A collaboration between:
USDA NRCS, USDA ARS, USDA Southwestern Climate Hub, USDA Southern Plains Climate Hub

Dust Mitigation Handbook

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The USDA Climate Hubs

Converting Science to Action

www.climatehubs.usda.gov

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USDA Climate Hubs

- **MISSION**: Develop and deliver science-based, region-specific information and technologies so that agricultural and natural resource land managers are empowered to make climate-informed decisions.
- The Climate Hubs Program is a ***OneUSDA*** approach to addressing the impacts of climate change on working lands. The program does this by connecting USDA Research Agencies to Program agencies to build resilience to a changing climate.

Agricultural Research Service | NRCS Natural Resources Conservation Service | Forest Service U.S. Department of Agriculture | APHIS | FSA Farm Service Agency | RMA

CY19 NRCS Liaison Projects

Since 2016, NRCS has provided liaisons to work with the Climate Hubs program. Liaisons and their projects for 2019 are listed below:

1. **Stacey Clark** is working with the Northern Forests Hub to advance climate adaptation throughout the Midwest and Northeastern region, with a special emphasis on NRCS and USDA partners.

2. **Chris Miller** is working with the Northeast and Southeast Hubs to provide an assessment of how agricultural producers in vulnerable coastal areas of the Eastern US and Gulf Coast can mitigate (short term) and adapt (long term) to more frequent coastal flooding and saltwater inundation in order to reduce lost farm and forest productivity.

3. **Charles Peacock** is developing regional case studies to expand the "Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast" workbook developed by the Climate Hubs.

4. **Justin Mount** is working with the Midwest Hub to improve understanding of how management factors/variables affect crop system wind and water erosion, water use efficiency, crop growth and production estimates

5. **Steve Smarik (18-19)** has worked over the last two years to develop a wind erosion and dust mitigation handbook, which you will be hearing more about today!

Chapter 1 - Impacts of Particulate Matter

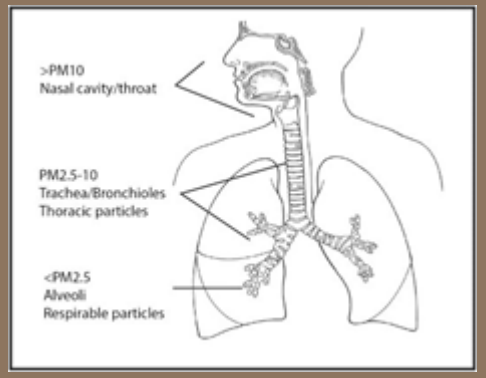
Greg Zwicke - USDA-NRCS

Scale of PM Impacts

PM can cause impacts on local, regional, and even global scales

Types of PM Impacts

- Health impacts



- Visibility impacts

- Deposition impacts

Chapter 2: Understanding Wind Erosion

Climate Considerations

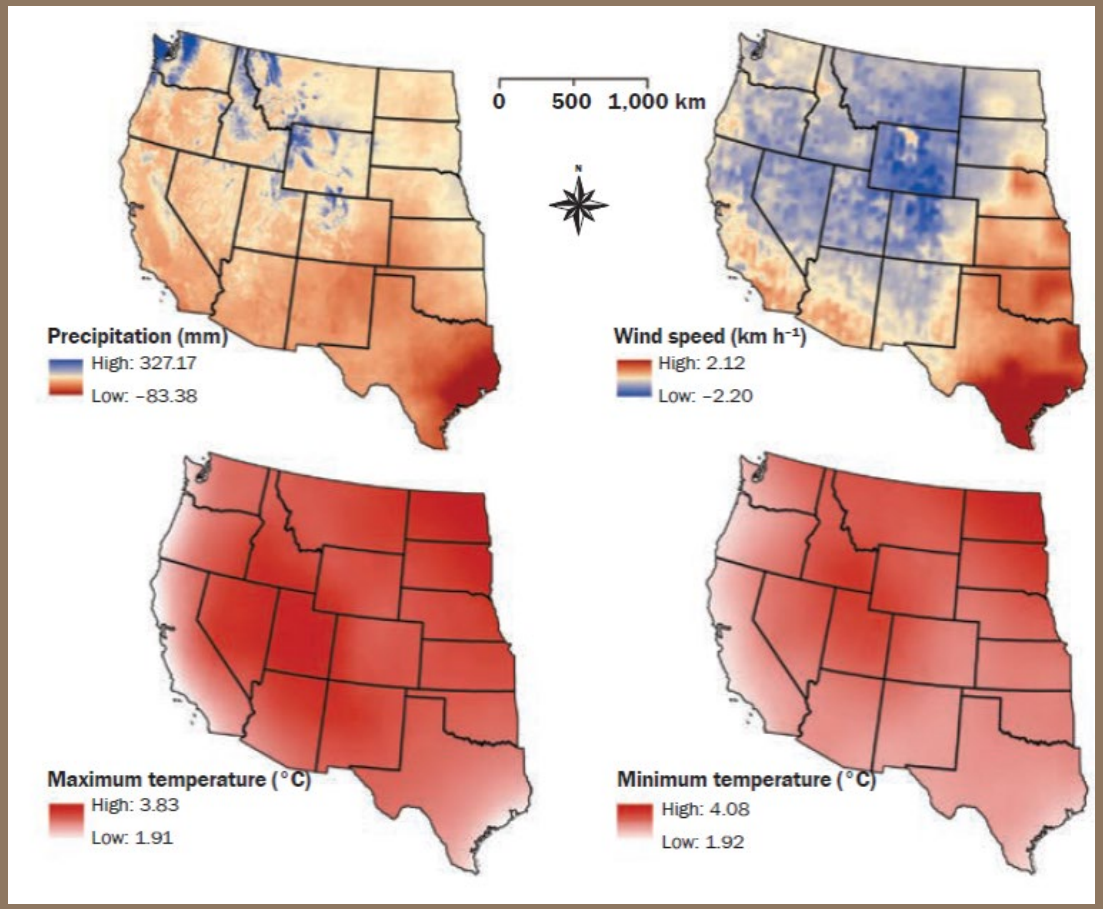
Brandon Edwards
Jornada Experimental Range

Implications

- Increased aeolian activity could have important ecological and hazard implications
- Overall, climate change is expected to increase vulnerability to wind erosion in many landscapes of the Southwest
- Understanding potential climate change impacts to wind erosion and dust emission is important for applying appropriate management and mitigation practices

Climate Change Projections

- There is very high confidence that CO_2 concentrations and temperatures across much of the West have been increasing over the past century, and that this trend is intensifying
- Predictions from CMIP5 further suggest mean temperatures across the West could increase by ~3.3°C (6°F) by the mid-21st century and ~5°C (9°F) by late-21st century under the RCP8.5, which is consistent with recent observations of emissions.



Climate Change Projections

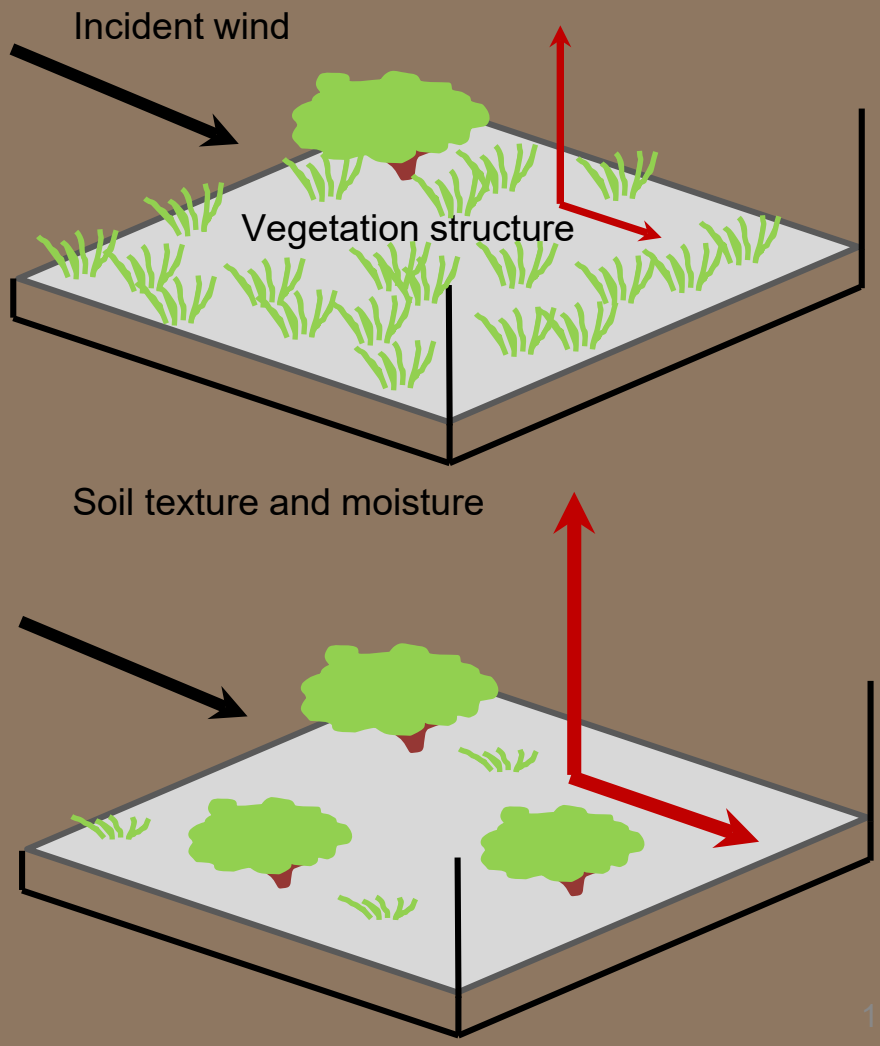
- Observed changes in annual precipitation are more variable, but annual drying trends have been observed for much of the Southwest
- In general, drying in the Southwest has been observed during spring and summer
- Projections for annual precipitation by the mid-21st century under RCP8.5 are more uncertain than for temperature but suggest continued drying, with drier winters and springs but wetter summers.
- Surface winds in the US have declined by ~10% over the last 30 years
- Patterns of seasonal wind-speed projections for mid-century are consistent with these evaluations but highly uncertain

Potential Impacts on Wind Erosion

- Projected changes in atmospheric CO_2 concentration, temperature, and precipitation will likely impact vegetation production, cover, and community composition in the Southwest
  - Coupled warming and drying trends in the Southwest will likely reduce overall net primary production, reducing vegetation cover, and could favor shifts to more woody species
  - Increased variability in precipitation also decreases overall ecosystem productivity and promotes shrub productivity at the expense of grasses, which could lead to shrub-grass transitions
  - Susceptibility to extreme events

Potential Impacts on Wind Erosion

- Wind erosion frequency and magnitude depend on the degree of soil exposure to the wind field, which is largely controlled by vegetation cover and community structure
- Decreases in overall cover and transitions from high-cover grasses to shrubs with bare interspaces effectively increase long-term vulnerability to wind erosion
- Increased frequency of convective storms could also increase the frequency of dust-related hazards



Management Considerations

- Given current vulnerability and uncertainty regarding future trajectories of vegetation cover and community structure, potential impacts of climate change on wind erosion should be explicitly considered in management decisions

- Management options to limit wind erosion are largely similar to those to address other disturbances, such as drought, fire, invasive species, and shrub encroachment

- Implementing active, planned management now that has multiple benefits, including for mitigating erosion, will very likely increase resilience and adaptability in the future

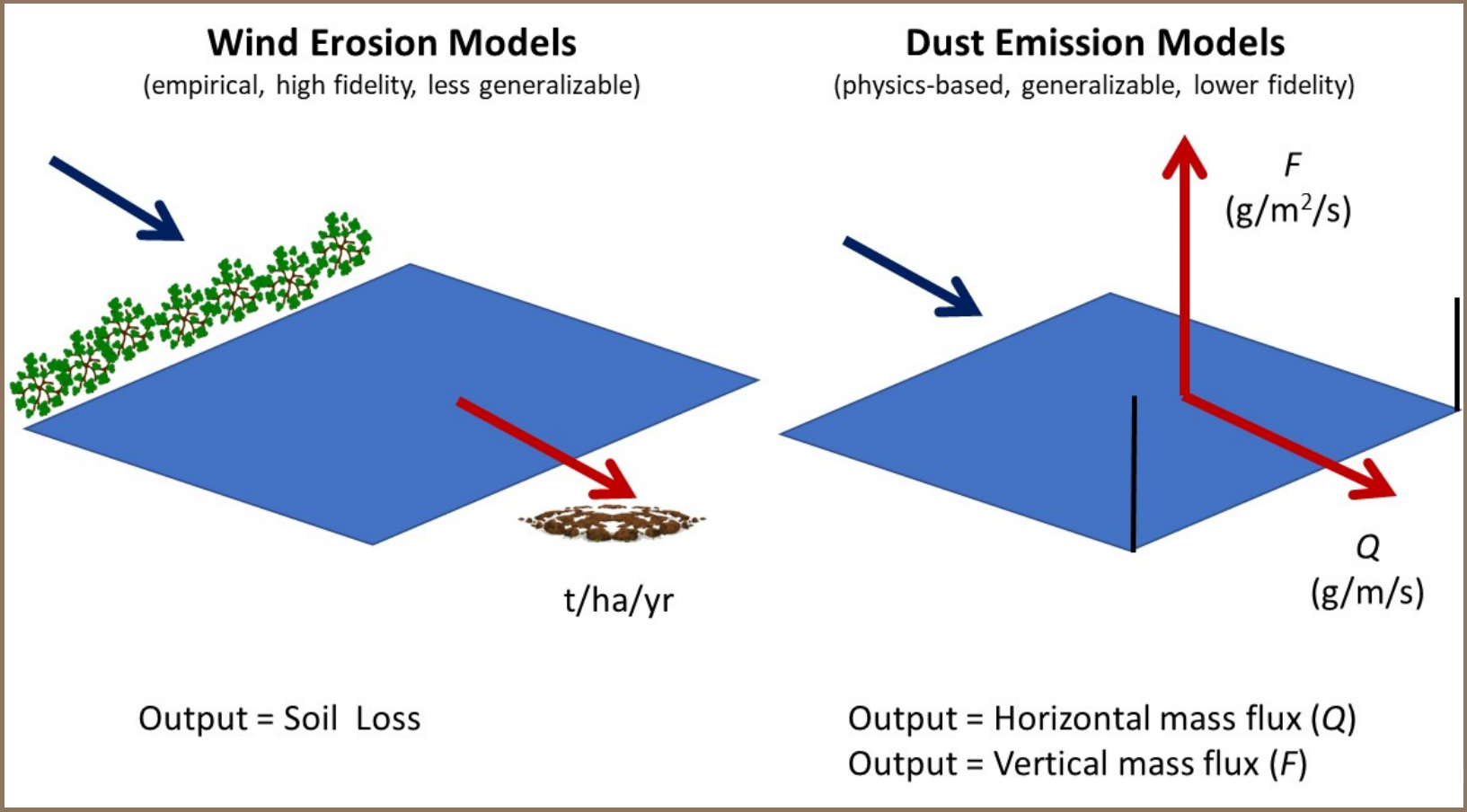
Chapter 3 – Wind Erosion Models

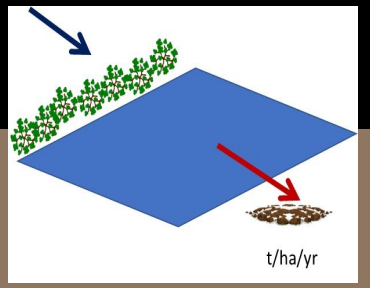
Nick Webb – Jornada Experimental Range

- Why use wind erosion models and what they estimate.
- Wind Erosion Equation (WEQ).
- Wind Erosion Prediction System (WEPS).
- Aeolian Erosion (AERO) model.

Why use wind erosion models?

- Obtain estimates of soil loss and sediment transport for ecological sites.
- Evaluate impacts of management practices.
- Inform selection of practices.





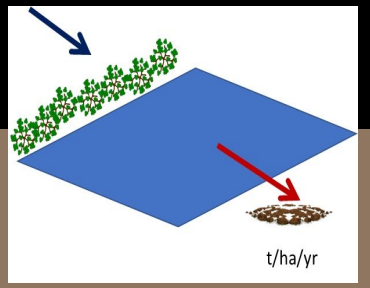
Wind Erosion Equation (WEQ)

The WEQ was published in 1965 to estimate soil loss by wind from agricultural fields.

Soil loss E= f(I,K,C,L,V)

where E is the average soil loss (tons/acre/year), I is the soil erodibility, K is the soil ridge roughness, C is the climatic factor, L is the field length along the prevailing wind erosion direction, V is the vegetative factor.

- Application limited to agricultural fields.
- Not physically based -> less generalizable.
- Does not represent effects of soil properties that are dynamic.

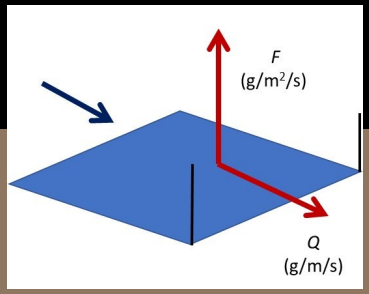


Wind Erosion Prediction System

- WEPS is a process-based, daily time-step model.
- Simulates weather, field conditions and soil loss by wind erosion.
- Relationships for surface conditions and erosion developed from field and laboratory studies.

- Includes sub-models for hydrology, crop growth and dynamic soil properties.
- Represents management practices.
- Enables users to test scenarios and evaluate practice effectiveness in reducing wind erosion.

- Applications currently limited to croplands.



Aeolian Erosion (AERO) model

- Available cropland wind erosion models (e.g., WEPS) do not currently extend to rangeland applications.

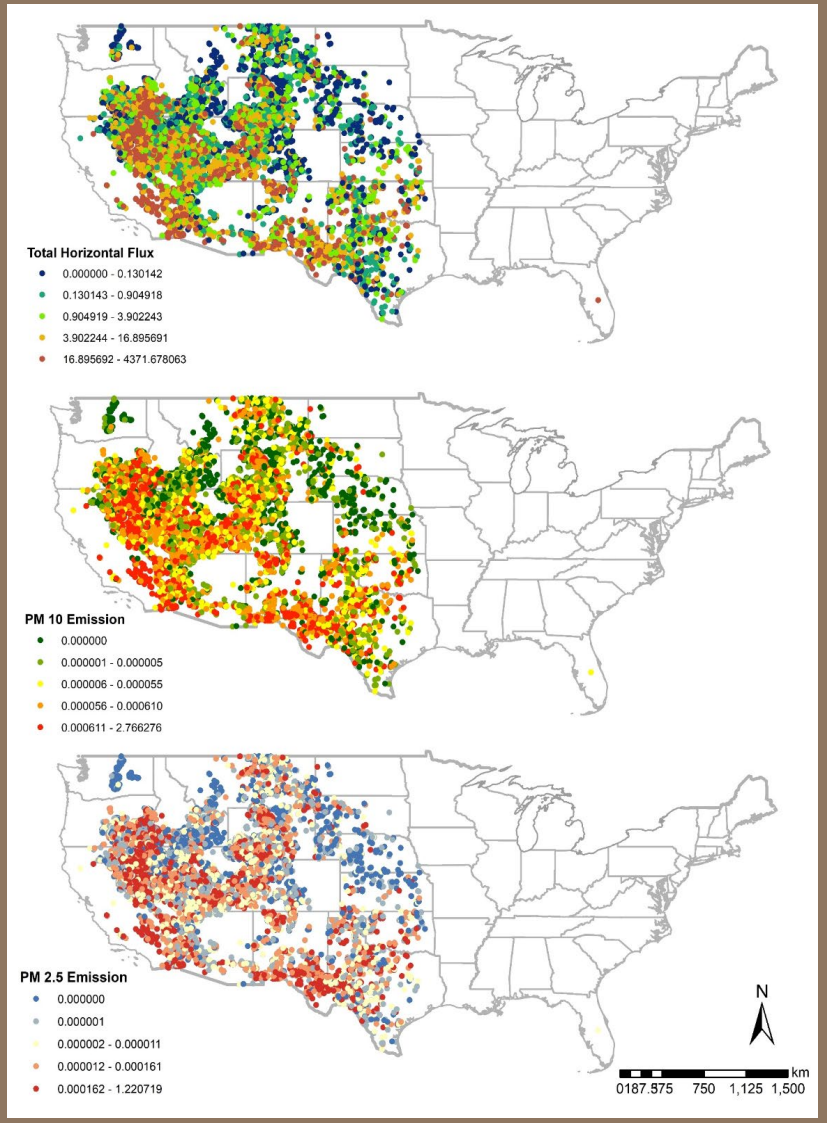
- AERO was developed from a selection of the best-available physics-based schemes to represent first-order controls on sediment transport and dust emission processes.

- Criteria for scheme selection included:

  1. High level of process fidelity.
  2. Low model complexity.
  3. Application to available soil and ecological monitoring data collected by the NRCS National Resources Inventory (NRI) and BLM Assessment, Inventory and Monitoring (AIM) programs.

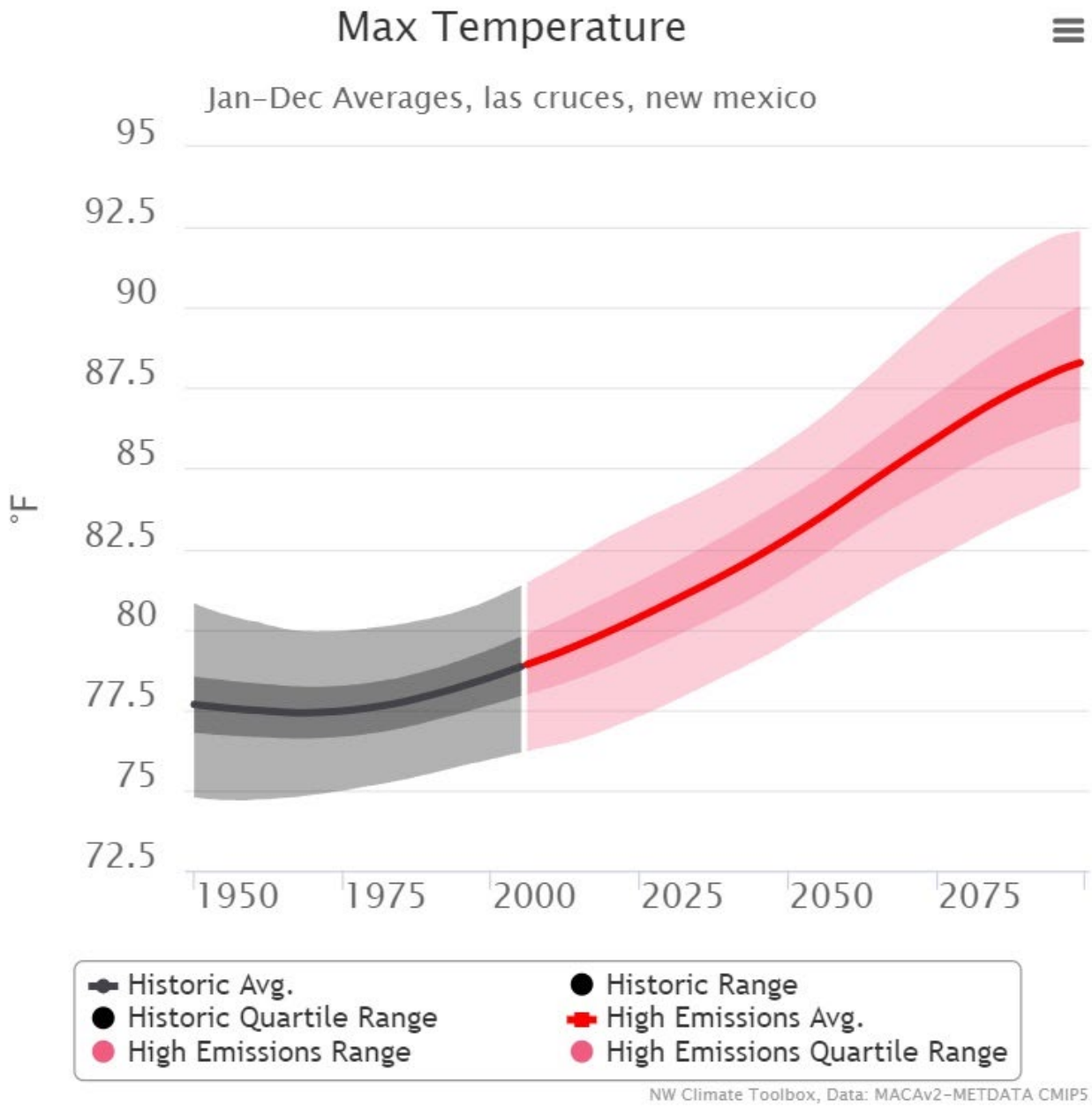
Aeolian Erosion (AERO) model

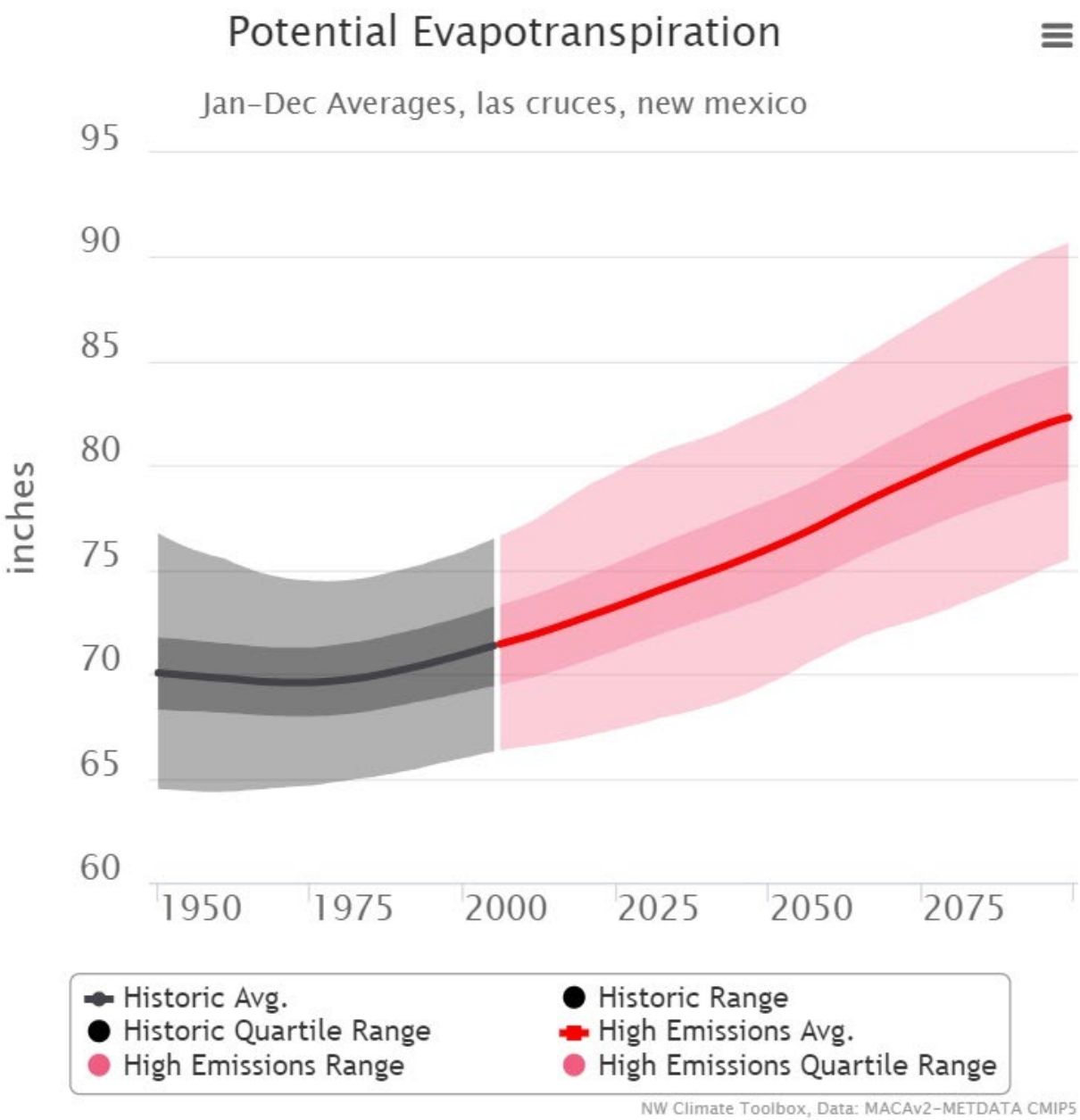
- AERO can be implemented in a time-series mode, probabilistic mode, and as a spatial model connected to a numerical weather model.
- Plot-scale estimates (NRI, AIM) will be integrated with ESDs in EDIT.
- Relate indicators of wind erosion to other indicators of ecosystem services and function to identify tolerable erosion amounts and responses to management.



Chapter 4
Measuring Airborne Particulates

- How airborne particulates are measured
- How the information can be used
- Links to sites where the information can be retrieved
  - US Environmental Protection Agency (EPA) Interactive Map of Air Quality Monitors.
  - IMPROVE Program data portal
  - National Wind Erosion Research Network


Max Temperature
Jan–Dec Averages, las cruces, new mexico
95
92.5
90
87.5
85
82.5
80
77.5
75
72.5
°F
1950
1975
2000
2025
2050
2075
Historic Avg.
Historic Range
Historic Quartile Range
High Emissions Avg.
High Emissions Range
High Emissions Quartile Range
NW Climate Toolbox, Data: MACAv2-METDATA CMIP5


Potential Evapotranspiration
Jan–Dec Averages, las cruces, new mexico
inches
95
90
85
80
75
70
65
60
1950
1975
2000
2025
2050
2075
Historic Avg.
Historic Range
Historic Quartile Range
High Emissions Avg.
High Emissions Range
High Emissions Quartile Range
NW Climate Toolbox, Data: MACAv2-METDATA CMIP5

To put into context:

- Some vegetation types will not survive in their existing environments
- Some seeds will lose their viability
- Some adventitious plants may invade
- Some soil microfauna will not survive
- Naturalized pasture may require planting of new varieties
- Ecosystem collapse may occur?


DUST CONTROL
Arizona Department of Environmental Quality - PROJECT #1
EarthCare Consultants, LLC
Responsible Individual
MARTY KOETHER (520) 449-3832
Dust Complaints: Call Pinal County Air Quality (520) 866-6929

Extended Drought

Large areas of Navajo, Apache and Coconino Counties were in D4 drought status for nearly a year, resulting in die-off perennial herbaceous vegetation.

Idle Cropland

- Realization that surface and groundwater supplies are finite
- Temporary fallow
- Long-term fallow
- Permanently abandoned

Chapter 5
Conservation Planning

- **Introduction to Conservation Planning**
- **Assessing Wind Erosion and Particulate Emissions**
- **Inventory the Resources**
- **Formulating and Evaluating Alternatives**
- **Analyzing Effects of Conservation Practices and Alternatives**

Introduction to Conservation Planning

1. Identify problems and opportunities
2. Determine objectives
3. Inventory the natural resources
4. Analyze the resource data
5. Formulate alternatives
6. Evaluate the alternatives
7. Make decisions
8. Implement the plan
9. Evaluate the implemented plan

Assessing Wind Erosion Resource Concern

- Cropland- assessing level of cover
  - Perennial cover, residue cover, tillage intensity
  - Wind Erosion Prediction System (WEPS)
  - Observation of aeolian deposits on fence rows, ditches, etc.
- Rangeland
  - Range Health Assessment

Inventory the Resources

- Soils
- Web Soil Survey
  - Wind Erodibility Group (WEG)
  - Wind Erosion Index (WEI)
  - Ecological Site Description
- Utilize WEPS to evaluate existing condition on cropland
  - Collect field data, tillage, irrigation schedule, crops grown, etc.
- Conduct Range Health Assessment

- WEG
  - Groups 1 thru 8, where 1 has a severe potential for wind erosion and 8 has no potential.
- WEI
  - Represents potential of wind erosion in tons/ac/year

Part 618 – Soil Properties and Qualities

Subpart B – Exhibits

618.95 Wind Erodibility Groups (WEG) and Index

WEG [1,3,4,5,7]	Properties of Soil Surface Layer	Dry Soil Aggregates More Than 0.84 mm (wt.%)	Wind Erodibility Index (I) (tons/ac/yr)
1	Very fine sand, fine sand, sand, or coarse sand[2]	1 2 3 5 7	310 250 220 180 160
2	Loamy very fine sand, loamy fine sand, loamy sand, and loamy coarse sand; very fine sandy loam and silt loam with 5 or less percent clay and 25 or less percent very fine sand; and sapric soil materials (as defined in *Soil Taxonomy*), except Folists.	10	134
3	Very fine sandy loam (but does not meet WEG criterion 2), fine sandy loam, sandy loam, and coarse sandy loam; noncalcareous silt loam that has greater than or equal to 20 to less than 50 percent very fine sand and greater than or equal to 5 to less than 12 percent clay.	25	86
4	Clay, silty clay, noncalcareous clay loam that has more than 35 percent clay and noncalcareous silty clay loam that has more than 35 percent clay; all of these do not have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high iron oxide content).	25	86
4L	Calcareous[6] loam, calcareous silt loam, calcareous silt, calcareous sandy clay, calcareous sandy clay loam, calcareous clay loam, and calcareous silty clay loam.	25	86
5	Noncalcareous loam that has less than 20 percent clay; noncalcareous silt loam with greater than or equal to 5 to less than 20 percent clay (but does not meet WEG criterion 3); noncalcareous sandy clay loam; noncalcareous sandy clay; and hemic soil materials (as defined in *Soil Taxonomy*).	40	56
6	Noncalcareous loam and silt loam that have greater than or equal to 20 percent clay; noncalcareous clay loam and noncalcareous silty clay loam that have less than or equal to 35 percent clay; silt loam that has parasesquic, ferritic, or kaolinitic mineralogy (high iron oxide content).	45	48
7	Noncalcareous silt; noncalcareous silty clay, noncalcareous silty clay loam, and noncalcareous clay that have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high content of iron oxide) and are Oxisols or Ultisols; and fibric soil materials (as defined in *Soil Taxonomy*).	50	38
8	Soils not susceptible to wind erosion due to rock and pararock fragments at the surface and/or wetness; and Folists.	--	0

Formulating and Evaluating Alternatives

- Utilize resource guides found in Section III of the Field Office Technical Guide (FOTG) to determine practices that address the resource concern.
- Consider the following resource concerns
  - Soil Erosion- Wind
  - Air Quality- Particulate Matter emissions
- Consult Conservation Practice list for appropriate practices acceptable to land user

Analyzing Effects of Conservation Practices and Alternatives

- Conservation Practice Physical Effects (CPPE)

Effects Quantification	Rating
Substantial Improvement	5
Moderate to Substantial Improvement	4
Moderate Improvement	3
Slight to Moderate Improvement	2
Slight Improvement	1
Not Applicable	0
Neutral	0
Slight Worsening	–1
Slight to Moderate Worsening	–2
Moderate Worsening	–3
Moderate to Substantial Worsening	–4
Substantial Worsening	–5

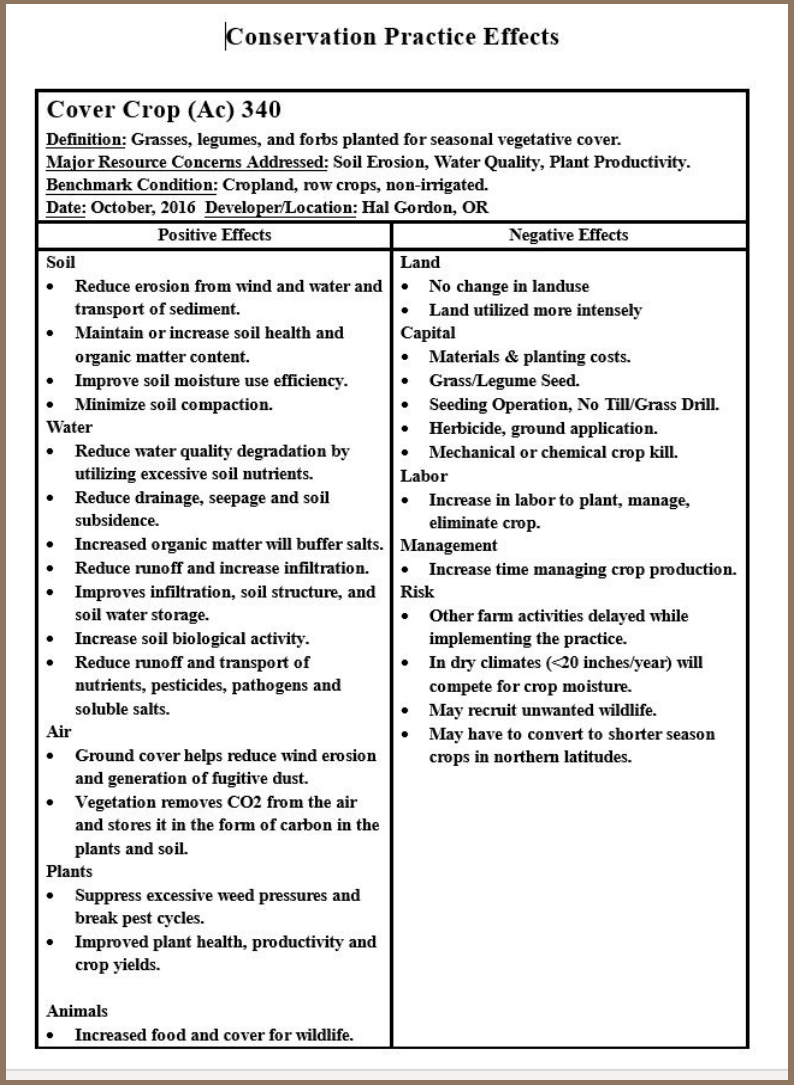
Figure 5-1. Conservation Practice Physical Effects (CPPE) ratings.[50]

Analyzing Effects of Conservation Practices and Alternatives

- Utilize the CPPE database to assess relative effectiveness of each practice's ability to address wind erosion or particulate matter emissions.
- Or alternatively, use the RMS Planning Tool. This tool auto-searches the database for practices that address resource concerns with corresponding CPPE value.

Analyzing Effects of Conservation Practices and Alternatives

- Utilize T-charts developed for each practice to analyze positive/negative effect.
- Use as talking points with land user



Conservation Practice Effects

Cover Crop (Ac) 340

Definition: Grasses, legumes, and forbs planted for seasonal vegetative cover.
Major Resource Concerns Addressed: Soil Erosion, Water Quality, Plant Productivity.
Benchmark Condition: Cropland, row crops, non-irrigated.
Date: October, 2016 **Developer/Location:** Hal Gordon, OR

Positive Effects	Negative Effects
Soil • Reduce erosion from wind and water and transport of sediment. • Maintain or increase soil health and organic matter content. • Improve soil moisture use efficiency. • Minimize soil compaction. **Water** • Reduce water quality degradation by utilizing excessive soil nutrients. • Reduce drainage, seepage and soil subsidence. • Increased organic matter will buffer salts. • Reduce runoff and increase infiltration. • Improves infiltration, soil structure, and soil water storage. • Increase soil biological activity. • Reduce runoff and transport of nutrients, pesticides, pathogens and soluble salts. **Air** • Ground cover helps reduce wind erosion and generation of fugitive dust. • Vegetation removes CO2 from the air and stores it in the form of carbon in the plants and soil. **Plants** • Suppress excessive weed pressures and break pest cycles. • Improved plant health, productivity and crop yields. **Animals** • Increased food and cover for wildlife.	**Land** • No change in landuse • Land utilized more intensely **Capital** • Materials & planting costs. • Grass/Legume Seed. • Seeding Operation, No Till/Grass Drill. • Herbicide, ground application. • Mechanical or chemical crop kill. **Labor** • Increase in labor to plant, manage, eliminate crop. **Management** • Increase time managing crop production. **Risk** • Other farm activities delayed while implementing the practice. • In dry climates (<20 inches/year) will compete for crop moisture. • May recruit unwanted wildlife. • May have to convert to shorter season crops in northern latitudes.

Chapter 6- Dust Mitigation on Cropland

NRCS Practice Name and Practice Code	CPPE Value for Wind Erosion
Alley Cropping 311	5
Amending Soil Properties with Gypsum Products 333	1
Conservation Cover 327	4
Conservation Crop Rotation 328	4
Cover Crop 340	4
Critical Area Planting 342	5
Cross Wind Ridges 588	4
Cross Wind Trap Strips 589C	4
Field Border 386	4
Field Operations Emissions Reduction 376	4
Hedgerow Planting 422	1
Herbaceous Wind Barriers 603	4
Mulching 484	4
Multi-Story Cropping 379	1
Residue and Tillage Management, No-till 329	5
Residue and Tillage Management, Reduced Till 345	4
Stripcropping 585	4
Surface Roughening 609	3
Vegetative Barrier 601	1
Windbreak/Shelterbelt Establishment 380	5

Dust Mitigation on Cropland

- Interrupt creep and saltation processes
- Slow down the wind at the soil surface
- Divert wind flow

By:

- Reducing soil disturbance
- Binding the soil particles together
- Keeping the soil surface covered
- Increasing surface friction- roughness
- Creating barriers to wind

Top Seven Practices

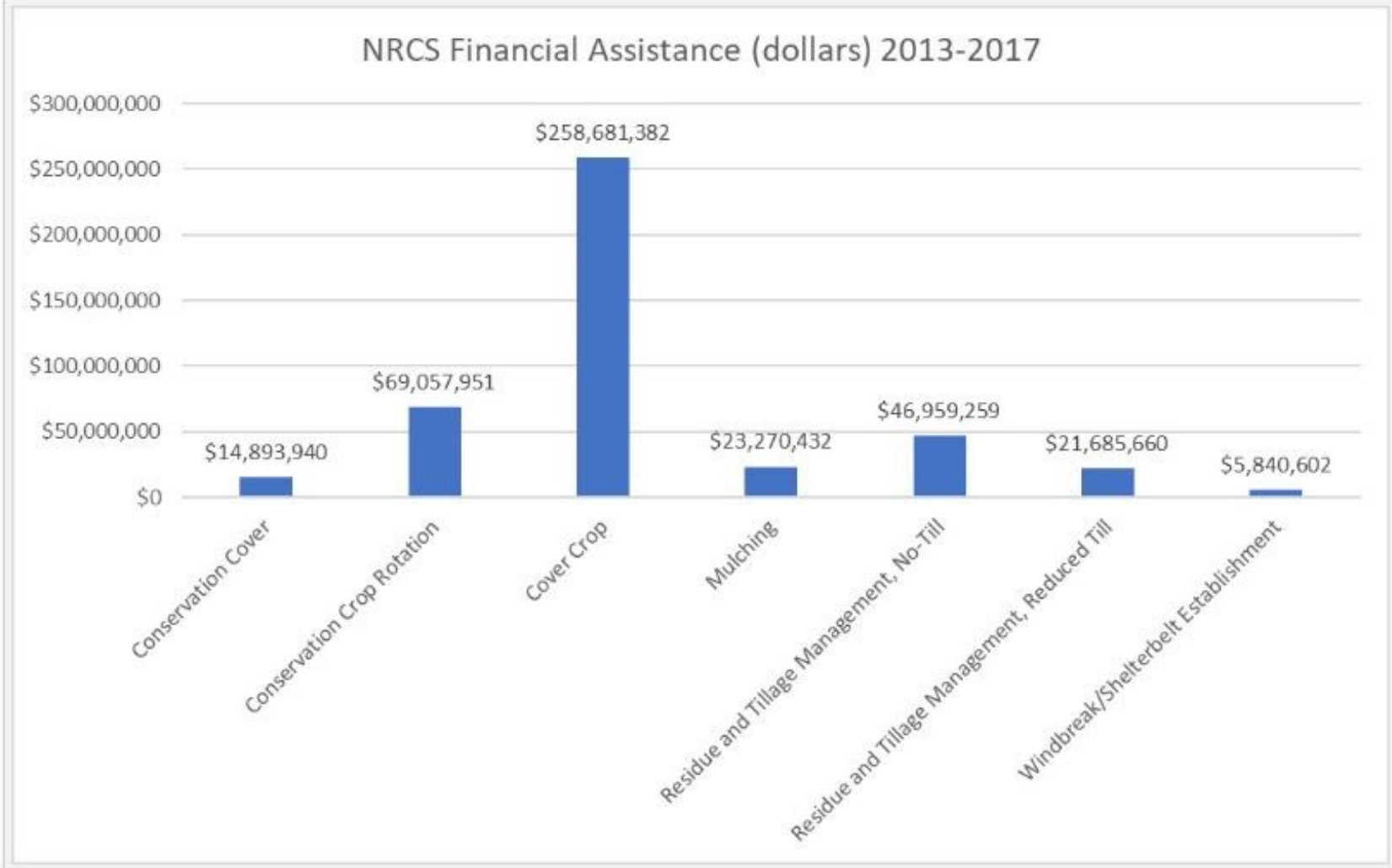


Figure 6-2. NRCS Financial assistance dollars spent on practices used to address wind erosion on cropland.

Next set (8-16)

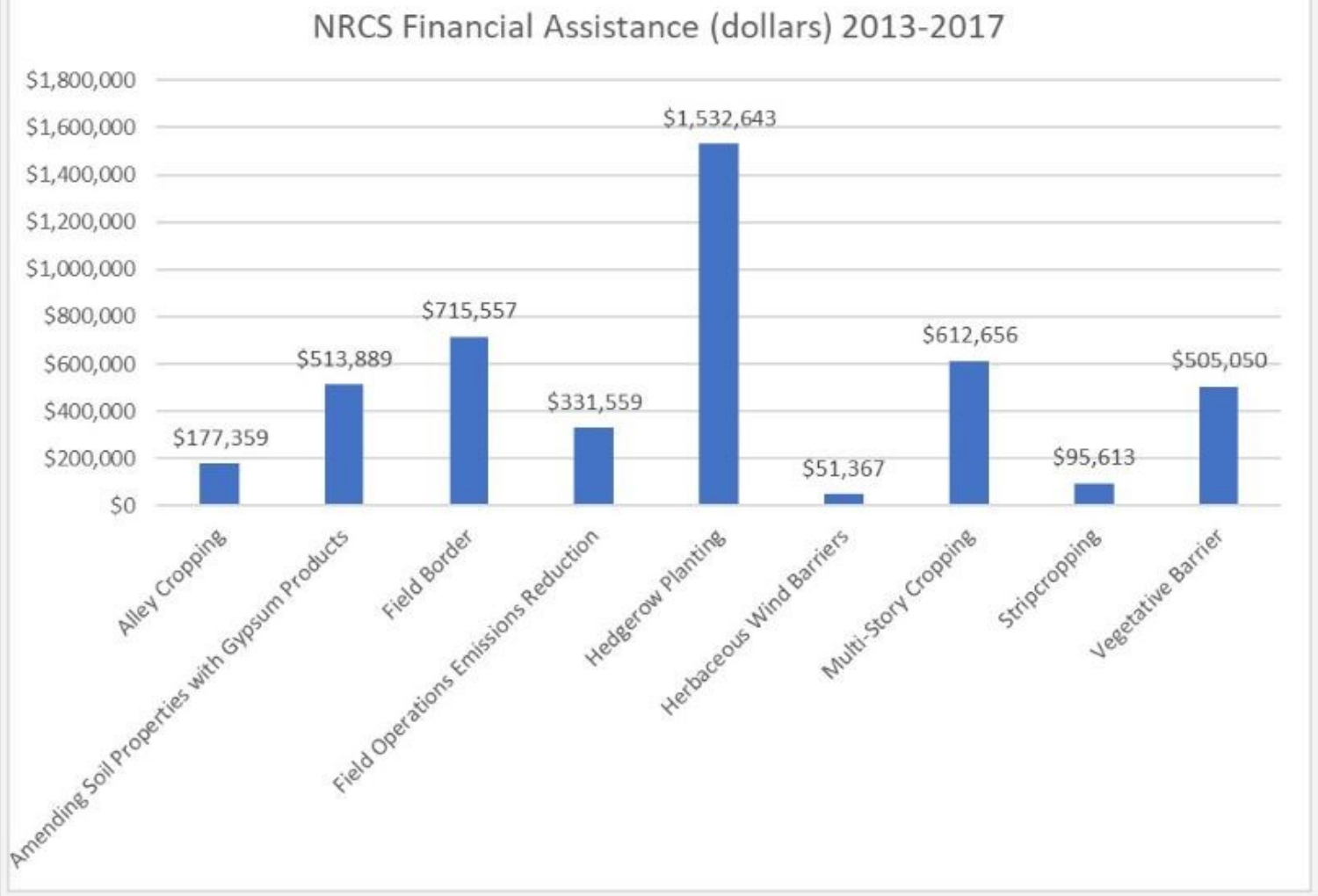
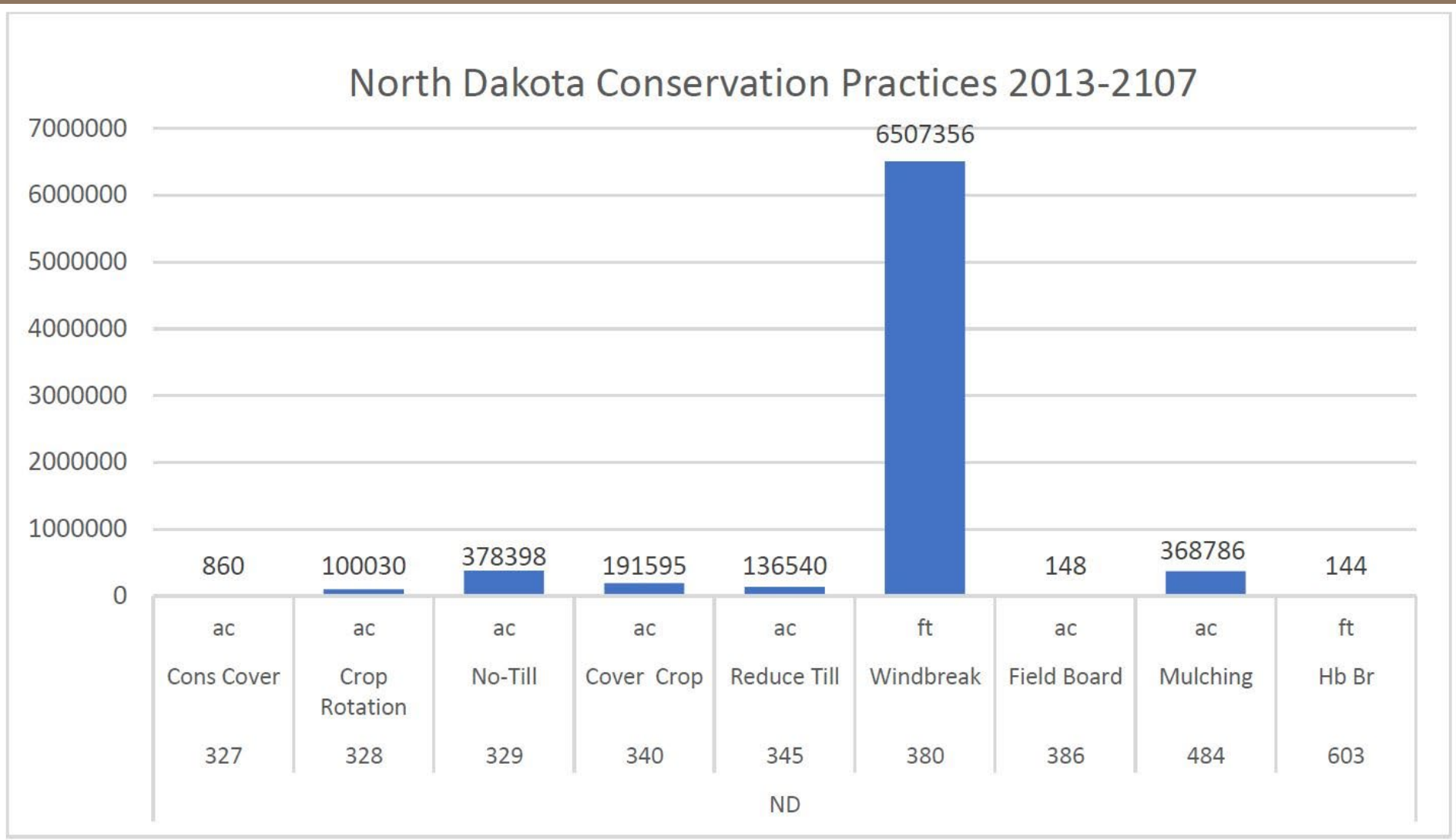
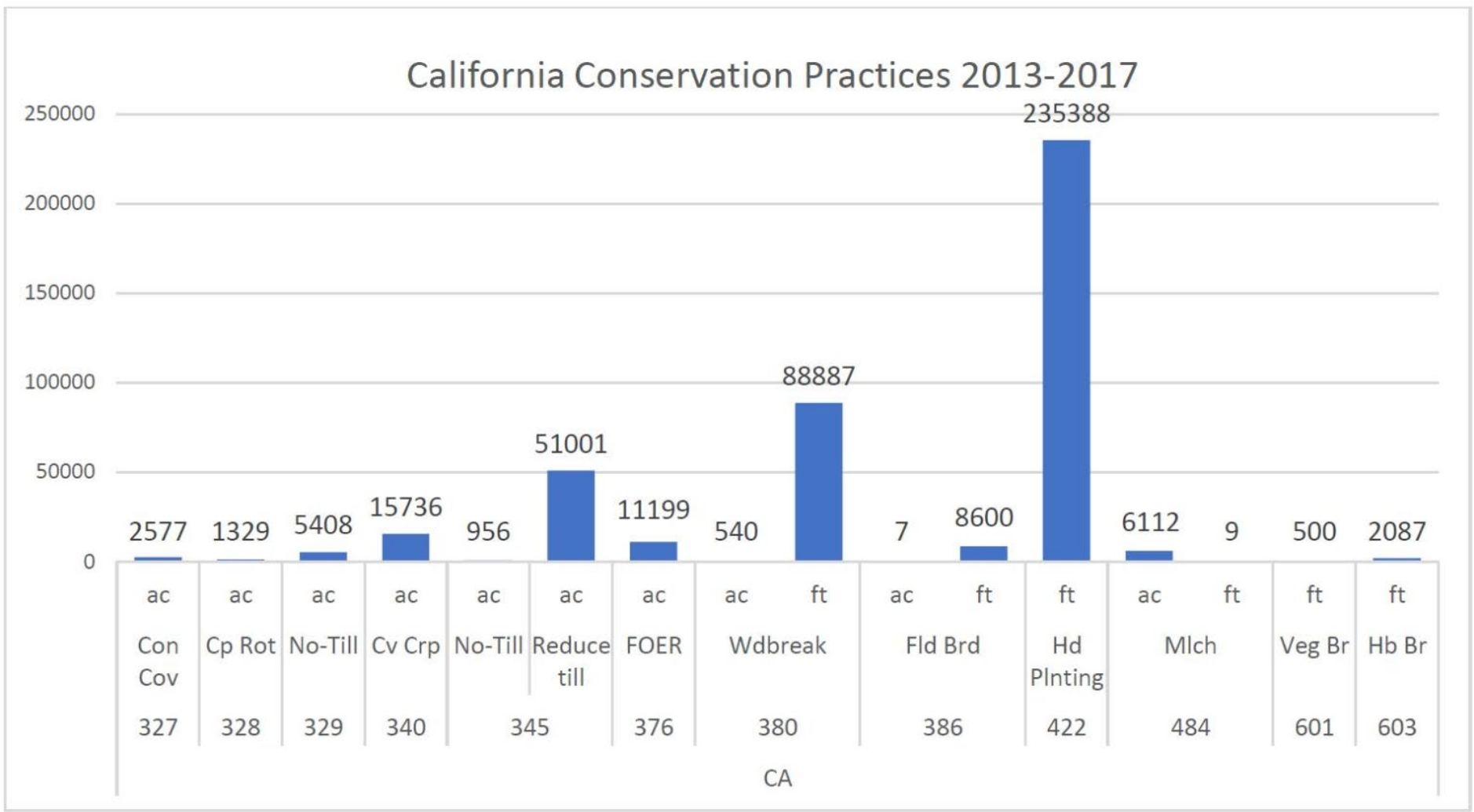


Figure 6-4. NRCS Financial assistance dollars spent on practices used to address wind erosion on cropland.

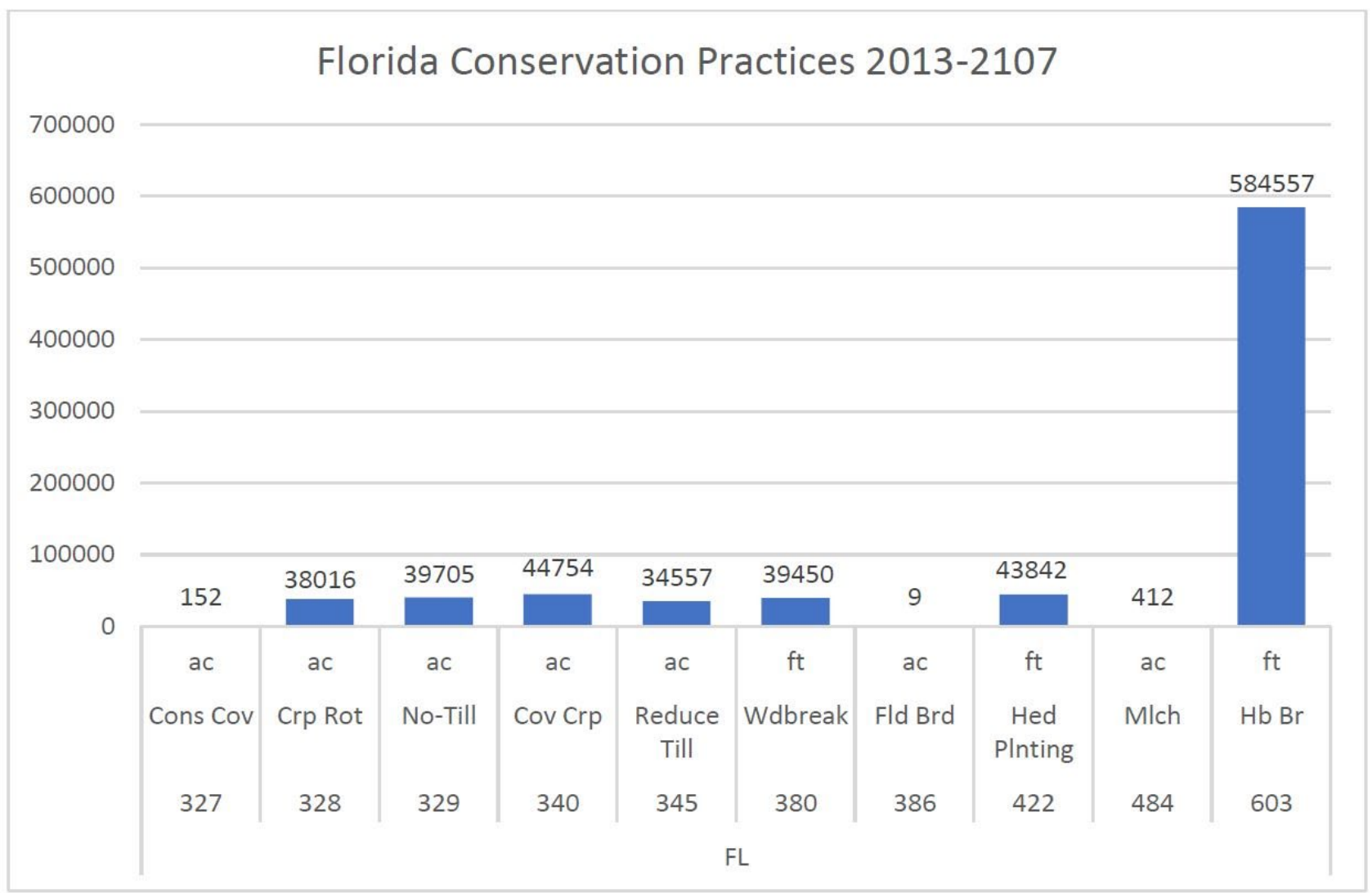
State Specific Graphs in Appendix B



State Specific Graphs in Appendix B



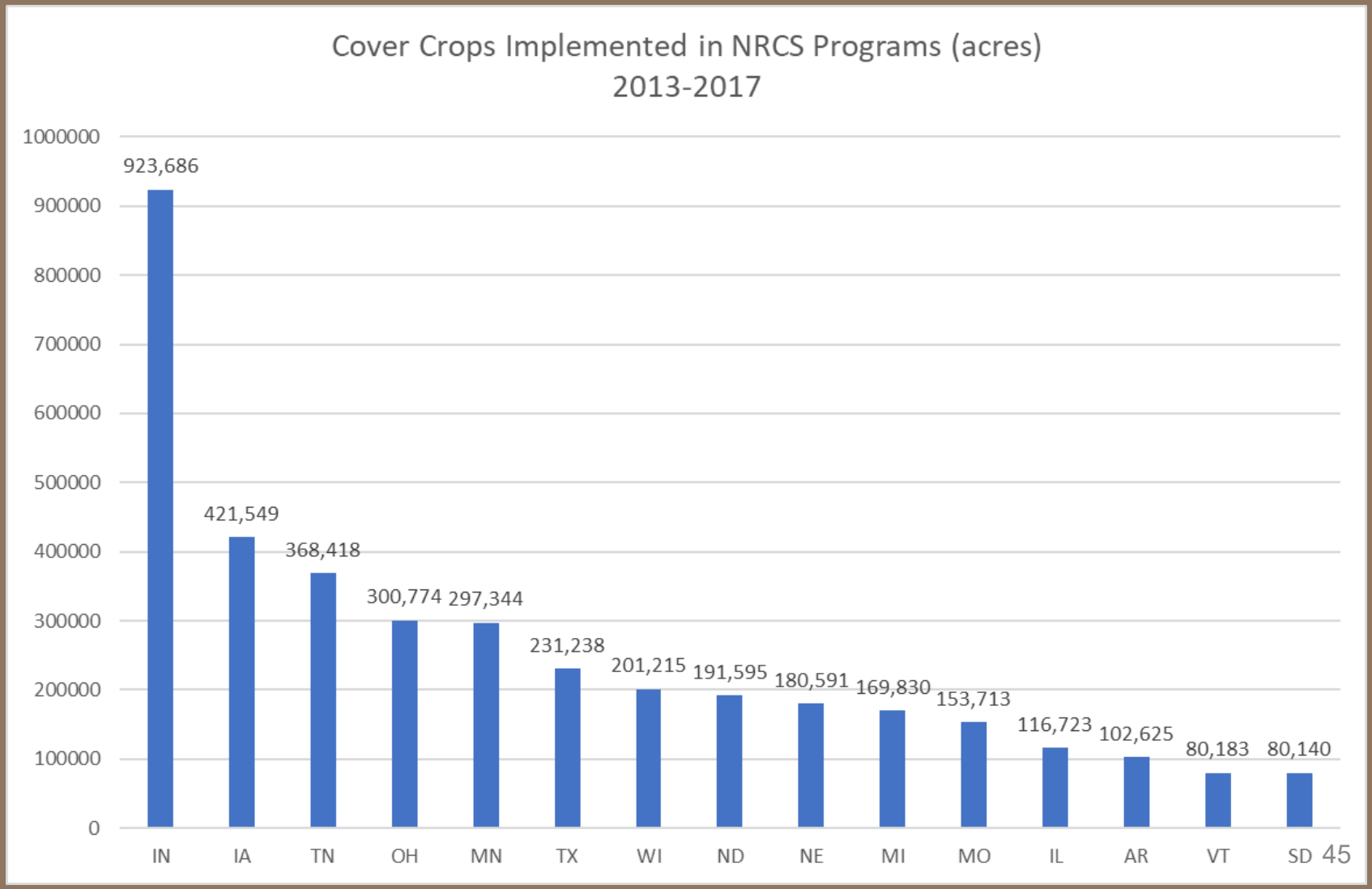
State Specific Graphs in Appendix B



Conservation Practices- Cropland

- Definition and description of each practice
- Hints on how best to implement the practice
- Links to pertinent guides
- Photographs of practice
- Graphs depicting top states that implement the practice

Practice Graphs



Practice Graphs

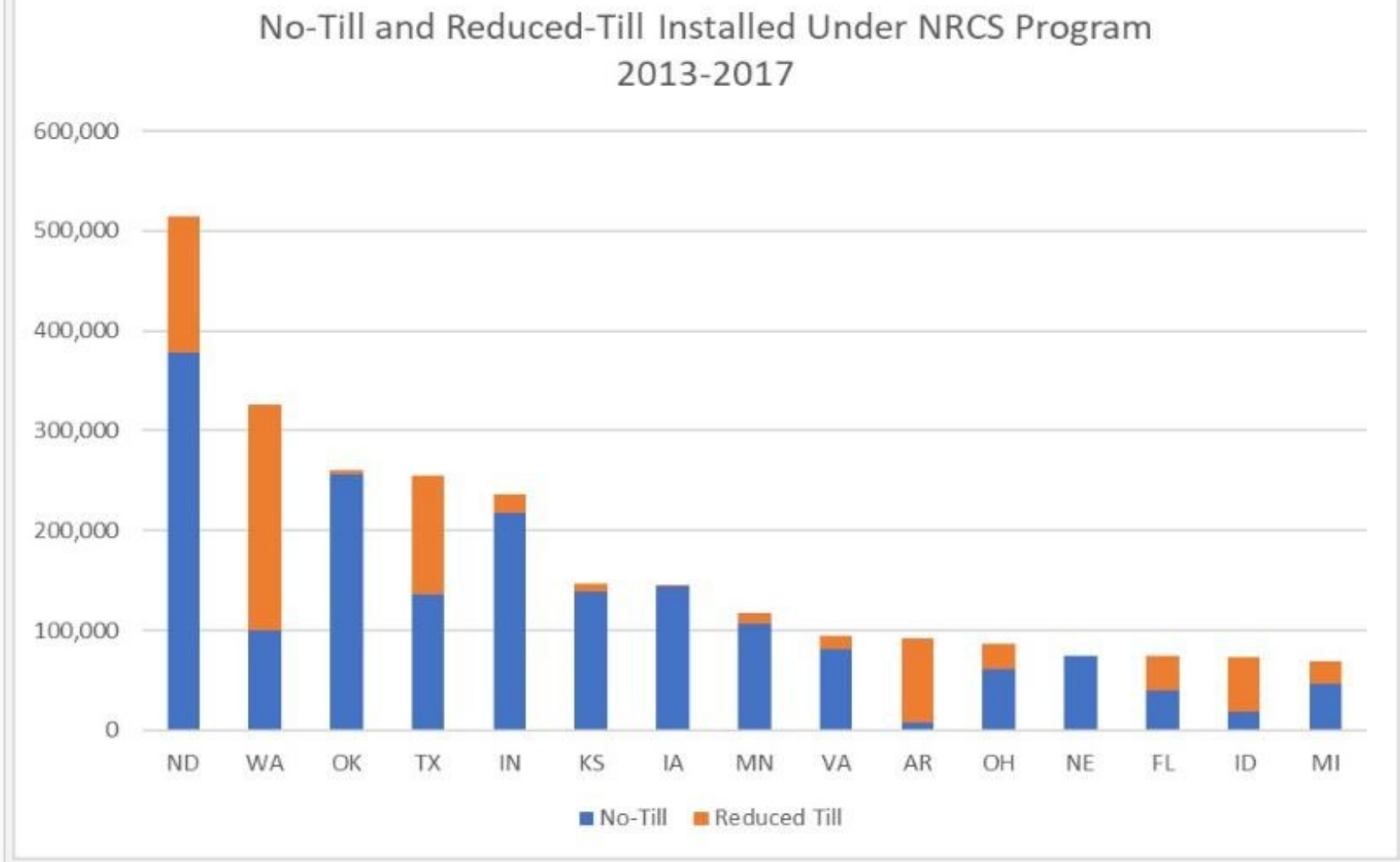


Figure 6-12. Top 15 States (by acres installed) installing Residue Management Practices during 2013-2017.

So why all the graphs?

- Gives farmers, ranchers and conservation practitioners a glimpse of what works in their state
- Allows agencies to assess staffing needs/organizational structure based on expertise needed
- States might recognize new opportunities
- Share expertise

Assembling the Plan

- Know the wind direction during critical erosion potential periods
- Wind roses are a graphic tool that displays relative frequency of wind direction and wind speed at a specified location over a specified time period

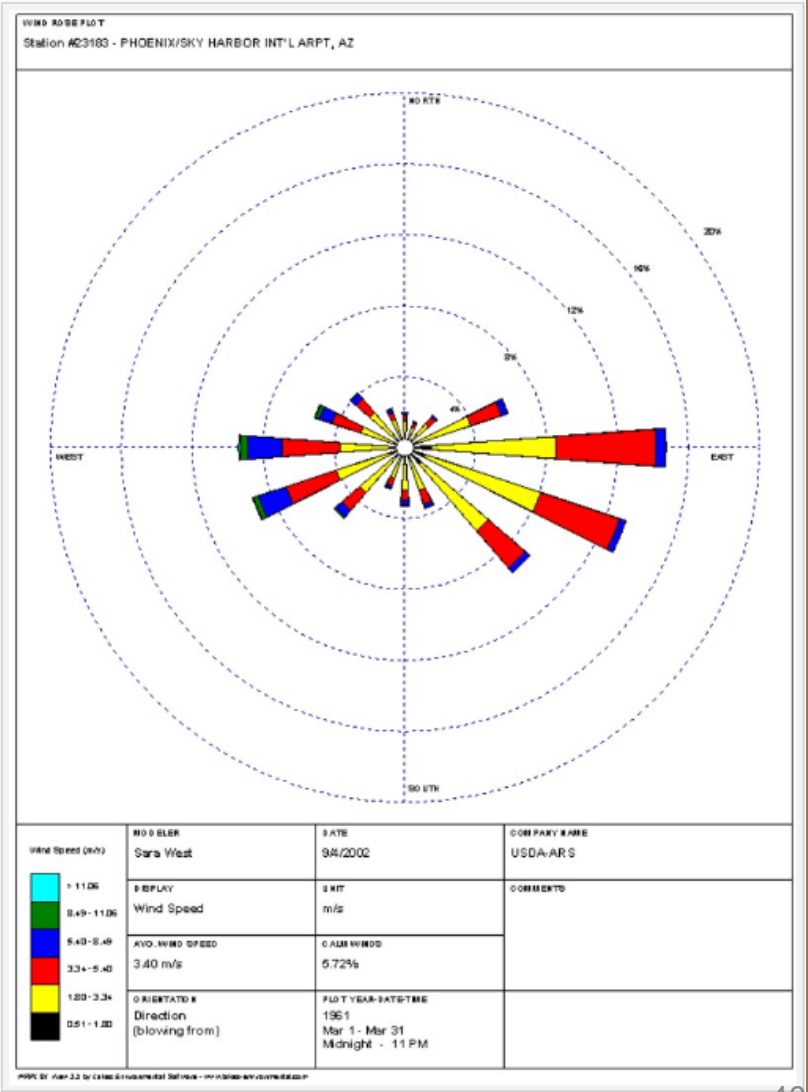
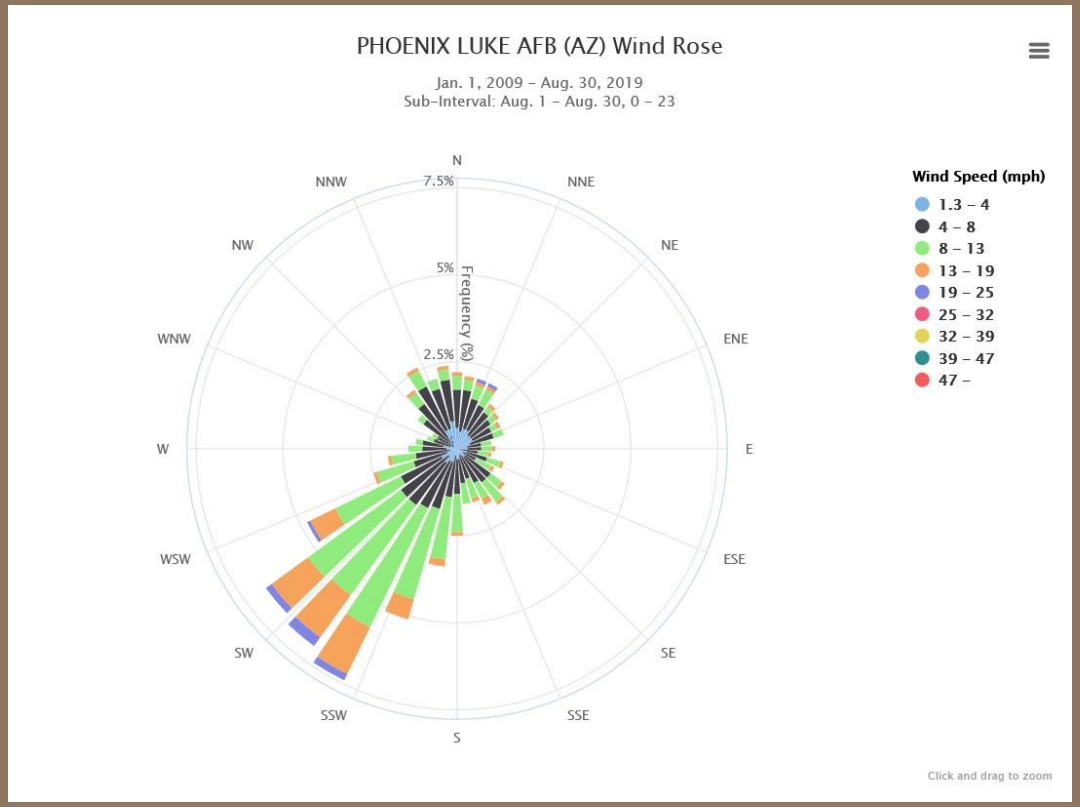


Figure 6-58. Wind rose for Phoenix for the month of March for years 1961-1990.78

Wind Roses

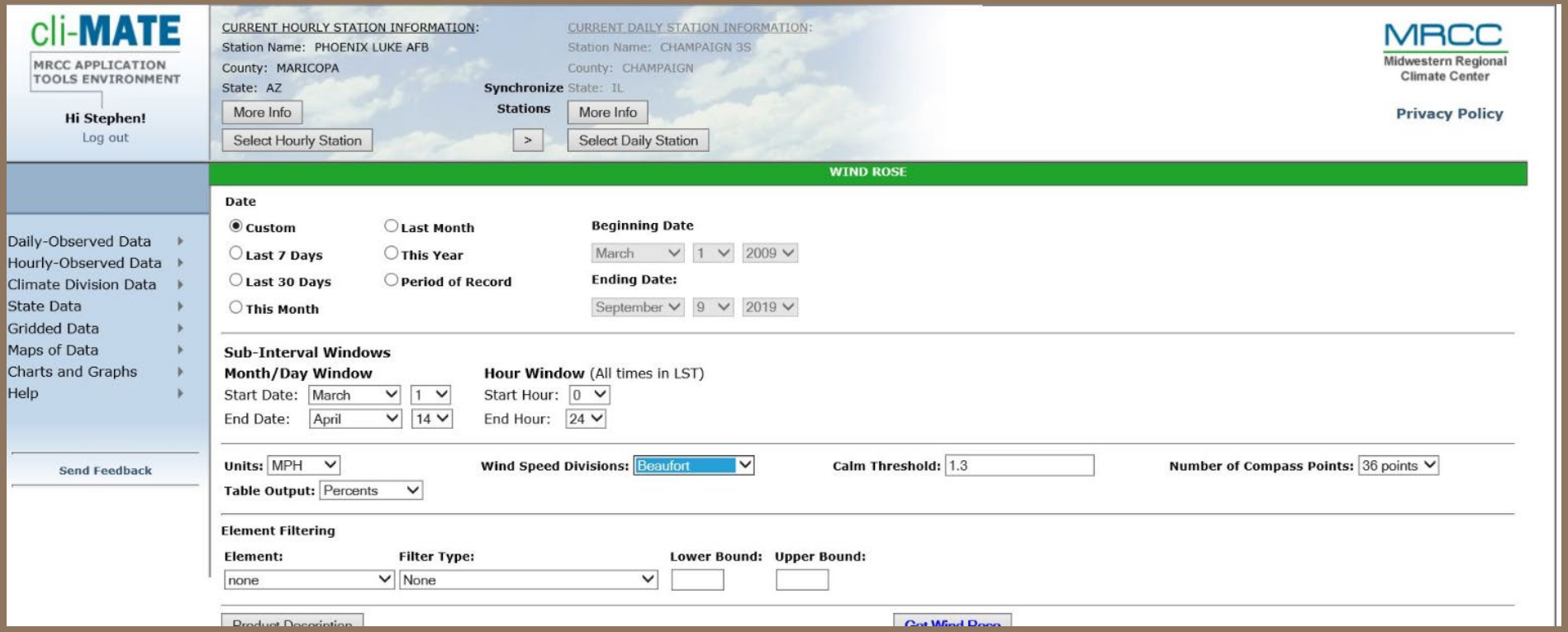
- Alternative site to retrieve wind roses:

https://mrcc.illinois.edu/CLIMATE/



Wind Roses

Superior interface to select weather station, time periods, and other variables



Chapter 7- Dust Abatement on Rangeland, Natural Areas, Unpaved Surfaces

NRCS Practice Name and Practice Code	CPPE Value for Wind Erosion
Access Control 472	1
Anionic Polyacrylamide (PAM) Erosion Control 450	2
Brush Management 314	1
Critical Area Planting 342	5
Dust Control on Unpaved Roads and Surfaces 373	5
Forage and Biomass Planting 512	1
Grazing Land Mechanical Treatment 548	1
Heavy Use Area Protection 561	2
Herbaceous Weed Control 315	4
Land Reclamation, Landslide Treatment 453	2
Prescribed Burning 338	2
Prescribed Grazing 528	4
Range Planting 550	4
Restoration of Rare or Declining Natural Communities 643	2
Riparian Forest Buffer 391	2
Riparian Herbaceous Cover 390	2
Road/Trail/Landing Closure and Treatment 654	1
Silvopasture Establishment 381	3
Trails and Walkways 575	1
Tree/Shrub Establishment 612	5
Water Well 642	2
Watering Facility 614	2

Grazing Lands Practices

- Encouraging robust vegetative growth- Prescribe Grazing
- Providing Cover- Heavy Use Area Protection
- Distributing livestock – Watering facilities
- Limiting traffic- Road/Trail/Landing Closure and Treatment

Grazing Lands Practices

- Practices with inherent risks
- Although practices are meant to encourage vegetative growth there is temporary reduced cover
- Plan practices when there is least chance of dust emissions
- Prescribed Burning
- Brush Management
- Grazing Land Mechanical Treatment

Practice Graphs

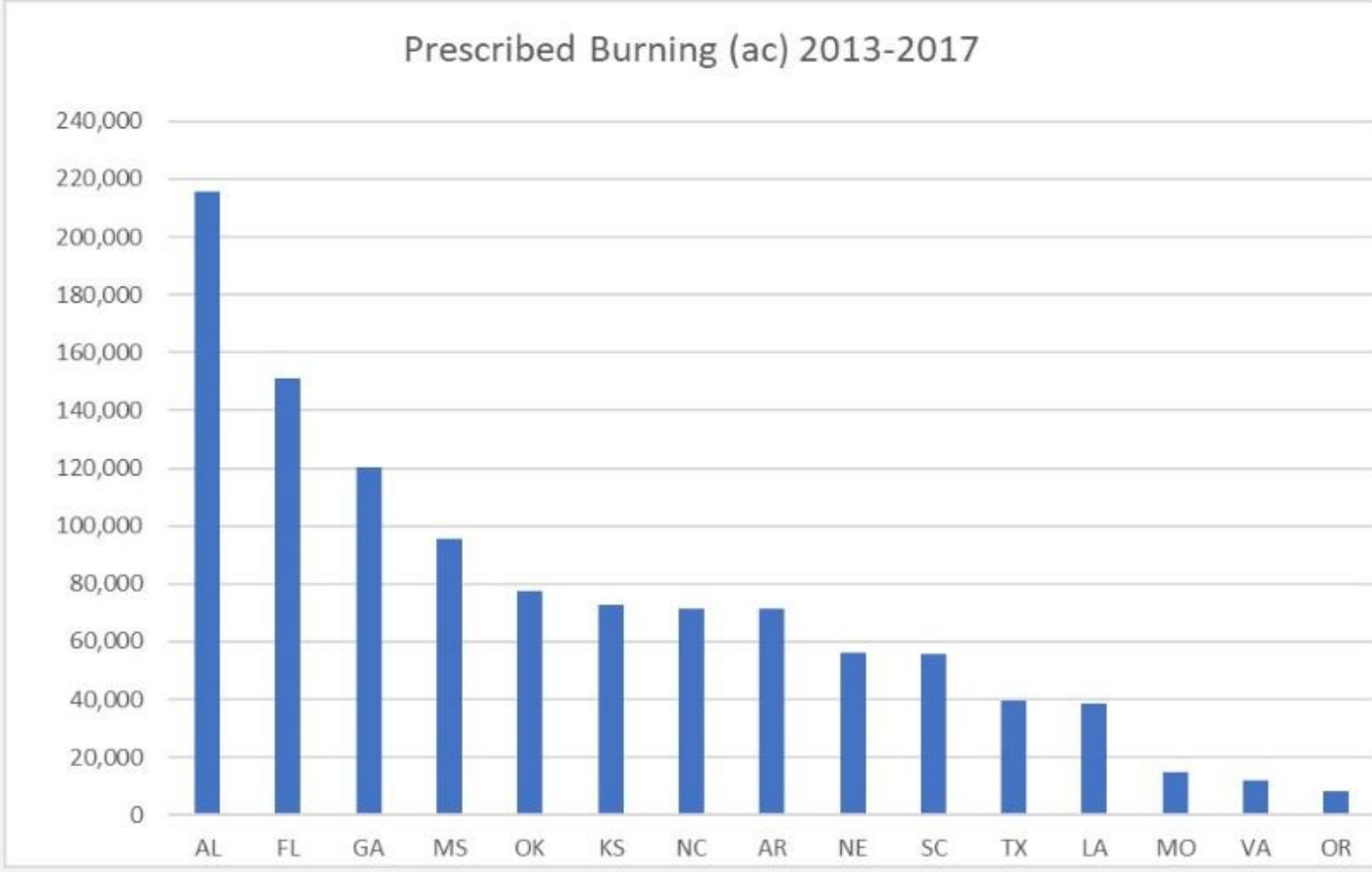


Figure 7-35. Top 15 states (by acres) implementing Prescribed Burning (338) during 2013-2017.

Chapter 8 – USDA Programs

- Highlights programs available to farmers, ranchers, and private forest owners to implement conservation practices
- Focuses on programs of the Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA)
- Information is based on current program regulations but absent of unpublished rule changes brought forth from 2018 Farm Bill

NRCS Programs – Environmental Quality Incentives Program (EQIP)

- All practices discussed in this handbook are available through this program, but maybe not in your state
- Discusses financial assistance available
- Describes Payment Schedules, Payment Rates, Practice Scenarios
- Requirement to follow Conservation Practice Standard and Specifications

NRCS Programs – Conservation Stewardship Program

- Five-year contracts to maintain level of stewardship and improve at least one resource concern
- Practices similar to EQIP but include "enhancements" to practices already applied
- Include bundled enhancements to address a specific resource concern
- Opportunity to renew for another five years
- Must include all ag lands in the operation

NRCS Programs – Regional Conservation Partnership Program (RCPP)

- Partners sponsor / leverage funding to address recognized resource concerns on watershed, landscape or community scale
- Umbrella program that includes EQIP, CSP, Healthy Forest Reserve Program, PL-566 Watershed Authorities, Ag Conservation Easement Program
- 2018 Farm Bill authorizes RCCP funding and three funding pools- state, multi-state, and Critical Conservation Areas

FSA Programs – Conservation Loans

- Loans available to farmers and ranchers to implement practices recommended by NRCS
- Helps pay for up front costs of implementing practices
- Can include wind erosion practices including establishing and improving permanent pastures.

FSA Programs – Conservation Reserve Program (CRP)

- Long-term contracts (10-15 years) to protect environmentally sensitive lands
- Repurposes sensitive ag lands to conservation benefits by providing permanent cover
- Must control soil erosion, improve water quality, and/or reduce loss of wildlife habitat
- Includes a rental payment and cost-share to establish vegetative cover

FSA Programs – Conservation Reserve Enhancement Program (CREP)

- Partner Program
- Requires state agreement/contribution
- 10-15 year contracts similar to CRP requirements

FSA Programs – Emergency Conservation Program (ECP)

- Restoring farmland and conservation structures that have been damaged by natural disasters
- Cannot be used to remedy or address conservation problems that existed before the applicable natural disaster

FSA Programs – Emergency Forest Restoration Program (EFRP)

- Provides financial assistance to eligible owners of nonindustrial private forest (NIPF) land for use in the emergency restoration of land damaged by natural disasters
- Natural disaster must have resulted in damage that if untreated would impair or endanger the natural resources
- Land also must be suitable for growing trees and have had tree cover immediately before the natural disaster

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