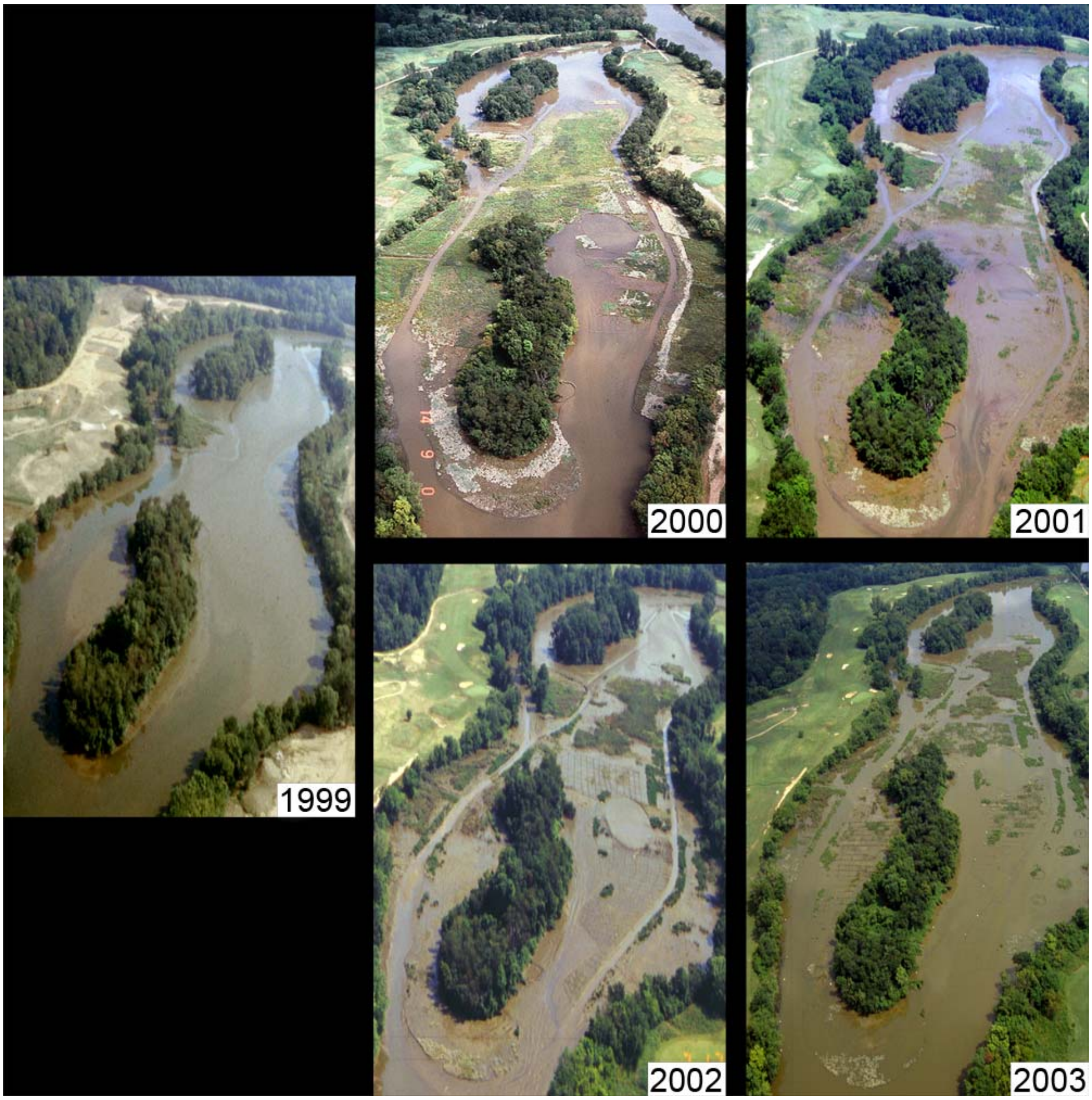
# Year 4 (2003) Annual Report
# For the Kingman Monitoring Project

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# Fourth Year Annual Report (2003) for the Kingman Marsh Vegetation Monitoring Project

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# Fourth Year Annual Report (2003) for the Kingman Marsh Vegetation Monitoring Project

## Introduction

The fourth year post-reconstruction (2003) reflected the continued impact to the marsh restoration likely as a result of excessive goose grazing and low sediment elevation. The replanting of portions of Kingman Areas 1 and 2 with *Peltandra virginica* and *Schoenoplectus tabernaemontani* in 2002 did result in some vegetation restoration; however, in Kingman Area 2 the S. *tabernaemontani* did not survive whether in the replanted areas or areas that had established plants from the original plantings. There was no evidence for grazing as a cause for this species collapse so low elevation remains as a suspect cause.

In addition, observations (not documented as a factor in our studies) indicated very poor seedling regeneration in 2003, this despite a seemingly normal sandbank reported by Kristen Russello (University of Maryland). Poor seedling regeneration could ultimately mean continued decline of the marsh, since it has no way to regenerate other than by vegetative expansion by some perennials, or replanting. There seems to be a correlation as to where some seedlings are found and sediment elevation with almost all seedlings found at the uppermost elevations near mean high tide. Additional speculation suggests that 2003 being an extremely wet year, water levels may have been above average, which in effect would cause longer periods of inundation thereby reducing seed germination. However, initial analysis of water levels from the hydrologgers did not show significant water level increase in 2003 from 2002 an extremely dry year (Dr. Andy Baldwin and Kristen Russello, University of Maryland).

Following in our report will be the results from our monitoring effort in 2003. The bottom line seems to be continued decline in cover and number of species per unit area, but not significantly different from 2002. As in previous years results from Kingman Marsh will be compared to Kenilworth Marsh (reconstructed seven years prior in 1993), Dueling Creek (a non-reconstructed wetland remaining in the urbanized Anacostia) and Patuxent Marsh (a non-reconstructed marsh in a fairly undisturbed watershed nearby). The values of these reference sites for comparisons are partially offset since Kenilworth Marsh has been treated with herbicide to reduce common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*), while several of the transects at Patuxent came under the influence of an extensive beaver dam.

## 1. Total Vegetative Cover

Repeated measures analysis of variance indicates that Kingman and the comparison wetland sites are behaving differently over time with respect to total vegetative cover (Table 1). The specifics as to where differences occur over the four-year period of the study as well as within each sampling period including the two sampling periods represented for 2003 follow.

Significant differences were determined using Tukey tests. In the following graphs upper case letters are used to display significant year-to-year differences. Looking across the graph from year to year for the same site and sampling period, means that do not contain the same upper case letter differ significantly. Lower case letters are used to display significant differences between sites within a given sampling event. Looking at the column of points associated with a given sampling event, means that are not labeled with the same lower case letter indicate a significant difference between sites within the sampling event. Where no significant differences exist within the sampling event, or from year to year for a particular site and sampling period, no letters are displayed.

Total vegetative cover at Kingman Area 1 continued its decline in 2003, decreasing from 44.0 ± 8.4% in September 2002 to 23.5 ± 8.4% in September 2003 (Fig. 1a). Although the decrease from 2002 to 2003 was not statistically significant, September 2003 cover levels do represent a statistically significant decline with respect to both 2000 and 2001. Cover at Kingman Area 2 saw a smaller decrease in 2003, declining from 31.3 ± 19.2 % in September 2002, to 26.8 ± 19.2 % in September 2003. September 2003 values were significantly lower than values from 2000, but not lower than values from 2001 or 2002. The decline in total vegetative cover over time observed at both Kingman sites is thought to result from goose grazing and insufficient sediment elevation to sustain vegetative growth.

The comparison wetland sites have exhibited no statistically significant year-to-year differences in total vegetative cover during the 2000 through 2003 timeframe (Fig.1a). The sharp drop in cover at Kenilworth Mass Fill 1 in September 2001, although not statistically significant, reflects the herbicide treatment of *Phragmites* earlier in the growing season.

Total vegetative cover at the comparison wetlands remained high in 2003, averaging 96.8 ± 11.4 % for Patuxent and 96.7 ± 12.1 % for Kenilworth Mass Fill 2. These values are significantly greater than the corresponding values for Kingman Area 1 (Fig, 1b). Values for Dueling Creek, Kenilworth Mass Fill 1, and Kingman Area 2 fell in between and showed no statistically significant between-treatment differences.

**2. Species Richness**

Species richness is used as a measure of the number of species per sector. Results of the repeated measures analysis of variance (Table 1) indicate that Kingman and the comparison wetlands are behaving differently over time with respect to species richness.

The number of species observed per sector at Kingman remained low in 2003 (Fig. 2a). By September 2003 the number of species observed in each sector averaged just 2.0 ± 1.0 at Kingman Area 1, and 1.5 ± 1.8 at Kingman Area 2. These values do not represent a significant decline with respect to values from 2001 or 2002, but they do represent a significant change from the values of 11.7 ± 1.0 and 12.5 ± 1.8 observed at Kingman Areas 1 and 2, respectively, in September 2000.

Among the comparison wetlands, only Kenilworth Mass Fill 1 has exhibited any statistically significant year-to-year differences in species richness during the 2000 through 2003-time period (Fig. 2a), with a significant decline to 4.1 ± 1.5 in September 2001 following herbicide treatment targeted at *Phragmites*. By September 2003, species richness at Mass Fill 1 had rebounded to 7.0 ± 1.5. Species richness at Patuxent was somewhat lower in 2003 than in previous years, probably reflecting a reduction in seed germination and presence of annuals as a result of beaver activity and increased flooding. This decline was not statistically significant.

Although species richness values have tended to be lower at Kingman than at Patuxent and Dueling Creek (the non-reconstructed wetlands), statistically significant differences among treatments within a sampling event were limited to the July 2002 sampling event, when species richness was significantly greater at Patuxent than at Kingman Area 1 (Fig. 2b).

**3. Diversity**

Diversity is a concept that incorporates both species richness and the evenness of distribution of those species. Repeated measures analysis of variance indicates that Kingman and the comparison wetlands are behaving differently over time with respect to diversity (Table 1).

Diversity remained low at Kingman Areas 1 and 2 in 2003, with values for the Shannon Index significantly lower in 2003 than in 2000 (Fig. 3a). Diversity at the comparison wetlands showed no statistically significant year-to-year differences during 2000 through 2003. Likewise, there were no statistically significant differences between treatments within sampling events for 2003, although the values suggest that diversity was lower at Kingman than at the comparison wetlands (Fig. 3b).

**4. Cover by Species**

The most prevalent 'cover type' at Kingman in 2003 was 'No Cover,' averaging 75 ± 4% for Kingman Area 1 and 70 ± 6 % for Area 2. At Kingman Area 1 (Fig. 4a), green arrow arum (*Peltandra virginica*) and purple loosestrife, at 9 ± 2% and 6 ± 2%, respectively, were the only plant species that met the 5 % cover required for status as a dominant (as defined in 2000). None of the three species that qualified as dominants in Year 1 (marsh seedbox, *Ludwigia palustris*; black willow, *Salix nigra;* and pickerelweed, *Pontedaria cordata*) remained as dominants in 2003. Of the seven planted species, only the unpalatable *P. virginica* that grows at relatively low sediment elevations provided more than 5% cover and a small portion of that can be attributed to replanting.

At Kingman Area 2, only two species qualified as dominants in 2003: cattail (*Typha latifolia*) and green arrow arum, with 16 ± 7 % and 8 ± 5 %, respectively (Fig. 4b). The increase in cover by green arrow arum can be attributed to the replanting of this species in 2002. Seven species that qualified as dominants at Kingman Area 2 in 2000 were no longer dominants in 2003. These species consisted of: pickerelweed, softstem bulrush (*Schoenoplectus tabernaemontani*), marsh seedbox, fall panicgrass (*Panicum dichotomiflorum*), redroot flatsedge (*Cyperus erythrorhizos*), broadleaf arrowhead

(*Sagittaria latifolia*), and blunt spikerush (*Eleocharis obtusa*). Of the seven planted species, only arrow arum contributed more than 5% cover in 2003 and *Schoenoplectus pungens* seems to have disappeared altogether from the transects.

We took a closer look at the pattern of cover by *S. tabernaemontani* at Kingman Area 2, which is a planted species, because we were surprised to see it disappear from there in 2003. Clearly the planted plants established well in 2001, the year following planting, but declined thereafter even though there was some replanting in 2002 (Fig. 5). Field observations did not support goose grazing as a cause (in fact, *S. tabernaemontani* was selected for replanting since it does not seem to be preferred by geese) leaving some other factor, such as duration of inundation as a probable cause.

Cover by dominant species was considerably greater in the comparison wetlands than at Kingman. At Kenilworth Mass Fill 1, where total vegetative cover had rebounded to 94 ± 17% by September 2003 (compared to 33 ± 17% in September 2001, following herbicide treatment), four species qualified as dominants in 2003 (Fig. 4c). These species consisted of rice cutgrass (*Leersia oryzoides*), narrowleaf cattail (*Typha angustifolia*), reed canarygrass (*Phalaris arundinacea*), and green arrow arum. Among the 2000/2003 comparisons, two stand out. *Phragmites* decreased sharply from 2000 to 2003 reflecting herbicide treatment, while *Peltandra* increased sharply, no doubt due at least in part to reduced competition from the *Phragmites*.

At Kenilworth Mass Fill 2, where herbicide treatments were not yet showing an effect in 2003, total vegetative cover remained high (97 ± 12 % in September 2003). *Phragmites*, rice cutgrass, river bulrush (*Schoenoplectus fluviatilis*), green arrow arum, and cattails qualified as dominants at Mass Fill 2 in 2003 (Fig. 4d).

Rice cutgrass, green arrow arum, dotted smartweed (*Polygonum punctatum*), and halberdleaf tearthumb (*Polygonum arifolium*) comprised the dominants at Dueling Creek in 2003 (Fig. 4e), where total vegetative cover remained fairly high (86 ± 15 % in September 2003).

Six species qualified as dominants at Patuxent in 2003: green arrow arum, H*ydrilla* (*Hydrilla verticillata*), yellow pond-lily (*Nuphar lutea*), sweet flag (*Acorus calamus*), halberdleaf tearthumb, and broadleaf cattail (Fig. 4f). Beaver dam influence is reflected in the sharp increases in 'No Cover,' as well as cover by green arrow arum, H*ydrilla*, and cattail, all perennials. The three annuals present as dominants in 2000 declined sharply by 2003, also as a result of the beaver dam influence. These annuals consisted of the halberdleaf and arrowleaf tearthumbs, as well as impatiens (*Impatiens capensis*).

**5. Cover by Annuals**

Vegetative cover by annuals[1] at Kingman Area 1 declined significantly after Year 1, when it averaged 24 ± 4 % in September 2000; by September 2003 cover by annuals still showed no signs of recovery at Kingman Area 1, averaging only 1 ± 4 % (Fig. 6a). Kingman Area 2 underwent a similar decline in cover by annuals after Year 1, though in

[1] The USDA PLANTS database (USDA, NRCS, 2004) was used to categorize species' duration.

this case the decline was not statistically significant. It is important to note the almost total lack of contribution by annuals at either Kingman site after 2000. Even though any annuals there would be volunteers, it is still striking as to how strong the combined influence of grazing and low sediment elevation must be. No statistically significant year-to-year differences were observed in the comparison wetlands at Kenilworth Marsh or Dueling Creek.

The most striking aspect of the graph of cover by annuals (Fig. 6a) occurred at Patuxent, where cover by annuals decreased significantly from 77 ± 6% in September 2002 to 15 ± 6% in September 2003. This can be directly attributed to the construction of an extensive beaver dam in 2002. It appears that prior to the beaver dam construction, annuals were able to flourish in the conditions at Patuxent, even though hydrologger data identified a hydrologic regime at Patuxent consistent with low marsh conditions (Neff, 2002). The decrease in cover by annuals at Patuxent in 2003 suggests that the increased inundation has pushed the annuals past the level at which they can flourish.

Taking a closer look at specific transects at Patuxent (Fig. 7), we can see that Transects 2, 3, 4 and 6, which were flooded by the beaver dam, have exhibited significant drops in cover by annuals. The effect of flooding or long periods of inundation is to thwart seed germination, an effect that is strongly reflected by suppressed growth of annuals (being seed dependent each year as opposed to perennials). This point is important at Patuxent, but should also be kept in mind in the context of Kingman, where lower elevations likely limit contribution from the seed bank and further thwart regeneration following goose grazing.

Cover by annuals in Patuxent's Transect 1, which is located on the opposite side of Route 4 from the beaver dam, exhibited a significant decline in July 2003, perhaps due to the generally wet year, but was able to rebound by September 2003 (Fig. 7). Transect 5, which is below the beaver dam, has seen relatively high inundation and low cover by annuals throughout the course of the monitoring, and does not appear to have been significantly impacted by the beaver dam.

Another interesting aspect of the graph of cover by annuals is the comparison between treatments within any given sampling event. Figure 6b illustrates that, until construction of the beaver dam in 2003, cover by annuals was significantly greater at Patuxent than at the wetlands reconstructed at Kingman, with the other comparison wetlands falling in between, and not differing significantly from Patuxent or Kingman. During 2003, with the conditions in most of Patuxent's transects no longer favorable towards annuals, cover by annuals decreased to levels more comparable to those at the other comparison wetlands. Not surprisingly, then, there were no significant differences between treatments within the July or September 2003 sampling events.

## 6. Cover by Perennials

Relative cover by perennials (as a proportion of the total cover) remained stable at all sites during 2003 except at Patuxent, where the relative cover by perennials increased from 34 ± 8% in September 2002 to 86 ± 8% in September 2003, as a result of beaver dam activity (Fig. 8a). Absolute cover by perennials (Fig. 9a) also increased significantly at Patuxent from September 2002, when its mean was 44 ± 13%, to September 2003, with a mean of 81 ± 13%.

Absolute cover also showed a significant decrease at Kingman Area 1, from 64 ± 8% in September 2001 to 23 ± 8% in September 2003. The lack of a corresponding decrease in relative cover of perennials in 2003 (Fig. 8a) shows that although the relative cover was decreasing, as a reflection of the decrease in total cover, perennials played a consistently strong role for the vegetation remaining at Kingman Area 1 during the 2003 timeframe.

Kenilworth Mass Fill 2 showed a sharp, but not statistically significant drop in absolute cover by perennials in September 2001, as a result of spraying for *Phragmites* (Fig. 9a). Subsequent years have seen a rapid recovery at Mass Fill 2, as other perennials, released from competition with *Phragmites*, have increased in absolute cover. Relative cover by perennials at Mass Fill 2 did not show a corresponding drop in September 2001, indicating that although cover was reduced dramatically as a result of spraying, what was left was largely perennials (Fig. 8a).

In terms of differences between sites within a given sampling event, relative cover by perennials was consistently greater at Kingman Area 1 than at Patuxent, the natural reference site (Fig. 8b). In 2003, when relative cover by perennials increased at Patuxent as a result of the beaver dam activity, there were no significant differences between sites. Absolute cover of perennials showed few statistically significant differences between sites within sampling events, providing limited evidence for greater cover by perennials at Kenilworth Mass Fill 2 than at Kingman Area 1 (Fig. 9b).

**7. Cover by Exotics**

Cover contributed by exotics[2] has generally been characterized by high variability and little in the way of statistically significant trends (Fig.10). The only statistically significant trend over time has been a small increase in cover by exotics at Kingman Area 1, reflecting increases in cover by the non-native *Phragmites* and purple loosestrife, which survive at the higher elevations and are not eaten by geese. Other trends over time may reflect interesting phenomena, such as a decrease at Kenilworth Mass Fill 1 in September 2001 as a result of targeted spray of *Phragmites*, or an increase at Patuxent in 2003 with increased *Hydrilla* as a result of the beaver dam, but they are not statistically significant.

None of the differences among areas within a sampling event are statistically significant, although there are some suggestions that cover by exotics is typically higher at Kenilworth (due to *Phragmites*, purple loosestrife, reed canary grass and narrow-leaved cattail) than at the more natural Patuxent and Dueling Creek. This finding reinforces the choice of Dueling Creek as a comparison site, showing it isn't so disturbed at this time that it invites exotics.

[2] The USDA PLANTS database (USDA, NRCS, 2004) was used to categorize species' origin.

**8. Sørenson's Similarity Matrix**
Sørenson's similarity coefficients reflect some of the changes that have occurred in species composition between 2000 and 2003 (Table 2). Although based on presence/absence rather than quantitative data, the coefficients do provide some additional insight into the changes that have taken place. Comparison of the matrices for 2000 and 2003 indicate that from the presence/absence standpoint, Kingman Area 1 has become more similar to all of the comparison sites than it was in 2000. This is not too surprising, since many of the species present during the first year of construction at Kingman were weedy pioneer species that would not be expected to persist long-term in a freshwater tidal wetland. Species composition at Kingman Area 2 also seems to have become more similar to that of the comparison sites, though less dramatically than for Area 1.

**Surface Elevation Tables (SETs)**
The Surface Elevation Tables (SETs) installed at Kingman and Kenilworth in October 2002 have produced preliminary data regarding accretion and subsidence at these sites. The data have not yet been analyzed statistically, but are being provided here as preliminary results.

The SET data from Kingman indicate that during 2003, elevation at Kingman decreased an average of 6.16 ± 13.06 mm as measured in March 2003, but then increased to 13.73 ± 8.21 mm above the original baseline by October 2003 (Fig. 11a).[3] During the same timeframe, accretion at the site, as measured by amount of deposition on the feldspar markers located at each SET, increased steadily, averaging 53.07 ± 14.31 mm in October 2003. The amount of consolidation/subsidence at the five SET locations at Kingman averaged 39.34 mm in October 2003 (i.e., the difference between the sediment deposited on the feldspar markers and the overall elevation changes measured by the SET apparatus).

Kenilworth experienced increases in both elevation and accretion during this timeframe, accompanied by consolidation/subsidence (Fig. 11b). By October 2003, elevation, as measured by the five SETs located at Kenilworth, had increased an average of 10.97 ± 7.84 mm. Accretion, the amount of deposition on the feldspar marker horizon, measured 40.57 ± 12.96 mm in Ocotber 2003. Consolidation/subsidence (accretion minus the overall change in elevation) measured 29.60 mm.

Although from the statistical standpoint it is preferable to look at the data at the site level, with replication resulting from having five SETs at each site, data from individual SETs can provide useful insights into what is happening at a finer scale. Figures 12 and 13 graph data from the individual SETs located at Kingman and Kenilworth, respectively. Figure 12 indicates that four of the five SETs located at Kingman experienced increases in overall elevation and accretion during 2003. SET 3, with an original baseline elevation

[3] Although the initial 2004 data are included in the SET graphs, their discussion will be reserved for the 2004 report.

of 1.71' NGVD (National Geodetic Vertical Datum) '29, experienced a 61.17 mm increase in overall elevation as measured with the SET apparatus in October 2003. Accretion of 95.50 mm of sediment was measured on the feldspar markers at SET 3 during the same sampling event, revealing that SET 3 had also experienced 34.33 mm of consolidation. At the other end of the spectrum, SET 1, with a comparable baseline of 1.68' NGVD '29, experienced considerable scouring, with a decrease in overall elevation and obliteration of the feldspar marker horizon after March 2003. By October 2003, overall elevation at SET 1, measured with the SET apparatus, reflected a decrease of 52.84 mm with respect to the original baseline. It was not possible to measure consolidation, since the feldspar marker was lost to scouring.

At Kenilworth, the greatest changes in elevation and accretion were recorded for SET 3, which had an original baseline of 2.5' NGVD '29 (Fig. 13). In October of 2003 overall elevation for SET 3 measured an increase of 45.53 mm, accretion measured 89.33 mm, and consolidation is calculated as 43.80 mm. At Kenilworth the opposite end of the spectrum is represented by SET 2 (original baseline of 2.1' NVGD '29). SET 2 saw a net loss of 20.14 mm of overall elevation by October 2003, accompanied by an accretion of 14.67 mm. Consolidation is calculated at 34.81 mm.

In conclusion, the SET and feldspar data indicate a general pattern of accretion accompanied by some consolidation at both Kingman and Kenilworth during 2003, although data from the individual SETs show that this was not the case at all of the SET locations.

**References**

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA

Kneff, Kelly. 2002. Plant colonization and vegetative change at a restored tidal freshwater wetland in Washington, D.C. University of Maryland. M.S. Thesis

# Tables

**Table 1. Repeated Measures Analysis of Variance table of vegetative parameters for all areas for 2000 through 2003.**
Significance noted as * (<0.05); ** (<0.01); *** (<0.001); **** (<0.0001). Expression written:
Fvalue (Numerator df, Denominator df).

| | Area | Year | Area x Year | Month(Year) | Area x Month(Year) |
|---|---|---|---|---|---|
| **Cover** | 11.88****(5,27.43) | 6.04**(3,62.97) | 3.72****(15,68.07) | 5.48***(4,62.91) | 4.38****(20,70.81) |
| **Species Richness** | 1.89(5,27.35) | 79.08****(3,85.95) | 19.74****(15,71.28) | 2.56*(4,85.79) | 2.56***(20,74.29) |
| **Diversity** | 3.62*(5,27.01) | 62.62****(3,72.58) | 15.41****(15,69.05) | 3.19*(4,74.14) | 3.17***(20,71.80) |
| **Annuals** | 13.41****(5,30.63) | 25.21****(3,197.63) | 13.21****(15,197.19) | 4.41**(4,197.59) | 1.31(20,197.09) |
| **Perennials** | 4.36**(5,29.49) | 2.04(3,71.61) | 4.00****(15,65.67) | 4.10**(4,71.55) | 4.03****(20,68.22) |
| **Exotics** | 3.12*(5,29.86) | 0.77(3,24.94) | 2.99***(15,73.99) | 0.35(4,24.93) | 1.38(20,77.18) |

**Table 2. Sørenson's Similarity Matrix**

**(a) 2000**

| | Kingman Area 1 | Kingman Area 2 | Kenilworth MF1 | Kenilworth MF2 | Dueling Creek | Patuxent |
|---|---|---|---|---|---|---|
| **Kingman Area 1** | 1 | 0.63 | 0.23 | 0.32 | 0.26 | 0.28 |
| **Kingman Area 2** | | 1 | 0.21 | 0.28 | 0.26 | 0.22 |
| **Kenilworth MF1** | | | 1 | 0.53 | 0.71 | 0.33 |
| **Kenilworth MF2** | | | | 1 | 0.61 | 0.35 |
| **Dueling Creek** | | | | | 1 | 0.46 |
| **Patuxent** | | | | | | 1 |

**(b) 2003**

| | Kingman Area 1 | Kingman Area 2 | Kenilworth MF1 | Kenilworth MF2 | Dueling Creek | Patuxent |
|---|---|---|---|---|---|---|
| **Kingman Area 1** | 1 | 0.55 | 0.57 | 0.54 | 0.44 | 0.54 |
| **Kingman Area 2** | | 1 | 0.39 | 0.47 | 0.35 | 0.35 |
| **Kenilworth MF1** | | | 1 | 0.48 | 0.50 | 0.41 |
| **Kenilworth MF2** | | | | 1 | 0.54 | 0.43 |
| **Dueling Creek** | | | | | 1 | 0.51 |
| **Patuxent** | | | | | | 1 |

# Figures

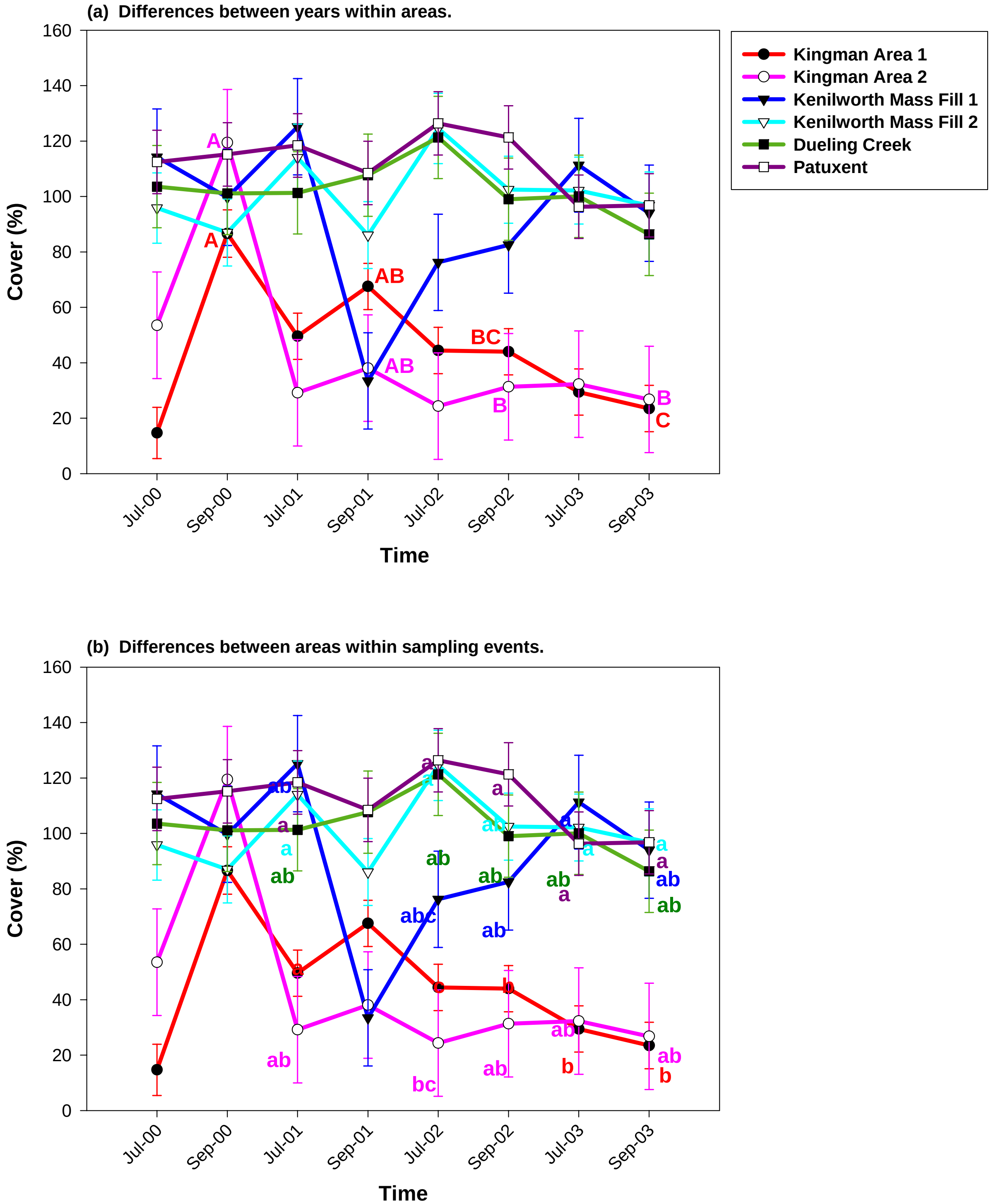



**Figure 1. Total vegetative cover of areas over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha$ = 0.05). Within areas (Fig. 1a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 1b), means sharing the same lower-case letters are not significantly different. Unlabeled series have no significant differences.

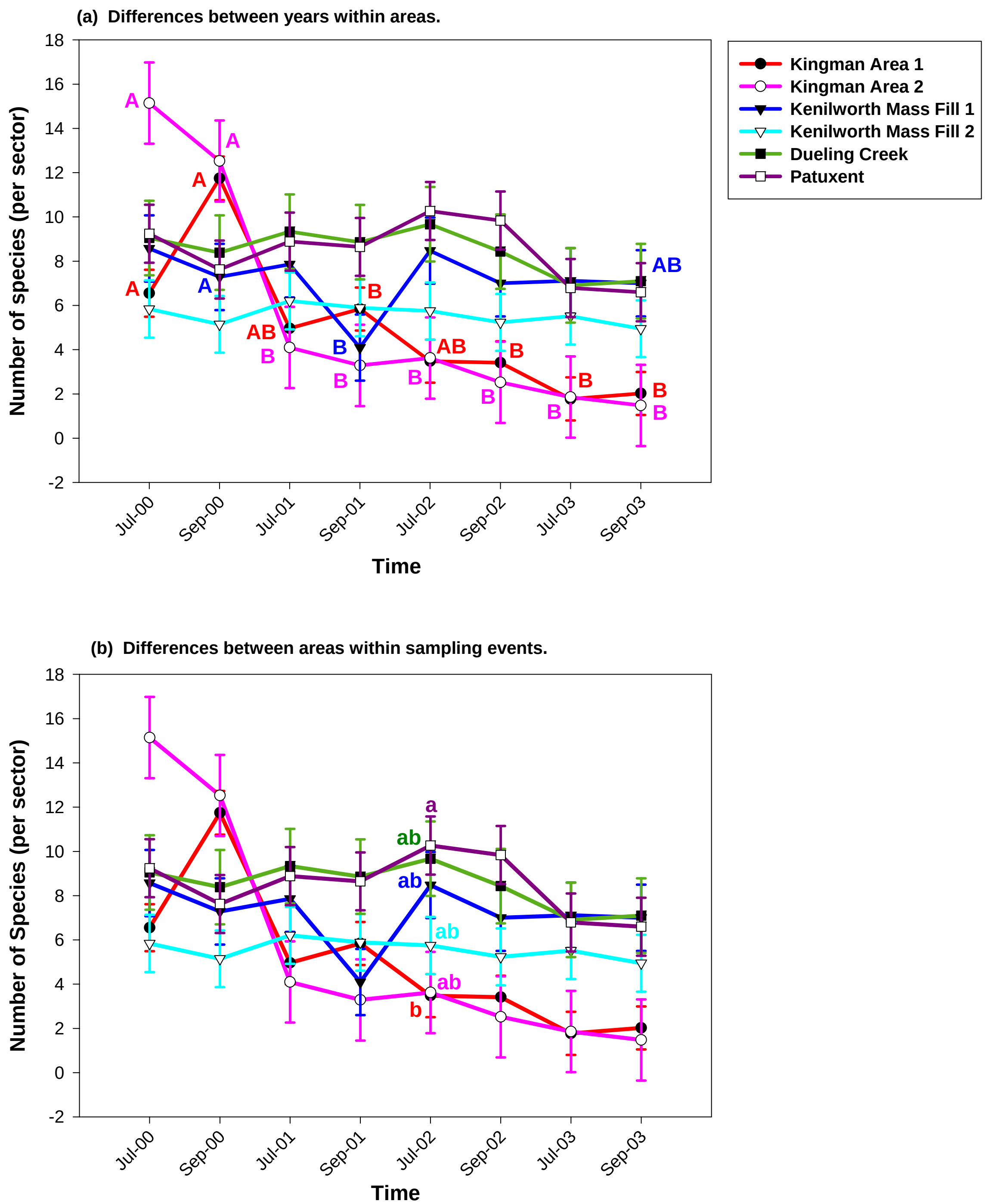



**Figure 2. Species richness of areas over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas (Fig. 2a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 2b), means sharing the same lower-case letters are not significantly different. Unlabeled series have no significant differences.

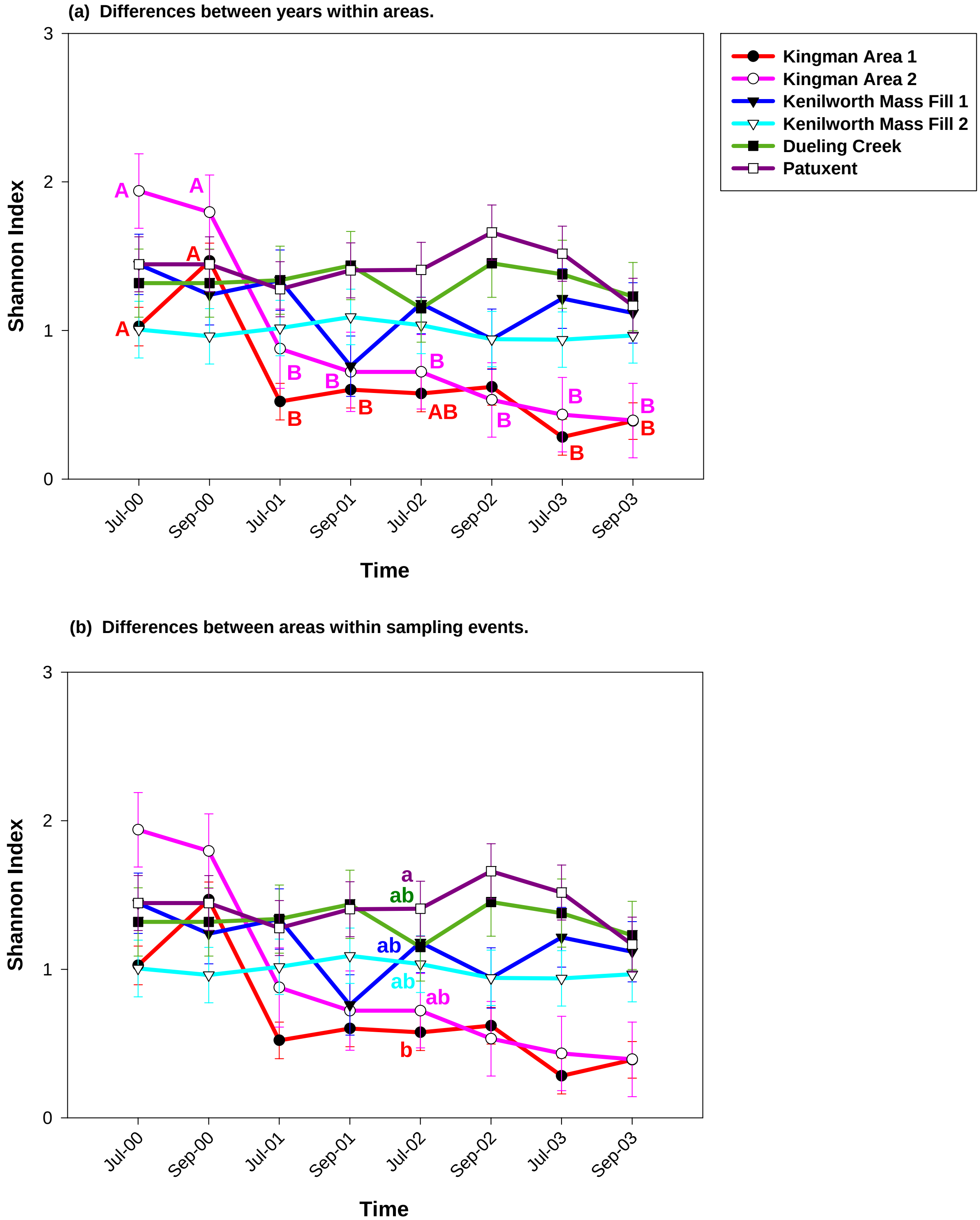



**Figure 3. Diversity of areas over time.**
The Shannon Index was used as an indicator of diversity. Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas (Fig. 3a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 3b), means sharing the same lower-case letters are not significantly different.

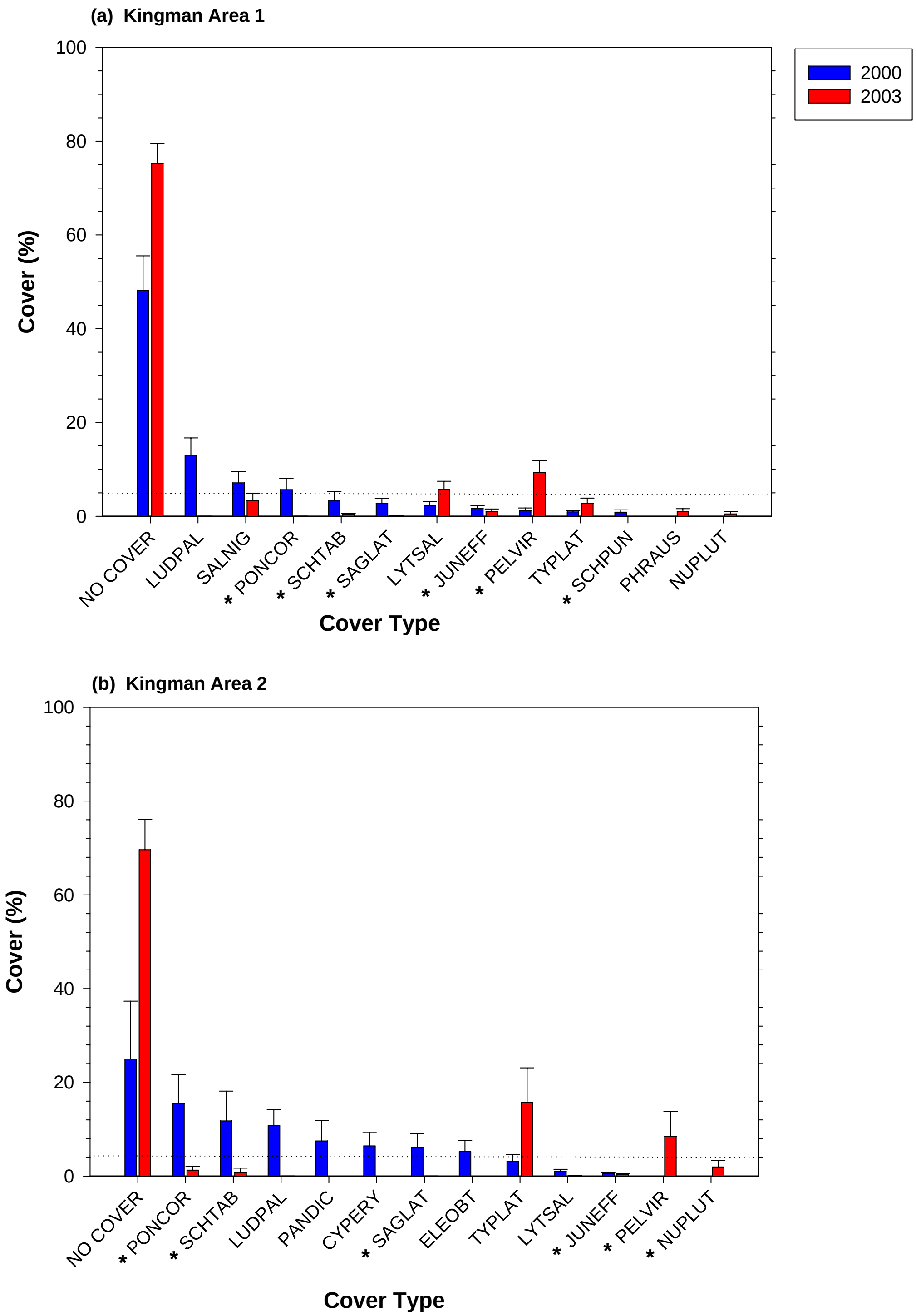
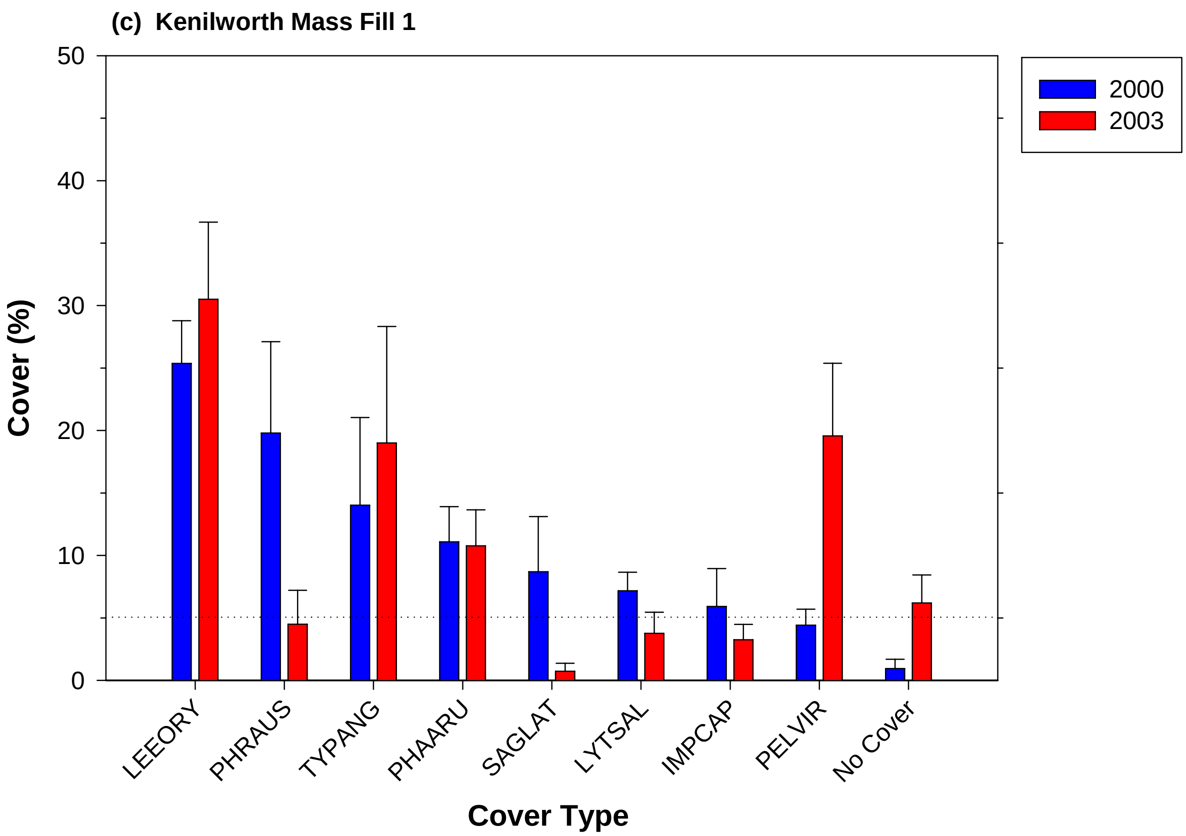
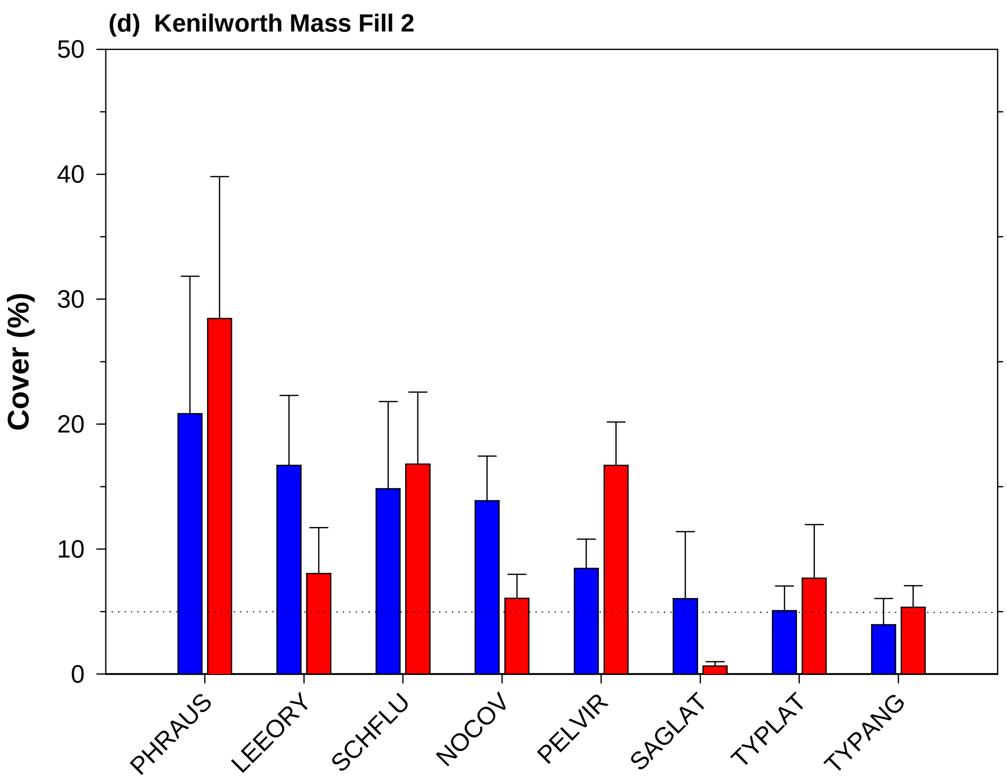
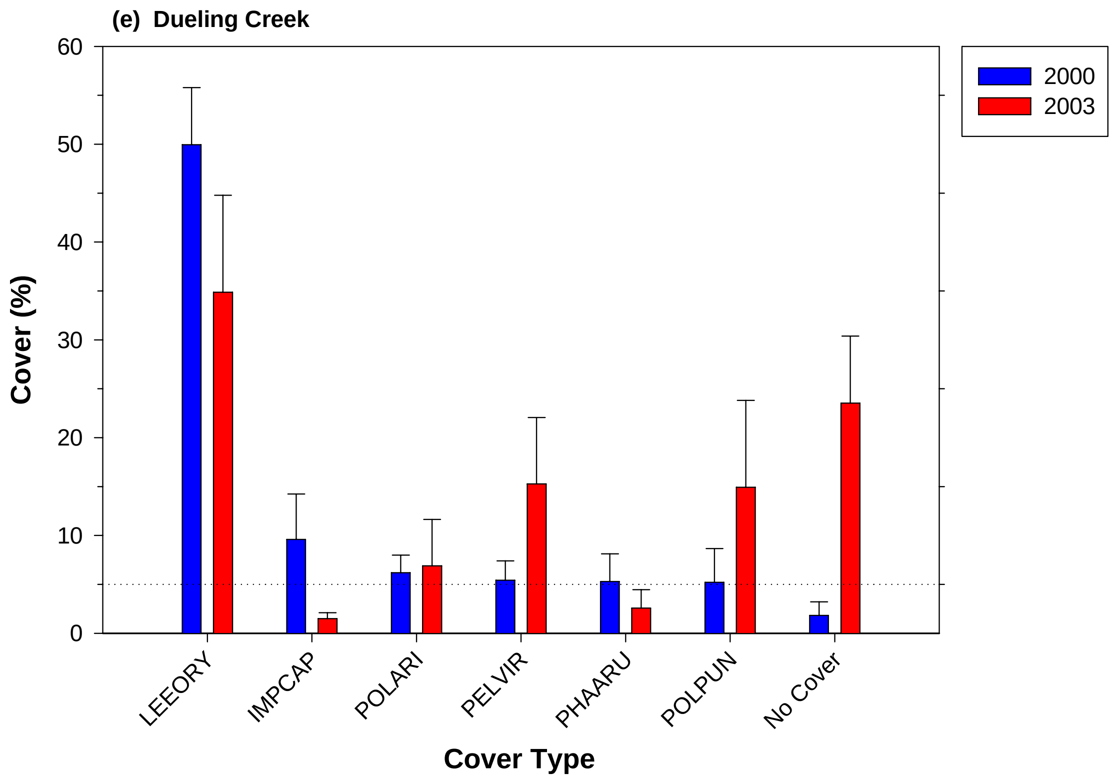



**Figure 4. Cover by species.**
Data points represent means ± 1SE based on data from July and September of each year.
Species shown consist of dominant species (with an annual mean ≥ 5%), species planted at Kingman (*), and species of specieal concern *(Lythrum salicaria, Phragmites australis,* and *Typha* spp.)


(c) Kenilworth Mass Fill 1
2000
2003
Cover (%)
0
10
20
30
40
50
LEEORY
PHRAUS
TYPANG
PHAARU
SAGLAT
LYTSAL
IMPCAP
PELVIR
No Cover
Cover Type


(d) Kenilworth Mass Fill 2
Cover (%)
0
10
20
30
40
50
PHRAUS
LEEORY
SCHFLU
NOCOV
PELVIR
SAGLAT
TYPLAT
TYPANG


(e) Dueling Creek
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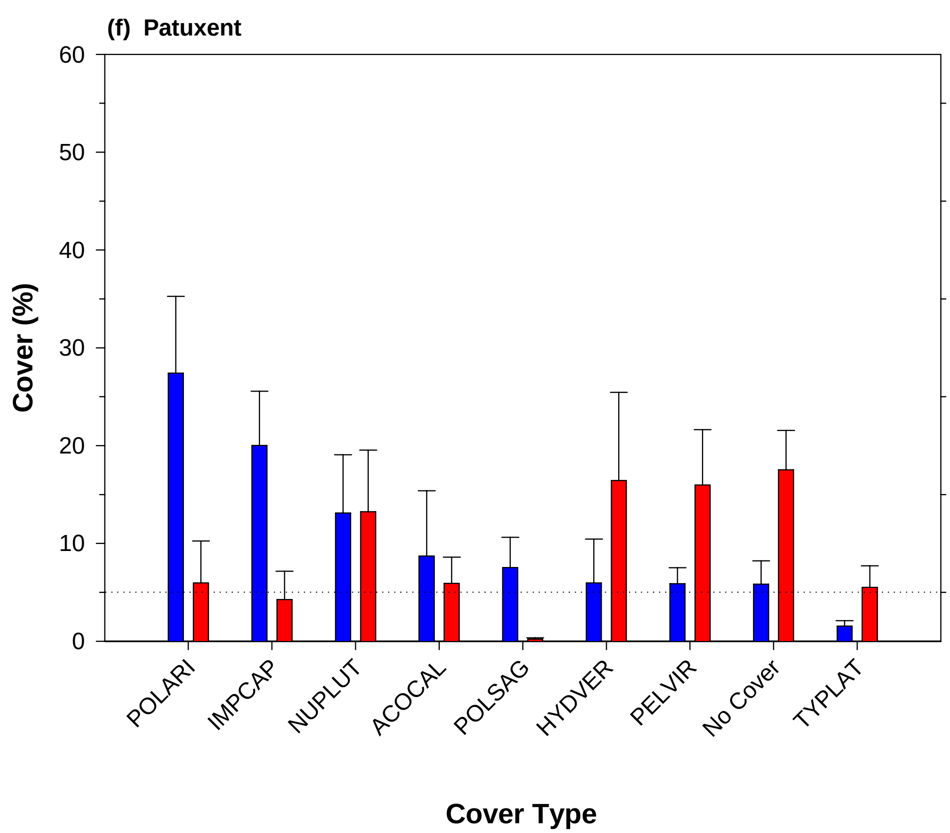
(f) Patuxent
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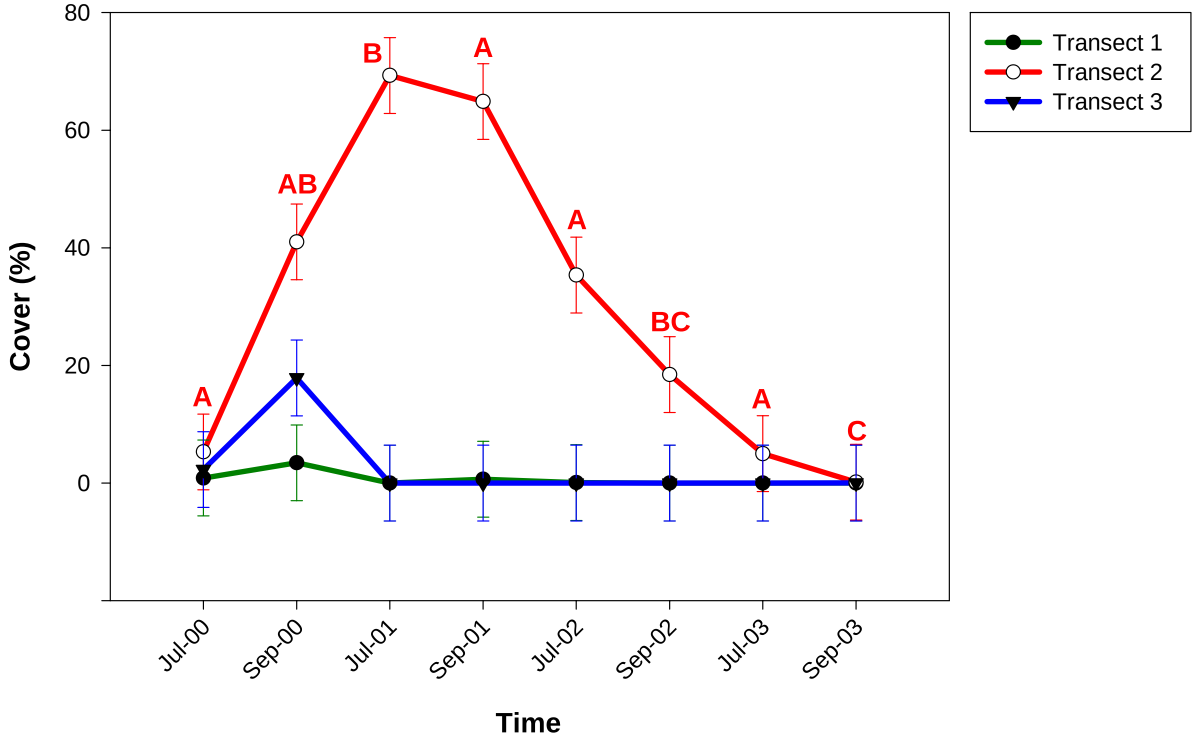



**Figure 5. Cover by *Schoenoplectus tabernaemontani* at Kingman Area 2 over time.** Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within transects, means sharing the same upper-case letters are not significantly different from year to year. Transects lacking labels had no significant year-to-year differences.

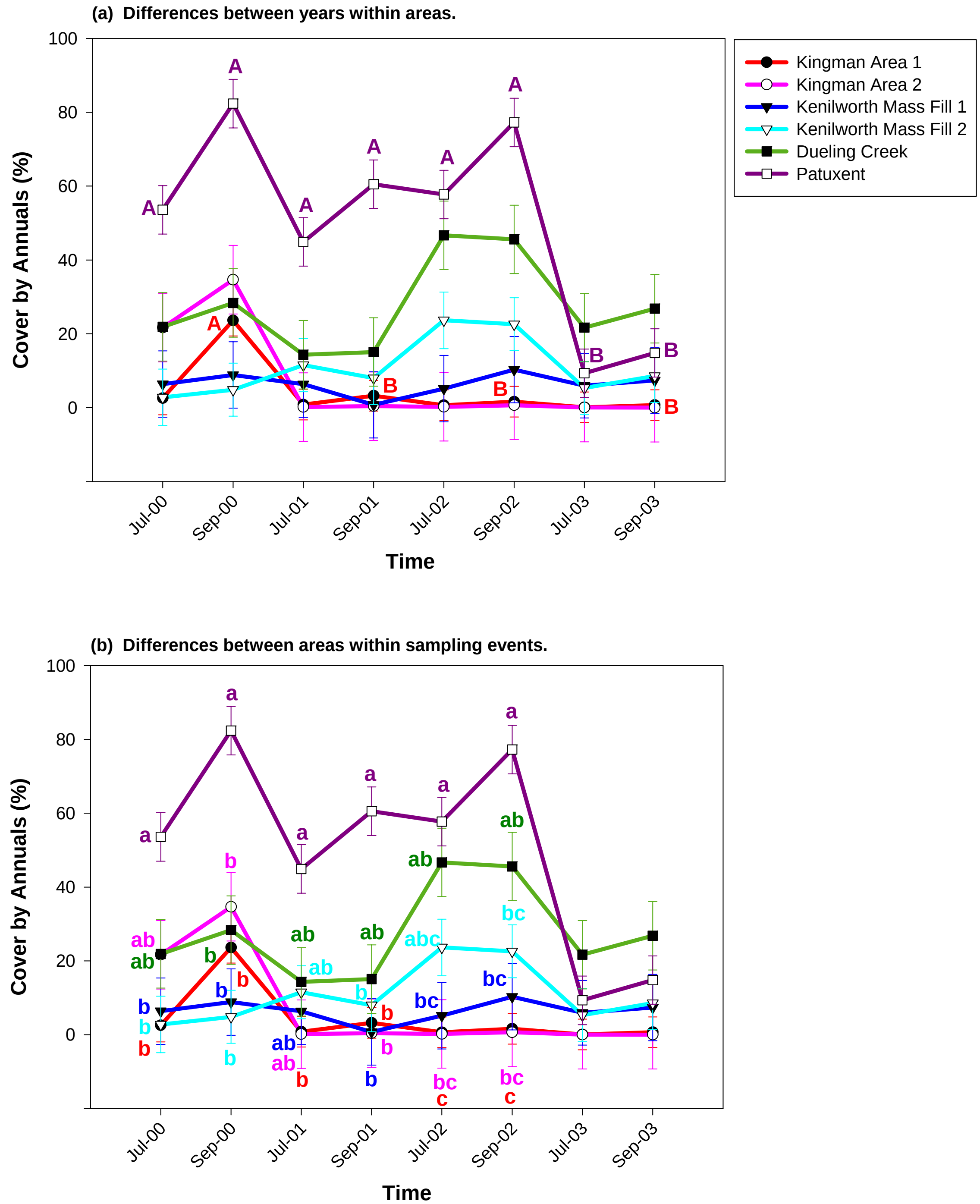



**Figure 6. Cover by annuals over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas (Fig. 6a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 6b), means sharing the same lower-case letters are not significantly different. Unlabeled series had no significant differences.

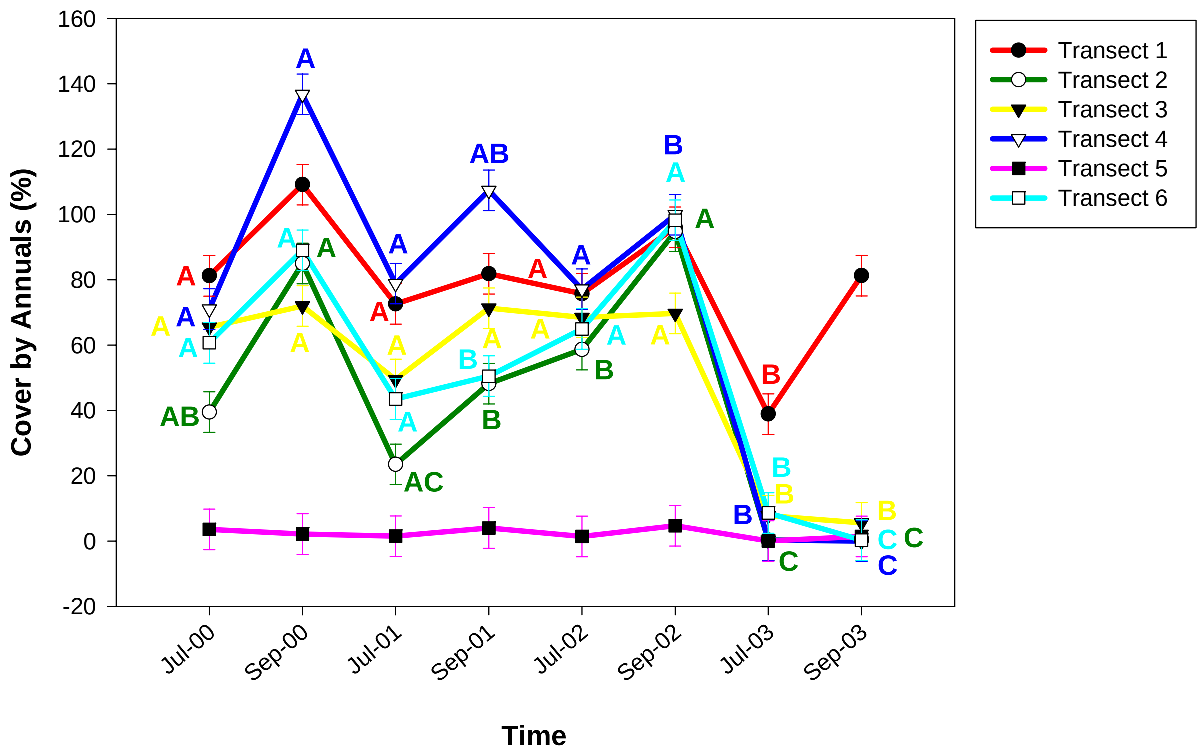



**Figure 7. Cover by annuals at Patuxent over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha$ = 0.05). Within transects, means sharing the same upper-case letters are not significantly different from year to year. Transects lacking labels had no significant year-to-year differences.

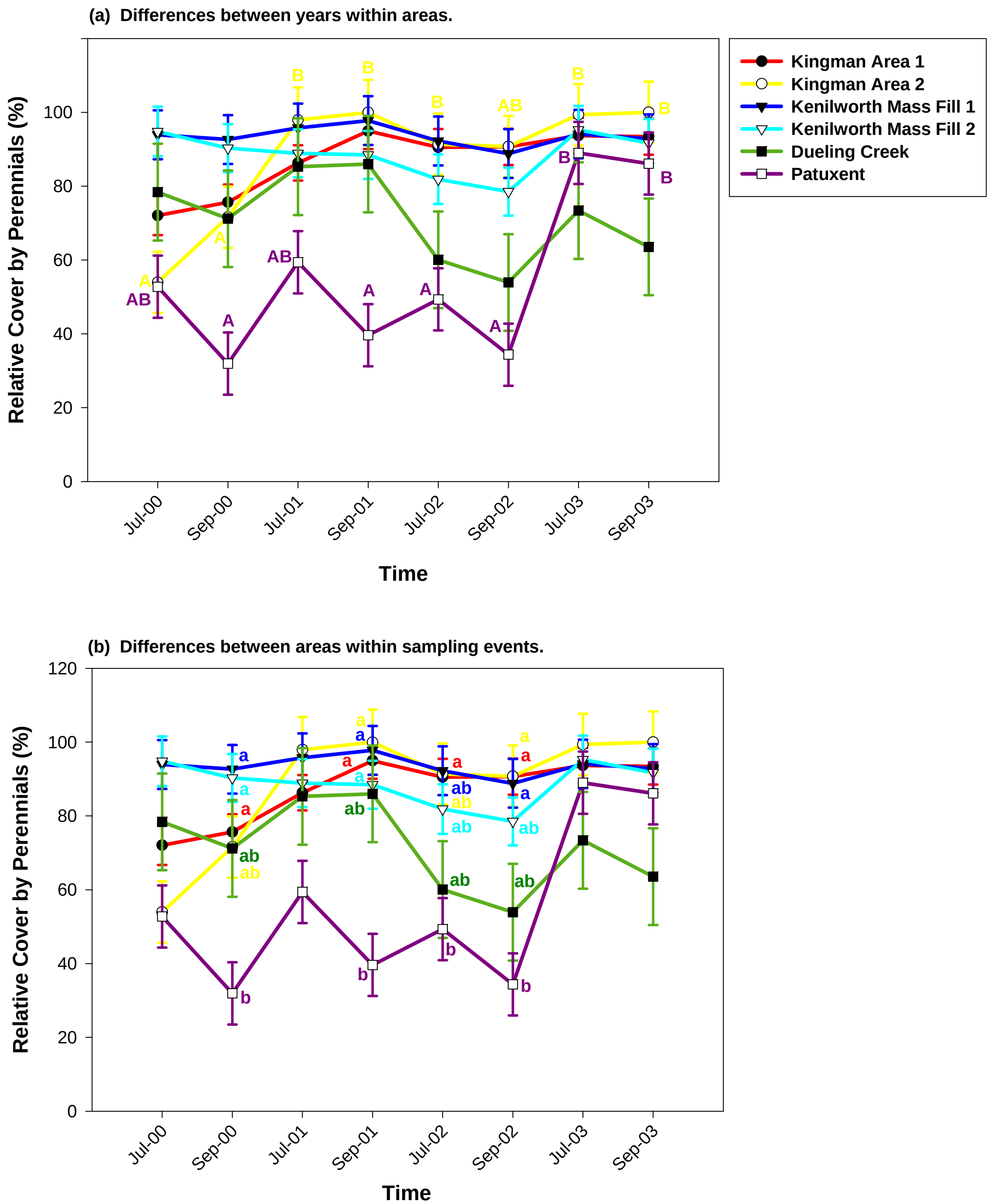



**Figure 8. Relative cover by perennials over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas (Fig. 8a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 8b), means sharing the same lower-case letters are not significantly different. Unlabeled series have no significant differences.

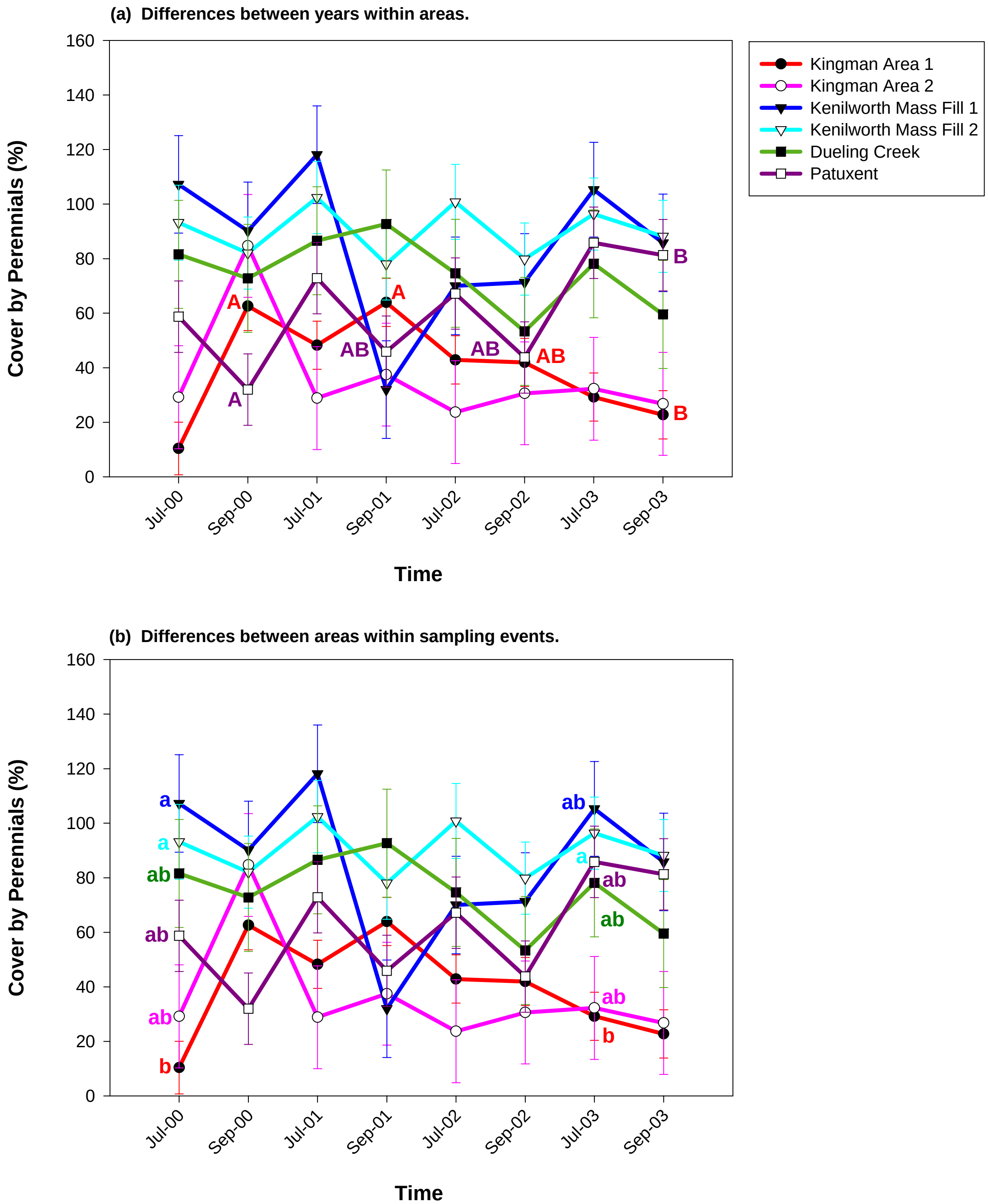



**Figure 9. Cover by perennials over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas (Fig. 9a), means sharing the same upper-case letters are not significantly different from year to year. Within a sampling event (Fig. 9b), means sharing the same lower-case letters are not significantly different. Unlabeled series have no significant differences.

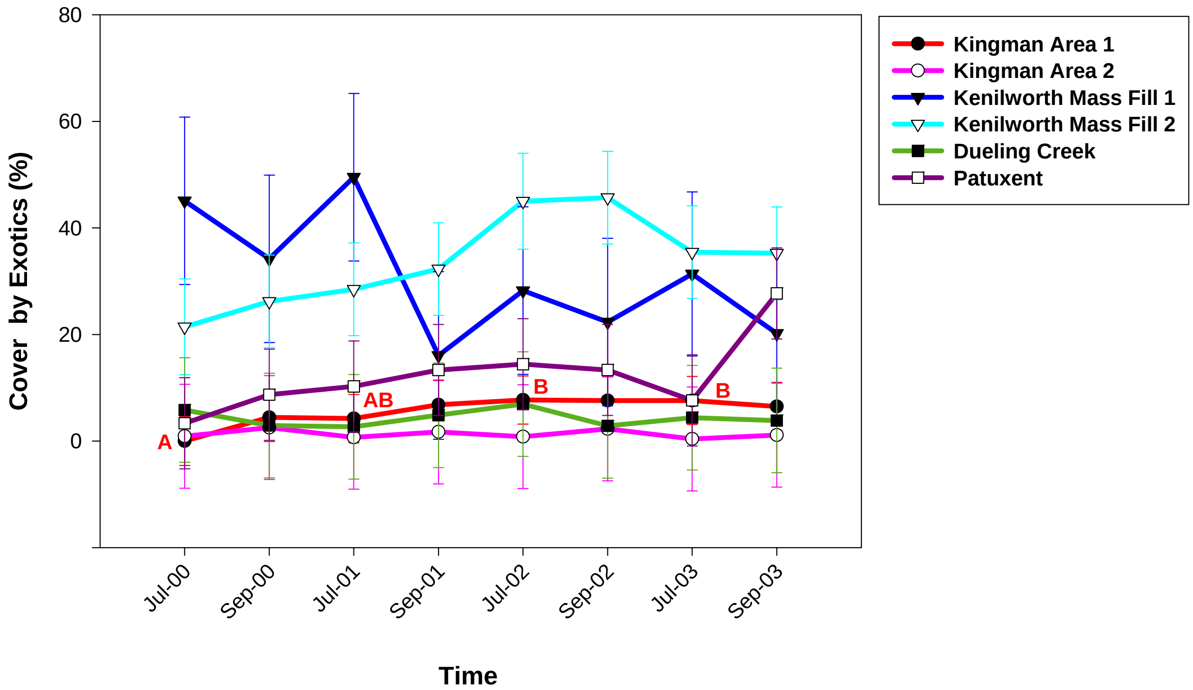



**Figure 10. Cover by exotics over time.**
Data points represent least square means ± 1SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within areas, means sharing the same upper-case letters are not significantly different from year to year. Transects lacking labels had no significant year-to-year differences. There were no significant differences between areas within sampling events.

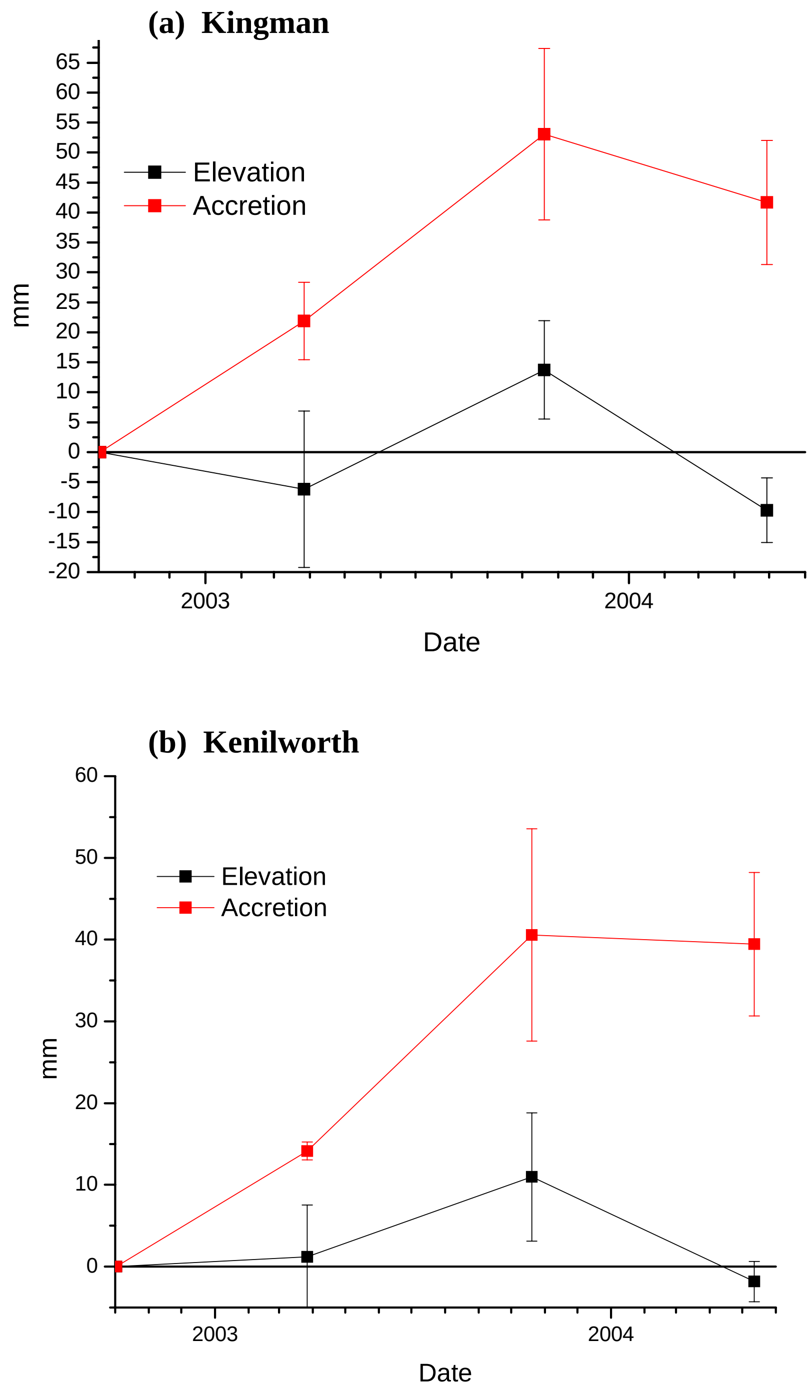
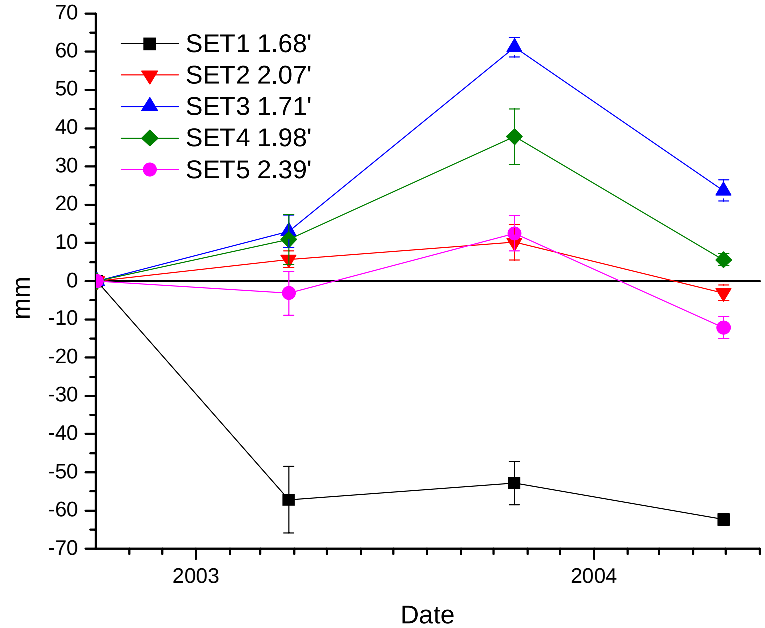
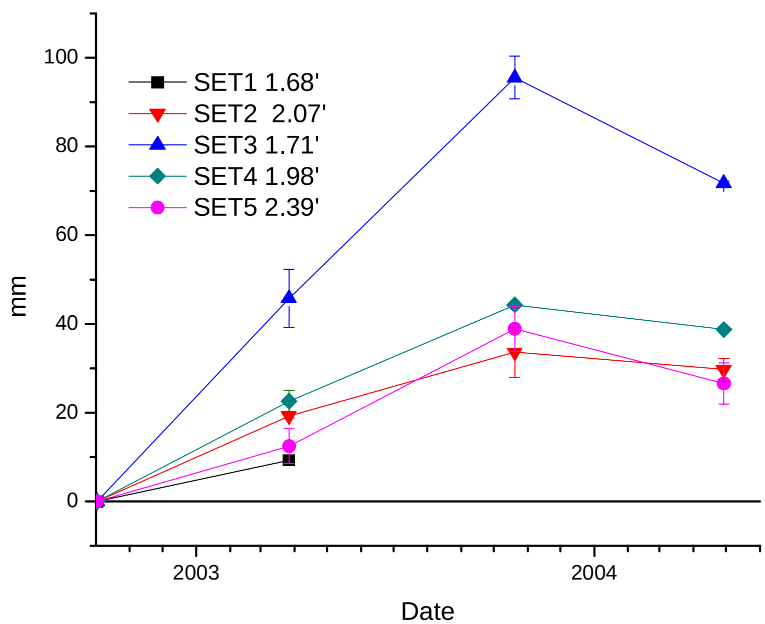



**Figure 11. Changes in overall elevation and accretion at Kingman and Kenilworth.** Data represent means ± 1 SE.

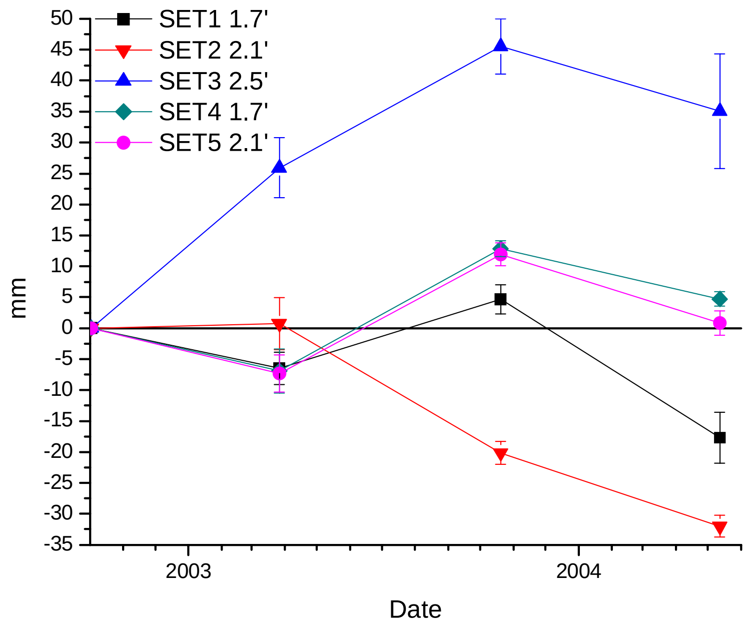



(a) - Change in elevation as measured by the Surface Elevation Table (SET).

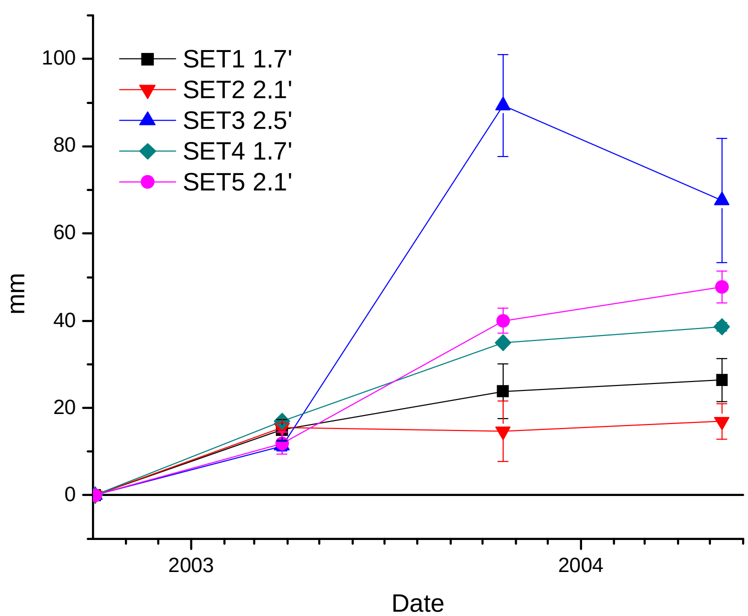



(b) - Deposition on the feldspar marker surface or sediment accretion. The feldspar marker was lost to scour at SET1 after spring 2003.

**Figure 12. Changes in overall elevation and accretion at individual SETs at Kingman.**




(a) - Change in elevation as measured by the Surface Elevation Table (SET).




(b) - Deposition on the feldspar marker surface or sediment accretion.

**Figure 13. Changes in overall elevation and accretion at individual SETs at Kenilworth.**

# Annual Report (2003) for the Kingman Marsh Avian Monitoring Project

**Mary M. Paul, Richard S. Hammerschlag, Cairn C. Krafft**

## Introduction

The year 2003, the third year of the bird study, provided a valuable set of avian information at Kingman and Kenilworth but the consistency of some of the data may have been affected by a series of weather extremes. Most of the river trail at Kenilworth was inaccessible for about six weeks, which undoubtedly affected the nesting birds and their monitoring. Two of the 5- minute point counts located along this trail could not be covered during this early summer time period. The boardwalk at Kenilworth was closed as well for a couple of weeks as trees had fallen over on it blocking access. Then, twenty-two more trees came down (NPS staff, personal communication) on the river trail during hurricane Isabel in September. With so many large trees down much of the forest canopy opened up thus changing the habitat.

In December 2002 construction began on the new spur off the boardwalk overlooking Kenilworth Mass Fill 2. Numbers of birds observed then may have been lower then normal due to the disturbance from the machinery during the construction. The boardwalk extension was completed at the end of April providing an additional point count into the wetland.

### Species richness, abundance and frequency

The following is a nonstatistical summary of all of the birds observed in the two marshes and surrounding areas using the timed point counts as well as the species observed between the point counts. Although some species are not considered wetland dependent species, the wetland can still serve to benefit and attract them by providing additional food, cover and water. Wetland oriented species may also be attracted to the surrounding areas.

Table 1 shows the compilations of all species observed during Year 3 of the bird study (2003) with frequency and abundance as well as total numbers observed by season. There were a total of 144 species seen at both sites combined. This represents 66% of all species observed in the entire District of Columbia and reported to the District of Columbia Composite Bird Sightings. Kenilworth attracted a total of 127 species, which is down 2 from 2002 but up 18 species from 2001. Kingman had a total of 98 species, which is the lowest number of species observed in all three years of monitoring (2001-2003). Year 1 had 105 species and Year 2 had 120 species. There were a total of 83 species common to both sites. Four species of birds occurred prior to the completion of the reconstruction of Kingman Marsh in 2000 but not since. Twenty-one species were equal or nearly equal in total abundance. There were 44 species unique to Kenilworth (an increase of 18 species from last year) and 15 species (down 8 species from Year 2) exclusive to Kingman. Cumulatively from 2001-2003 between the two sites 174 species have been recorded. There have been 139 species sighted at Kingman and 157 species sighted at Kenilworth. They have 122 species in common. Seventeen species are exclusive to Kingman and 35 are unique to Kenilworth.

Double-crested Cormorants were more frequent and abundant at Kingman than at Kenilworth in 2003, as they had been in both of the previous years. In 2003, frequency of Double-crested Cormorant observations was 18 of 42 possible dates for Kingman, compared to 12 of 42 possible dates for Kenilworth. Abundances at Kingman and Kenilworth in 2003 were 18 and 12 for Kingman and Kenilworth, respectively. Their total numbers increased at both sites but especially at Kingman. Currently Double-crested Cormorant populations are increasing in our area (FWS, personal communication).

This year (2003) Kingman had a greater variety and abundance of herons (266 individuals of 5 species) than Kenilworth (123 individuals of 4 species), but in Year 1 Kenilworth had a greater variety of herons and in Year 2 the two sites were equal. In all years Kingman had a greater abundance of herons. Green Herons were more frequent and abundant at Kingman than at Kenilworth in 2003 (frequency: 6 of 42 at Kingman and 4 of 42 at Kenilworth; abundance: 6 at Kingman and 4 at Kenilworth), whereas they had been equal in number in Year 1 and greater in number at Kenilworth in Year 2.

Twelve species of waterfowl were observed between the two sites during 2003. New to the list of species were a lone Canvasback and a Ring-necked Duck both observed at Kingman. Species richness of waterfowl was greater at Kingman than at Kenilworth during 2003 (10 species observed at Kingman, compared to 9 species at Kenilworth). Wood Duck and American Black Duck were again more frequent and abundant at Kenilworth than at Kingman, as they have been in previous years. Frequency of observation of Wood Duck was 25 of 42 for Kenilworth, compared to 3 of 42 for Kingman. Abundances of Wood Duck were 75 and 18 at Kenilworth and Kingman, respectively. Similarly, frequency of American Black Duck was 16 of 42 at Kenilworth, compared to only 1 of 42 at Kingman, with abundances of 63 and 2 at Kenilworth and Kingman, respectively. There were no Northern Pintails observed at Kingman whereas they were sighted in Year 2. American Green-winged Teal was more frequent and abundant at Kingman than at Kenilworth in 2003, with a frequency of 5 of 42 at Kingman compared to only 1 of 42 for Kenilworth. Abundances were 21 at Kingman compared to only 3 at Kenilworth. Mallard and Common Merganser numbers were relatively equal between the two sites, with 576 and 579 sightings of Mallards and 48 and 45 sightings of Common Merganser at Kingman and Kenilworth, respectively. Hooded Mergansers were more frequent and abundant at Kingman than at Kenilworth in 2003, with frequencies of 6 of 42 and 4 of 42, and abundances of 54 and 22, at Kingman and Kenilworth, respectively. This is in contrast to previous years, when they were present more frequently at Kenilworth in Year 1 and less frequently at Kenilworth, but in equal numbers, in Year 2.

There were 4.7 times as many Canada Geese (migratory and resident) observed at Kingman during 2003 than at Kenilworth (8,802 counts compared to 1,876, keeping in mind that many of these would represent repeat observations of the same birds on different dates). Frequency of observation was 40 of 42 for Kingman, compared to 32 of 42 for Kenilworth. The population is maintaining itself at Kingman whereas they have declined 65 % at Kenilworth since 2001 (Table 2).

The newly reconstructed Kingman marsh was created in the midst of the Langston Golf Course where there was an already established population of Canada Geese for many years. The tender newly established plants were nutrient rich and were especially beneficial for the developing goslings and for replenishing the energy reserves of the nesting females. Many opportunistic geese from the surrounding areas, including Kenilworth, also discovered it and the population increased at Kingman. Kenilworth is very thick, lush and well established since it has been less impacted by goose grazing and has been in place seven years more than Kingman. Kenilworth also was threatened with geese grazing when it was first reconstructed (Susan Rudy, NPS, personal communication) but has since outgrown the pressures from grazing.

The elevated population of Canada Geese at Kingman continues to set back the efforts of the marsh restoration due to overgrazing the vegetation particularly in the spring when the goslings feed voraciously and the female adults need to restore their energy reserves from nesting. Revival of the Kingman Marsh is being attempted through the installation of the perimeter fencing and the replanting of less palatable plants for the geese. The average number of resident Canada Geese at both sites combined, in the spring and summer, is around 213 in all three years combined. In the winter the population grows to an average of 315. The geese are very mobile and tend to move around a lot throughout the day to go from resting areas at night to feeding areas during the day.

In 2004 Anacostia-wide surveys consisting of simultaneous counts (census counts) of resident Canada Geese took place on two dates with a high number of 694 on July 17, 2004. Many geese come to feed on the golf course at dusk and large numbers are concentrated here (Golf course personnel and Peter May, personal communication).

Kenilworth had greater species richness and abundance compared to Kingman with respect to raptors (90 counts of 8 species at Kenilworth compared to 61 counts of 6 species at Kingman). In year two Kingman had greater species richness. In all years Kenilworth has had greater abundance, with Red-shoulder Hawks (42) and Ospreys (20) as the top two raptors in abundance in 2003, as they were in the previous years. Bald Eagles were about equal in numbers at both sites (10 at Kingman and 9 at Kenilworth), as they had been in Year 1, and frequency between the two sites was about equal (10 of 42 for Kingman and 8 of 42 for Kenilworth).

Seven species of shorebirds (plovers and sandpipers) were observed at each of the two sites, but Kingman hosted a greater total number of birds (374 compared to 169) as it has in prior years. The species richness and total numbers were down at both sites compared to Year 2. The top five most abundant species of shorebirds at both sites combined were Killdeer (212), Greater Yellowlegs (90), and Semi-palmated (53), Spotted (26) and Solitary (14) Sandpipers. Greater Yellowlegs and Semi-palmated Sandpipers were more abundant and frequent at Kingman, with abundances of 71 and 19 for Greater

Yellowlegs, and 50 and 3 for Semi-palmated Sandpipers, at Kingman and Kenilworth, respectively. Killdeer were more frequent (18 of 42 vs. 15 of 42) and abundant (115 vs. 97) at Kenilworth than at Kingman. Spotted Sandpipers were about equal in number between the two sites and Solitary Sandpipers were more abundant at Kenilworth (12 vs. 2) with equal frequency between the two sites (2 of 42). American Woodcock was added to the species list since it was found in the meadow at Kingman on one occasion in the spring.

Kingman had a greater abundance (1,905 vs. 725), species richness (6 vs. 5), and frequency of gulls and terns in 2003 compared to Kingman. It has had greater species richness in all years. Forster's Tern was a new species added to the comprehensive list since it was observed once at Kingman.

A new visitor to Kenilworth was a Common Nighthawk observed overhead on two occasions. Chimney Swift were more frequent (17 of 42 compared to 13 of 42) and 2.3 times more abundant (293 vs. 125) at Kenilworth compared to Kingman in 2003. This is in contrast to previous years when they had been slightly less abundant at Kingman. Overall numbers of Chimney Swift were down compared to the two prior years.

Belted Kingfishers were more frequent (28 of 42 vs. 14 of 42) and abundant (52 vs. 17) at Kenilworth compared to Kingman, as they have been in the two previous.

The top two flycatcher species were Eastern Phoebe and Eastern Kingbird and they also nested at both sites. Eastern Phoebe was more abundant (16 compared to 5) and counted more frequently (12 of 42 compared to 5 of 42) at Kenilworth compared to Kingman. The Willow Flycatcher made an appearance at Kenilworth on three occasions but did not nest as it did in 2002.

Crows were more abundant at Kingman than at Kenilworth (1,553 vs. 904) as they were in Year 1, but not in Year 2.

Species richness of swallows was equal at both sites (4 species), but Kingman had a greater abundance than Kenilworth (221 compared to 195). Bank Swallow was observed at Kenilworth on one occasion but not at all at Kingman. Barn Swallow abundances were about equal at each site (89 and 82 at Kingman and Kenilworth, respectively). Tree Swallow numbers were about equal in abundances (avg. = 84) and frequencies (avg. = 13.5 of 42) for Kingman and Kenilworth in 2003.

House and Marsh Wren were only observed at Kingman. Kenilworth hosted over 2 ½ times as many Carolina Wren (128 vs. 49) and also more Winter Wren (6 vs. 2) compared to Kingman. One of the successes of Kingman Area 1 has been the nesting of Marsh Wren for two consecutive years. They frequently nest in cattails. No young were observed for definite confirmation but singing males heard throughout the breeding season indicate that they probably nested there (as per 2nd Maryland/DC Breeding Bird Atlas project handbook).

Kinglets and Blue-gray Gnatcatchers were (again this year), more abundant (90 vs. 24) and frequent at Kenilworth. Golden-crowned Kinglets were observed solely at Kenilworth for the third year in a row. Six of the seven species of thrushes that occur in D.C. were observed between the two sites. Kenilworth had greater species richness of thrushes, but Kingman had greater abundance (302 vs. 166) as it did the year before. Eastern Bluebird numbers (3 birds on 3 dates at Kingman only) were way down this year from previous years. The most abundant thrush species was American Robin.

Of the mimids, only Northern Mockingbird were more abundant at Kingman than at Kenilworth (132 vs. 53) with about equal frequency to Kenilworth. Many fledglings were observed in the summer along the golf course. Both sites had all three mimid species that occur in D.C. European Starlings were again quite numerous at Kingman. They occurred almost twice as frequently (33 of 42 compared to 18 of 42) and three times as abundantly (1137 compared to 409) at Kingman as at Kenilworth. This is down from last year. Cedar Waxwing were again on the order of 10 times more abundant at Kingman than Kenilworth (231 vs. 23), though the frequency of observation was basically the same at both sites (6 and 5 of 42 at Kingman and Kenilworth).

Twenty species of warblers occurred between the two sites in 2003. Birds observed in Year 3 but not Year 2 are Tennessee, Chestnut-sided, Ovenbird, Canada Warbler and Yellow-breasted Chat. Kingman had eight species of warblers whereas Kenilworth hosted all 20 species encountered. Of particular interest is the great abundance (68) and frequency (15 of 42) of Common Yellowthroat, which is a marsh bird, at Kenilworth. Common Yellowthroat utilize the marsh for food, habitat, and nesting. One can frequently hear them calling from the marsh throughout the breeding season. Ten species of sparrows were seen between the two sites, an increase of two from the previous year. The species richness and abundance were about equal between the two sites where previously Kingman had hosted greater species richness and abundance. An important habitat for the sparrows in the winter is the meadows at Kingman especially the large one near the two ponds. This is mowed annual usually in the late winter. It would be good if it could be mowed as late in the winter/early spring (late March) as possible to continue to provide critical cover and food for wintering birds while not interfering with the germination of the meadow flowers such as the black-eyed susan.

## Statistical Analyses

Statistical analyses were made using repeated measures analysis of variance to see if there were any significantly different features between Kingman and Kenilworth Marshes for the five-minute point counts in Year 3. Means expressed below are least square means ± 1 SE, unless noted otherwise. There were six timed point counts at each site.

Analysis of seasonal abundance data revealed that significantly more birds were observed at Kingman during the winter season than during the remaining seasons (Fig. 1). By comparison, there were no significant differences among the seasonal abundances for Kenilworth. During the winter season, significantly more birds were observed at Kingman (78 ± 11 birds per 5-minute point count) than at Kenilworth (29 ± 10). During the remaining seasons there were no significant differences between the numbers of birds observed at Kingman and Kenilworth.

Thinking that the Canada Goose numbers might be responsible for Kingman's high winter abundances, we tried excluding them and re-running the analysis (Fig. 2). This revised analysis lowered Kingman's winter abundances (to 25 ± 3), eliminating the significant difference in winter abundances with Kenilworth (22 ± 3), and showing that the only significant differences in total seasonal abundances between Kingman and Kenilworth in the December 2002 through November 2003 time period were due to Canada Geese. However, the revised analysis does show that Kingman experienced a significant seasonal effect on abundance that was independent of the presence of Canada Geese, since the winter abundances at Kingman, even with the Canada Goose numbers excluded, were significantly greater than the abundances during the remaining seasons.

Analysis of seasonal species richness showed no significant within-season differences between Kingman and Kenilworth in the mean number of bird species observed during a five-minute point count (Fig. 3). Seasonal differences within-site were significant for both sites, however, and the pattern exhibited at Kingman differed slightly from that exhibited at Kenilworth. At Kingman the greatest species richness occurred in spring and summer, with a least square mean in summer 2003 of 6 (± 1) bird species observed during a five-minute point count. At Kenilworth, the greatest species richness occurred in winter, spring, and summer, with a least square mean in summer 2003 of 5 (± 1) species. It is also interesting to note at Kingman that species richness peaked in spring and summer, in contrast to the total abundances (with or without Canada Geese), which peaked in winter.

Figure 4 shows the seasonal abundances (mean ± 1 SE per 5-minute point count) for the ten most prevalent species by site and season. Defining the most abundant of these as seasonal dominants (mean ≥ 1 bird per 5-minute point count), only one species met the criterion at both sites during each season- the Canada Goose. Mallards met the seasonal dominant criterion for all seasons at Kingman and three of the four seasons at Kenilworth. Ring-billed Gull met the seasonal dominant criterion for three of the four seasons at Kingman, and two of the four seasons at Kenilworth. Crows (most often Crow species and Fish Crows) met the seasonal dominant criterion at both sites during the winter and spring seasons. These data show that there are many similarities in the species composition of the seasonal dominants for Kingman and Kenilworth.

The graphs also portray many differences in species composition between Kingman and Kenilworth, especially in species that were included in the top ten most abundant and therefore appear in the graphs, but did not meet the criterion for seasonal dominant (mean ≥ 1 bird per 5-minute point count). Examples of these differences include Great Blue Heron, which appears in the top ten at Kingman three out of four seasons, but does not appear in the top ten at Kenilworth in any of the seasons. Kenilworth lacks such a single species that consistently makes it to its top ten list, but not the top ten list for Kingman. There are a number of species, however, that appear among the top ten for Kenilworth in one season, but not for Kingman in any season, including American Black Duck and Wood Duck.

**Sørenson's Similarity Index**

Similarity of species composition at the two study areas was determined using Sørenson's similarity index. Sørenson's similarity index compares presence/absence data from two areas to produce an index that varies from 0 if the areas have no species in common, to 1 if both areas have all species in common. In 2003 the calculated index is slightly lower then in 2002 (0.74 compared to 0.81), but roughly the same as the value for 2001 (0.76). Future data should clarify whether the drop observed in 2003 reflected natural variability in the system, or the start of a trend of divergence in avian species composition between Kingman and Kenilworth.

## Breeding Birds

In 2003 there were 57 species of breeding birds observed at Kingman and 56 species of breeding birds at Kenilworth in and around the marshes. There were 46 species common to both but 11 nesting species unique to Kingman and 10 exclusive to Kenilworth. A list of breeding birds and the criteria are presented in Table 3. The results were also sent to the D.C. coordinator for the 2$^{nd}$ Maryland/DC Breeding Bird Atlas project.

**Comparison with Other wetlands**

Information concerning the bird-life from four local tidal wetlands in the area was looked at to draw some comparisons to Kingman and Kenilworth Marshes. The information was not collected in the same manor or time period was derived simply from their total species lists with no consideration of total numbers or frequency. Cumulatively from 2001-2003 between Kingman and Kenilworth, 174 species have been recorded. There have been 139 species sighted at Kingman and 157 species sighted at Kenilworth. They have 122 species in common. Seventeen species are exclusive to Kingman and 35 are unique to Kenilworth.

Dyke Marsh Preserve is the last major tidal freshwater wetland on the upper Potomac River. Threats to this system include river pollution from nearby large-scale development projects and bridge construction. Like the Anacostia wetlands, portions have been dredged out at Dyke Marsh as part of sand and gravel mining operations. This preserve encompasses 550 acres of developed parkland, river shoreline and marsh. The park extends from the Alexandria City line south along the Potomac for 2 ½ miles. A total of 246 species were observed through 2000.

Another nearby tidal wetland is the Jug Bay area of the Patuxent River . Two hundred and seventy-three species have been observed with over 100 confirmed nesting. Staff and volunteers combined resources to produce a checklist. Jug Bay is a freshwater tidal marsh with large concentrations of waterfowl and wading birds. It is a critical stopover for many Neotropical migrants. There are a variety of habitats for birds here, including open water, tidal freshwater marshes, tidal mudflats, shrub-scrub swamps, forested uplands and open fields. It is a 15-mile radius park. The wetland is comprised of 2000 acres. Two hundred and seventy three species have been observed there with over 100 confirmed nesting. Staff and volunteers combined resources to produce the checklist. Even though the wetland character is similar to the Anacostia, the considerably larger scale and history makes it a bit .difficult to compare directly. The American Bird Conservancy had designated Jug Bay a "Nationally important bird area" because of its high numbers and diversity of birds. Some important bird species that are missing at Kingman but present at Jug Bay include Least Bittern, American Bittern, Snowy Egret, Gadwall, Northern Pintail, Virginia Rail, Sora, King Rail, Forster's Tern, Acadian Flycatcher, American Coot, Red-throated Loon and Tundra Swan.

A third nearby wetland that was very intensively monitored is at Fort McHenry in Baltimore. This is a 7-acre urban reconstructed marsh with 3 acres of upland that has been monitored by Jim Peters from 1999-2004, which is approximately the same time period that Kingman has been monitored. Jim monitors the wetland 5-6 hours per day everyday of the week year round. There are no point counts, only walk-throughs that repeat hour after hour. There have been a total of 217 species reported in 4 ½ years. This is 56 less species then at Jug Bay and 43 more than found at Kingman and Kenilworth combined. There have been Virginia and Sora Rails in migration. Virginia Rails have tried to nest there but were flooded out by the tides. There have been a large number of Swamp Sparrow present at Fort McHenry.

Another wetland reconstructed by the Army Corps of Engineers is at Hart-Miller Island in the Chesapeake Bay near Baltimore. This is an artificially elevated wetland on top of dredge spoil material with brackish water. Since 1977 there have been 275 species recorded on or around the island including 13 breeding species.

Essentially all of the species found in the Anacostia marshlands have been noted at these other wetlands. In time as the Anacostia wetlands mature and expand it might be expected that the species list will approximate these other wetlands, especially those species that rely on the wetlands.

## References

Johnston, David. 2000. The Dyke Marsh Preserve Ecosystem.

# Tables

**Table 1. Frequencies and abundances of bird species at Kingman and Kenilworth during 2003.**
The Second Maryland/DC Breeding Bird Atlas Project Handbook, produced by the Maryland Ornithological Society, was used during species identification. The seasonal time periods have been defined as follows: Winter (W) = Dec-Feb; Spring (Sp) = Mar-May; Summer (Su) = Jun-Aug; Fall (F) = Sep-Nov. * Represents the annual sum of observations, including repeat observations of the same birds.

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| **Common Name** | **Kingman** | **Kenilworth** | **Kingman and / or Kenilworth** | **Sp (of 11)** | **Su (of 12)** | **F (of 11)** | **W (of 8)** | **Kingman** | **Kenilworth** | |
| **Cormorant** | | | | | | | | | | |
| Double-crested Cormorant | 18 | 12 | 23 | 7 | 6 | 10 | 0 | 73 | 21 | 21 |
| **Herons & Egret** | | | | | | | | | | |
| Great Blue Heron | 39 | 32 | 41 | 10 | 12 | 11 | 8 | 178 | 75 | 6 |
| Great Egret | 16 | 13 | 16 | 0 | 8 | 8 | 0 | 75 | 43 | 7 |
| Snowy Egret | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Little Blue Heron | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| Green Heron | 6 | 4 | 7 | 1 | 6 | 0 | 0 | 6 | 4 | 1 |
| Black-crowned Night-Heron | 6 | 0 | 6 | 1 | 5 | 0 | 0 | 6 | 0 | 1 |
| **Vultures** | | | | | | | | | | |
| Black Vulture | 0 | 4 | 4 | 1 | 0 | 3 | 0 | 0 | 6 | 3 |
| Turkey Vulture | 7 | 5 | 12 | 7 | 2 | 1 | 2 | 9 | 8 | 3 |
| **Ducks & Geese** | | | | | | | | | | |
| Canada Goose | 40 | 32 | 42 | 11 | 12 | 11 | 8 | 8802 | 1876 | 561 |
| Wood Duck | 3 | 25 | 26 | 9 | 7 | 9 | 1 | 18 | 75 | 9 |
| American Black Duck | 1 | 16 | 17 | 4 | 2 | 7 | 4 | 2 | 63 | 5 |
| Mallard | 41 | 38 | 42 | 11 | 12 | 11 | 8 | 576 | 579 | 42 |
| Blue-winged Teal | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 4 | 3 |
| Northern Pintail | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 0 | 8 | 7 |
| American Green-winged Teal | 5 | 1 | 6 | 5 | 0 | 0 | 1 | 21 | 3 | 9 |
| Canvasback | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Ring-necked Duck | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 2 |
| Hooded Merganser | 9 | 4 | 10 | 3 | 0 | 0 | 7 | 54 | 22 | 11 |
| Common Merganser | 6 | 4 | 8 | 3 | 0 | 0 | 5 | 48 | 45 | 17 |
| domestic white duck | 12 | 0 | 12 | 6 | 2 | 2 | 2 | 12 | 0 | 1 |

**Table 1. (Cont.)**

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| Common Name | Kingman | Kenilworth | Kingman and / or Kenilworth | Sp (of 11) | Su (of 12) | F (of 11) | W (of 8) | Kingman | Kenilworth | |
| **Hawks** | | | | | | | | | | |
| Osprey | 10 | 9 | 12 | 7 | 3 | 2 | 0 | 13 | 20 | 2 |
| Bald Eagle | 10 | 8 | 17 | 4 | 6 | 4 | 3 | 10 | 9 | 2 |
| Northern Harrier | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Sharp-shinned Hawk | 3 | 2 | 4 | 0 | 1 | 3 | 0 | 3 | 2 | 1 |
| Cooper's Hawk | 5 | 2 | 6 | 0 | 0 | 3 | 3 | 7 | 3 | 2 |
| Red-shouldered Hawk | 17 | 23 | 27 | 10 | 4 | 7 | 6 | 19 | 42 | 4 |
| Red-tailed Hawk | 8 | 6 | 11 | 4 | 0 | 3 | 5 | 9 | 8 | 2 |
| American Kestrel | 0 | 4 | 4 | 0 | 1 | 3 | 0 | 0 | 5 | 2 |
| **Plovers** | | | | | | | | | | |
| Killdeer | 15 | 18 | 26 | 7 | 6 | 6 | 7 | 97 | 115 | 20 |
| **Sandpipers** | | | | | | | | | | |
| Greater Yellowlegs | 12 | 9 | 14 | 2 | 5 | 7 | 0 | 71 | 19 | 12 |
| Lesser Yellowlegs | 2 | 1 | 3 | 3 | 0 | 0 | 0 | 2 | 3 | 3 |
| Solitary Sandpiper | 2 | 2 | 4 | 2 | 2 | 0 | 0 | 2 | 12 | 4 |
| Spotted Sandpiper | 7 | 6 | 10 | 3 | 4 | 3 | 0 | 13 | 13 | 3 |
| Semipalmated Sandpiper | 6 | 2 | 7 | 1 | 5 | 1 | 0 | 50 | 3 | 13 |
| Least Sandpiper | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 3 |
| Pectoral Sandpiper | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| Common Snipe | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| American Woodcock | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| **Gulls & Terns** | | | | | | | | | | |
| Laughing Gull | 5 | 2 | 5 | 0 | 2 | 3 | 0 | 58 | 4 | 20 |
| Ring-billed Gull | 35 | 26 | 35 | 9 | 8 | 10 | 8 | 1688 | 706 | 131 |
| Herring Gull | 10 | 4 | 12 | 3 | 0 | 2 | 7 | 78 | 5 | 49 |
| Great Black-backed Gull | 14 | 6 | 16 | 4 | 0 | 4 | 8 | 77 | 9 | 8 |
| Caspian Tern | 3 | 1 | 3 | 2 | 1 | 0 | 0 | 3 | 1 | 1 |
| Forster's Tern | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |

**Table 1 (Cont.)**

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| **Common Name** | **Kingman** | **Kenilworth** | **Kingman and / or Kenilworth** | **Sp (of 11)** | **Su (of 12)** | **F (of 11)** | **W (of 8)** | **Kingman** | **Kenilworth** | |
| **Doves** | | | | | | | | | | |
| Rock Dove | 9 | 3 | 12 | 2 | 3 | 6 | 1 | 104 | 4 | 40 |
| Mourning Dove | 7 | 6 | 11 | 2 | 4 | 5 | 0 | 14 | 6 | 5 |
| **Cuckoo** | | | | | | | | | | |
| Yellow-billed Cuckoo | 0 | 7 | 7 | 3 | 4 | 0 | 0 | 0 | 17 | 1 |
| **Nightjars & Swift** | | | | | | | | | | |
| Common Nighthawk | 0 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 3 | 1 |
| Chimney Swift | 13 | 17 | 18 | 4 | 11 | 3 | 0 | 125 | 293 | 57 |
| **Hummingbird & Kingfisher** | | | | | | | | | | |
| Ruby-throated Hummingbird | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| Belted Kingfisher | 13 | 28 | 32 | 7 | 7 | 10 | 8 | 17 | 52 | 2 |
| **Woodpeckers** | | | | | | | | | | |
| Red-headed Woodpecker | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Red-bellied Woodpecker | 14 | 28 | 32 | 9 | 6 | 9 | 8 | 23 | 71 | 3 |
| Yellow-bellied Sapsucker | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Downy Woodpecker | 15 | 34 | 37 | 11 | 9 | 9 | 8 | 21 | 80 | 3 |
| Hairy Woodpecker | 2 | 14 | 16 | 5 | 3 | 4 | 4 | 3 | 16 | 1 |
| Northern (Yellow-shafted) Flicker | 21 | 23 | 33 | 7 | 10 | 9 | 7 | 40 | 47 | 5 |
| Pileated Woodpecker | 4 | 2 | 6 | 3 | 0 | 0 | 1 | 4 | 2 | 1 |
| **Flycatchers** | | | | | | | | | | |
| Eastern Wood-Pewee | 1 | 2 | 3 | 2 | 0 | 1 | 0 | 1 | 2 | 1 |
| Yellow-bellied Flycatcher | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Acadian Flycatcher | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Willow Flycatcher | 0 | 3 | 3 | 1 | 2 | 0 | 0 | 0 | 3 | 1 |
| Least Flycatcher | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Eastern Phoebe | 5 | 12 | 17 | 6 | 7 | 4 | 0 | 5 | 16 | 2 |
| Great Crested Flycatcher | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 3 | 1 |
| Eastern Kingbird | 8 | 10 | 13 | 3 | 9 | 1 | 0 | 16 | 15 | 3 |

**Table 1 (Cont.)**

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| Common Name | Kingman | Kenilworth | Kingman and / or Kenilworth | Sp (of 11) | Su (of 12) | F (of 11) | W (of 8) | Kingman | Kenilworth | |
| **Vireos** | | | | | | | | | | |
| White-eyed Vireo | 2 | 5 | 6 | 3 | 2 | 1 | 0 | 2 | 8 | 1 |
| Warbling Vireo | 1 | 8 | 8 | 3 | 5 | 0 | 0 | 2 | 19 | 3 |
| Red-eyed Vireo | 2 | 14 | 14 | 4 | 10 | 0 | 0 | 2 | 36 | 5 |
| **Jays & Crows** | | | | | | | | | | |
| Blue Jay | 7 | 10 | 14 | 5 | 0 | 8 | 1 | 33 | 97 | 12 |
| Crow sp. | | | | | | | | 737 | 435 | 75 |
| American Crow | 29 | 24 | 37 | 11 | 8 | 11 | 7 | 268 | 263 | 100 |
| Fish Crow | 35 | 27 | 36 | 11 | 12 | 6 | 8 | 548 | 206 | 60 |
| **Lark and Swallows** | | | | | | | | | | |
| Purple Martin | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Tree Swallow | 13 | 14 | 16 | 8 | 8 | 0 | 0 | 85 | 83 | 9 |
| Northern Rough-winged Swallow | 11 | 10 | 13 | 6 | 7 | 0 | 0 | 46 | 29 | 5 |
| Bank Swallow | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Barn Swallow | 15 | 15 | 18 | 5 | 12 | 1 | 0 | 89 | 82 | 29 |
| **Chickadee, Titmouse, Nuthatch & Creeper** | | | | | | | | | | |
| Carolina Chickadee | 13 | 29 | 32 | 10 | 9 | 5 | 8 | 23 | 70 | 4 |
| Tufted Titmouse | 2 | 21 | 23 | 10 | 7 | 1 | 5 | 2 | 31 | 4 |
| White-breasted Nuthatch | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 2 | 1 |
| **Wrens** | | | | | | | | | | |
| Carolina Wren | 18 | 40 | 41 | 11 | 11 | 11 | 8 | 49 | 128 | 5 |
| House Wren | 13 | 0 | 13 | 3 | 10 | 0 | 0 | 21 | 0 | 2 |
| Winter Wren | 1 | 4 | 5 | 0 | 0 | 2 | 3 | 2 | 6 | 1 |
| Marsh Wren | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 12 | 0 | 2 |
| **Kinglets & Gnatcatcher** | | | | | | | | | | |
| Golden-crowned Kinglet | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 2 |
| Ruby-crowned Kinglet | 4 | 8 | 12 | 4 | 0 | 3 | 5 | 7 | 14 | 2 |
| Blue-gray Gnatcatcher | 10 | 16 | 16 | 7 | 9 | 0 | 0 | 17 | 72 | 5 |

**Table 1 (Cont.)**

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| Common Name | Kingman | Kenilworth | Kingman and / or Kenilworth | Sp (of 11) | Su (of 12) | F (of 11) | W (of 8) | Kingman | Kenilworth | |
| **Thrushes** | | | | | | | | | | |
| Eastern Bluebird | 3 | 0 | 3 | 2 | 0 | 0 | 1 | 3 | 0 | 1 |
| Gray-cheeked Thrush | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Swainson's Thrush | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 5 | 2 |
| Hermit Thrush | 0 | 2 | 2 | 1 | 0 | 0 | 1 | 0 | 2 | 1 |
| Wood Thrush | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| American Robin | 13 | 19 | 23 | 1 | 9 | 8 | 5 | 299 | 157 | 200 |
| **Mimids** | | | | | | | | | | |
| Gray Catbird | 12 | 21 | 21 | 4 | 9 | 8 | 0 | 37 | 85 | 8 |
| Northern Mockingbird | 25 | 23 | 29 | 3 | 7 | 11 | 8 | 132 | 53 | 14 |
| Brown Thrasher | 3 | 4 | 6 | 0 | 6 | 0 | 0 | 3 | 7 | 3 |
| **Starling, Pipit, & Waxwing** | | | | | | | | | | |
| European Starling | 33 | 18 | 36 | 9 | 12 | 10 | 5 | 1137 | 409 | 110 |
| Cedar Waxwing | 6 | 5 | 11 | 2 | 2 | 4 | 3 | 231 | 23 | 100 |
| **Wood Warblers** | | | | | | | | | | |
| Tennessee Warbler | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| Nashville Warbler | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 3 | 1 |
| Northern Parula | 0 | 6 | 6 | 3 | 3 | 0 | 0 | 0 | 12 | 3 |
| Yellow Warbler | 6 | 4 | 8 | 4 | 4 | 0 | 0 | 12 | 13 | 3 |
| Chestnut-sided Warbler | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Magnolia Warbler | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 6 | 3 |
| Black-throated Blue Warbler | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 5 | 3 |
| Yellow-rumped (Myrtle) Warbler | 3 | 10 | 11 | 6 | 0 | 4 | 1 | 4 | 134 | 23 |
| Black-throated Green Warbler | 0 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 3 | 1 |
| Palm Warbler | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 2 | 1 |
| Bay-breasted Warbler | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Blackpoll Warbler | 1 | 3 | 4 | 3 | 0 | 0 | 0 | 2 | 36 | 10 |
| Black-and-white Warbler | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 3 | 2 |

**Table 1 (Cont.)**

| | Frequency | | | | | | | Abundance | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency- # dates observed (of 42 possible) | | | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth | | | | Abundance- total counted * (12/02 - 11/03) | | Maximum Daily # Observed at Kingman and Kenilworth Combined |
| **Common Name** | **Kingman** | **Kenilworth** | **Kingman and / or Kenilworth** | **Sp (of 11)** | **Su (of 12)** | **F (of 11)** | **W (of 8)** | **Kingman** | **Kenilworth** | |
| **Wood Warblers (Cont.)** | | | | | | | | | | |
| American Redstart | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 2 |
| Prothonotary Warbler | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 2 |
| Ovenbird | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Northern Waterthrush | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 1 |
| Common Yellowthroat | 5 | 15 | 15 | 4 | 10 | 1 | 0 | 8 | 68 | 4 |
| Canada Warbler | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 1 |
| Yellow-breasted Chat | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Tanager** | | | | | | | | | | |
| Scarlet Tanager | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 9 | 4 |
| **Sparrows** | | | | | | | | | | |
| Eastern Towhee | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2 | |
| American Tree Sparrow | 2 | 0 | 2 | 1 | 0 | 1 | 0 | 8 | 0 | 7 |
| Chipping Sparrow | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 4 | 4 |
| Field Sparrow | 0 | 3 | 3 | 1 | 0 | 2 | 0 | 0 | 4 | 1 |
| Savannah Sparrow | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 3 |
| Fox Sparrow | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Song Sparrow | 37 | 32 | 39 | 11 | 11 | 9 | 8 | 313 | 166 | 19 |
| Swamp Sparrow | 2 | 10 | 10 | 1 | 0 | 3 | 6 | 4 | 24 | 4 |
| White-throated Sparrow | 19 | 23 | 24 | 9 | 0 | 7 | 8 | 197 | 304 | 26 |
| Dark-eyed Junco | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 2 | 3 | 3 |
| **Cardinal, Grosbeaks, Bunting** | | | | | | | | | | |
| Northern Cardinal | 37 | 42 | 42 | 11 | 12 | 11 | 8 | 174 | 254 | 6 |
| Rose-breasted Grosbeak | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 1 |
| Blue Grosbeak | 1 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 3 | 1 |
| Indigo Bunting | 16 | 13 | 17 | 4 | 11 | 2 | 0 | 47 | 43 | 4 |

**Table 1 (Cont.)**

| Common Name | Frequency: Frequency- # dates observed (of 42 possible): Kingman | Kenilworth | Kingman and / or Kenilworth | Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth: Sp (of 11) | Su (of 12) | F (of 11) | W (of 8) | Abundance: Abundance- total counted * (12/02 - 11/03): Kingman | Kenilworth | Maximum Daily # Observed at Kingman and Kenilworth Combined |
|---|---|---|---|---|---|---|---|---|---|---|
| **Blackbirds & Orioles** | | | | | | | | | | |
| Bobolink | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 13 | 10 |
| Red-winged Blackbird | 21 | 33 | 34 | 11 | 12 | 11 | 0 | 163 | 1032 | 170 |
| Common Grackle | 14 | 17 | 19 | 6 | 12 | 1 | 0 | 80 | 105 | 33 |
| Brown-headed Cowbird | 7 | 4 | 7 | 4 | 3 | 0 | 0 | 12 | 24 | 20 |
| Orchard Oriole | 1 | 4 | 4 | 3 | 1 | 0 | 0 | 2 | 11 | 3 |
| Baltimore Oriole | 5 | 4 | 6 | 3 | 3 | 0 | 0 | 7 | 16 | 3 |
| **Winter Finches** | | | | | | | | | | |
| House Finch | 3 | 5 | 7 | 3 | 1 | 2 | 1 | 11 | 15 | 6 |
| American Goldfinch | 24 | 17 | 27 | 6 | 12 | 6 | 3 | 92 | 33 | 6 |
| **Weaver Finch** | | | | | | | | | | |
| House Sparrow | 6 | 0 | 6 | 2 | 4 | 0 | 0 | 11 | 0 | 5 |

**Table 2. Seasonal numbers of Canada Goose observed at Kingman and Kenilworth.**
Numbers represent seasonal means of the total number of Canada Goose observed at (a) Kingman or (b) Kenilworth per sampling day. The seasonal time periods have been defined as follows: Winter = Dec-Feb; Spring = Mar-May; Summer = Jun-Aug; Fall = Sep-Nov.
* Spring 2000 data were collected prior to marsh completion.

**(a) Kingman Marsh**

| YEAR | WINTER | SPRING | SUMMER | FALL | Annual Average |
|---|---|---|---|---|---|
| 2000 | | *164 | | | |
| | | | | | |
| 2001 | 238 | 218 | 173 | 142 | **193** |
| 2002 | 265 | 237 | 235 | 173 | **228** |
| 2003 | 449 | 179 | 145 | 137 | **228** |
| **Overall Seasonal Average** | **317** | **211** | **184** | **151** | |

**(b) Kenilworth Marsh**

| YEAR | WINTER | SPRING | SUMMER | FALL | Annual Average |
|---|---|---|---|---|---|
| 2001 | 77 | 17 | 44 | 94 | **58** |
| 2002 | 101 | 42 | 16 | 30 | **47** |
| 2003 | 40 | 34 | 23 | 82 | **45** |
| **Overall Seasonal Average** | **73** | **31** | **28** | **69** | |

**Table 3. Breeding bird documentation for Kingman and Kenilworth during 2003.**
* Breeding bird criteria are taken from the Second Maryland / DC Breeding Bird Atlas Project Handbook, 2002 through 2006, produced by the Maryland Ornithological Society. Criteria and code definitions are located after the table.

| | Breeding Criteria* | |
|---|---|---|
| **Name** | **Kingman** | **Kenilworth** |
| 1. Great Blue Heron | Probable-T | Probable-T |
| 2. Green Heron | Probable-T | Probable-T |
| 3. Black-crowned Night Heron | Probable-T | |
| 4. Turkey Vulture | Probable-T | Possible-X |
| 5. Canada Goose | Confirmed-FL | Confirmed-FL |
| 6. Wood Duck | Possible-X | Probable-T |
| 7. American Black Duck | Possible-X | |
| 8. Mallard | Confirmed-FL | Confirmed-FL |
| 9. Osprey | Probable-T | Confirmed-NB |
| 10. Bald Eagle | Probable-T | Probable-T |
| 11. Sharp-shinned Hawk | Possible-X | |
| 12. Red-shouldered Hawk | Probable-T | Probable-T |
| 13. Red-tailed Hawk | | Probable-P,T |
| 14. American Kestrel | | Possible-X |
| 15. Killdeer | Probable-T | Probable-T |
| 16. Rock Dove | Possible-X | |
| 17. Mourning Dove | Probable-T | Probable-T |
| 18. Yellow-billed Cuckoo | | Probable-T |
| 19. Chimney Swift | Probable-T | Probable-T |
| 20. Belted Kingfisher | Probable-T | Probable-T |
| 21. Red-bellied Woodpecker | Probable-T | Probable-T |
| 22. Downy Woodpecker | Probable-T | Confirmed-FL |
| 23. Hairy Woodpecker | | Confirmed-FL |
| 24. Yellow-shafted Woodpecker | Probable-T | Probable-T |
| 25. Pileated Woodpecker | Probable-T | |
| 26. Willow Flycatcher | | Probable-T |
| 27. Eastern Phoebe | Possible-X | Confirmed-FL |
| 28. Eastern Kingbird | Confirmed-FL | Probable-P,T |
| 29. White-eyed Vireo | Possible-X | Probable-T |
| 30. Warbling Vireo | | Probable-T |
| 31. Red-eyed Vireo | Possible-X | Probable-T |
| 32. American Crow | Confirmed-FY | Probable-T |

**Table 3. (Cont.)**

| | Breeding Criteria* | |
|---|---|---|
| **Name** | **Kingman** | **Kenilworth** |
| 34. Tree Swallow | Confirmed-NY | Confirmed-NY,FL |
| 35. Northern Rough-winged Swallow | Confirmed-FY | Confirmed-FY |
| 36. Barn Swallow | Confirmed-FY | Probable-T |
| 37. Carolina Chickadee | Probable-T | Confirmed-NB |
| 38. Tufted Titmouse | Probable-T | Confirmed-FY,FL |
| 39. White-breasted Nuthatch | | Possible-X |
| 40. Carolina Wren | Probable-A,P,T | Probable-A,P,T |
| 41. House Wren | Probable-B | |
| 42. Marsh Wren | Probable-T | |
| 43. Blue-gray Gnatcatcher | Probable-T | Confirmed-FL |
| 44. Eastern Bluebird | Possible-X | |
| 45. American Robin | Confirmed-FL | Confirmed-FL |
| 46. Gray Catbird | Probable-T | Probable-T |
| 47. Northern Mockingbird | Confirmed-FL | Confirmed-FL |
| 48. Brown Thrasher | Probable-T | Confirmed-FL |
| 49. European Starling | Confirmed-FY,FL | Confirmed-FL |
| 50. Cedar Waxwing | Possible-X | Possible-X |
| 51. Northern Parula | | Probable-T |
| 52. Yellow Warbler | Probable-T | Probable-T |
| 53. Prothonotary Warbler | | Possible-X |
| 54. Common Yellowthroat | Probable-T | Probable-T |
| 55. Eastern Towhee | | Confirmed-FL |
| 56. Song Sparrow | Confirmed-FL | Probable-T |
| 57. Northern Cardinal | Confirmed-FL | Probable-T |
| 58. Blue Grosbeak | Possible-X | |
| 59. Indigo Bunting | Probable-T | Probable-T |
| 60. Red-winged Blackbird | Probable-T,A | Confirmed-FY |
| 61. Common Grackle | Confirmed-FL | Confirmed-FY,FL |
| 62. Brown-headed Cowbird | Probable-T | Probable-T |
| 63. Orchard Oriole | | Probable-T |
| 64. Baltimore Oriole | Probable-T | Possible-X |
| 65. House Finch | Possible-X | |
| 66. American Goldfinch | Confirmed-FL | Probable-T |
| 67. House Sparrow | Probable-T | |

**Table 3. (Cont.)**

**BREEDING CRITERIA AND CODES ***

**POSSIBLE**

X – Species heard or seen in breeding habitat within Safe Dates.

**PROBABLE**

A – Agitated behavior or anxiety calls from adult. Parent birds respond to threats with distress calls by attacking intruders.

P – Pair observed in suitable breeding habitat within Safe Dates.

T – Territorial behavior or singing male present at same location at least 2 different days (observation separated by at least 5 days). Territoriality can be presumed from defensive encounters between individuals of the same species, or by observing a male singing from a variety of perches within a small area.

C- Courtship or copulation observed. This includes displays, courtship feeding, and birds mating.

N- Visiting probable nest site. Primarily applies to cavity nesters. This code applies when a bird is observed visiting the site repeatedly, but no further evidence is seen.

B – Nest building by wrens or excavation by woodpeckers. Both groups build dummy or roosting nests at the same time they are building a real one, but an unmated male will exhibit the same behavior.

**CONFIRMED**

NB – Nest building (except wrens and woodpeckers) or adult carrying nesting material. Carrying sticks is part of the courtship ritual (code "C") for some species.

FL – Recently fledged young or downy young. This includes dependent young only. Young cowbirds begging for food confirm both the cowbird and the host species.

FY – Adult carrying food for young.

# Figures

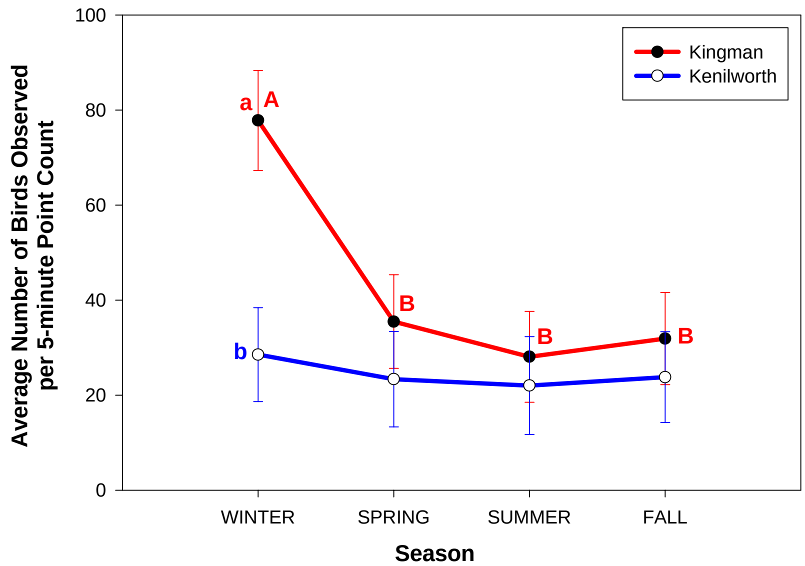



**Figure 1. Seasonal abundance of all birds observed at Kingman and Kenilworth during 2003.** Graph presents seasonal least square means (± 1 SE) for total number of birds observed during one 5-minute point count. Within areas, means sharing the same upper case letters do not differ significantly among seasons (Tukey's studentized range test of least square means; overall α = 0.05). Within seasons, means sharing the same lower case letters do not differ significantly. Unlabeled series have no significant differences.

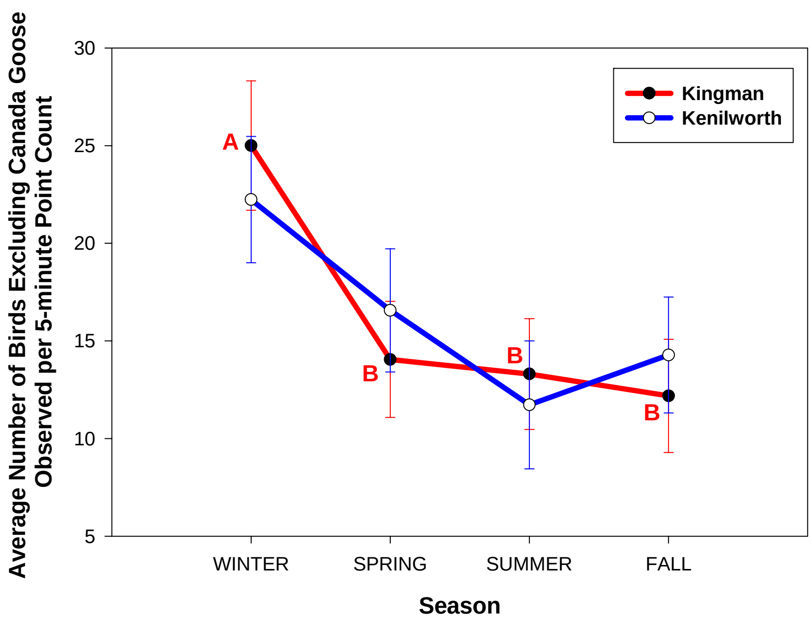



**Figure 2. Seasonal abundance of birds excluding Canada Goose observed at Kingman and Kenilworth during 2003.** Graph presents seasonal least square means (+/- 1 SE) for total number of non- Canada Goose birds observed during the 5- minute point counts. Within areas, means sharing the same upper case letters do not differ significantly among seasons (Tukey's studentized range test of least square means; overall α = 0.05). Unlabeled series have no significant differences. There were no significant differences among areas within seasons.

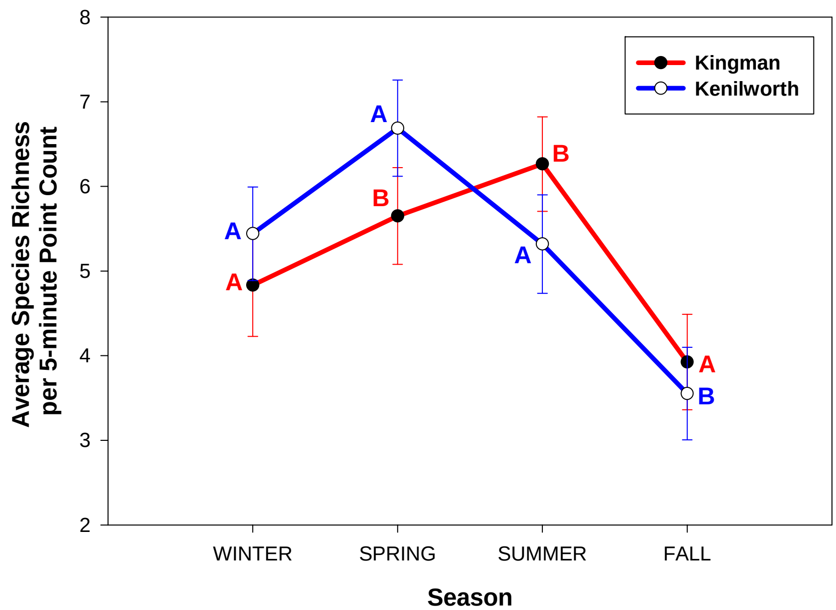
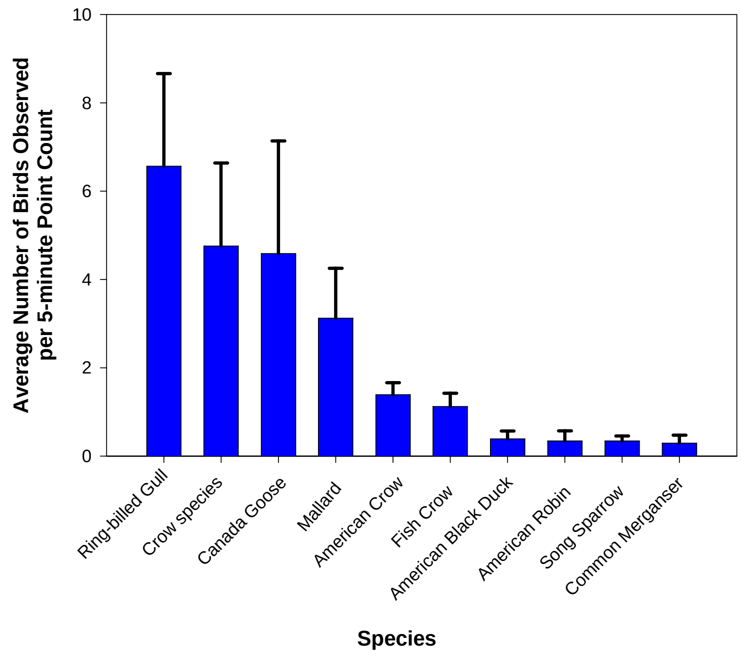
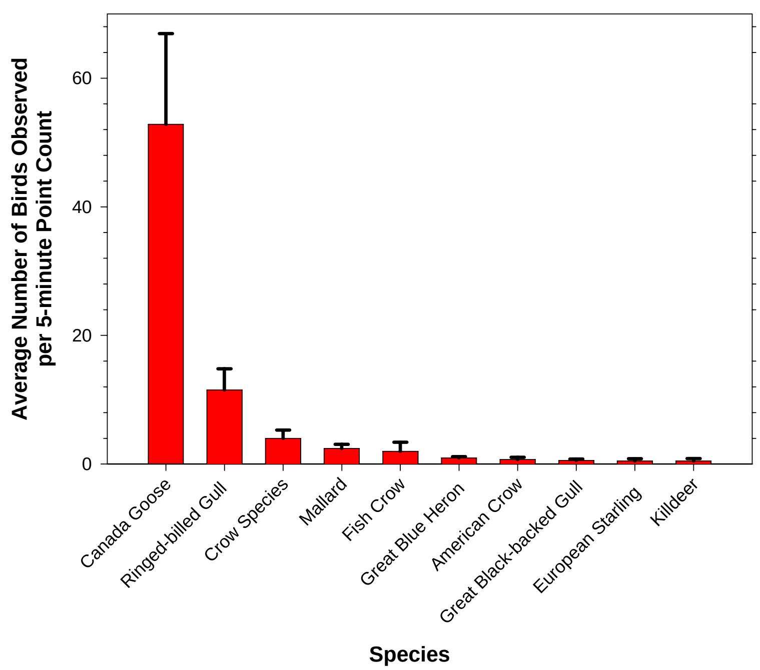



**Figure 3. Seasonal species richness of birds observed at Kingman and Kenilworth during 2003.** Graph presents seasonal least square means (+/- SE) for total number of bird species observed per 5-minute count. Within areas, means sharing the same upper case letters do not differ significantly among seasons (Tukey's studentized range test of least square means; overall $\alpha = 0.05$). There were no significant differences among areas within seasons.

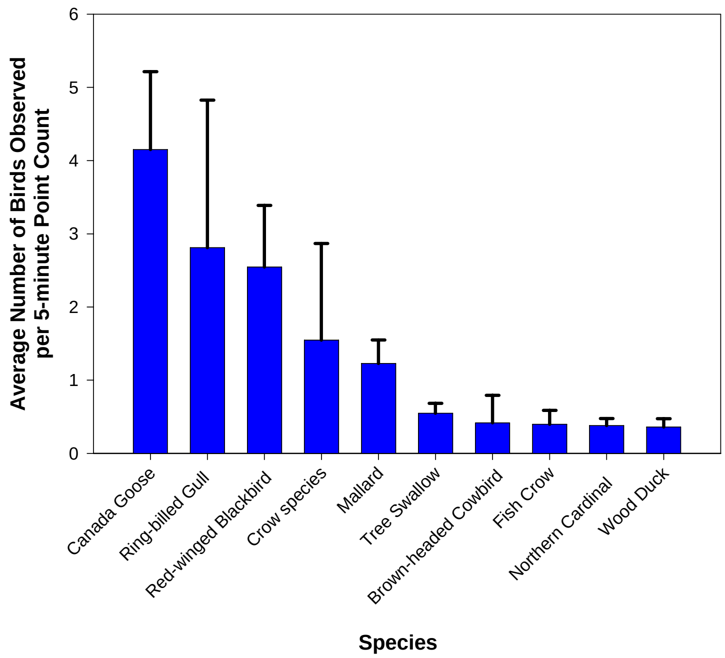



**a) Kenilworth Winter 2002**

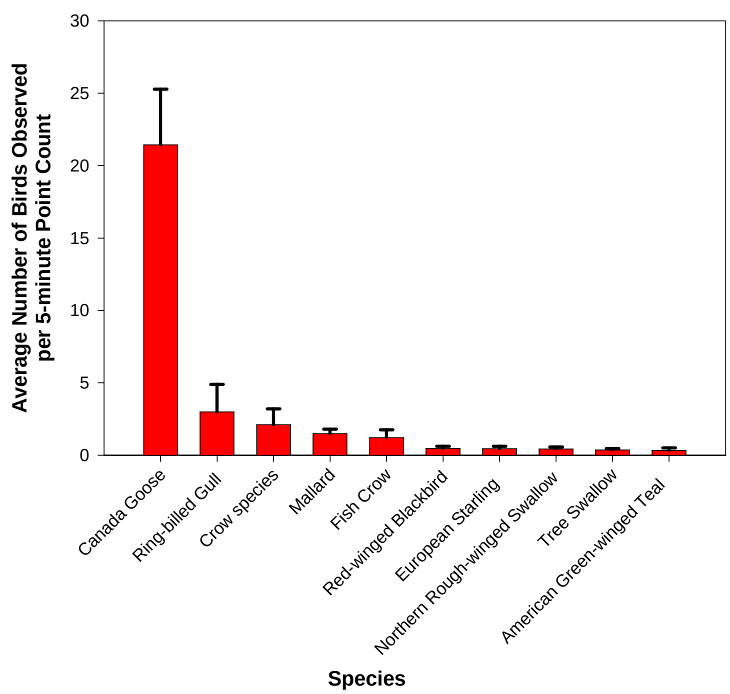



**b) Kingman Winter 2002**

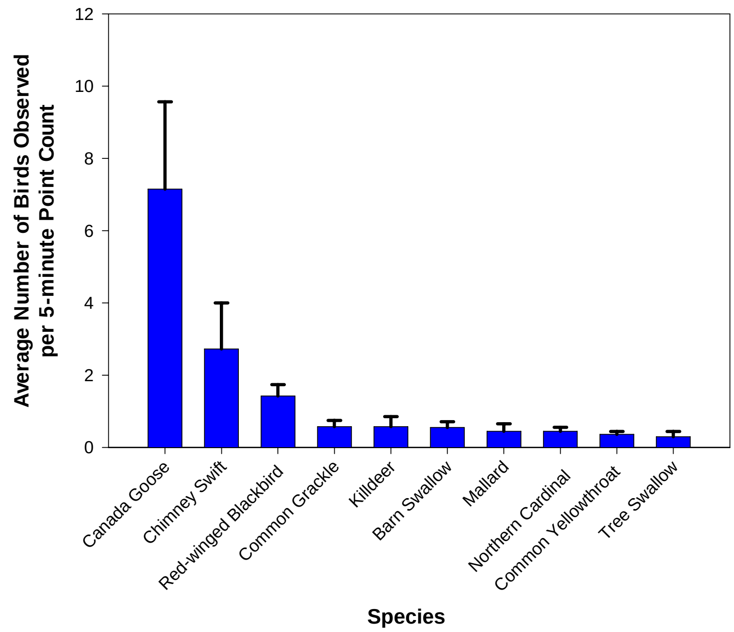
**Fig. 4. Seasonal abundances of most prevalent bird species at Kingman and Kenilworth for 2003.** Graphs present seasonal abundance means (+/- 1 SE) for the total number of individuals per species observed per 5-minute count. The top ten most abundant species are graphed for each area.



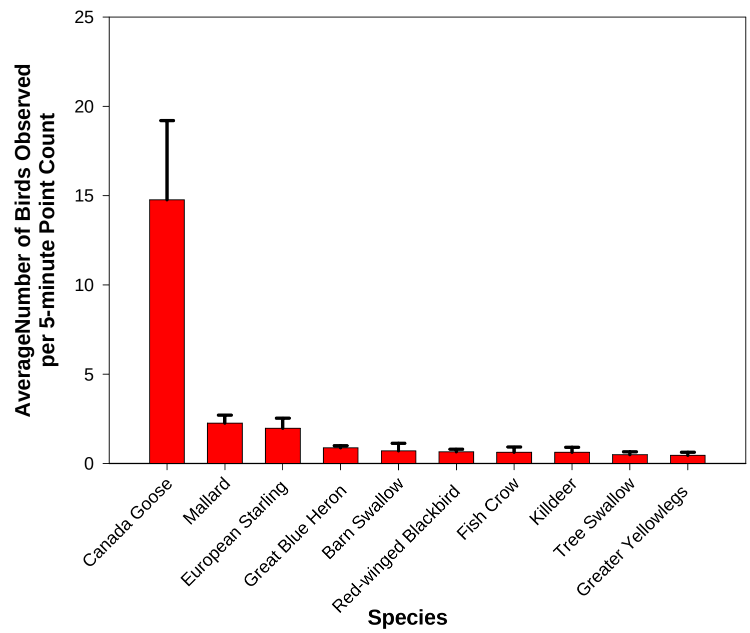

**c) Kenilworth Spring 2003**



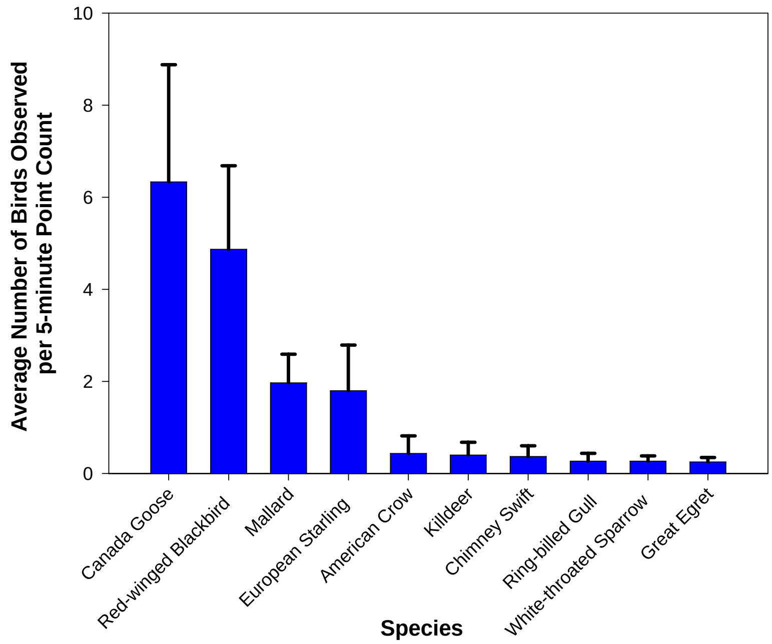

**d) Kingman Spring 2003**



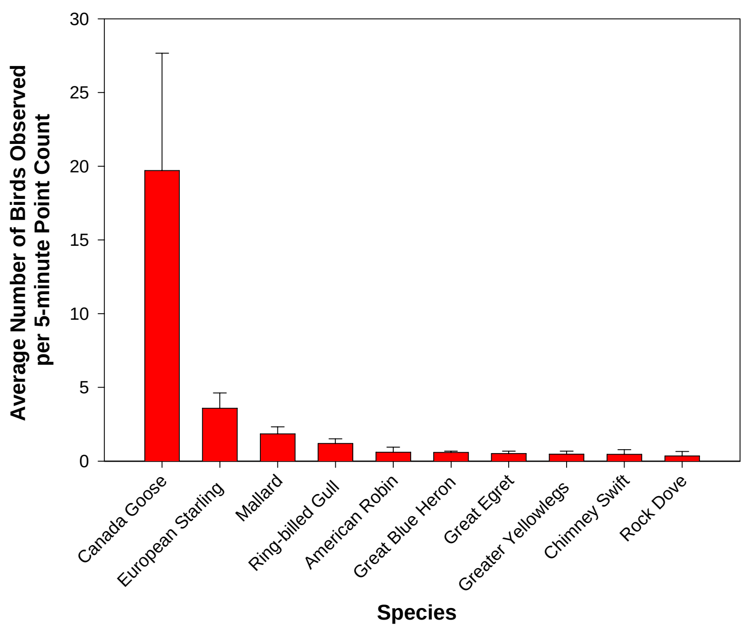

**e) Kenilworth Summer 2003**




**f) Kingman Summer 2003**

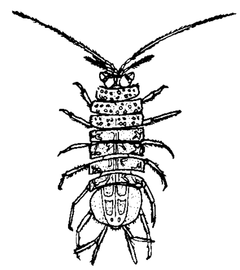


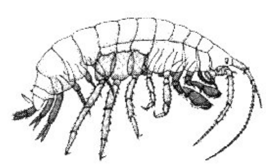

**g) Kenilworth Fall 2003**




**h) Kingman Fall 2003**

Annual Report (2003) for the Benthic Macroinvertebrate Populations of Urban Freshwater Tidal Wetlands in the Anacostia River, Washington, D.C.





Kevin D. Brittingham
Dick Hammerschlag

**Abstract:**

Considerable work has been conducted on the benthic populations of such aquatic systems as streams and lakes, but there remains a paucity of effort on tidal wetlands, especially freshwater. This study will characterize the benthic communities establishing themselves on recently reconstructed urban freshwater tidal wetlands in Washington, D.C. in comparison to a similar relict wetland in the Anacostia as well as to a reference tidal wetland in the nearby Patuxent River watershed. The focus of the study will be the two main areas of Kingman Marsh, which were reconstructed from Anacostia dredge material by the U.S. Army Corps of Engineers in 2000. Populations from this 'new' marsh will be compared to those of similarly reconstructed Kenilworth Marsh (1993) just one-half a mile upstream, as well as to the relict Dueling Creek Marsh on the Anacostia and the outside reference Patuxent Marsh in an adjacent watershed. Benthic organisms will be collected using selected techniques including the Ekman bottom grab sampler, sediment corer, D-net and Hester-Dendy sampler. Samples will be collected at least seasonally from tidal channels, tidal mudflats, three vegetation/sediment zones (low, middle and high marsh), and pools. Data collected from this study will provide valuable information on the extent that benthic macroinvertebrate communities can serve as an indicator of the relative success of freshwater tidal marsh reconstruction.

**Background and Justification:**

The U.S. Army Corps of Engineers (COE) is the lead agency in the effort to reconstruct and restore freshwater tidal wetlands along the Anacostia River in Washington, D.C. This large-scale effort involving millions of dollars justifies a rigorous monitoring program to evaluate the level of success in recreating the wetlands and their habitat. The areas in question had once been vital freshwater tidal wetlands but had been mandatorily dredged by the COE during the first half of the 20th century. Recently, the COE has used various program components to justify rebuilding some of the lost wetlands using dredge material available from the heavily sedimented Anacostia River channel. The wetland areas involved are located in the District of Columbia on National Park Service (NPS) lands.

Monitoring has been designed not just to determine whether the COE generally achieved its goals, but to learn from the procedures involved what worked well and what could be improved for the next project. The U.S. Geological Survey at Patuxent Wildlife Research Center (USGS PWRC) in Laurel, Maryland has been a leader in documenting the pre-and post-reconstruction status of urban freshwater tidal wetlands in the Anacostia River. This project is being conducted in response to requests by the District of Columbia Department of Environmental Health, Baltimore District of the Corps of Engineers and the National Capital Region of the National Park Service. These agencies wish to utilize the expertise residing at USGS PWRC to conduct a detailed benthic study covering the Anacostia wetlands. Collected data is to be analyzed and used to support required monitoring and project baseline studies for the numerous wetland reconstruction projects in the Anacostia watershed being implemented by COE.

The high cost, high visibility and challenging circumstances for successful freshwater tidal wetland reconstruction in urbanized Washington, D.C. justify multi-year monitoring to measure the level of marsh reconstruction success. Benthic taxa and population level data are used as a short-term indicator given that most members of the benthic macroinvertebrate community have relatively short life cycles. We expect to rapidly evaluate whether and to what extent the urban reconstructed wetlands are evolving toward reference wetlands, providing suitable habitat and whether there are pollution effects. It should be re-emphasized that literature review has revealed a paucity of information pertaining to the invertebrate communities of freshwater tidal wetlands.

There are special challenges in pursuing this work due to the play of tidal cycles and fluxes determining varying inundation periods for the marsh zones. The benthic communities may well respond to the tidal regimes as they can to periods of flooding. We will attempt to characterize the benthic populations in as many of the resulting marsh zones (habitat areas) as proves useful and viable. A measure of adaptive sampling will be involved. Nonetheless the characterization of these benthic communities, relying especially on metrics such as abundance, taxonomic richness and pollution tolerance, will provide a practical bioassessment. These determinations will be compared to other indicators to further validate the usefulness of benthic organisms as short- term indicators of reconstructed wetland health. Such information will be important as a “yardstick” to assess progress for the reconstructed Anacostia wetlands and others like them. This study will also utilize information from others involving the marshes in question concerning such parameters as vegetation, hydrology, sedimentation processes, soil structure and soil properties. Since the Anacostia is a tributary to the Chesapeake Bay, this study will be contributing to the base of information used to better understand the ecology of the Chesapeake Bay system.

**Objectives:**

While the overall objective of this study is to evaluate the relative success of urban freshwater tidal marsh reconstruction, there are a number of task-oriented goals that will also be pursued. The study hypothesis is that the benthic community can provide a viable bioassessment of the reconstructed urban freshwater tidal habitat; or, more statistically stated as a null hypothesis - the benthic community will not suffice as an indicator of successful wetland reconstruction. Project tasks will include:

1. Identifying to the extent practical the benthic organisms inhabiting the urban Anacostia marshes (Kingman, Kenilworth and Dueling Creek) as compared to the more rural Patuxent Marsh area.
2. Determining whether time of marsh establishment (age) relates to differing benthic communities by evaluating as a series: Kingman Marsh as reconstructed in 2000, Kenilworth Marsh as reconstructed in 1993, Dueling Creek as a disturbed but last remaining relict marsh area in the Anacostia, and a relatively undisturbed Patuxent marsh area in an outside, but nearby watershed.
3. Evaluating the influence of marsh (sediment) elevations (elevation gradient effect) and tidal regimes on benthic community composition in the freshwater tidal system by

sampling channel; mud flats (exposed at low tide); low, middle and high marsh zones; and stable but temporary pools.
4. Using combinations of quantifiable methods of sampling such as the Ekman dredge and corers coupled with qualitative benthic sampling devices such as sweeps with D-nets and placement of Hester-Dendy samplers over periods of time.
5. Comparing the benthic populations of the reconstructed marshes (Kingman and Kenilworth) with the non-reconstructed marsh areas of Dueling Creek and Patuxent.
6. Evaluating the various wetland benthic communities for pollution tolerance.
7. Comparing the results from this study with those from similar wetland projects as may be reported in the literature.
8. Concluding to what extent the benthic community can serve as one of the indicators of successful freshwater tidal marsh reconstruction.

**Year 1 activities (2002):**

The study proposal went through peer review at the Patuxent Wildlife Research Center with minimal recommended adjustments to the study. The detailed sampling schedule as well as the methods for sampling and objectives for the study can be seen in the project proposal.

Preliminary sampling started in September of 2001 to determine the effectiveness of the sampling gear and identify possible sampling sites. As a result, six habitat units (channel, mudflat, low marsh, middle marsh, high marsh, and pools) were selected to be sampled in the four freshwater tidal wetlands (Patuxent, Dueling Creek, Kenilworth, and Kingman).

Sampling for 2002 began on January 25 and ended on December 2, 2002. There were nearly 500 samples collected from the four wetlands. A full suite of samples (15 per site x 6 sites = 90 samples) required about four days of effort to collect for each time period. Processing and identification of each sample requires over a full hour to identify invertebrates present, with some samples containing over 500 organisms. Validation of correct identifications has been pursued through a network of biologists who are current members of the North American Benthological Society.

All of the 2002 Hester-Dendy (HD) samples have been processed and identified, which represents some 81,000 organisms. The HD samplers are used for the pools and channels, which are inundated most of the time. Nearly sixty taxonomic units are present in the HD collection, with more pending validation. Preliminary findings show certain organisms such as Chironomids (aquatic fly larvae), which are the most abundant to have densities close to 12,000 per meter squared ($m^2$). Densities are calculated by taking the actual number of organisms found in a sample and multiplying it by the conversion factor for meter squared. Oligochaetes (aquatic worms) are second in abundance with densities near 4,000 per $m^2$. Amphipod and Isopod densities are close to 1,000 per $m^2$.

**Year 2 activities (2003):**

Year 2 activities for the Benthic Project cover work conducted and initiated during the period encompassed by this Annual Report (2003) for the Kingman Monitoring Project. Sampling started in late February - early March 2003, which was a bit later than planned due to the prolonged, intense winter and was completed by the end of November 2003. A total of 480 samples were collected from the four wetlands in 2003, with only a winter and spring sample remaining for the study (2004). Sample processing (picking and identifying) has been very time consuming, with each sample taking an average of 1.5 hours to complete. Currently there are approximately 300 samples left to process, which should take three months to finish.

The Hester-Dendy data from 2002 (not previously reported) (Table 1 a&b) has been put in spreadsheet format, allowing for some preliminary data analysis, however, this represents only a small fraction of the total data set. Figure 1 identifies the total abundance for the pool HD's from the six wetlands, and Figure 2 shows the total abundance for the channel HD's. The pool HD total abundance is similar for all the sites, except Kingman Area 2, which can be explained by a very high presence of chironomids. The chironomid density got as high as 5,000 per $m^2$ in the pool HD, which was the highest for any site. The channel total abundance was higher for all sites, with Kenilworth Mass Fill 2 and Dueling Creek having the lowest abundance. Taxonomic richness for the 2002 HD data is shown in Figure 3. Channel taxa richness is higher than pool richness, with Kenilworth Mass Fill 2 having the highest richness, but (as seen in Figure 2) the lowest abundance. Kingman Area 2 has the lowest taxa richness but the highest abundance, which can be explained by a very high chironomid density (nearly 12,000 per $m^2$). These high abundances can be seen in Figures 4 and 5. These figures represent the three major taxa groups, Chironomidae, Oligochaete, and Crustacea (which is represented by the amphipod *Gammarus*, and an isopod *Asellus*).

All of the Ekman and dip net samples for 2002 have been processed, however the data has not been entered into spreadsheet format. Although not all the samples have been identified, some interesting findings are emerging. Mudflat samples have low diversity but very high abundance, with some samples having densities of chironomids and oligochaetes ranging from 5,000 to 12,000 per $m^2$. Vegetated zones have a greater diversity than mudflats and channels, however pool habitats are showing the greatest diversity. Overall, the benthic community composition is similar for the Kingman, Kenilworth, and Dueling Creek marshes, however the Patuxent marsh is not similar with its higher diversity and abundance. When comparing Total Vegetative Coverage data from the four marshes to preliminary benthic abundance data, one interesting thing stands out, the abundance seems to be correlated to the vegetative cover. Sites with greater vegetative cover have higher benthic abundance (this is not statistically based, just determined from looking at raw benthic numbers). However, this and other correlations will be determined statistically for the Final Report. One additional point that should be noted, is that this study will be useful on a management/monitoring level, in that the multiple sampler approach used by this study will demonstrate the most effective method in determining the macroinvertebrate community composition for freshwater tidal wetlands.

An abstract was submitted and accepted to the North American Benthological Society 52nd Annual Meeting in Vancouver, B.C. The meeting was held on June 5th to June 11th, 2004, at the University of Vancouver. There was good feedback from the talk, with many contacts made for validation of specimens and correspondence for upcoming data analysis. There was also an expressed interest for the Final Report and a possible updated presentation for next year's Conference in New Orleans (2005).

# Tables

Table 1a.Kingman POOL Hester-Dendy Sampler

| | F01 | W02 | SP02 | SU02 | SU02 | F02 | W02 | SP02 | SU02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | KG1P | KG1P | KG1P | KG1P | KG1P | KG1P | KG2P | KG2P | KG2P | KG2P | TOTAL | Total/$m^2$ |
| *Beezia/palpomia* | | | | | | | | | | | 0 | 0 |
| chironomid | 5 | 3 | 98 | 5 | 7 | 13 | 13 | 370 | 436 | 356 | 1306 | 13060 |
| Dolichopodidae | | | | | | | | | | | 0 | 0 |
| Psychodidae | | | | | | | | | | | 0 | 0 |
| Stratiomydae | | | | | | | | | | | 0 | 0 |
| tipulidae | | | | | | | | | | | 0 | 0 |
| tabanidae | | | | | | | | | | | 0 | 0 |
| Zavrelimyia | | | | | | | | | | | 0 | 0 |
| unkwn snail | | | | | | | | | | | 0 | 0 |
| Limpet | | | | | | | | | 4 | | 4 | 40 |
| Lymnaeidae | | | | | | | | | | | 0 | 0 |
| physidae | 8 | 3 | 12 | | | | 1 | | | | 24 | 240 |
| planorbidae | 1 | | 1 | 1 | | 1 | | | 27 | 4 | 35 | 350 |
| vivipardae | | | | | | | | | | | 0 | 0 |
| libellulidae/corduliidae | 1 | 1 | | | | | | | | | 2 | 20 |
| *Ischnura* | 3 | | | | | | | 1 | | | 4 | 40 |
| *Gammarus* | 2 | | 18 | | | | | 13 | 11 | 3 | 47 | 470 |
| *Asellus* | | | | | | | | | | | 0 | 0 |
| *Cyrnellus* | | | | | | 6 | | | 6 | 11 | 23 | 230 |
| collembola | 1 | | | | | | | | | | 1 | 10 |
| unkwn beetle | | | | | | | | | | | 0 | 0 |
| *Berosus* | | | | | | | | | | | 0 | 0 |
| dytiscidae | | | | | | | | | | | 0 | 0 |
| Lampyridae | | | | | | | | | | | 0 | 0 |
| *Mesovelia* | | | | | | | | | | | 0 | 0 |
| *Corbicula* | 2 | | | | | | | | | | 2 | 20 |
| spharid | | 1 | 4 | | | | | | 2 | | 7 | 70 |
| oligochaete | 54 | 35 | 60 | 25 | 8 | 141 | 117 | 2 | 42 | 6 | 490 | 4900 |
| nematoda | | | | | | | | | 2 | | 2 | 20 |
| turbellarian | | | | | | | | | | | 0 | 0 |
| *Desserobdella phalera* | | | 1 | | | | | | | | 1 | 10 |
| *Erpobdella punctata* | | | | | | | | | | | 0 | 0 |
| *Gloiobdella elongata* | | | | | | | | | | | 0 | 0 |
| *Helobdella fusca* | | | | | | | | | | | 0 | 0 |
| *Helobdella stragnalis* | | | | | | | | | | | 0 | 0 |
| *Mooreobdella microstoma* | | 9 | | | | | | | | | 9 | 90 |
| unkwn leech | | | | | | | | | | | 0 | 0 |
| *Placobdella sp?* | | | | | | | | | | | 0 | 0 |
| TOTAL organisms | 77 | 52 | 194 | 31 | 15 | 161 | 131 | 386 | 530 | 380 | 1957 | 19570 |
| TOTAL/$m^2$ | 770 | 520 | 1940 | 310 | 150 | 1610 | 1310 | 3860 | 5300 | 3800 | | |

KG1 = Kingman Area 1

KG2 = Kingman Area 2

Table 1a. Kenilworth POOL Hester-Dendy Sampler

| | W02 | SP02 | SU02 | F02 | W02 | SP02 | SU02 | SU02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | KW1P | KW1P | KW1P | KW1P | KW2P | KW2P | KW2P | KW2P | KW2P | TOTAL | Total/m$^2$ |
| *Beezia/palpomia* | 1 | | | | | 1 | | | | 2 | 20 |
| chironomid | 10 | 4 | 4 | 31 | 1 | 27 | 9 | 24 | 27 | 137 | 1370 |
| Dolichopodidae | | 3 | | | | | | | | 3 | 30 |
| Psychodidae | | | | | | | | | | 0 | 0 |
| Stratiomydae | | | 1 | | | | | | | 1 | 10 |
| tipulidae | | | | | | | | | | 0 | 0 |
| tabanidae | | | | | | | | | | 0 | 0 |
| Zavrelimyia | | | | | | | | | | 0 | 0 |
| unkwn snail | | | | | | | | | | 0 | 0 |
| Limpet | | | | | | | | | | 0 | 0 |
| Lymnaeidae | | | | | | | | | | 0 | 0 |
| physidae | | | | | 2 | | 13 | | 4 | 19 | 190 |
| planorbidae | | | | | | 1 | | | | 1 | 10 |
| vivipardae | | | | | | | | | | 0 | 0 |
| libellulidae/corduliidae | | | | | | | | | | 0 | 0 |
| *Ischnura* | | | | | | | | | | 0 | 0 |
| *Gammarus* | | | | | 19 | | | | 12 | 31 | 310 |
| *Asellus* | 3 | 3 | | | 44 | | | | 9 | 59 | 590 |
| *Cyrnellus* | | | | | | | | | | 0 | 0 |
| collembola | | | | | | | | | | 0 | 0 |
| unkwn beetle | | 2 | | | | | | | | 2 | 20 |
| *Berosus* | | | | | | | | | | 0 | 0 |
| dytiscidae | | | | | | | | | | 0 | 0 |
| Lampyridae | | | | | | | | | | 0 | 0 |
| *Mesovelia* | | | | | | 4 | | | | 4 | 40 |
| *Corbicula* | | | | | | | | | | 0 | 0 |
| spharid | | | | 9 | 1 | 7 | 4 | 4 | 3 | 28 | 280 |
| oligochaete | 21 | 25 | 2 | 79 | 4 | 83 | 8 | 21 | 49 | 292 | 2920 |
| nematoda | | | | | | | | | | 0 | 0 |
| turbellarian | | | | | | | | | | 0 | 0 |
| *Desserobdella phalera* | | | | | 2 | | | | 1 | 3 | 30 |
| *Erpobdella punctata* | | | | 1 | | | | | | 1 | 10 |
| *Gloiobdella elongata* | | | | | | | | | | 0 | 0 |
| *Helobdella fusca* | | | | | | | | | | 0 | 0 |
| *Helobdella stragnalis* | | | | | | 2 | 3 | | 1 | 6 | 60 |
| *Mooreobdella microstoma* | | | | | | | | | | 0 | 0 |
| unkwn leech | | | | | | | | | | 0 | 0 |
| *Placobdella sp?* | | | | | | | | | | 0 | 0 |
| TOTAL organisms | 35 | 37 | 7 | 120 | 73 | 125 | 37 | 49 | 106 | 589 | 5890 |
| TOTAL/m$^2$ | 350 | 370 | 70 | 1200 | 730 | 1250 | 370 | 490 | 1060 | | |

KW1 = Kenilworth Mass Fill1

KW2 = Kenilworth Mass Fill 2

Table 1a. Dueling and Patuxent POOL Hester-Dendy Sampler

| | W02 | SP02 | SU02 | F02 | F01 | W02 | SP02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | PAXP | PAXP | PAXP | PAXP | DCP | DCP | DCP | DCP | TOTAL | Total/m$^2$ |
| *Beezia/palpomia* | | | | | | 3 | 2 | | 5 | 50 |
| chironomid | 2 | | 14 | 1 | | 6 | 3 | 26 | 52 | 520 |
| Dolichopodidae | | | | | | | 3 | 1 | 4 | 40 |
| Psychodidae | | | | | | | 2 | | 2 | 20 |
| Stratiomydae | | 3 | | | | | | | 3 | 30 |
| tipulidae | | | | | | 1 | | | 1 | 10 |
| tabanidae | | | | | 1 | | | | 1 | 10 |
| Zavrelimyia | | | | | | | | | 0 | 0 |
| unkwn snail | | 2 | | | | | 2 | | 4 | 40 |
| Limpet | | | | | | | | | 0 | 0 |
| Lymnaeidae | | 2 | | | | | | | 2 | 20 |
| physidae | | | | 1 | 12 | 4 | | 1 | 18 | 180 |
| planorbidae | | | | | | | | | 0 | 0 |
| vivipardae | | | | | | | | | 0 | 0 |
| libellulidae/corduliidae | | | | | | | | | 0 | 0 |
| *Ischnura* | 3 | | | | | | | | 3 | 30 |
| *Gammarus* | | | | | | | | | 0 | 0 |
| *Asellus* | | | 1 | | | | | | 1 | 10 |
| *Cyrnellus* | | | | | | | | | 0 | 0 |
| collembola | | | | | | 60 | 32 | 21 | 113 | 1130 |
| unkwn beetle | | | | | | | | | 0 | 0 |
| *Berosus* | | | | | | | | | 0 | 0 |
| dytiscidae | | | | | | | | | 0 | 0 |
| Lampyridae | | 1 | | | | | | | 1 | 10 |
| *Mesovelia* | | | | | | | | | 0 | 0 |
| *Corbicula* | | | | | | | | | 0 | 0 |
| spharid | | 64 | 15 | | 12 | 1 | 9 | | 101 | 1010 |
| oligochaete | | | | 4 | 97 | 8 | 8 | 34 | 151 | 1510 |
| nematoda | | | | 1 | | 8 | | 6 | 15 | 150 |
| turbellarian | | | | | | | 15 | | 15 | 150 |
| *Desserobdella phalera* | | | | | | | | | 0 | 0 |
| *Erpobdella punctata* | | | | | | | 1 | | 1 | 10 |
| *Gloiobdella elongata* | | | | | | | 11 | | 11 | 110 |
| *Helobdella fusca* | | | | | | | | | 0 | 0 |
| *Helobdella stragnalis* | | | | | | | | | 0 | 0 |
| *Mooreobdella microstoma* | | | | | | | | | 0 | 0 |
| unkwn leech | | | | | | | | | 0 | 0 |
| *Placobdella sp?* | | | | | | | | | 0 | 0 |
| TOTAL organisms | 5 | 72 | 30 | 7 | 122 | 91 | 88 | 89 | 504 | 5040 |
| TOTAL/m$^2$ | 50 | 720 | 300 | 70 | 1220 | 910 | 880 | 890 | | |

PAX = Patuxent DC = Dueling Creek

Table 1b. KingmanCHANNEL
Hester-Dendy Sampler

| | F01 | W02 | SP02 | SU02 | SU02 | F02 | W02 | SP02 | SU02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | KG1TG | KG1TG | KG1TG | KG1TG | KG1TG | KG1TG | KG2TG | KG2TG | KG2TG | KG2TG | TOTAL | Total/m$^2$ |
| *Beezia/palpomia* | | | | | | | | | | | 0 | 0 |
| chironomid | 48 | 45 | 103 | 151 | 66 | 185 | 166 | 26 | 210 | 230 | 1230 | 12300 |
| Dolichopodidae | | | | | | | | | | | 0 | 0 |
| Psychodidae | | | | | | | | | | | 0 | 0 |
| Stratiomydae | | | | | | | | | | | 0 | 0 |
| tipulidae | | | | | | | | | | | 0 | 0 |
| tabanidae | | | | | | | | | | | 0 | 0 |
| Zavrelimyia | | | | | | | | | 1 | | 1 | 10 |
| unkwn snail | | | | | | | | | | | 0 | 0 |
| Limpet | | | | | | | | | | | 0 | 0 |
| Lymnaeidae | | | | | | | | | | | 0 | 0 |
| physidae | | 1 | 1 | | 1 | 1 | 3 | | | 3 | 10 | 100 |
| planorbidae | | | | | | 1 | 1 | 3 | 3 | 18 | 26 | 260 |
| vivipardae | | | 1 | | | | | | | | 1 | 10 |
| libellulidae/corduliidae | | | | | | | | | | | 0 | 0 |
| *Ischnura* | | 1 | | | | | | | | | 1 | 10 |
| *Gammarus* | 20 | 39 | 107 | | 4 | 6 | 40 | 1 | 3 | | 220 | 2200 |
| *Asellus* | | | | | | | | | | | 0 | 0 |
| *Cyrnellus* | | | | | | 2 | | | 24 | 54 | 80 | 800 |
| collembola | | | | | | | | | | | 0 | 0 |
| unkwn beetle | | | | | | | | | | | 0 | 0 |
| *Berosus* | | | | | | | | | | | 0 | 0 |
| dytiscidae | | | | | | | | | | | 0 | 0 |
| Lampyridae | | | | | | | | | | | 0 | 0 |
| *Mesovelia* | | | | | | | | | | | 0 | 0 |
| *Corbicula* | | | | 1 | | | | | | | 1 | 10 |
| spharid | 5 | 1 | | 4 | 3 | | | | | | 13 | 130 |
| oligochaete | 82 | 10 | 21 | 31 | 94 | 9 | 32 | 62 | 5 | 5 | 351 | 3510 |
| nematoda | | | | | 1 | | | | | | 1 | 10 |
| turbellarian | | | | | | | | | | 7 | 7 | 70 |
| *Desserobdella phalera* | 2 | | 1 | 3 | 3 | | 3 | 2 | | | 14 | 140 |
| *Erpobdella punctata* | | | | | 1 | | | | | | 1 | 10 |
| *Gloiobdella elongata* | | | | | | | | | | | 0 | 0 |
| *Helobdella fusca* | | | | | | | | | | | 0 | 0 |
| *Helobdella stragnalis* | | | | | | | | | | | 0 | 0 |
| *Mooreobdella microstoma* | | | | | | | | | | | 0 | 0 |
| unkwn leech | | 1 | | | | | | 1 | | | 2 | 20 |
| *Placobdella sp?* | | | | | | | | | | | 0 | 0 |
| TOTAL organisms | 157 | 98 | 234 | 190 | 173 | 204 | 245 | 95 | 246 | 317 | 1959 | 19590 |
| TOTAL/m$^2$ | 1570 | 980 | 2340 | 1900 | 1730 | 2040 | 2450 | 950 | 2460 | 3170 | | |

KG1 = Kingman Area 1

KG2 = Kingman Area 2

Table 1b. Kenilworth CHANNEL Hester-Dendy Sampler

| | W02 | SP02 | SU02 | F02 | F01 | W02 | SP02 | SU02 | SU02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | KW1TG | KW1TG | KW1TG | KW1TG | KW2TG | KW2TG | KW2TG | KW2TG | KW2TG | KW2TG | TOTAL | Total/$m^2$ |
| *Beezia/palpomia* | 2 | | | | | | | | | | 2 | 20 |
| chironomid | 11 | 43 | 92 | 47 | | 1 | 4 | 4 | 2 | 28 | 232 | 2320 |
| Dolichopodidae | | | | | | | | | | | 0 | 0 |
| Psychodidae | | | | | | | | | | | 0 | 0 |
| Stratiomydae | | | | | | | | | | | 0 | 0 |
| tipulidae | | | | | | | | | | | 0 | 0 |
| tabanidae | | | | | | | | | | | 0 | 0 |
| Zavrelimyia | | | | | | | | | | | 0 | 0 |
| unkwn snail | | | | | | | | | | | 0 | 0 |
| Limpet | | | | | | | | | | | 0 | 0 |
| Lymnaeidae | | | | | | | | | | | 0 | 0 |
| physidae | 38 | 2 | 4 | 19 | | | 4 | | | 2 | 69 | 690 |
| planorbidae | 1 | | 6 | 8 | | | | | | 4 | 19 | 190 |
| vivipardae | | | | | | | | | | | 0 | 0 |
| libellulidae/corduliidae | | | | | | | | | | | 0 | 0 |
| *Ischnura* | | | | | | | | | | | 0 | 0 |
| *Gammarus* | 34 | | | 42 | | | | | | 28 | 104 | 1040 |
| *Asellus* | 96 | | | 1 | 6 | 19 | 8 | | | 1 | 131 | 1310 |
| *Cyrnellus* | | | | 1 | | | | | | 1 | 2 | 20 |
| collembola | | | 1 | | | | 1 | 1 | | | 3 | 30 |
| unkwn beetle | | | | | | | | | | | 0 | 0 |
| *Berosus* | | | | | | | | | | | 0 | 0 |
| dytiscidae | | | | | | | | | | | 0 | 0 |
| Lampyridae | | | | | | | | | | | 0 | 0 |
| *Mesovelia* | | | | | | | | | | | 0 | 0 |
| *Corbicula* | | | | | | | | | | | 0 | 0 |
| spharid | 8 | 3 | | | 11 | 11 | 7 | 4 | 2 | 2 | 48 | 480 |
| oligochaete | 13 | 229 | 108 | 15 | 74 | 32 | 67 | 85 | 16 | 18 | 657 | 6570 |
| nematoda | 4 | | | | | | 1 | | 1 | | 6 | 60 |
| turbellarian | | | | | | | | | | | 0 | 0 |
| *Desserobdella phalera* | 3 | 1 | 4 | | | | | | | 1 | 9 | 90 |
| *Erpobdella punctata* | | | | | 1 | | | | | | 1 | 10 |
| *Gloiobdella elongata* | | | | | | | | 1 | | | 1 | 10 |
| *Helobdella fusca* | | | | | | | | | | | 0 | 0 |
| *Helobdella stragnalis* | | | | | | | | | | 1 | 1 | 10 |
| *Mooreobdella microstoma* | | | | | | | | | | | 0 | 0 |
| unkwn leech | 13 | | | | | | 1 | | 1 | | 15 | 150 |
| *Placobdella sp?* | | | | | 1 | | | | | | 1 | 10 |
| TOTAL organisms | 223 | 278 | 215 | 133 | 93 | 63 | 93 | 95 | 22 | 86 | 1301 | 13010 |
| TOTAL/$m^2$ | 2230 | 2780 | 2150 | 1330 | 930 | 630 | 930 | 950 | 220 | 860 | | |

KW1 = Kenilworth Mass Fill 1

KW2 = Kenilworth Mass Fill 2

Table 1b. Dueling and Patuxent CHANNEL Hester-Dendy Sampler

| | W01 | W02 | SP02 | SU02 | SU02 | F02 | F01 | W02 | SP02 | SU02 | SU02 | F02 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | PXTG | PXTG | PXTG | PXTG | PXTG | PXTG | DCTG | DCTG | DCTG | DCTG | DCTG | DCTG | TOTAL | Total/m2 |
| *Beezia/palpomia* | | | | | | | | | | | | | 0 | 0 |
| chironomid | 3 | 1 | 73 | 26 | | | 5 | 2 | 14 | 62 | 51 | 53 | 286 | 2860 |
| Dolichopodidae | | | | | | | | | | | | | 0 | 0 |
| Psychodidae | | | | | | | | | | | | | 0 | 0 |
| Stratiomydae | | | | | | | | | | | | | 0 | 0 |
| tipulidae | | | | | | | | | | | | | 0 | 0 |
| tabanidae | | | | | | | | | | | | | 0 | 0 |
| Zavrelimyia | | | | | | | | | | | | | 0 | 0 |
| unkwn snail | | | | 3 | | | | | | | | | 3 | 30 |
| Limpet | | | | | | | | | | | | 1 | 1 | 10 |
| Lymnaeidae | | | | | | | | | | | | | 0 | 0 |
| physidae | | 2 | 13 | | 1 | 2 | | 1 | 3 | | | 1 | 21 | 210 |
| planorbidae | 3 | 3 | 2 | 8 | | 1 | | | 5 | 3 | 1 | 26 | 46 | 460 |
| vivipardae | | | 1 | | | | | | | | | | 1 | 10 |
| libellulidae/corduliidae | | | | | | | | 1 | | | | | 1 | 10 |
| *Ischnura* | 5 | | | | | | 1 | | | | | | 1 | 10 |
| *Gammarus* | 23 | | 34 | 24 | 357 | 155 | 39 | 12 | 5 | 2 | | 4 | 632 | 6320 |
| *Asellus* | 74 | 4 | 29 | 16 | 10 | | | 1 | | | | | 56 | 560 |
| *Cyrnellus* | | | | | | | | | | | | | 0 | 0 |
| collembola | 1 | | | | | | | | | | | | 0 | 0 |
| unkwn beetle | | | | | | | | | | | | | 0 | 0 |
| *Berosus* | | 1 | | | | | | | | | | | 0 | 0 |
| dytiscidae | | | 1 | | | | | | | | | | 1 | 10 |
| Lampyridae | | | | | | | | | | | | | 0 | 0 |
| *Mesovelia* | | | | | | | | | | | | | 0 | 0 |
| *Corbicula* | | | | | | | | | | | | | 0 | 0 |
| spharid | 7 | | 9 | 1 | 1 | 3 | | | 1 | 3 | | 1 | 19 | 190 |
| oligochaete | 28 | 3 | 4 | 31 | | | 12 | 7 | 6 | 6 | 131 | 22 | 219 | 2190 |
| nematoda | | | | | | | | | | 1 | | | 1 | 10 |
| turbellarian | | | | | | 3 | | 2 | | | | 3 | 8 | 80 |
| *Desserobdella phalera* | 1 | | 3 | 4 | 1 | | | 4 | | 2 | | 2 | 16 | 160 |
| *Erpobdella punctata* | | | | | | | | | | | | | 0 | 0 |
| *Gloiobdella elongata* | | | | | | | | | | | | | 0 | 0 |
| *Helobdella fusca* | | | | | | | | | | 2 | | | 2 | 20 |
| *Helobdella stragnalis* | 5 | | 7 | 1 | 4 | | | | | | | | 12 | 120 |
| *Mooreobdella microstoma* | | | | | | | | | | | | | 0 | 0 |
| unkwn leech | | | 21 | | | | | | | | | | 21 | 210 |
| *Placobdella sp?* | | | | | | | | | | | | | 0 | 0 |
| TOTAL organisms | 150 | 14 | 197 | 114 | 374 | 164 | 57 | 30 | 34 | 81 | 183 | 113 | 1347 | 13470 |
| TOTAL/$m^2$ | 1500 | 140 | 1970 | 1140 | 3740 | 1640 | 570 | 300 | 340 | 810 | 1830 | 1130 | | |

PX= Patuxent

DC = Dueling Creek

# Figures

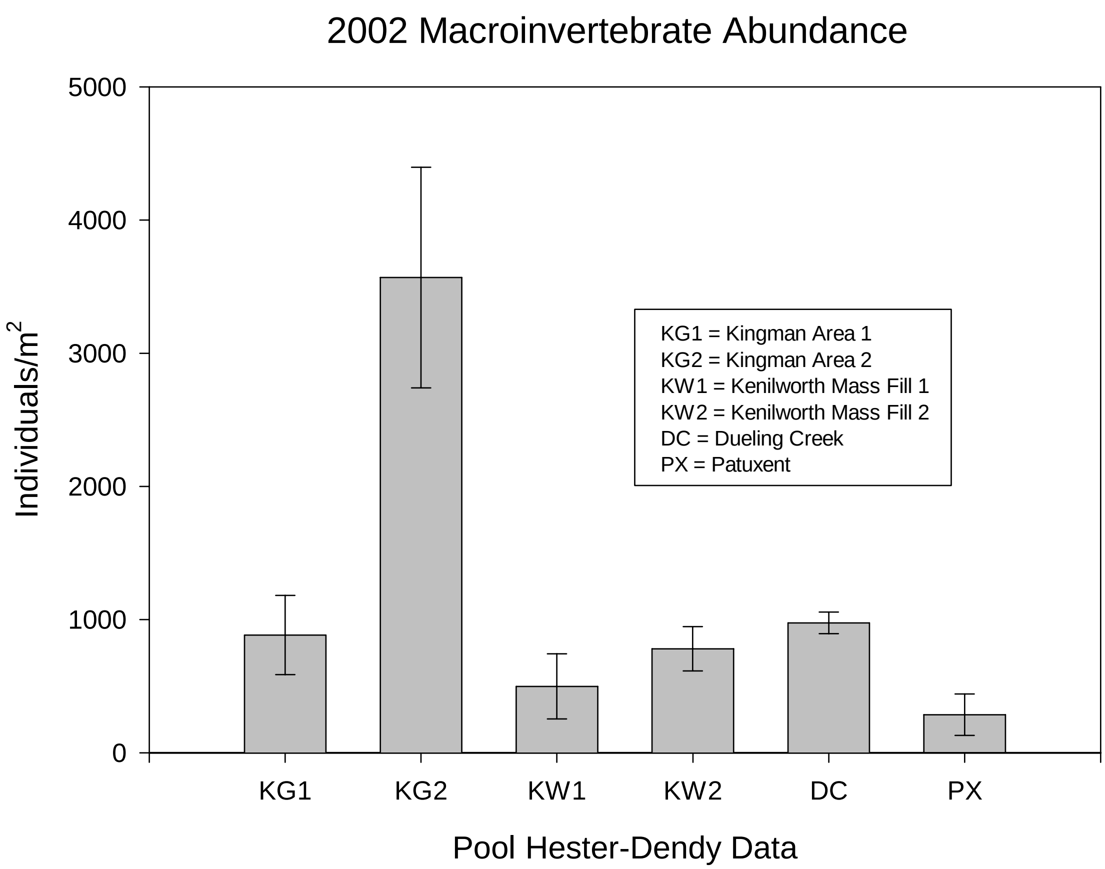



Figure 1: 2002 macroinvertebrate abundance data from pool Hester-Dendy's.

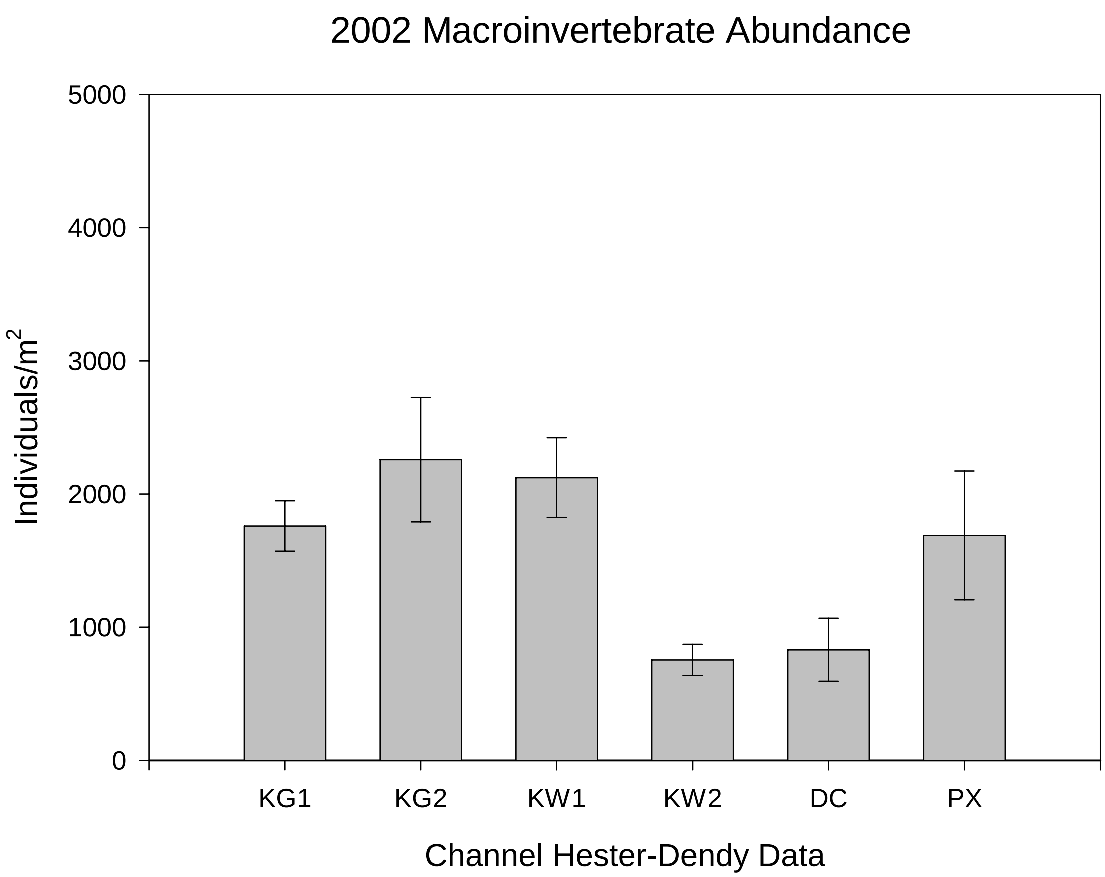



Figure 2: 2002 macroinvertebrate abundance data from channel Hester-Dendy's.

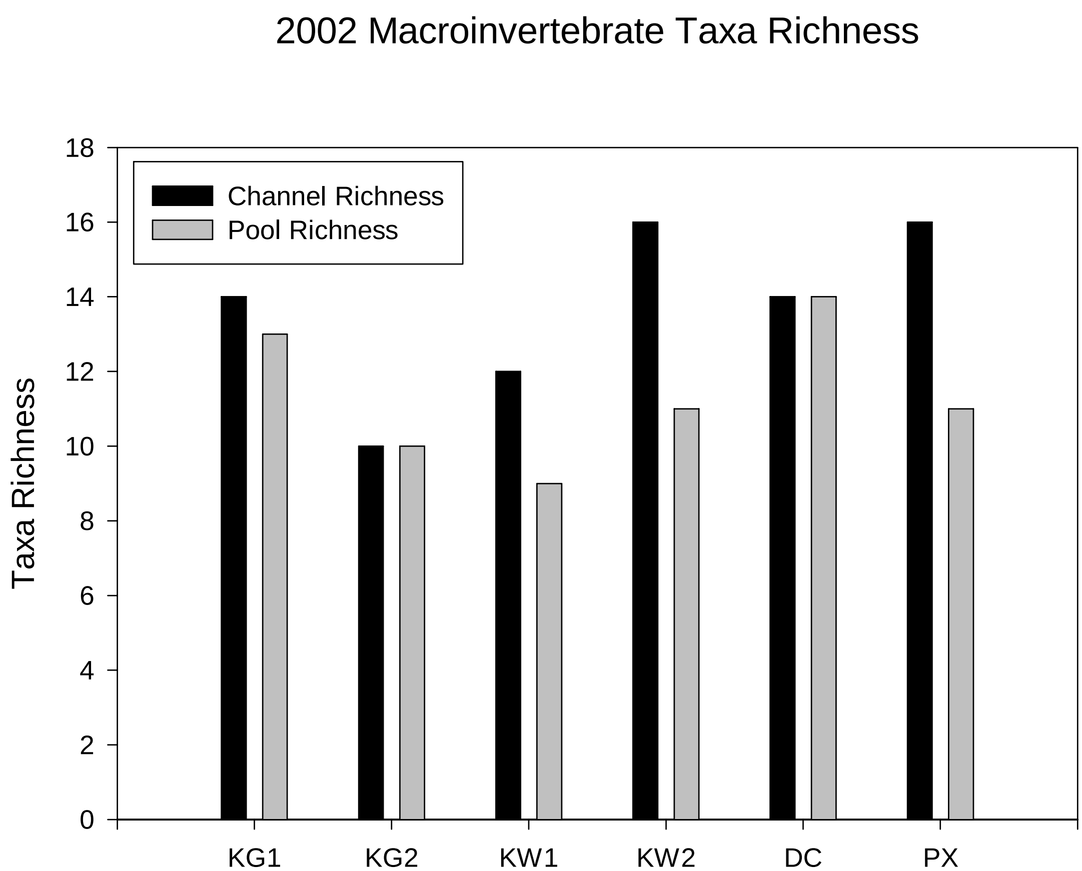



Figure 3: 2002 Macroinvertebrate Taxa Richness data from channel and pool Hester-Dendy's.

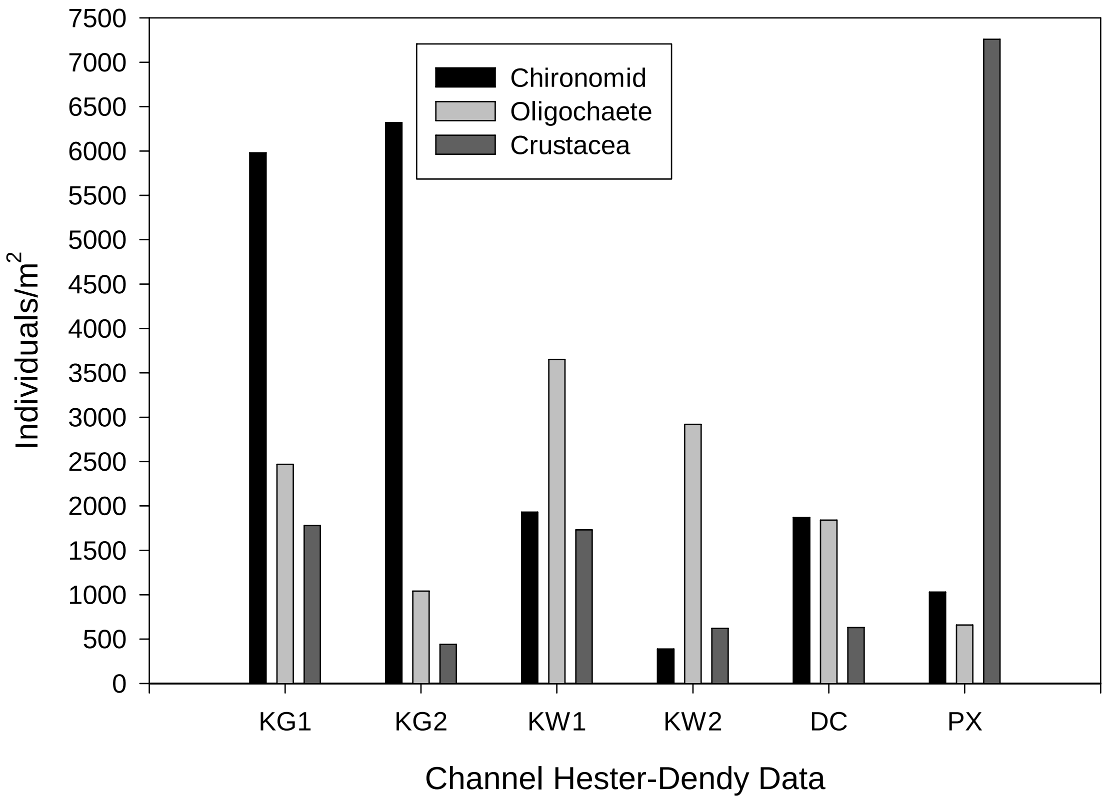



Figure 4: 2002 major taxa groups for channel Hester-Dendy data.

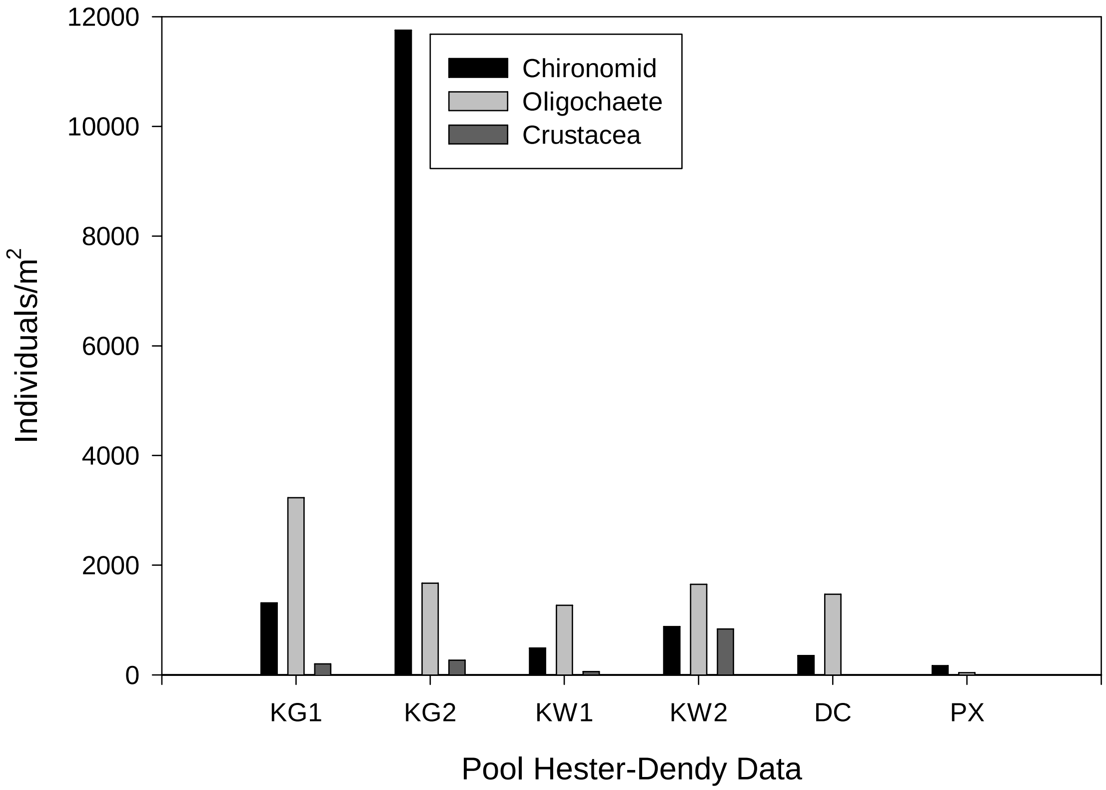



Figure 5: 2002 major taxa groups for pool Hester-Dendy data.