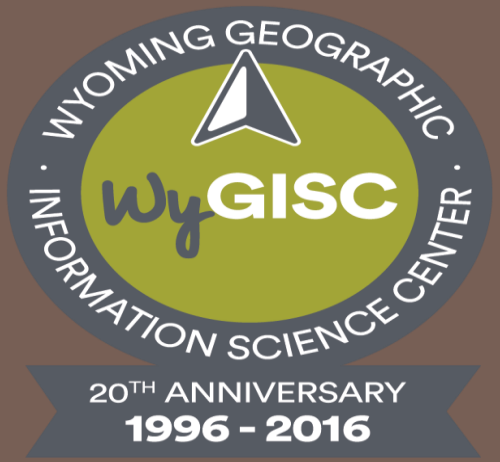
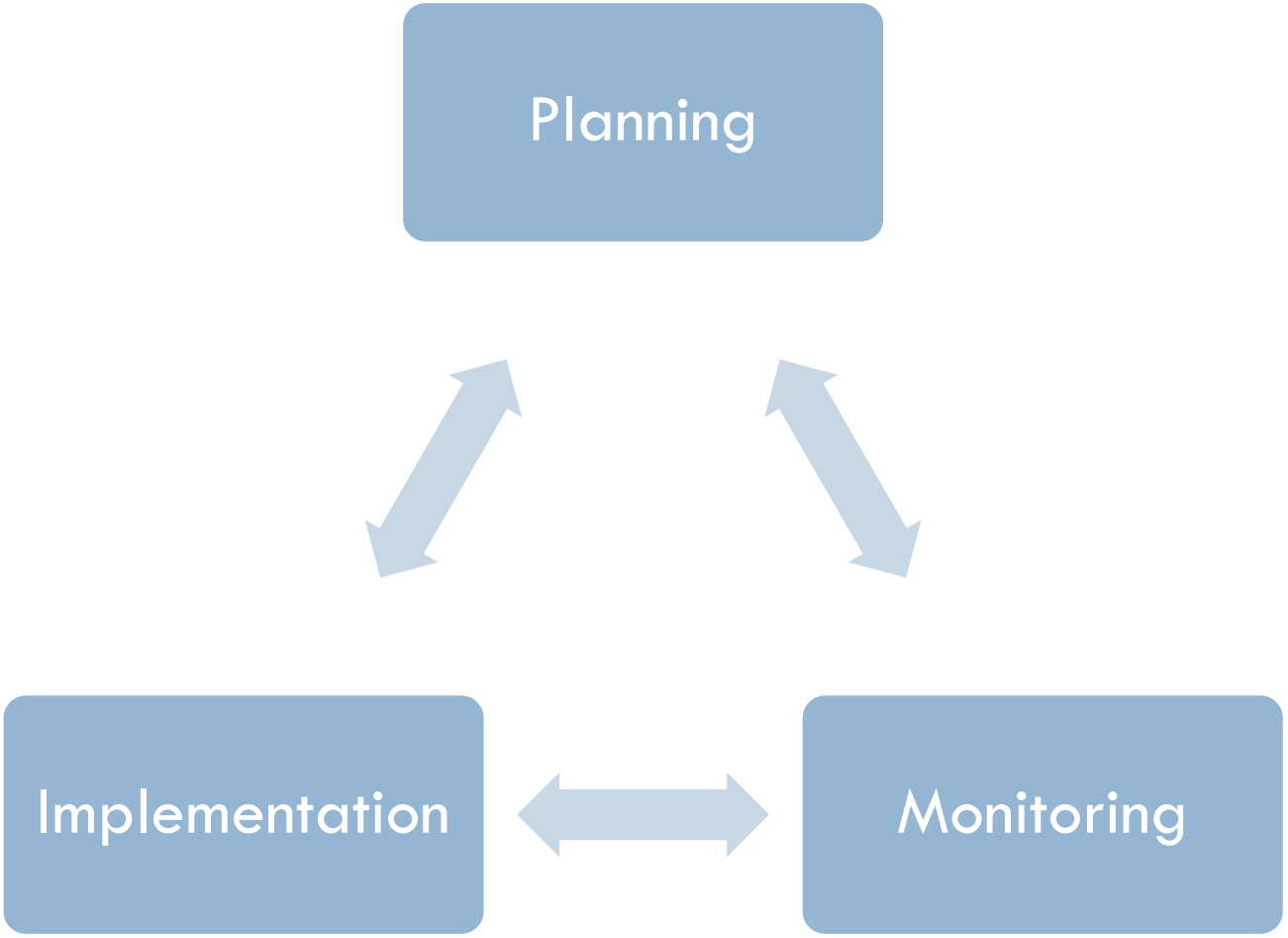
IMPROVING MONITORING EFFICACY FOR MULTIPLE LAND USE AND DATABASE IMPROVEMENT



Michael Curran (UW-WRRC), Nicholas Graf (UW-WyGISC), Karen Rogers (WGFD), Pete Stahl (UW-WRRC)

Reclamation as a process



Planning

- Location
- Land use goals
- Regulatory requirements

  Reference Site Selection/Baseline Inventory
- What's available/affordable (seed mixes)?

Reclamation Requirements

Field Office	Percent Cover	Erosion Control/Soil Stability **	Weeds **	Grass Richness** *	Forb Richness	Forb Density Or Frequency	Shrub Richness	Shrub Density or frequency	Plant Vigor **
Jonah Interagency Office	Greater than or equal to reference site	Site must be stable according to BLM Tech Note 346	No noxious weeds or highly competitive Invasives	At least 2 bunch grass species and 3 total species	Equal or greater than reference	At least 75% of reference	Equal to or greater than reference	At least 50% of reference with no more than 10% rabbitbrush	Plants must be resilient as displayed by root system, flowers, and see d heads
Pinedale Anticline Project Office	Plant community sufficient to minimize visual impacts, provide habitat and forage, impede noxious weed invasion	Plant community must stabilize soils	No state or federally listed noxious weeds. Active treatment in place for weedy bromes	At least 2 bunch grass species and 3 total species	Equal to or greater than reference within 5 years	At least 75% of reference within 5 years	Equal to or greater than reference within 5 years	At least 50% of reference within 5 years	Plants must be resilient as above. Removal of external influences required for a t least 1 year
Kemmerer BLM	Greater than or equal to 80% of reference site	Disturbed areas are immediately stabilized by mulching	Less than or equal to 10% of total vegetative cover						
Rawlins BLM	Greater than or equal to 80% of reference site	Erosion features equal to or less than reference	No noxious weeds						
WDEQ	Greater than or equal to 70% of reference	Grass must extend to any active roadway unless permanent anchor in place							

Reference Sites (SERI 2004)

- Reference Ecosystem – A model for planning a restoration project
- Natural Ecosystem – Developed by natural processes and is self-organizing and maintaining
- Cultural (or semi-natural) Ecosystem – Developed under the joint influence of natural processes and human-imposed organization

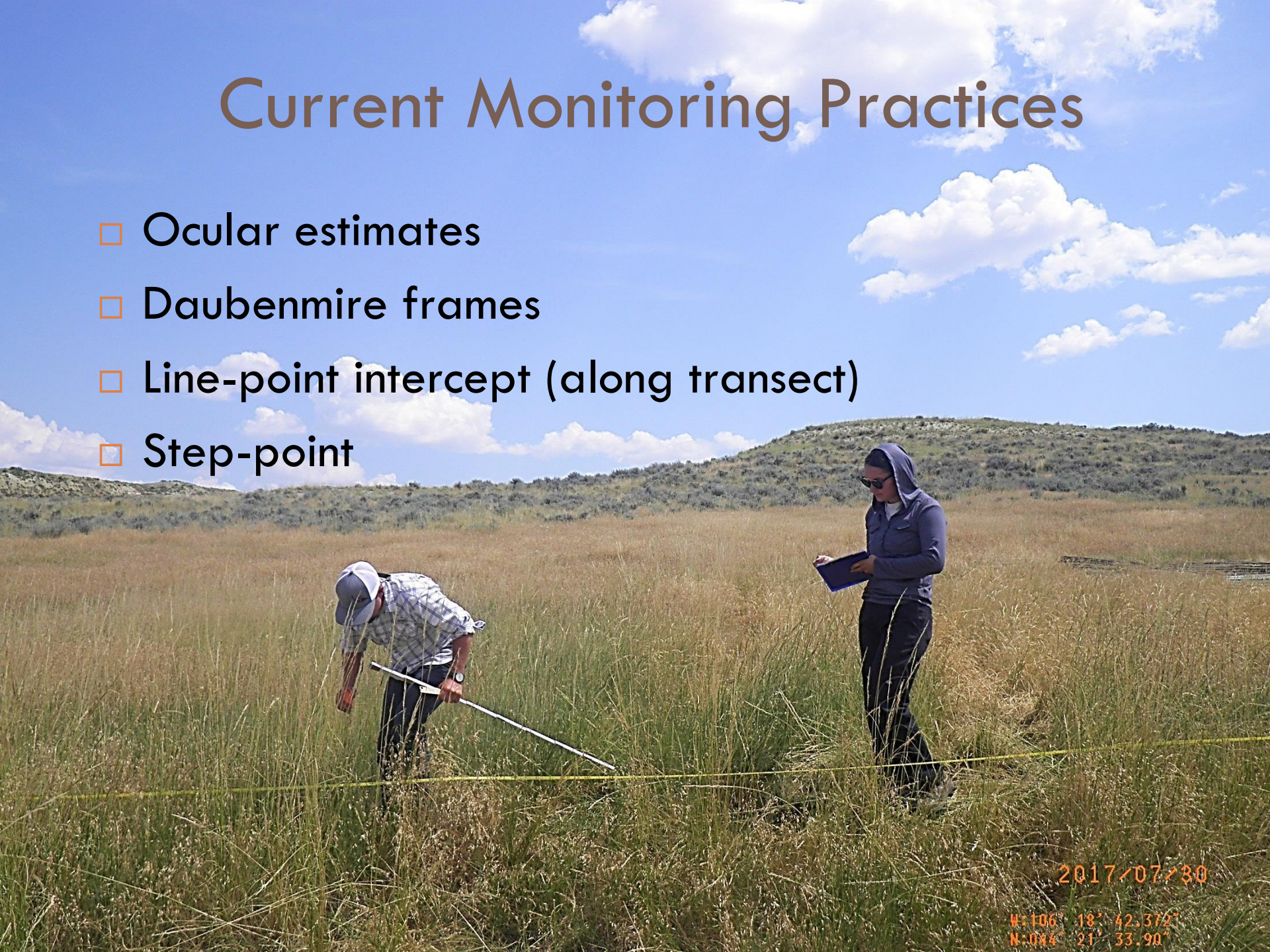
Implementation

Monitoring

- A sound monitoring plan should be:
  - Cost-effective
  - Defensible (Quantitative, Repeatable, etc.)
  - Able to measure 'Core indicators' or 'key performance indicators'
  - Able to meet needs of multiple stakeholders/regulatory criteria
  - Able to Improve Decision Making

Current Monitoring Practices

- Ocular estimates
- Daubenmire frames
- Line-point intercept (along transect)
- Step-point



Using images and spatially balanced sampling design

- Image-based monitoring (Cagney et al. 2011)
- SamplePoint (Booth and Cox 2006)
  - Free, easy to use software for image analysis
- Balanced acceptance sampling (Robertson et al. 2013)
  - "It makes intuitive sense to spread the sample evenly over the study area"

Balanced Acceptance Sampling (Robertson et al. 2013, 2017)

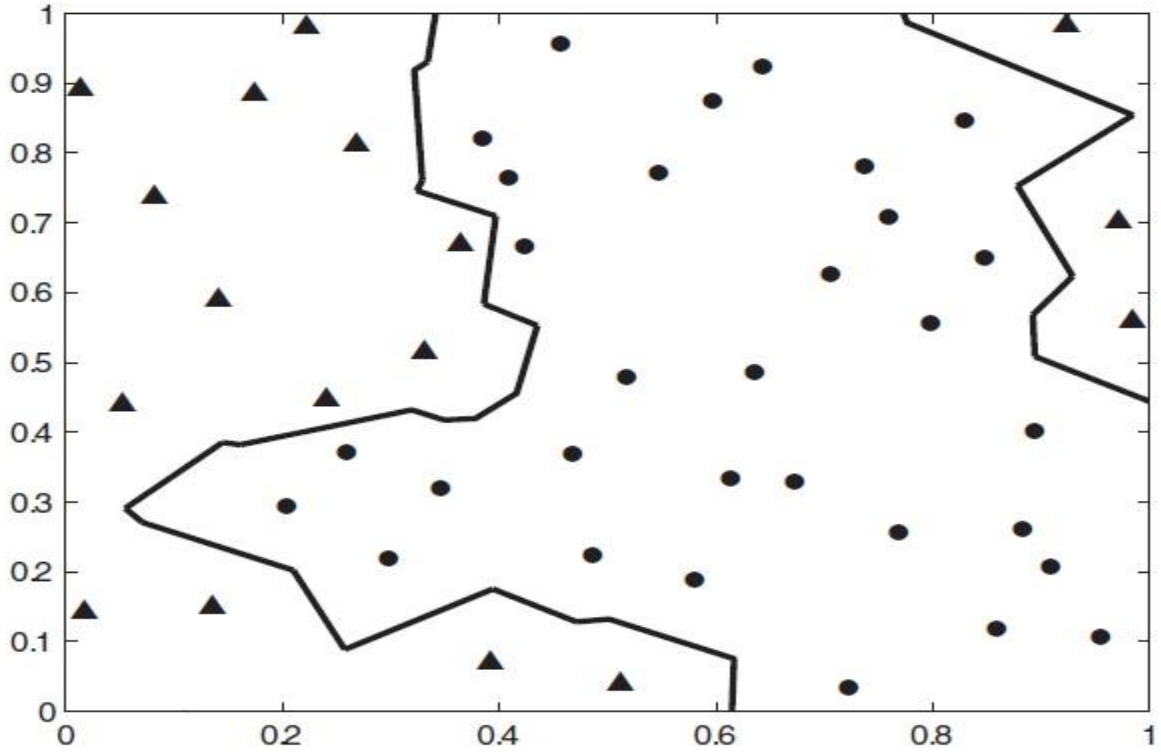


Figure 1. Selecting $n = 30$ spatially well-balanced BAS points in a two-dimensional study area. Points denoted ● are in the study area and points denoted ▲ are not. A total of $\nu = 47$ random-start Halton points were used to obtain the sample.

Utilizing Geo-tagged Imagery and Spatially Balanced Sampling (Curran et al. *In Review – Restoration Ecology)*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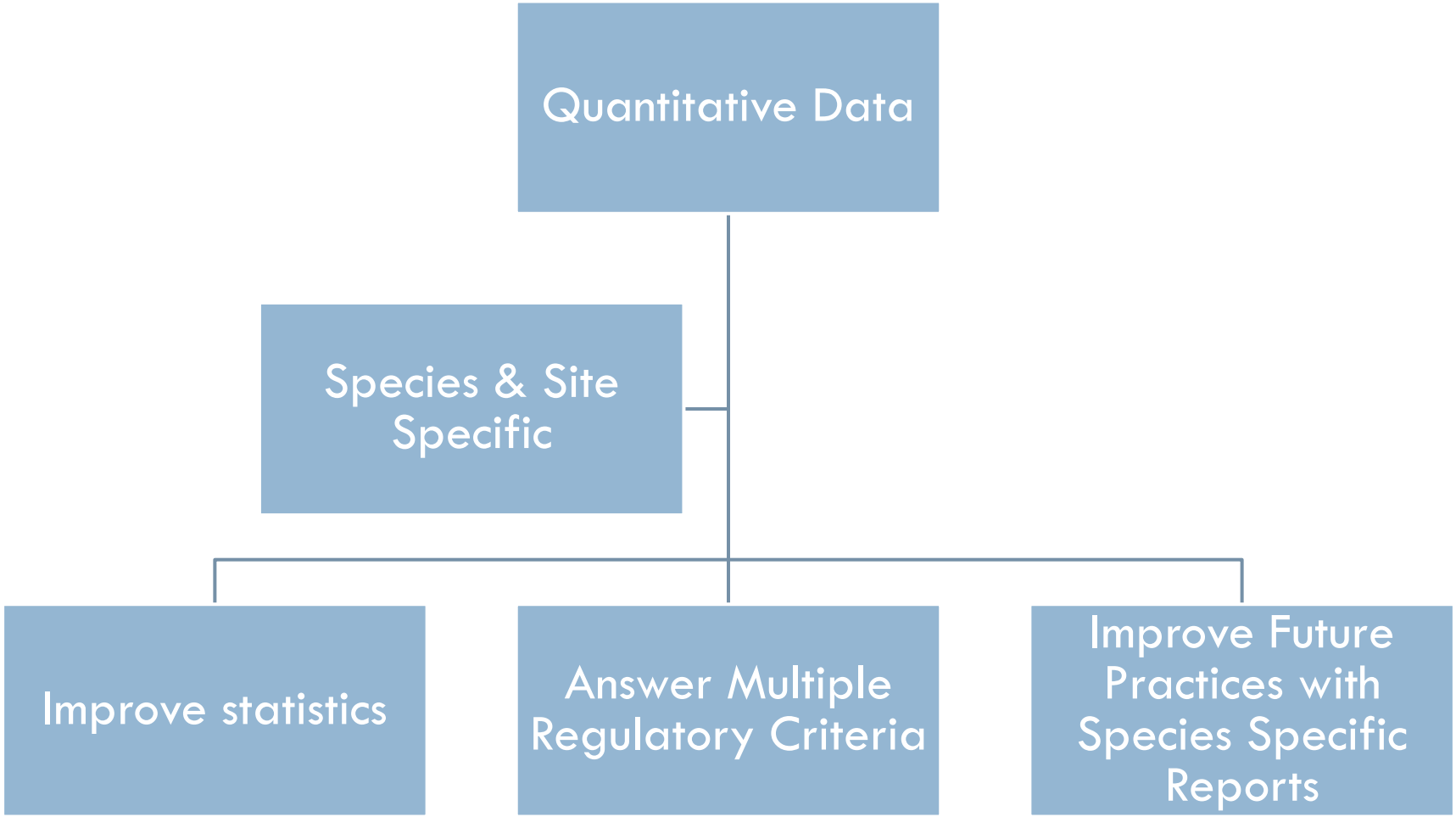
Report Generation



WDEQ/SGEO/Field Office Criteria

- WDEQ SWPPP
  - 70% cover compared to reference
- SGEO
  - 2 native forb species, 2 native grass species (1 bunch), within 60 m of =/> 5% sagebrush
- BLM Field Offices
  - Each one different
  - JIO/PAPO most stringent in state
  - Appendix M

WDEQ/SGEO/Field Office Criteria (con't)

- JIO Criteria
  - Ground cover on reclaim must be =/> reference (pass)
  - Forb richness =/> reference (pass)
  - Forb density =/> 75% reference (pass)
  - Shrub density =/> 50% reference (pass)
  - Shrub richness =/> reference (fail)
  - Grass richness (3 grasses, at least 2 bunch) (pass)
  - Site stable/lack of erosion features (pass)
    - * documented outside of SamplePoint
  - Plants resilient based on seed heads (pass), flowers (pass), roots(?)

Collect Once, Use Many Times

DATA

Queries

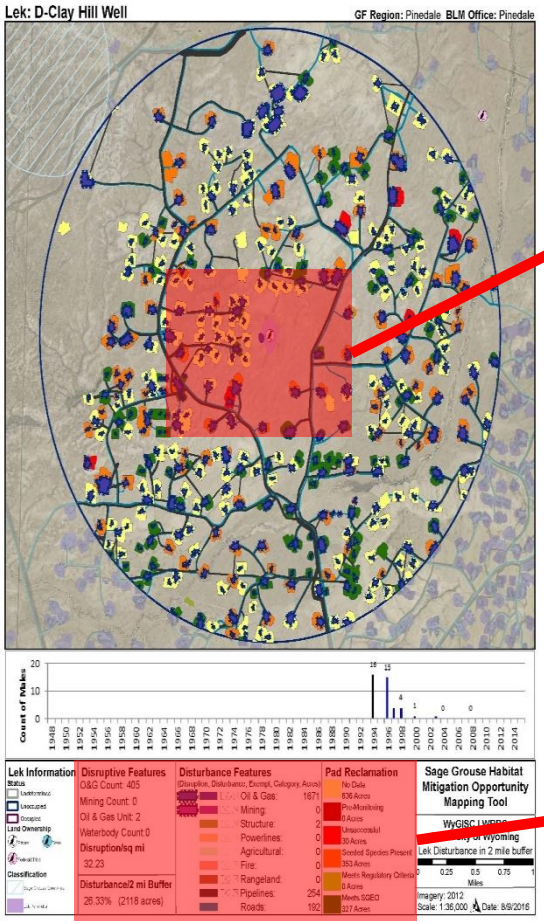
X

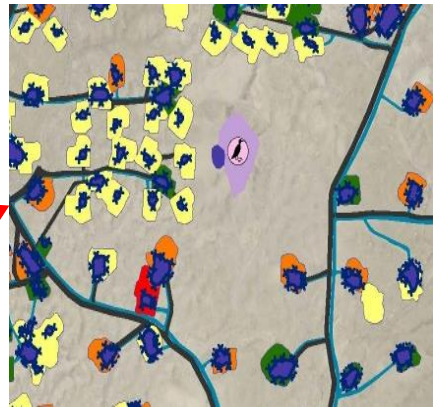
Y

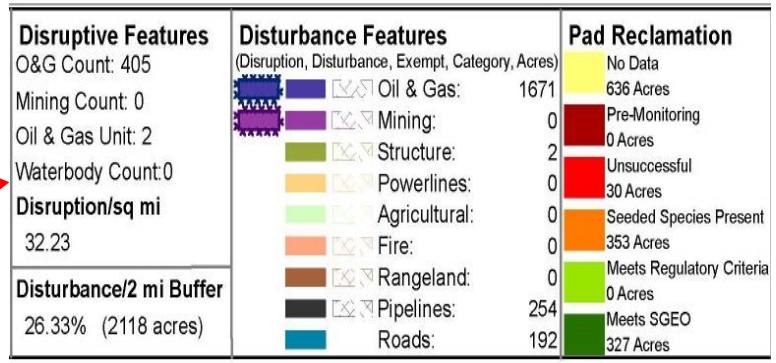
Z

Agencies

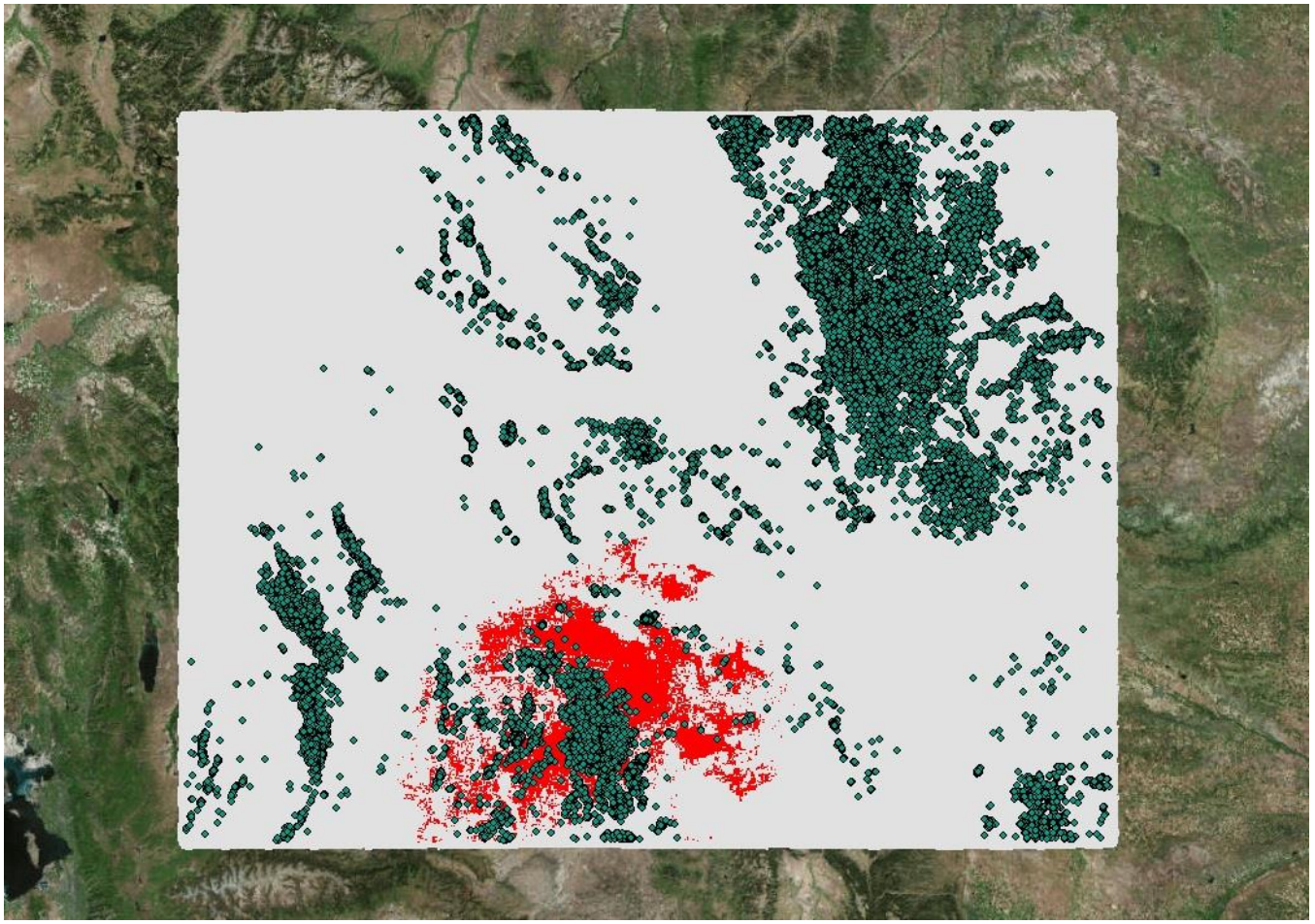
MOM Tool Example







Pocket Gopher



Operator Dashboard

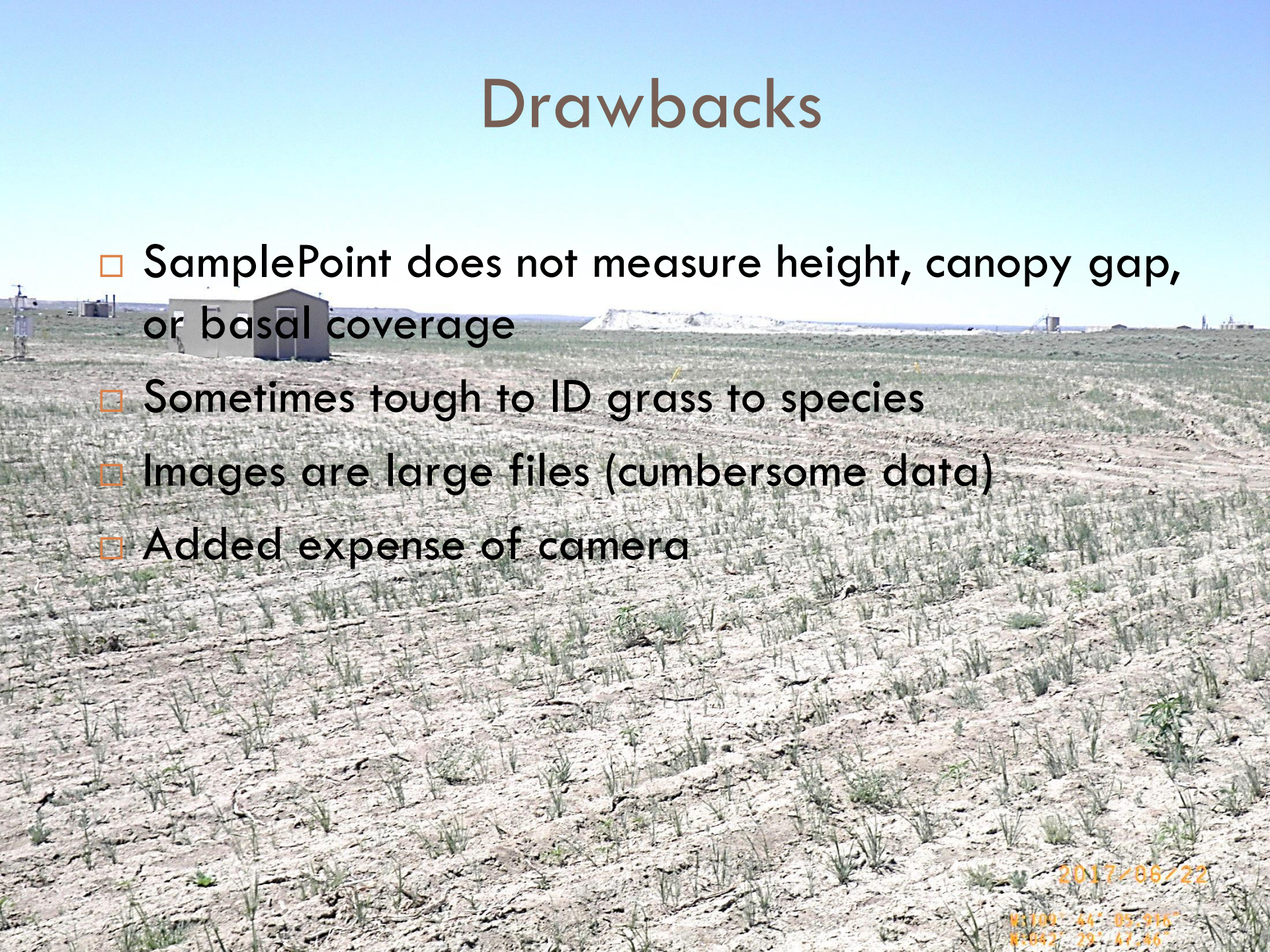
WYOMING GEOGRAPHIC INFORMATION SCIENCE CENTER
WyGISC
20TH ANNIVERSARY
1996 - 2016

Large scale (Warren Resources/Anadarko/Southland/EFTS)

- 1,800 pads monitored prior to Aug 1.
- Quantitative reports generated daily
- Geo-spatial component allows for data/photos to be linked to site
- Technicians (1 person team) doing 10-12 sites per day (data collection and report generation)
  - Transect method (2 person team) was doing ~7 sites per day (data collection)

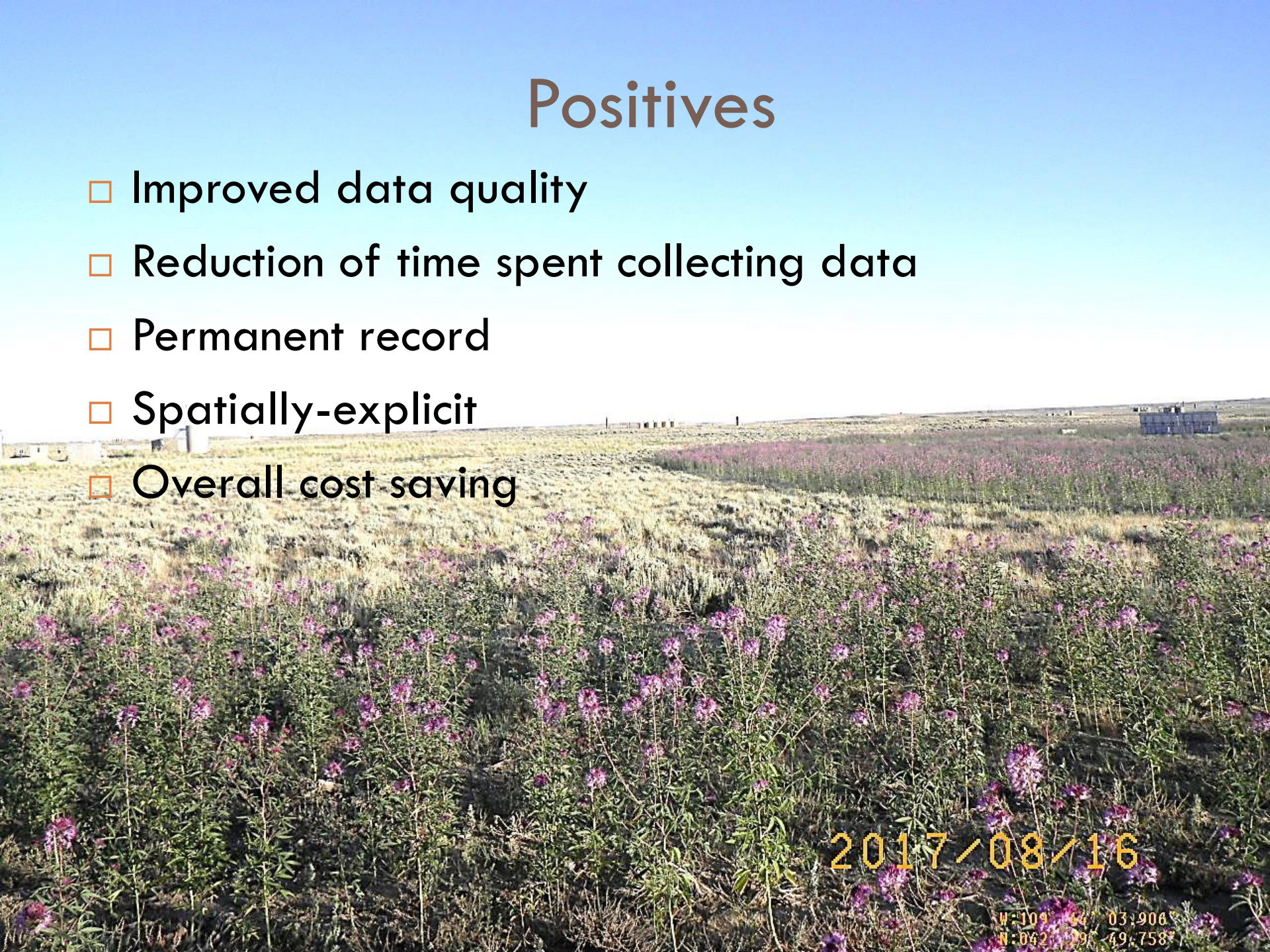
Drawbacks

- SamplePoint does not measure height, canopy gap, or basal coverage
- Sometimes tough to ID grass to species
- Images are large files (cumbersome data)
- Added expense of camera



Positives

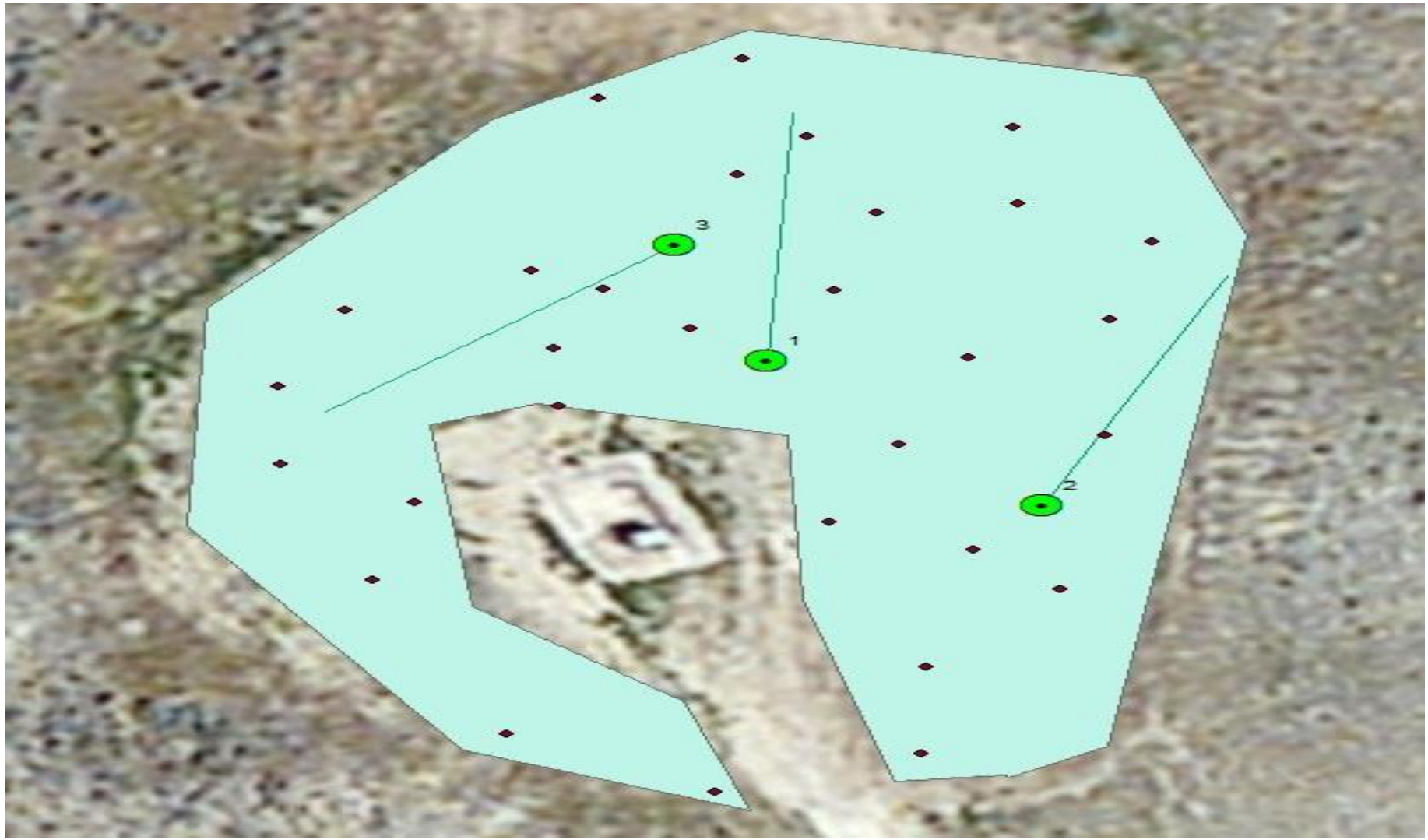
- Improved data quality
- Reduction of time spent collecting data
- Permanent record
- Spatially-explicit
- Overall cost saving



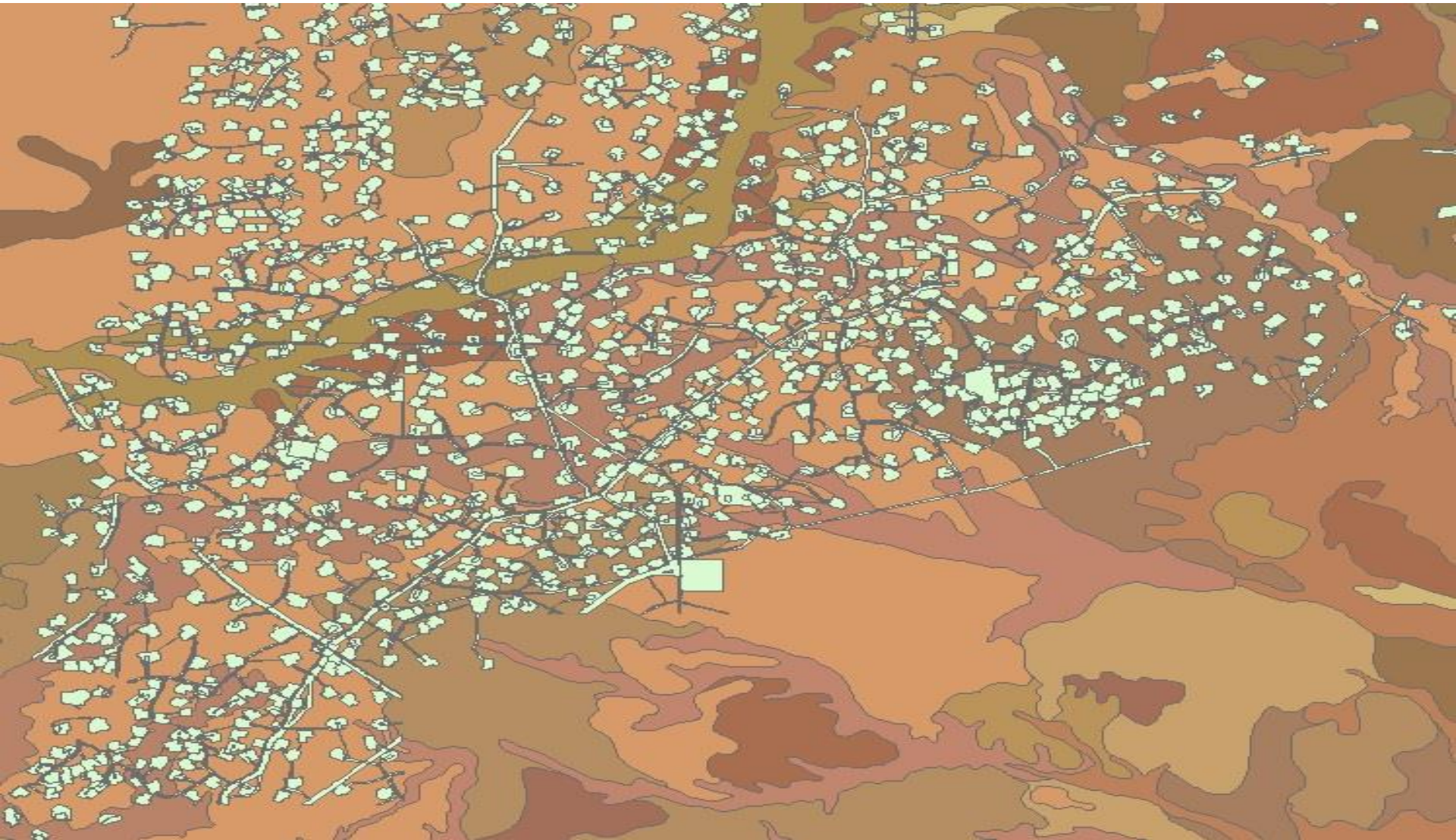
Future Research

- Direct comparison between methods
- Improving reference site selection
- Life cycle monitoring for reclaimed sites

WRRC-BLM Study (Buffalo & Rawlins offices)



Ecological Site Descriptions: Suggestions for Improvements and Use as Reference Sites (Curran et al. *in prep.*)



Acknowledgements

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- Anadarko Petroleum Corporation
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- BLM
- WGFD
- WWNRT
- PAW
- CPNPP