

Field Survey Protocol: Phreatophyte Vegetation Assessments Without Drones

Site Selection/Identification:

- Vegetated areas of interest lie within areas of potential groundwater discharge (i.e., areas where shallow (< 30 ft) groundwater is consumed by phreatophyte evapotranspiration).
- Statistically significant (p-value < 0.1) decreasing trends in Landsat-derived vegetation indices (e.g., normalized difference vegetation index (NDVI) or enhanced vegetation index (EVI)) around the area of interest.
- Statistically significant (p-value < 0.1) increasing trends in depth to water (i.e., decreasing water levels) from nearby pumping/monitoring wells.

Field Supplies:

- Digital Camera
- Access to a geographic information system (GIS) on a laptop.
- GPS equipment
- DNRGPS software to connect GPS location to GIS in real time.
- Access to spatial data sets in a GIS
 - EVI/NDVI trend map
 - Water level measurements and trends
 - Photograph locations/descriptions shapefile
 - Potential groundwater discharge/phreatophyte boundaries
 - Land surface temperature imagery
 - True color national agriculture imagery program (NAIP) imagery
 - Nevada roads shapefile

Site Assessment:

A site assessment without use of a drone includes field methods and office methods using free high-resolution (1m) NAIP imagery. The steps below are for each site.

1. For a given area of assessment, determine the area you can assess in 20-30 minutes maximum. Find an approximately central location in the study area to walk a 10m × 100m belt transect perpendicular to the long axis of the valley (no need for a tape, as 1 good step = 1 m). Note in the datasheet the GPS locations of both ends of the transect. If the area is large enough, you may need >1 transects separated by 200m.
2. Take 5 photos: one straight down at the ground and one horizontal for each cardinal direction with the camera/cell phone/iPad at 25m and 75m along the belt transect. It would be good practice to always follow the same pattern (e.g., north→east→south→west).
3. Record species composition of the vegetation community based on what you think the aerial cover would be looking down from a drone. Remember that percent cover is generally less looking down from a drone or satellite (which is more accurate) than what one might estimate by foot.
 - a. Trying to figure out continuous species cover is too time consuming, so it is recommended to create cover interval categories and always use the same mid-point to describe that category (example below). Estimates of cover should be an average ocular estimate from walking the entire belt transect. It is not the most accurate method, but it is fast. You may

need several people on the same transect or make several passes to capture all variables suggested below. If the transect is too heterogenous, feel free to assess by section, and average all. A 100m transect is long, so heterogeneity should be expected.

- 5% for 0%-9%
- 15% for 10-19%
- 30% for 20% to 39%
- 65% for 40% to 89%
- 95% for 90% to 100%

You can use less classes, but be more discerning closer to 0% and 100%.

- b. Measure cover category for the following native vegetation (If there's not enough time and it's not important for the questions you are asking, you can just document groups of vegetation like trees, shrubs, grasses rather than species):
 - greasewood (*Sarcobatus vermiculatus*)
 - rabbitbrush (*Ericameria nauseosa*)
 - basin big sagebrush (*Artemisia tridentata* spp. *tridentata*)
 - Native riparian trees (cottonwood, willow, Wood's rose)
 - Bulrush-cattail marsh (graminoids tolerant of saturated soils, semi-permanent surface water)
 - Graminoid, other (e.g., inland saltgrass, basin wildrye, sedges, reeds, or similar)
 - c. Measure cover category for non-native riparian trees such as tamarix and Russian olive that are in the belt transect (including cover from individuals not rooted in the belt transect)
 - d. Measure cover category for non-native noxious species cover (e.g., Knapweeds, tall whitetop, thistles). If you do not know your species (i.e., whether they are non-native), take photographs to get help later during post-processing. These species are often bright in the infrared.
 - e. Measure the cover category of non-native annual species (e.g., cheatgrass, medusahead, tansy mustard) as they are indicators of soil collapse due to overgrazing.
 - f. Measure cover category of introduced species seedlings (mostly for private lands and not to species, but expect intermediate wheatgrass in wetter areas, crested wheatgrass, Siberian wheatgrass – mostly in low elevation sites, and Kentucky bluegrass, also in wetter areas), especially those that might throw off the greenness interpretation.
4. Record any impacts to vegetation if observed in the belt transect:
- a. Qualitative indicators of stress or mortality of dominant shrubs
 - 1 is low: <15% stem mortality (you are looking for gray branches and stems)
 - 2 is intermediate: 15% to 49% stem mortality
 - 3 is high: >49% stem mortality

You are encouraged to use your past data for calibration of these qualitative indicators.
 - b. Percent cover of bare ground. This is an important metric of local overgrazing and predictor of fine soil and organic matter loss.

- c. If possible, the binary presence of creek/wash incision. This is a good sign of historic overgrazing and vegetation conversion (e.g., from basin wildrye to shrubs).
5. In the office:
- a) Using NAIP imagery during office post-processing (or other free imagery with more resolution), measure the distance from the midpoint of the transect (50m) to the closest fence or water source for livestock. Also, use the imagery to determine the percent cover of standing (open) water, if relevant (e.g., areas with creeks, wetlands, reservoirs, other sources of standing water).
 - b) Digitize boundaries around representative areas of interest (AOIs) to compute zonal statistics and correlate spatial averages of EVI, precipitation (PPT), and reference evapotranspiration (ET_o).
 - c) Record the depth to groundwater in the area if data is available.
 - d) Ensure that the potential groundwater discharge/phreatophyte boundary is delineated accurately in the area.

Sample Site Form

A01/FID-0

See protocols for instructions

Site ID:

Soldier Meadows Riparian South

Field crew:

Christine A. Blake M. Dave Page

Date:

7/17/19

Weather:

Sunny/light wind

GPS Transect start:

GPS Transect end:

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

lots of dead willow
and basin big sage.
very tall big sage.
Some sage might be
dying due to waterlogging
others in dry
areas.
(at least
now)

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Site is in
wash a few
miles upstream
from a reservoir
dirt
tank.

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood	15	1
Rabbitbrush		
Basin big sagebrush	15	3
Riparian trees (Cottonwood/Willow/Wood's rose)	15	3
Bulrush-cattail marsh		
Graminoid, other <i>Great basin wild rye (mostly) Four Wing</i>	30	
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species	27	
Introduced species seeding that may throw off greenness		
Standing (open) water	107	
Bare ground	57	
Cow pies		

Depth to groundwater:

ft / m (circle appropriate unit)

Well ID:

Office assessment of distance to nearest:

Fence

ft / m (circle appropriate unit)

Water source

ft / m (circle appropriate unit)

Sample Site Form

See protocols for instructions

Site ID: Silver Meadows West well 2Field crew: CMA, BM, DPDate: 7/18/19 Weather: _____

GPS Transect start: _____

GPS Transect end: _____

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood		
Rabbitbrush		
Basin big sagebrush		
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh		
Graminoid, other	80%	
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species	15%	
Introduced species seeding that may throw off greenness		
Standing (open) water		
Bare ground	5%	
Cow pies	1%	

Depth to groundwater: _____ ft / m (circle appropriate unit)

Well ID: _____

Office assessment of distance to nearest: Fence _____ ft / m (circle appropriate unit)

Water source _____ ft / m (circle appropriate unit)

Sample Site Form

See protocols for instructions

Site ID: Soldier Meadows West Wet 1Field crew: Christine Blake Dave PDate: 7/18/19 Weather: _____

GPS Transect start: _____

GPS Transect end: _____

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

Meadow area is
largely drying

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood		
Rabbitbrush		
Basin big sagebrush		
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh - 50% , 45% sedge	95%	2
Graminoid, other		
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species		
Introduced species seeding that may throw off greenness		
Standing (open) water		
Bare ground		
Cow pies		

Depth to groundwater: _____ ft / m (circle appropriate unit)

Well ID: _____

Office assessment of distance to nearest: Fence _____ ft / m (circle appropriate unit)

Water source _____ ft / m (circle appropriate unit)

Sample Site Form

See protocols for instructions

Site ID: Soldier Meadows West 1Field crew: Christine, Blake, DaveDate: 7/18/19 Weather: _____

GPS Transect start: _____

GPS Transect end: _____

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

- Site may have burned or may have been previously wet
- anomalous red patch maybe sage mortality
- large forbs w/ yellow flowers in a couple of spots
- greasewood & sage around periphery of transect. Main area of declining trend appears to be sage mortality

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood	5%	1
Rabbitbrush <i>snakeweed</i>		
Basin big sagebrush	15	3
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh		
Graminoid, other		
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species <i>Russian Thistle, other invasive forbs</i>	15	
Introduced species seeding that may throw off greenness <i>Cheatgrass</i>	15	
Standing (open) water		
Bare ground	50	
Cow pies	2	

Depth to groundwater: _____ ft / m (circle appropriate unit)

Well ID: _____

Office assessment of distance to nearest: Fence _____ ft / m (circle appropriate unit)

Water source _____ ft / m (circle appropriate unit)

A01/ FID 5

Sample Site Form
See protocols for instructions

Site ID: Soldier Meadow Springs NW
 Field crew: Blake, Christine, Dave
 Date: 7/17/1 Weather: _____
 GPS Transect start: _____
 GPS Transect end: _____

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

Center line goes from
grasses + fine sedges to taller/
thicker sedges w/
greasewood along
periphery.

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Top of transect
is spring
outlet
surrounding
upland is
mix of
cheatgrass
+ sage w/
some
rabbitbrush

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood	15	1
Rabbitbrush		
Basin big sagebrush		
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh		
Graminoid, other <i>sedges</i>	65	
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species		
Introduced species seeding that may throw off greenness	<i>Cheatgrass 5-10 on outer periphery</i>	
Standing (open) water	2	
Bare ground	5	
Cow pies		

Depth to groundwater: _____ ft / m (circle appropriate unit)

Well ID: _____

Office assessment of distance to nearest: Fence _____ ft / m (circle appropriate unit)

Water source _____ ft / m (circle appropriate unit)

Sample Site Form

See protocols for instructions

A01 / FID 6

Site ID:

Soldier Meadows Drone 1 Springhead

Field crew:

Christine, Blake, Dave P.

Date:

7/17/19

Weather:

GPS Transect start:

GPS Transect end:

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

multiple channels

upland is big

2x2-3 ft wide channels

heavily grazed

upland veg probably mostly

invasives, tamarisk

dead trees

down stream

from transect

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood		
Rabbitbrush		
Basin big sagebrush		
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh	30	1
Graminoid, other	65	
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species		
Introduced species seeding that may throw off greenness		
Standing (open) water	5	
Bare ground	5	
Cow pies	5	

Depth to groundwater:

ft / m (circle appropriate unit)

Well ID:

Office assessment of distance to nearest:

Fence

ft / m (circle appropriate unit)

Water source

ft / m (circle appropriate unit)

Sample Site Form

See protocols for instructions

Site ID:

Soldier Meadow SW Wet/Riparian

Field crew:

CMA BM PP

Date:

7/18/19

Weather:

GPS Transect start:

GPS Transect end:

Table 1. Cover categories (modify as needed for project)

Cover category	Cover range
5%	0% to 9%
15%	10% to 19%
30%	20% to 39%
65%	40% to 89%
95%	90% to 100%

stream
 narrow corridor
 with giant sedge/bulrush
 alongside, very tall
 healthy greasewood
 surrounding

Table 2. Qualitative indicators of stress or mortality of dominant shrubs

Qualitative indicator	Description
1 (low)	<15% stem mortality (gray branches and stems)
2 (intermediate)	15% to 49% stem mortality
3 (high)	>49% stem mortality

Record cover category from Table 1 and stress/mortality from Table 2 for the following:

Vegetation type	Cover category (%)	Stress/Mortality
Native vegetation		
Greasewood	30	1
Rabbitbrush		
Basin big sagebrush		
Riparian trees (Cottonwood/Willow/Wood's rose)		
Bulrush-cattail marsh	50	1
Graminoid, other		
Non-native tree species (Tamarix, Russian olive)		
Non-native noxious species		
Introduced species seeding that may throw off greenness		
Standing (open) water	10	
Bare ground		
Cow pies	2	

Depth to groundwater:

ft / m (circle appropriate unit)

Well ID:

Office assessment of distance to nearest:

Fence

ft / m (circle appropriate unit)

Water source

ft / m (circle appropriate unit)