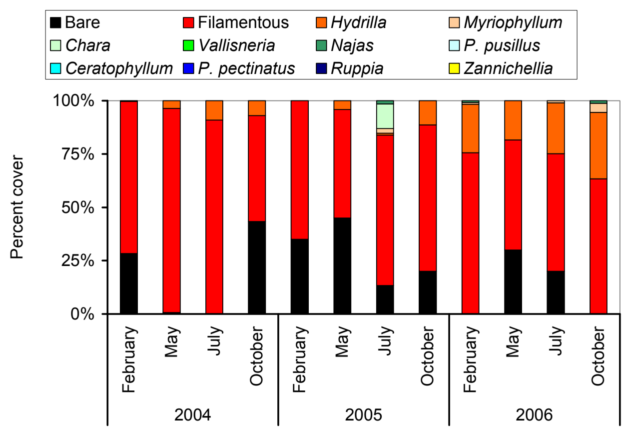

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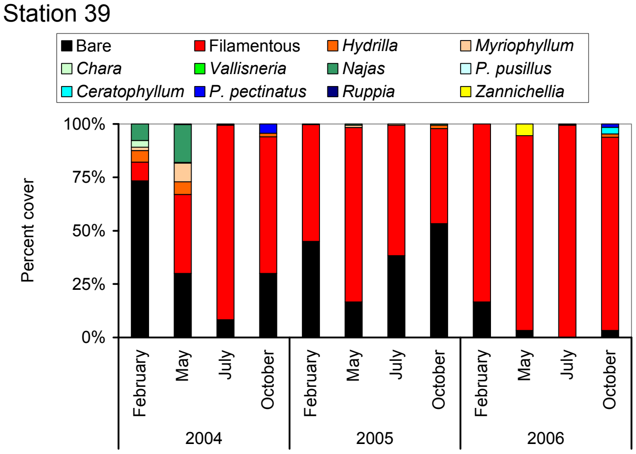

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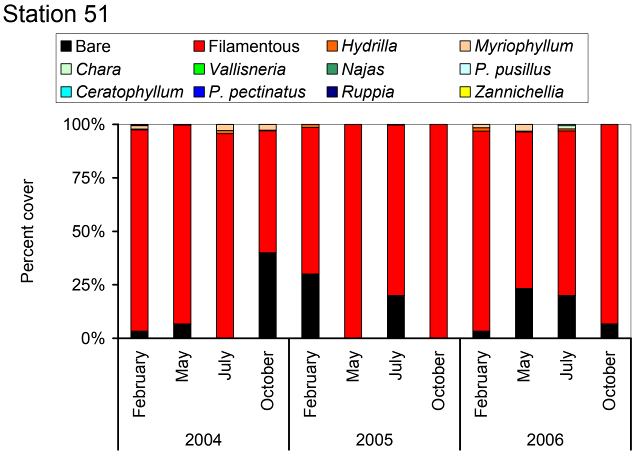

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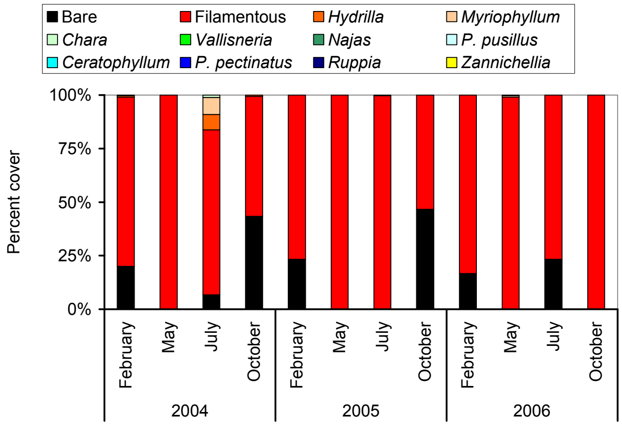

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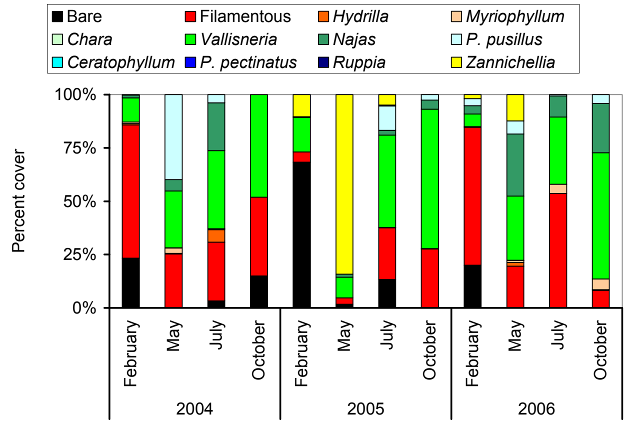

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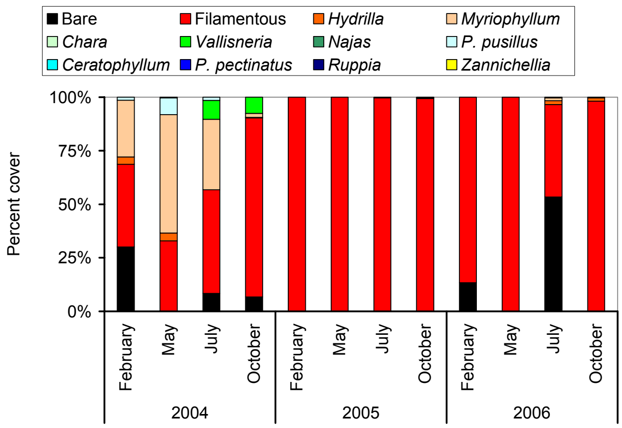

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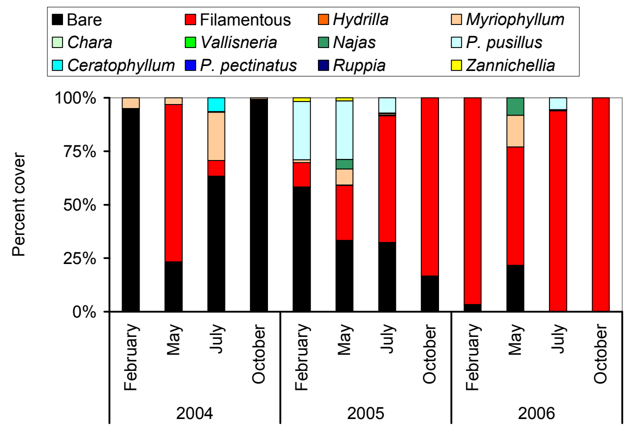

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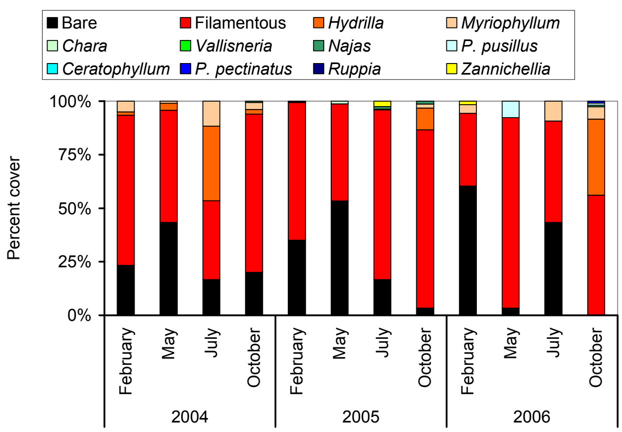

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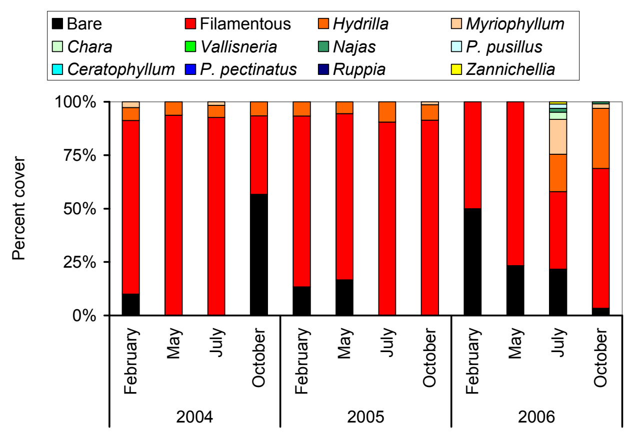

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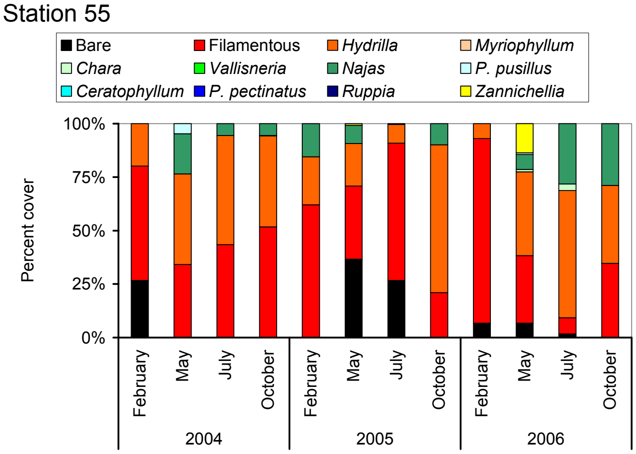

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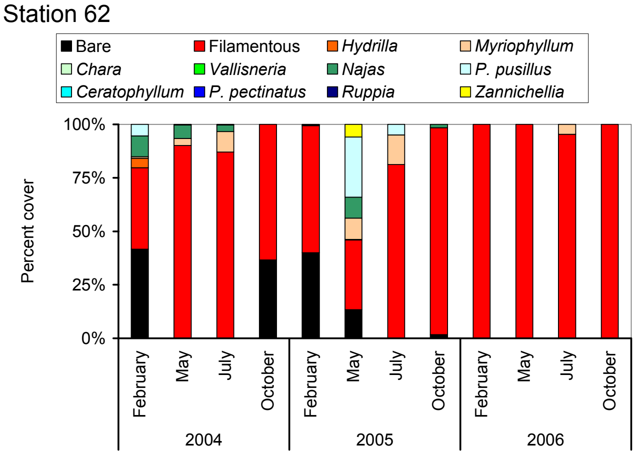


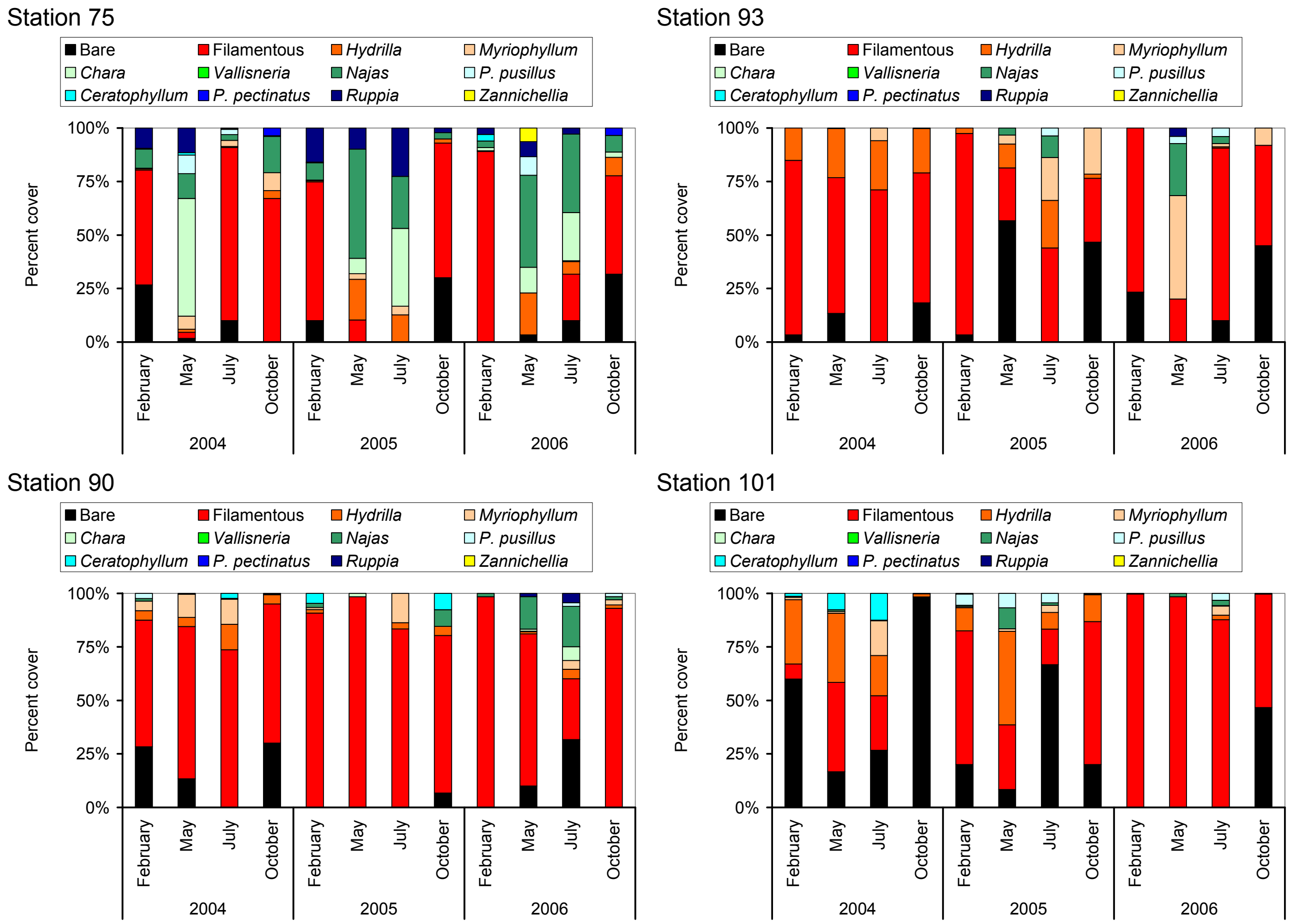
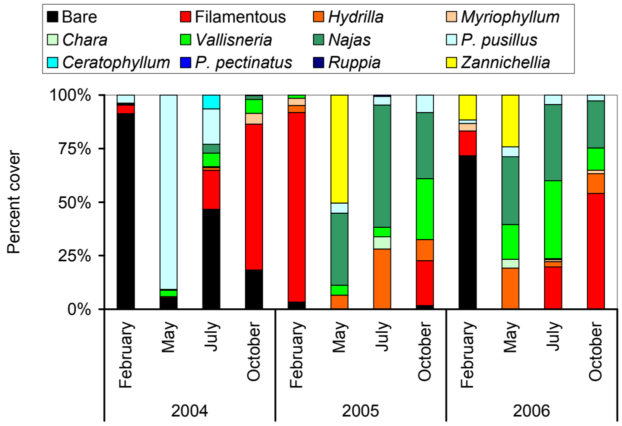


Figure 25. Relative contributions to mean percent cover at stations in the group of 28.

Station 5



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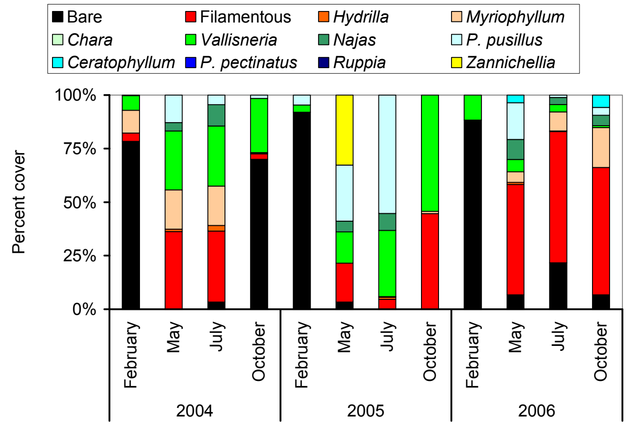

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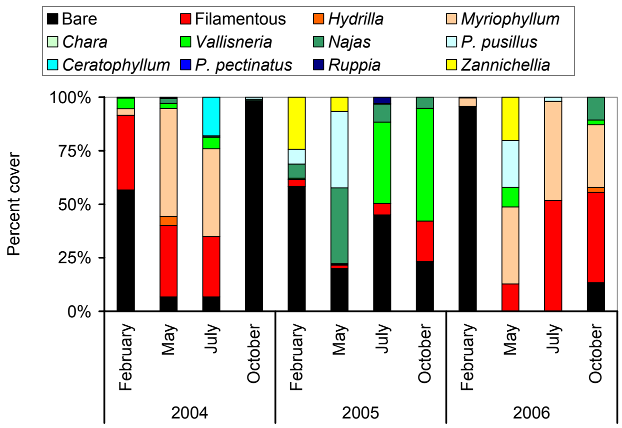

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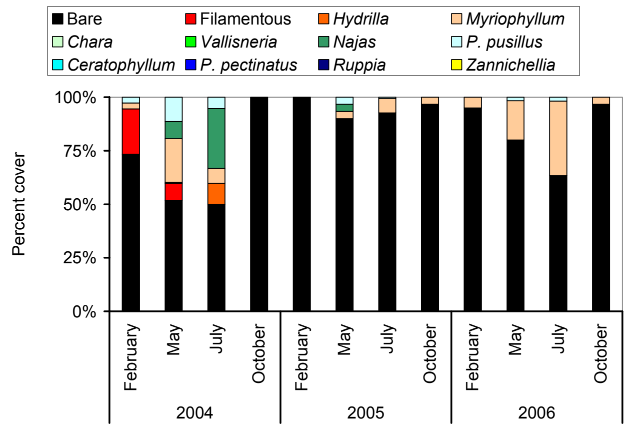

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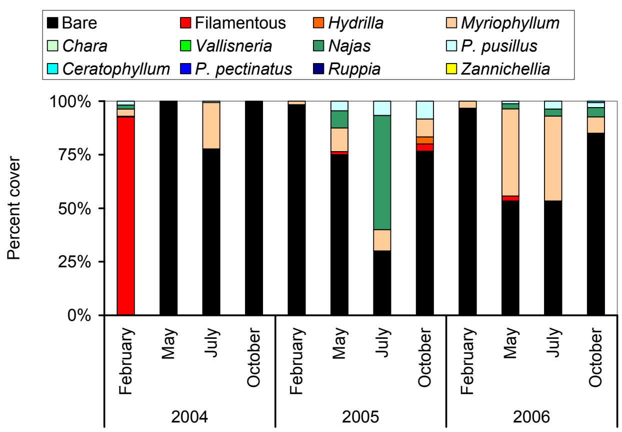

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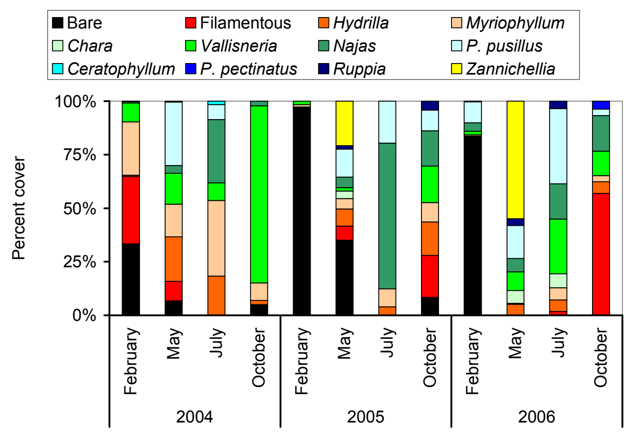

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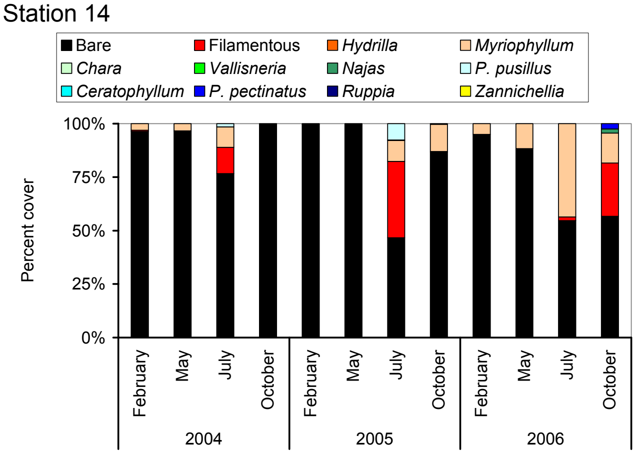

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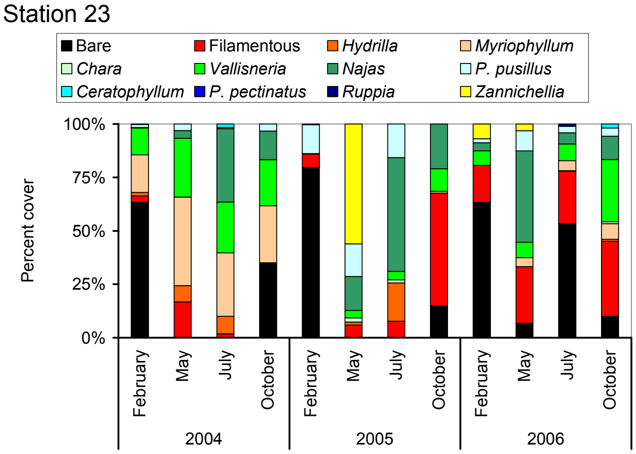

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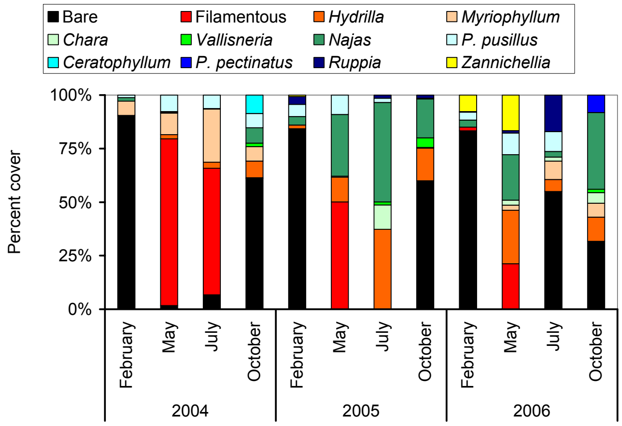

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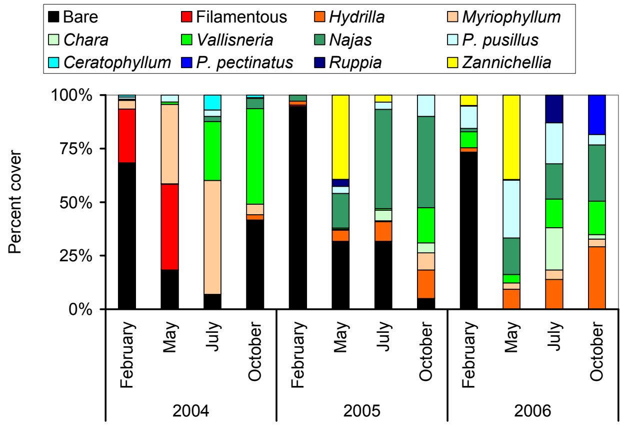

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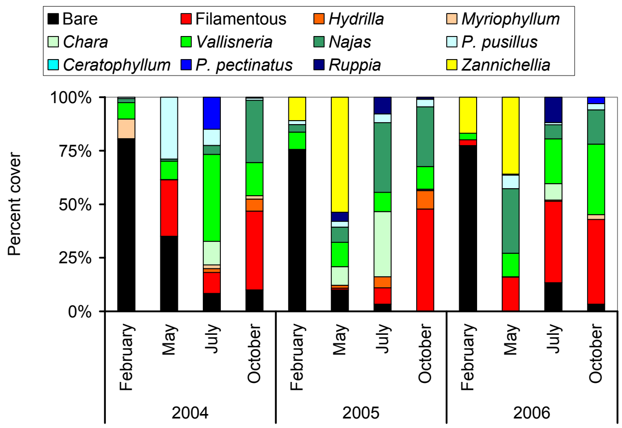

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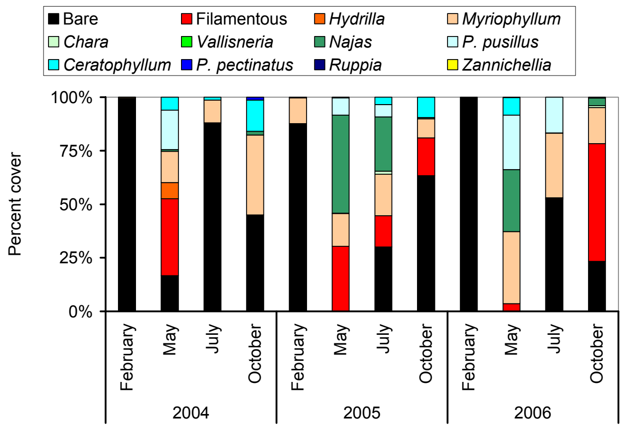

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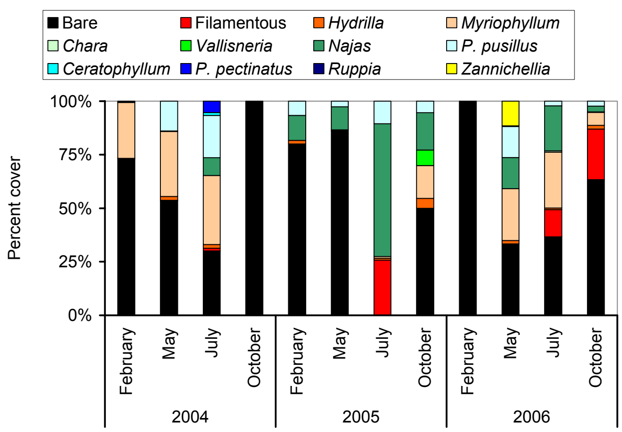

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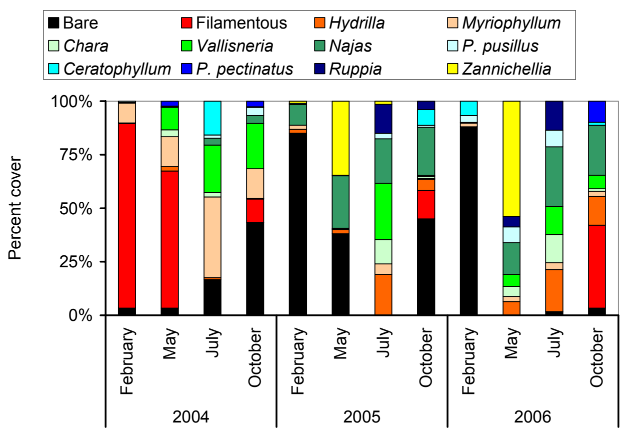

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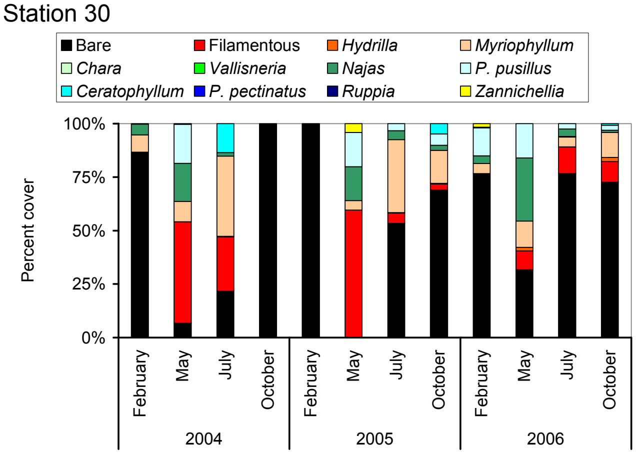

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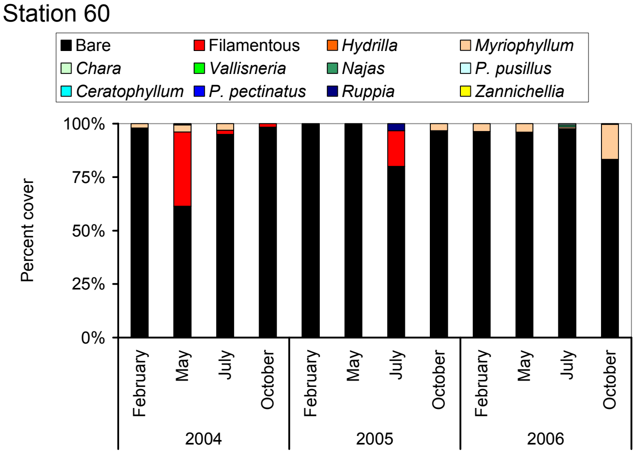

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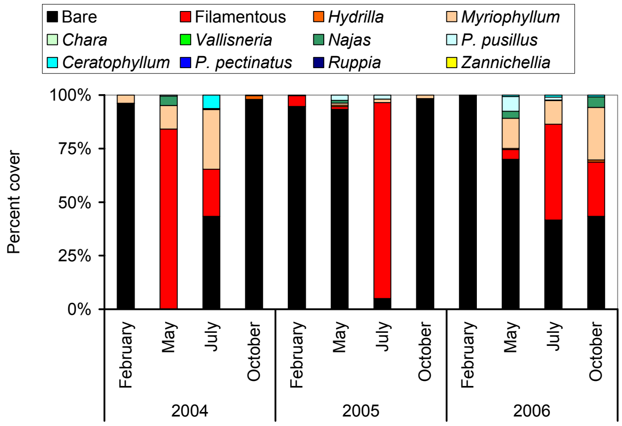
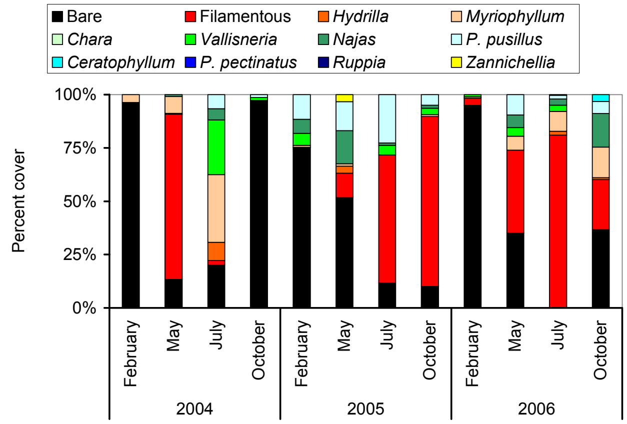
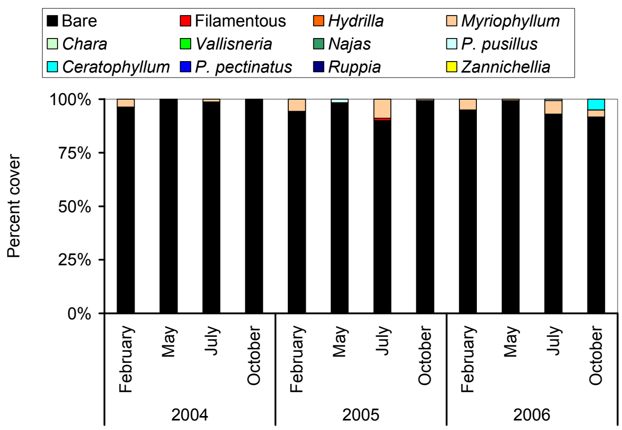


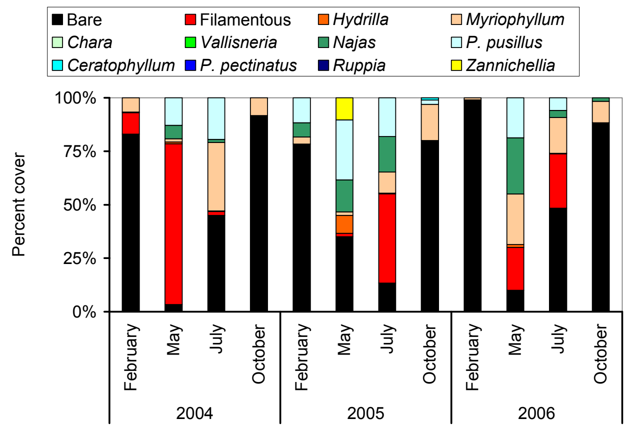
Station 67



Station 63



Station 68



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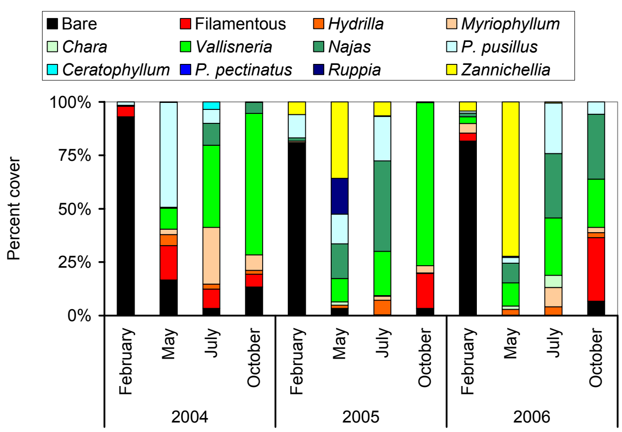
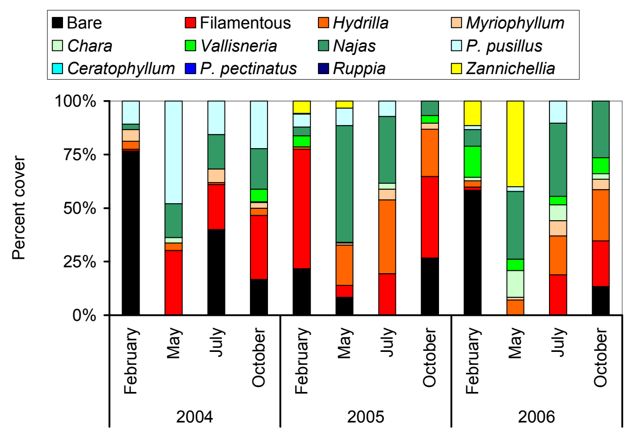
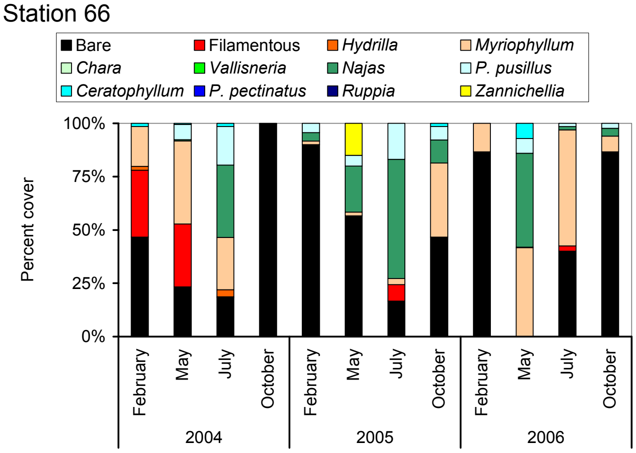


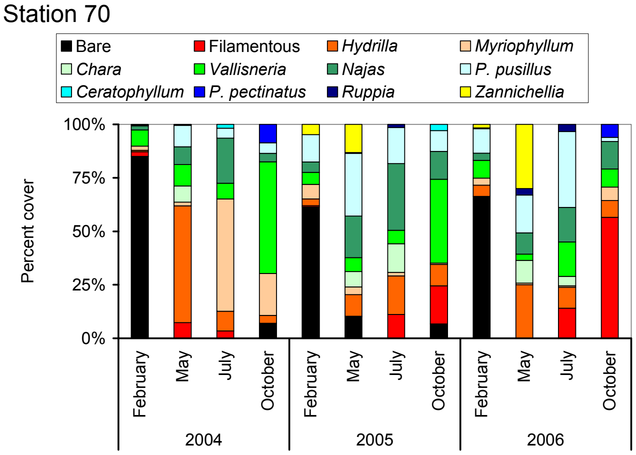
Station 69



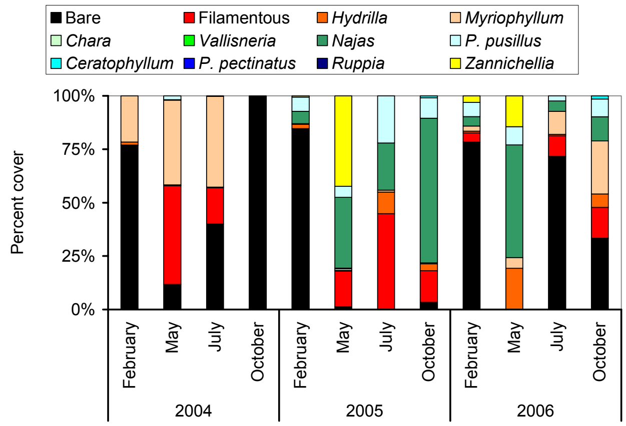
Station 66



Station 70



Station 71



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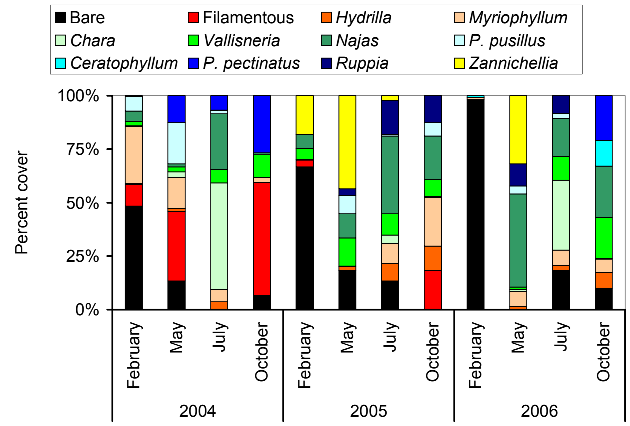
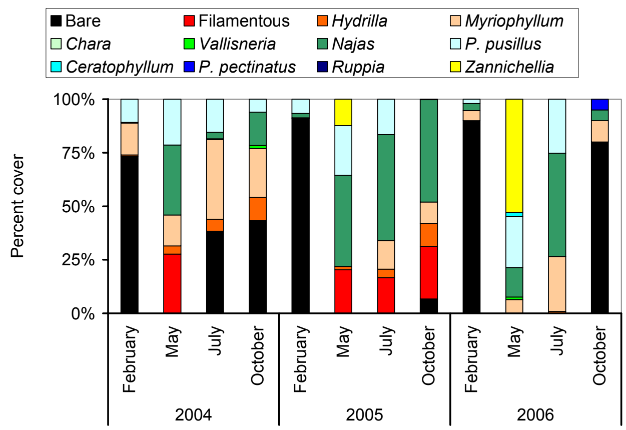


Station 73



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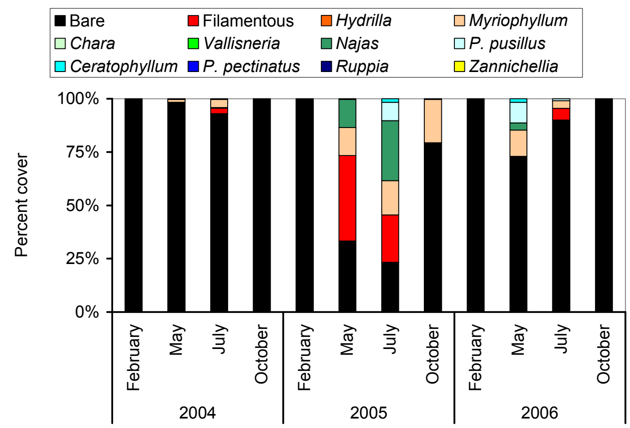
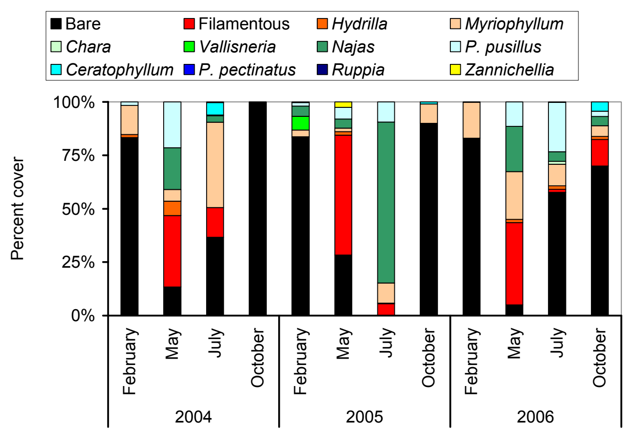
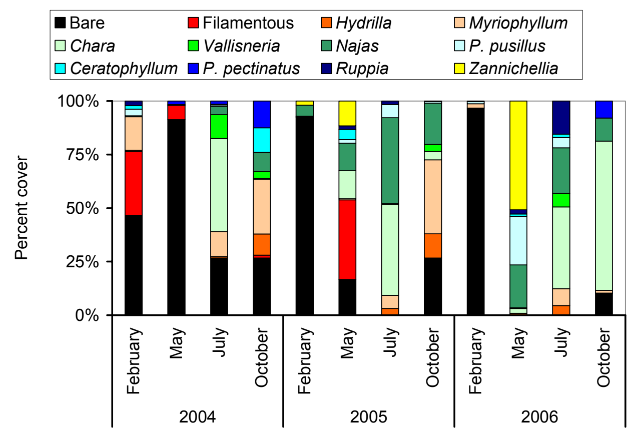


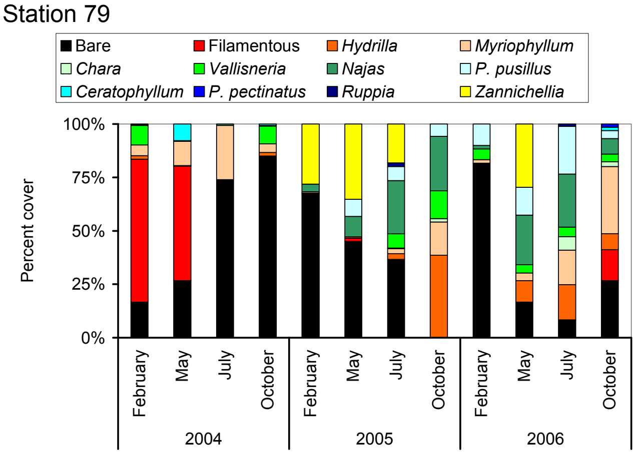
Station 78



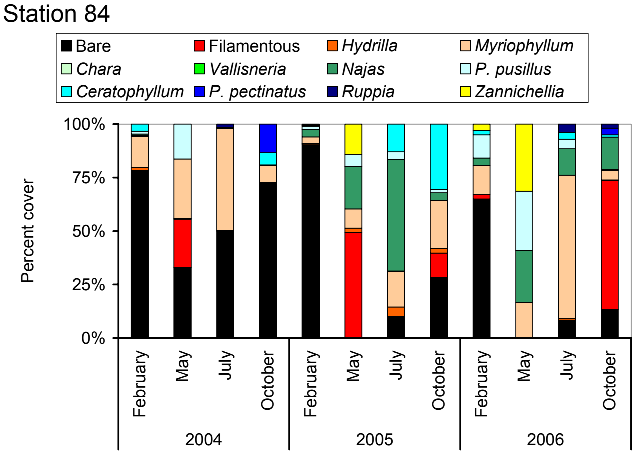
Station 83



Station 79



Station 84



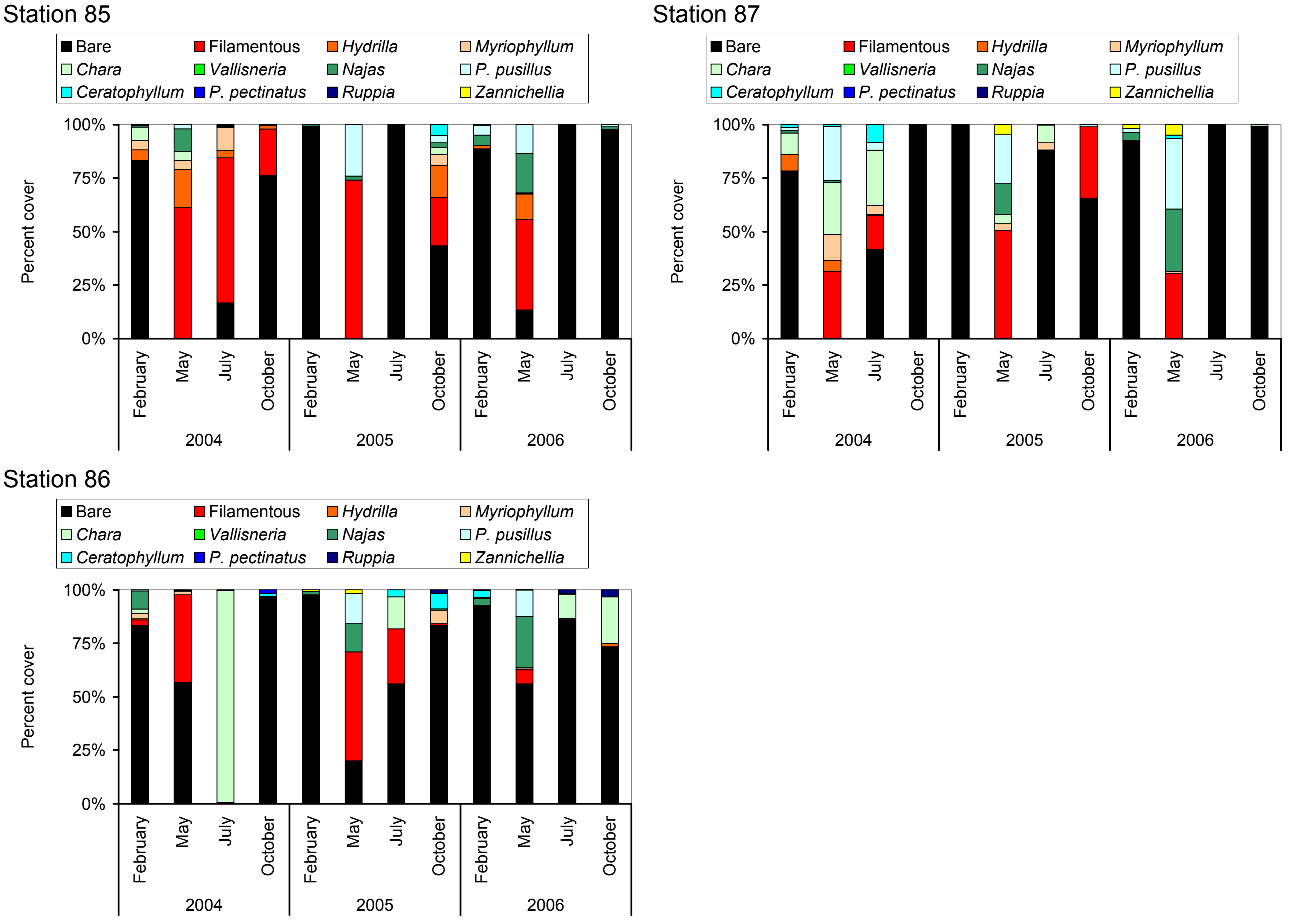
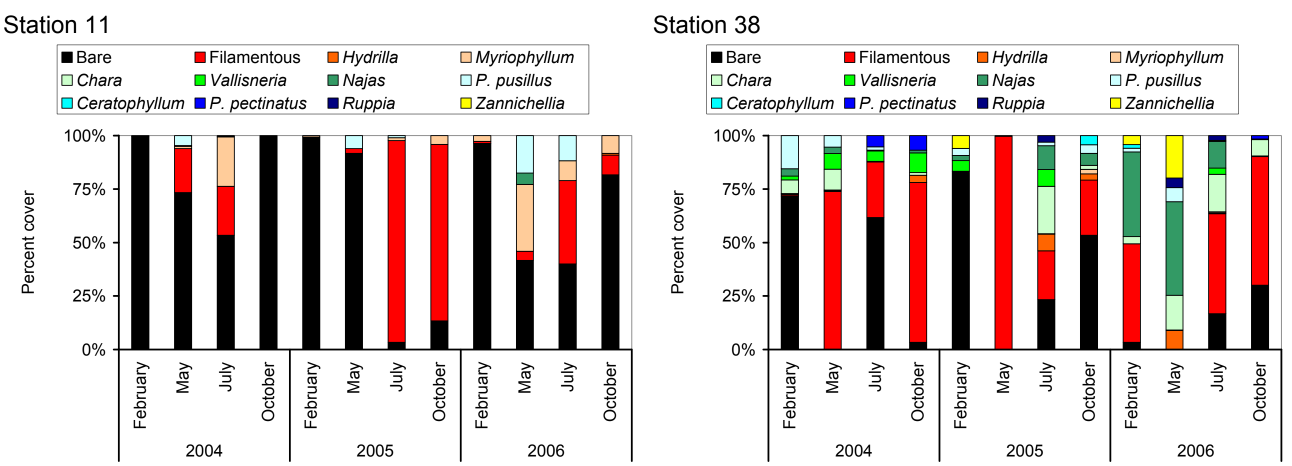


Figure 26. Relative contributions to mean percent cover at stations in the group of 35.



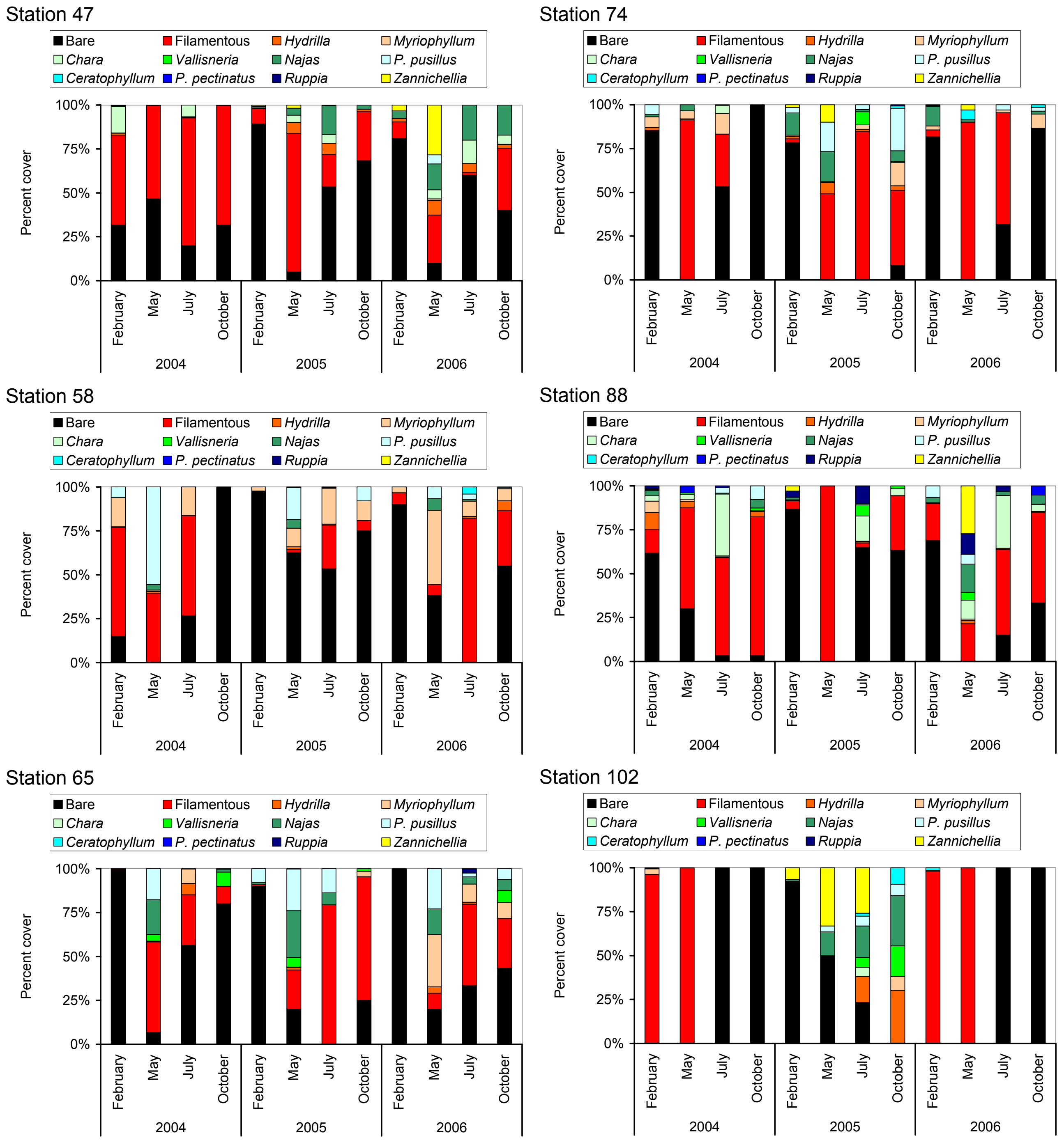
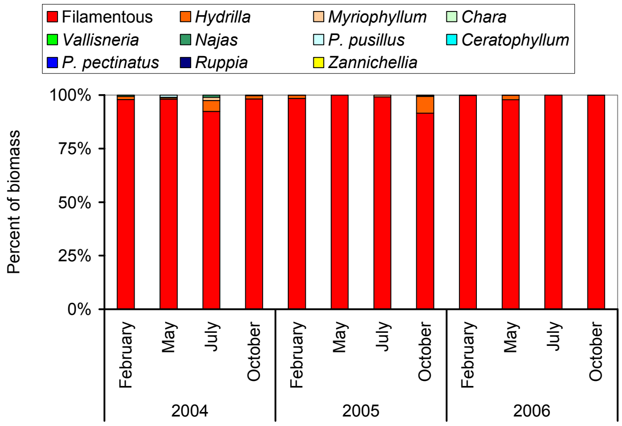
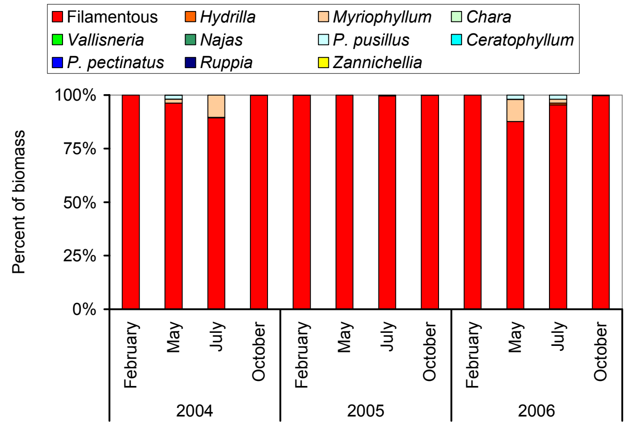


Figure 27. Relative contributions to mean percent cover at stations in the group of 8.

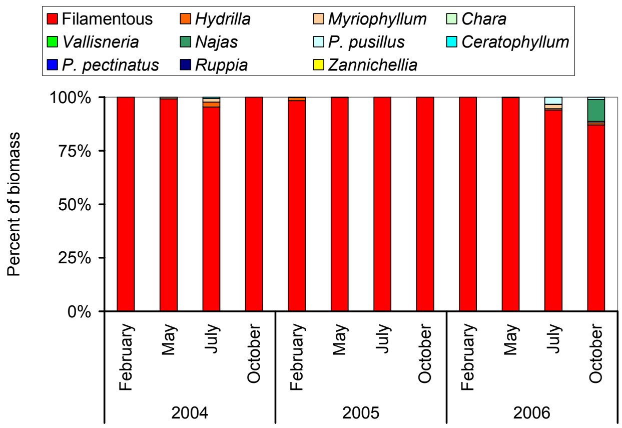
Station 1



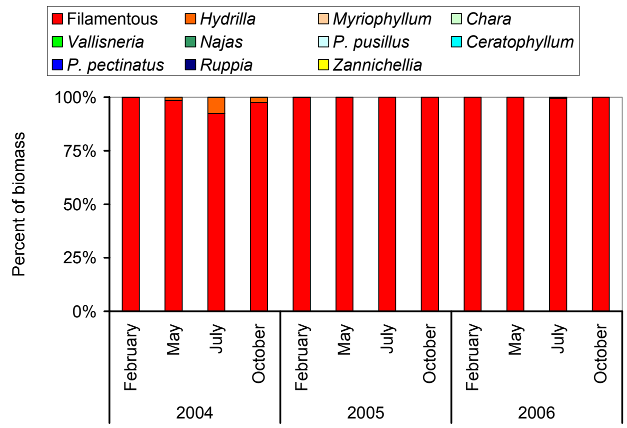
Station 6



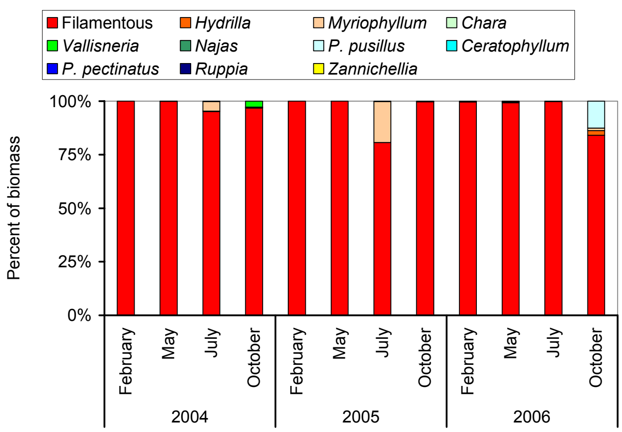
Station 2



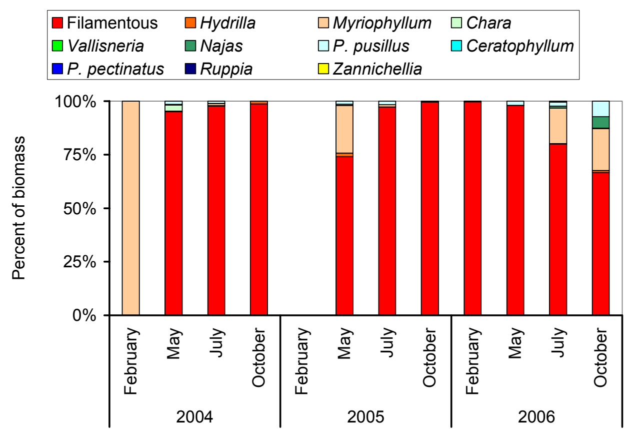
Station 8



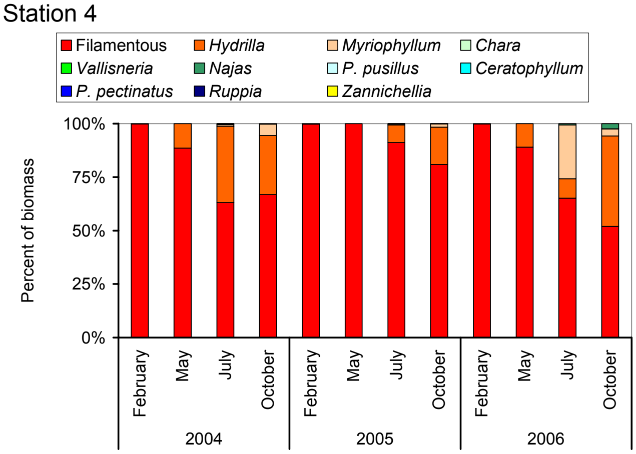
Station 3



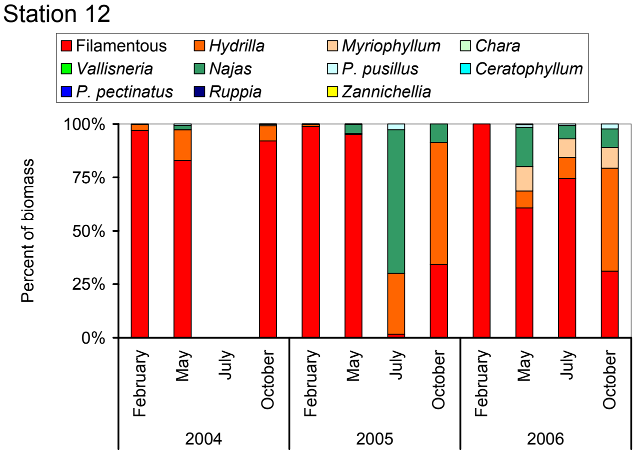
Station 10



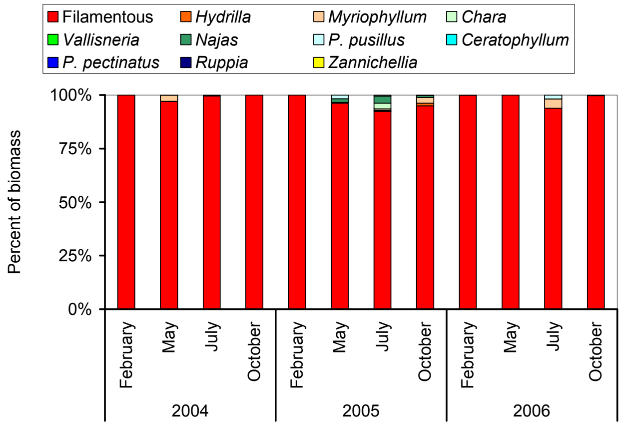
Station 4



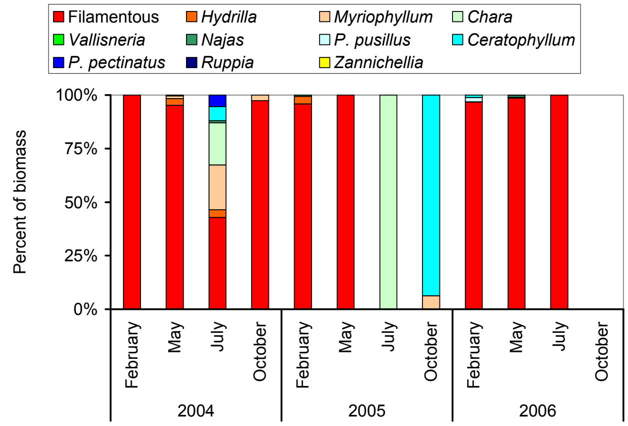
Station 12



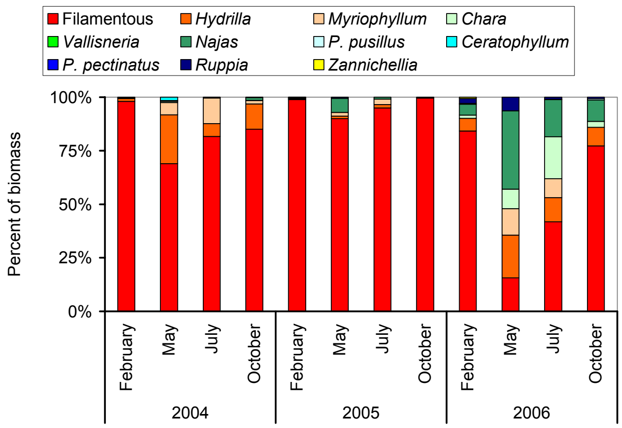
Station 16



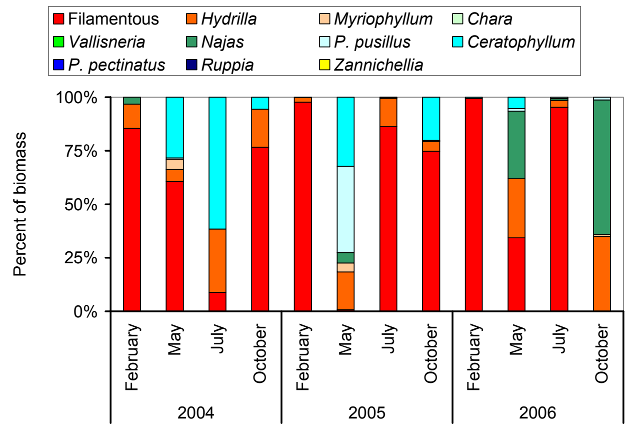
Station 44



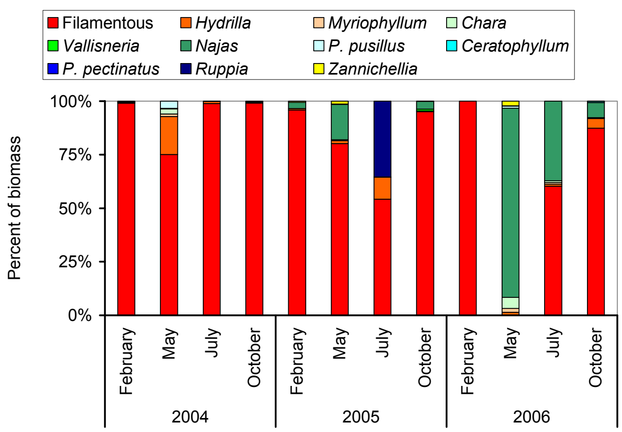
Station 27



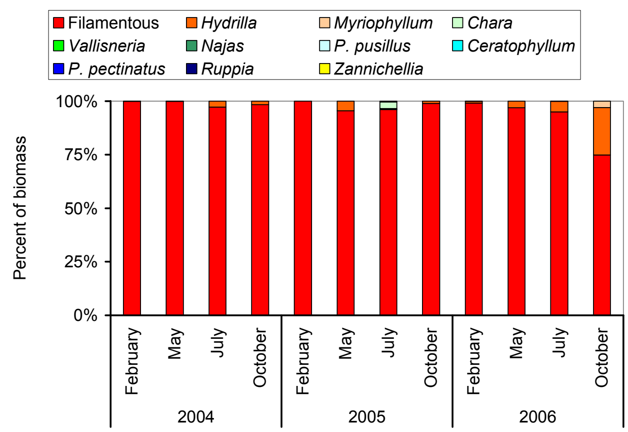
Station 49



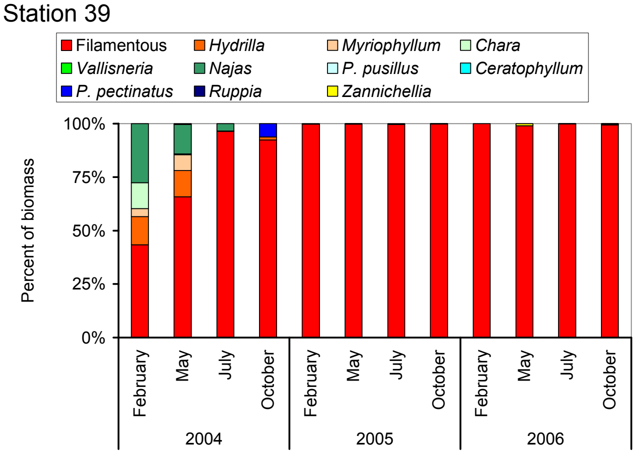
Station 31



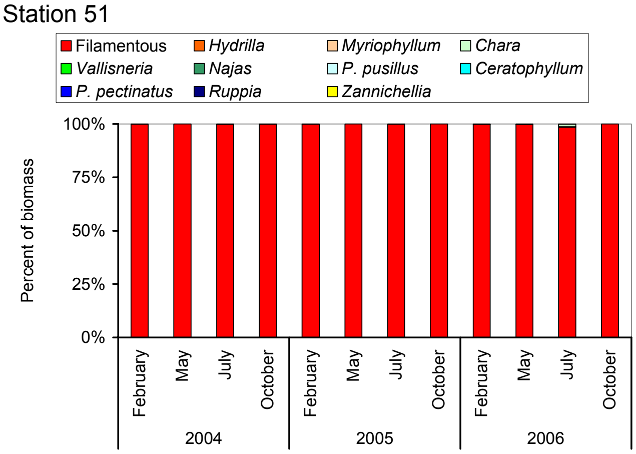
Station 50



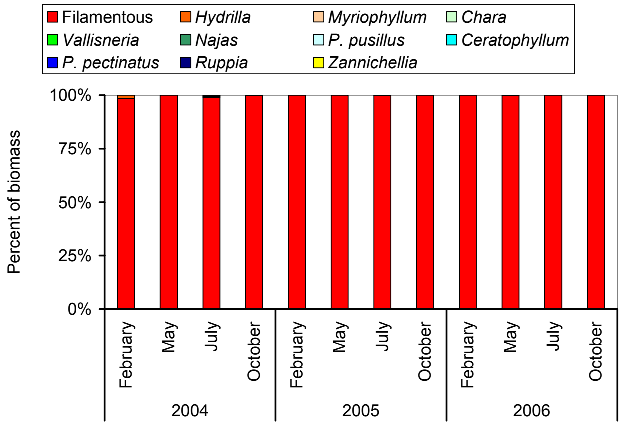
Station 39



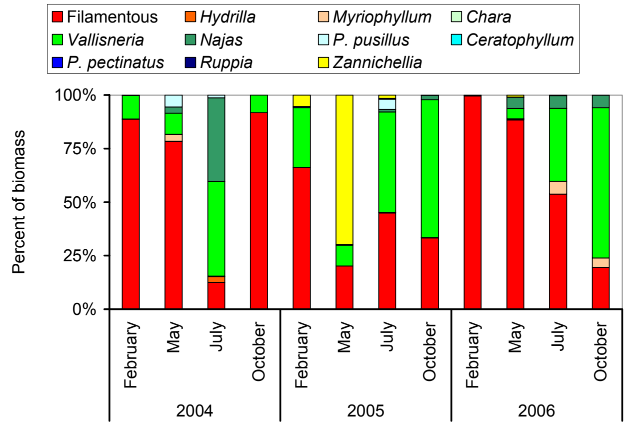
Station 51



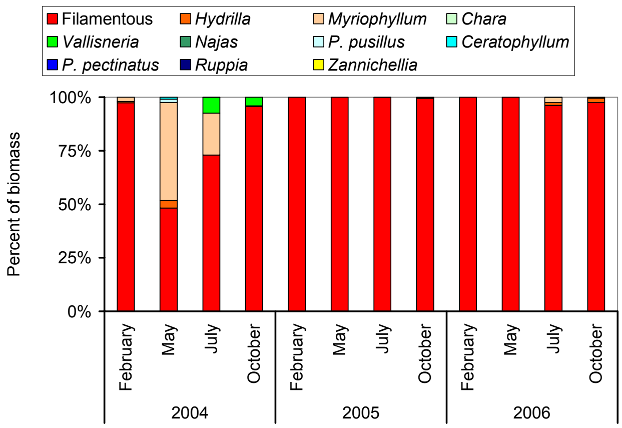
Station 52



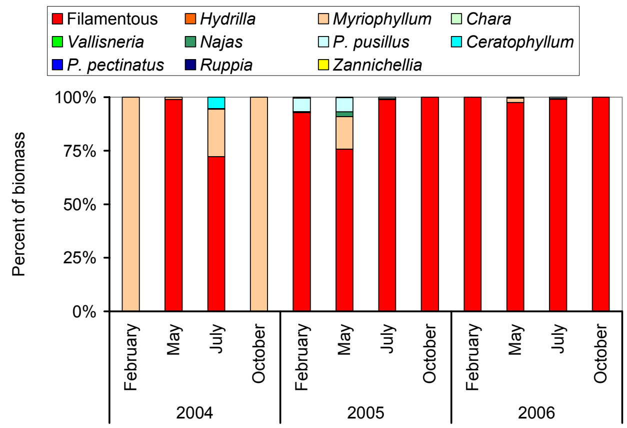
Station 56



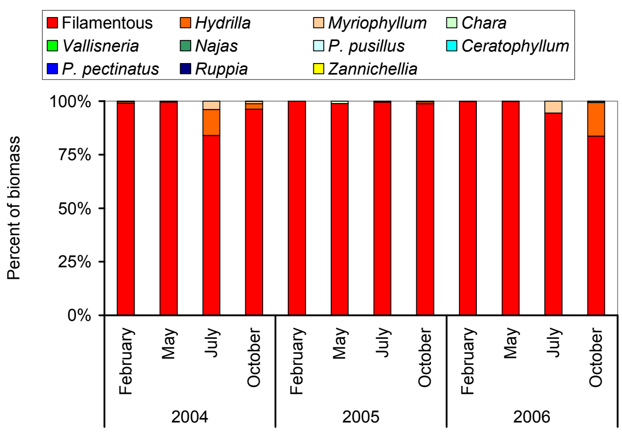
Station 53



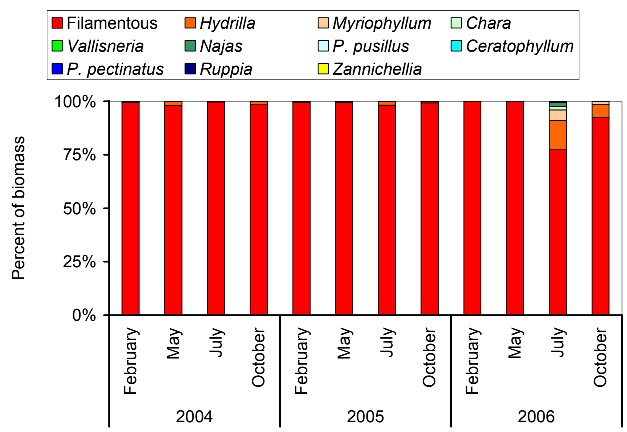
Station 57



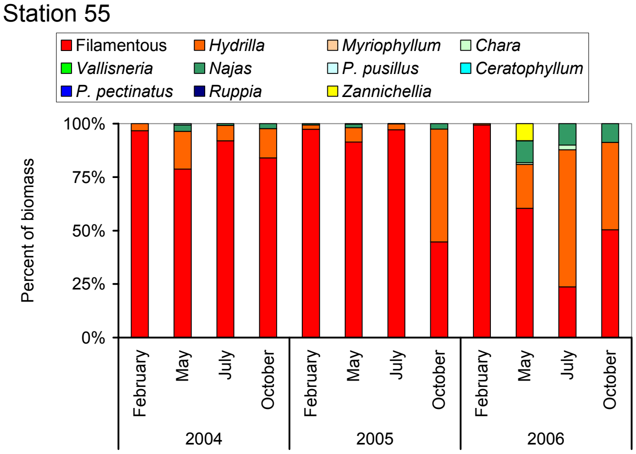
Station 54



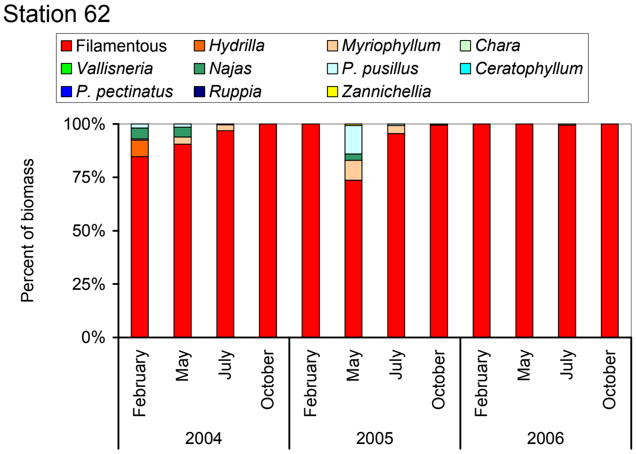
Station 59



Station 55



Station 62



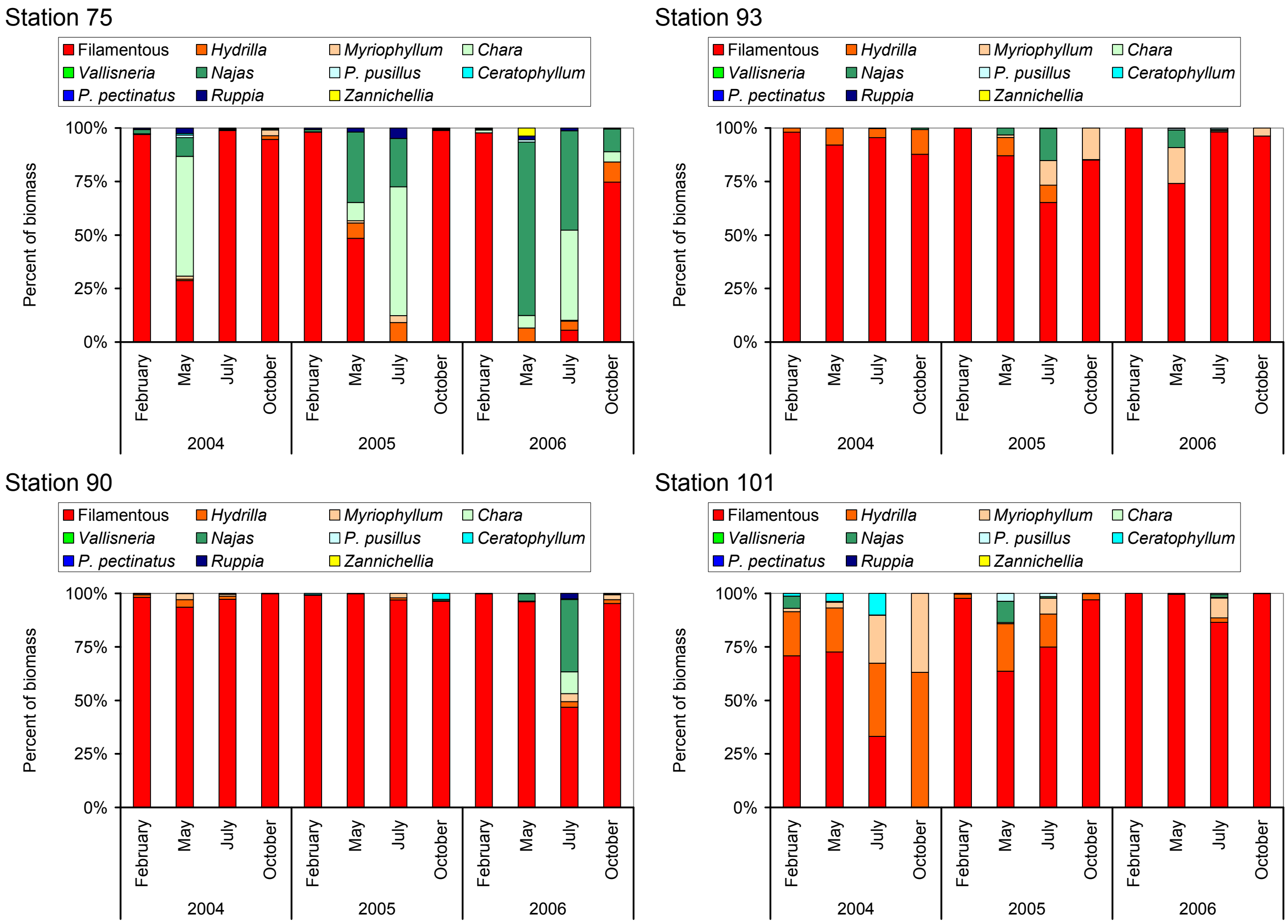
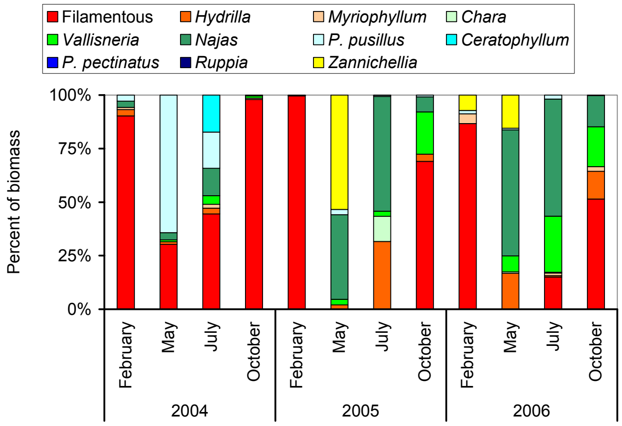
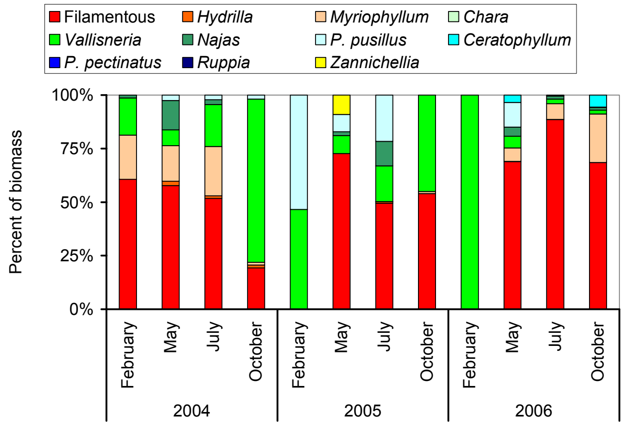


Figure 28. Relative contributions to mean biomass at stations in the group of 28.

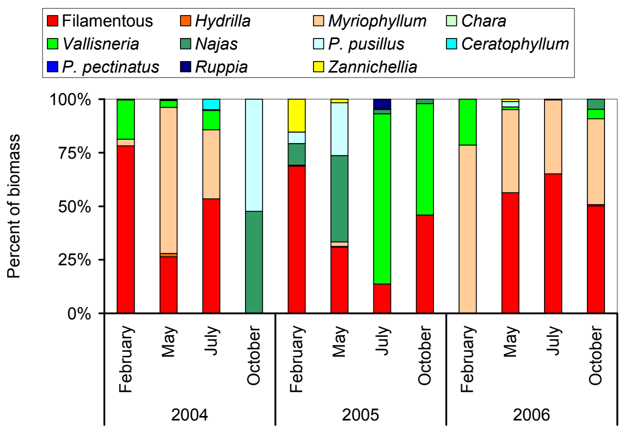
Station 5



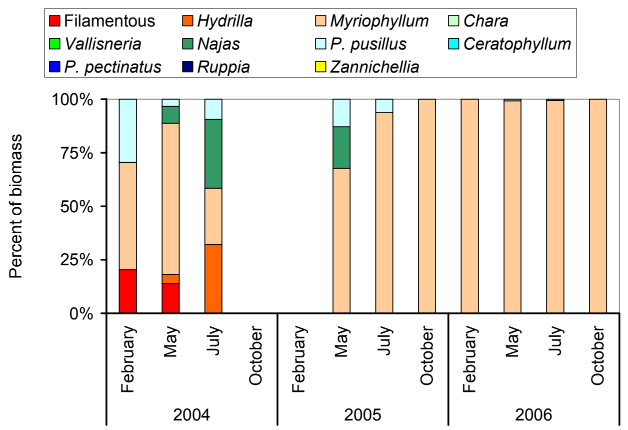
Station 15



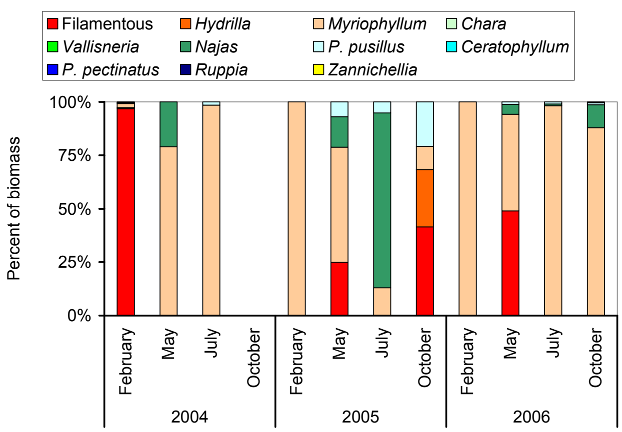
Station 9



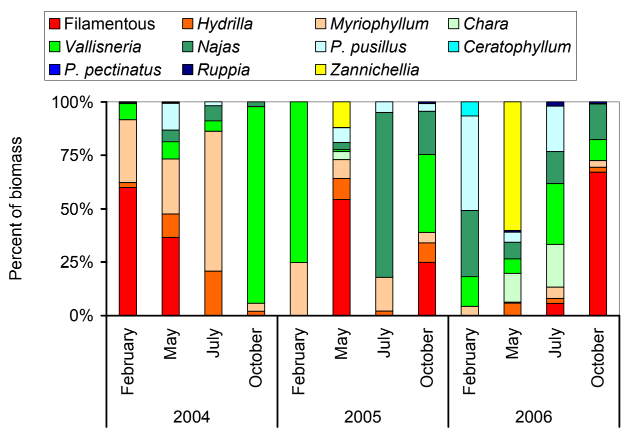
Station 18



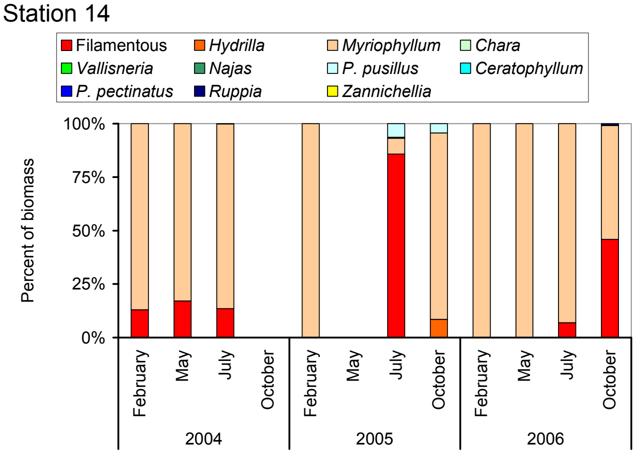
Station 13



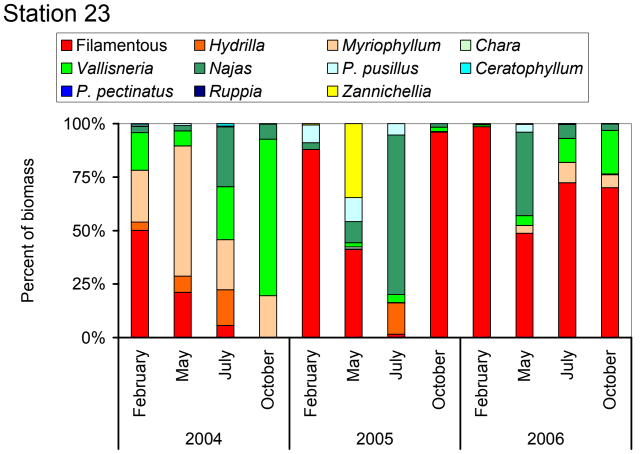
Station 20



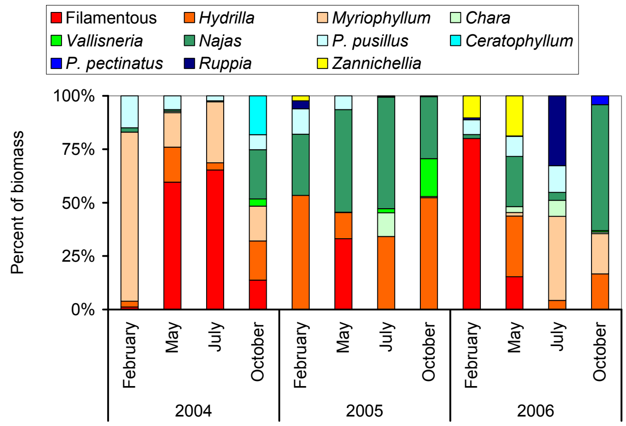
Station 14



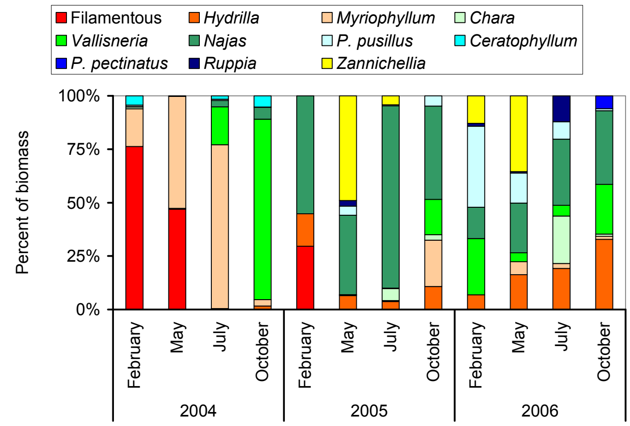
Station 23



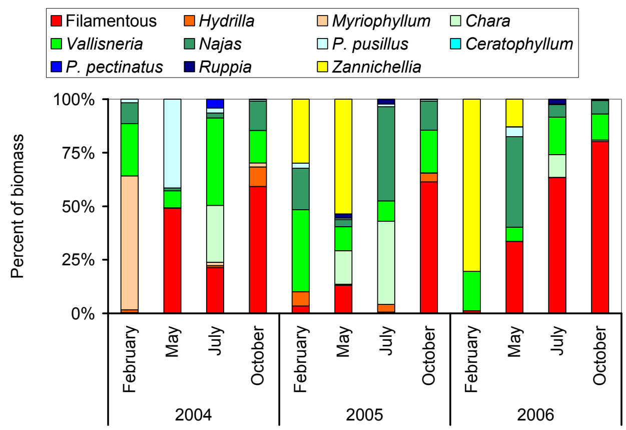
Station 24



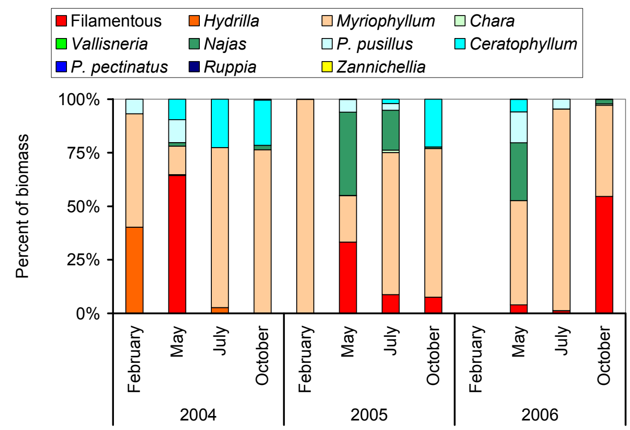
Station 33



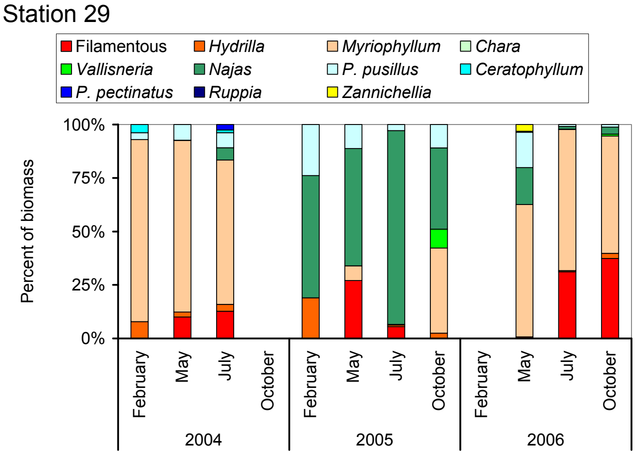
Station 26



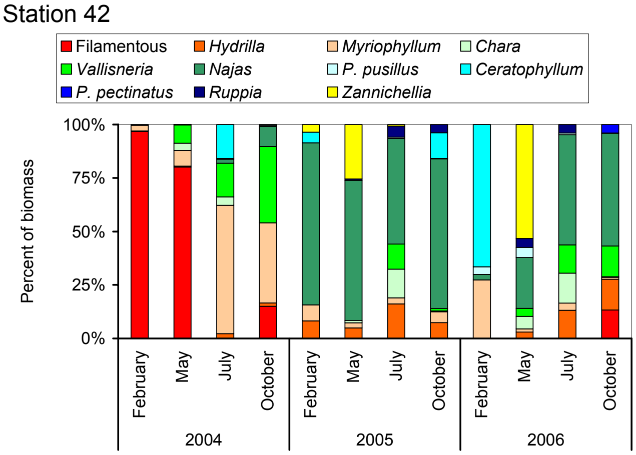
Station 37



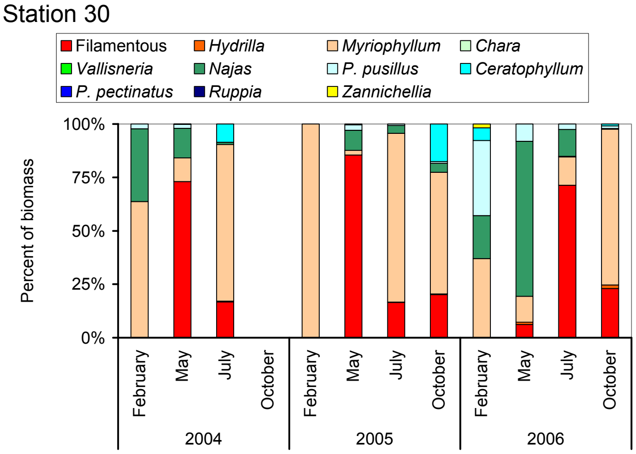
Station 29



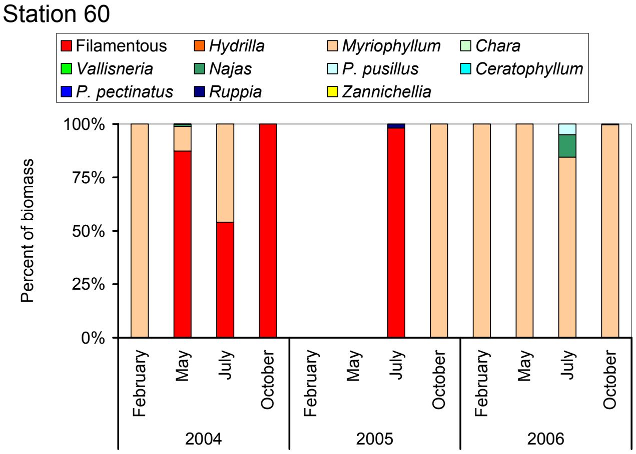
Station 42



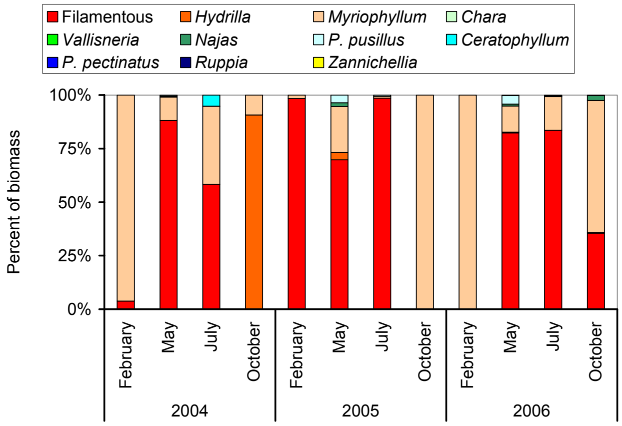
Station 30



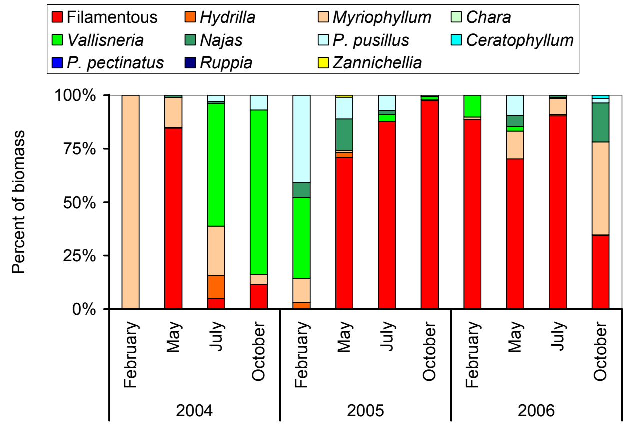
Station 60



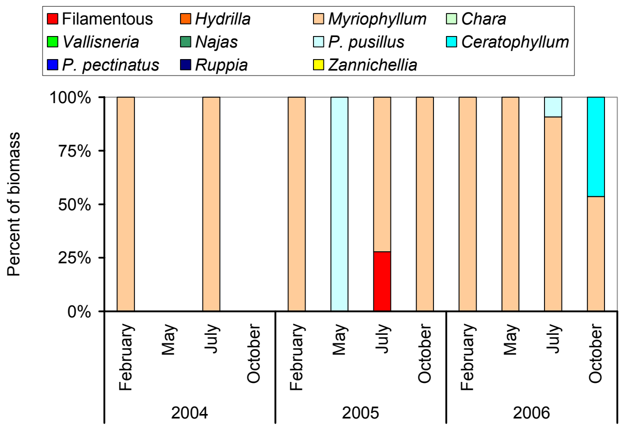
Station 61



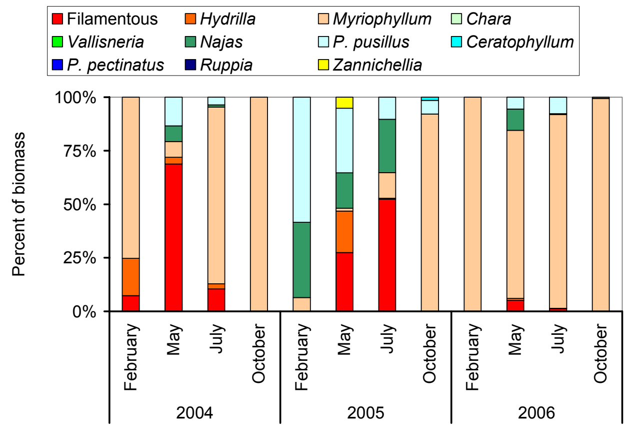
Station 67



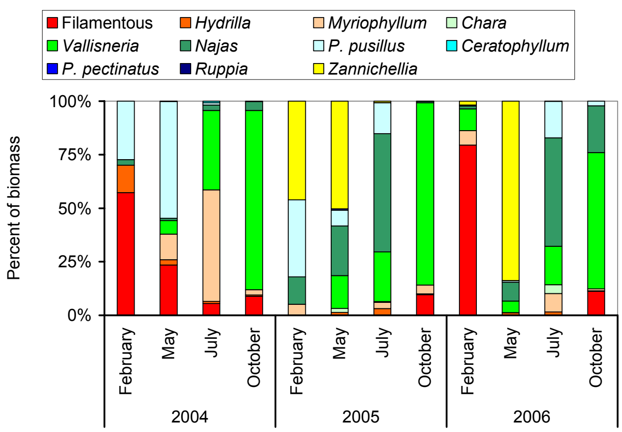
Station 63



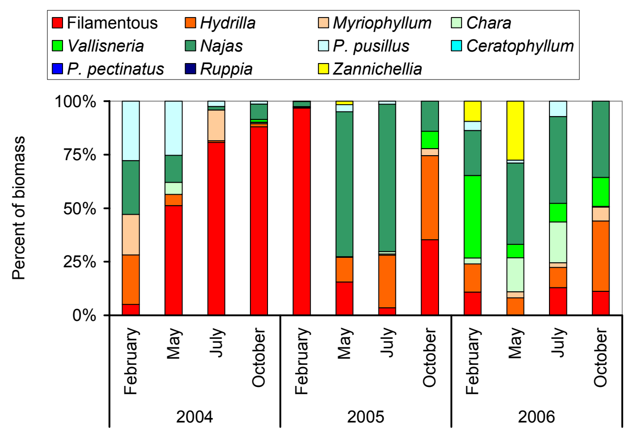
Station 68



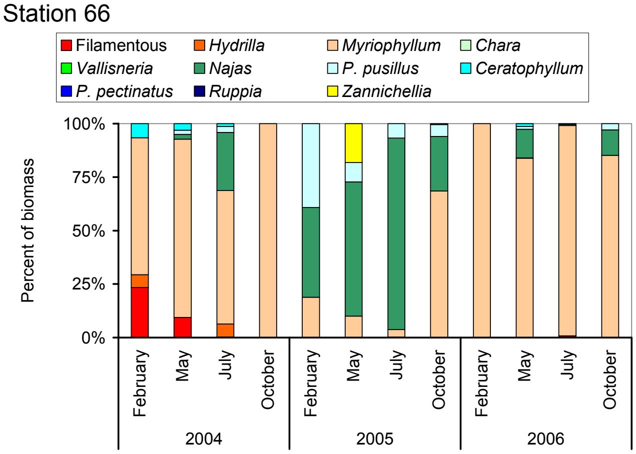
Station 64



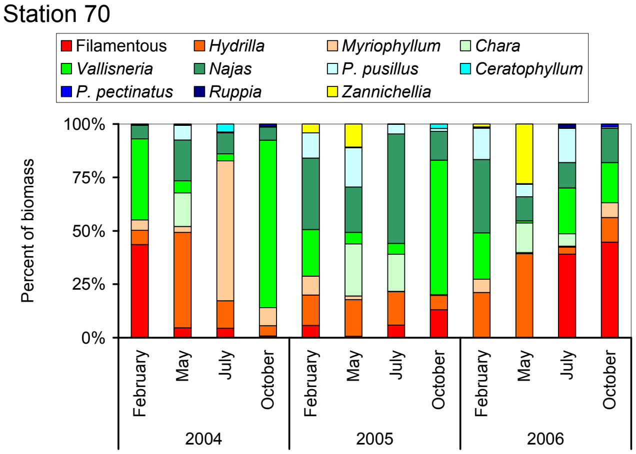
Station 69



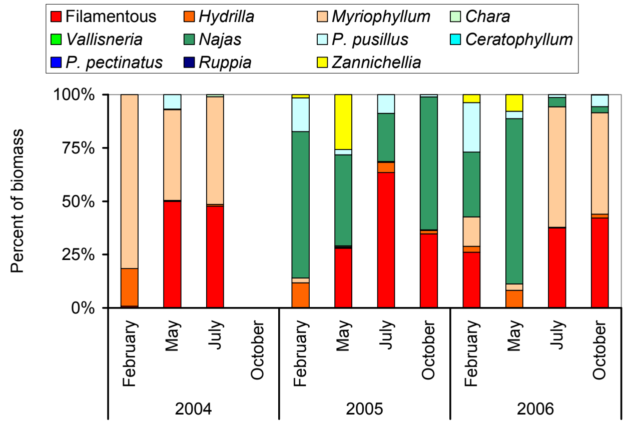
Station 66



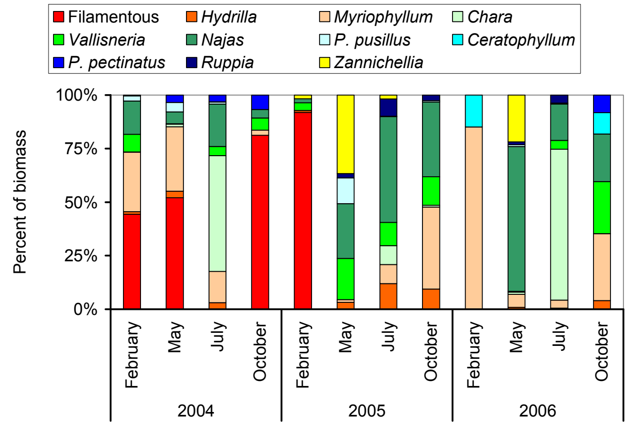
Station 70



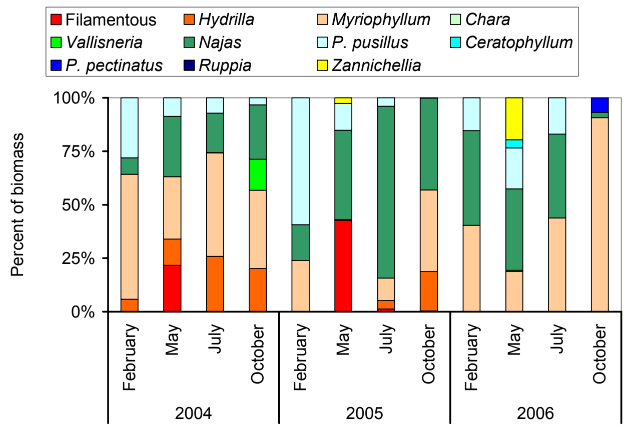
Station 71



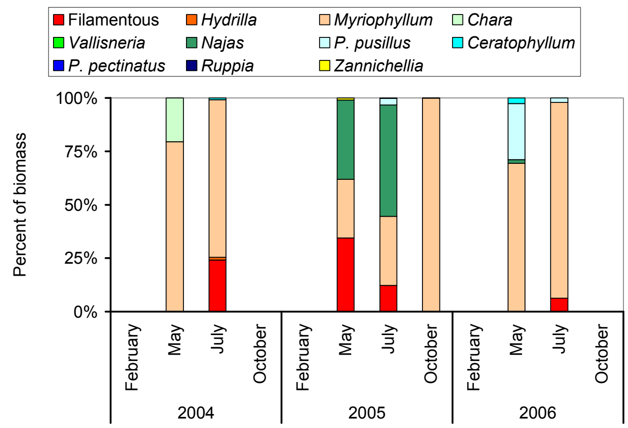
Station 80



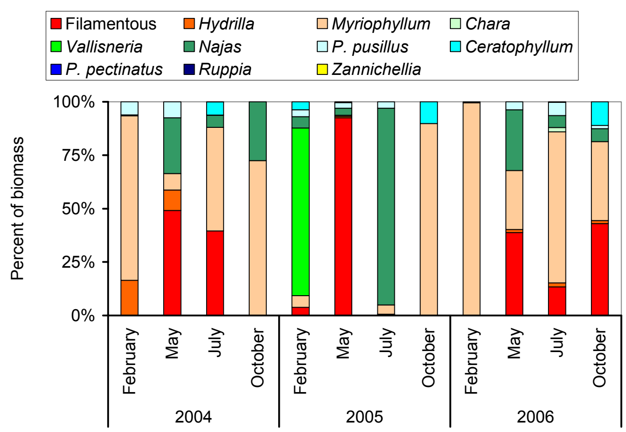
Station 73



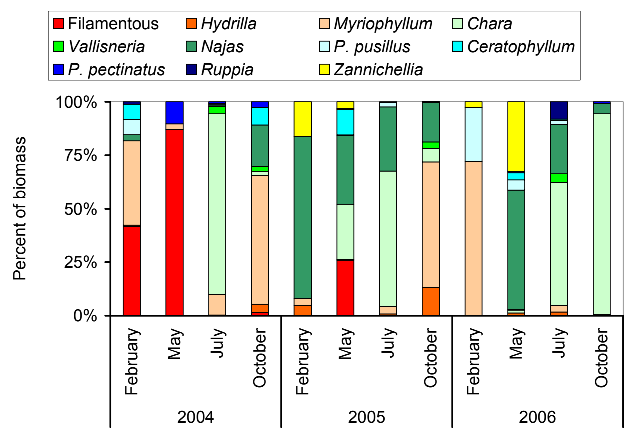
Station 81



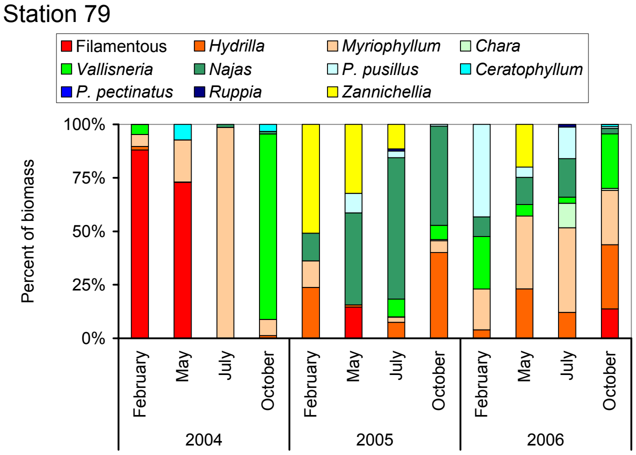
Station 78



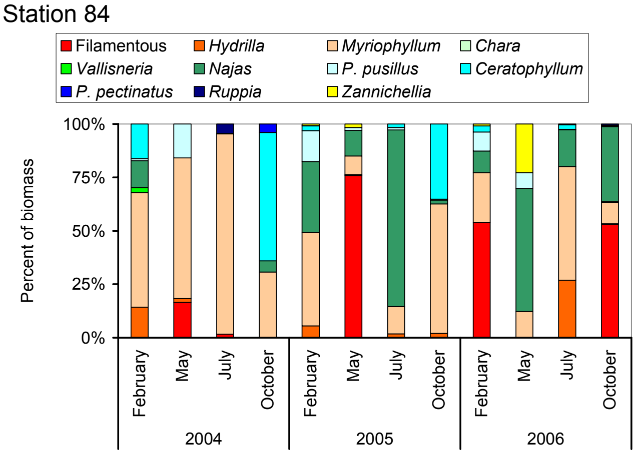
Station 83



Station 79



Station 84



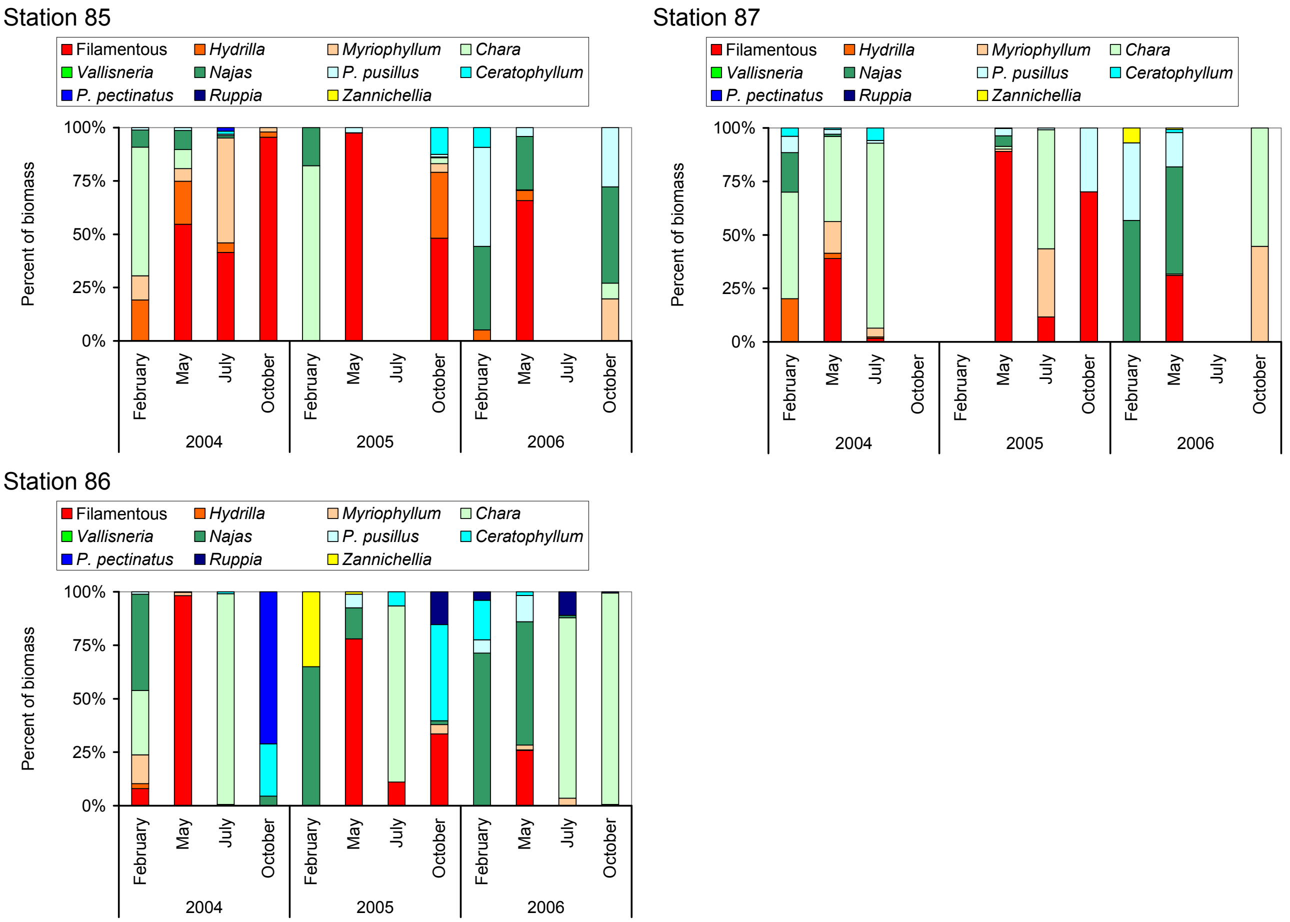
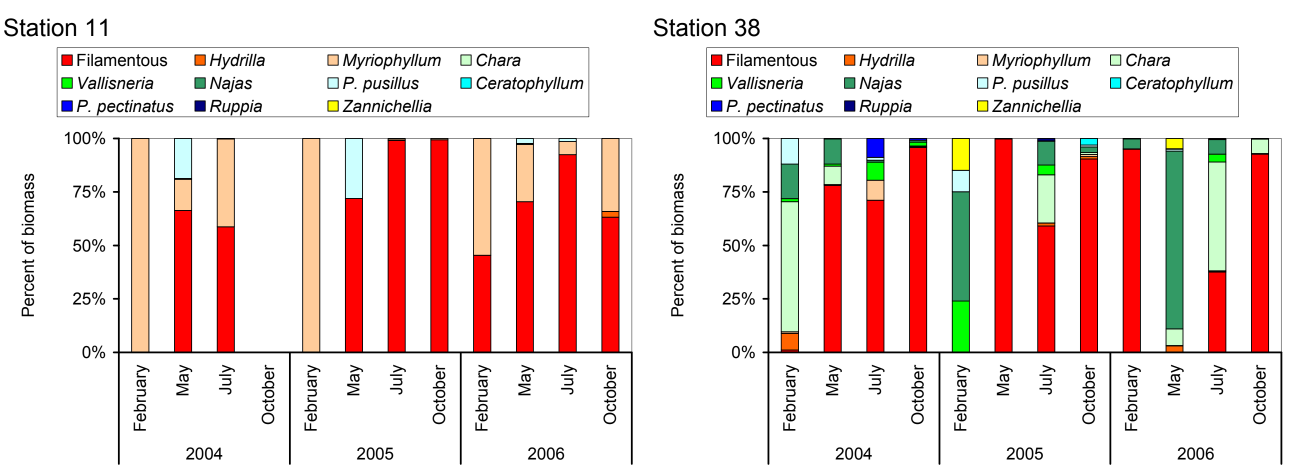


Figure 29. Relative contributions to mean biomass at stations in the group of 35.



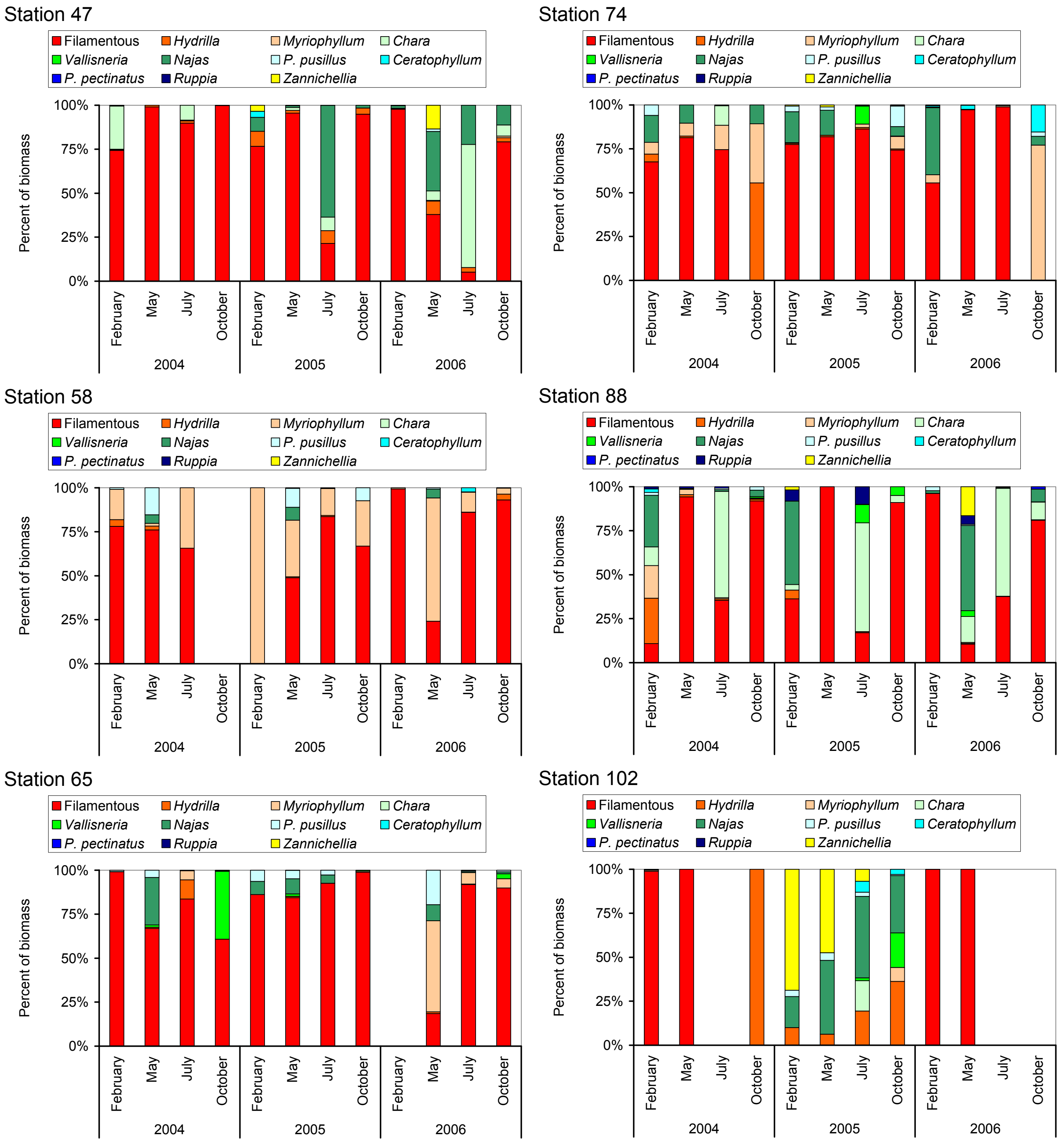


Figure 30. Relative contributions to mean biomass at stations in the group of 8.

Bay-wide spatial pattern – correlation with sediment depth

Data from Belanger et al. (2005) were used to examine sediment depth as a way to explain the spatial pattern in vegetation. Thirty-eight stations were matched to stations in this study.

Sediment depths at stations in the group of 35, the intermediate group of 8, and the group of 28 did not exhibit a clear spatial trend (Figure 31). Sediment depths ranged from 0–4.7 feet at stations in the group of 35, 0.8–4.0 feet across the intermediate stations, and 0–2.5 feet at stations in the group of 28.

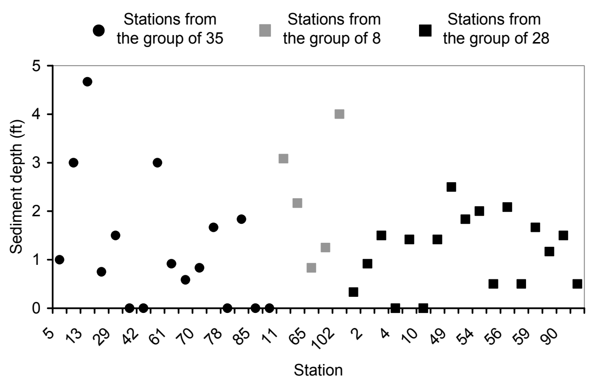


Figure 31. Sediment depths for groups of stations.

Bay-wide spatial pattern – correlation with environmental conditions

The Southwest Florida Water Management District provided measures of environmental conditions taken at 12 stations between June 2003 and October 2006 (Figure 32). From the measures provided, depth, horizontal Secchi distance, turbidity, color, conductivity, temperature, pH, and concentrations of dissolved oxygen, nitrite and nitrate, total nitrogen, orthophosphate, total phosphorus, and chlorophyll *a* were selected for use in an ordination designed to identify consistent spatial patterns. Twelve anomalous values were deleted, values below minimum detection limits were set at zero, and sampling events with all missing values or zeros were excluded. The remaining data were range standardized [standardized value = (value – minimum value)/range of values] before ordination in order to balance the influence of measures with absolute values spanning several orders of magnitude.

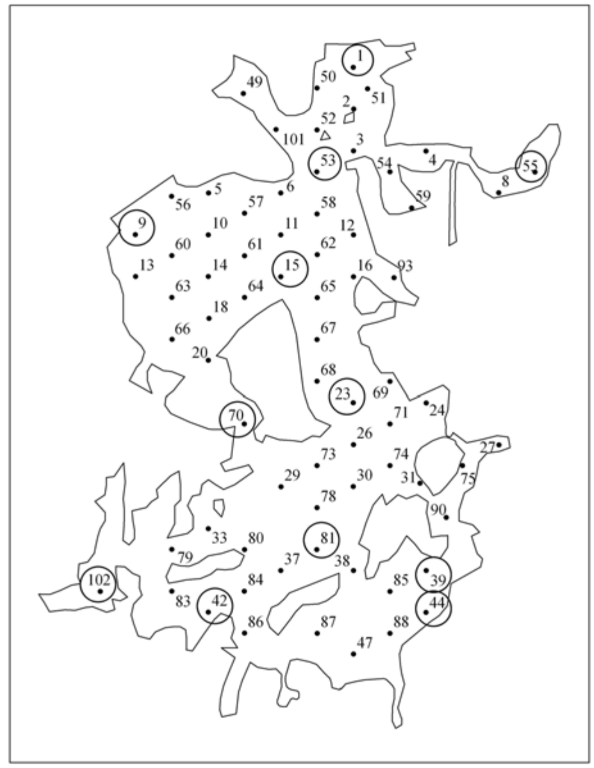


Figure 32. Stations for environmental sampling. 1 = KBN1, 9 = KBN4, 15 = KBN5, 23 = KBC7, 39 = KBS8, 42 = KBS11, 44 = KBS9, 53 = KBN3, 55 = KBN2, 70 = KBC6, 81 = KBS10, 102 = KBS12

A three-dimensional ordination separated Stations 9, 15, 23, 42, 70 and 81 from Stations 1, 39, 44, 53, 55 (Figure 33). These stations also were grouped together by ordinations based on percent cover or biomass data. Station 102, one of the intermediate stations in the other ordinations, appeared to be an outlier in the ordination based on environmental conditions (Figure 33).

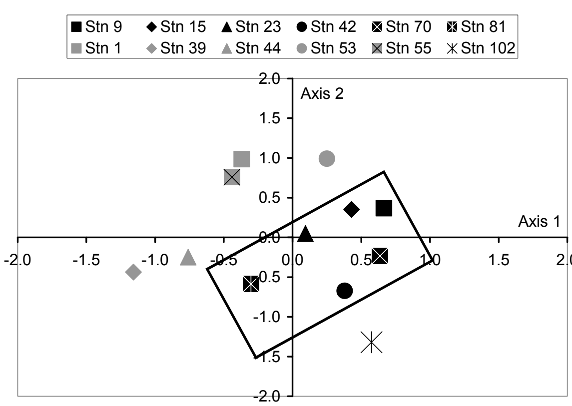
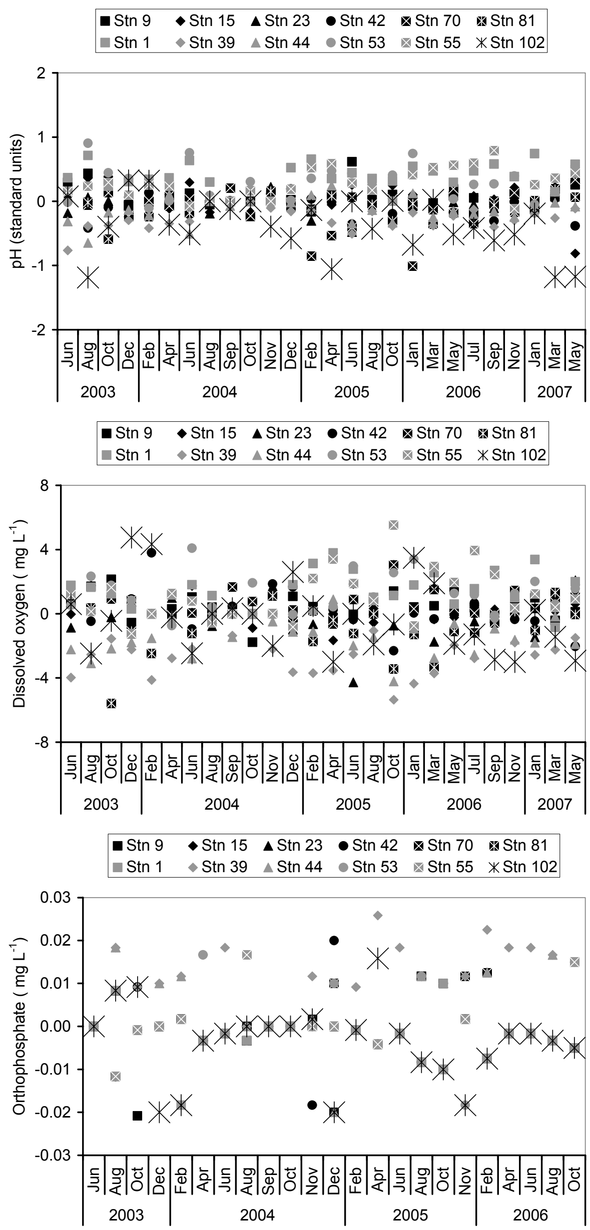


Figure 33. Ordination based on environmental conditions. For clarity, only two of the three dimensions are shown. stress = 0.1021

Data were examined to elucidate parameters that led to groupings. Mean values for each sampling period were calculated using data from all stations. Differences of raw data from these means illustrated the contribution of various parameters to the pattern seen in the ordination.

Five of the thirteen parameters did not appear to strongly influence the ordination (Figure 34). Overall, pH values, concentrations of dissolved oxygen, concentrations of orthophosphate, concentrations of total phosphorus, and concentrations of total nitrogen were not consistently higher or lower than mean values at one set of stations.



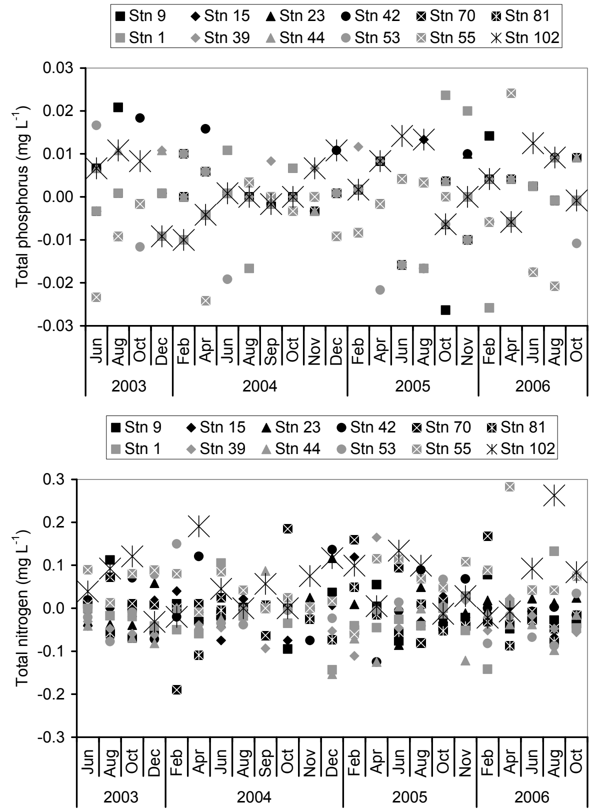


Figure 34. Differences from mean environmental conditions that did not exhibit a pattern among groups of stations.

Eight parameters influenced the ordination (Figure 35). Temperatures and depths tended to be lower and color values higher at Station 102, which could be related to decreased thermal buffering in a shallower water column and leaching of chromophoric dissolved organic matter from nearby wetlands. Turbidity and concentrations of chlorophyll *a* tended to be lower at Stations 1, 39, 44, 53 and 55, which contributed to longer horizontal Secchi distances. At these stations, concentrations of nitrite plus nitrate tended to be higher and conductivities tended to be lower. Overall, the trends indicated that these stations were near sources of groundwater, which was confirmed by mapping approximate locations of major springs (Figure 36; Rosenau et al. 1977).

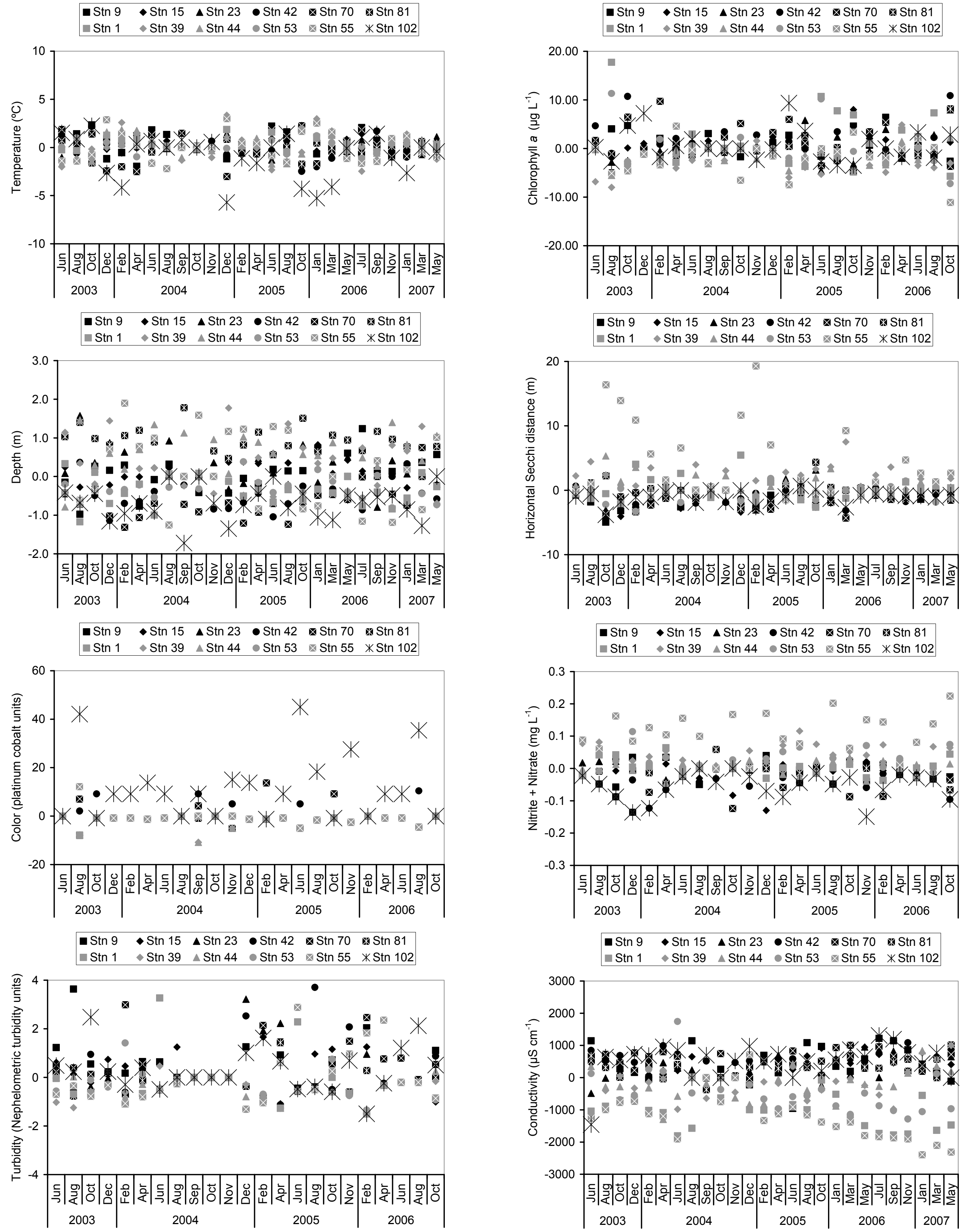


Figure 35. Differences from mean environmental conditions that exhibited a pattern among groups of stations.

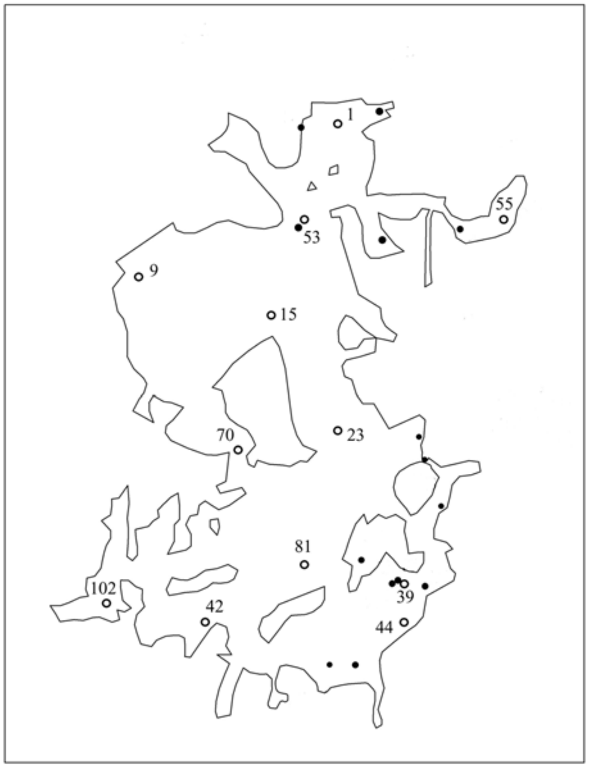


Figure 36. Approximate locations of major springs in Kings Bay (Rosenau et al. 1977). black circles = springs, open circles = stations for environmental sampling

Spatial and temporal variation – the effect of vegetation management

In Kings Bay, management of submersed aquatic vegetation in could yield both spatial and temporal patterns in coverage and biomass. Harvesting, skimming, “grubbing” and spraying are employed to maintain navigable waterways in most months.

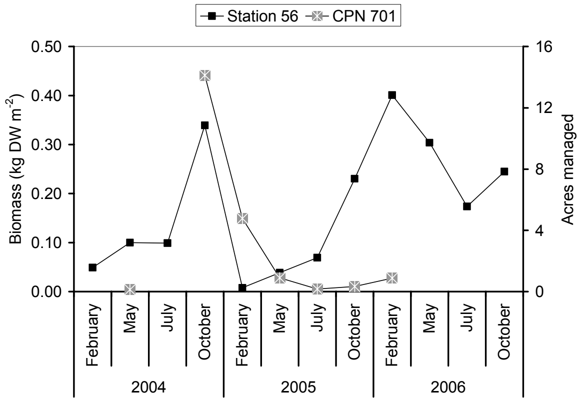
Without coordinates for management activities, the effect of vegetation management can only be estimated. In an effort to identify potential effects, data for management activities were obtained from Citrus County Aquatic Services.

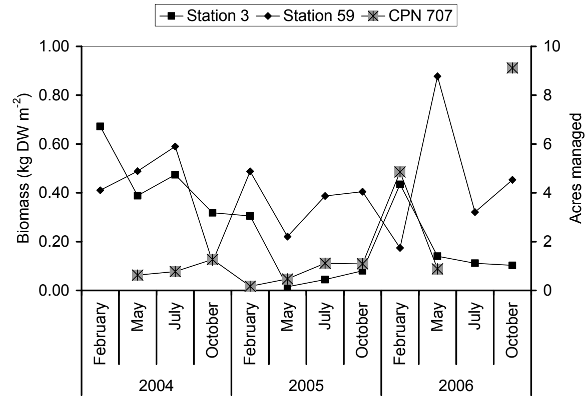
Stations sampled for vegetation were considered potentially affected if they were near one of the designated management areas (designated by a CPN number). Biomass of total submersed aquatic vegetation (SAV) was considered the most illustrative measure for the effects of vegetation management. All management methods, that is harvesting, skimming, “grubbing” or herbicide treatment, should reduce biomass. It is not clear that these methods would consistently affect percentage cover.

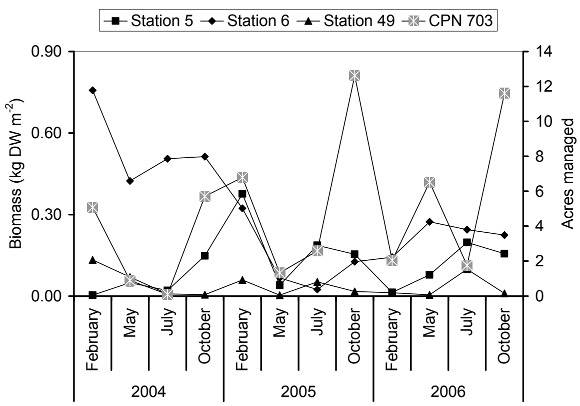
The intensity of management leading up to each sampling period was estimated by summing the number of acres managed in a given area since the previous sampling period. These estimates were not standardized to a given time interval. Thus, data for vegetation management comprised:

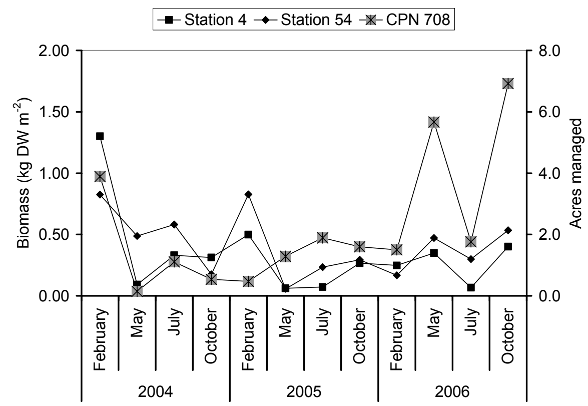
- the sum of all acres managed in November, December, January and February for comparison to February vegetation sampling;
- the sum of all acres managed in March, April and May for comparison to May vegetation sampling;
- the sum of all acres managed in June and July for comparison to July vegetation sampling; and
- the sum of all acres managed in August, September and October for comparison to October vegetation sampling.

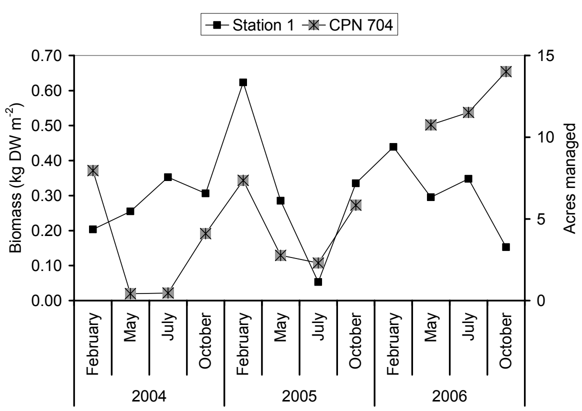
In general, management activity did not appear to affect the biomass of SAV at stations sampled during this study (Figure 37). Intense management activity in the periods before vegetation sampling seldom corresponded with obvious decreases in biomass. It appears that management activities typically do not take place at stations used in vegetation sampling.

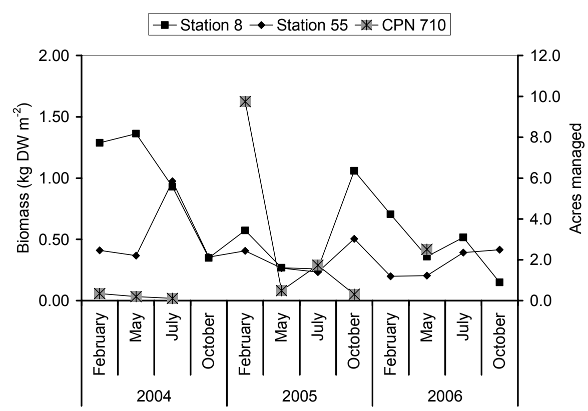

Station 56
CPN 701
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006

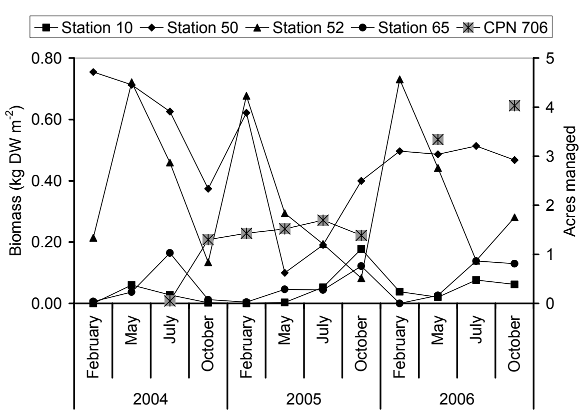

Station 3
Station 59
CPN 707
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006

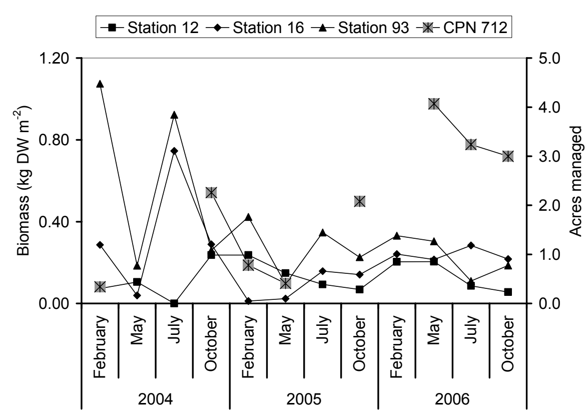

Station 5
Station 6
Station 49
CPN 703
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006


Station 4
Station 54
CPN 708
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006


Station 1
CPN 704
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006


Station 8
Station 55
CPN 710
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006


Station 10
Station 50
Station 52
Station 65
CPN 706
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006


Station 12
Station 16
Station 93
CPN 712
Biomass (kg DW m-2)
Acres managed
February May July October
2004 2005 2006

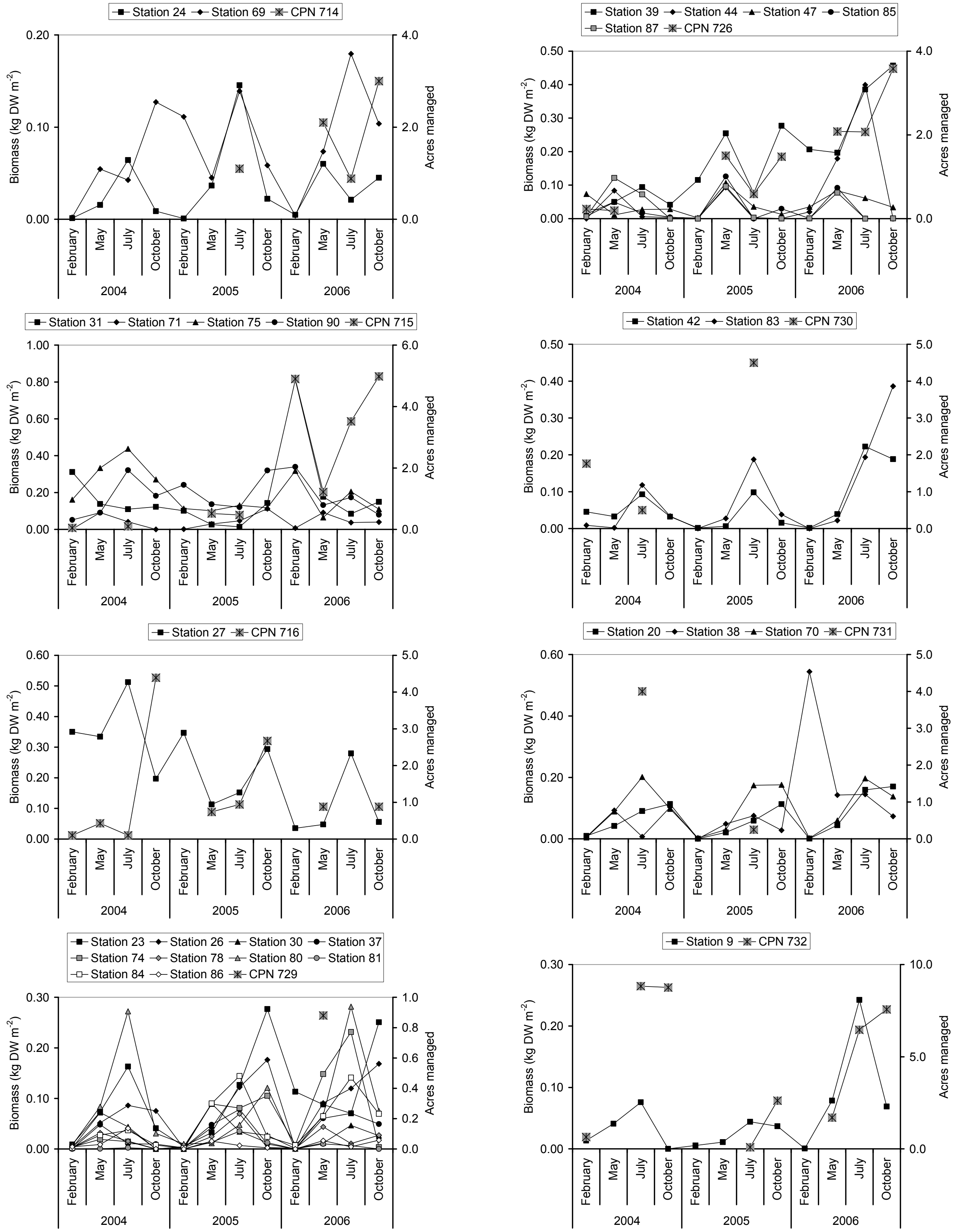


Figure 37. Biomass of total submersed aquatic vegetation and intensity of vegetation management. DW = dry weight; Station = vegetation sampling station; CPN = vegetation management area

Short-term temporal variation – the effect of hurricanes in 2004

Kings Bay was subjected to short-term pulses of high salinity water when Hurricanes Frances, Ivan and Jeanne passed nearby during September 2004. These hurricanes drove pulses of coastal water into the bay raising salinities to 6–20 ppt for two or three days (Figure 38; Frazer et al. 2006). Salinities during the pulses rose and fell with the tides as is typical in Kings Bay. Eventually, inputs of fresh water diluted salinities to typical background levels.

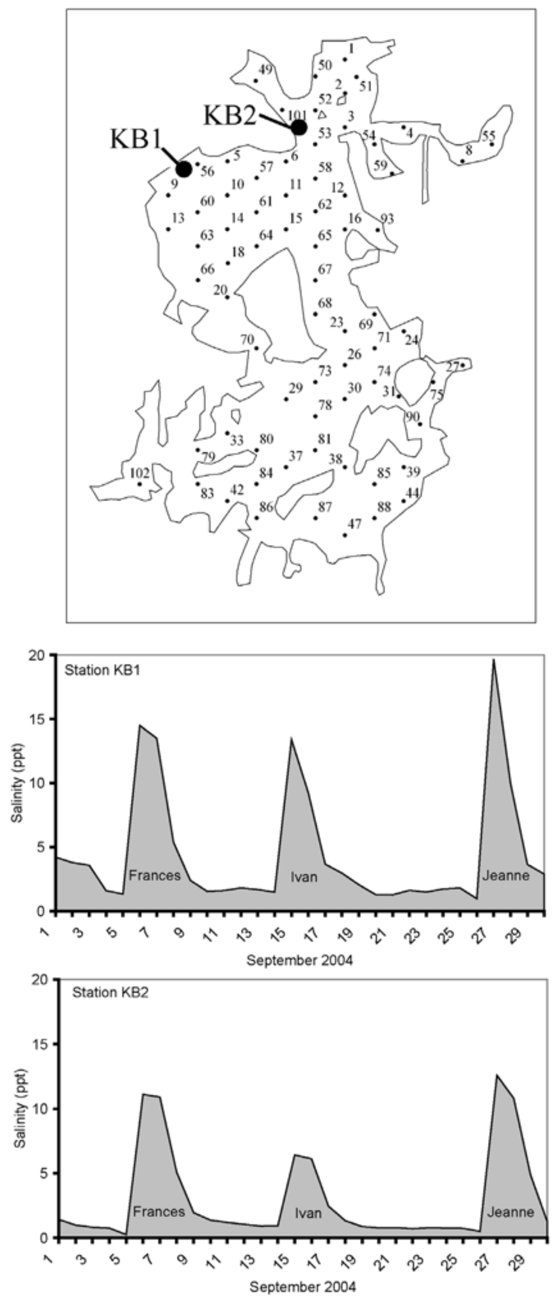


Figure 38. Salinity measured at two points in Kings Bay (KB1 and KB2).

The frequencies of occurrence of *Chara* spp., *Hydrilla verticillata*, *Myriophyllum spicatum*, *Najas guadalupensis*, *Potamogeton pusillus*, and filamentous algae decreased between July and October 2004 at some stations in Kings Bay (Figure 39). Frequencies of occurrence for these plants and algae decreased by 10–20% across the group of 43 stations, whereas, only the frequency of occurrence for *M. spicatum* decreased a similar amount across the group of 36 stations. Similar decreases did not occur in 2005 and 2006. In contrast, the frequency of occurrence for *Vallisneria americana* across both groups of stations in October 2004 was slightly higher than the frequency of occurrence in July 2004 and similar to values recorded in October 2005 and 2006 (Figure 39).

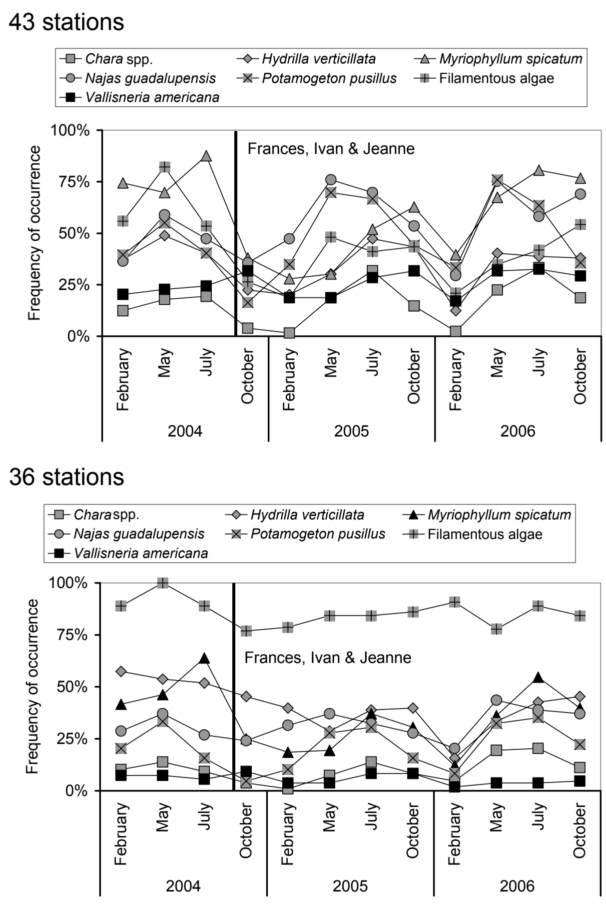
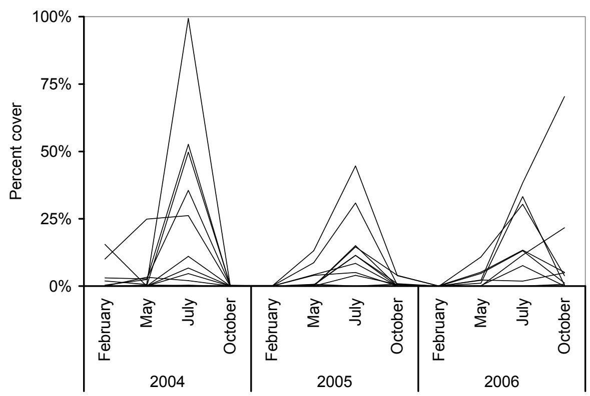


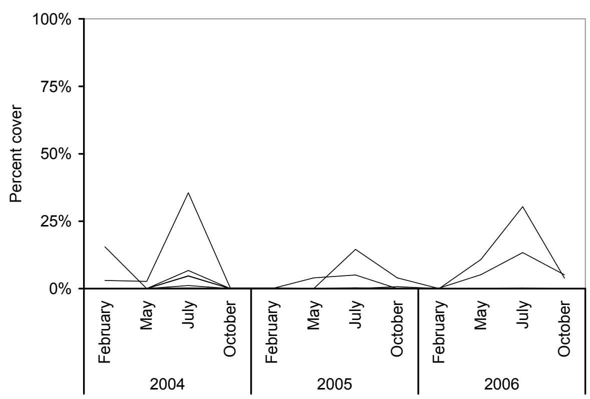
Figure 39. Frequency of occurrence, with the passage of three hurricanes indicated by the vertical line.

Coverage and biomass of most common taxa decreased in October 2004, and in many cases, these values were lower than those recorded in October 2005 or 2006 (Figures 40, 41). *Hydrilla verticillata*, *Myriophyllum spicatum*, *Najas guadalupensis* and *Potamogeton pusillus* decreased at 45%–90% of stations (Table 2). Coverage and biomass of filamentous algae decreased at approximately 60% of stations, except for coverage at stations in the group of 36, which only decreased at 20% of stations. In contrast, the coverage and biomass of *Vallisneria americana* in October 2004 decreased at less than 25% of stations in the group of 43 and at none of the stations in the group of 36.

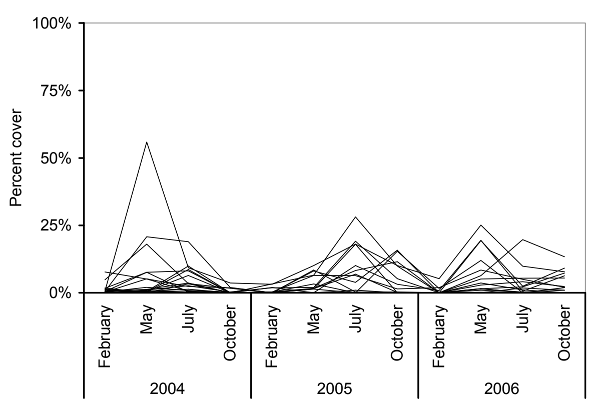
Chara spp. at 12 of 43 Stations



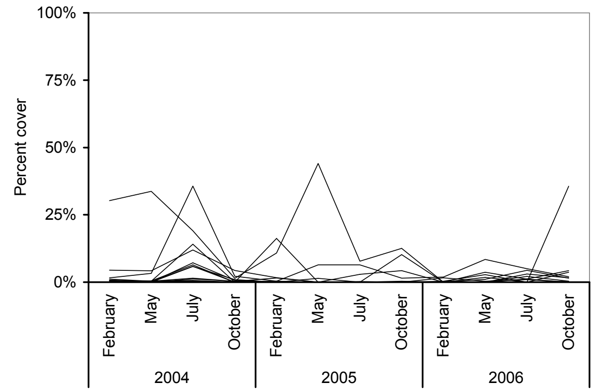
Chara spp. at 6 of 36 Stations



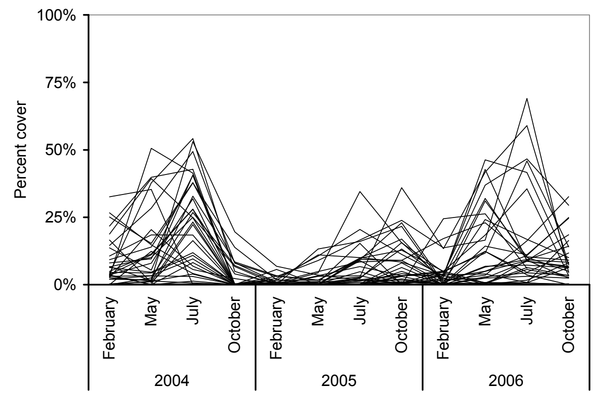
Hydrilla verticillata at 20 of 43 Stations



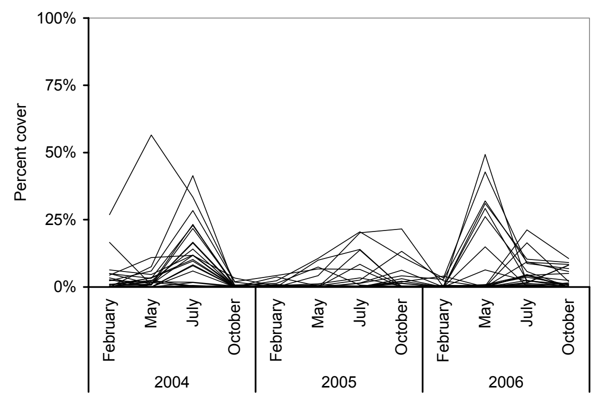
Hydrilla verticillata at 12 of 36 Stations



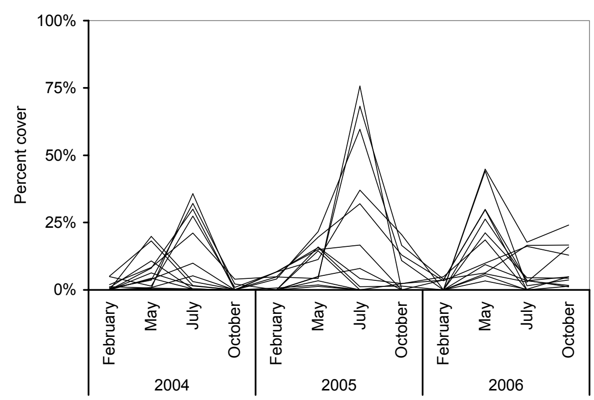
Myriophyllum spicatum at 34 of 43 Stations



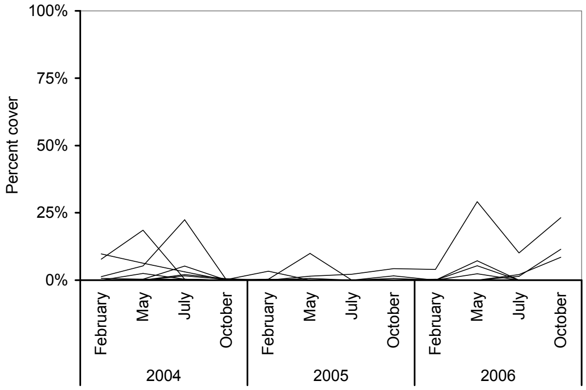
Myriophyllum spicatum at 26 of 36 Stations



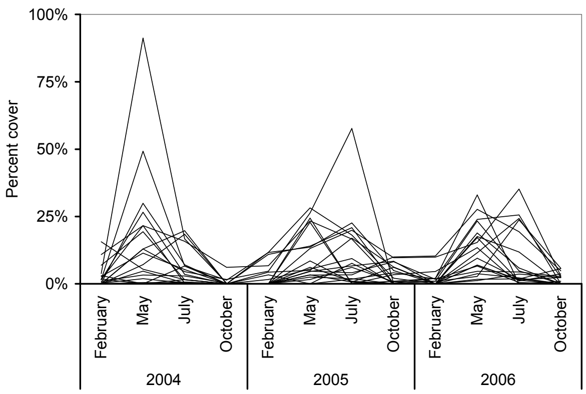
Najas guadalupensis at 14 of 43 Stations



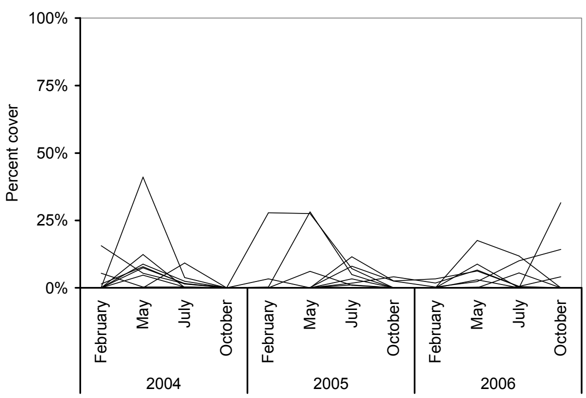
Najas guadalupensis at 9 of 36 Stations



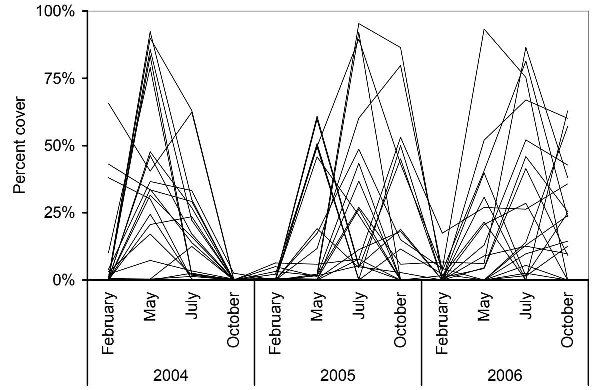
Potamogeton pusillus at 20 of 43 Stations



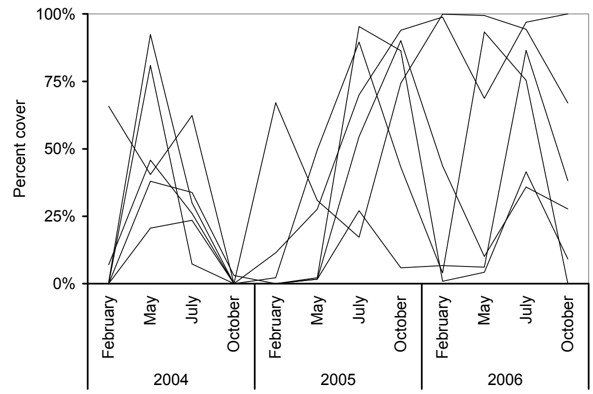
Potamogeton pusillus at 11 of 36 Stations



Filamentous algae at 20 of 43 Stations



Filamentous algae 6 of 36 Stations



Vallisneria americana at 3 of 43 Stations

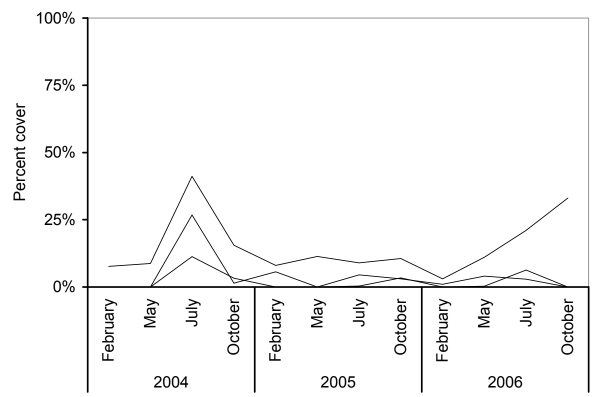
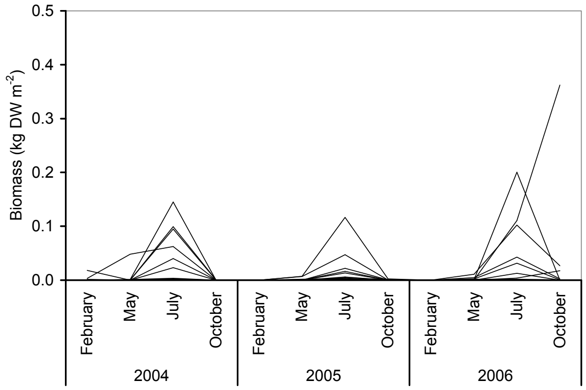
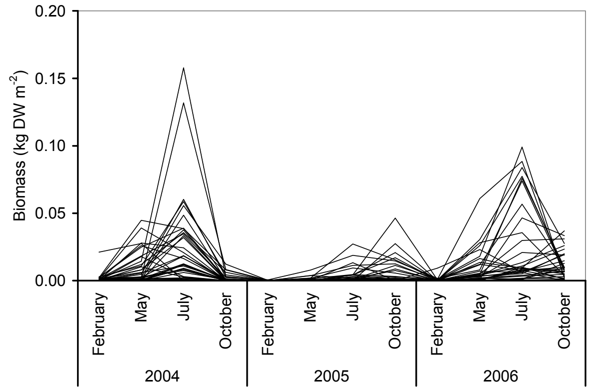


Figure 40. Back-transformed mean percent cover at stations where values decreased in October 2004.

Chara spp. at 12 of 43 Stations

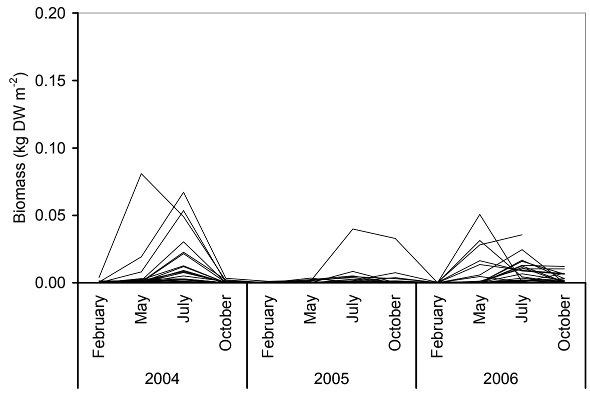


Myriophyllum spicatum at 38 of 43 Stations

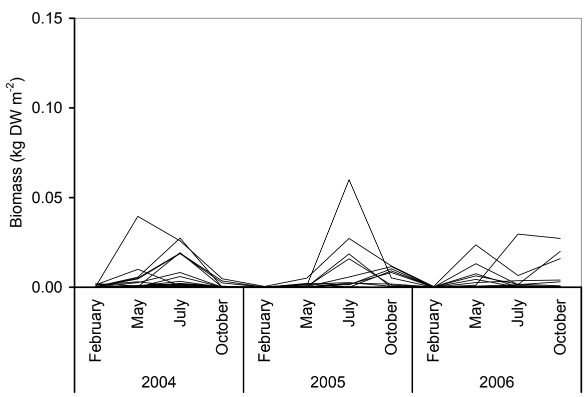


Chara spp. at 6 of 36 Stations

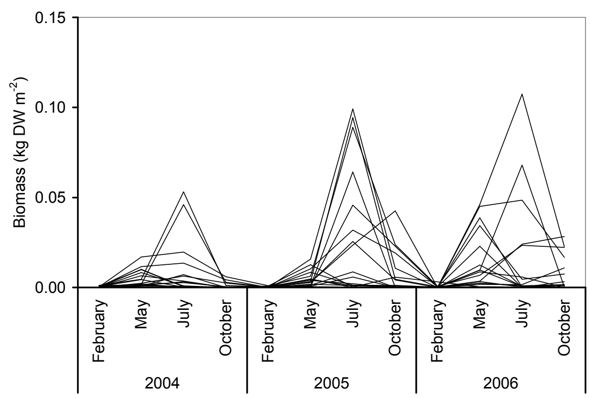
Myriophyllum spicatum at 27 of 36 Stations



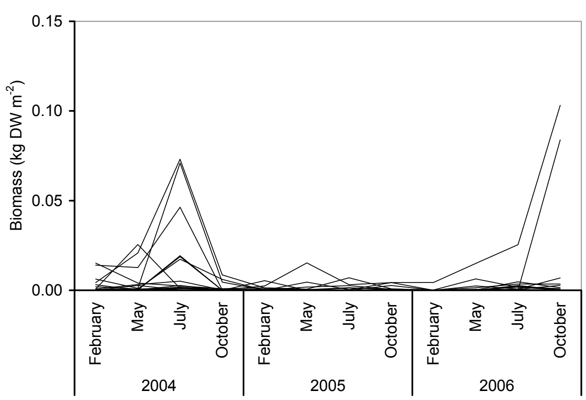
Hydrilla verticillata at 21 of 43 Stations



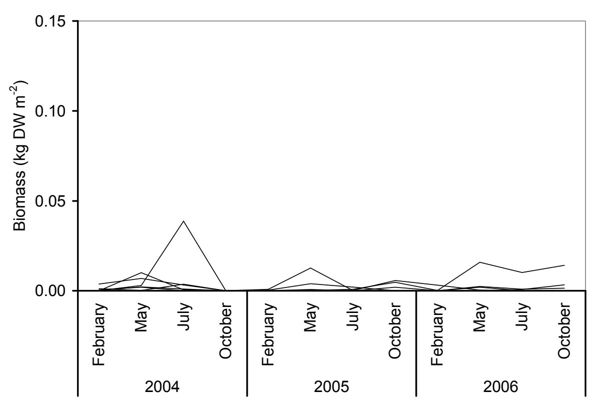
Najas guadalupensis at 20 of 43 Stations



Hydrilla verticillata at 15 of 36 Stations



Najas guadalupensis at 9 of 36 Stations



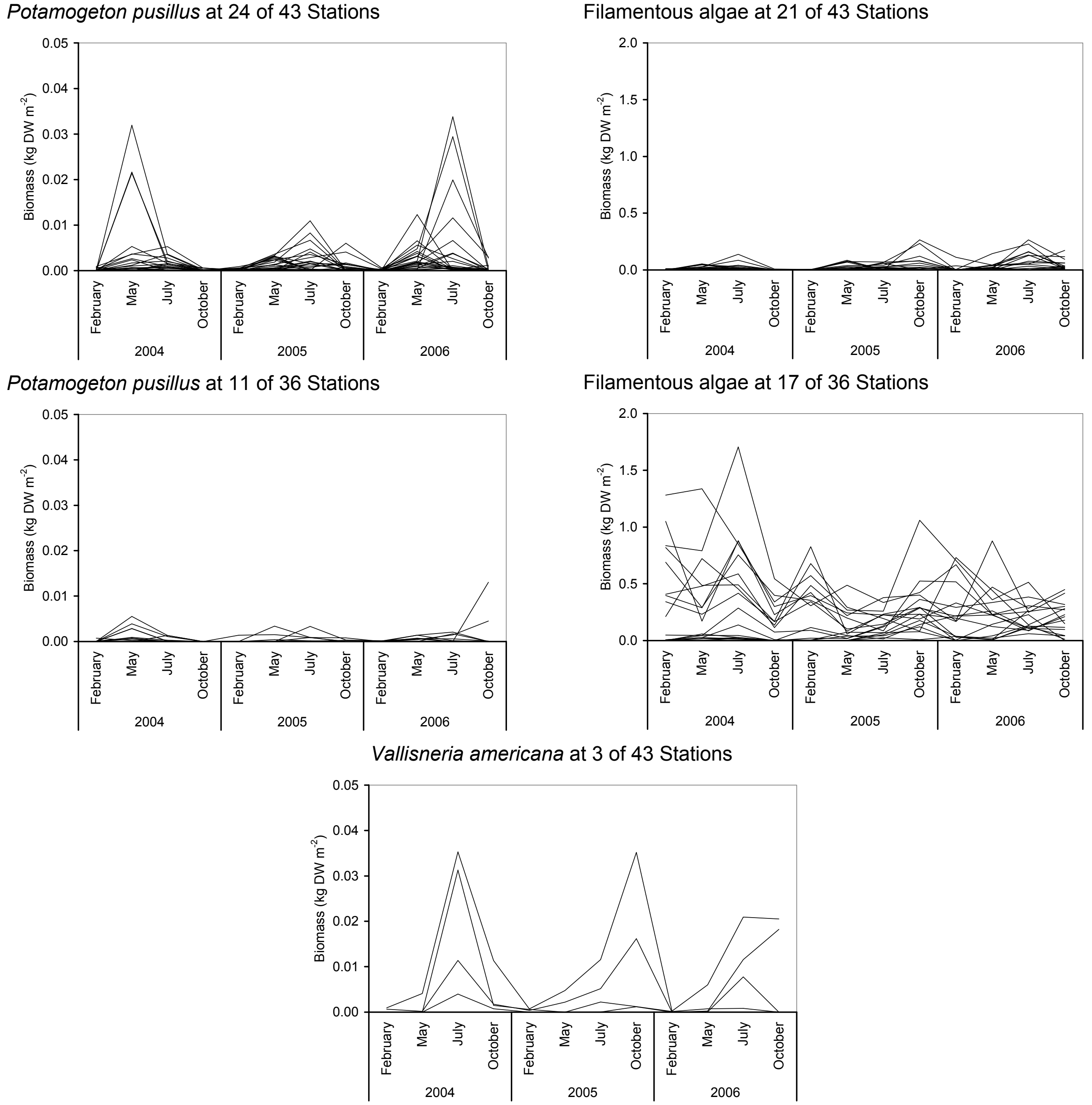


Figure 41. Back-transformed mean biomass at stations where values decreased in October 2004.

Table 2. Numbers of stations where cover and biomass decreased in October 2004 from a non-zero value in July 2004.

Taxon	Group of Stations	Percent cover		Biomass	
		July > 0	October decrease	July > 0	October decrease
Hydrilla verticillata	43	28	20	28	21
	36	26	12	26	15
Myriophyllum spicatum	43	42	34	42	38
	36	30	25	30	27
Najas guadalupensis	43	31	14	31	20
	36	18	9	18	9
Potamogeton pusillus	43	29	20	29	24
	36	13	11	13	11
Filamentous algae	43	34	20	34	21
	36	30	6	30	17
Vallisneria americana	43	19	3	19	4
	36	6	0	6	0

Decreases in coverage and biomass probably resulted from physiological stress created when pulses of high salinity water were driven into the bay by three hurricanes. Coverage or biomass of at least one taxon decreased at 68 of the 71 stations (Figure 42). Submersed aquatic vegetation was not recorded at Stations 12 and 102 in July 2004, so coverage and biomass could not decrease in October 2004. Three types of submersed aquatic vegetation were found at Station 49 in both July and October 2004. Coverage and biomass of filamentous algae increased (from < 1% to 2% and 0.0007 kg DW m^{-2} to 0.004 DW kg m^{-2}). *Hydrilla verticillata* coverage increased (from 5% to 6%), although its biomass decreased (from 0.002 kg DW m^{-2} to 0.0009 kg DW m^{-2}). *Ceratophyllum demersum* coverage and biomass decreased (from 10% to 3% and 0.005 kg DW m^{-2} to 0.0003 kg DW m^{-2}). The decreases in coverage and biomass of *C. demersum* and biomass of *H. verticillata* indicated an effect similar to other stations. In addition, the presence of groundwater from springs may have provided some relief for *H. verticillata* and filamentous algae at stations in the group of 36.

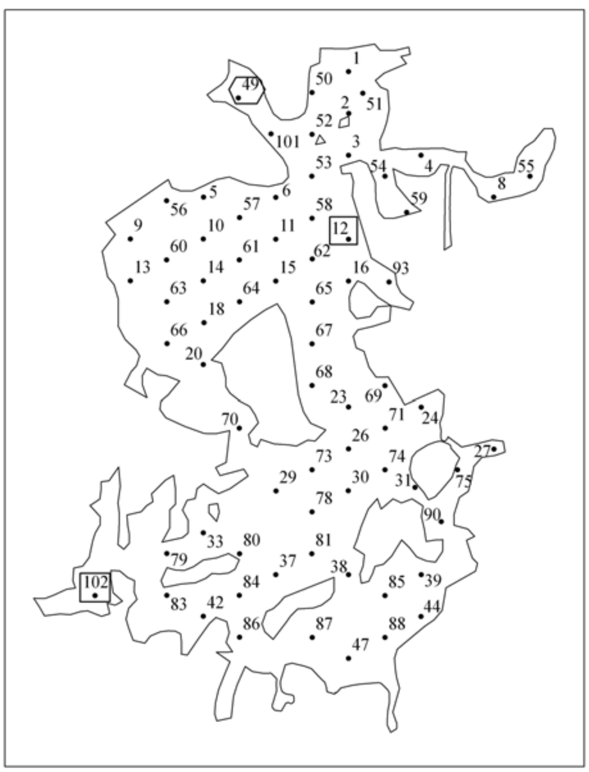


Figure 42. Stations where coverage or biomass did not decrease in October 2004. squares = stations without common taxa in July 2004, hexagon= station without a decrease

Repeated temporal variation – the annual effect of manatees

Manatees used Kings Bay throughout this study; however, mean numbers of adult manatees in the bay more than doubled between November and March in all three years (Figure 43; data from the Chassahowitzka National Wildlife Refuge). During these times, manatees used the bay as a warm-water refuge, and they have been reported to graze on submersed aquatic vegetation while seeking refuge (Hauxwell et al. 2004a, b).

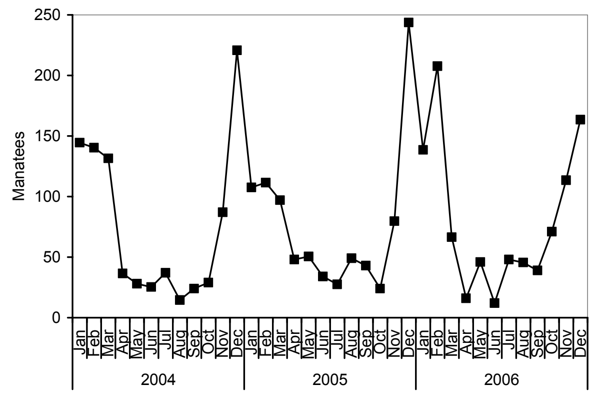
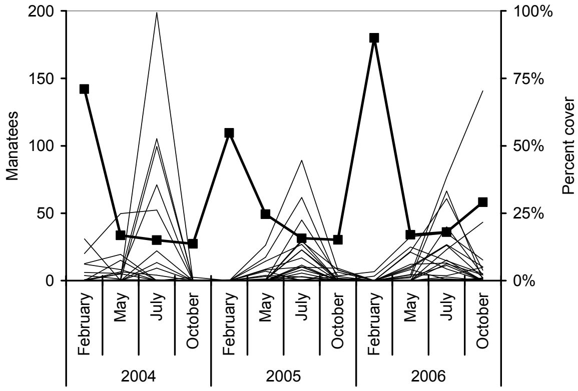


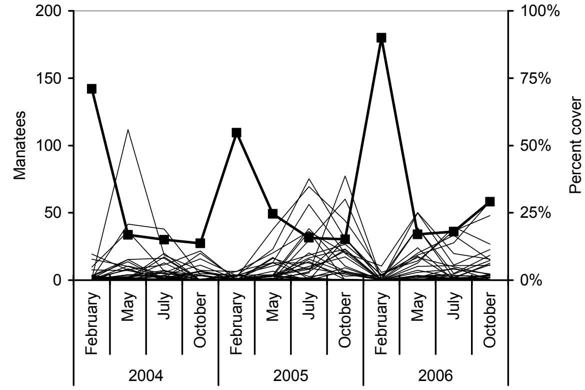
Figure 43. Mean numbers of adult manatees in Kings Bay.

Back-transformed mean percent cover and back-transformed mean biomass of common taxa typically were inversely related to numbers of adult manatees averaged over the month before and the month of sampling (Figures 44, 45). At most stations, coverage and biomass for all taxa were low when manatee numbers were high, except for filamentous algae and *Zannichellia palustris*. Filamentous algae appeared to be less affected by manatees, especially at stations in the group of 36, and *Z. palustris* coverage and biomass tended to increase in February during each year it was present. Random sampling of "patches" may have led to increases in coverage of various taxa at a few stations in February 2004, 2005 or 2006. In general, increased coverage did not translate into obvious increases in biomass, which suggested that the plants persisted with decreased standing crops due to grazing.

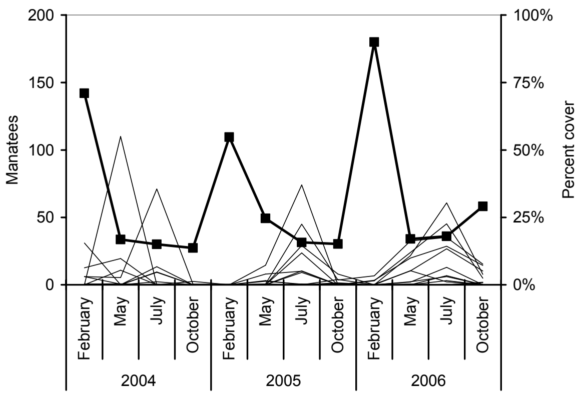
Chara spp. at 43 Stations



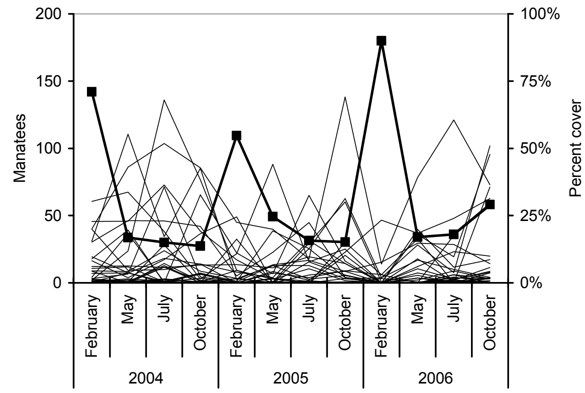
Hydrilla verticillata at 43 Stations



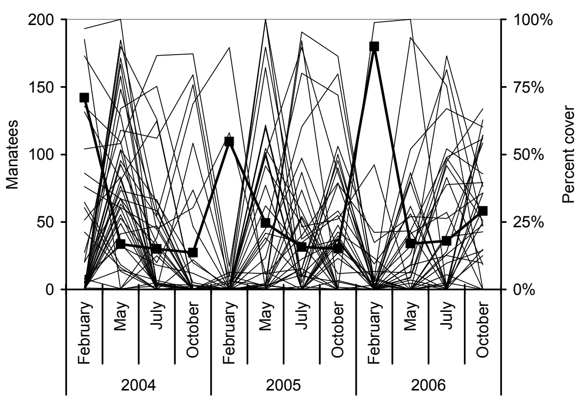
Chara spp. at 36 Stations



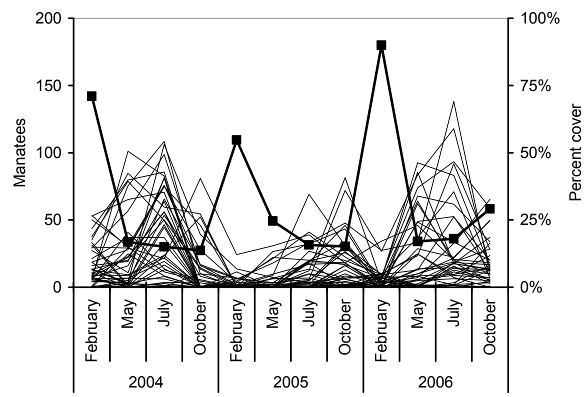
Hydrilla verticillata at 36 Stations



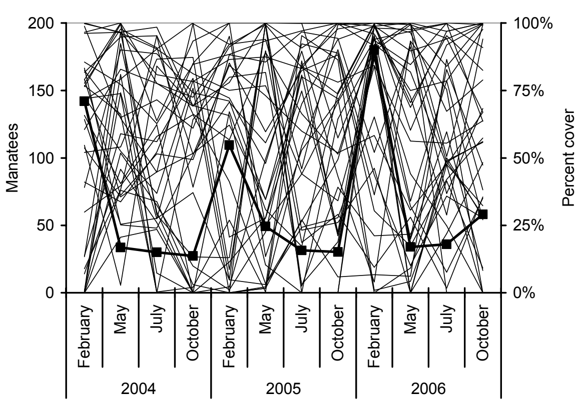
Filamentous algae at 43 Stations



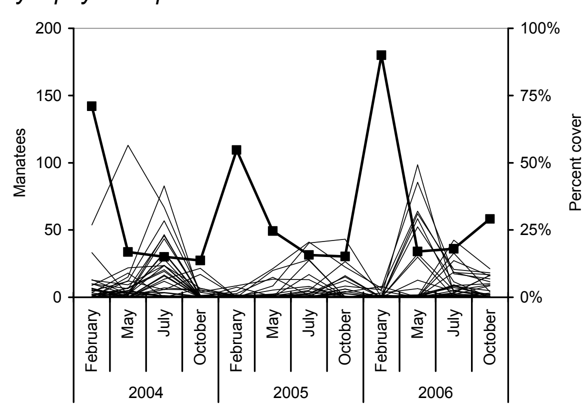
Myriophyllum spicatum at 43 Stations



Filamentous algae at 36 Stations



Myriophyllum spicatum at 36 Stations



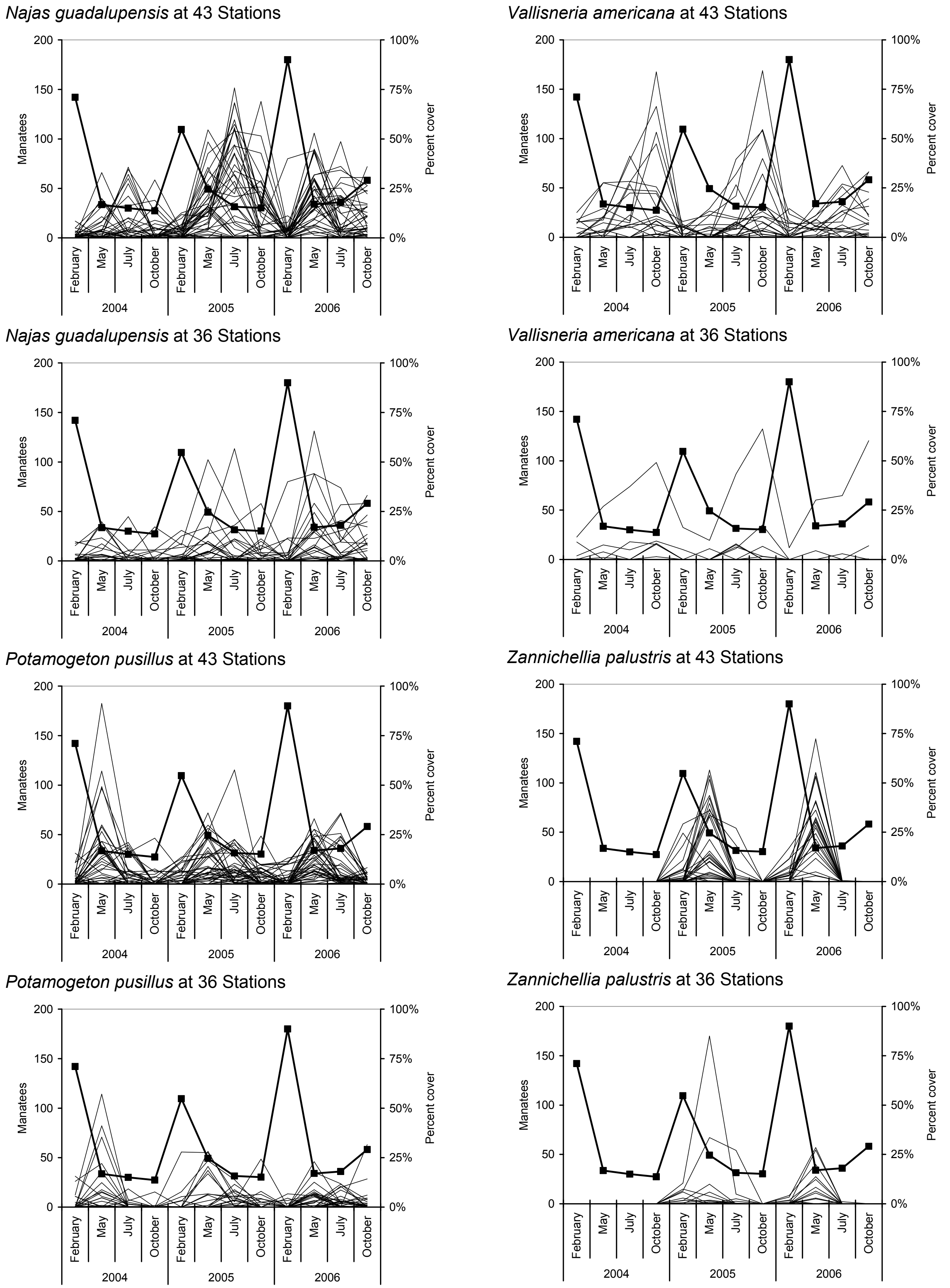
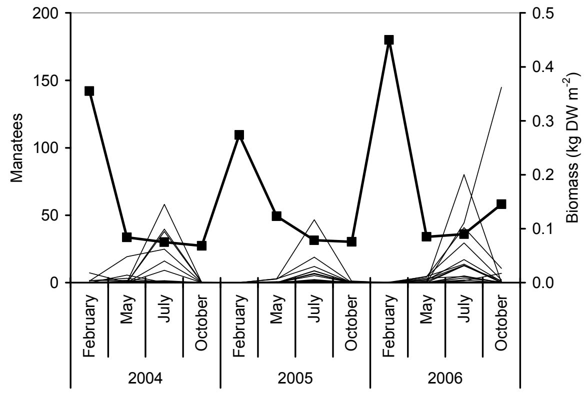
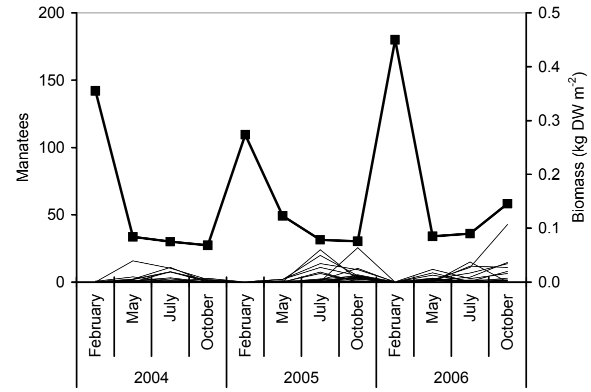


Figure 44. Mean number of adult manatees in Kings Bay and back-transformed mean percent cover. black squares = mean of counts of manatees during the month before and the month of vegetation sampling

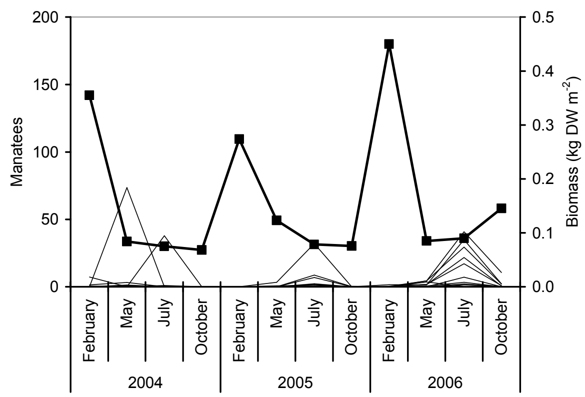
Chara spp. at 43 Stations



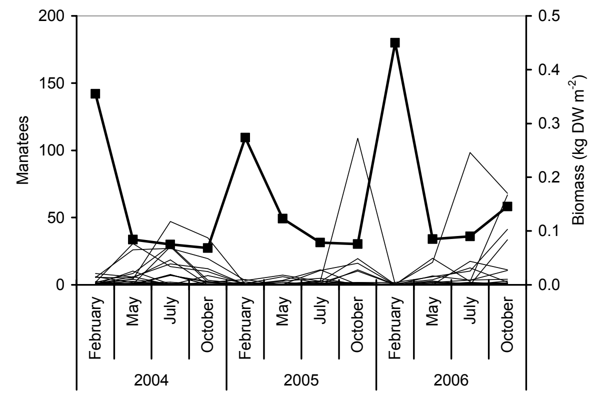
Hydrilla verticillata at 43 Stations



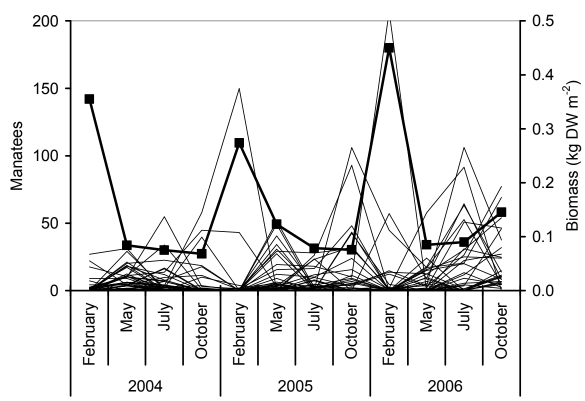
Chara spp. at 36 Stations



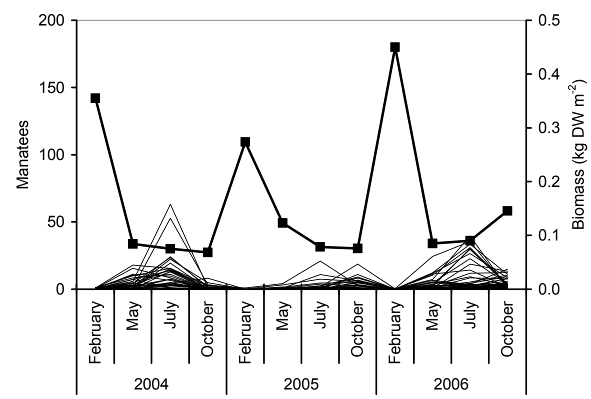
Hydrilla verticillata at 36 Stations



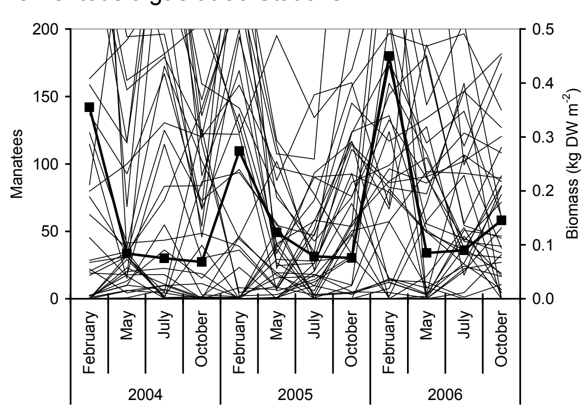
Filamentous algae at 43 Stations



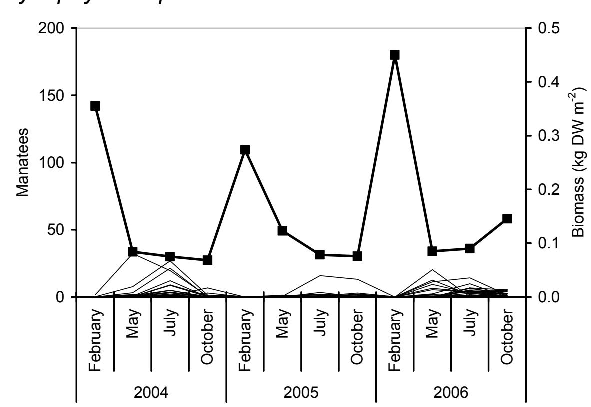
Myriophyllum spicatum at 43 Stations



Filamentous algae at 36 Stations



Myriophyllum spicatum at 36 Stations



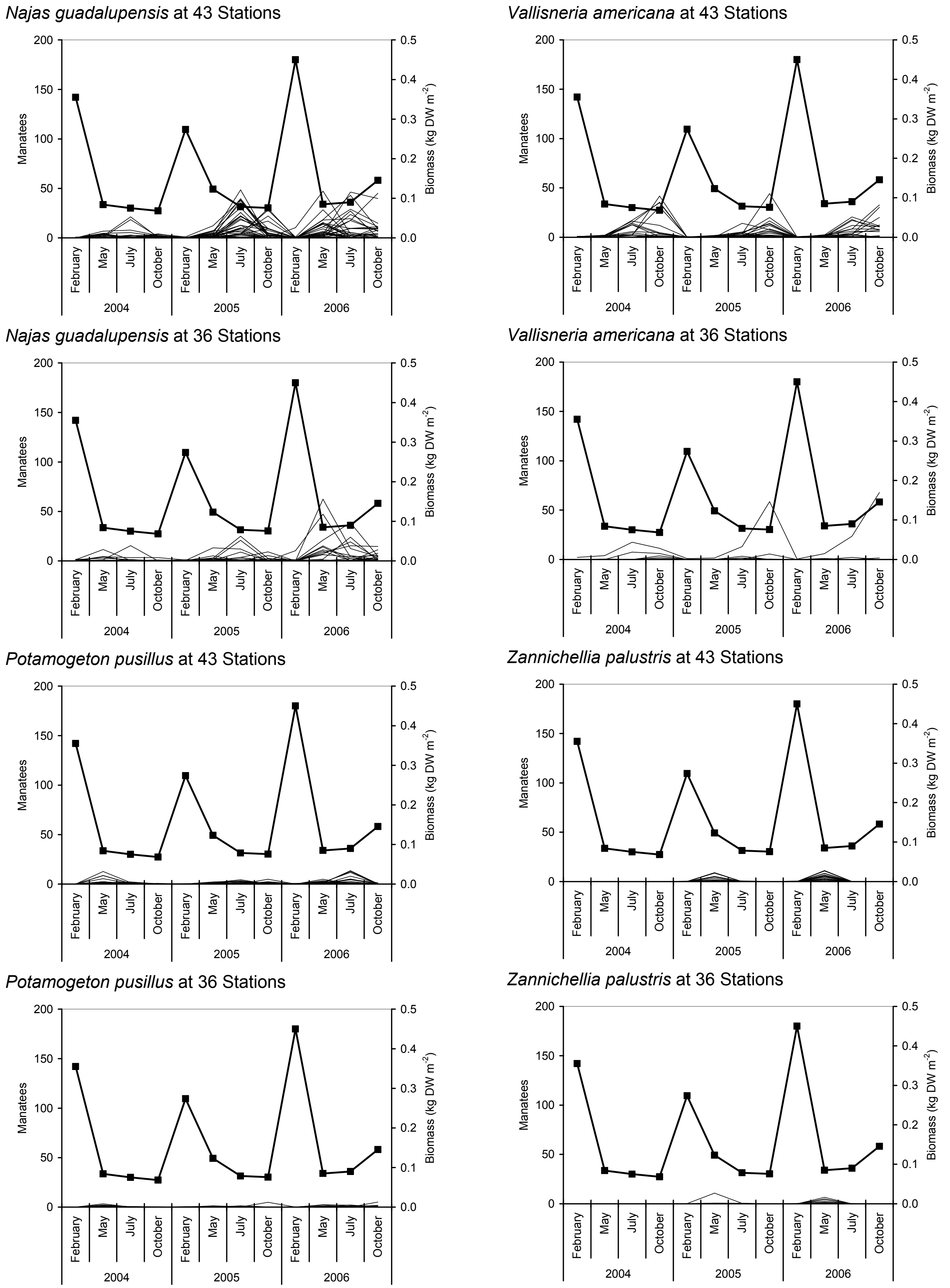
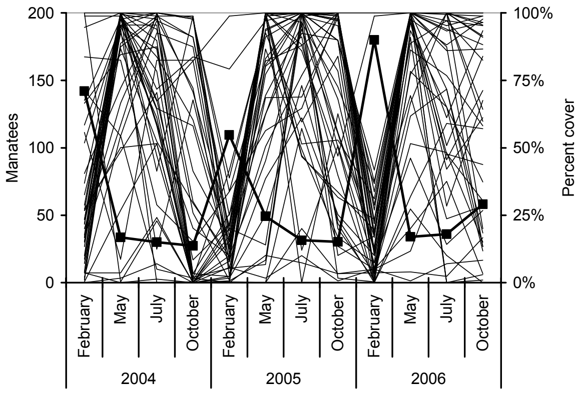


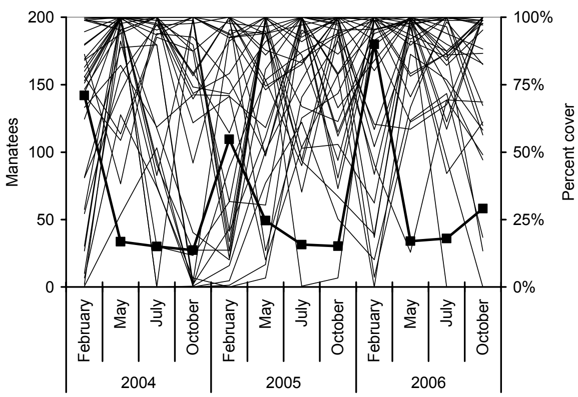
Figure 45. Mean number of adult manatees in Kings Bay and back-transformed mean percent cover.
black squares = mean of counts of manatees during the month before and the month of vegetation sampling

Overall, manatees affected the standing crops of most plants and algae in Kings Bay. The impact was clearest at stations in the group of 43, which had less coverage of filamentous algae. Decreased mean percent cover of total submersed aquatic vegetation and increased mean percent cover of bare substratum in February sampling periods illustrated the cumulative impact of grazing by manatees (Figure 46).

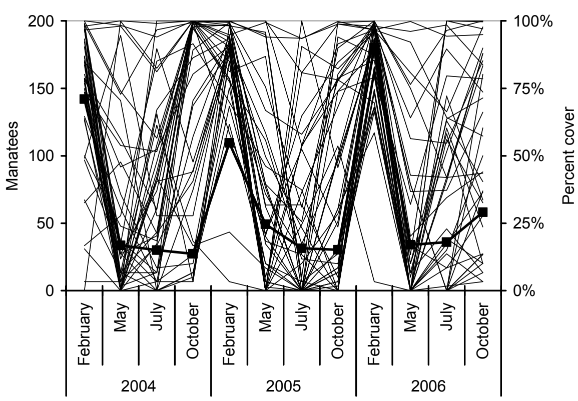
SAV at 43 Stations



SAV at 36 Stations



Bare substratum at 43 Stations



Bare substratum at 36 Stations

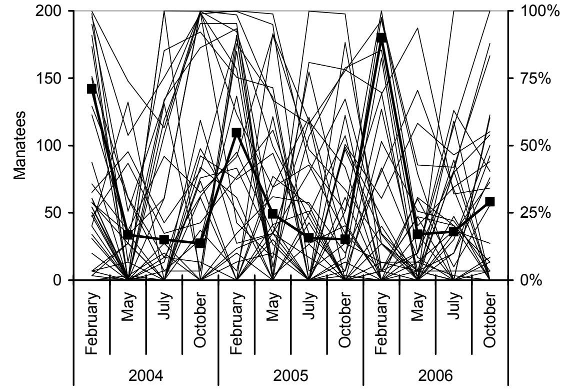


Figure 46. Mean number of adult manatees in Kings Bay and back-transformed mean percent cover. black squares = mean of counts of manatees during the month before and the month of vegetation sampling

CONCLUSIONS

The biomass of vegetation in Kings Bay has decreased and remained relatively stable since the early 1990s (Figure 47). After 1994 and throughout this study, samples typically yielded less than 5 kg wet weight m^{-2}. In contrast, the mean biomass of submersed aquatic vegetation has declined from 4.0 to 1.0 kg wet weight m^{-2} in the Weeki Wachee River, 0.7 to 0.2 kg wet weight m^{-2} in the Homosassa River, and 1.4 to 0.9 kg wet weight m^{-2} in the Chassahowitzka River since 1998–2000 (Frazer et al. 2006). These changes may be due to increased periphyton loads caused by increasing concentrations of nutrients, especially nitrates and soluble reactive phosphorus (Frazer et al. 2006).

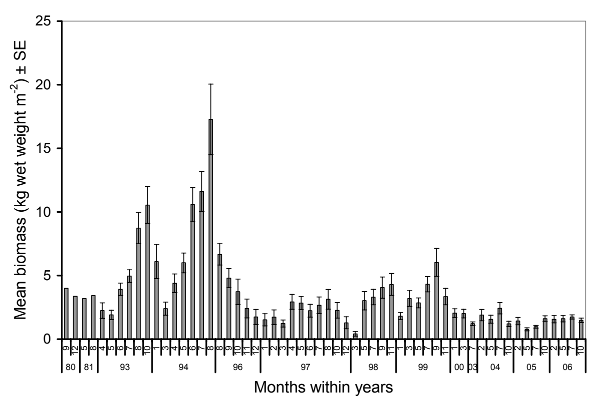


Figure 47. Biomass of submersed aquatic vegetation (Haller, et al. 1983, Terrell and Canfield 1996, Mataraza et al. 1999, Hoyer et al. 2001, and this report).

Causes of the decrease and stability in biomass of submersed aquatic vegetation in Kings Bay remain uncertain due to gaps in data collection and differences in survey methods. However, water quality may influence the coverage and biomass of vegetation in Kings Bay and the Homosassa, Chassahowitzka and Weeki Wachee Rivers (Table 3; Frazer et al. 2006). Maximum mean concentrations of nitrate plus nitrite (NOx) and total nitrogen in Kings Bay were 45%–75% lower than maximum values recorded in the Weeki Wachee, Chassahowitzka and Homosassa Rivers during 2006. Maximum concentrations of soluble reactive phosphorus and total phosphorus were more similar across the four systems. Properly designed studies could characterize the relationships among coverage and biomass of vegetation and concentrations of different macronutrients.

Table 3. Maximum concentrations of nutrients. KB = Kings Bay[1], Ho = Homosassa[2], Ch = Chassahowitzka[2], WW = Weeki Wachee[2], NOx = nitrate plus nitrite, TN = total nitrogen, SRP = soluble reactive phosphorus, TP = total phosphorus

Nutrient	Maximum concentration (µg L^{-1})			
	KB	Ho	Ch	WW
NOx	187	507	549	746
TN	345	673	633	813
SRP	25	22	16	21
TP	32	39	39	25

[1] Data from Southwest Florida Water Management District
[2] Data from Frazer et al. 2006

Data collected during this study highlighted a consistent spatial pattern in the distribution of submersed aquatic vegetation. A group of 35 stations in the southern and western portions of the bay yielded relatively diverse vegetation; a group of 28 stations was characterized by filamentous algae and, to some extent, *Hydrilla verticillata*; and 8 stations yielded an intermediate mix of vegetation. This spatial pattern did not correlate with sediment depth or management of aquatic vegetation, but the pattern was related to water quality parameters. In particular, filamentous algae and *H. verticillata* tended to dominate the vegetation near springs where conductivities were higher, concentrations of nitrate plus nitrite (NOx) were higher, concentrations of chlorophyll *a* were lower, turbidities were lower, and horizontal Secchi distances were longer. Interpreting the causal relationships underpinning this correlation requires diagnostic studies that disentangle the influences of covarying parameters.

Two temporal patterns in percentage cover and biomass of some taxa were discerned during this study. Decreases in October 2004 were not seen in October 2005 or 2006, and repeated decreases were recorded in all February sampling periods. Neither temporal pattern appeared to be related to management of aquatic vegetation. Overall, it appeared that harvesting, skimming, “grubbing” and spraying did not affect stations sampled during this study. Decreases in vegetation at most stations in October 2004 followed the passage of three hurricanes during September 2004. Higher salinity water was pushed into Kings Bay, and it appeared to stress submersed aquatic vegetation other than *Vallisneria americana*, which may have experienced a release from competition with *Hydrilla verticillata* and *Myriophyllum spicatum*, and filamentous algae, which may have been bathed in freshwater from nearby springs. Decreases in percentage cover and biomass of most taxa in February of all years accompanied increases in the numbers of adult manatees seen in the bay and an increased likelihood of grazing. In contrast to other taxa, *Zannichellia palustris* first appeared in February 2005, and its cover and biomass peaked in May of 2005 and 2006 in a manner consistent with a seasonal growth cycle. Furthermore, the coverage and biomass of filamentous algae changed at some stations, but it remained dominant at most stations in the group of 28. Apparently, manatees grazed less on filamentous algae, especially where it was dominant.

Managers attempting to restore vegetation in Kings Bay should consider short-term changes in salinity caused by storms and increased grazing by manatees during winter months. Vegetation should be established before hurricane seasons, and manatees may need to be excluded from recently planted sites. In addition, removal of competing plants and algae may promote the growth of *Vallisneria americana*, as was observed in October 2004. Diagnostic studies would provide valuable assessments of these management options.

Storms and grazing by manatees did not appear to “reset” the submersed aquatic vegetation assemblage in Kings Bay. High coverage and biomass of filamentous algae and, to some extent, *Hydrilla verticillata* persisted near springs. In-depth explanation of this persistent spatial pattern requires diagnostic studies that isolate and examine the effects of potential causal factors.

ACKNOWLEDGMENTS

We thank the staff and students of the UF/IFAS, Department of Fisheries and Aquatic Sciences for assistance in the field and lab. Joyce Kleen and James Kraus of the USFWS, Crystal River National Wildlife Refuge facilitated the project and provided data. The Citrus County Aquatic Services Division went beyond the call of duty to provide data. We thank Veronica Craw and Gary Williams of the Southwest Florida Water Management District for their guidance and assistance as project managers, and dedicate this work to the memory of Amy Remley. Funding was provided through the Surface Water Improvement and Management (SWIM) program of the Southwest Florida Water Management District.

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APPENDIX A: COORDINATES FOR SAMPLING STATIONS

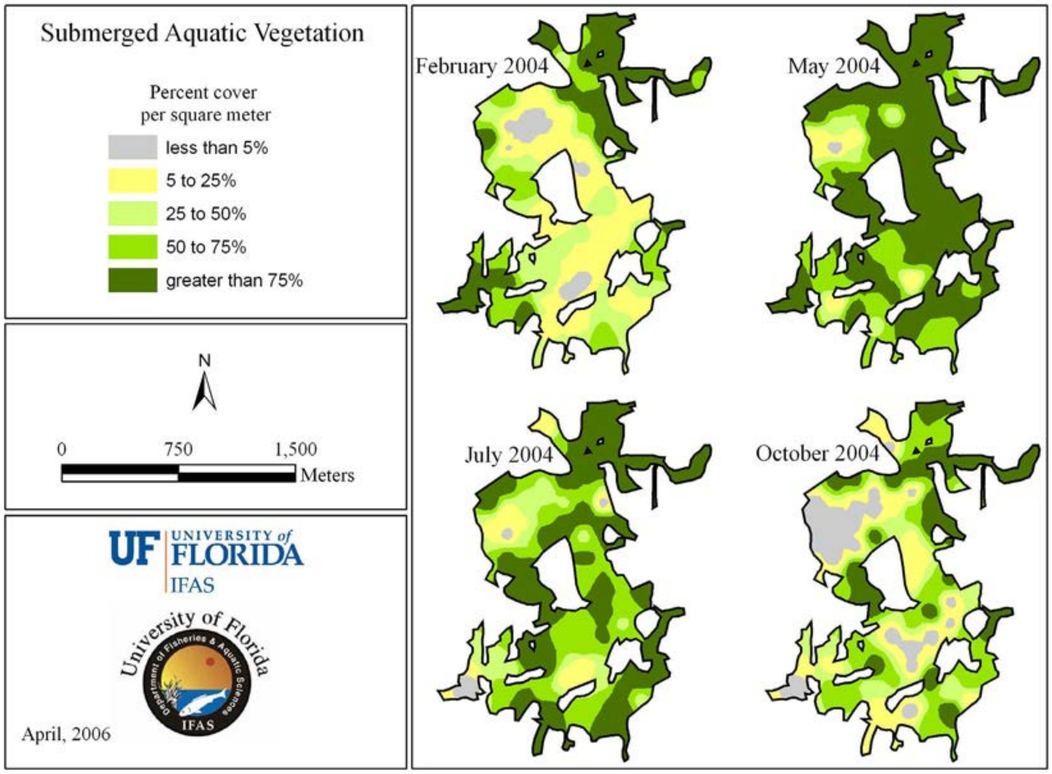
Station	Latitude	Longitude	Station	Latitude	Longitude
1	28.89814	-82.59752	54	28.89473	-82.59611
2	28.89677	-82.59749	55	28.89479	-82.59072
3	28.89540	-82.59747	56	28.89383	-82.60420
4	28.89543	-82.59478	57	28.89331	-82.60149
5	28.89396	-82.60284	58	28.89332	-82.59879
6	28.89399	-82.60015	59	28.89356	-82.59528
8	28.89409	-82.59206	60	28.89189	-82.60417
9	28.89256	-82.60553	61	28.89192	-82.60147
10	28.89259	-82.60282	62	28.89199	-82.59877
11	28.89262	-82.60013	63	28.89052	-82.60415
12	28.89265	-82.59743	64	28.89055	-82.60145
13	28.89119	-82.60551	65	28.89058	-82.59875
14	28.89122	-82.60280	66	28.88915	-82.60412
15	28.89125	-82.60011	67	28.88921	-82.59873
16	28.89128	-82.59741	68	28.88784	-82.59871
18	28.88985	-82.60275	69	28.88787	-82.59600
20	28.88848	-82.60276	70	28.88643	-82.60139
23	28.88717	-82.59735	71	28.88650	-82.59598
24	28.88720	-82.59465	73	28.88510	-82.59867
26	28.88580	-82.59733	74	28.88513	-82.59596
27	28.88586	-82.59193	75	28.88516	-82.59327
29	28.88439	-82.60000	78	28.88372	-82.59865
30	28.88443	-82.59731	79	28.88229	-82.60402
31	28.88457	-82.59483	80	28.88232	-82.60132
33	28.88299	-82.60268	81	28.88235	-82.59863
37	28.88165	-82.59996	83	28.88092	-82.60400
38	28.88168	-82.59726	84	28.88095	-82.60130
39	28.88171	-82.59457	85	28.88101	-82.59590
42	28.88025	-82.60263	86	28.87958	-82.60128
44	28.88034	-82.59455	87	28.87961	-82.59858
47	28.87894	-82.59722	88	28.87964	-82.59588
49	28.89723	-82.60159	90	28.88346	-82.59385
50	28.89744	-82.59886	93	28.89127	-82.59590
51	28.89744	-82.59698	101	28.89607	-82.60036
52	28.89607	-82.59884	102	28.88088	-82.60666
53	28.89470	-82.59882			

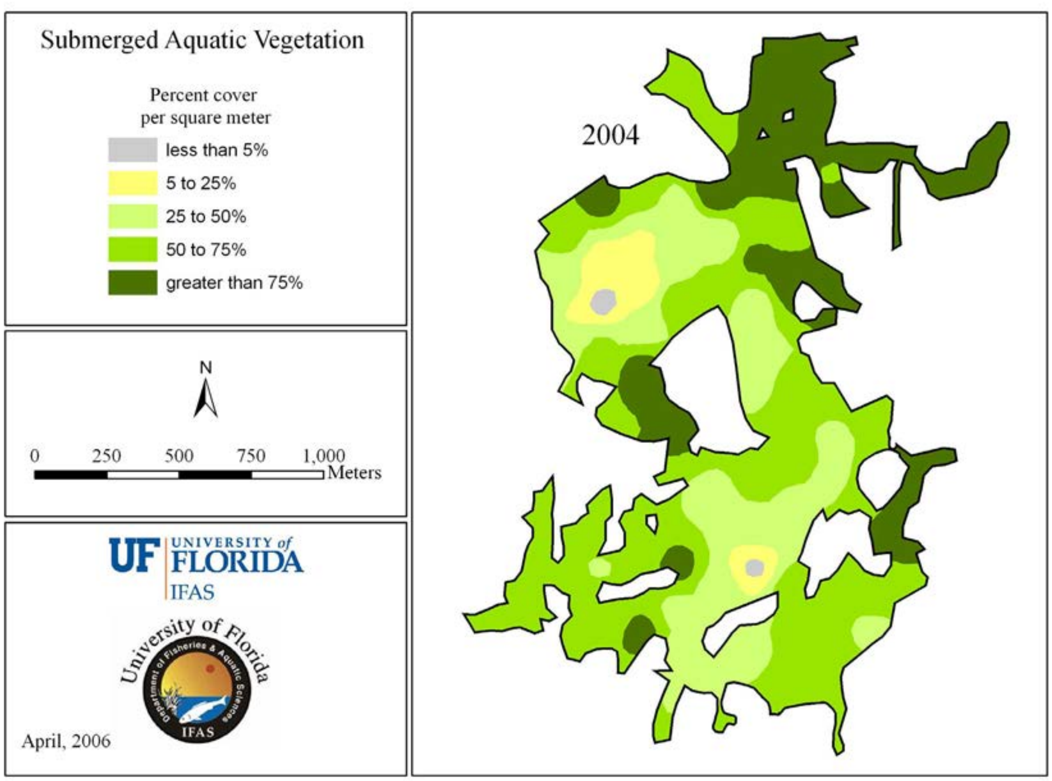
APPENDIX B: WET WEIGHT TO DRY WEIGHT RATIOS

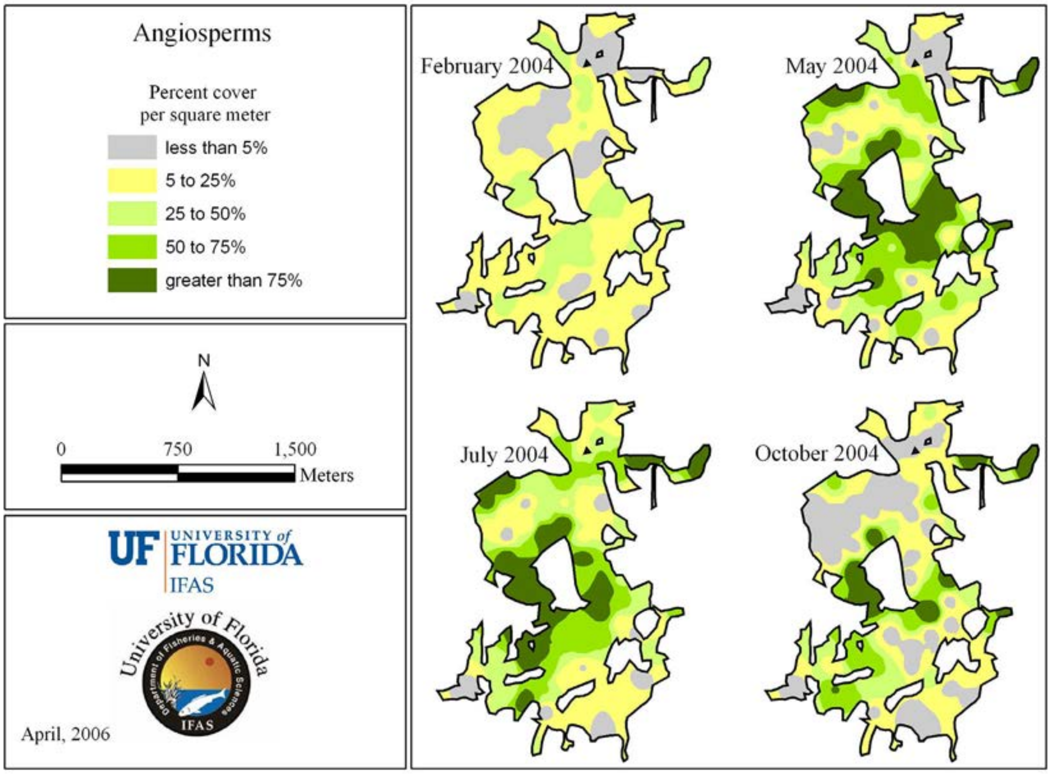
Category	Wet weight to dry weight ratio[1]			Number of samples
	Mean	95% confidence limit		
		Lower	Upper	
Submersed aquatic vegetation	10.74	10.51	10.97	1092
Angiosperms	12.47	12.26	12.67	762
Macroalgae	6.75	6.47	7.03	330
Ceratophyllum demersum	12.05	11.06	13.03	23
Chara spp.	7.70	7.14	8.26	49
Filamentous algae	6.58	6.27	6.90	281
Hydrilla verticillata	12.44	12.01	12.87	174
Myriophyllum spicatum	13.10	12.75	13.46	216
Najas guadalupensis	12.40	11.89	12.91	153
Potamogeton pectinatus	10.71	8.91	12.52	8
Potamogeton pusillus	10.58	10.24	10.91	120
Ruppia maritima	10.63	9.42	11.83	11
Vallisneria americana	15.04	14.39	15.70	57

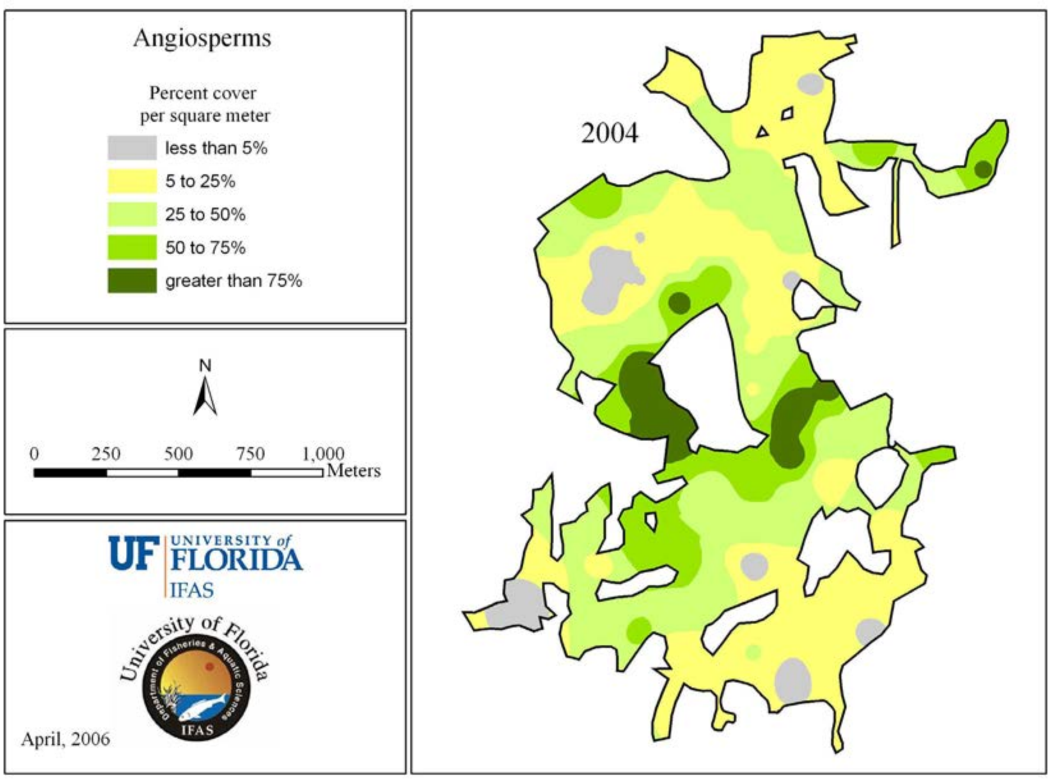
[1] Wet weights can be estimated by multiplying dry weights by the appropriate ratio. All ratios were determined from data collected in February and May 2004.

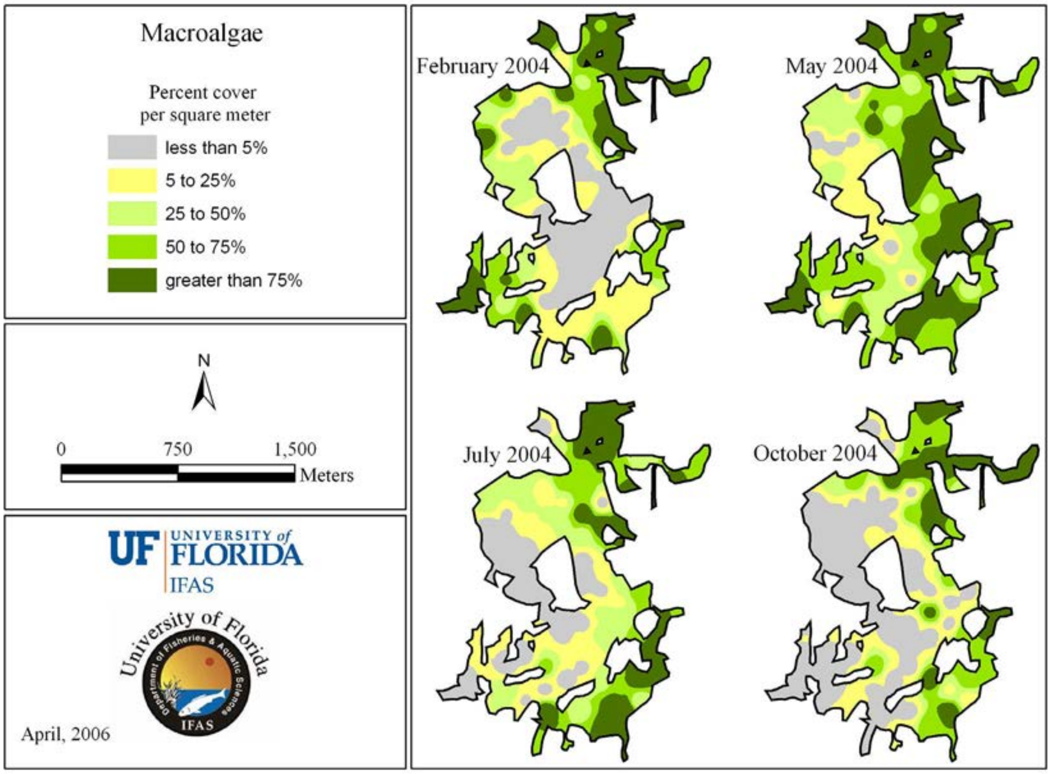
APPENDIX C: MAPS OF INTERPOLATED PERCENT COVER DATA BASED ON BRAUN–BLANQUET CATEGORIES (BRAUN–BLANQUET 1965)

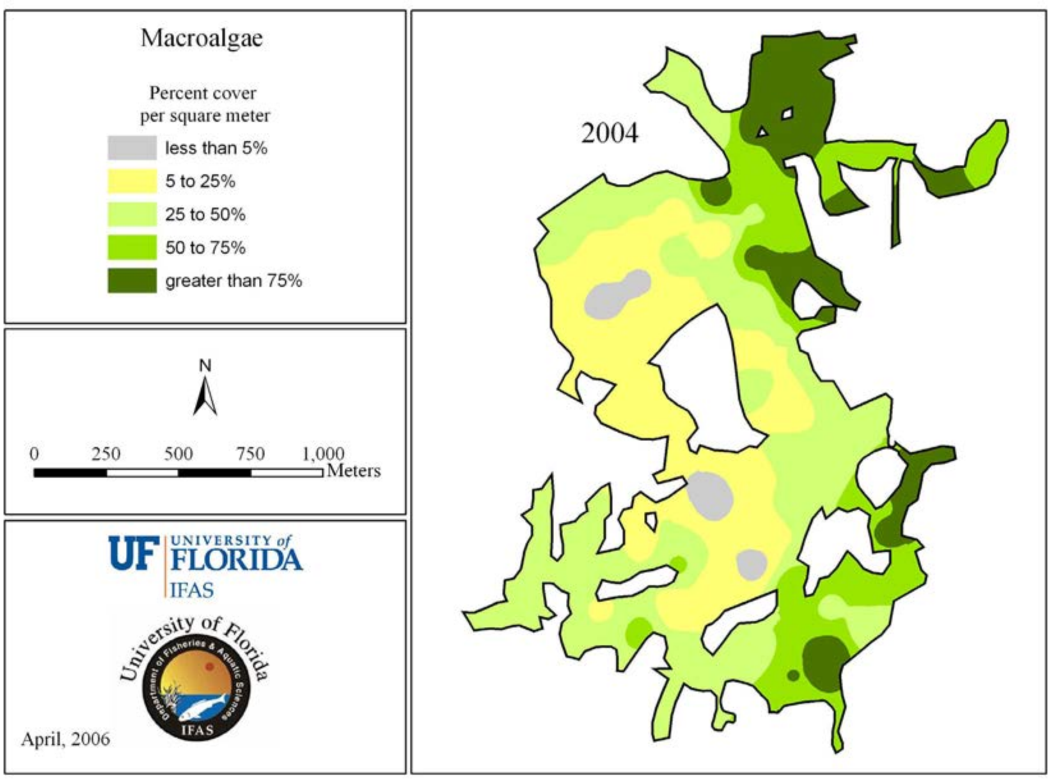


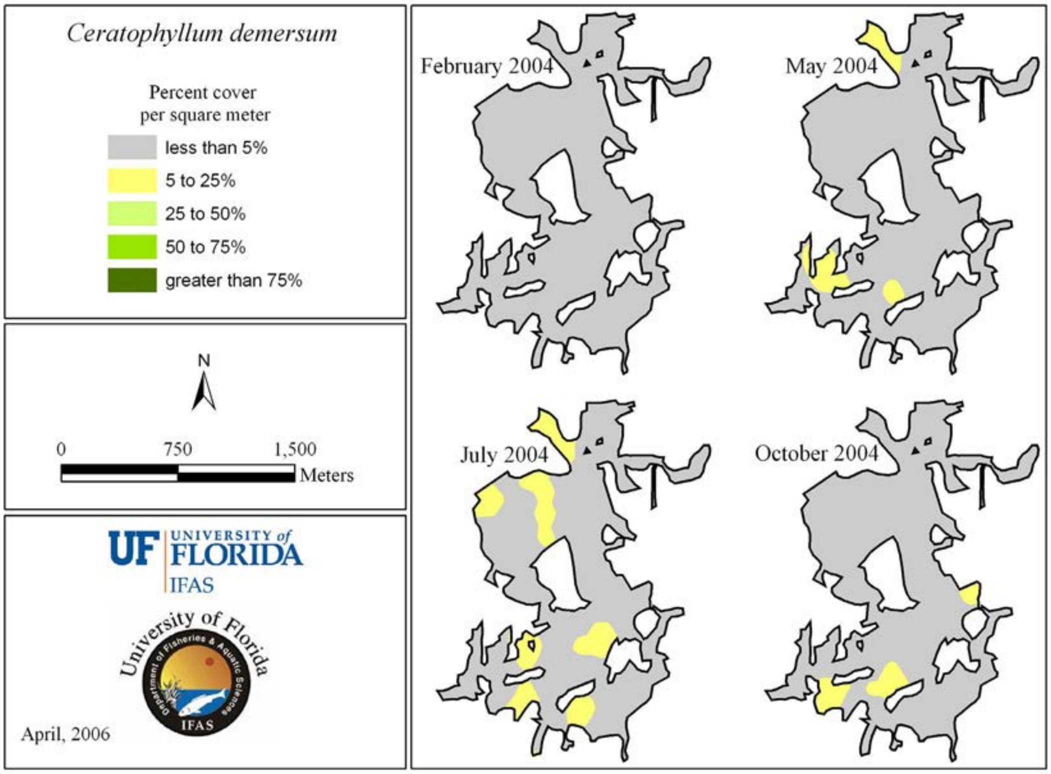


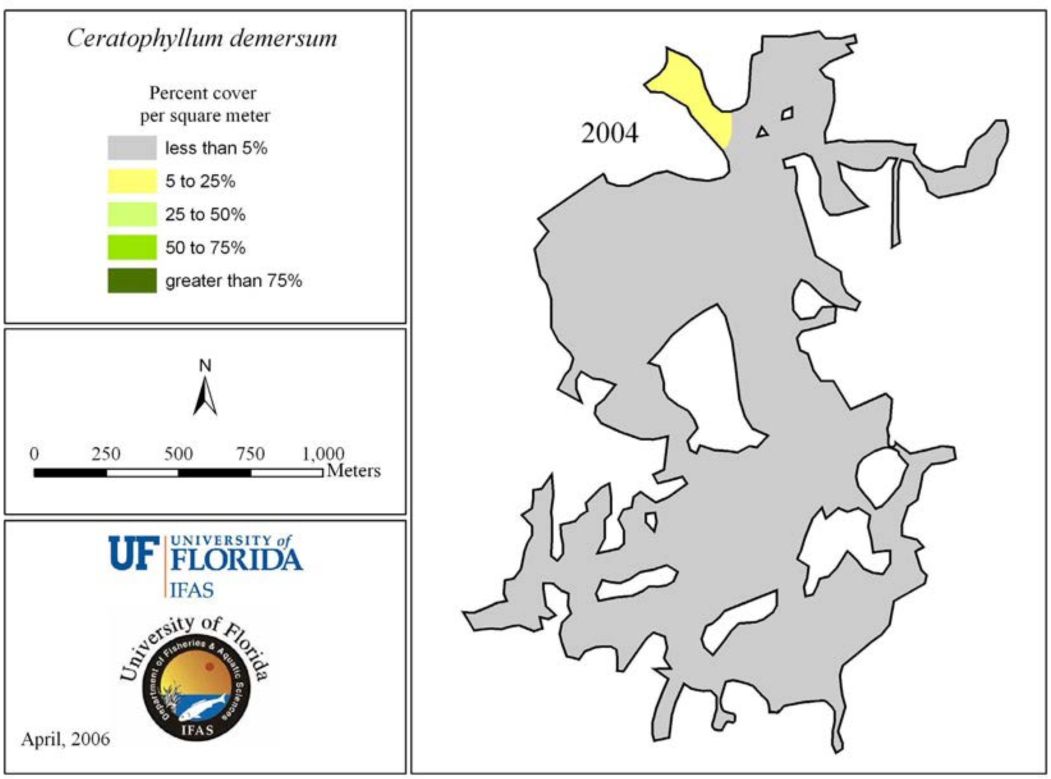

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

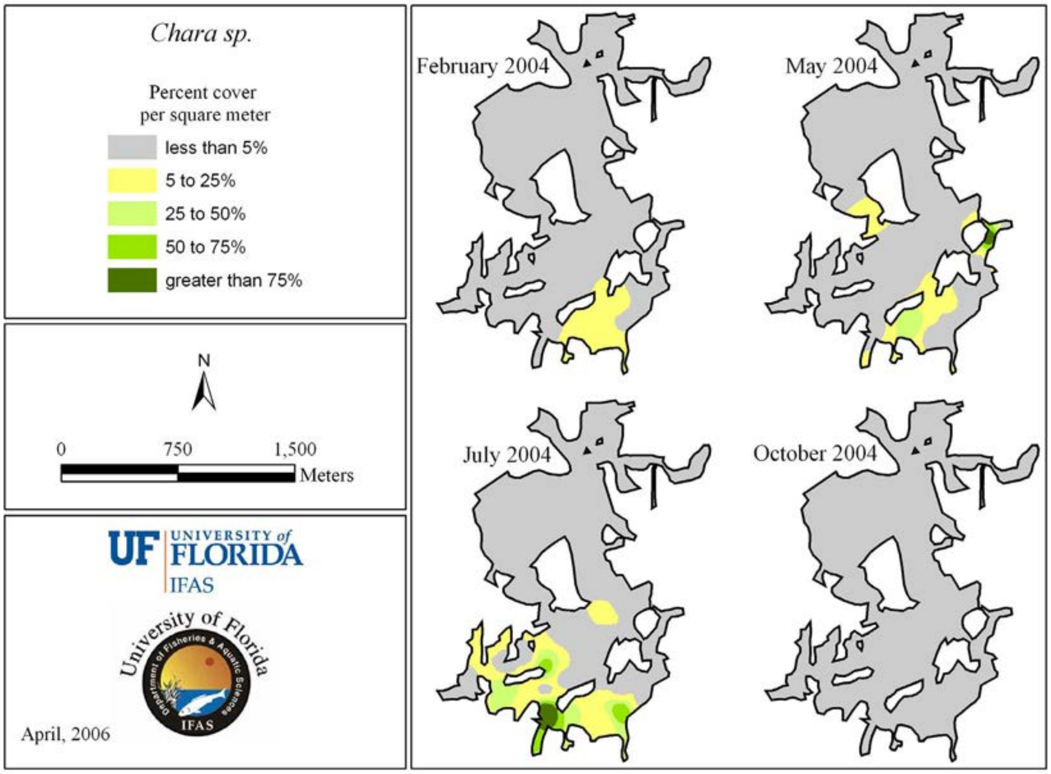

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

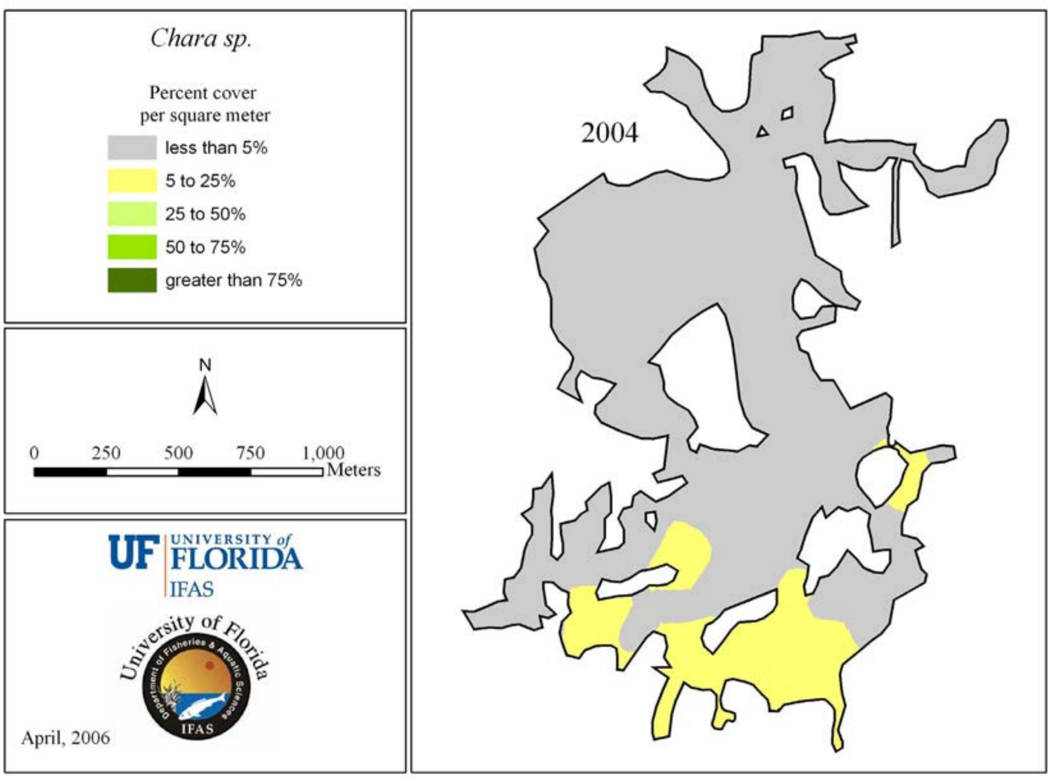

Macroalgae
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2004
May 2004
July 2004
October 2004

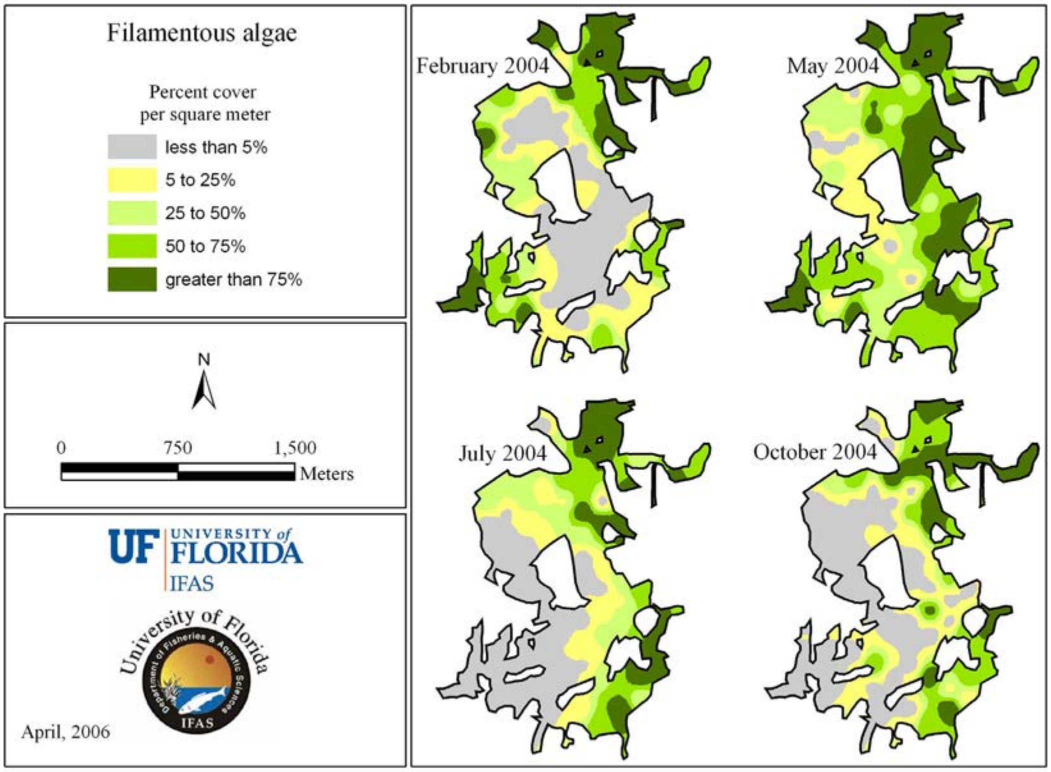

Macroalgae
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2004

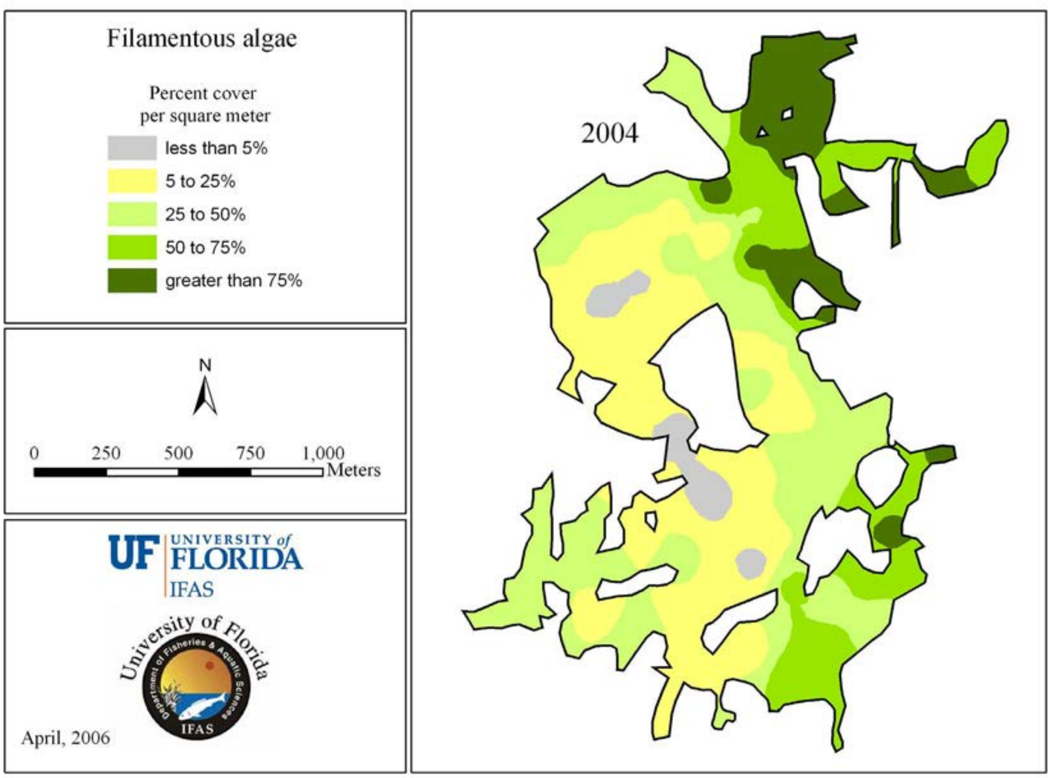

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

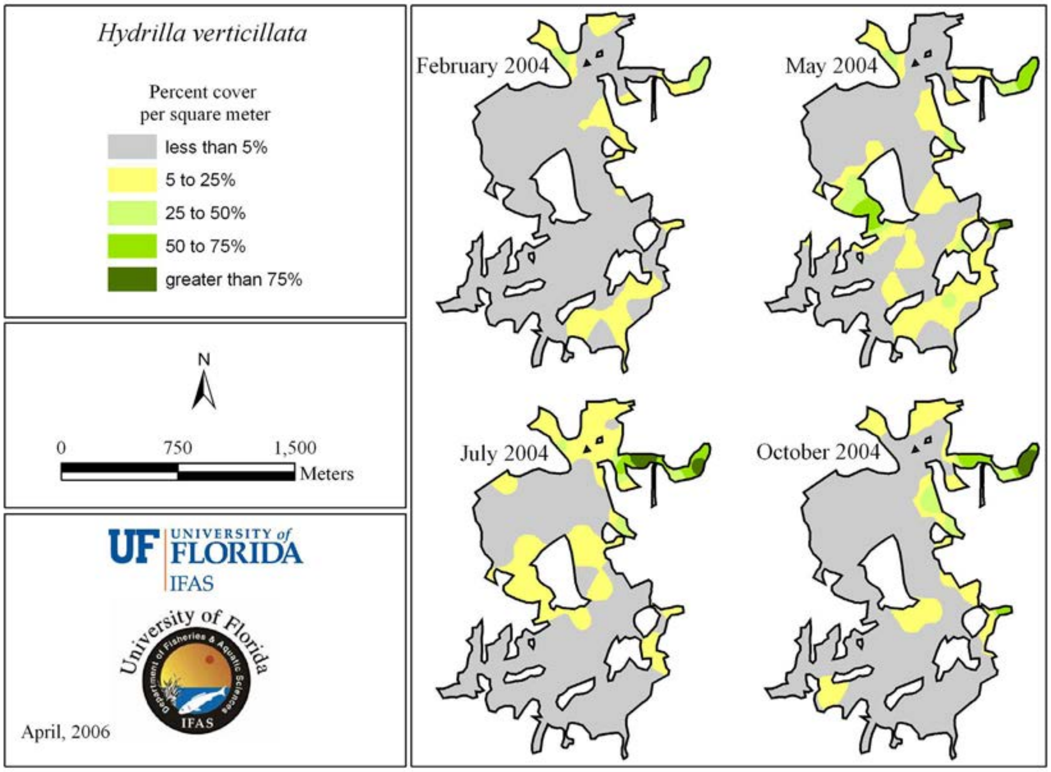

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

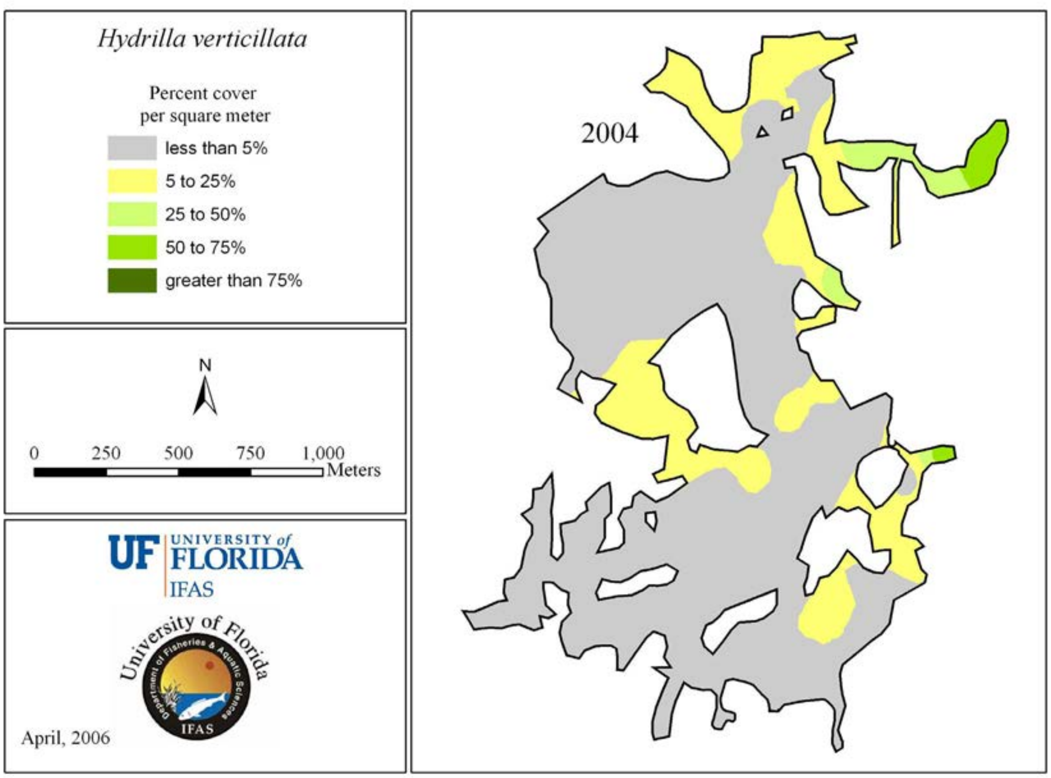

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

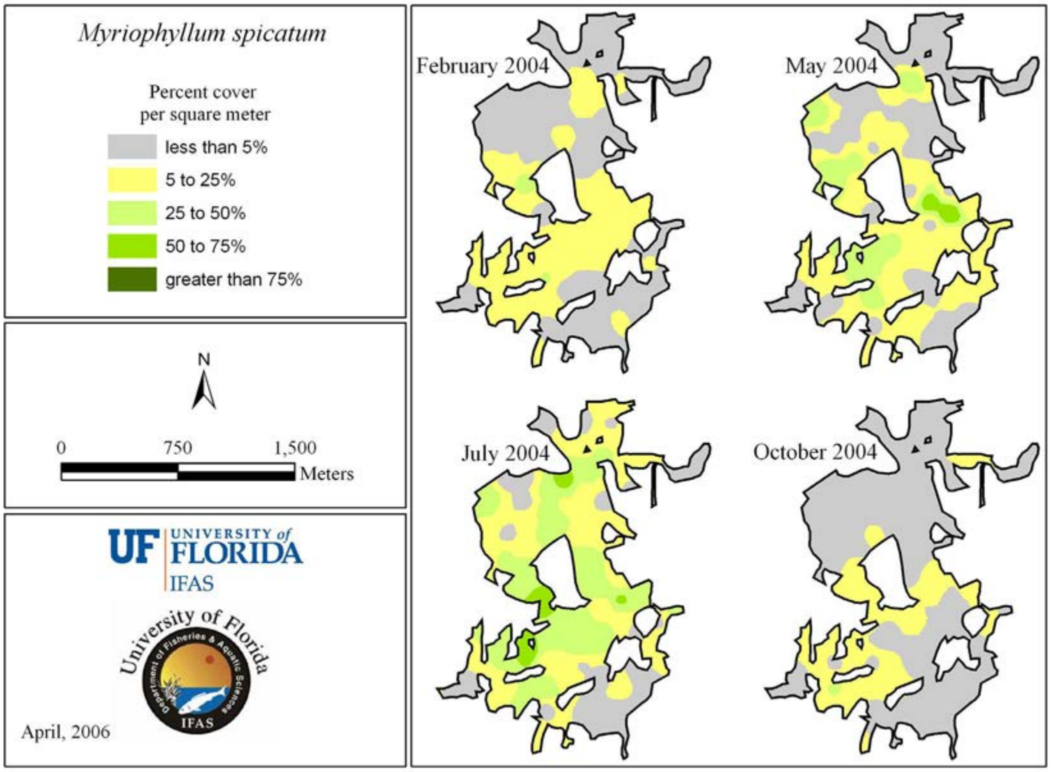

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

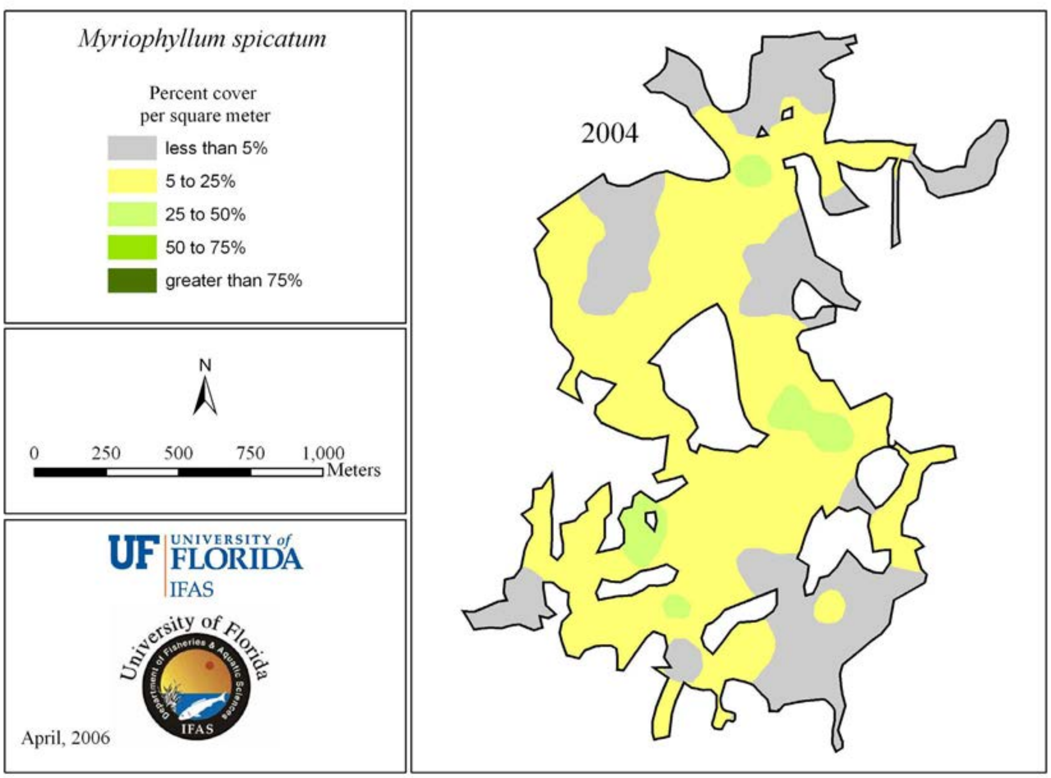

Filamentous algae
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

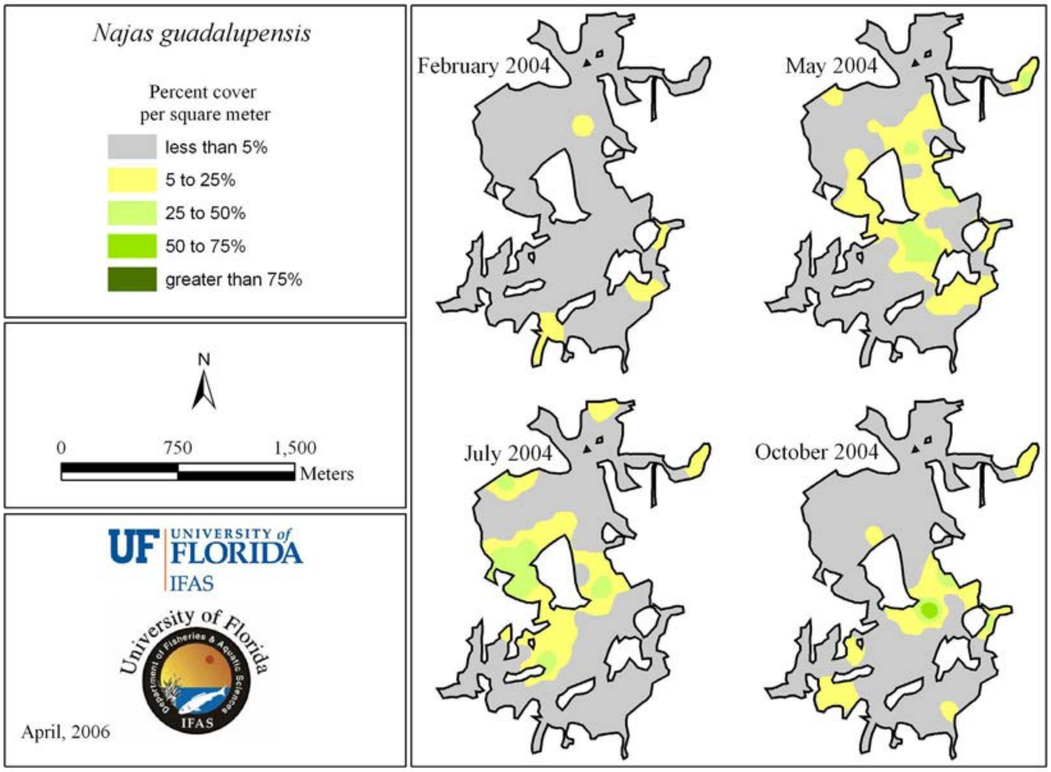

Filamentous algae
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

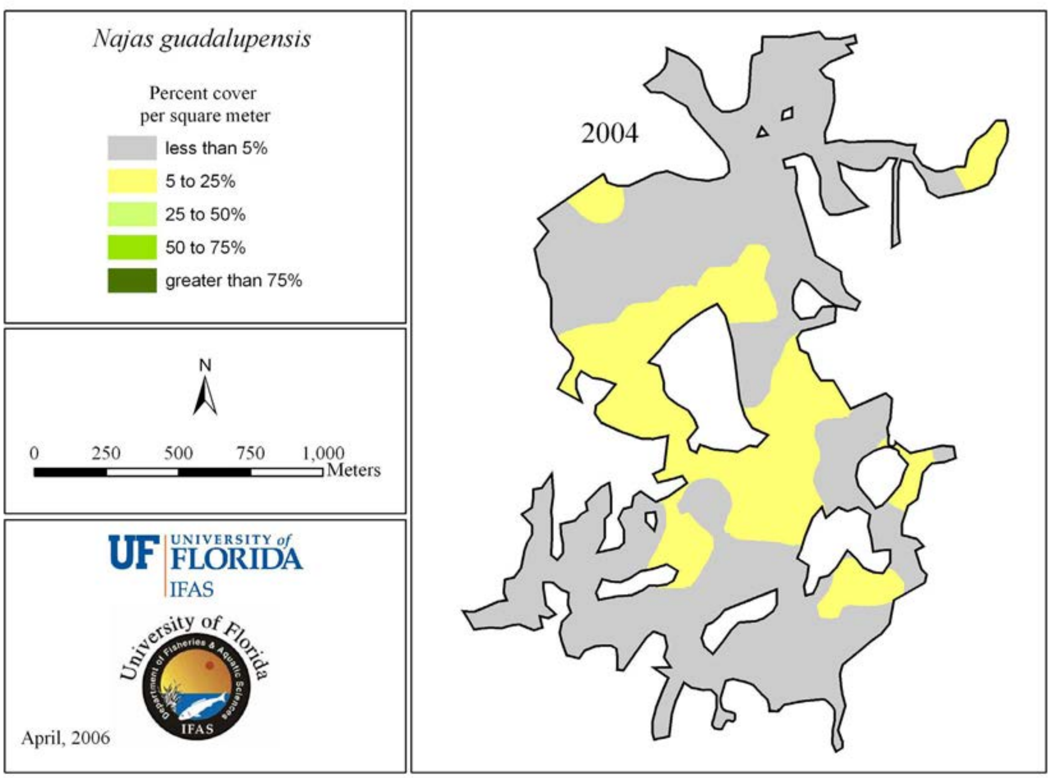

Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

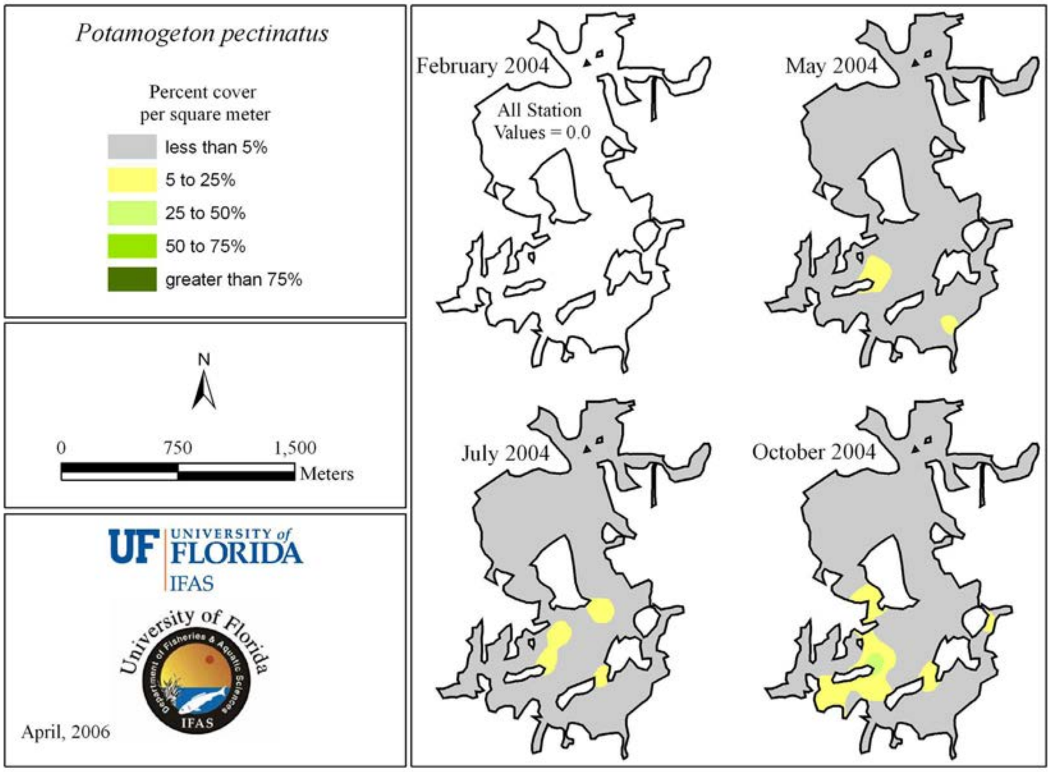

Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2004

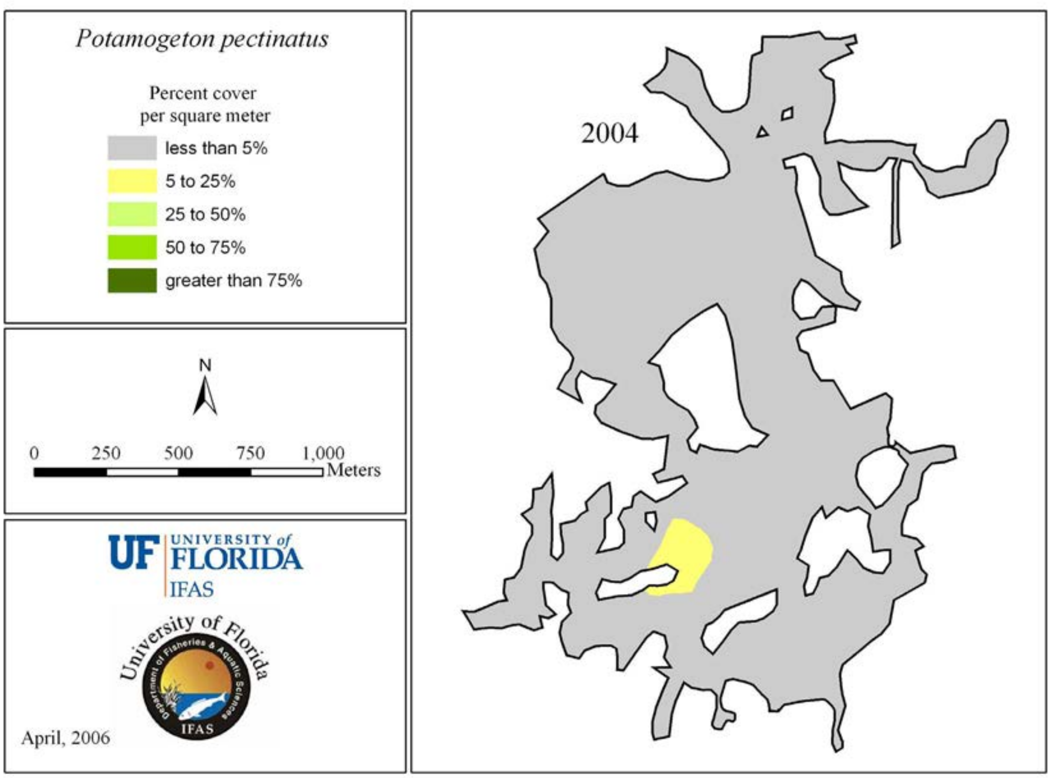

Myriophyllum spicatum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

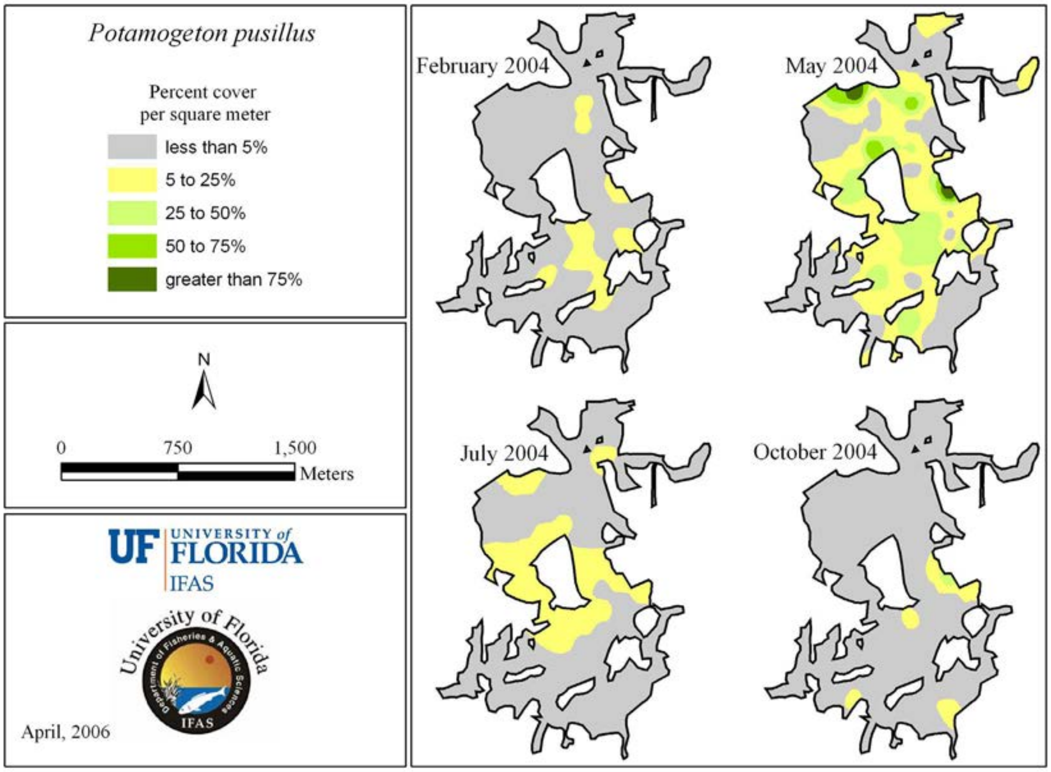

Myriophyllum spicatum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

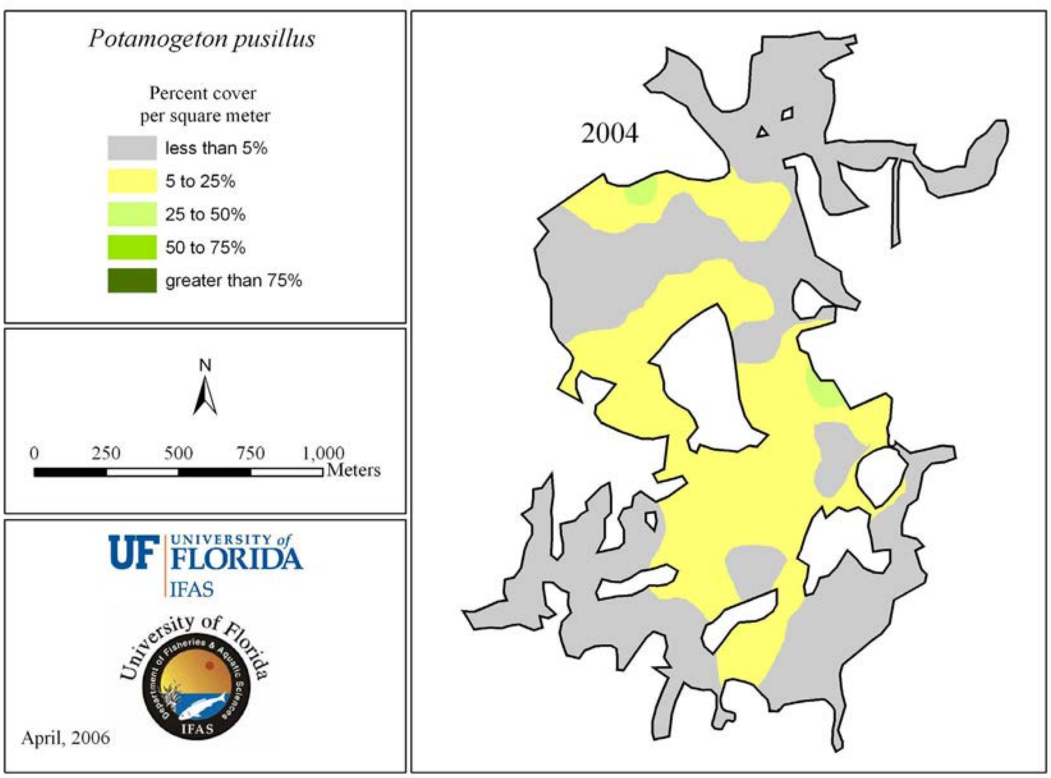

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

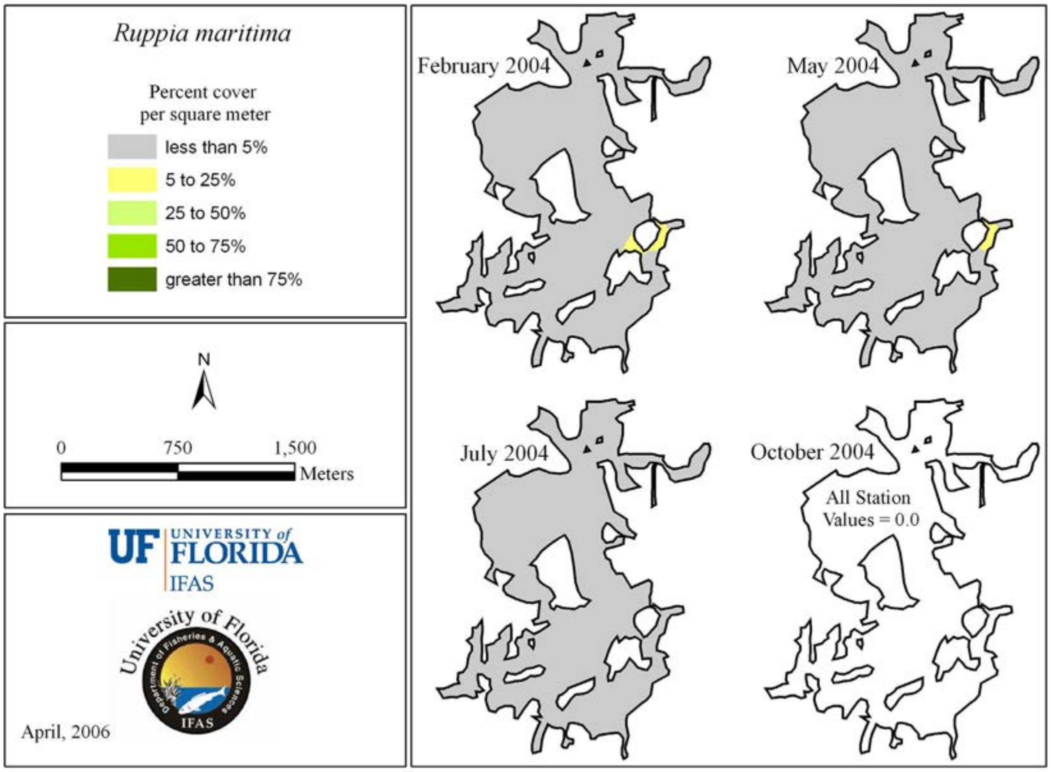

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2004

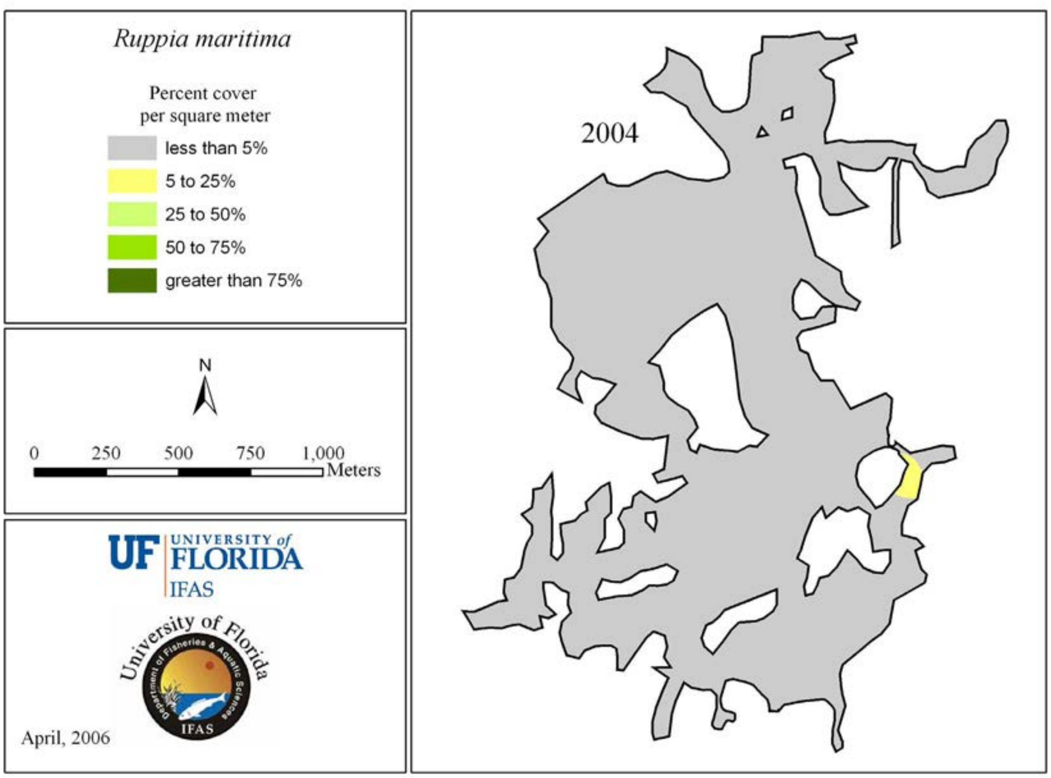

Potamogeton pectinatus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2004
All Station
Values = 0.0
May 2004
July 2004
October 2004

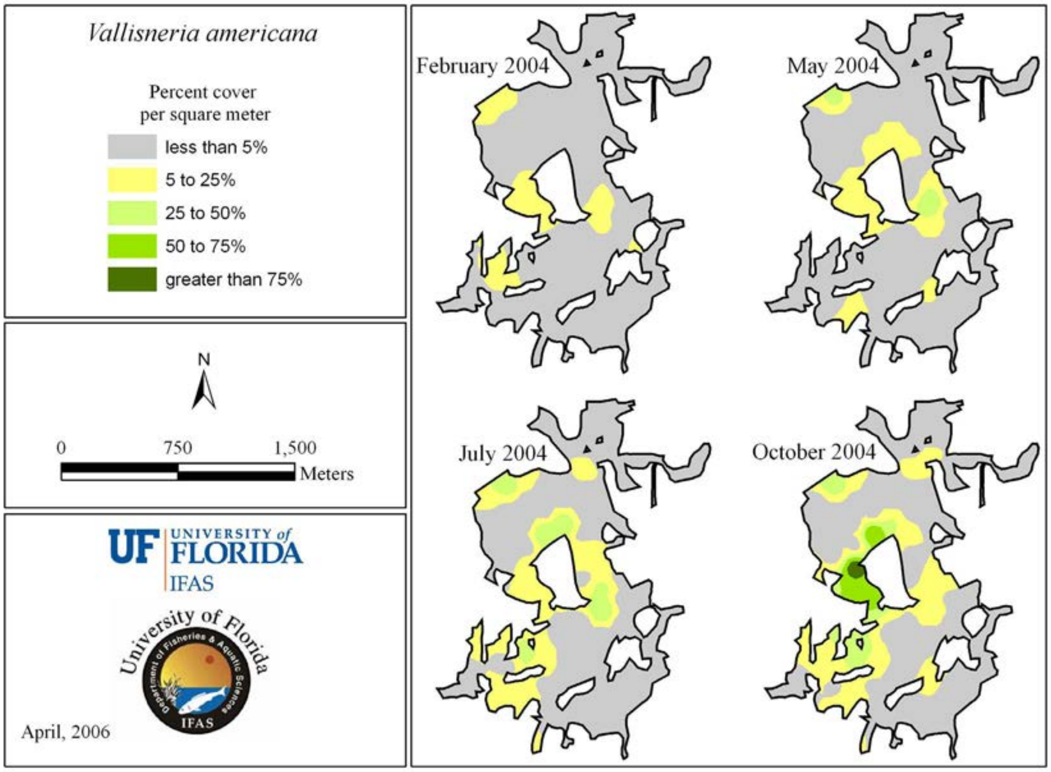

Potamogeton pectinatus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2004

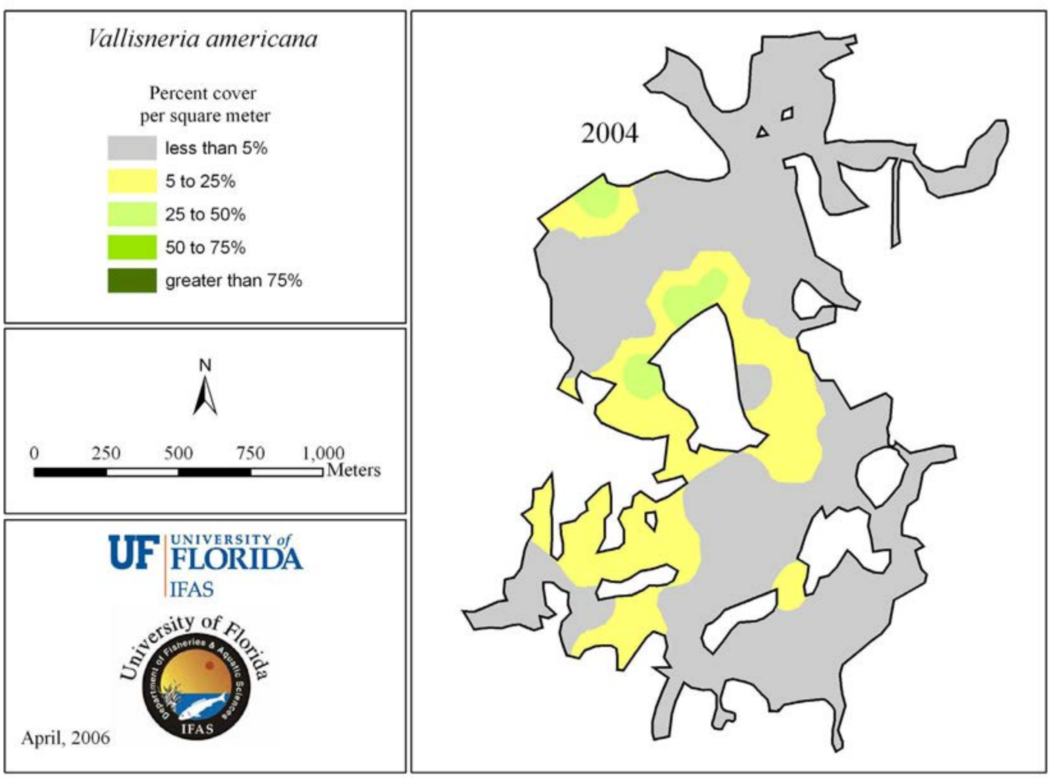

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

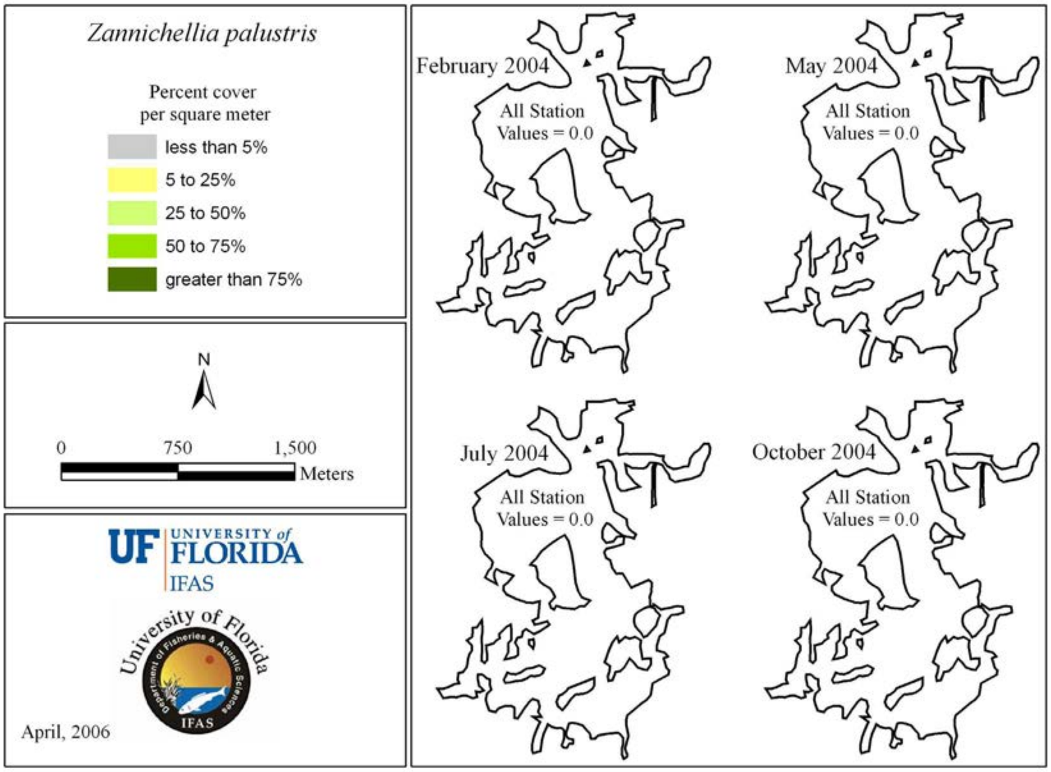

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

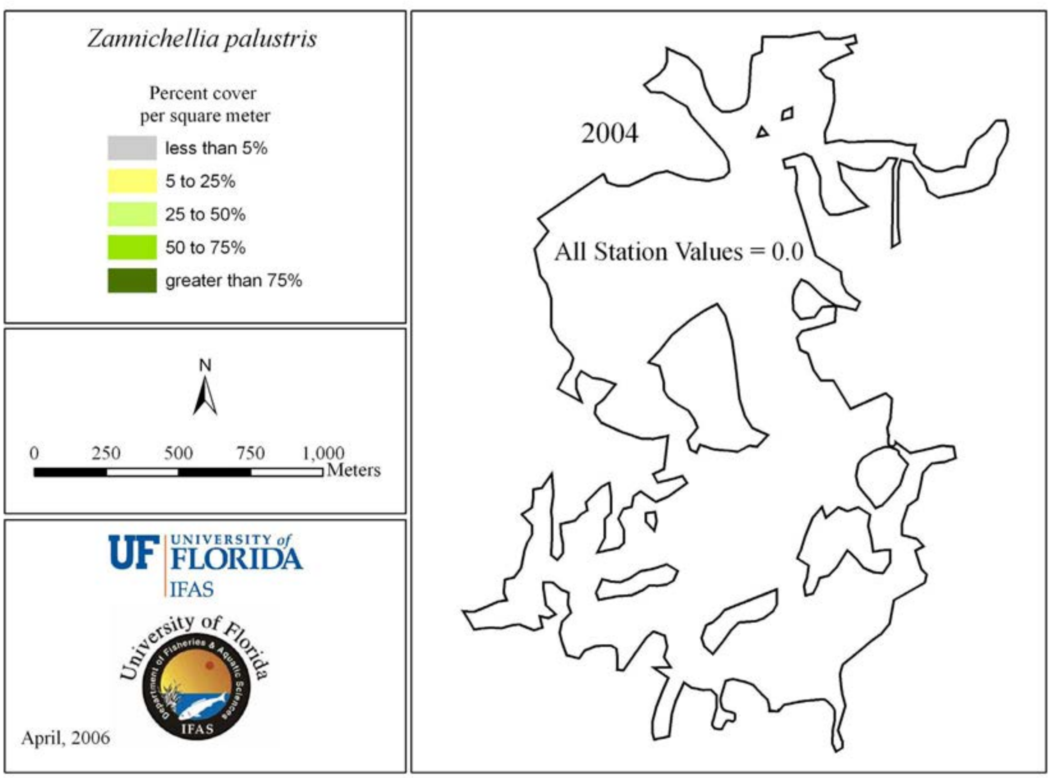

Ruppia maritima
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004
All Station
Values = 0.0

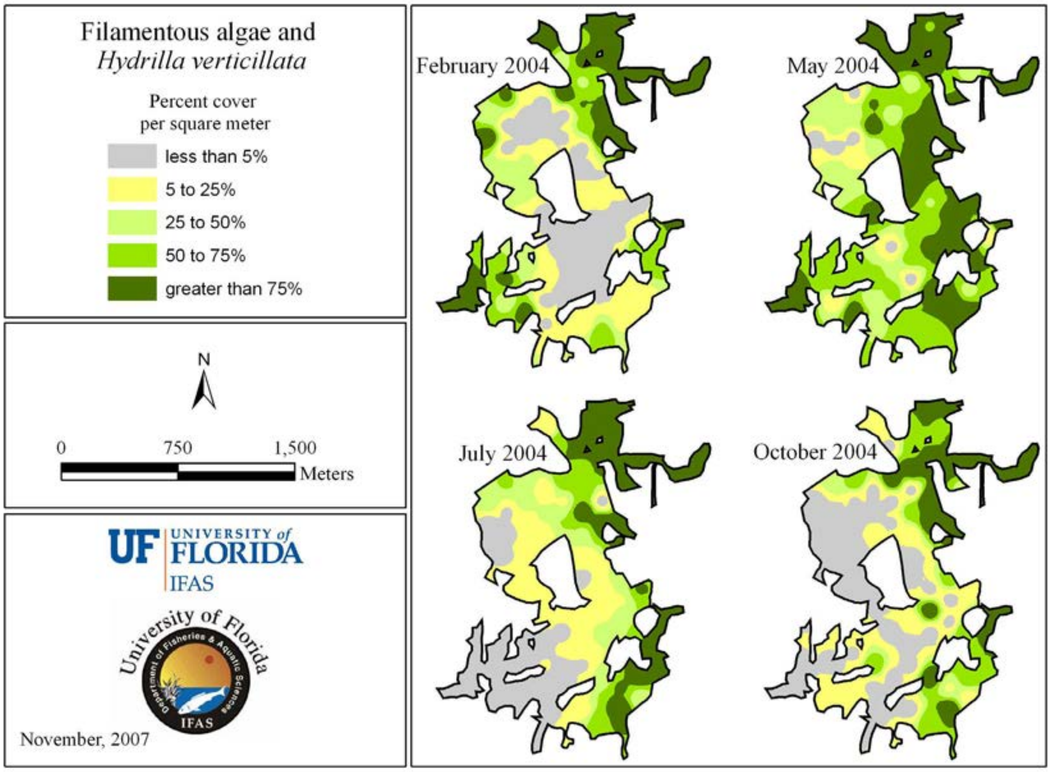

Ruppia maritima
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

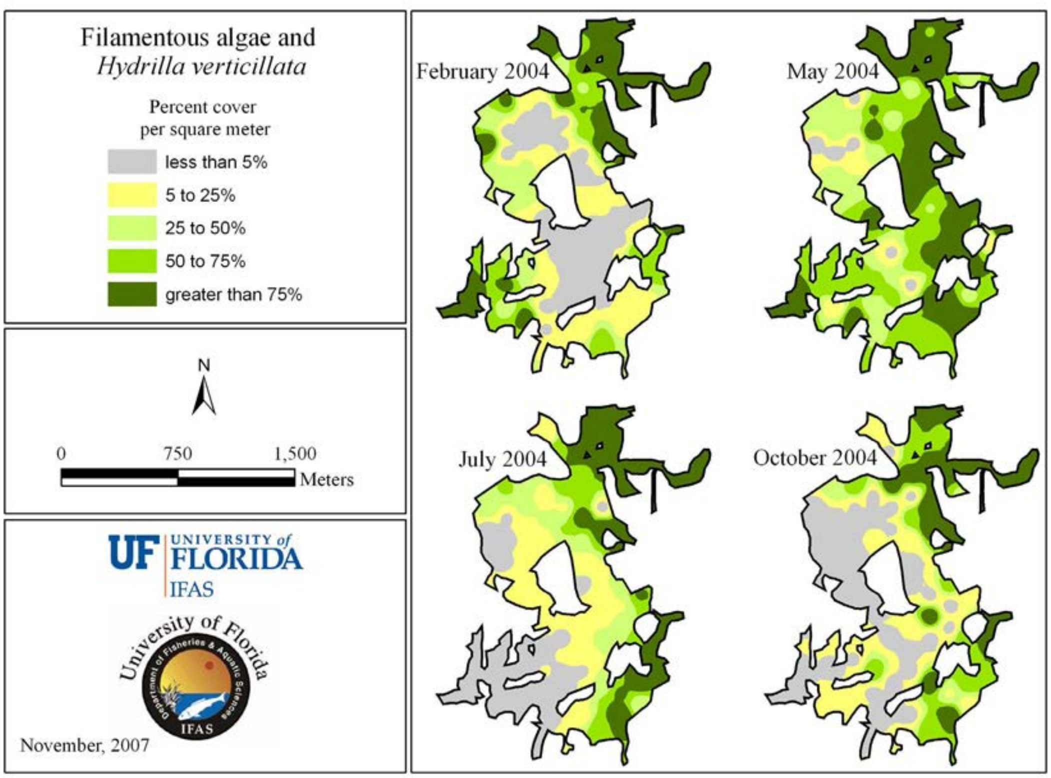

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

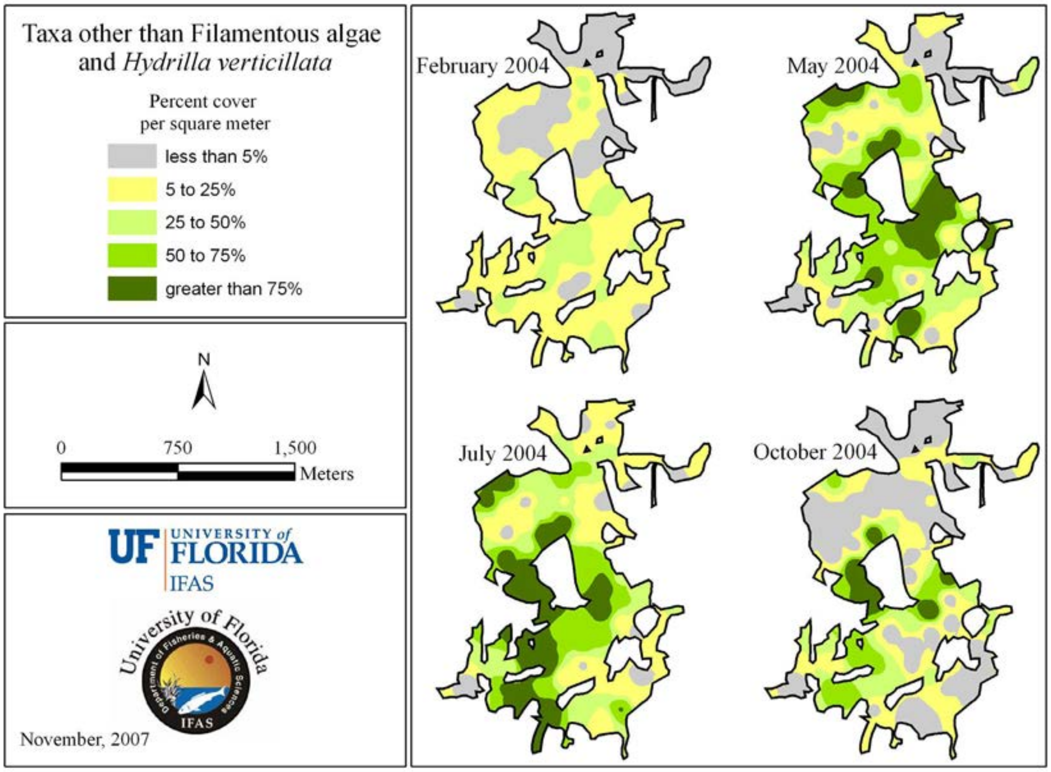

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2004

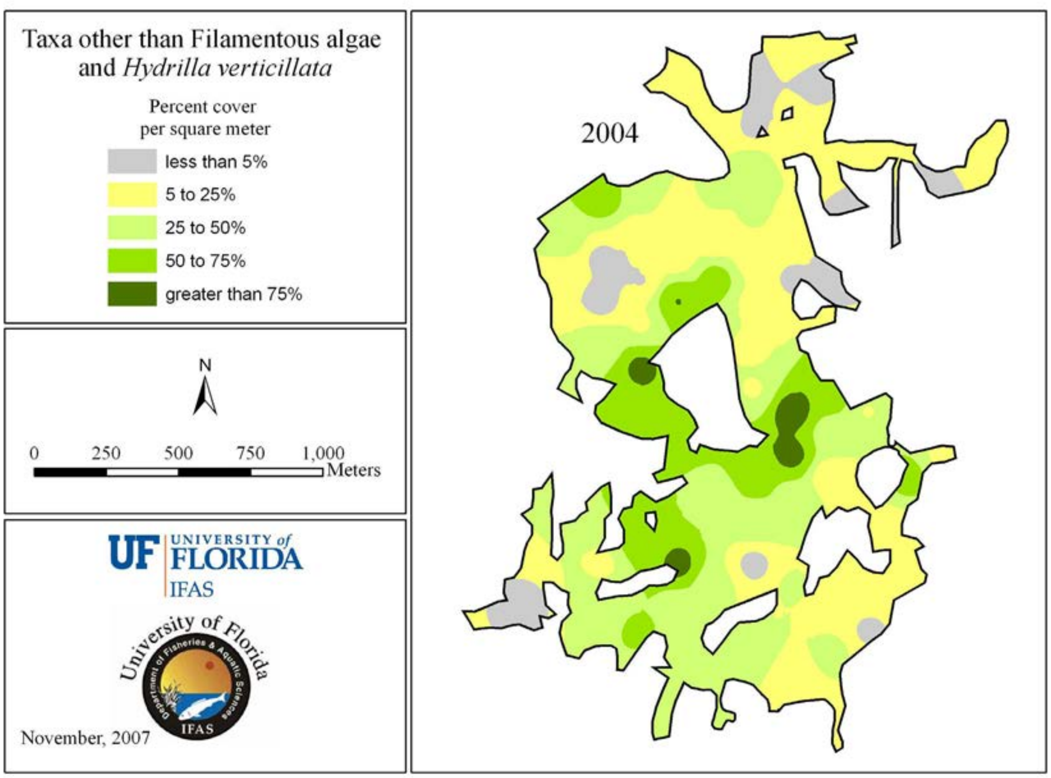

Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
All Station
Values = 0.0
May 2004
All Station
Values = 0.0
July 2004
All Station
Values = 0.0
October 2004
All Station
Values = 0.0

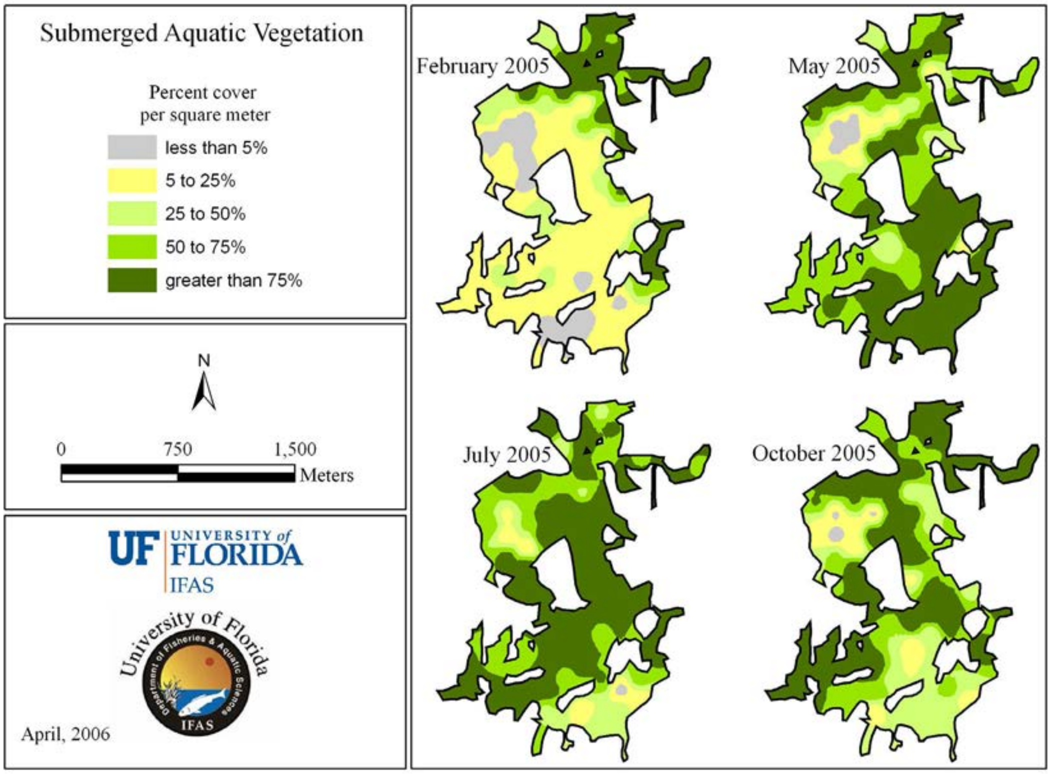

Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004
All Station Values = 0.0

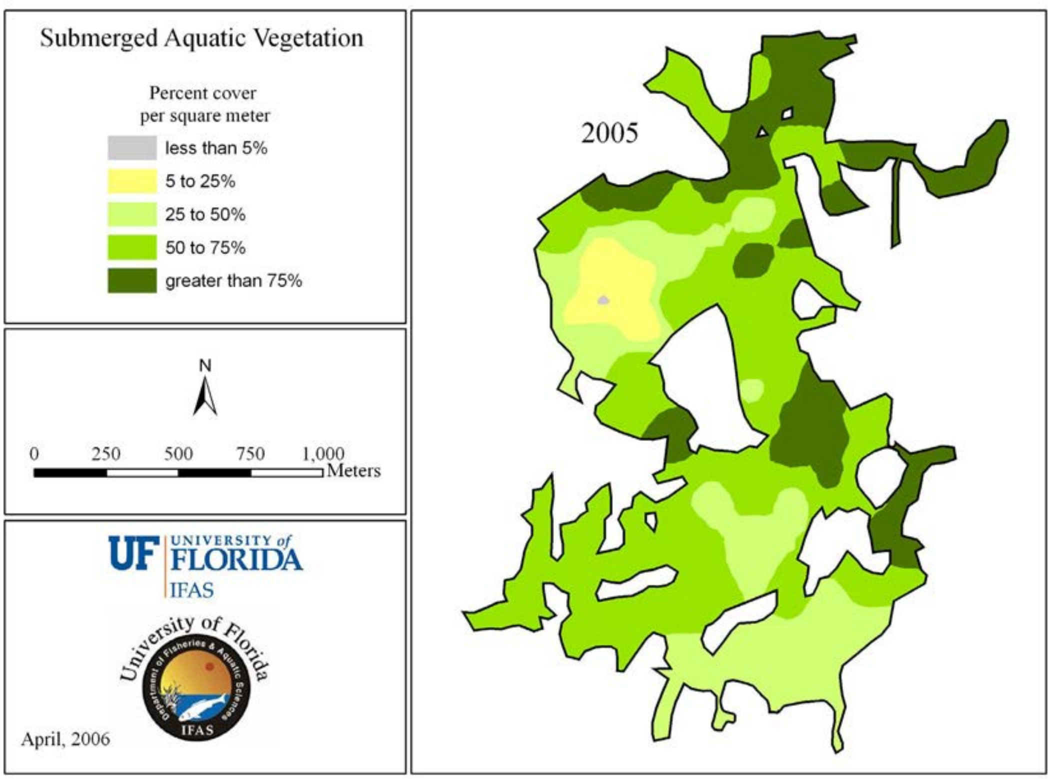

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
November, 2007
February 2004
May 2004
July 2004
October 2004

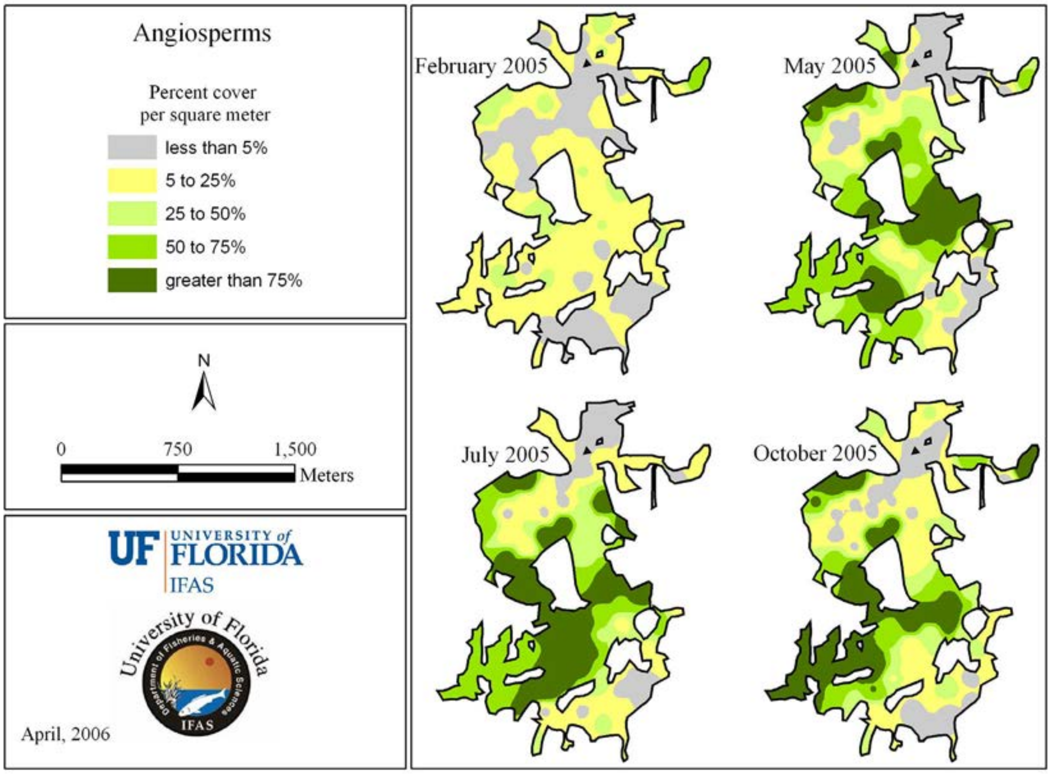

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
November, 2007
February 2004
May 2004
July 2004
October 2004

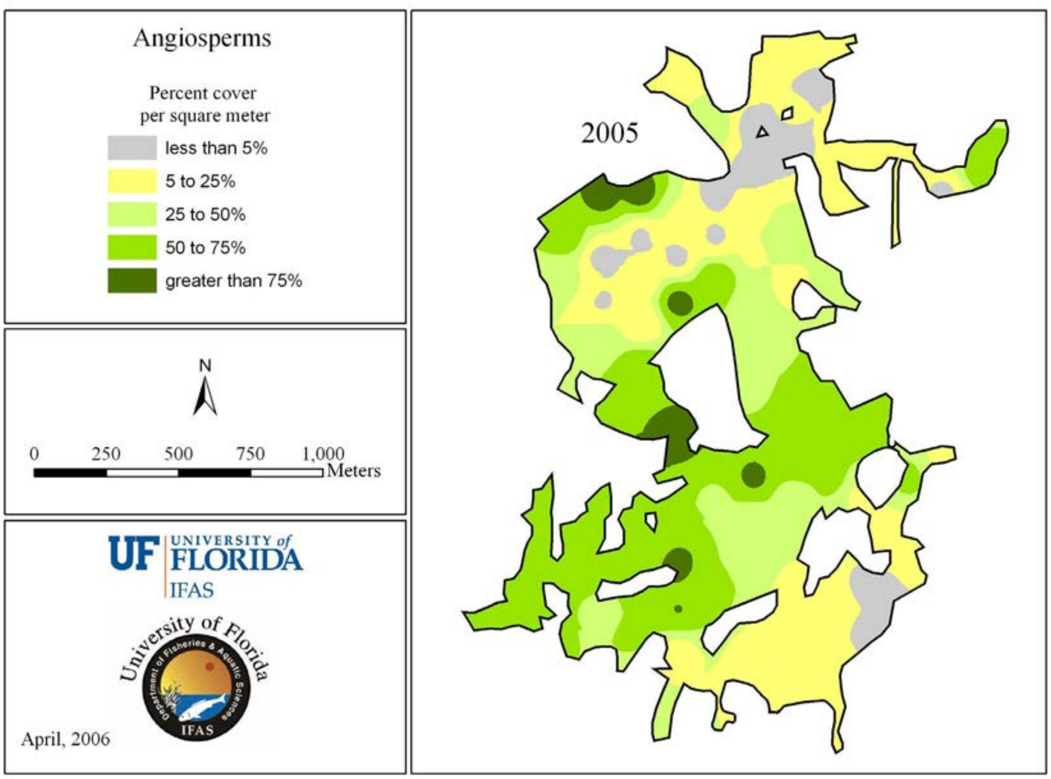

Taxa other than Filamentous algae
and *Hydrilla verticillata*
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
February 2004
May 2004
July 2004
October 2004

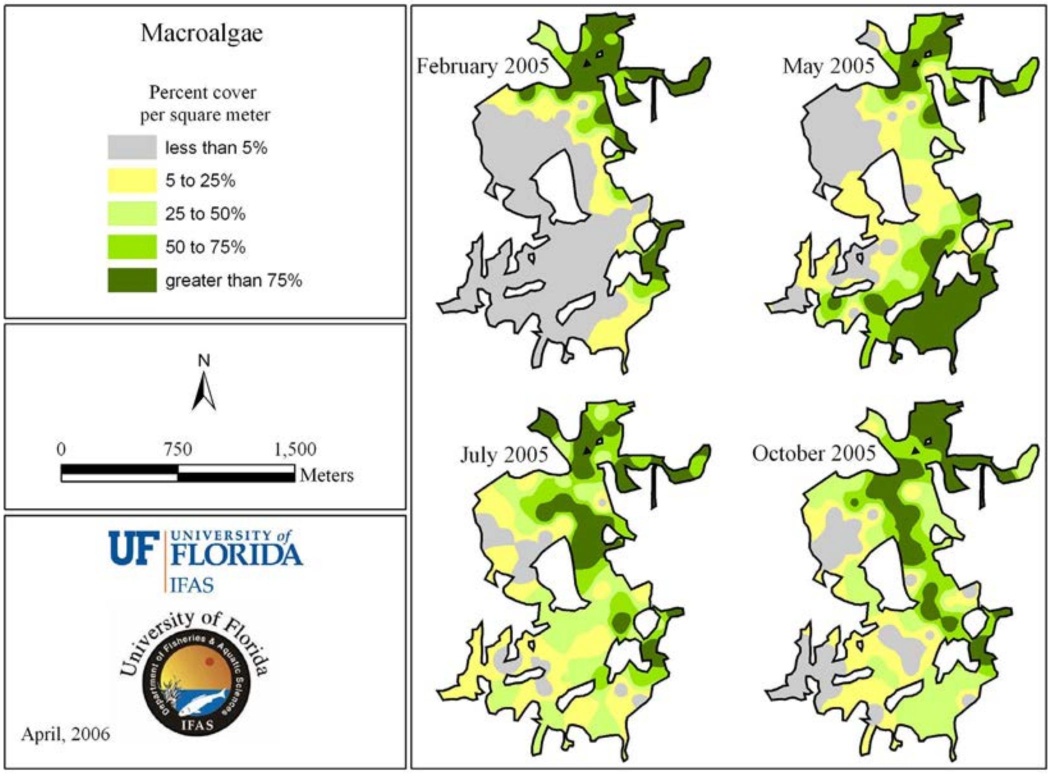

Taxa other than Filamentous algae
and *Hydrilla verticillata*
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
2004

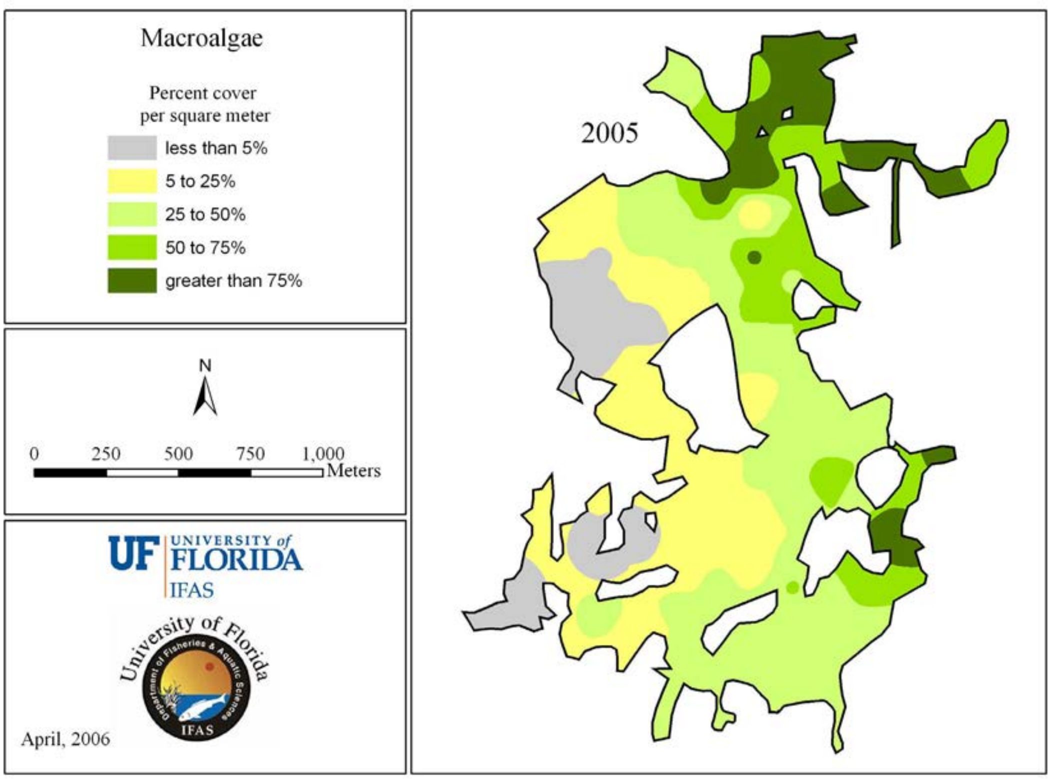

Submerged Aquatic Vegetation
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

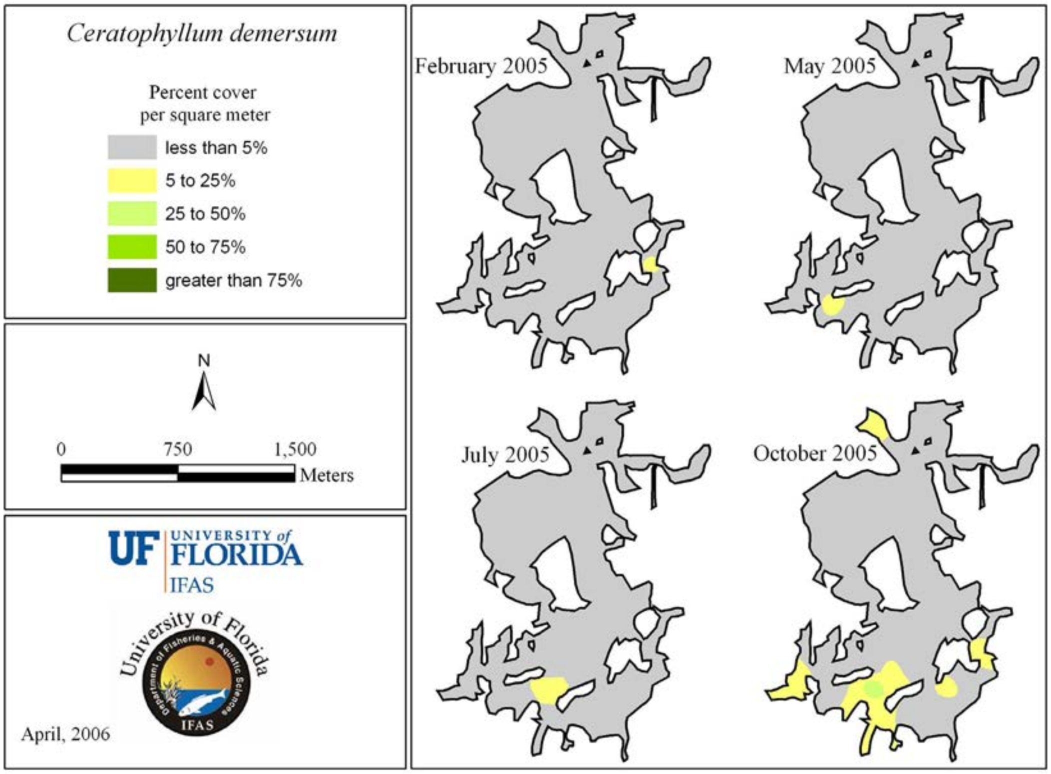

Submerged Aquatic Vegetation
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

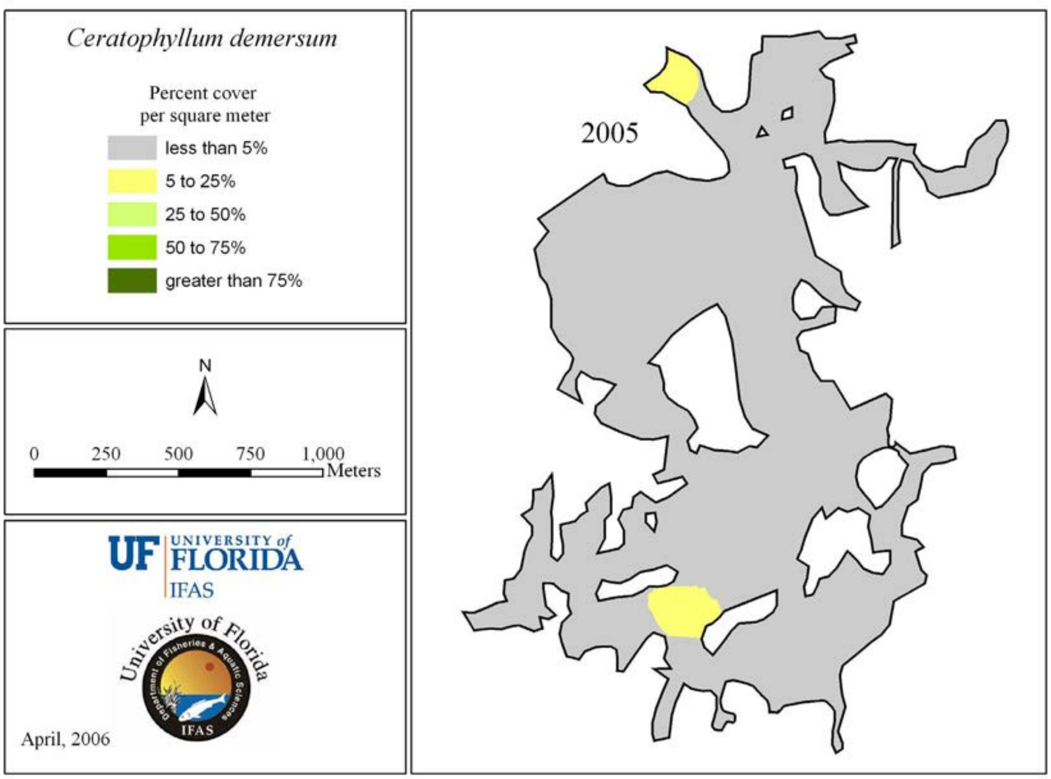

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

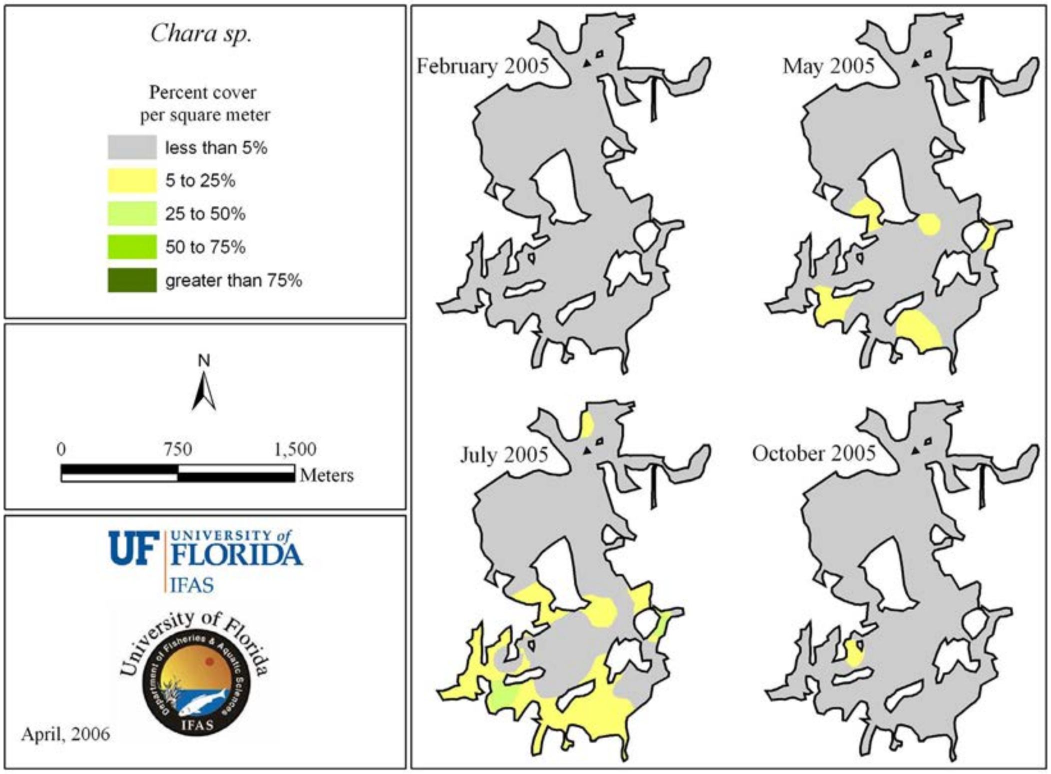

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

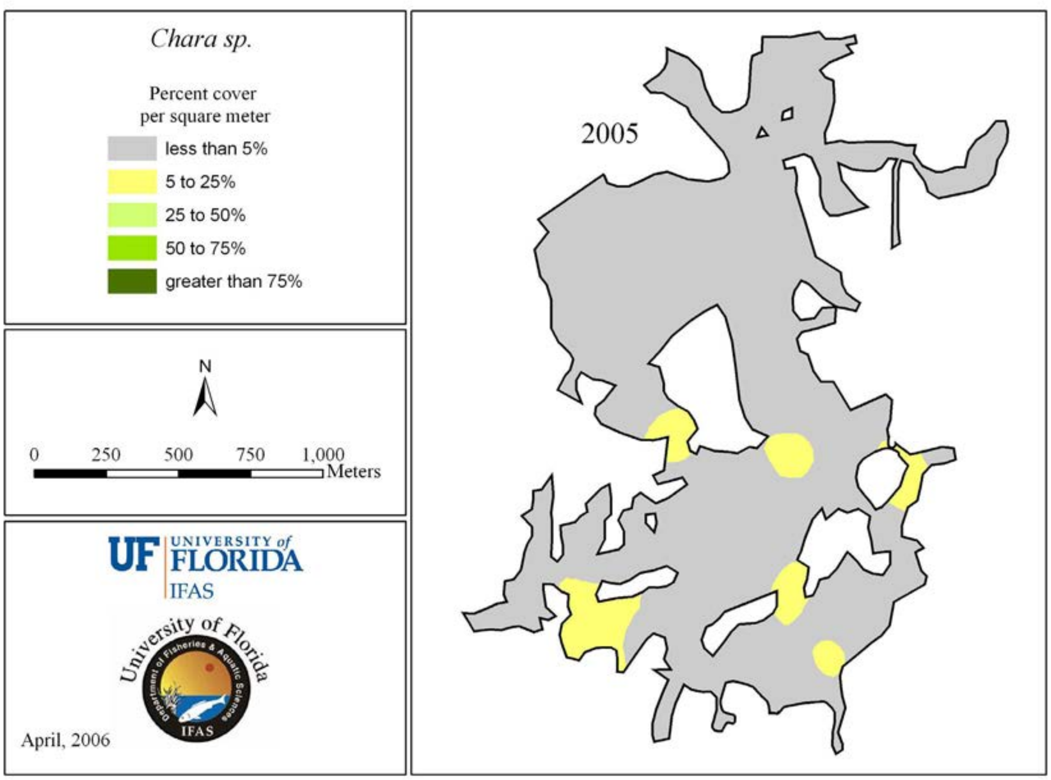

Macroalgae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

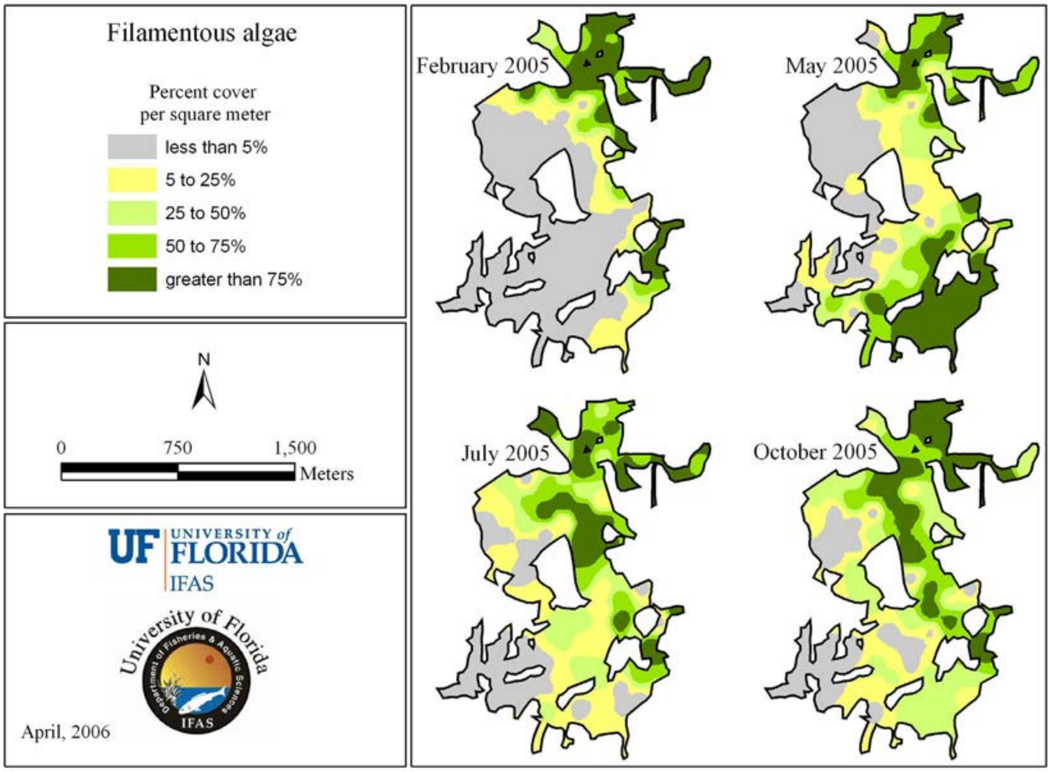

Macroalgae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

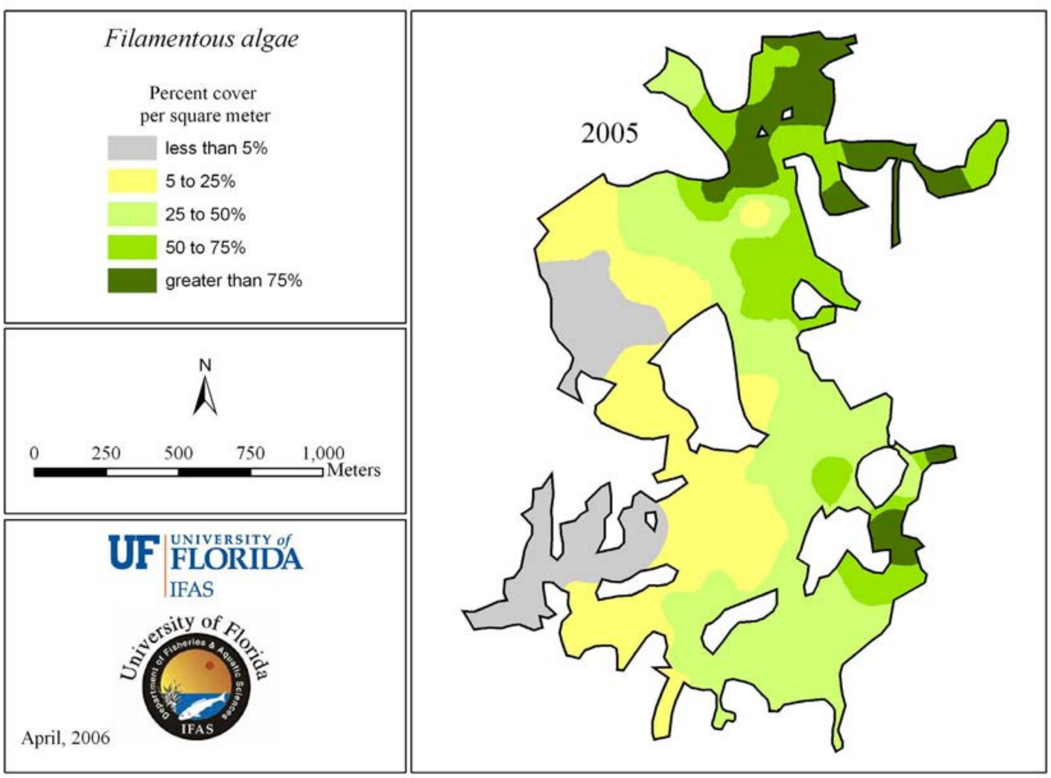

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

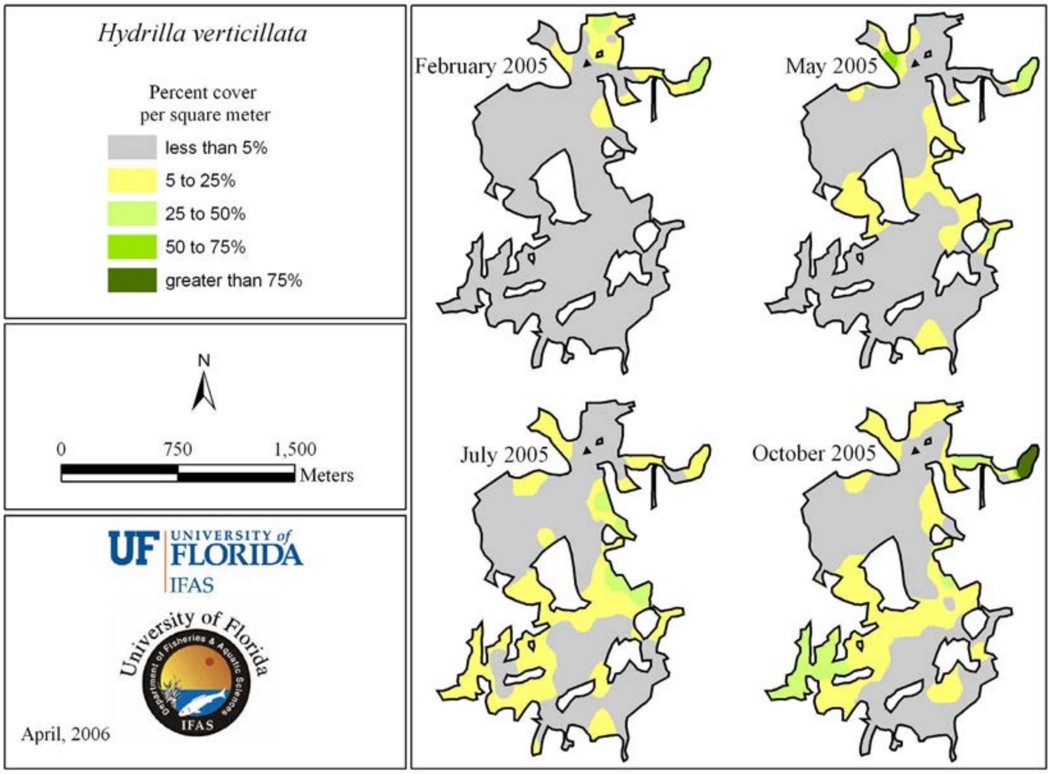

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

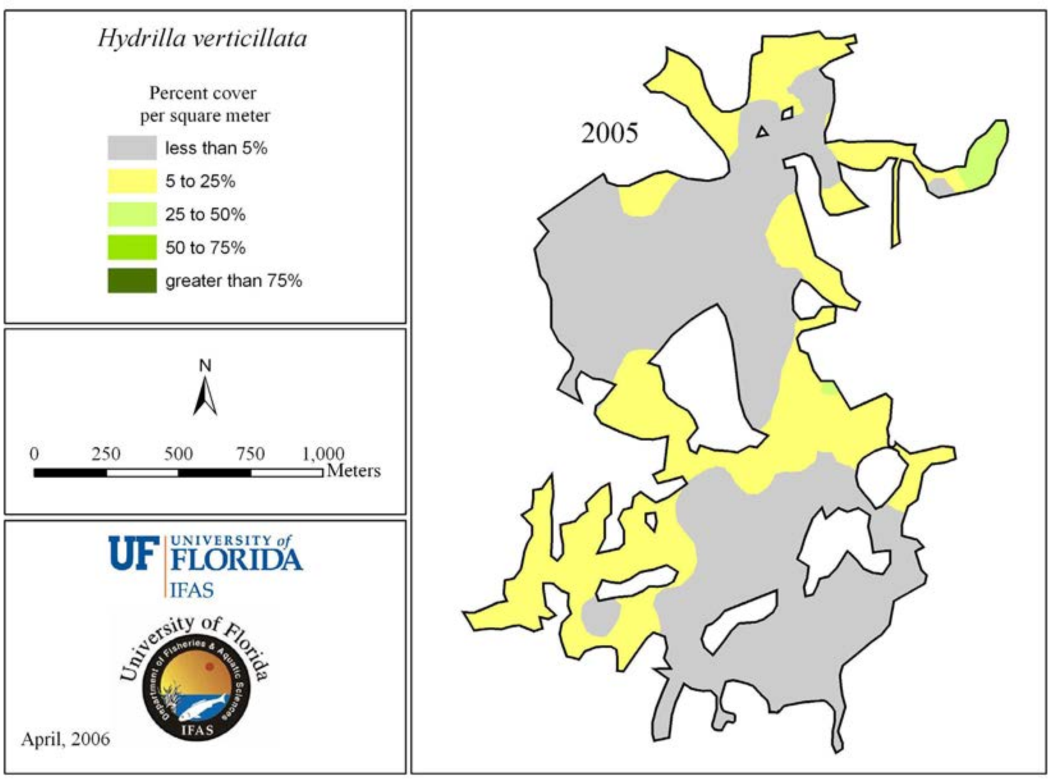

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005

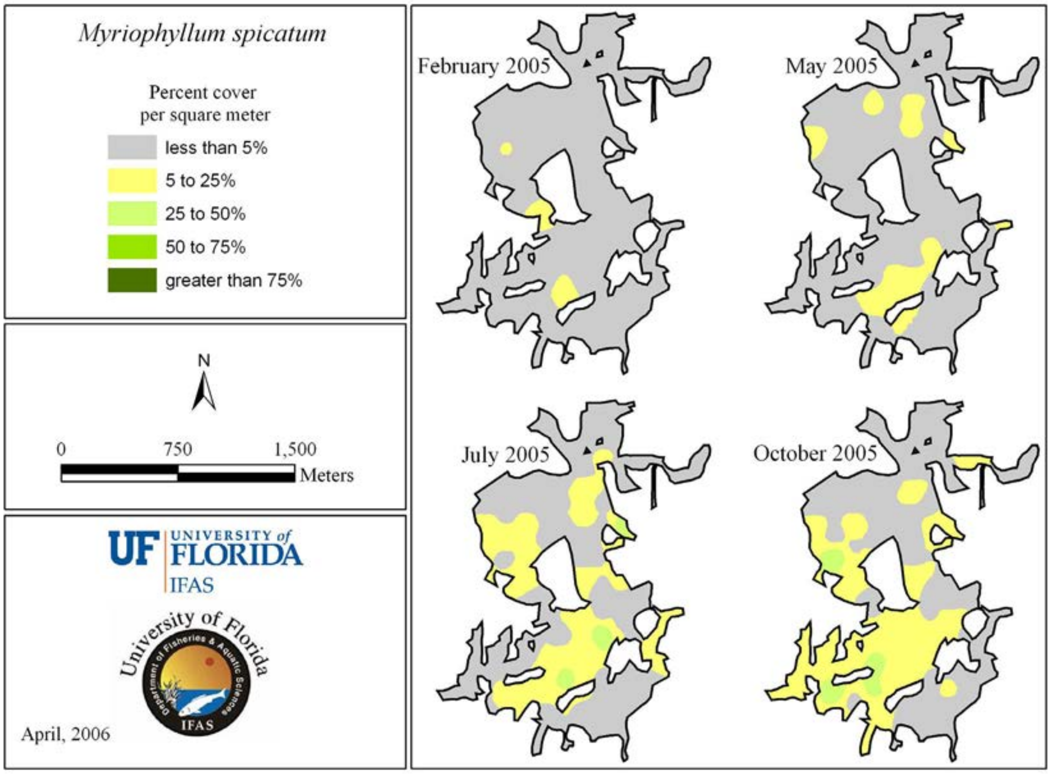

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005

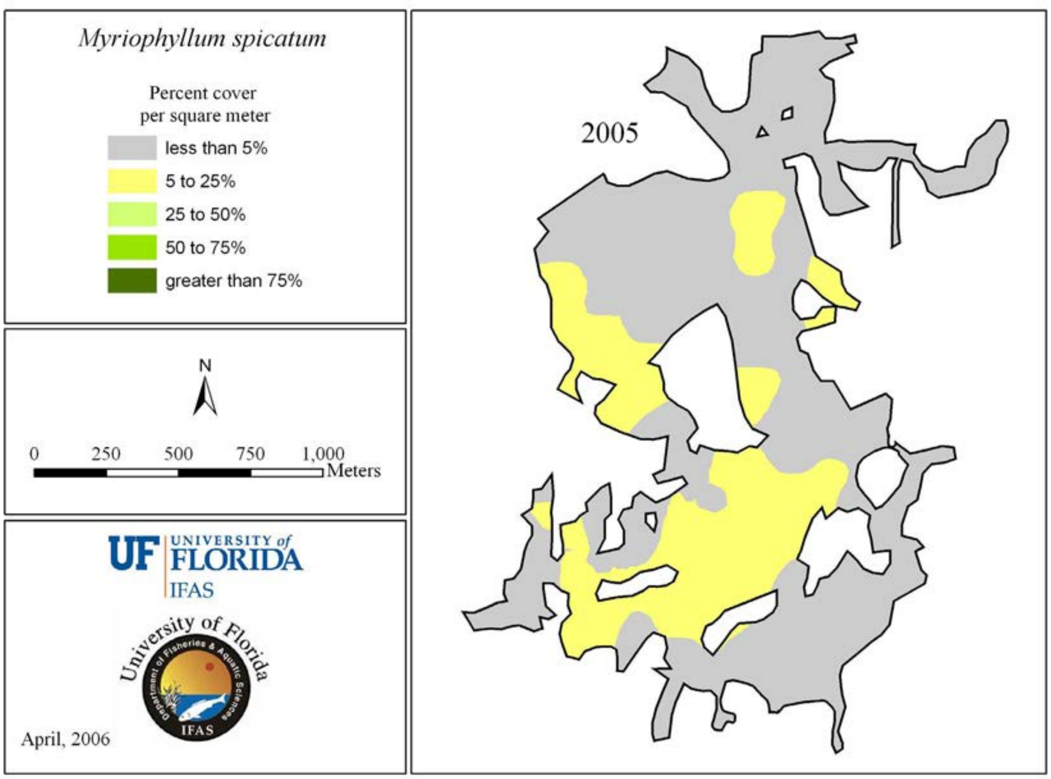

Filamentous algae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

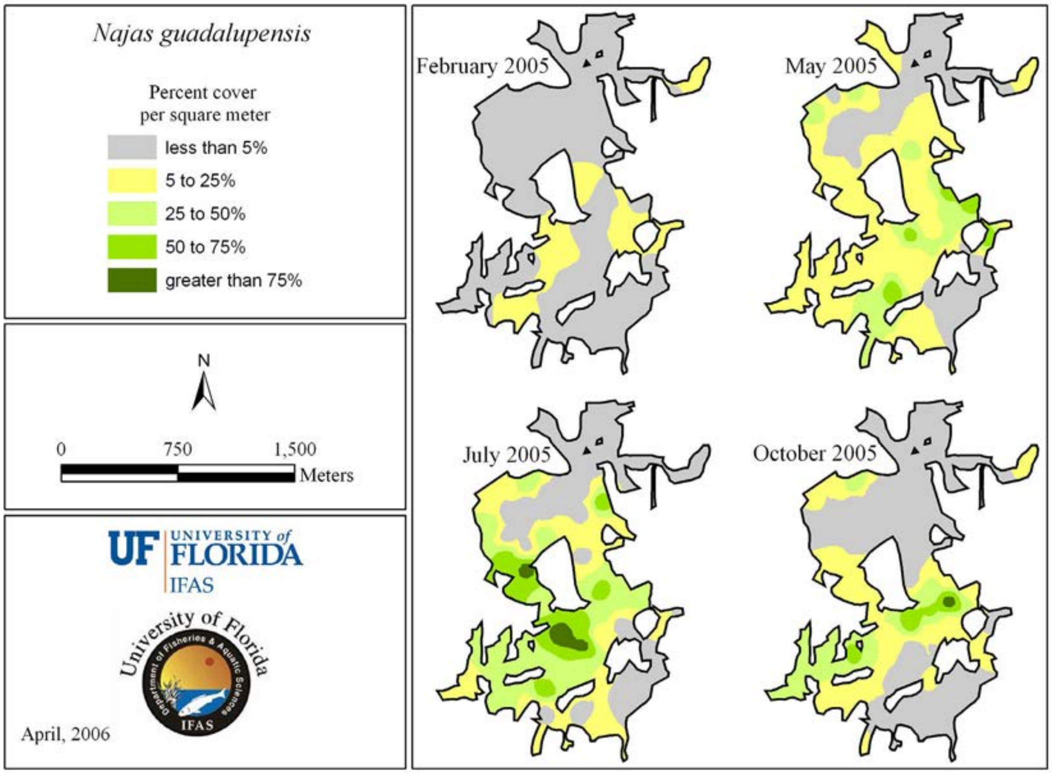

Filamentous algae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

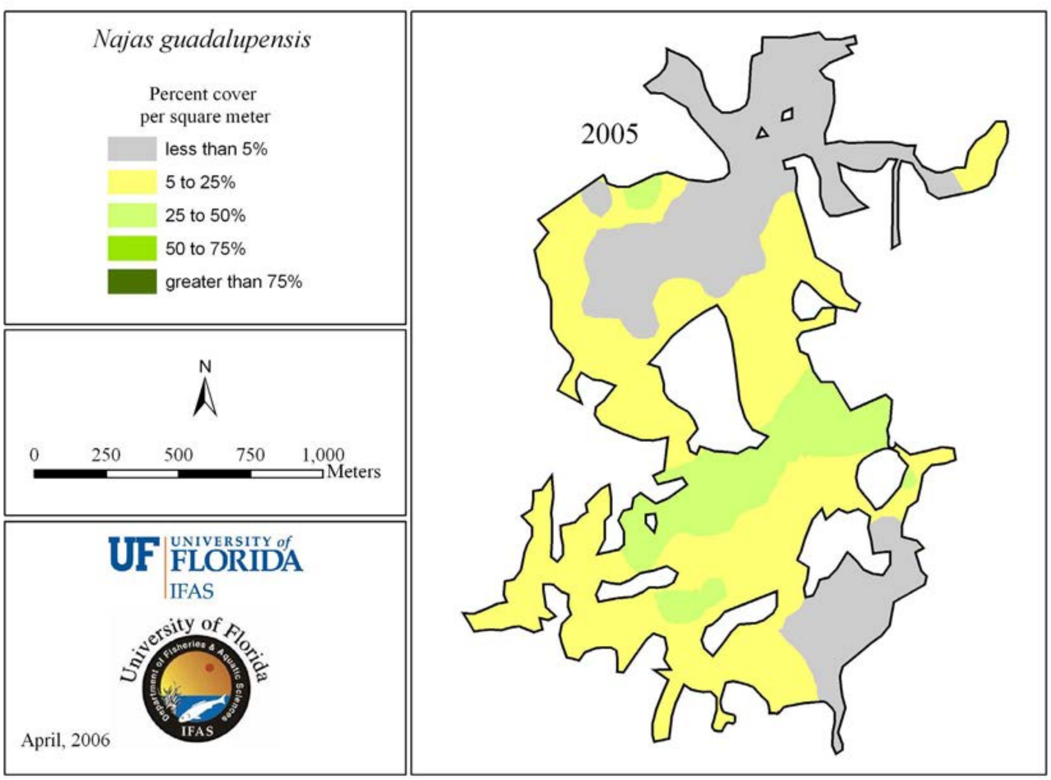

Hydrilla verticillata
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005

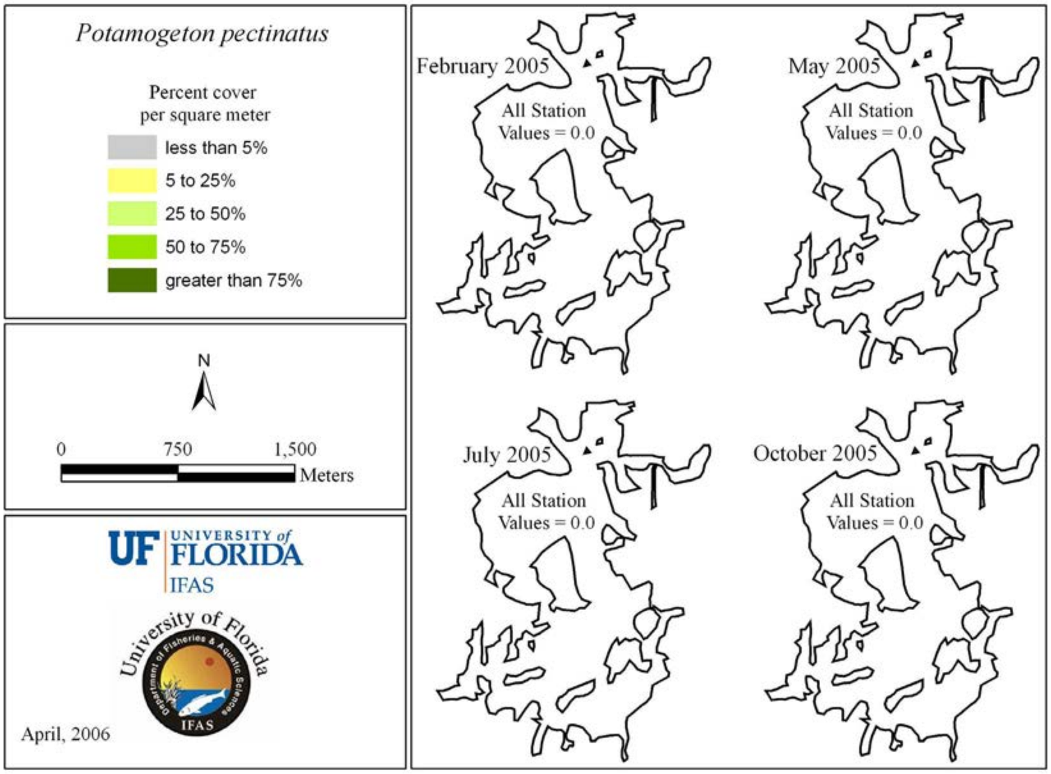

Hydrilla verticillata
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005

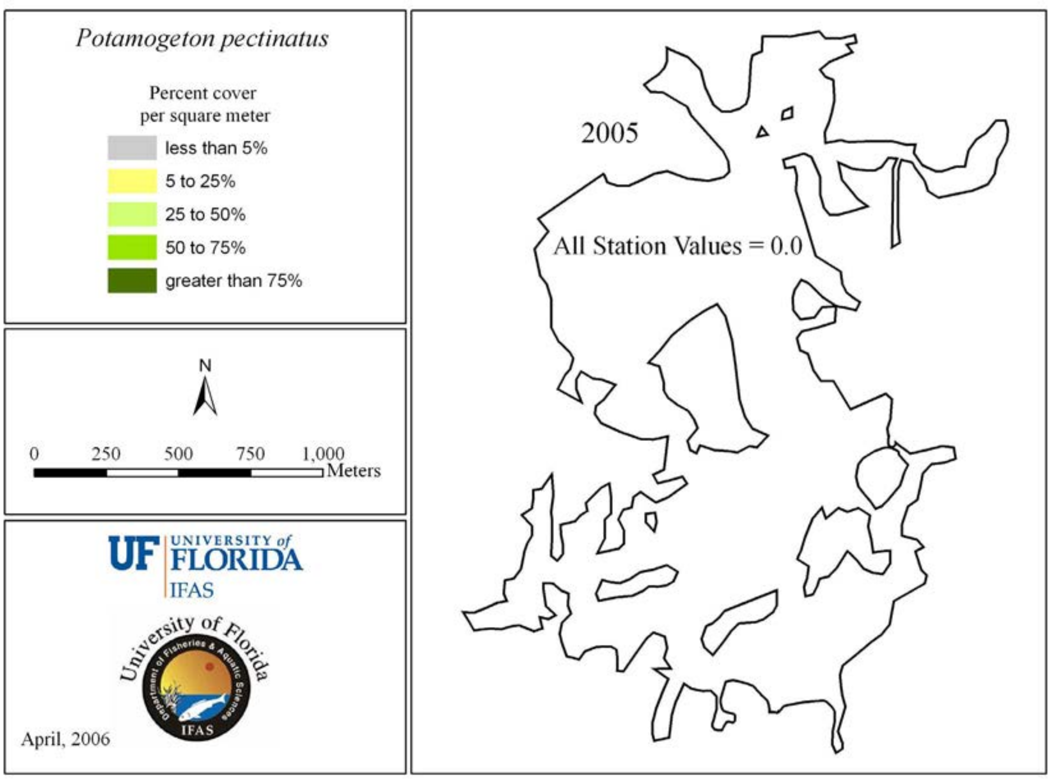

Myriophyllum spicatum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

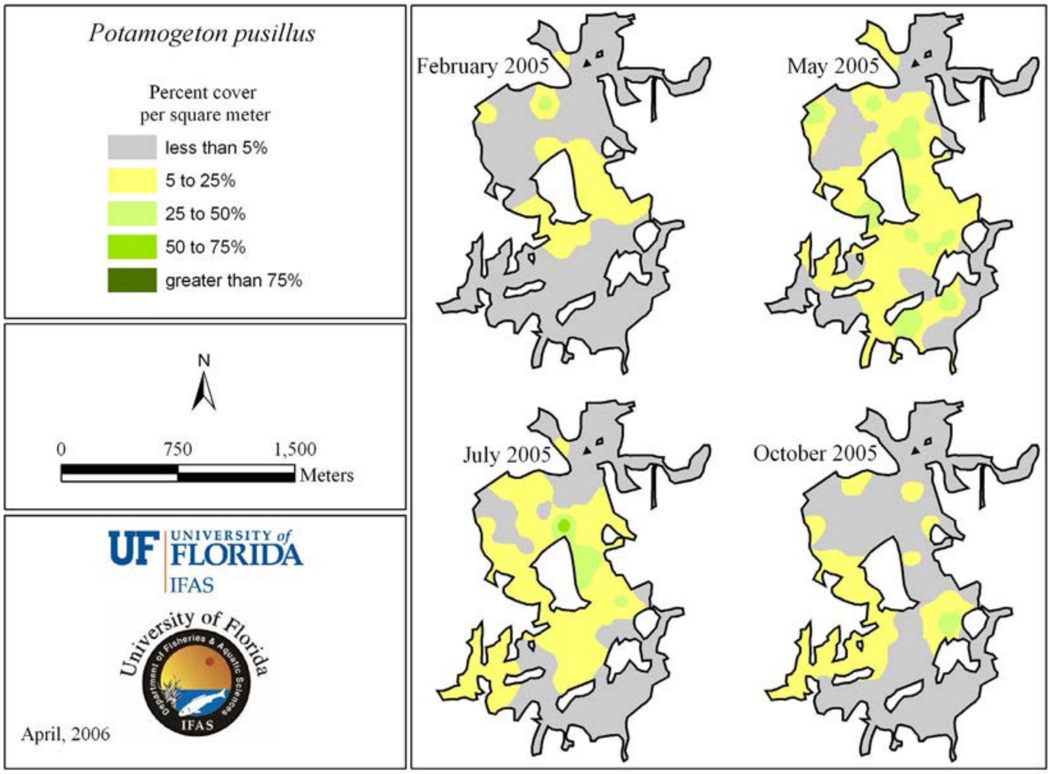

Myriophyllum spicatum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2005

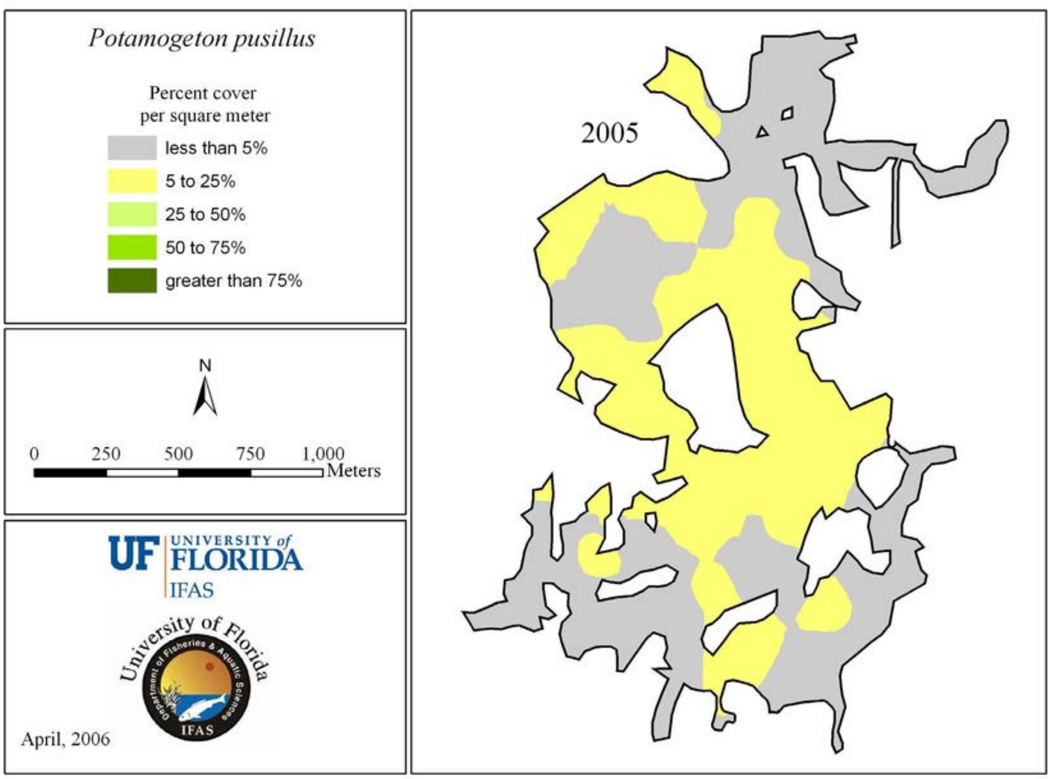

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005

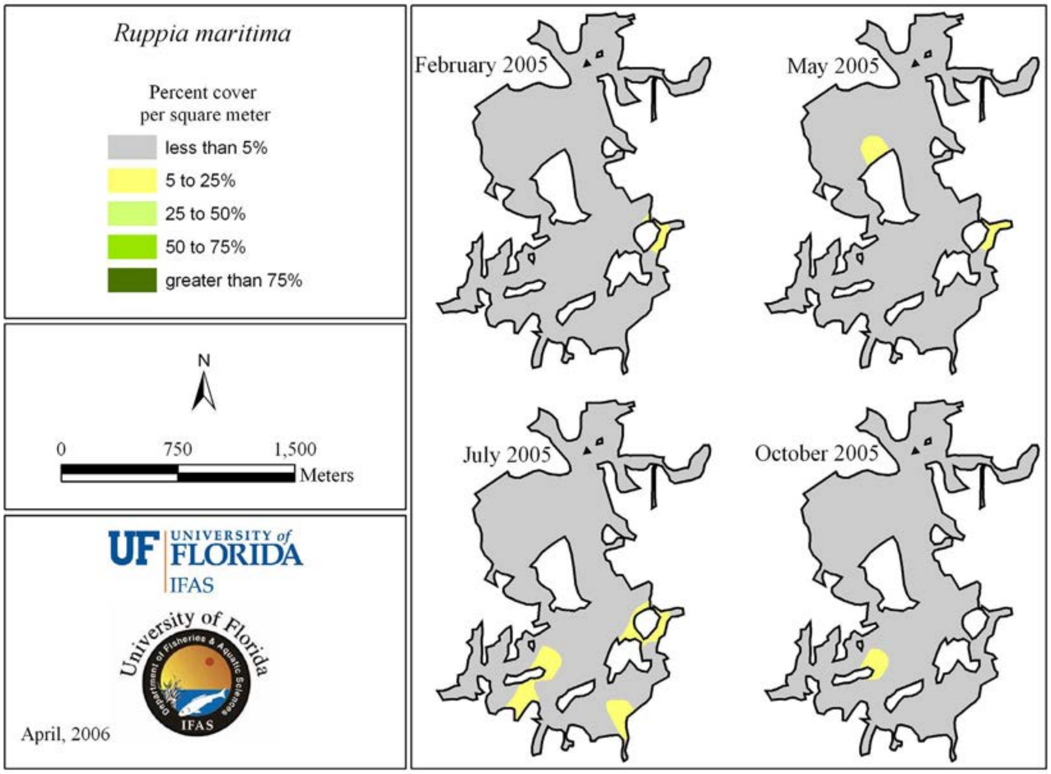

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005

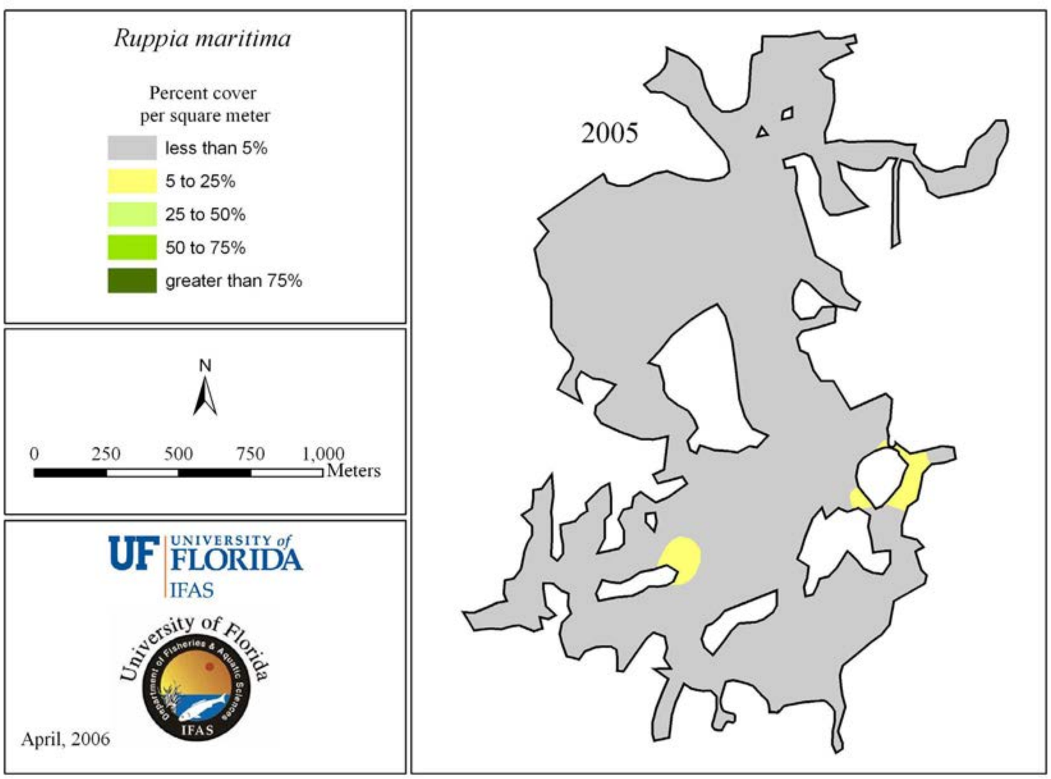

Potamogeton pectinatus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
All Station
Values = 0.0
May 2005
All Station
Values = 0.0
July 2005
All Station
Values = 0.0
October 2005
All Station
Values = 0.0

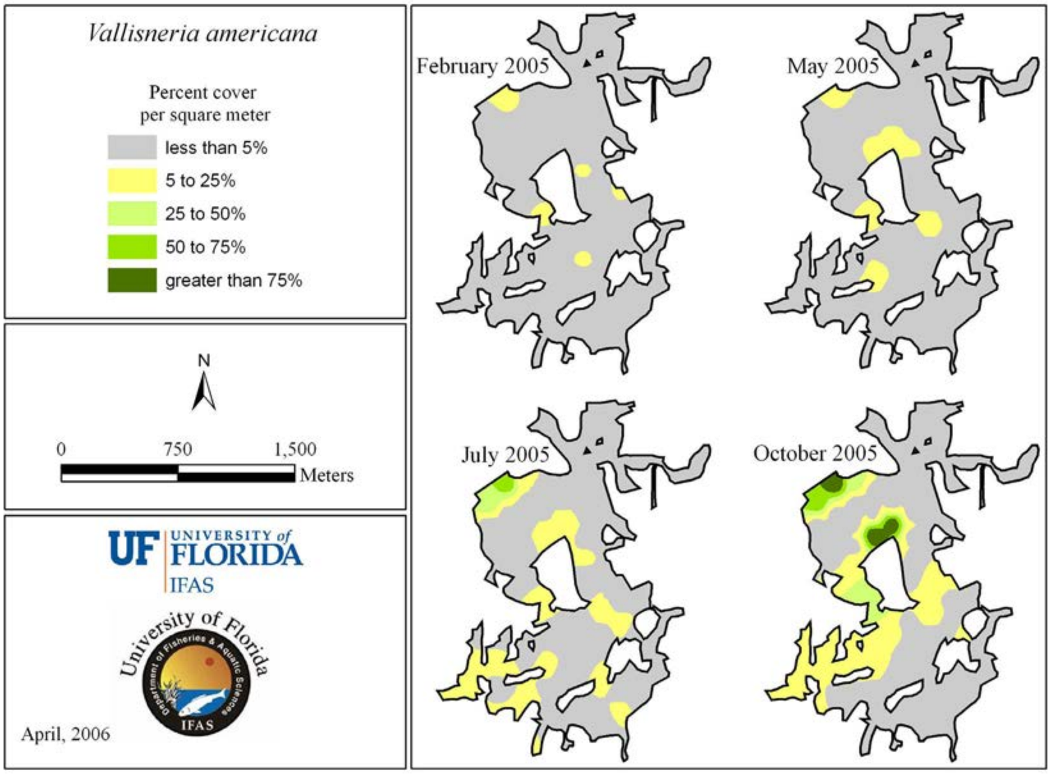

Potamogeton pectinatus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005
All Station Values = 0.0

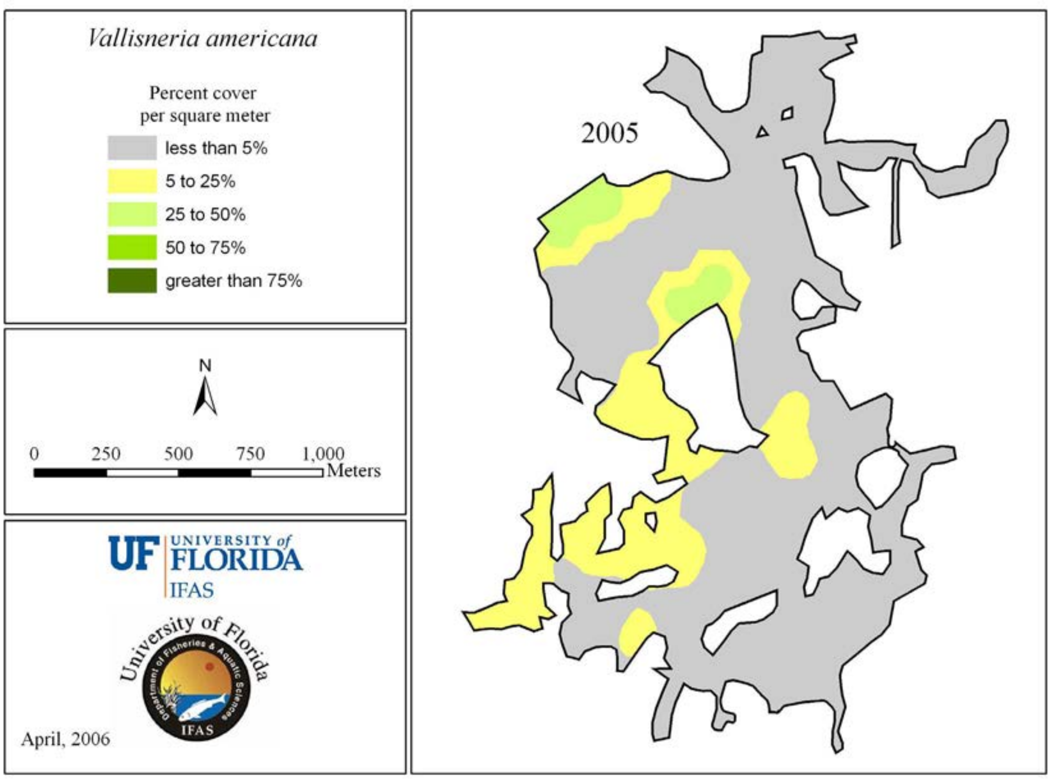

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

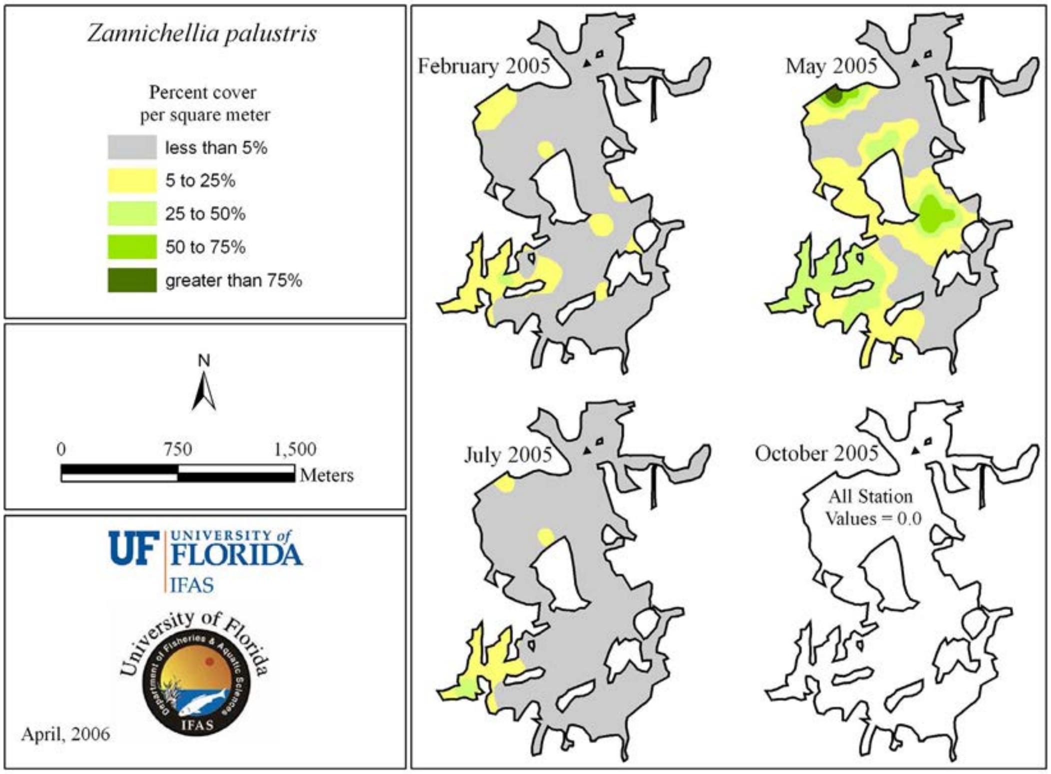

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2005

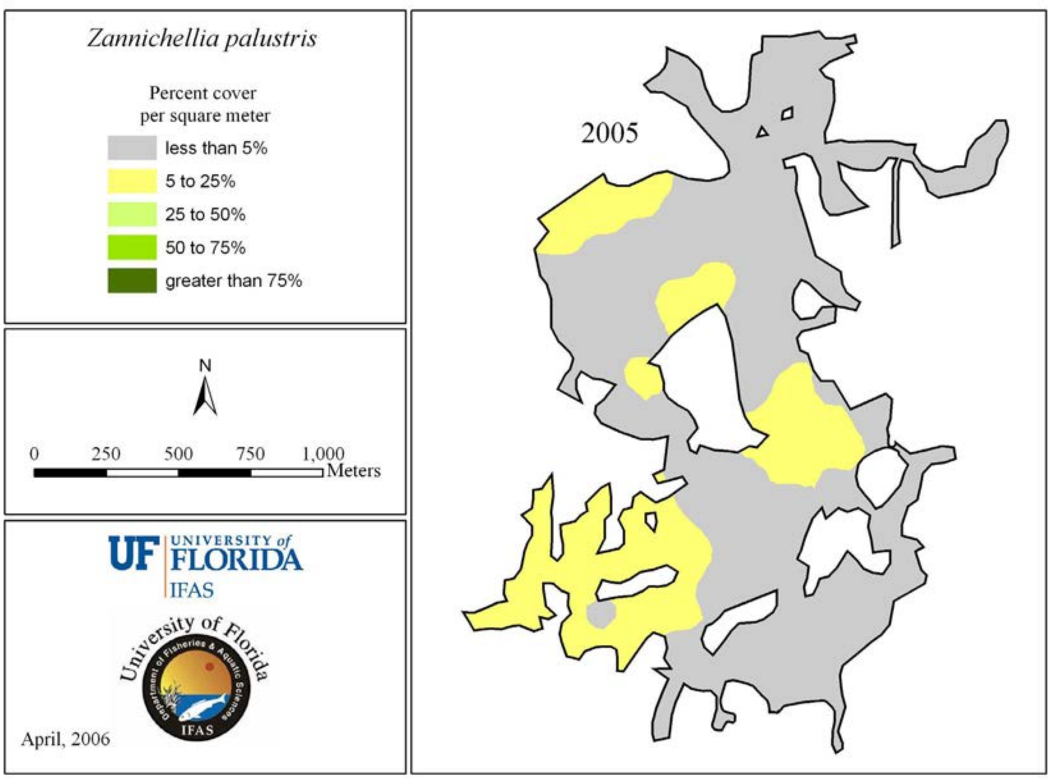

Ruppia maritima
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

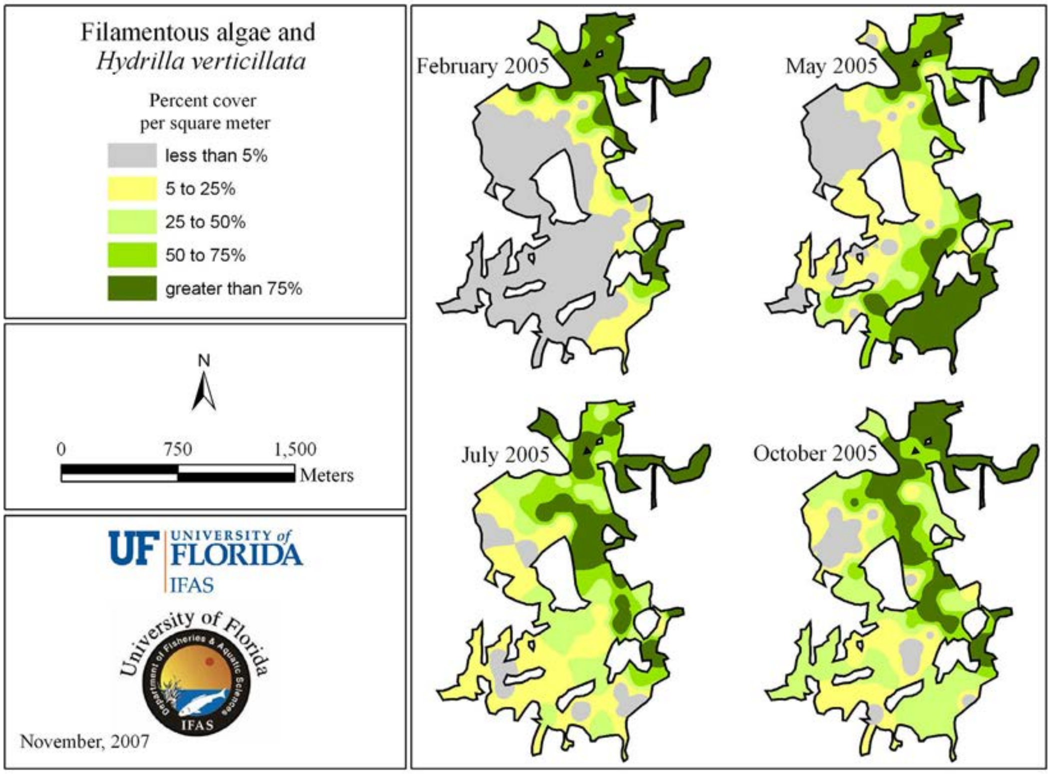

Ruppia maritima
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

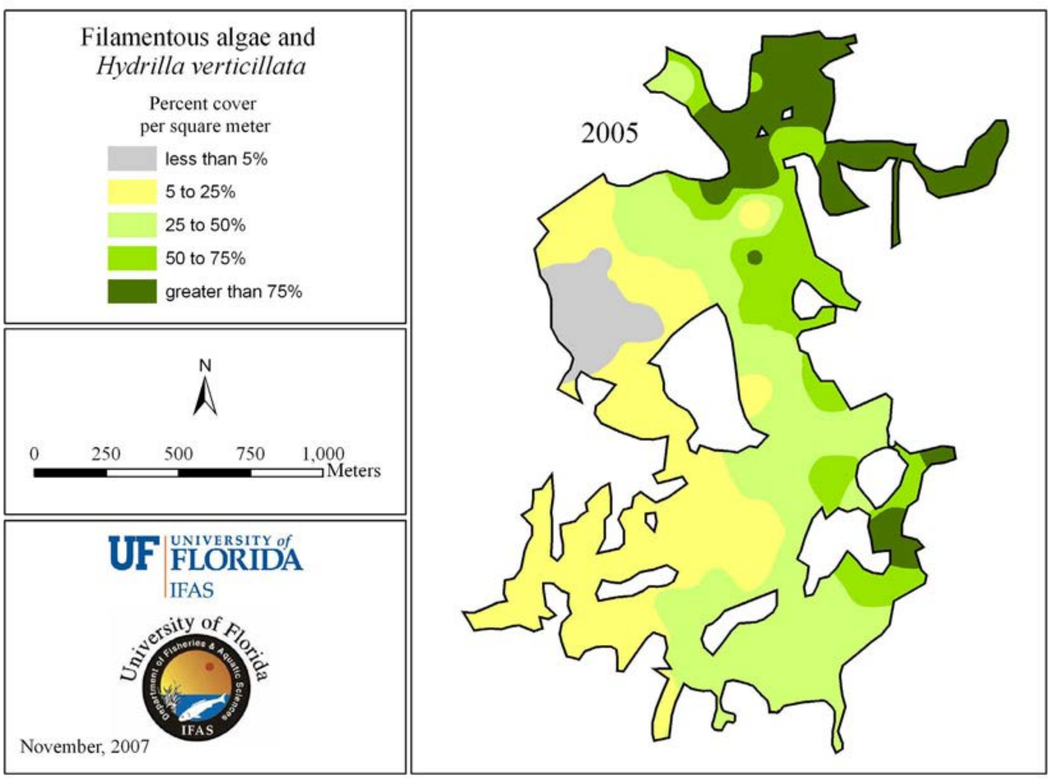

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

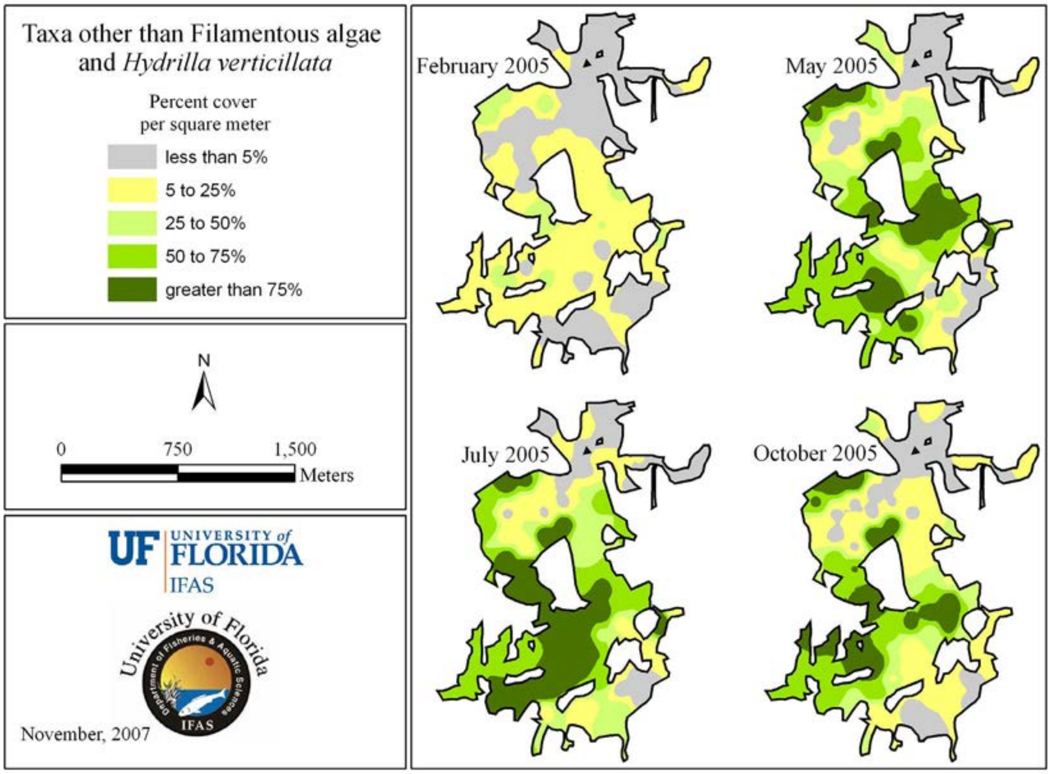

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

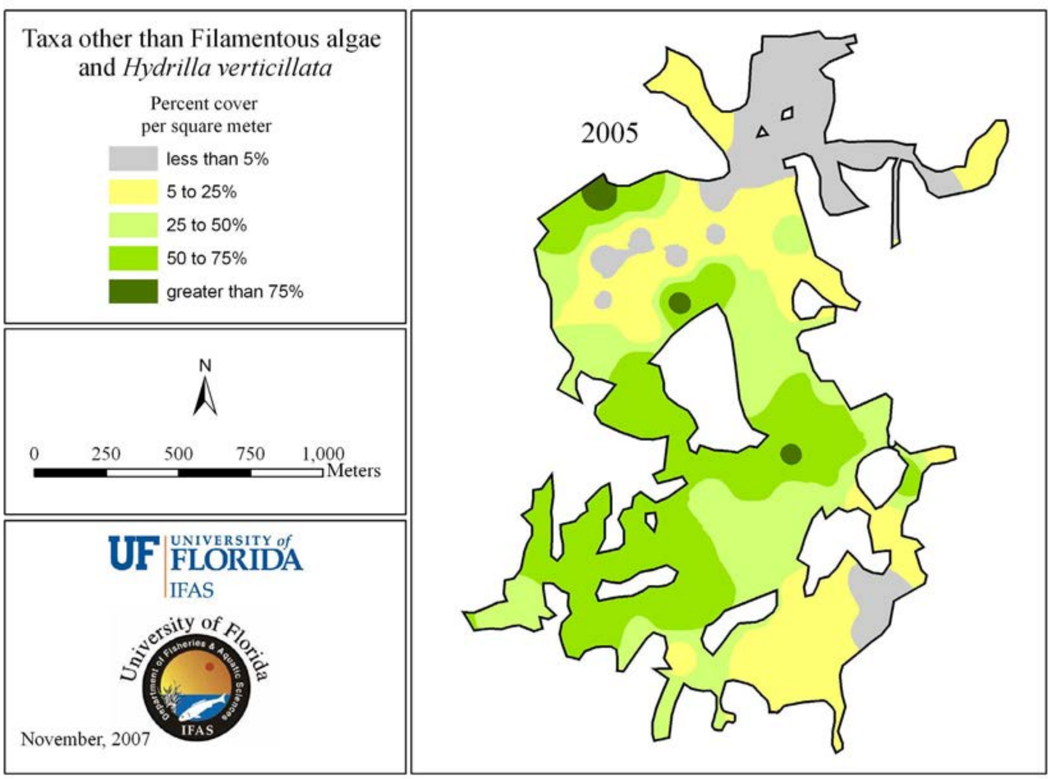

Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005
All Station
Values = 0.0

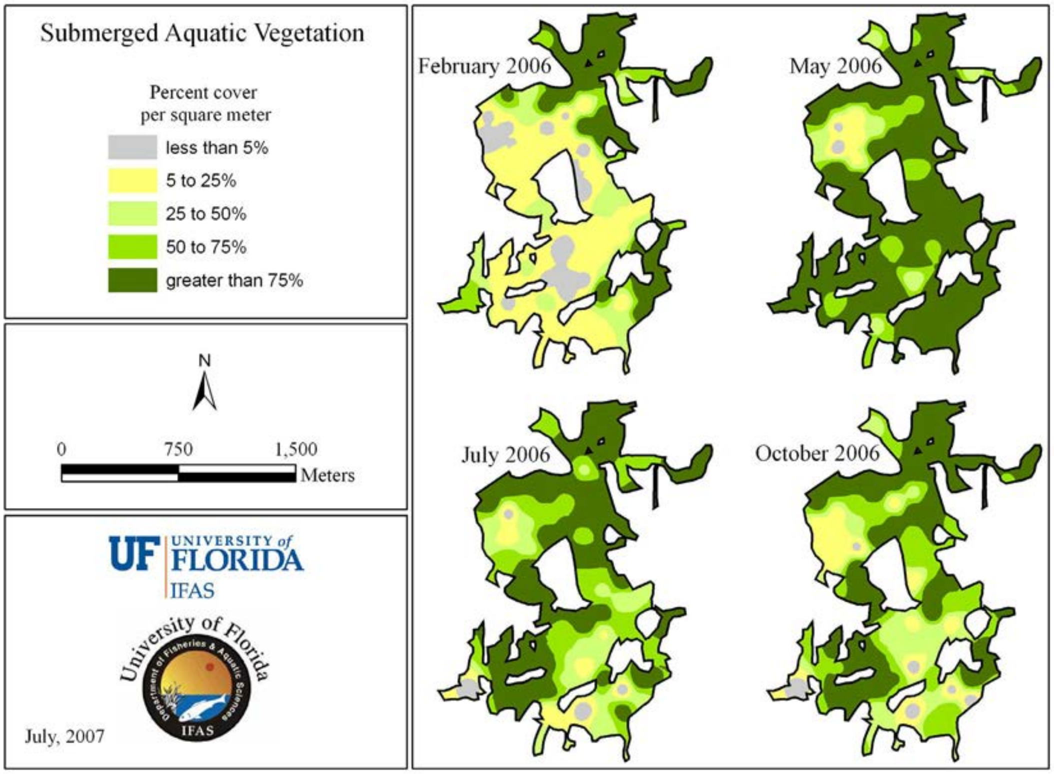

Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2005

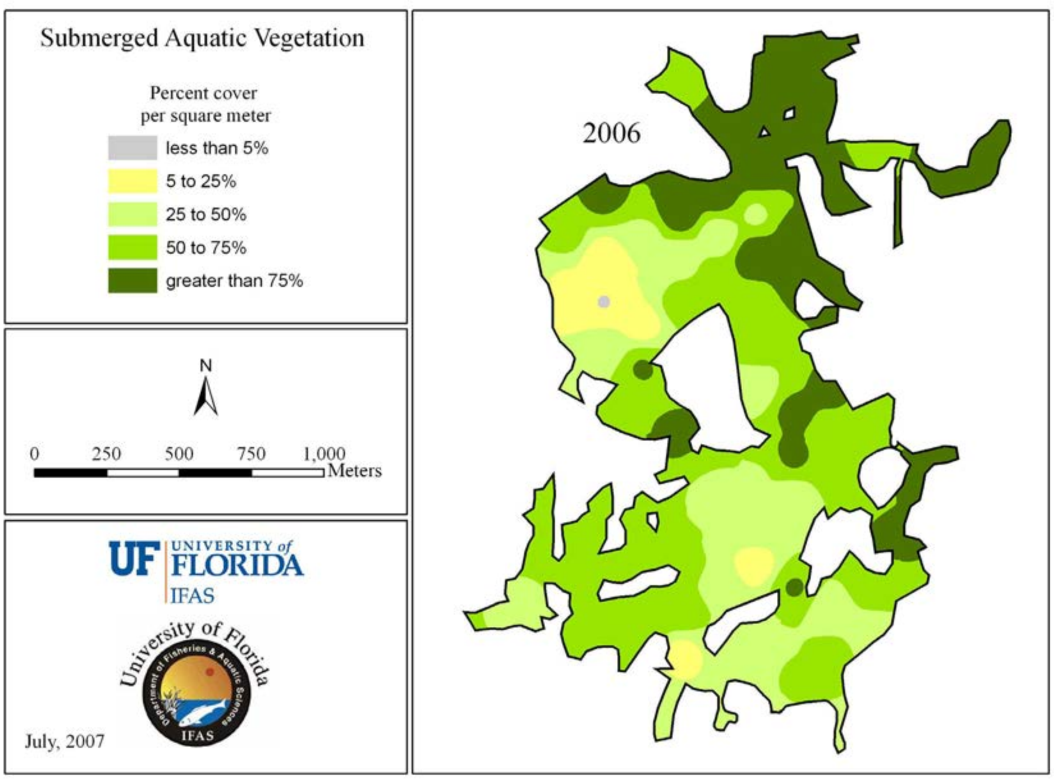

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
February 2005
May 2005
July 2005
October 2005

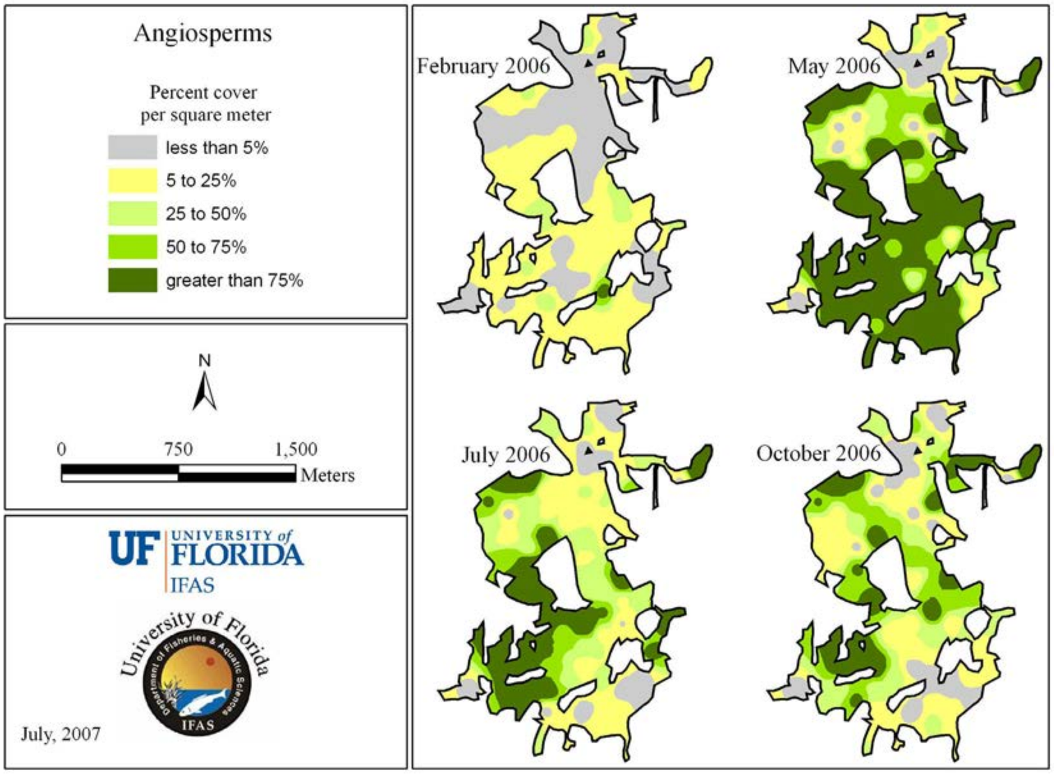

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
2005

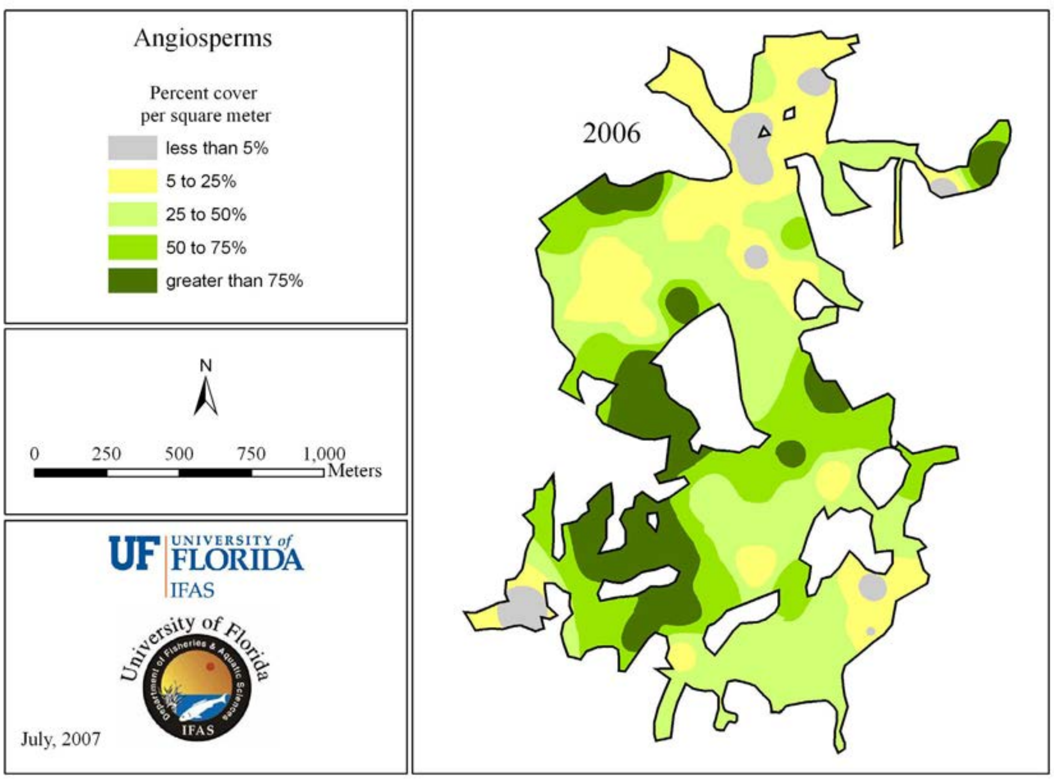

Taxa other than Filamentous algae and *Hydrilla verticillata*
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
February 2005
May 2005
July 2005
October 2005

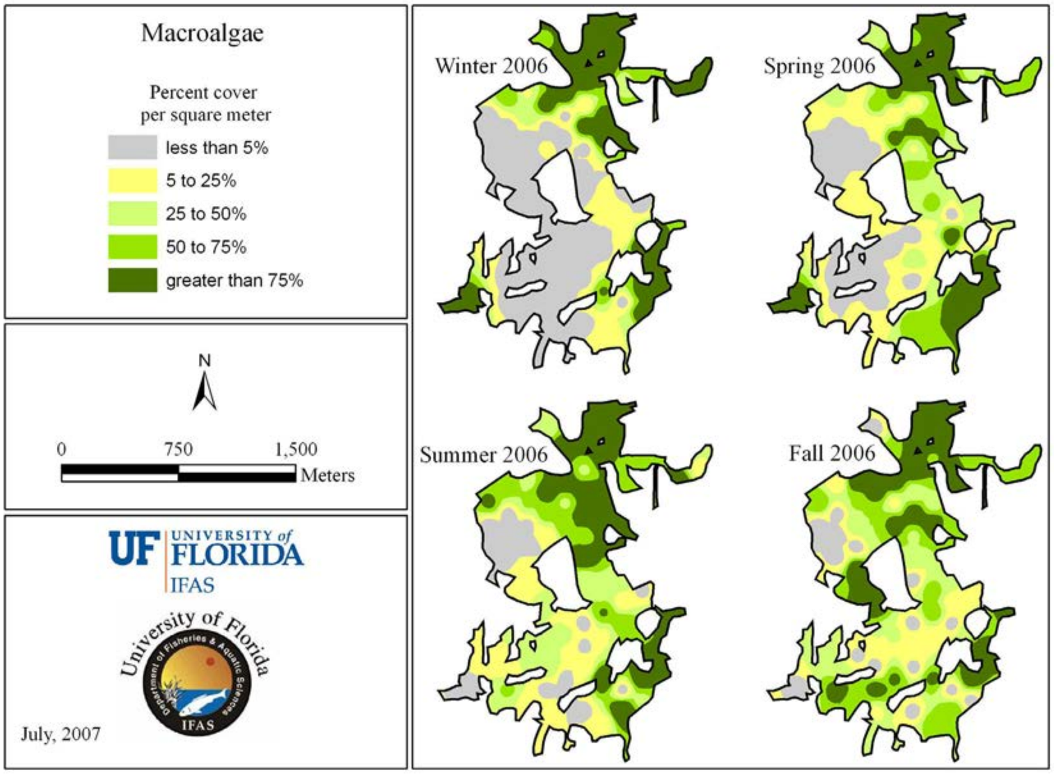

Taxa other than Filamentous algae and *Hydrilla verticillata*
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
2005

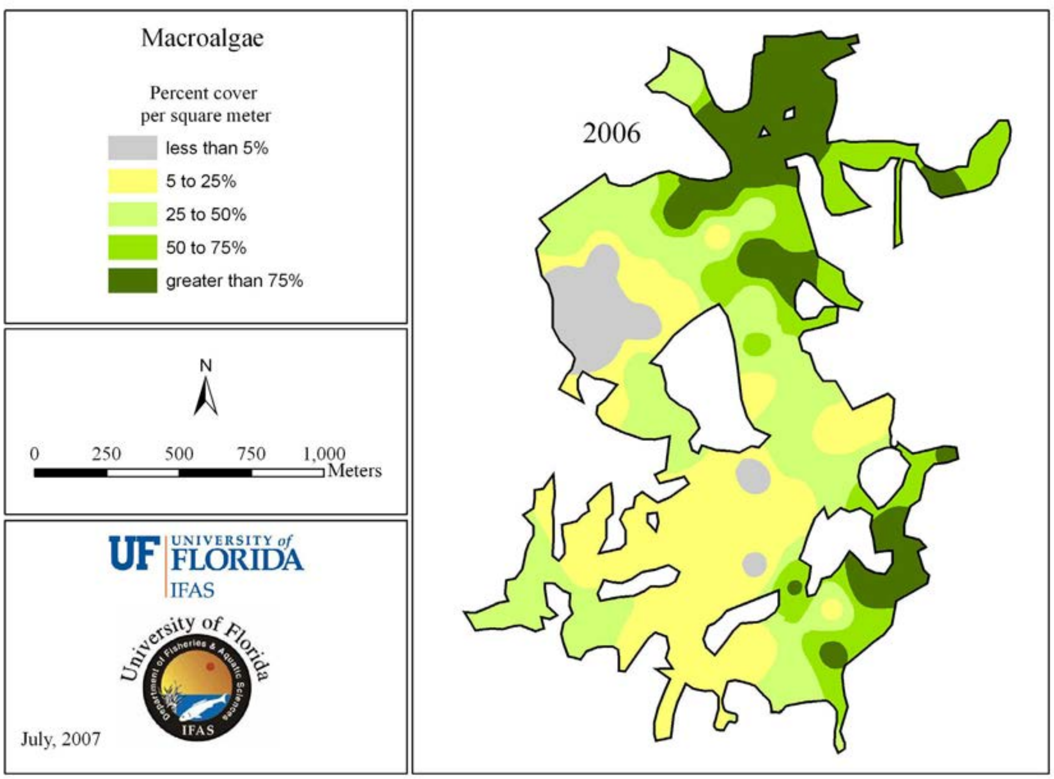

Submerged Aquatic Vegetation
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

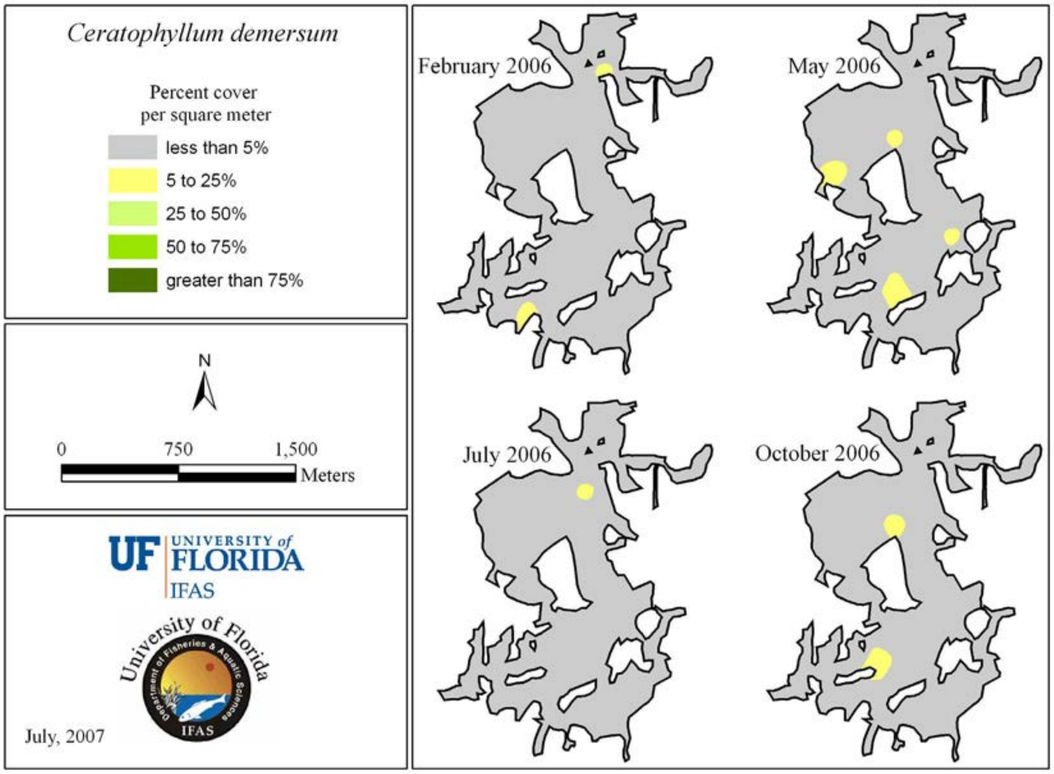

Submerged Aquatic Vegetation
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
2006

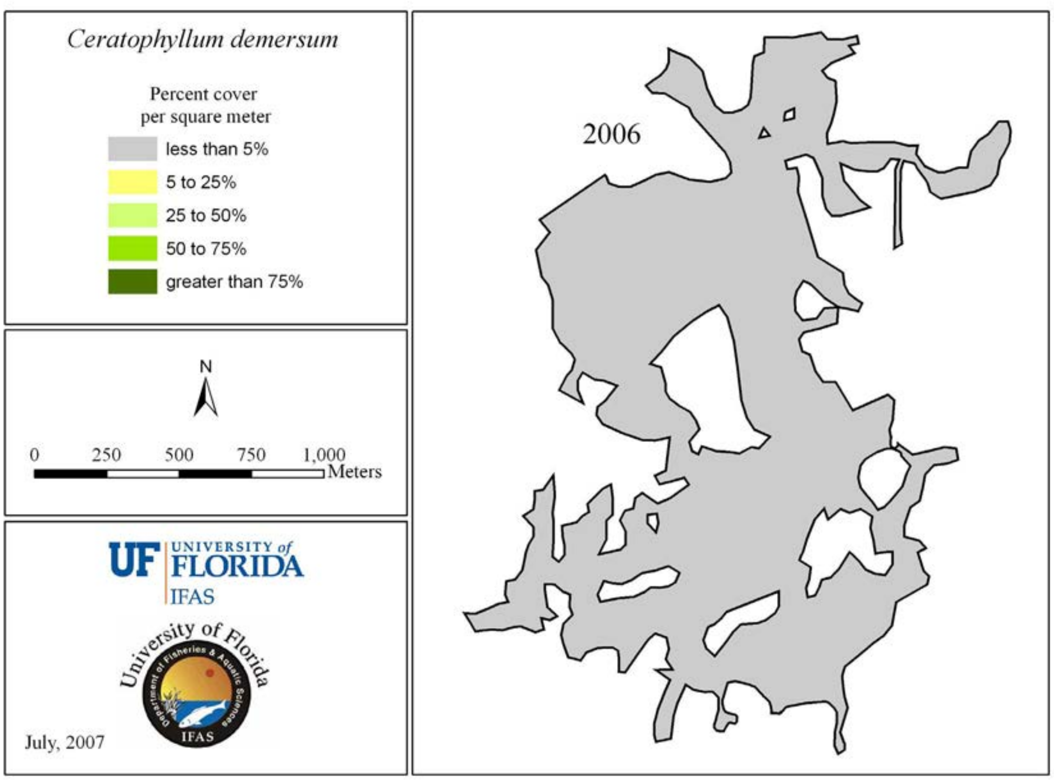

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

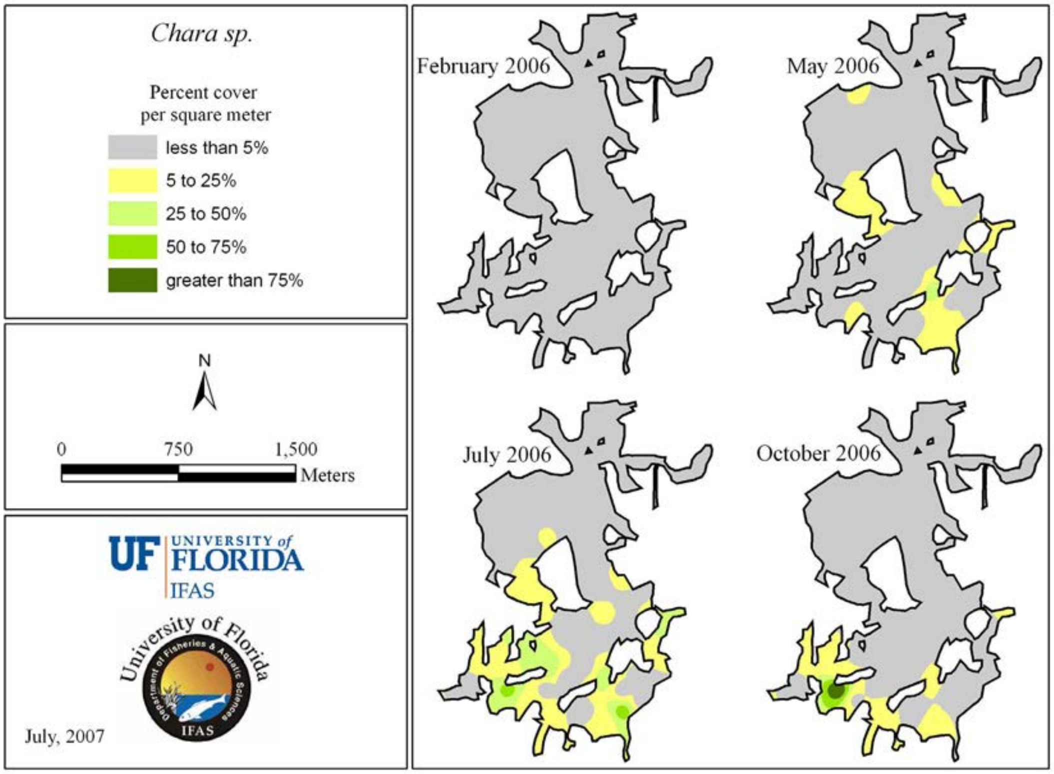

Angiosperms
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

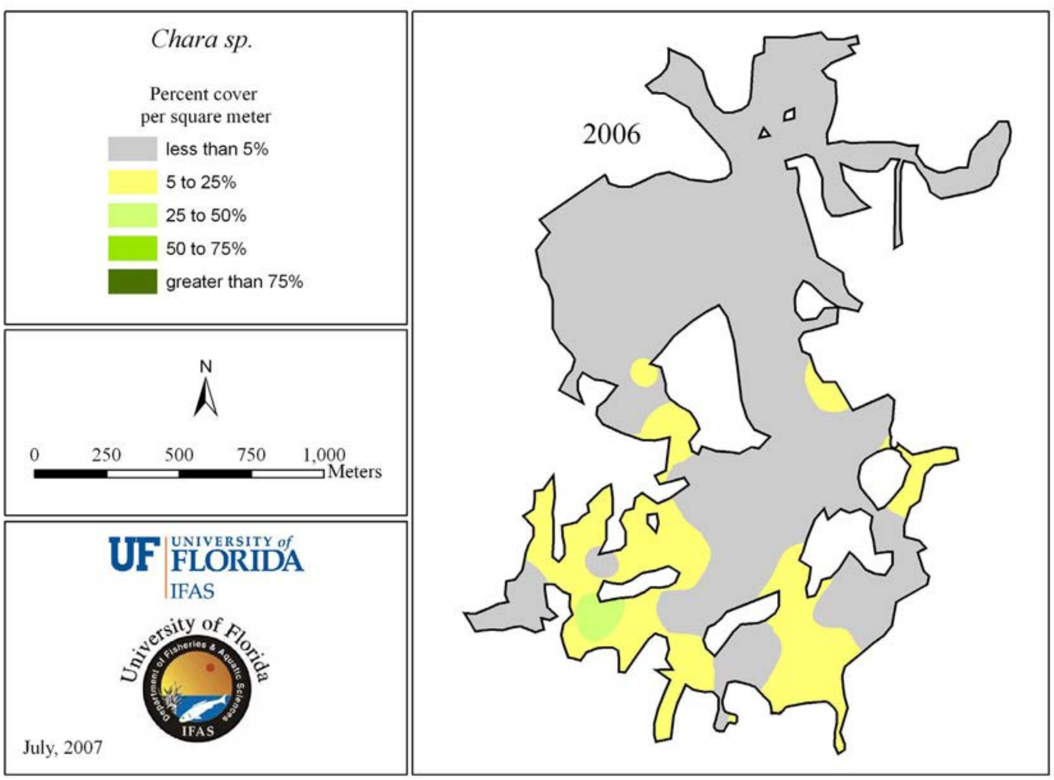

Macroalgae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
Winter 2006
Spring 2006
Summer 2006
Fall 2006

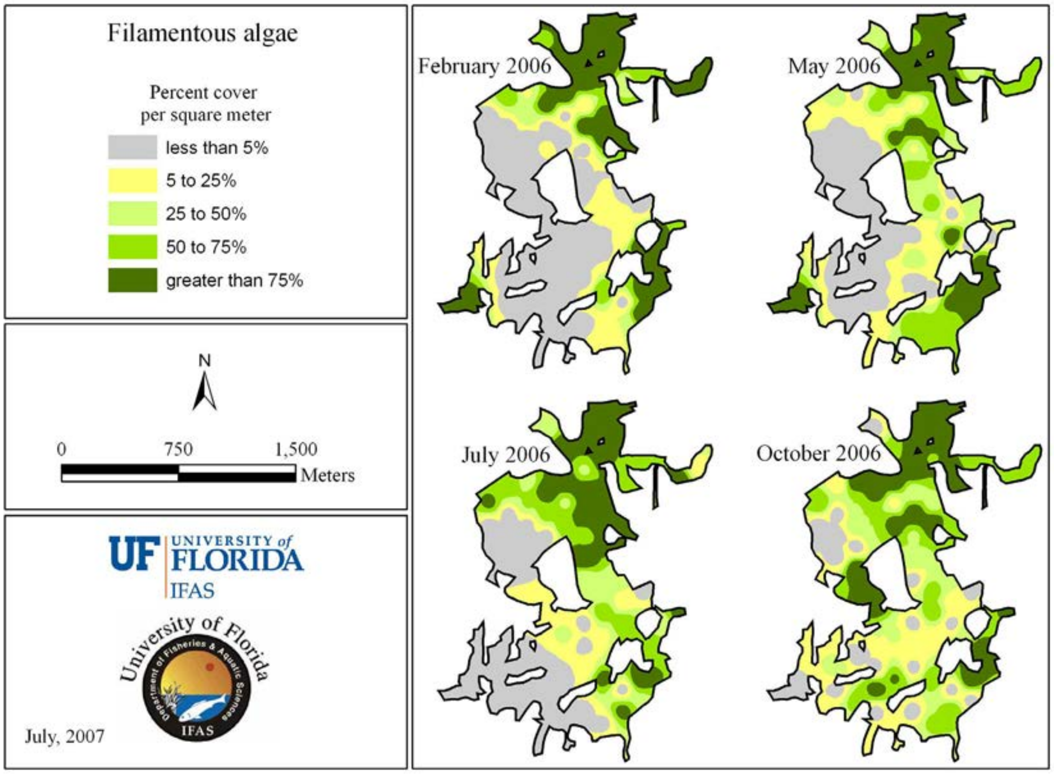

Macroalgae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

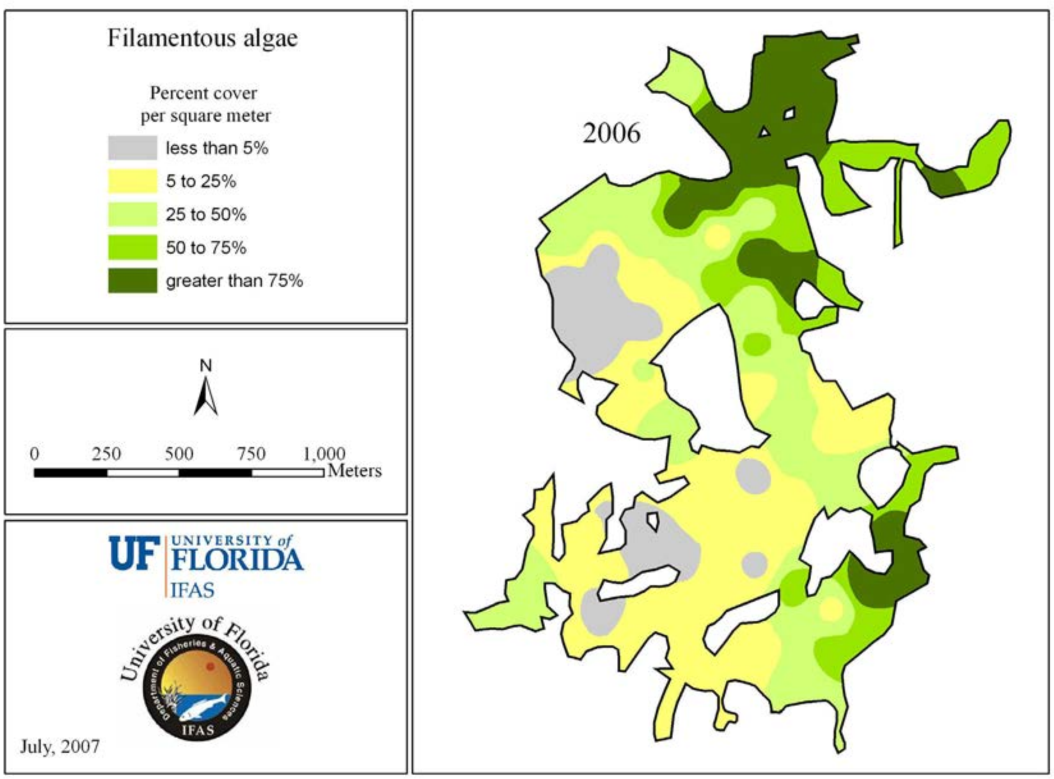

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

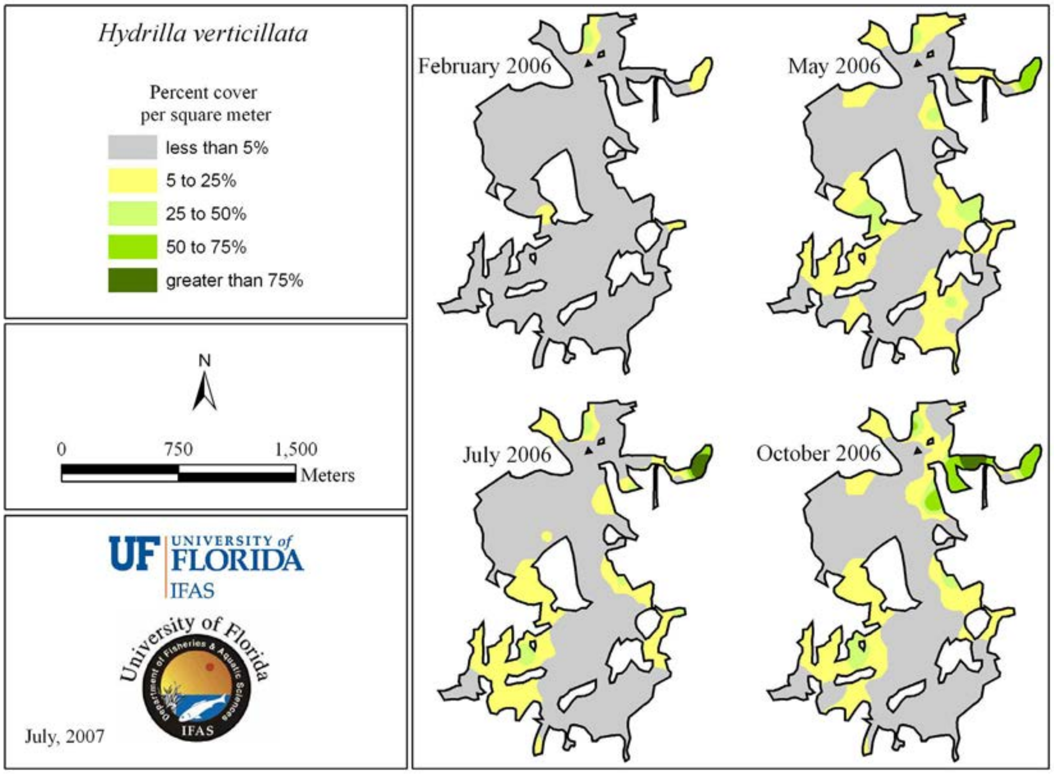

Ceratophyllum demersum
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UNIVERSITY of FLORIDA
IFAS
July, 2007
2006

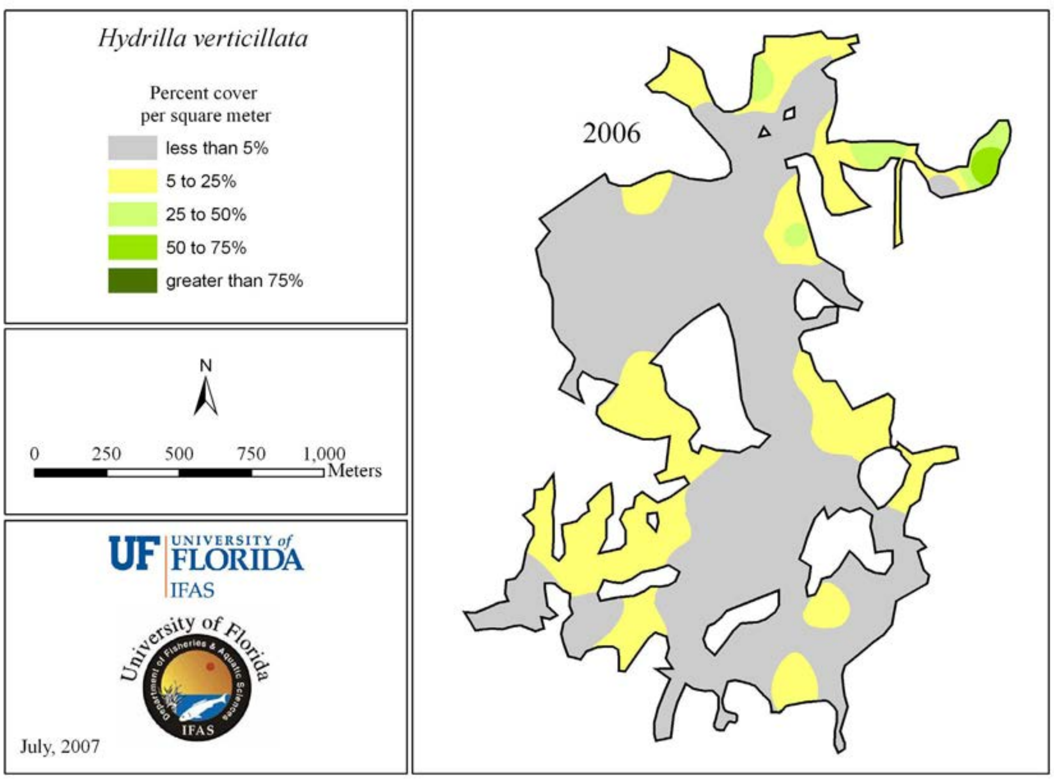

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0 750 1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

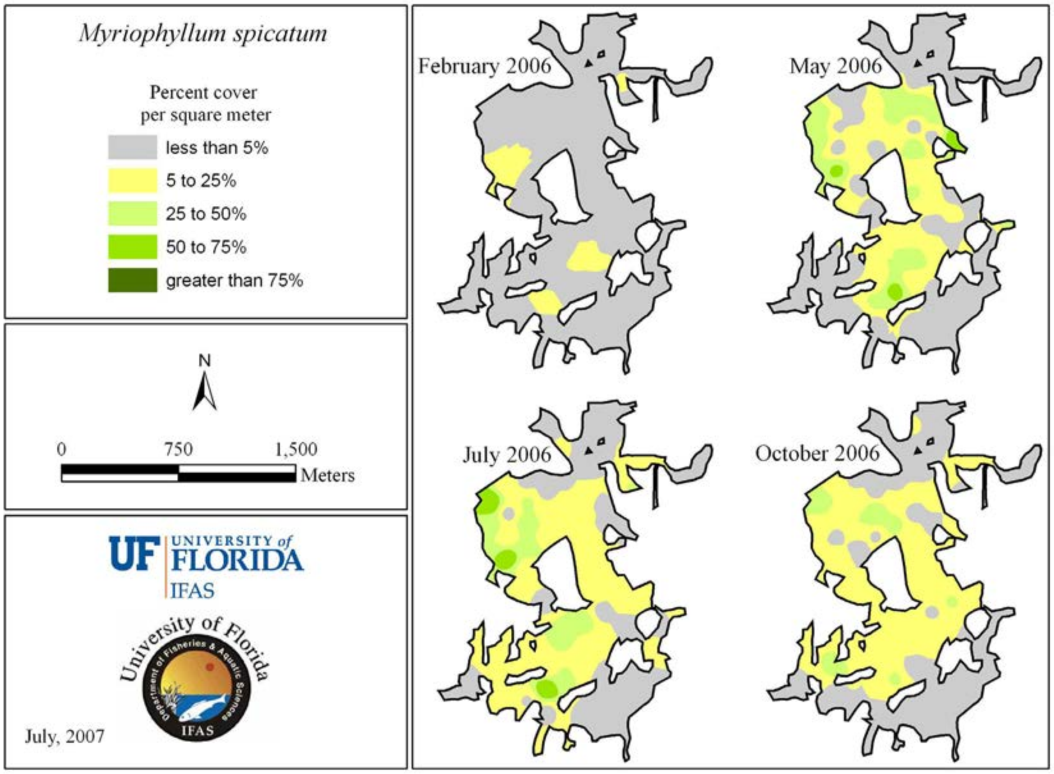

Chara sp.
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0 250 500 750 1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
2006

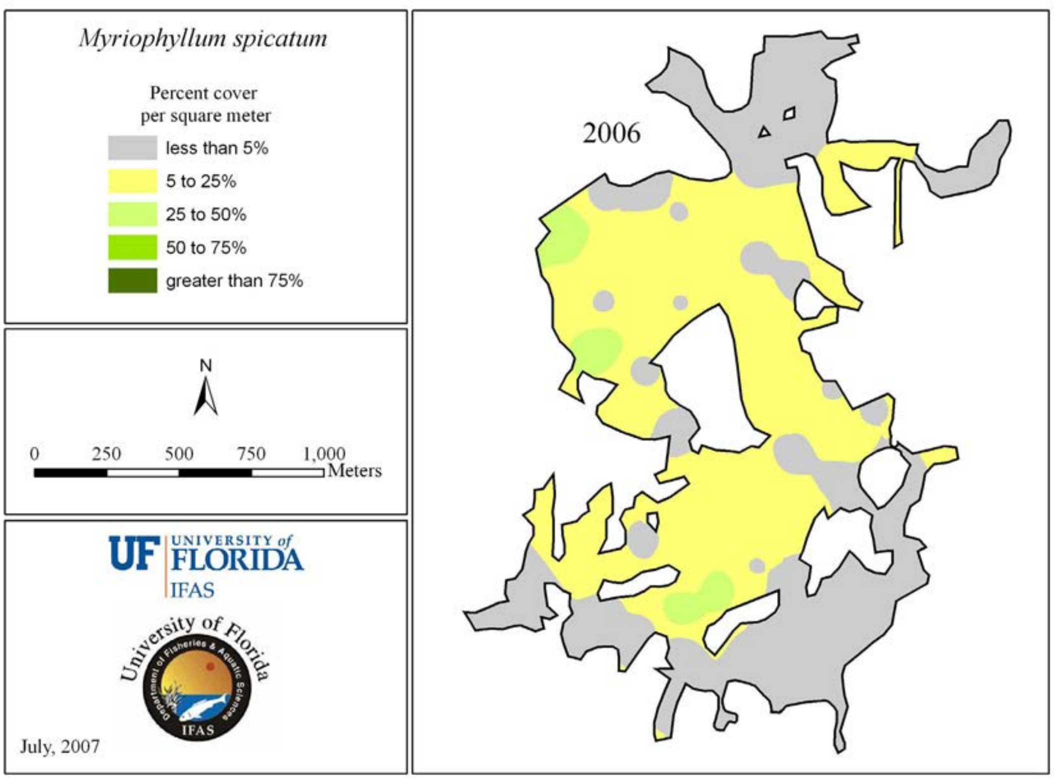

Filamentous algae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

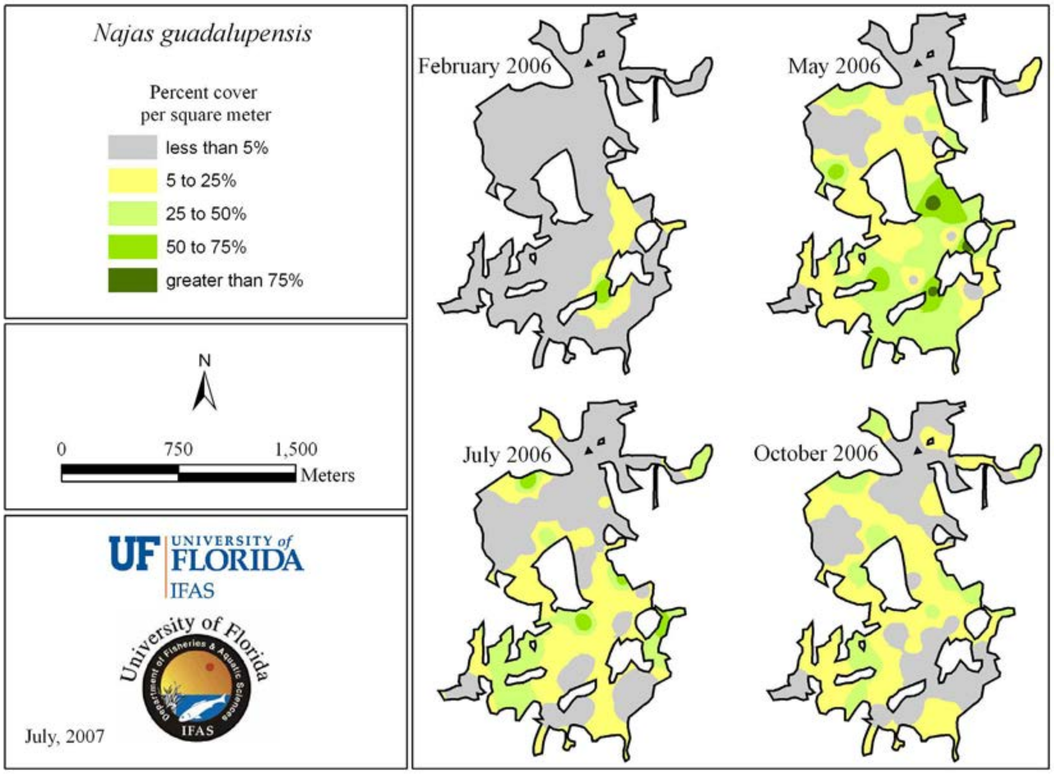

Filamentous algae
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

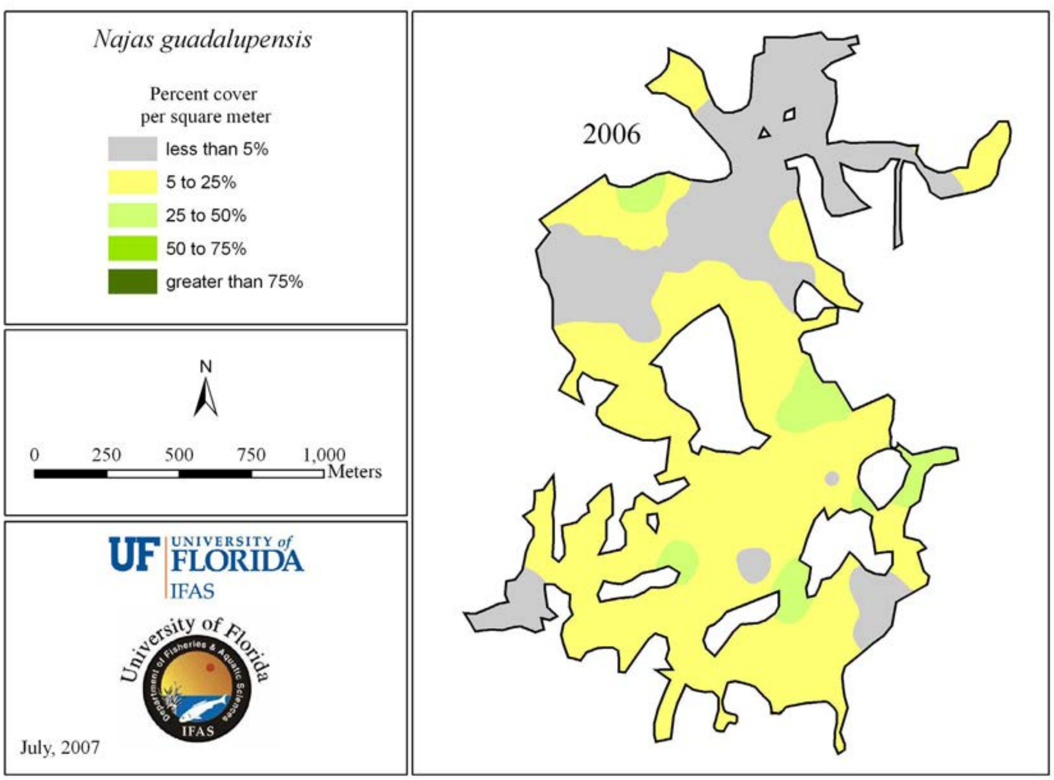

Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

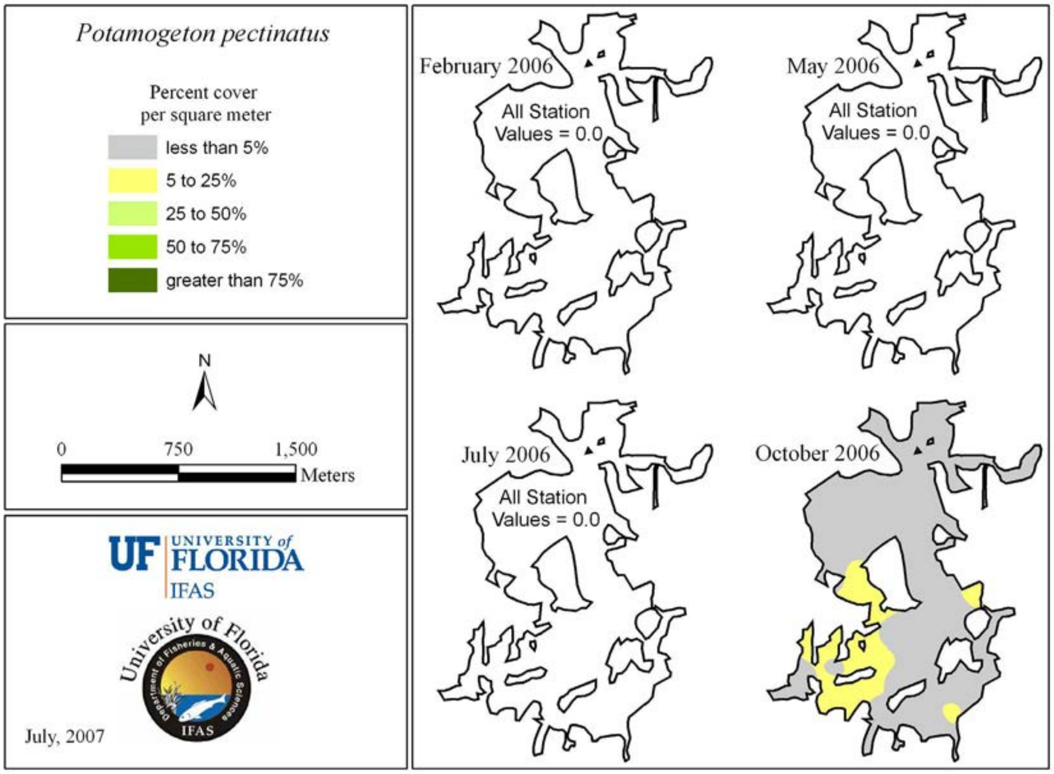

Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

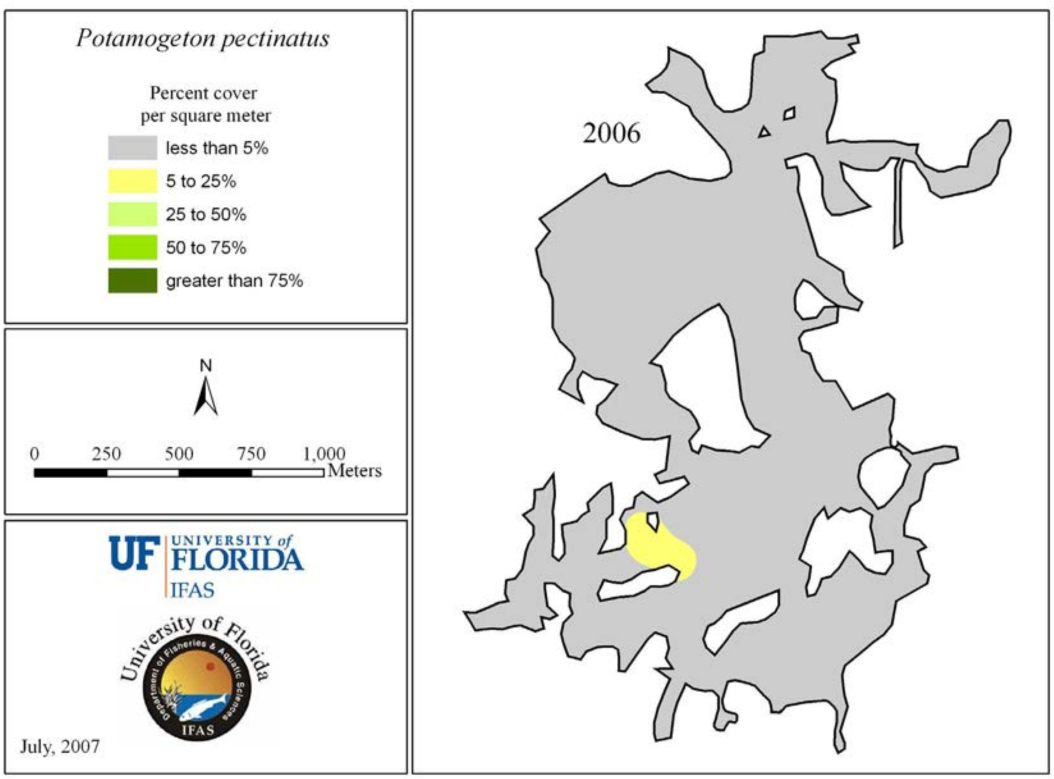

Myriophyllum spicatum
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

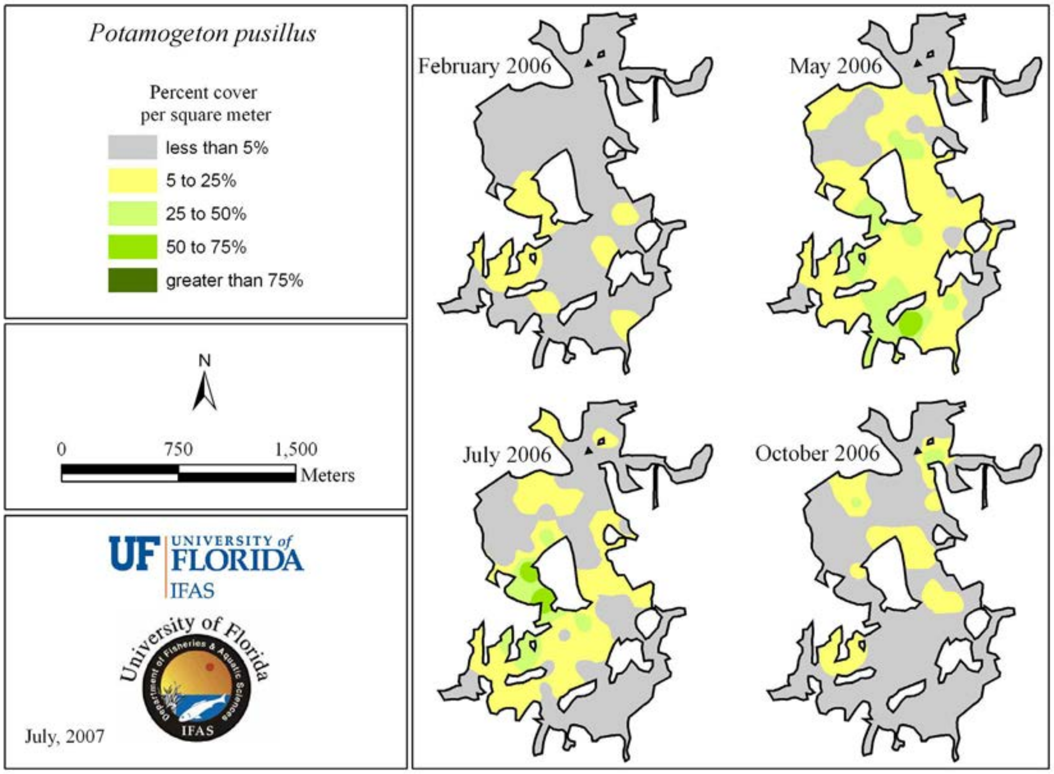

Myriophyllum spicatum
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

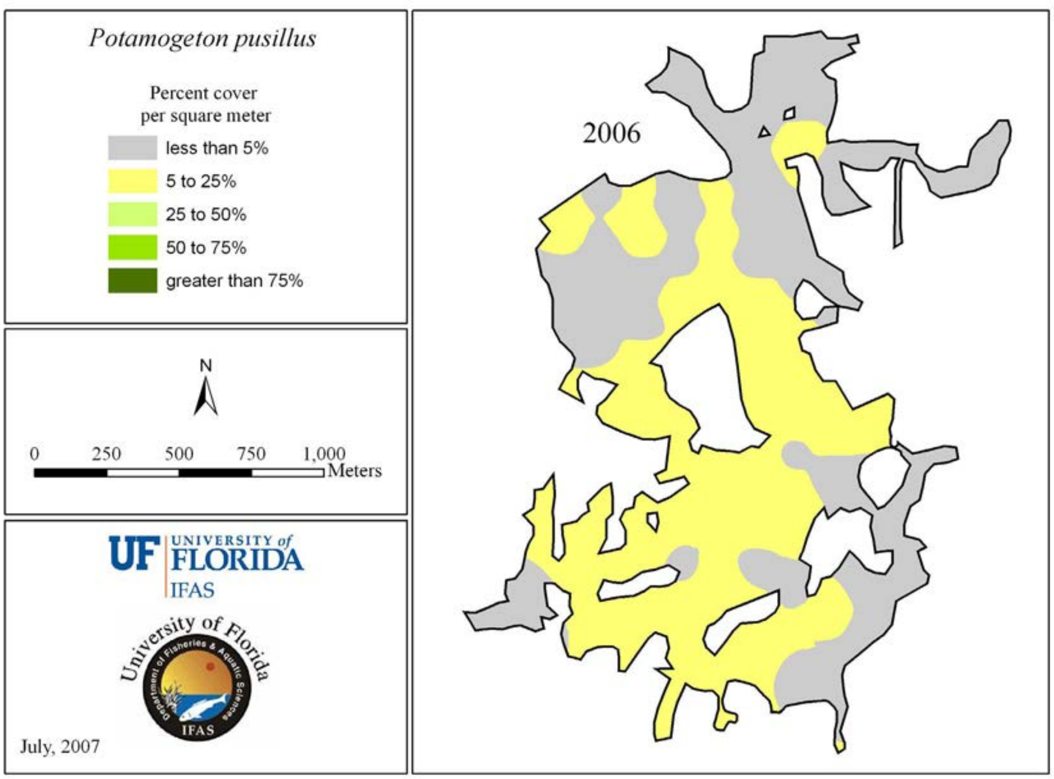

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UNIVERSITY of
FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

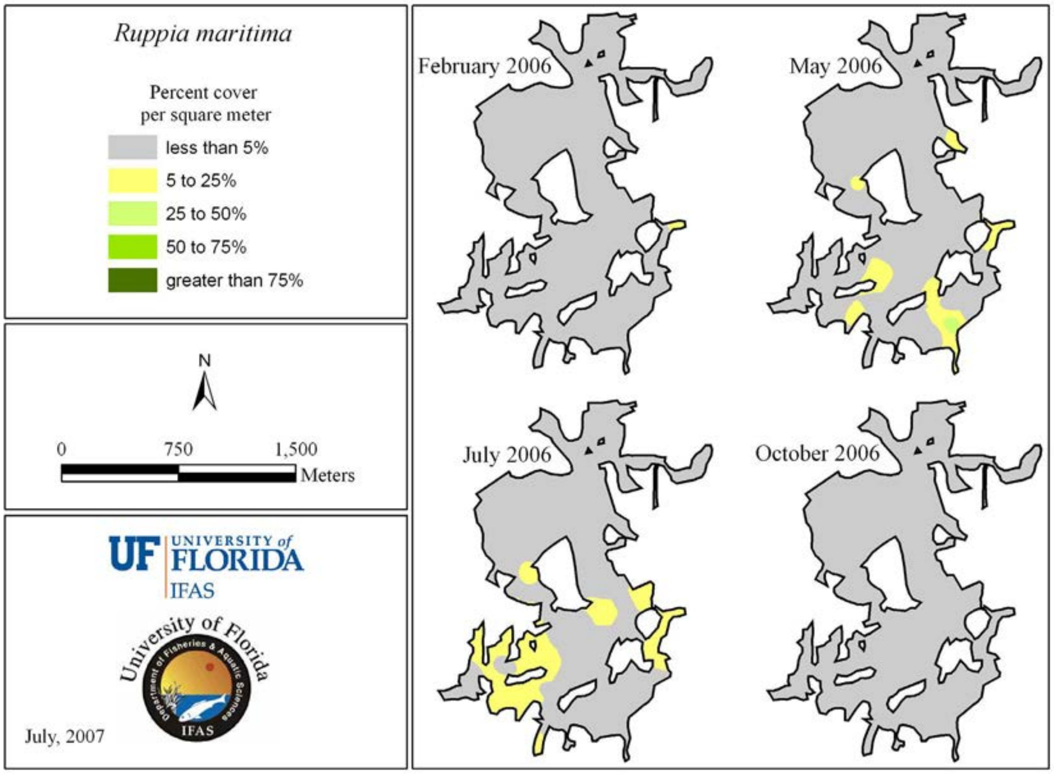

Najas guadalupensis
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UNIVERSITY of
FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

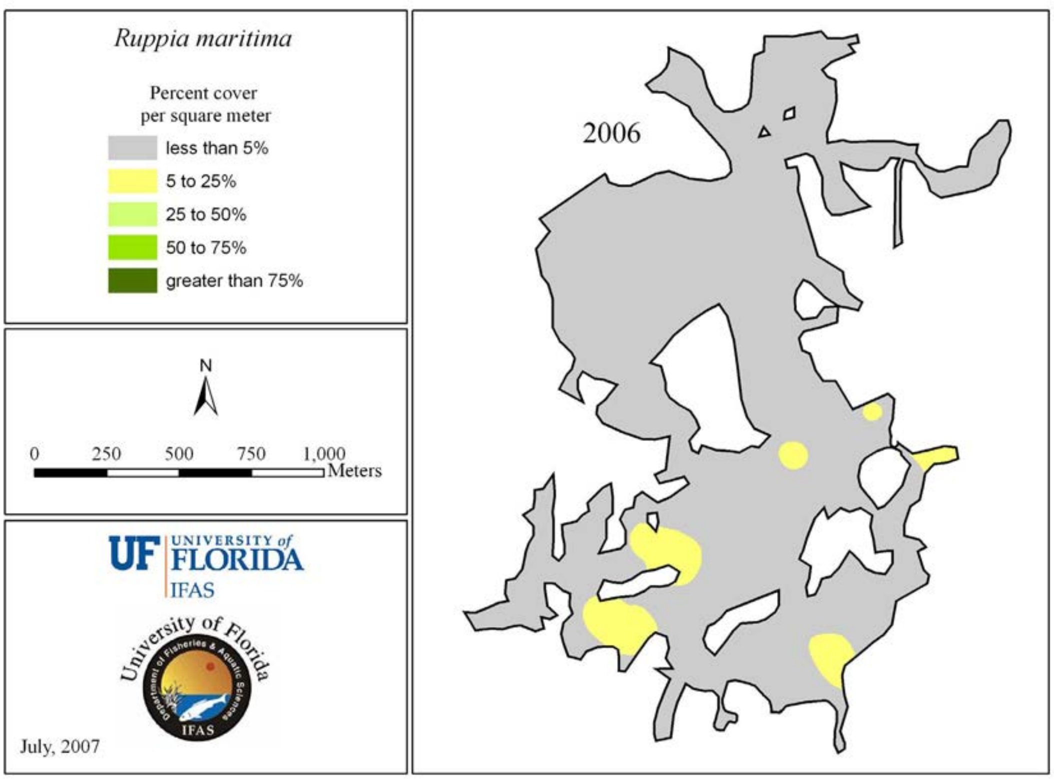

Potamogeton pectinatus
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0 750 1,500 Meters
UF UNIVERSITY of FLORIDA IFAS
University of Florida
July, 2007
February 2006
All Station Values = 0.0
May 2006
All Station Values = 0.0
July 2006
All Station Values = 0.0
October 2006

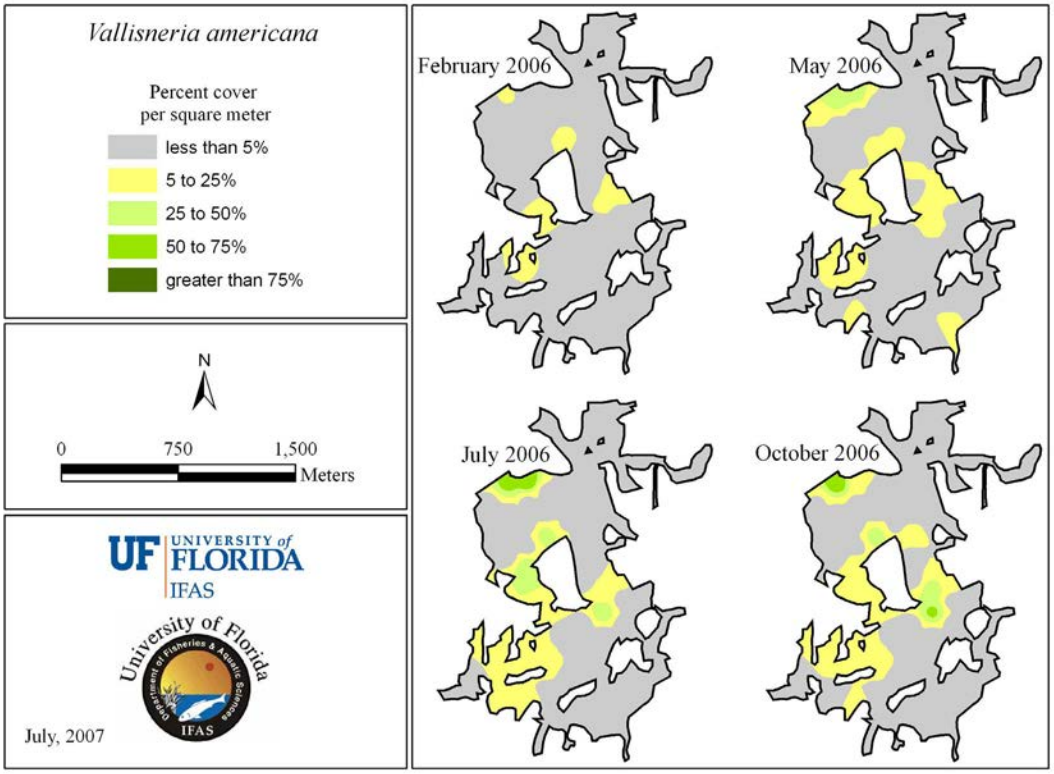

Potamogeton pectinatus
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0 250 500 750 1,000 Meters
UF UNIVERSITY of FLORIDA IFAS
University of Florida
July, 2007
2006

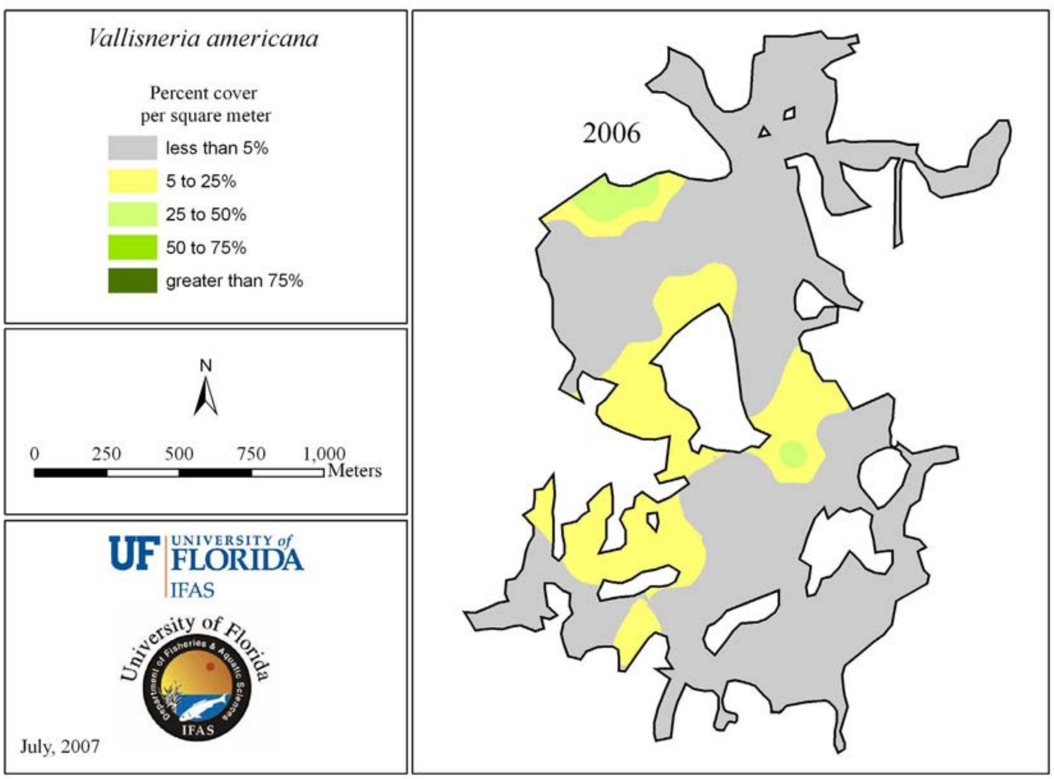

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

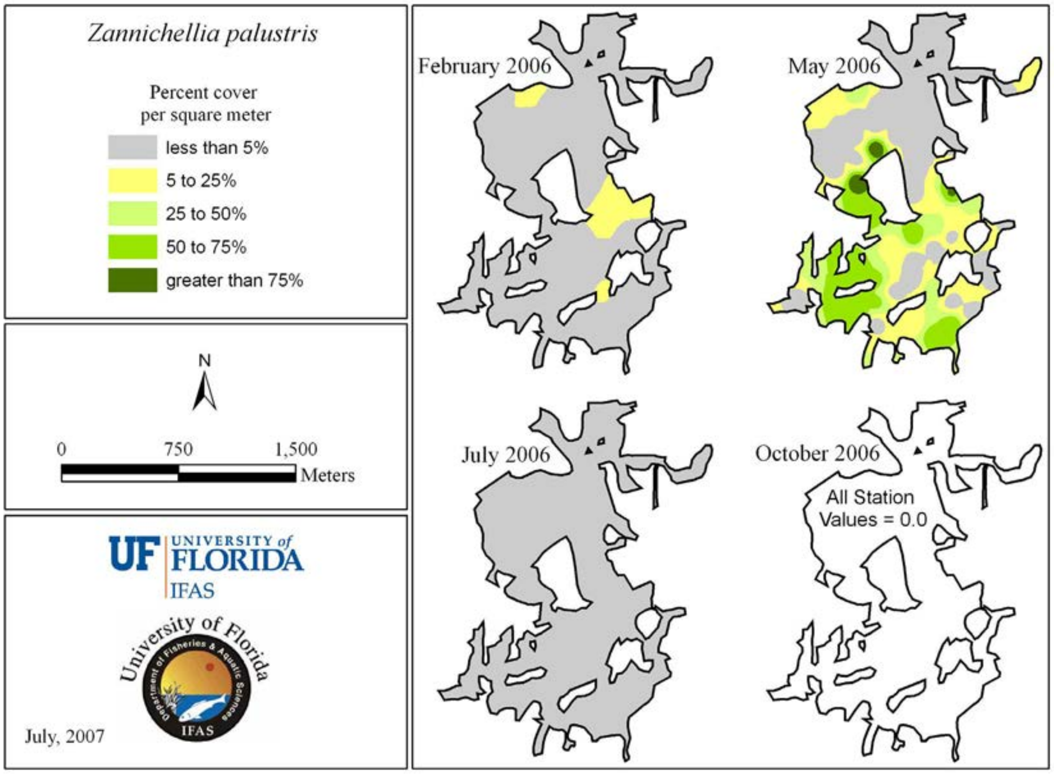

Potamogeton pusillus
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

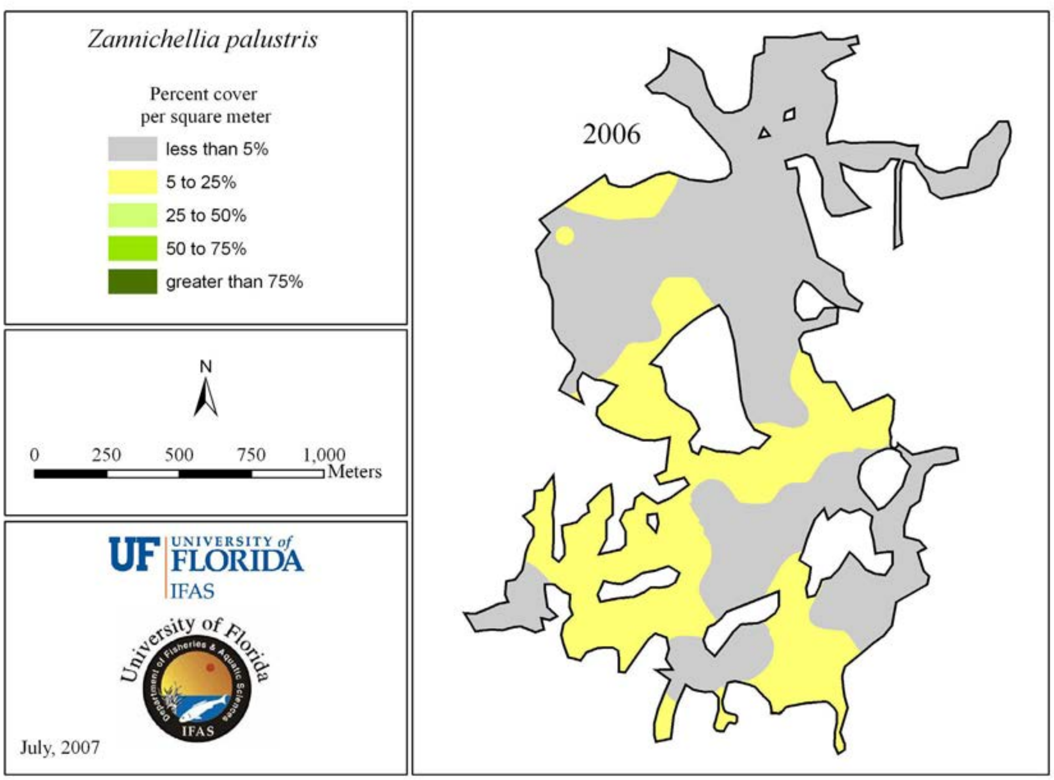

Ruppia maritima
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

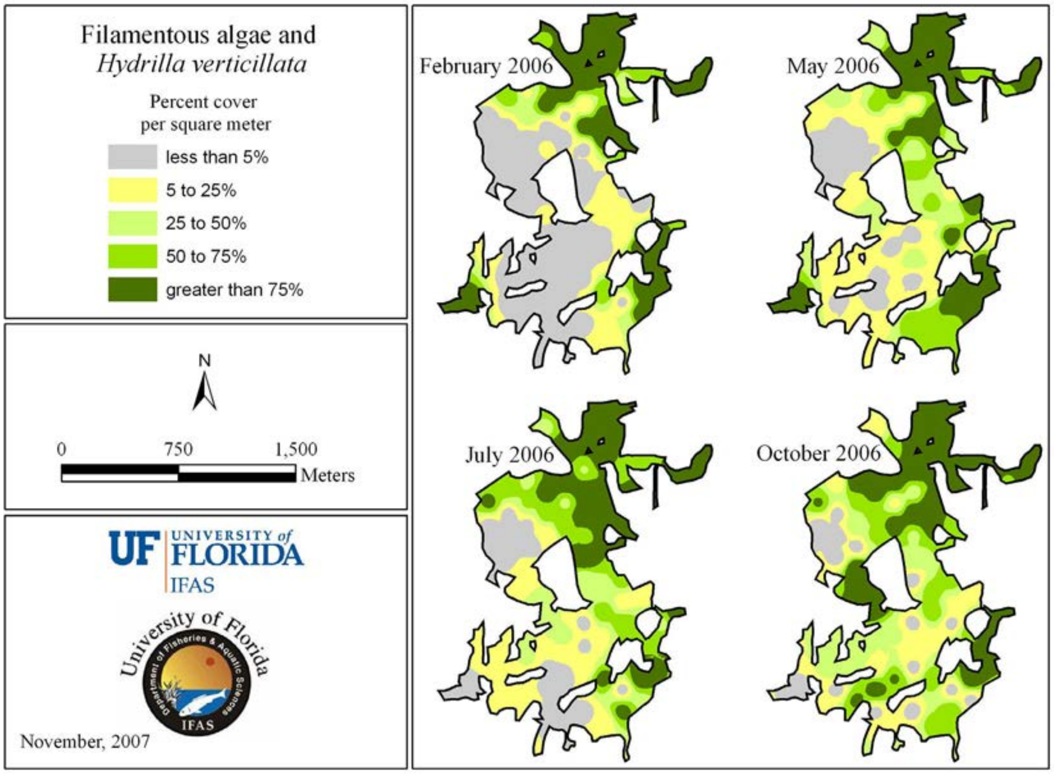

Ruppia maritima
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

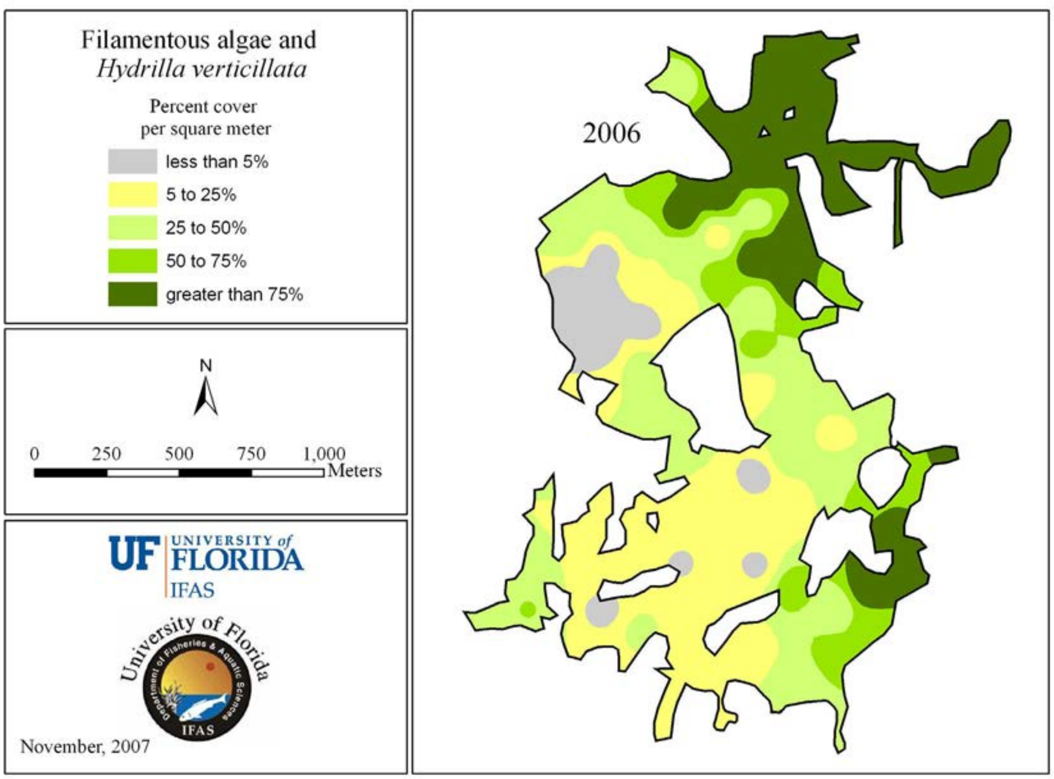

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

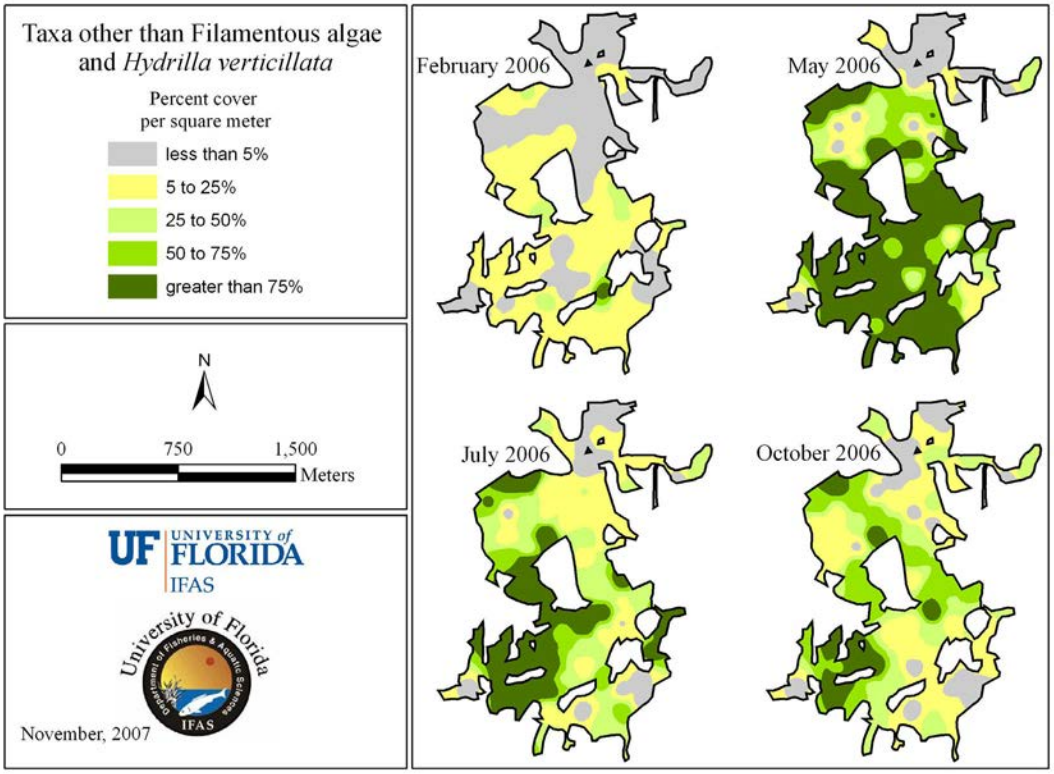

Vallisneria americana
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

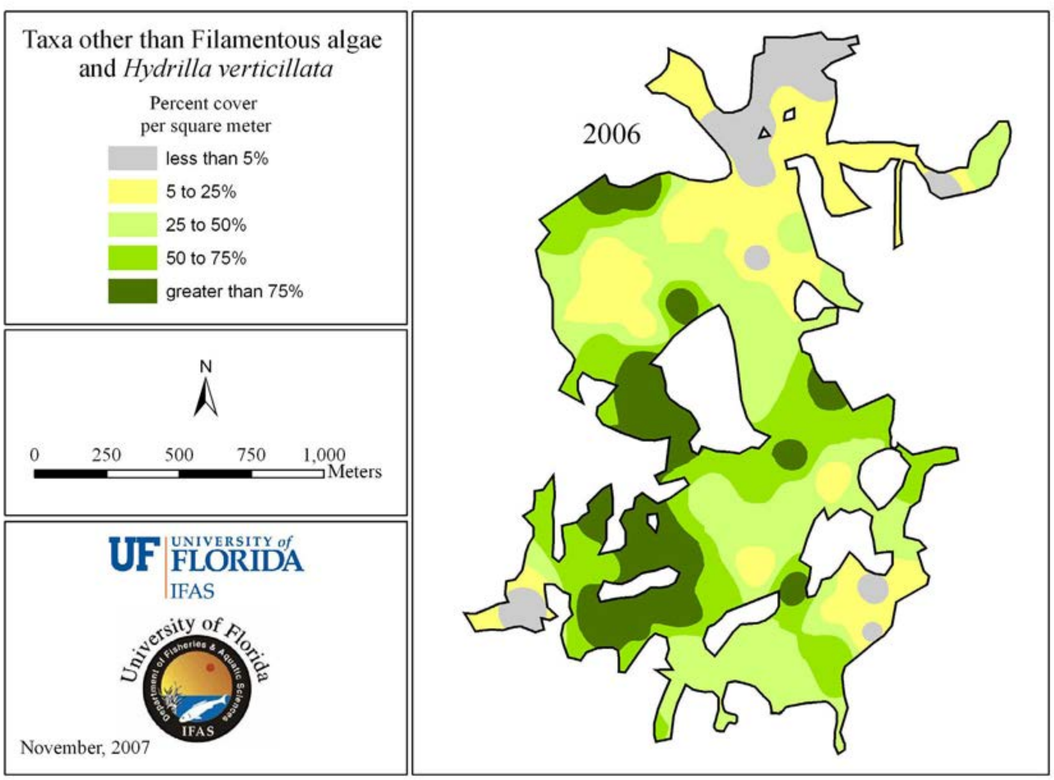

Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006
All Station
Values = 0.0


Zannichellia palustris
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

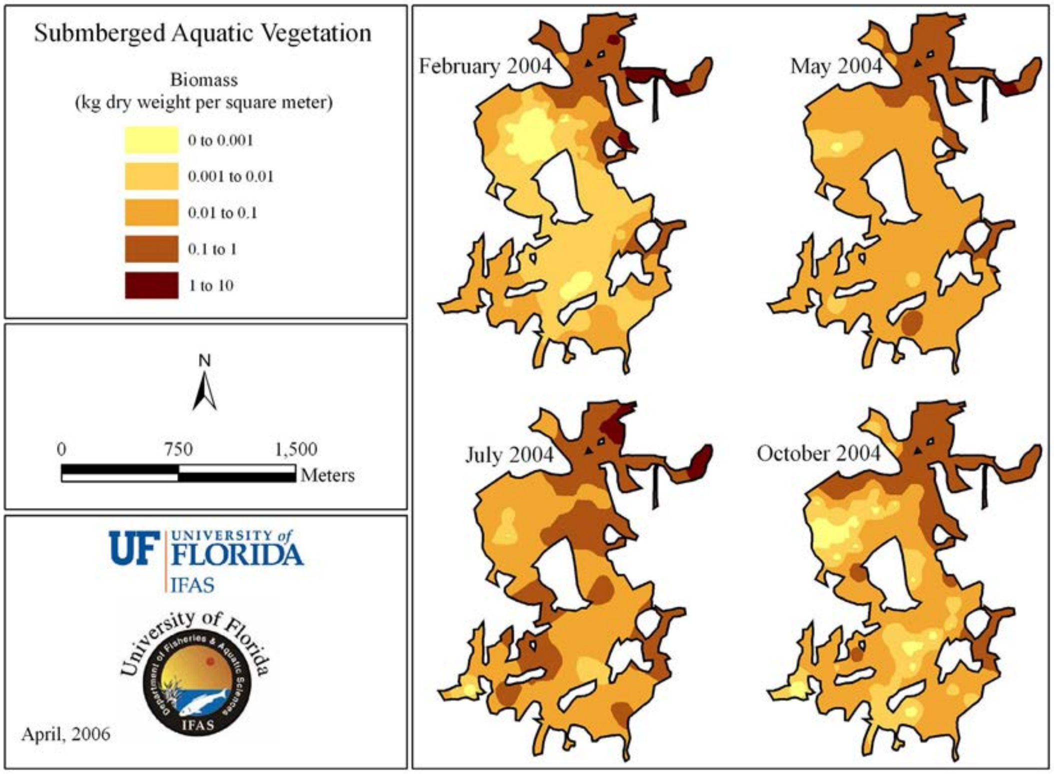

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
February 2006
May 2006
July 2006
October 2006

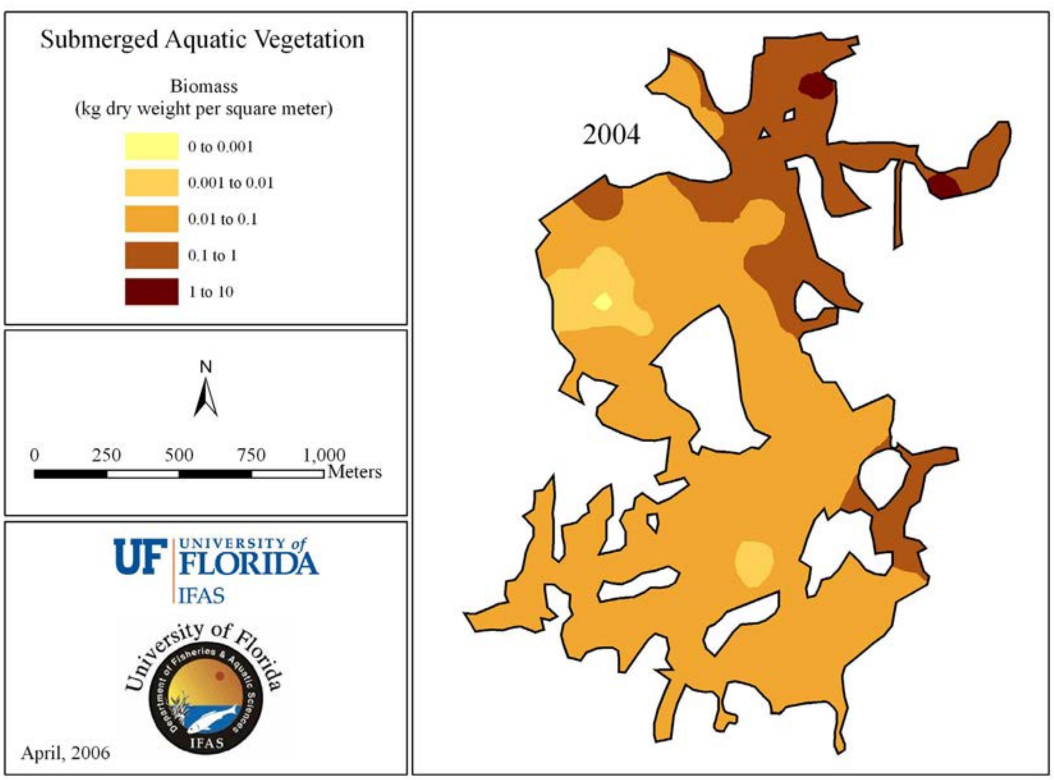

Filamentous algae and
Hydrilla verticillata
Percent cover
per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
2006

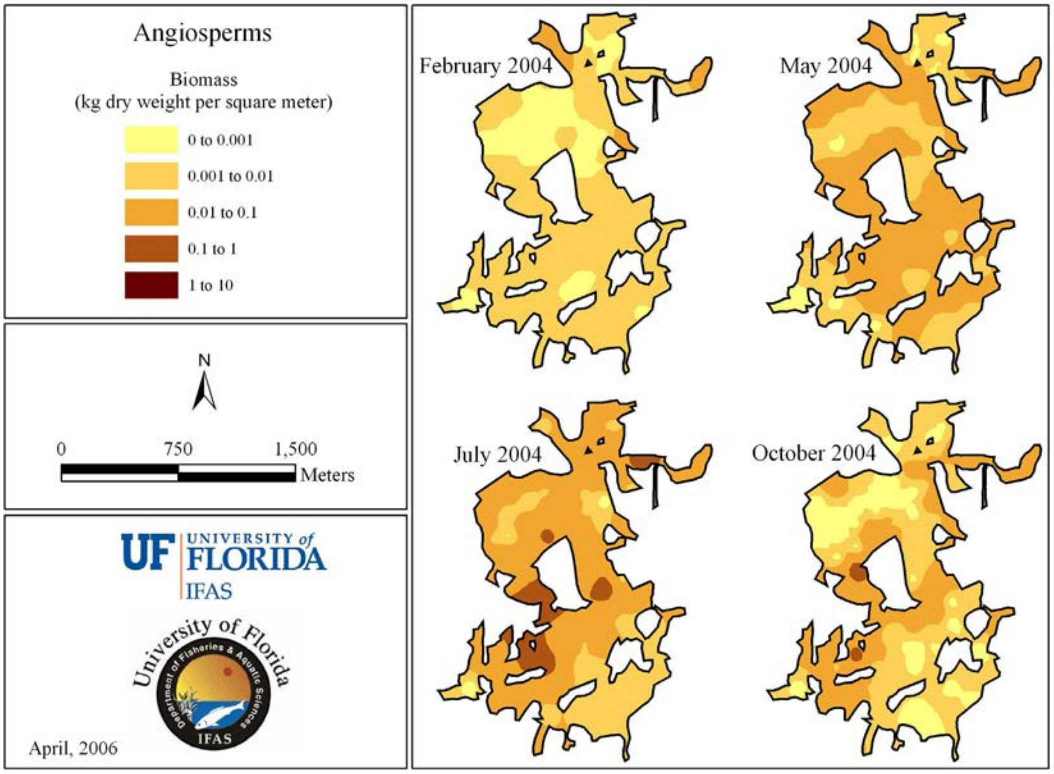

Taxa other than Filamentous algae and *Hydrilla verticillata*
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
November, 2007
February 2006
May 2006
July 2006
October 2006

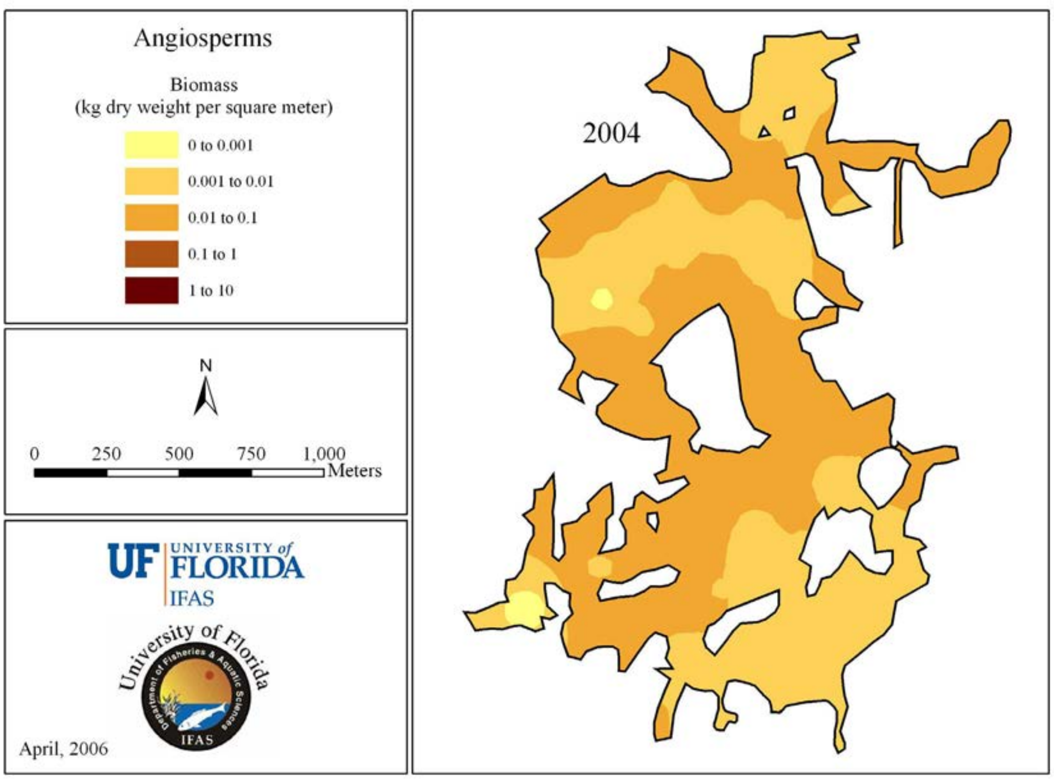

Taxa other than Filamentous algae and *Hydrilla verticillata*
Percent cover per square meter
less than 5%
5 to 25%
25 to 50%
50 to 75%
greater than 75%
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
November, 2007
2006

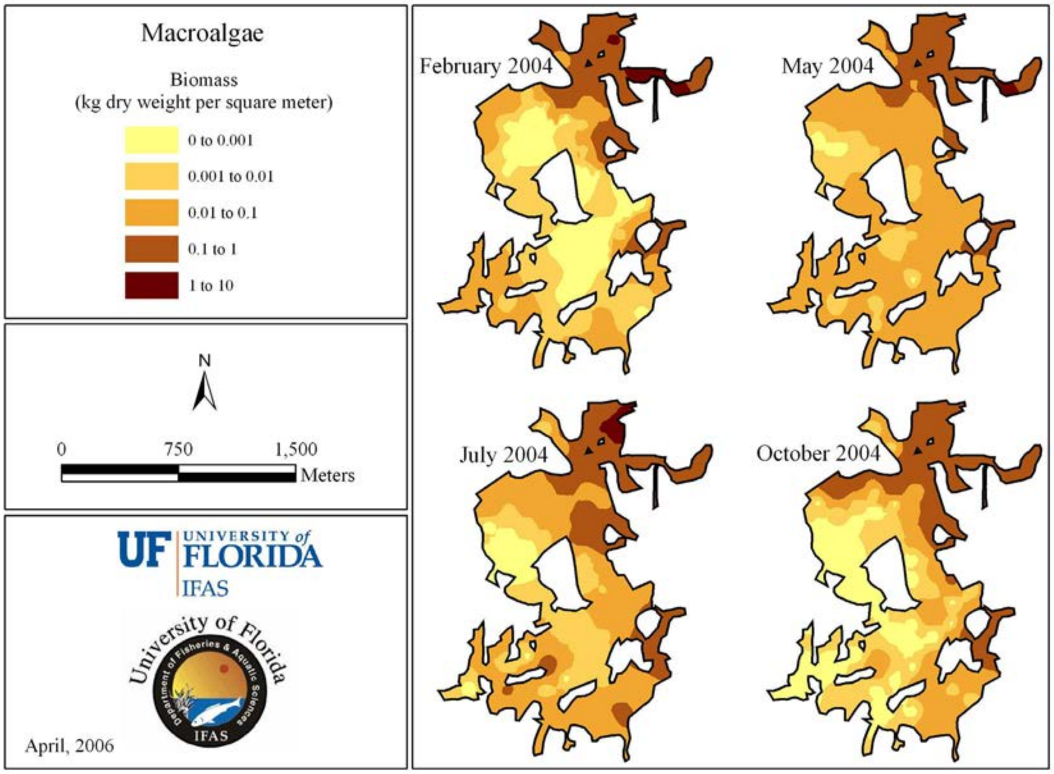
APPENDIX D: MAPS OF INTERPOLATED BIOMASS DATA

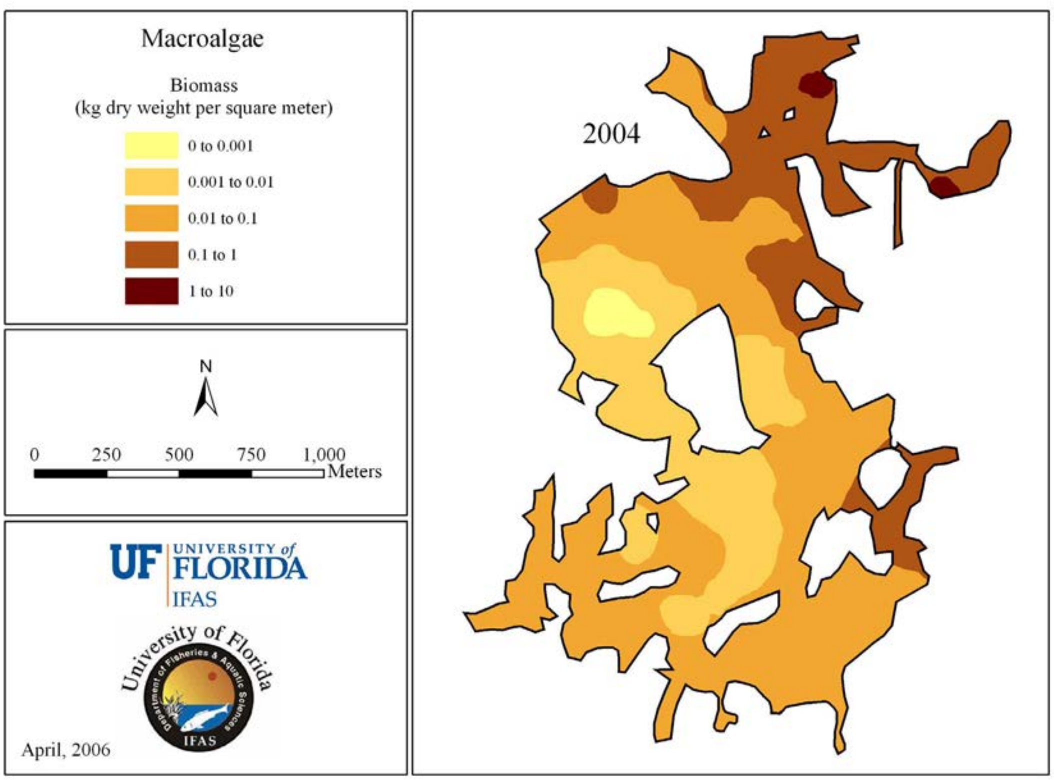


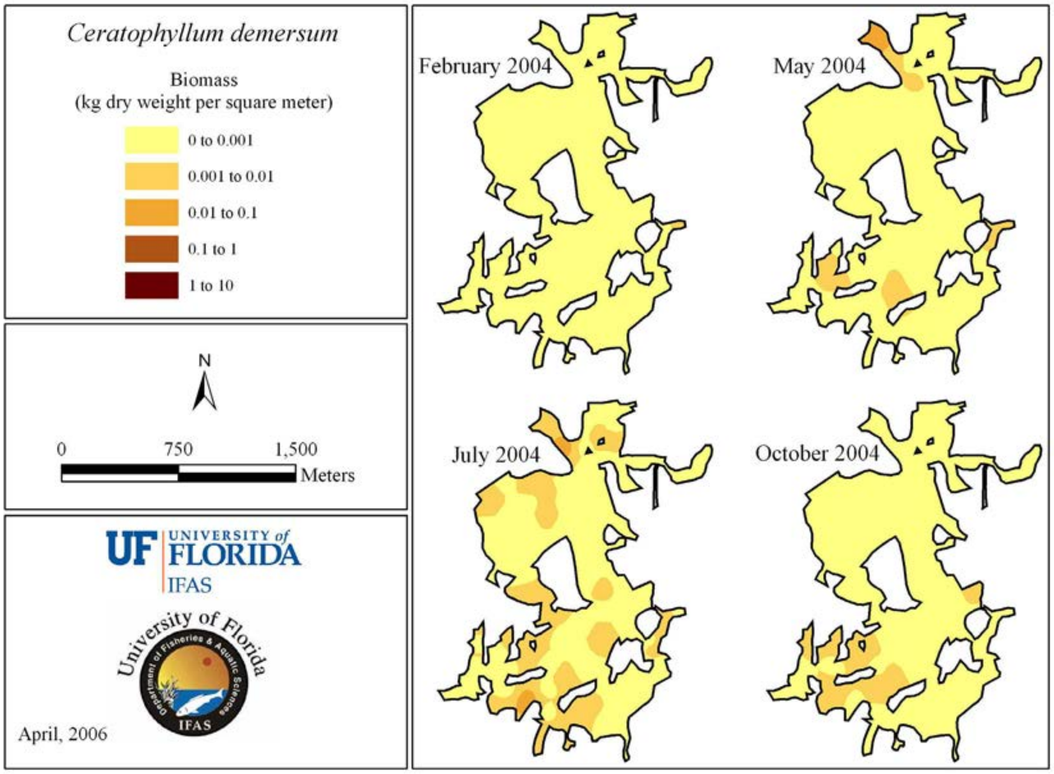


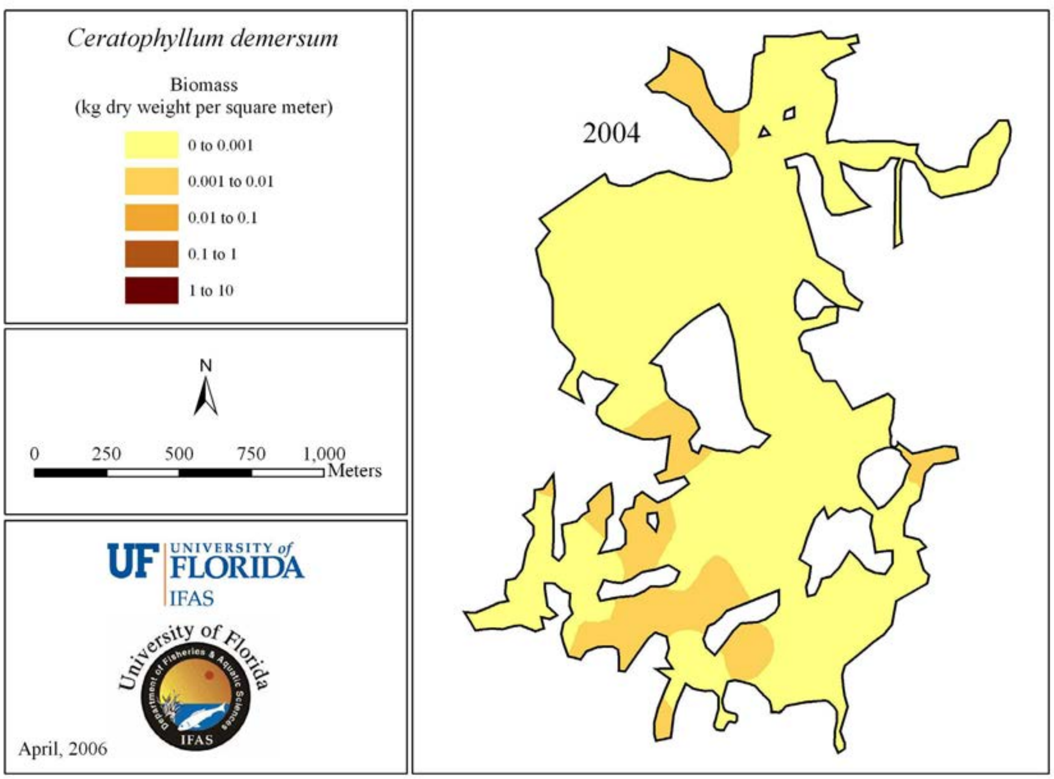

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

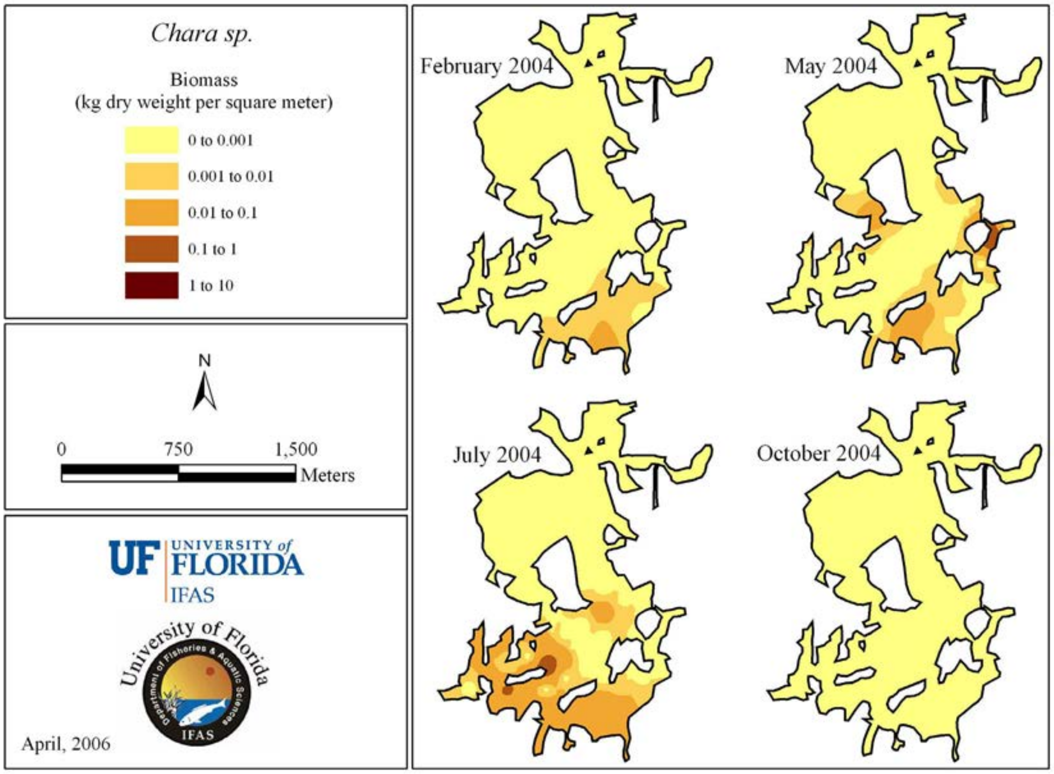

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

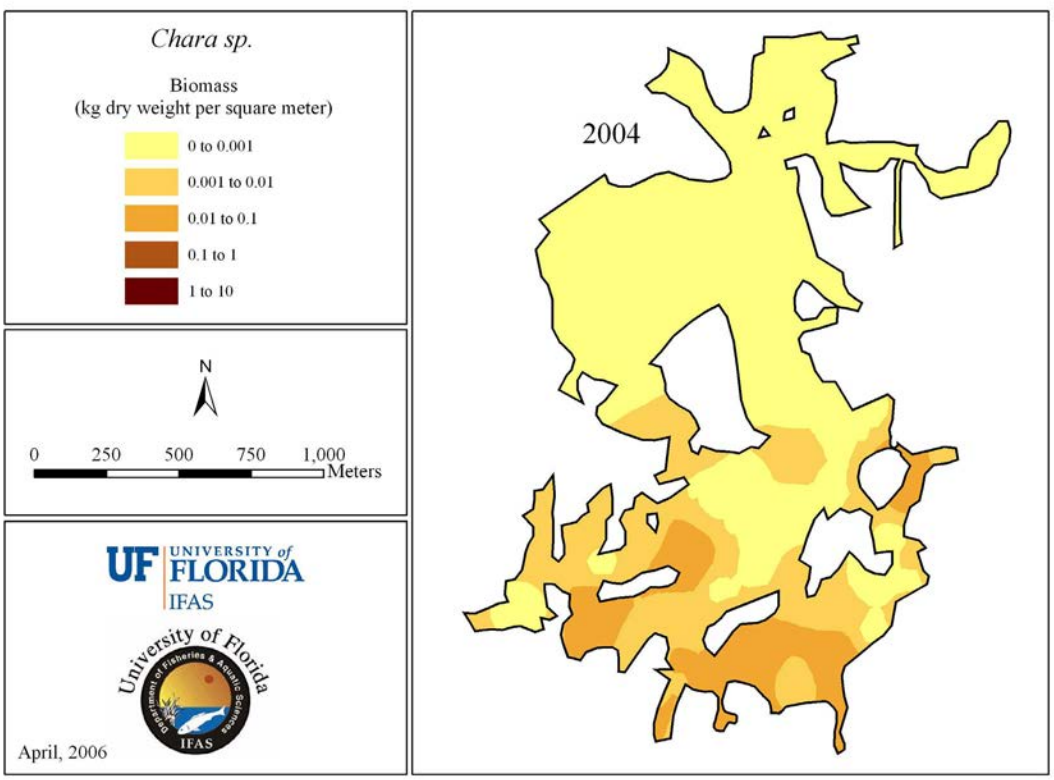

Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

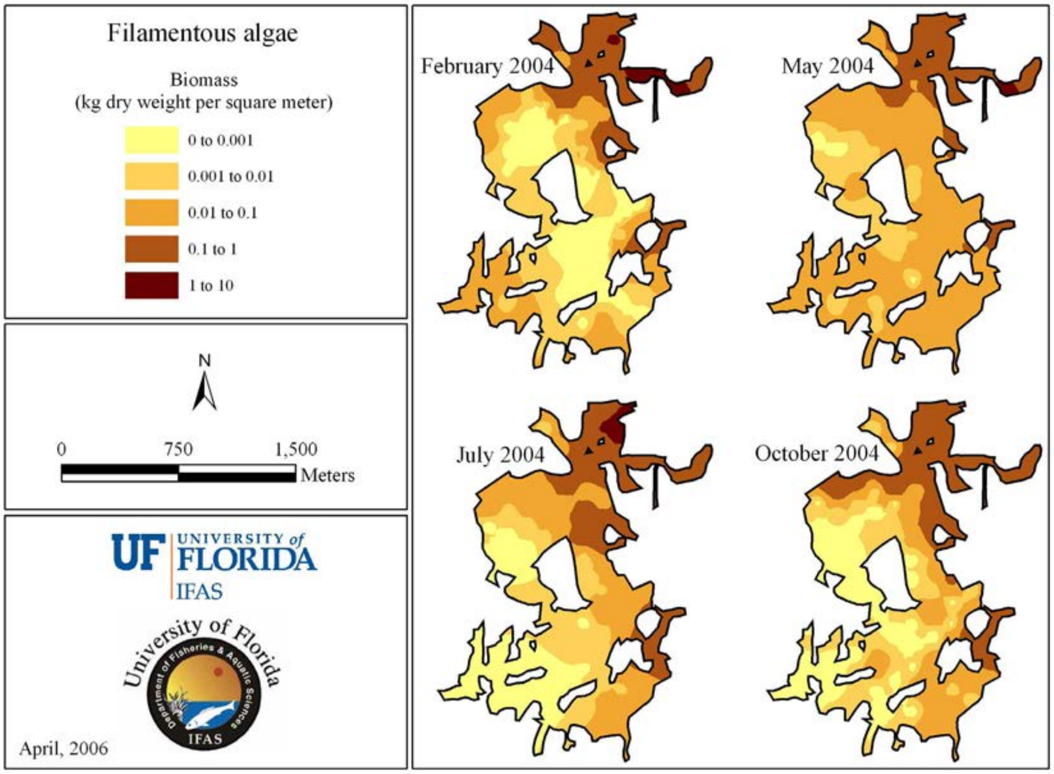

Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

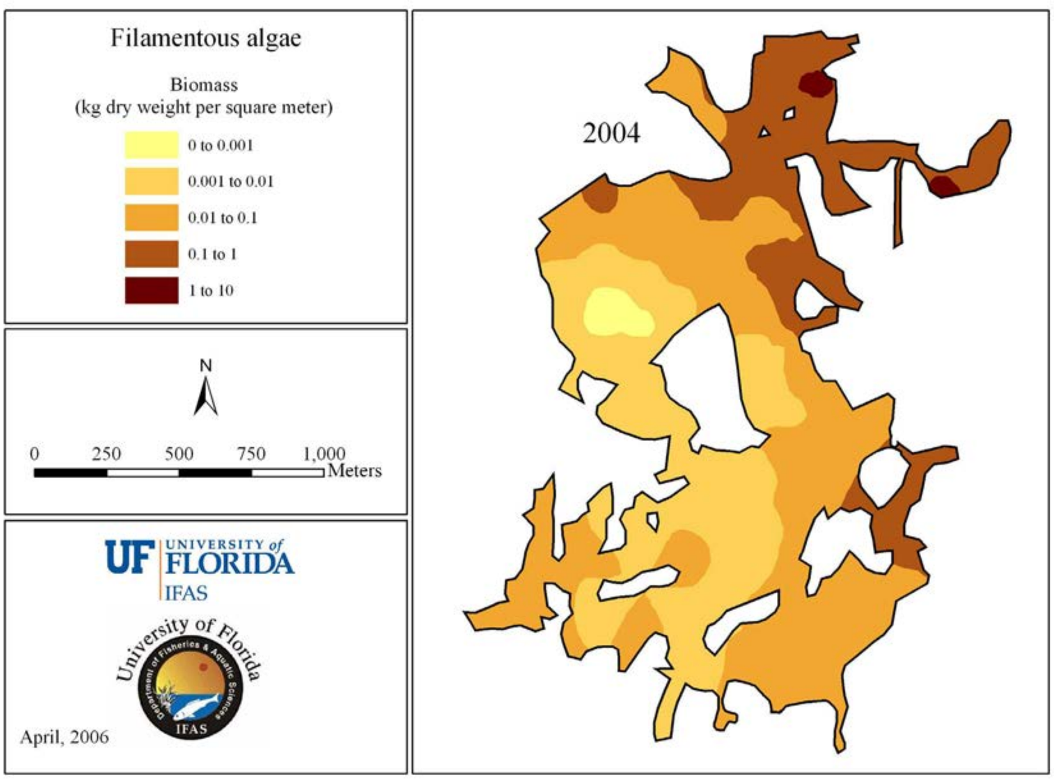

Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
April, 2006
February 2004
May 2004
July 2004
October 2004

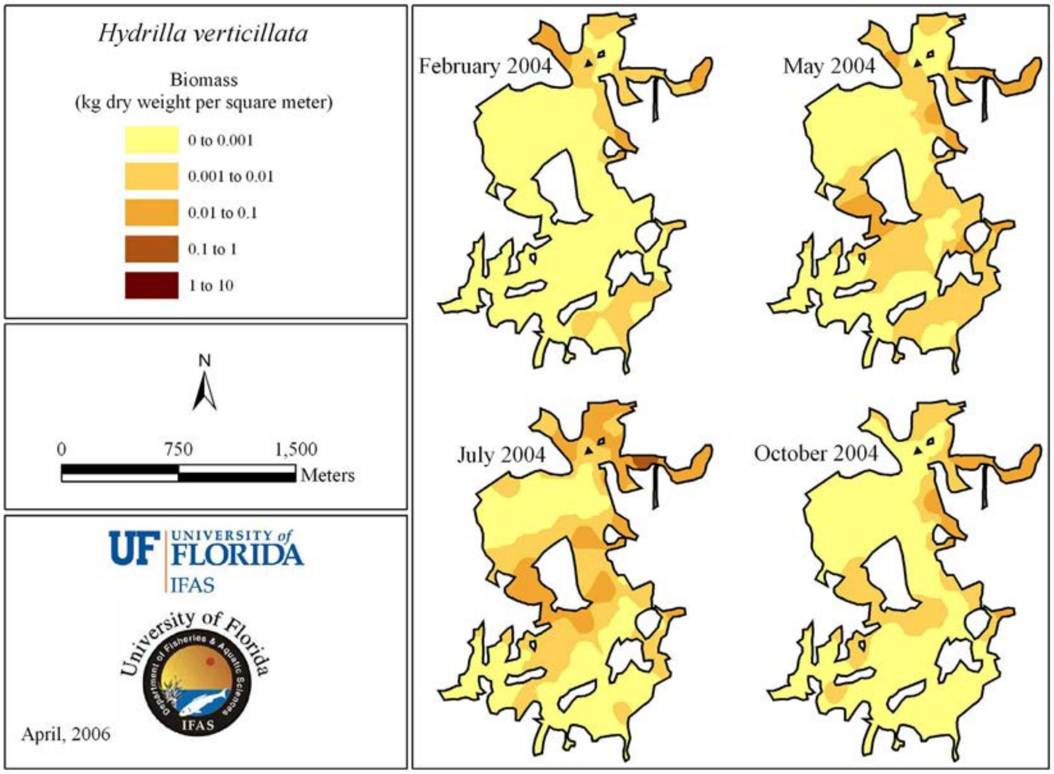

Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
April, 2006
2004


Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

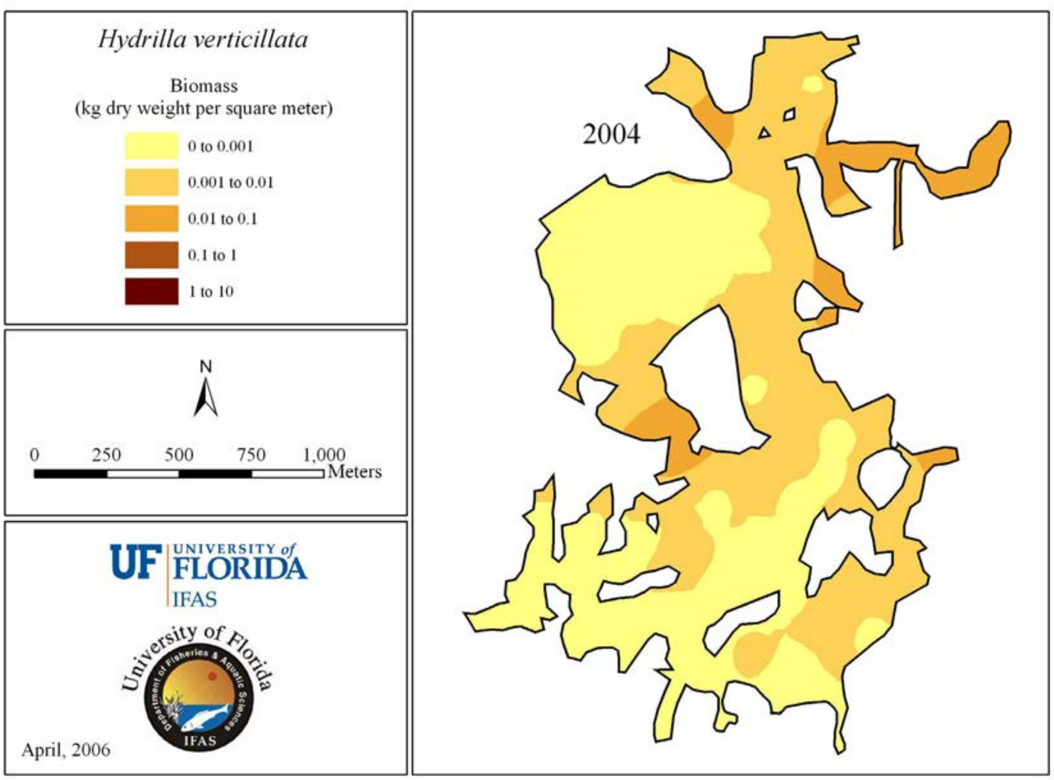

Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UNIVERSITY of FLORIDA
IFAS
April, 2006
2004


Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

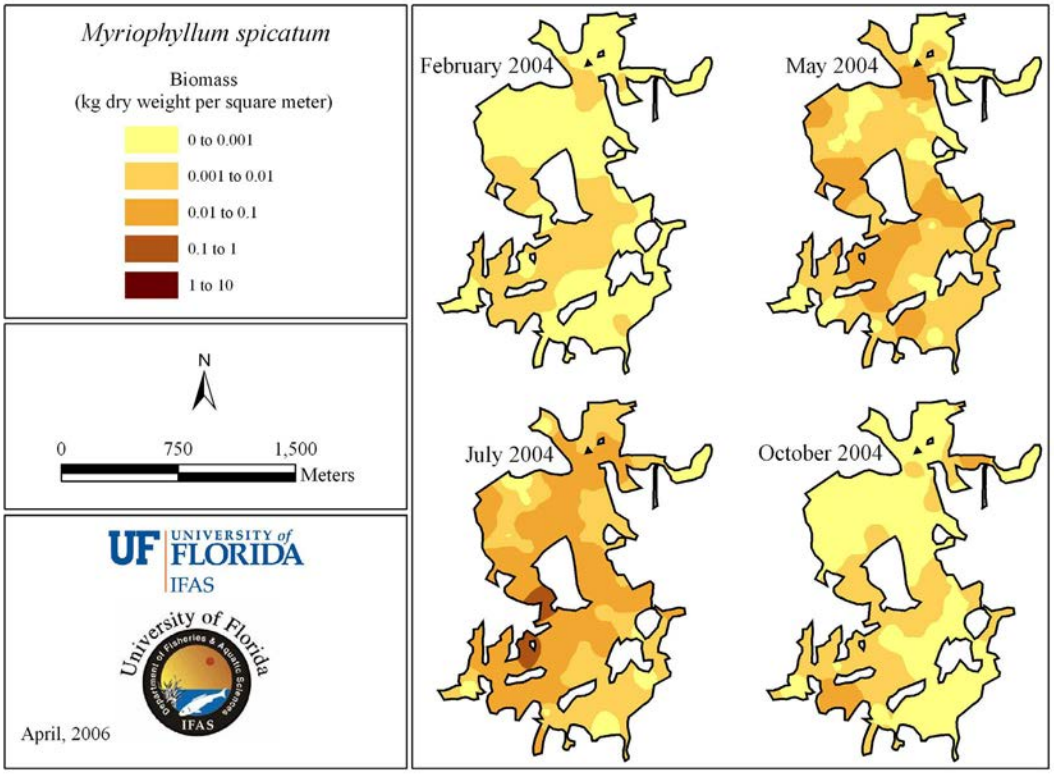

Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

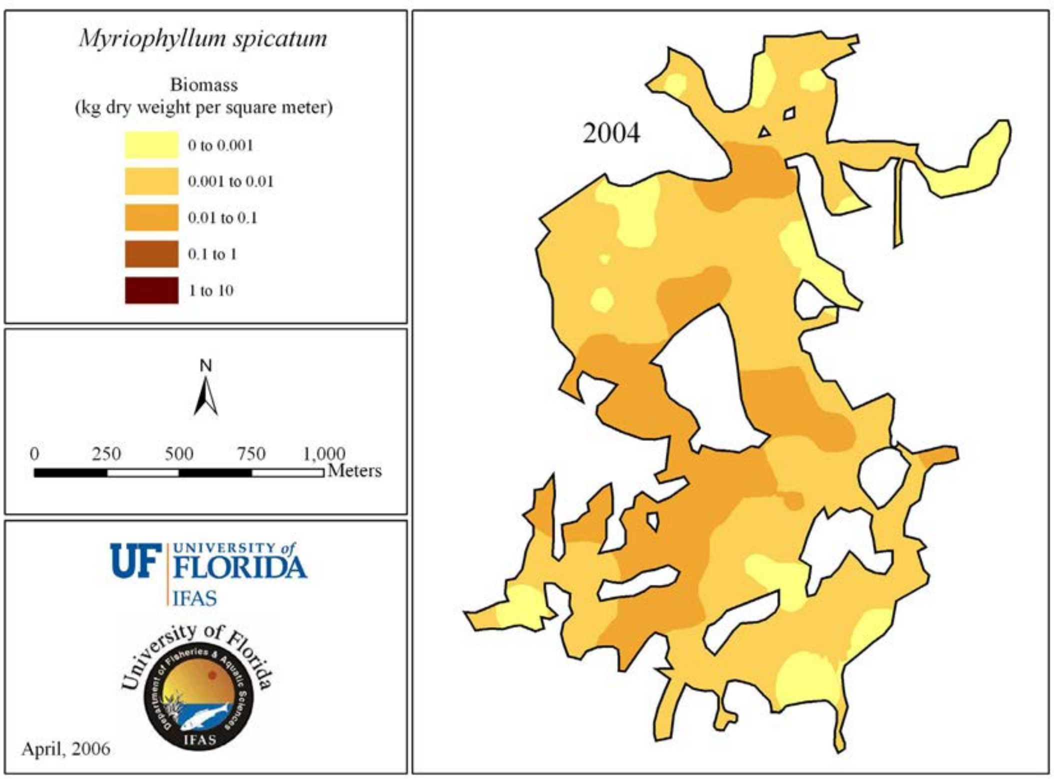


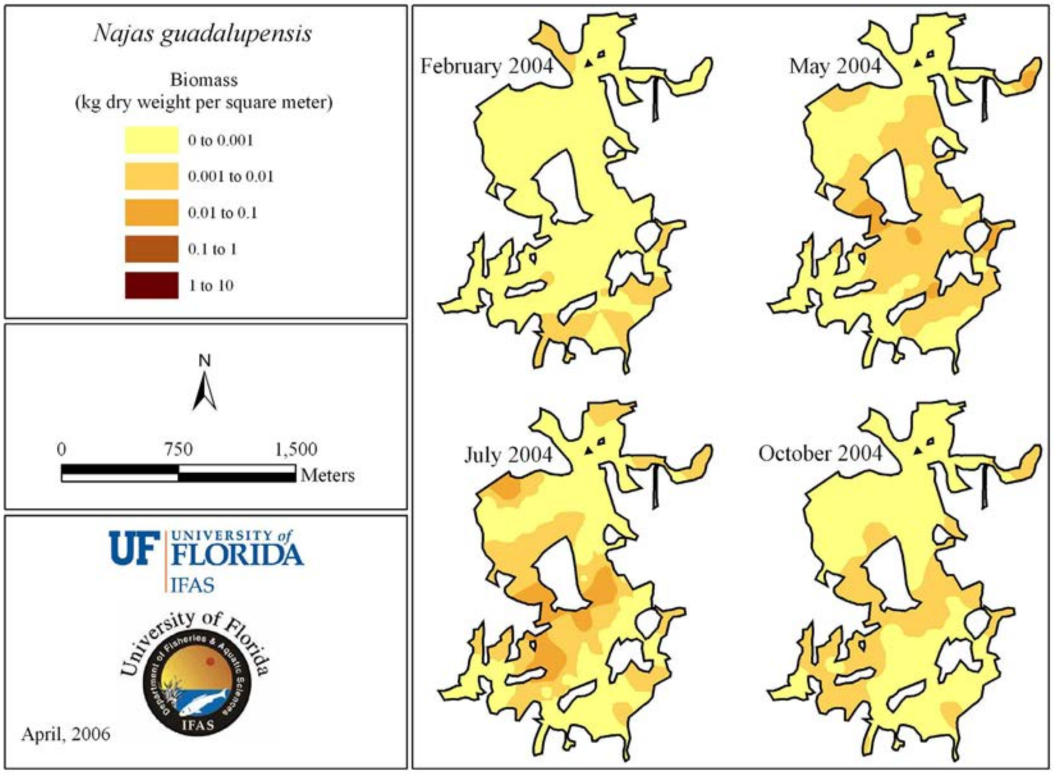
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
April, 2006
February 2004
May 2004
July 2004
October 2004

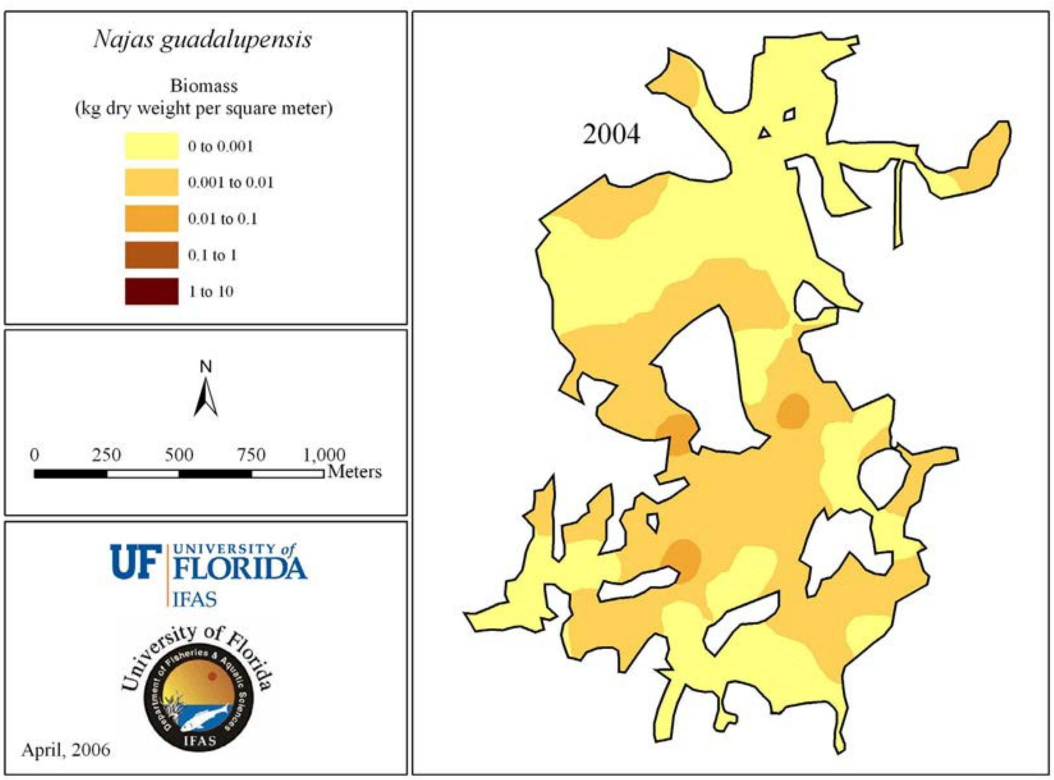


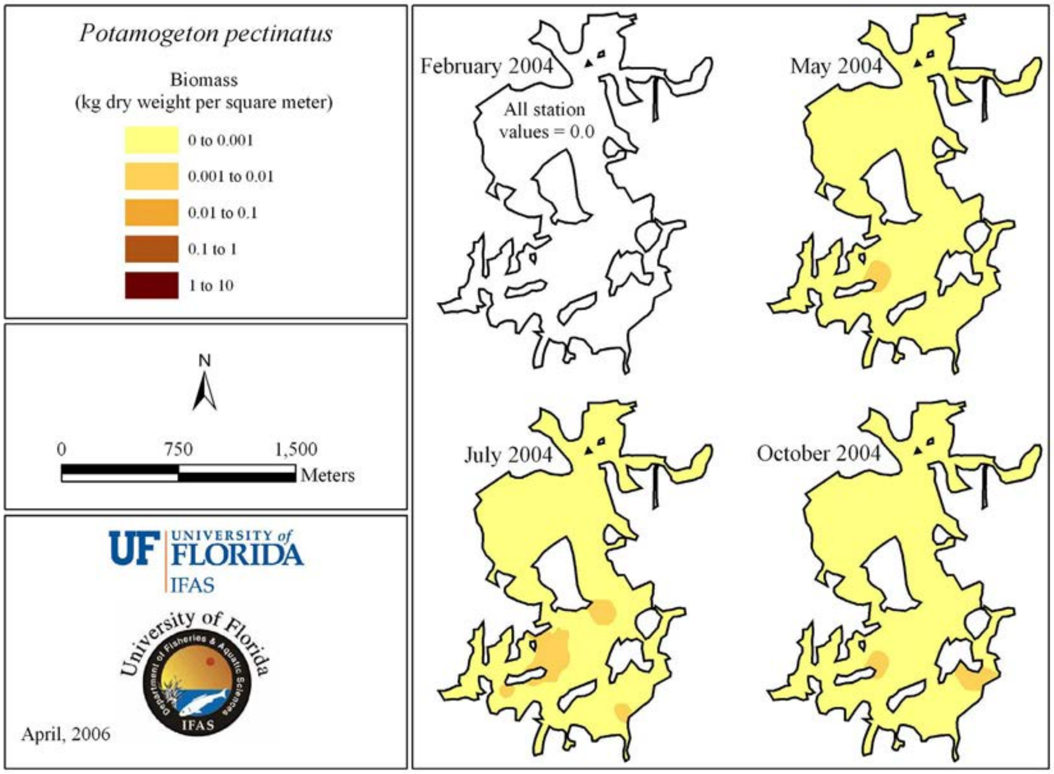
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
April, 2006
2004

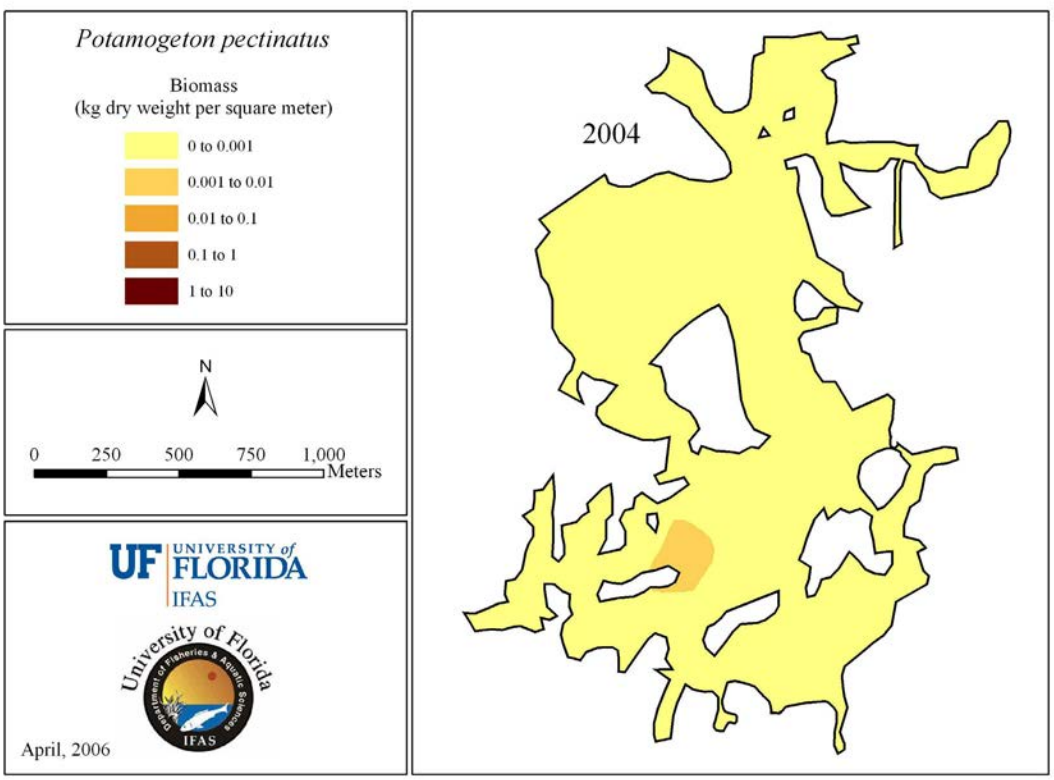

Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

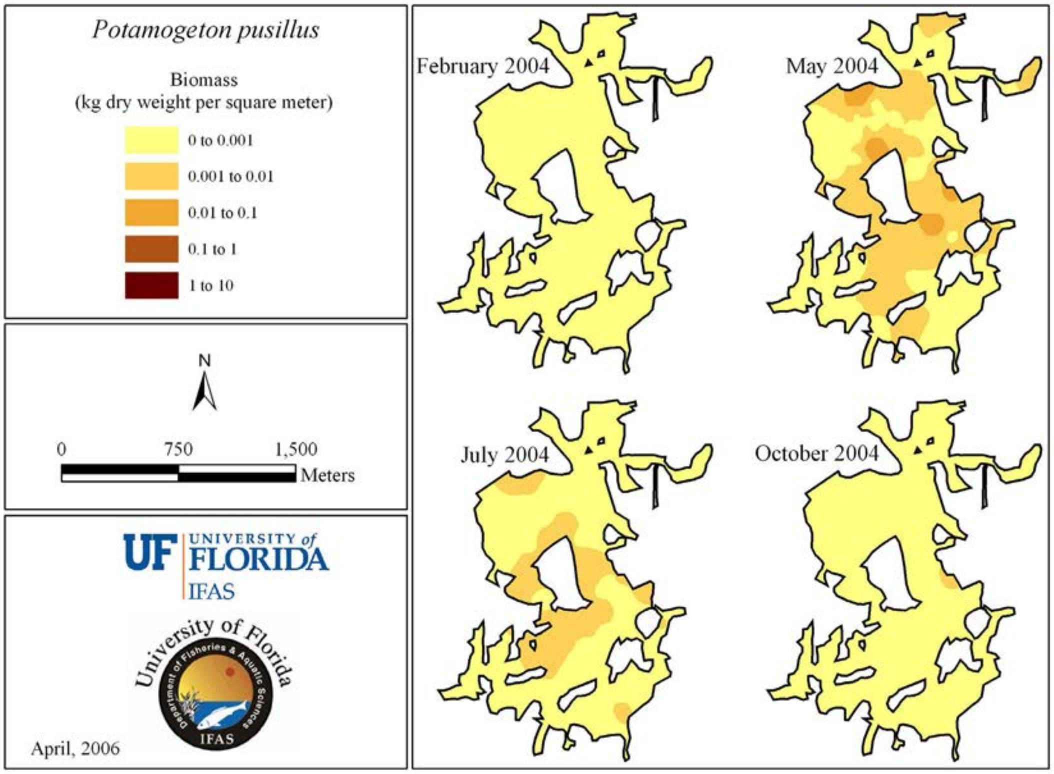

Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2004

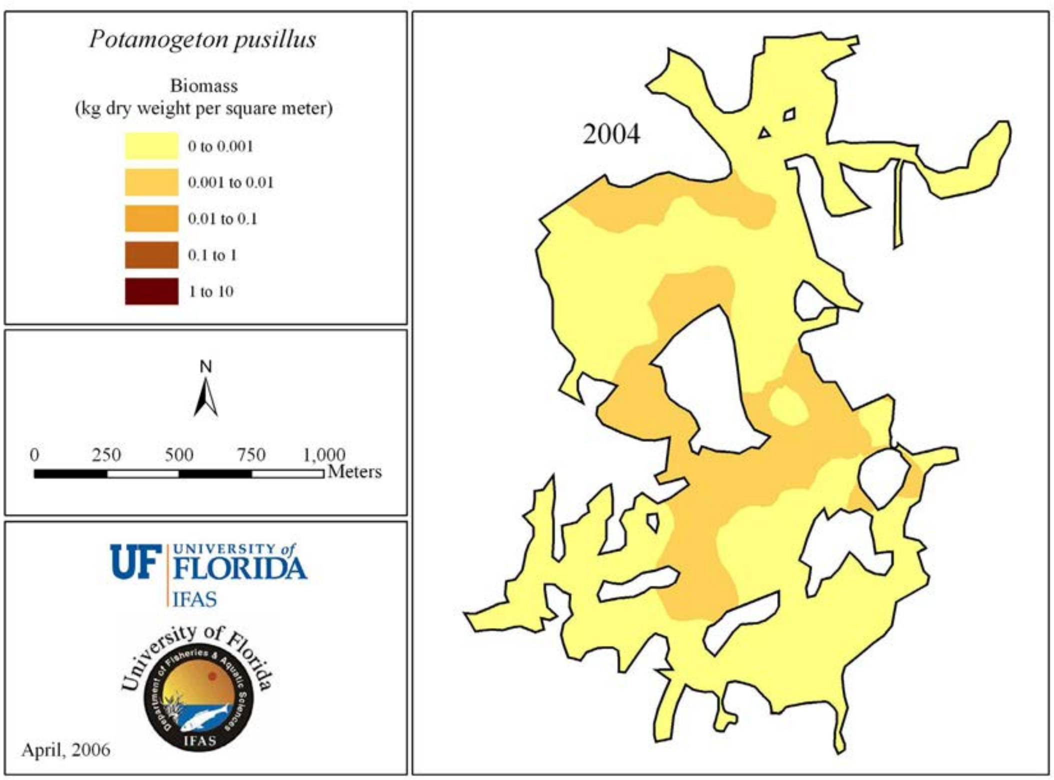

Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

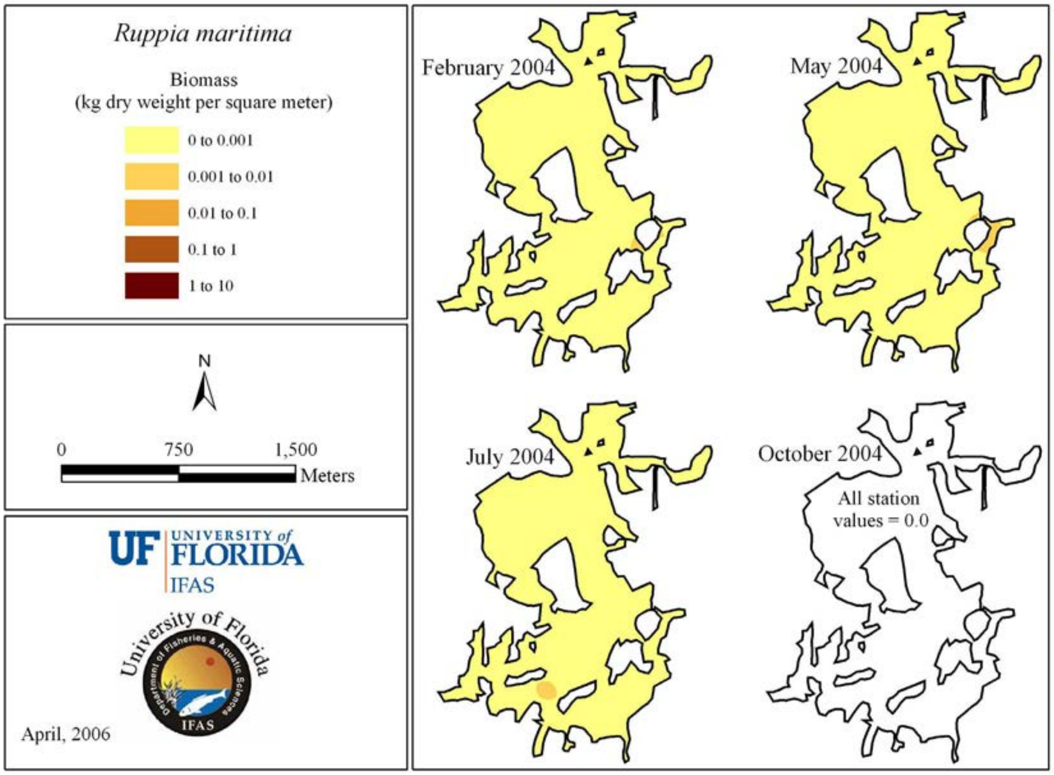

Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

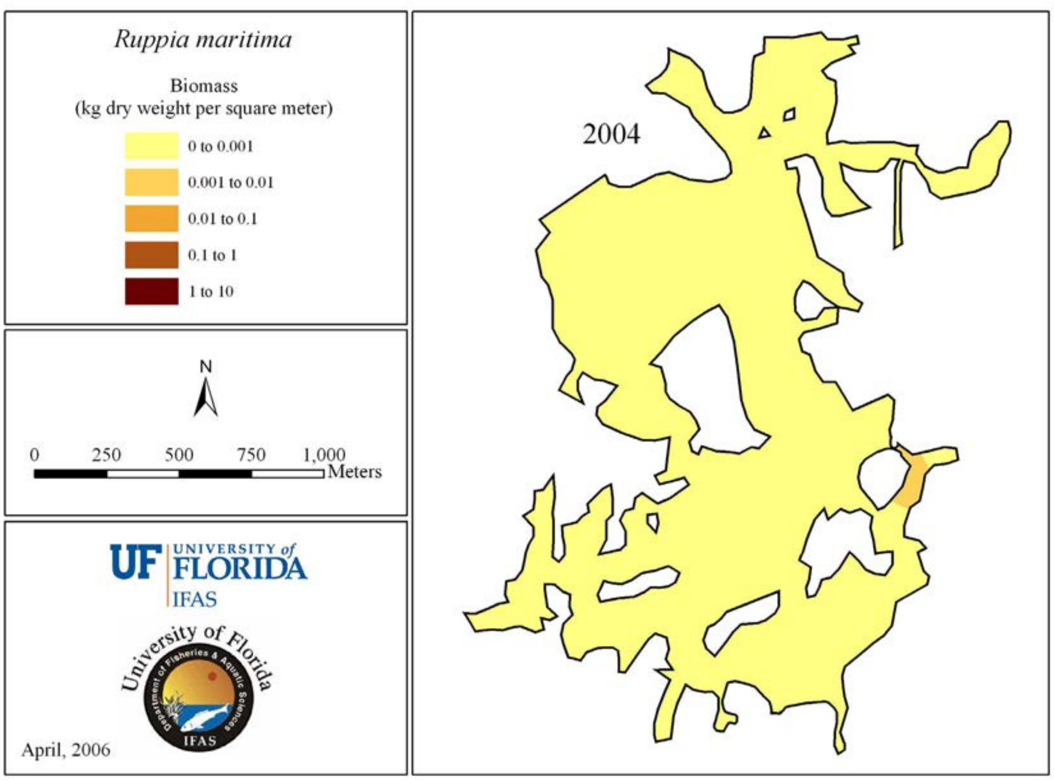

Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
All station
values = 0.0
May 2004
July 2004
October 2004

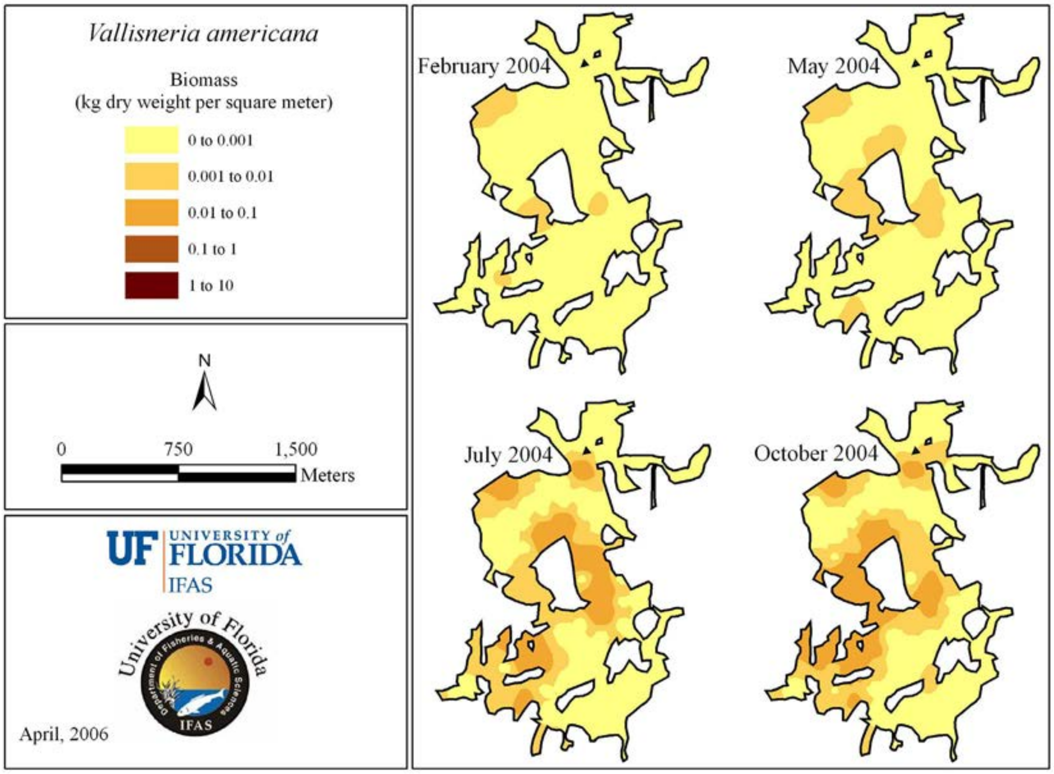

Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

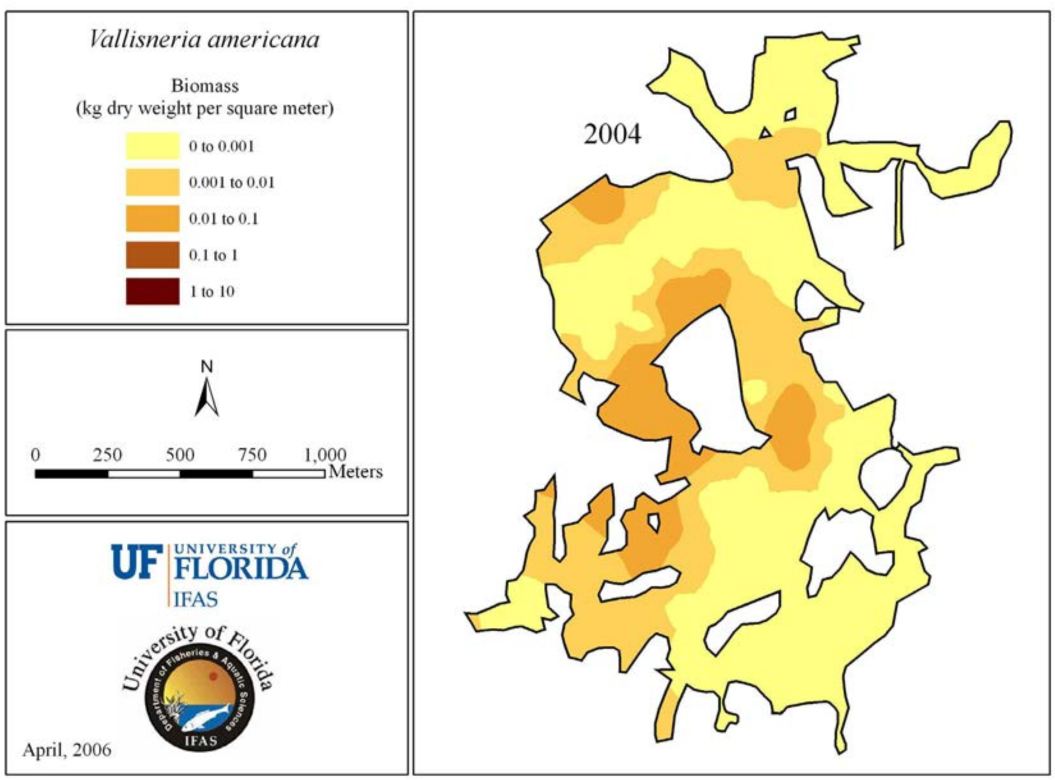

Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004

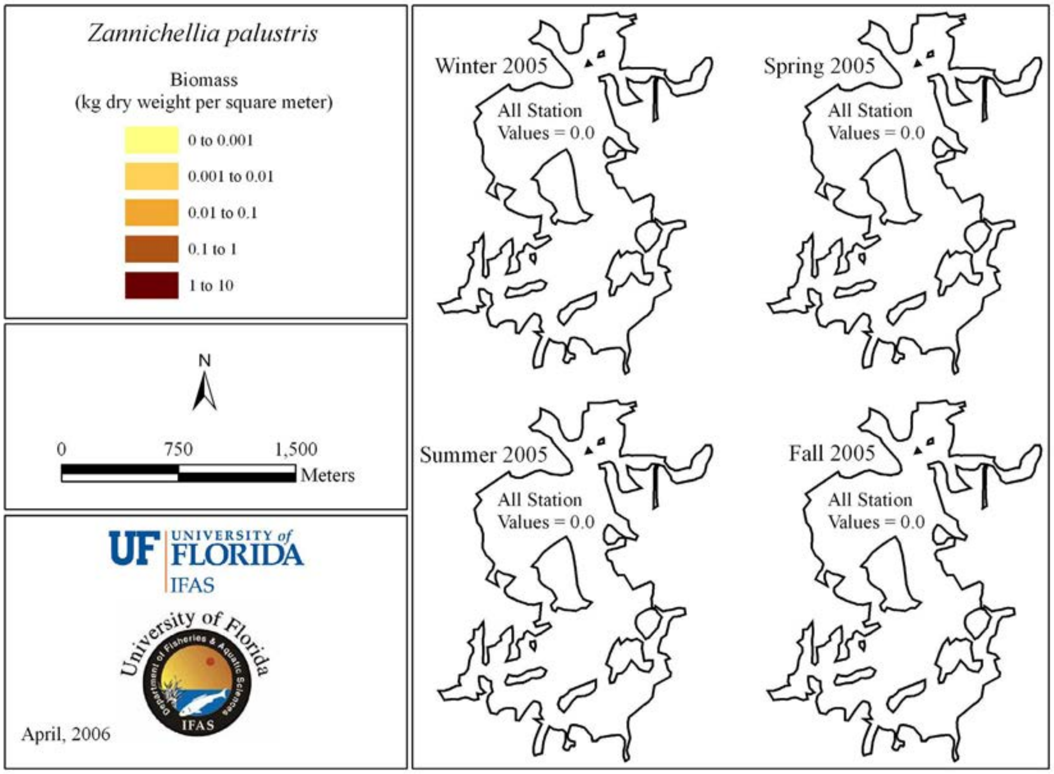

Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2004

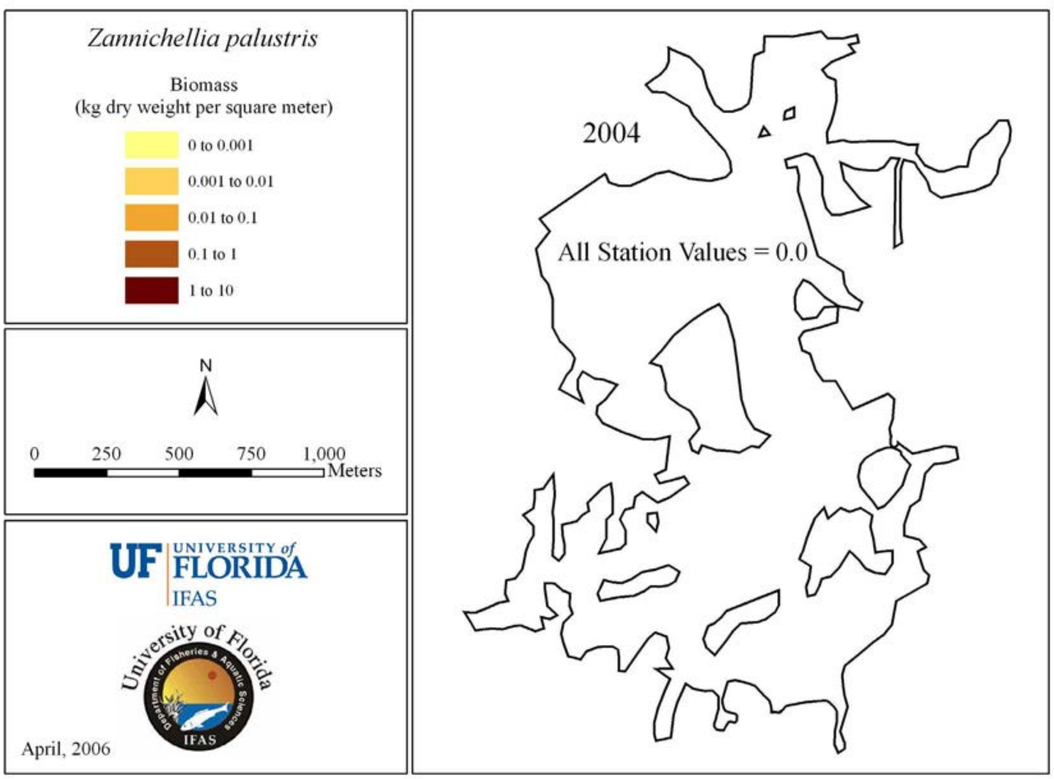

Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2004
May 2004
July 2004
October 2004
All station
values = 0.0

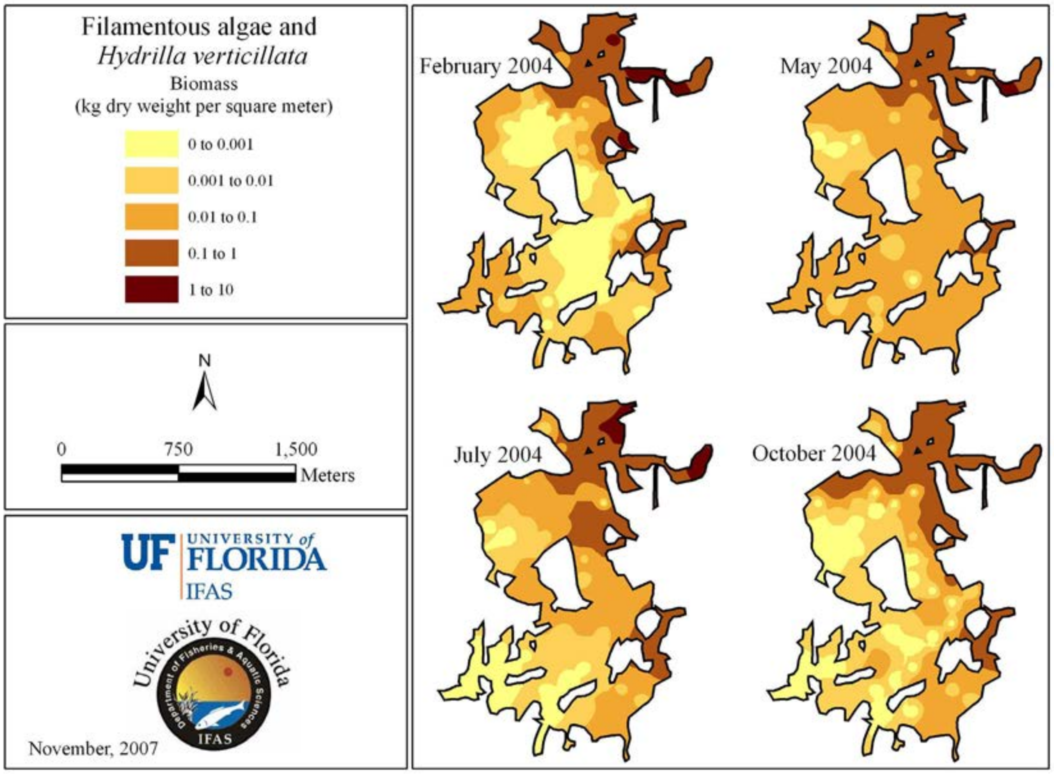

Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2004

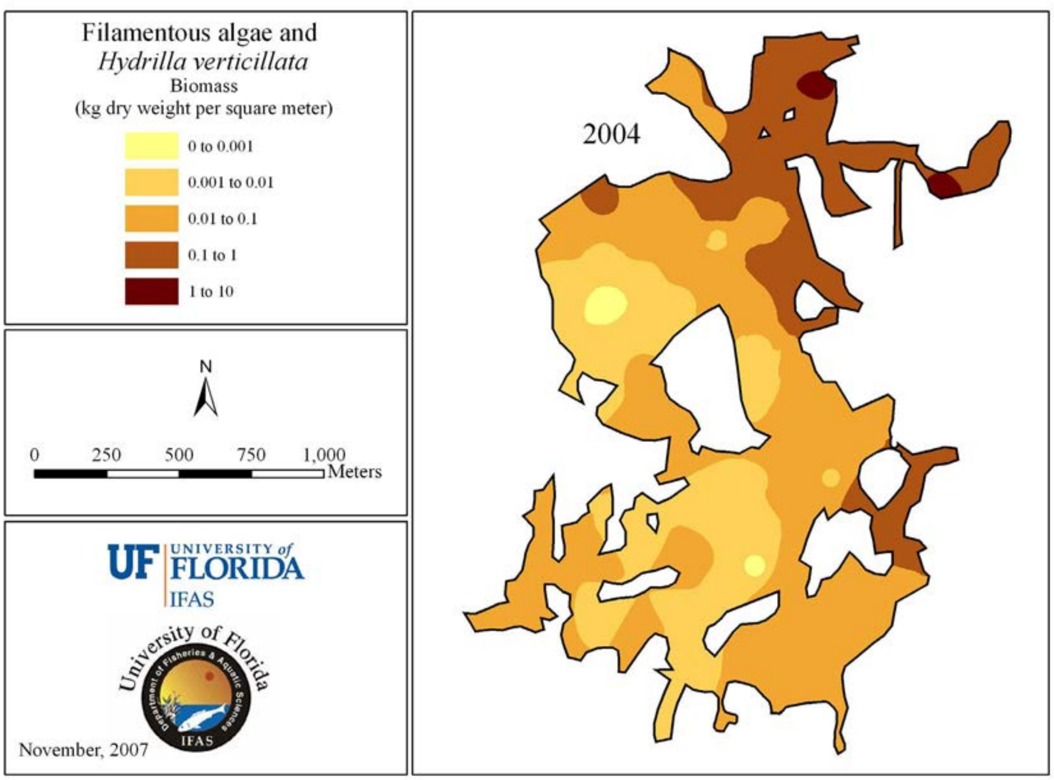

Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2004
May 2004
July 2004
October 2004

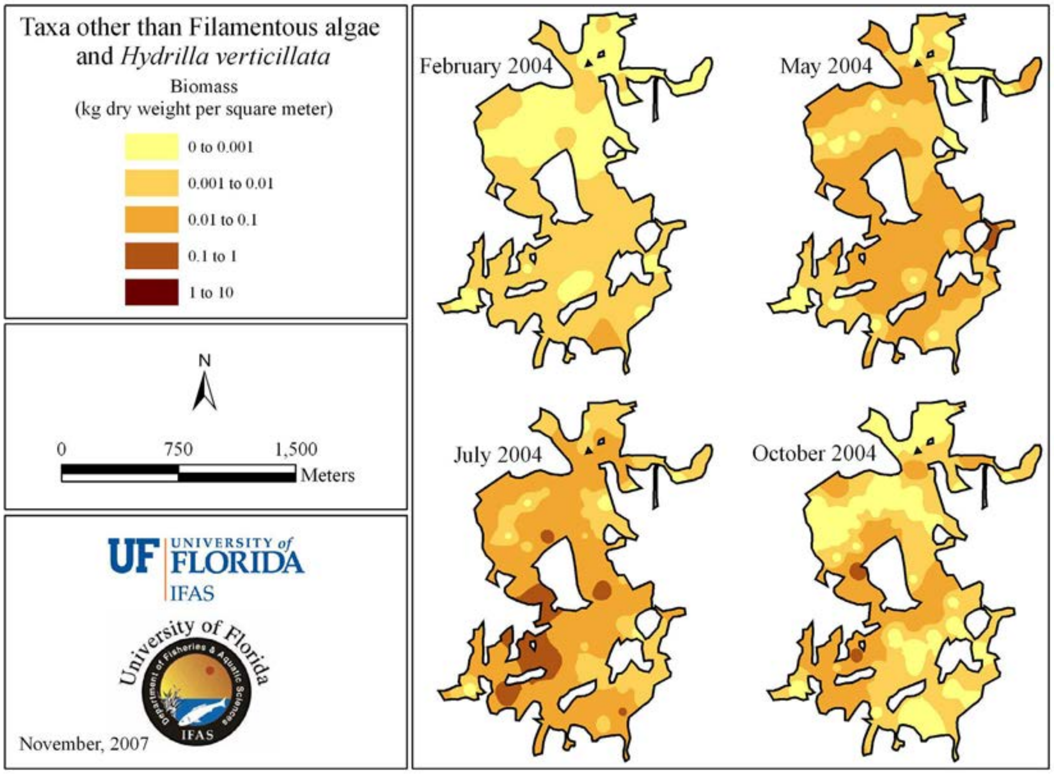

Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2004

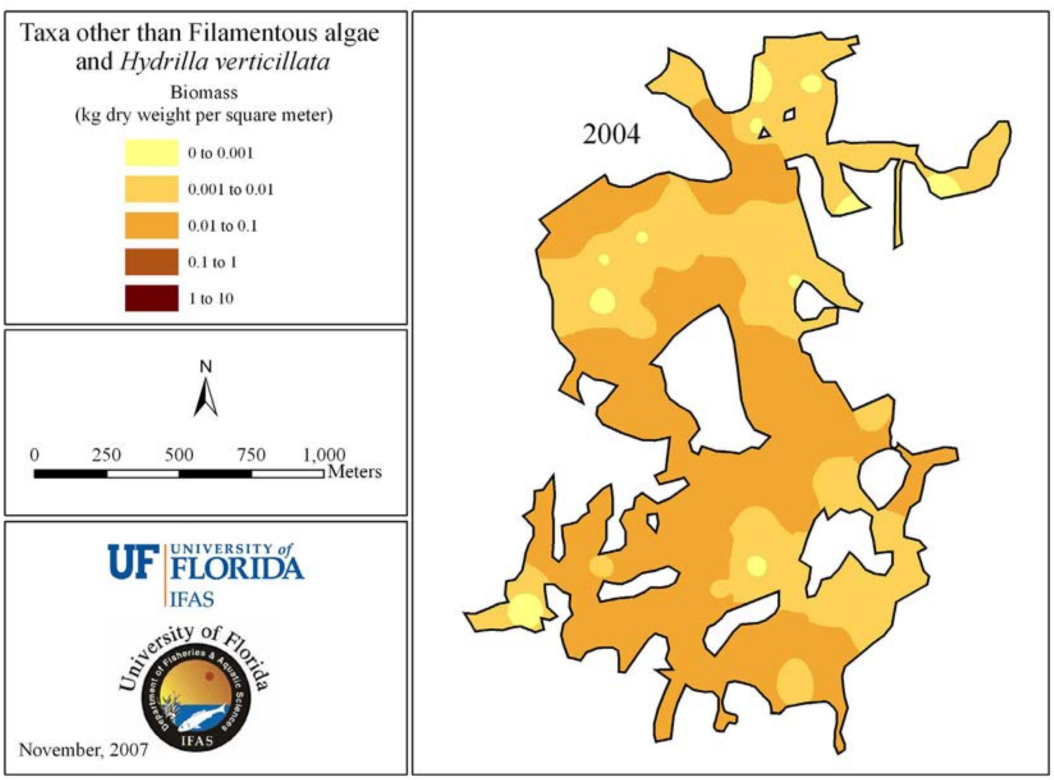

Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
Winter 2005
All Station Values = 0.0
Spring 2005
All Station Values = 0.0
Summer 2005
All Station Values = 0.0
Fall 2005
All Station Values = 0.0

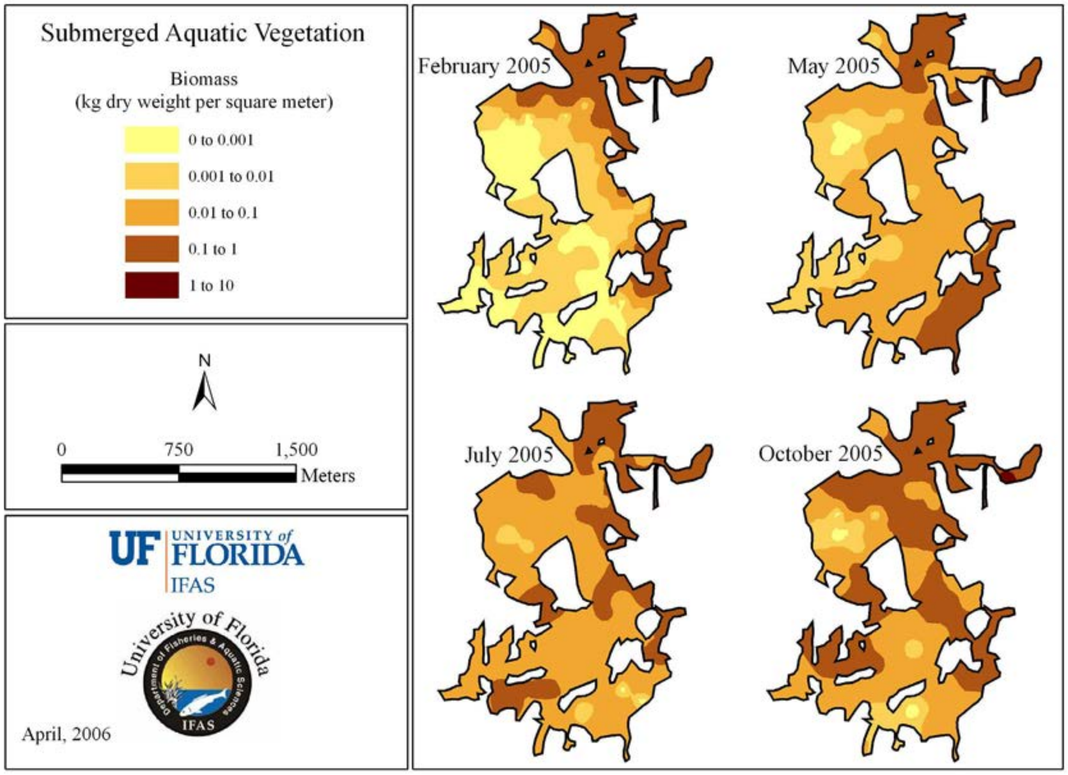

Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2004
All Station Values = 0.0

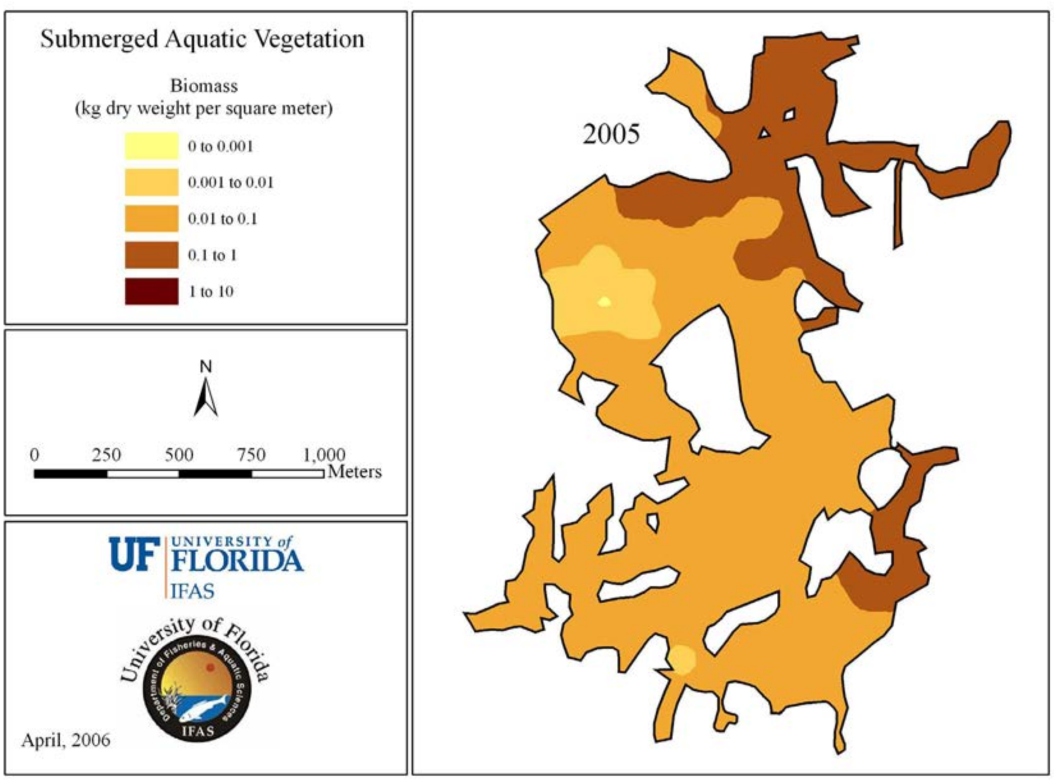

Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
November, 2007
February 2004
May 2004
July 2004
October 2004

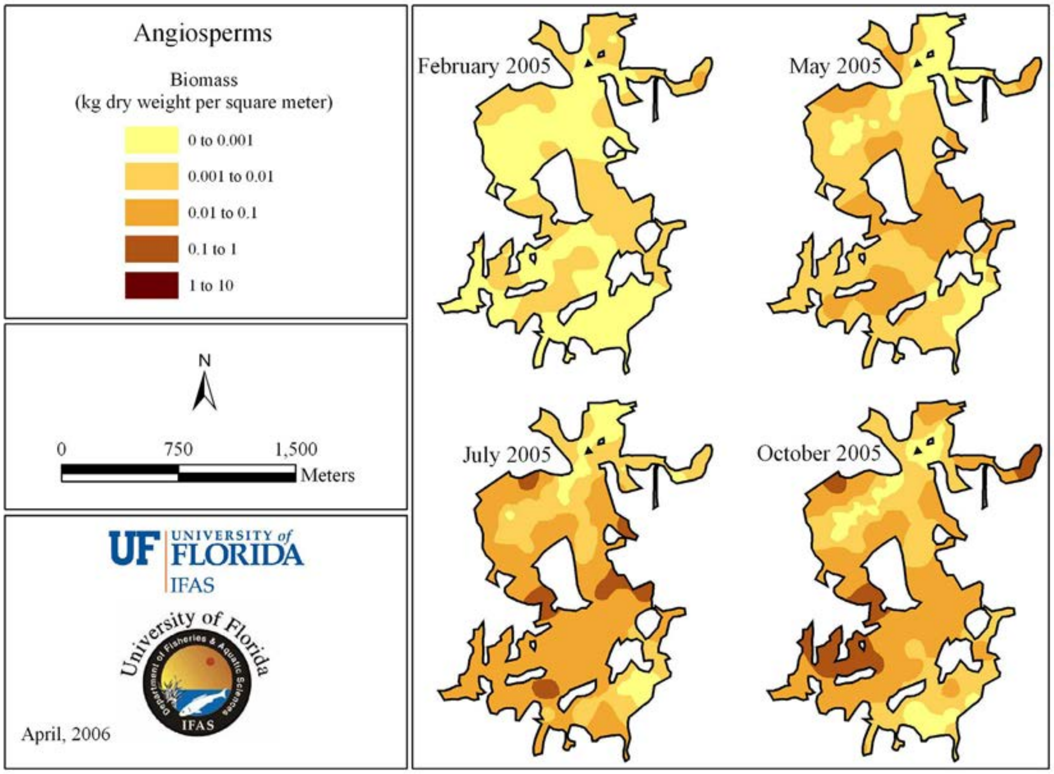

Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
November, 2007
2004

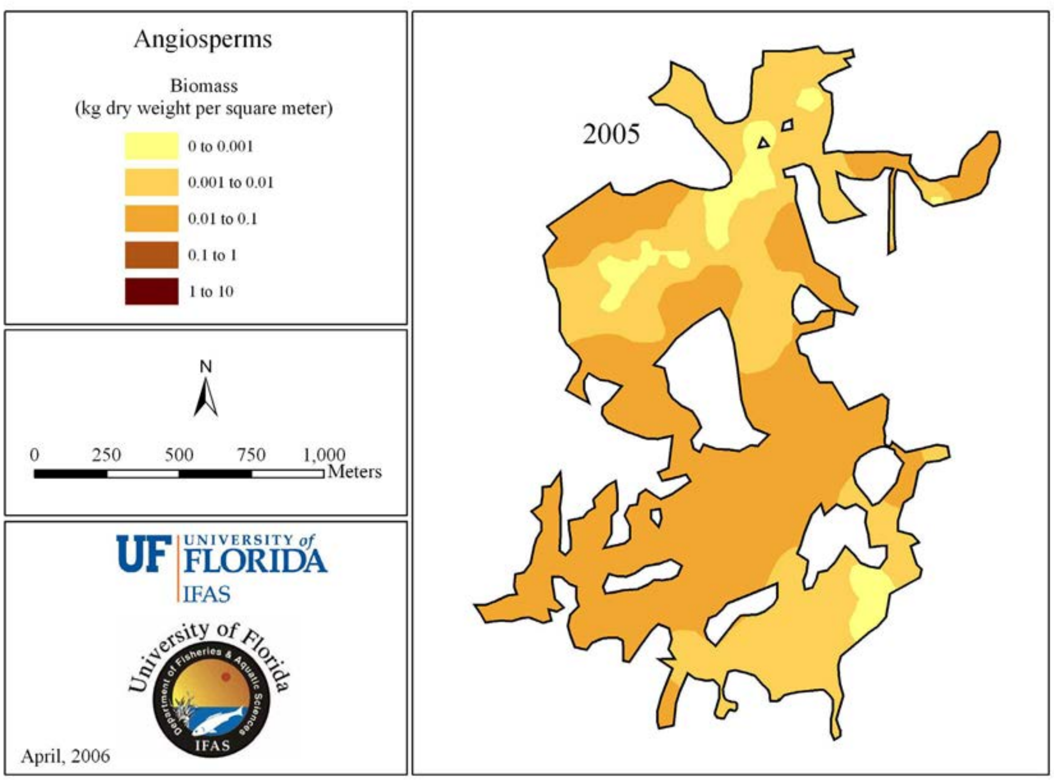

Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
February 2004
May 2004
July 2004
October 2004

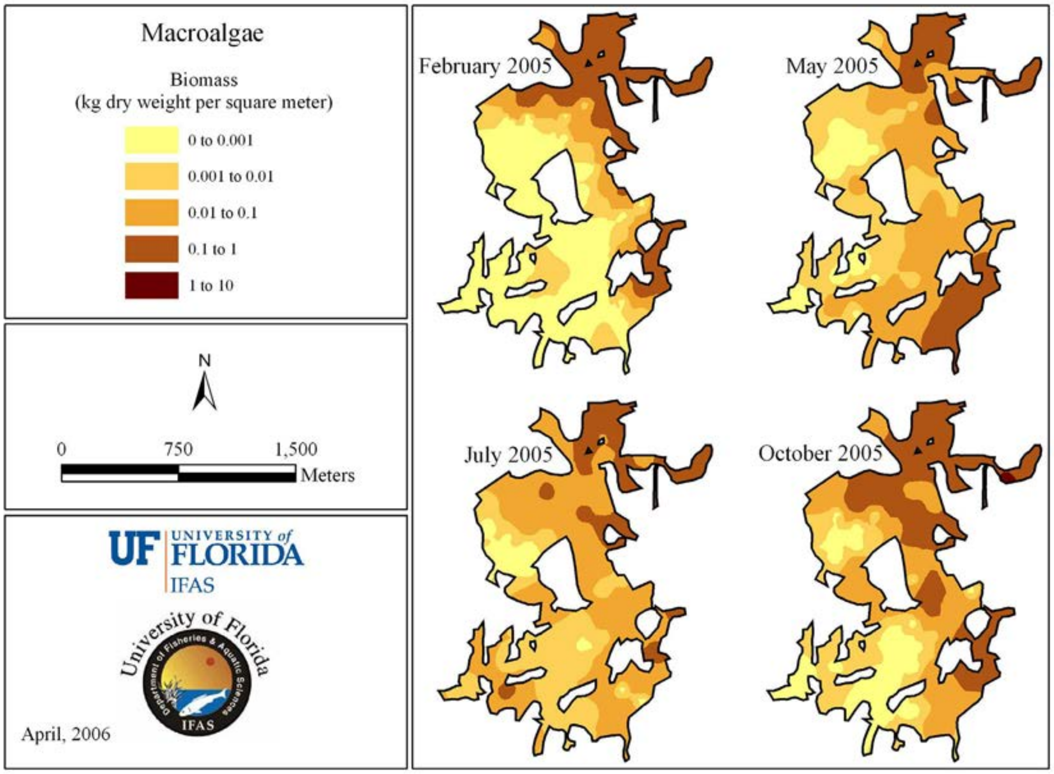

Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
2004

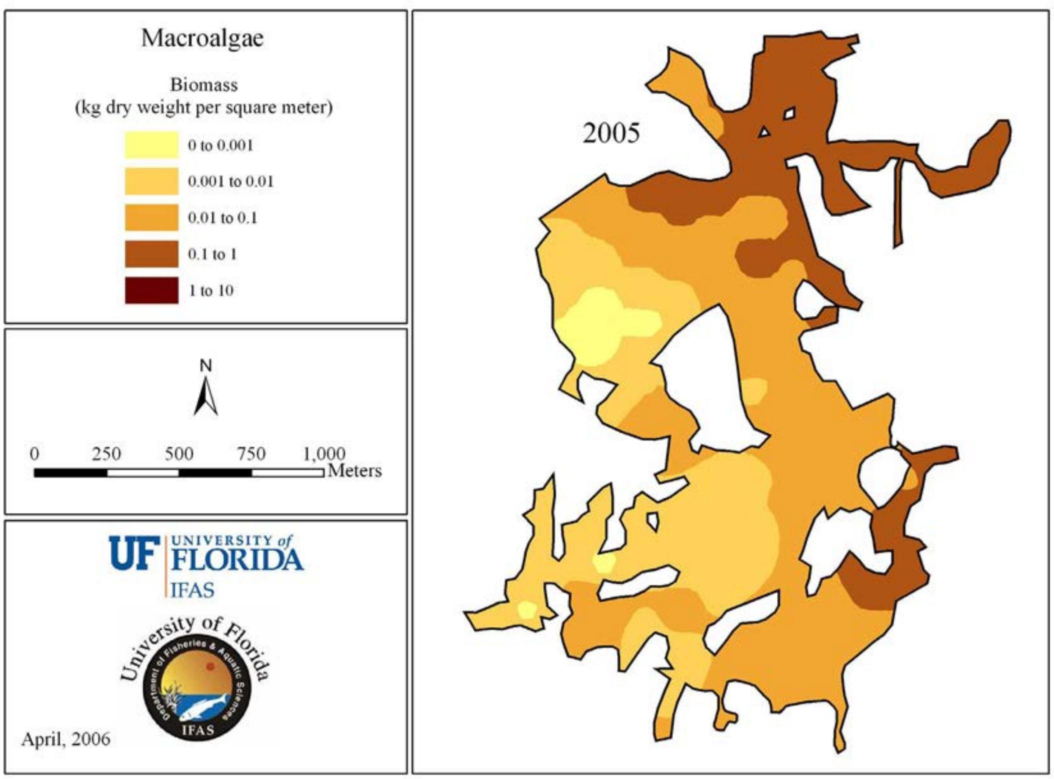

Submerged Aquatic Vegetation
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

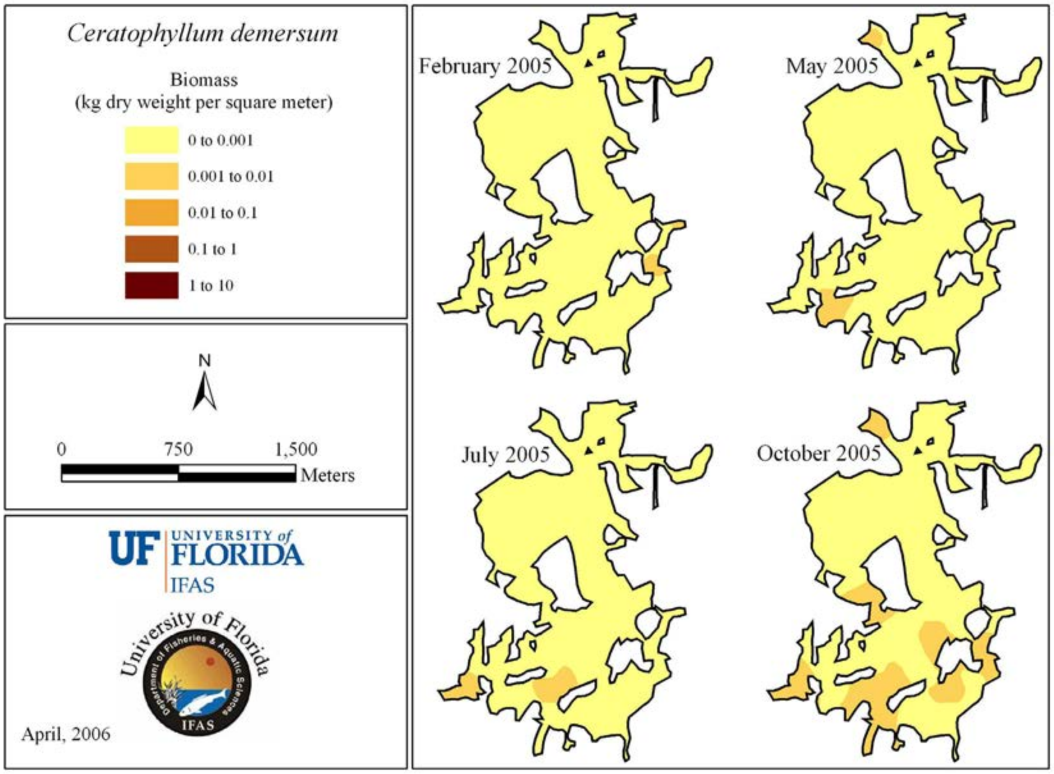

Submerged Aquatic Vegetation
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
April, 2006
2005

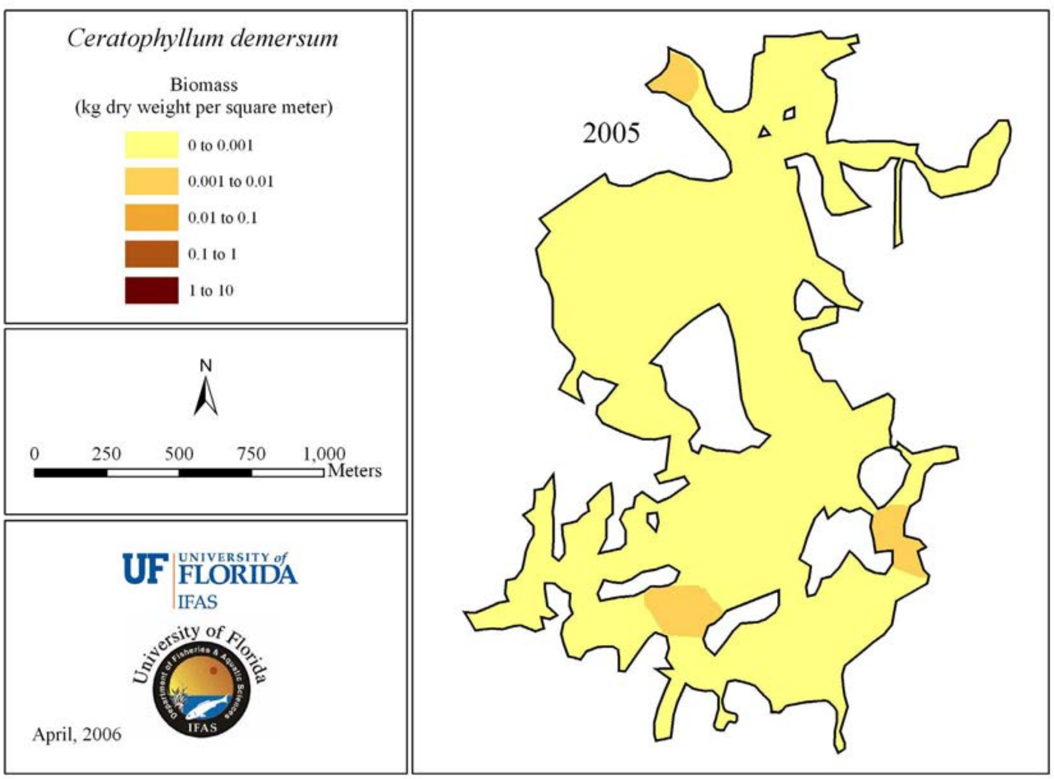

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

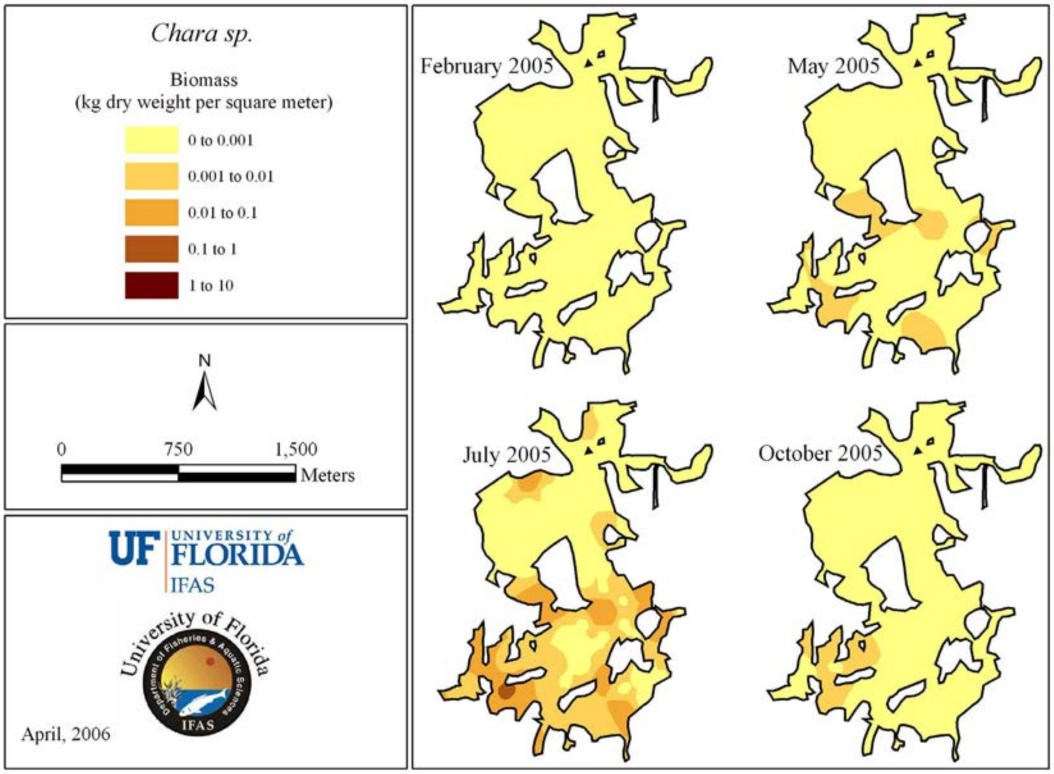

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005


Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
April, 2006
February 2005
May 2005
July 2005
October 2005


Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
April, 2006
2005


Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005


Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2005


Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
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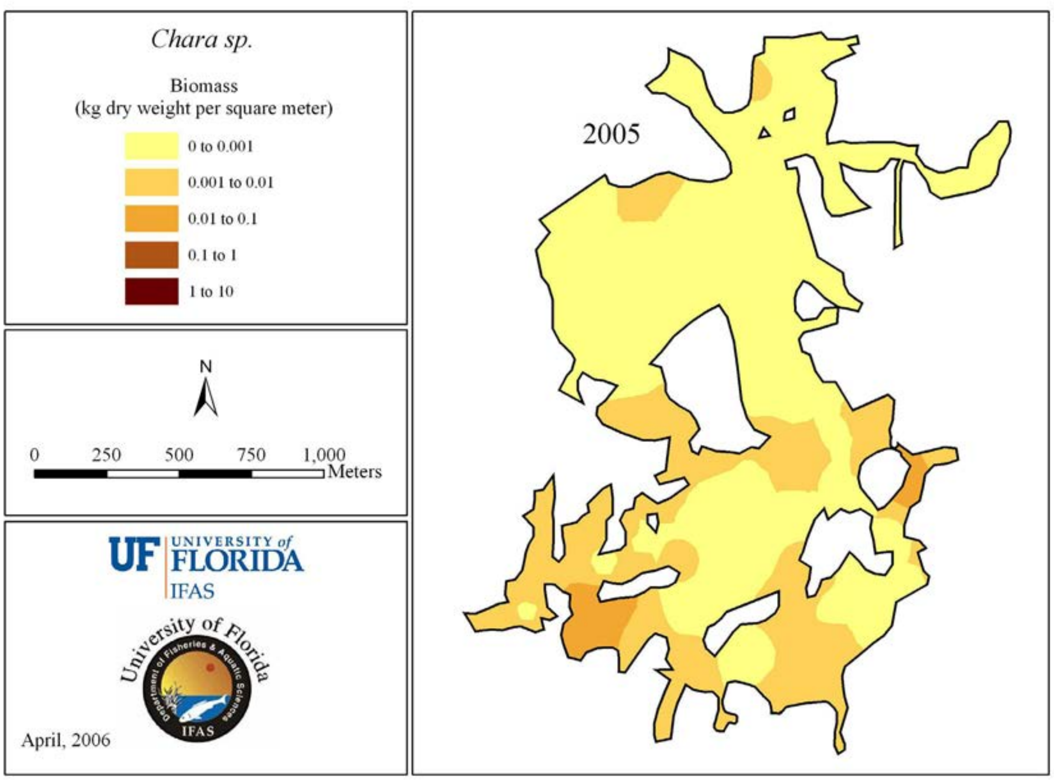
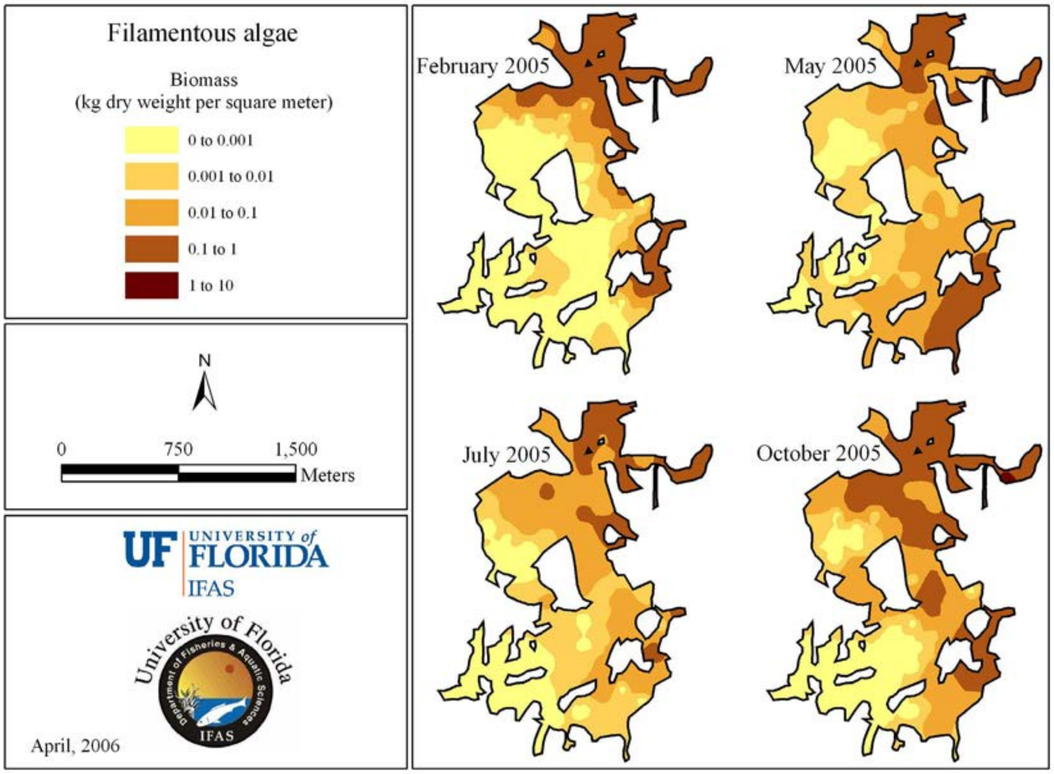
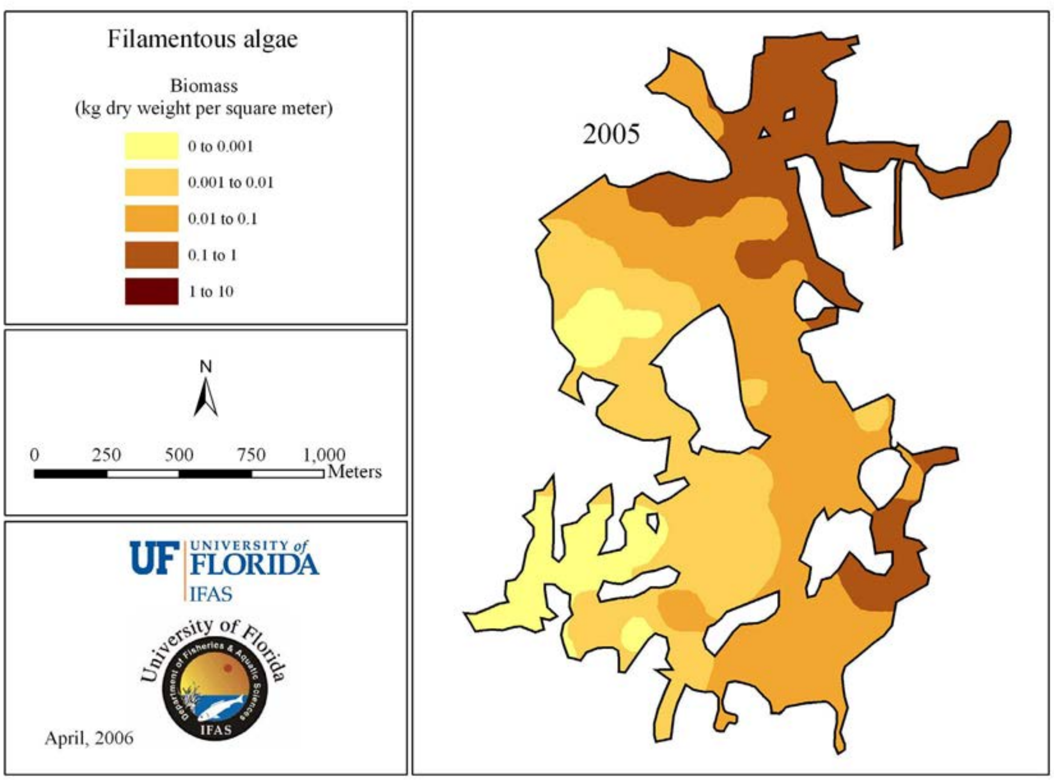
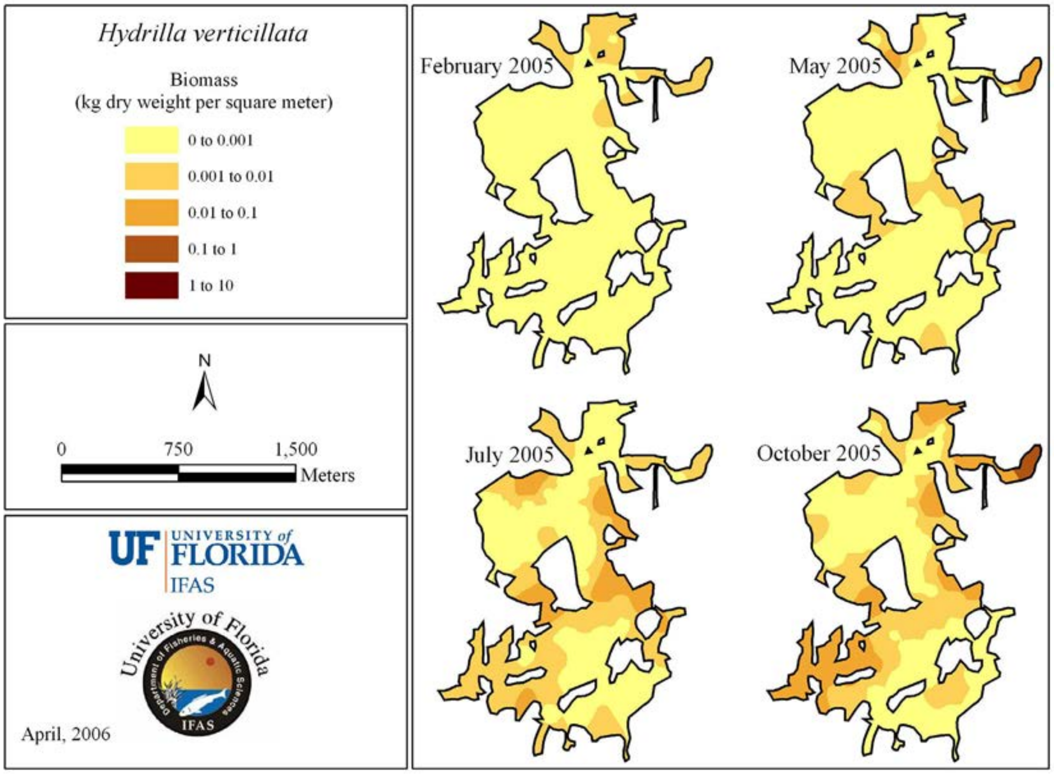
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

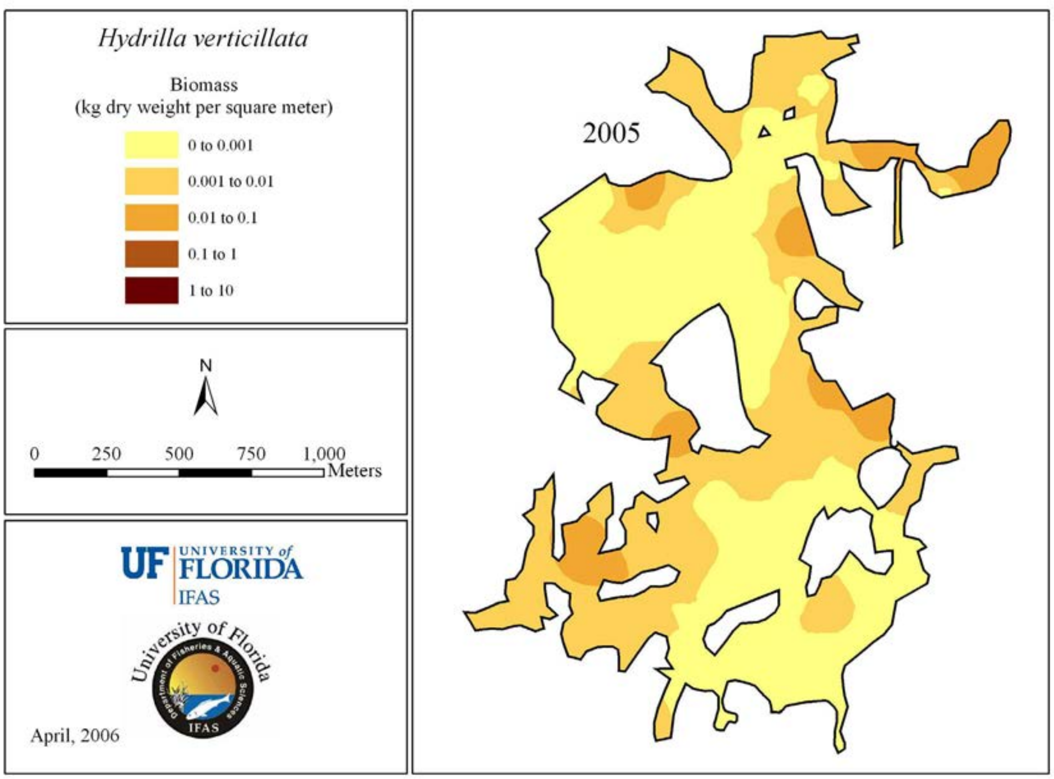

Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005


Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

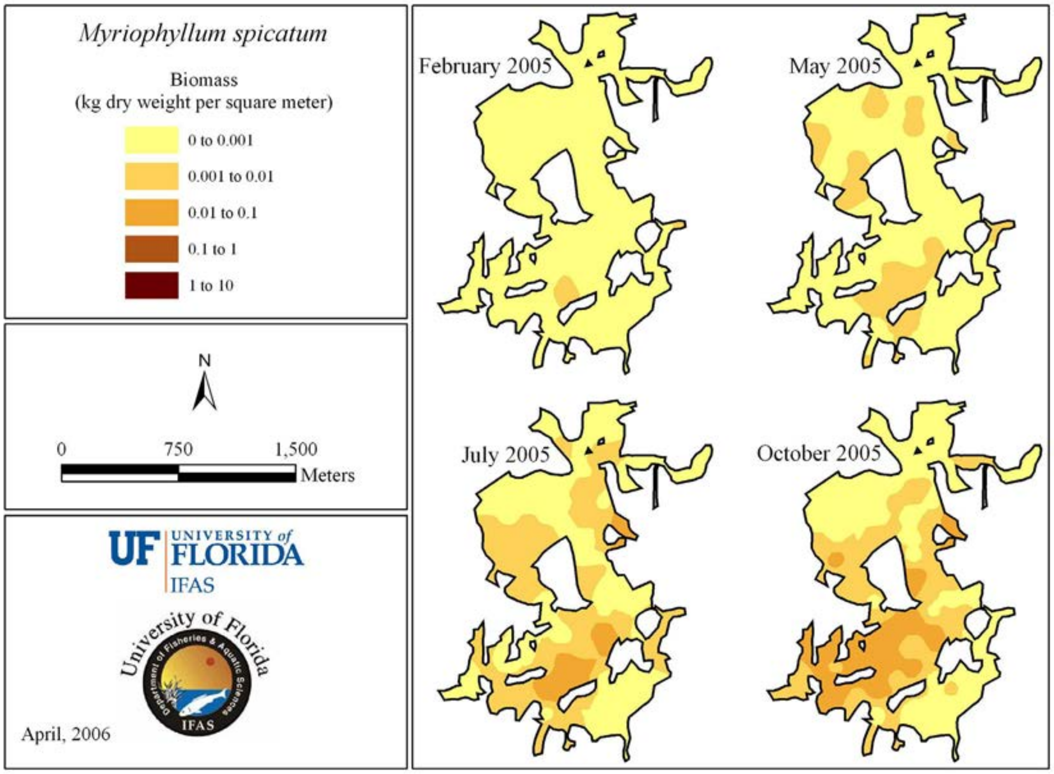

Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005

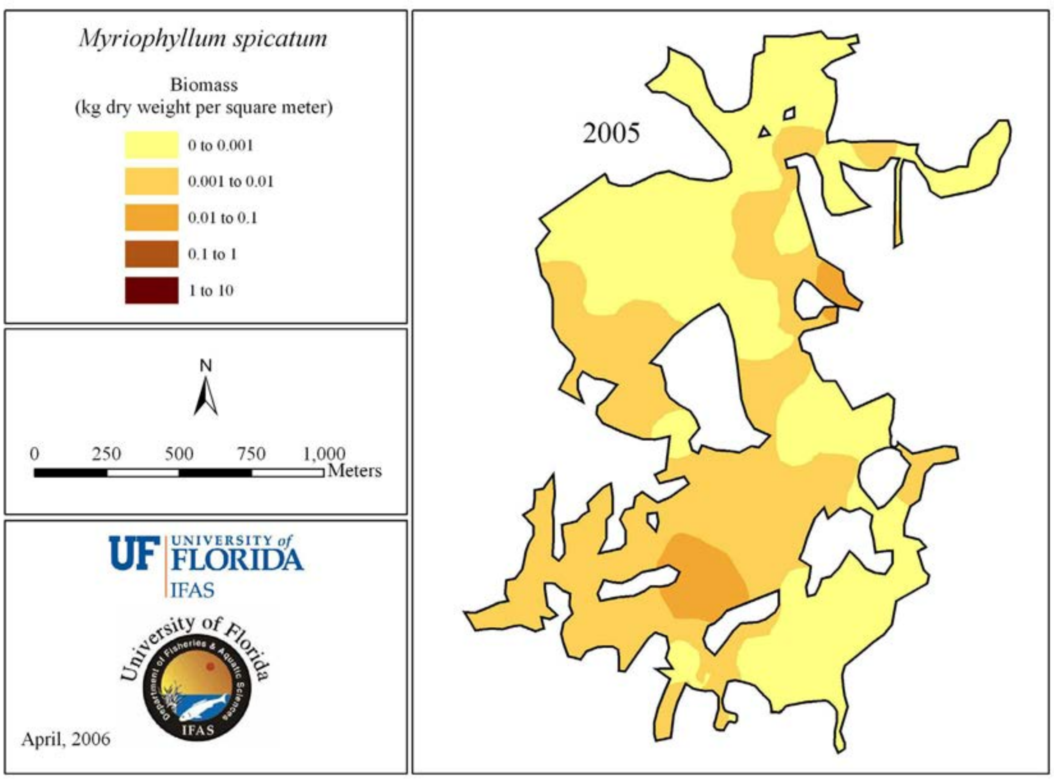


Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005



Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005


Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005


Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
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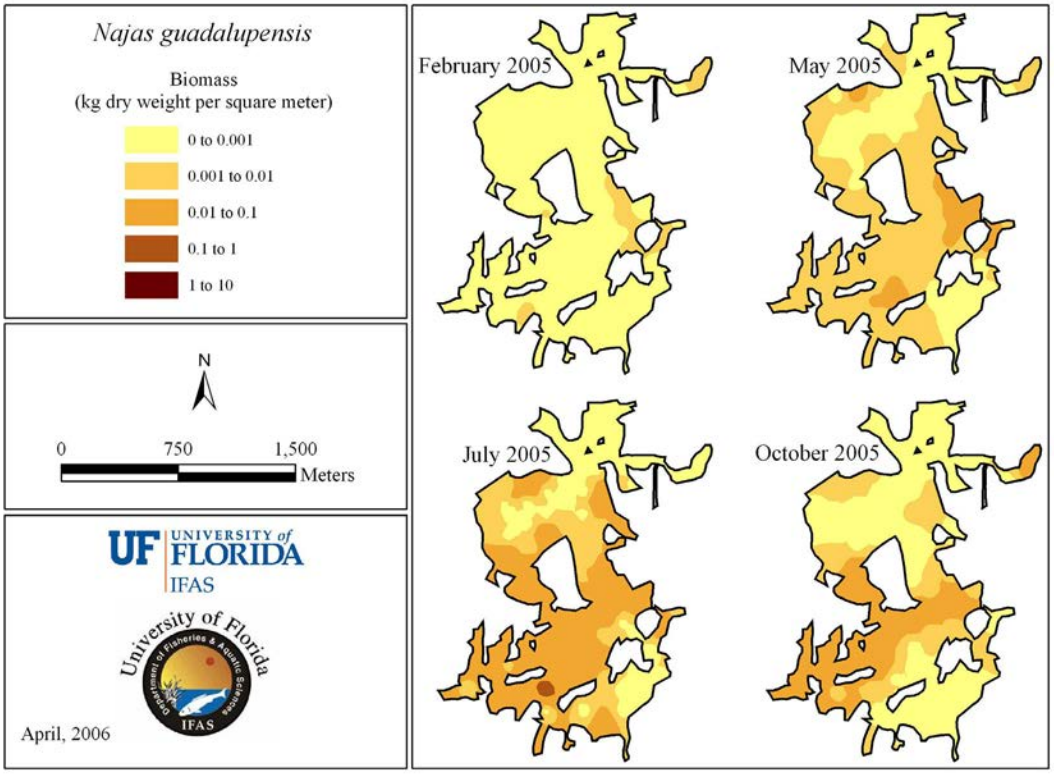
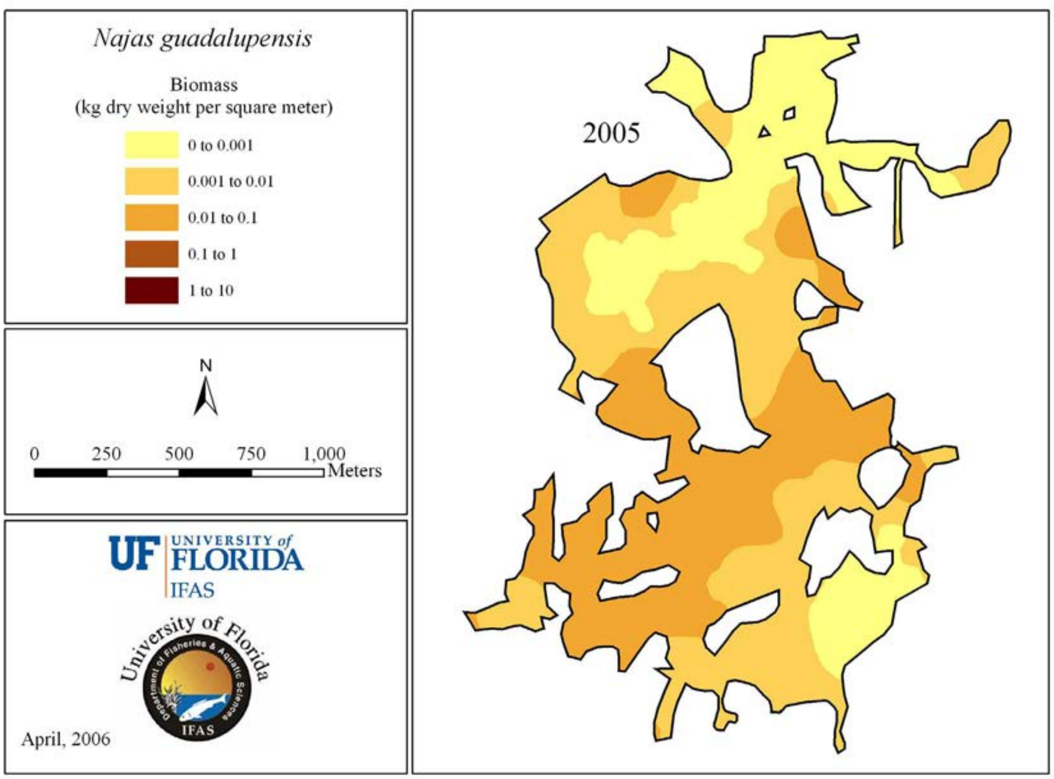
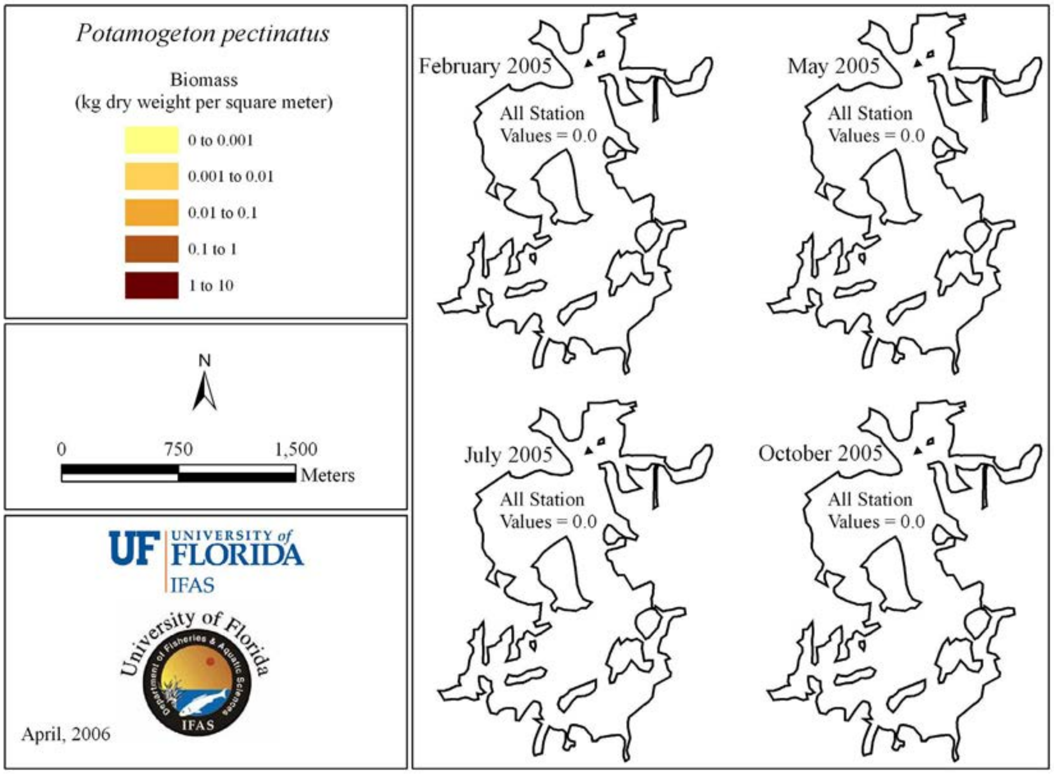
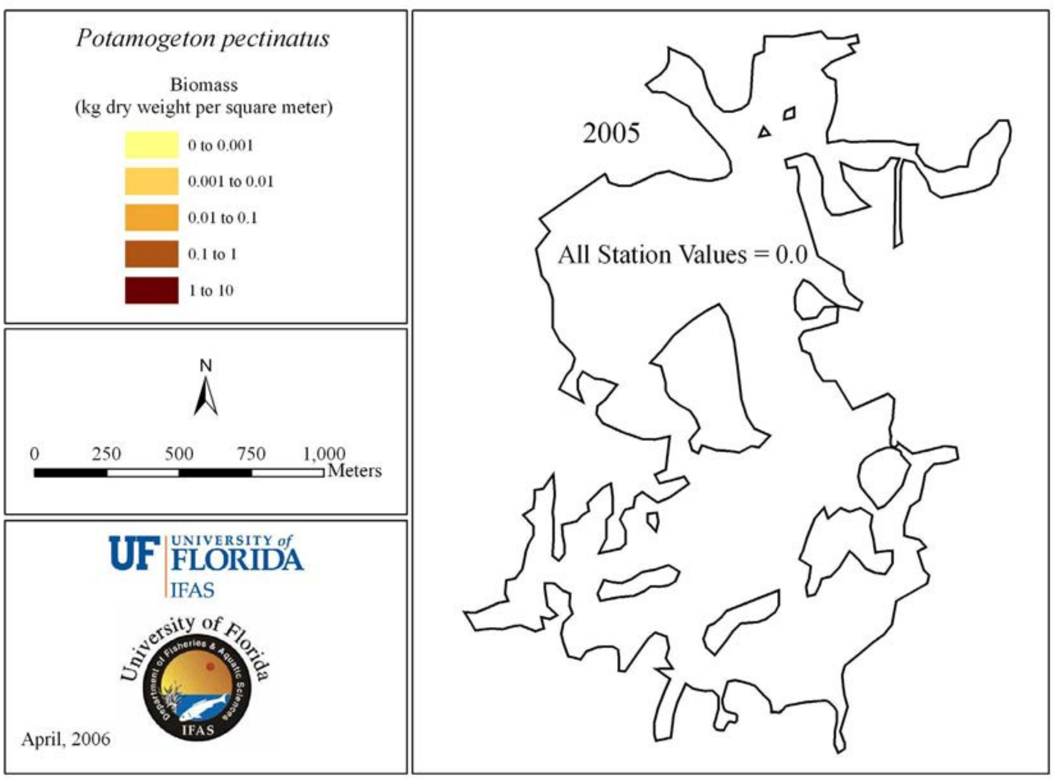
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005


Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005


Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UNIVERSITY of FLORIDA
IFAS
April, 2006
2005


Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
April, 2006
February 2005
All Station Values = 0.0
May 2005
All Station Values = 0.0
July 2005
All Station Values = 0.0
October 2005
All Station Values = 0.0


Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
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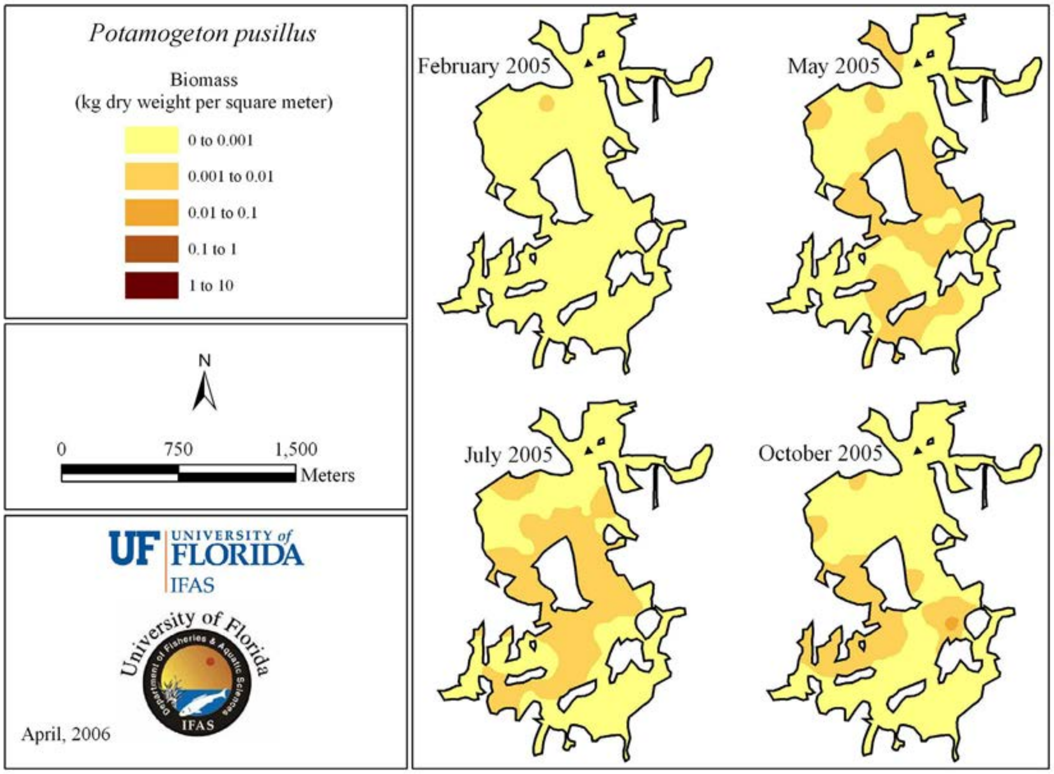
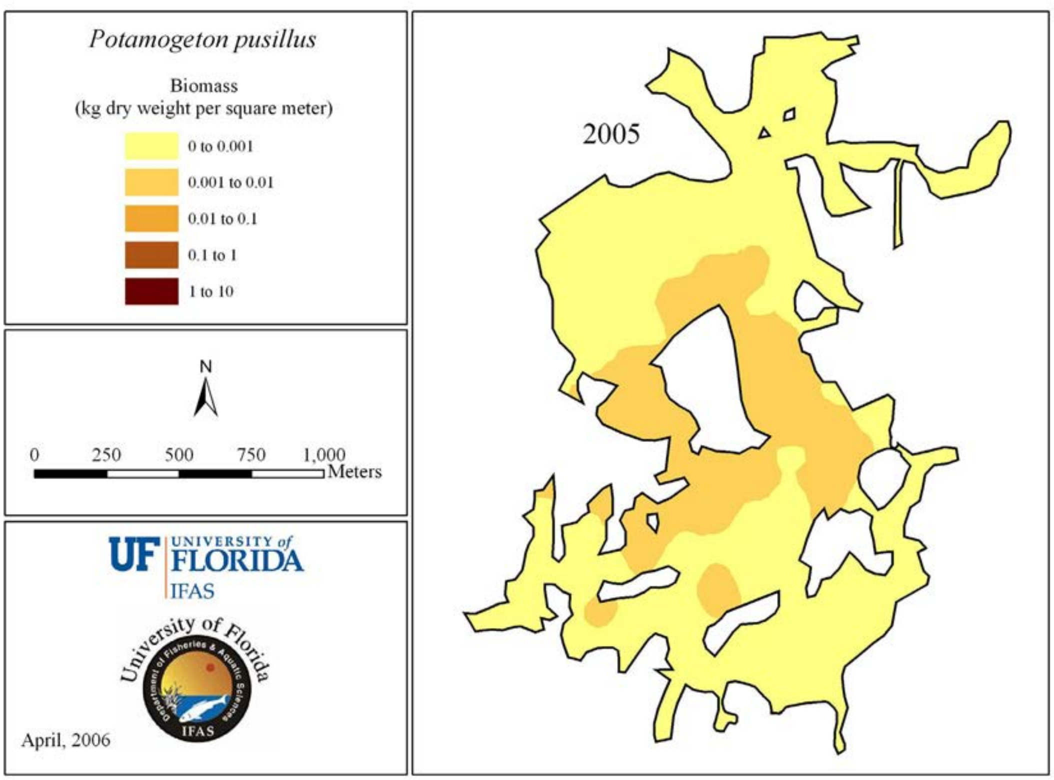
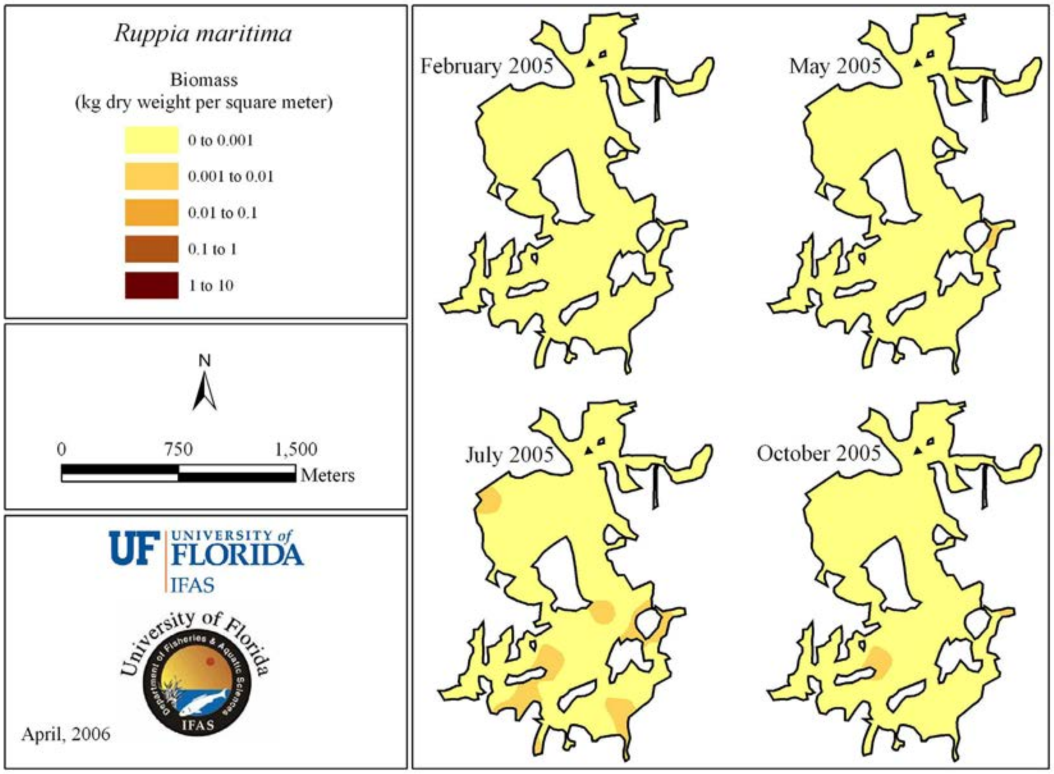
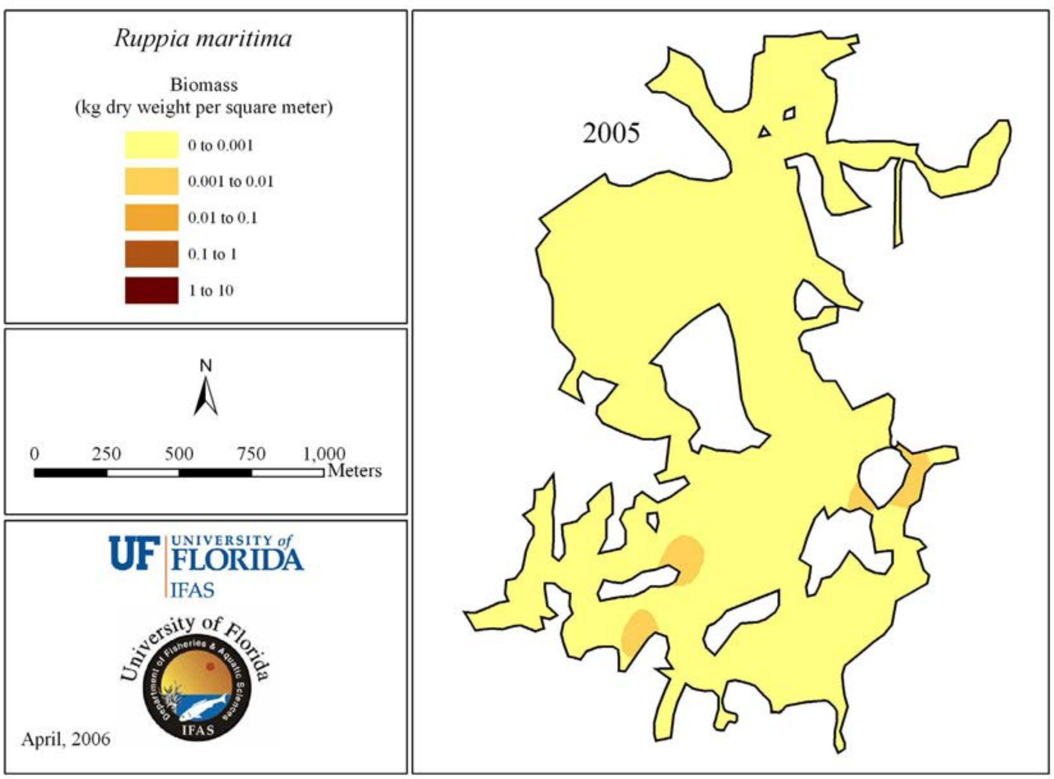
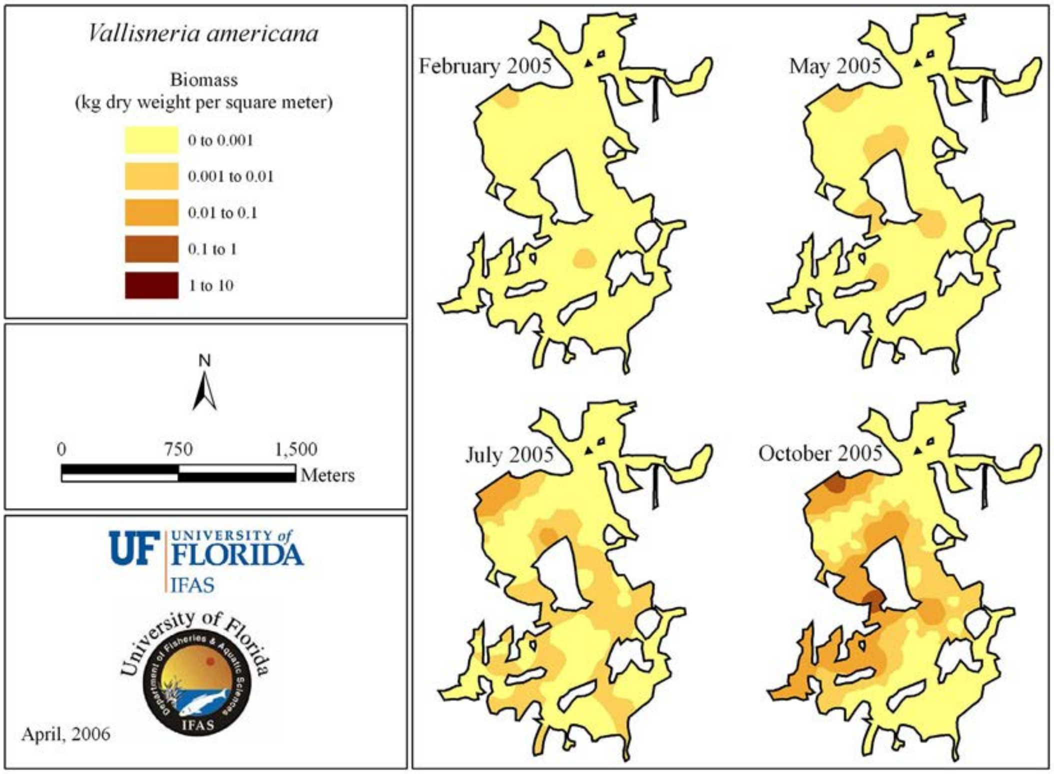
250
500
750
1,000
Meters
April, 2006
2005
All Station Values = 0.0


Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005

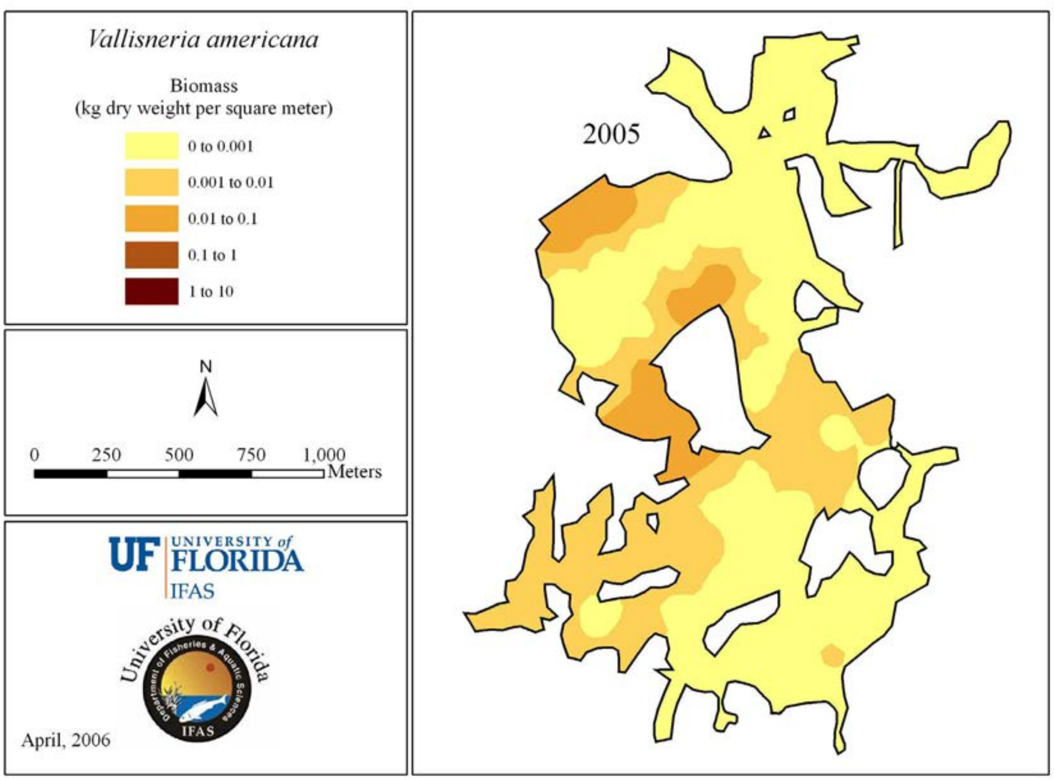

Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
April, 2006
2005


Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
April, 2006
February 2005
May 2005
July 2005
October 2005

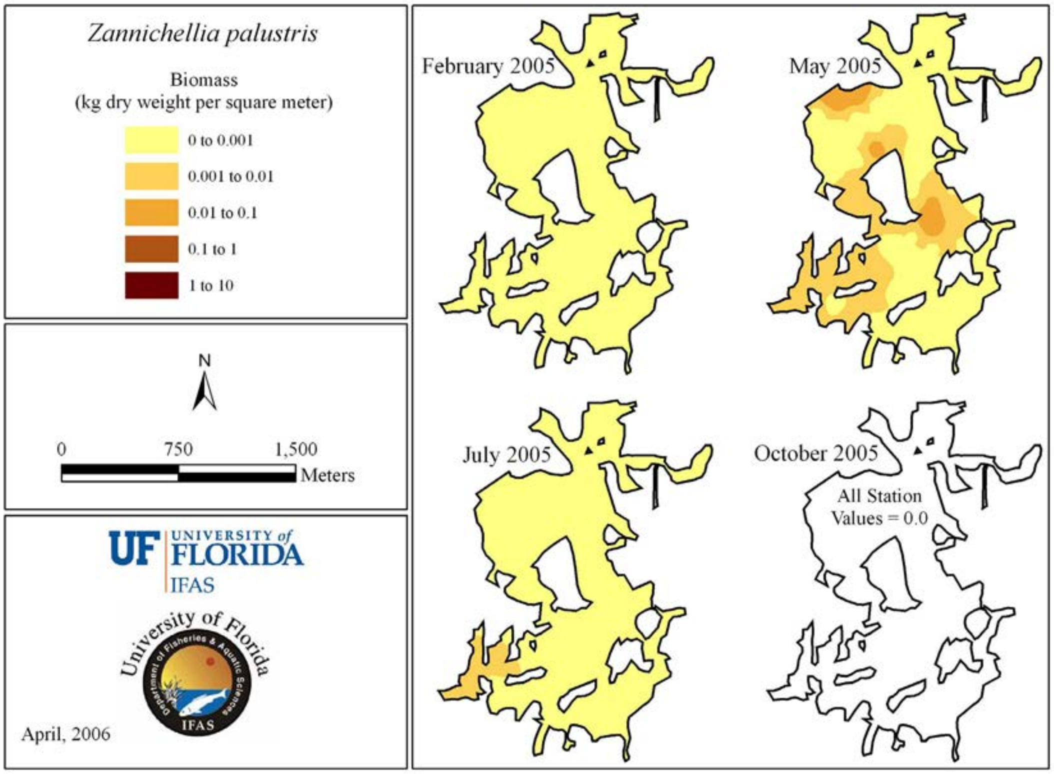

Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
April, 2006
2005



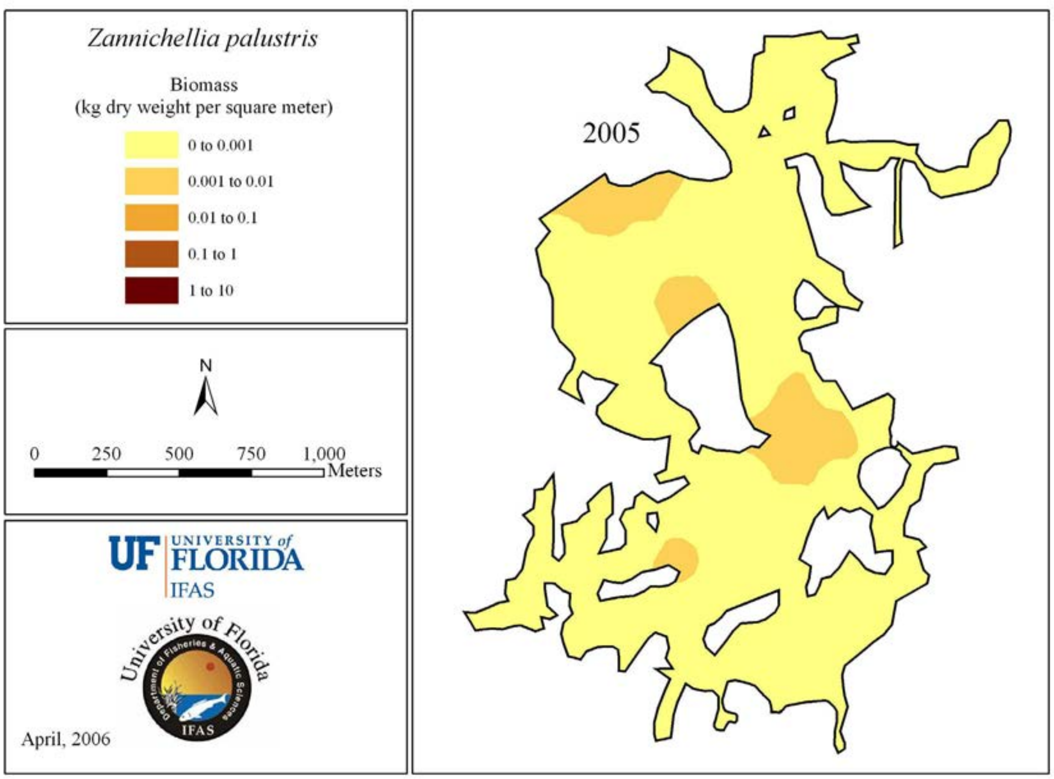
Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
February 2005
May 2005
July 2005
October 2005



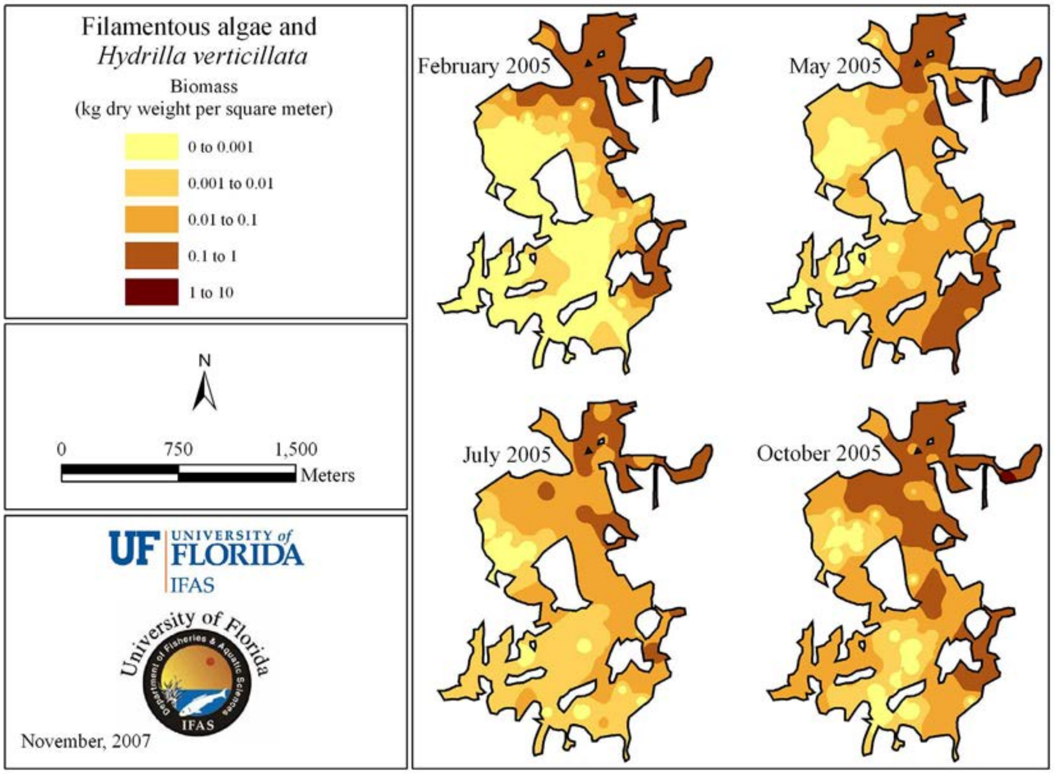
Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
April, 2006
2005

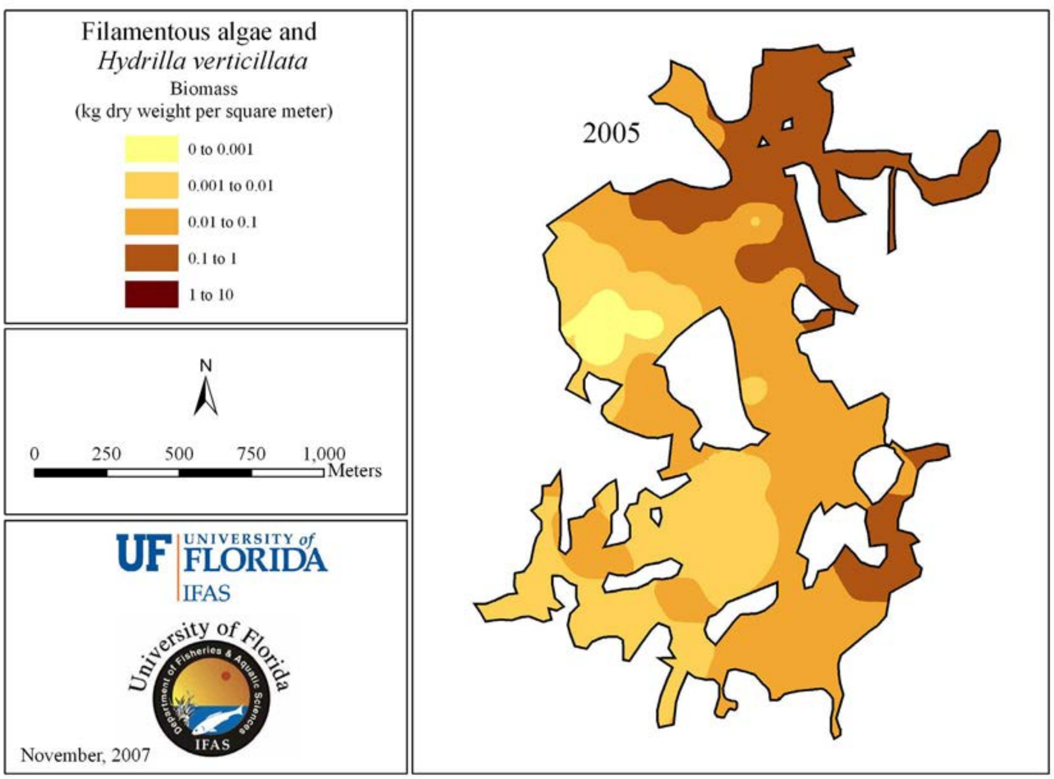


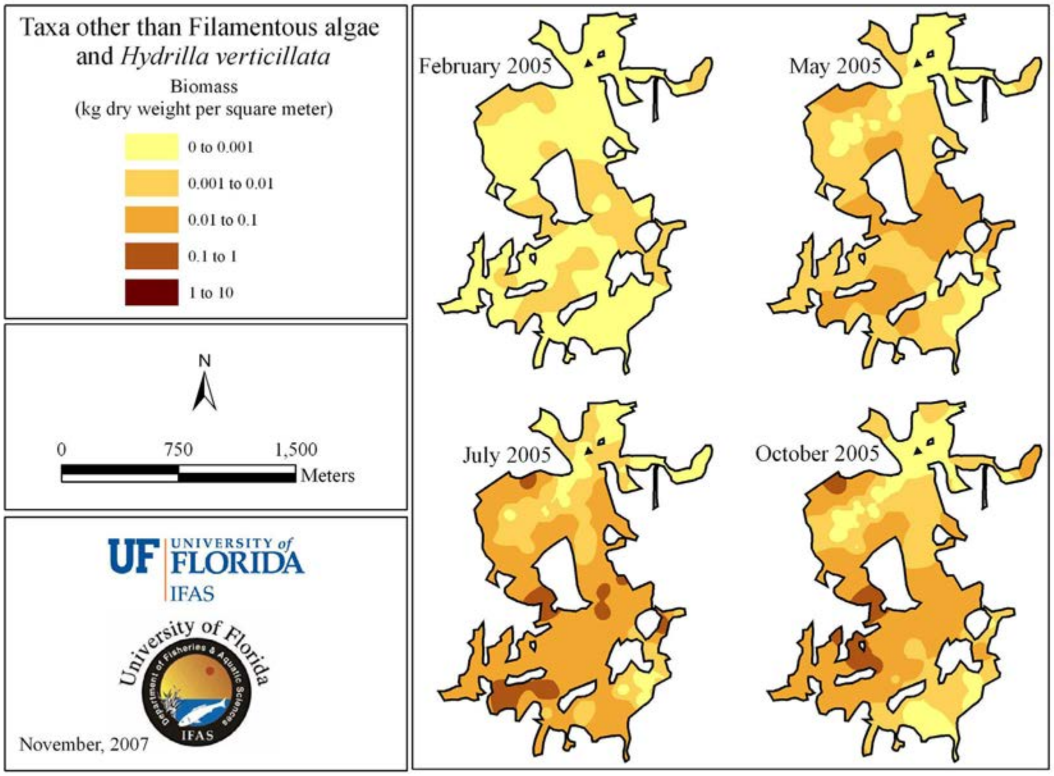
Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
February 2005
May 2005
July 2005
October 2005
All Station Values = 0.0

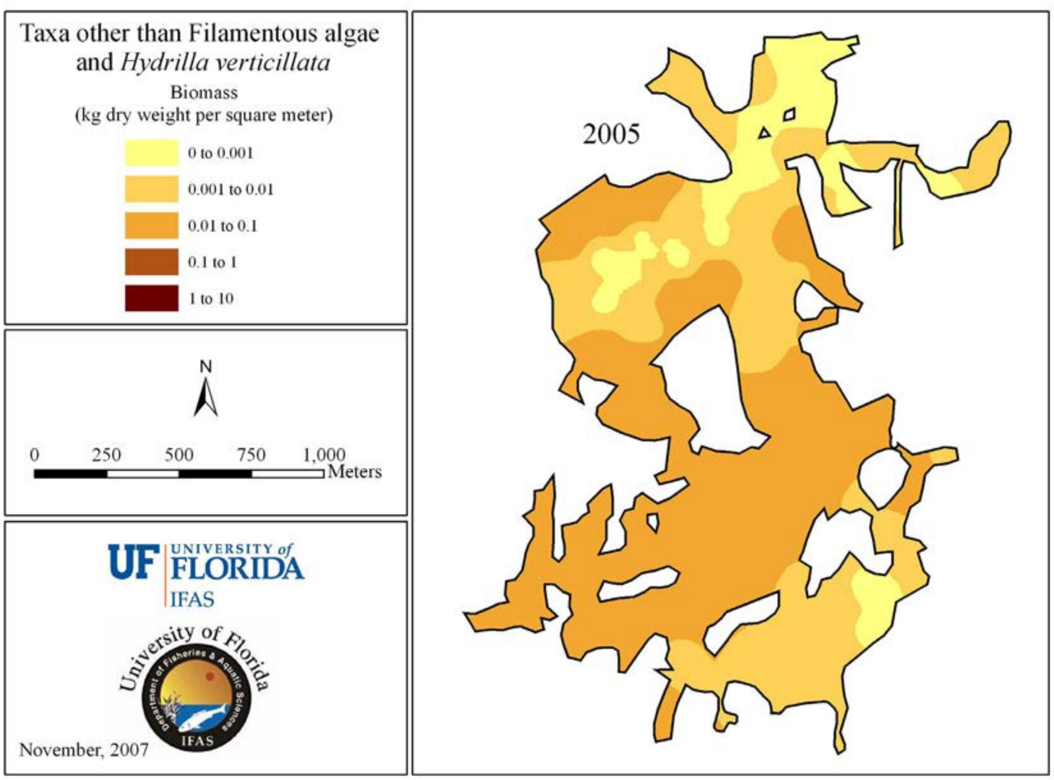


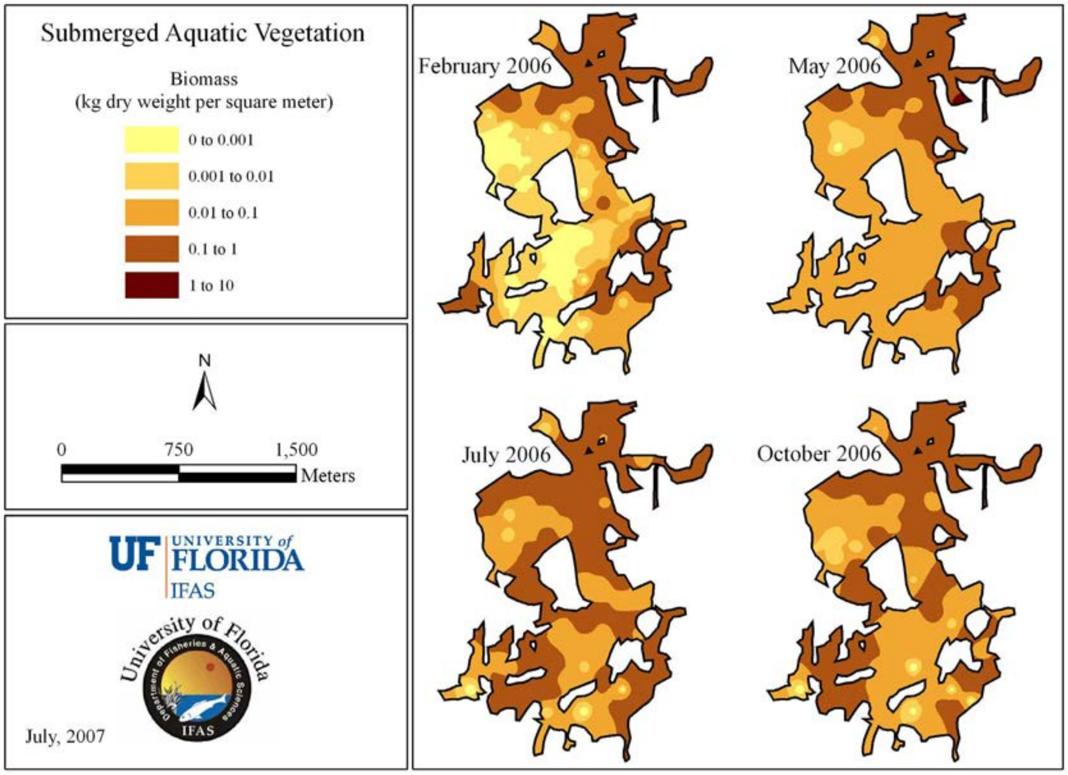
Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
April, 2006
2005

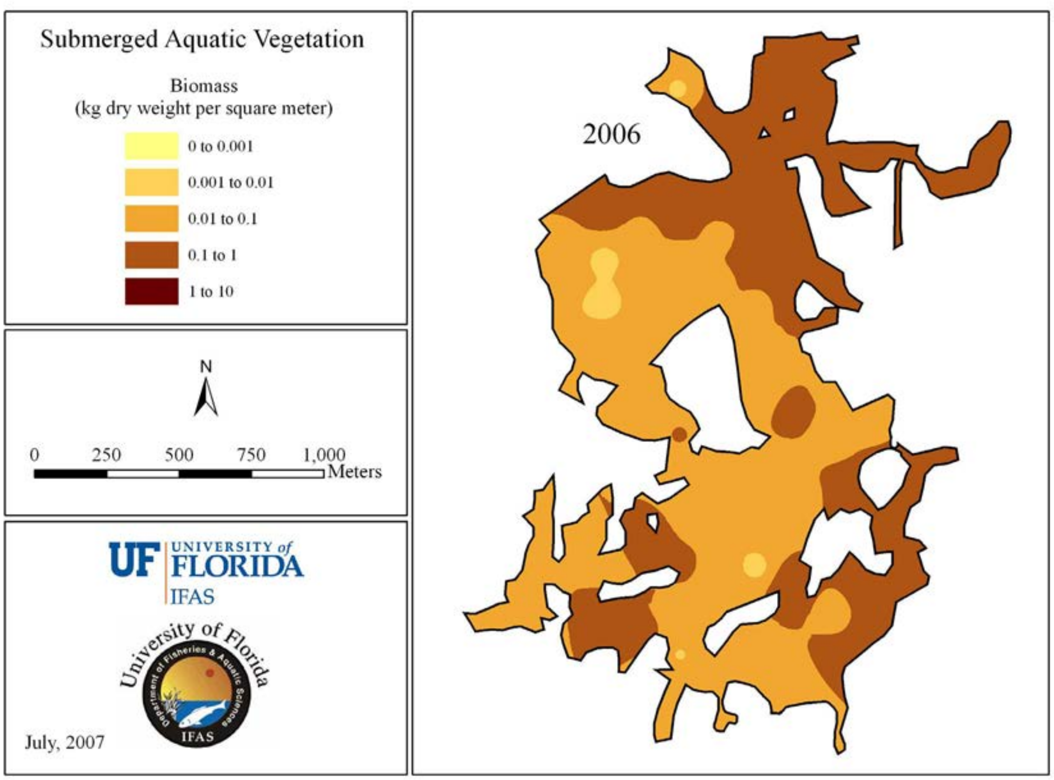

Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
November, 2007
February 2005
May 2005
July 2005
October 2005

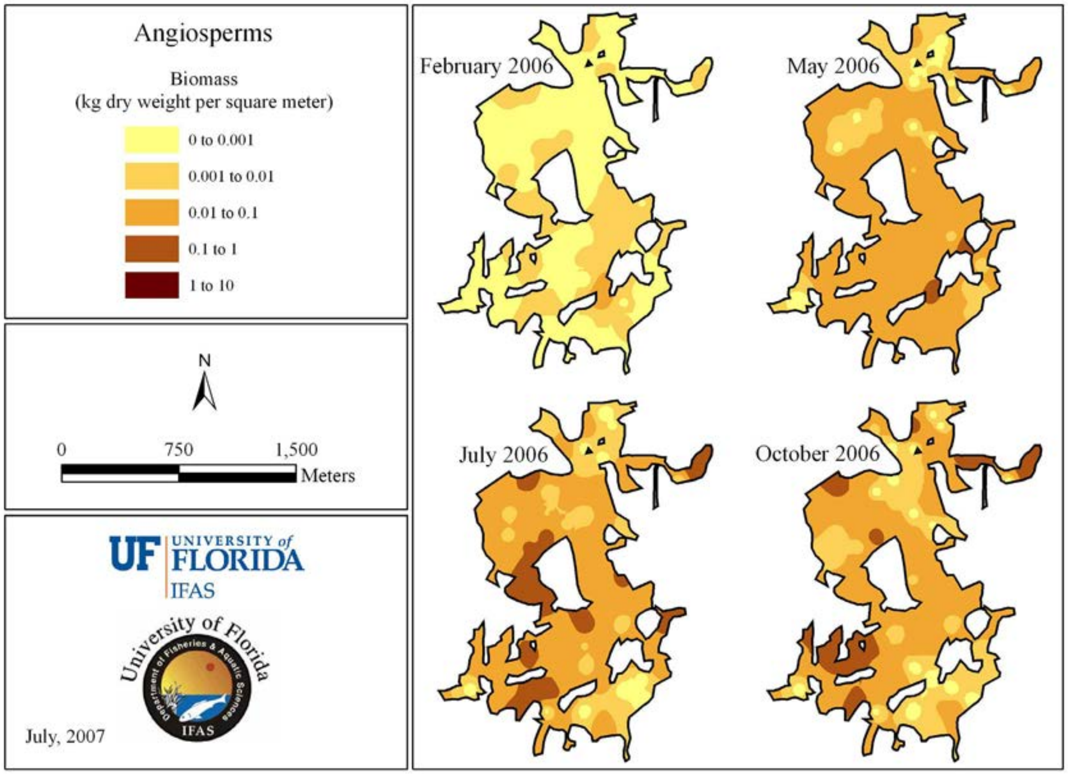

Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
November, 2007
2005

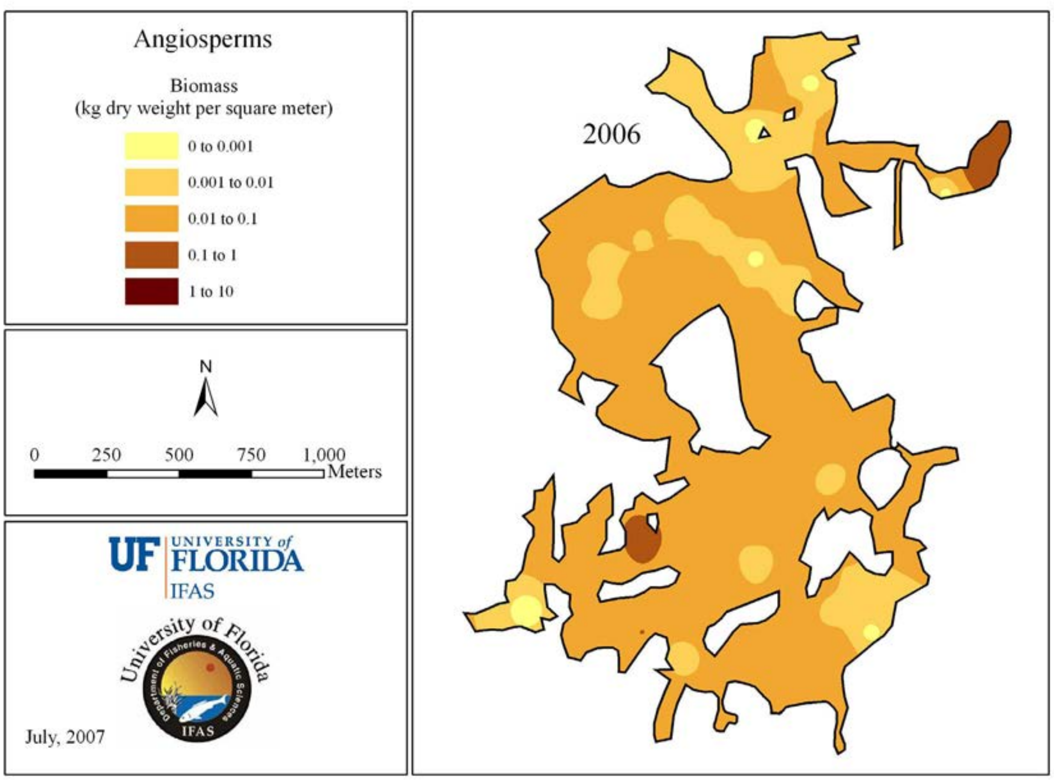

Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
February 2005
May 2005
July 2005
October 2005

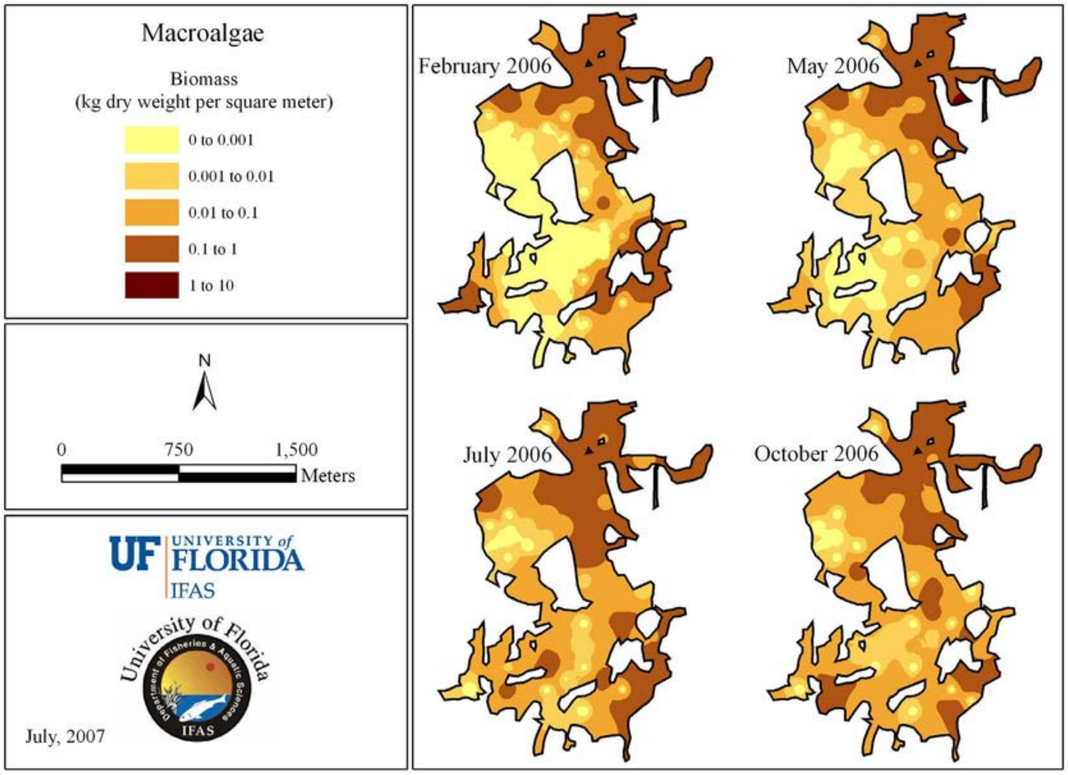

Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
November, 2007
2005

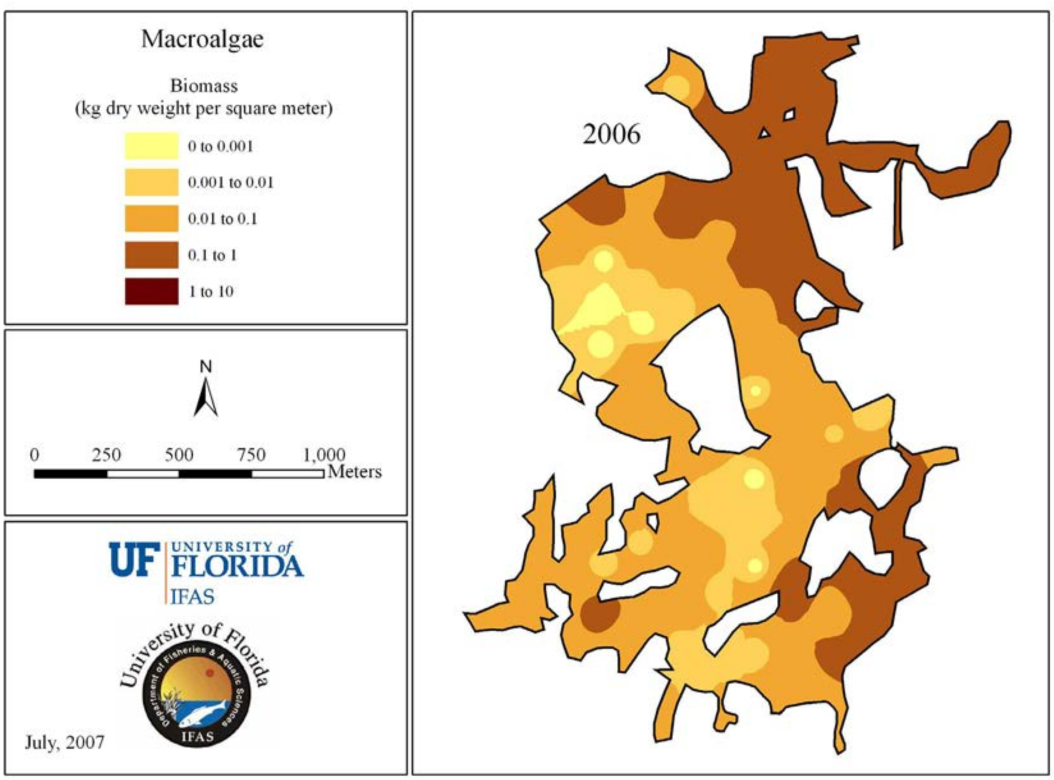

Submerged Aquatic Vegetation
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

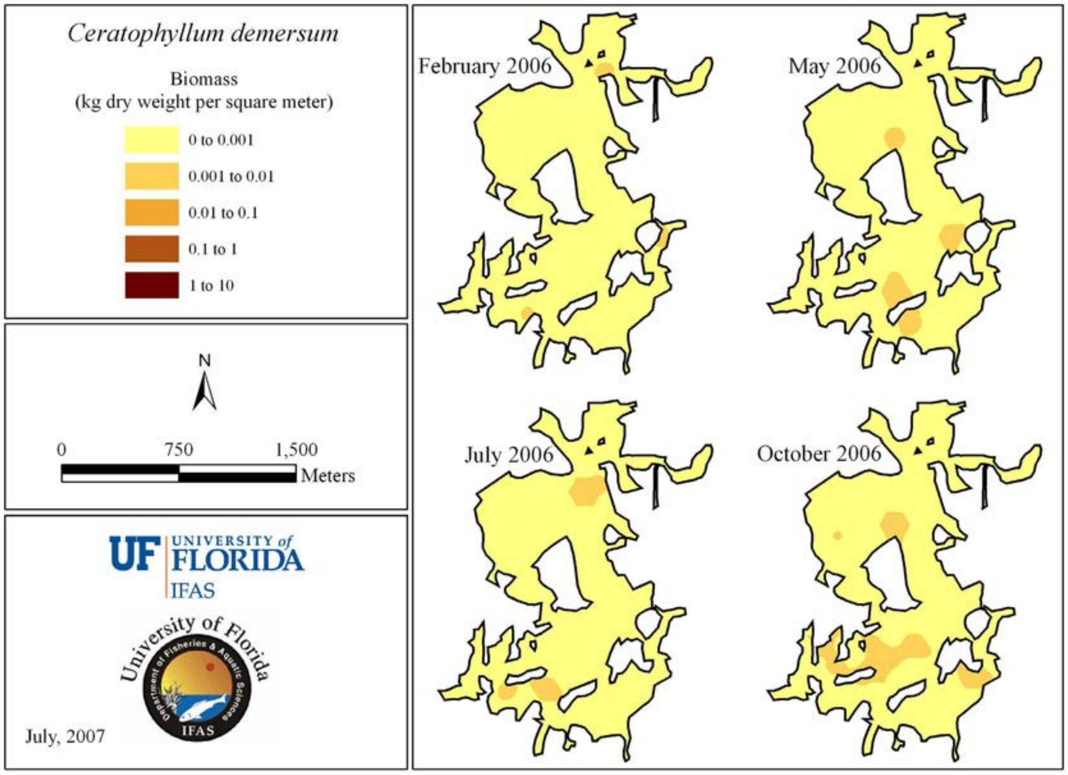

Submerged Aquatic Vegetation
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

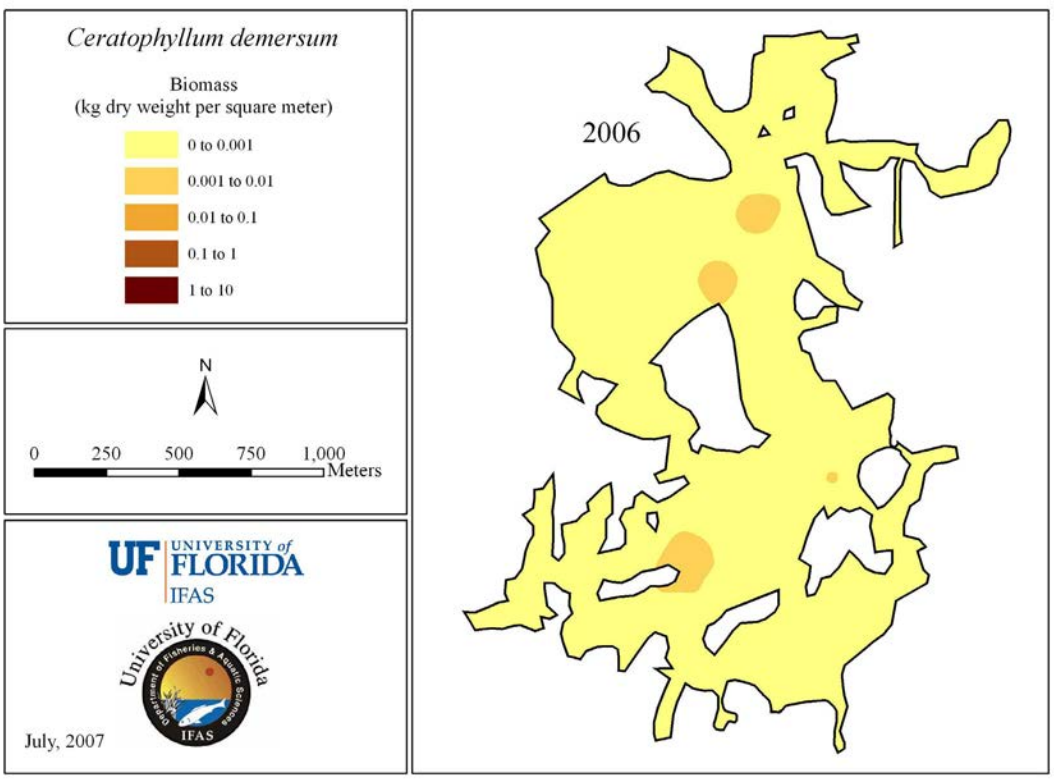

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
February 2006
May 2006
July 2006
October 2006

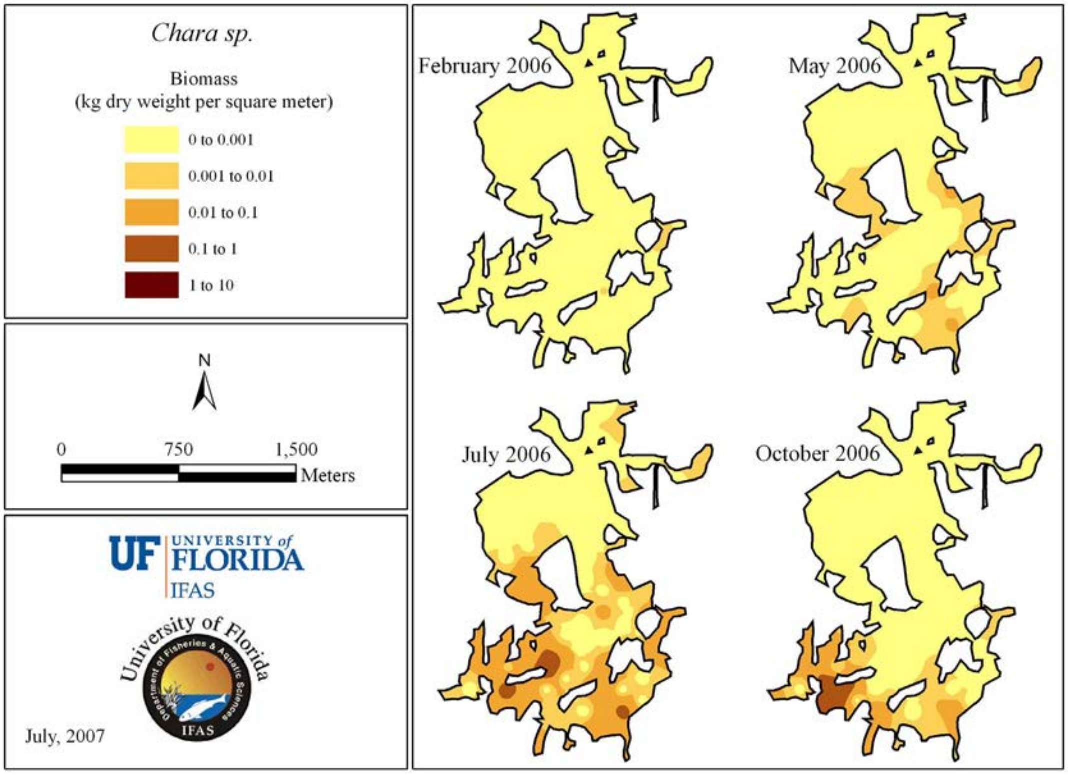

Angiosperms
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
2006

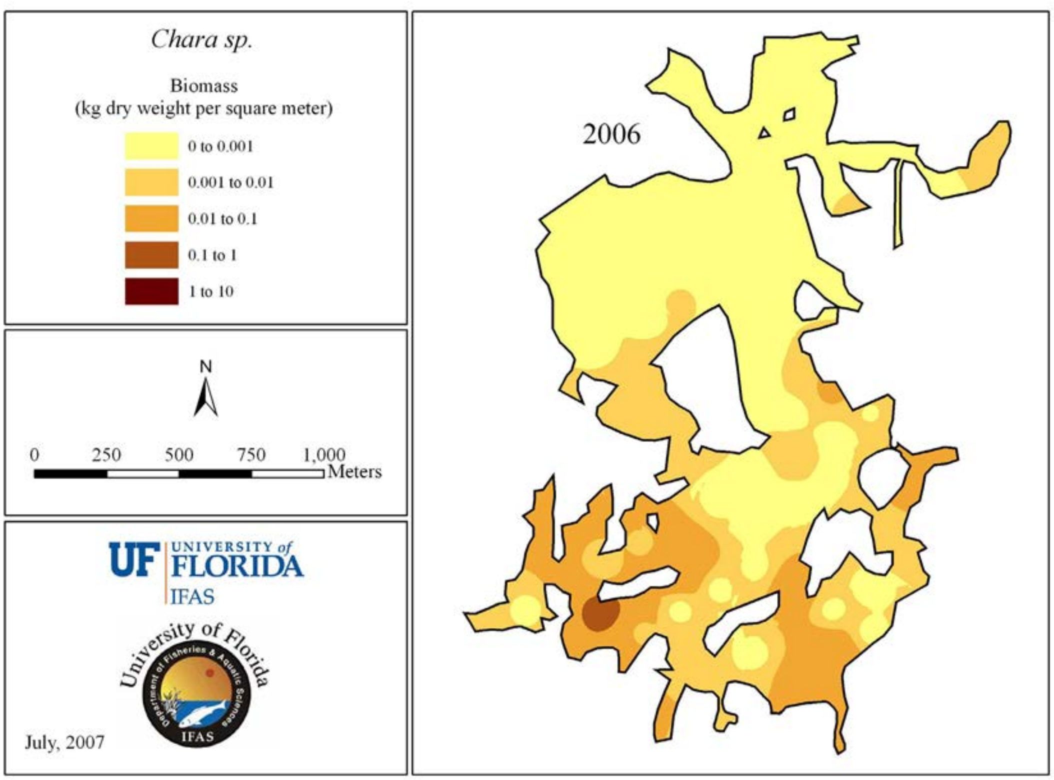

Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

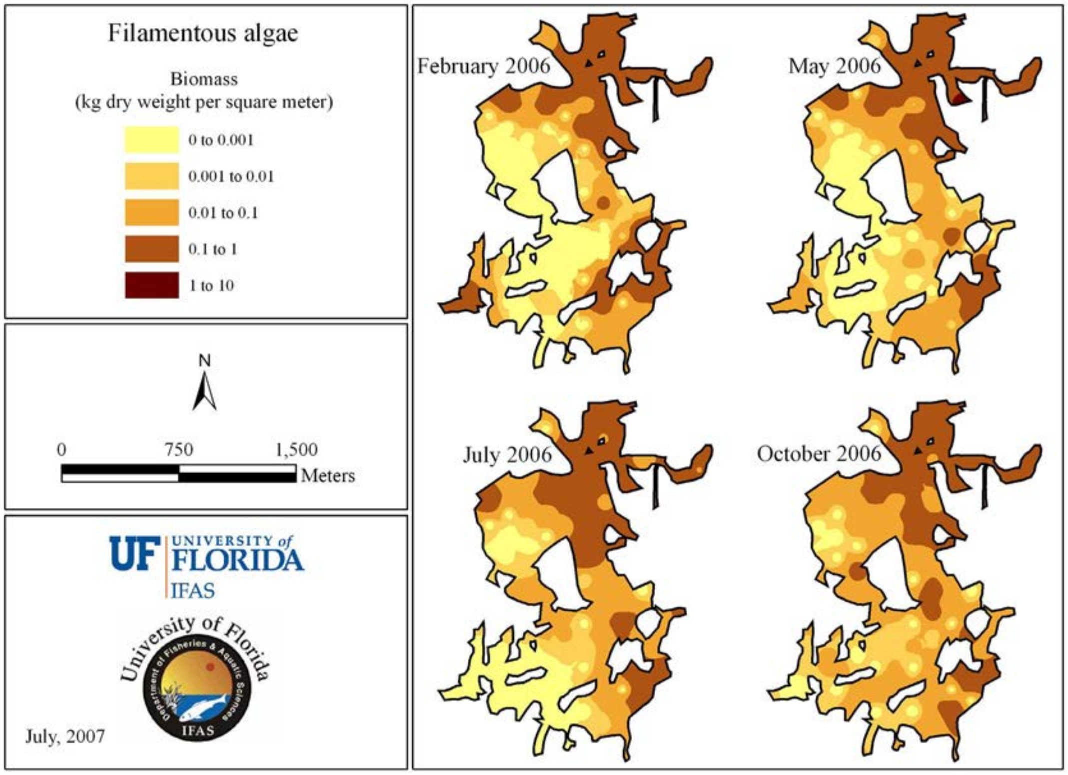

Macroalgae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

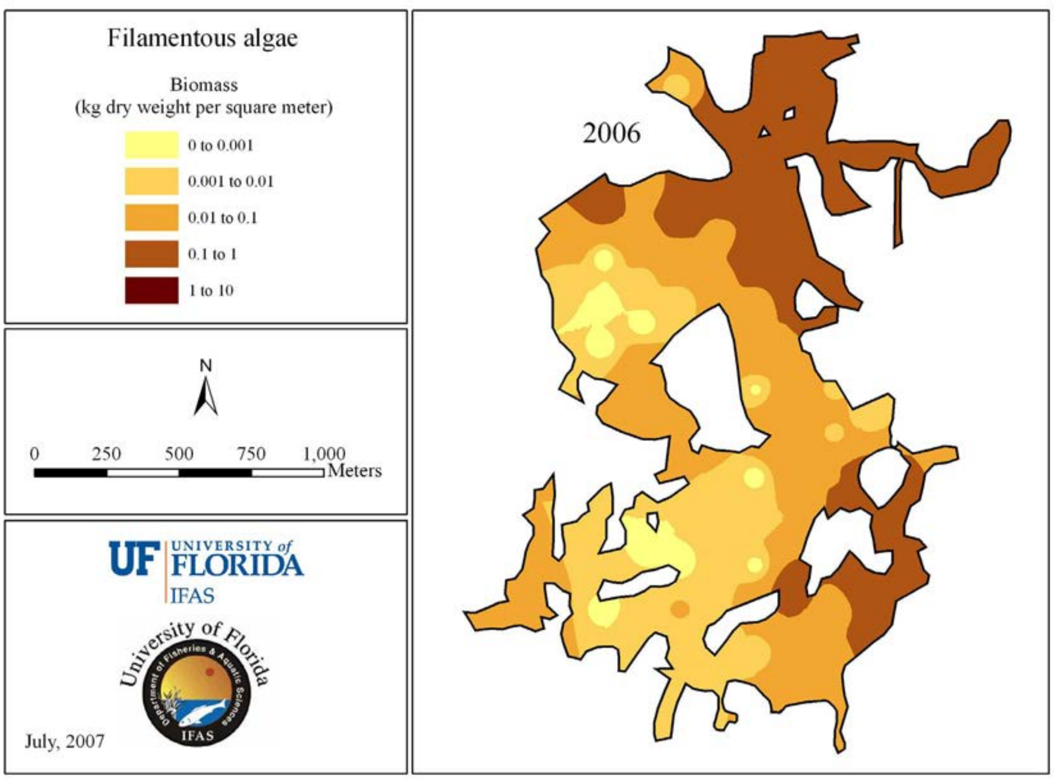

Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

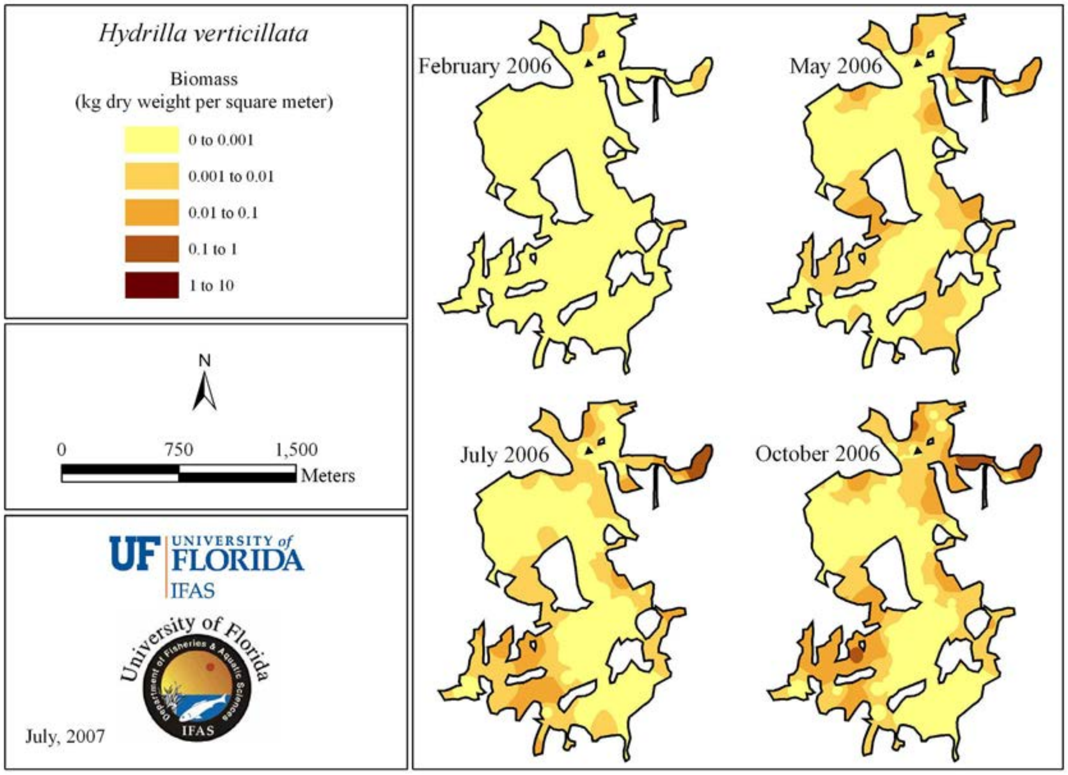

Ceratophyllum demersum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

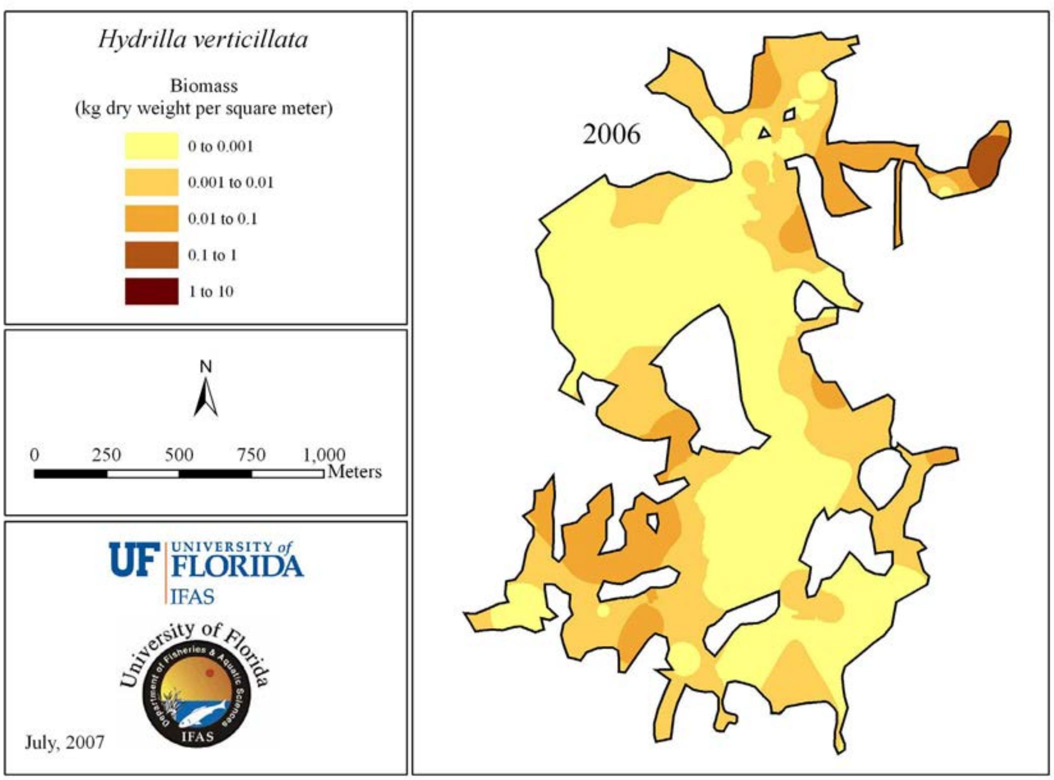

Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

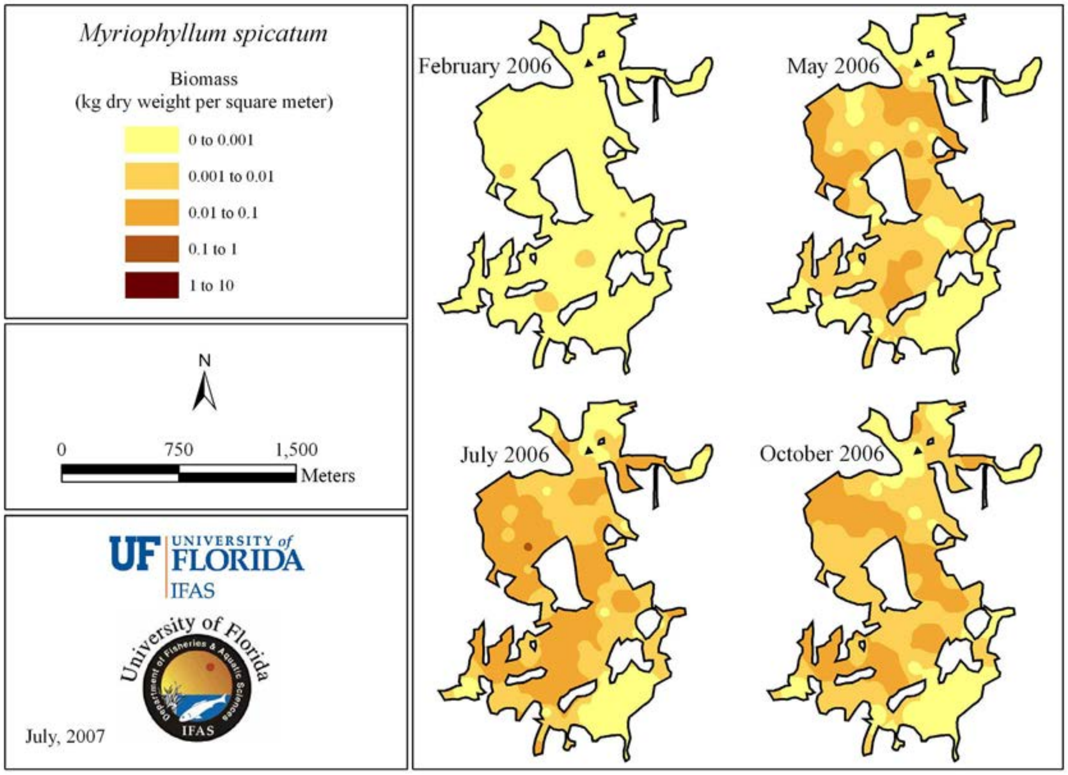

Chara sp.
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006

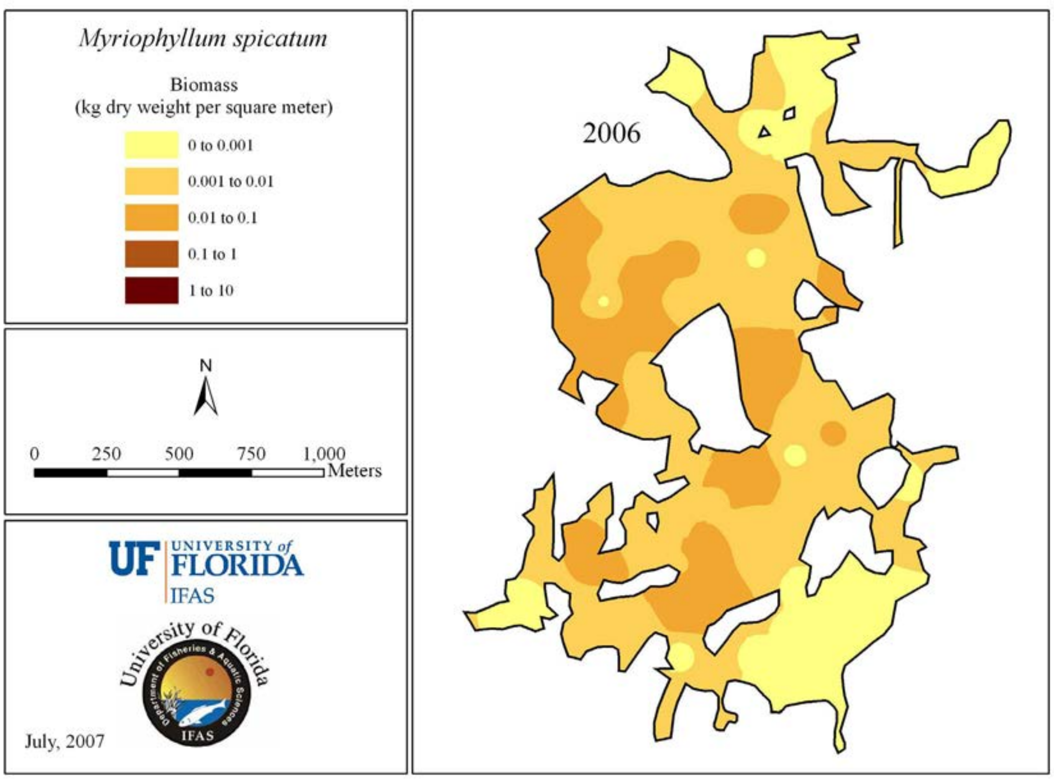

Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0 750 1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
February 2006
May 2006
July 2006
October 2006

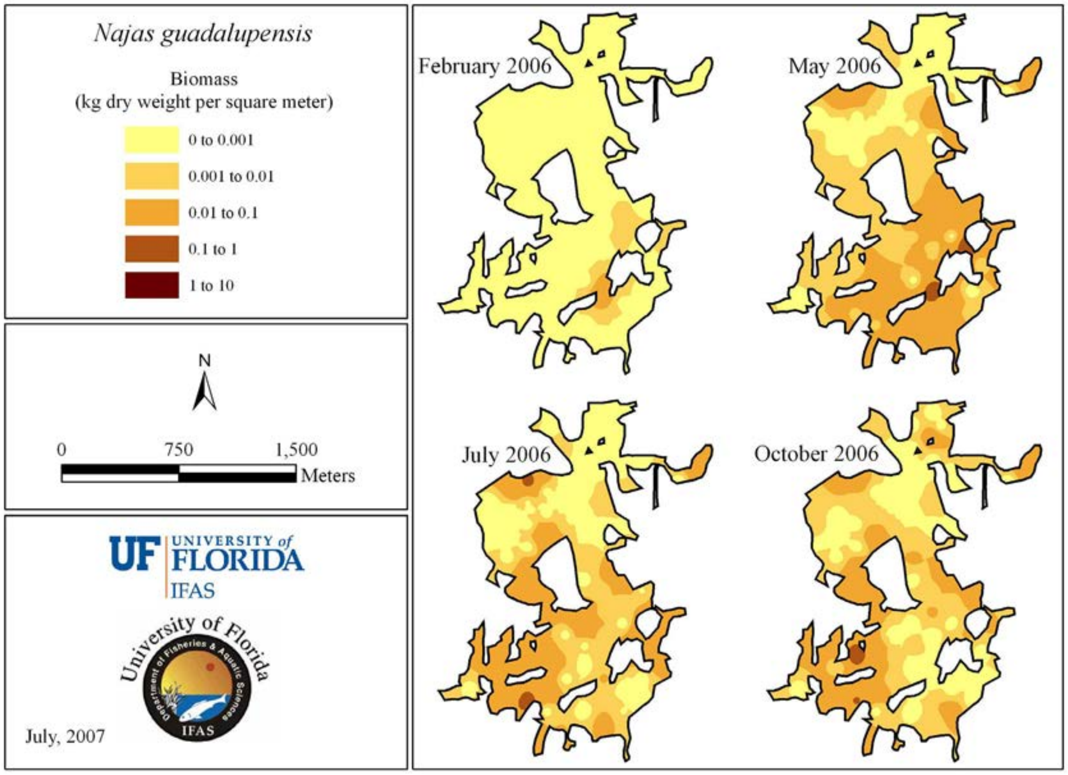

Filamentous algae
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0 250 500 750 1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
2006

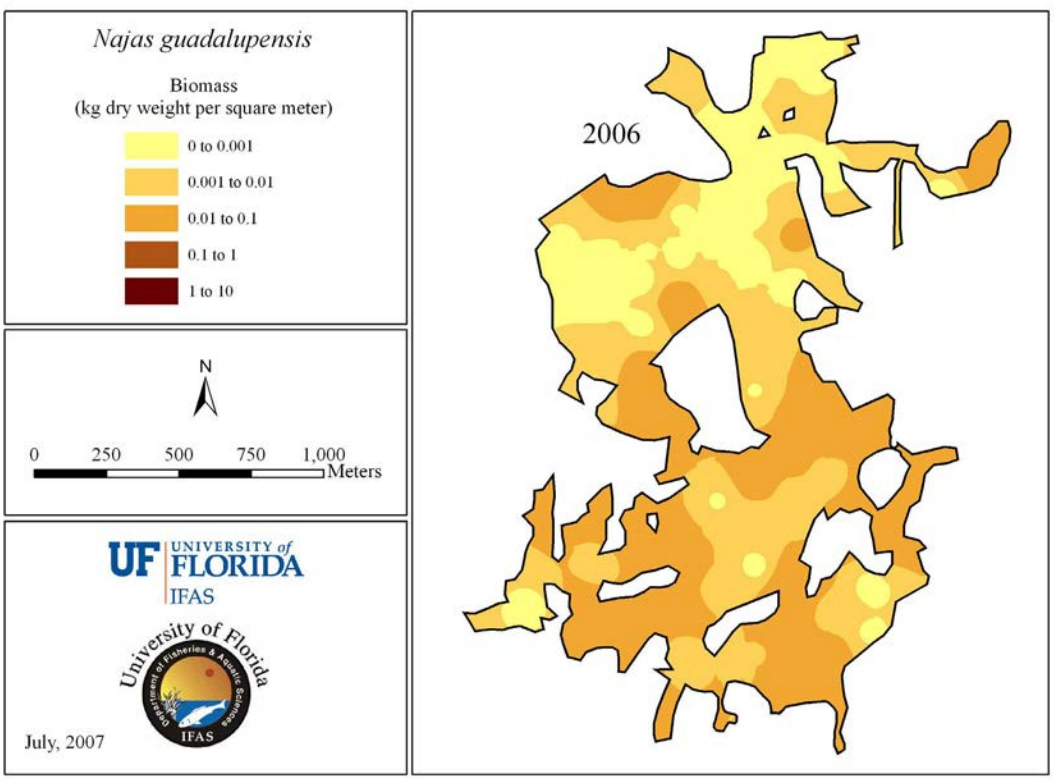

Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

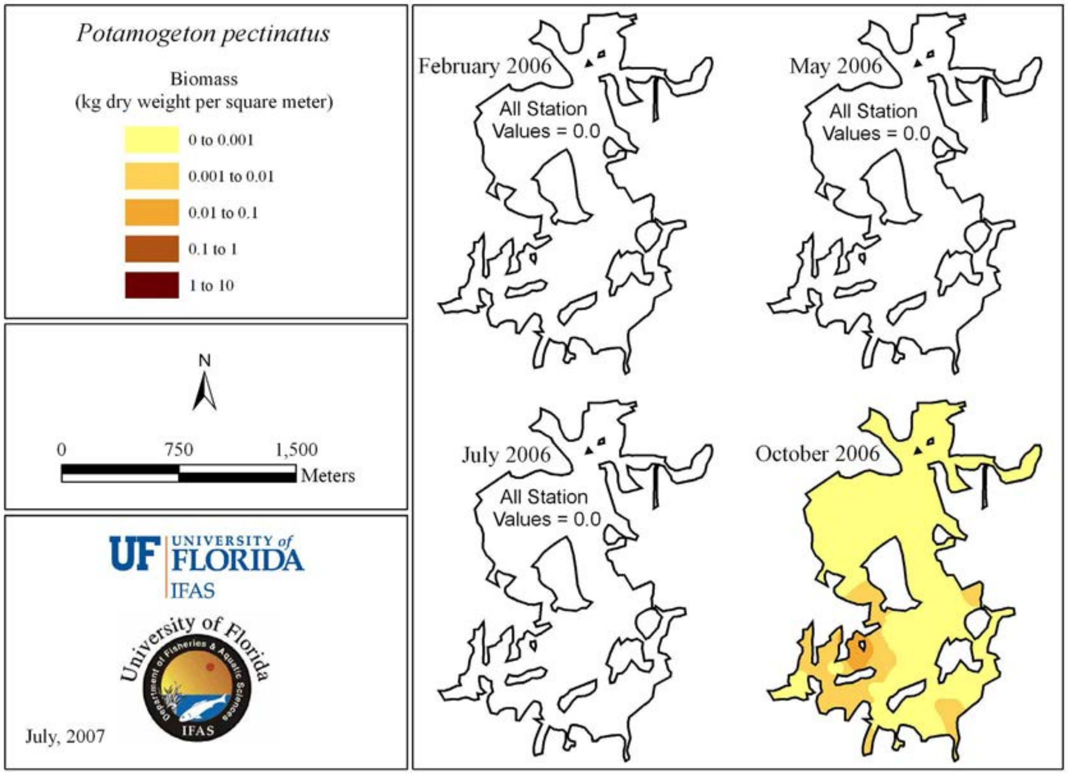

Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
July, 2007
2006

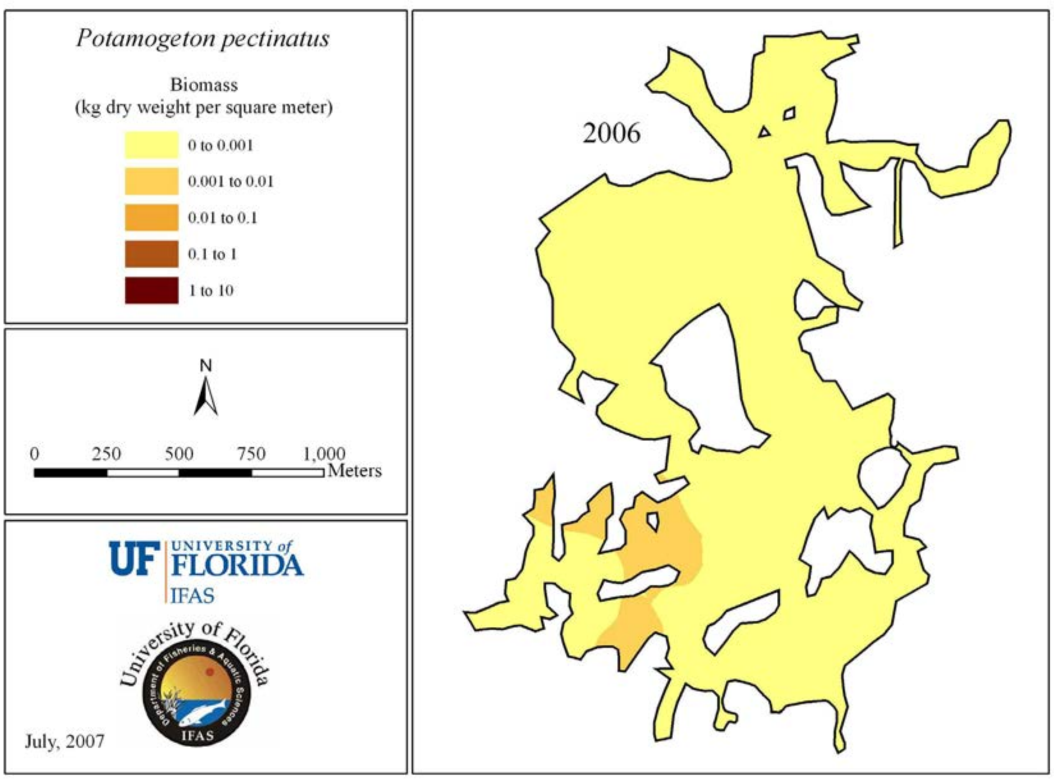

Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

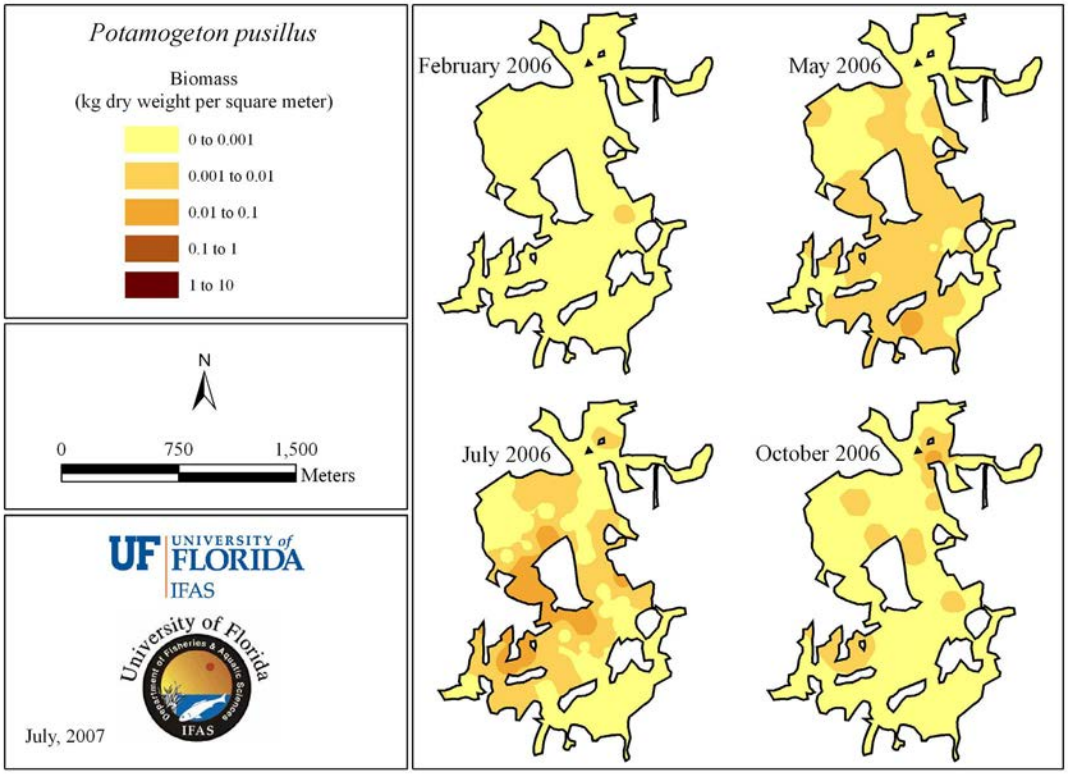

Myriophyllum spicatum
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006


Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

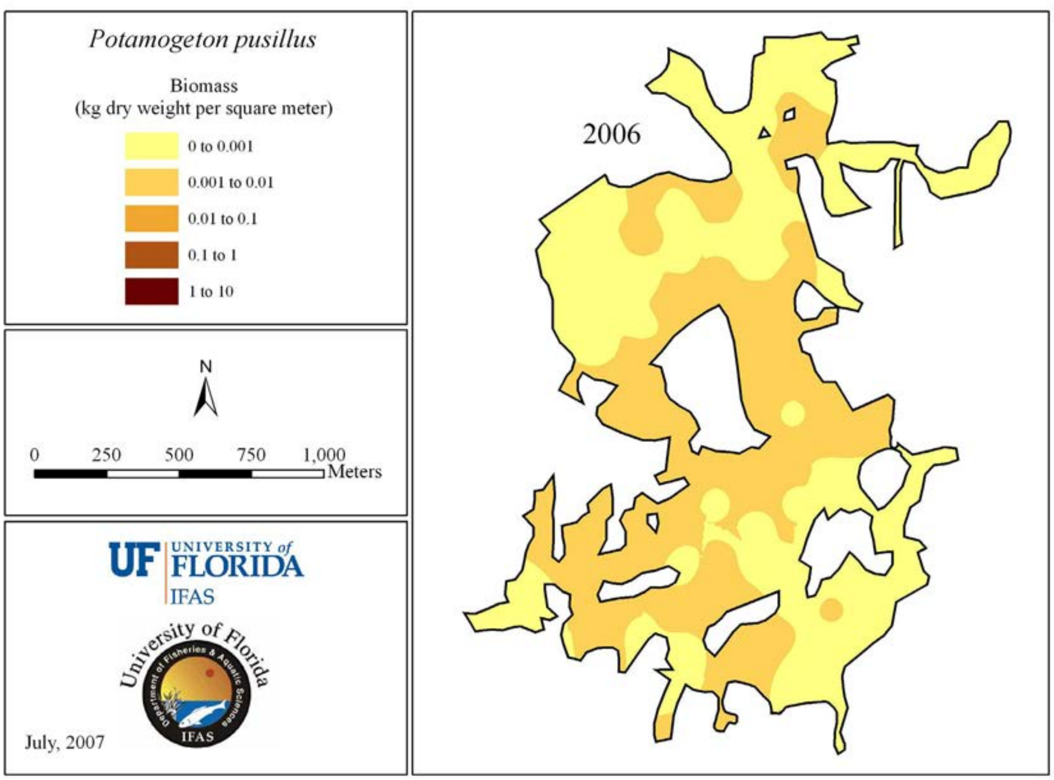

Najas guadalupensis
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
Department of Fisheries & Aquatic Sciences
IFAS
July, 2007
2006


Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0 750 1,500 Meters
UF UNIVERSITY of FLORIDA IFAS
July, 2007
February 2006
All Station Values = 0.0
May 2006
All Station Values = 0.0
July 2006
All Station Values = 0.0
October 2006

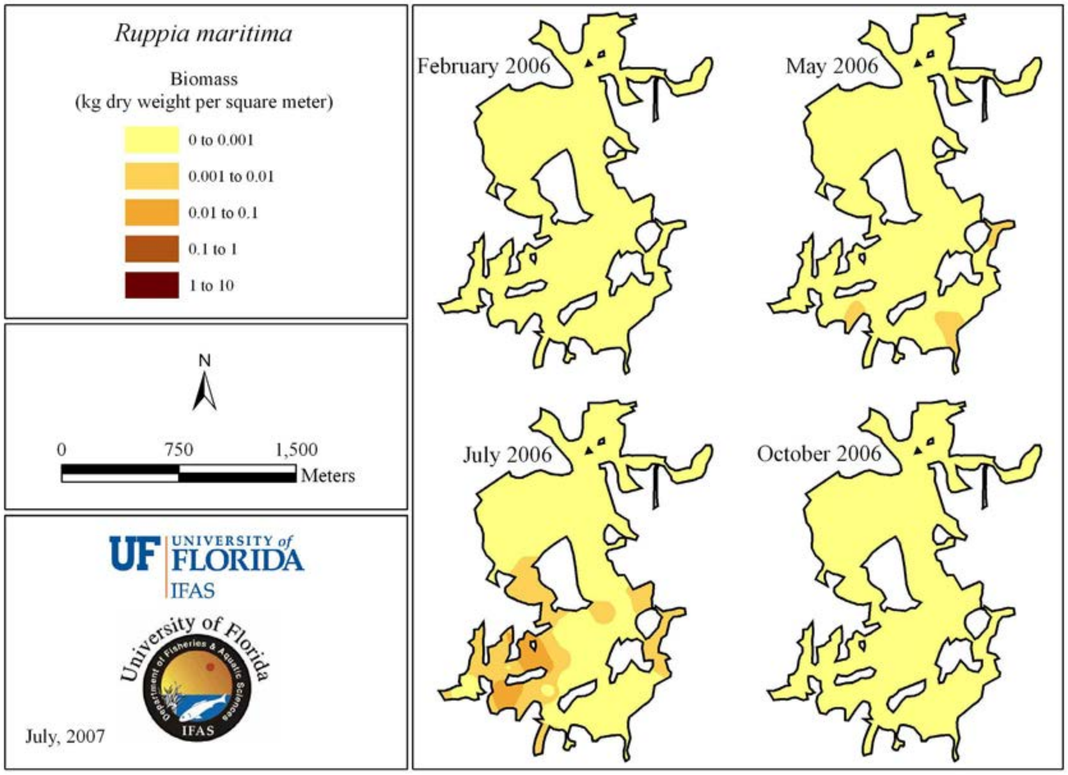

Potamogeton pectinatus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0 250 500 750 1,000 Meters
UF UNIVERSITY of FLORIDA IFAS
July, 2007
2006

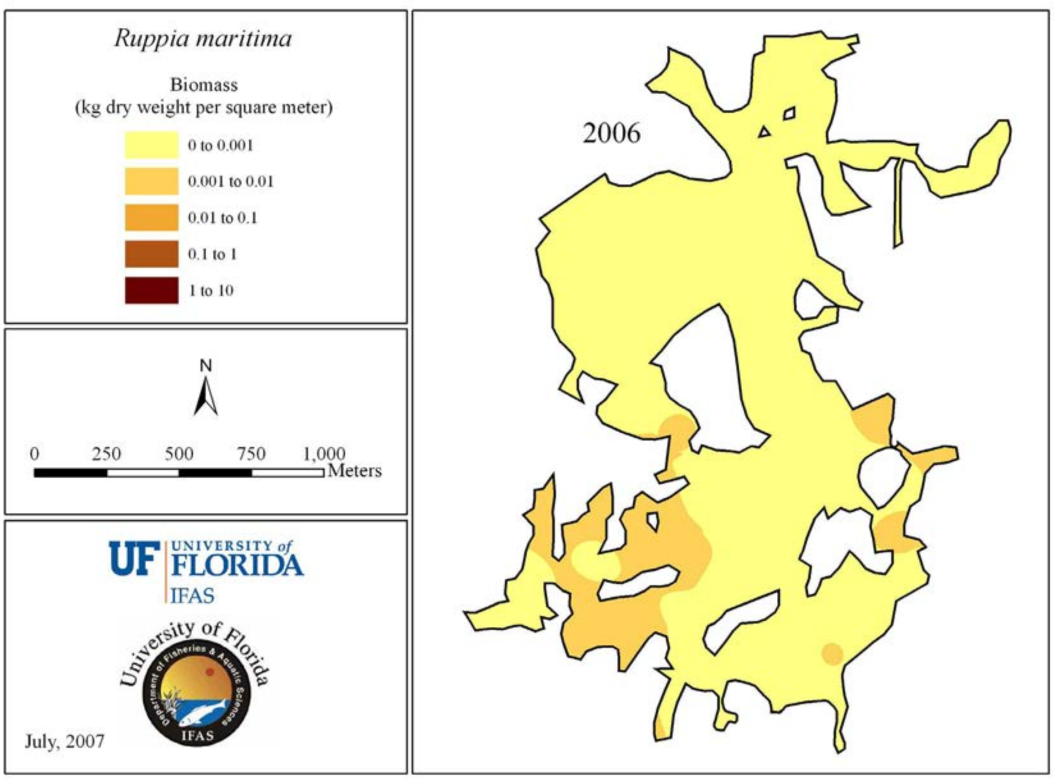


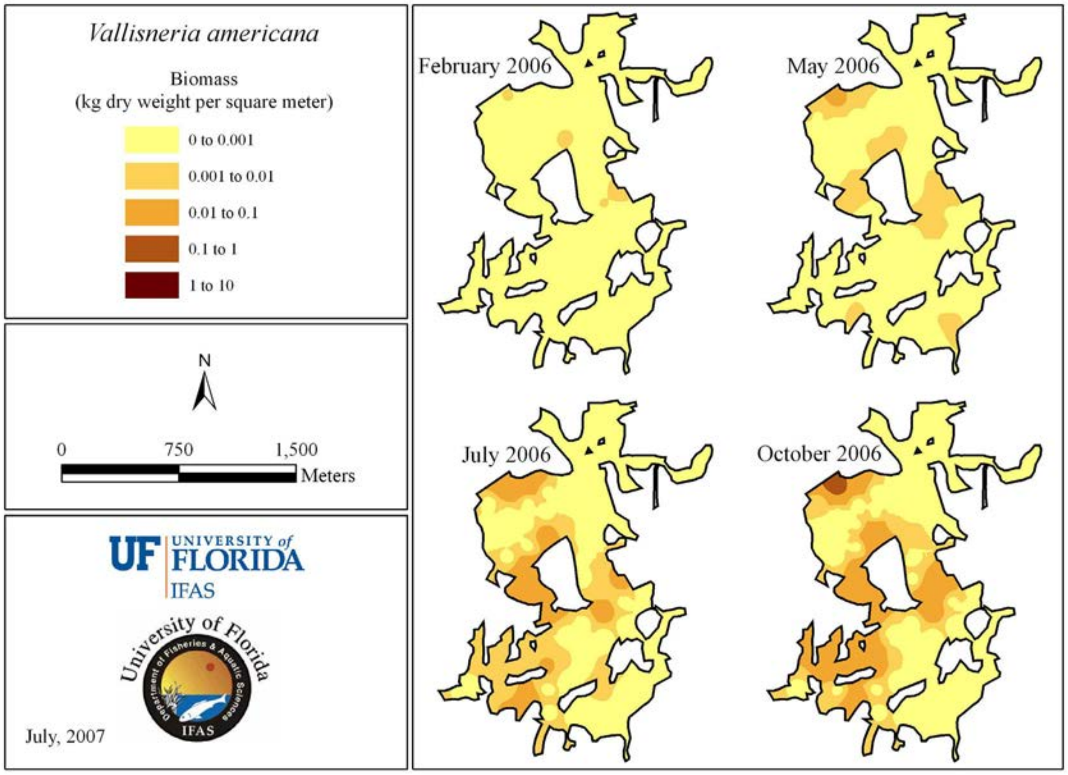
Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

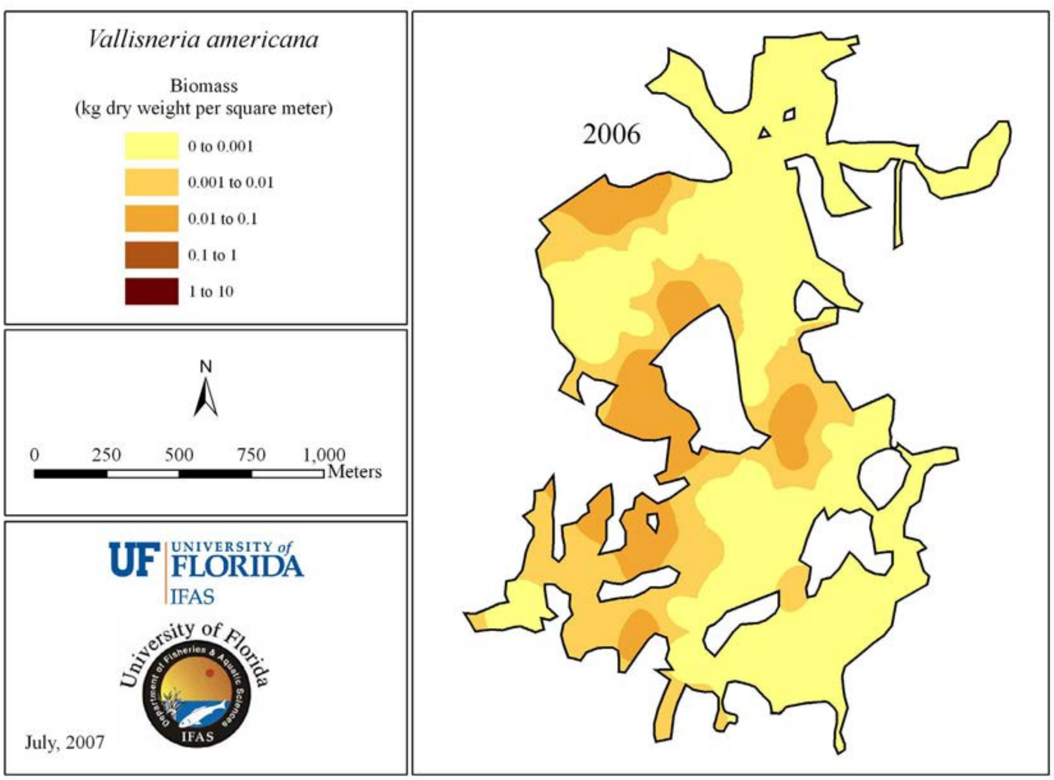


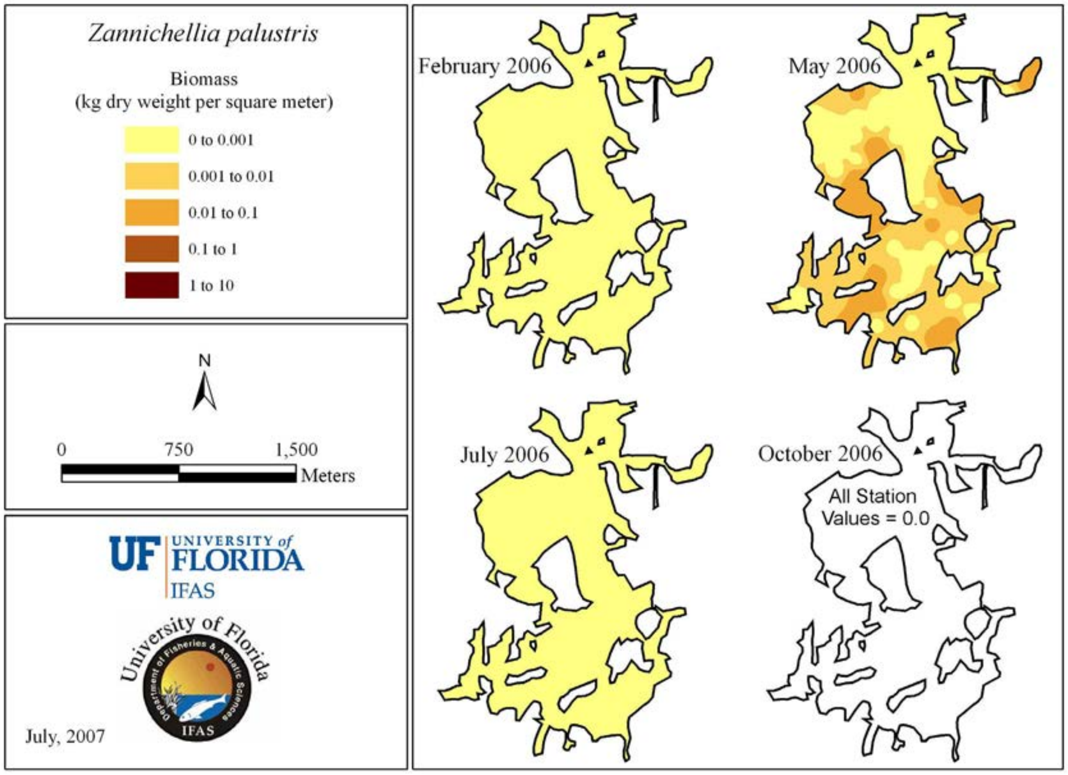
Potamogeton pusillus
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
2006

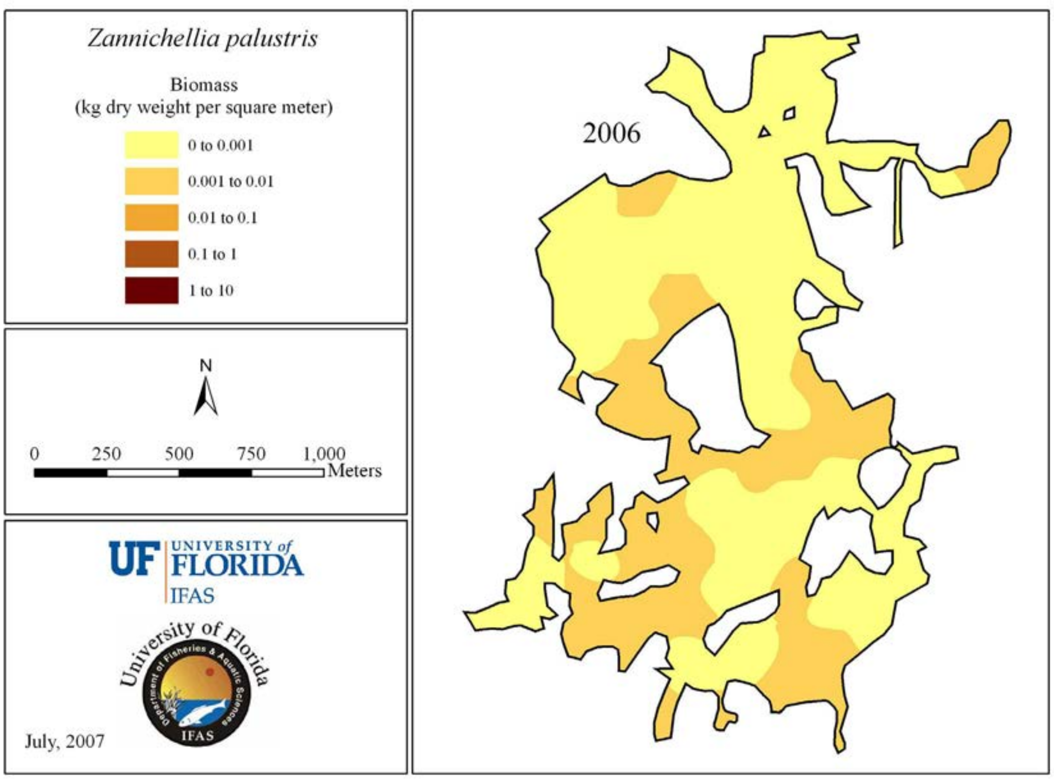

Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006

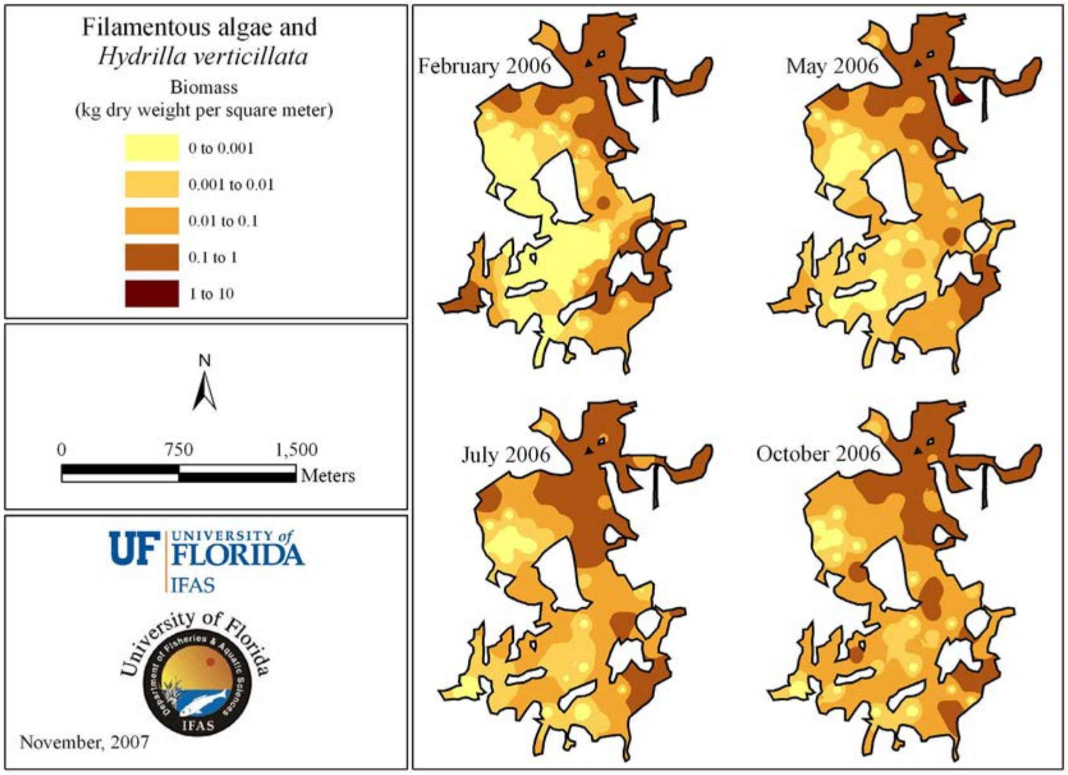

Ruppia maritima
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
2006

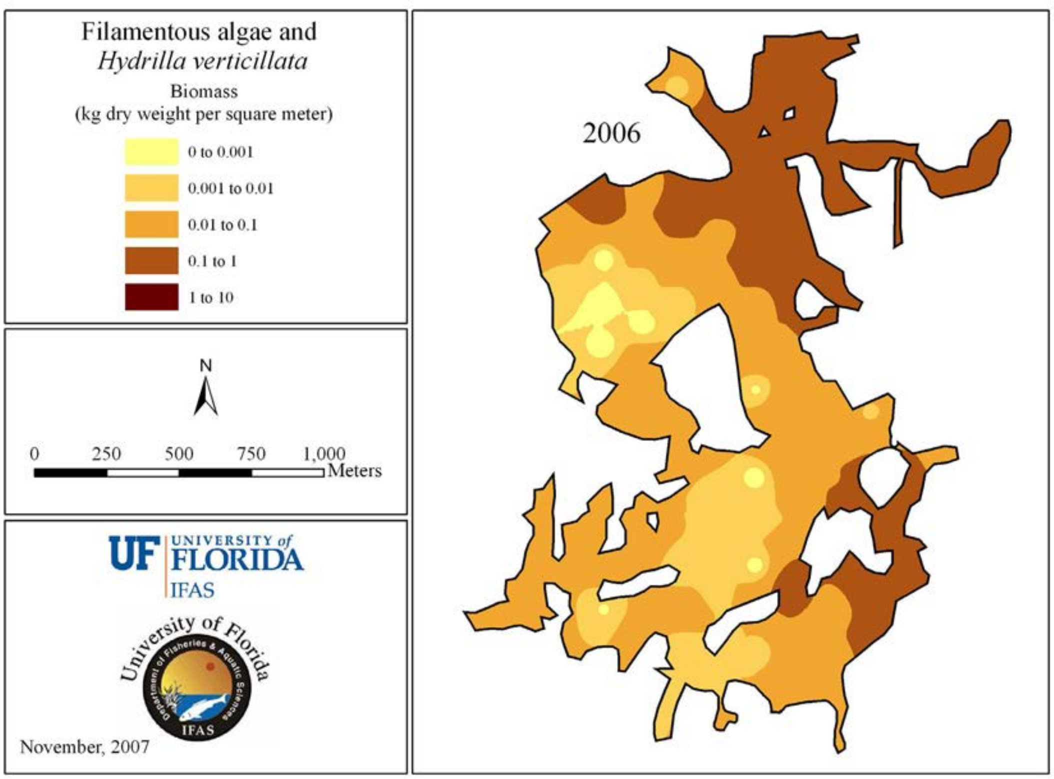

Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
February 2006
May 2006
July 2006
October 2006

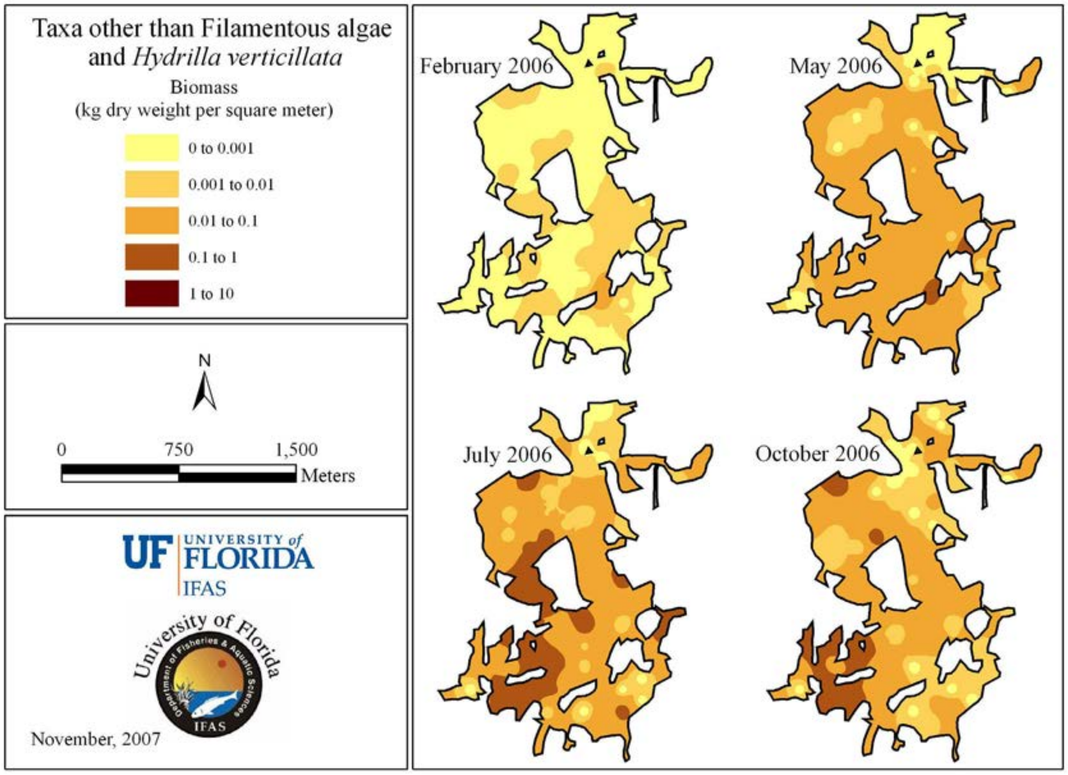

Vallisneria americana
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
July, 2007
2006

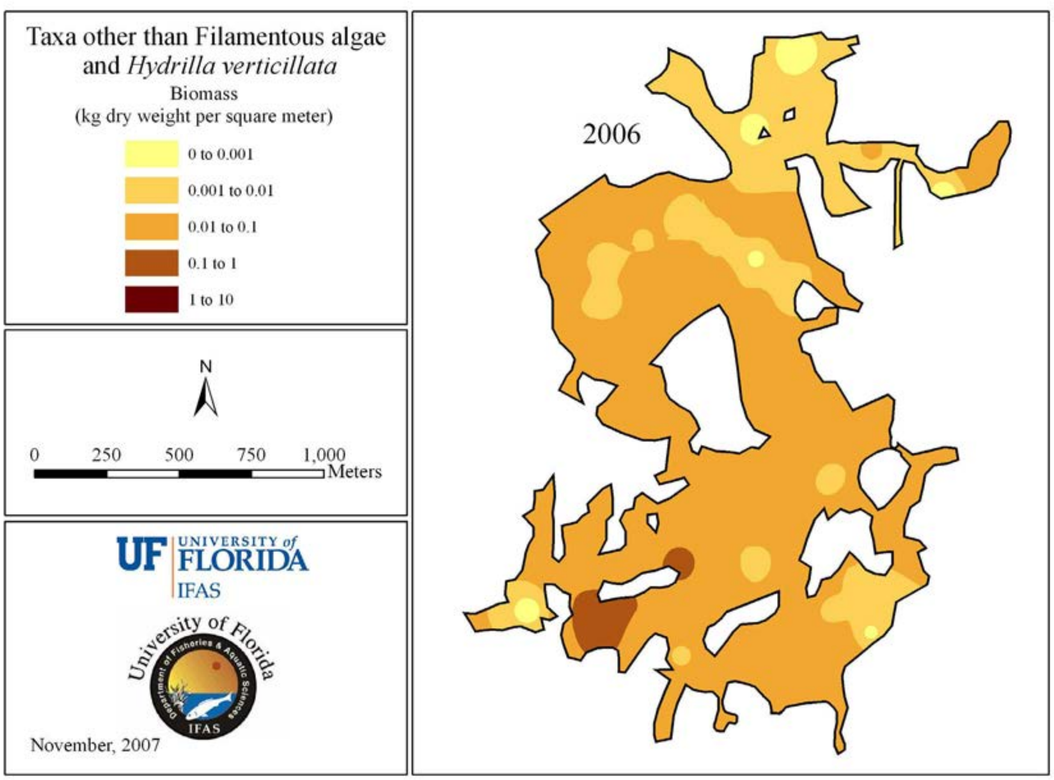

Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
February 2006
May 2006
July 2006
October 2006
All Station
Values = 0.0


Zannichellia palustris
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
July, 2007
2006


Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
February 2006
May 2006
July 2006
October 2006


Filamentous algae and
Hydrilla verticillata
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
2006


Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
750
1,500
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
February 2006
May 2006
July 2006
October 2006


Taxa other than Filamentous algae and *Hydrilla verticillata*
Biomass
(kg dry weight per square meter)
0 to 0.001
0.001 to 0.01
0.01 to 0.1
0.1 to 1
1 to 10
N
0
250
500
750
1,000
Meters
UF UNIVERSITY of FLORIDA
IFAS
University of Florida
IFAS
November, 2007
2006

APPENDIX E: METADATA FOR MAPS OF INTERPOLATED PERCENT COVER AND BIOMASS DATA

METADATA FOR MAPS OF INTERPOLATED PERCENT COVER DATA

- Identification Information
- Data Quality Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information
- Distribution Information
- Metadata Reference Information

Identification_Information:
Citation:
Citation_Information:
Originator:
Frazer, T.K., C.A. Jacoby and R.A. Swett; Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Publication_Date: November 2007
Title: Kings Bay Vegetation Evaluation 2004, 2005, and 2006: Percent Cover
Geospatial_Data_Presentation_Form: vector digital data
Online_Linkage: N/A
Description:
Abstract:

A series of polygon shapefiles (ESRI, Inc.) were created (in ArcGIS 9.2) that contain estimates (interpolations) of percent areal coverage for 14 SAV community components in Kings Bay, Citrus County, Florida for the years 2004, 2005, and 2006. The estimates of percent areal coverage at unsampled locations in the Bay are based on measurements made at 71 sample locations that were distributed throughout the bay. The fourteen SAV components observed and measured were: (1) total SAV (the combination of all angiosperms and macroalgae), (2) angiosperms (flowering, vascular plants), (3) macroalgae (primarily filamentous forms), (4) *Ceratophyllum demersum*, (5) *Chara* spp., (6) filamentous algae (including *Lyngbya* spp.), (7) *Hydrilla verticillata*, (8) *Myriophyllum spicatum*, (9) *Najas guadalupensis*, (10) *Potamogeton pectinatus*, (11) *Potamogeton pusillus*, (12) *Ruppia maritima*, (13) *Vallisneria americana* and (14) *Zannichellia palustris*. For each of the 14 SAV components, fifteen polygon shapefiles of interpolated areal coverage were created: one for each of the four sampling periods (February, May, July and October) in each of the three years (2004, 2005 and 2006) and one to portray average annual coverage.

The measurements of percent areal coverage made for each of the 14 SAV components at each of the 71 field stations were used to estimate percent coverage values at unsampled locations within Kings Bay. To be consistent with methods employed by Frazer and Hale in 2001 (i.e., An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL), Inverse Distance Weighting (IDW) was used as the interpolation method. Estimated values were interpolated into a grid using the ESRI ArcMap v.9.x IDW algorithm (Geostatistical Wizard) using the following values for the method parameters: power = 3, neighborhood search, neighbors to include = 5 (include at least 5), searching ellipse angle = 0, major and minor semiaxis radius = 400, and sector mode = 0. The resulting grid was converted to a shapefile containing polygonal geometry, with each polygon representing one of the following classes of percent coverage: less than 5 percent coverage; 5 to 25 percent coverage; 25 to 50 percent coverage; 50 to 75 percent coverage; and greater than 75 percent coverage.

The naming convention for each of the shapefiles that represent percent cover is as follows (note that no observations were made of *Potamogeton pectinatus* in February 2004, February, May, July and October 2005, and February, May and July in 2006; *Ruppia maritima* in October 2004; *Zannichellia palustris* in February, May, July and October 2004, October 2005, and October 2006; therefore, no shapefiles are available):

1) SAV: SAV_Cover_Spring_200x, SAV_Cover_Summer_200x, SAV_Cover_Fall_200x, SAV_Cover_Winter_200x, SAV_Cover_Annual_200x
2) Angiosperms: Ang_BM_Spring_200x, Ang_BM_Summer_2005, Ang_BM_Fall_200x, Ang_BM_Winter_200x, Ang_BM_Annual_200x
3) Macroalgae: Malg_BM_Spring_200x, Malg_BM_Summer_200x, Malg_BM_Fall_200x, Malg_BM_Winter_200x, Malg_BM_Annual_200x
4) *Ceratophyllum demersum*: Cera_Cover_Spring_200x, Cera_Cover_Summer_200x, Cera_Cover_Fall_200x, Cera_Cover_Winter_200x, Cera_Cover_Annual_200x
5) *Chara* sp.: Chara_Cover_Spring_200x, Chara_Cover_Summer_200x, Chara_Cover_Fall_200x, Chara_Cover_Winter_200x, Chara_Cover_Annual_200x
6) Filamentous algae: Falg_Cover_Spring_200x, Falg_Cover_Summer_200x, Falg_Cover_Fall_200x, Falg_Cover_Winter_200x, Falg_Cover_Annual_200x
7) *Hydrilla verticillata*: Hydr_Cover_Spring_200x, Hydr_Cover_Summer_200x, Hydr_Cover_Fall_200x, Hydr_Cover_Winter_200x, Hydr_Cover_Annual_200x
8) *Myriophyllum spicatum*: Myrio_Cover_Spring_200x, Myrio_Cover_Summer_200x, Myrio_Cover_Fall_200x, Myrio_Cover_Winter_200x, Myrio_Cover_Annual_200x
9) *Najas guadalupensis*: Najas_Cover_Spring_200x, Najas_Cover_Summer_200x, Najas_Cover_Fall_200x, Najas_Cover_Winter_200x, Najas_Cover_Annual_200x
10) *Potamogeton pectinatus*: Ppec_Cover_Spring_200x, Ppec_Cover_Summer_200x, Ppec_Cover_Fall_200x, Ppec_Cover_Winter_200x, Ppec_Cover_Annual_200x
11) *Potamogeton pusillus*: Ppus_Cover_Spring_200x, Ppus_Cover_Summer_200x, Ppus_Cover_Fall_200x, Ppus_Cover_Winter_200x, Ppus_Cover_Annual_200x
12) *Ruppia maritima*: Rup_Cover_Spring_200x, Rup_Cover_Summer_200x, Rup_Cover_Fall_200x, Rup_Cover_Winter_200x, Rup_Cover_Annual_200x
13) *Vallisneria americana*: Val_Cover_Spring_200x, Val_Cover_Summer_200x, Val_Cover_Fall_200x, Val_Cover_Winter_200x, Val_Cover_Annual_200x
14) *Zannichellia palustris*: Zan_Cover_Spring_200x, Zan_Cover_Summer_200x, Zan_Cover_Winter_200x, Zan_Cover_Annual_200x

Purpose:

The polygon shapefiles were produced as part of a quantitative estimate of submersed aquatic vegetation within Kings Bay for the years 2004, 2005, and 2006. The project objective was to establish a vegetation evaluation and monitoring program to complement other activities and data acquisition efforts in Kings Bay.

Time_Period_of_Content:
Time_Period_Information:
Multiple_Dates/Times:
Single_Date/Time:
Calendar_Date: February, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: May, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: July, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: October, 2004, 2005, and 2006
Currentness_Reference:

Data were collected in 2004, 2005, and 2006 during winter (February), spring (May), summer (July) and fall (October)

Status:
Progress: Data collection complete for the 2004, 2005, and 2006 study
Maintenance_and_Update_Frequency: No updates are planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -82.609222
East_Bounding_Coordinate: -82.589508
North_Bounding_Coordinate: 28.899136
South_Bounding_Coordinate: 28.876374
Keywords:
Theme:
Theme_Keyword_Thesaurus: Other
Theme_Keyword: SAV
Theme_Keyword: Submersed Aquatic Vegetation
Theme_Keyword: angiosperms
Theme_Keyword: macroalgae
Theme_Keyword: Ceratophyllum demersum
Theme_Keyword: Chara sp.
Theme_Keyword: Filamentous algae
Theme_Keyword: Hydrilla verticillata
Theme_Keyword: Myriophyllum spicatum
Theme_Keyword: Najas guadalupensis
Theme_Keyword: Potamogeton pectinatus
Theme_Keyword: Potamogeton pusillus
Theme_Keyword: Ruppia maritima
Theme_Keyword: Vallisneria americana
Theme_Keyword: Zannichellia palustris
Place:
Place_Keyword_Thesaurus: Other
Place_Keyword: Kings Bay
Place_Keyword: Citrus County
Place_Keyword: Florida
Temporal:
Temporal_Keyword: winter 2004, 2005, and 2006
Temporal_Keyword: spring 2004, 2005, and 2006
Temporal_Keyword: summer 2004, 2005, and 2006
Temporal_Keyword: fall 2004, 2005, and 2006
Access_Constraints: None
Use_Constraints:
Abundance of benthic vegetation likely varies due to many physical and biological factors, including seasonal changes, grazing, and mechanical harvest.
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: T.K. Frazer
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Research Professor
Contact_Address:
Address_Type: mailing address
Address: 7922 NW 71st St.
City: Gainesville
State_or_Province: Florida
Postal_Code: 32653
Country: USA
Contact_Voice_Telephone: 352-392-9617
Contact_Facsimile_Telephone: 352-392-3672

Contact_Electronic_Mail_Address: frazer@ufl.edu

Data_Set_Credit:

Jason Hale, Emily Hall, Stephen Larson, Chanda Littles, Kelly Robinson, Darlene Saindon, Kristen Dormsjo, Katherine Lazar, Vince Politano, and Ray Valla of the UF/IFAS, Department of Fisheries and Aquatic Sciences for assistance in the field and lab. Joyce Kleen and James Kraus of the USFWS, Crystal River National Wildlife Refuge for facilitating the project and providing data. Citrus County Aquatic Management for providing data. Amy Remley, Veronica Craw and Gary Williams of the Southwest Florida Water Management District for guidance and assistance as project managers. Funding provided through the Surface Water Improvement and Management (SWIM) program of the Southwest Florida Water Management District.

Security_Information:
Security_Classification_System: N/A
Security_Classification: Unclassified
Native_Data_Set_Environment:
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.0.722

Data_Quality_Information:

Completeness_Report:

Field sampling was conducted in 2004, 2005, and 2006 during winter (February), spring (May), summer (July) and fall (October) at 71 stations previously established by Frazer and Hale (2001, An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL, University of Florida; the ESRI shapefile Sample_stations contains the locations of the 71 stations). At each of the 71 sampling stations in each of the aforementioned sampling periods, divers visually estimated the percent cover of all SAV (broadly defined as angiosperms and macroalgae) present within three replicate 0.25 square meter quadrats. Separate areal coverage estimates were made for angiosperms (flowering, vascular plants) by species as well as attached macroalgae and filamentous forms. Following the in situ collection of all coverage data, the aboveground biomass within these same quadrats was removed by the divers, placed into uniquely labeled plastic bags and transported to the University of Florida for subsequent processing in the laboratory. In the laboratory, SAV from each quadrat sample were cleaned and hand separated by species/type and dried at 70° C to a constant dry weight. Fresh weight measurements were made of 1,140 February and May 2005 SAV samples that had been gently blotted with absorbent paper to remove adhering water. Vegetation weights typically were recorded to the nearest 0.001 g to quantify biomass for each of the sorted plant and algal groups. The 2004, 2005, and 2006 Kings Bay sampling effort resulted in 2,556 unique SAV samples. For subsequent analyses, data were averaged by station for each sampling period (February, May, July, and October). Interpolated maps of coverage and biomass were generated, using mean data from each of the aforementioned 71 sampling stations, for (1) each of the recognized taxonomic groupings (see abstract) and (2) each of the 12 sampling periods.

Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
No correction for SA of GPS signals yields horizontal accuracy between 5 and 30 m.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: N/A

Lineage:
Process_Step:
Process_Description:
The measurements of percent areal coverage made for each of the 14 SAV components (see metadata abstract and metadata completeness report) at each of the 71 field stations were used to estimate percent coverage values at unsampled locations within Kings Bay. To be consistent with methods employed by Frazer and Hale in 2001 (i.e., An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL), Inverse Distance

Weighting (IDW) was used as the interpolation method. Estimated values were interpolated into a grid using the ESRI ArcMap v.9.x IDW algorithm (Geostatistical Wizard) using the following parameter values: power = 3, neighborhood search, neighbors to include = 5 (include at least 5), searching ellipse angle = 0, major and minor semiaxis radius = 400, and sector mode = 0. The resulting grid was converted to a shapefile containing polygonal geometry. Each polygon represented one of the following classes of percent coverage: less than 5 percent coverage; 5 to 25 percent coverage; 25 to 50 percent coverage; 50 to 75 percent coverage; and greater than 75 percent coverage.
Process_Date: May 2005, March 2006, and July 2007
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Robert A. Swett
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Assistant Professor
Contact_Voice_Telephone: 352-392-6233
Contact_Electronic_Mail_Address: raswett@ifas.ufl.edu

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: G-polygon
Point_and_Vector_Object_Count: Varies

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Transverse Mercator
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -81.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.000004
Ordinate_Resolution: 0.000004
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: D_North_American_1983_HARN

Ellipsoid_Name: Geodetic Reference System 80
Semimajor_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: See metadata abstract for shapefile names
Attribute:
Attribute_Label: FID
Attribute_Definition: Internal feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features.
Attribute:
Attribute_Label: Classes
Attribute_Definition: Defines the range of percent cover that the polygon encompasses
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 0
Enumerated_Domain_Value_Definition: less than 5 percent cover
Enumerated_Domain:
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition: 5 to 25 percent cover
Enumerated_Domain:
Enumerated_Domain_Value: 2
Enumerated_Domain_Value_Definition: 25 to 50 percent cover
Enumerated_Domain:
Enumerated_Domain_Value: 3
Enumerated_Domain_Value_Definition: 50 to 75 percent cover
Enumerated_Domain:
Enumerated_Domain_Value: 4
Enumerated_Domain_Value_Definition: greater than 75 percent cover
Attribute_Value_Accuracy_Information:
Attribute_Value_Accuracy:
Based on IDW interpolation using 71 sample stations in Kings Bay
Attribute_Value_Accuracy_Explanation:
See metadata abstract and processing steps for method description
Attribute:
Attribute_Label: Value_Min
Attribute_Definition: Minimum percent cover within the class
Attribute:
Attribute_Label: Value_Max
Attribute_Definition: Maximum percent cover within the class

Distribution_Information:
Resource_Description: Downloadable Data
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Transfer_Size: varies

Metadata_Reference_Information:
Metadata_Date: 20071106
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: R.A. Swett or T.K. Frazer
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Assistant Professor and Research Professor
Contact_Address:
Address_Type: mailing address
Address: 7922 NW 71st St.
City: Gainesville
State_or_Province: FL
Postal_Code: 32653
Country: USA
Contact_Voice_Telephone: 352-392-6233 or 352-392-9617
Contact_Electronic_Mail_Address: raswett@ifas.ufl.edu or frazer@ufl.edu
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_Use_Constraints: None
Metadata_Security_Information:
Metadata_Security_Classification_System: N/A
Metadata_Security_Classification: Unclassified
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

METADATA FOR MAPS OF INTERPOLATED BIOMASS DATA

- Identification Information
- Data Quality Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information
- Distribution Information
- Metadata Reference Information

Identification_Information:
Citation:
Citation_Information:
Originator:
T.K. Frazer, T.K., C.A. Jacoby and R.A. Swett; Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Publication_Date: November 2007
Title: Kings Bay Vegetation Evaluation 2004, 2005, and 2006: Biomass
Geospatial_Data_Presentation_Form: vector digital data
Online_Linkage: N/A
Description:
Abstract:
A series of polygon shapefiles (ESRI, Inc.) were created (in ArcGIS 9.2) that contain estimates (interpolations) of biomass (kg dry weight per square meter) for 14 SAV community components in Kings Bay, Citrus County, Florida for the years 2004, 2005, and 2006. The estimates of biomass at unsampled locations in the Bay are based on measurements made at 71 sample locations that were distributed throughout the bay. The fourteen SAV components observed and measured were: (1) total SAV (the combination of all angiosperms and macroalgae), (2) angiosperms (flowering, vascular plants), (3) macroalgae (primarily filamentous forms), (4) *Ceratophyllum demersum*, (5) *Chara* sp., (6) filamentous algae, (7) *Hydrilla verticillata*, (8) *Myriophyllum spicatum*, (9) *Najas guadalupensis*, (10) *Potamogeton pectinatus*, (11) *Potamogeton pusillus*, (12) *Ruppia maritima*, (13) *Vallisneria americana* and (14) *Zannichellia palustris*. For each of the 14 SAV components, fifteen polygon shapefiles of interpolated biomass were created: one for each of the four sampling periods (February, May, July and October) in each of three years (2004, 21005 and 2006) and one to portray average annual biomass.
The measurements of biomass made for each of the 14 SAV components at each of the 71 field stations were used to estimate biomass values at unsampled locations within Kings Bay. To be consistent with methods employed by Frazer and Hale in 2001 (i.e., An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL), Inverse Distance Weighting (IDW) was used as the interpolation method. Estimated values were interpolated into a grid using the ESRI ArcMap v.9.x IDW algorithm (Geostatistical Wizard) using the following values for the method parameters: power = 3, neighborhood search, neighbors to include = 5 (include at least 5), searching ellipse angle = 0, major and minor semiaxis radius = 400, and sector mode = 0. The resulting grid was converted to a shapefile containing polygonal geometry, with each polygon representing one of the following biomass classes (kg dry weight per square meter): 0 to 0.001; 0.001 to 0.01; 0.01 to 0.1; 0.1 to 1.0; and 1.0 to 10.0.

The naming convention for each of the shapefiles that present biomass estimates is as follows (note that no observations were made of *Potamogeton pectinatus* in February 2004, February, May, July and October 2005, and February, May and July in 2006; *Ruppia maritima* in October 2004; *Zannichellia palustris* in February, May, July and October 2004, October 2005, and October 2006; therefore, no shapefiles are available):

1) SAV: SAV_BM_Spring_200x, SAV_BM_Summer_200x, SAV_BM_Fall_200x, SAV_BM_Winter_200x, SAV_BM_Annual_200x
2) Angiosperms: Ang_BM_Spring_200x, Ang_BM_Summer_200x, Ang_BM_Fall_200x, Ang_BM_Winter_200x, Ang_BM_Annual_200x
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4) *Ceratophyllum demersum*: Cera_BM_Spring_200x, Cera_BM_Summer_200x, Cera_BM_Fall_200x, Cera_BM_Winter_200x, Cera_BM_Annual_200x
5) *Chara* sp.: Chara_BM_Spring_200x, Chara_BM_Summer_200x, Chara_BM_Fall_200x, Chara_BM_Winter_200x, Chara_BM_Annual_200x
6) Filamentous algae: Falg_BM_Spring_200x, Falg_BM_Summer_200x, Falg_BM_Fall_200x, Falg_BM_Winter_200x, Falg_BM_Annual_200x
7) *Hydrilla verticillata*: Hydr_BM_Spring_200x, Hydr_BM_Summer_200x, Hydr_BM_Fall_200x, Hydr_BM_Winter_200x, Hydr_BM_Annual_200x
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9) *Najas guadalupensis*: Najas_BM_Spring_200x, Najas_BM_Summer_200x, Najas_BM_Fall_200x, Najas_BM_Winter_200x, Najas_BM_Annual_200x
10) *Potamogeton pectinatus*: Ppec_BM_Spring_200x, Ppec_BM_Summer_200x, Ppec_BM_Fall_200x, Ppec_BM_Winter_200x, Ppec_BM_Annual_200x
11) *Potamogeton pusillus*: Ppus_BM_Spring_200x, Ppus_BM_Summer_200x, Ppus_BM_Fall_200x, Ppus_BM_Winter_200x, Ppus_BM_Annual_200x
12) *Ruppia maritima*: Rup_BM_Spring_200x, Rup_BM_Summer_200x, Rup_BM_Fall_200x, Rup_BM_Winter_200x, Rup_BM_Annual_200x
13) *Vallisneria americana*: Val_BM_Spring_200x, Val_BM_Summer_200x, Val_BM_Fall_200x, Val_BM_Winter_200x, Val_BM_Annual_200x
14) *Zannichellia palustris*: Zan_BM_Spring_200x, Zan_BM_Summer_200x, Zan_BM_Winter_200x, Zan_BM_Annual_200x

Purpose:

The polygon shapefiles were produced as part of a quantitative estimate of submersed aquatic vegetation within Kings Bay for the years 2004, 2005, and 2006. The project objective was to establish a vegetation evaluation and monitoring program to complement other activities and data acquisition efforts in Kings Bay.

Time_Period_of_Content:
Time_Period_Information:
Multiple_Dates/Times:
Single_Date/Time:
Calendar_Date: February, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: May, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: July, 2004, 2005, and 2006
Single_Date/Time:
Calendar_Date: October, 2004, 2005, and 2006
Currentness_Reference:

Data were collected in 2004, 2005, and 2006 during winter (February), spring (May), summer (July) and fall (October)

Status:
Progress: Data collection complete for the 2004, 2005, and 2006 study
Maintenance_and_Update_Frequency: No updates are planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -82.609222
East_Bounding_Coordinate: -82.589508
North_Bounding_Coordinate: 28.899136
South_Bounding_Coordinate: 28.876374
Keywords:
Theme:
Theme_Keyword_Thesaurus: Other
Theme_Keyword: Biomass
Theme_Keyword: SAV
Theme_Keyword: Submersed Aquatic Vegetation
Theme_Keyword: angiosperms
Theme_Keyword: macroalgae
Theme_Keyword: Ceratophyllum demersum
Theme_Keyword: Chara sp.
Theme_Keyword: Filamentous algae
Theme_Keyword: Hydrilla verticillata
Theme_Keyword: Myriophyllum spicatum
Theme_Keyword: Najas guadalupensis
Theme_Keyword: Potamogeton pectinatus
Theme_Keyword: Potamogeton pusillus
Theme_Keyword: Ruppia maritima
Theme_Keyword: Vallisneria americana
Theme_Keyword: Zannichellia palustris
Place:
Place_Keyword_Thesaurus: Other
Place_Keyword: Kings Bay
Place_Keyword: Citrus County
Place_Keyword: Florida
Temporal:
Temporal_Keyword: winter 2004, 2005, and 2006
Temporal_Keyword: spring 2004, 2005, and 2006
Temporal_Keyword: summer 2004, 2005, and 2006
Temporal_Keyword: fall 2004, 2005, and 2006
Access_Constraints: None
Use_Constraints:
Abundance of benthic vegetation likely varies due to many physical and biological factors, including seasonal changes, grazing, and mechanical harvest.
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: T.K. Frazer
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Research Professor
Contact_Address:
Address_Type: mailing address
Address: 7922 NW 71st St.
City: Gainesville
State_or_Province: Florida
Postal_Code: 32653
Country: USA
Contact_Voice_Telephone: 352-392-9617

Contact_Facsimile_Telephone: 352-392-3672
Contact_Electronic_Mail_Address: frazer@ufl.edu
Data_Set_Credit:
Jason Hale, Emily Hall, Stephen Larson, Chanda Littles, Kelly Robinson, Darlene Saindon, Kristen Dormsjo, Katherine Lazar, Vince Politano, and Ray Valla of the UF/IFAS, Department of Fisheries and Aquatic Sciences for assistance in the field and lab. Joyce Kleen and James Kraus of the USFWS, Crystal River National Wildlife Refuge for facilitating the project and providing data. Citrus County Aquatic Management for providing data. Amy Remley, Veronica Craw and Gary Williams of the Southwest Florida Water Management District for guidance and assistance as project managers. Funding provided through the Surface Water Improvement and Management (SWIM) program of the Southwest Florida Water Management District.
Security_Information:
Security_Classification_System: N/A
Security_Classification: Unclassified
Native_Data_Set_Environment:
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.0.722

Data_Quality_Information:
Completeness_Report:
Field sampling was conducted in 2004, 2005, and 2006 during winter (February), spring (May), summer (July) and fall (October) at 71 stations previously established by Frazer and Hale (2001, An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL, University of Florida; the ESRI shapefile Sample_stations contains the locations of the 71 stations). At each of the 71 sampling stations in each of the aforementioned sampling periods, divers visually estimated the percent cover of all SAV (broadly defined as angiosperms and macroalgae) present within three replicate 0.25 square meter quadrats. Separate areal coverage estimates were made for angiosperms (flowering, vascular plants) by species as well as attached macroalgae and filamentous forms. Following the in situ collection of all coverage data, the aboveground biomass within these same quadrats was removed by the divers, placed into uniquely labeled plastic bags and transported to the University of Florida for subsequent processing in the laboratory. In the laboratory, SAV from each quadrat sample were cleaned and hand separated by species/type and dried at 70° C to a constant dry weight. Fresh weight measurements were made of 1,140 February and May 2005 SAV samples that had been gently blotted with absorbent paper to remove adhering water. Vegetation weights typically were recorded to the nearest 0.001 g to quantify biomass for each of the sorted plant and algal groups. The 2004, 2005, and 2006 Kings Bay sampling efforts resulted in 2,556 unique SAV samples. For subsequent analyses, data were typically averaged by station for each sampling period (February, May, July, and October). Interpolated maps of coverage and biomass were generated, using mean data from each of the aforementioned 71 sampling stations, for (1) each of the recognized taxonomic groupings (see abstract) and (2) each of the 12 sampling periods.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
No correction for SA of GPS signals yields horizontal accuracy between 5 and 30 m.
Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report: N/A

Lineage:
Process_Step:
Process_Description:
The measurements of biomass made for each of the 14 SAV components (see metadata abstract and metadata completeness report) at each of the 71 field stations were used to estimate biomass at unsampled locations within Kings Bay. To be consistent with methods employed by Frazer and Hale in 2001 (i.e., An Atlas of Submersed Aquatic Vegetation of Kings Bay, Citrus County, FL), Inverse Distance Weighting (IDW) was used as the interpolation method. Estimated values were interpolated into a grid using the ESRI ArcMap v.9.x IDW algorithm (Geostatistical Wizard) using the following parameter values: power = 3, neighborhood search, neighbors to include = 5 (include at least 5), searching ellipse angle = 0, major and minor semiaxis radius = 400, and sector mode = 0. The resulting grid was converted to a shapefile containing polygonal geometry, with each polygon representing one of the following biomass classes (kg dry weight per square meter): 0 to 0.001; 0.001 to 0.01; 0.01 to 0.1; 0.1 to 1.0; and 1.0 to 10.0.
Process_Date: May 2005, March 2006, and July 2007
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Robert A. Swett
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Assistant Professor
Contact_Voice_Telephone: 352-392-6233
Contact_Electronic_Mail_Address: raswett@ifas.ufl.edu

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: G-polygon
Point_and_Vector_Object_Count: Varies

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Transverse Mercator
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -81.000000
Latitude_of_Projection_Origin: 0.000000
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.000004
Ordinate_Resolution: 0.000004
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: D_North_American_1983_HARN
Ellipsoid_Name: Geodetic Reference System 80

Semimajor_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: See metadata abstract for shapefile names
Attribute:
Attribute_Label: FID
Attribute_Definition: Internal feature number.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain:
Sequential unique whole numbers that are automatically generated.
Attribute:
Attribute_Label: Shape
Attribute_Definition: Feature geometry.
Attribute_Definition_Source: ESRI
Attribute_Domain_Values:
Unrepresentable_Domain: Coordinates defining the features.
Attribute:
Attribute_Label: Classes
Attribute_Definition: Defines the range of biomass that the polygon encompasses (kg dry weight per square meter)
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 0
Enumerated_Domain_Value_Definition: 0 to 0.001
Enumerated_Domain:
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition: 0.001 to 0.01
Enumerated_Domain:
Enumerated_Domain_Value: 2
Enumerated_Domain_Value_Definition: 0.01 to 0.1
Enumerated_Domain:
Enumerated_Domain_Value: 3
Enumerated_Domain_Value_Definition: 0.1 to 1.0
Enumerated_Domain:
Enumerated_Domain_Value: 4
Enumerated_Domain_Value_Definition: 1.0 to 10.0
Attribute_Value_Accuracy_Information:
Attribute_Value_Accuracy:
Based on IDW interpolation using 71 sample stations in Kings Bay
Attribute_Value_Accuracy_Explanation:
See metadata abstract and processing steps for method description
Attribute:
Attribute_Label: Value_Min
Attribute_Definition: Minimum biomass within the class
Attribute:
Attribute_Label: Value_Max
Attribute_Definition: Maximum biomass within the class

Distribution_Information:
Resource_Description: Downloadable Data
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Transfer_Size: varies

Metadata_Reference_Information:
Metadata_Date: 20071106
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: R.A. Swett or T.K. Frazer
Contact_Organization:
Department of Fisheries and Aquatic Sciences, Institute of Food and Agricultural Sciences, University of Florida
Contact_Position: Assistant Professor and Research Professor
Contact_Address:
Address_Type: mailing address
Address: 7922 NW 71st St.
City: Gainesville
State_or_Province: FL
Postal_Code: 32653
Country: USA
Contact_Voice_Telephone: 352-392-6233 or 352-392-9617
Contact_Electronic_Mail_Address: raswett@ifas.ufl.edu or frazer@ufl.edu
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_Use_Constraints: None
Metadata_Security_Information:
Metadata_Security_Classification_System: N/A
Metadata_Security_Classification: Unclassified
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile