Habitat Associations of the Threatened *Sclerocactus wetlandicus*: Vegetation and Soil Characteristics

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Sclerocactus wetlandicus Hochstätter, a federally listed threatened cactus endemic to the Uinta Basin of northeastern Utah, is threatened by energy development. We lack data quantifying edaphic and plant community characteristics of occupied habitat, whether these characteristics differ from those of unoccupied habitat, and how closely reclaimed well pads resemble undisturbed sites. An understanding of habitat characteristics will help guide energy development compatible with conservation, identify areas suitable for introduction of additional populations, and determine the suitability of reclaimed well pads for reintroduction.

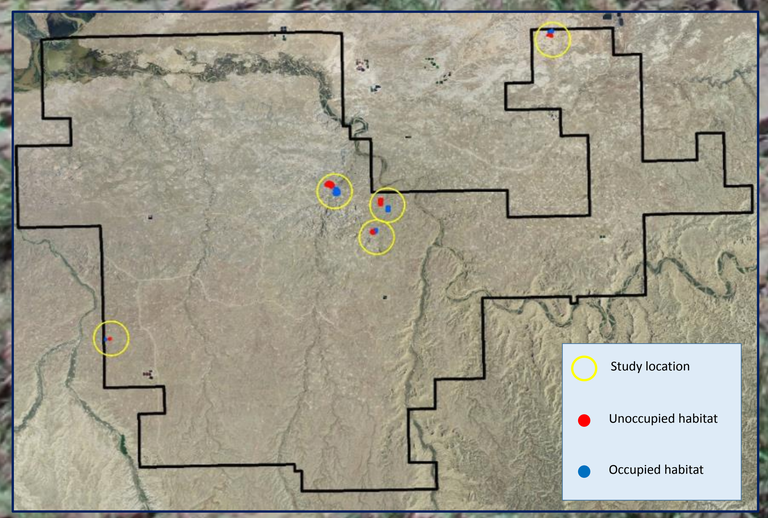
Specific objectives were to determine:

1) Whether vegetation and soil properties differ between cactus-occupied and cactus-unoccupied sites, and
2) How similar vegetation and soils of reclaimed well pads are to occupied sites.

Methods: Our study area was the Greater Natural Buttes Area south of Vernal, Utah, on land managed by the Bureau of Land Management and leased to Anadarko Petroleum Corporation. The study area receives 12 to 30 cm of mean annual precipitation and has a mean annual air temperature of 7 to 9˚ C.

To address our objectives we compared the vegetative communities and soils of 4 habitat types:

1) Undisturbed *S. wetlandicus*-occupied site at a location centered on a *S. wetlandicus* individual (**occupied present**)
2) Undisturbed *S. wetlandicus*-occupied site at a location with no *S. wetlandicus* individual within 15 m (**occupied absent**)
3) Undisturbed *S. wetlandicus*-absent site at least 50 m from any *S. wetlandicus* individual (**unoccupied**)
4) Reclaimed well pad site (**well pad**)



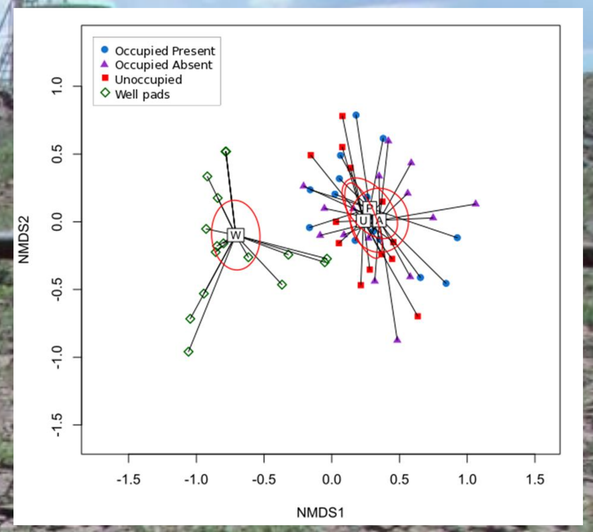
The 5 densest populations of *S. wetlandicus* were identified and occupied sampling polygons (sites) were created around them. Within each occupied polygon, 3 randomly selected cacti at least 15 m apart were used as **occupied present** sampling locations, and 3 points at least 15 m from any *S. wetlandicus* plant were randomly selected for the **occupied absent** sampling locations. These sites were paired with unoccupied polygons (sites) of similar size and with similar geologic and lithologic features as the occupied polygons but had no *S. wetlandicus* plants within 50 m. For **unoccupied** sampling locations, 3 randomly selected points at least 15 m from each other were located in each unoccupied polygon. Lastly, 18 disturbed and reclaimed well pads were sampled.

Vegetation was sampled with the line-point intercept method with 150 points in an 8 x 8 m plot centered on each location. Soil profiles were manually excavated 50 cm away from a cactus (occupied present) or other perennial plant, described, and sampled by genetic horizon. Soil samples were returned to Utah State University for laboratory analysis. Field moist and oven dry weights were recorded for all samples. Each soil sample was air-dried, sieved <2-mm, and analyzed in the laboratory for inorganic C, total C, organic C; electrical conductivity, total nitrogen (N), pH, extractable cations, available P, gypsum, and particle size distribution.

Non-metric multidimensional scaling (NMDS) ordination was used to find and describe vegetation community patterns. In our analyses, the distance matrix was comprised of Bray-Curtis dissimilarities. We applied NMDS to the data containing proportional species cover by plot. Vegetation community composition was compared among habitat types with permutational multivariate analysis of variances (PERMSNOVA) based on Bray-Curtis dissimilarity distance matrices. Soil characteristics were compared among habitats with ANOVA.

Results, vegetation: NMDS of vegetation data for **occupied present**, **occupied absent**, **unoccupied**, and **well pad** sites revealed **two clusters of sites, with well pads on the left and other habitat types on the right**. Permutational multivariate analysis shows a significant difference among habitat types. If well pads are removed the test is no longer significant for the 3 remaining habitat types, demonstrating that:

1) **well pads do not resemble undisturbed vegetation and**
2) **occupied and unoccupied habitats are not distinguishable in vegetation**.



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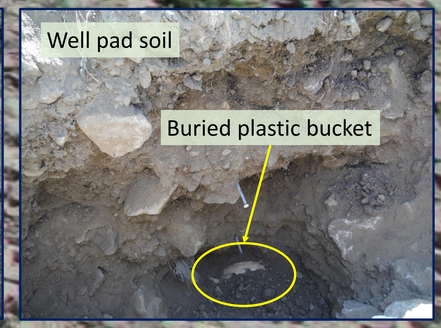
Results, soils: Undisturbed soils were shallow or moderately deep to bedrock, and classified into the order of Entisols (Lithic Ustic Torriorthents or Ustic Torriorthents). Soils/sediments on well pads were generally deeper, often to fragmental material, and often with anthropogenic materials, such as a bucket, silt fence, and cables.



Soil properties at **occupied present**, **occupied absent**, and **unoccupied** sites did not differ. However, soil properties at these sites differed from those of **well pads** ($p<0.05$). **Well pad soils/sediments were significantly higher in**: **1) available phosphorus, 2) electrical conductivity, 3) soluble boron (as borate), 4) soluble sulfur (as sulfate), 5) soluble sodium, 6) soluble magnesium, and 7) soluble potassium**, which indicate much higher salt content. Compared to undisturbed sites, well pads also had significantly lower slopes. Bare soil cover was much higher and biological crusts cover was much lower on well pads than on undisturbed soils.

Results indicate:

1) **Well pad soils do not resemble undisturbed soils and**
2) **Soils of occupied and unoccupied habitats are not distinguishable**.

Conclusions: Occupied and unoccupied sites were indistinguishable in vegetation and soil characteristics, but reclaimed well pads differed dramatically in both vegetation and soil characteristics from undisturbed sites.