Second Year Annual Report (2001) for the Kingman Marsh Vegetation Monitoring Project

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The key element affecting the successful establishment of an emergent marsh system at Kingman during 2001, the second year in the existence of the reconstructed wetlands there, was grazing pressure by the high resident Canada goose (*Branta canadensis* maxima) population. Fencing had been installed during the planting process in 2000 as a necessary adaptive management element to protect the young plants from the geese and ducks. Most of the fencing yielded cells about 20 X 30 meters in size which were considered tight enough to severely reduce fly-ins and eliminate swim-ins. This system worked well in 2000 as installed by ERM and permitted successful establishment of planted and volunteer vegetation. Towards the end of the year 2000 growing season the fence structure started to fall apart, such that along with the desire not to retain fencing at the marsh for aesthetic and ecological reasons, as well as the healthy establishment of marsh vegetation that had occurred (actually rather similar in effect to the successful initial vegetation establishment that had taken place at Kenilworth Marsh in 1993), it was decided to remove the remaining fence netting during the winter of 2000-2001. In retrospect this action proved to be a mistake since the large resident goose population occupying the adjacent golf course area was poised to graze much of the palatable marsh vegetation as it emerged in the spring of 2001. The pervasive grazing coupled with relatively low sediment elevations led to the development of barren mud flats covering over half the reconstructed marsh. Portions that remained vegetated were composed of non-palatable marsh species or existed at higher elevations where the vegetation had a chance to outgrow the waterfowl grazing pressure. It should be the function of this report to document the impacts to the marsh system vegetation structure from the waterfowl grazing as well as provide additional data collected for the seed bank and soil study components.

It is important to recall that water tubes were used as containment structure for the placement of the dredge material during construction in 2000. They were retained during planting (removed in mid-August 2000) and used to keep out most of the tidal water so that planting could occur at all times (particularly since the planting had been delayed at Kingman Cell 1). A spin-off result was that more seedlings became established than might normally due to the tidal restriction. The apparent decline in species in 2001 at Kingman could also be partially attributed to an expectable reduction from the abnormally high number promoted in 2000.

Study design, methods and site descriptions may be found in the Year 1 (2000) Annual Report. Considerably more detail may also be obtained from the MS Thesis prepared by Kelly Phyillaier Neff (University of Maryland and USGS) covering much of the same information base under support provided by this project.

1. Vegetation

a. Cover

The reconstructed Kingman Marsh was constructed with two separate marsh areas about a quarter of a mile apart - Area 1 (Cell 1) of about 30 acres and Area 2 (Cell 2) of about 5 acres. Figures 1 and 2 depict the vegetation cover at Kingman Area 1 and Area 2 provided by the major species during 2000, and 2001 the year of focus for this report (the data reported is from September only since Kingman Marsh was not fully established in July 2000). The first thing to notice is the decline in cover in 2001- almost total loss in many cases - of most of the species, but with some notable exceptions. Surviving species, including *Ludwigias, Salix, Lythrum, Juncus, Peltandra, Typha and Schoenoplectus tabermontanae* (both sites combined), increased in cover presumably because they are largely unpalatable to the waterfowl. Important freshwater tidal marsh species such as *Pontederia, Cyperus, Sagittaria*, and most of the grasses were grazed out or lost to altered hydrology. The impact from the grazing could also be seen by the dramatic increase in the no cover category in 2001. It might also be noted that as of 2001 Phragmites is yet but a minor contributor to cover, but certainly a species that should be dealt with at this stage before it becomes a larger problem. A cursory glance at Figure 3 might suggest a similar phenomenon of wetland loss was taking place at Kenilworth Mass Fill 1 but a closer look should reveal a more selective species decline. In fact, the loss of cover here was due to directed herbicide treatment by National Park Service staff to remove the large monocultural patches of *Phragmites australis* and associated concentrations of *Lythrum salicaria* (purple loosestrife). Even though the data averages the two later sampling periods of July and September and the herbicide treatments were initiated in August, the effect still shows but would be even more dramatic if just the September time period were used. No cover was just a very minor component (as opposed to the Kingman situation). Kenilworth Mass Fill 2 (Figure 4), which did not receive herbicide treatment, displayed no pattern, just annual fluctuations in detected species cover. Of concern should be the extensive cover provided by Phragmites even though the cover did not increase from 2000 to 2001. Herbicide treatment of Phragmites in Mass fill 2 by the National Park Service (NPS) should take place in 2002. Similarly, there were no important changes in vegetation cover from 2000 to2001 at the non-reconstructed reference wetlands at Dueling Creek in the Anacostia (Figure 5) nor at the Patuxent Marsh (Figure 6). Neither of these sites possess Phragmites and Dueling has a small > 5% population of loosestrife. Dueling has a large contribution from rice cutgrass (*Leersia oryzoides*) while Patuxent continues to have important inputs from the halberd-leaved tear thumb (*Polygonum arifolium*) and sweetflag (*Acorus calamus*). Sweetflag has a strong seasonal appearance pattern being an early grower and decliner. The significant presence of *Nuphar lutea* and even *Hydrilla verticillata* at Patuxent reflects the relatively low elevation of the marsh (Figure 7) as indicated by the higher per cent of time inundated (~35%) which interestingly and importantly corresponds rather closely with Kingman Areas 1 and 2. Whereas Kenilworth Mass Fill 1, which we know to be of high elevation with respect to the tidal coverage, displays a much lower period of inundation (~10%). These inundation levels will be higher than those obtained using annual data since we computed these on data just involving the growing season (March - October) since that is the period when inundation periods affect plant growth. Winter tides are lower by about half a foot than summer tides due to reduced gravitational pull from the sun. Synoptically, Figure 8 gives the vegetative cover for each site in July and September for the two years of study and portrays the declines in cover for 2001 at Kingman Areas 1 and 2 as well as Kenilworth Mass Fill 1 but not at Mass fill 2, Dueling or Patuxent even though the Tukey-Kramer statistical test revealed no significant differences. At least the similarities between years at the reference sites would suggest no major weather factor was at work.

Unfortunately, only a rather small and unrepresentative area (largest patch was higher than much of the planted marsh) was left unplanted at the Kingman Marsh during reconstruction. This makes it difficult to determine how much volunteer plant establishment could be relied upon for the species that were planted. At any rate the cover contributed by volunteer plants of the planted species at the unplanted sites was quite small (> 2%). In fact only 3 of the 6 planted species were found in the unplanted area in 2001. Again, while not the best of evidence, this still points to the purpose of planting desired species if you want them to provide cover in the short term. However, even planting desired species is of little avail if exposed to goose grazing. Of the six planted species (excluding Nuphar) the 3 palatable species were decimated (*Sagittaria, Pontederia and Schoenoplectus pungens*) while the less palatable ones *(Peltandra, Schoenoplectus tabermontanae and Juncus effusus*) did increase and provided an important component of the remaining marsh structure in 2001, especially if you discount input by ground cover species such as Ludwigia. The long-term contribution by the planted species will likely be related to periods of inundation, competition from invasive species and grazing pressure from wildlife.

b. Richness

The sharp decline (about 50%) in species richness as depicted on a transect basis (# of species found) at Kingman Area 1 and Area 2 in 2001 versus what was found the first year (2000) was most likely due to the pressure from goose grazing (Figure 9). It should be noted that the reference areas at Dueling, Patuxent and Mass Fill 2 at Kenilworth displayed no such decline. At Kenilworth Mass Fill 1 there was a decline in September 2001 (but not July 2001), which reflected effects from herbicide treatment in August 2001 for Phragmites and Lythrum. Also noteworthy is that in 2000, the year of reconstruction, species richness was high at Kingman Marsh (higher than reference wetlands) presumably due to colonization of the new landscape by a wide array of species before competition and soil saturation could take place. Also, the tidal restriction controlled by the water tubes before they were removed in August of 2000 may have promoted greater seedling establishment in 2000 than would have occurred without the tidal restriction. The grazing effect coupled with species dropout for various reasons (such as not really being adapted to a tidal marsh regime) in 2001 at Kingman reduced species richness well below that of the reference areas. While there were over 90 species found at Kingman Area 1 in 2000 there were only about one-third of that detected in 2001. While some decline as mentioned earlier should be anticipated as more upland and poorly adapted species fall out, the reduction in one year down to species numbers at the reference sites was unexpected and likely reflects, at least in part, loss of habitat (sediment reduction from erosion and consolidation) and species specific loss due to grazing.

Using species richness as an indicator of wholesome marsh conditions, both unreconstructed reference wetlands (Dueling and Patuxent) possess a greater species richness than Kenilworth (reconstructed in 1993) and Kingman (Figure 10). Kenilworth had a high number of species (over 100) in its early years (based upon surveys of the whole marsh), which compared favorably with reference wetlands; thus it is possible to blame its current species shortage on the invasion and relatively recent cover dominance now exerted by Phragmites, Lythrum and Typha. Although the percent contribution by non-native species in terms of number of species for all the wetlands was near 5% or less, the actual cover contribution at Kingman Area 1 was close to 10% while that at the Kenilworth marshes was more than 20%.

c. Biomass

Along with cover, overall biomass (as peak standing biomass) was reduced in 2001, as large portions of the reconstructed Kingman Marsh remained unvegetated as a result of grazing pressure and low elevations. However, growth of the unpalatable species was undiminished and produced dry weights per unit area equal or greater than in 2000. This may be especially true for Kingman Area 1 (KL1) where the data did show a biomass increase in 2001 despite the grazing pressure (Figure 11). Nonetheless, the biomass at Kingman was still well below that for the other (reference) wetlands. The high biomass values at Kenilworth (MF 1 and MF 2) may be attributed to Phragmites and Typha. Given the herbicide treatment for Phragmites at MF 1 (treatment occurred too late to affect biomass in 2001) one would expect a sharp biomass decline there in 2002. I can provide no particular rationale for the apparent biomass decline at Patuxent in 2001 unless it is within natural variation.

2. Soils

In 2001 soils were analyzed for texture, organic matter, redox potential, nutrients and metals. More detailed work in comparison to Year 1 (2000) will be performed in subsequent years.

a. Soil structure and organic matter (OM)

Kingman and Kenilworth MF1 soils were high in sand content at all three sampled elevations for both 2000 and 2001 reflecting the sandy dredged material source in the Anacostia channel and lack of any sorting (Table 1a and 1b). Dueling Creek, however, had more silt. At the same time there was wide variation from sample to sample in the sand/silt/clay contents at Kingman Marsh exposing at this early marsh stage an overall heterogeneous and as we shall see mostly mineral soil system. It might be suspected given that the soil material at the reconstructed wetlands was hydraulically placed that higher sand and even cobble might be expected close to where the outlets of the pipelines discharged with lesser concentrations with distance. It would also be suspected that the sand depth would thin out with distance from wherever the discharge pipes were placed; but to date the data has not been analyzed for this effect. It would also be of interest to see if there is any correlation between sites where Phragmites patches have established and the sandiness of the soils at Kenilworth. However, there maybe a second factor involved with this and that is elevation since the places of discharge probably coned a bit higher which would benefit Phragmites establishment especially in areas where elevation may be limiting. At this point Kingman is too young to demonstrate this effect, besides most of the elevations are lower at Kingman.

It would be expected that the soil structural component to change most dramatically from Year 1 would be soil organic matter since the placed soils were largely mineral and could not benefit from pre-existing vegetation. However, from the work of Kelly Phyillaier Neff organic matter levels at Kingman did not change from 2000 to 2001. This information would suggest it will take some time for organic matter to build up in the newly placed wetland soils. This situation seems to be corroborated by comparisons with the other wetland sites (Fig, 12) where the organic matter was similar at the Anacostia wetlands but did possess higher organic matter in the upper level sampled = 0-7.5 cm. Significantly, the long standing Patuxent Marsh had almost 40% organic matter compared to 6% at Kingman Area 1. The fact that the reference wetlands possessed higher OM in the upper level reflects the decomposition of aerial plant parts and to a lesser extent surficial roots (OM did not change with depth at Kingman). Organic matter build-up in the reconstructed wetland soils as compared to reference sites could be an indicator of maturity and successful establishment. In time one would expect a build-up of organic matter in the upper horizon due to contribution from decay of surface detritus and surficial roots.

c. Metals and nutrients

The long and short story on sediment metal content seems to me one of no particular patterns among the wetlands. The concentrations are reasonably similar across the board with the possible statistical exception of cadmium (Figure 13). The metal concentrations are for the sediment and not pore water. Nonetheless the concentrations of several of the metals are high enough to indicate at least moderate pollution.

Both total nitrogen and phosphorus were several times higher at Patuxent Marsh than the Anacostia marshes, but the Anacostia marsh concentrations were all similar (Figures 14 and 15). For whatever reasons, perhaps sewage treatment plants upstream or enhanced agricultural runoff, the nutrient levels in the Patuxent Marsh soils are elevated above those in the Anacostia which should also be high due to the known high levels present in the water column. It's especially surprising since there is sufficient plant growth at the Patuxent marsh to utilize soil nutrients. Perhaps the answer lies in the high OM matter in the Patuxent soils, which may be adsorbing the nutrient forms. Even the sulfur levels are higher at Patuxent than in the other marshes, but only with limited statistical significance (Figure 16).

d. Redox

Oxygen levels dropped in the Kingman soils from 2000 to 2001. Some reduction might have been anticipated as the freshly placed soils in 2000 may have still been somewhat aerated (Figure 17). However, the decline was from moderate elevations relative to the other Anacostia sites to low levels for this parameter. These results to date suggest this aspect of the soil system is still in flux. Stabilization of redox readings over time could serve as an indicator of successful marsh establishment. What remains to be seen is whether the negative redox levels experienced at Patuxent are normal or a function of the elevated organic matter and nutrients which could be supporting a healthy microbial population which are using much of the soil oxygen and reducing the redox levels.

3. Seed source studies:

Seed sources were monitored in 2001 and where possible compared to data from 2000. Sources included the dredge material used to build the site, tidal influxes bearing seed, debris rafts and wind. Geese may introduce or redistribute seed from grazing and defecation. Subsurface soils were also checked for seed at Kingman Marsh in 2000 to verify that the seed in the surface layers were mostly from the sediment and not brought in during the time frame between deposition and sampling. Methodologies for collection and germinating seed used by Kelly Phyillaier Neff were presented in the First Year Annual Report.

The subsurface soils from Kingman and the Anacostia River sediments had similar seed density (Figure 18) and richness (Figure 19) in 2000 as Kingman surface soils. This suggests there was little seed dispersal onto the Kingman surface after sediment placement, but before seed bank samples were taken. The seed found in the Anacostia River sediment suggests that the dredge material does provide a small amount of seed, but little in comparison to other sources. In 2000, the density of seeds emerging from the seed bank samples was significantly lower at the Kingman Cell 1 than at the Kenilworth sites, and Kingman Cell 2 than Kenilworth Mass fill 1. Seedling emergence and species richness increased significantly in 2001 at both Kingman sites, with seed densities increasing by >36 times and richness increasing by 6 to 8 times more than those found in 2000. This may be a vital point as it demonstrates the production of a viable soil seed bank from year 1 to year 2. It also suggests the decline in species cover at Kingman was not due to seed bank decline. In 2000, richness of the seeds was significantly lower at Kingman Cell 1 than at the Kenilworth areas, and richness at Kingman cell 2 was significantly lower than Kenilworth Mass Fill 1. Richness increased significantly over the year at the Kingman sites. There were no significant differences in richness in 2001 between areas.

The Anacostia River sediment was dominated by *Juncus* spp., *Lindernia dubia*, *Ludwigia palustrus*, Poaceae spp., and a smaller amount of *Lythrum salicaria*. These species were similar to those of Kingman soils in 2000. Kenilworth Mass Fill 1 had large amounts of *Juncus*, *Cyperus*, *Typha*, and *Leersia*. All the urban reference sites had *Lythrum*, with Mass Fill 1 having the largest amount. *Typha* was also present at all the reference sites, but densities were much higher at the Kenilworth areas. In 2001, *Cyperus* was more important at the Kingman sites, while *Lythrum* seed densities were still low. Since the species *Cyperus* spp., *Juncus effuses*, *Leersia oryzoides*, *Lindernia dubia*, *Lythrum salicaria*, and *Typha* spp. were also found by Baldwin and Derico (2000) in the seed bank of Kenilworth in 1996, it is believed that the seeds of these species are well distributed along the Anacostia waterway, and any restoration site along this river will receive seeds of a similar species composition in the first few years. Some variation in the above can be expected depending whether the data is based on cover contribution of each species or the number of individuals. Most of this data was based on seed densities and resultant germinated seedlings but could be compared to the cover measured in the field along the transects. Similarly, the proportion of native species in the seed bank (Table 2) may appear greater than when expressed in terms of densities or cover.

Kingman did not have a high percentage contribution by introduced species in the seed bank in 2000 or 2001, and the proportion introduced did not change over the year (Table 2). However, Kenilworth Mass Fill 1 and Dueling Creek had at least 50% contribution by introduced species in the seed bank in both years. It should be noted that although the seed bank input at Kingman may appear low, based on the number of non-native seeds the actual species number in the marsh cover in 2000 was quite high being over 25% (First Year Annual Report).

Seed Traps

The following information was provided by Kelly Phyillaier Neff from her thesis work on this project and inserted into this report. The data was derived from her seed collections and germination processes as previously described.

Many species were found in the seed traps, especially the water traps and the trawling traps (Table 3). Debris collections from 2000 had a high seed density (approx. 75 seeds per sample) and a high ratio of richness to density. Although goose feces did contain some seeds, the density was low (approx. 5 seeds per sample). Seed densities per m^2 for trawling were higher within Kenilworth Marsh (0.8 seeds/m^2) and Dueling Creek (1.3 seeds/m^2) than along the Anacostia River (range of 0.1 to 0.2 seeds/m^2), although not significantly. Water traps collected a large number of seeds (526 seeds/m^2) while wind traps collected a smaller amount (62 seeds/m^2). Due to the large amount of birds perching on the wind traps and evidence of bird feces on the traps, it is likely these traps collected more seed dispersed by bird than by wind. There were 131 species found in the combined seed studies at Kingman. Many of the species found in the vegetation were also found in the seed.

The majority of the species were found in the water-dispersal traps, including the trawls, water traps, and debris traps. This suggests that water dispersal into the site was the most important mechanism. Dispersal into Kingman was high due to the large degree of connectivity with the landscape, via tidal water of the river. It is clear that propagule availability is not a limiting factor. If the wetland conditions (i.e. hydrology) are appropriate for seed germination and herbivores are not extreme, this site would have a large amount of species volunteering, as was seen in 2000. Inexpensive seed studies prior to planting can reveal available propagules.

Some important species of the other urban sites were not yet present at Kingman, which may be a problem with seed not reaching the site. These included *Zizania aquatica* and *Polygonum arifolium*. *Phragmites*, although not present in the Kingman seed bank, was found as a rhizome in a trawl sample, and will likely continue to be dispersed via vegetative propagules, possibly becoming a dominant species in future years. *Lythrum salicaria* was present in Anacostia sediment, Kingman Area 1 seed bank, and all dispersal traps, but not in goose feces. Clearly, strong dispersal ability, including producing an enormous amount of viable seed (evidenced by high buried seed densities seen in this study at Kenilworth), is important in establishment of this species. However, this species was found in similar quantities in the vegetation of all urban sites and there was no significant increase in cover over the year at Kingman. In addition, Kenilworth values of *Lythrum* in 2000 (7.1% at MF1 and 0.8% at MF2) and 2001 (5.1% at MF1 and 0.9% at MF2) did not increase since the 1997 Kenilworth study (6.4%). Although the 1997 study did not sample exactly the same transects, it is unlikely this species increased significantly at Kenilworth during that time. Therefore, it seems that *Lythrum* cover develops quickly at a site and then stabilizes, so cover does not increase significantly over time. *Typha* disperses well, being present in the Anacostia sediment, Kingman seed bank, and the water dispersed traps. However, after a year, seed densities and vegetative cover of *Typha* spp. was still much lower at Kingman than at Kenilworth, suggesting that it takes a few years for densities of these undesirable species to dominate the seed bank or the vegetation.

4. Hydrology

The all-important effort to document sediment elevations at the reconstructed wetlands particularly with respect to inundations by the tidal cycles commenced in early 2001. Periods (mostly frequency and duration) of inundation are acknowledged to control the vegetation community and resultant habitat. Thus in the tidal marsh reconstruction business it is essential to get the sediment elevations right or you likely will not attain the design marsh. Measurement of the on-site tidal cycles was accomplished through the installation of hydrologgers (tidal data logging wells) at each of the marsh sites. The hydrologgers (Ecotone Model WL-80 produced by Remote Data systems) were placed in locations lower than the transects, usually in secondary tidal guts, so as to be able to capture all waters covering the transects. Each of these vertical wells also had a calibration line which was used as an internal benchmark for relative elevations and absolute elevations when surveyed off nearby verified benchmarks on land. The hydrologgers recorded water levels in the wetlands every 15 minutes, thereby providing an excellent record of the actual tide cycles. The data off the hydrologgers was downloaded every 3 months or so and stored on disks for analysis. In coordination with the hydrologgers, the relative elevations (to the hydrologger calibration point) of each and every transect sector was determined. By Year 3 it was possible to ascertain absolute elevations once the calibration points for the hydrologgers at Kingman and Kenilworth were surveyed in. From the work conducted in 2001 the relative elevations of the study wetlands to each other were ascertained based on the percent of time inundated. While this is composited data it is valuable to note that the elevations as relating to inundation existing at Kingman are proximate to those at Patuxent (Figure 7). One might be better placed comparing vegetation structure at Kingman to Patuxent than the other Anacostia marshes, which were significantly higher (less inundated). Kenilworth MF 1, which we have consistently recognized as high marsh, certainly revealed itself as seldom being inundated by tides. However, personal observations suggest that this flat, poorly drained wetland does remain quite wet by trapping rainwater and infrequent contributions from high tides. This chart does make relative sense from our field observations, which have led us to believe Dueling Creek is relatively high. Actually MF2 percent time inundation should reflect MHT or 2.1' NGVD'29. The given 28% or so then is considerable since I would expect MHT to be exceeded infrequently, maybe 10% of the time - so there is some discrepancy here. However, by referring to the elevation (absolute) chart (Figure 20) for the sectors everything appears consistent with observations. For example, MF2 does straddle 2.1 ft. KL1-planted has a wider range of elevations than KL-2 but the means are similar. While the unplanted areas at KL-1 may be of limited usefulness, it is worthwhile to note that they (the higher unplanted section) certainly do reflect the high end of elevations at KL-1. Also, MF-1 at Kenilworth does appear to be quite high by this data. Note that the other wetland sites cannot be displayed for absolute elevations since we have not located any nearby benchmarks for them. This figure also displays the strong difference in elevations for our reconstructed Anacostia wetlands. KL1-planted has a portion that is quite low -perhaps too low, while the rest of the site should provide a good low marsh/mid marsh mix. KL2 should turn out to be mostly low marsh. MF2 looks to be good mid marsh based on the elevations, while MF1 is closer to high marsh. These relationships are based upon elevation ranges that I believe are most correct where low marsh is centered on 1.7' NGVD '29, and similarly mid-marsh is at 2.1' and high marsh at 2.5'. It may be that we'll have to do a better job of mapping elevations at these wetlands and focus on areas of like elevations for comparisons of vegetation communities and the like as opposed to whole marsh data as we have tended to do. The dependency of species on elevation can be gleaned for a plot of Phragmites presence versus elevation (Figure 21). This figure shows a pretty sharp demarcation where Phrag establishes at or above the 2.1' NGVD 29 elevation. It certainly stands to reason that the lower sections of KL1 and KL2 should be planted since they are unlikely to produce volunteer plants from seedlings. This is what the USCOE has done in 2002 in combination with tight fencing to encourage revegetation of previously failed portions that were decimated by geese and unable to respond via the seed germination route. Even grazed plantings no doubt found it more difficult to recover at the lower elevations. While the fencing cannot remain forever, they should certainly be maintained for several years until a reasonable goose management plant can be implemented.

To better document the sediment processes, Sediment Elevation Tables will be installed during 2002 (Year 3 of the study) at Kingman and Kenilworth. This system should help provide insights to rates of sediment consolidation, erosion and deposition.

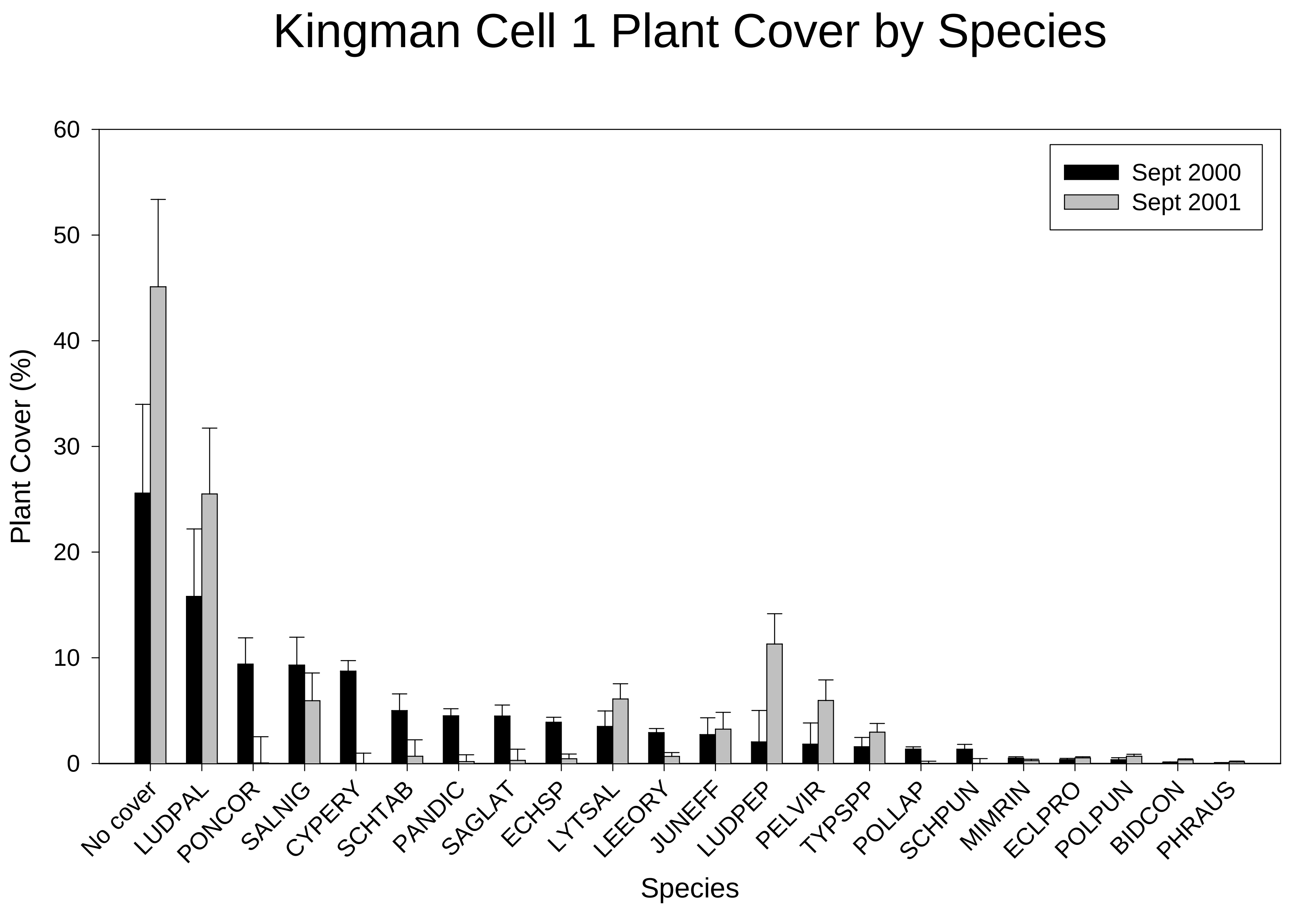

Figure 1. Plant contribrution by top 15 most dominant species and other species of interest for each year in September.

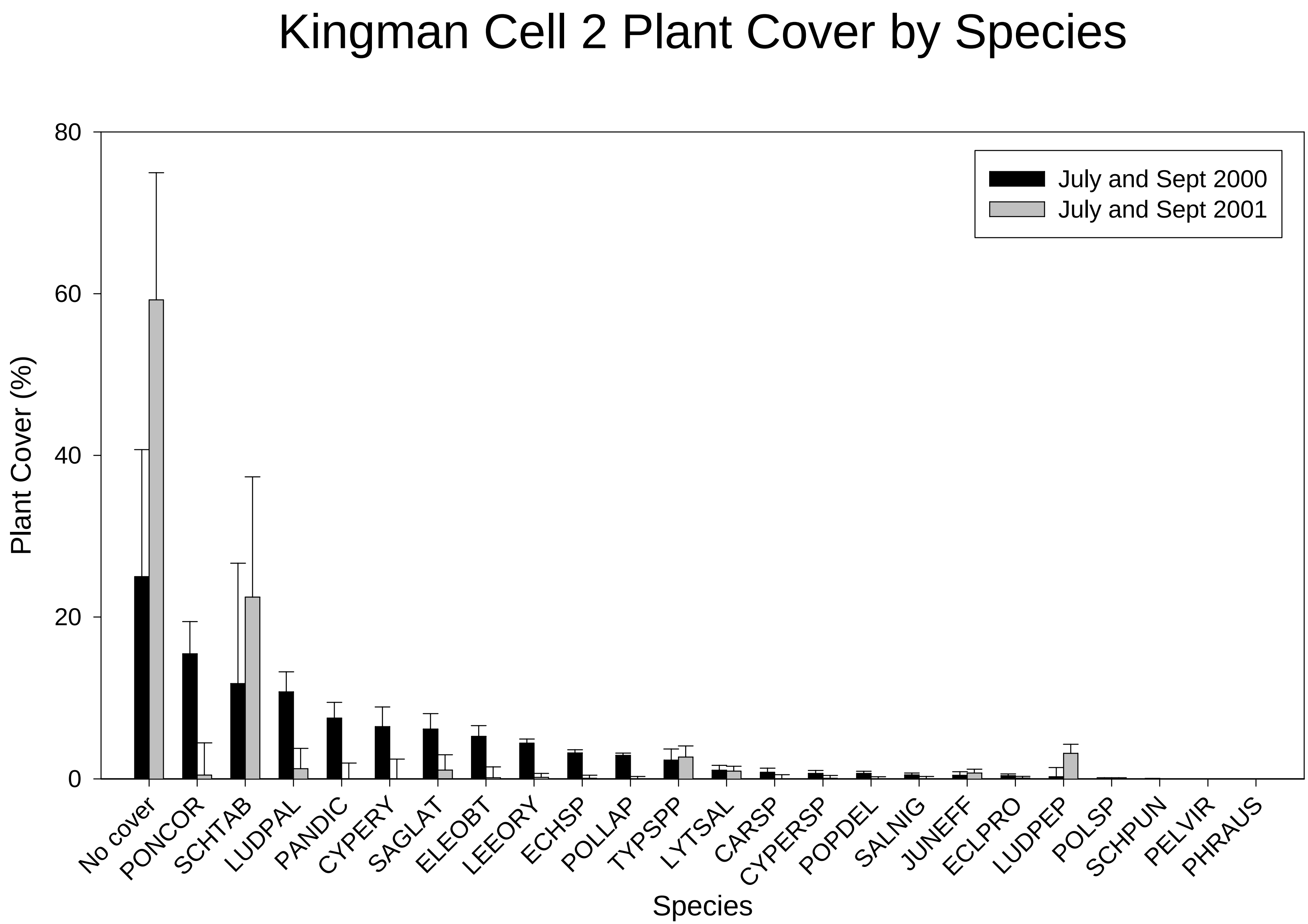

Figure 2. Plant contribrution by top 15 most dominant species and other species of interest for each year in July and September combined.

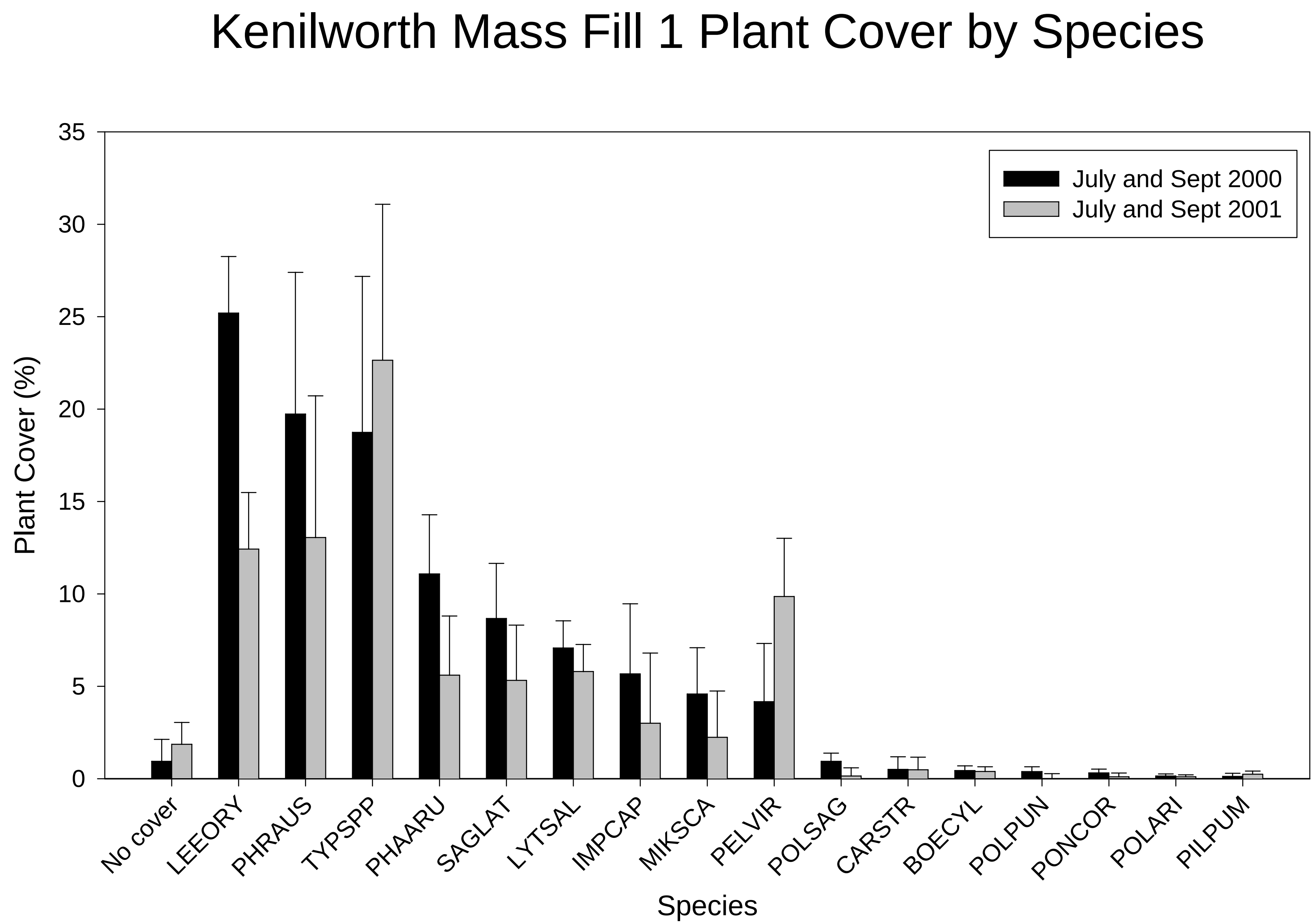

Figure 3. Plant contribrution by top 15 most dominant species and other species of interest for each year in July and September combined.

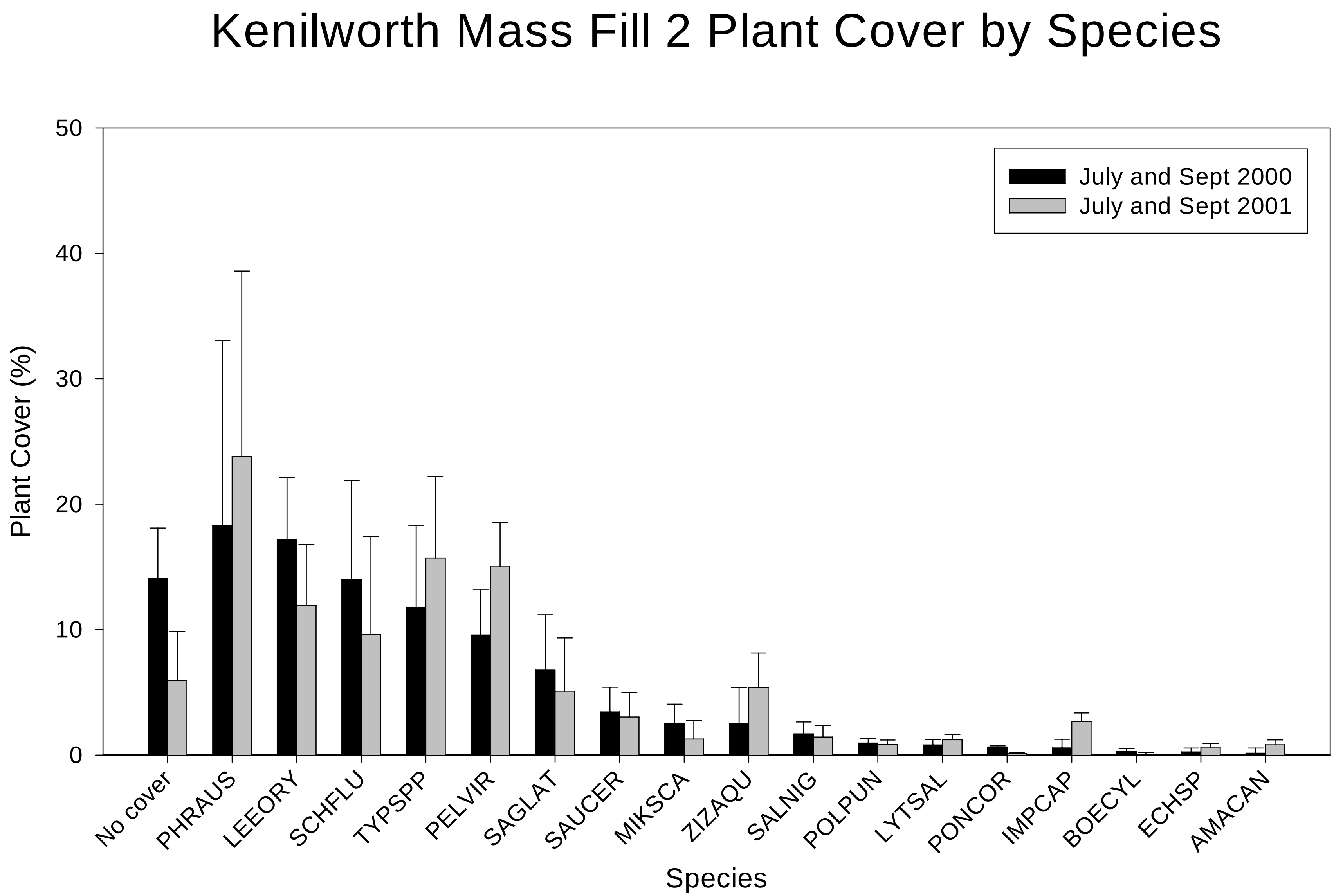

Figure 4. Plant contribrution by top 15 most dominant species and other species of interest for each year in July and September combined.

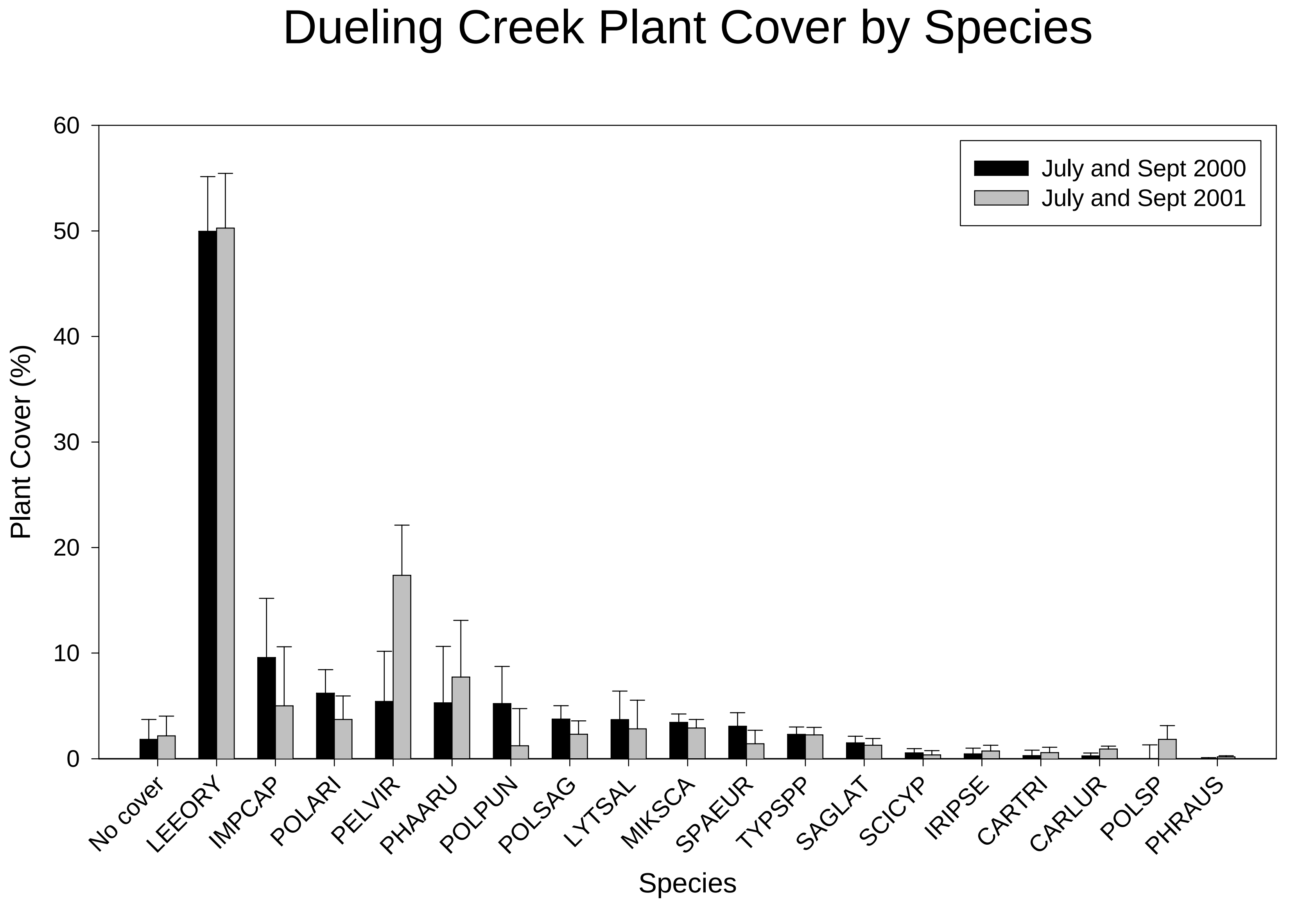

Figure 5. Plant contribrution by top 15 most dominant species and other species of interest for each year in July and September combined.

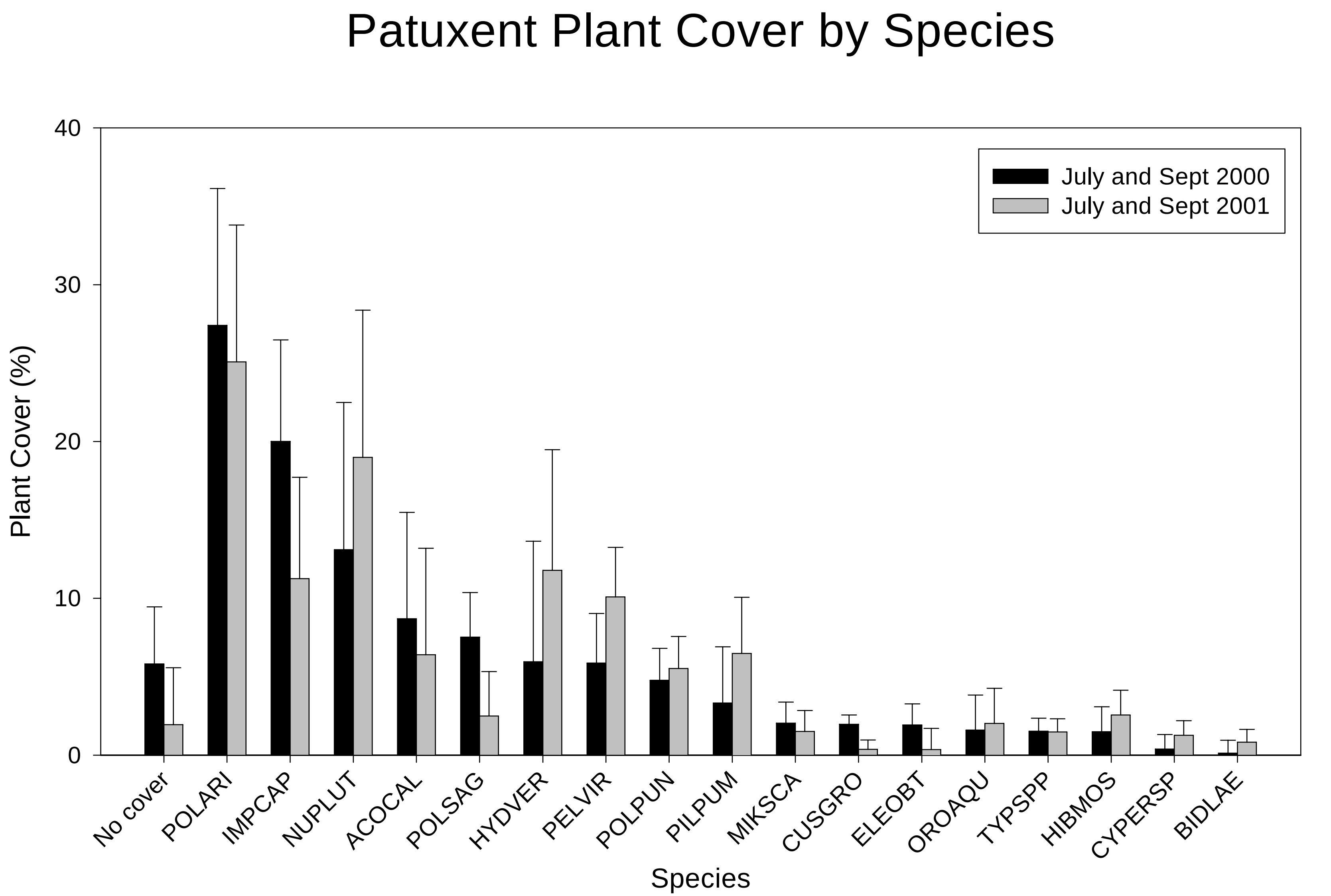

Figure 6. Plant contribrution by top 15 most dominant species and other species of interest for each year in July and September combined.

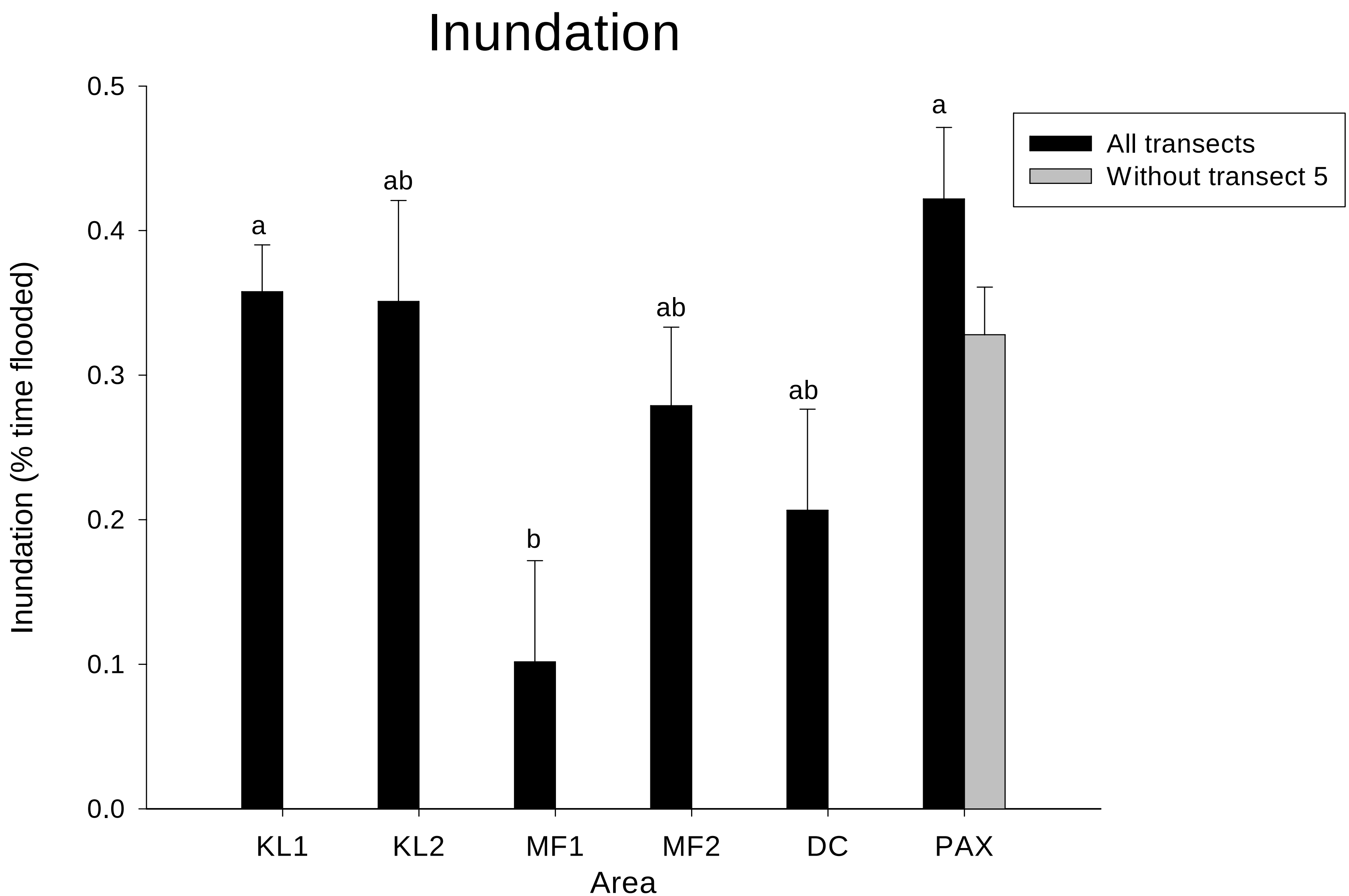

Figure 7. Percent time inundated for each area. Values are mean±SE. Different letters denote significance. (Tukey-Kramer test).

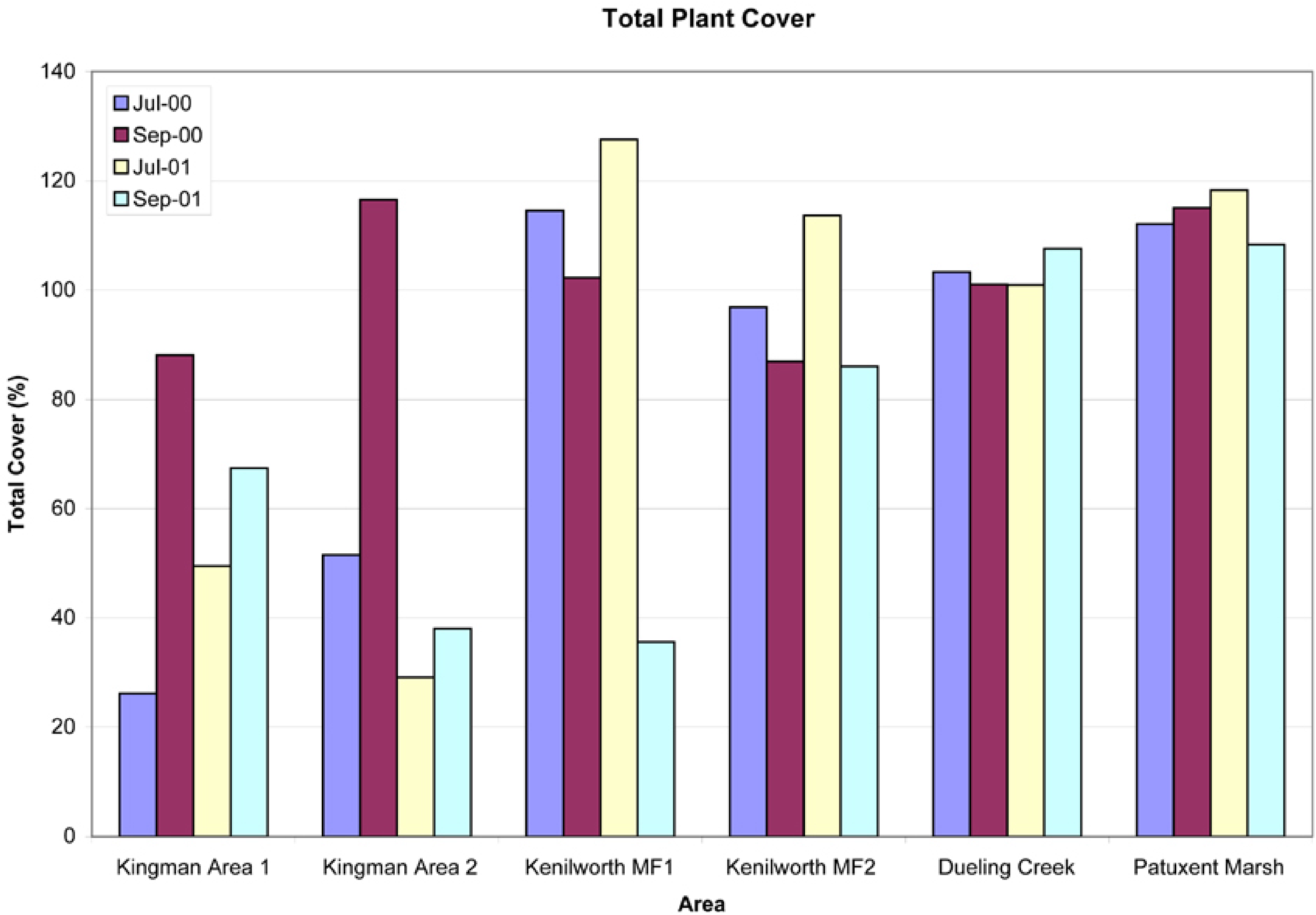

Figure 8. Vegetative cover in July and September 2000 and 2001.

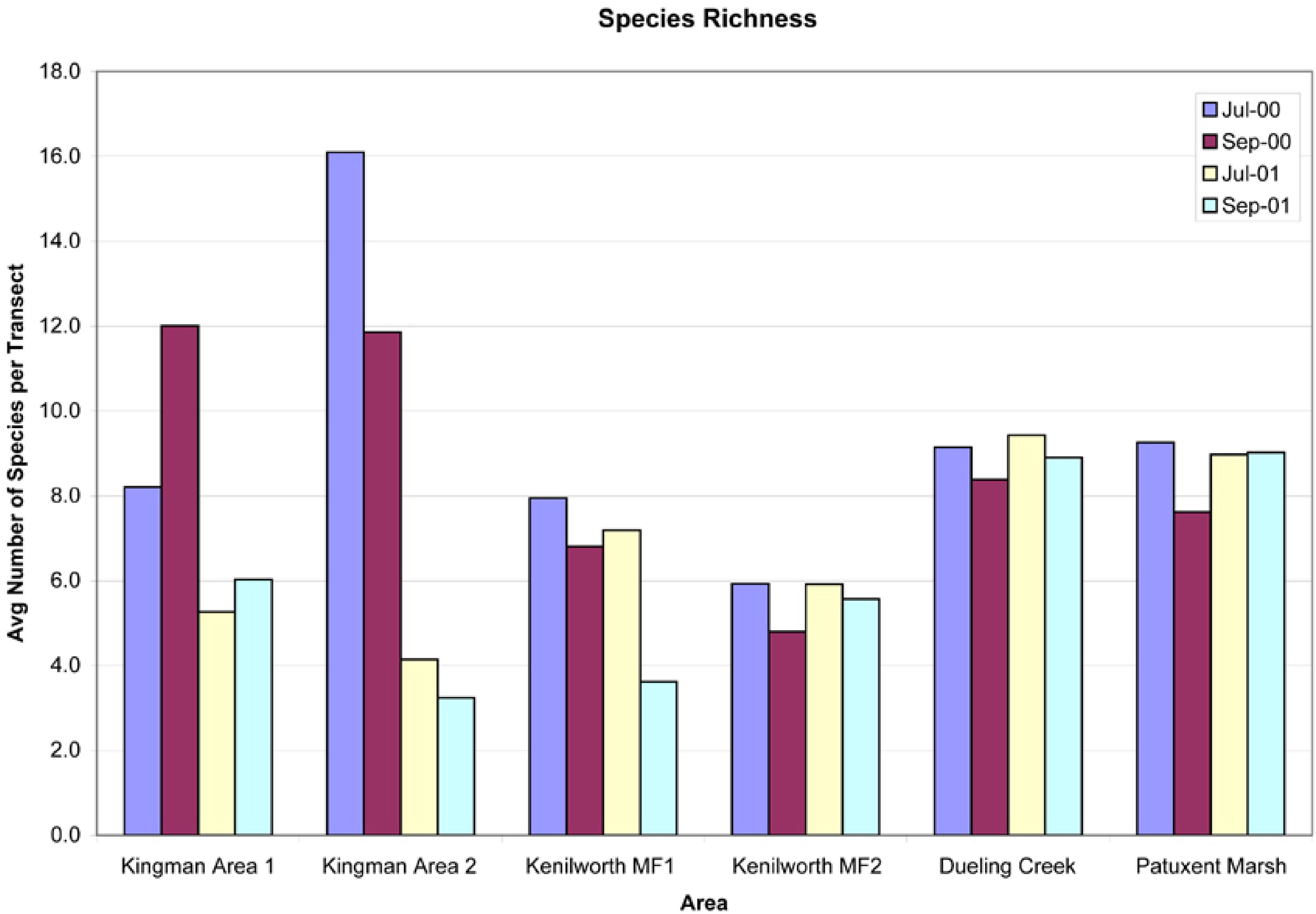

Figure 9. Species richness in July and September 2000 and 2001.

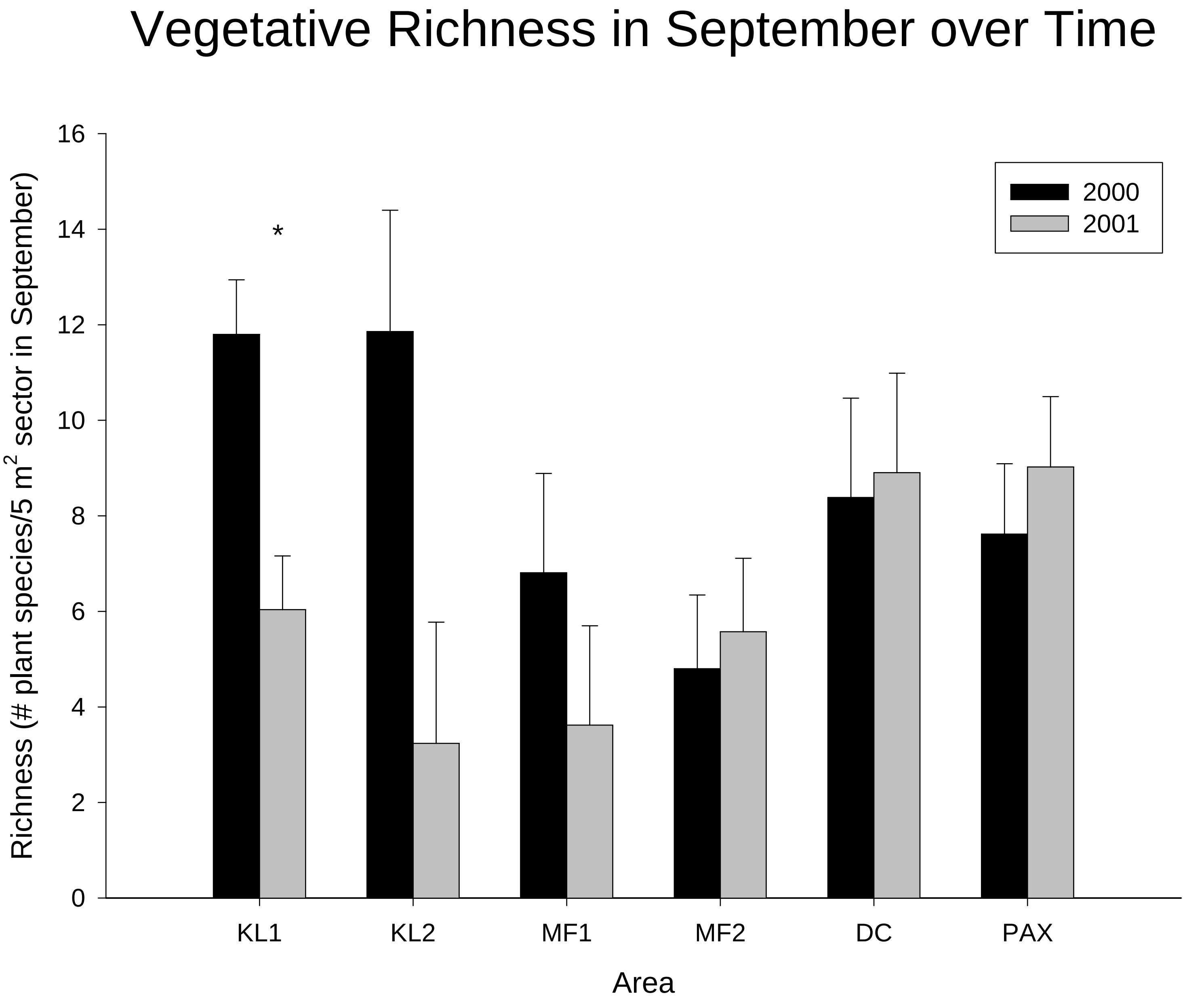

Figure 10. Vegetative richness of each area over time. "*" denotes significant difference within area between dates (Tukey-Kramer test).

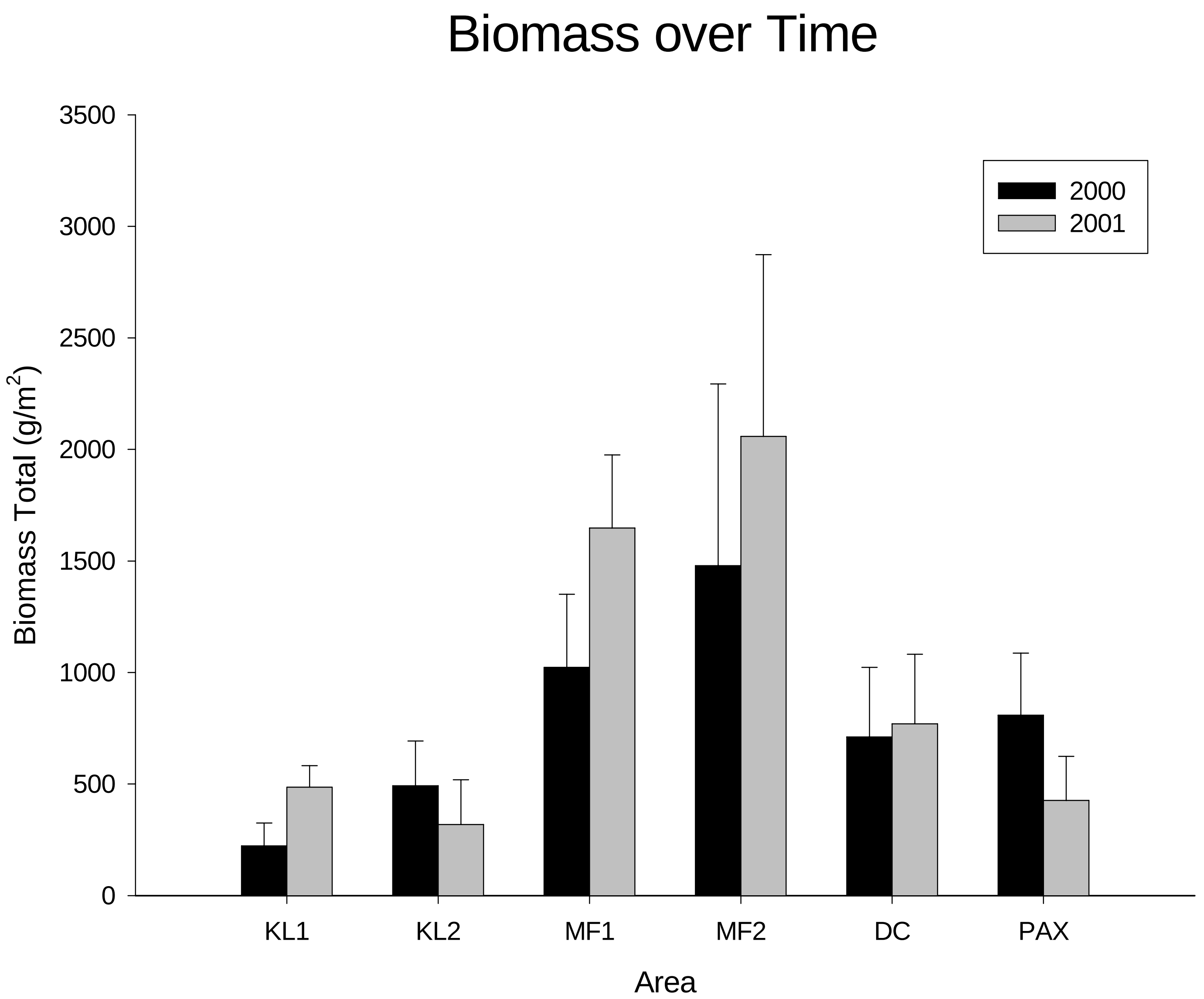

Figure 11. Vegetative biomass of each area for 2000 and 2001. There were no significant differences within areas between sample dates (Tukey-Kramer test).

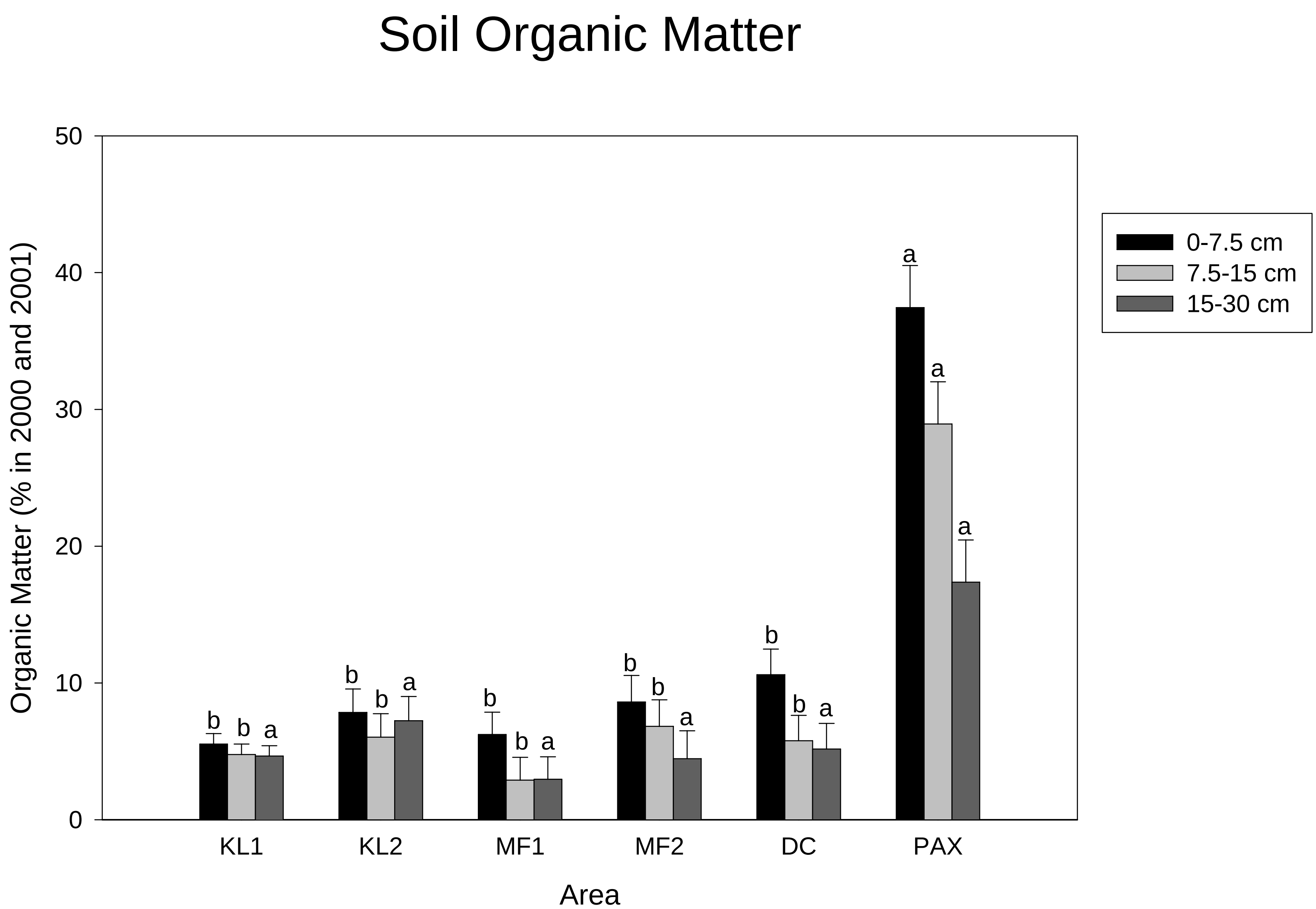

Figure 12. Percent organic matter for each area by depth in 2000 and 2001 combined.
Letters designate significance between areas by depth. (Tukey-Kramer test)

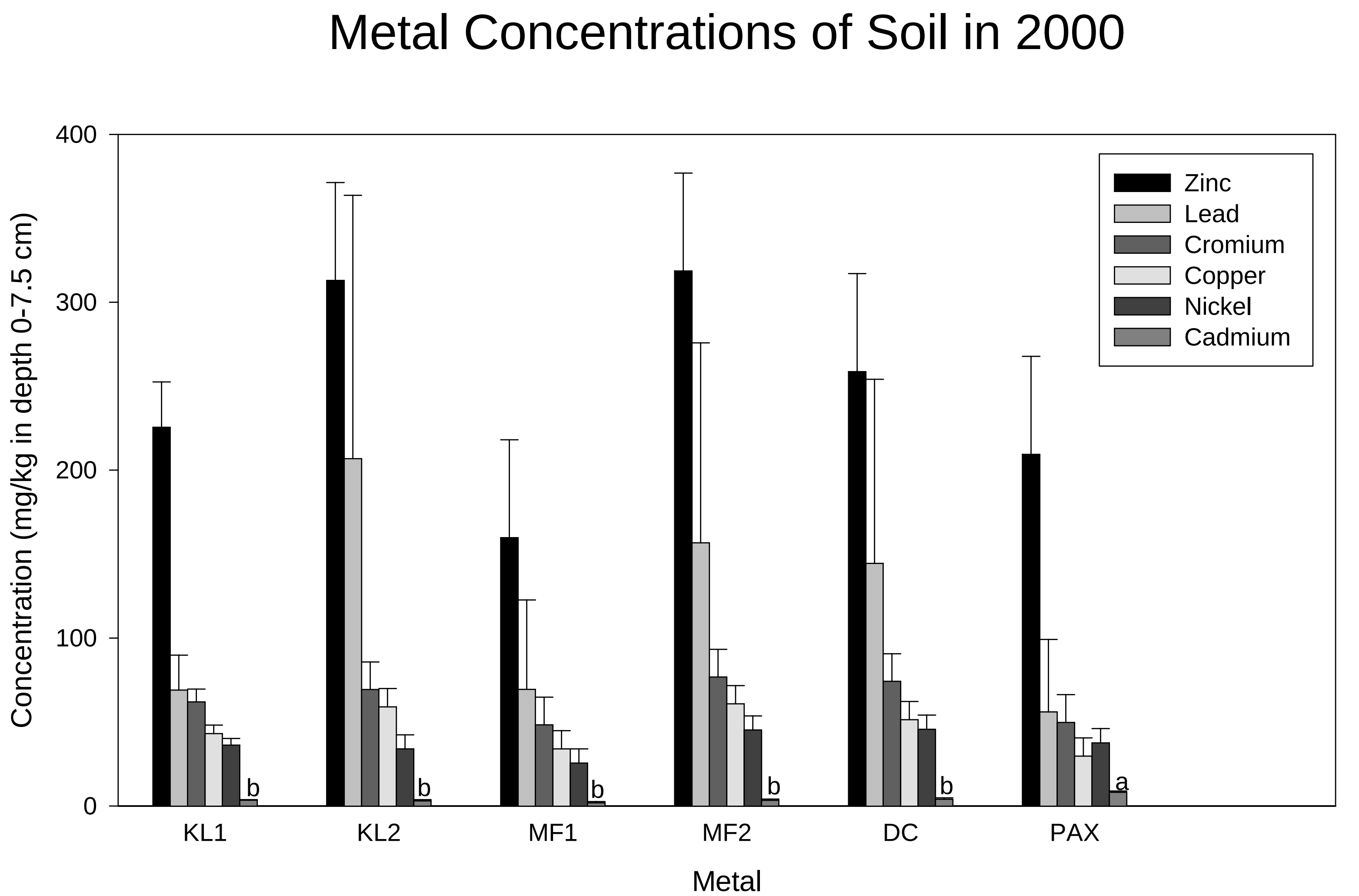

Figure 13. Metal concentrations for each area in 2000 at depth 0-7.5 cm. Values are mean±SE except lead, which is mean+upper confidence limit. Letters denote significant differences between areas. (Tukey-Kramer test)

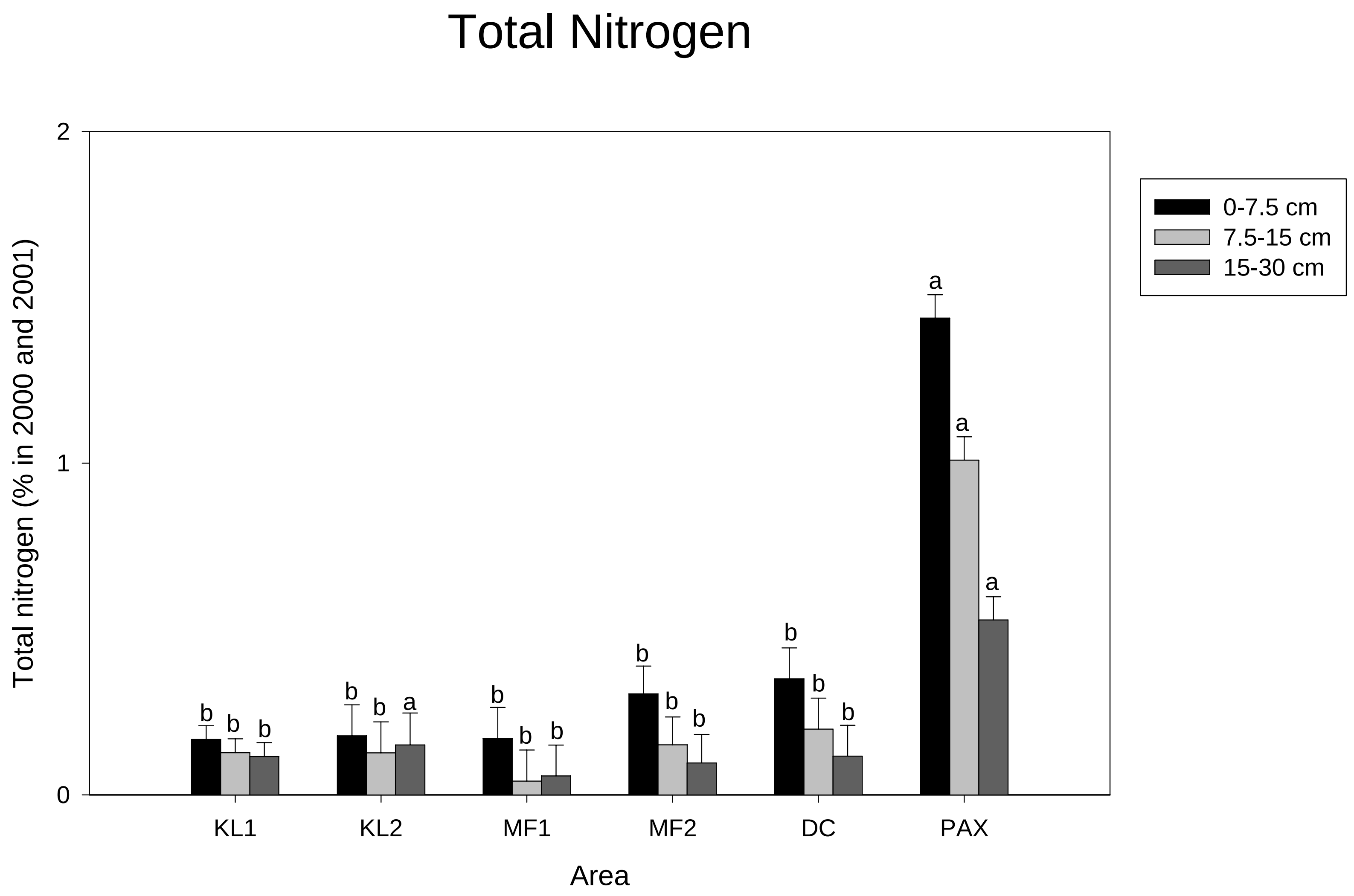

Figure 14. Percent total nitrogen for each areas by depth in 2000 and 2001 combined.
Letters designate significance between areas within depth. (Tukey-Kramer test)

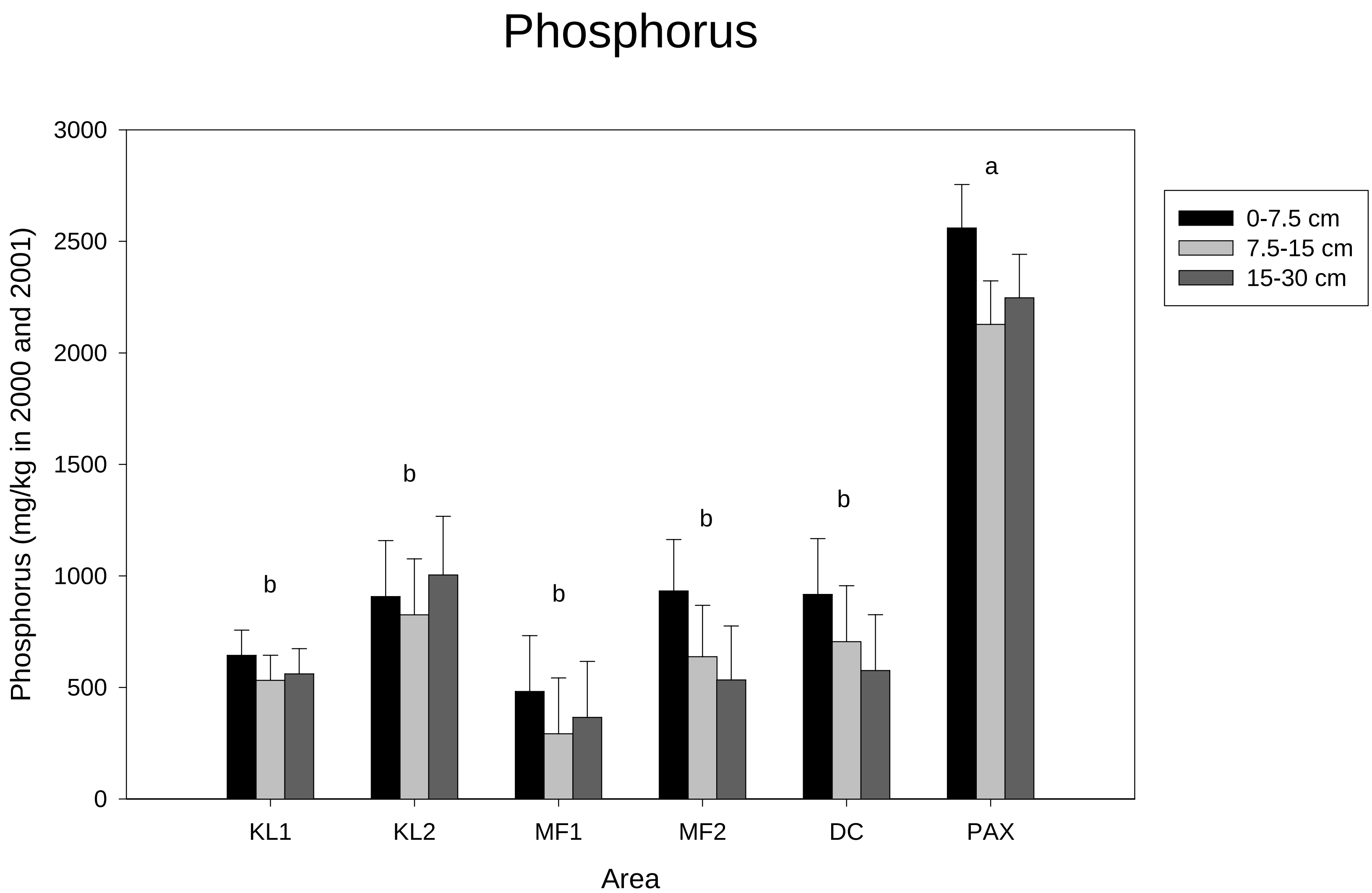

Figure 15. Phosphorus concentrations for each area by depth in 2000 and 2001 combined. Letters designate significance between areas. (Tukey-Kramer test)

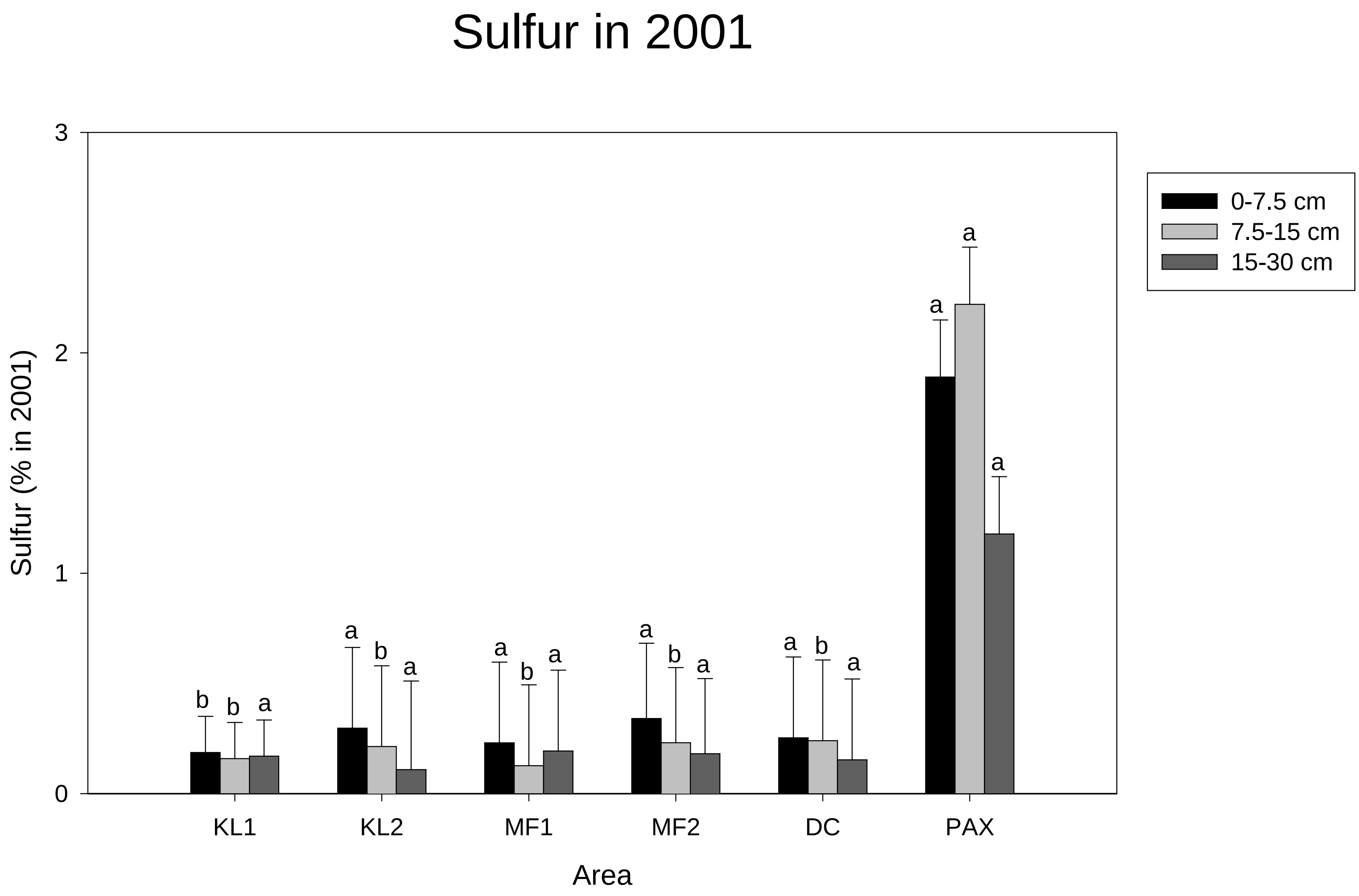

Figure 16. Percent sulfur for each area by depth in 2001.
Different letters denote significance between area by depth. (Tukey-Kramer test)

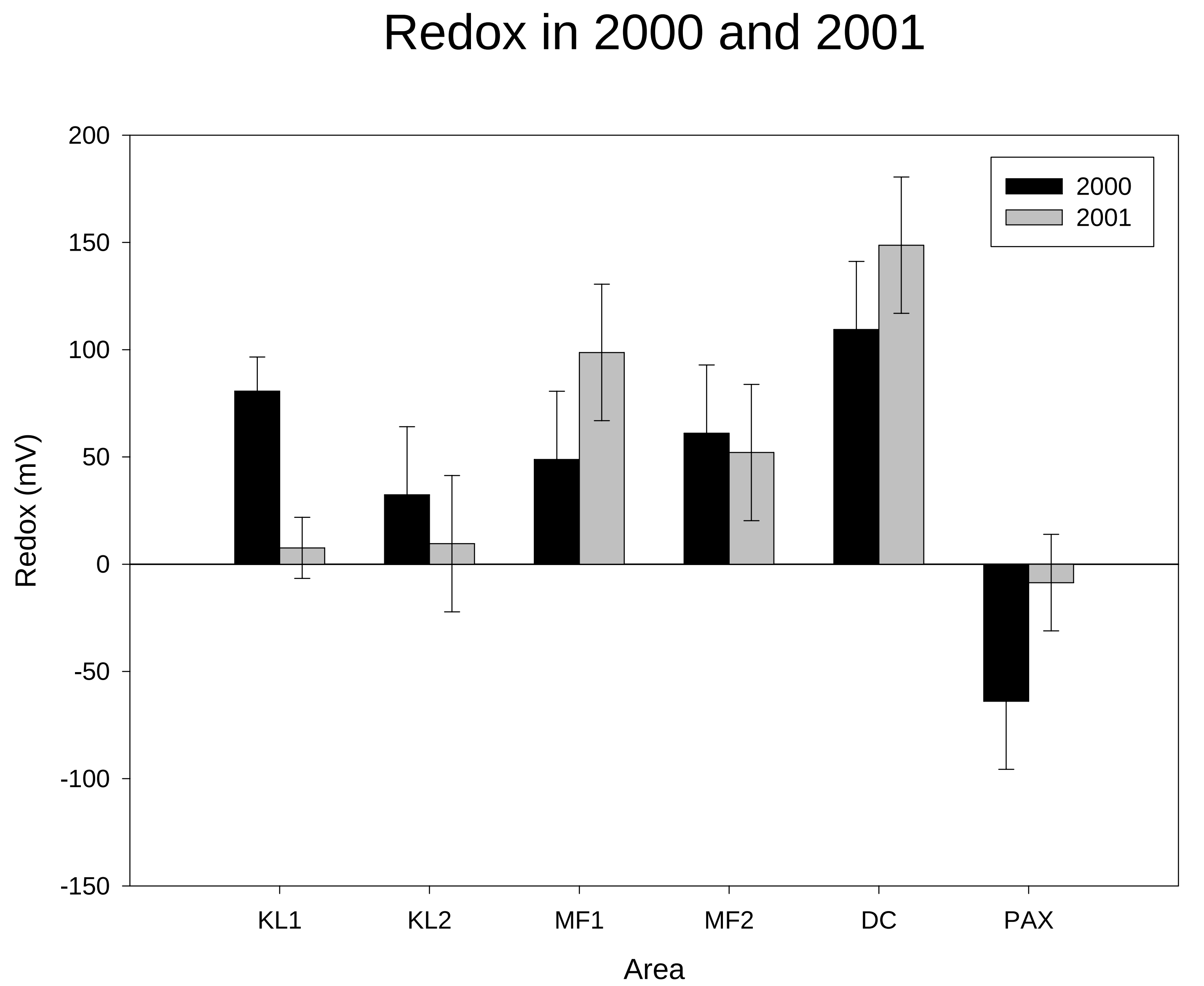

Figure 17. Redox potential for all areas over time. There were no significant differences within area over the year. (Tukey-Kramer test)

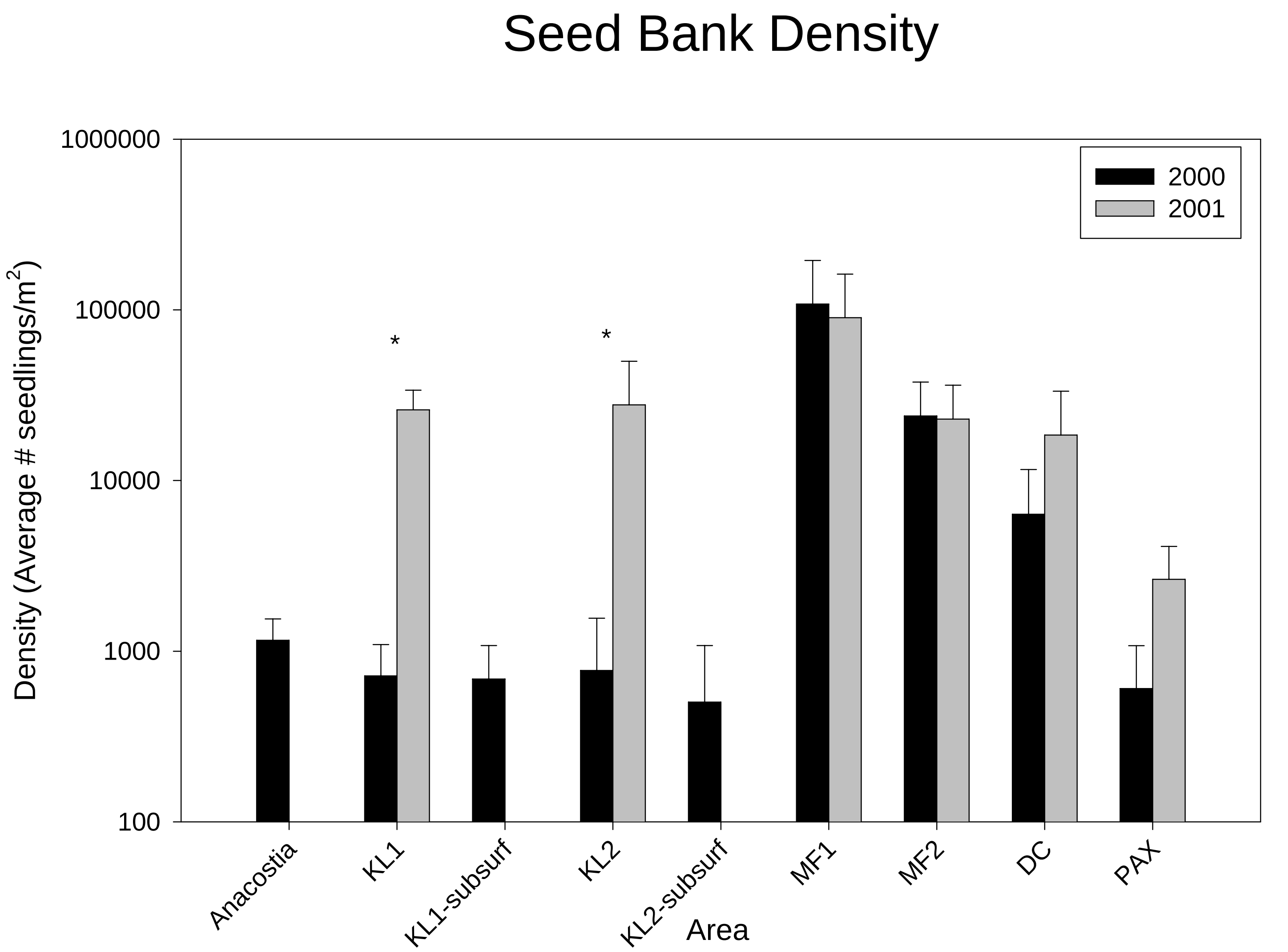

Figure 18. Seed bank density of each year over time within a sampling date. Values are mean+upper confidence limits in log scale. "*" denotes significance between years. (Tukey Kramer test)

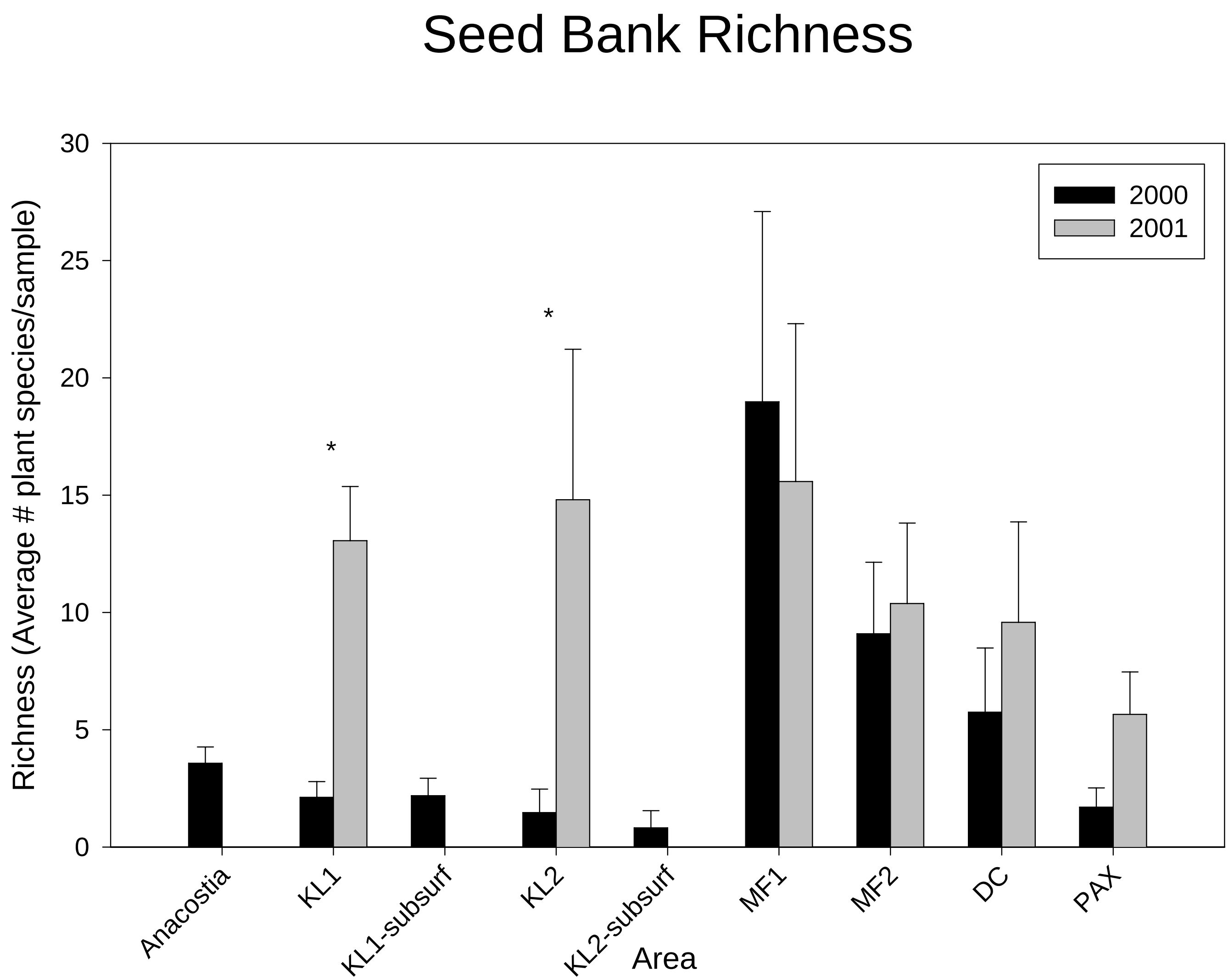

Figure 19. Seed bank richness of each year over time within a sampling date. Values are mean+upper confidence limits in log scale. "*" denotes significance between years. (Tukey Kramer test)

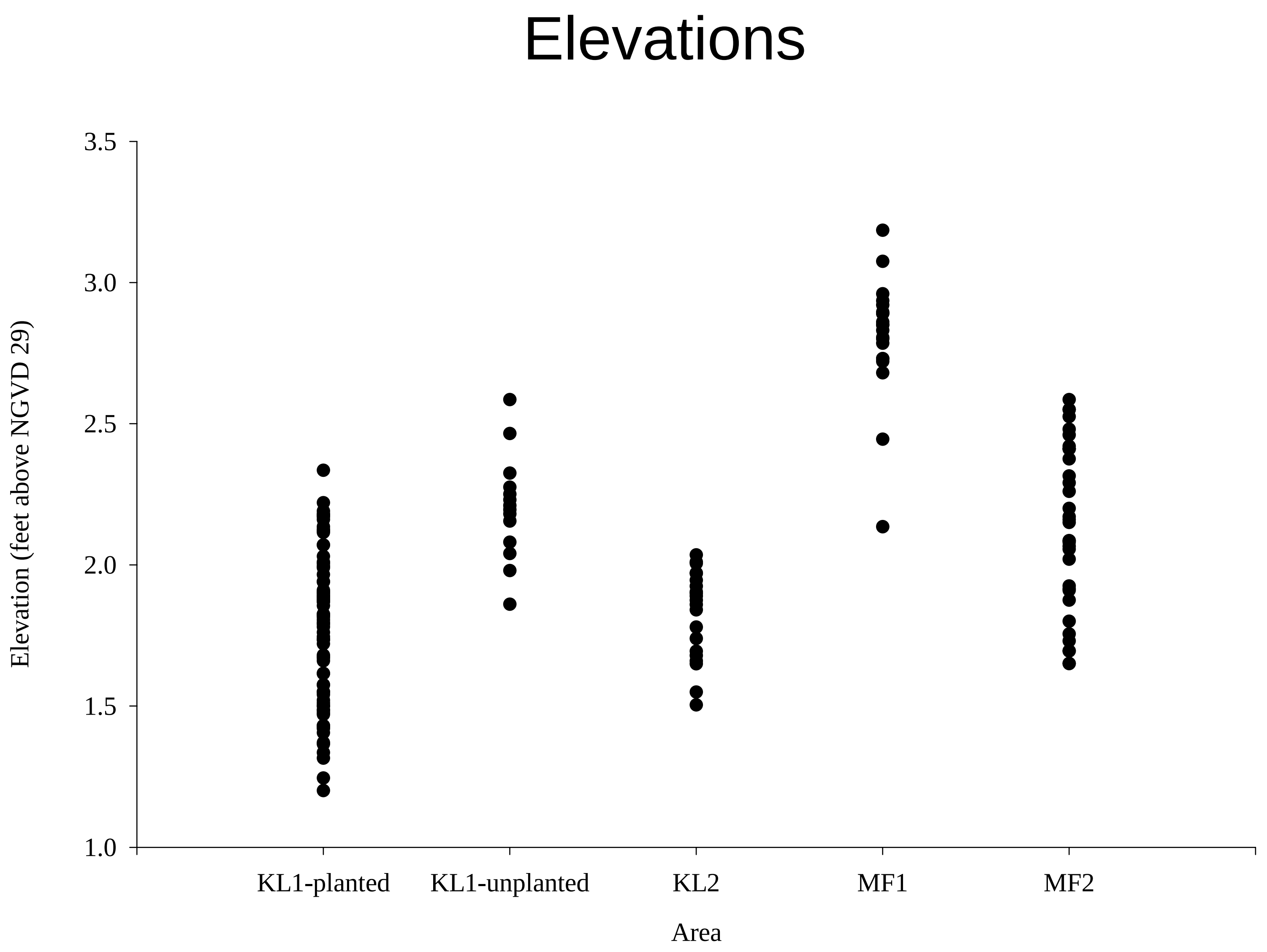

Figure 20. Elevation of all sectors for Kingman Cell 1 planted and the two higher unplanted transects, Kingman Cell 2, Kenilworth Mass Fill 1, and Kenilworth Mass Fill 2.

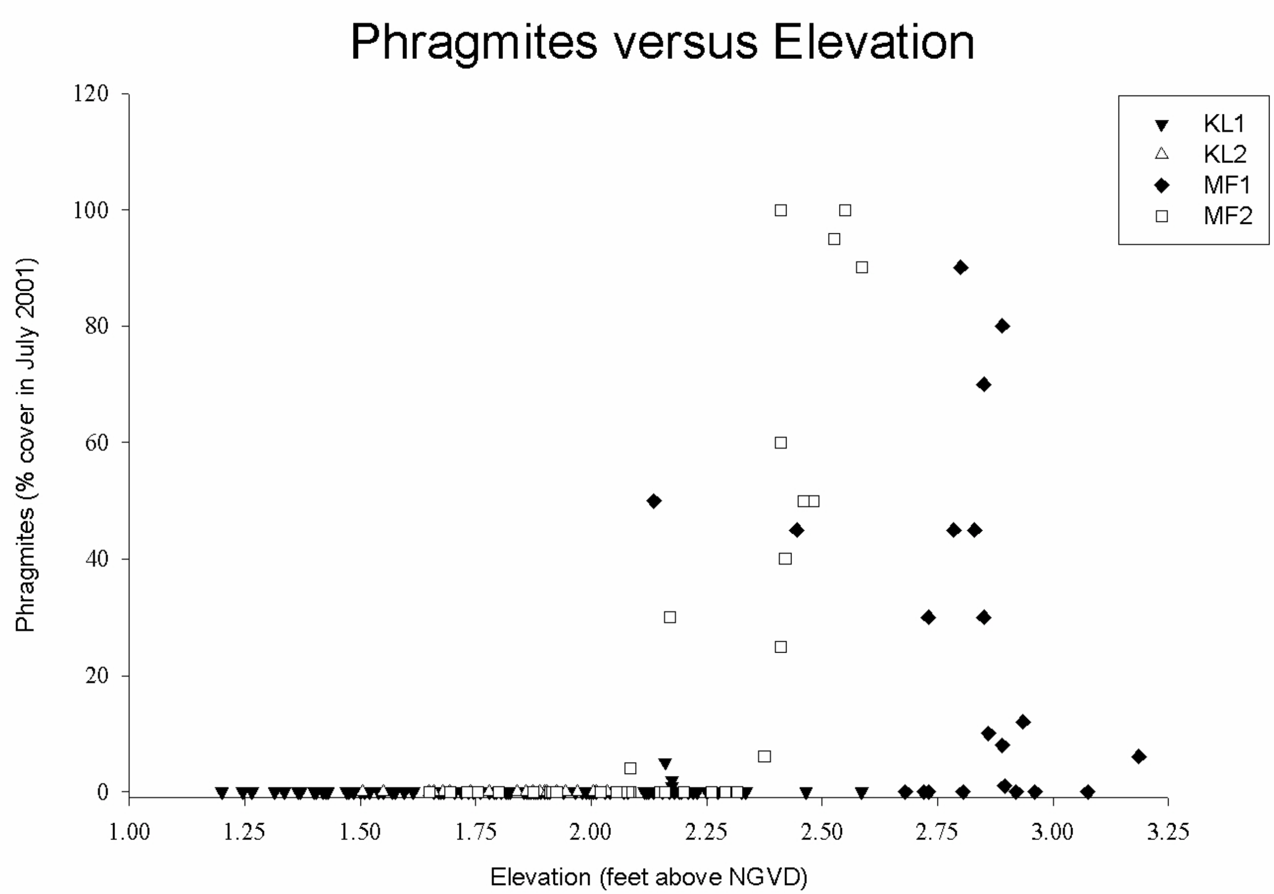

Figure 21. Relationship of percent cover *Phragmites australis* to elevations at Kingman and Kenilworth.

Table 1a. Means and SE for soil variables in 2000. " * " denotes estimated organic matter based on regression equation with organic carbon. "MS" denotes missing samples.

Depth	Parameter	KL1	KL2	MF1	MF2	DC	PAX
0-7.5 cm	Sand (%)	47.87 (5.68)	34.67 (12.40)	57.00 (12.40)	20.00 (12.40)	18.67 (12.40)	MS
	Silt (%)	33.30 (3.58)	41.00 (7.80)	31.33 (7.80)	48.0 (7.80)	46.00 (7.80)	MS
	Clay (%)	18.79 (2.55)	24.33 (5.56)	11.67 (5.56)	32.00 (5.56)	35.33 (5.56)	MS
	Total Carbon (%)	2.89 (0.66)	4.44 (1.45)	2.83 (1.45)	5.43 (1.33)	5.08 (1.45)	19.78 (1.20)
	Organic Matter (%)	5.98 (0.82)	8.70 (1.86)	6.34 (1.71)	11.13 (2.25)	11.35 (2.12)	39.20 (1.91)*
7.5-15 cm	Sand (%)	52.94 (5.68)	44.67 (12.40)	75.67 (12.40)	22.33 (12.40)	26.00 (12.40)	49.89 (17.79)
	Silt (%)	32.73 (3.58)	37.67 (7.80)	17.00 (7.80)	52.67 (7.80)	41.33 (7.80)	23.69 (11.60)
	Clay (%)	14.29 (2.55)	17.67 (5.60)	7.33 (5.60)	25.00 (5.60)	32.67 (5.60)	26.93 (8.24)
	Total Carbon (%)	2.49 (0.66)	3.96 (1.45)	1.05 (1.45)	3.37 (1.33)	2.45 (1.45)	14.41 (1.20)
	Organic Matter (%)	4.81 (0.82)	6.96 (1.86)	2.89 (1.81)	7.53 (2.25)	4.74 (2.12)	43.54 (3.20)*
15-30 cm	Sand (%)	51.23 (5.68)	42.00 (12.40)	62.67 (12.40)	29.27 (14.13)	27.33 (12.40)	29.19.00 (11.24)
	Silt (%)	34.44 (3.58)	38.33 (7.80)	28.33 (7.80)	45.71 (7.80)	41.33 (7.80)	31.78 (7.21)
	Clay (%)	14.29 (2.55)	19.67 (5.56)	9.00 (5.56)	25.40 (6.41)	31.33 (5.56)	39.06 (5.13)
	Total Carbon (%)	2.51 (0.66)	4.01 (1.45)	1.82 (1.45)	2.56 (1.47)	2.45 (1.45)	6.10 (1.20)
	Organic Matter (%)	4.35 (0.82)	6.02 (1.86)	3.03 (1.71)	5.07 (2.58)	4.39 (2.12)	13.73 (2.25)

Table 1b. Means and SE for soil variables in 2001.

Depth	Parameter	KL1	KL2	MF1	MF2	DC	PAX
0-7.5 cm	Sand (%)	49.46 (5.80)	56.33 (12.40)	60.0 (12.40)	44.33 (12.40)	28.67 (12.40)	43.17 (8.77)
	Silt (%)	34.74 (3.67)	30.00 (7.80)	30.00 (7.80)	37.33 (7.80)	39.33 (7.80)	31.00 (5.52)
	Clay (%)	15.76 (2.61)	14.00 (5.56)	10.33 (5.56)	18.33 (5.56)	31.67 (5.56)	25.83 (3.93)
	Total Carbon (%)	2.89 (0.65)	3.99 (1.45)	3.29 (1.45)	4.24 (1.33)	5.11 (1.45)	16.89 (1.03)
	Organic Matter (%)	5.09 (0.81)	6.97 (1.86)	6.12 (1.71)	6.09 (2.25)	9.86 (2.12)	32.45 (3.06)
7.5-15 cm	Sand (%)	55.33 (5.80)	58.67 (12.40)	61.67 (12.40)	38.33 (12.40)	23.67 (12.40)	36.17 (8.77)
	Silt (%)	30.08 (3.67)	26.67 (7.80)	29.33 (7.80)	40.33 (7.80)	39.00 (7.80)	26.33 (5.52)
	Clay (%)	14.56 (2.61)	14.67 (5.56)	9.33 (5.56)	21.33 (5.56)	37.33 (5.56)	37.67 (3.93)
	Total Carbon (%)	2.60 (0.65)	3.55 (1.45)	1.61 (1.45)	3.20 (1.33)	3.25 (1.45)	11.91 (1.03)
	Organic Matter (%)	4.73 (0.81)	5.11 (1.86)	2.90 (1.71)	6.13 (2.25)	6.80 (2.12)	23.92 (3.06)
15-30 cm	Sand (%)	52.39 (5.81)	59.67 (12.40)	57.67 (12.40)	64.67 (12.40)	29.67 (12.40)	27.50 (8.77)
	Silt (%)	32.36 (3.67)	25.67 (7.80)	32.00 (7.80)	21.33 (7.80)	39.67 (7.80)	28.33 (5.52)
	Clay (%)	15.23 (2.62)	15.00 (5.56)	10.67 (5.56)	14.00 (5.56)	30.67 (5.56)	44.17 (3.93)
	Total Carbon (%)	2.76 (0.65)	5.24 (1.57)	1.84 (1.45)	2.25 (1.33)	2.19 (1.45)	8.46 (1.03)
	Organic Matter (%)	4.96 (0.81)	8.44 (2.03)	2.89 (1.71)	3.86 (2.25)	5.96 (2.12)	17.79 (3.06)

Table 2. Proportion native and non-native seed bank species for all areas by year.

Year	Origin	ANA	KL1	KL2	MF1	MF2	DC	PAX
2000	Native	72.4	91.7	94.1	36.0	78.0	34.7	75.0
	Non-native	13.4	3.3	0	55.3	5.9	54.0	6.3
	Other	14.2	5	5.9	8.8	16.1	11.3	18.8
2001	Native		85.7	85.6	48.1	80.9	44.1	89.5
	Non-native		2.5	0	50.4	15.2	49.7	0.7
	Other		11.8	14.4	1.5	3.9	6.2	9.9

Table 3. Mean and SE of individual plant species found in each seed collection method for all areas. Species means are actual means, not divided by length of trawl. Trawl density per m2 are divided by trawl length. Trawl locations are as follows: 1=Anacostia River, north of Kenilworth; 2=Dueling Creek; 3=Anacostia River, between Dueling Creek and Kenilworth; 4=Kenilworth; 5=Anacostia River, between Kenilworth and Kingman

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Ace rub	0	0	1.0	1.0	0	0	2.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0
Ace sac	1.0	0.6	0	0	0	0	2.0	1.0	0	0	0.0	0.0	0	0	2.8	2.1	0	0
Aln rub	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Aln ser	0	0	0	0	0	0	1.5	0.5	0	0	0.0	0.0	0	0	0	0	0	0
Ama bli	0	0	0	0	0.7	0.3	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Ama can	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
And vir	0	0	0	0	0	0	0	0	0	0	0.1	0.0	0	0	0	0	0	0
Art vul	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Ast sp	0.3	0.3	0	0	0	0	0	0	0	0	0.1	0.0	0	0	0	0	0	0
Bas hys	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
Bet nig	0	0	0	0	0.3	0.3	0	0	0.3	0.3	0.3	0.1	0	0	0	0	0	0
Bid bid	0	0	0	0	0.3	0.3	0	0	1.3	1.3	0.2	0.1	0	0	0	0	0	0
Bid fro	2.7	2.7	2.0	1.0	4.0	2.5	3.0	1.0	6.3	1.9	3.9	0.6	0.1	0.1	1.0	0.6	0	0
Bis sp	3.3	2.4	0.5	0.5	1.7	1.2	5.0	3.0	2.0	1.2	1.5	0.2	0.1	0.1	0	0	0	0
Boe cyl	84.3	68.4	136.5	56.5	82.7	53.5	48.0	14.0	72.3	33.3	9.8	1.2	0.6	0.6	8.5	5.6	0	0
Carex sp	0	0	0.5	0.5	0.7	0.7	1.5	1.5	0	0	0	0	0	0	0	0	0	0
Car pen	0	0	0	0	0.3	0.3	0	0	0	0	0.3	0.1	0	0	0	0	0	0
Car sp1	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Car tri	0.7	0.7	2.0	1.0	1.3	0.9	0	0	4.3	2.2	0.1	0.1	0	0	0.3	0.3	0	0
Cel sca	0.3	0.3	0	0	0	0	0	0	0	0	0.2	0.1	0.4	0.4	0	0	0	0
Cep occ	3.3	3.3	1.0	1.0	4.7	4.2	0	0	2.3	2.3	0.5	0.2	0	0	0	0	0	0
Che amb	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
Cic bul	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Cle aln	0	0	0	0	0	0	0.5	0.5	0	0	0.0	0.0	0	0	0	0	0	0

(continued)

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Cle ter	0.7	0.7	0	0	0	0	0	0	0.3	0.3	0.3	0.1	0	0	0	0	0	0
Compo sp	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0	0	0	0
Con can	0.3	0.3	2.5	1.5	0	0	0	0	1.3	0.3	0.4	0.2	0	0	0.8	0.3	0.4	0.2
Cyp dac	1.7	1.7	0	0	0	0	0	0	0	0	0.1	0.03	0.1	0.1	0	0	0.2	0.2
Cyp A	0.3	0.3	1	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Cyp B	0	0	0	0	0	0	0	0	0	0	0.4	0.2	0	0	1.3	1.3	0	0
Cyp C	0	0	0	0	0	0	0	0	0.7	0.7	0.3	0.2	0.1	0.1	0.3	0.3	0	0
Cyp clump	1.0	1.0	0	0	0	0	0	0	1.7	1.7	0.2	0.1	0.1	0.1	0	0	0	0
Cyp E	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0
Cyper sp	2.3	0.3	0.5	0.5	8.3	4.2	8.0	7.0	1.0	0.6	1.8	0.6	0.1	0.1	5.3	2.1	0	0
Cyp ery	1.0	0.6	0.5	0.5	7.0	3.5	5.5	3.5	12.7	11.7	24.5	4.5	2.6	1.2	0.3	0.3	0	0
Cyp fla	0	0	0	0	5.0	3.6	0	0	11.3	11.3	0.6	0.2	0	0	0	0	0	0
Cyp odo	4.0	2.1	2.5	1.5	8.0	2.6	4.0	3.0	18.3	1.9	6.0	0.8	1.2	0.5	3.0	1.5	0.4	0.4
Cyp str	0.3	0.3	0	0	0	0	0.5	0.5	0.3	0.3	1.0	0.2	0.2	0.1	0.8	0.5	0	0
Dig isc	1.0	1.0	0	0	0	0	0	0	0	0	0.1	0.03	0.1	0.1	0	0	0	0
Dig san	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0	0
Duc ind	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0.3	0.3	0	0
Ech sp	0	0	0.5	0.5	0	0	0.5	0.5	0	0	0.1	0.04	0	0	0	0	0.2	0.2
Ecl pro	3.7	1.5	4.0	0.0	4.3	1.9	13.0	10.0	12.3	2.7	3.2	0.4	0.3	0.2	1.5	0.9	0	0
Ele obt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0	0
Epi col	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2
Eup per	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0	0
Eup rug	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0	0
Eup ser	0	0	0	0	0	0	1.5	1.5	0.3	0.3	0.02	0.02	0	0	0	0	0	0
Fern2	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0
Fra pen	0.3	0.3	4.0	4.0	1.3	0.9	1.0	1.0	0	0	0	0	0	0	0	0	0	0
Hel aut	0	0	0	0	0	0	0	0	0.3	0.3	0.02	0.02	0	0	0	0	0	0
Hib mos	0	0	0	0	0	0	0	0	0.3	0.3	0.05	0.03	0	0	0	0	0	0

(continued)

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Imp cap	0	0	4.5	4.5	0.3	0.3	1.5	0.5	0.7	0.3	0	0	0	0	0	0	0	0
Iri pse	0	0	0	0	0	0	1.5	1.5	0.7	0.7	0.1	0.05	0	0	0.3	0.3	0	0
Jun deb	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun eff	0	0	0	0	0	0	0	0	0	0	0.4	0.4	0.3	0.3	4.0	2.4	0	0
Jun sp	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Jun ten	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	3.0	1.5	0	0
Kyl bre	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0.0	0.0	0	0
Lee ory	4.3	0.7	28.5	26.5	1.7	0.3	8	8	1.3	0.9	0.2	0.1	0	0	0.5	0.5	0	0
Lin dub	0	0	0	0	0.3	0.3	0	0	0	0	0.1	0.1	0	0	14.0	14.0	0.2	0.2
Lir tul	1.7	0.9	0	0	0.3	0.3	6.0	5.0	2.7	2.7	0.1	0.05	0	0	0.3	0.3	0	0
Lol aru	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0	0	0	0
Lon bel	0	0	0	0	0	0	0	0	0	0	0.1	0.05	0	0	0	0	0	0
Lud lep	0	0	0	0	0	0	0	0	0.3	0.3	0.1	0.04	0.12	0.1	0	0	0	0
Lud pal	6.7	3.8	0	0	36.3	26.3	135.0	132.0	20.0	17.0	2.0	0.4	0.6	0.3	1.0	0.7	0.2	0.2
Lud pep	0	0	0	0	0.3	0.3	0	0	0	0	0.1	0.03	0	0	0.3	0.3	0	0
Lyc ame	4.3	2.8	1.5	0.5	3.7	2.2	14.5	3.5	8.3	1.2	0.4	0.1	0	0	0.5	0.5	0	0
Lyc eur	0	0	0	0	0	0	0	0	0.3	0.3	0.03	0.02	0	0	0	0	0	0
Lyc rub	0	0	0	0	0.7	0.3	7.5	5.5	0.3	0.3	0.1	0.1	0	0	0	0	0	0
Lyc sp	0	0	0	0	0	0	0	0	0	0	0.2	0.2	0	0	0	0	0	0
Lyc und	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
Lyc vir	0.7	0.7	0	0	1.7	1.2	2.0	1.0	1.0	1.0	0.3	0.1	0	0	0.3	0.3	0	0
Lyt sal	0.7	0.7	2.0	0.0	0.3	0.3	1.5	0.5	0	0	0.5	0.3	0.1	0.1	0.5	0.3	0	0
Mem pip	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
Mic vim	0	0	0	0	0	0	0	0	0.3	0.3	0.02	0.02	0	0	0	0	0	0
Mik sca	0	0	7.0	7.0	0.7	0.7	5.0	5.0	1.0	0.6	0.05	0.03	0	0	0.3	0.3	0	0
Mim ala	0	0	0	0	0	0	1.0	1.0	0.3	0.3	0.03	0.02	0	0	0	0	0	0
Mim rin	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0	0
Mim sp	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0	0

(continued)

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Mor alb	46.3	46.3	0	0	0	0	0	0	27.0	27.0	0.4	0.1	0.2	0.1	0	0	0	0
Muh sch	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Oen sp	1.0	0.6	0	0	0.3	0.3	0.5	0.5	0	0	0.1	0.0	0	0	0.3	0.3	0	0
Ono sen	0	0	0	0	0	0	0	0	0.3	0.3	0.0	0.0	0	0	0	0	0	0
Oxa str	0	0	0	0	0	0	0	0	0	0	0.1	0.0	0	0	0	0	0	0
Pan dic	0	0	0	0	0	0	0	0	0.7	0.3	0.0	0.0	0	0	0	0	0	0
Pel vir	0	0	0	0	0	0	2.5	2.5	0.3	0.3	0	0	0	0	0	0	0	0
Pen sed	0	0	0	0	0.7	0.3	0	0	0	0	0.1	0.0	0	0	0	0	0	0
Pha aru	2.0	1.0	1.5	0.5	0.7	0.7	0	0	0.3	0.3	0.0	0.0	0	0	0	0	0	0
Phr aus	0	0	0	0	0	0	1.0	1.0	0	0	0	0	0	0	0	0	0	0
Phy ame	0.3	0.3	0	0	0	0	1.5	1.5	0	0	0.0	0.0	0	0	0	0	0	0
Pil pum	1.0	0.6	22.0	20.0	0.7	0.3	1.5	1.5	1.0	0.6	0.1	0.0	0	0	0	0	0	0
Pla maj	0.3	0.3	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Pla occ	0.3	0.3	0.5	0.5	1.3	1.3	1.0	1.0	0.7	0.7	0.9	0.3	0	0	0	0	0	0
Poace sp	0	0	0	0	0.3	0.3	0	0	0	0	0.1	0.0	0.1	0.1	0	0	0	0
Poace spE	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Poace spT	3.0	3.0	1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa pra	0.3	0.3	0	0	0	0	0	0	0.3	0.3	0.4	0.2	0.1	0.1	1.5	0.9	0	0
Pol ari	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pol ces	0.3	0.3	0	0	0.3	0.3	1.0	1.0	0	0	0.0	0.0	0	0	0.5	0.5	0	0
Pol gla	0.3	0.3	0	0	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Pol hyd	0	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0	0.3	0.3	0	0
Pol pen	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Pol per	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0	0
Pol pun	0	0	0.5	0.5	0.3	0.3	6.0	2.0	0	0	0.0	0.0	0	0	0.5	0.5	0	0
Pol sag	0	0	2.0	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pol sp	0.3	0.3	0	0	0.3	0.3	0	0	0	0	0.0	0.0	0	0	0	0	0	0
Pon cor	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0

(continued)

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Pop del	0	0	0	0	1.0	0.6	0	0	0.3	0.3	0.0	0.0	0	0	0	0	0	0
Ran sce	0	0	0	0	0.7	0.7	0	0	0.7	0.7	0.1	0.1	0	0	0.3	0.3	0	0
Rob pse	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	2.3	1.7	0	0
Ror isl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0	0
Ror pal	0.7	0.7	0	0	2.3	2.3	0.5	0.5	3.0	3.0	0.3	0.1	0	0	0	0	1.2	1.2
Ros mul	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0	0
Rum sp	11.0	4.0	3.0	1.0	2.7	1.8	4.0	4.0	3.3	2.0	0.2	0.1	0	0	2.0	2.0	0	0
Rum ver	0	0	0	0	0.3	0.3	0	0	0	0	0.1	0.03	0	0	0	0	0	0
Sag lat	0.3	0.3	0.5	0.5	0.7	0.3	1.5	1.5	2.3	2.3	0.02	0.02	0	0	0	0	0	0
Sal nig	2.0	2.0	0.5	0.5	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0.2	0.2
Sau cer	0	0	0	0	0	0	0	0	0.7	0.3	0.02	0.02	0	0	0	0	0	0
Sch flu	0.7	0.3	1.5	1.5	1.0	1.0	4.5	4.5	1.0	1.0	0.8	0.2	0.1	0.1	0	0	1.4	1.4
Sculat	1.0	1.0	0	0	0	0	0	0	0	0	0.2	0.1	0	0	0	0	0	0
Scu sp	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0	0	0	0
Sen vul	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0	0	0	0
Son asp	0	0	0.5	0.5	0.3	0.3	0	0	0.3	0.3	0.3	0.2	0	0	0	0	0	0
Son ole	0	0	0	0	0	0	0	0	0.3	0.3	0.02	0.02	0	0	0	0	0	0
Sym lan	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0	0	0	0	0	0
Tar off	0.7	0.3	0	0	0	0	0	0	0	0	0.05	0.03	0	0	1.8	1.8	0	0
Tox rad	0	0	0	0	0	0	0	0	0	0	0.05	0.04	0	0	0	0	0	0
Tri cam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0	0
Tri vir	0	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0	0
Typ spp	10.3	10.3	1.5	0.5	0.3	0.3	28.5	28.5	3.3	2.8	0.0	0.0	0	0	0	0	0	0
UK bud	0	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0	0
UK DI	0.7	0.7	1.0	0.0	1.0	0.6	0.5	0.5	1.0	1.0	0.3	0.1	0.2	0.1	1.8	0.8	0.4	0.4
UK DI C	0.7	0.7	0	0	0	0	0	0	0.7	0.7	0.5	0.4	0.2	0.2	0	0	0	0
UK DI S	0	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0	0	0	0	0
UK MO	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0.3	0.3	0	0

(continued)

	Trawl locations										Water		Wind		Debris		Goose	
	1		2		3		4		5									
Species	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
UK WO E	0	0	0	0	0	0	0	0	0.3	0.3	0.0	0.0	0.1	0.1	0	0	0	0
UK WO	0.3	0.3	0	0	0	0	0	0	0.3	0.3	0.1	0.0	0	0	0	0	0	0
UK WO B	1.3	1.3	0	0	0	0	2	2	0	0	0.0	0.0	0	0	0	0	0	0
Ulm rub	0	0	0	0	0	0	0	0	0	0	0.4	0.1	0	0	11.3	10.6	0	0
Wis sin	0	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0	0.3	0.3	0	0
density/ sample	62.4	32.2	114.3	39.4	41.2	32.2	167.2	30.39	77.2	32.1	63.6	32.2	7.52	39	74.8	55.7	5.2	56
total area (m2)	355		85		481		208		316		0.1		0.1		NA		NA	
seeds/m2	0.1	0.24	1.3	0.3	0.1	0.24	0.8	0.3	0.2	0.2	526	39	62	76	NA		NA	
richness/ density	0.1	0.12	0.1	0.15	0.2	0.12	0.1	0.15	0.1	0.1	0.3	0.03	0.6	0.1	0.3	0.1	0.6	0.1
total spp	49		32		46		45		60		105		24		40		11	