

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

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Abstract

Foliage-height density (FDH) of perennial vascular plants and percent cover of annual vascular plants were estimated for the riparian vegetation along Pueblo Colorado Wash within the boundaries of the Hubbell Trading Post National Historic Site, Apache County, Arizona. This is the third year of replication for the summer sampling and the second year of replication for the fall sampling. Thirteen transects were measured in June and September 2002. There were few apparent differences in perennial vegetation between the summer of 2001 and fall of 2002, except where additional efforts had been made to eradicate the exotic shrubs *Elaeagnus angustifolius* (Russian-olive) and *Tamarix ramosissima* (salt-cedar). Along the upland transects, the percent cover for *Chrysothamnus nauseosus* was higher. The most positive change within the riparian transects was the presence of *Salix lasiolepis* and *S. exigua*, which were not recorded previously.

Introduction

The primary purpose of the latest measurement was to further 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 in spring of 1998 and 2001 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 that which preceded its invasion by exotic species.

In order to estimate composition and structure of the present channel vegetation, foliage-height density or foliar-height density (FHD) by species of perennial vascular plants and percent cover by species of annual vascular plants were measured along bankside transects. 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. Both south-bank and north-bank transects were measured mid-summer 1998 and south-bank transects were remeasured early fall 1998. Thus, vegetation within the treated area was estimated before and after the period of highest average rainfall for central Arizona (Bulk 1985). In 2001, transects were measured in mid-August and, because of a lack of significant rainfall, were not remeasured in the fall. In 2002, sampling was done in June and in September.

Methods

Vegetation sampling

Vegetation sampling along both sides of Pueblo Colorado Wash was conducted 21-22 June and repeated 22-23 September 2002. Measurements were taken along thirteen 40m transects that had been established along the intermittent stream channel in 1998 (Table 1). The objectives of the transects were to estimate foliage-height density of perennial vegetation and cover of annuals. Foliage-height distribution was recorded as "hits" along vertical poles. In addition to providing a measure of vegetation structure, this method estimates total foliage-height density, which is simply the number of hits divided by the number of possible hits and vegetation volume (TVV) or the sum total of cubic decimeters within the transect's rectangular box ($40\text{m} \times 1\text{dm} \times \text{vegetation height} [\infty]$) that contain vegetation. My method is a modified version of the vertical-line intercept or foliage-height density of MacArthur & MacArthur (1961), MacArthur & Horn (1969) and vegetation volume of Mills et al. (1991). The resolution of 1dm by 1m cylinders is adequate for woody vegetation but rather coarse for herbaceous perennials. I chose foliage-height distribution estimation over 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.

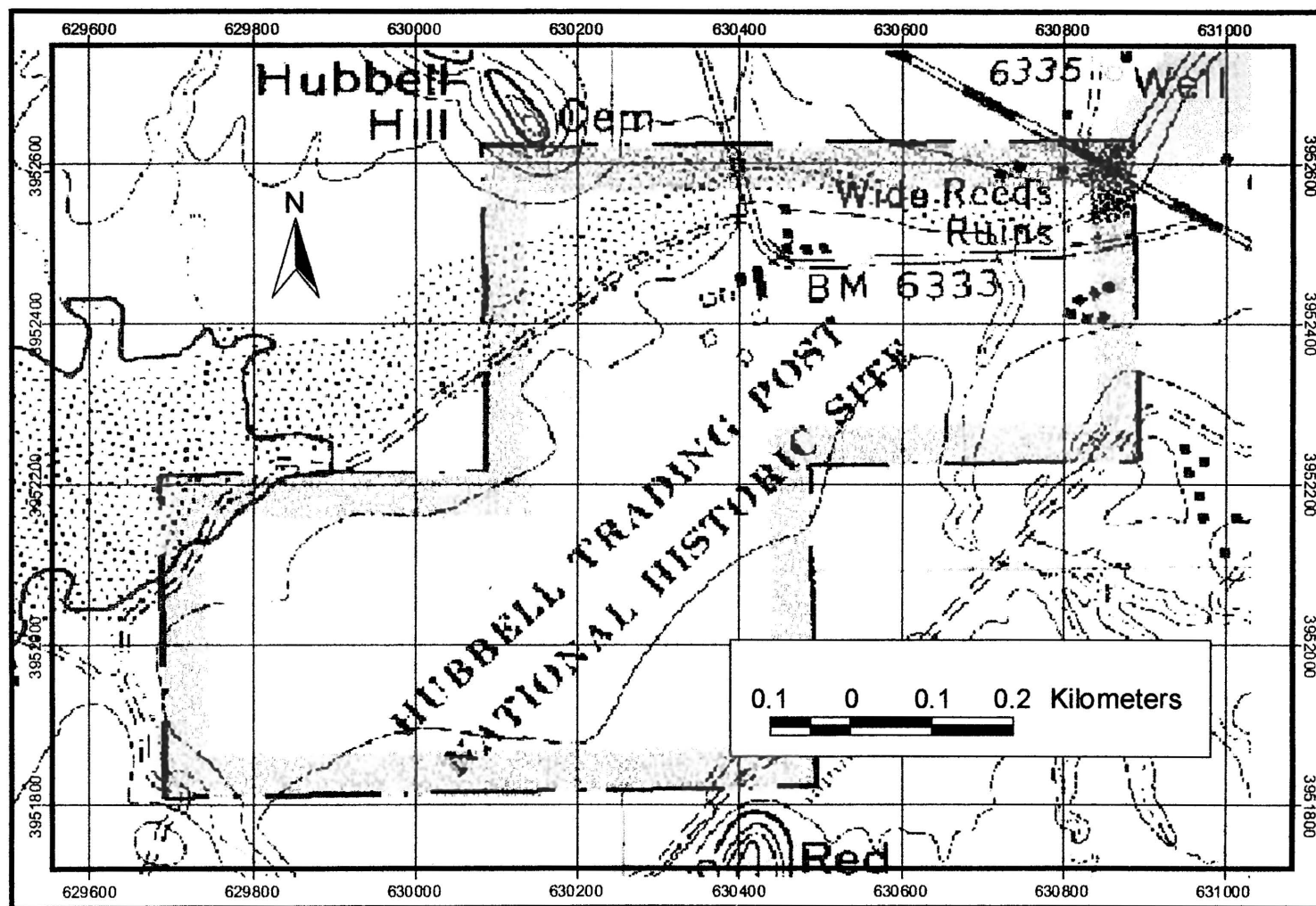


Figure 1. Hubbell Trading Post National Historical Site, UTM grid (NAD 27) shown in green.

Table 1. Locations of transects (N/A = not available)					
transect number	UTM coordinates of transect at 00m (NAD 27, zone 12)	heading east of magnetic north from reference point	distance from reference point	reference point	UTM coordinates of reference points
1	06 30 323mE 39 52 505mN	25°	50m	1	06 30 394mE 39 52 470mN
2	06 30 382mE 39 52 572mN	297°	70.1m	2	06 30 439mE 39 52 530mN
3	06 30 472mE 39 52 596mN	355°	27.8m	3	06 30 471mE 39 52 570mN
4	06 30 550mE 39 52 588mN	358°	67.8m	4	06 30 554mE 39 52 507mN
5	06 30 635mE 39 52 562mN	321°	21.7m	5	06 30 647mE 39 52 541mN
6	06 30 720mE 39 52 544mN	296°	46.0m	6	06 30 757mE 39 52 514mN
7	06 30 814mE 39 52 534mN	259°	12.7m	7	N/A
8	06 30 280mE 39 52 528mN	N/A	N/A	N/A	N/A
9	06 30 347mE 39 52 602mN	N/A	N/A	N/A	N/A
10	06 30 560mE 39 52 627mN	N/A	N/A	N/A	N/A
11	06 30 646mE 39 52 604mN	N/A	N/A	N/A	N/A
12	06 30 731mE 39 52 580mN	N/A	N/A	N/A	N/A
13	06 30 813mE 39 52 574mN	N/A	N/A	N/A	N/A

The present analysis was modified from Mills et al. (1991) by recording "hits" of perennial vegetation along the vertical axes by meters instead of by decimeters. From a practical perspective, this facilitated an increase in the number of transects thereby enhancing statistical significance. MacArthur & Horn (1969) used a telephoto lens to measure vertical distances with an accuracy of approximately 0.5m.

Seven reference points were selected within the Park boundaries such that they were as evenly distributed as possible and easily relocated (Table 1). At least one photograph was taken of each with a reference placard placed at the point.

Starting points (00m) of transects were established non-randomly at ca. 100m increments along the channel without bias with respect to the condition of the vegetation. The transects were situated at least 40m from the Park boundary in order to avoid boundary effects. Starting points were marked with 0.5in rebar at a point 20m bankside from the water's edge or the outer edge of obligate wetland graminoids, such as *Eleocharis parishii* Britton (Parish spikerush) and *Scirpus pungens* Vahl (common three-square). The transects were directed perpendicular toward the stream channel for 20m, then, to the right along the channel edge regardless of sinuosity for an additional 20m. The bearing from the starting point to the turn was recorded as degrees east of magnetic north.

Measurements were taken every two meters along the transect beginning with meter two. A nine meter collapsible pole was set vertically and living perennial vegetation within 1dm of the pole was recorded in height increments of 1m. This was done by recording the acronym of the plant species that fell within a particular meter mark on the pole. Thus for each 40m transect, vegetation volume, according to species, was sampled within twenty cylinders with a radius of 1dm.

At each 2m point along each transect a 20cm by 50cm (0.1m²) Daubenmire Grid was laid on top of the herbaceous layer and the cover of annuals was estimated by counting the number of squares occupied. The cover was recorded as cover classes one through seven (1= <1%, 2= 1-5%, 3= 5-25%, 4= 25-50%, 5= 50-75%, 6= 75-95%, 7= 95-100%).

Results and discussion

There was a slight increase in FHD for all transects three between summer 2001 and summer 2002 (Figure 2, Table 3). Although the FHD along Transect 12 was considerably higher in 2001, it was owing to the canopy of *Populus deltoides* over only three transect points, which can be affected by a slight difference in the position of the transect or wind velocity and direction.

There were some notable changes in species composition (figure 3). The most important difference between the summer of 2001 and 2002 was the presence of *Salix lasiolepis* (arroyo willow), *S. exigua* (coyote willow), and *S. acutus* (bulrush). All three of these native species are indicators of healthy riparian habitat. They were absent on the 2001 transects and present on the 2002 transects. In the upland transect legs, the native species *Chrysothamnus nauseosus* (rabbitbrush) and *Pascopyrum smithii* (western wheatgrass) increased in cover.

Average percent cover of annuals for each transect continue to show a dramatic variation between the summer and fall sampling of 1998 (Figure 4) reflecting the effects of the monsoon rains. With further sampling, there will undoubtedly be a high correlation between percent cover of annuals and rainfall.

Table 2. Summary of vegetation type, canopy height, and foliage-height density (FHD) data for each transect by date.

Transect	Vegetation association	Data								
		summer 1998			fall 1998			summer 2001		
		Max. height (m)	Ave. height* (m)	FHD (m³/m²)	Max. height (m)	Ave. height (m)	FHD (m³/m²)	Max. height (M)	Ave. height (m)	FHD (m³/m²)
1	<i>Eleocharis parishii</i>	1	0.15	0.15	1	0.50	0.6	1	0.6	0.65
2	<i>Scirpus pungens</i>	2	0.40	0.5	1	0.40	0.4	2	0.75	0.8
3	<i>Scirpus pungens</i>	10	0.95	1.25	11	1.40	1.65	1	0.55	0.55
4	<i>Pascopyrum smithii</i> → <i>Scirpus pungens</i>	1	0.20	0.2	1	0.40	0.6	1	0.55	0.55
5	<i>Pascopyrum smithii</i> → <i>Chrysothamnus nauseosus</i>	1	0.30	0.35	1	0.35	0.45	2	0.4	0.45
6	<i>Scirpus pungens</i>	1	0.35	0.55	1	0.45	0.7	1	0.3	0.3
7	<i>Chrysothamnus nauseosus</i> → <i>Scirpus pungens</i>	2	0.55	0.7	2	0.50	0.6	1	0.55	0.65
8	<i>Elaeagnus angustifolia</i> → <i>Scirpus pungens</i>	7	1.10	1.35	N/A	N/A	N/A	1	0.85	0.85
9	<i>Elaeagnus angustifolia</i> → <i>Scirpus pungens</i>	6	1.95	1.9	N/A	N/A	N/A	1	0.25	0.25
10	<i>Tamarix ramosissima</i>	7	1.85	1.25	N/A	N/A	N/A	7	1.9	1.35
11	<i>Elaeagnus angustifolia</i> → <i>Scirpus pungens</i>	5	1.80	1.7	N/A	N/A	N/A	4	1.0	0.9
12	<i>Populus deltoides</i>	12	2.25	1.8	N/A	N/A	N/A	13	2.3	1.25
13	<i>Populus deltoides</i>	12	1.65	1.8	N/A	N/A	N/A	12	1.65	1.2

*average height here is the sum of the maximum heights for all transect points divided by the number of points (20)

Table 3. Summary of vegetation type, canopy height, and foliage-height density (FHD) data for each transect by date.

Transect	Present vegetation association	Data								
		June 2002			September 2002					
		Max. height (m)	Ave. height* (m)	FHD (m³/m²)	Max. height (m)	Ave. height (m)	FHD (m³/m²)			
1	<i>C. nauseosus</i> → <i>S. pungens</i>	1	0.75	0.95	2	0.70	0.95			
2	<i>C. nauseosus</i> → <i>S. pungens</i>	2	0.85	0.95	2	0.85	1.10			
3	<i>E. glauca</i> → <i>S. pungens</i>	1	0.70	0.95	1	0.75	0.90			
4	<i>C. nauseosus</i> → <i>S. pungens</i>	2	0.60	0.85	2	0.95	1.10			
5	<i>C. nauseosus</i> → <i>D. spicata</i>	1	0.45	0.55	2	0.65	0.95			
6	<i>C. nauseosus</i> → <i>S. pungens</i>	1	0.70	0.70	1	0.70	0.70			
7	<i>P. smithii</i> → <i>S. pungens</i>	1	0.75	0.95	1	0.85	0.95			
8	<i>S. cryptandrus</i> → <i>M. asperifolia</i>	1	0.90	1.40	1	0.85	0.85			
9	<i>S. cryptandrus</i> → <i>Scirpus pungens</i>	1	0.45	0.55	1	0.40	0.50			
10	<i>T. ramosissima</i> → <i>M. asperifolia</i>	6	1.75	1.5	6	1.60	1.70			
11	<i>S. cryptandrus</i> → <i>Scirpus pungens</i>	2	0.75	0.95	1	0.75	0.75			
12	<i>Populus deltoides</i> → <i>Scirpus pungens</i>	14	2.75	2.15	12	2.35	1.95			
13	<i>Populus deltoides</i> → <i>Scirpus pungens</i>	13	1.45	1.35	14	1.70	1.20			

*average height here is the sum of the maximum heights for all transect points divided by the number of points (20)

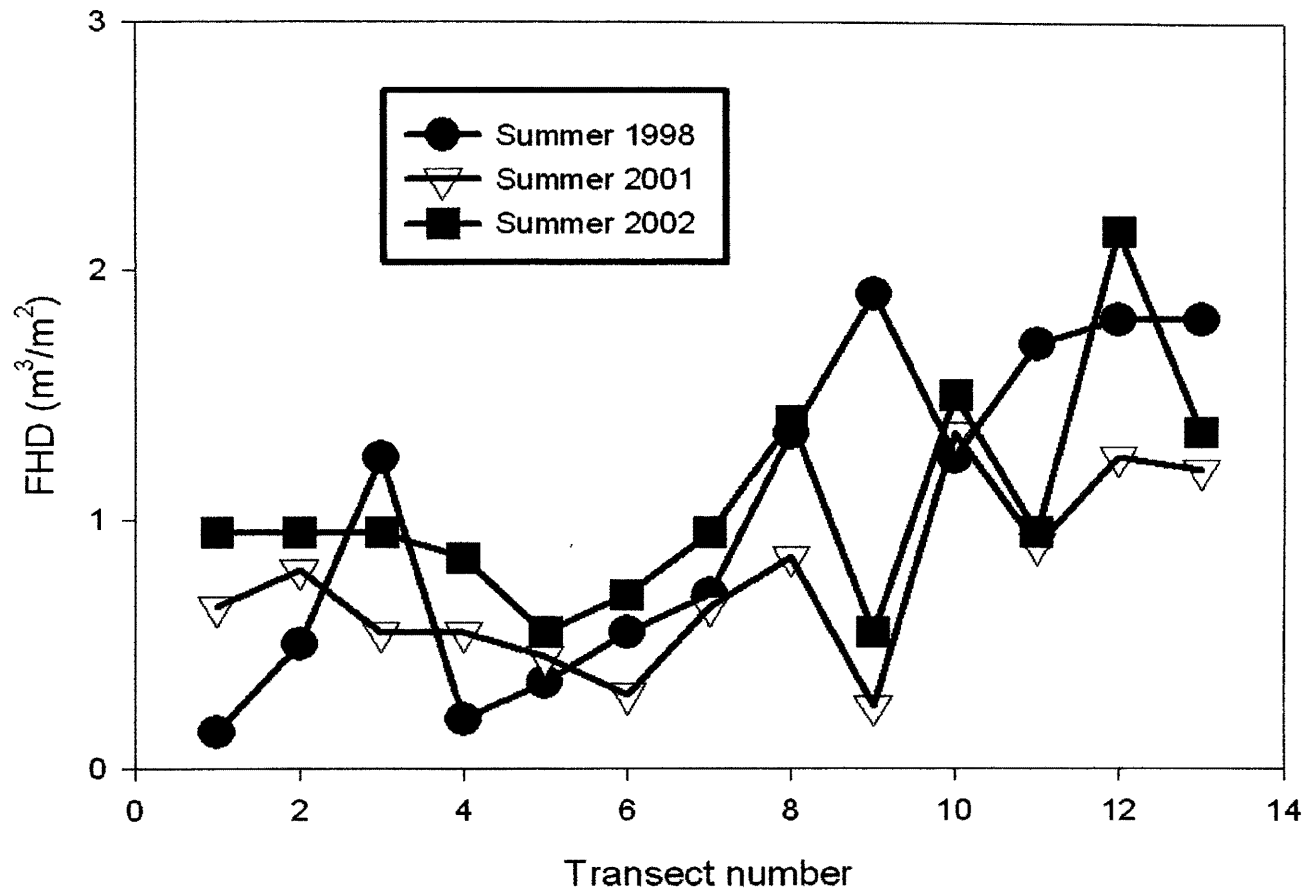


Figure 2. Comparison of FHD between summer 1998, 2001, and 2002 for each transect.

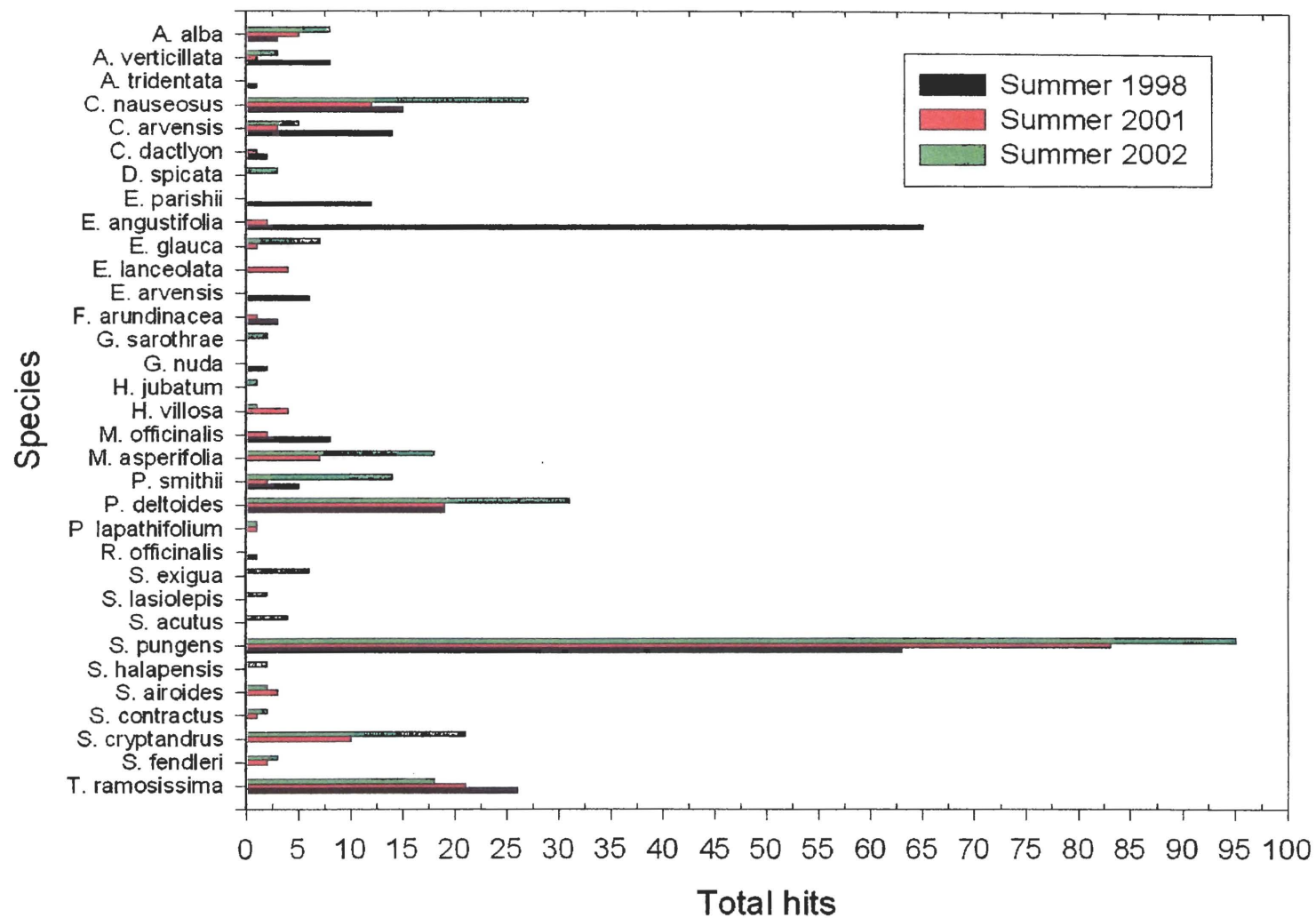


Figure 3. Total hits (FHD) for all transects, by species.

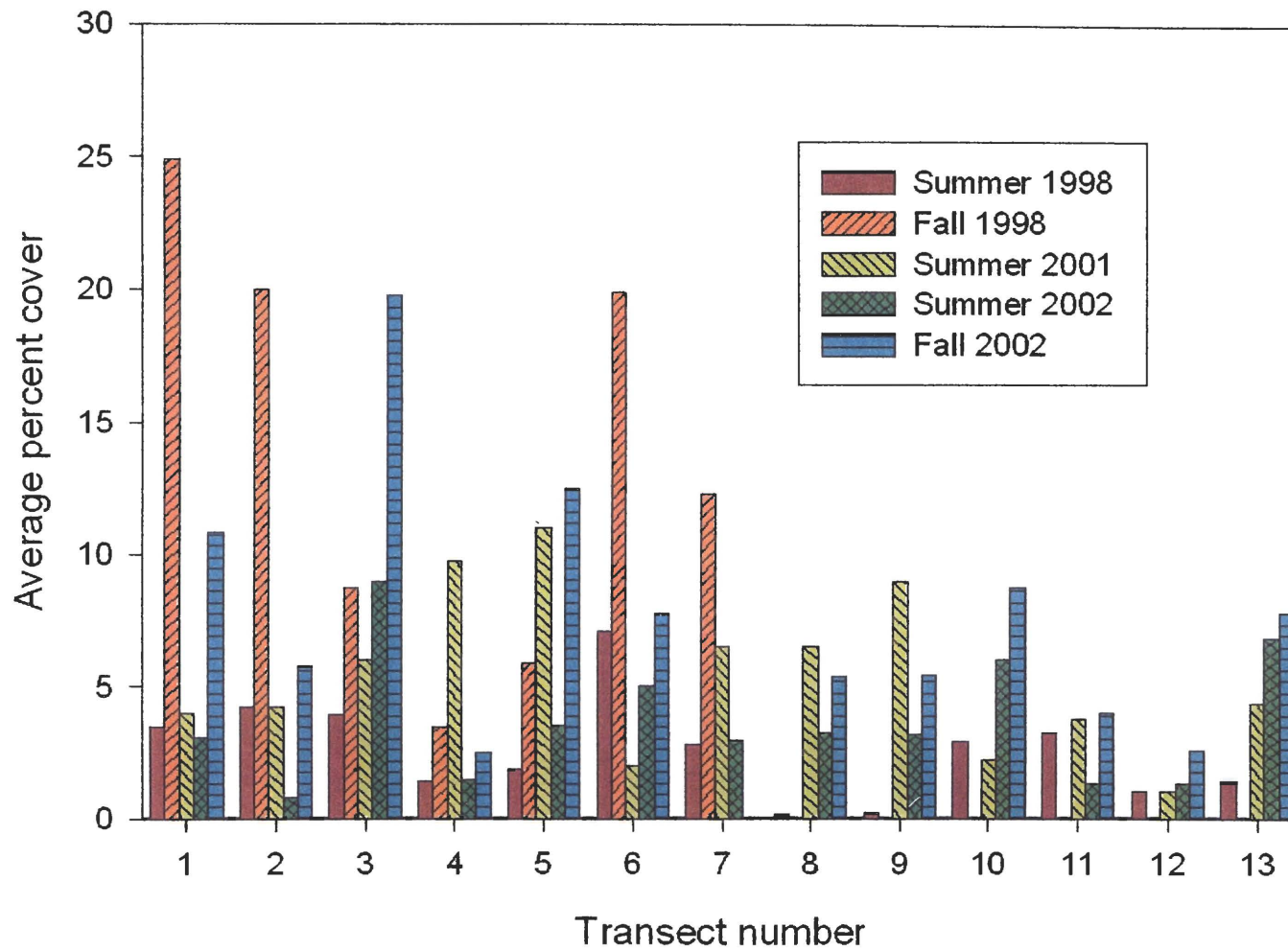


Figure 4. Average percent cover of annuals.

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