

The Santa Rita Experimental Range Repeat Photography Archive Shows Desert Grassland Dynamics Across 121 Years and 115 Locations

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THE SANTA RITA EXPERIMENTAL RANGE (SRER)

History

- Oldest continuously operating rangeland research facility in the United States (1902-present):
- Long record of observations, photographs, and systematic remeasurement that allow us to understand vegetation changes
- Over 200 permanent transects provide long-term (from 12 to more than 70 years) records of vegetation measurements completed at 1 to 7-year intervals

Diverse Environment

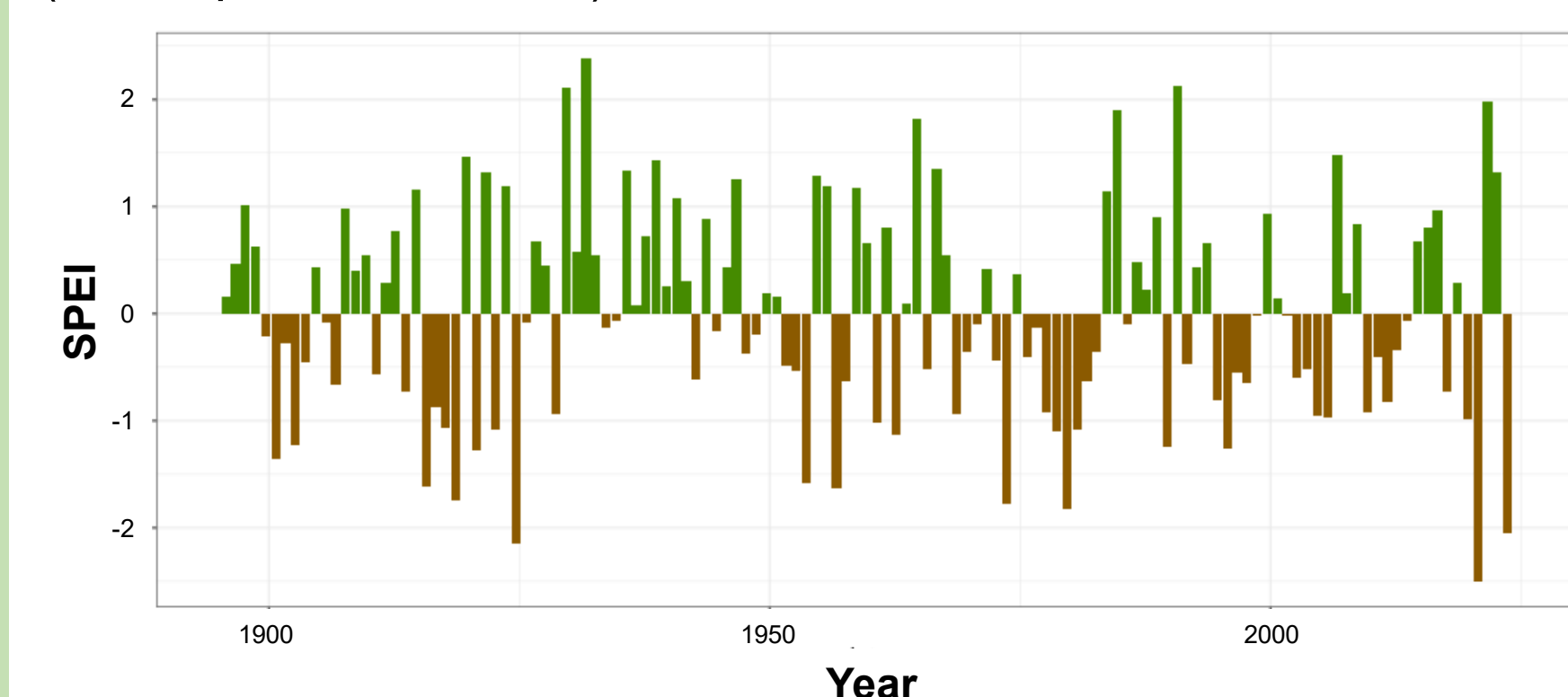
- 21,000 ha across the western alluvial skirt of the Santa Rita Mountains
- 900-1,400 m elevation range ascending to SE
- 18 Ecological Sites (Breckenfeld & Robinett 2003)
- Vegetation is Desert Grasslands, a mixture of short trees, shrubs, cacti and other succulents, perennial grasses, and other herbaceous species

Precipitation

- 275-450 mm rainfall range, with distinct summer and winter patterns

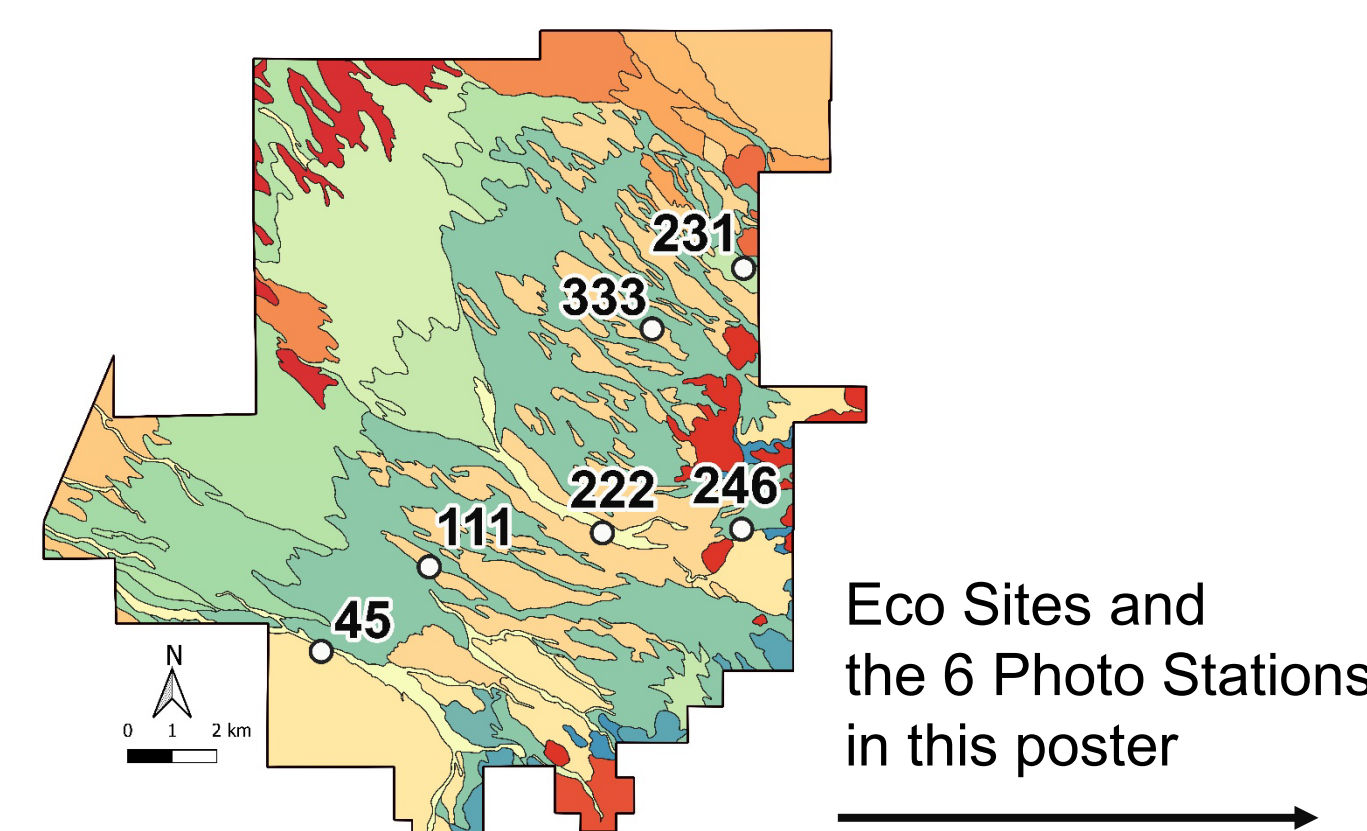
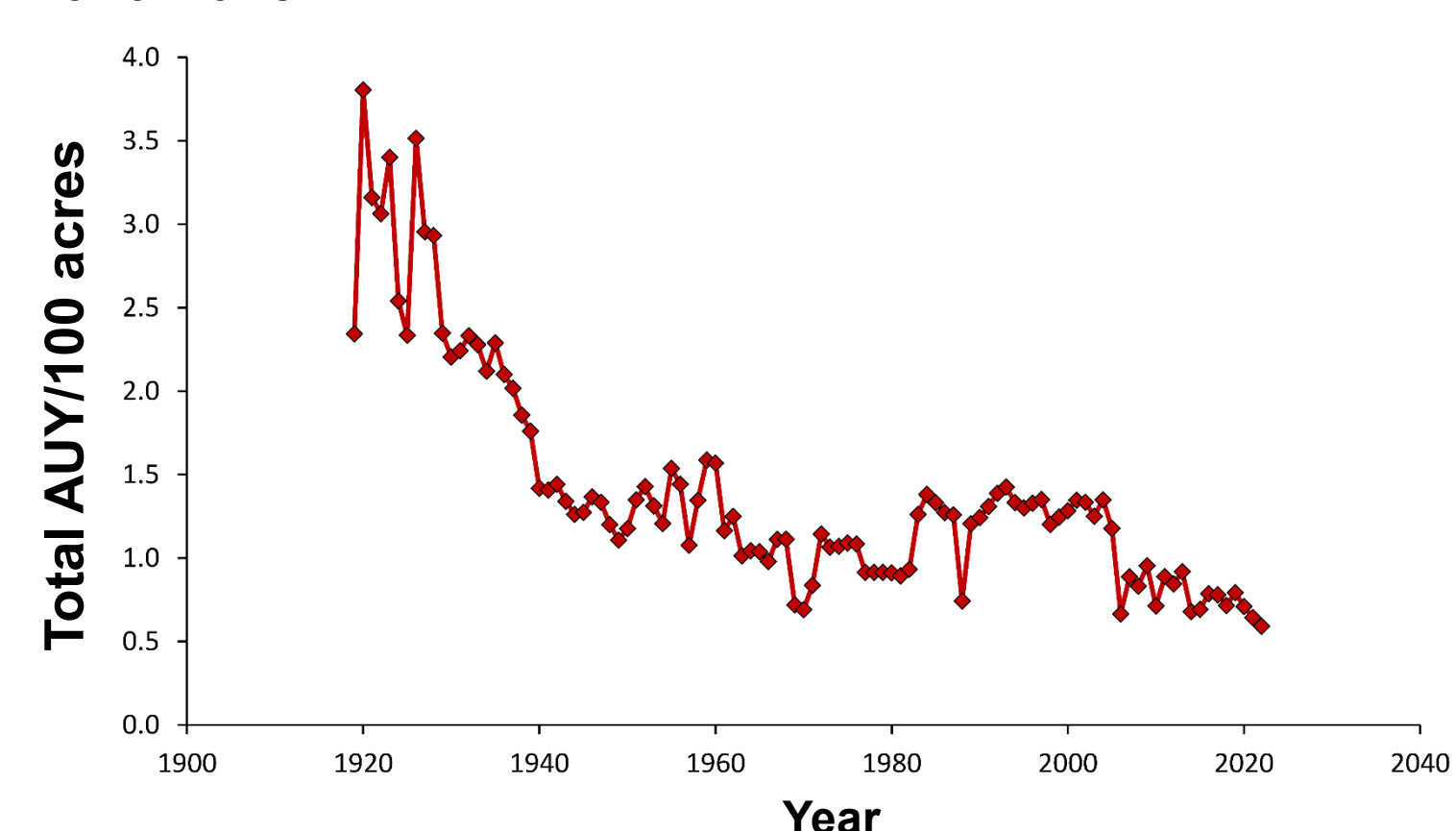
Standardized Precipitation-Evaporation Index (SPEI)

Summer, June-September, 1885-2023
 Lat. 31.8326, Long. -110.8488
 (SPI Explorer Tool V2.0)



Grazing

Animal Unit Year (AUY) per 100 Acres by Year 1919-2023



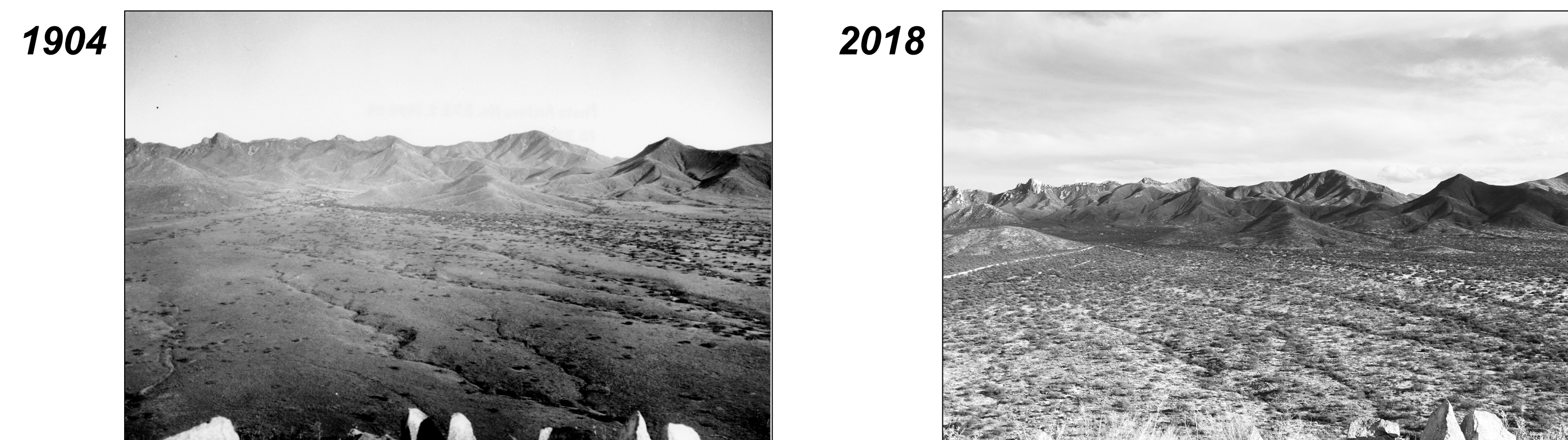
Eco Sites and the 6 Photo Stations in this poster

DESERT GRASSLAND DYNAMICS: COMPARING GENERAL PATTERNS WITH EXCEPTIONS SUGGESTS REASONS FOR DYNAMICS

CENTURY CHANGES

General Pattern

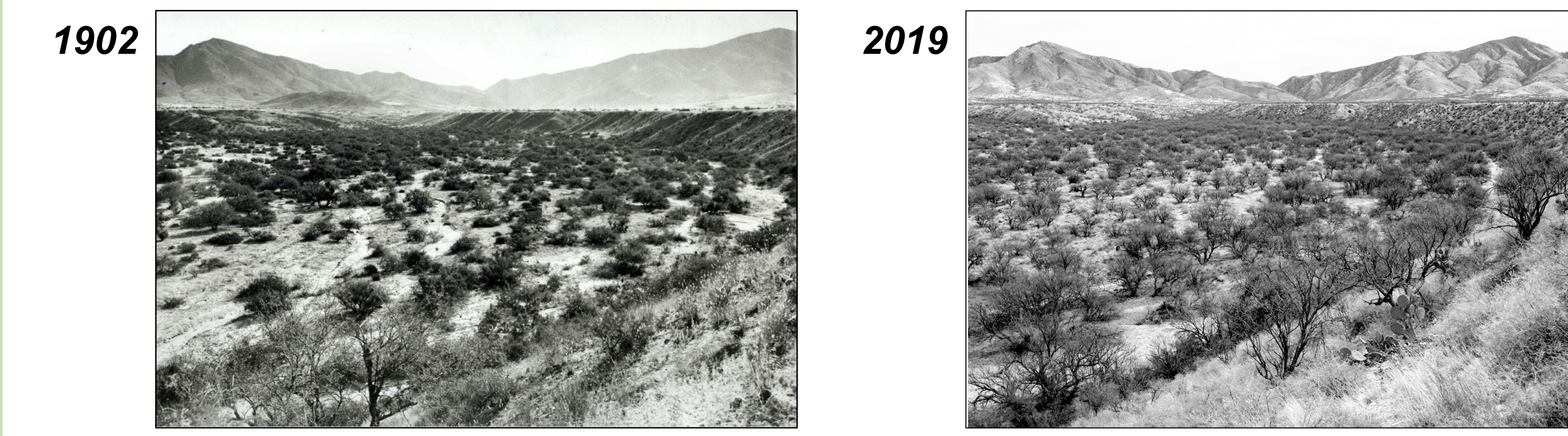
Mesquite increase in grasslands



PS 333.2. Looking E from 1,228 m Huernano Butte: In 1904, the landscape was open grasslands with *Celtis pallida* (desert hackberry) plants concentrated near the drainages and scattered in the grassland. By 2018, *Prosopis velutina* (mesquite) had increased and converted the open grassland to a savanna, but *C. pallida* had not increased, and the plants present in 1900 were still present in 2018.

Exception: Landscape Position

Mesquite and other woody species already common in Box Canyon wash

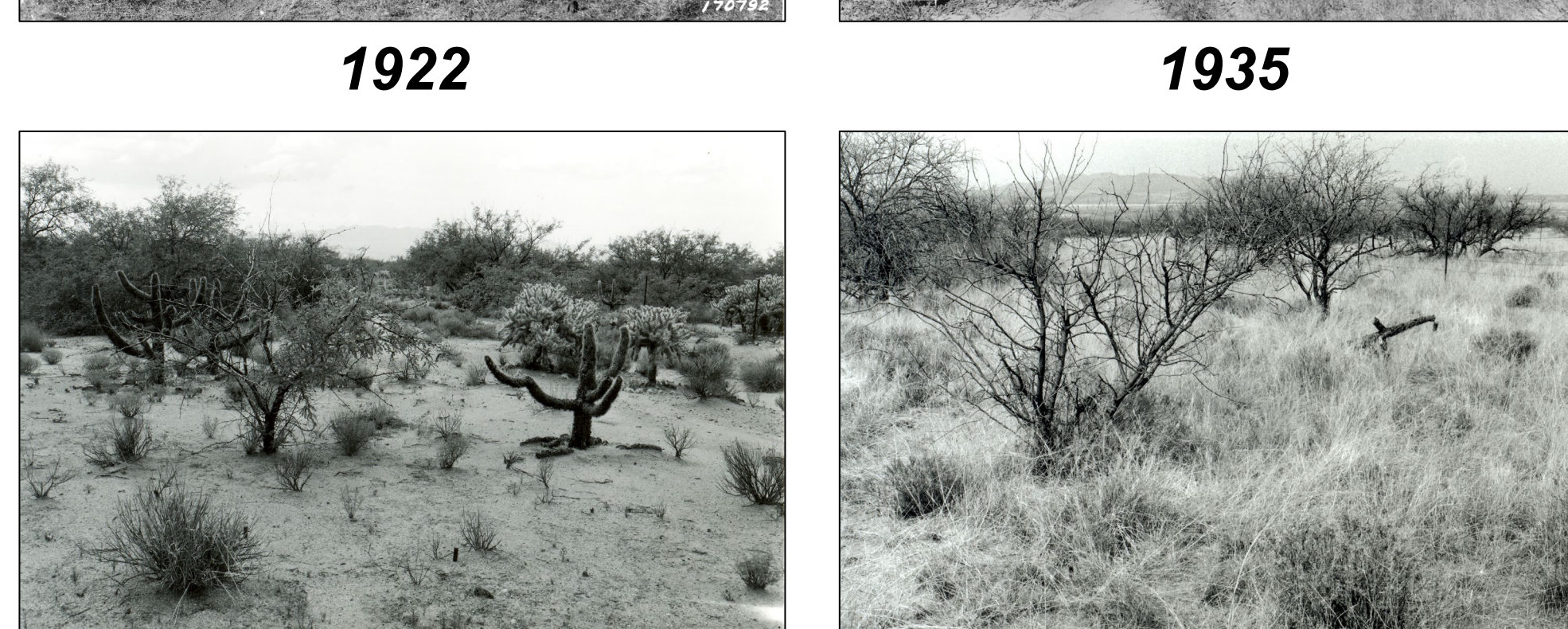
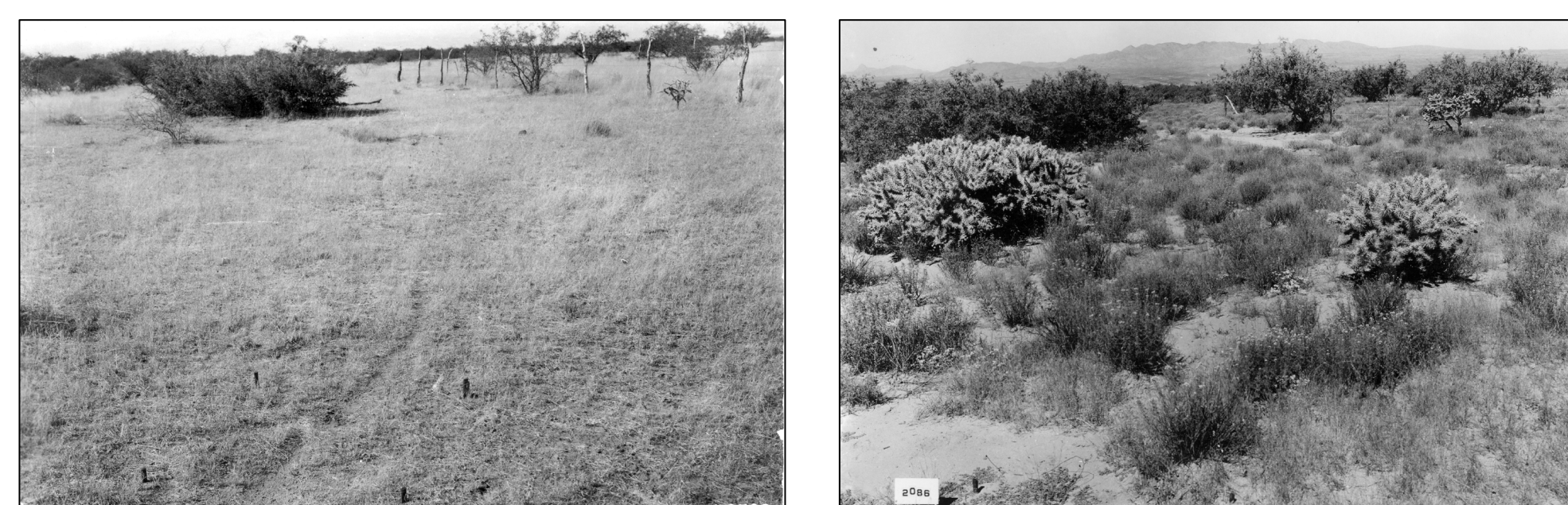


PS 222.1. Looking E into Box Canyon wash, at 1,150 m: In 1902, mesquite and other woody plants abundant and confined to the wash but mesquite absent in landscape beyond the wash rim. In 2019, slightly more trees in the wash but many new trees in the grasslands (dark, horizontal line above wash rim).

DECADAL CHANGES

General Pattern

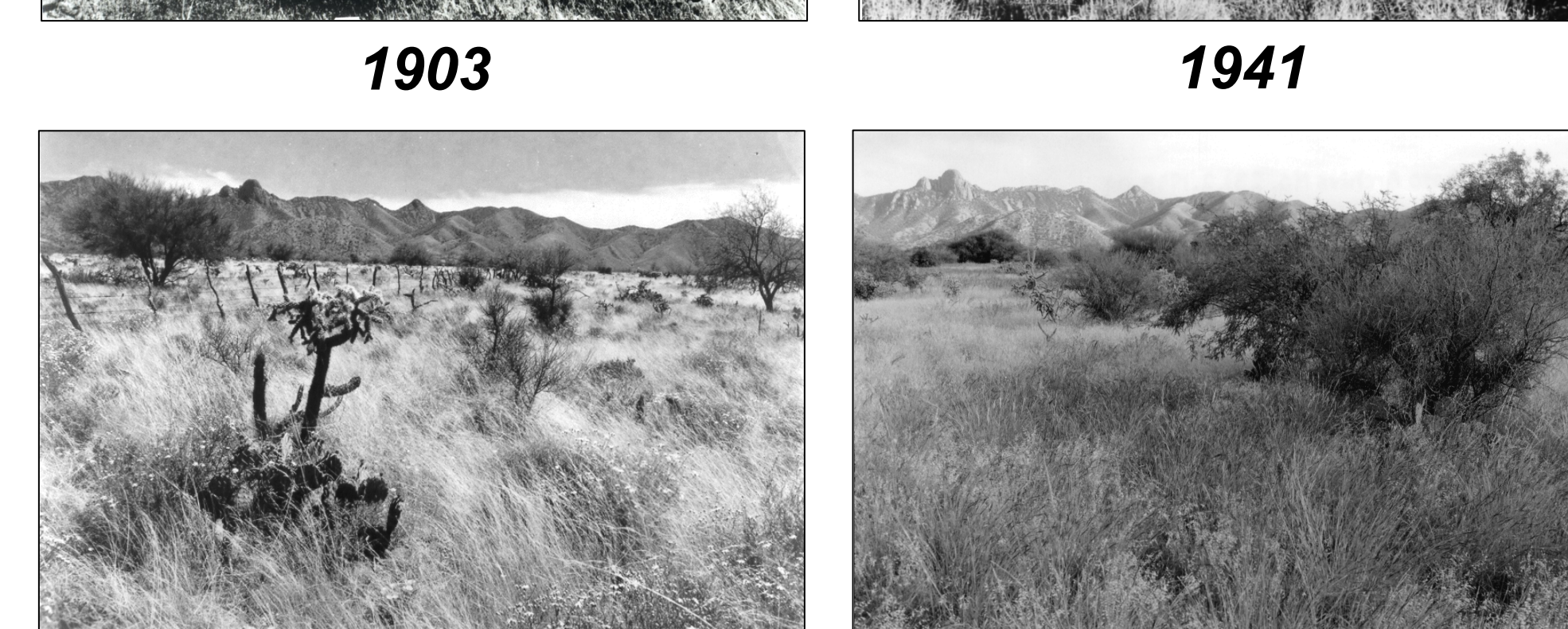
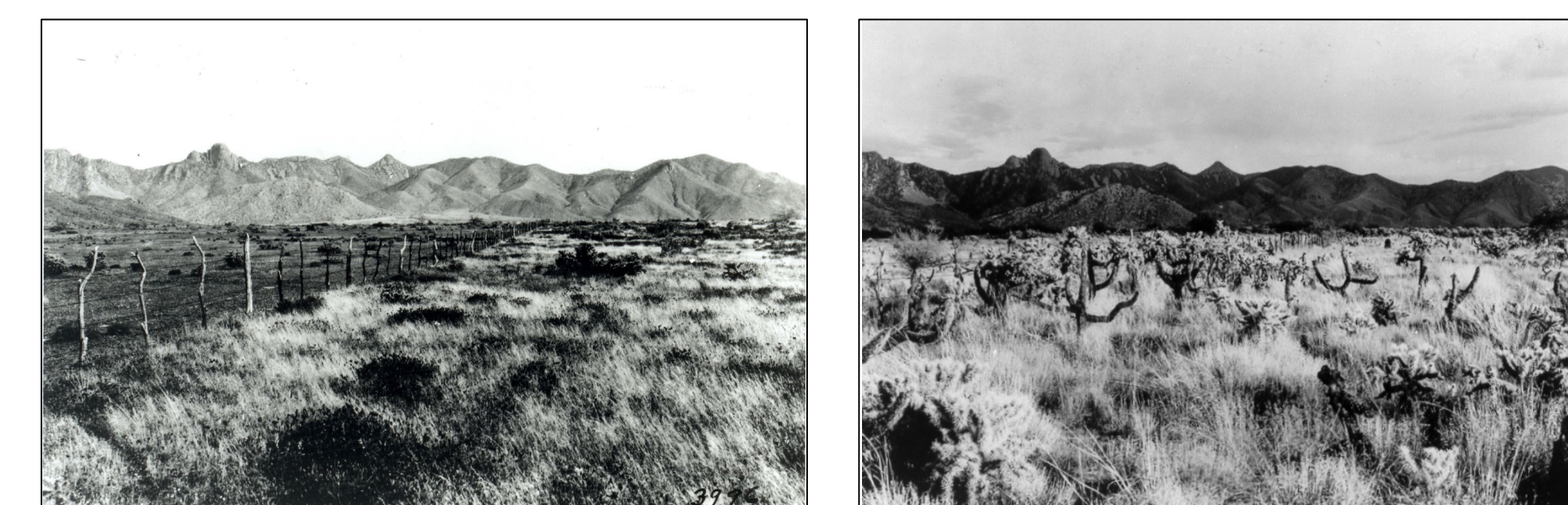
Burweed and cactus cycles, Lehmann lovegrass arrives



PS 111.1. Looking W, on sandy loam upland, at 1,100 m: In 1922, sparse tree presence and no shrubs in foreground. In 1935, eruptions of *Isocoma tenuisecta* (burweed) and *Cylindropuntia* spp. (cholla), and small mesquite established in burweed plant. In 1958, decline of burweed and cholla, and growth of mesquite. In 1990, dominance of nonnative *Eragrostis lehmanniana* (Lehmann lovegrass) and decline of burweed.

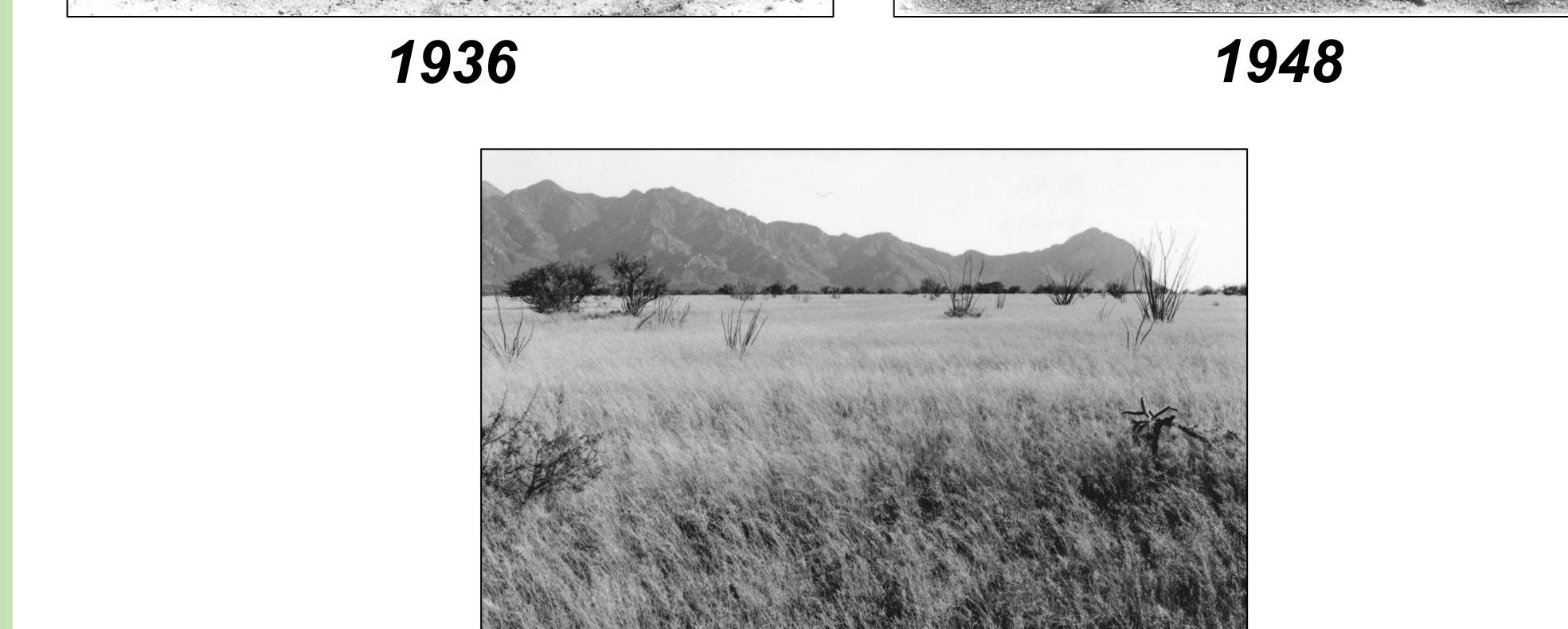
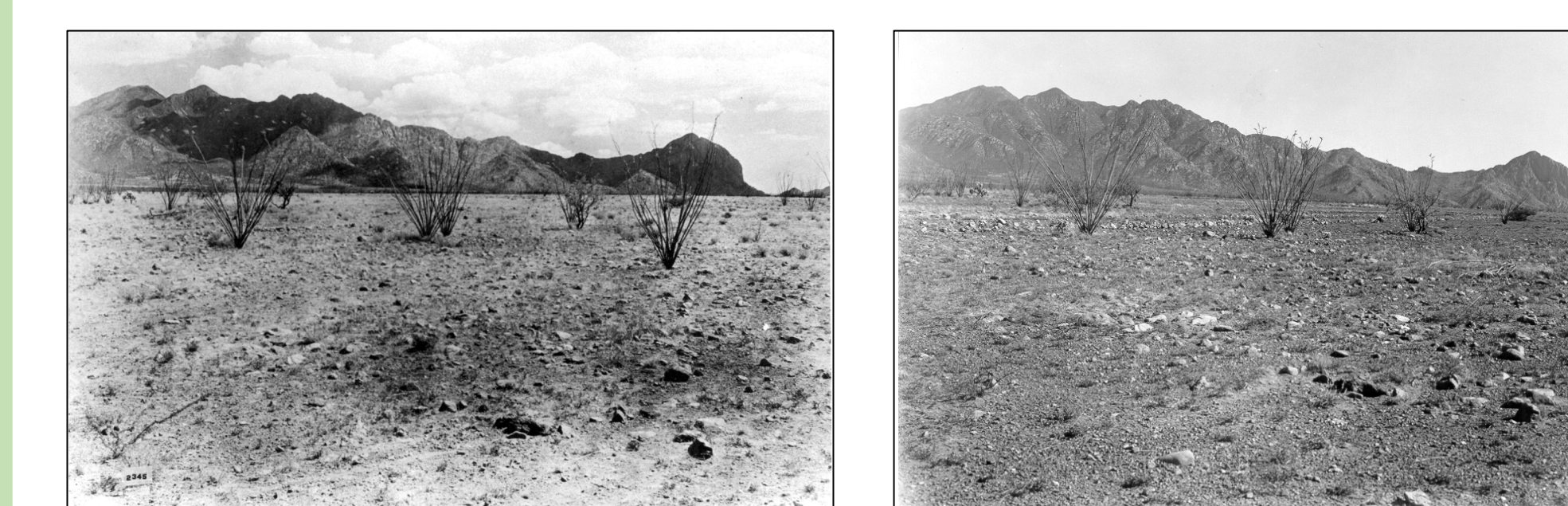
Exceptions: Different Soils

Burweed and cactus cycles but no Lehmann lovegrass



PS 231.2. Looking E, on deep, sandy loam soil, at 1,080 m: In 1903, abundant grass. In 1941, cholla and burweed eruption. In 1962, decline of cholla and burweed and increase in grass biomass. In 1993, increased size of *Parkinsonia florida* (blue palo verde), mesquite, and *Opuntia* spp. (prickly pear). Lehmann lovegrass is never present.

Increase in Lehmann lovegrass but absence of shrubs and cacti



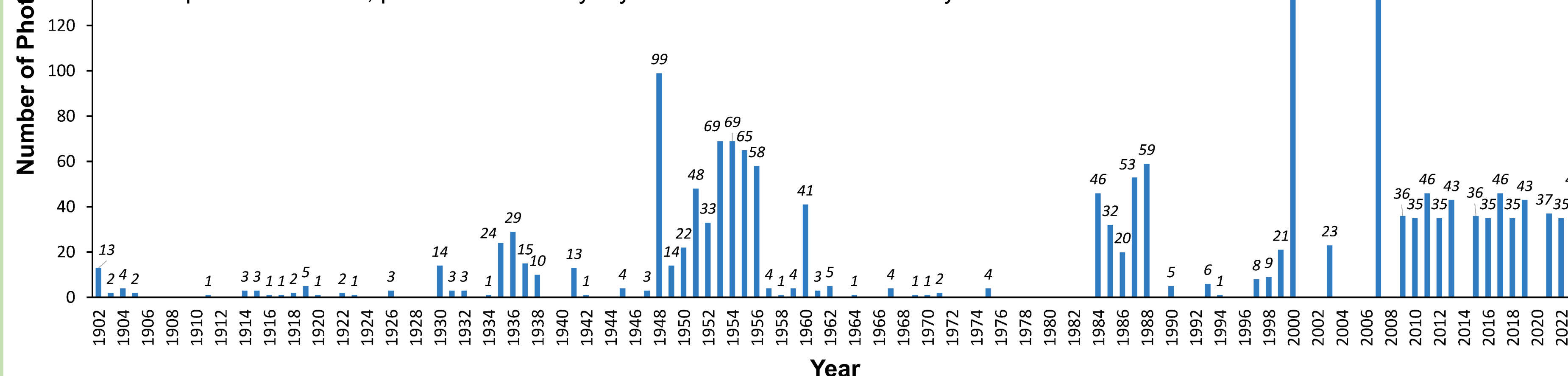
PS 045.2. Looking E across Madera Canyon alluvial fan with clay-loam soil at 1,100 m: In 1936, very sparse grass cover, scattered *Fouquieria splendens* (ocotillo), and three mesquite trees. From 1936 to 1948, grass decline but no other changes. In 1993, nonnative Lehmann lovegrass is dominant, with persistence of ocotillo, *Acacia greggii* (catclaw acacia), and the three mesquite that were present in 1936.

THE REPEAT PHOTOGRAPHY ARCHIVE

The Repeat Photography collection provides a long-term and landscape-scale representation of vegetation dynamics (i.e., changes in mesquite, burweed, cactus, and perennial grasses) at the century, decadal, and annual time scales across the SRER.

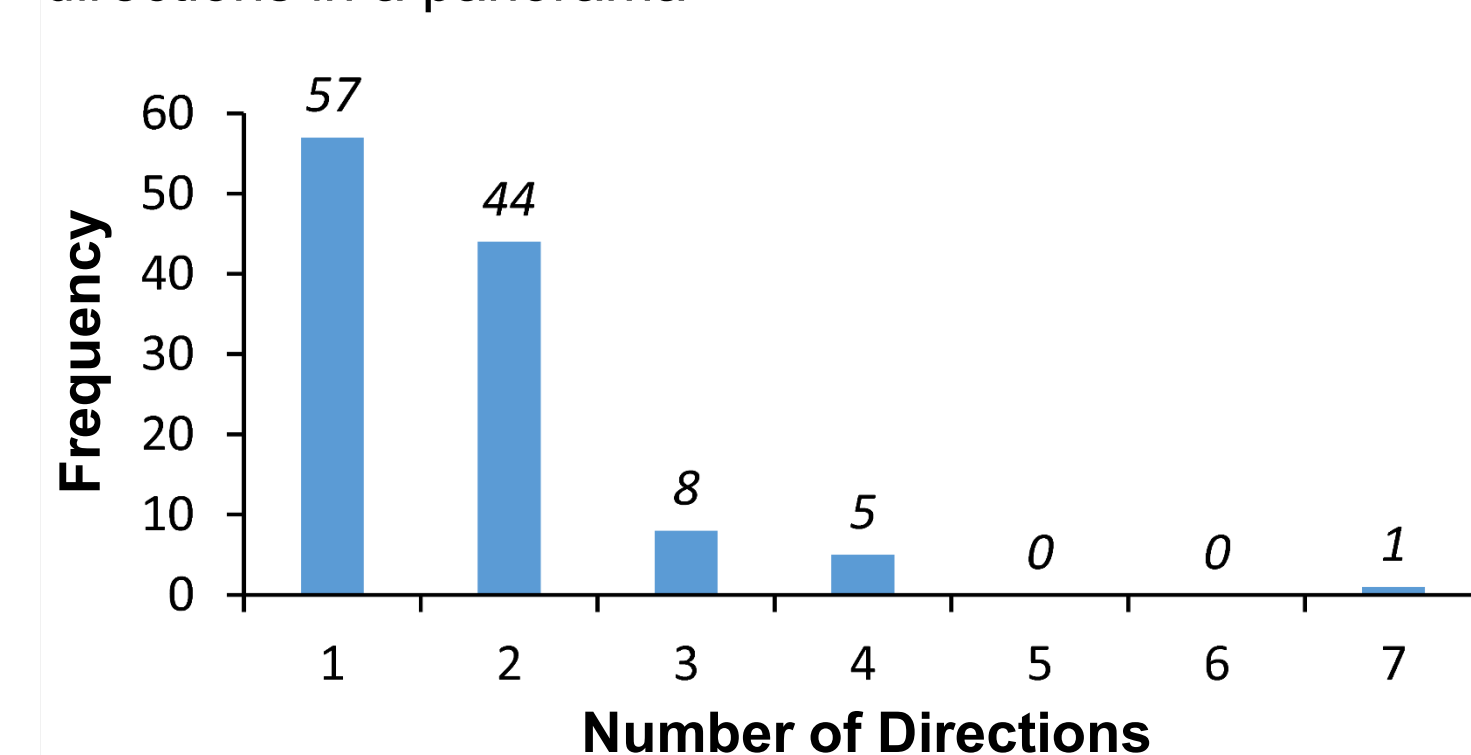
Number of Photos by Year (1902-2023)

- 115 Photo Stations (PS), 121 years, 1919 images
- Earliest photographs (1902-1905) from 16 different locations; most PS were established from 1930 to 1950
- Average interval between photographs ~ 15-20 years, 28 PS have repeat photos taken twice a year (1936, 1948, from 1951 to 1956, 1984, and 1987), two PS have photos taken 98 years apart. Since 2000, photos taken every 6 years with about 20% annually



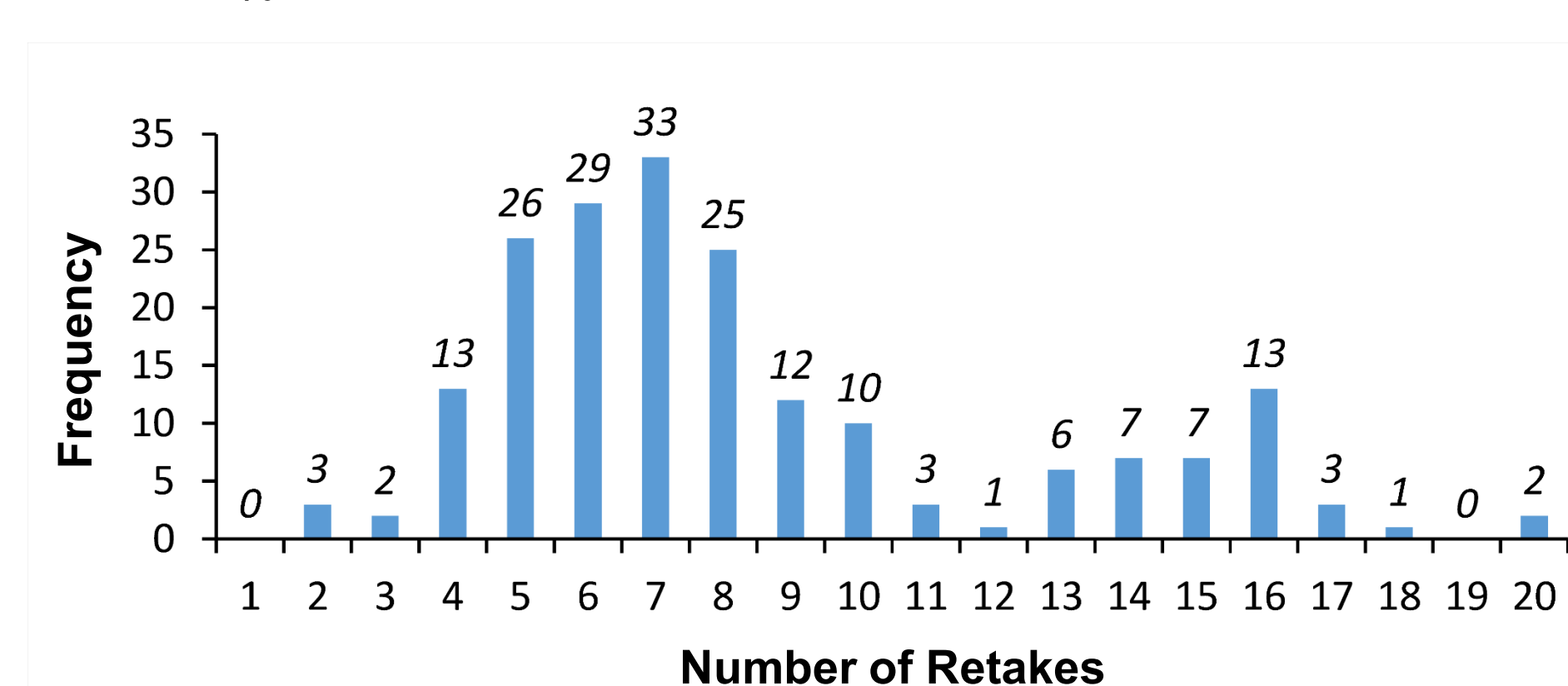
Number of Directions by PS (n=115)

Over 50% of PS have images facing at least two directions, but one site (PS042) has photos taken from seven different directions in a panorama



Number of Retakes by PS Direction (n=196)

Over 50% of PS directions have 5 to 8 retakes, and about 15% have more than 15 retakes



ANNUAL CHANGES

General Pattern

Consecutive years show grass increase and decrease following dry and wet summers

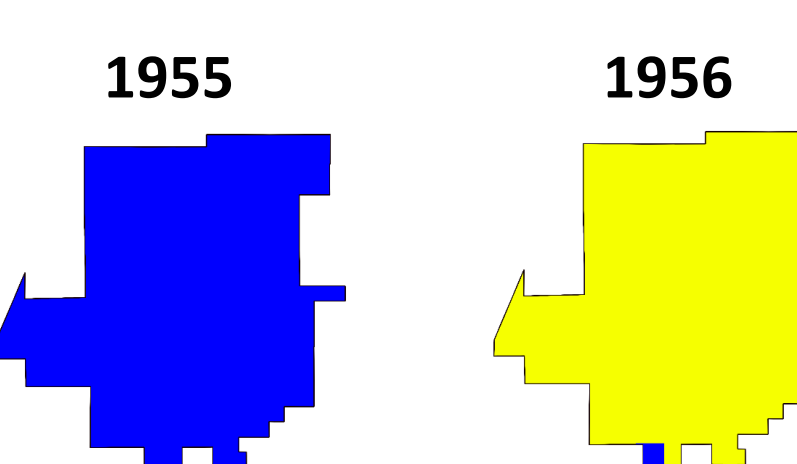
PS 246.1. Looking NE at 1,316 m and 213 mm average summer (July-September) precipitation: In September 1955, abundant grass following wet summer (334 mm). In October 1956, decline in grass abundance following dry summer (87 mm).



No Exceptions: Limited Locations

No exceptions to this trend were observed because all the photos taken in the summers 1955 and 1956 were at higher elevations (> 1,000 m) and received similar amounts of precipitation in 1955 and 1956.

SRER summer SPEI



Maps of SPEI ≤ -1.0 drought patches (yellow cells) among the 100 1.5 x 1.5 km cells on the SRER for summers (June-September) 1955 and 1956 using the SPEI index (McClaran & Wei 2014).