

Analysis of the streamside vegetation within the Hubbell Trading Post Historic Site, Apache County, Arizona

Interim Report: Summary of 2004 sampling

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Abstract

Vegetation sampling, which included year five of repeated measurements along transects and year one of measurements from random points, was conducted along Pueblo Colorado Wash within the boundaries of the Hubbell Trading Post National Historic Site, Apache County, Arizona. Transect data included the estimation of foliage-height density (FHD) of perennial vascular plants and percent cover of annual vascular plants. Random point data included estimation of the height and density of woody perennials using the point-center quarter method (PCQ), percent canopy cover, cover of herbaceous perennials, and cover of annuals.

FHD increased by 10% between the 2003 and 2004 sampling. Although there was only a slight increase in FHD for *Salix exigua*, PCQ indicated that *S. exigua* was a major woody component of the stream vegetation, with an absolute density exceeded only by *C. nauseosus*. FHDs for the native grasses *Elymus canadensis* and *Pascopyrum smithii* fell in 2004 but greatly increased for *Agrostis viridis*.

Average percent cover for annuals followed the trend in 2003, with the summer data showing a greater percent cover than in the fall. The overall average cover of annuals of Fall 2004 was 10.1 along transects and 13.5 as measured with the PCQ method.

Overall absolute densities for woody species was 641.9 inds/ha along the streambed and 757.4 inds/ha in the upland. The lower density along the streambed probably reflects the weed-tree removal efforts. Because of the increased upland area sampled by PCQ in comparison to the transect method, several species were sampled that did not occur along transects.

Introduction

The primary goal of this study was to assess changes in vascular riparian vegetation along Pueblo Colorado Wash of the Hubbell Trading Post Historic Site (Figure 1). Along most of the channel, attempts were made during the spring of 1998 and 2000 to eradicate the exotic shrubs *Elaeagnus angustifolius* L. (Russian-olive) and *Tamarix ramosissima* Ledeb. (salt-cedar). It is the long-term goal of the U. S. Park Service to reestablish the channel vegetation to a physiognomy similar to that which preceded the invasion of exotic species.

Two independent methodologies were used for the 2004 sampling; one, which was year five of repeated sampling, included measurements taken along permanent transects; and, another, which was conducted for the first year, included measurements taken from random points. The transect method was designed to estimate composition and structure of channel vegetation, including foliage-height density or foliar-height density (FHD), by species, of perennial vascular plants, and percent cover, by species, of annual vascular plants. Random point data, which was performed only during the fall sampling, included estimation of the height and density of woody perennials using the point-center quarter method (PCQ), percent canopy cover, cover of herbaceous perennials, and cover of annuals. The second method was introduced primarily to increase overall sample size, estimate additional parameters, and to expand sampling farther into the flood plain.

Sampling was performed in midsummer and repeated in early fall, after the period of highest average rainfall for central Arizona (Bulk 1985). Sampling during previous years was identical with the following exceptions: only south-bank transects were remeasured early fall 1998, and, because of the lack of sufficient summer rainfall in 2001, transects were not remeasured in the fall of that year.

Methods

Transects

Vegetation sampling along both sides of Pueblo Colorado Wash was conducted July and September 2004. Measurements were taken along thirteen 40m transects that had initially been established along the intermittent stream channel in 1998 (Table 1, Figure 1). Except for a single site, transects were paired; one on each side of the bank, six transects along the north bank and seven along the south bank. Foliage-height density was recorded as "hits" along vertical poles. It was calculated simply as the number of hits divided by the number sampling points along each transect. The method used herein is a modified version of the vertical-line intercept or foliage-height density of MacArthur & MacArthur (1961), MacArthur & Horn (1969) and total vegetation volume (TVV) of Mills et al. (1991). FHD was chosen instead of the line intercept method because the latter estimates vegetation cover only and does not account for vegetation height or structure within the canopy. Also FHD or TVV correlates closely with breeding bird densities (Mills et al. 1991), which is a primary management concern for the Park.

Percent cover of annuals was also measured along transects simply by estimating percent cover, by species, within a 0.1m² Daubenmire grid every two meters, beginning with transect meter two.

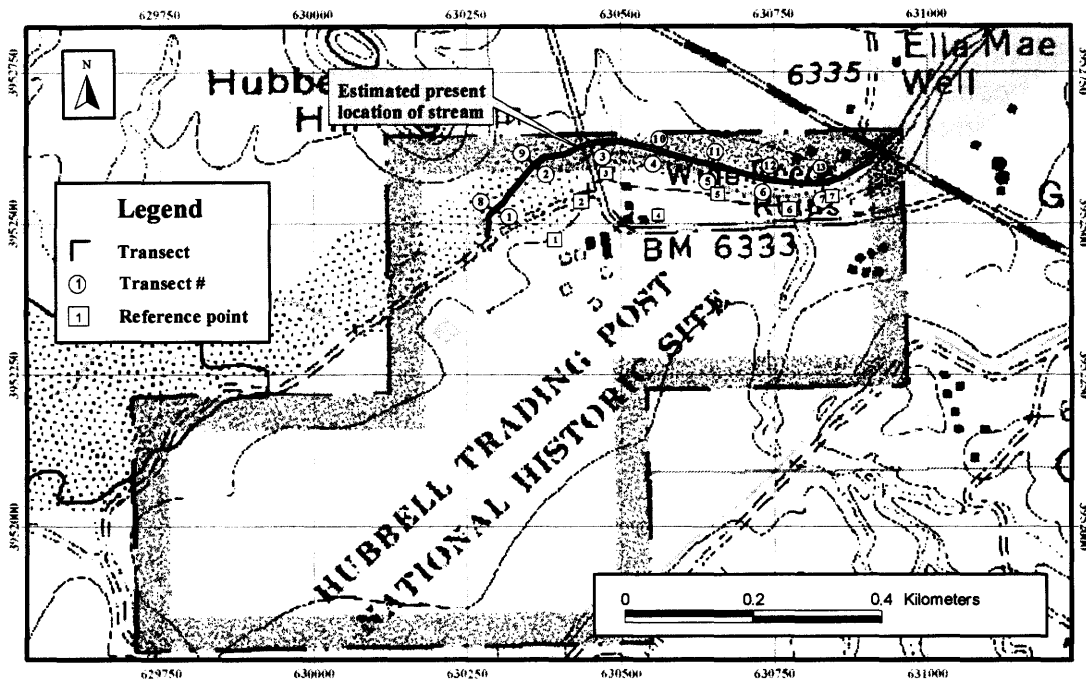


Figure 1. Hubbell Trading Post National Historic Site (Ganado USGS 7.5' topographic quadrangle), showing locations of transects, reference points, and probable present location of streambed (accuracy ± 8 m). UTM grid (NAD 27) shown as green lines.

Point-center quarter

A modified PCQ method was used to estimate the height and density of woody perennials, percent canopy cover, cover of herbaceous perennials, and cover of annuals. Points were established by using random UTM coordinates acquired from a table of random numbers. The ranges of numbers corresponded to the ranges of the UTM northings and eastings within the study area. Points were uploaded into a GPS unit and located parsimoniously in the field by using the "nearest waypoint" function of the GPS unit. At each point, the distance to and the height of the nearest woody perennial were measured within each of four quadrants (corresponding to the four cardinal directions). In addition, percent canopy cover was estimated, and percent cover for herbaceous perennials and annuals were estimated within 1.0m² and 0.1m² Daubenmire grids, respectively.

Relative density of woody plants was calculated by dividing the number of species hits by the number of points. Absolute density was then calculated by multiplying relative density by the total density: $10,000\text{m}/\text{ha}/(\text{average distance m})^2/\text{individual}$.

Average percent cover of annuals and perennials was calculated by adding the percentages of each species per quadrant, and dividing by the sample size (50 for upland and 50 for riparian).

Results and Discussion

FHD increased by 10% between the 2003 and 2004 sampling (Table 2, Fig 2). FHD of *Scirpus pungens* remained at approximately the same as it was in 2003, while that of *Chrysothamnus nauseosus* continued to increase in 2004. There were also slight increases in FHD of both *Populus* and *Salix*. FHDs for the native grasses *Elymus canadensis* and *Pascopyrum smithii* fell in 2004 but greatly increased for *Agrostis viridis* (Fig 3).

Average percent cover for annuals followed the trend in 2003, with the summer data showing a greater percent cover than fall. The overall average cover for 2004 remained similar to 2003, with the exception of transect 5 (2004 has much greater cover) and transects 9, 10, and 11 (2003 has much greater cover). The overall average cover of annuals in fall of 2004 was 10.1 along transects and 13.5 as measured with the PCQ method (Tables 6, 9). *Bromus tectorum* dominated the annual flora of the floodplain legs of transects and *Xanthium strumarium* dominated the streamside legs of transects (Table 3).

Overall absolute densities for woody species was 641.9 inds/ha along the streambed (Table 4) and 757.4 inds/ha in the upland (Table 7). The lower density along the streambed probably reflects the weed-tree removal efforts. PCQ indicated that *S. exigua* was a major woody component of the stream vegetation, exceeded only by *C. nauseosus* (Fig. 4). Because of the increased upland area sampled by PCQ in comparison to the transect method, several species were sampled that did not occur along transects.

The percent cover of herbaceous perennials along the stream was nearly eight times greater (63.1)(Table 5) than that for the upland (8.2) (Table 8). Relative percent covers among herbaceous perennial species were similar to those of their relative FHDs (Figs 3,5).

Percent canopy cover was 0.6% along the stream and 6.7% within the floodplain.

Table 1. Locations of transects and reference points (N/A = not available).

Transect number	UTM coordinates of transect at 00m (NAD 27, zone 12))		Heading east of magnetic north of first transect leg	Heading east of magnetic north from reference point	Distance from reference point	Reference point	UTM coordinates of reference points (NAD 27, zone 12))	
	mE	mN					mE	mN
South bank transects								
1	06 30 320	39 52 507	296°	25°	50m	1	06 30 394	39 52 470
2	06 30 382	39 52 572	309°	297°	70.1m	2	06 30 439	39 52 530
3	06 30 472	39 52 596	355°	355°	27.8m	3	06 30 471	39 52 570
4	06 30 550	39 52 588	350°	358°	67.8m	4	06 30 554	39 52 507
5	06 30 635	39 52 562	000°	321°	21.7m	5	06 30 647	39 52 541
6	06 30 720	39 52 544	000°	296°	46.0m	6	06 30 757	39 52 514
7	06 30 814	39 52 534	345°	259°	12.7m	7	06 30 825	39 52 536
North bank transects								
8	06 30 280	39 52 528	125°	N/A	N/A			
9	06 30 347	39 52 602	129°	N/A	N/A			
10	06 30 560	39 52 627	185°	N/A	N/A			
11	06 30 646	39 52 604	180°	N/A	N/A			
12	06 30 731	39 52 580	180°	N/A	N/A			
13	06 30 813	39 52 574	165°	N/A	N/A			

Table 2. Summary of vegetation association, canopy height, and foliage-height density (FHD) data for each transect by date.										
Transect number	Vegetation association	Data								
	Bank→streamside	Fall 2003			Summer 2004			Fall 2004		
		Max. Ht. (m)	Ave. Ht* (m)	FHD (m ³ /m ²)	Max. Ht. (m)	Ave. Ht* (m)	FHD (m ³ /m ²)	Max. Ht. (m)	Ave. Ht* (m)	FHD (m ³ /m ²)
1	<i>C. nauseosus</i> → <i>S. pungens</i>	2	0.75	0.75	1	0.55	1.10	1	0.55	0.80
2	<i>C. nauseosus</i> → <i>P. smithii</i>	2	0.80	0.80	2	0.80	0.80	2	0.75	0.80
3	<i>E. repens</i> → <i>E. glauca</i>	1	0.70	0.75	1	0.60	0.90	1	0.55	0.95
4	<i>C. nauseosus</i> → <i>S. pungens</i>	2	0.95	1.1	2	1.00	1.20	3	0.95	0.95
5	<i>C. nauseosus</i> → <i>C. nauseosus</i>	2	0.75	0.85	2	0.60	0.60	2	0.80	0.85
6	<i>C. nauseosus</i> → <i>S. pungens</i>	2	0.80	0.80	3	0.90	0.95	2	0.70	0.80
7	<i>P. smithii</i> → <i>S. pungens</i>	2	0.90	1.00	2	0.85	0.85	2	1.00	1.10
8	<i>M. asperifolia</i> → <i>S. exigua</i>	2	0.90	1.15	2	1.00	1.65	3	1.00	1.60
9	<i>S. cryptandrus</i> → <i>S. pungens</i>	1	0.35	0.35	1	0.40	0.50	1	0.35	0.35
10	<i>T. ramosissima</i> → <i>E. glauca</i>	6	1.5	1.2	6	1.70	1.90	6	1.70	1.85
11	<i>S. fendleri</i> → <i>S. pungens</i>	2	0.60	0.75	1	0.60	0.70	1	0.65	0.95
12	<i>P. deltoides</i> → <i>S. pungens</i>	14	2.65	2.05	12	2.50	2.00	12	2.3	1.65
13	<i>P. deltoides</i> → <i>S. pungens</i>	13	1.2	0.85	14	1.55	1.05	14	1.75	1.3
Overall average		3.9	1.0	1.0	3.8	1.0	1.1	3.8	1.0	1.1
*average height here is the sum of the maximum heights for all transect points divided by the number of points (20)										

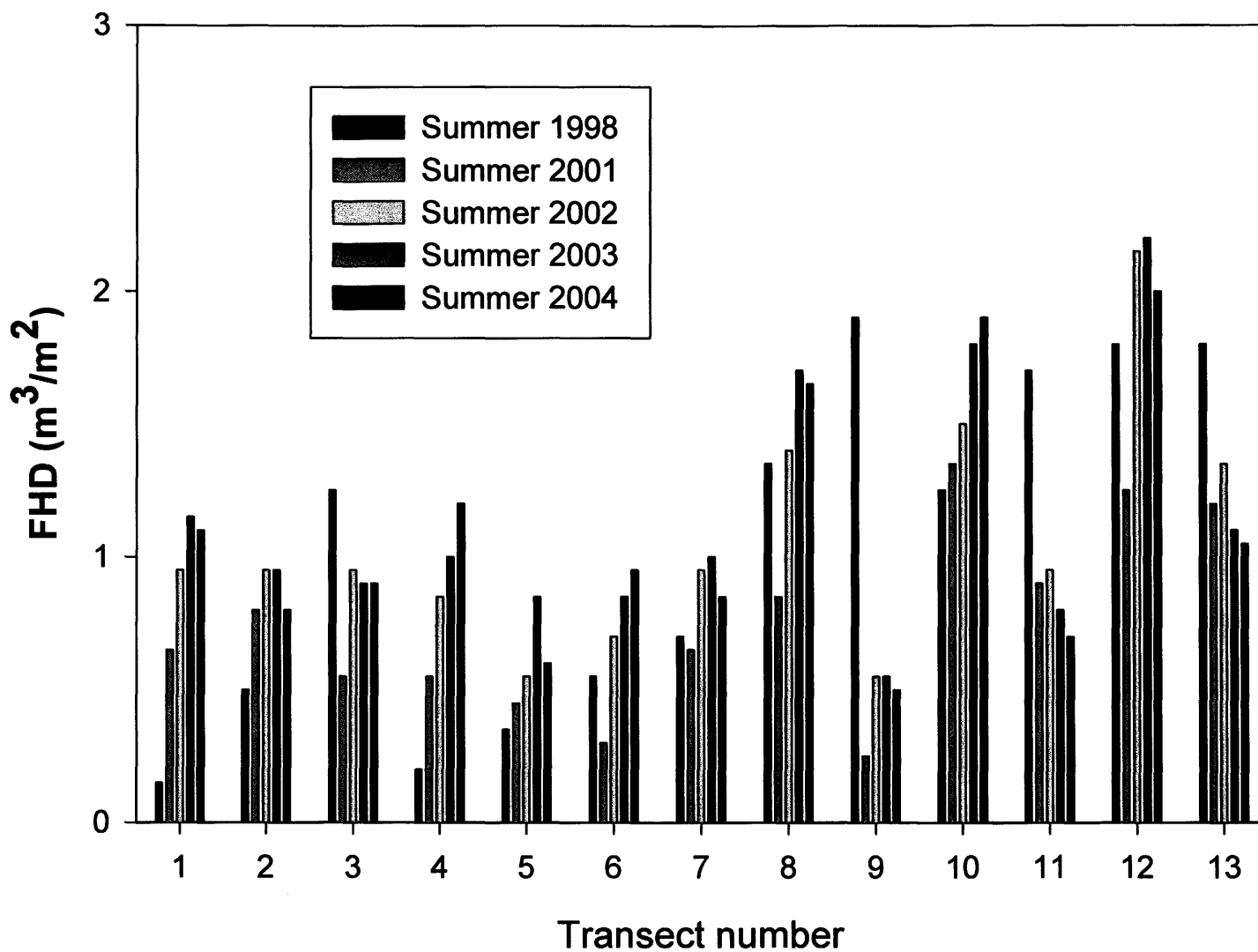


Figure 2. Comparison of FHD for summer 1998, 2001, 2002, 2003 and 2004 transects.

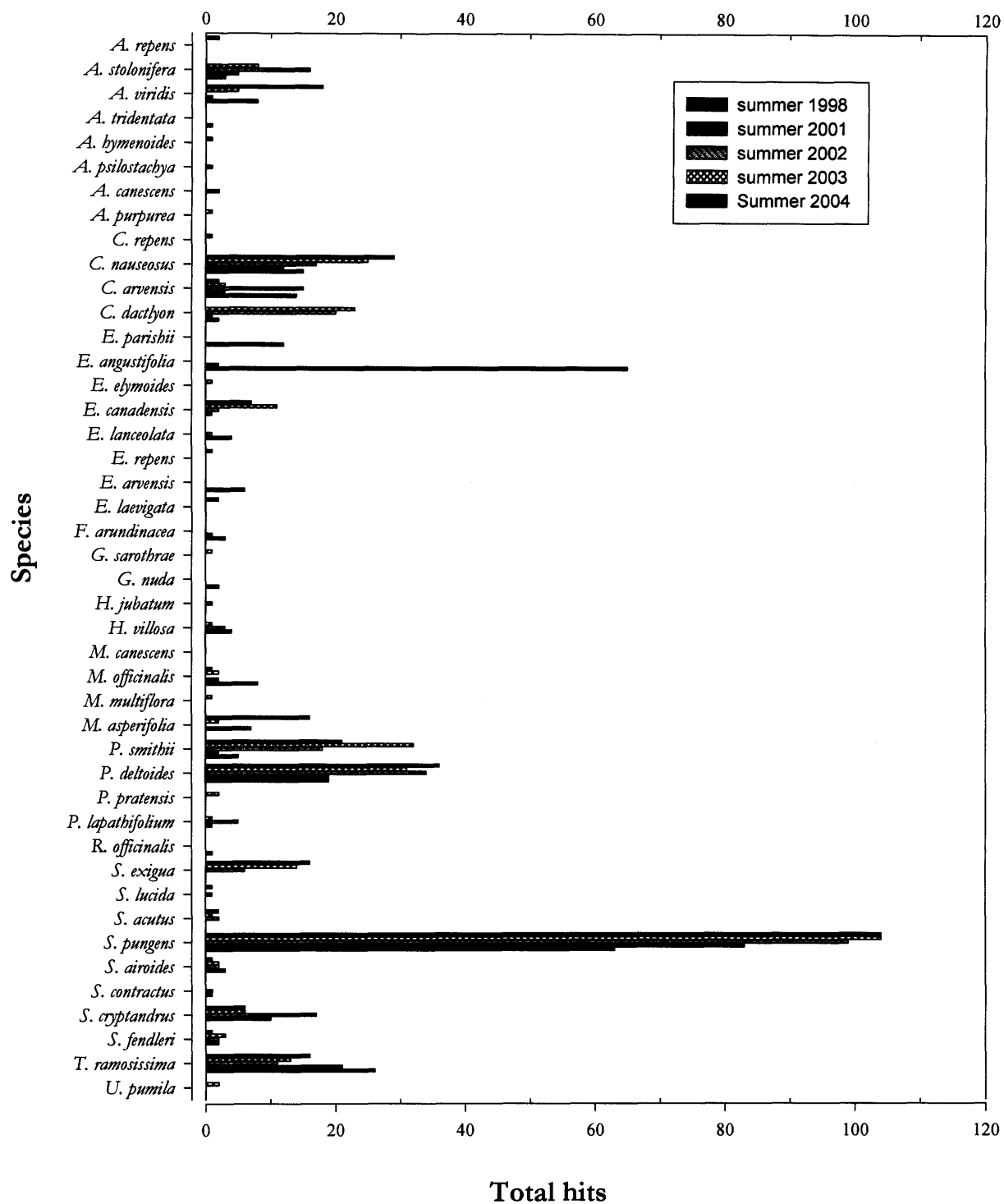


Figure 3. Total hits (FHD) of perennials for all transects, by species.

Table 3. Comparison among transects of overall average percent cover and annuals with the greatest cover.

Transect number	Fall 2003		Summer 2004		Fall 2004	
	Annuals with greatest cover	Overall ave. % cover	Annuals with greatest cover	Overall ave. % cover	Annuals with greatest cover	Overall ave. % cover
1	<i>Salsola kali</i>	16.3	<i>S.kali</i>	24.3	<i>X. strumarium</i>	14.5
2	<i>S. kali</i>	9.4	<i>Bromus tectorum</i>	11.25	<i>X. strumarium</i>	14.5
3	<i>Xanthium strumarium</i>	16.3	<i>B. tectorum</i>	33.0	<i>X. strumarium</i>	25.25
4	<i>Polygonum aviculare</i>	10.5	<i>B. tectorum</i>	9.5	<i>X. strumarium</i>	9.25
5	<i>P. aviculare</i>	9.0	<i>B. tectorum</i>	28.5	<i>X. strumarium</i>	18.0
6	<i>Lactuca serriola</i>	8.3	<i>B. tectorum</i>	24.25	<i>S. kali</i>	8.0
7	<i>Gaura parviflora</i>	2.5	<i>B. tectorum</i>	9.5	<i>X. strumarium</i>	11.0
8	<i>Bouteloua barbata</i>	8.0	<i>Erodium cicutarium</i>	4.5	<i>X. strumarium</i>	7.75
9	<i>S. kali</i>	17.8	<i>S.kali</i>	8.25	<i>X. strumarium</i>	7.0
10	<i>Kochia scoparia</i>	9.0	<i>B. tectorum</i>	16.25	<i>X. strumarium</i>	2.0
11	<i>Portulacca oleracea</i>	13.3	<i>Hordeum leporinum</i>	8.0	<i>X. strumarium</i>	2.75
12	<i>S. kali</i>	3.3	<i>B. tectorum</i>	2.25	<i>X. strumarium</i>	1.25
13	<i>L. serriola</i>	2.0	<i>B. tectorum</i>	10.5	<i>S. kali</i>	10.5
Overall average		9.7		14.6		10.1

Table 4. Absolute density of riparian woody species (ind/ha).

Species	Fall 2004
<i>Atriplex</i>	
<i>canescens</i>	3.2
<i>Chrysothamnus</i>	
<i>nauseosus</i>	263.2
<i>Elaeagnus</i>	
<i>angustifolia</i>	12.8
<i>Populus</i>	
<i>deltoides</i>	80.2
<i>Salix exigua</i>	215.1
<i>Salix lucida</i>	6.4
<i>Tamarix</i>	
<i>ramosissima</i>	16.0
<i>Ulmus pumila</i>	3.2
Total	641.9

Table 5. Average percent cover of riparian perennial species

Species	Fall 2004
<i>Agrostis</i>	
<i>viridis</i>	1.6
<i>Elymus</i>	
<i>canadensis</i>	2.2
<i>Melilotis</i>	
<i>officinalis</i>	1.0
<i>Muhlenbergia</i>	
<i>asperifolia</i>	9.2
<i>Pascopyrum</i>	
<i>smithii</i>	3.0
<i>Scirpus</i>	
<i>pungens</i>	46.1
Total average	63.1

Table 6. Average percent cover of riparian annuals.

Species	Fall 2004
<i>Ambrosia</i>	
<i>acanthicarpa</i>	0.1
<i>Conyza</i>	
<i>canadensis</i>	1.6
<i>Grindelia</i>	
<i>aphanactis</i>	0.4
<i>Muhlenbergia</i>	
<i>asperifolia</i>	0.8
<i>Polygonum</i>	
<i>aviculare</i>	5.5
<i>Salsola kali</i>	0.1
<i>Xanthium</i>	
<i>strumarium</i>	16.4
Total average	24.9

Table 7. Absolute density of upland woody species (ind/ha).

Species	Fall 2004
<i>Amorpha</i>	
<i>fruticosa</i>	3.8
<i>Amelanchier</i>	
<i>utahensis</i>	3.8
<i>Atriplex</i>	
<i>canescens</i>	162.9
<i>Berberis</i>	
<i>fremontii</i>	11.4
<i>Chrysothamnus</i>	
<i>nauseosus</i>	424.2
<i>Elaeanthus</i>	
<i>angusifolia</i>	7.6
<i>Forestiera</i>	
<i>pubescens</i>	3.8
<i>Juniperus</i>	
<i>monosperma</i>	37.9
<i>Populus</i>	
<i>deltoides</i>	49.2
<i>Quercus</i>	
<i>pungens???</i>	3.8
<i>Rhus trilobata</i>	22.7
<i>Robinia</i>	
<i>neomexicana</i>	7.6
<i>Tamarix</i>	
<i>ramosissima</i>	15.1
<i>Ulmus pumila</i>	3.8
Total	757.4

Table 8. Average percent cover of upland perennial species

Species	Fall, 2004
<i>Achnatherum hymenoides</i>	0.3
<i>Aristida purpurea</i>	0.2
<i>Convolvulus arvensis</i>	0.1
<i>Heterotheca villosa</i>	1.2
<i>Opuntia phaeacantha</i>	0.6
<i>Pascopyrum smithii</i>	1.9
<i>Sporobolus cryptandrus</i>	3.0
<i>Sphaeralcea fendleri</i>	1.3
Total average	8.2

Table 9. Average percent cover of upland annuals.

Species	Fall 2004
<i>Erodium cicutarium</i>	0.1
<i>Grindelia aphanactis</i>	0.1
<i>Munroa squarrosa</i>	0.1
<i>Salsola kali</i>	1.04
<i>Xanthium strumarium</i>	0.5
Total average	1.8

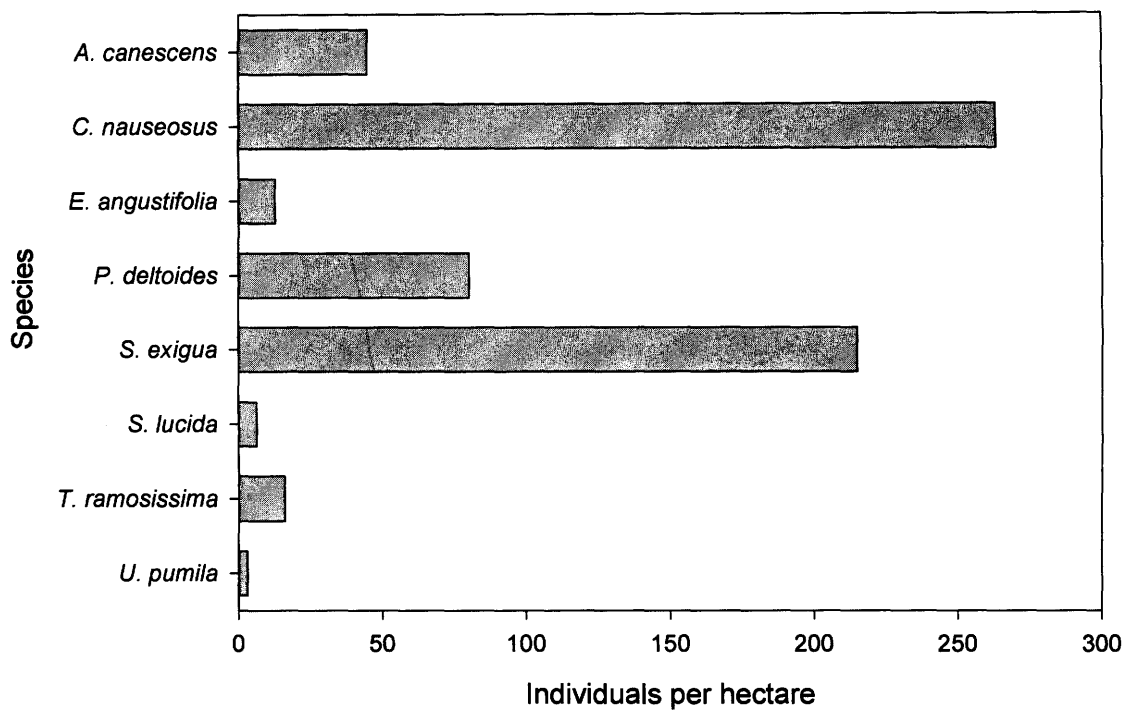


Figure 4. Comparison of the absolute densities of riparian woody perennials, Fall 2004.

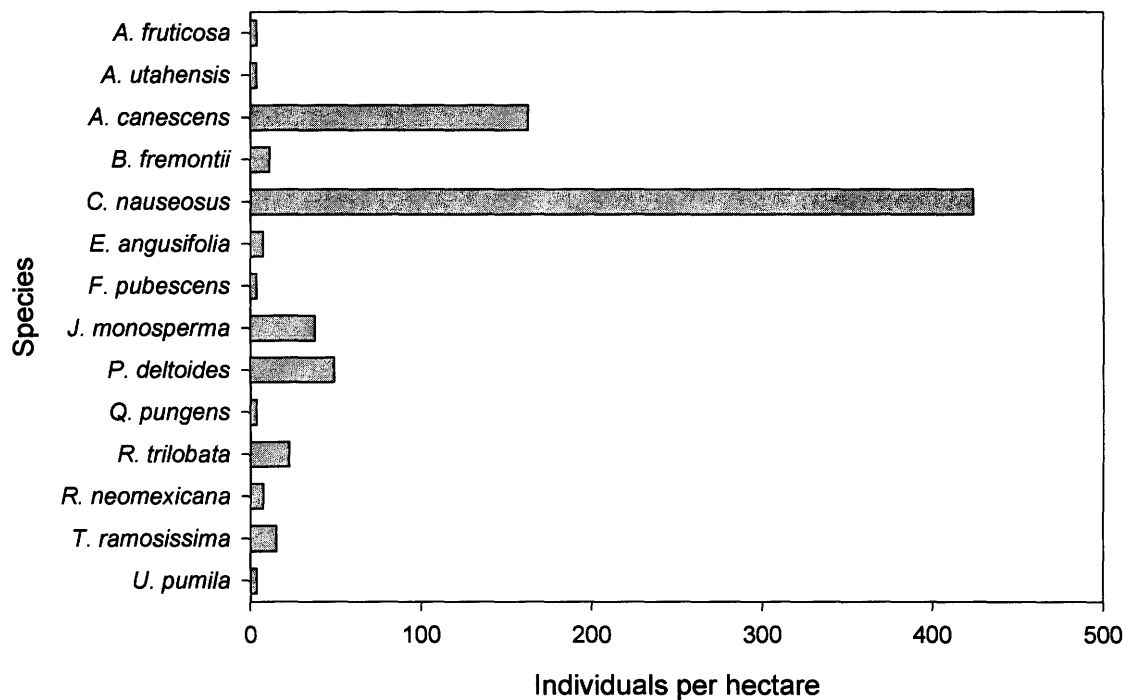


Figure 5. Comparison of the absolute densities of upland herbaceous perennials, Fall 2004.

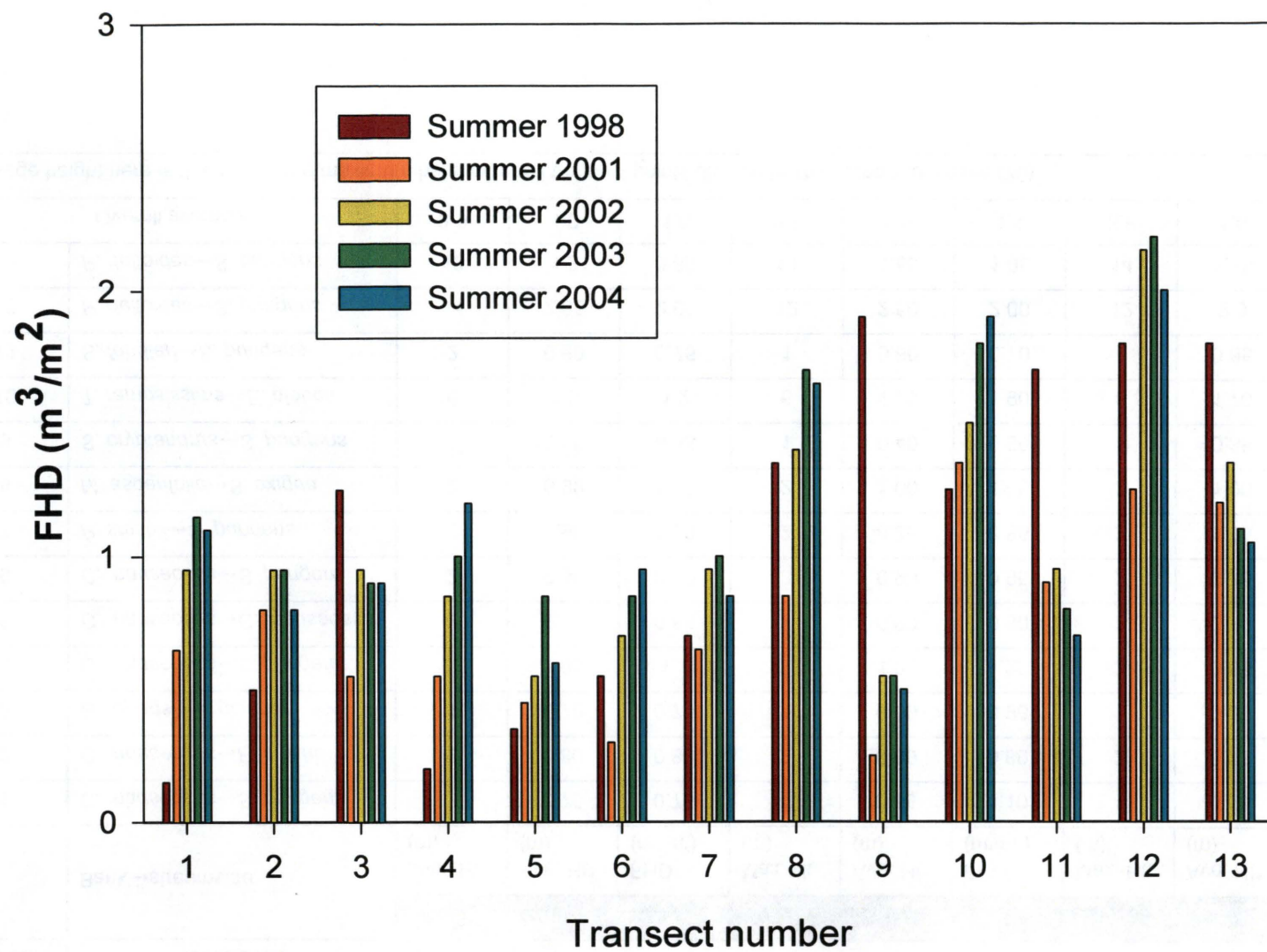


Figure 2. Comparison of FHD for summer 1998, 2001, 2002, 2003 and 2004 transects.