



Incorporating Mapped Land Use/Land Cover Data into Phase 7 CAST

Ag Modeling Team (AMT) Meeting

May 9, 2025

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U.S. Geological Survey, Lower Mississippi Gulf Water Science Center

Photo by Will Parson/Chesapeake Bay Program, [CBP Flickr](#)

Outline

- I. Background
 - I. What is Land Use?
 - II. Three sources of “truth” and definitions
- II. Comparing Phase 7 Land Use to Census of Agriculture
- III. Comparing Phase 7 Land Use to Census of Agriculture and Common Land Units
- IV. Explaining Outliers
- V. Comparing Phase 6 Land Use to Phase 7 Land Use
- VI. Requests from the AMT
 - I. Discussion/Questions

Requests for the AMT

We are not requesting any new decisions from the AMT at this time. We are looking to reaffirm previous decisions made by the partnership:

01

Reaffirm using spatially explicit LULC to determine total agricultural acres.

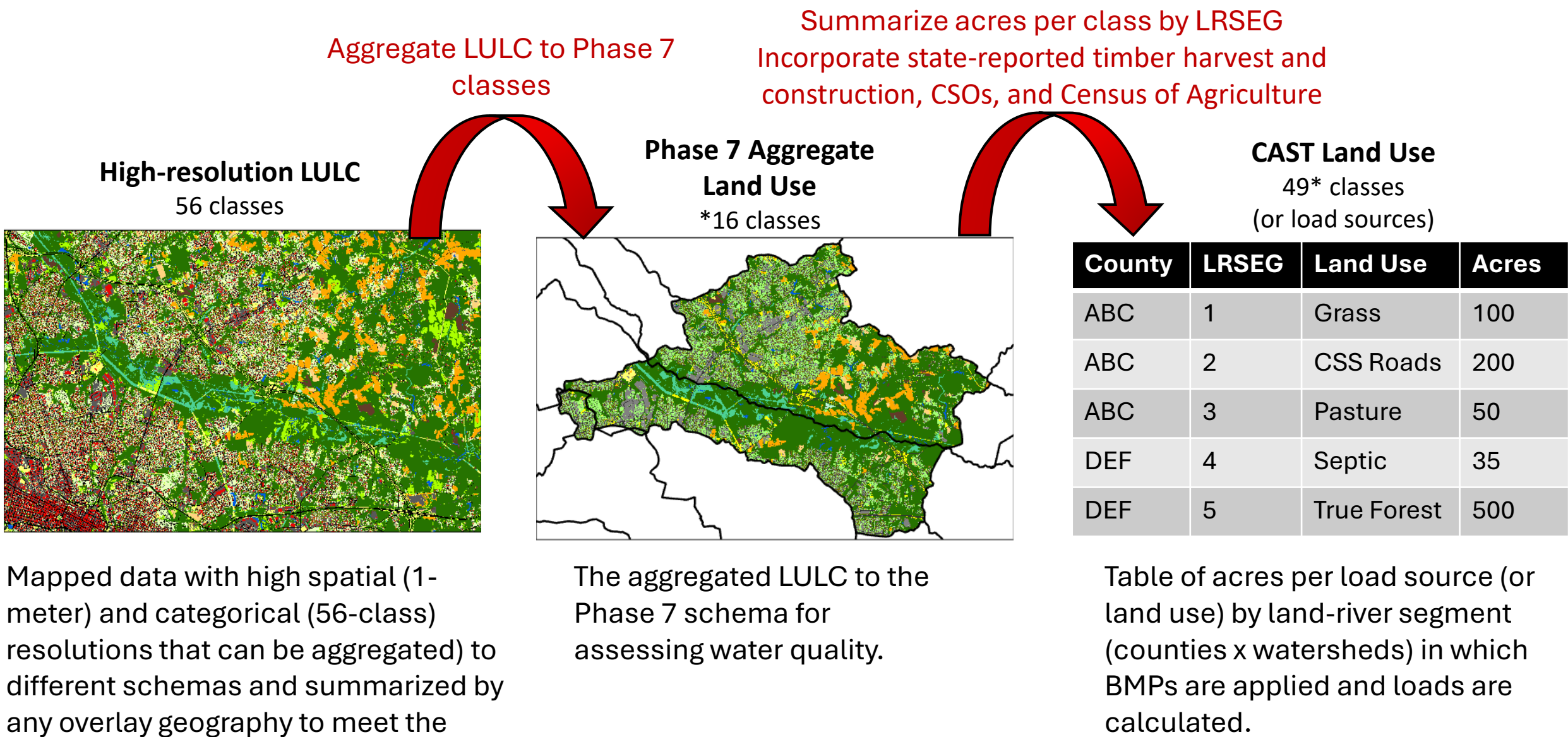
Decision made by AgWG May/April 2021

02

Reaffirm BMPs are allocated based on % of crop and pasture determined by LULC.

Decision made by AgWG May/April 2021

What does “land use” mean?



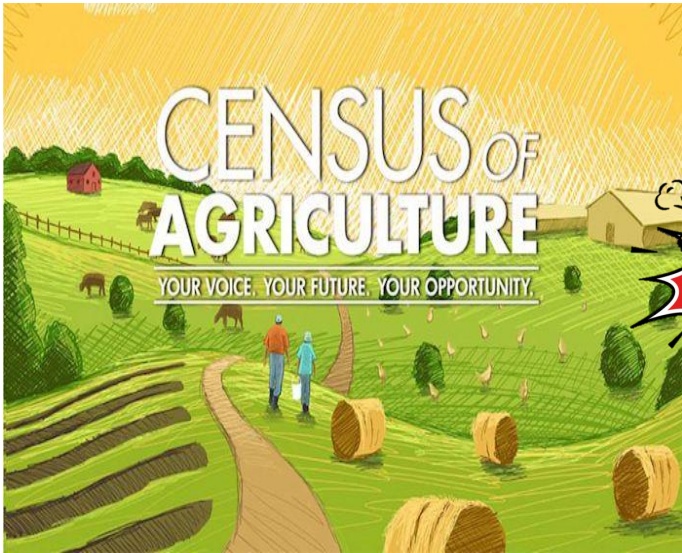
Mapped data with high spatial (1-meter) and categorical (56-class) resolutions that can be aggregated to different schemas and summarized by any overlay geography to meet the needs of a variety of projects

The aggregated LULC to the Phase 7 schema for assessing water quality.

Table of acres per load source (or land use) by land-river segment (counties x watersheds) in which BMPs are applied and loads are calculated.

CSO = Combined Sewer Overflows
* Final classification schema for Phase 7 has not yet been approved.

Comparing three sources of “truth”



Census of Agriculture (COA)

USDA-NASS

- Reported data
- Publicly available



Common Land Units (CLUs)

USDA-FSA

- Mapped data
- Private



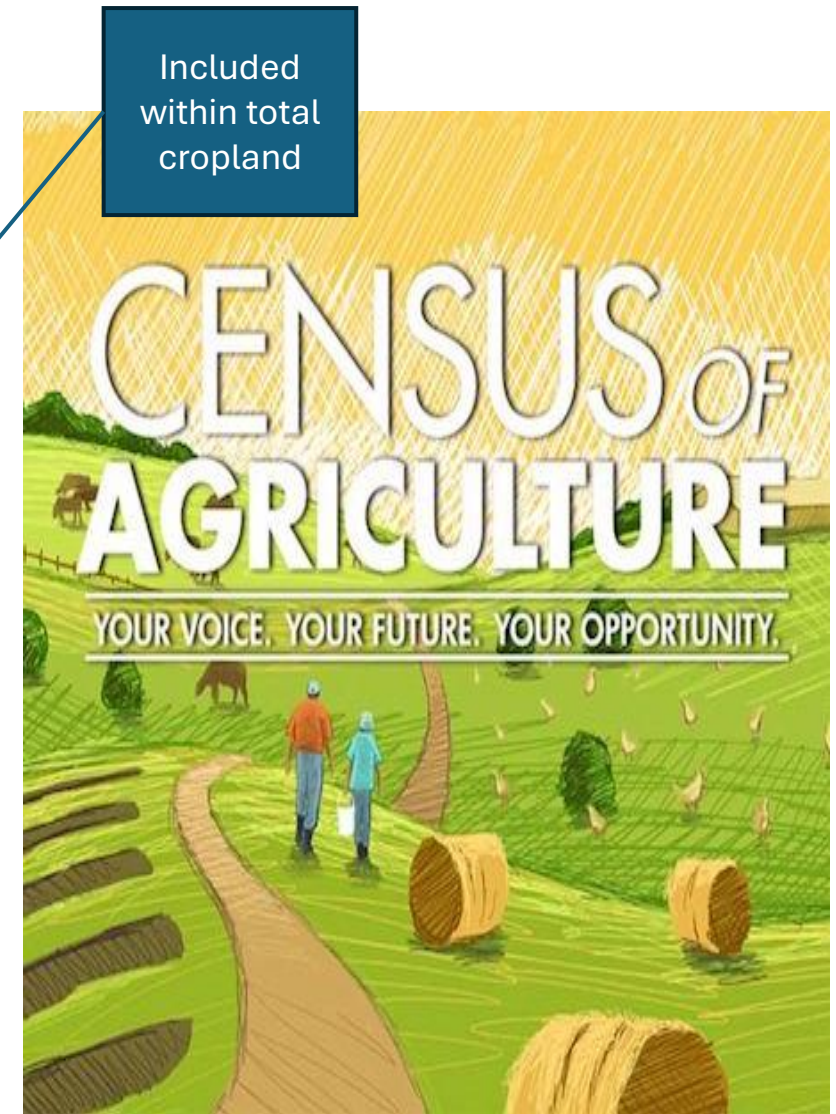
High-resolution Land Use/Land Cover (LULC)

USGS/CBP

- Mapped data
- Publicly available

COA Definitions

- **Total cropland.** This category includes cropland harvested, other pasture and grazing land that could have been used for crops without additional improvements, cropland on which all crops failed or were abandoned, cropland in summer fallow, and cropland idle or used for cover crops or soil improvement but not harvested and not pastured or grazed.
 - **Forage- land used for all hay and all haylage, grass silage, and greenchop.** Data shown represent the area harvested with each acre counted only once if dry hay, haylage, grass silage, or greenchop were cut from the same acreage or if there were multiple cuttings of dry hay, haylage, grass silage, or greenchop. Data exclude corn silage and sorghum silage.
- **Permanent pasture and rangeland, other than cropland and woodland pastured.** This land use category encompasses grazable land that does not qualify as woodland pasture or cropland pasture. It may be irrigated or dry land. In some areas, it can be a high-quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland.
- **Land enrolled in the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), or Conservation Reserve Enhancement Program (CREP).** CRP is a program established by the USDA in 1985 that takes land prone to erosion out of production for 10 to 15 years and devotes it to conservation uses. In return, farmers receive an annual rental payment for carrying out approved conservation practices on the conservation acreage. The WRP, FWP, and CREP programs are included under the Conservation Reserve Program. Operations with land enrolled in the CRP, WRP, FWP, or CREP were counted as farms, given they received \$1,000 or more in government payments, even if they had no sales and otherwise lacked the potential to have \$1,000 or more in sales.



COA Definitions

Data Item (Appendix B)	QuickStats Variable
Total Cropland	AG LAND, CROPLAND - ACRES
Permanent pasture and rangeland, other than cropland and woodland pastured	AG LAND, PASTURELAND, (EXCL CROPLAND & WOODLAND) - ACRES
Land enrolled in the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), or Conservation Reserve Enhancement Program (CREP).	GOVT PROGRAMS, FEDERAL, CONSERVATION & WETLANDS - ACRES
*Forage- land used for all hay and all haylage, grass silage, and greenchop	HAY & HAYLAGE - ACRES HARVESTED

** Included within total cropland*

CLU Definitions

CLU is defined as the smallest unit that has:

- a permanent, contiguous boundary
- common land cover management
- a common owner
- a common producer association.



A

CLU Land Classification Codes

Following are CLU land classification codes relationship to Level II USGS categories.

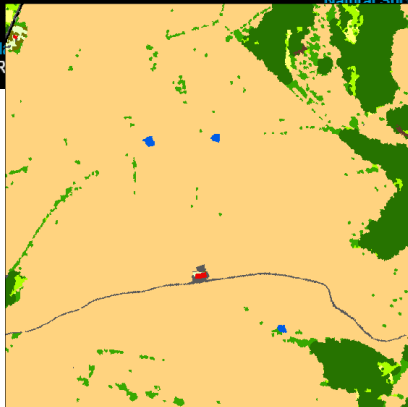
CLU Class	CLU Code	Standard Color	Relationship to Level II USGS Categories	
			Code	Name
Urban	01	Red	11	Residential
			12	Commercial and Services
			13	Industrial
			14	Transportation, Communications, and Utilities
			15	Industrial and Commercial Complexes
			16	Mixed Urban or Built-up Land
			17	Other Urban or Built-up Land
Cropland	02	Light Brown	21	Cropland and Pasture
			22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
Rangeland	03	Tan	31	Herbaceous Rangeland
			32	Shrub and Brush Rangeland
			33	Mixed Rangeland
			62	Nonforested Wetland
Forest	04	Dark Green	41	Deciduous Forest Land
			42	Evergreen Forest Land
			43	Mixed Forest Land
			61	Forested Wetland
Water Body	05	Blue	51	Streams and Canals
			52	Lakes
			53	Reservoirs
			54	Bays and Estuaries
Mined Land	06	Rose	75	Strip Mines, Quarries, and Gravel Pits
Barren	07	Grey	71	Dry Salt Flats
			72	Beaches
			73	Sandy Areas Other Than Beaches
			74	Bare Exposed Rock
			76	Transitional Areas
			77	Mixed Barren Land
Tundra	08	Light Green	81	Shrub and Brush Tundra
			82	Herbaceous Tundra
			83	Bare Ground Tundra
			84	Wet Tundra
			85	Mixed Tundra
Perennial Snow and Ice	09	Light Blue (Ice)	91	Perennial Snowfields
			92	Glaciers
Other Agriculture	10	Light Yellow	21	Confined Feeding Operations
			22	Other Agricultural Land

LULC Definitions

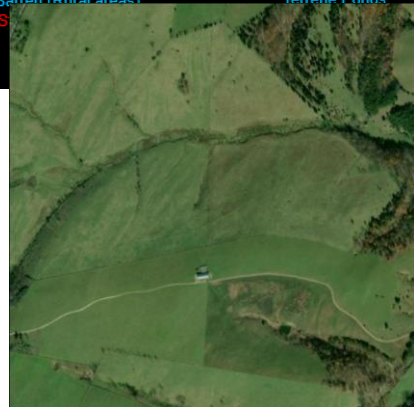
Proposed Aggregation of High-Res LULC for Phase 7

- | | | |
|--|---|---|
| 1. Impervious, Roads
Roads | 8. Compacted Pervious
Extractive Barren
Suspended Succession Barren
Suspended Succession Herbaceous
Suspended Succession Shrubland
Natural Succession Herbaceous (urban areas) | 12. Wetlands, Riverine Non-forested
Riverine Wetlands Barren
Riverine Wetlands Herbaceous
Riverine Wetlands Shrubland
Riverine Wetlands Harvested Forest |
| 2. Impervious, Non-Roads
Structures
Other Impervious (Parking lots, driveways)
Extractive Impervious | 9. Construction
Bare Developed (Urban areas?)
Solar Field Barren
Natural Succession Barren (Urban areas)
Reported Data from States | 13. Wetlands, Terrene Non-forested
Terrene Wetlands Barren
Terrene Wetlands Herbaceous
Terrene Wetlands Shrubland
Terrene Wetlands Harvested Forest |
| 3. Tree Canopy Over Impervious
TC over Roads
TC over Structures
TC over Other Impervious | 10. Forest
Forest
Forested, Other
Natural Succession Herbaceous (rural areas)
Natural Succession Shrubland
Riverine Wetlands Tree Canopy
Riverine Wetlands Forest
Terrene Wetlands Tree Canopy
Terrene Wetlands Forest | 14. Cropland
Cropland Barren
Cropland Herbaceous
Orchards and Vineyards Barren
Orchards and Vineyards Herbaceous
Orchards and Vineyards Shrubland |
| 4. Turf Grass
Turf Grass | 11. Harvested Forest (2)
Harvested Forest Barren
Harvested Forest Herbaceous
Natural Succession Barren (Rural areas) | 15. Pasture and Hay
Pasture and Hay Barren
Pasture and Hay Herbaceous |
| 5. Tree Canopy over Turf Grass
Tree Canopy over Turf Grass | | 16. Water
Lakes & Reservoirs
Riverine Ponds
Terrene Ponds |
| 6. Solar Infrastructure
Solar Field Panel Arrays | | |
| 7. Solar Pervious
Solar Field Herbaceous
Solar Field Shrubland | | |

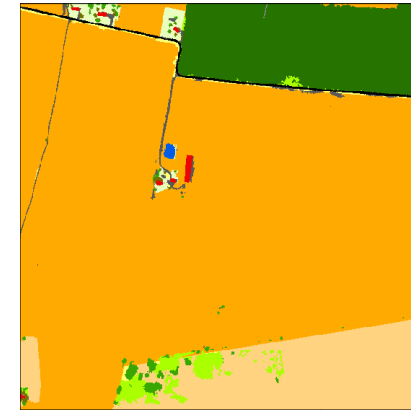
Blue = LULC 56-cl
White = Phase 7 R



2022 ed LULC
Pasture/Hay



Imagery



2022 ed LULC
Cropland



Imagery



Cropland (CROP)

Low vegetation, shrubland and barren lands used for the production of grains, legumes, vegetables, fruits and nuts, grapevines, or other agricultural crops.

Raster Value(s): 80-84

Detailed (56) land use/land cover (LULC) included in this class:

- [Cropland Barren](#)
- [Cropland Herbaceous](#)
- [Orchards and Vineyards Barren](#)
- [Orchards and Vineyards Herbaceous](#)
- [Orchards and Vineyards Shrubland](#)



Pasture and Hay (PAST)

Low vegetation and barren lands used for grazing livestock (e.g., cattle, goats, sheep) or producing fodder (e.g., hay and alfalfa).

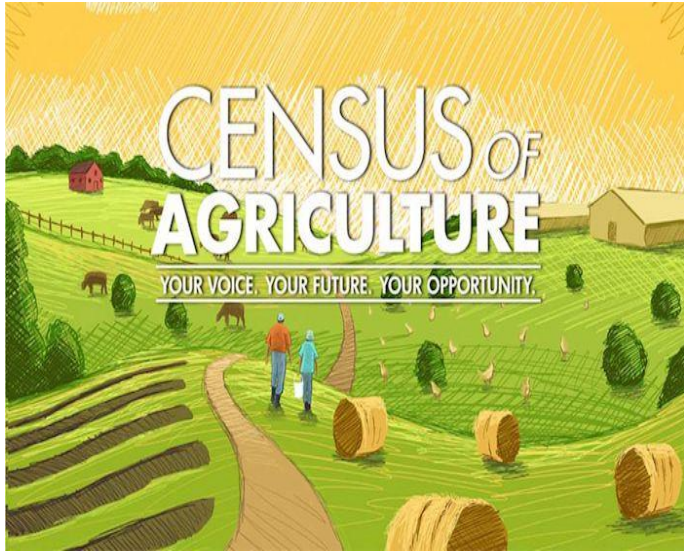
Raster Value(s): 85-86

Detailed (56) land use/land cover (LULC) included in this class:

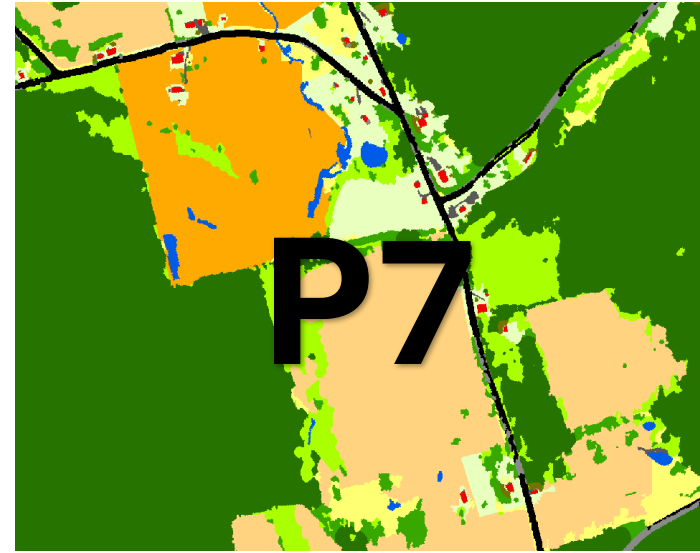
- [Pasture and Hay Barren](#)
- [Pasture and Hay Herbaceous](#)

Defining Total Agriculture, Cropland and Pasture for Comparison

	COA 	CLU 	LULC 
Cropland	[Total Cropland – Hay/Haylage] + Conservation Reserve Program (CRP)	N/A	Cropland
Pasture/Hay	Pastureland, Excl Cropland and Woodland + Hay/Haylage	N/A	Pasture and Hay
Total Agriculture	Total Cropland + Pastureland, Excl Cropland and Woodland + Conservation Reserve Program (CRP)	Class #2	Cropland + Pasture and Hay



2022 Census of
Agriculture (COA)

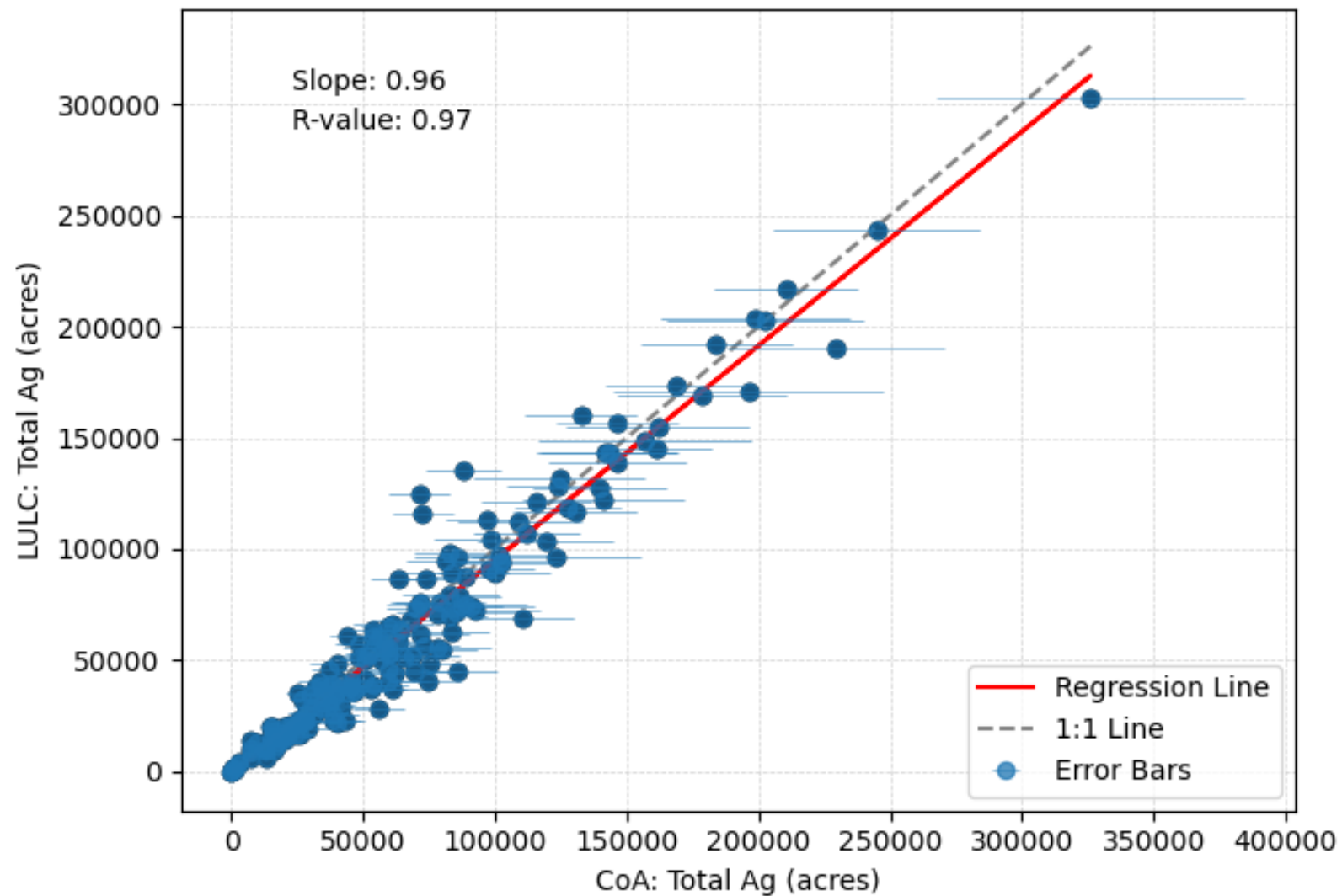


2021/2022
Land Use/Land Cover (LULC)

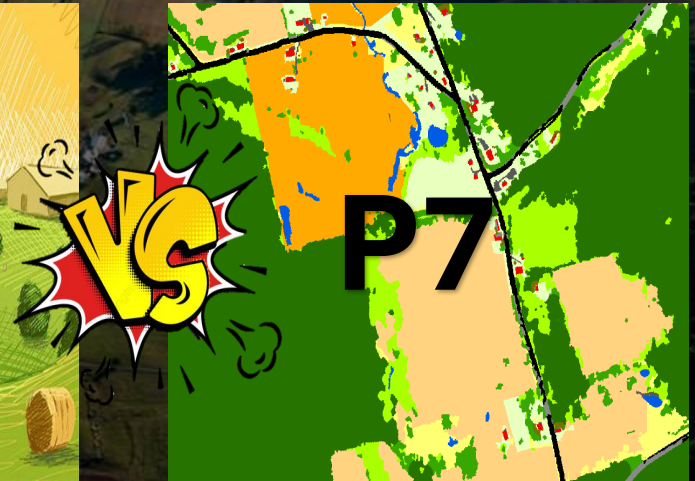
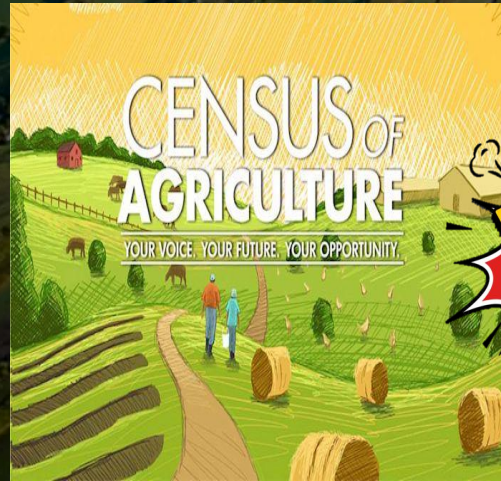
Comparing the COA to the Phase 7 LULC

Years 2021/2022

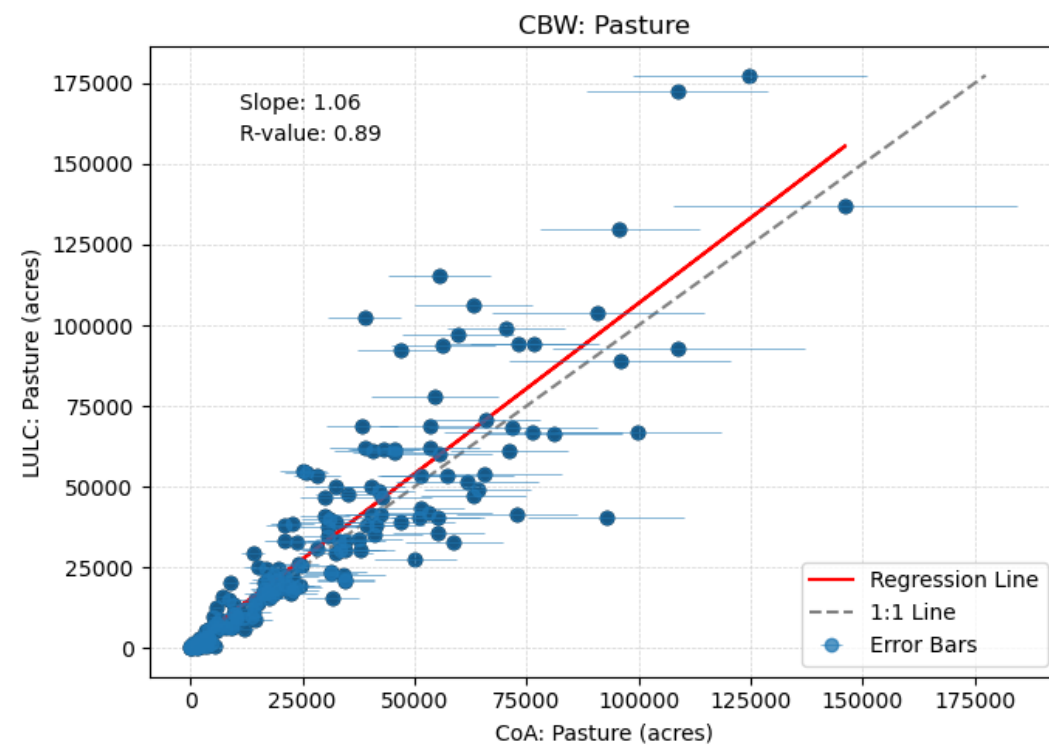
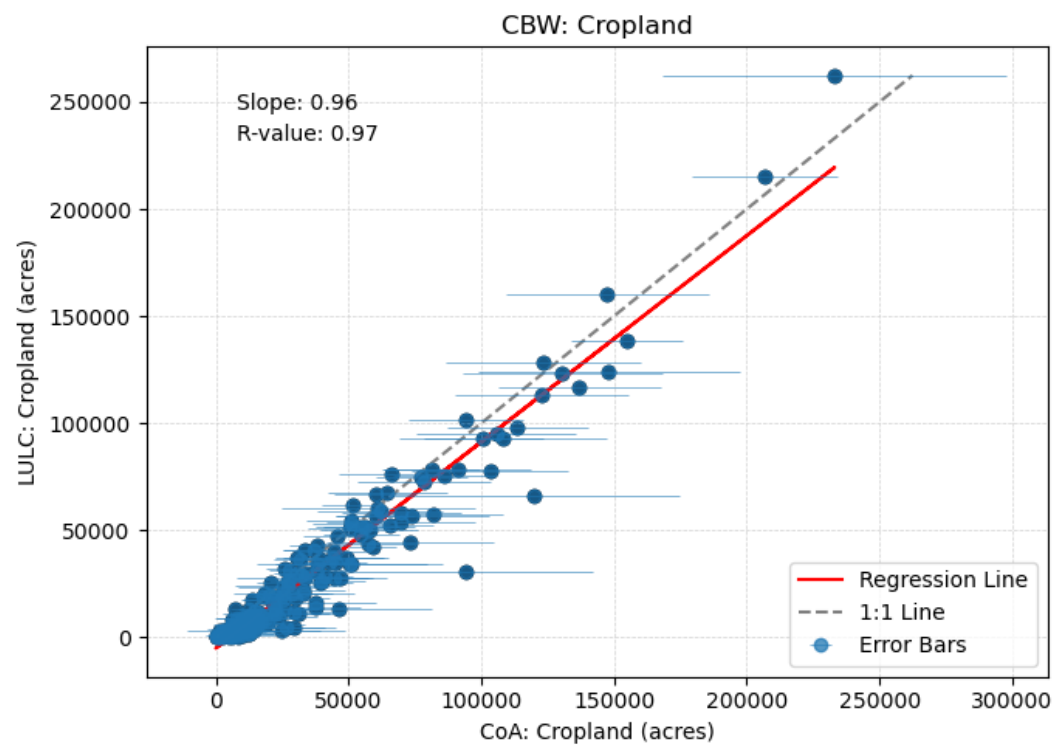
CBW: Total Agriculture



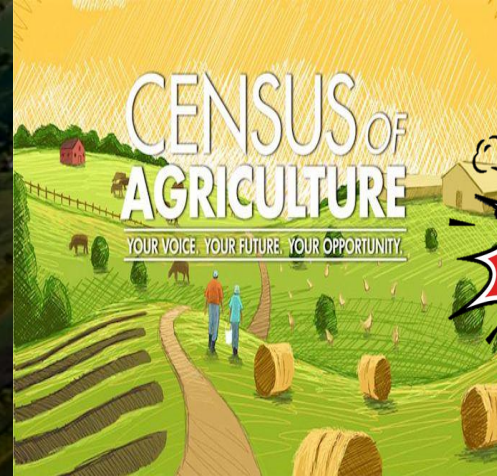
Takeaway



For years 2021/22, the Phase 7 LULC aligns well with the Census of Agriculture for total agricultural land.

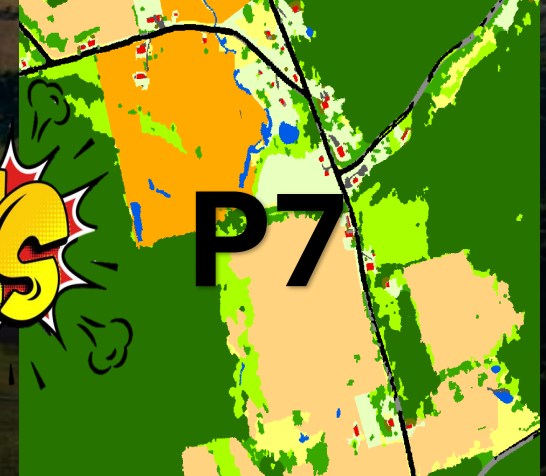


Takeaway

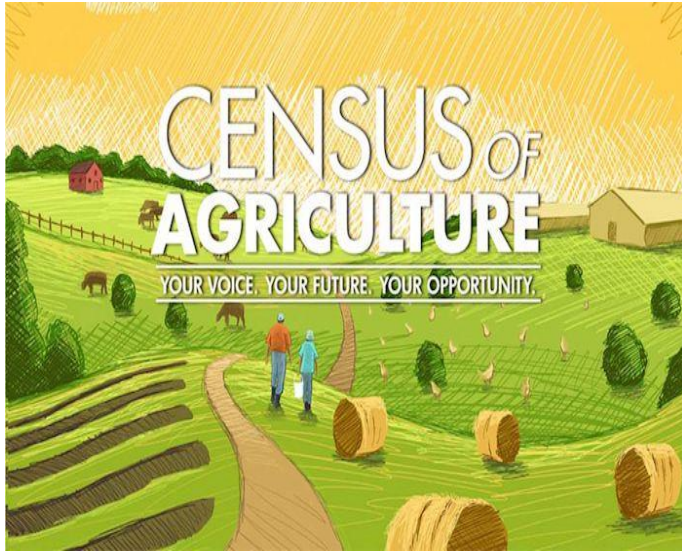


VS

P7



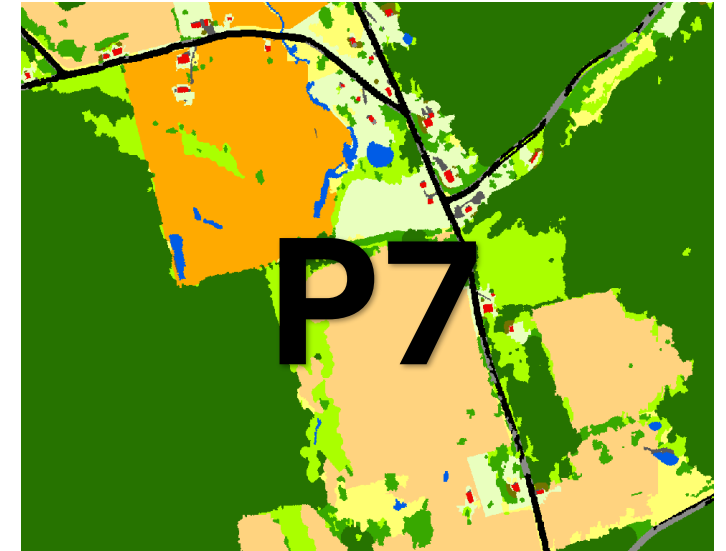
For the years 2021/22, the Phase 7 LULC acres of pasture/hay and cropland align well with the Census of Agriculture, despite slightly more variation than total agriculture.



2022 Census of
Agriculture (COA)



2023 Common Land
Units (CLUs)

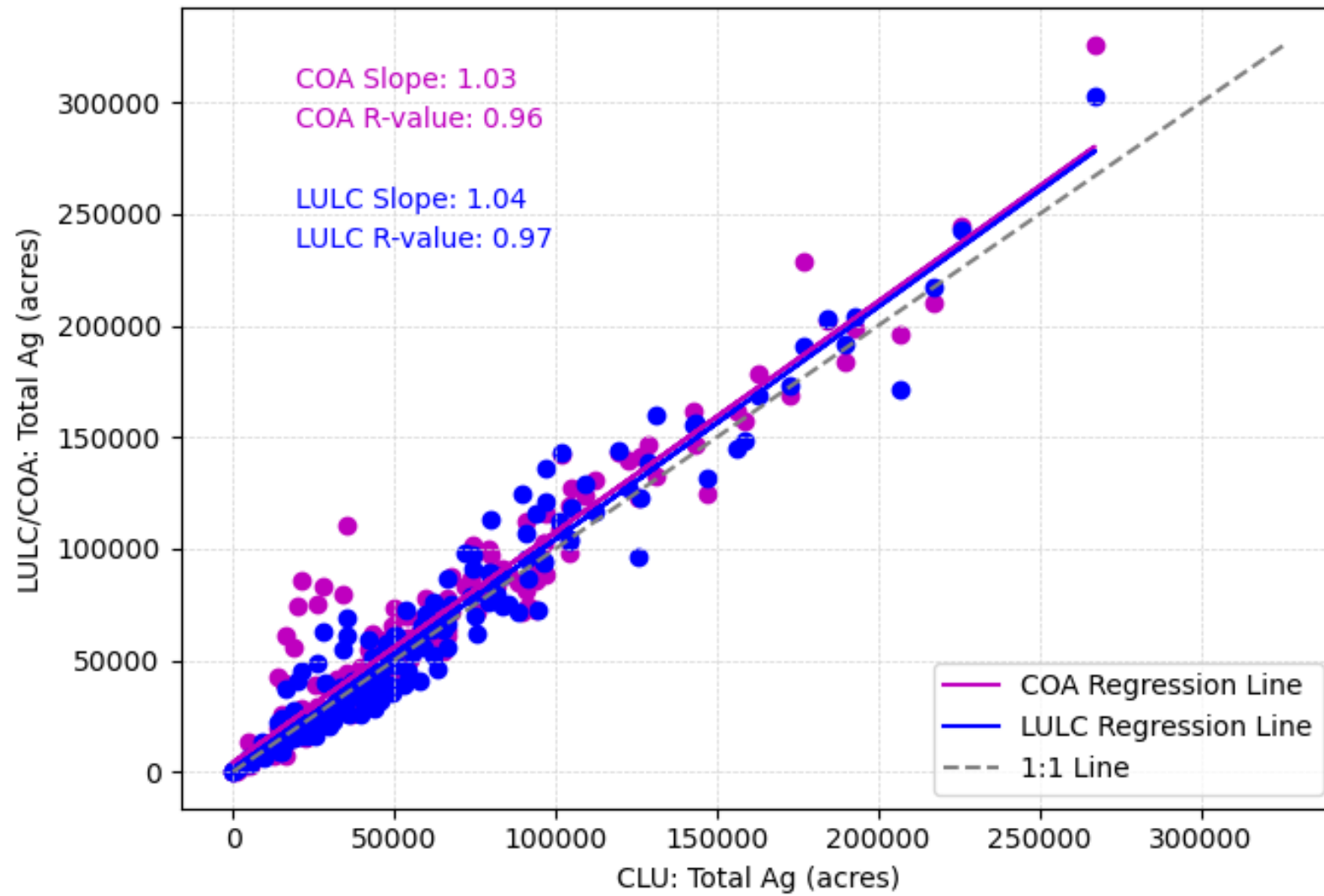


2021/2022
Land Use/Land Cover (LULC)

Comparing COA and CLUs to Phase 7 LULC

Years 2021/2022/2023

CBW: Total Agriculture

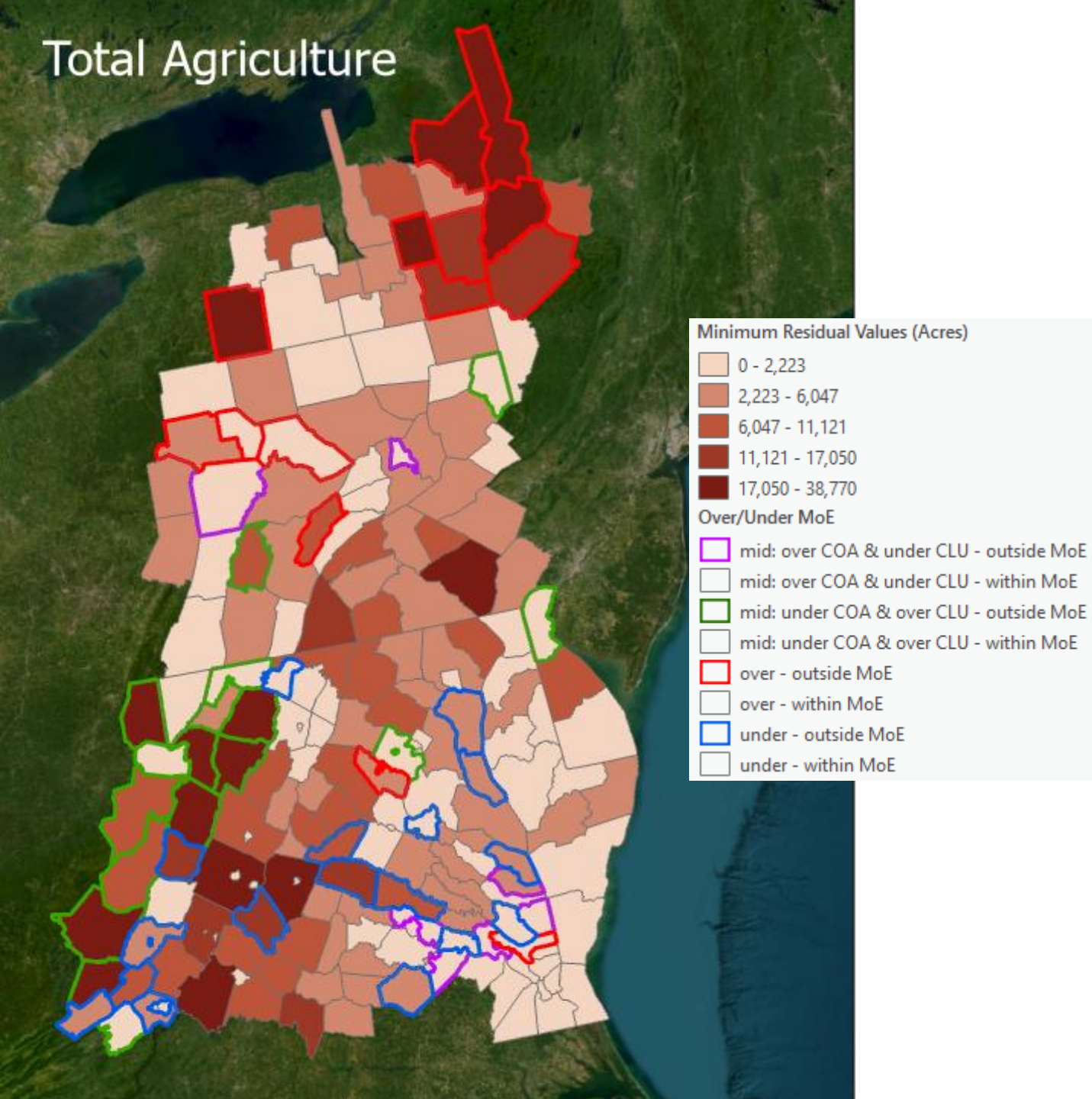


Takeaway



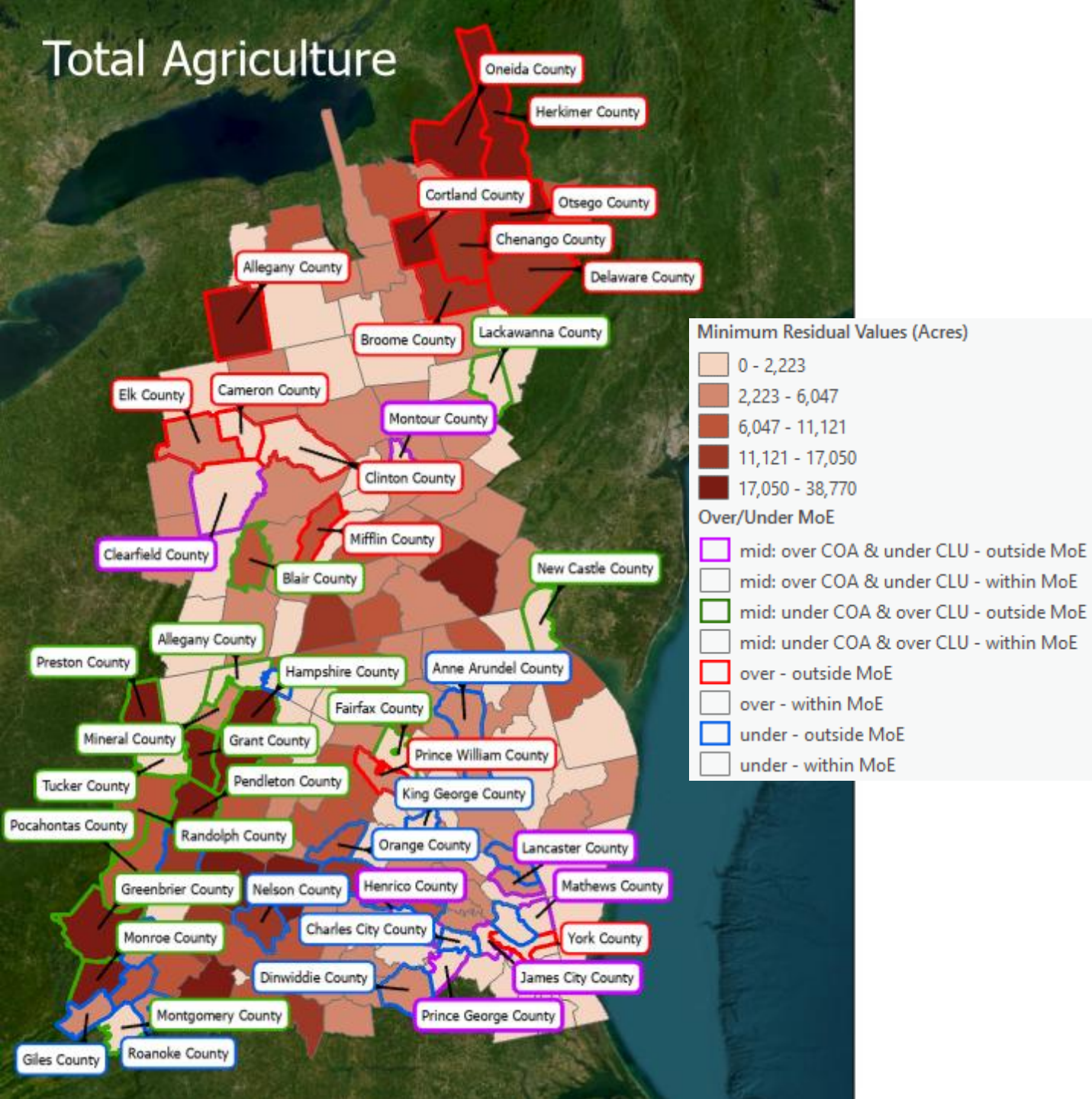
The COA and CLU data bracket the realm of possibility for what is mapped as total agriculture. The “truth” is likely between these two estimates – and that’s typically where our LULC estimates exist.

Total Agriculture

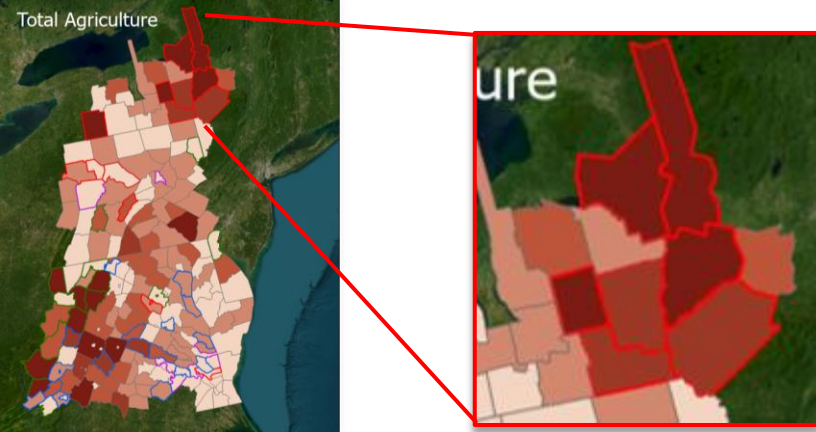


Where does the
LULC over-map and
under-map
agriculture in the
watershed?

Total Agriculture



Where does the
LULC over-map and
under-map
agriculture in the
watershed?



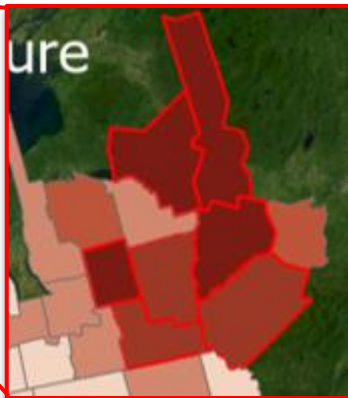
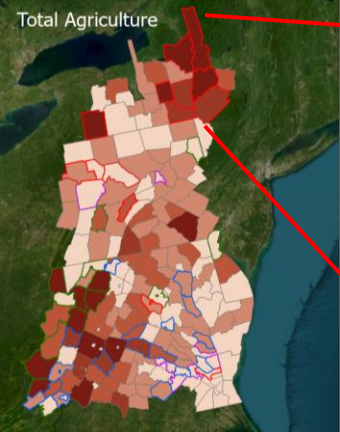
Counties LULC **over-maps** ag compared to both COA and CLUs: New York

County	FIPS	LULC	COA	Hi_COA	Lo_COA	CLU
Allegany	36003	124,416	71,472	82,938	60,006	89,353
Herkimer	36043	115,756	72,520	84,155	60,885	93,994
Otsego	36077	135,677	88,280	102,476	74,084	96,907
Oneida	36065	160,054	132,808	154,009	111,607	131,291
Cortland	36023	86,391	63,485	73,776	53,194	66,167

Hi_COA: High COA estimate accounting for county-specific margin of error.

Lo_COA: Low COA estimate accounting for county-specific margin of error.

Note: most of the major outlier counties in NY are straddling the CBW, not within.

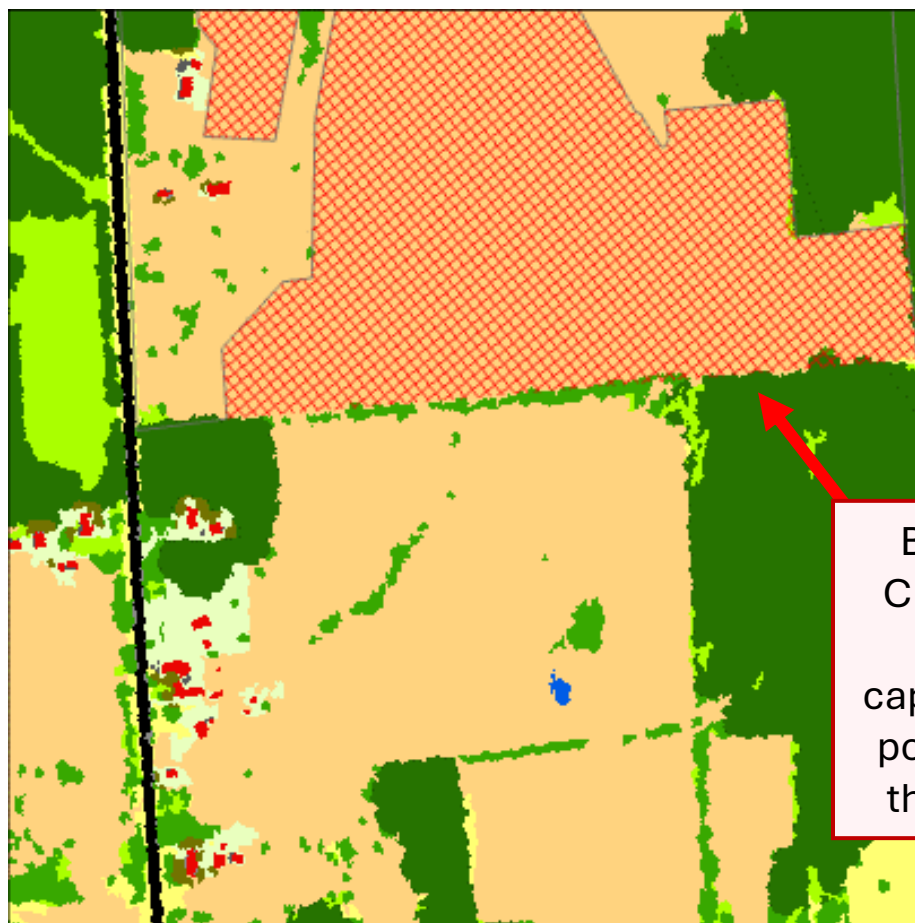


Counties LULC over-maps ag compared to both COA and CLUs: New York

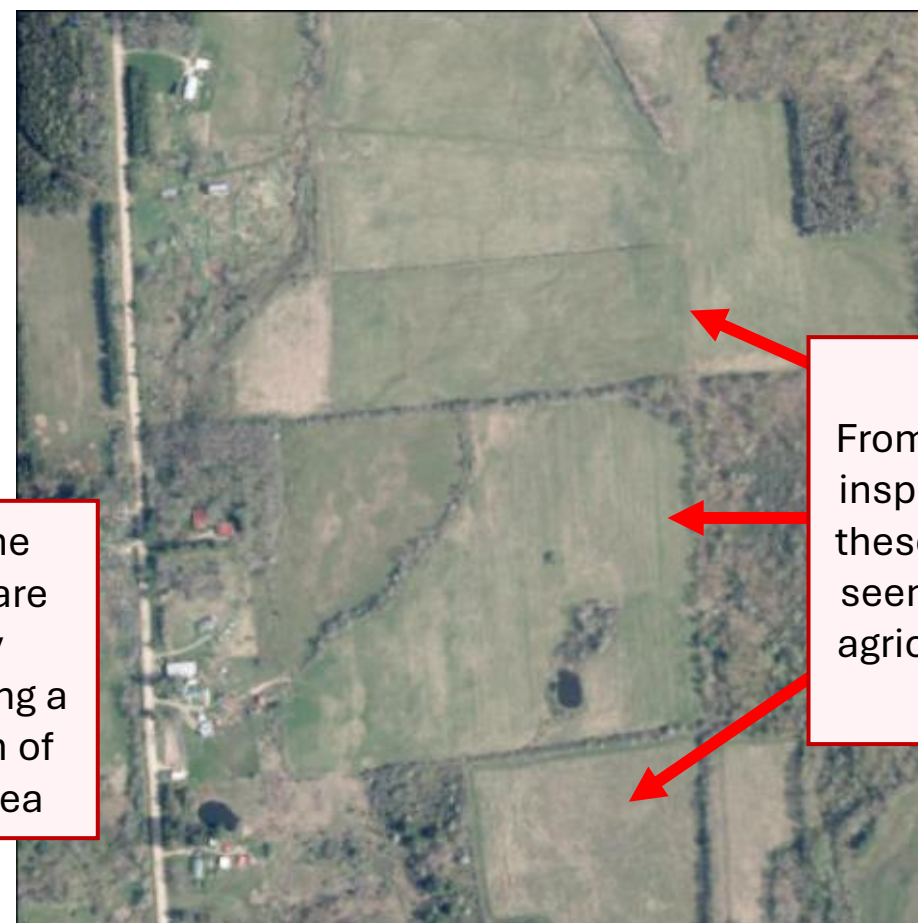
- Water
- Natural Succession
- Impervious Roads
- Impervious Structures
- Impervious, Other
- Tree Canopy over Impervious
- Tree Canopy over Turf Grass
- Turf Grass
- Pervious Developed, Other
- Forest
- Forested, Other
- Harvested Forest
- Wetlands, Riverine Non-forested
- Wetlands, Terrene Non-forested
- Wetlands, Tidal Non-forested
- Cropland
- Pasture and Hay
- Extractive

CLU Classification

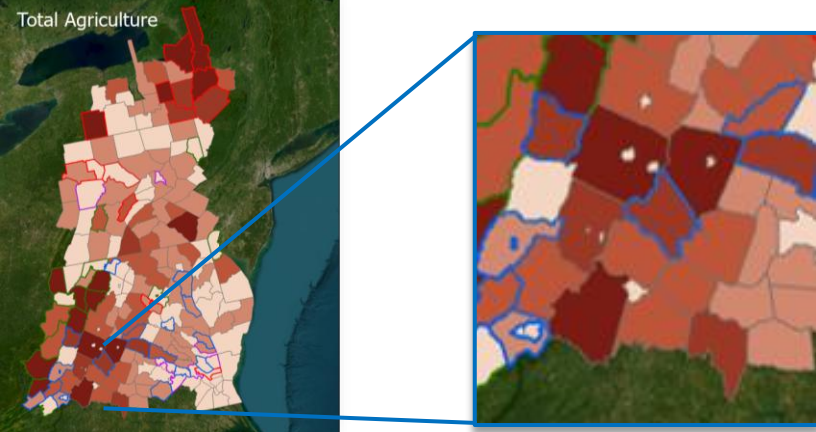
- Class 2 (Crop + Pasture)



But the CLUs are only capturing a portion of this area



From visual inspection, these areas seem to be agriculture.



Counties LULC **under-maps** ag compared to both COA and CLUs: Virginia

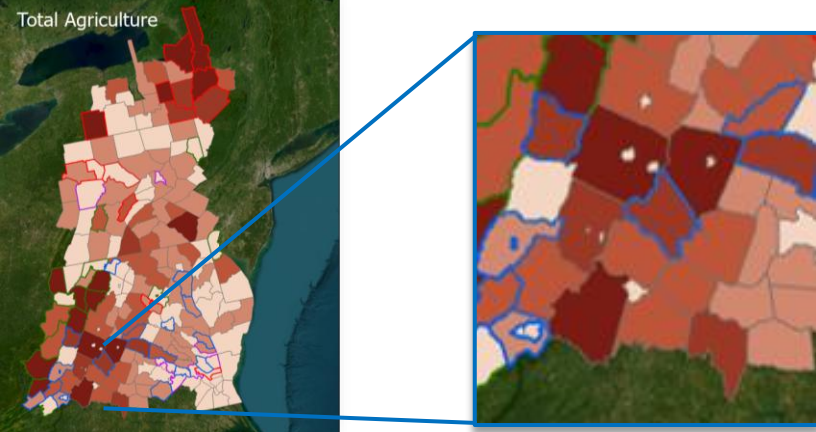
County	FIPS	LULC	COA	Hi_COA	Lo_COA	CLU
Highland	51091	40,717	59,416	75,223	43,609	57,767
Louisa	51109	39,034	53,297	67,079	39,516	53,048
Nelson	51125	25,857	38,505	48,538	28,472	39,340

Hi_COA: High COA estimate accounting for county-specific margin of error.

Lo_COA: Low COA estimate accounting for county-specific margin of error.

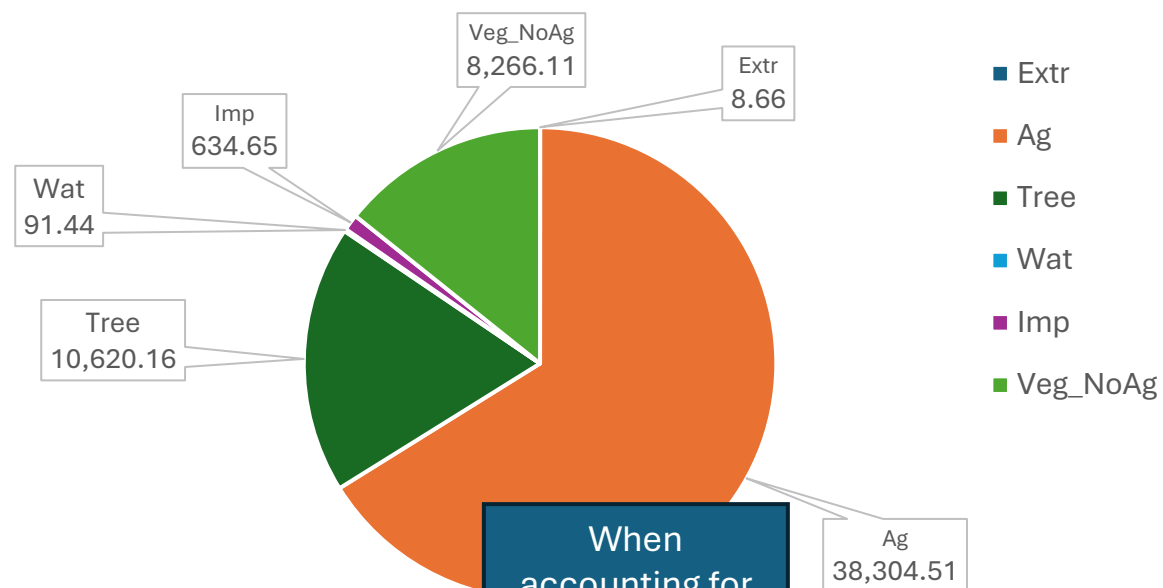
LULC is under-mapping ag in these counties, but is just barely under the COA margin of error. The total difference in acres is not substantial.

LULC also may be “under-mapping” because the CLU footprint captures non-agricultural land uses in some cases. See next slide.



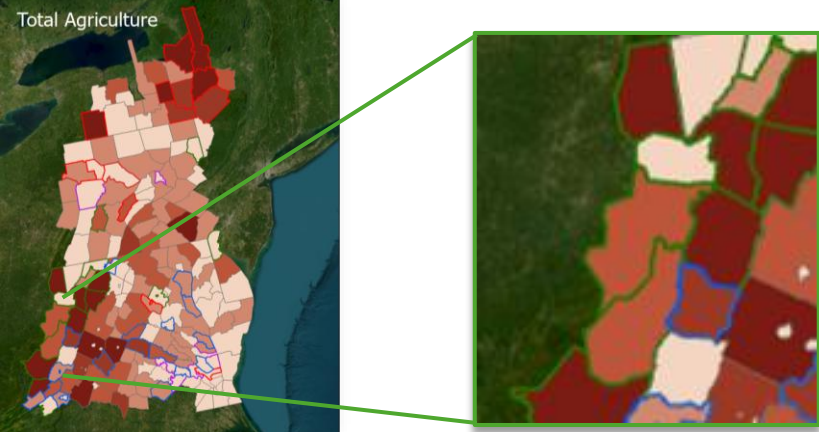
Example: Highland County, Virginia

Composition of land uses in CLU footprint: Highland County, VA



	Acres
Total Ag LULC	40,717
Total Ag CLU	57,767
CLU (without Tree, Imp, and Water)	46,579
COA Margin of Error	7,374
CLU (Low Estimate)	39,205

When accounting for this, the CLU and LULC estimates are more similar

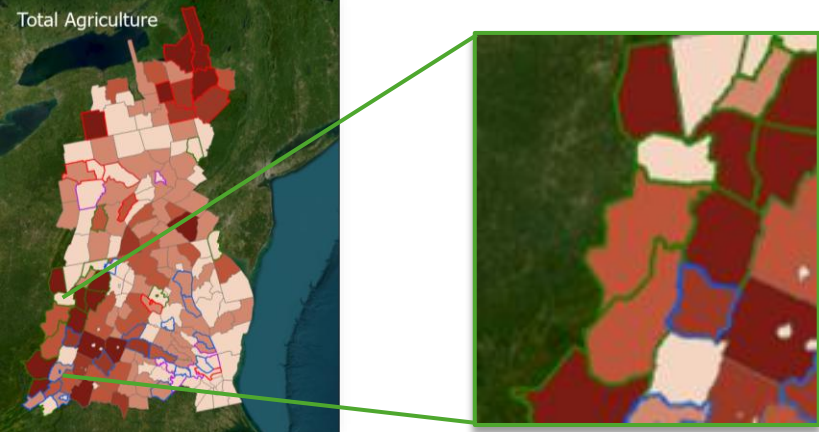


Counties LULC **under-maps** ag compared to COA and **over-maps** compared to CLUs: West Virginia

County	FIPS	LULC	COA	Hi_COA	Lo_COA	CLU
Grant	54023	37,247	61,076	71,525	50,627	16,477
Hampshire	54027	48,620	75,485	88,234	62,736	26,261
Hardy	54031	40,908	74,737	87,555	61,919	20,132
Pendleton	54071	44,783	85,810	100,687	70,933	21,008
Preston	54077	54,781	79,641	93,044	66,238	33,835

Hi_COA: High COA estimate accounting for county-specific margin of error.
 Lo_COA: Low COA estimate accounting for county-specific margin of error.

Note: some of the major outlier counties in WV are straddling the CBW, not within.



Counties LULC **under-maps** ag compared to COA and **over-maps** compared to CLUs: West Virginia

Why are we over-mapping compared to CLUs?

Top Crops in Acres *

Forage (hay/haylage), all	16,936
Corn for grain	861
Corn for silage/greenchop	278
Cultivated Christmas trees	(D)
Soybeans for beans	(D)

[Grant](#)

Top Crops in Acres *

Forage (hay/haylage), all	32,758
Corn for grain	2,560
Soybeans for beans	1,465
Corn for silage/greenchop	285
Cultivated Christmas trees	(D)

[Preston](#)

Top Crops in Acres *

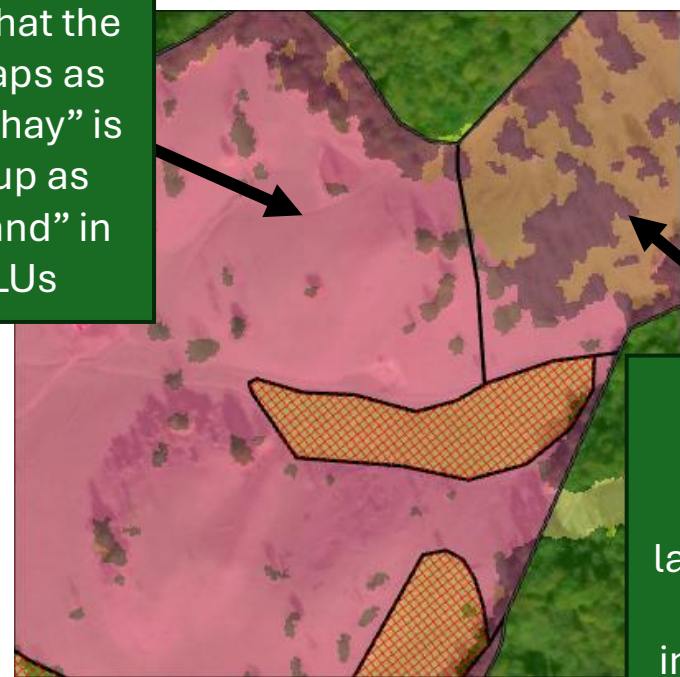
Forage (hay/haylage), all	29,061
Corn for grain	1,358
Vegetables harvested, all	407
Soybeans for beans	334
Apples	179

[Hampshire](#)

According to the Census, these counties have significant hay/haylage & alfalfa production. The LULC may be mis-classifying some of these acres as Natural Succession or Suspended Succession.

Why are we under-mapping compared to COA?

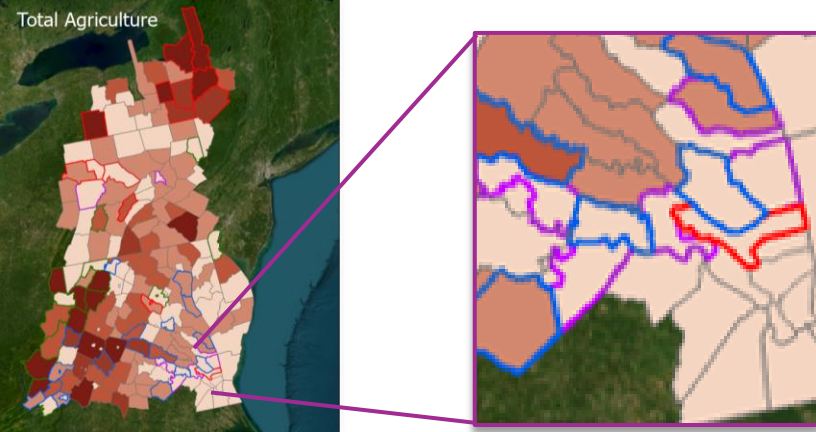
A lot of what the LULC maps as “pasture/hay” is picked up as “Rangeland” in the CLUs



CLU Classification

- Class 2 (Crop + Pasture)
- Class 3 (Rangeland)

However, “Rangeland” also classifies a lot of land uses outside of agriculture – including wetlands, natural succession, and forest.



Counties LULC **over-maps** ag compared to COA and **under-maps** compared to CLUs: Virginia/Pennsylvania

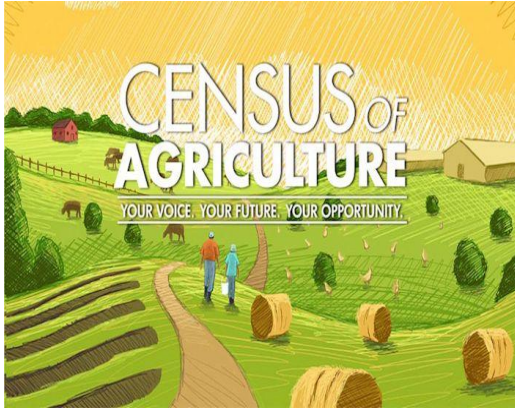
County	FIPS	LULC	COA	Hi_COA	Lo_COA	CLU
Clearfield	42033	46,078	37,080	43,829	30,331	46,500
Henrico	51087	10,153	6,964	8,736	5,192	12,383
Lancaster	51103	13,791	7,570	9,463	5,677	16,295
Prince George	51149	20,635	15,590	19,469	11,711	23,000

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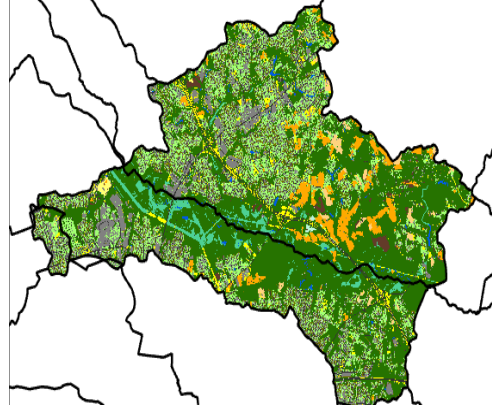
LULC estimates typically align well with the CLU estimates in these counties.



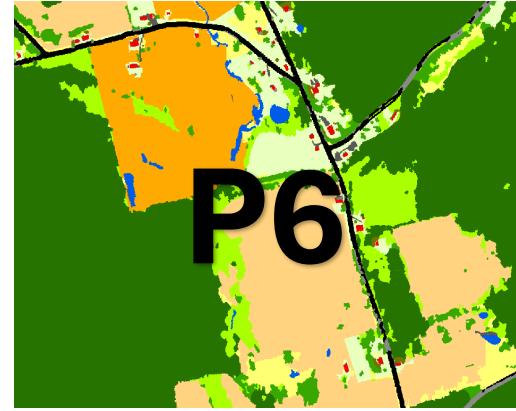
2012 Census of
Agriculture



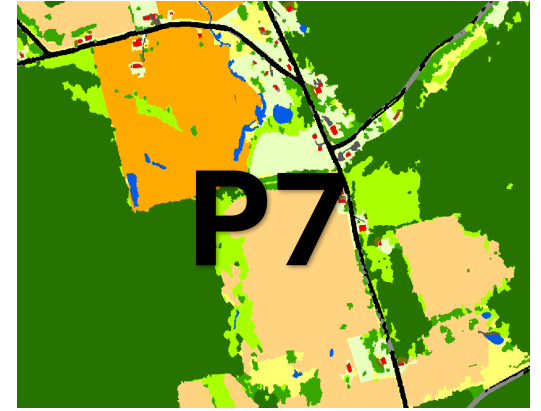
2013/14
Phase 6
CAST Land Use



2013/14
Phase 6
Land Use/
Land Cover



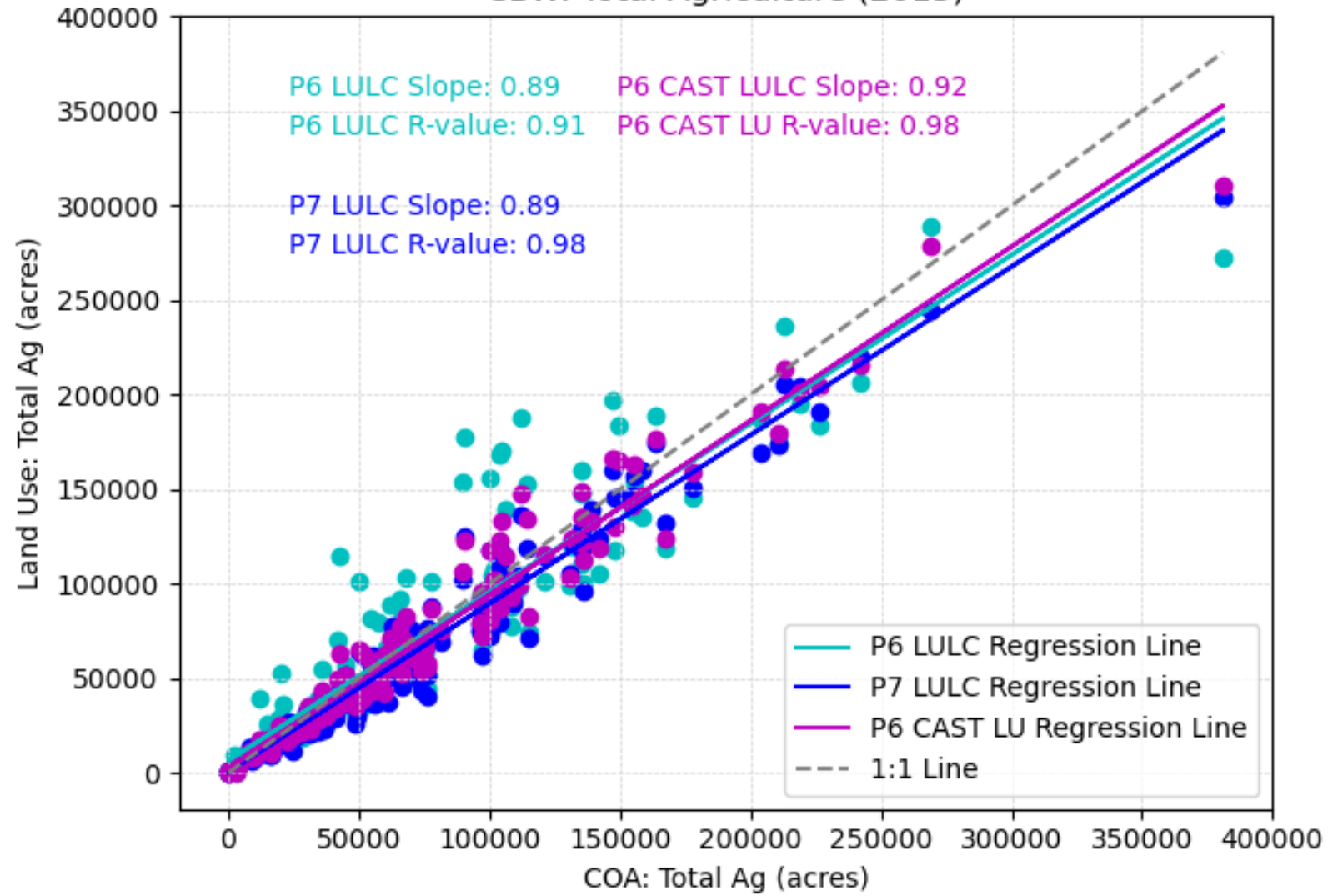
2013/14
Phase 7
Land Use/
Land Cover



Comparing Phase 6 LU to Phase 7 LU

Years 2012/2013/2014

CBW: Total Agriculture (2013)



Requests for the AMT

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Reaffirm using spatially explicit LULC to determine total agricultural acres.

Decision made by AgWG May/April 2021.

02

Reaffirm BMPs are allocated based on % of crop and pasture determined by LULC.

Decision made by AgWG May/April 2021.

An aerial photograph of a rural landscape featuring a patchwork of green and brown agricultural fields, interspersed with dark green forested areas. A winding road or path is visible in the lower-left quadrant, and a small cluster of buildings is situated near the bottom center. The lighting suggests a late afternoon or early morning scene, with long shadows cast across the terrain.

Questions & Feedback

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An aerial photograph of a rural landscape, likely in the Chesapeake Bay watershed, showing a patchwork of green and brown agricultural fields, a winding road, and some farm buildings. The image is used as a background for the document.

Acronym List

- AgWG: Agriculture Workgroup
- AMT: Agricultural Modeling Team
- CAST: Chesapeake Assessment Scenario Tool
- CBP: Chesapeake Bay Program
- CBW: Chesapeake Bay Watershed
- CLU: Common Land Unit
- COA: Census of Agriculture
- CRP: Conservation Reserve Program
- FSA: Farm Service Agency
- LULC: Land Use/Land Cover
- MoE: Margin of Error
- NASS: National Agricultural Statistics Service
- P6: Phase 6 [Watershed Model]
- P7: Phase 7 [Watershed Model]
- USDA: United States Department of Agriculture
- USGS: United States Geological Survey

References/Additional Information

- Census of Agriculture Definitions - Appendix B:
https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_US/usappxb.pdf
- Census of Agriculture - Aggregations for Cities to Counties:
agcensusmaps.nass.usda.gov
- AgWG Decisions about using high-res LULC: [April 2021 Meeting](#)
- Phase 6 [CAST land use documentation](#)
- Common Land Unit (CLU) Manual:
https://www.fsa.usda.gov/Internet/FSA_File/8-cm.pdf