A Tale of Two Single Mountain Alpine Endemics: *Packera franciscana* and *Erigeron mancus*

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Abstract. Both the San Francisco Peaks ragwort, *Packera franciscana* and the La Sal daisy, *Erigeron mancus* are endemic to treeline/alpine habitats of the single mountain they inhabit. There is little habitat available for these plant species to migrate upward in a warming climate scenario. For *P. franciscana*, 2008 estimates indicate over 18,000 ramets in a 4 m band along a recreational trail in the Arizona San Francisco Peaks, a trail-side population centroid of 3667 m, and that the population is producing and dispersing seed. We also mapped the 2008 distribution of *E. mancus* patches along the La Sal Mountain crestline in Utah.

Both the San Francisco Peaks ragwort, *Packera franciscana* (Greene) W.A. Weber and A. Löve, and the La Sal daisy, *Erigeron mancus* Rydberg, are endemic to treeline and alpine habitats of the single mountain they inhabit. *Packera franciscana* is known only from the San Francisco Peaks in Arizona (Greenman 1917, Trock 2006) (Figure 1) where it has been reported to mostly occur between 3525 m and 3605 m elevation (Dexter 2007) or more generally 3200-3800 m (Trock 2006) with a range size of 85 ha (Dexter 2007). Since the elevation of the highest peak on the mountain is 3851 m, there is little habitat available for the plant to migrate upward in a warming climate scenario, and it has been widely speculated that the species is vulnerable to extinction due to climate change. In 1985 the distribution of *P. franciscana* on the San Francisco Peaks was mapped (Dexter 2007), but prior to our study, no published data were available on species abundance. *Erigeron mancus* only inhabits the La Sal Mountains in Utah (Cronquist 1947) (Figure 1) where it occurs in alpine meadows between 3000-3800 m elevation (Nesom 2006). In sharp contrast to *P. franciscana* which predominately inhabits loose talus slopes (USFWS 1983), *E. mancus* occupies stable substrates, which greatly facilitates field measurements. No published information about the population biology of these species is available. Consequently, *P. franciscana* was listed as a Threatened species under the Endangered Species Act by the U.S. Fish and Wildlife Service (1983) and *E. mancus* is on the Forest Service Region Four Sensitive Plant List.

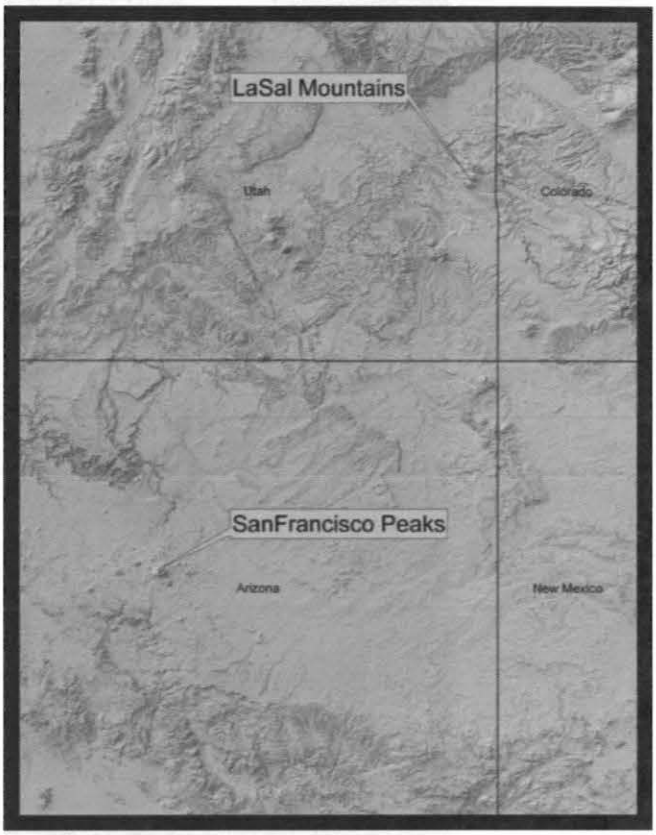

Figure 1. Map of the two study areas as isolated single mountains on the Colorado Plateau.

Kruckeberg and Rabinowitz (1985) note that narrow endemics can be locally abundant in specific habitats but geographically restricted, a description that may fit both species. Biologists have noted that *P. franciscana* is fairly abundant locally (Trock 2006, USFWS 1983) and our observations concur. We know of no density or population size data to support this observation, yet such data are critical for recovery of the species under the Endangered Species Act. In a changing climate scenario with increased temperatures and changes in amount, type, and patterns of precipitation, it becomes difficult to predict population trends. Our study will

define baseline population densities along permanent transects under the current climate and allow the detection of future population trends. Specifically, our objectives are to: 1) establish a statistically robust sampling protocol for long-term population density trends; 2) determine the elevation of patch centroids along these transects to allow early detection of altitudinal migration driven by climate change; and 3) provide data for ongoing formal species assessments, management responses, and, in the case of *P. franciscana,* revision of the 20-year old Species Recovery Plan (Phillips and Phillips 1987).

METHODS

In September 2008 (after the monsoon rains), we established an elevational transect along a designated recreational trail through *Packera franciscana* habitat to estimate the density of *P. franciscana* ramets, mid-September flowering/fruiting phenology, and the population centroid elevation as it intersects the trail (Figure 2). Sample points were established at 25 m intervals along a transect starting at 3550 m elevation and extending 1425 m along the trail to an elevation of 3798 m. At each sample point we counted *P. franciscana* ramets (upright stems) within 12 individual 1 m^2 frames arranged to

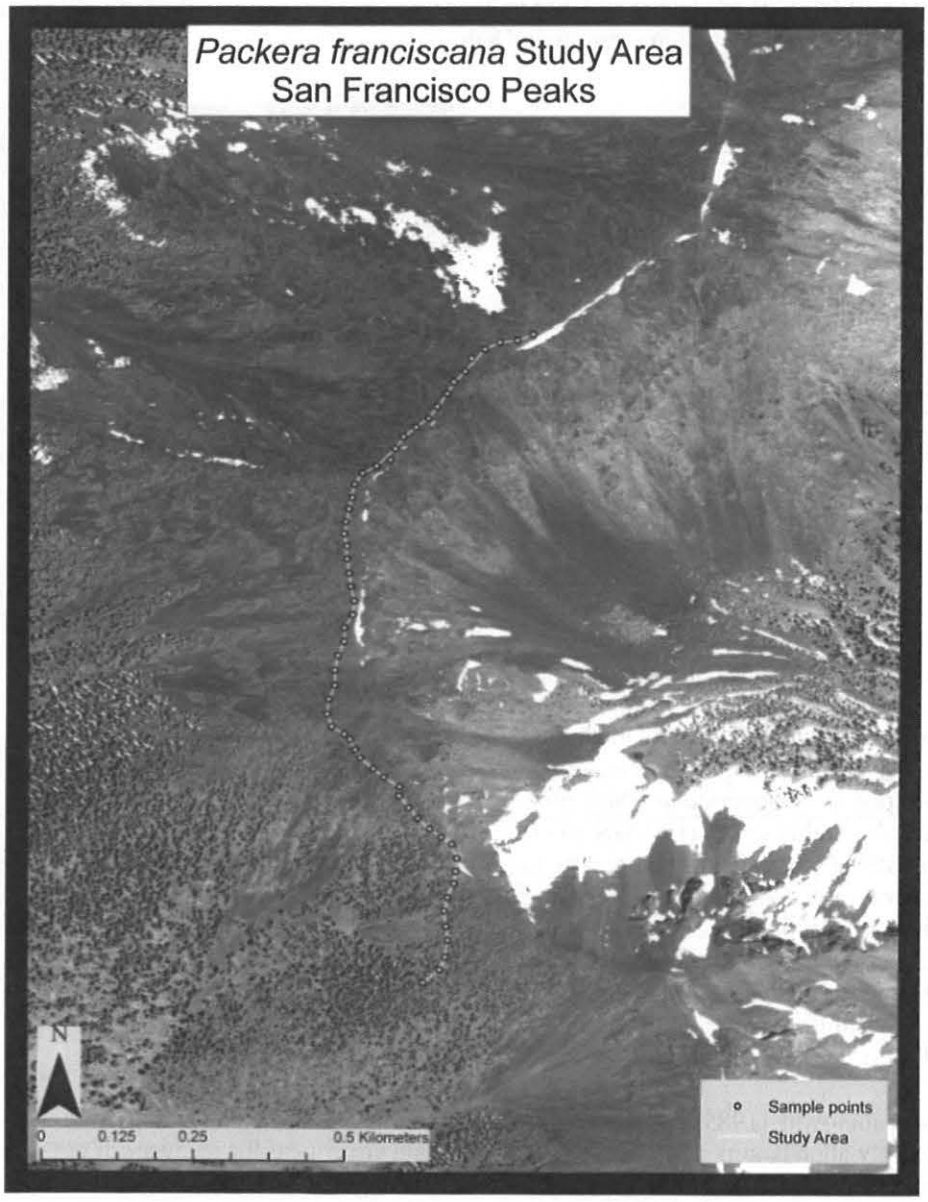

Figure 2. Location of the *Packera franciscana* trailside transect on the outslope of the volcanic caldera at and above treeline.

allow flexibility for trail curvature (Figure 3). Sampling frames were omitted when they overlapped previously counted frames, covered recent trail maintenance areas, or covered vertical drop-off > 5 m. Counts of ramets with flower, fruit, or both were also made within each frame. Coordinates for latitude, longitude, and elevation were made for each sample point with a Trimble® Geo XT 2005 Series GPS. Descriptive statistics were calculated with SAS/STAT 9.1 (2002-2003). Population centroid was calculated as the mean elevation of occurrence weighted by the number of ramets / sample point.

In July 2008, we mapped polygons of *E. mancus* patches with the Trimble® Geo XT 2005 Series GPS in three areas near and within Mt. Peale Research Natural Area, which is located in the Middle Group of peaks on La Sal Mountain. These polygons were plotted on a topographic map with ArcMap 9.2.

RESULTS

The September 2008 density estimate for *P. franciscana* along the recreational trail was 3.19 ramets / m^2 (SE □ 1.09), indicating that there are over 18,000 ramets in the 4 m band along the transect. A population centroid was located at 3667 m elevation. We counted a total of 1881 ramets of which 91 percent were vegetative, eight percent were in fruit, and one percent were flowering. Only seven ramets were in both flower and fruit.

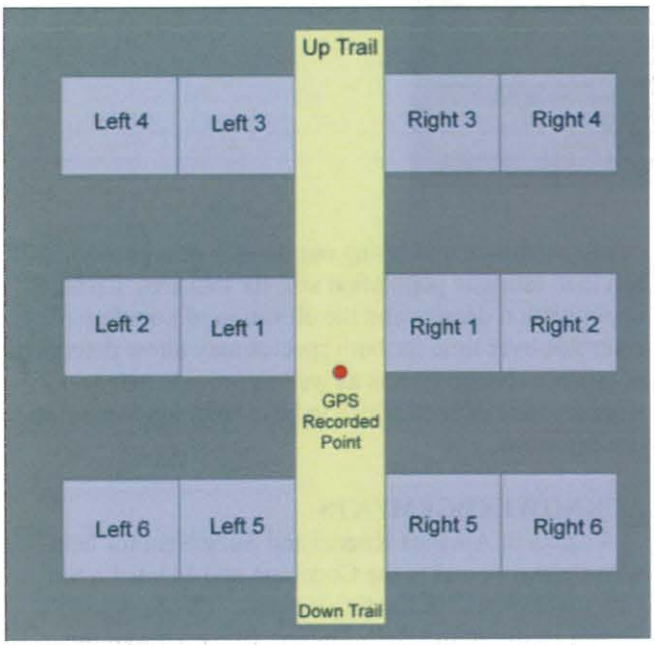

Figure 3. Arrangement and sampling sequence of 1 m^2 frames to measure ramet density.

Erigeron mancus mapping work in July 2008 revealed a relatively continuous series of *E. mancus* patches along the west ridge up to Mt. Laurel in the La Sal Middle Group of peaks, from the talus field at 3725 m down to 3475 m just above treeline, as well as along the La Sal Middle Group crestline at 3650 m (Figure 4). Our observations indicate that it can be abundant within its microhabitat niche on dry, windy ridgelines but less abundant to absent on nearby more mesic midslopes

DISCUSSION

Phillips and Peterson (1980) reported a *P. franciscana* population density range of 50-370 plants per 100 m^2 on the San Francisco Peaks but did not clearly define plants as ramets or genets (clumps or clones) (Figure 5). However, later references to clump size would indicate that they were using the latter concept. On a per 100 m^2 basis, our density measurements are similar at the upper end of their density range (319 vs. 370), which is probably a reflection of the different "plant" definitions. Given the difficulty of defining and counting clumps and clones in the field, ramets provide a more accurate way to assess population density. Even though ramet density may inflate the number of functional plants, it is an accurate reflection of photosynthetic and reproductive potential. Phillips and Peterson (1980) also reported that 13% of the *P. franciscana* plants were adult (sexually reproducing) which again is comparable to the 9% of ramets we sampled which were flowering and/or fruiting. These results and our estimate of >18,000 *P. franciscana* ramets in a very small portion of its range would indicate that the species is persisting and reproducing.

We interpret the successful production of fruit, which we observed actively dispersing by upslope winds in mid-September, as an indication that *P. franciscana* can sexually reproduce on the San Francisco Peaks. Seed viability studies may provide additional support for this interpretation. Examination of plant root systems would be necessary to determine if ramets originate from seed or from existing perennial rhizotamous clones. Rhizomes can produce large patches of ramets which may be the primary method of reproduction (USFWS 1983) but we also found single isolated ramets during our sampling which could be the result of seed dispersal or rhizome fragments moving downslope in the talus substrate *P. franciscana* inhabits. Plants inhabiting the upper portions of talus slopes would seem to be the result of seed dispersal since avalanches and downslope creep of talus fields would carry existing *P. franciscana* plants downslope. We noted dead *P. franciscana* plants at the base of some avalanche chutes. The population centroid of 3667 m we measured is above the 3525-3605 m elevation range for most *P. franciscana* noted by Dexter (2007) and near the upper end of the 3350-3750 m main

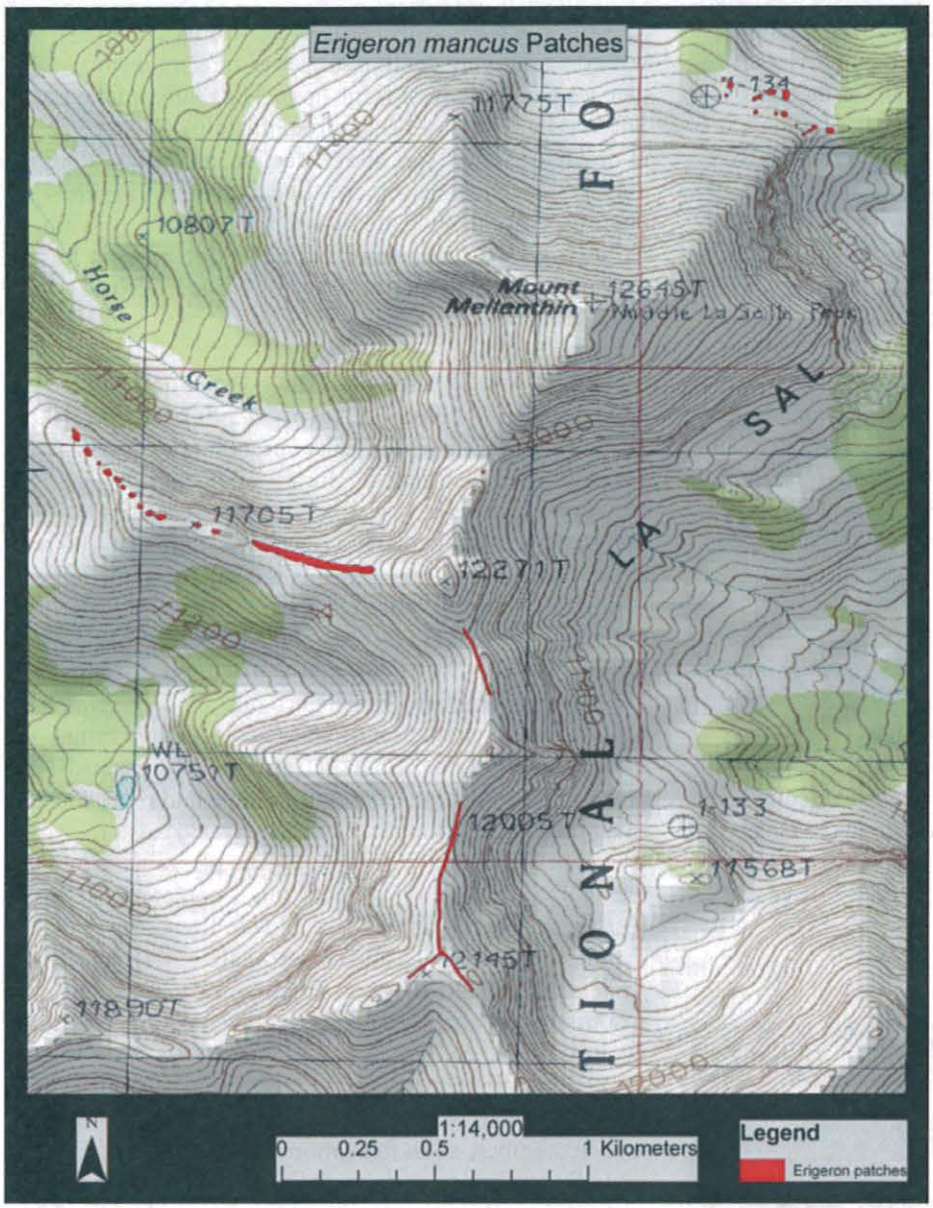

Figure 4. *Erigeron mancus* patches along the ridge up to Laurel Mt. and along the crestline of the Middle Group of La Sal mountain.

occurrence range in earlier reports (Phillips and Peterson 1980, U.S. Fish and Wildlife Service 1983). However, our transect is located on a drier west-southwest slope which may account for the higher occurrence elevation. More mesic slopes may have lower patch centroids; a hypothesis we intend to test by establishing a northeast aspect, trail-side transect in 2009.

We plan the second trail-side transect and annual measurements of both transects to detect *P. franciscana* population trends. Sampling in subsequent years may indicate trends in population density, changes in September phenology, or elevational migration within its habitat. We also plan to measure the change in *E. mancus* density along an elevational transect through the *E. mancus* patches shown in Figure 4. By measuring patch widths along this elevational transect, we can calculate patch size and, using our density measurements, can then estimate population size for this area. Changes in population density and the elevation of population centroids over time for both species may allow detection of climate change effects as well as provide managers with accurate data on which to base land and recreation use decisions.

ACKNOWLEDGEMENTS

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Figure 5. Clonal habit of *Packera franciscana*.

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Addendum

The planned population size and density estimates for *E. mancus* were completed in summer 2009 and published in 2010 (Fowler and Smith 2010). We also added the second trailside transect for *P. franciscana* in 2009 and published the 2008-2009 results in Fowler and Sieg (2010). A second *P. franciscana* manuscript covering the 2010-2012 time frame is in preparation.

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