Use of Cover Crops for Revegetation After Energy Development in Northern Mixed Grass Prairie

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USDA-ARS

USDA United States Department Of Agriculture Agricultural Research Service

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Goals of this project

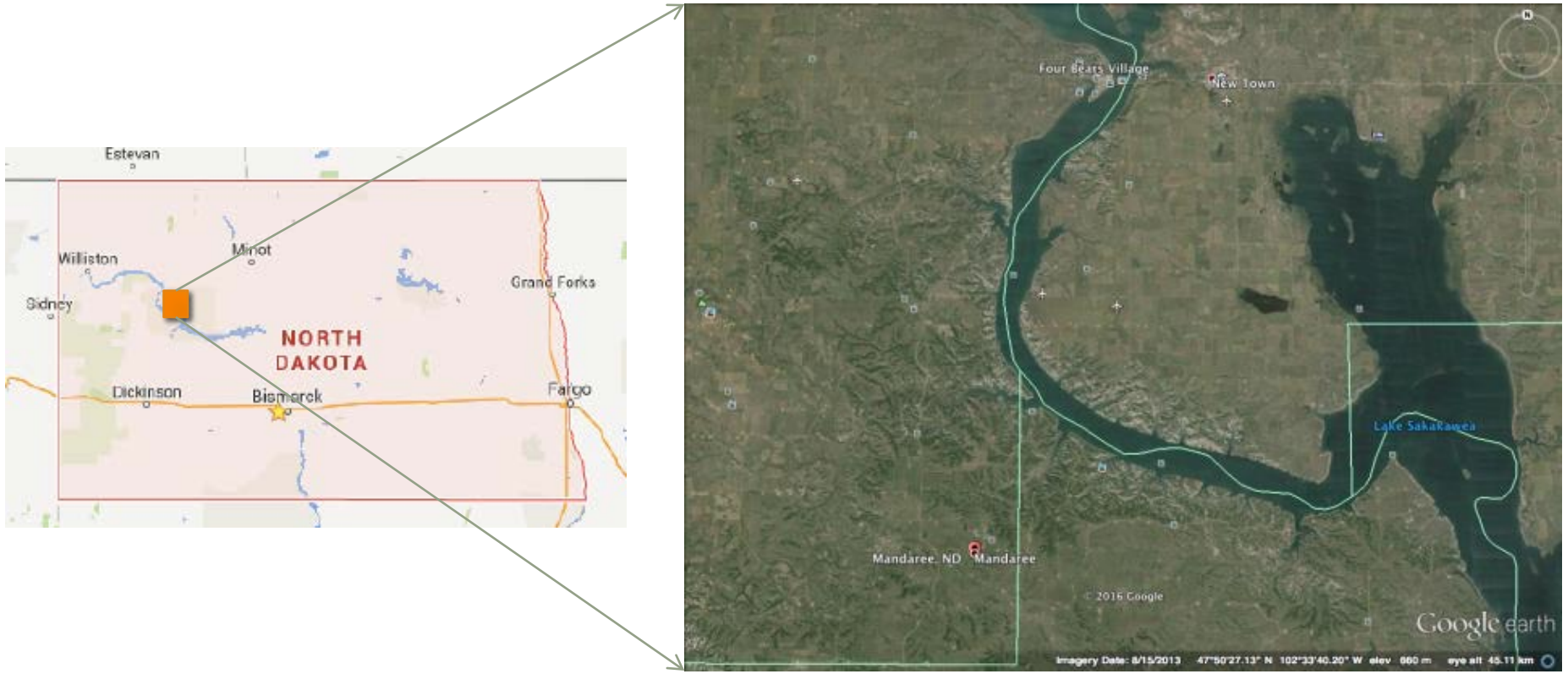
- To improve revegetation success with an overall reduction of associated costs
- Promote soil vitality with a diversity of cover crops that promote topsoil development and increase water infiltration (reducing runoff)
- Preemptively out-space and reduce the establishment of noxious weeds
- More effectively promote the establishment of native grass species and bolster communities of pollinators and other beneficial insects

Why reclaim?

8/15/2013

9/28/2016

North Dakota Study Site



Revegetation seed mix

western wheatgrass, green needlegrass, slender wheatgrass, blue grama, sideoats grama, little bluestem and prairie junegrass

Erosion happens!

Revegetation often occurs on structureless soils

How cover crops build soil health

- carbon feeds microbes
- exudates build aggregates
- roots make pores

picture courtesy of Clarence Chavez, NRCS

photo: notillfarmer.com

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Roots build soils

Using cover crops for revegetation

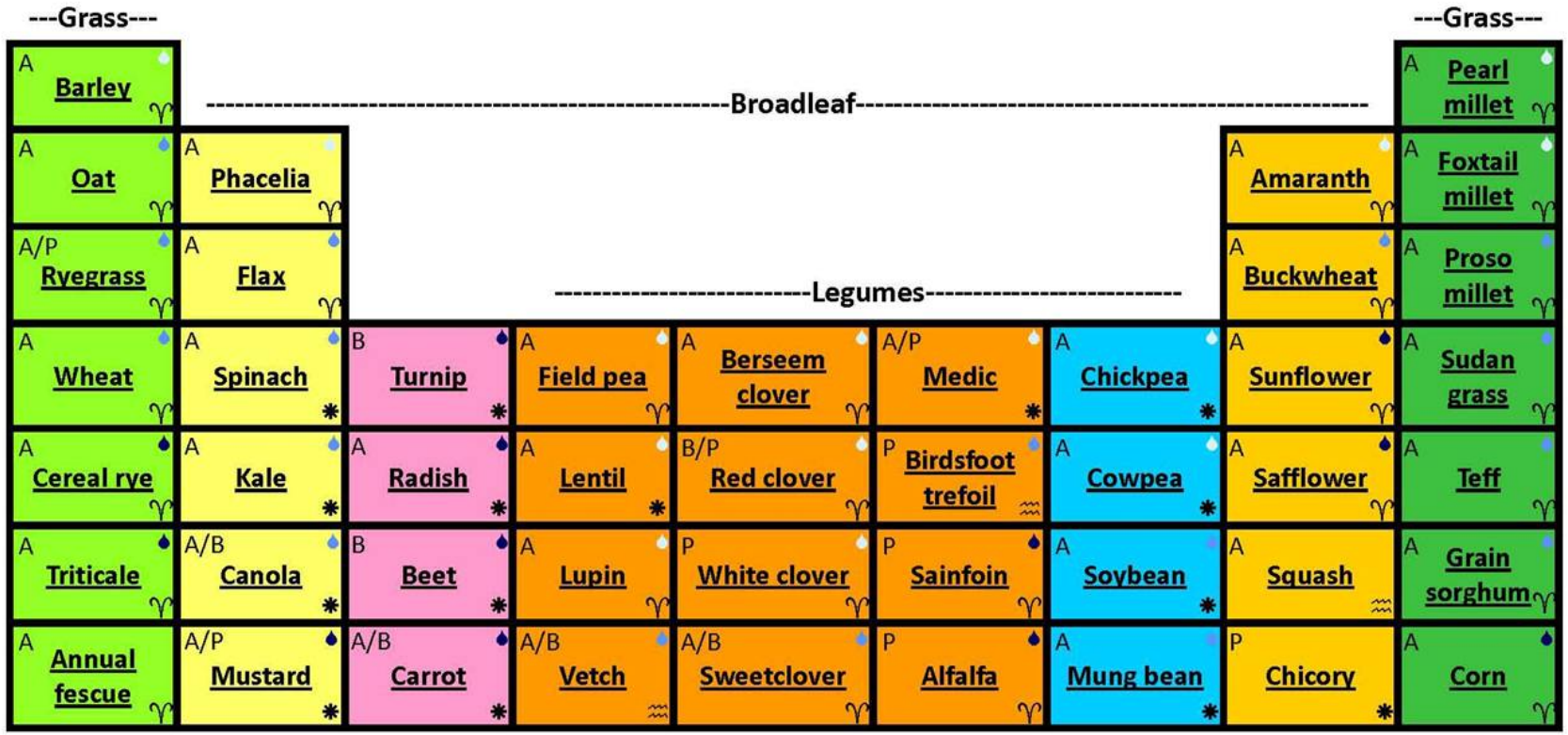
2015

2016

Cover Crop Chart

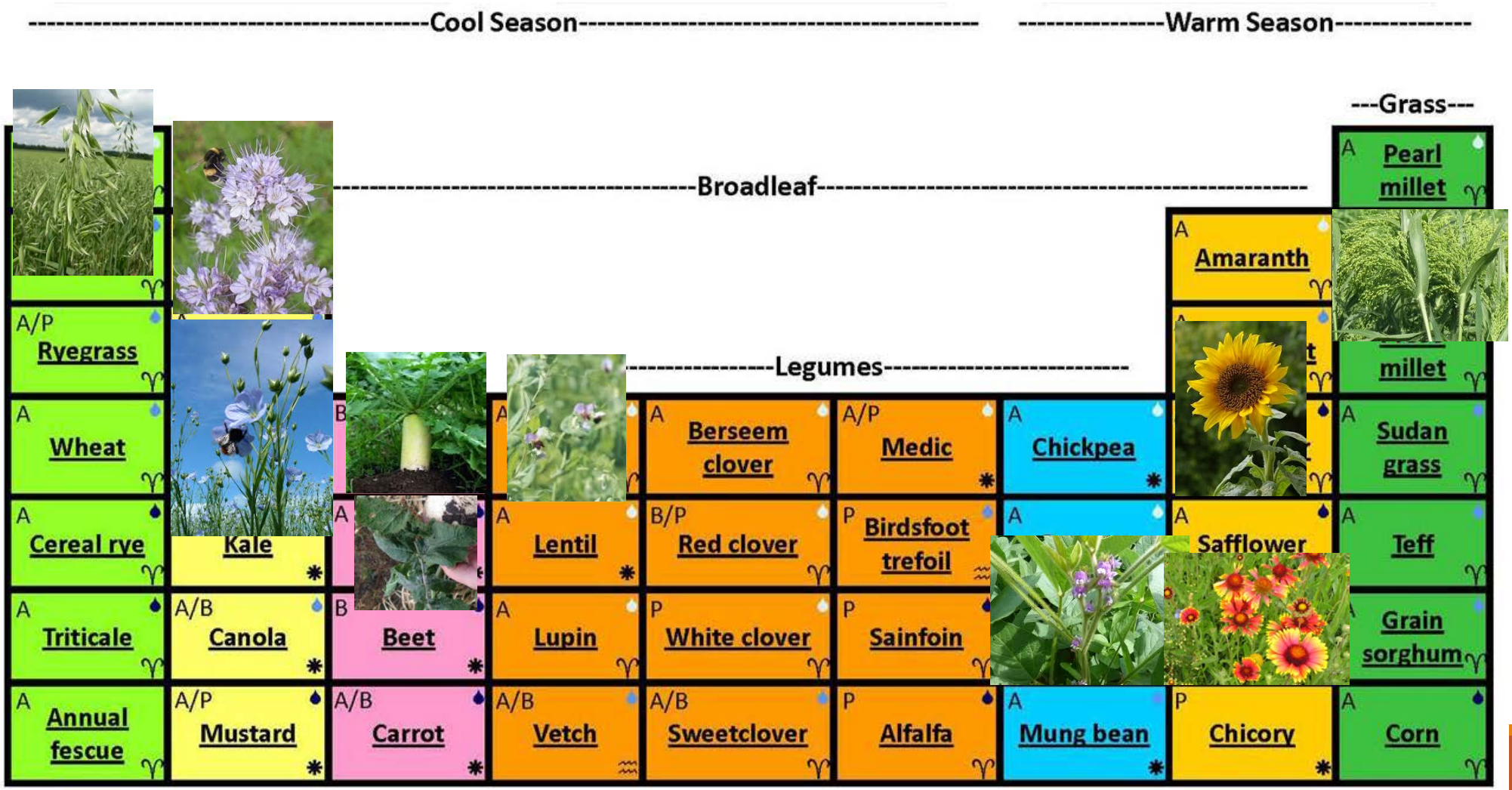
AREA 4 SCD

GROWTH CYCLE	RELATIVE WATER USE	PLANT ARCHITECTURE
A = Annual	= Low	= Upright
B = Biennial	= Medium	= Upright-Spreading
P = Perennial	= High	= Prostrate



Cover crop cocktail:

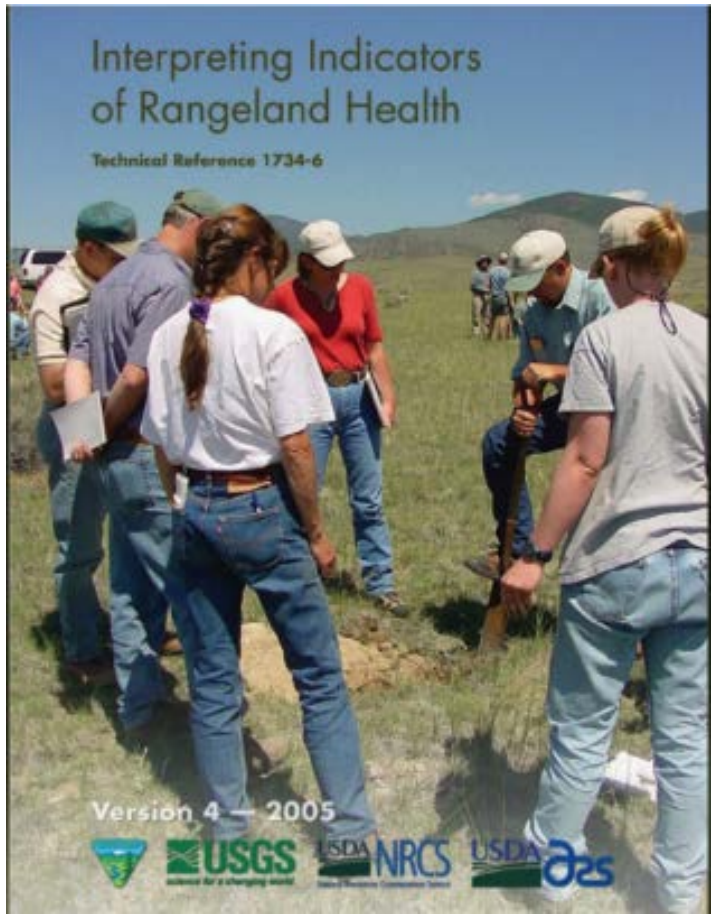
oat, phacelia, flax, radish, turnip, field pea, soybean, sunflower, blanketflower, millet

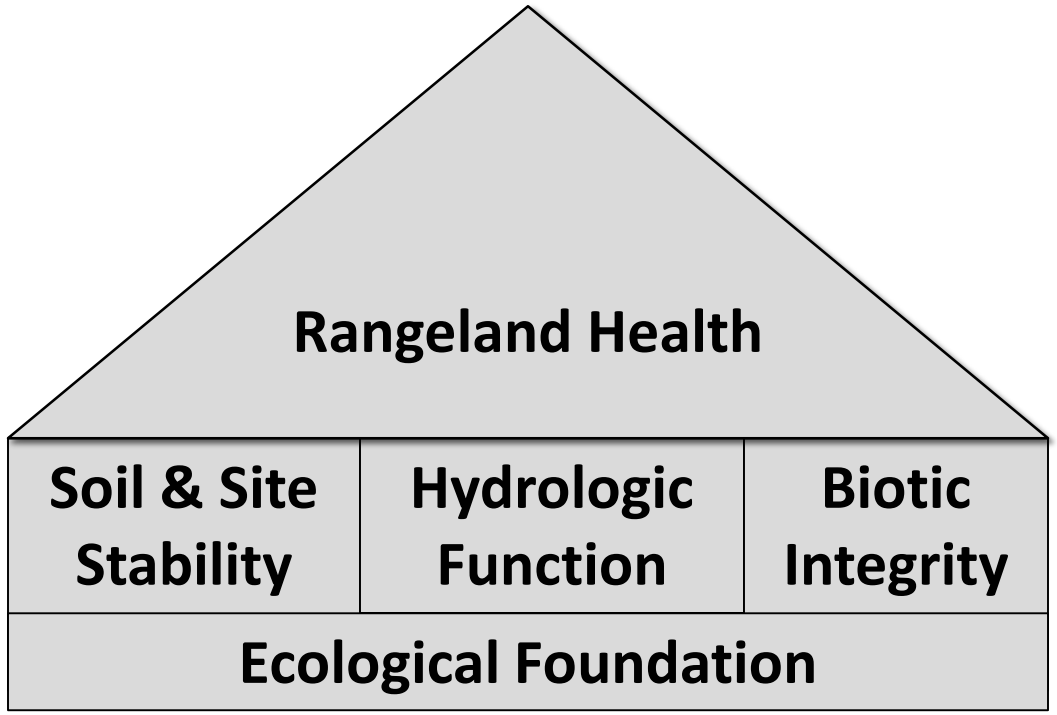


Questions to answer in cover crop study

- Do cover crops grow at harsh reclamation sites?
- Do cover crops reduce perennial grass establishment?
- Do cover crops reduce weeds?
- Do cover crops reduce erosion?
- Do cover crops build soil aggregates?

Interpreting Indicators of Rangeland Health





Indicators and attributes

Indicator no.	Indicator	Attribute
1	Rills	SSS, HF
2	Water flow patterns	SSS, HF
3	Pedestals and/or terracettes	SSS, HF
4	Bare ground (%)	SSS, HF, LCC
5	Gullies	SSS, HF
6	Wind-scoured, blowouts and/or deposition areas	SSS
7	Litter movement	SSS
8	Soil surface resistance to erosion	SSS, HF, BI
9	Soil surface loss or degradation	SSS, HF, BI
10	Plant community composition and distribution relative to infiltration and runoff	HF
11	Compaction layer	SSS, HF, BI
12	Functional/structural groups	BI
13	Plant mortality/decadence	BI, LCC
14	Litter amount	HF, BI
15	Annual production	BI, LCC
16	Invasive plants	BI
17	Reproductive capability of perennial plants	BI

Results

Do cover crops grow at harsh reclamation sites?

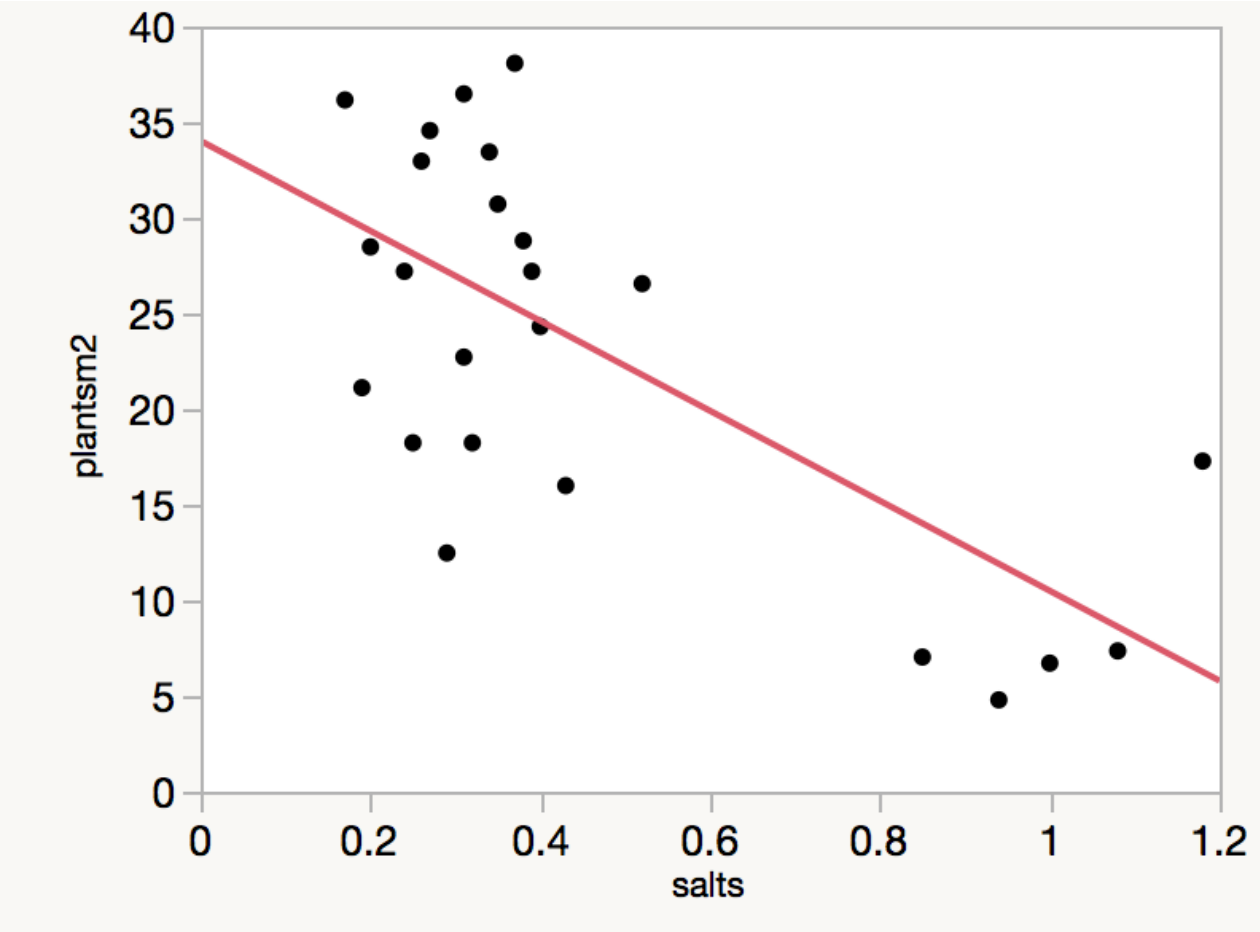
2014

Oat: some persistence to 2015
20-40% frequency

2015

Phacelia, Sunflower, soybean, radish, turnip, blanketflower, flax, field pea, oat, millet
all established at all sites
Oats 100% frequency

Plants respond strongly to salts in soil



Do cover crops reduce perennial grass establishment?

2014

28 (±7) plants/m^2 no Oat

30 (±6) with Oat

2015

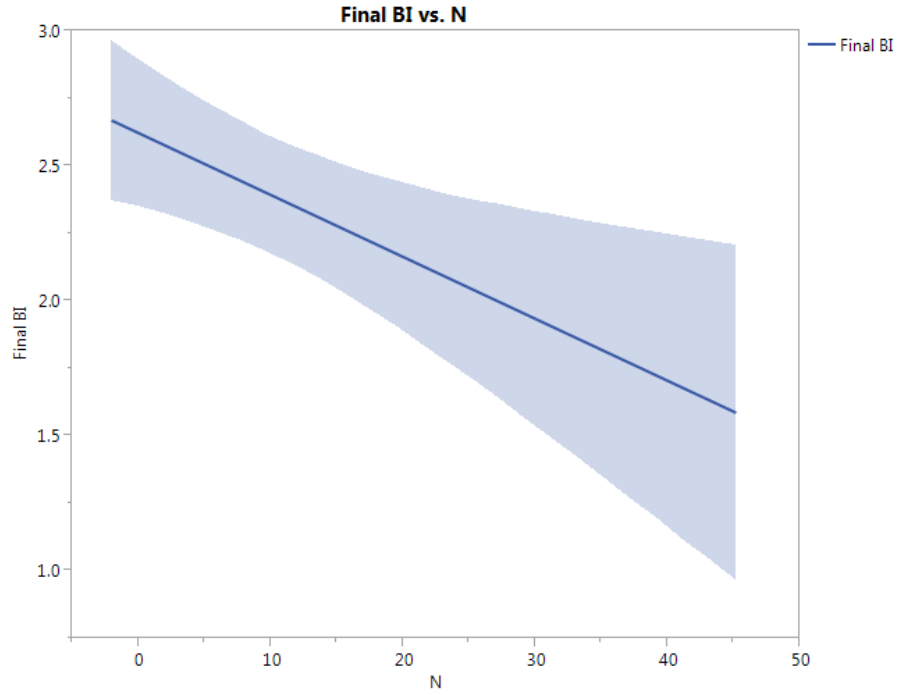
21 (±7) plants/m^2 Oat only

17 (±7) CCC

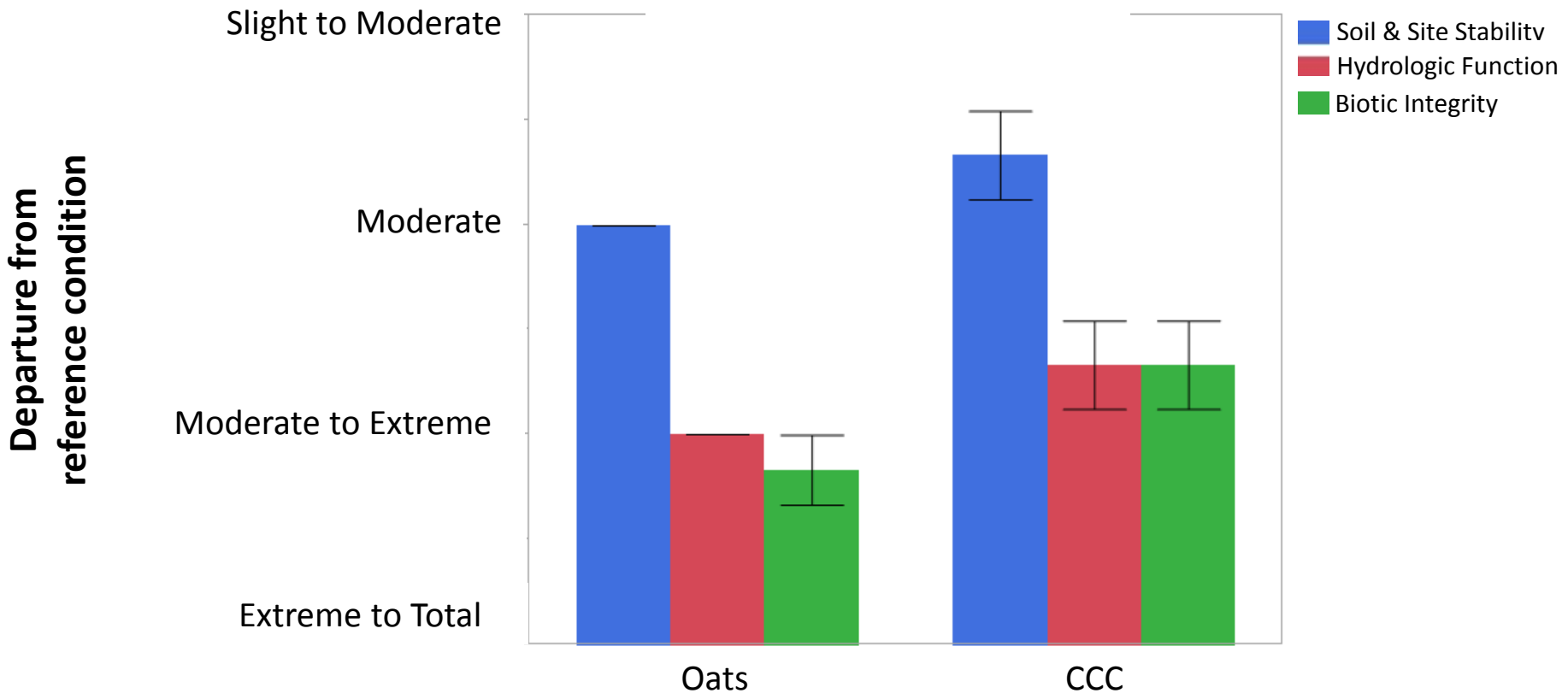
Cover crops do not compete with desirable perennial grasses!

Weeds Respond to Increased Fertility

- Weeds increased with increased fertility
- Increased weeds drove a decrease in biotic integrity
- **Plots with oats rated better than those without oats.**



Range health results



Questions to answer in cover crop study

- Do cover crops grow at harsh reclamation sites? YES
- Do cover crops reduce perennial grass establishment? NO
- Do cover crops reduce weeds? YES (Oat cover crop)
- Do cover crops reduce erosion? NOT IN FIRST YEAR
- Do cover crops build soil aggregates? CANT TELL YET

Year 2 of sampling – Unanswered questions

- Do cover crops grow at harsh reclamation sites? YES
- Do cover crops reduce perennial grass establishment? NO
- Do cover crops reduce weeds? (Oat cover crop)
- Do cover crops reduce erosion?
- Do cover crops build soil aggregates?

Not enough time has passed

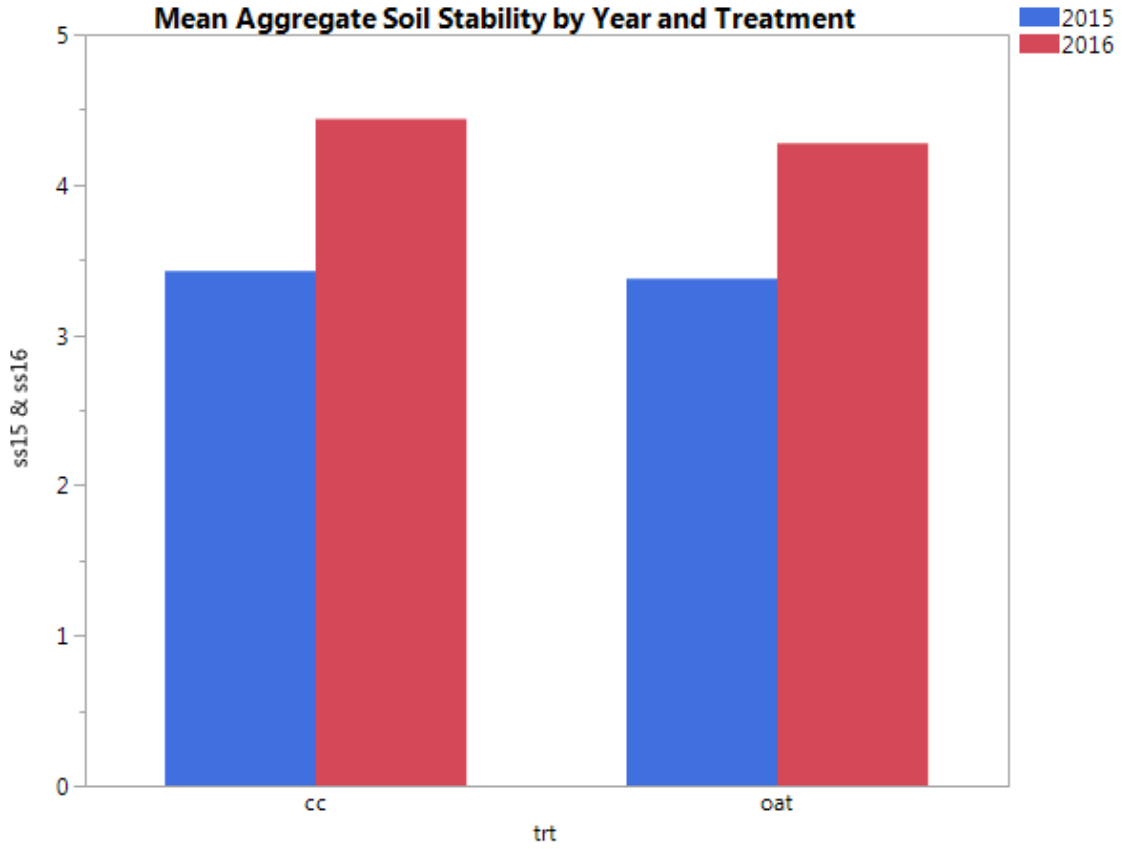
Do cover crops reduce erosion?

- Based on indicators of rangeland health, there was an increase in signs of erosion between 2015 and 2016.
- Oats appeared to have largest slowdown effect on erosion.
- Difference were not large enough to change rangeland health rating category.

Do cover crops build soil aggregates?

- There has been an increase from 3.4 to 4.3 (scale of 1-6) is in field aggregate stability values between 2015 and 2016 with no difference in treatments.

- Increases in soil aggregate stability correlated with:
  - high initial soil OM (r^2=5.1; P=0.009)
  - litter cover (r^2=0.40; P=0.027)
  - plant cover (r^2=0.55; P=0.006)



What have we learned?

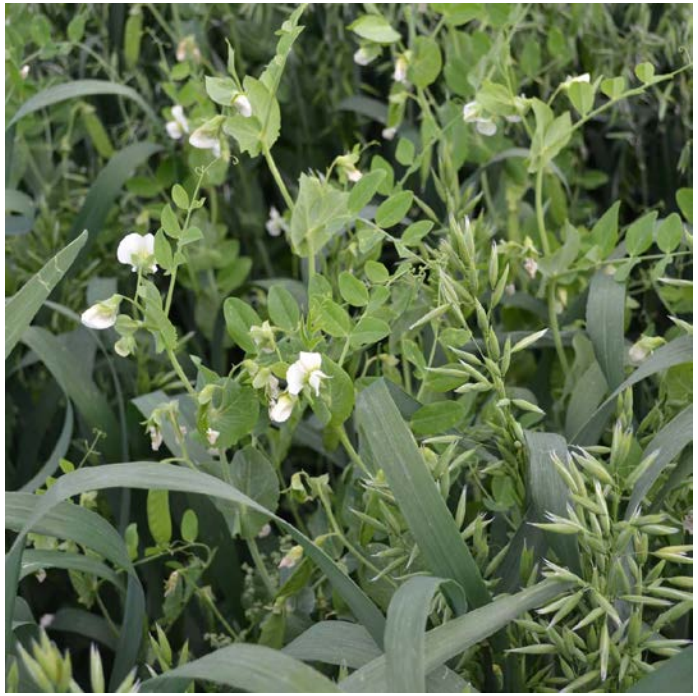
- Soil chemistry among reclamation sites within the same ecological site varied widely.
- When prairie soils contain a concentrated, buried salt layer, this layer should either be left intact or removed during the construction phase prior to reclamation.
- In ungrazed interim oilfield reclamations, soil chemistry had an effect on plant establishment.

What have we learned?

- Adding an annual cover crop to the perennial grass seed mix had no effect on perennial grass establishment and a positive effect on rangeland health.
- Positive effect of oats on invasives.
- IIRH method was effective for evaluating reclamation success and communicating results.

Future direction

We will test if the long-term benefits of cover crops in agricultural systems transfer to restoration, but cover crops that establish at low densities due to stressful soil conditions may only have small effects in reclamations. Especially in these already water-limited growing conditions of the northern Great Plains.



The Hollywood version

Our version

Acknowledgements

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Thank you

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Seed costs

western wheatgrass, green needlegrass, slender wheatgrass, blue grama, sideoats grama, little bluestem

$100/acre

Oat

$3.40/acre

CCC

$7/acre