Visual Obstruction Reading (VOR) Protocol

- At multiple points along a transect, or at points arranged in a grid covering a target sampling area, we collect vegetation visual obstruction readings (VOR) as a combined measure of vegetation height-density. Depending on point layout, one can take observations on the pole in each of the 4 cardinal directions, or just in two opposite directions.

- We used a modified "Robel pole" (see Robel 1970) made of 3.4-cm wide PVC. Increments are modified to be 1 cm each (instead of Robel's original 1 dm increments), with alternating white and black bands. The first band closest to the ground is "band 1", and every 10th increment (10, 20, 30 cm etc) is colored red to facilitate readings without seeing actual numbers marked on the pole. Readings are taken with the observer's eye positioned 4 m away from the pole and 1 m above the ground.

- We record the lowest interval that is not completely obscured by vegetation (e.g. if the first 3 intervals are completely obscured and a portion of the fourth interval is partially visible, record a 4). We also record the highest interval with any kind of vegetation visible in front of it.

- In addition, *record the species that is responsible for causing the obstruction associated with the LOW reading;* if more than one species is involved, record the tallest species associated with the LOW reading. Only one species code is recorded for each reading – there will be no species recorded in association with the HIGH reading. See example ppt file.

- See the next slide for instructions on how to read the low and high values from the pole, and the species associated with the low reading. Recording the species is not an original part of the method, but can be useful in understand how VOR varies in relation to species composition.

- If you are sampling in areas with shrubs, additional protocol definitions may be added that specify how to take readings in cases where a portion of pole is visible in between portions covered by the shrub canopy (e.g. 1-4 cm obscured, 5-7 visible, but then 8-12 cm obscured by shrub canopy). In the absence of such additional protocols, the default is to record the "lowest interval that is not completely obscured by vegetation", as defined above.

Robel Pole Method Examples:

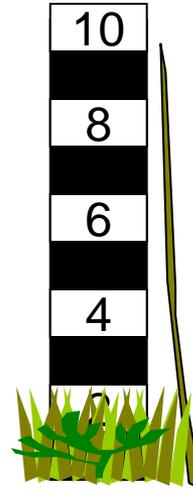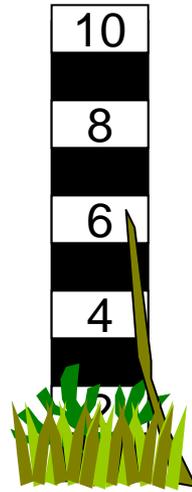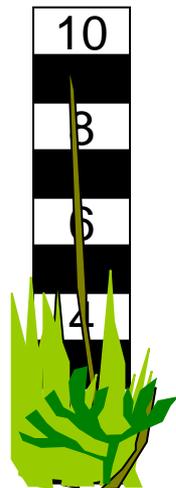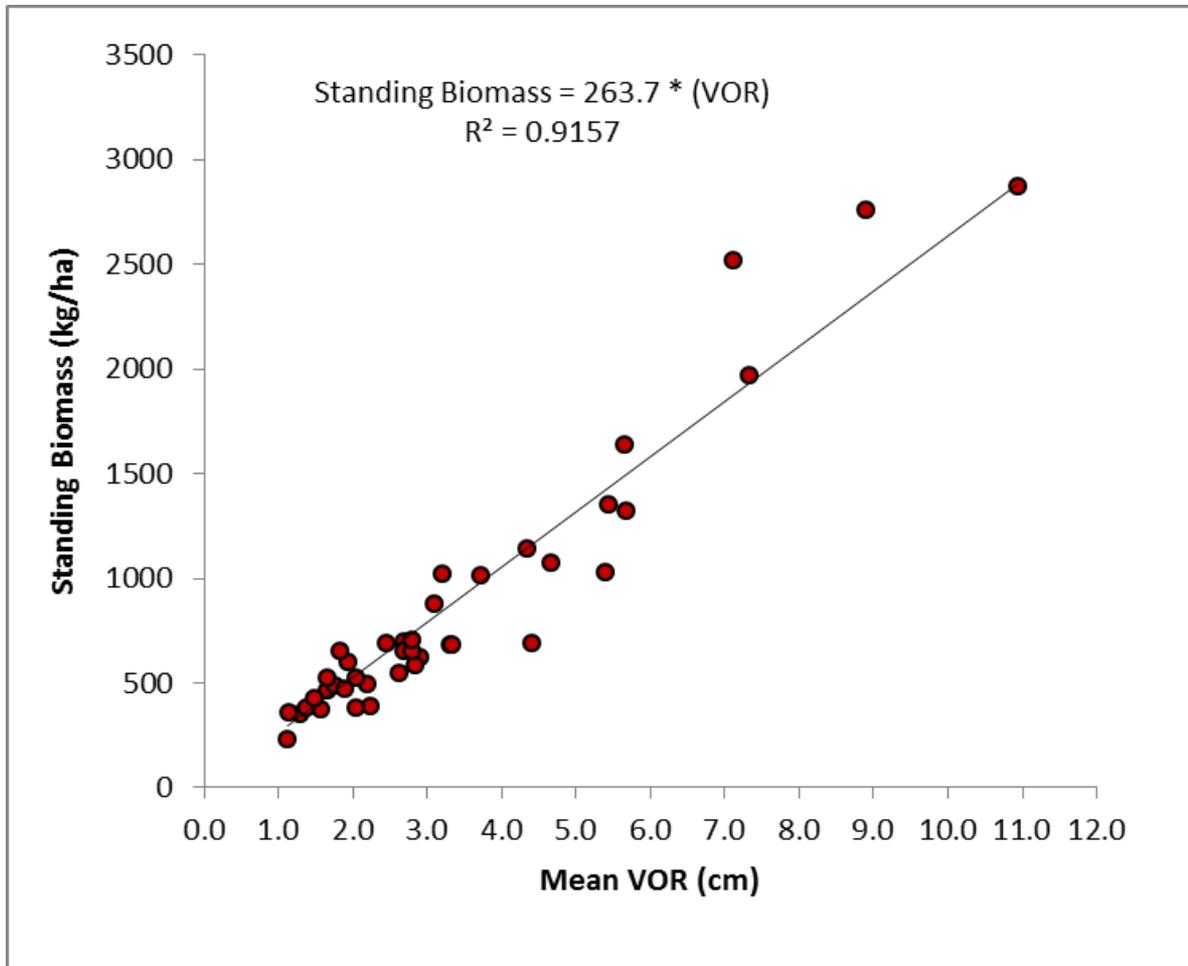|						
High reading:	10	9	6	2	1	1	0
Low reading:	4	3	2	2	1	0	0
Species:	BOGR	BOGR	SPCO	BOGR	BOGR	BOGR	BARE
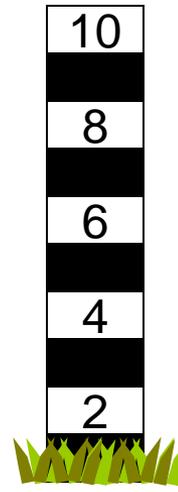
VOR Measurements in Shortgrass Steppe

Predicting herbaceous biomass from VOR: data from CPER, 2008 - 2013

Standing Biomass = 263.7 * (VOR)
$R^2 = 0.9157$

Relationship between standing biomass and visual obstruction in shortgrass steppe excluding quadrats containing subshrubs. Regression is based on 40 sites measured during 2008, 2009, 2012, and 2013. For each site, we clipped standing crop and measured VOR at each of 8 – 20 quadrats. Regression is fit with intercept of zero.

Predicted Standing Herbaceous Biomass from mean VOR (cm)

Mean VOR (cm)	Predicted kg/ha	Predicted lbs/ac
0	0	0
1.3	340	300
1.4	370	330
1.5	400	360
1.6	420	370
1.7	450	400
1.8	470	420
1.9	500	450
2.0	530	470
2.1	550	490
2.2	580	520
2.3	610	540
2.4	630	560
2.5	660	590

Minimum Standing Crop Thresholds for Loamy and Sandy Plains Pastures?

	ANPP (kg/ha)	Residual assuming take half/leave half (including non-cattle removal)	Residual thresold assuming 60% of ANPP
Production on Loamy Plains	700	350	400
Production on Sandy Plains	1050	525	580

Predicted Standing Herbaceous Biomass from mean VOR (cm)

Mean VOR (cm)	Predicted kg/ha	Predicted lbs/ac
0	0	0
1.3	340	300
1.4	370	330
1.5	400	360
1.6	420	370
1.7	450	400
1.8	470	420
1.9	500	450
2.0	530	470
2.1	550	490
2.2	580	520
2.3	610	540
2.4	630	560
2.5	660	590

Potential Initial VOR Thresholds for AGM?

Assuming 60% Residual ANPP Goal	Mean VOR (cm)	Predicted Biomass (kg/ha)
Residual Threshold for Loamy	1.5	400
Residual Threshold for Sandy	2.2	580

Proposed method to monitor VOR in a given pasture

- 8 permanently marked transects per pasture
- 10 VOR readings per pasture, measured weekly while cattle are in the pasture
- Mean of the 80 VOR readings used to guide timing of move to next pasture
- Could potentially take second reading in a week if close to threshold
- Need for concurrent measurement in pasture(s) to which cattle will be moved?