Demography and Monitoring of Welsh's Milkweed (*Asclepias welshii*) at Coral Pink Sand Dunes

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Abstract: Results are presented of a 12-year monitoring program on the Coral Pink Sand Dunes and Sand Hills populations of the threatened Welsh's milkweed, *Asclepias welshii* N & P Holmgren. The species is an early seral member of the dune flora, colonizing blowouts and advancing with shifting dunes. When an area stabilizes and other vegetation encroaches, *A. welshii* is crowded out. Reproduction is by seeds and rhizomes, with the latter being more important. Three growth forms and their significance in colony dynamics are recognized. Monitoring has measured fluctuations in stem counts, vegetative competition, off-road vehicle impacts, and the general instability of the environment.

Welsh's milkweed, *Asclepias welshii* N & P Holmgren, is a herbaceous perennial sand dune endemic that was described in 1979, based on a collection made in 1978 at Coral Pink Sand Dunes in Kane County, Utah (Cronquist et al. 1984). Four populations of *A. welshii* are known, located roughly along an 80 km line paralleling the Utah-Arizona border where suitable habitats occur, at elevations ranging from 1700 to 2000 m. The colony on the eastern end of this line is about 25 km west of Page, Arizona. Another is within the Paria wilderness area straddling the Utah-Arizona border, and the largest population is on the Coral Pink Sand Dunes west of Kanab, Utah. The fourth population is about 12 km northeast of the Coral Pink Sand Dunes in the Sand Hills. The Page, Paria, and Sand Hills populations all occur in small isolated areas of suitable habitat, whereas *A. welshii* is abundant and widespread over the Bureau of Land Management administered dunes, with colonies extending to the southwest into the adjacent Coral Pink Sand Dunes State Park.

Asclepias welshii was officially listed as threatened in 1987. The major factor determining this listing was the potential threat from off-road vehicle (ORV) activity within the relatively small confines of the dunes. The dunes themselves are part of the Moquith Mountain wilderness study area. The studies reported here were therefore initiated in 1989 in part to determine the impact of ORV activity on the BLM-administered portion (approximately half) of the Coral Pink Sand Dunes, as well as on the nearby Sand Hills milkweed site.

In standard taxonomic treatments of *A. welshii* (e.g., Welsh et al. 1987, Cronquist et al. 1984) the species is described on the basis of mature specimens only. No mention is made of the fact that another growth form commonly occurs, which has narrow linear leaves, similar in appearance to those of *A. subverticillata*. Seedlings and stems arising from smaller rhizomes that may be several years old have this form, which is here designated as the "primary" stage. Primary stems may emerge among mature stems within a colony, or spread out away from existing groups of mature stems as the milkweed invades new territory.

In addition to the mature and primary growth forms there is a form that exhibits leaf shapes and sizes intermediate between the two, which we call the "secondary" stage. A casual examination of an area may cause one to overlook the stems in the primary stage, resulting in an incorrect interpretation of the existing state of *A. welshii*.

Aerial stems of *A. welshii* arise from an extensive rhizome system that may be buried from a few centimeters to several meters below the surface. Some evidence suggests that rhizomes actually penetrate the sandstone bedrock that underlies the dunes. It is possible that all of the visible stems in a colony originate from a single plant or its clones; any estimation of the total number of *A. welshii* plants in a given location is merely speculation. Therefore stem counts constitute the database for this study.

Methods

This project was initiated in 1989, when six permanent plots measuring 23 x 23 m were established. Five of the plots are on the Coral Pink Sand Dunes and one (Plot 6) is on the Sand Hills. Two plots previously established by the Bureau of Land

Management are also included in the study. Stem counts of the three growth forms have been made annually except for 1990.

The plots are assigned to one of three loosely defined habitat types:

Type I. A stable community of mixed dune shrubs and grasses with minimal sand movement (Plot 5 and BLM Plot 3).

Type II. The tops and faces of dunes where sand movement is continual, resulting in removal of large amounts of sand from the top and windward (southwest) side of the dunes and deposition of this sand on the leeward face (Plots 1, 3, 4, and 6).

Type III. Blowout areas where several meters of sand and most or all of the vegetation, including *A. welshii*, have been removed by the wind (Plot 2 and BLM Plot 2).

Other Sites. In addition to the standard plots described above, two other sites are being closely monitored. The first is a plot established in 1992 to determine the impact of competition from other species on *A. welshii* growth. This plot is adjacent to Plot 5, which acts as a control. Seven *A. welshii* stems were initially included within the plot: four in the primary growth stage and three in the secondary. Numerous stems of all three types were just outside the plot near those seven. All other vegetation was removed and continues to be weeded out annually.

The second site is a colony of *A. welshii* growing in a major ORV trail, where vehicles pass directly over the colony on a regular basis. Data have been collected since 1992.

Results

The spring of 2000 was exceptionally windy and dry. In the most exposed areas, including some of the study plots, 0.5–1.5 m of sand was moved at measured locations. Because of the weather conditions the sand was dry to greater than normal depths for that time of year. Growth, especially of primary stems, into the dryer upper sand levels was inhibited. This resulted in stem counts that were lower than those of the previous year in all plots. The results for each plot are grouped into the three habitat types described above.

Group I: Plots in Stable Areas (Plots 5 and BLM Plot 3)

Plot 5: Between 1991 and 1999 the number of *A. welshii* stems in Plot 5 has remained steady, fluctuating between 37 and 50. Primary stem numbers remain very low, an indication that competition from other species is restricting the spread of *A. welshii* (Figure 1).

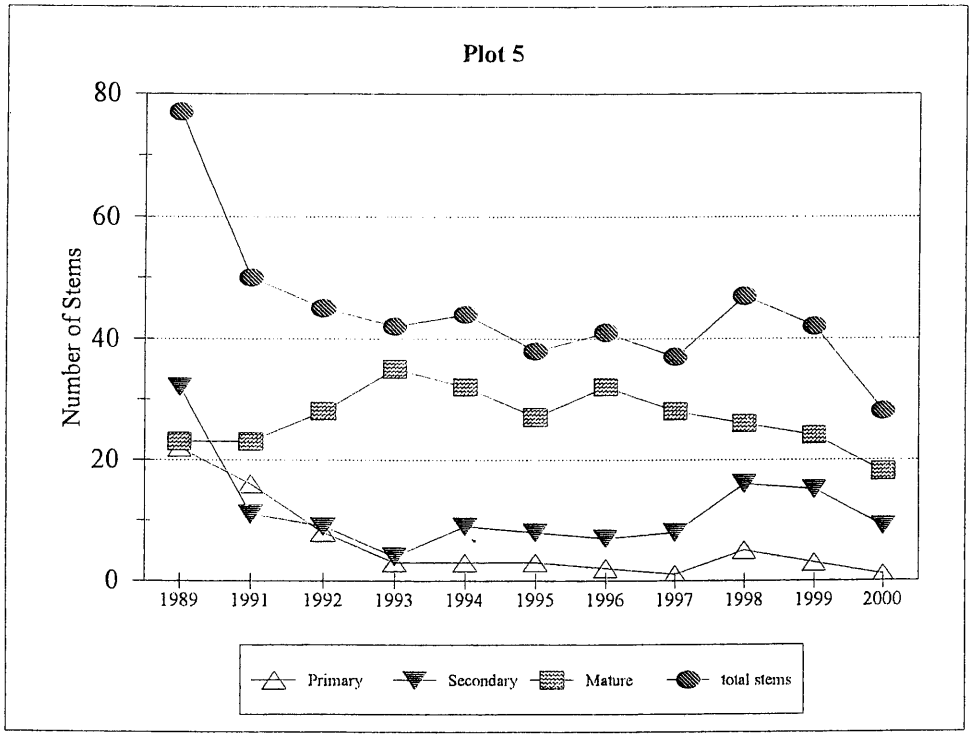
BLM Plot 3: *A. welshii* in this plot has shown a steady decline since 1989. Ground cover by other species in the plot is near maximum. The community is dominated by *Wyethia scabra, Calamovilfa gigantea, Chrysothamnus nauseosus,* and *Sophora stenophylla*. Only five *A. welshii* stems were counted in 2000. One secondary stem was growing by itself near the southwest corner of the plot. The other four stems, all mature, are part of a group growing mostly outside the plot among the *Wyethia* and under ponderosa pines. If present conditions continue, where competition is so great, this milkweed group cannot survive for many more years (see Figure 1).

Group II: Plots Where Sand Removal and Redeposition Is Continual (Plots 1, 3, 4, and 6)

Plot 1: The front of the dune upon which Plot 1 is located has advanced approximately one meter since 1989, while more than a meter of sand has been removed from the windward side. Because of a good cover of shrubs and grasses, such large-scale sand movement is not so obvious unless measured against plot corner posts. The brow and face of the dune originally bore 400 mature stems. This number has declined to less than 100. Primary and secondary stem numbers have remained steady (Figure 2).

Plot 3: This plot has also had more than a meter of sand removed from the south half of the plot and deposited on the north. The northwest corner post has been buried and the northeast post is barely protruding. The total number of stems has declined steadily since 1992, from a high of 172, to 29 this year (see Figure 2). However, the decline within this plot is not representative of the *A. welshii* population as a whole on the dune. The single largest colony of *A. welshii* at Coral Pink Sand Dunes grows here. The plot was placed on the edge of the colony and the colony is moving with the advancing dune; it is not diminishing in size. More seedlings have been observed in this area than in any other.

Plot 4: This is also on the crest of an actively moving dune. The dynamics are similar to that of Plot 3. Originally the entire plot had a good cover of blowout grass, *Redfieldia flexuosa,* but in 1990 the southwest third of the plot was blown out, resulting in the removal of the grass as well as *A. welshii.* Apparently deeply buried *A. welshii* rhizomes survived, because mature stems have returned to the



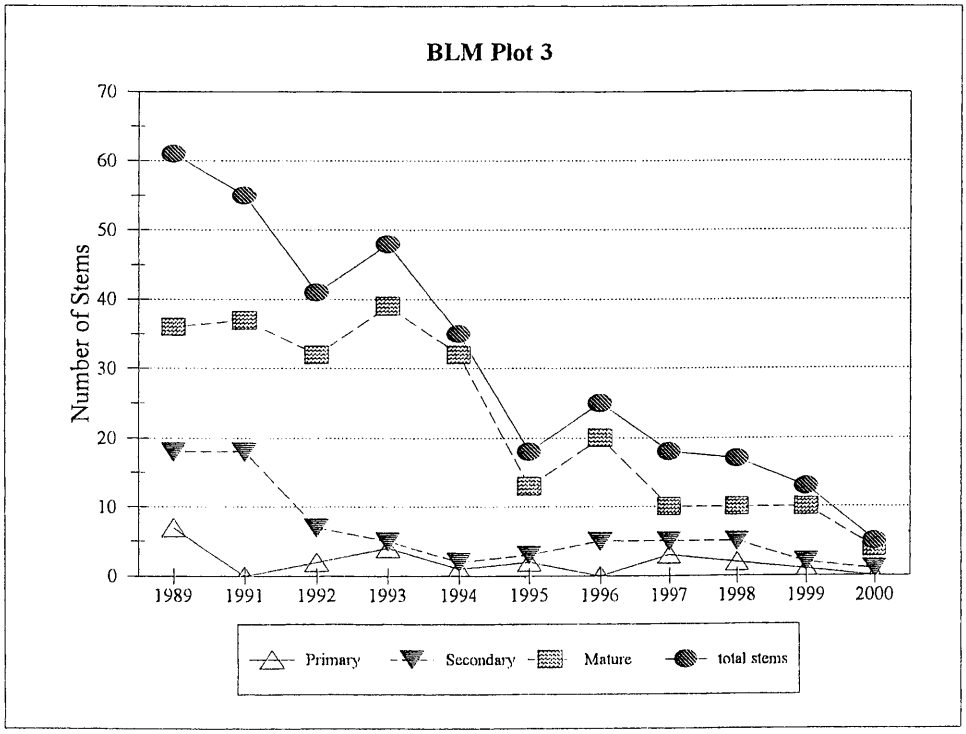
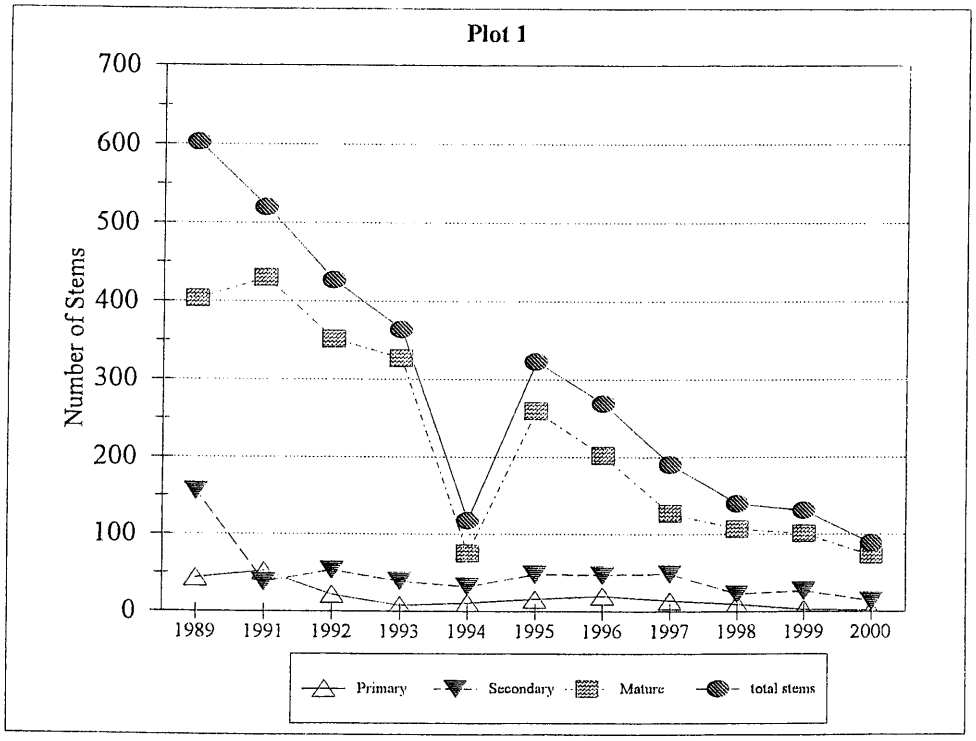


Figure 1. Habitat type I: Plot 5 and BLM Plot 3.



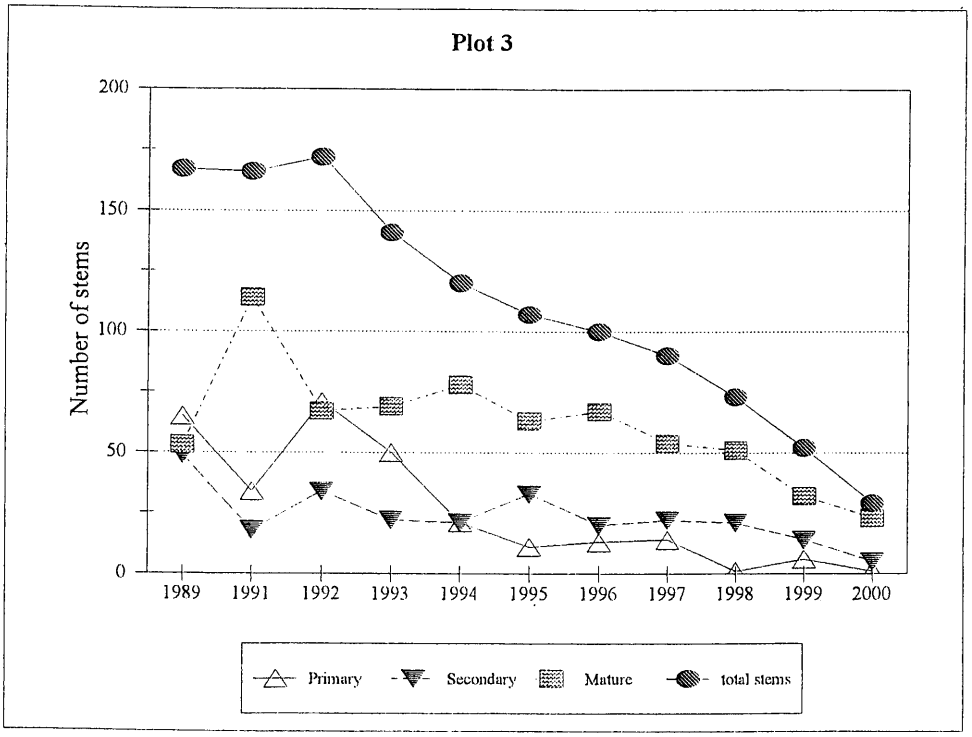


Figure 2. Habitat type II: Plots 1 and 3.

blowout site within a year of their disappearance. This could not have happened as quickly from rhizomes growing into the blowout area from the outside.

The production of primary stems is also high in this plot, especially in the areas where sand is being deposited and blowout grass is prevalent. In spite of adverse conditions, Plot 4 is one of two that up until this year has continued to show an increase in number of stems (Figure 3).

Plot 6 (Sand Hills): Plot 6 has also shown an overall increase in number of stems through 1999. After a dip in 1993 the number has climbed from 129 to 216. The plot is on the top of the dune that is home to the majority of milkweed growing in the Sand Hills. Most of the stems in this colony are located on the face of the dune outside the plot. *A. welshii* has been blown out of the south side of the plot as the sand has been removed by the wind and has been deposited on the dune face. *A. welshii* is not recovering in this blown-out area as it is in Plot 4 (see Figure 3).

Group III: Blowout Areas
(BLM Plot 2 and Plot 2)

BLM Plot 2: The plot is located on the northeast end of the dunes, on the side of a steep, formerly oak-covered dune. Large volumes of sand have been blown away and the plot area is littered with pieces of oak debris with sizes up to 20 cm in diameter and several meters long. This debris helps stabilize the sand and creates numerous pockets on the dune surface where wind effects are reduced. The total number of *A. welshii* stems in the plot has fluctuated from year to year, but continues to have a slight overall upward trend.

Plot 2: This plot is of special interest because of the nature of its population of *A. welshii*. Prior to 1989 virtually all vegetation was removed in a blowout. When the plot was established that year 805, *A. welshii* stems were counted, 680 in the primary stage and 117 in the secondary (Figure 4). Only eight mature stems were present. Many more primary stems were growing outside the plot; they were not seedlings as was first thought. With careful excavation their origins could be traced to mature stems.

Besides *A. welshii* the only other species present consisted of a few clusters of blowout grass, *Redfieldia flexuosa*. The plot seemed ideal to observe changes from a single species to a stable, mixed community of dune perennials.

The number of *A. welshii* stems increased each year until 1995, when it reached 1542 (see Figure 4). During this 7-year period the percent of stems in each of the three stages remained nearly the same. This was unexpected. It was assumed that as *A. Welshii* spread, food accumulation in the rhizome system would lead to an increase in secondary and mature stem numbers, with a relative drop in the number of primary stems. Since 1995 there has been a general decrease in stem numbers but the ratio of the three stem types has remained about the same. So far there has been no maturation of the colony, only a general decrease in stem number (see Figure 4).

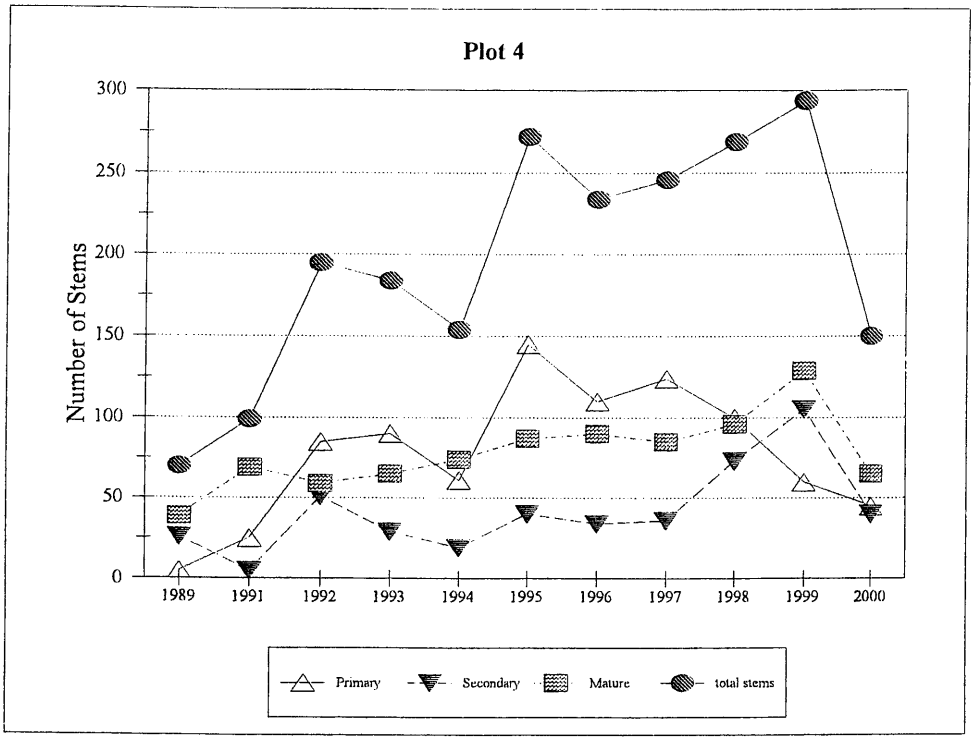
By 1995 other perennial species had become established, so a count of all the species was undertaken. As with *A. welshii*, aerial stems or clusters were counted as separate entities. The counts for rhizomatous species are subjective because each protruding stem was counted even though connections to other stems were known. In 1996, the total count of *A. welshii* as well as the combined total of all other species had decreased. In 2000 the two rhizomatous species, *Eriogonum leptocladon* and *Redfieldia flexuosa*, accounted for 86 percent of the total of all other species, with *Eriogonum alatum* accounting for another 11 percent. The non-milkweed count was more than twice that of *A. welshii* (Table 1).

Other Sites

Plant competition plot: The initial stem number of 7 in 1992 has increased to 338 in 1999 (Figure 5). Most of the increase was in the primary and secondary stages. These two growth forms are the most vulnerable to the effect of the dry windy spring. The decrease in total number of stems in 2000 was greater than in any other plot because of the higher percentage of primary and secondary stems in the plot compared to the other plots.

ORV-impacted site: *A. welshii* stems in this colony have increased steadily until this year (Figure 6). Primary and secondary stem numbers have been greater than the number of mature stems every year. This is consistent with data from other sites where competition is lacking. No other plants occur in the area, enabling the milkweed to spread freely.

Unlike the study plots that are on the crests or sides of dunes, this colony is located in a low area on the lee side of a large dune. Large-scale movement of sand is not obvious, but because of the location there is considerable movement across the site with a relatively small net change in sand deposition or removal.



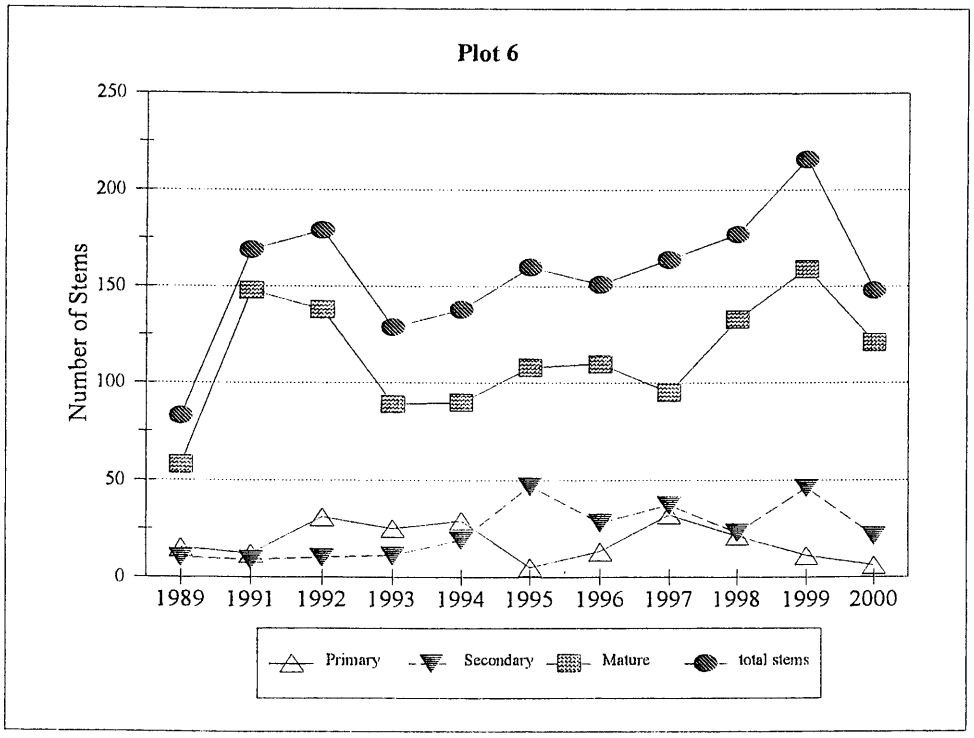
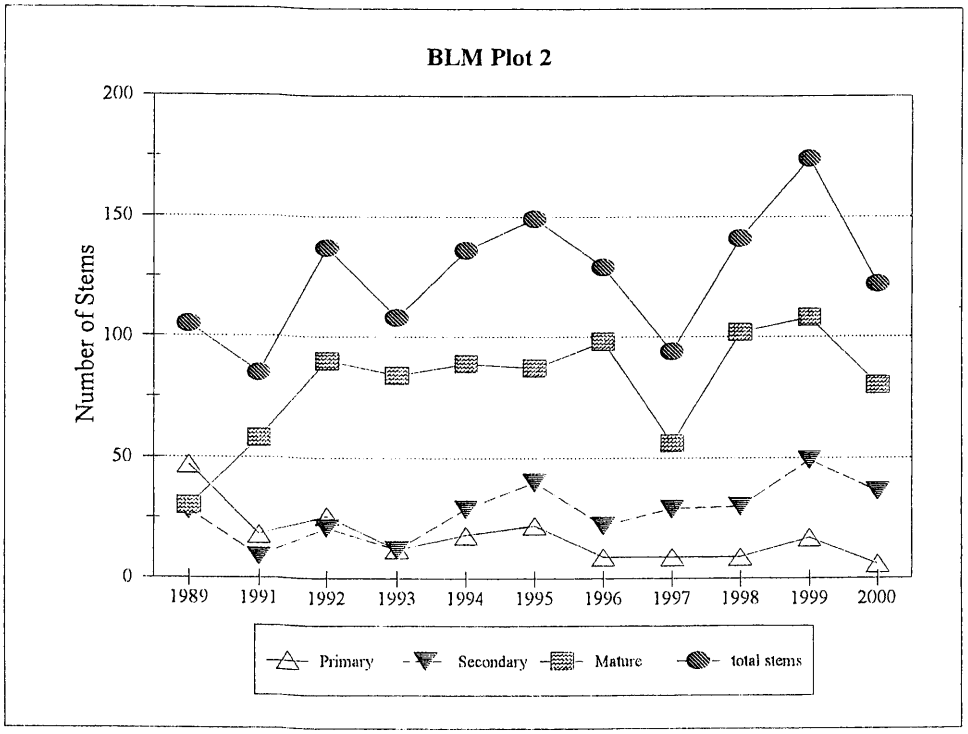


Figure 3. Habitat type II: Plots 4 and 6.



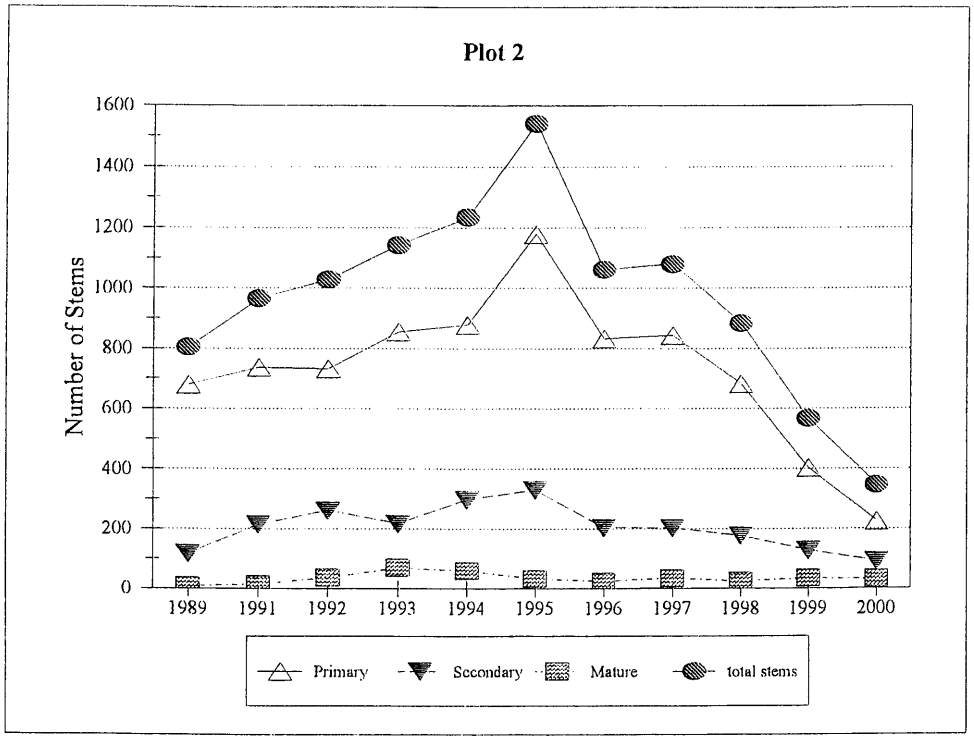


Figure 4. Habitat type III: BLM Plot 2 and Plot 2.

Table 1. Total count of all species in Plot 2 from 1995 to 2000.

Species	1995	1996	1997	1998	1999	2000
Artemisia campestris	3	3	3	2	2	3
Chrysothamnus nauseosus	1	5	3	2	4	2
Eriogonum alatum	48	18	30	17	62	87
Eriogonum leptocladon	157	45	113	108	135	136
Psoralidium lanceolatum	0	0	4	4	7	6
Wyethia scabra	6	2	5	4	4	5
Calamovilfa gigantea	0	0	0	0	0	10
Muhlenbergia pungens	0	0	1	1	1	1
Redfieldia flexuosa	117	34	126	245	229	558
Total other species	332	107	285	383	434	807
Asclepias welshii	1542	1061	1081	884	567	347

Discussion

Asclepias welshii is a pioneer or low seral species that is adapted to the constant change of active sand dunes. Its large flat seeds are rapidly buried by the drifting sand near where they drop from the fruits. They are dispersed only short distances by the wind. Temperature and soil moisture conditions are rarely suitable for widespread germination over large areas at any one time. In most years seedlings are seldom seen, but at times the number of seedlings on a specific dune may exceed 50. Attempts to determine seedling survival over more than one season indicate a survival rate of less than one percent. For example, in July of 1995 while attempting to locate a place for an additional study plot in the Sand Hills, a site was discovered where approximately 80 seedlings were found in an area of about 60 square meters. Upon returning in 1996 to establish a plot that would include the seedlings, not a single milkweed stem was present.

Rhizomes are the chief means of dispersal and survival for *A. welshii.* Clusters of mature stems arise from subterminal meristems of large rhizomes lying 16 cm or more beneath the surface. The tips of these large rhizomes do not elongate appreciably, so that clusters of stems emerge at the same location year after year. Lateral underground branches and single aerial stems having the primary, secondary, and mature forms originate from nodes and branches some distance from the apex of the larger rhizomes. Long rhizome segments exposed by the drifting sand have been found with all three stem types growing from them. Deeply buried rhizomes that escape blowouts are the source of rapid regrowth into highly disturbed areas.

These studies have produced no evidence that ORVs constitute the major threat to the existence of *A. welshii.* The plot where all other species have been removed and the colony growing in the ORV trail are both increasing in the absence of other species. The *A. welshii* population in Plot 2, once rapidly increasing as primary stems grew into unoccupied space, is on the decline as other species begin to spread through the plot.

Plot 5, on the other hand, which acts as a control for the competition plot, is barely able to support a small, static *A. welshii* population in the midst of heavy competition from other species. *A. welshii* in BLM Plot 3 has all but disappeared under extreme competition.

None of the eight plots are in areas that are normally impacted by ORVs. Plot 3 has had vehicle tracks crossing it occasionally in the past, but drifting sand and growth of blowout grass and sand buckwheat around the area have obscured the obvious trails leading to the site. Vehicle visits to the plot have been rare in the past 3 years.

Other plots slightly impacted by vehicle traffic are Plot 6 in the Sand Hills and BLM Plot 2. Plot 6 is remote and rarely visited by anyone. In 1999, however, an ORV rider discovered the dune where the plot is located and spent some time riding through it, making several trips up and down the dune face.

BLM Plot 2 is on the northeast end of Coral Pink Sand Dunes and at one time an entrance or exit trail crossed the corner of the plot. No *A. welshii* grows in the impacted area. In 1997 that end of the dunes was closed to vehicle traffic.

No evidence of ORV activity has been seen at any other plot, yet *A. welshii* populations are declining or barely increasing in all of them. This

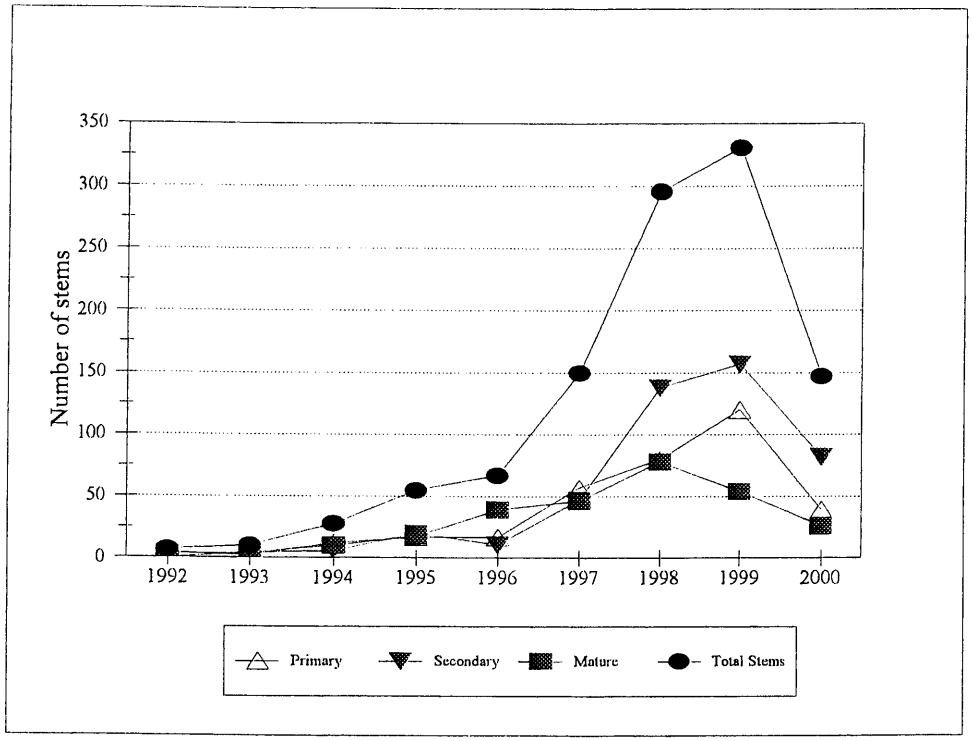


Figure 5. Stems in plot with competition removed.

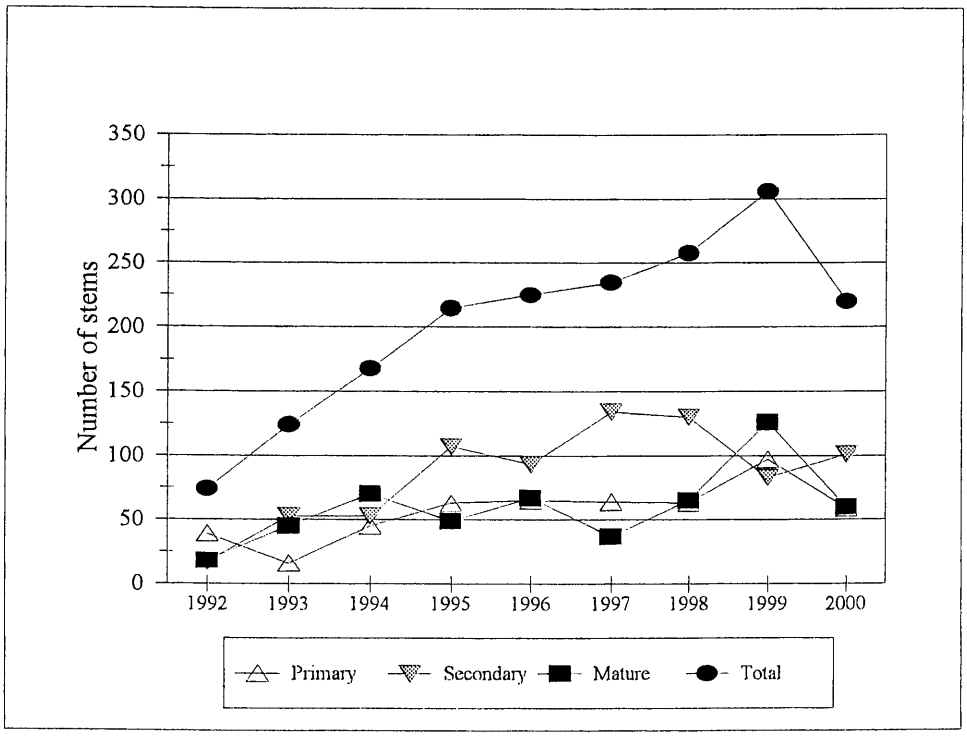


Figure 6. Stems in colony impacted by ORVs.

exemplifies the unstable nature of *A. welshii* colonies. As the habitat waxes and wanes, so does Welsh's milkweed.

Since 1980 Coral Pink Sand Dunes State Park personnel have maintained records of ORV use over the entire dunes area. From 1980 through 1984 there were fewer than 10,000 vehicles per year on the dunes. In 1986 usage peaked at 23,957 ORVs, then dropped to fewer than 7000 in 1991. Since then the numbers have fluctuated between about 6100 and 8700 per year, about a third that of 1986 (Figure 7). Moreover, not all the vehicles counted actually enter the BLM portion of the dunes.

Several factors played a role in sand dune and *A. welshii* management decisions made in the mid 1980s. First, the cost of the Model T of ATVs (all-terrain vehicles), the Honda three-wheeler, was within the budget of almost anyone who had an interest in such things. As a result ATV sales, as well as ORV numbers at Coral Pink Sand Dunes, soared (see Figure 7). At about the same time efforts to protect *A. welshii* were initiated, resulting in its official listing as a threatened species in 1987. The huge influx of ORVs resulted in the government policy statement that "ORVs constituted the single greatest threat to the survival of *A. welshii*." The Welsh's milkweed recovery plan (U.S. Fish and Wildlife Service 1992) also listed ORVs as the major threat to *A. welshii* survival.

While these events were transpiring, the sale of new three-wheeled ATVs was banned. Since few casual three-wheeler users could afford a four-wheeled ATV, the use of ORVs on the sand dunes dropped rapidly. The annual use of ORVs since 1991 has fluctuated between 6500 and 8500 vehicles.

Anyone currently traveling anywhere in southern Utah can't help but be impressed by the number of four-wheeled ATVs being transported about in trailers or pickups; it is obvious that possession of four-wheelers is no longer limited to the wealthy. It could easily be assumed that a proportionate number of these vehicles are headed for Coral Pink Sand Dunes. The figures, however, do not bear out this assumption. There has been no such increase in activity. The main reason for this is that the new four-wheelers are purchased primarily for hunting or other mountain-related activities. They are not designed for travel on sand dunes. In the higher gears they don't have the combination of power and speed necessary to traverse the high steep dunes, and in low gear excess power tends to cause them to bury themselves in the sand as they attempt to climb a dune. The two-stroke, racing-type machines perform much better on the dunes but they do not have the versatility or general appeal of the four-trax type of ATV. Consequently their use on the dunes has not increased.

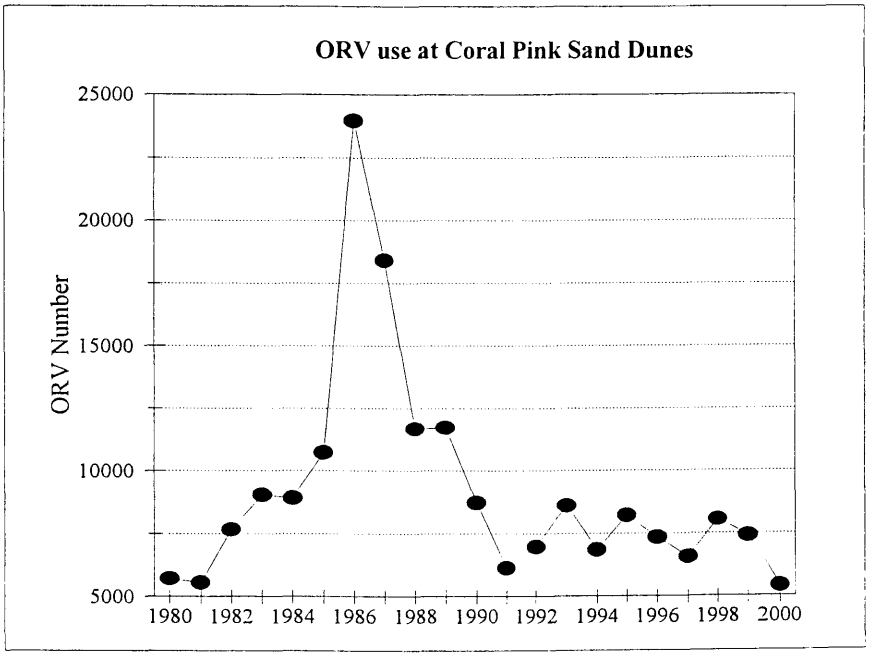


Figure 7. Annual use of ORVs at Coral Pink Sand Dunes.

For the past 4 years dune buggies have been counted separately from other ORVs, but their numbers are included in the totals. They have not shown an increase in this period, continuing to make up about 10 percent of the ORV total each year.

This study of *A. welshii* was initiated near the end of the major ORV impact period, which also coincided with a serious education and enforcement effort by state and federal agencies designed to keep riders on open areas and trails and off the dune vegetation. Twelve years of observation has shown that compliance with these objectives has improved, although some individuals still do not comply and damage to the vegetation still occurs.

In the development of a management plan for *A. welshii,* the most fundamental issue, the species' position in the sand dunes community, has not been addressed. *A. welshii* is not a component of a stable dunes community; it is a pioneer on open moving dunes, disappearing as the dunes become stabilized by shrubs and grasses. It thrives under disturbed conditions where competition is reduced or eliminated. Such conditions may be found on actively moving sand dunes or in other disturbed sites. In the Sand Hills, *A. welshii* is restricted to the still-moving front of the Sand Hills themselves, the only remaining "active" dune in the system.

The majority of *A. welshii* plants on the Coral Pink Sand Dunes are found on dune faces, dune crests, or as remnants of colonies along the edges of blown-out areas. None of these locations suggest that *A. welshii* is a member of a stable, mature dune community.

A. welshii is a "new" species; consequently, in the past its distribution and abundance was unknown and of no interest. Old photographs in the possession of Coral Pink Sand Dunes State Park show that plant cover on the dunes has increased in recent years. This could mean that *A. welshii* was more abundant in the past when there was less vegetation. Its present distribution may be simply a reflection of the adaptation of *A. welshii* to a habitat that is continuing to shrink, not because of disturbance but because of lack of disturbance. If this is the case, as these studies suggest, then a management plan that would increase the numbers of *A. welshii* must include provisions for reducing competing vegetation, possibly by chemical or mechanical weeding. Excluding man and his machines from the Coral Pink Sand Dunes, no matter how well intended, will not help solve the problem of the survival of *Asclepias welshii.*

Acknowledgments

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