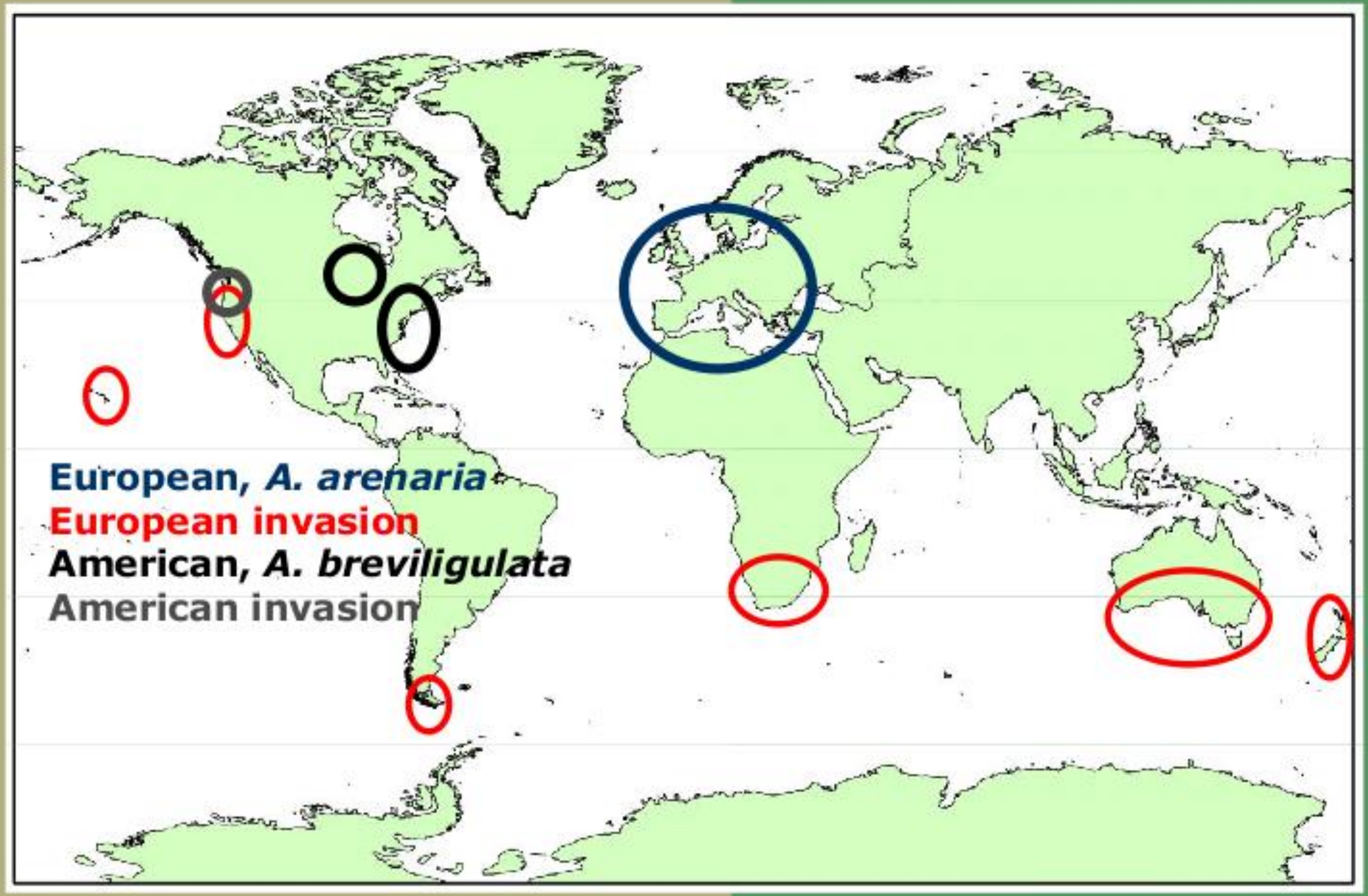
- What is sand?
- Where does it come from?
- Waves and wave energy
- How global climate change will influence waves and wave transport
- Dune types and formation
- Natural dune communities
- Introduced beachgrass and influence on beach and dunes
- Surf zone and sand dwelling organisms and food web
- Snowy plover biology
- Oregon beach law
- Field trip

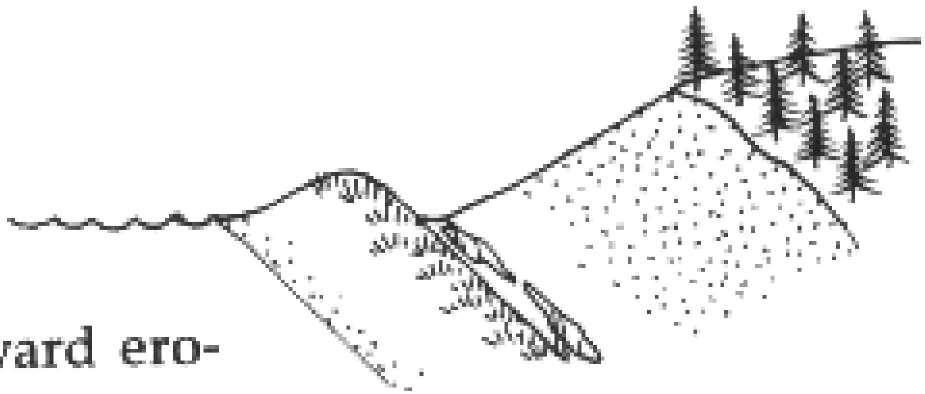

European beachgrass
(*Ammophila arenaria*)
American beachgrass
(*Ammophila breviligulata*)

Beach grass invasion biogeography



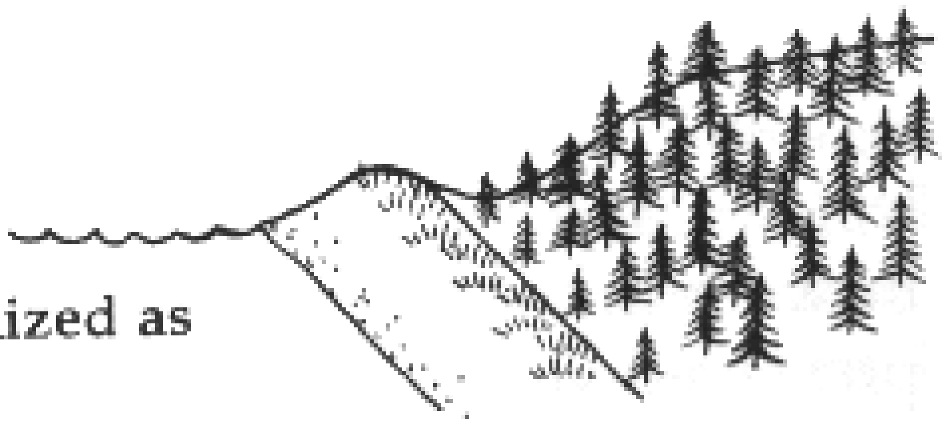
Hacker, 2008

European beachgrass invades, traps beach sand blowing inland, builds foredune.

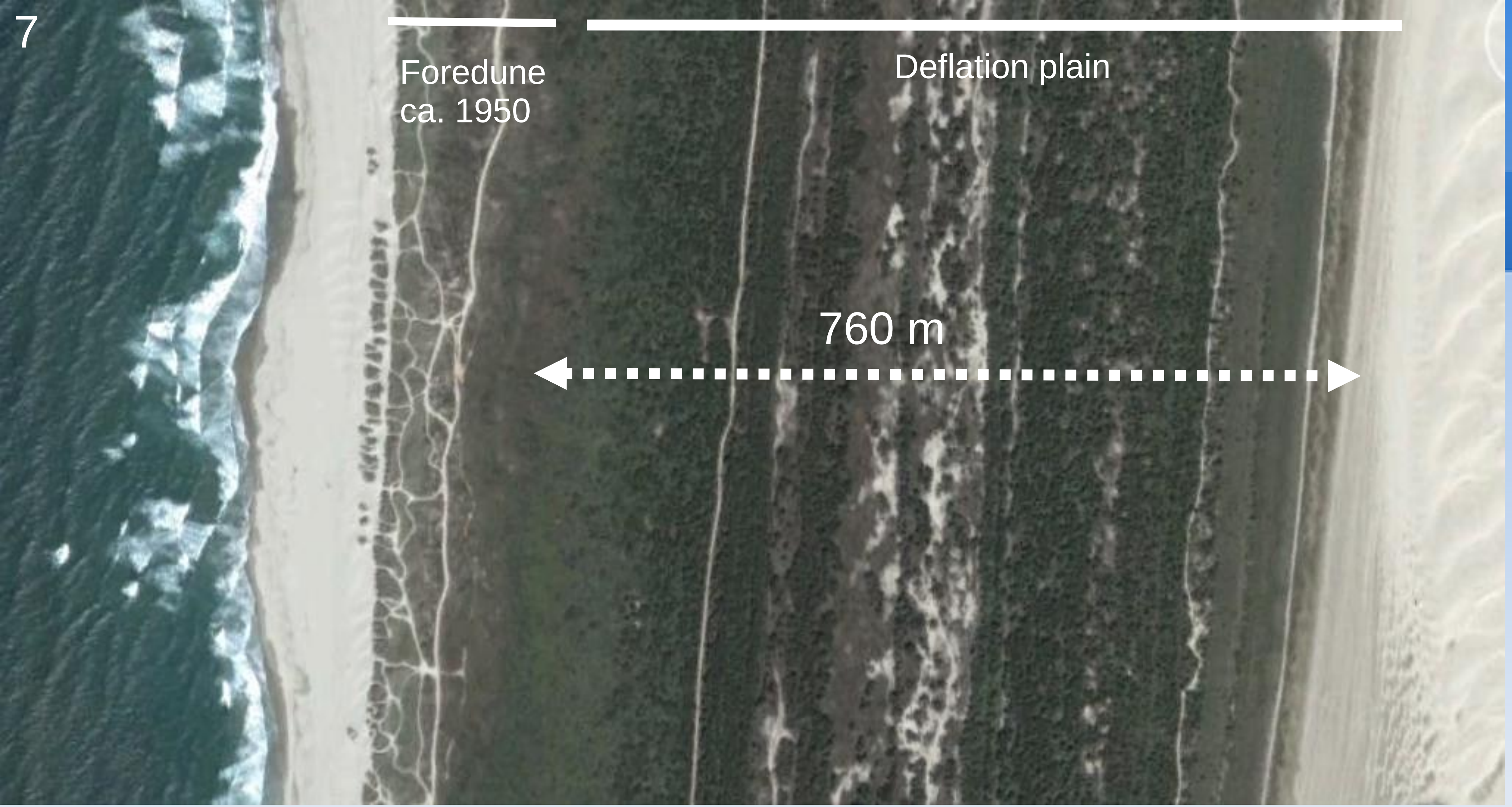


Foredune traps beach sand, allows leeward erosion to water table, creating deflation areas.

Deflation areas colonized by vegetation.



Eventually previous active sand is stabilized as succession pregresses to forest.



760 m / 60 years = 12 meters per year

8


1939
South Jetty Rd.


1984

Wiedemann and Pickart, 2004

Fig. 4.1. Parabola dunes at Humboldt Bay, northern California. View is to the south. The distance from shore to parabola tip exceeds 1000 m. (Photograph by A. Wiedemann, June 1983)

Photos: Andrea J. Pickart

Fig. 1. The native dune grasses *Leymus mollis* and *Poa macrantha* mix with forbs, including *Abronia latifolia* (yellow sand verbena) and *Lathyrus littoralis* (beach pea), on the foredune at the Lanphere Dunes Unit, Humboldt Bay National Wildlife Refuge.

Fig. 6a. An *Ammophila*-dominated foredune at the Lanphere Dunes in February 1992, prior to restoration (members of the California Conservation Corps are beginning the removal process). Pickart, 2008

Fig. 6b. The same location in July 2001, five years after restoration work was completed.

Pickart, 2008

Fig. 4.4. Typical steep profile foredune vegetated with *Ammophila arenaria* prior to restoration. Humboldt Bay, California. (Photograph by A. Pickart)

Fig. 10. Restored foredune grassland at the Lanphere Dunes Unit, Humboldt Bay National Wildlife Refuge. Pickart, 2008

Fig. 8. Bulldozers removing *Ammophila arenaria* for a western snowy plover habitat restoration project at the South Spit, managed by the Bureau of Land Management (beachgrass was first burned to reduce biomass).

Pickart, 2008

Fig. 9. Charred remains of *Ammophila arenaria* at MacKerricher State Park. In one method of control, beachgrass is burned to stimulate regrowth, then treated with herbicide.

Pickart, 2008

History of Dune Grass Invasions

Meanwhile...
A "stealth" Invader

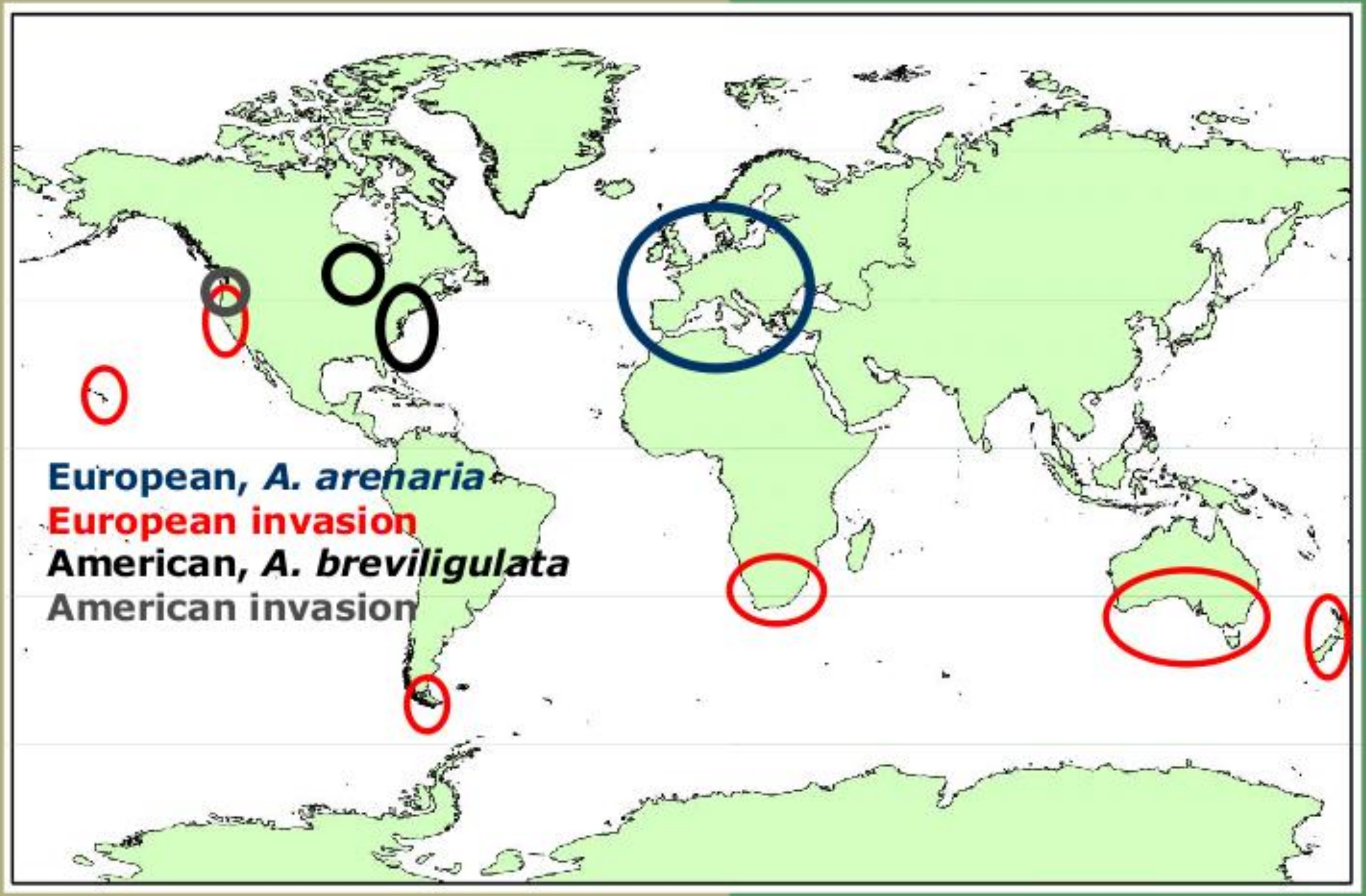
In mid-1930's, the American beach grass, *Ammophila breviligulata*, was introduced near Columbia River

Native to east coast and Great Lakes region of US

Hacker, 2008

http://www.science.oregonstate.edu/~zarnetsp/PNW_Dunes_Website/DuneGrassInvasion_PNW_Hacker.pdf

Beach grass invasion biogeography



Hacker, 2008

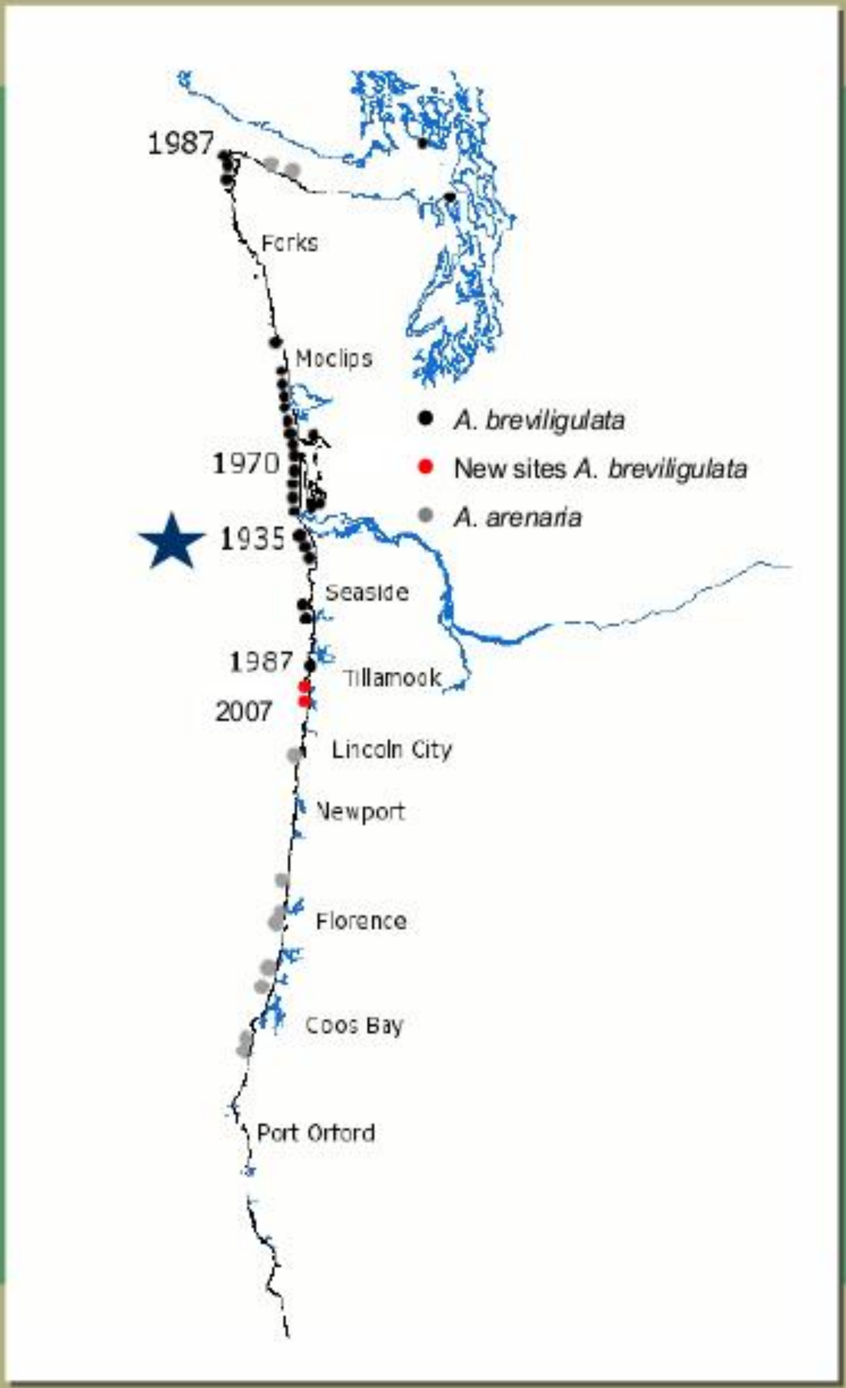

21a

21b

Ammophila breviligulata is spreading…

north into Washington where it is the dominant grass species and south into Oregon as far as Pacific City.

In Oregon, it may or may not dominate a site.

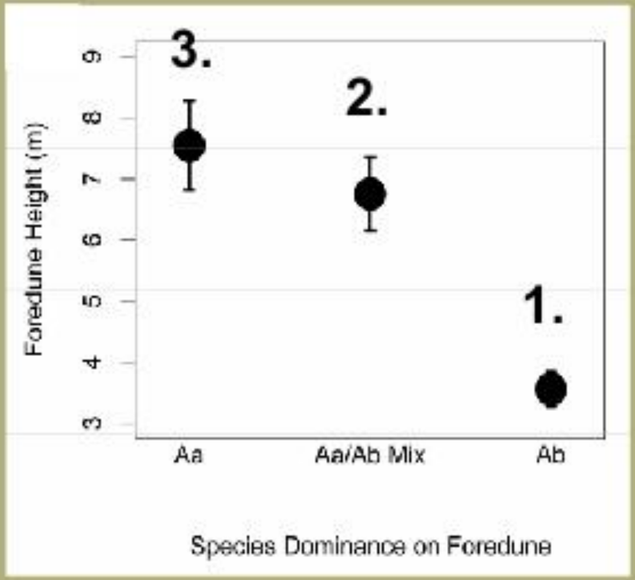


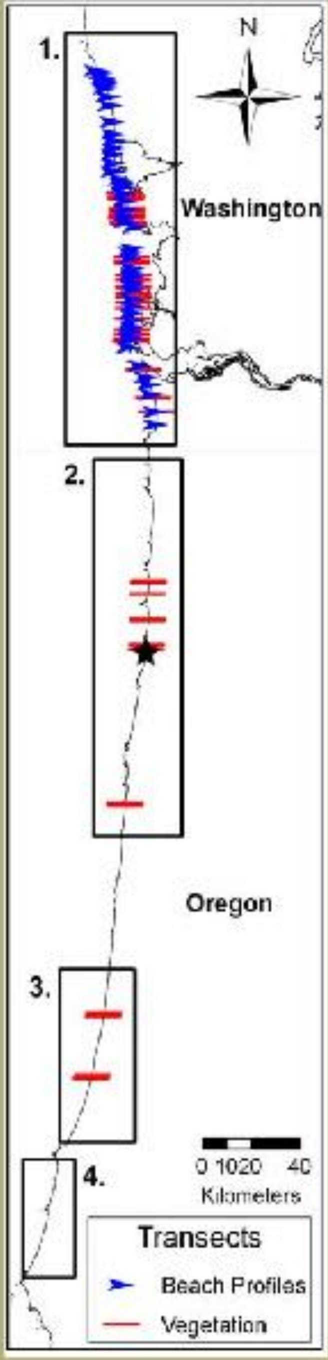
Hacker, 2008

23

Implication #1

Decreased dune height





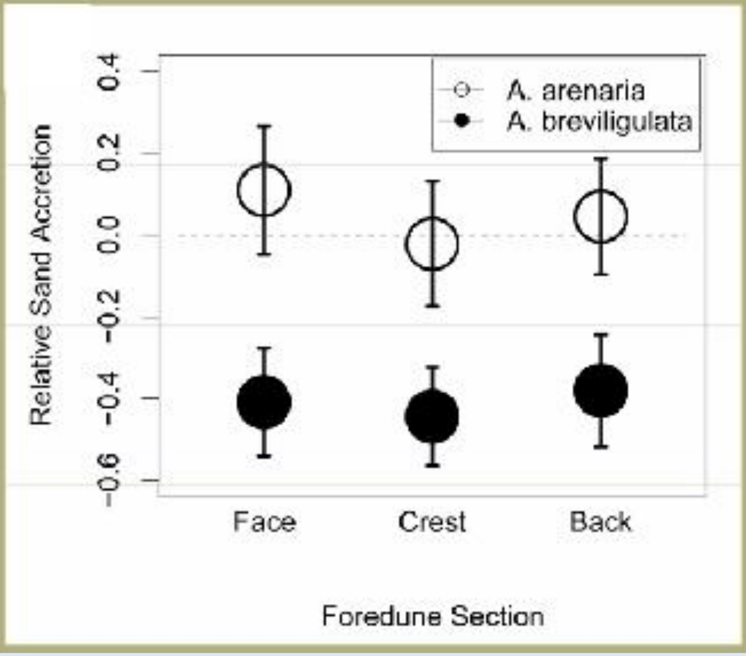
Hacker, 2008

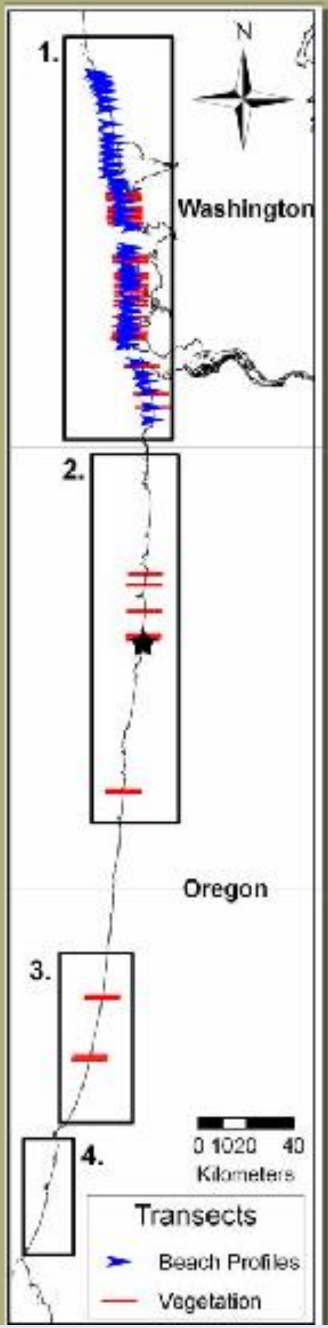
Decreased dune height

Possible Causes?

1. *A. breviligulata* accretes less sand but competitive

Field Observations





Hacker, 2008

Effects on animal community

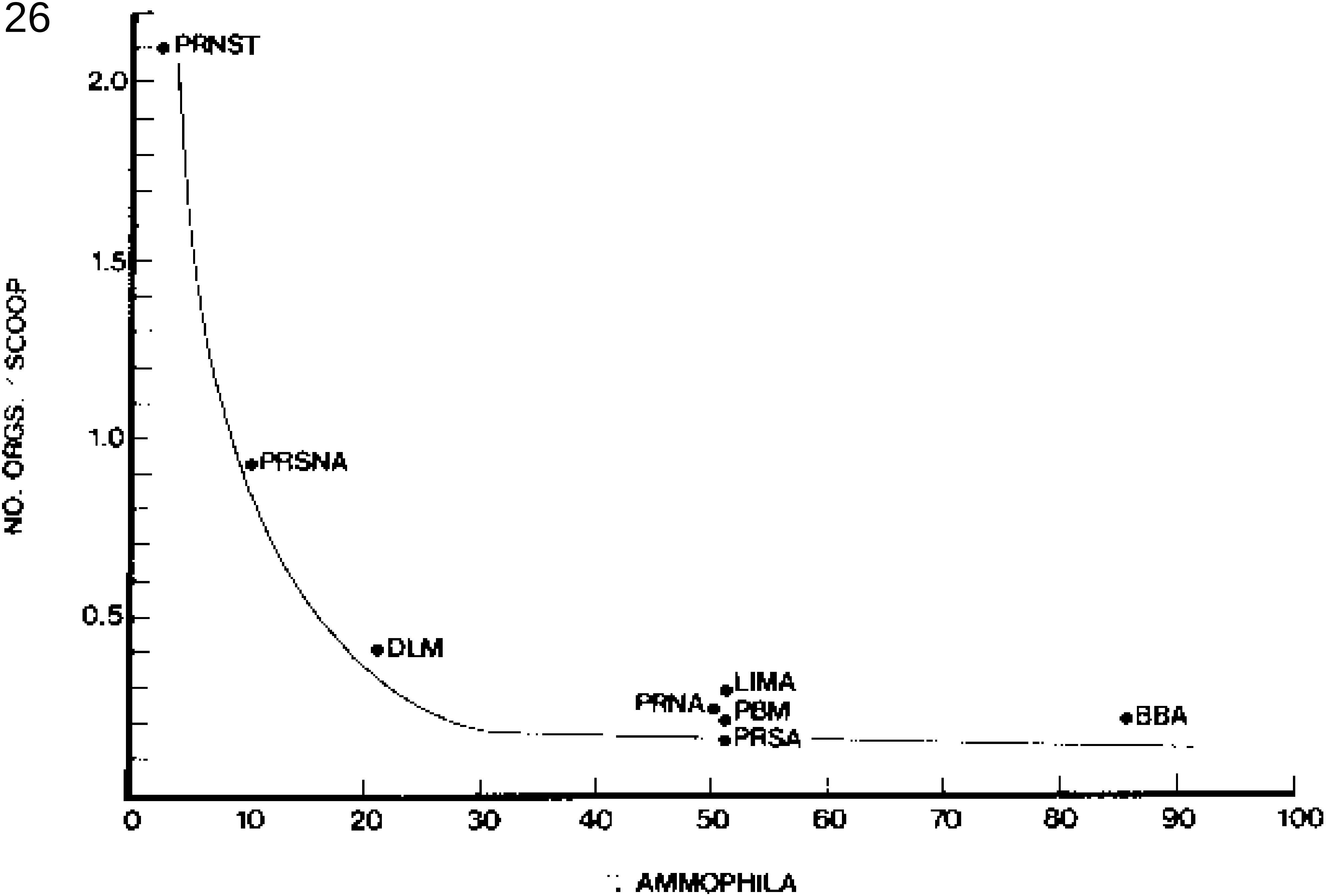
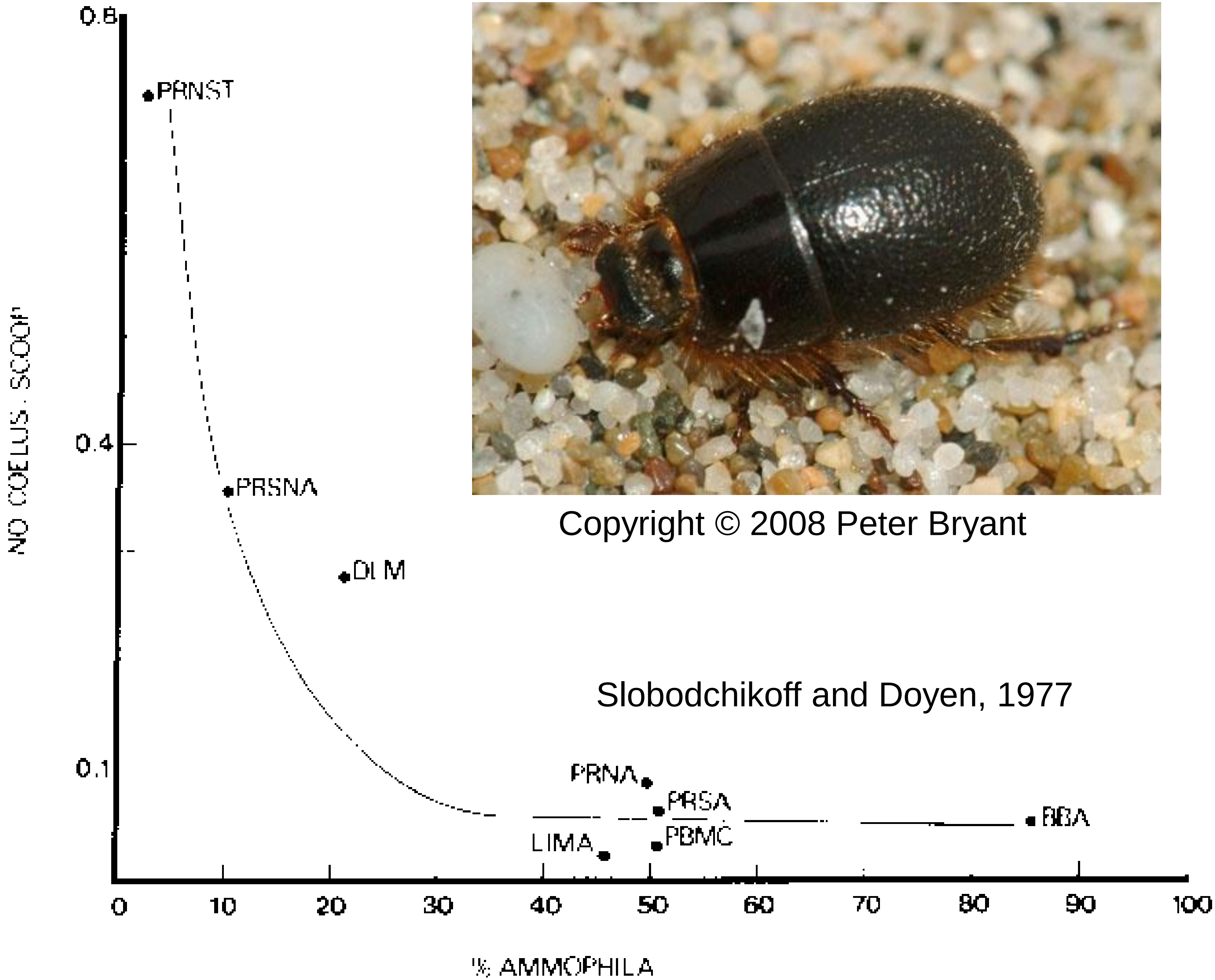


FIG. 2. Density of organisms in relation to percentage surface cover of *Ammophila arenaria*.

Slobodchikoff and Doyen, 1977



Copyright © 2008 Peter Bryant

Slobodchikoff and Doyen, 1977

FIG. 5. Density of *Coelus ciliatus* in relation to percentage surface cover of *Ammophila arenaria*.

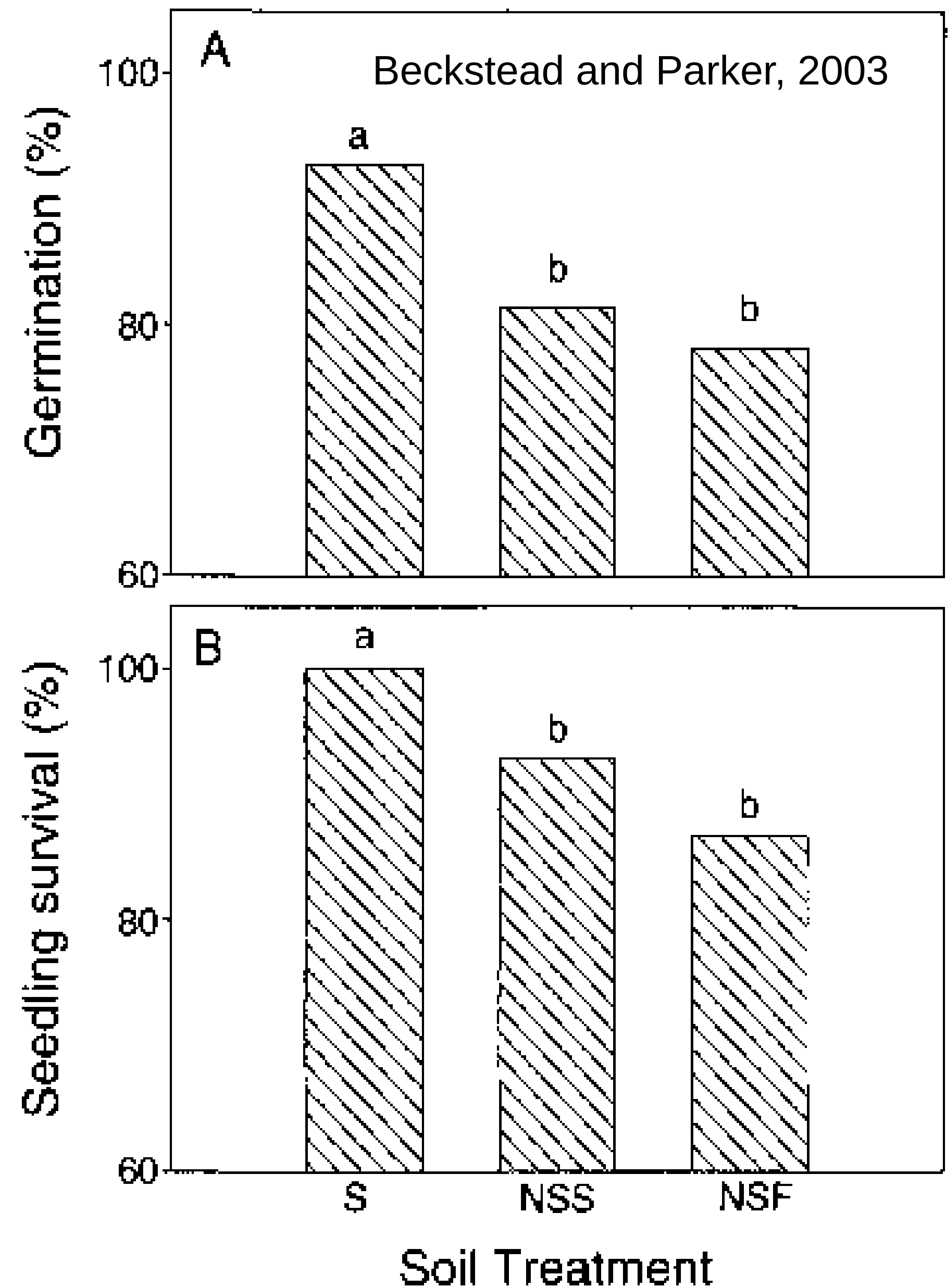
Wilbur L. Bluhm

Abronia latifolia (native)
yellow sandverbena
unknown Co.; locality unknown; 0m; 43.6592° N -124.2057° W
June 16, 1976

Abronia latifolia (native)
yellow sandverbena
Curry Co.; Langlois
photo by Julie Reinwand Kierstead May 4, 1983 OFP confirmed

Abronia latifolia (native)
yellow sandverbena
Lane Co.; Heceta Dunes ACEC
photo by Bruce Neil Newhouse June 21, 2005 OFP confirmed

Natural enemies hypothesis?


A
Beckstead and Parker, 2003
Germination (%)
100
80
60
a
b
b
B
Seedling survival (%)
100
80
60
a
b
b
S
NSS
NSF
Soil Treatment

Beckstead and Parker, 2003

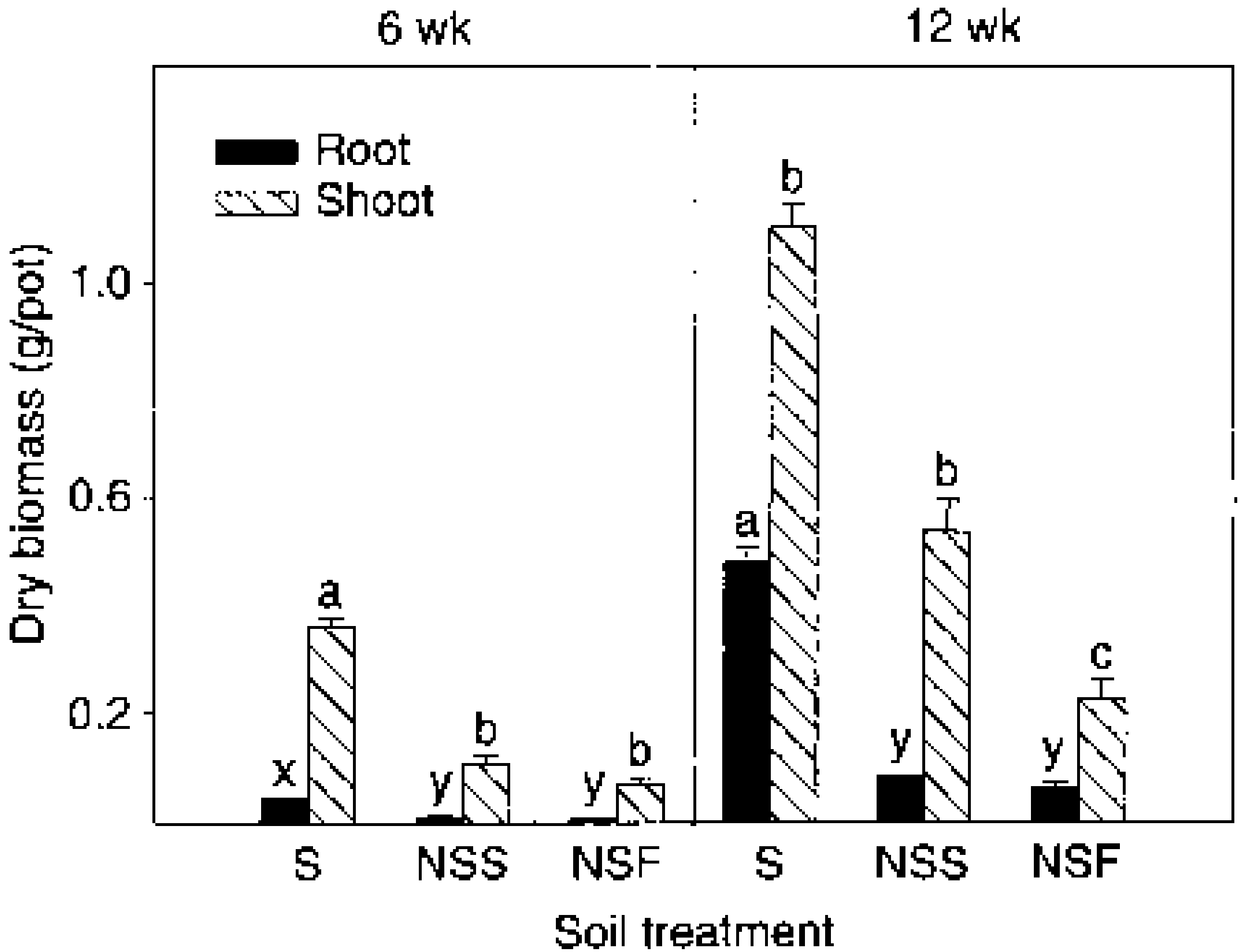
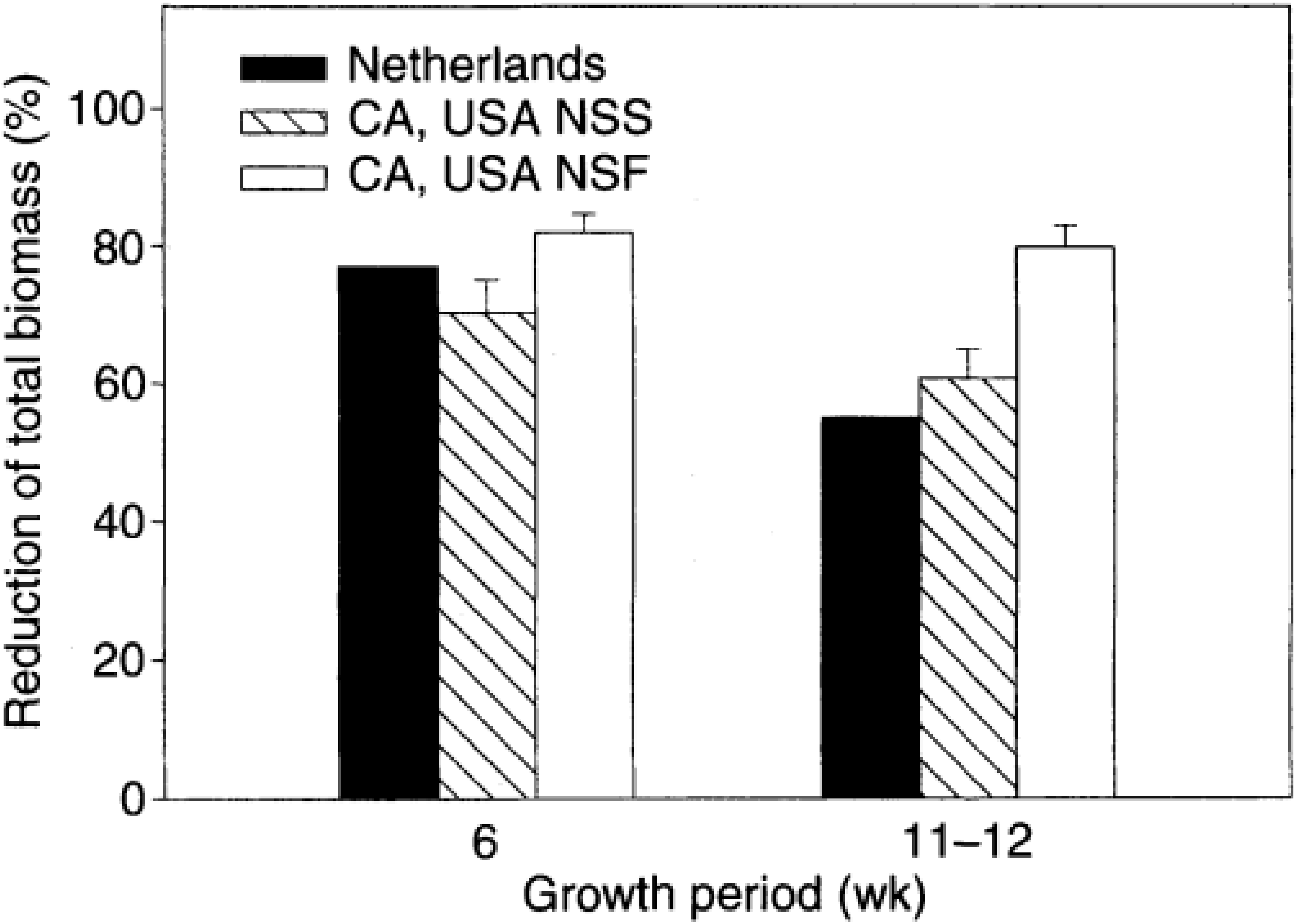


FIG. 2. Effects of soil sterilization treatments (S, sterilized; NSS, nonsterilized stored; NSF, nonsterilized fresh) on root and shoot biomass at 6- and 12-wk growth periods (means + 1 SE; for sample sizes, see *Methods*). Different small letters indicate significant differences ($P < 0.05$) between treatments for roots (x and y) and shoots (a, b, and c) within each growth period using a Bonferroni multiple comparison method following ANOVA.

Beckstead and Parker, 2003



Ammophila decline

Van der Putten and Peters, 1997

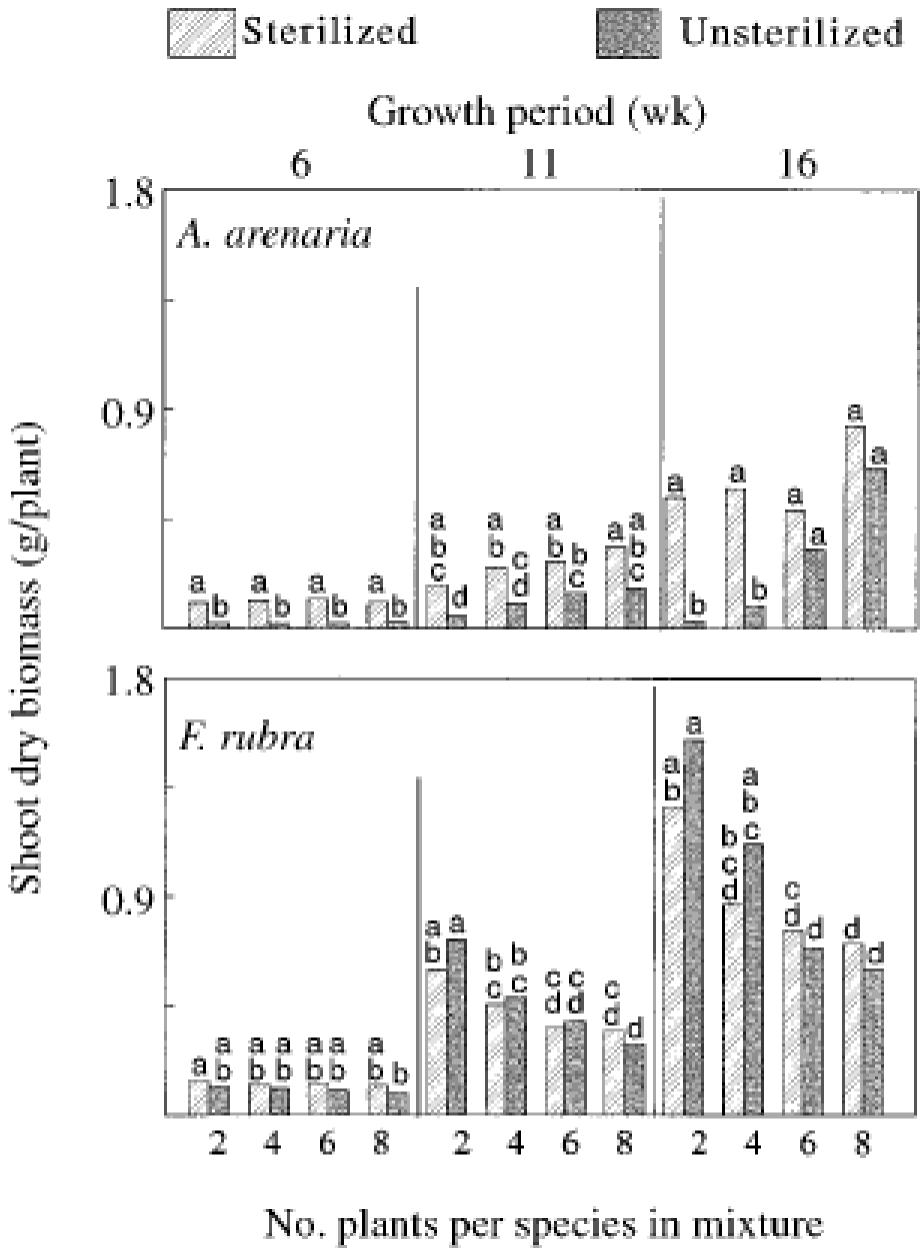


FIG. 3. Average shoot biomasses per plant of *Ammophila arenaria* and *Festuca rubra* in monocultures, as well as in the different mixtures on sterilized and unsterilized soil from the root zone of *A. arenaria* at three successive harvest dates, i.e., after 6, 11, and 16 wk of growth (Expt. 2). Significant differences within each plot are indicated by different letters.

Dune grasses fix nitrogen

Dalton et al., 2004

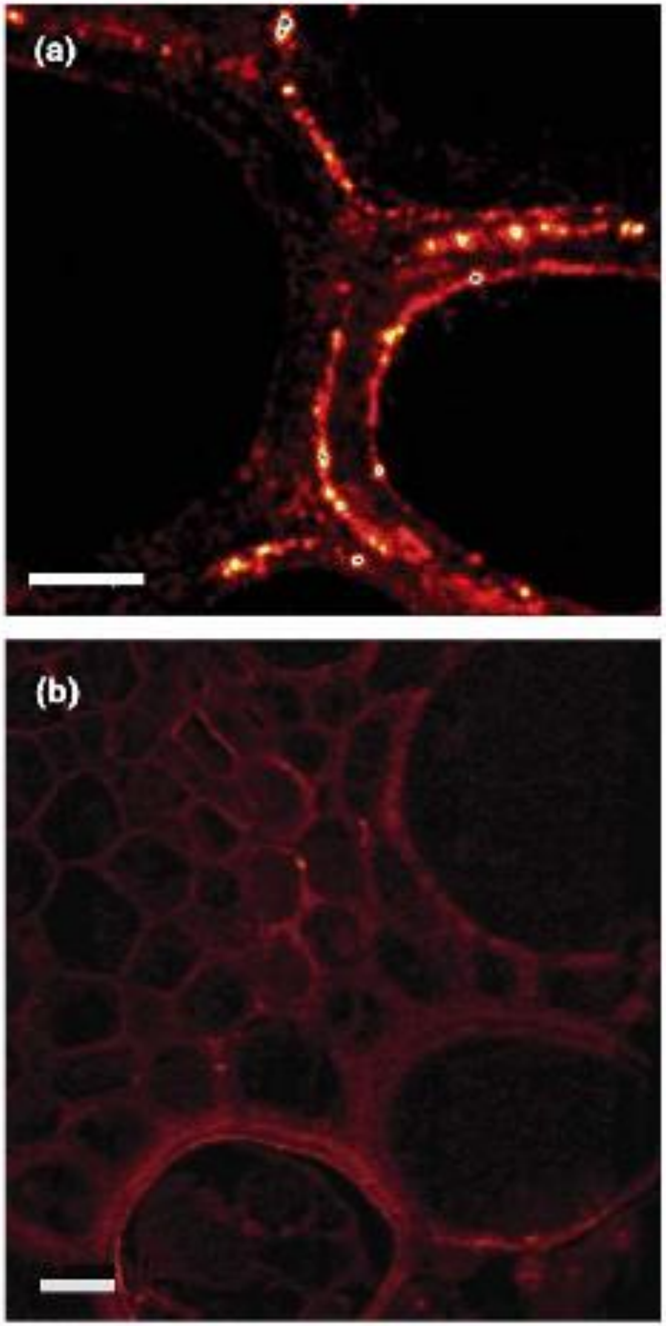


Fig. 5. (a) Fluorescence immunolocalization of nitrogenase in the cell walls of rhizomes of *Elymus mollis*. Bar = 5 μm. (b) Negative control with rabbit normal serum. Bar = 10 μm.

Dalton et al., 2004

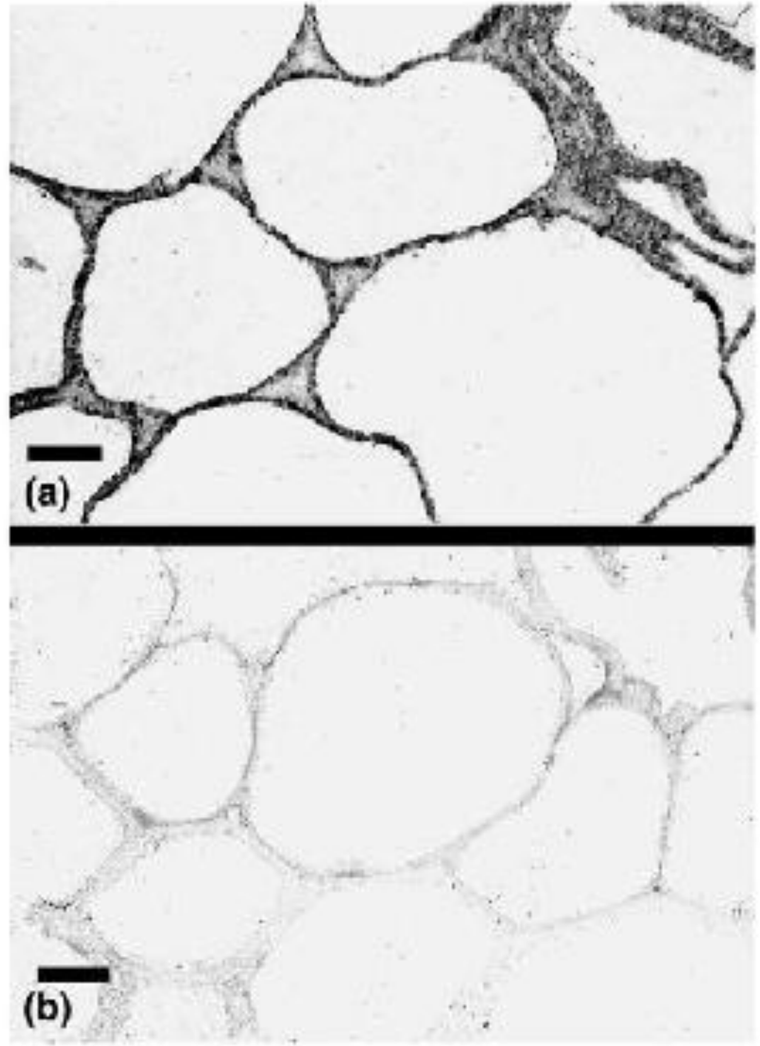
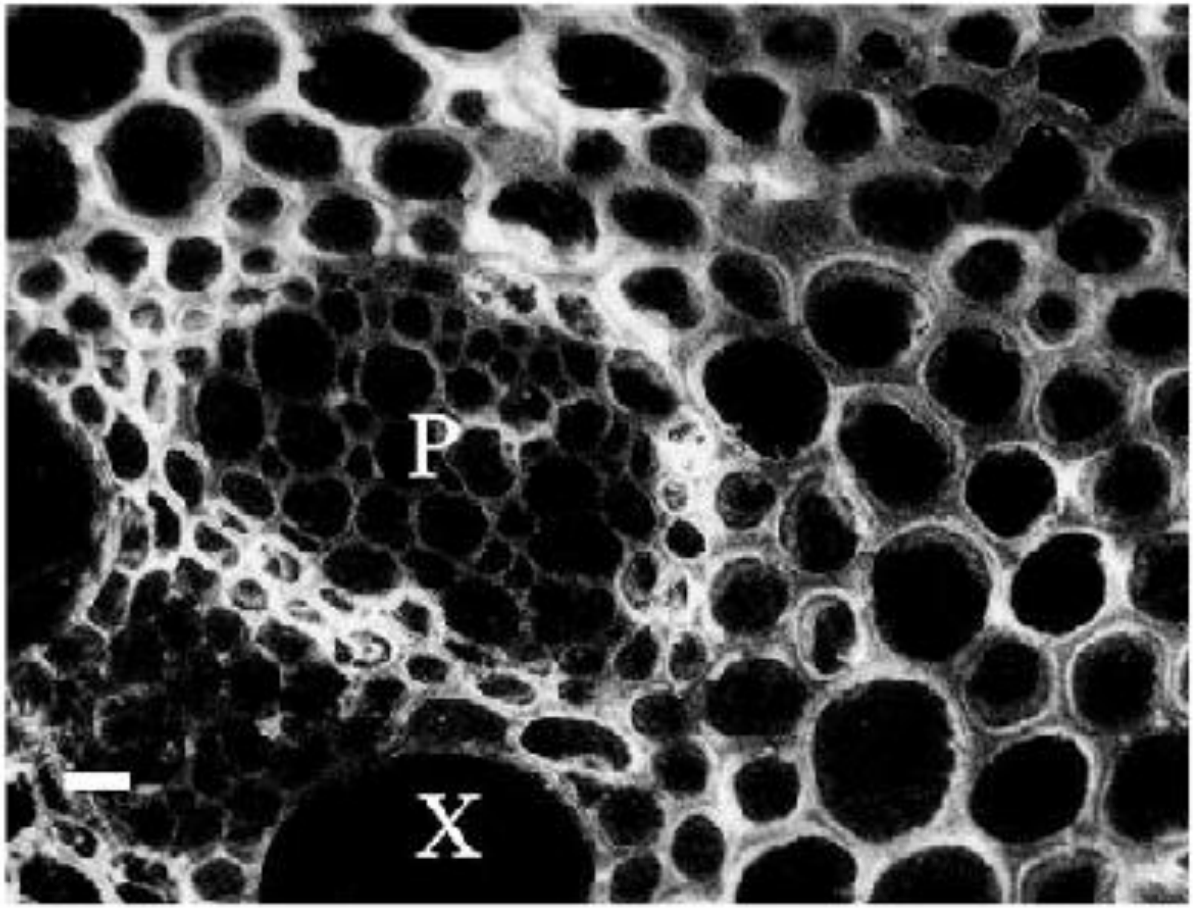


Fig. 3. (a) Silver-enhanced immunogold localization of bacteria in the cell walls of rhizomes of *Ammophila arenaria* as visualized with light microscopy. The primary antibody was raised against whole cells of *Stenotrophomonas maltophilia* isolated from *Ammophila arenaria*. (b) Negative control with rabbit normal serum. Scale bar = 5 μm for (a) and (b).



Dalton et al., 2004

Fig. 4. Silver-enhanced immunogold localization of nitrogenase in the cell walls of rhizomes of *Ammophila arenaria* as visualized with light microscopy The image is inverted so that silver grains appear as bright spots. P, phloem; X, xylem. Scale bar = 10 µm.

Table 1
Acetylene reduction activity (ARA) for dune grasses from the Oregon coast

	ARA ± SEM (nmol C_2H_4 g^{-1} FW h^{-1})	Maximum ARA (mmol C_2H_4 g^{-1} FW h^{-1})	Replicates
Ammophila arenaria			
Field collected and surface-sterilized			
Rhizomes	0.761 ± 0.502	24.8[a]	50
Greenhouse grown, washed but not surface-sterilized			
Roots	0.15 ± 0.1	1.0	10
Rhizomes	6.25 ± 5.1	38.6	7
Stems	0.17 ± 0.0	1.6	18
Greenhouse grown and surface-sterilized			
Roots	1.39 ± 0.49	4.87	9
Rhizomes	3.78 ± 1.47	14.2	9
Stem	0.094 ± .02	0.261	16
Elymus mollis			
Field collected and surface-sterilized			
Roots (July)	0.69 ± 0.17	1.03	3
Rhizomes (July)	0.12 ± 0.08	0.27	3
Stem (October + April)	0.26 ± 0.06	0.44	6
Roots (October + April)	3.51 ± 0.20	3.71	6
Rhizomes (October + April)	0.38 ± 0.08	0.61	6

Field samples were taken from coastal dunes near Florence, OR during June and July, 1999 unless noted otherwise. Greenhouse samples were from plants grown in pots of sand for 3 weeks. Values shown were corrected for background traces of C_2H_4 and for possible endogenous production of C_2H_4 by plant tissues.

[a] This sample contained 1.09×10^8 cfu/g FW which compares to 1.11×10^7 for other samples (see Table 2).

Dalton et al., 2004

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http://www.science.oregonstate.edu/~zarnetsp/PNW_Dunes_Website/DuneGrassInvasion_PNW_Hacker.pdf