METHODS FOR DEVELOPING THE CAST LAND USE

LAND USE WORKGROUP – MAY 5, 2021

JESSICA RIGELMAN, J7 LLC

OLIVIA DEVEREUX, DEVEREUX CONSULTING, INC.

OVERVIEW

1. Data consistency assessment
2. Interpolate among all years
3. Combine with the Agriculture Census
4. Incorporate the construction and harvested forest acres reported by the states
5. Projections
6. Changes incorporated into CAST-21, pending Partnership support
7. Review of data

GENERAL OBJECTIVES FOR A MODEL LAND USE

Model purpose: Estimate the trend in pollutants due to changes in inputs

- Maintain a consistent trend in land use change for assessing BMPs and their load reductions
- The land use trend should reflect the trend in mapped changes


Mapped land uses for 1984, 1991, 2001, 2006, 2013
Combined Sanitary Sewers
Land use error rates
Construction and Harvested Forest Acres from States or Calculated
CAST LAND USE
Land Data Team: 12 land uses for 2013, 2017, and 2025
National Agricultural Statistical Service: Agricultural Census
MS4 acres
Agencies

1. DATA CONSISTENCY ASSESSMENT

- Combined sanitary sewer (CSS) acres are constant through time
  - Changes to CSS due to sewer hookups are handled in wastewater inputs
  - Move CSS crop and pasture to CSS mixed open
  - Move CSS wetland and water to CSS forest
- Federal agency land are constant through time
  - Federal, Maryland State, and Maryland State Highway land are moved from crop and pasture to nonfederal agency type
  - Proportional adjustments are made for years other than 2013 to keep the total for each agency in each land-river segment the same as 2013

2. INTERPOLATION

- Mapped land uses previously were provided for:
  - 1984, 1991, 2001, 2006, 2013
- New mapped land uses anticipated for:
  - 2017 and 2025
- Linear interpolation between 1985 and 2025
- Land-river segments do not change in total acres
  - Each land-river segment's total acres are set to be equivalent to the CBLCM 2013 land-river segment acres
  - This accommodates the difference due to tidal wetlands which are included in the CBLCM but are not in CAST

3. NATIONAL AGRICULTURAL STATISTICAL SERVICE

- The Agricultural Census is conducted in years ending in 2 and 7
- In years for which acres of crops are provided by the Census of Agriculture (1982, 1987, 1992, 1997, 2002, 2007, 2012, and 2017), those acres are used directly in estimating the total land use acres after considering any acres upon which two crops may have been grown. Acres of crops and pasture in intervening years are interpolated.
- The Agricultural Census is available only at the county scale
- PROPOSED CHANGE: Use the mapped agricultural land use and fit the crops, hay, and pasture into that mapped agricultural area proportionally

3. PROPORTIONING OF AG CENSUS

- Agricultural land uses are apportioned from the county level to land-river segments based on the relative proportion of land-river segment acres to county acres using the three mapped classes: total agriculture, pasture, or cropland.
- Relative proportions of total agriculture are used to allocate: Permitted Feeding Space and Non-Permitted Feeding Space.
- Relative proportions of pasture are used to allocate: Ag Open Space, Legume Hay, Other Hay, and Pasture.
- Relative proportions of cropland are used for all other agricultural land uses.

3. ADJUSTMENTS TO THE AGRICULTURAL CENSUS

- Accommodating agriculture in Virginia's cities
  - Virginia has 39 cities in the Chesapeake Region that have unique Federal Information Processing (FIPs) codes
  - The Agricultural Census does not include records for these cities; however, the mapped land use includes agricultural classes for some.
  - These cities are assigned a fraction of Agricultural Census crop, yield, and animal data based on a neighboring county that has agricultural data.
- All counties intersecting the Chesapeake Bay watershed are fully modeled
  - The amount of crop and pasture in land-river segments is determined using the fraction of crop and pasture within the watershed from the Mapped Land Use. The fraction can vary between zero and one. This fraction is calculated for each year of the Mapped Land Use and interpolated for all other years. This is particularly significant for counties partially out of the watershed
  - States may submit this fraction for animals but not land use

4. FEEDING SPACE

- Feeding space includes include barnyards or feedlots and structures such as dairy barns or poultry houses. The production areas can be large sources of nutrient runoff if improperly maintained with BMPs
- Feeding space is not included in the Agricultural Census or in the mapped land use
- The area is calculated as an average areas per animal of roofed structure and, for some animal types, barnyard multiplied by the estimated number of animals produced in each county
- States provide the fraction of permitted vs. not permitted

4. FEEDING SPACE

- Animal production area continues to be determined by the Bay Program as a calculation outside of the land cover datasets. While NASS does not have anything specific to address those land areas, Mr. Mueller suspects they are mapped as urban by NLCD and incorporated into the CDL as urban.
- Farm buildings are mapped by NLCD (and therefore by CDL too) as impervious surface and development and incorporated into CDL as developed classes.
- While the amount of feeding space needs to be tied to the amount of animals, not just aerial imagery, recent investigations into the mapping of animal production areas from aerial imagery show promise that it may be possible to map these areas for CAST-23.
- CAST-21 will keep the same methodology for feeding space as has been used in all other Phase 6 model versions.

4. CONSTRUCTION AND HARVESTED FOREST

- Construction acres are not available from the mapped land use and would not reflect the average trend
- Construction is submitted by states or calculated
  - 1.29 * (current year + 1 developed acre – current year's developed acre)
  - developed land use acres are reduced proportionally to accommodate construction acres
- Harvested forest is submitted by states or 1.5% of forest
  - True forest is reduced proportionally to accommodate harvested forest acres.

4. MAINTAINING CONSTANT LAND-RIVER SEGMENT SIZE WITH THE ADDITION OF FEEDING SPACE

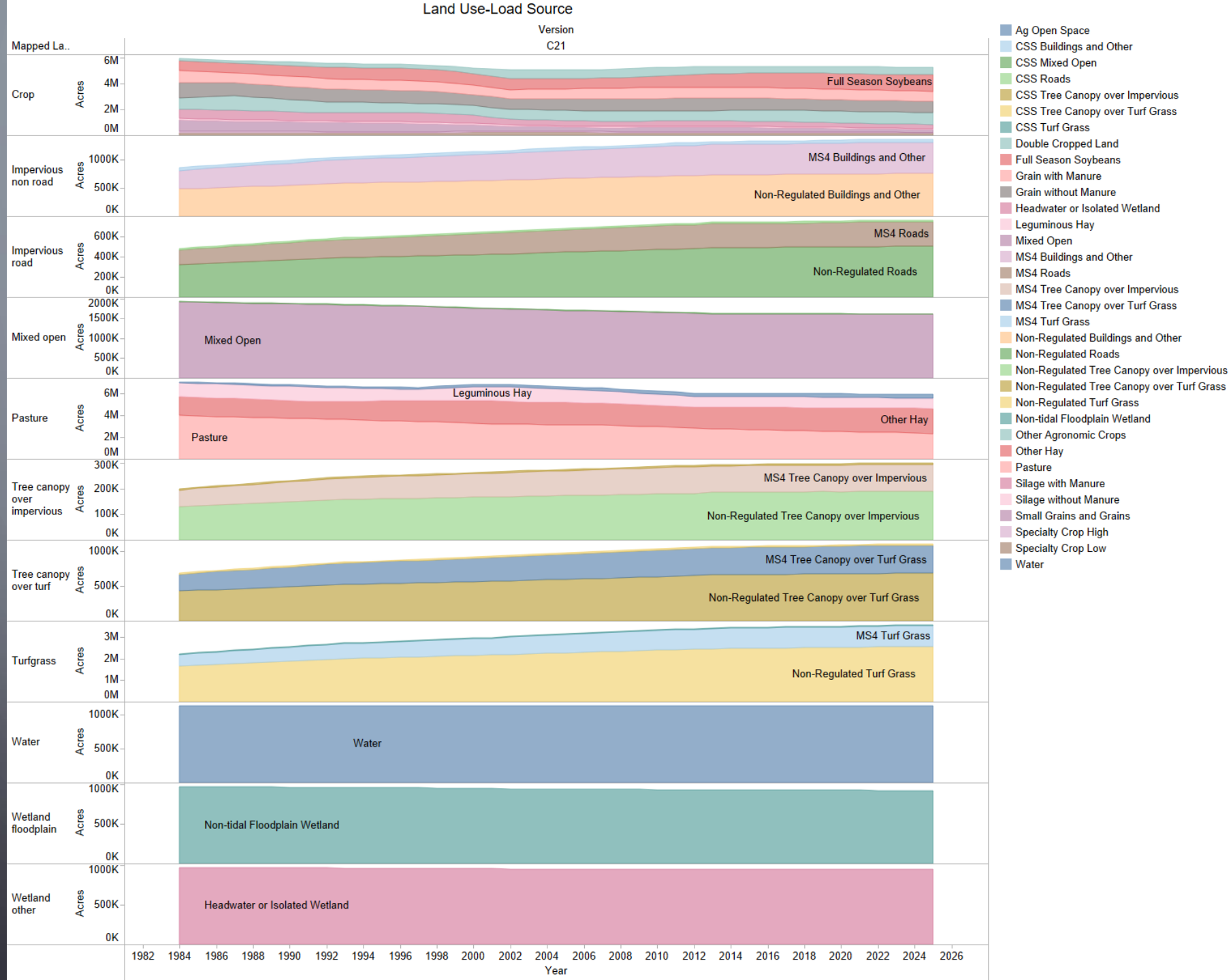
- Agricultural, developed, and natural land uses are adjusted to accommodate feeding space acres using relative error rates in a "true-up" process.
- Land uses with high error were adjusted a greater percentage than land uses with a low error rate.
- Example:
  - Land-river segment = 100 acres
    - It has only three land uses that were estimated as 15 acres of CSS roads, 75 acres of corn, and 35 acres of feeding space.
    - Land use total = 15 acres above the available acres in the land-river segment.
  - Assume that the error rate is 0% for CSS roads, 30% for corn and 0% for feeding space
  - Available adjustment is 0 acres for CSS roads, 22.5 acres for corn and 0 acres for feeding space. The total adjustment needed is 15 acres and the available adjustment totals 22.5 acres giving an adjustment ratio of 0.66
  - The final acres would be 15 acres of CSS roads, 50 acres of corn, and 35 acres of feeding space.
- Error rates are by state except for agriculture where they are by county
- For decreases there is a comparison of the prior year to the current year and the developed land use for the prior year is reduced proportionally to meet the current year. These are added to mixed open and hay/pasture since those classes are most likely to be confused with turfgrass.

5. LAND USE CHANGE AND PROJECTIONS

- Calculated as the difference between the original version of the 2013 mapped land use and the new 2017 for each land-river segment and agency and added to the CAST trued-up land use aggregated to the mapped land use categories 2013 acres
- The difference between the new 2017 and 2025 land use is calculated and added on to the 2017 in the previous step. Years between 2017 and 2025 are interpolated
- The true-up steps are followed for creating the final land use.

MAPPED LAND USE CLASSES

Number	Land Use Class Abbreviation	Land Use Class
1	CRP	crop
2	INR	impervious non road
3	IR	impervious road
4	WLF	wetland floodplain
5	WLO	wetland other
6	PAS	pasture
7	FORE	forest
8	MO	mixed open
9	TCI	tree canopy over impervious
10	TCT	tree canopy over turf
11	TG	turfgrass
12	WAT	water


Land Use-Load Source
Version
Mapped La..
C21
Crop
Acres
6M
4M
2M
0M
Full Season Soybeans
Impervious non road
1000K
500K
0K
MS4 Buildings and Other
Non-Regulated Buildings and Other
Impervious road
600K
400K
200K
MS4 Roads
Non-Regulated Roads
Mixed open
2000K
1500K
1000K
Mixed Open
Pasture
Leguminous Hay
Other Hay
Tree canopy over impervious
300K
MS4 Tree Canopy over Impervious
Non-Regulated Tree Canopy over Impervious
Tree canopy over turf
MS4 Tree Canopy over Turf Grass
Non-Regulated Tree Canopy over Turf Grass
Turfgrass
3M
2M
1M
MS4 Turf Grass
Non-Regulated Turf Grass
Water
Wetland floodplain
Non-tidal Floodplain Wetland
Wetland other
Headwater or Isolated Wetland
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
Year
Ag Open Space
CSS Buildings and Other
CSS Mixed Open
CSS Roads
CSS Tree Canopy over Impervious
CSS Tree Canopy over Turf Grass
CSS Turf Grass
Double Cropped Land
Full Season Soybeans
Grain with Manure
Grain without Manure
Headwater or Isolated Wetland
Leguminous Hay
Mixed Open
MS4 Buildings and Other
MS4 Roads
MS4 Tree Canopy over Impervious
MS4 Tree Canopy over Turf Grass
MS4 Turf Grass
Non-Regulated Buildings and Other
Non-Regulated Roads
Non-Regulated Tree Canopy over Impervious
Non-Regulated Tree Canopy over Turf Grass
Non-Regulated Turf Grass
Non-tidal Floodplain Wetland
Other Agronomic Crops
Other Hay
Pasture
Silage with Manure
Silage without Manure
Small Grains and Grains
Specialty Crop High
Specialty Crop Low
Water

6. AGRICULTURAL ACRES

- The total agricultural acres in CAST currently comes from “Land in farms” (Table 8, Census of Agriculture) minus “Total woodland” and minus “Land in farmsteads, homes, buildings, livestock facilities, ponds, roads, wasteland, etc.”
- NASS’ Mr. Mueller suggested using the CBP spatially explicit land use to define agricultural land commensurate with the definition above as it likely has greater accuracy.
- NASS recommended using NLCD & CDL for determining the spatial distribution of cropland and pasture within a county, where better data are unavailable.
- This would lead to proportioning of NASS crop types and pasture types to the mapped land use crop and pasture acreages for 2013 and 2017.

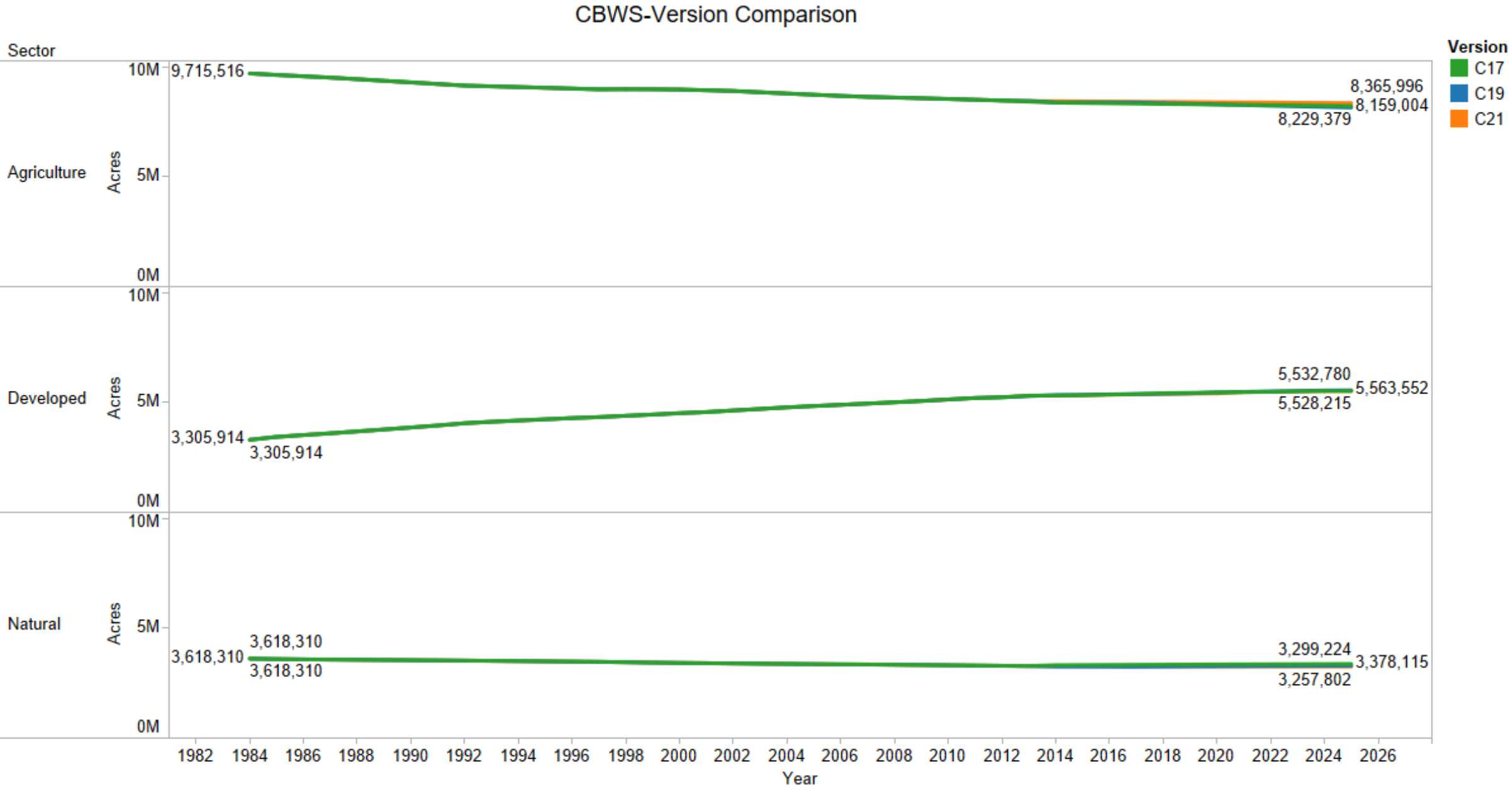
6. PROPOSED LAND USE CHANGE INCORPORATED INTO CAST-21

- Use mapped agricultural acres and fit the agricultural census crops, pasture, and hay types into the mapped agricultural area
- Decision expected by the Agricultural Workgroup at the May 20 meeting

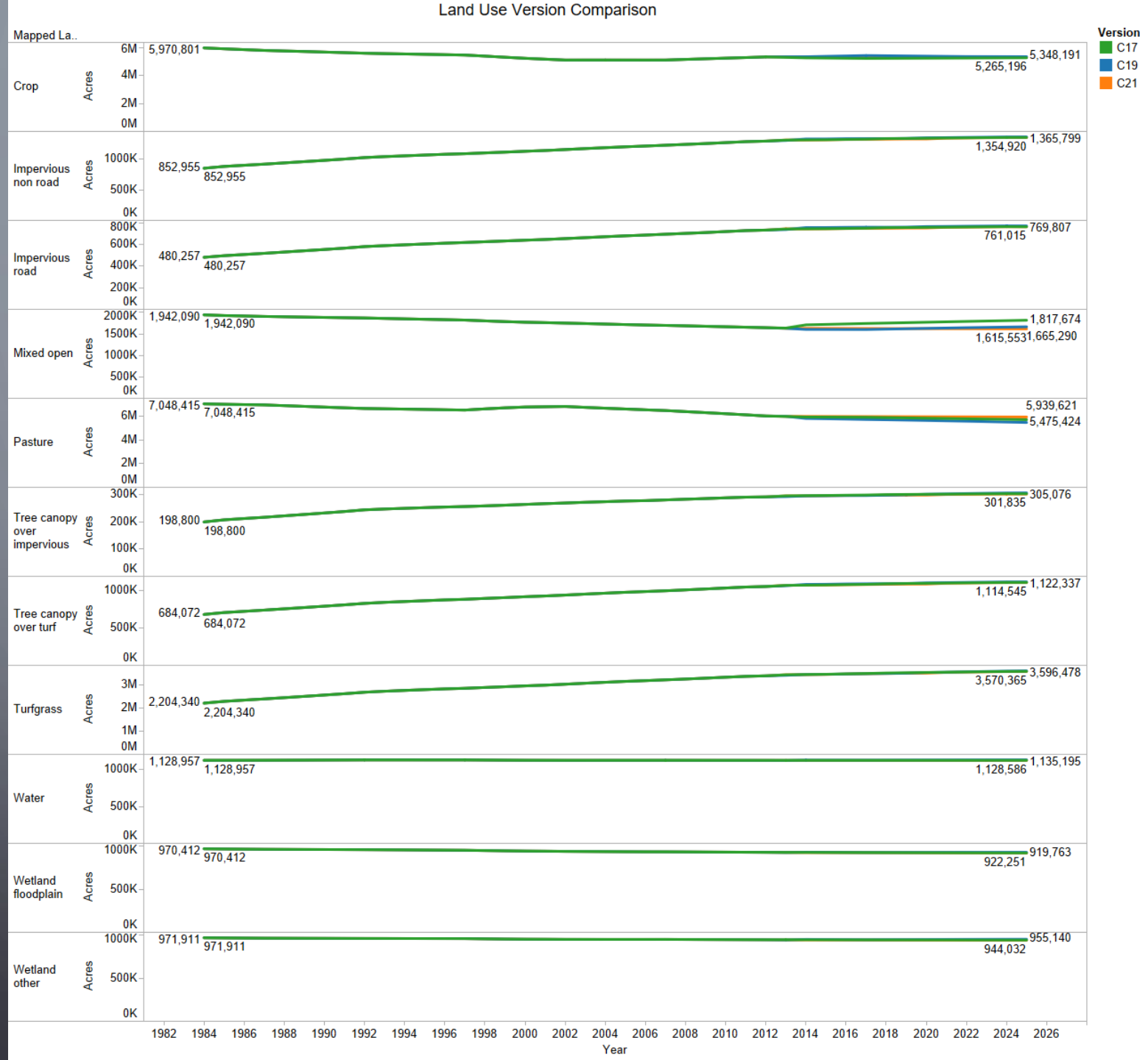
State	C19 2017 Acres	C21 2017 Acres	Difference	Percent Change
PA	3,890,655	3,958,033	67,378	2%
WV	599,726	577,983	(21,743)	-4%
MD	1,541,368	1,545,629	4,261	0%
DE	426,213	403,185	(23,028)	-5%
NY	2,113,708	2,274,282	160,574	8%
VA	2,910,655	2,846,675	(63,980)	-2%
Total	11,482,325	11,605,787	123,462	1%

RESULTS WITH CHANGE IN AG ACRE METHODS

- More accuracy in local placement of acres in addition to overall acres
- NOTE: These data use the mapped land use provided for CAST-19, not what the Land Data Team is developing currently



NOTE: These data use the mapped land use provided for CAST-19, not what the Land Data Team is developing currently



NOTE: These data use the mapped land use provided for CAST-19, not what the Land Data Team is developing currently

Modeling Crop Rotations in an Annual Model

January

January

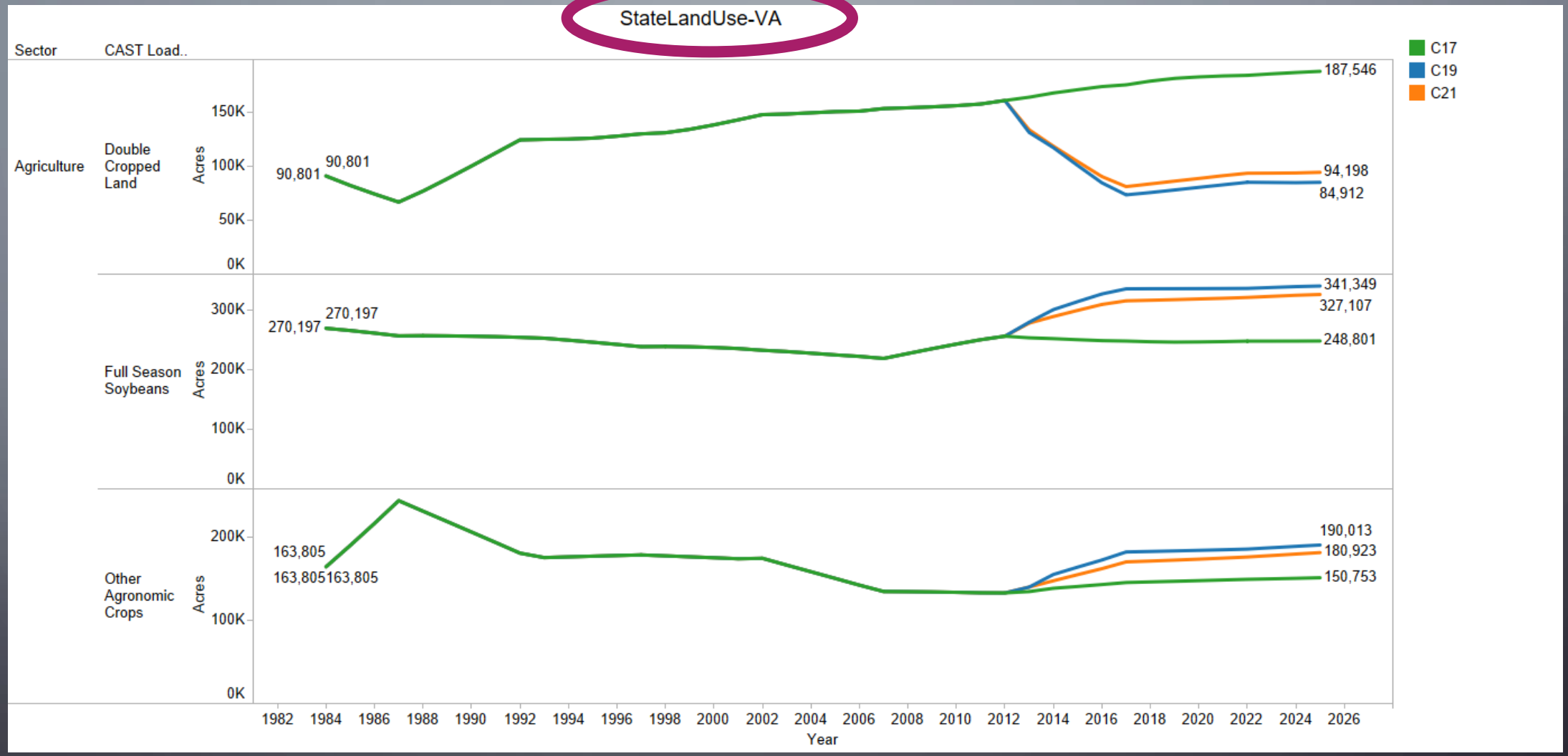
January

Year 1 | Year 2 | Year 3

winter | spring | summer | fall

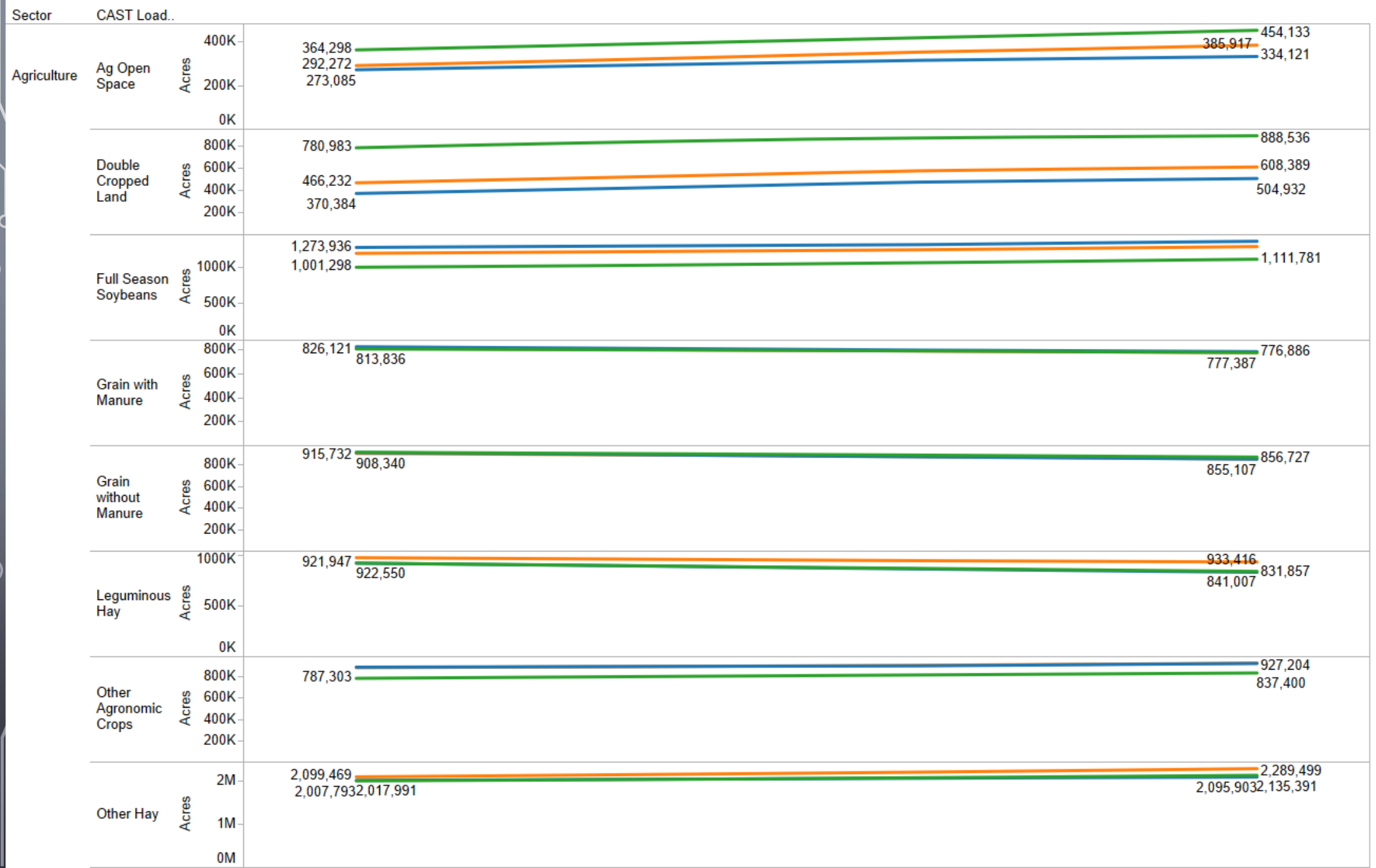
DATA AND METHOD

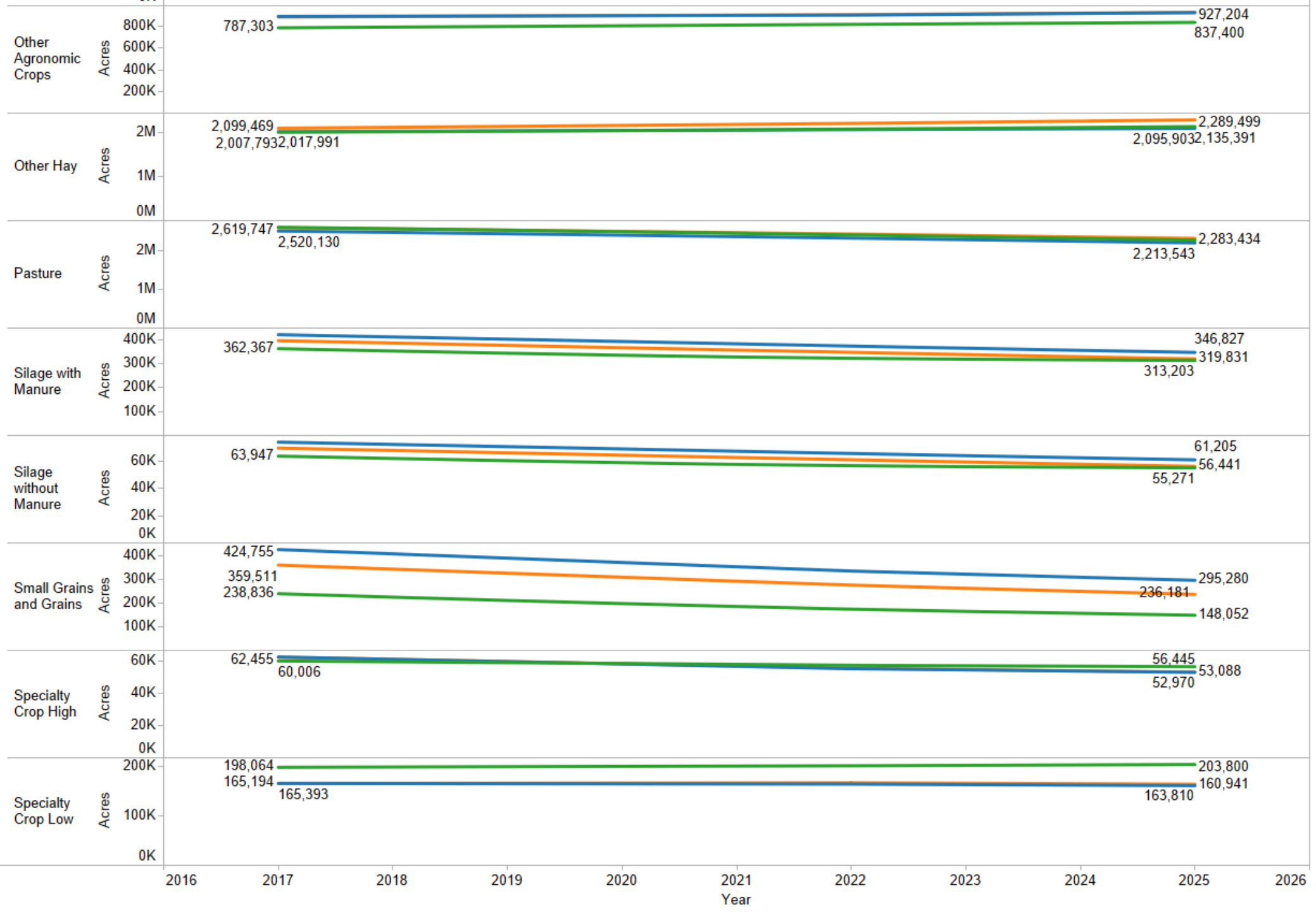
- Data Needed
  - Ag Census Harvested Cropland area – total cropland area
  - Ag Census individual crops area – summed for a total of all crops planted
  - Ag Census early crop and late crop areas (Group 1 & 2)
    - Group 1 & 2 crops were determined by each state
    - Group 1 is primarily corn, sorghum, and soybeans
    - Group 2 is primarily small grains
- Method
  - Actual double cropped area is the minimum of:
  1. Area of crops in excess of the total cropland
  2. Group 1
  3. Group 2
  - These calculations are performed at the county scale for each year.

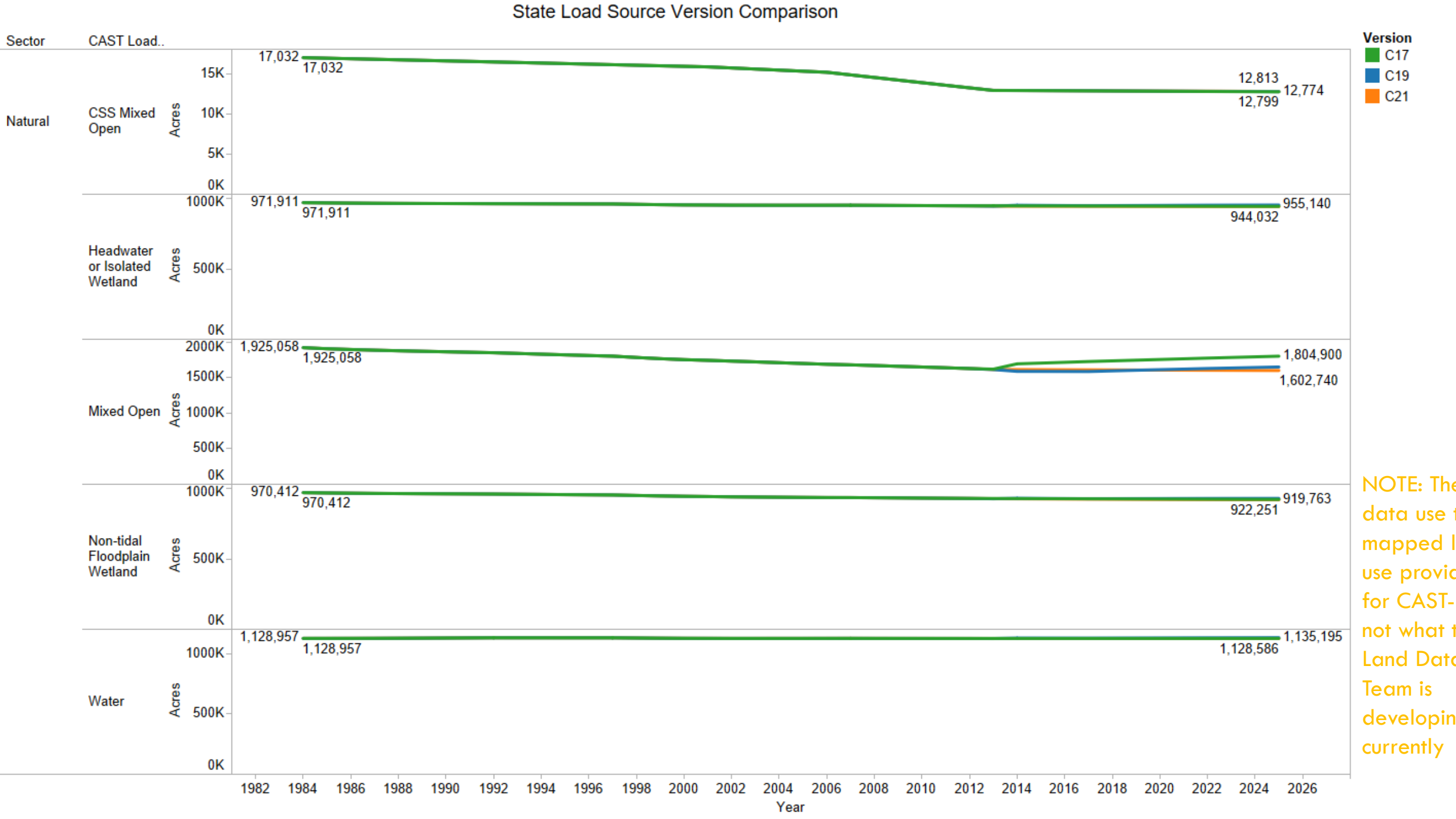


NOTE: These data use the mapped land use provided for CAST-19, not what the Land Data Team is developing currently

State Load Source Version Comparison




Other Agronomic Crops
Acres
800K
600K
400K
200K
787,303
927,204
837,400
Other Hay
Acres
2M
1M
0M
2,099,469
2,007,793
2,017,991
2,289,499
2,095,903
2,135,391
Pasture
Acres
2M
1M
0M
2,619,747
2,520,130
2,283,434
2,213,543
Silage with Manure
Acres
400K
300K
200K
100K
362,367
346,827
319,831
313,203
Silage without Manure
Acres
60K
40K
20K
0K
63,947
61,205
56,441
55,271
Small Grains and Grains
Acres
400K
300K
200K
100K
424,755
359,511
238,836
295,280
236,181
148,052
Specialty Crop High
Acres
60K
40K
20K
0K
62,455
60,006
56,445
53,088
52,970
Specialty Crop Low
Acres
200K
100K
0K
198,064
165,194
165,393
203,800
160,941
163,810
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Year


State Load Source Version Comparison
Sector
CAST Load..
Natural
CSS Mixed Open
Headwater or Isolated Wetland
Mixed Open
Non-tidal Floodplain Wetland
Water
Acres
17,032
17,032
12,813
12,799
12,774
971,911
971,911
955,140
944,032
1,925,058
1,925,058
1,804,900
1,602,740
970,412
970,412
919,763
922,251
1,128,957
1,128,957
1,135,195
1,128,586
Version
C17
C19
C21
Year
NOTE: The
data use
mapped
use provi
for CAST-
not what
Land Data
Team is
developin
currently

VIEW COMPARISON OF ACRES

HTTPS://PUBLIC.TABLEAU.COM/PROFILE/OLIVIA.DEVEREUX#!/VIZHOME/LANDUSEEXPLORATION/CBWS-VERSIONCOMPARISON

NOTE: These data use the mapped land use provided for CAST-19, not what the Land Data Team is developing currently

CAST-21 SCHEDULE

- September 1, 2021 - All data and methods approved
- November 1, 2021 - CAST-21 Beta release
- December 1, 2021 – Jurisdictional comments due
- January 1, 2022 - Final CAST-21 release