



# Virginia Land Cover Quality Control/Quality Assessment

Wednesday March 2, 2016





# Agenda Topics

- Welcome & Agenda (Dan Widner)
- Brief Project overview (Dan Widner)
- Project Classifications and their accuracy targets (WorldView)
- Sample Size (John Scrivani)
- QAQC Process (Sanborn)
  - Define production units (mosaic datasets)
  - Prepare imagery and ancillary data
- Accuracy Assessment Principles (Sanborn)
  - Objectivity and Consistency
    - Ensures repeatable and unbiased assessments
- Fuzzy Logic (Sanborn)
- Questions

Agency



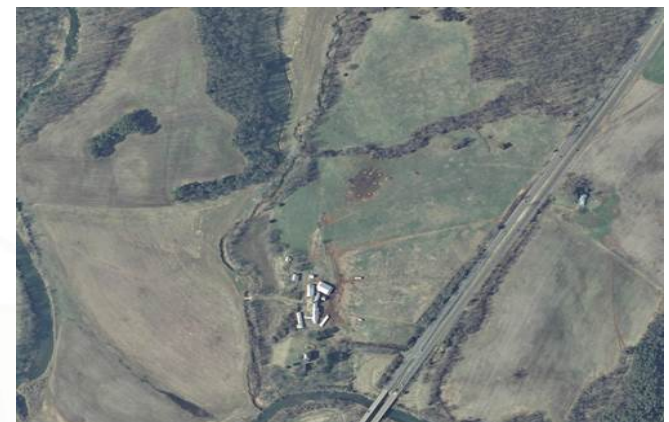
	Land Cover Classification	Minimum Mapping Unit	Accuracy Target
Herbaceous	Turf Grass	Less than 2 acres with land use exceptions	85%
Impervious	Extracted Impervious	Match resolution	95%
	Local & Statewide Impervious	Road centerline dependent	95%
Forest	Forest	1 acre w/ min width restrictions	95%
	Tree	Less than 1 acre	95%
	Harvested/Disturbed Forest	1 acre w/ min width restrictions	85%
Scrub/Shrub	Scrub/Shrub	1 acre w/ min width restrictions	85%
Agriculture	Cropland	1 acre w/ min width restrictions	85%
	Pastureland	1 acre w/ min width restrictions	85%
Wetlands	NWI/Other	As defined by NWI and TMI	85%
Barren	Barren	Higher than the resolution	85%
Water	Water	Higher than the resolution	95%

# Project Classifications & Accuracy Targets

# Classification Examples



Turf (brown) and Forest (dark green)  
vs.  
Tree (medium green)



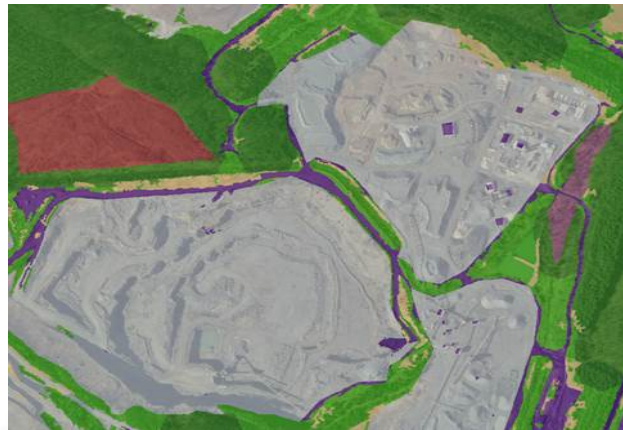
Cropland (yellow) vs. Pasture (lime green)

# Classification Examples



Harvested  
(red)

Barren (grey)





## Sample Size

- ~3900 total samples will be checked
- 95% confidence interval width of 1% for overall accuracy
- 95% confidence interval width of 4% for each category (assuming a categorical accuracy of 85%)
- Stratification of the samples will be nested by delivery areas
- A minimum of 20 samples will come from each classification category



## QAQC Process

- Define production units (mosaic datasets)
- Prepare imagery and ancillary data
  - Mosaic the datasets into one full mosaic
    - Calculate the proportion of each class in order to select random samples stratified throughout the extent of each delivery area.
  - Source imagery includes Virginia Base Map Program (VBMP) orthophotography collected in the spring of 2011, 2013, and 2014 (each year covering a certain part of the state with no overlaps; in the case of overlapping imagery from two time periods, only the most recent will be used).





## QAQC Process Continued

- May use NAIP (2012 and 2014) imagery to identify the extent of tree canopy.





## Accuracy Assessment Principles

### – Objectivity and Consistency

- Ensures repeatable and unbiased assessments
- Standard polygon sizes of the accuracy assessment sample (at a minimum, the MMU for the class being assessed)
- Same source imagery and ancillary datasets
- Same interpretation standards and classification scheme
- Sample units are assessed and interpreted independently of the map/spatial data being assessed

# Accuracy Assessment Principles Continued

- A minimum of 3900 samples will be chosen for the Commonwealth, stratified by land cover class and Delivery Area.

VITA Area 1 Point Stratification				
Class	Value	Sq Miles	Proportion	Points
Open Water	11	1823.9	0.184	287
Impervious	21	533.6	0.053	134
Barren	31	39.2	0.004	62
Forest	41	3111.9	0.314	484
Tree	42	921.6	0.093	125
Shrub/Scrub	51	25.0	0.003	50
Harvested/Disturbed	61	229.8	0.023	70
TurfGrass	71	771.0	0.078	116
Pasture	81	127.5	0.013	86
Cropland	82	1067.8	0.108	185
Woody Wetlands	91	862.7	0.087	135
Emergent Wetlands	92	410.8	0.041	82
Total		9924.9	1.000	1816



## Accuracy Assessment Principles Continued

- The number of sample units is based on the proportion of the land cover class in the mosaic dataset.
- A minimum of 50 samples per land cover class per mosaic dataset, for a rare class, i.e. mudflats, 50 points will not be found in certain mosaic datasets. In such a case, we will report the lower number and provide an explanation.
- Spatial autocorrelation is also used to ensure sample units are independent and spread apart from each other (at least 500m).





## Fuzzy Logic

- Fuzzy Set Theory, or Fuzzy Logic, is based on the idea that the landscape, or land cover, is not a set of discrete land cover types, but a continuum. It recognizes that, on the margins of classes that divide a continuum, an item may belong to both classes (Congalton and Green, 2009).





## Fuzzy Logic continued

- Independent photo interpreters label sample units as Primary and Fuzzy.
- Either label is considered correct when assembling the final error matrix.
- Sanborn would recommended using the Fuzzy matrix as the final accuracy measure.



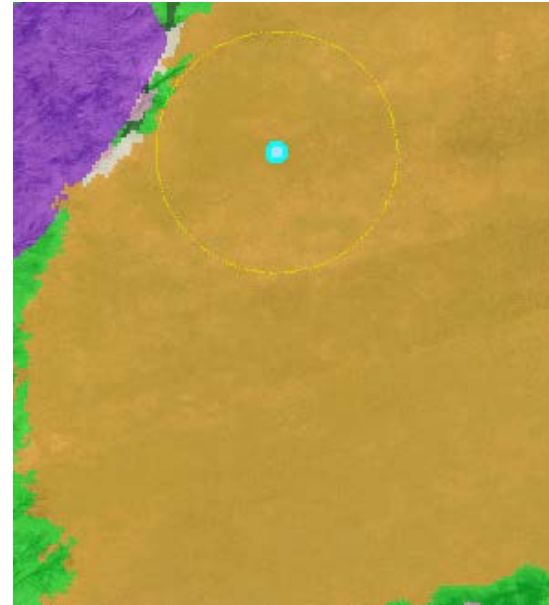
# Fuzzy Logic Example

- We labeled the primary call as pasture and fuzzy 1 call as cropland.



# Photo Interpretation

- Each sample unit is assessed by an independent photo interpreter independently of the land cover classification mosaic.





## Photo Interpretation Continued

- Sample units is acceptable if:
  - It is homogenous on the ground for the size of the MMU.
  - If it is not within a 500m of another sample unit of the same class.
- About 25% of sample units are Qced by another analyst once they have been photo interpreted.





# Deterministic Accuracy Matrix

VITA Bay Area 1 Deterministic Accuracy Matrix

Accuracy Assessment Labels

Map Labels	Water	Impervious	Barren	Forest	Tree	Scrub/Shrub	Harvested/Disturbed Forest	TurfGrass	Pasture	Cropland	Woody Wetlands	Emergent Wetlands	Total	User's Accuracy
	Water	276	0	2	0	1	0	0	0	0	0	0	0	3
Impervious	0	128	0	2	2	0	0	1	2	0	2	0	0	137 93.4%
Barren	0	3	56	0	0	3	0	2	0	0	0	0	5	69 81.2%
Forest	0	0	0	405	10	6	1	1	1	2	3	1	1	430 94.2%
Tree	0	1	0	42	107	1	3	16	3	5	0	0	0	178 60.1%
Scrub/Shrub	0	1	0	7	4	31	2	4	16	2	0	1	1	68 45.6%
Harvested/Disturbed Forest	0	0	0	1	1	4	64	0	3	1	1	0	0	75 85.3%
TurfGrass	0	1	3	21	0	5	0	84	9	10	1	0	0	134 62.7%
Pasture	0	0	0	0	0	0	0	4	46	9	0	0	0	59 78.0%
Cropland	0	0	0	0	0	0	0	3	6	156	0	0	0	165 94.5%
Woody Wetlands	2	0	0	5	0	0	0	1	0	0	127	1	1	136 93.4%
Emergent Wetlands	9	0	1	1	0	0	0	0	0	0	1	71	0	83 85.5%
<b>Total</b>	<b>287</b>	<b>134</b>	<b>62</b>	<b>484</b>	<b>125</b>	<b>50</b>	<b>70</b>	<b>116</b>	<b>86</b>	<b>185</b>	<b>135</b>	<b>82</b>		
<b>Producer's Accuracy</b>	<b>96.2%</b>	<b>95.5%</b>	<b>90.3%</b>	<b>83.7%</b>	<b>85.6%</b>	<b>62.0%</b>	<b>91.4%</b>	<b>72.4%</b>	<b>53.5%</b>	<b>84.3%</b>	<b>94.1%</b>	<b>86.6%</b>		
<b>Kappa</b>	<b>95.5%</b>	<b>95.2%</b>	<b>89.9%</b>	<b>78.6%</b>	<b>84.0%</b>	<b>60.5%</b>	<b>91.1%</b>	<b>70.2%</b>	<b>51.9%</b>	<b>82.8%</b>	<b>93.6%</b>	<b>85.9%</b>		



sanborn | www.sanborn.com  
1.866.726.2676

Overall Accuracy	85.4%
Kappa	83.3%
N	1816



# Fuzzy Accuracy Matrix

VITA Bay Area 1 Fuzzy Accuracy Matrix

## Accuracy Assessment Labels

	Water	Impervious	Barren	Forest	Tree	Scrub/Shrub	Harvested/Disturbed Forest	TurfGrass	Pasture	Cropland	Woody Wetlands	Emergent Wetlands	Total	User's Accuracy	
Water	278	0	1	0	1	0	0	0	0	0	0	0	2	282	98.6%
Impervious	0	130	0	1	2	0	0	0	2	0	2	0	0	137	94.9%
Barren	0	1	60	0	0	3	0	2	0	0	0	0	3	69	87.0%
Forest	0	0	0	421	0	2	1	1	1	2	1	1	1	430	97.9%
Tree	0	1	0	31	118	1	3	16	3	5	0	0	0	178	66.3%
Scrub/Shrub	0	1	0	6	2	43	2	4	8	2	0	0	0	68	63.2%
Harvested/Disturbed Forest	0	0	0	1	1	0	69	0	2	1	1	0	0	75	92.0%
TurfGrass	0	1	2	21	0	5	0	87	7	10	1	0	0	134	64.9%
Pasture	0	0	0	0	0	0	0	2	57	0	0	0	0	59	96.6%
Cropland	0	0	0	0	0	0	0	3	3	159	0	0	0	165	96.4%
Woody Wetlands	2	0	0	0	0	0	0	1	0	0	132	1	1	136	97.1%
Emergent Wetlands	8	0	1	1	0	0	0	0	0	0	0	0	73	83	88.0%
<b>Total</b>	<b>288</b>	<b>134</b>	<b>64</b>	<b>482</b>	<b>124</b>	<b>54</b>	<b>75</b>	<b>116</b>	<b>83</b>	<b>179</b>	<b>137</b>	<b>80</b>			
<b>Producer's Accuracy</b>	<b>96.5%</b>	<b>97.0%</b>	<b>93.8%</b>	<b>87.3%</b>	<b>95.2%</b>	<b>79.6%</b>	<b>92.0%</b>	<b>75.0%</b>	<b>68.7%</b>	<b>88.8%</b>	<b>96.4%</b>	<b>91.3%</b>			
<b>Kappa</b>	<b>95.9%</b>	<b>96.8%</b>	<b>93.5%</b>	<b>83.4%</b>	<b>94.6%</b>	<b>78.8%</b>	<b>91.7%</b>	<b>73.0%</b>	<b>67.6%</b>	<b>87.7%</b>	<b>96.1%</b>	<b>90.8%</b>			



sanborn | [www.sanborn.com](http://www.sanborn.com)  
1.866.726.2676

<b>Overall Accuracy</b>	<b>89.6%</b>
<b>Kappa</b>	<b>88.1%</b>
<b>N</b>	<b>1816</b>



# Questions?

[Dan.widner@vita.virginia.gov](mailto:Dan.widner@vita.virginia.gov)

804-416-6198