



Invasion History and Patterns of Spread by Sahara Mustard (*Brassica tournefortii*) in Southwestern North America

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Invasion History

- Sahara mustard first appeared in the Coachella Valley of the northwestern Colorado Desert in the 1920's
- Subsequently spread:
 - East
 - through the Sonoran Desert of CA and AZ (*during the mid-1900s?*)
 - and on into NM and TX (*when?*)
 - West
 - into the interior cismontane valleys of southern CA (*by mid-century, but only recently displaced other species as the dominant mustard in some places during the 1980s-1990s*)
 - North
 - through the Mojave Desert of CA, NV, AZ, and UT (*probably began during the early 1980s, but became dominant in some places by the late 1990s*)
 - on into the Colorado Plateau of UT (*around 2000*)
 - and the southwestern Great Basin in Owens Valley of CA (*probably by the late 1990s*)
 - South
 - into Mexico (*when did it get there?*)

Patterns of Spread

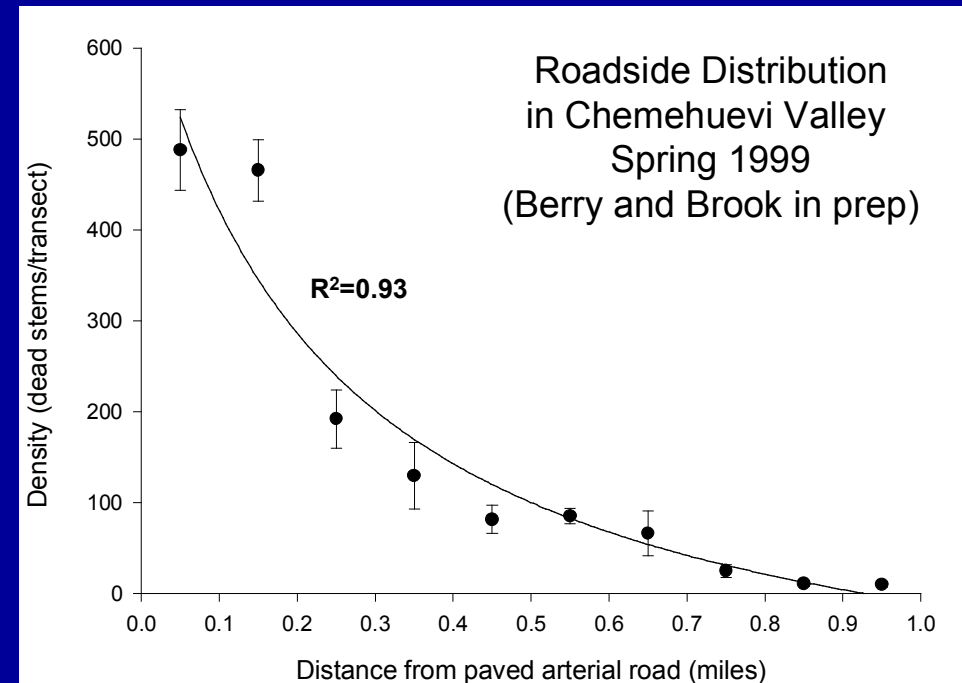
- Sahara mustard is currently absent from most wildland areas, although this perspective changed significantly during spring 2005.
- Where it does occur it is often only present along roadsides, which has been its primary pathway of spread.

Major Point #1

- Sahara mustard first arrived in North America during the early 1900s.
- It became a significant management concern during the late 1980s, and especially during the early 2000s.
- Roadsides are the primary pathway of spread.

Sahara Mustard Invasion of Paved Roadsides

- A study to compare stem densities of Sahara mustard at various distances up to 1 mile from the edge of a paved arterial road.
- This species was not previously detected at this site during plant surveys in 1977, 1979, 1982, 1988, or 1992.
- The 7-year period between 1992 and 1999 included two years of very high rainfall (1995 and 1998) which probably facilitated spread away from the roadside.



Major Point #2

- Sahara mustard can establish along paved roadsides and spread up to 1 mile into the open desert within 7 years.

Sahara Mustard Invasion of Paved Roadsides

A study to compare plant density, plant biomass, seed density, and seed biomass of Sahara mustard in beneath-canopy and interspace microhabitats along roadside berms compared to 20m off-road of major paved arterial roads.

2 sites with silty/rockysoils

1 site with sandy soils



Study Sites



Needles and Coachella sites

Silty/rocky soils

Atypical of invaded areas

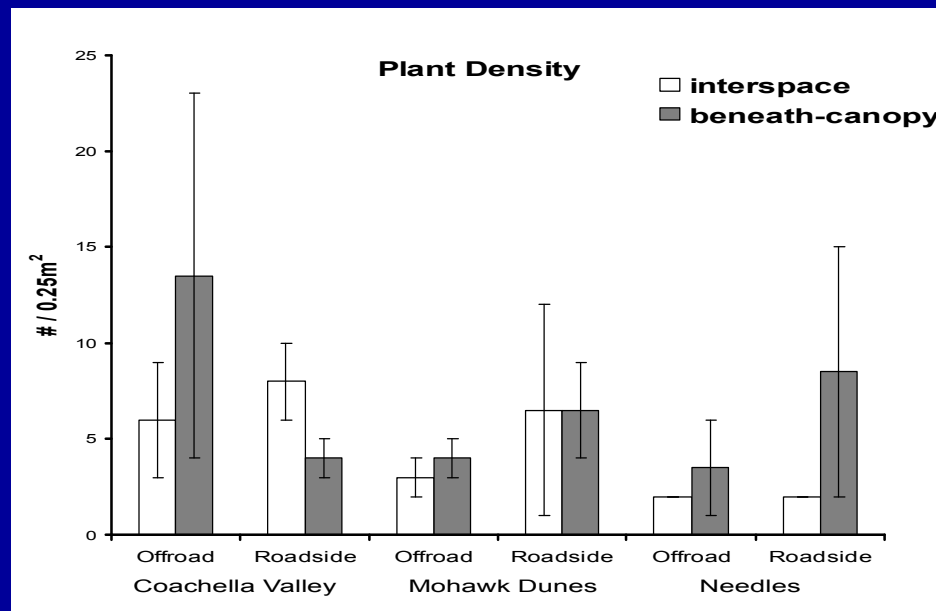


Mohawk dunes site

Sandy soils

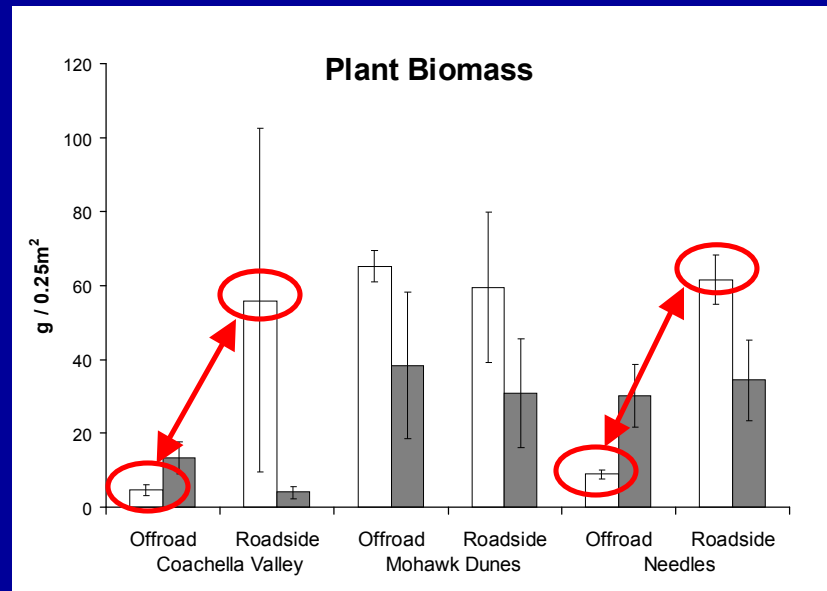
Typical of invaded areas

Plant Production Response to Paved Roads



Overall, plant density did not display any consistent trends between roadside and offroad areas

Plant Production Response to Paved Roads



In contrast, plant biomass was significantly higher in roadsides than offroad areas, except at the sandy-soiled Mohawk dune site.

Major Point #3

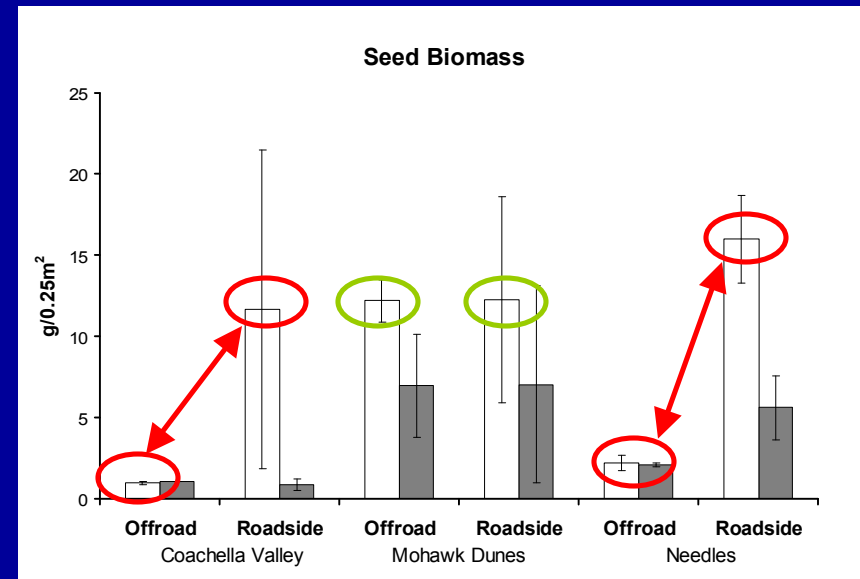
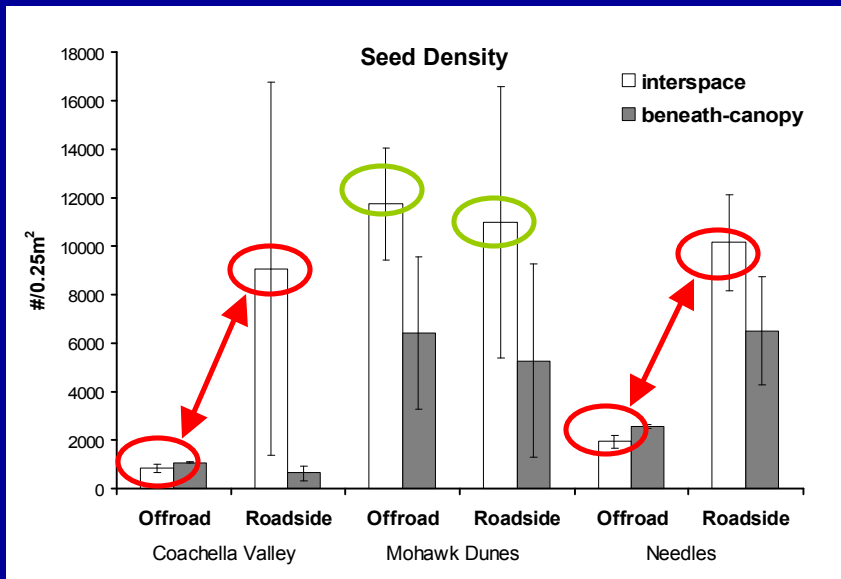
- Paved roads may have their greatest effects where soils are silty/rocky, conditions where Sahara mustard may otherwise have difficulty establishing.

Plant Production Response to Paved Roads



Plant biomass was especially high in roadside interspaces.

Seed Production Response to Paved Roads



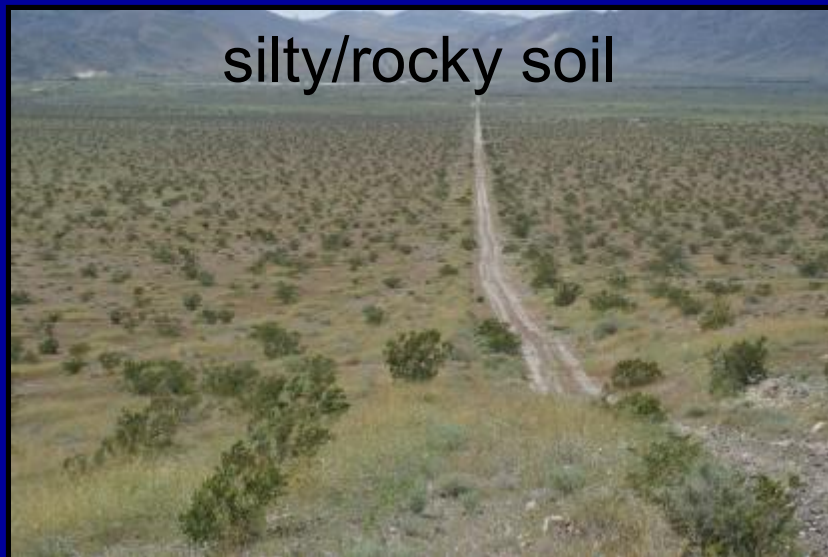
- Seed density and biomass were both higher in roadside than offroad interspaces at the two sites with silty/rocky soils, due to their strong positive relationships with plant biomass ($R^2 \sim 0.90$).
- Seed Density and biomass did not significantly differ between roadside and offroad areas at the site with sandy soils.

Major Point #4

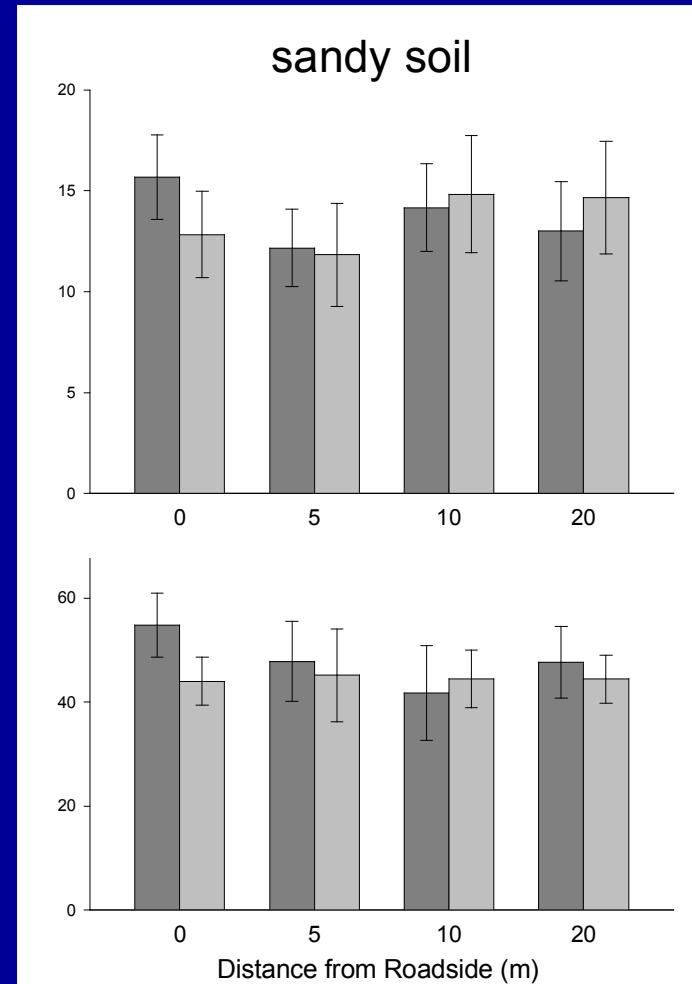
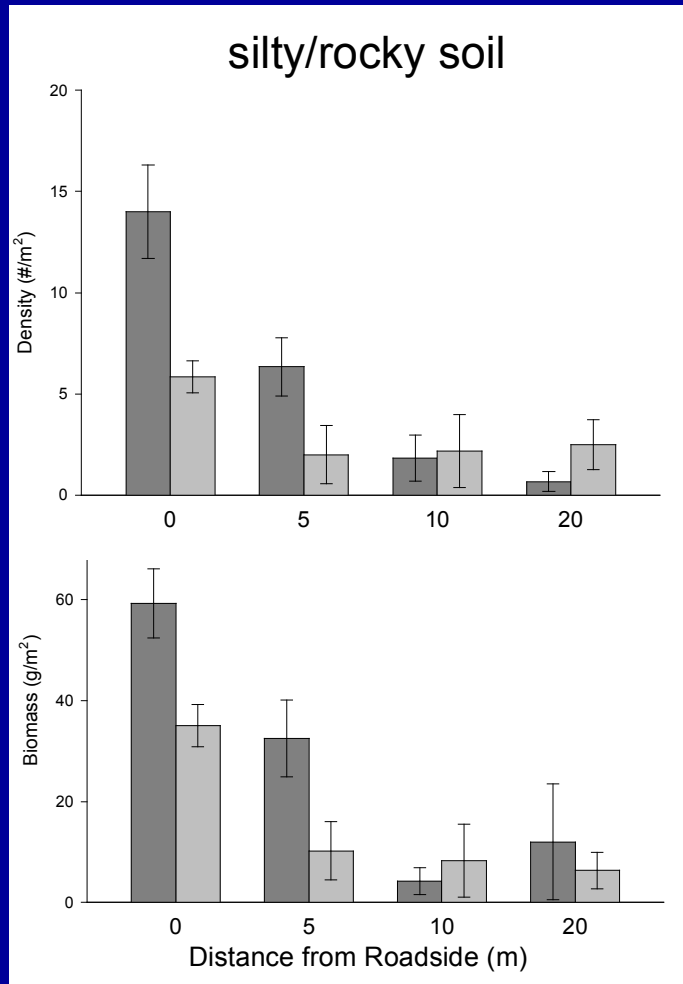
- Paved roads may facilitate the spread of Sahara mustard by promoting plant biomass and seed production in interspaces.
- Interspaces comprise approximately 85-90% of most creosotebush scrub landscapes which may otherwise be much less invasible.

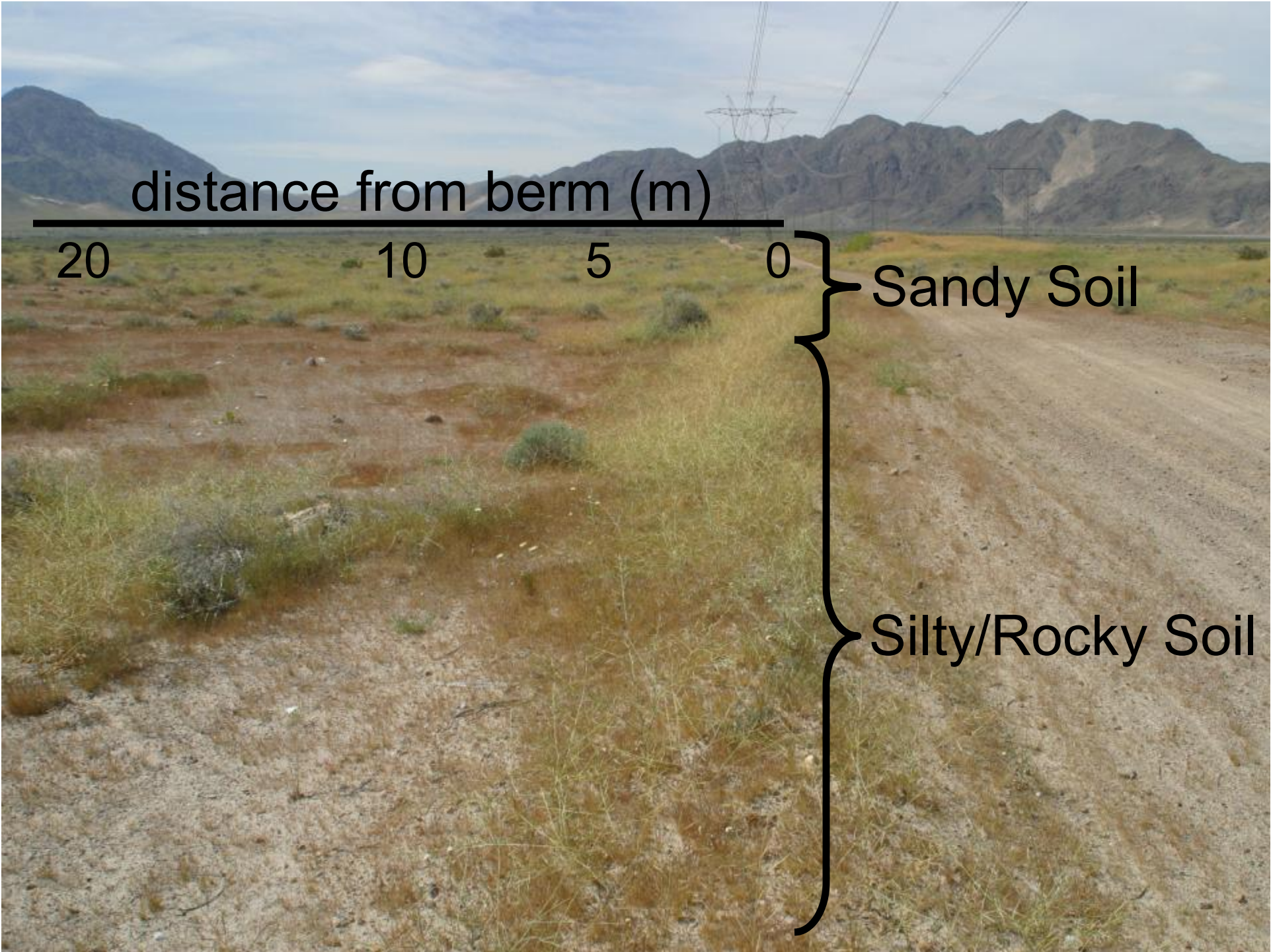
Sahara Mustard Invasion of Dirt Roadsides

To evaluate the pattern of spread along dirt roads I measured plant density and biomass of Sahara mustard at various distances from roads with and without berms in areas of silty/rocky compared to areas of sandy soils.



Density and biomass of Sahara mustard along dirt roads with berms (dark grey bars) and without berms (light grey bars)





distance from berm (m)

20

10

5

0

Sandy Soil

Silty/Rocky Soil

Major Point #5

- Berms along dirt roads appear to have their greatest effects on silty/rocky soils where Sahara mustard may otherwise have difficulty establishing.
- The deeper looser soils typical of roadside berms create localized soils conditions that Sahara mustard prefers.

Borrow Pits Used for Roadbed Materials Can be Havens for Sahara Mustard

- These areas are often in close proximity to major paved roads which Sahara mustard can use as pathways to spread into new areas.
- The roadbed materials collected from these sites inevitably contains Sahara mustard seeds which inoculate new sites where the materials are used.



Other Disturbed Areas Can Also Be Dominated by Sahara Mustard



Postfire Landscapes

OHV Open Areas



Preferentially establishing in motorcycle tracks

Ephemeral Washes Facilitate Spread Away from Roadsides and Other Disturbed Areas

- Washes have deeper and sandier soil than the surrounding landscape, conditions that Sahara mustard prefers.



Major Point #6

- Monitoring to detect new populations of Sahara mustard should focus on roadsides, washes, and other disturbed areas.

Recent Sahara mustard Dominance on Shallow/Rocky Soils on Hillslopes

- During spring 2005 Sahara mustard was found in significant stands on mid-slopes and mountaintops where it had not been previously observed.

River Mountains, NV



Calico Mountains, CA



- These newly discovered populations occurred in areas that could not be any more different than the deep sandy alluvial soils that Sahara mustard most frequently dominates.
- Extremely high rainfall during winter 2004-2005 clearly led to the high biomass of these stands which must have established and were previously overlooked in previous years when rainfall was much lower.



- Many of the hillslope patches are discontinuous with patches on alluvial soils in the valleys below.
- It is currently unknown how these disjunct patches became established.
- Extensive flocks of granivorous birds were observed foraging in these stands, and it may be that birds were the primary dispersal vectors.
- It is unlikely that rodents were the dispersal vector.
- Wind is another plausible dispersal vector, as plants often break off at the base and tumble across the landscape, disarticulating and spreading seeds in the process.

Major Point #7

- Suitable habitat for Sahara mustard may be more widespread than previously thought.

Take Home Messages

- Sahara mustard has been in southwestern North America for about 80 years.
- It has recently increased its range and dominance since the 1980s.
- It will very likely expand its range and dominance within the regions it currently occupies.
- It is unknown how far it will spread outside of the hot desert regions.