Table 1. Interpretation of Sequoia-Kings Canyon National Parks cluster analysis.

Cluster Characteristics					Code	Site	Cluster
Low Elevation & High Richness	Xeric	High Forb Richness			CPO2117	Potwisha Campground	1
					DHO2697	Hospital Rock Picnic Area	
		Moderate Forb Richness			CBU2822	Buckeye Campground	2
					DMF2112	Middle Fork Flume	
					DPB1398	Ash Mountain Park Boundary	
					DNF1773	North Fork Parking Lot	
					UCO2307	Colony Mill Dirt Road	
		Low and Upper Elevation Spp.			PCE4701	Cedar Grove Pack Station	3
	Mesic	Irrigated – High Richness			DAS1605	Ash Mountain Headquarters	4
		Riparian			RMF1545	Middle Fork of Kaweah River	5
					RNF1726	North Fork of Kaweah River	
					RYU1829	Yucca Creek	
					RSY1880	Sycamore Creek	
Mid to High Elevation Species	Grass Dominated & Low Forb Richness	Predominantly Annual Grasses	Low Elevation Spp. Moderate Richness		CSF3728	South Fork Campground	6
					DCS4897	Crystal Cave Parking Lot	
					TOL2189	Old Hidden Springs Trail	
			Mid Elevation spp. /Low Richness	*Bromus tectorum* & *Vulpia myuros*	CSH4564	Sheep Creek Campground	7
					GBE7620	Bearpaw Meadow	
					TBE7164	Giant Forest to Bearpaw Meadow Trail	
					TKA7621	Bearpaw Meadow to Kaweah Gap Trail	
					THI7779	High Sierra Trail	
					TLE5702	Lewis Creek Trail	
					CMO4764	Moraine Campground	
					TRA7314	Rae Lakes Trail (7000 ft)	
					DBI6323	Big Stump Picnic Area	
					DSE6350	Giant Forest Sewage Treatment Facility	
					PGR6417	Grant Grove Pack Station	
					DOR5356	Oriole Lake Air Strip	
					DMI6211	Milk Ranch Lookout	
				Riparian	RTR4573	Trauger's Creek	8
		Poa pratensis	*T. officianale* or Low Frequency Forbs	Low Frequency Forbs	CSW6223	Swale Campground	9
					TSE6072	Sequoia Lake Trail	
					CAT6415	Atwell Mill Campground	
					GKE6400	Kern Canyon Ranger Station Pasture	
					GHO8511	Hockett Meadow	
					TGI6344	Giant Forest Trail	
					DGF6440	Giant Forest Developed Area	
				Forb Primarily *Taraxicum officianale*	GGR7720	Grasshopper Meadow	10
					GWI8003	Williams Meadow	
					GAU8015	Austin Meadow	
					TKE8800	Kern Canyon Trail (8000 ft)	
					TRA9373	Rae Lakes Trail (9000 ft)	
					TMA7151	Marvin Pass Trail	
					TTA7891	Tar Gap Trail	
					TTU8560	Tuohy Meadow Trail	
					TKE6600	Kern Canyon Trail (6000 ft)	
					TKA7800	Bearpaw Meadow to Kaweah Gap Trail	
					THO7347	Atwell Mill Cg. to Hockett Meadow Trail	
			Presence of *Rumex acetosella* & *Spergularia rubra*		CCR6631	Crystal Springs Campground	11
					TRA6513	Rae Lakes Trail (6000 ft)	
					DWO7200	Wolverton Snow Park	
					GSU7340	Sugarloaf Meadow	
					GJR7380	J. R. Meadow	
					GSC7456	Scaffold Meadow	
					GJU8115	Junction Meadow	
					THA5506	Hart Loop Trail	
					TCM6700	Crescent Meadow	
					TRE6060	Redwood Canyon Trail	
	Forbs	Miscellaneous Forbs			CAZ6454	Azalea Campground	12
					DCO6533	Columbine Picnic Area	
					DGR6593	Grant Grove Developed Area	
					DRE7121	Red Fir Maintenance Yard	
					UCA6754	Kings River	
					TRA5143	Rae Lakes Trail (5000 ft)	

Table 1. Interpretation of Sequoia-Kings Canyon National Parks cluster analysis--Continued

Cluster Characteristics			Code	Site	Cluster
Mid to High Elevation Spp.	Forbs	Miscellaneous Forbs	UCA6754	Camp Conifer Dirt Road	12
			DCE4671	Cedar Grove Market and Lodge	
			ICE4890	Cedar Grove Paved Road	
			CDO6721	Dorst Campground	
			CCO7477	Cold Springs Campground	
			ISH2118	Shepard Saddle Paved Road	
			PWO7037	Wolverton Pack Station	
			PMI7878	Mineral King Pack Station	
		Bromus tectorum, Poa pratensis Verbascum thapsus & Miscellaneous Forbs	UOR5340	Oriole Lake Dirt Road	13
			GOR5353	Oriole Lake Meadow	
			UMI5718	Mineral King Dirt Road	
No Alien Species			TBL5763	Old Black Oak Trail	None
			TEV8511	Evelyn Lakes Trail	
			TMI8100	Mitchell Pass Trail	
			TNE8840	New Army Pass Trail	
			TSI10800	Siberian Outpost Trails	
			TSU8511	Sunset Lakes Trail	

Code: First letter: C = Campground, D = Development, G = Pasture/Meadow, I = Paved Road, P = Pack Station, R = Riparian, T = Trail, U = Dirt Road. Second and third letters: Unique site ID. Numerals: #### = Elevation (ft).

Sites in cluster 6 are uniquely rich in low elevation annual grasses and also possess species that are common at mid-elevations. Old Hidden Springs Trail at an elevation of 670 m (2,190 ft) is rich in low elevation annual grasses as expected and there are also mid elevation forb species at seeps and at stream crossings. The small corral at South Fork Campground (1,135 m; 3,730 ft) may be responsible for the large number of annual grasses found at the site. There is also a large number of annual grass species along the edges of Crystal Cave Parking Lot (1,490 m; 4,895 ft).

Cluster 7 is composed of sites that range from 1,370 m to 2,285 m (4,500 ft to 7,500 ft) in elevation and are relatively poor in mid-elevation species and rich in annual grass species. *Bromus tectorum* and *Vulpia myuros* are constant annual grass species. The inclusion of Grant Grove Pack Station (1,955 m; 6,415 ft) in the low-species-richness cluster is an artifact of sampling difficulties. The survey of that site was conducted after stock animals were placed in the corrals and many of the plants were either eaten or trampled beyond recognition. Cluster 8, Trauger's Creek (1,395 m; 4,575 ft), is relatively rich in low-elevation species. However, neither *Bromus tectorum* nor *Vulpia myuros* are found at that site. That factor, in addition to the presence of mid-elevation species in seeps and at stream crossings, and the presence of *Malus sylvestris*, accounts for the site's distinct cluster.

Clusters 9, 10 and 11 are notable for the presence of *Poa pratensis*. Sites in cluster 9, which range in elevation from 1,830 m to 2,590 m (6,000 ft to 8,500 ft), are relatively low in forb richness, while *Taraxicum officinale* is characteristic of the sites in cluster 10, which range in elevation from 2,135 m to 2,745 m (7,000 ft to 9,000 ft). *Rumex acetosella* and *Spergularia rubra* are characteristic of sites in cluster 11, which range in elevation from 1,980 m to 2,285 m (6,500 ft to 7,500 ft). Hart Loop Trail (1,680m; 5,505 ft), a lower-elevation site, is included in this cluster because of the mid- and high-elevation species present at stream crossings and moist areas.

Clusters 12 and 13 are relatively rich in mid- and high-elevation forb species. The sites in cluster 12 ranges in elevation from 1,370 m to 2,440 m (4,500 ft to 8,000 ft). The low elevation Shepherd Saddle Road site is the only exception, and it appears to be rich in mid- and upper-elevation forb species due to its proximity to Ash Mountain Corrals, Ash Mountain Shooting Range and Sycamore Creek. The sites in cluster 13 are at an elevation of 1,675 m (5,500 ft) and include the adjacent Oriole Lake Dirt Road and Oriole Lake Meadow sites in addition to Mineral King Dirt Road. The forb species at these sites are species that are typically dispersed in the dung of stock animals. Trespassing cattle from a nearby inholding graze the sites near Oriole Lake, and the Mineral King Dirt Road site is adjacent to the Mineral King Pack Station.

Nearly all of the sites where no alien species were found are above 2,440 m (8,000 ft). The exception is Old Black Oak Trail at 1,755 m (5,765 ft), a trail that has not been maintained for years. It is not clear why there are no alien species present at the other five sites as *Poa pratensis* and *Taraxicum officinale* are present along the Rae Lakes Loop Trail to elevations of 2,865 m (9,400 ft) and 2,990 m (9,800 ft) respectively.

Yosemite National Park

Survey and Quadrat Data Collection

1998 Field Methods - During the summer of 1998, field crews began sampling three patch types (campgrounds, developments, and corrals) and two corridor types (trails and roads). Alien species presence and cover estimates of alien and native species were obtained from all patch types. While presence/absence data were recorded for each corridor type, cover along trails and roads were not estimated because the distribution of nonnative plants along these linear landscape features was very patchy.

To conduct a survey, field crews compiled a complete list of plants in the study site. After making the list, the field crew placed each species into distribution classes and estimated the abundance of species on a log scale (0-10, 11-100, 101-1000, 1001-10,000, >10,000). Additionally, the distribution of each alien species was characterized as scattered individuals, scattered clumps of individuals, large clumps of many individuals, or widespread throughout the area. Trail and road surveys sometimes continued for several kilometers and species presence data were recorded in 1 km segments along the length of each survey.

A baseline transect was established along one edge of each patch and a random number table was used to randomly place sampling transects perpendicularly along the length of the baseline transect. Quadrats (1-m^2) were placed randomly along the sampling transects until thirty quadrats had been sampled. When thirty quadrats were sampled before the end of a sampling transect, the remainder of the sampling transect was also sampled to avoid biasing the data toward the beginning of the transect. In each quadrat, the cover of nonnative and native plant species was estimated to the nearest one percent. The cover of a particular species could not exceed 100 percent, but the total of all species in the quadrat frequently exceeded 100 percent. Additionally, a natural vegetation control site was established in undisturbed vegetation 50 m from five of the campground sites.

As was the case in Sequoia-Kings Canyon National Parks, the sample sites frequently contained areas such as parking lots or tent pads that were inappropriate for sampling, so quadrats had to pass rejection criteria before field crews sampled them. Randomly placed quadrats were rejected if more than 50 percent of the cover was incapable of supporting plant life (pavement, dirt roads, large boulders and trampled areas within 1 m of a structure). Areas where alien species are deliberately cultivated (lawns, flower pots, gardens) also were rejected. If the crews rejected several quadrats, they added additional transects until 30 quadrats were sampled. In areas that were sampled for cover, the canopy cover of shrubs and trees was also recorded. Shrub cover along the length of transects was measured using the line intercept method. Tree canopy cover was estimated using GRS brand densiometers at 100 regularly distributed points along the same transect. The quadrat sampling data were analyzed for exotic species richness and are included in the richness by elevation figures below.

1999 Field Methods - The survey crews measured the distribution of alien species in three types of patches (campgrounds, developments, corrals) and two types of corridors (trails and roads). Ten 50 by 2 m transects were randomly placed in each patch by establishing a baseline transect along one border known as a patch length (fig. 3a). The width of the target area was measured as a line perpendicular to the length, and a second baseline transect was established along the width border. Sampling transects were placed randomly along the two baseline axes. Whenever a sampling transect reached the boundary of a disturbed area or structure, the remainder of its sampling length was continued at the same position on the first axis and from

the 0 position of the second axis (fig. 3a). At 10 m intervals beginning at meter 0, 2 m x 1 m quadrats were placed with the 2 m axis perpendicular to the sampling transect (fig. 3b). The cover of individual alien species and the total cover of all native species were estimated in each quadrat. The total numbers of alien and native species present in each sampling transect were also recorded. Canopy cover was measured every 5 m along each sampling transect using the point-intercept method with a GRS brand densiometer. Because some alien species did not fall within the sampling transects, the entire sampling area was surveyed to compile a complete list of all alien species present. Areas with high densities of buildings or very few plants were not sampled, but surveyed only. The abundance of species in each patch was estimated on a log scale after the patch was surveyed.

Trails in Yosemite were sampled based on levels of use by hikers and recreational stock. The Yosemite National Park Wilderness Office supplied data on the number of backpacking wilderness permits issued on each trail, and the trails were grouped into three categories: low use (0-50 people/year), moderate use (51-1100 people/year) and high use (1101-6900 people/year). Seven trails were randomly selected for sampling from each use category. The Wilderness Office also supplied data on the number of stock using the trails in categories of low (3-10/day), medium (11-25/day), and high (26+/day). The concession stables provided route information for their daily rides in Yosemite Valley. Stock are only allowed on certain trails, and all trails open to stock use were sampled. The high use backpacking permit category contained the fewest number of trails, and most of these popular trails also received medium-high stock use. By comparison, low use backpacking permit trails had no stock use. No records were available for day-use by private stock parties on trails, so Mirror Lake Pack Trail and Yosemite Falls Trail had higher stock-use levels than indicated by the Wilderness Office data. Therefore, those trails were placed in the next higher stock-use category. At each trailhead the survey crews placed the first of ten 50 m by 2 m transects on the right side of and parallel to the trail, one meter from the tread of the trail. Subsequent transects were placed on alternating sides of the trail and were begun across from the end of the previous transect. Transects were sampled using the same methods as were used to sample patches. After sampling within the transects, the field crews walked 3 km from the trailhead, recording all alien species that occurred within 2 m of the trail in each kilometer. Abundances of alien species were

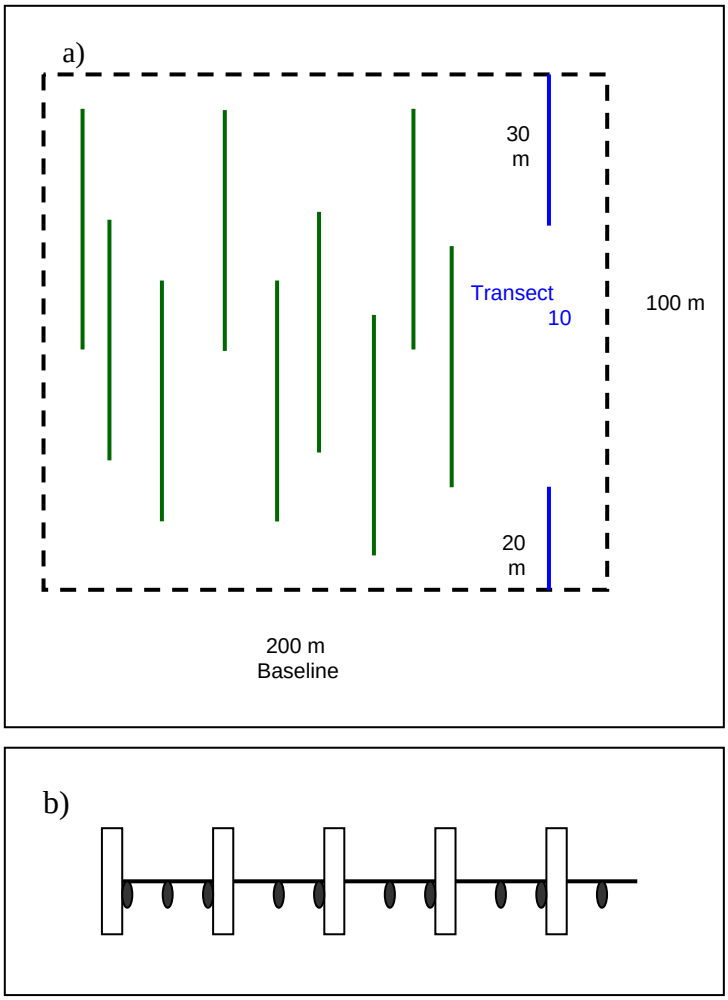

Figure 3. (a) Arrangement of 1999 transects in Yosemite National Park in campgrounds, developments and corrals that were sampled for alien species. Two dimensions of the sample site were measured, and the transects were arranged randomly along the two axes. When a transect ran outside of the sample area, as in Transect 10, it was continued at the same position on the first axis and from the 0 position of the second axis. **(b)** Sampling along 50 m transects. 1 by 2 m quadrats (rectangles) were placed every 10 m, and canopy cover was sampled every 5m (black points).