

Disturbance



Jayne Belnap
USGS - Southwest Biological Research Center





All have similar effects on soil crusts:

- Soil surface disturbance
- Annual grass
- Altered fire

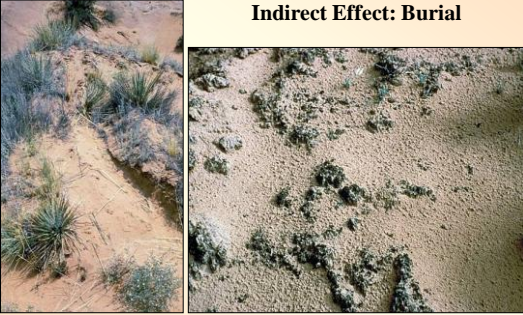
- Simplified community
- Reduced cover

- Less soil nitrogen, carbon, other nutrients
- Less stability
- Altered nutrient availability



Soil Surface Disturbance

Indirect Effect: Burial



Direct Effects of Soil Surface Disturbance



- Lose surface roughness
 - Greater water, wind velocity = greater erosion
 - Lose retention of dust, seeds, and organic matter
- Lose biodiversity

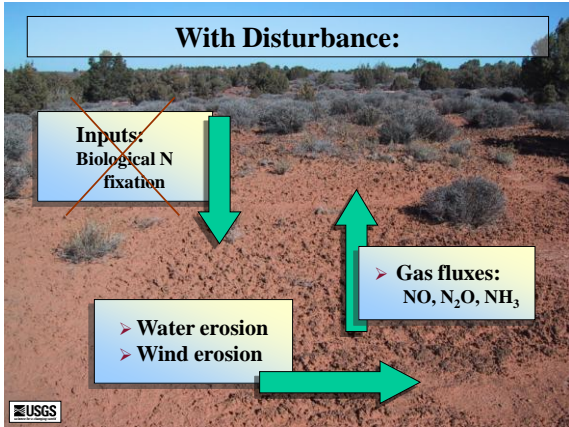


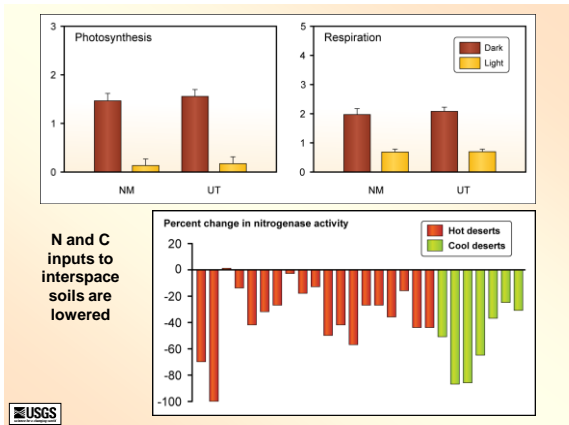
Direct Effects of Soil Surface Disturbance



- Nitrogen fixation stops
 - Soil aerated
 - Organisms buried







Direct Effects of Soil Surface Disturbance

Thirty years after disturbance

	Undisturbed		Disturbed	
	mean	std. error	mean	std. error
Organic matter (%)	2.6 ± 0.2		1.7 ± 0.2	
Nitrogen content (mg N/g)	0.41 ± 0.01		0.27 ± 0.03	
Mineralization potential (µgNH4-N/g)	11.1 ± 1.9		2.4 ± 0.1	
Soil δN (‰)	3.6 ± 0.4		5.1 ± 0.3	
Plant δN (‰)	1.1 ± 0.7		2.6 ± 0.3	

USGS

Direct Effects of Soil Surface Disturbance

Albedo increases/Soil temperature decreases



USGS

Direct Effects of Soil Surface Disturbance



- **Lose soil stability**
 - **Filaments smashed**
 - **Organisms buried**
 - **Lichens, mosses lost**

USGS

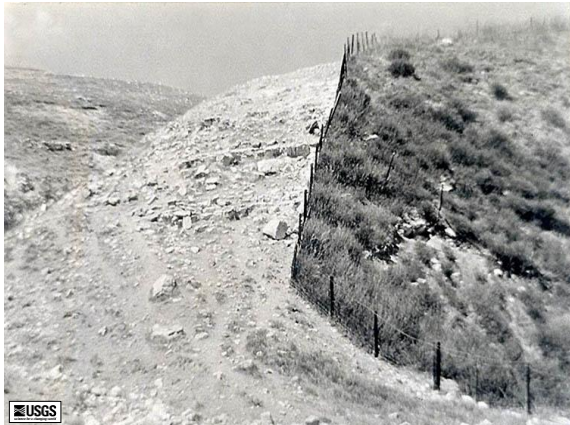


USGS

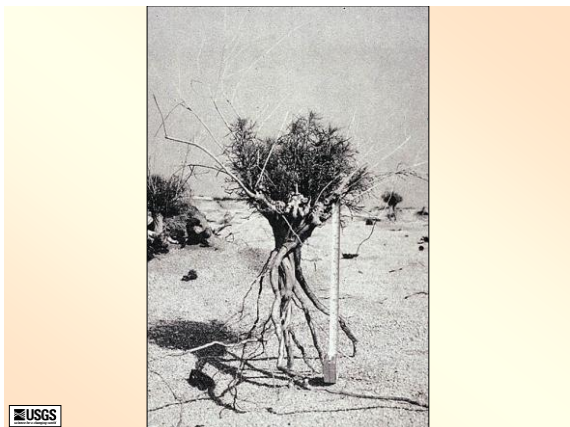
Dust Front Approaching Lubbock, Texas Ahead of Spring Convective Storm



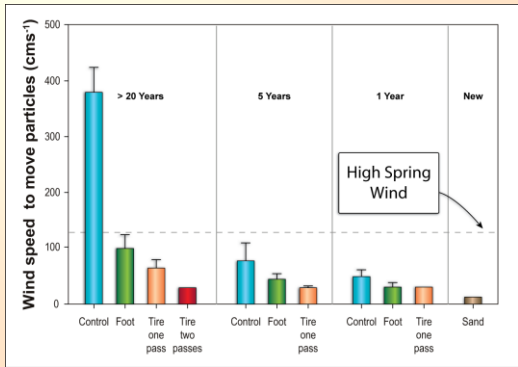
USGS



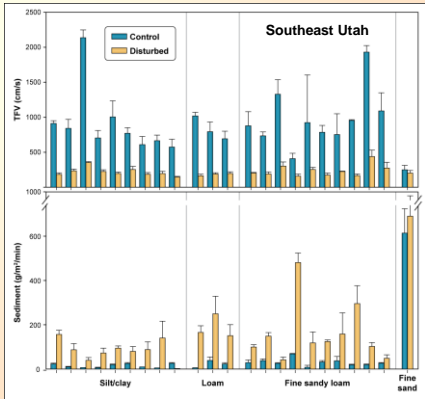
USGS



USGS

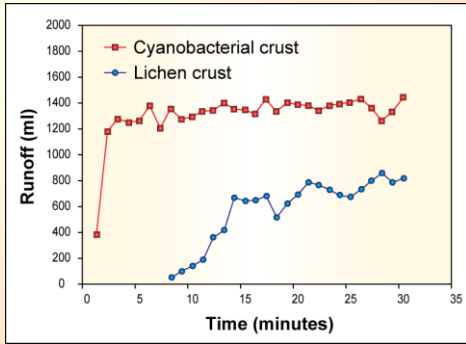


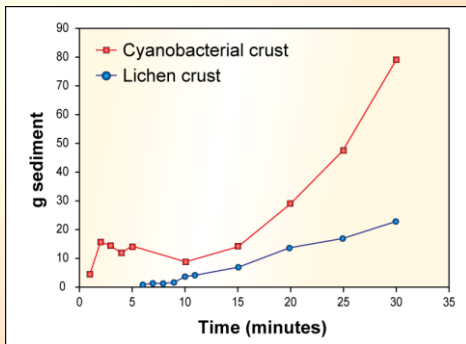
USGS

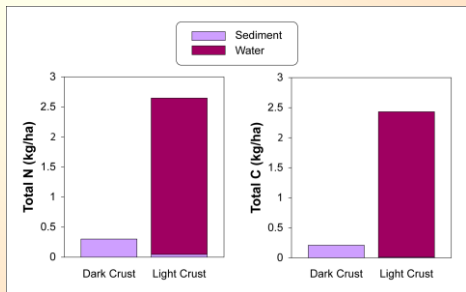




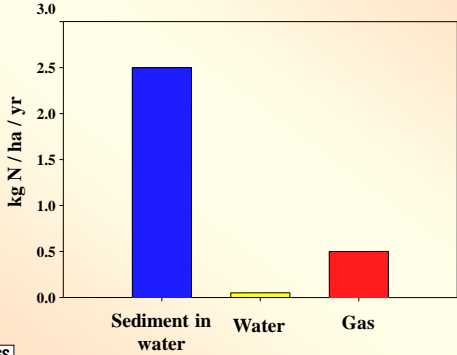
USGS







Nitrogen losses on the Colorado Plateau

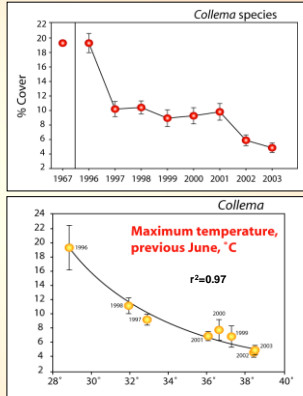
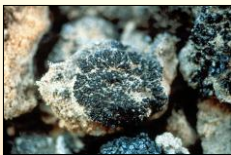


Climate Change

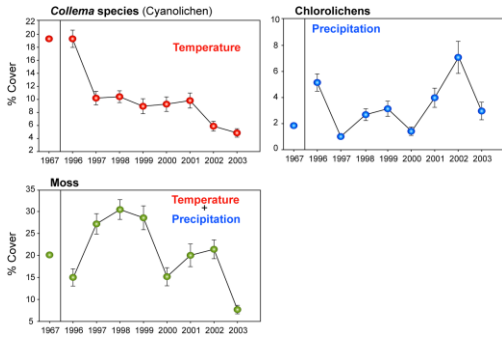
- Altered temperature
- Altered precipitation timing, amounts



Temperature



Climate

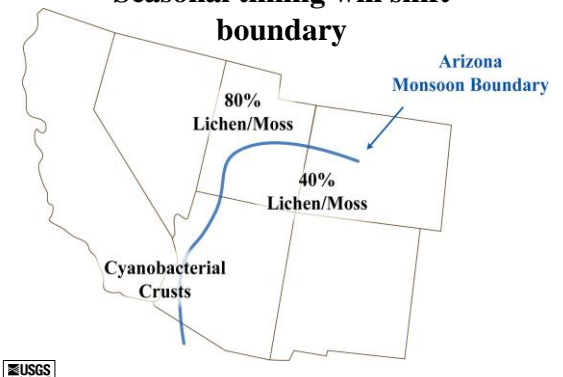


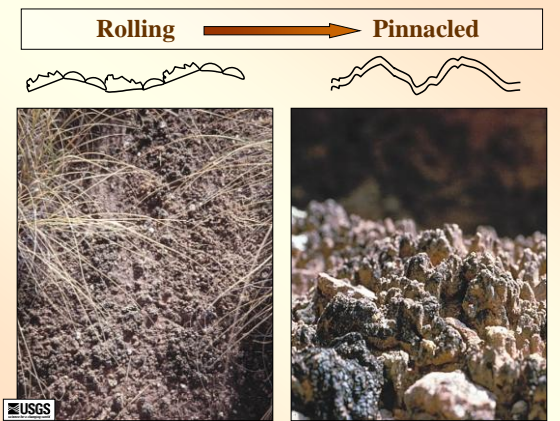
When precipitation frequency is increased

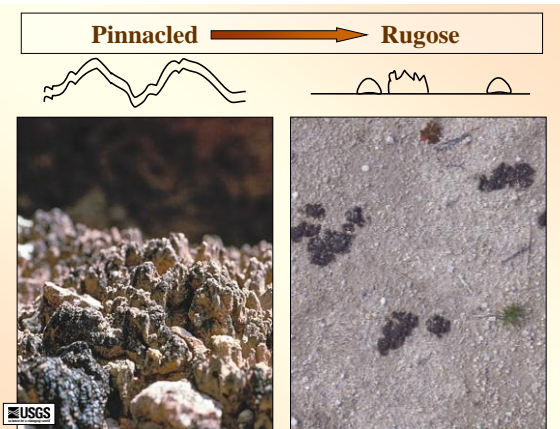
- Carbon deficit results
- < Chlorophyll *a*
- < UV-protective pigments
- > Mortality

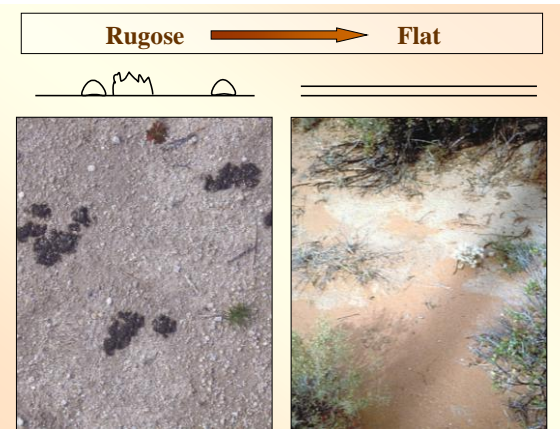


Seasonal timing will shift boundary









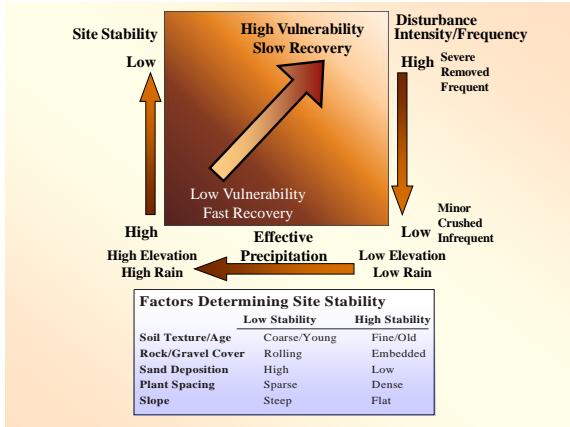
Land use and climate change reinforce each other

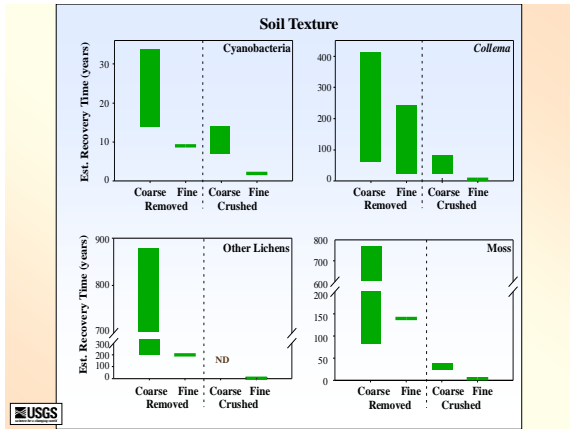
- Change in crust composition
 - Less soil N, C
- Less stability, increased dust
- Smoother surface
 - Less water
 - Less seeds
 - Less organic material

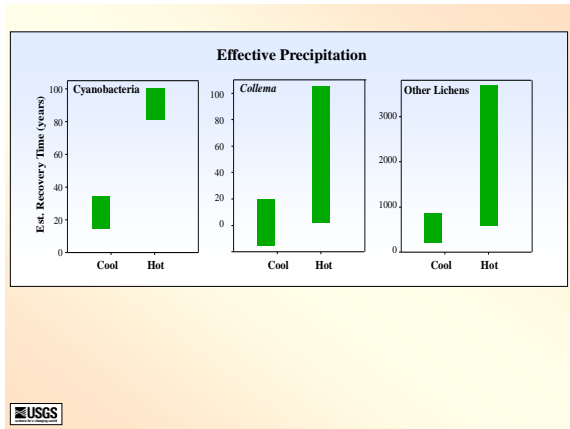


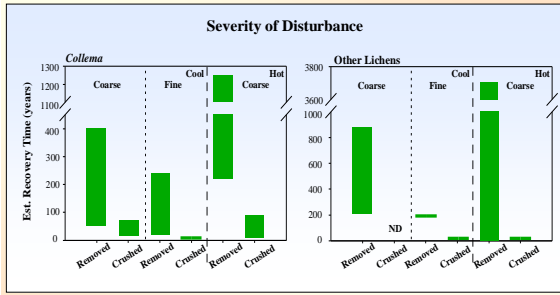


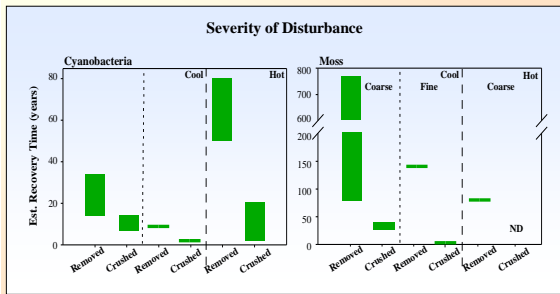
Recovery











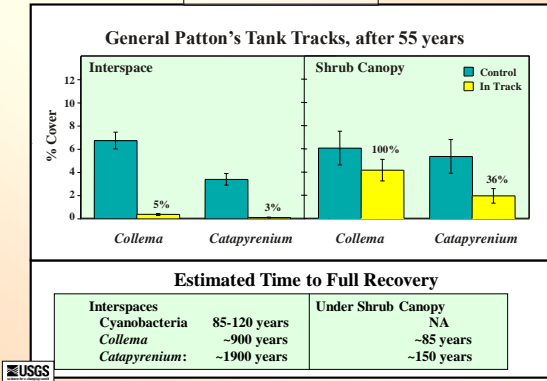
Disturbance Characteristics



- Severity: crushed, removed/buried
- Frequency: redisturbance for recolonization
- Shape and shape: crusts recolonize from the edges



Placement Matters

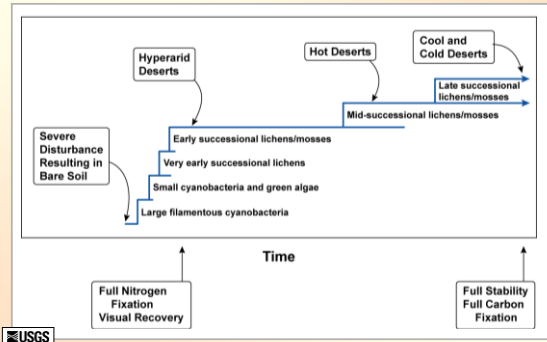


Elevation matters

Skidoo Townsite, April 1998

	Control Sites	Streets and Alleys	% Difference	P	Years to Recovery
Cyanobacteria	12.78	15.22	19	0.07	
<i>Collema</i> sp.	18.19	6.79	-63	<0.0001	219
<i>Fulgensia</i> sp.	1.47	0.70	-53	0.01	172
<i>Psora decipiens</i>	2.03	0.34	-83	<0.0001	490
<i>Aspicilia reptans</i>	5.03	2.58	-49	<0.0001	160
<i>Tonia</i> sp.	1.09	0	-100	<0.0001	█
<i>Heppia</i> sp.	0.31	0	-100	0.02	█
<i>Catapyrenium squamulosum</i>	10.21	0.83	-92	<0.0001	1007
Moss	13.22	14.88	13	0.23	
Annual Plant	2.75	4.88	78	0.002	
Perennial Plant	14.25	15.11	6	0.80	
Litter	2.41	3.80	58	0.18	
Rock	16.25	34.87	115	<0.0001	

Recovery Sequence of Crust Species



Recovery Time

Desert	Cyanobacteria biomass	Early lichens	Mid-lichens and mosses	Late lichens and mosses
Mojave (hot, low elevation)	50 - 100	200 - 1200	600 - ?	?
Mojave (hot, high elevation)	14-34	50 - 400	200 - ?	?
Colorado Plateau (cool, low elevation)				
No. Great Basin (very cool, low elevation)		20	60	125

↑ Visual
↑ Nitrogen fixation
↑ Carbon fixation
Soil Stability



Recovery: Is it linear?

	2-5 years	10-14 years
Cyanobacteria	45-110	14-34
Moss	400	42
Lichen	85	50



How can we enhance recovery?

(Nutrients? Water? Need to understand processes)

- ✓ Reduce disturbance
- ✓ Plant cover
- ✓ Inoculation
- ✓ Fertilization?





How to inoculate

1. Commercial inoculant
2. Collect and spread
3. Collect as chunks (alter shape)
4. Storage
5. Fertilize?
6. Stabilize surfaces?

**Resistance
Old Soils**

Serengeti



Australia



Oman