

# Site assessment for restoration

David A. Bainbridge

Restoration Ecologist

San Diego

# Environmental history

*To understand the present we need to understand the past*

- Indigenous people actively managed their environments and the ecosystems we see today were shaped by them
- And by hunters, trappers, miners, ranchers, farmers, developers, and ....
- Global change, regional pollution, invasive exotics, fire, etc.

# The rate of change

- Often changes in landscape are fast and noted by observers -- as overgrazing was in the Southwest
- But these comments are often forgotten and it is assumed it always looked “like this”
- Sometimes the rate of change is slower and only seeing before and after photos enables us to realize how much has changed

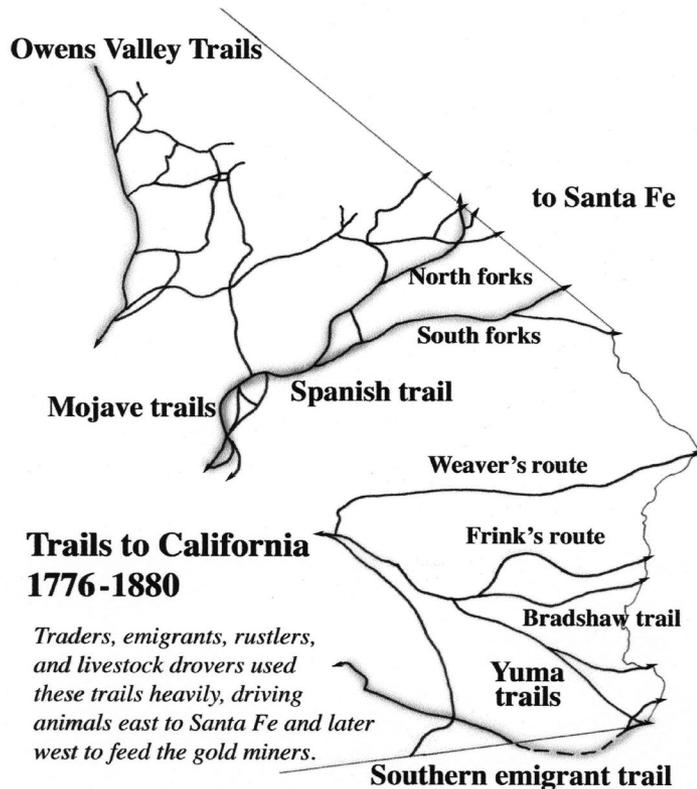
# The '49ers

- The impact of the Gold Rush is often neglected
- The number of animals and people who crossed the desert was incredible
- Herds of sheep, cattle, oxen, goats and horses wiped out plants around waterholes, springs and river crossings and introduced alien weeds.

# Tools for understanding site history

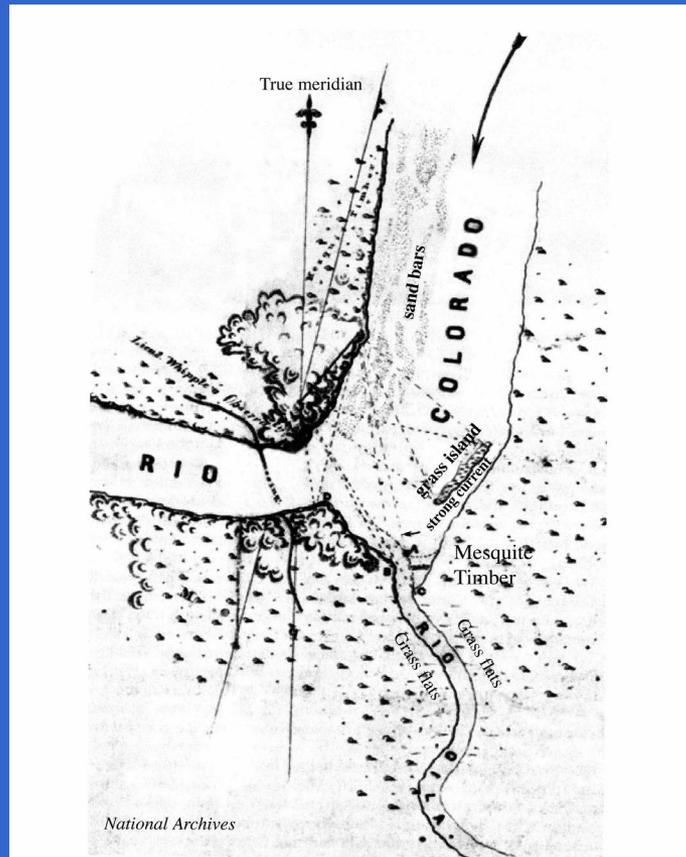
- aerial photographs to the 1920s
  - interviews and oral histories
- books, photographs, property records, surveys and newspapers
- illustrations, diaries, land grants, and journals
  - archeological records
- tree rings, sediment, pack rat nests, pollen and other ecological records
  - Google earth

# Desert Routes



- Untold thousands of sheep and cattle crossed the desert
- In the winter of 1858-59 alone 100,000 sheep crossed the Colorado River

# Historical records are useful



National Archives

- Early explorers and surveys can be very informative
- Photos from the late 1800s and early 1900s often reveal the worst overgrazing and erosion

Whipple survey 1849 Gila River mouth

# Characterizing disturbance

- We would like to learn as much as possible without spending much time or money
  - We can often do this by looking at the ecosystem and landscape attributes
    - Landscape - including human impacts
    - Ecosystem structure
    - Ecosystem function
    - Direction of changes
    - Keystone species and vital characteristics
    - Plants (native and exotic), soil, animals, birds, reptiles, insects, water and energy flow, etc.

# Human impact

- Current use
- Past historic use
- Prehistoric use
- Economics - true cost accounting
- Laws and regulations
- Politics

# Key factors - soil

- Air photos and Google Earth can provide a good first look at disturbance patterns, but the most important impacts are often below ground
- Physical, hydrologic, chemical, and biological factors change, most commonly in ways that make conditions less favorable for soil microbes and plant establishment

# Simple tests

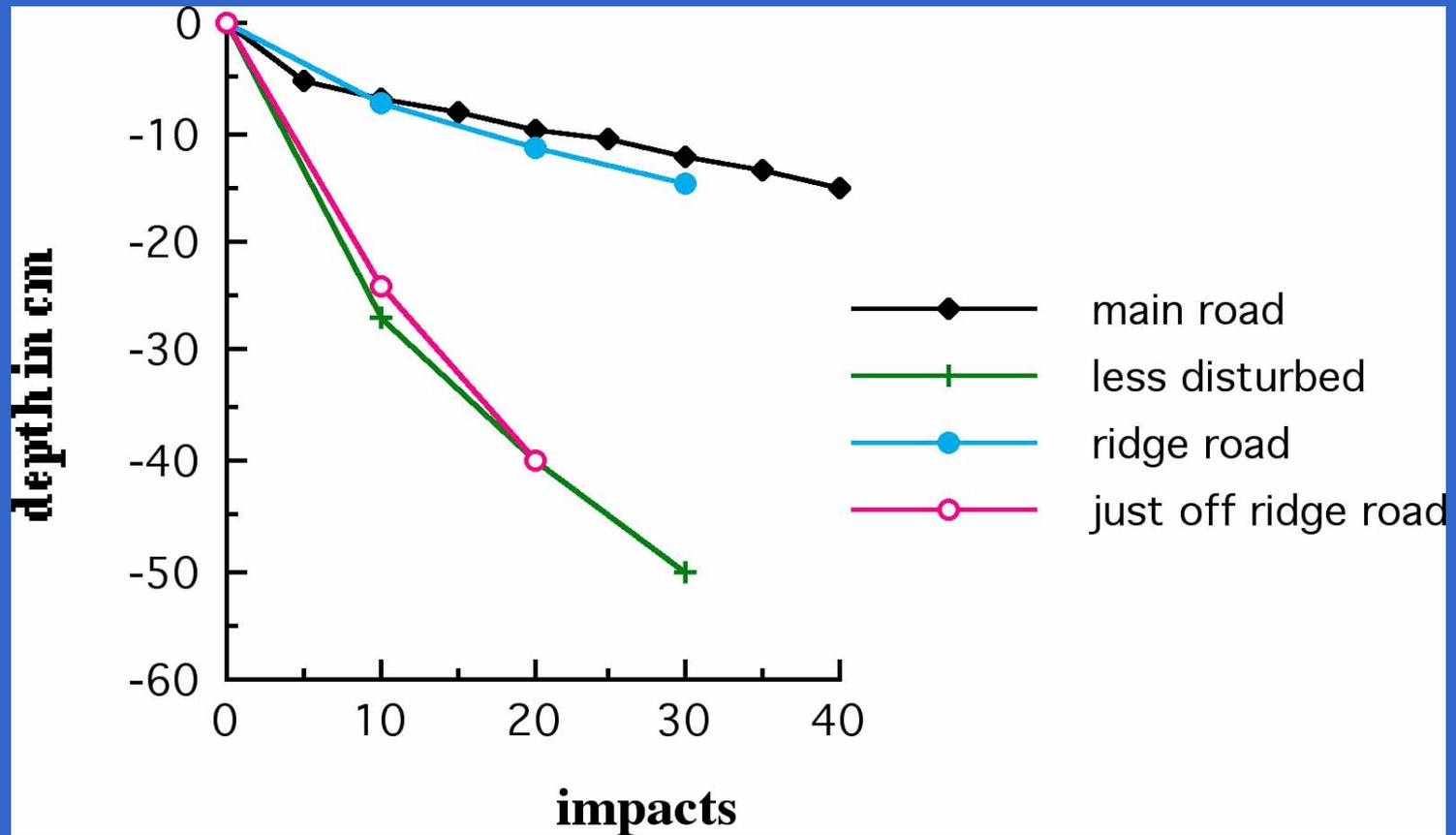
- Infiltration, fertility, soil strength, erosion, and biological activity
  - **impact penetrometer** or by measuring **bulk density**
  - small double-ring **infiltrometer** or **soil moisture** measurements
    - **texture** analysis
  - **chemical** and **biological** assays, such as the mycorrhizal and bacterial infectivity assessments.

# Soil strength

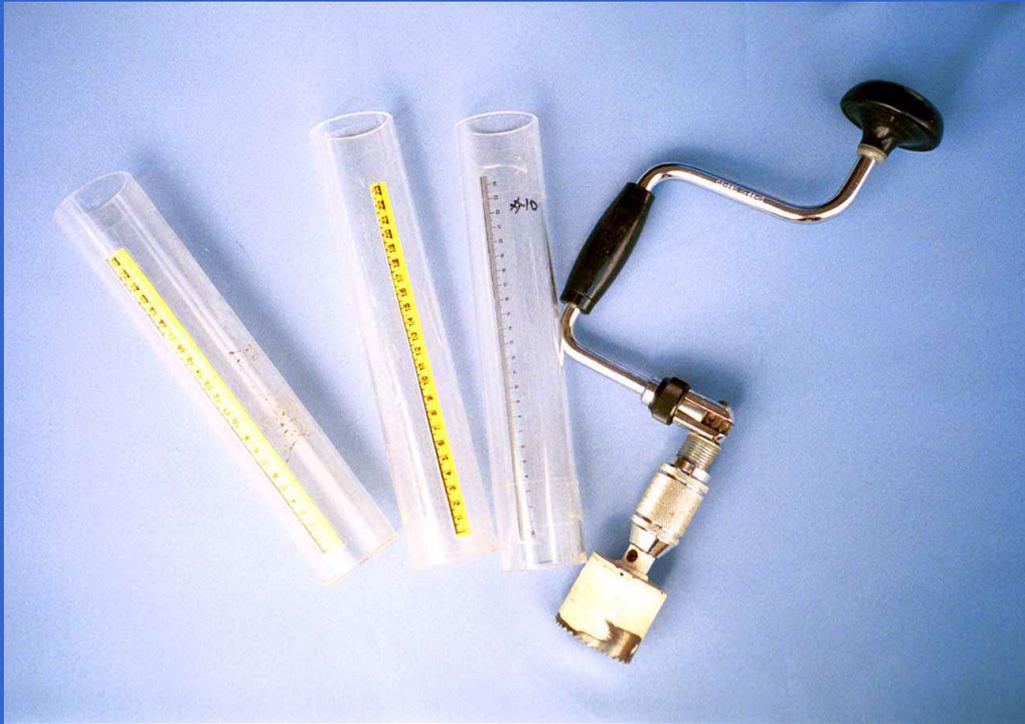
- The impact penetrometer is a low cost tool for assessing site disturbance



# Dramatic changes



# Infiltration



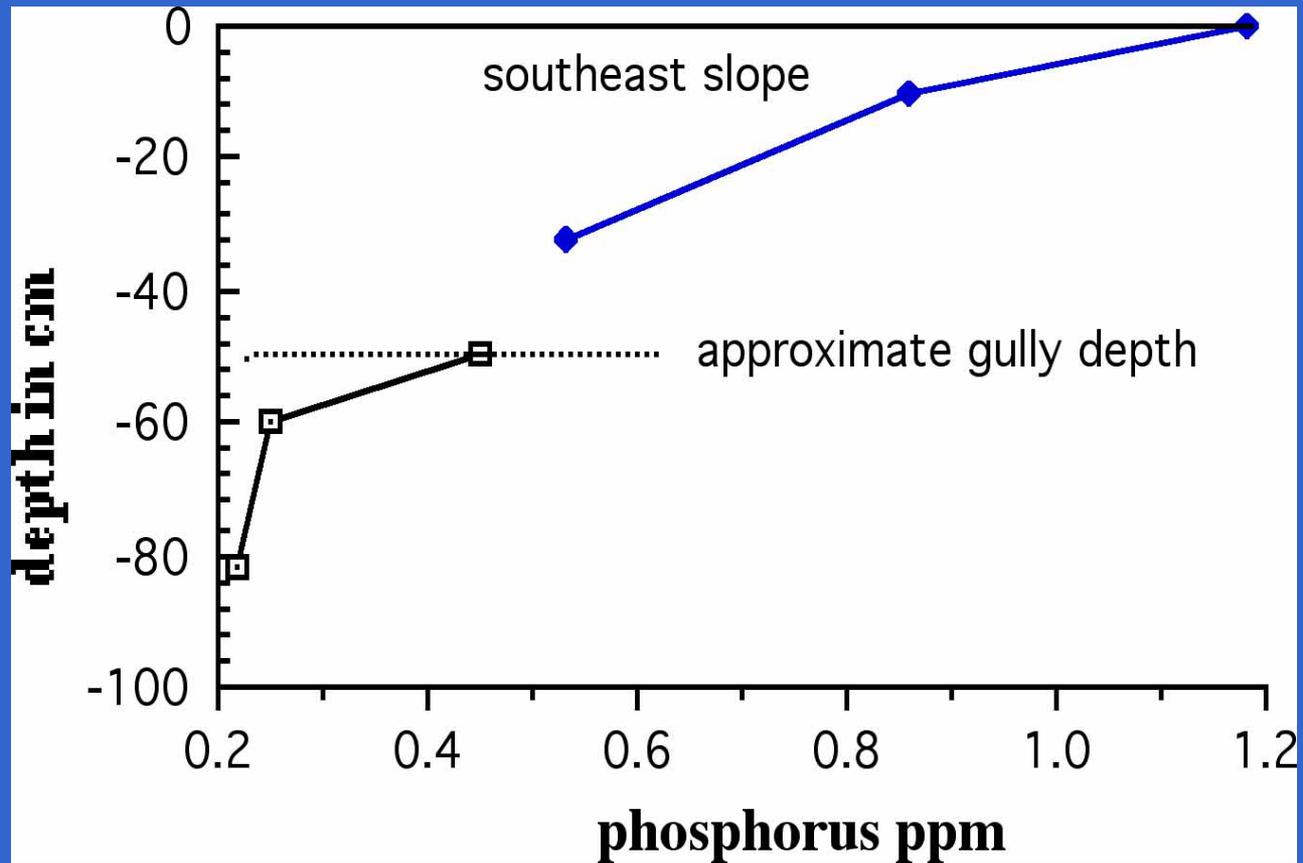
- Low cost infiltrometers can provide useful information

# Infiltration between plants

	<u>cm/hr</u>	<u>decline</u>
Control	0.9	--
Motorcycle	0.2	-77%
Truck	0.6	-33%

*after Eckert et al., 1979*

# Soil chemistry



# Soil biota

- Compaction and disturbance can also reduce soil organism populations
  - Total numbers of fungi, bacteria, nematodes, ants, termites and arthropods may decline dramatically
- These effect water, nutrient cycling and plant establishment

# Termites and ant mounds

- A useful indicator of health compared to a reference site
- Burrows and soil surface (sand, gravel, litter) characteristics can also be assessed quickly



# Burrows

- Who, what, where, when?
- Burrows are a quick indicator of activity and ecosystem health



# Cryptobiotic crusts

- Soil crusts are also important - and little understood
- The Mojave and Colorado desert crusts are often less visible than the dark crusts of Sonora and the Great Basin



# Plant community analysis

- Which plants?
- What was here before 1900, 1800?
- What relationships between plants?
- Rare and endangered species present
- Exotic, invasive
- Relevé or quadrats or ....

# Exotics



- This picture illustrates the exotic invasion of the low deserts of the Southwest
- Grasses, mustards and other species increase fire risk and change water availability and plant establishment

# What is worst?

- Which factors are most unfavorable -- and what can be done about it?
  - Soil - rip, pit, imprint, mulch
  - Plants - container plant
  - Water - surface shaping, irrigation, rainfall harvesting
  - Weed management?
  - Herbivory?

# Where do you invest?

- Assessment?
- Fencing and signs?
- Soil remediation?
- Weed control?
- Planting?
- Plant protection?
- Irrigation?

# No easy answers

- Tough choices have to be made in most desert restoration work
- The cost of rehabilitation (\$10,000+ acre) far outweighs the value of the land (perhaps as low as \$300 acre) and funding
- Long term maintenance and monitoring is desirable - 5 to 10 years is good when possible, 20 would be better

# A general approach

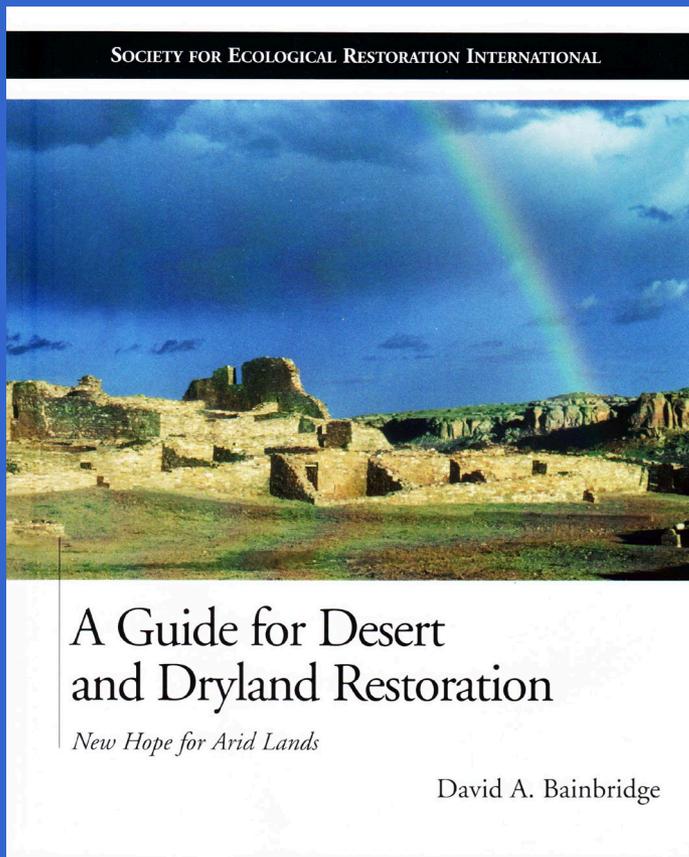
- Collect native seeds
  - Weed control
- Rip, spade or fork soil if compacted
- Grow a mix of species with a range of container sizes
- Plant with irrigation and protection

# This can work well



- Container planting with irrigation
- Dramatic results are not uncommon
- Planted in 1990, photo 2 in 1995
- Deep pipe drip from remote tank for 2 summers

# More information



- ***Journal of Arid Environments***
- The experience based guidelines for budgeting and accounting in restoration project management, as well as for selecting and maintaining equipment and keeping teams productive and cheerful are essential reading for project managers.
- I strongly recommend this book to restoration ecologists, consultants and university libraries. *Sue Milton*
- ***FROM ISLAND PRESS, AMAZON OR YOUR LOCAL BOOKSTORE***