Chesapeake Bay Program
A Watershed Partnership

Phase 6 Land Use

Co-Chairs:
Karl Berger, Metropolitan Washington Council of Governments
Jennifer Tribo, Hampton Roads Planning District Commission

Coordinator:
Peter Claggett, U.S. Geological Survey

Outline of Presentation

1. Incorporating local land use information into Phase 6

2. Developing a GIS polygon coverage map with final land uses

3. Improving forecasting and backcasting change methods

4. Producing 2025 land use projections

5. Developing differential loading rates

6. Reviewing list of proposed Phase 6 land uses
   - Vote to approve

7. Reviewing 2014-2015 Progress and Milestone Land Use
   - Vote to approve

Local Land Use Data Request

Phase 1

(Feb 2013 – Sept. 2014)

- Collect readily available land use and related datasets from localities via a formal request.
- Evaluate similarities and differences among received datasets.

Phase 2

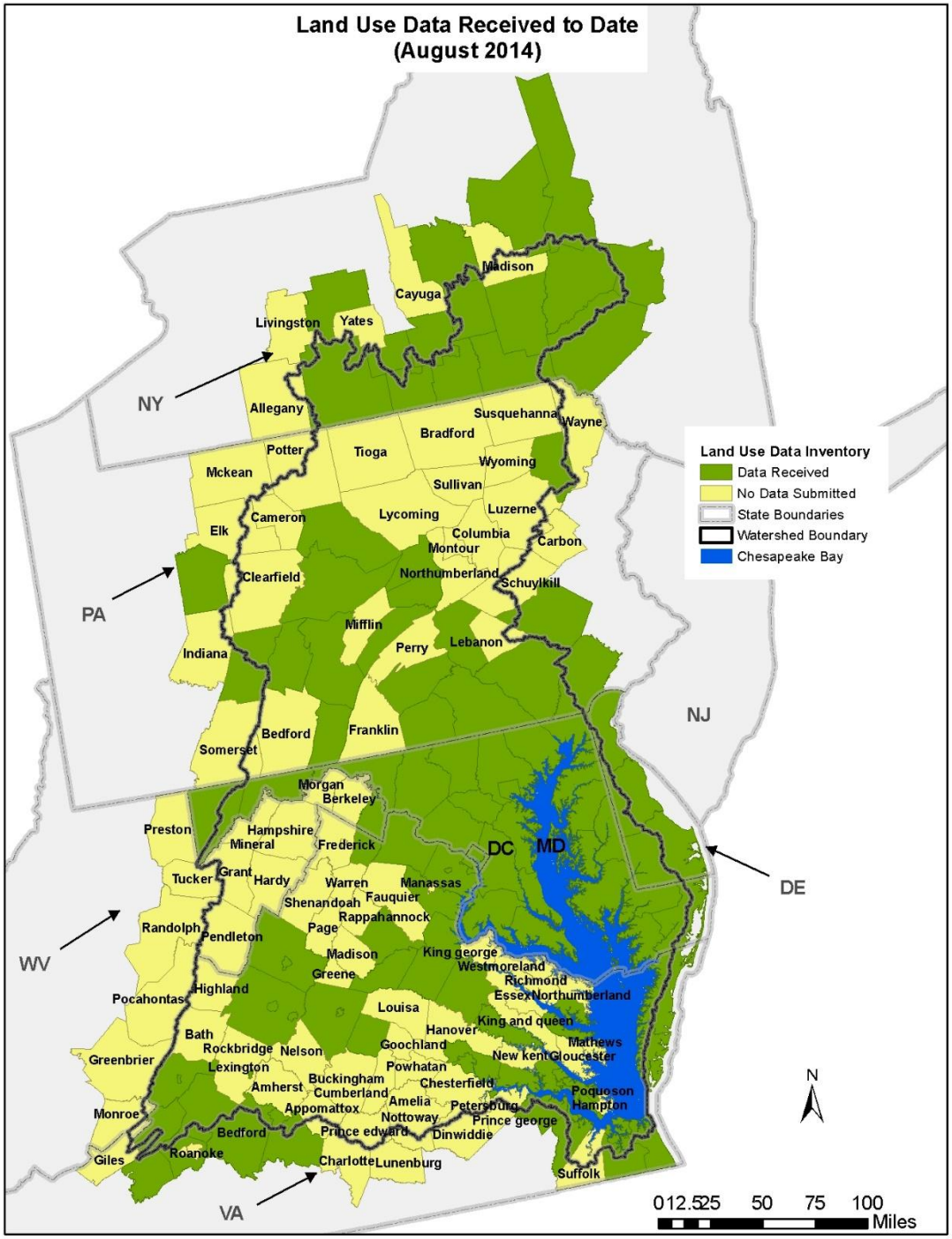
(Oct. 2013 – September 2014)

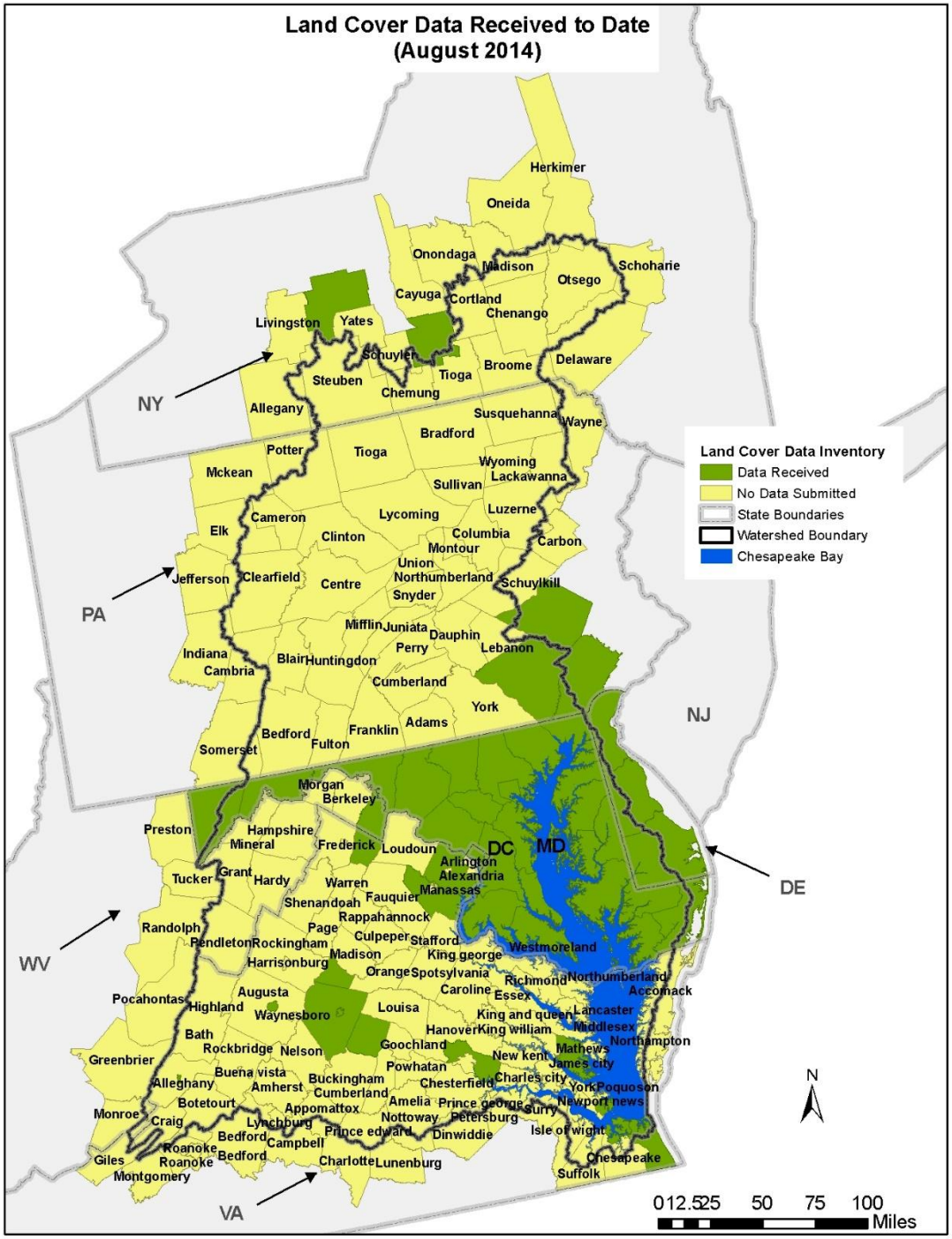
- Identify gaps in the types and locations of data received.
- Re-prioritize data needs:
- Target localities for additional data collection and solicit directly to their agencies (e.g., GIS, Public Works, Tax Assessment, and/or Planning).

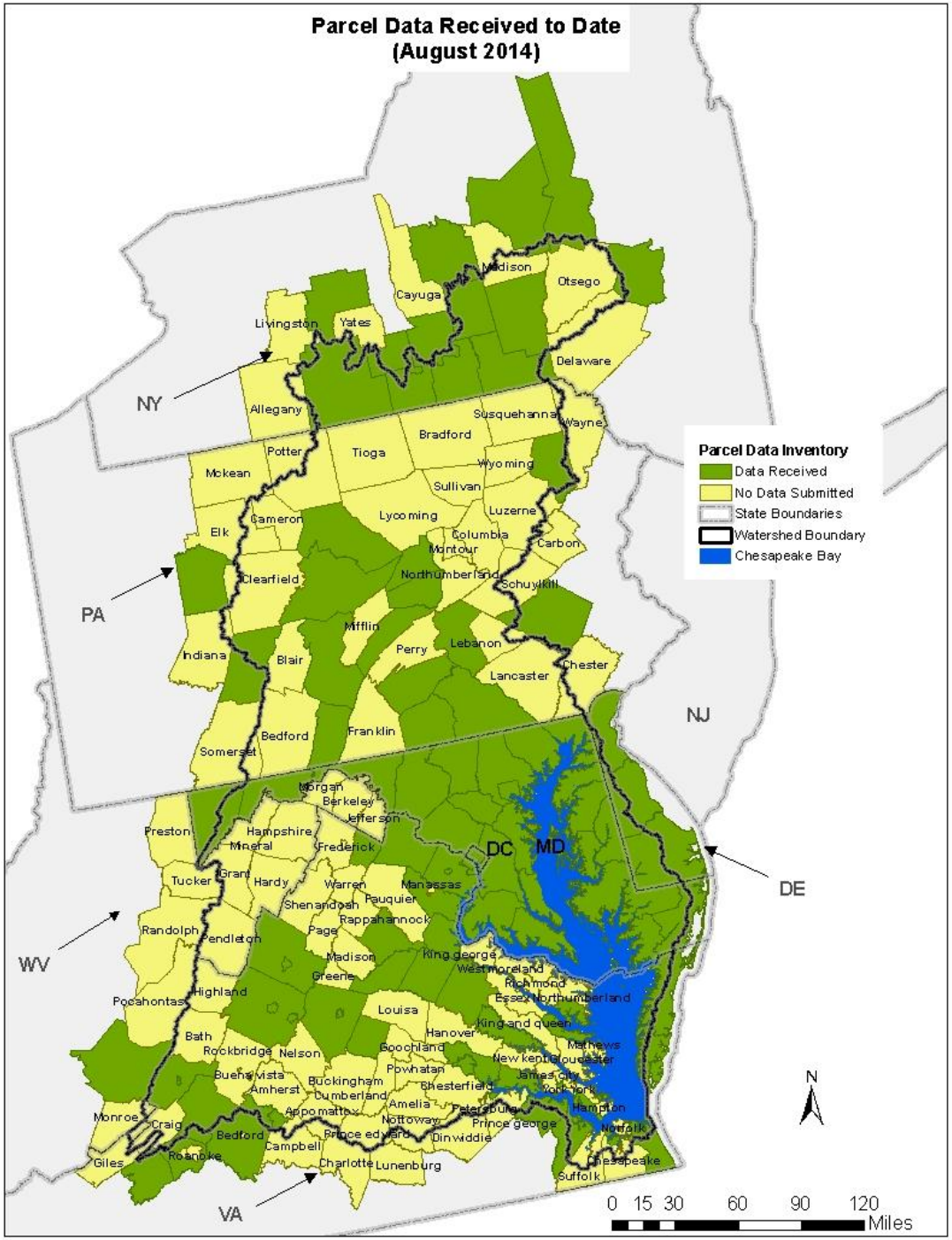
Phase 3

(October 2014 – May 2016)

- Solicit and accept updates to data from localities.
- All local data from jurisdictions must be submitted by May 31st, 2016.


Land Use Data Received to Date
(August 2014)
Land Use Data Inventory
Data Received
No Data Submitted
State Boundaries
Watershed Boundary
Chesapeake Bay
NY
PA
WV
VA
MD
DC
DE
NJ
Madison
Cayuga
Livingston
Yates
Allegany
Susquehanna
Wayne
Bradford
Tioga
Potter
Wyoming
Mckean
Sullivan
Luzerne
Lycoming
Cameron
Elk
Columbia
Montour
Carbon
Clearfield
Northumberland
Schuylkill
Mifflin
Perry
Lebanon
Indiana
Bedford
Franklin
Somerset
Morgan
Berkeley
Preston
Hampshire
Mineral
Frederick
Tucker
Grant
Hardy
Warren
Manassas
Fauquier
Shenandoah
Rappahannock
Randolph
Pendleton
Page
Madison
King george
Westmoreland
Greene
Richmond
Highland
Essex
Northumberland
Pocahontas
Louisa
King and queen
Hanover
Bath
Goochland
Mathews
Rockbridge
Nelson
New kent
Gloucester
Greenbrier
Lexington
Powhatan
Buckingham
Chesterfield
Amherst
Cumberland
Poquoson
Hampton
Amelia
Petersburg
Appomattox
Monroe
Nottoway
Prince george
Bedford
Prince edward
Dinwiddie
Giles
Roanoke
Charlotte
Lunenburg
Suffolk
N
0 12.5 25 50 75 100
Miles


Land Cover Data Received to Date
(August 2014)
Land Cover Data Inventory
Data Received
No Data Submitted
State Boundaries
Watershed Boundary
Chesapeake Bay
NY
PA
WV
VA
NJ
DE
MD
DC
Herkimer
Oneida
Onondaga
Madison
Schoharie
Otsego
Cayuga
Cortland
Chenango
Livingston
Yates
Schuyler
Tioga
Broome
Delaware
Steuben
Chemung
Allegany
Susquehanna
Wayne
Bradford
Potter
Tioga
Wyoming
Lackawanna
Mckean
Sullivan
Cameron
Lycoming
Luzerne
Elk
Clinton
Columbia
Carbon
Montour
Union
Jefferson
Clearfield
Centre
Northumberland
Schuylkill
Snyder
Mifflin
Juniata
Dauphin
Perry
Lebanon
Indiana
Blair
Huntingdon
Cambria
Cumberland
York
Bedford
Franklin
Adams
Fulton
Somerset
Morgan
Berkeley
Preston
Hampshire
Mineral
Frederick
Loudoun
Arlington
Alexandria
Manassas
Tucker
Grant
Hardy
Warren
Fauquier
Shenandoah
Rappahannock
Randolph
Page
Culpeper
Stafford
Rendleton
Rockingham
Madison
King george
Westmoreland
Harrisonburg
Orange
Spotsylvania
Richmond
Northumberland
Caroline
Accomack
Augusta
Essex
Pocahontas
Highland
Waynesboro
Louisa
King and queen
Lancaster
Middlesex
Bath
Hanover
King william
Northampton
Rockbridge
Nelson
Goochland
Mathews
Greenbrier
New kent
James city
Powhatan
Buena vista
Buckingham
Chesterfield
Charles city
York
Poquoson
Alleghany
Amherst
Cumberland
Botetourt
Amelia
Prince george
Surry
Newport news
Monroe
Appomattox
Nottoway
Petersburg
Craig
Lynchburg
Prince edward
Dinwiddie
Isle of wight
Bedford
Campbell
Roanoke
Giles
Roanoke
Bedford
Charlotte
Lunenburg
Chesapeake
Montgomery
Suffolk
N
0 12.5 25 50 75 100
Miles


Parcel Data Received to Date
(August 2014)
Parcel Data Inventory
Data Received
No Data Submitted
State Boundaries
Watershed Boundary
Chesapeake Bay
NY
PA
WV
VA
NJ
DE
MD
DC
Madison
Otsego
Cayuga
Livingston
Yates
Delaware
Allegany
Susquehanna
Wayne
Bradford
Potter
Tioga
Wyoming
Mckean
Sullivan
Luzerne
Cameron
Lycoming
Elk
Columbia
Montour
Carbon
Clearfield
Northumberland
Schuylkill
Mifflin
Lebanon
Indiana
Blair
Perry
Chester
Lancaster
Bedford
Franklin
Somerset
Morgan
Berkeley
Jefferson
Preston
Hampshire
Mineral
Frederick
Manassas
Tucker
Grant
Hardy
Warren
Pauquier
Shenandoah
Rappahannock
Randolph
Pendleton
Page
King george
Madison
Westmoreland
Greene
Richmond
Highland
Essex
Northumberland
Pocahontas
Louisa
King and queen
Hanover
Bath
Mathews
Rockbridge
Nelson
Goochland
New kent
Gloucester
Powhatan
Buena vista
Buckingham
James city
Amherst
Chesterfield
York
Cumberland
Amelia
Hampton
Monroe
Appomattox
Petersburg
Craig
Nottoway
Prince george
Norfolk
Bedford
Prince edward
Dinwiddie
Campbell
Giles
Roanoke
Charlotte
Lunenburg
Chesapeake
Suffolk
N
0 15 30 60 90 120
Miles

Additional land use related data recently received from:

West Virginia:
Berkley County

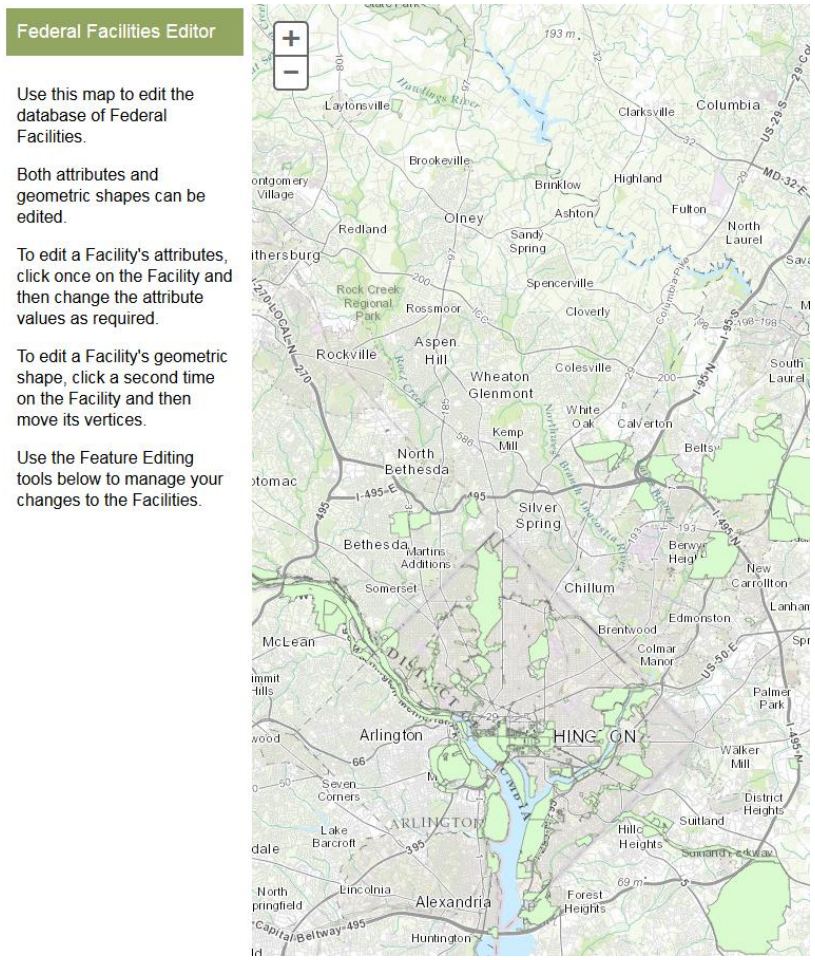
New York:
Cortland County

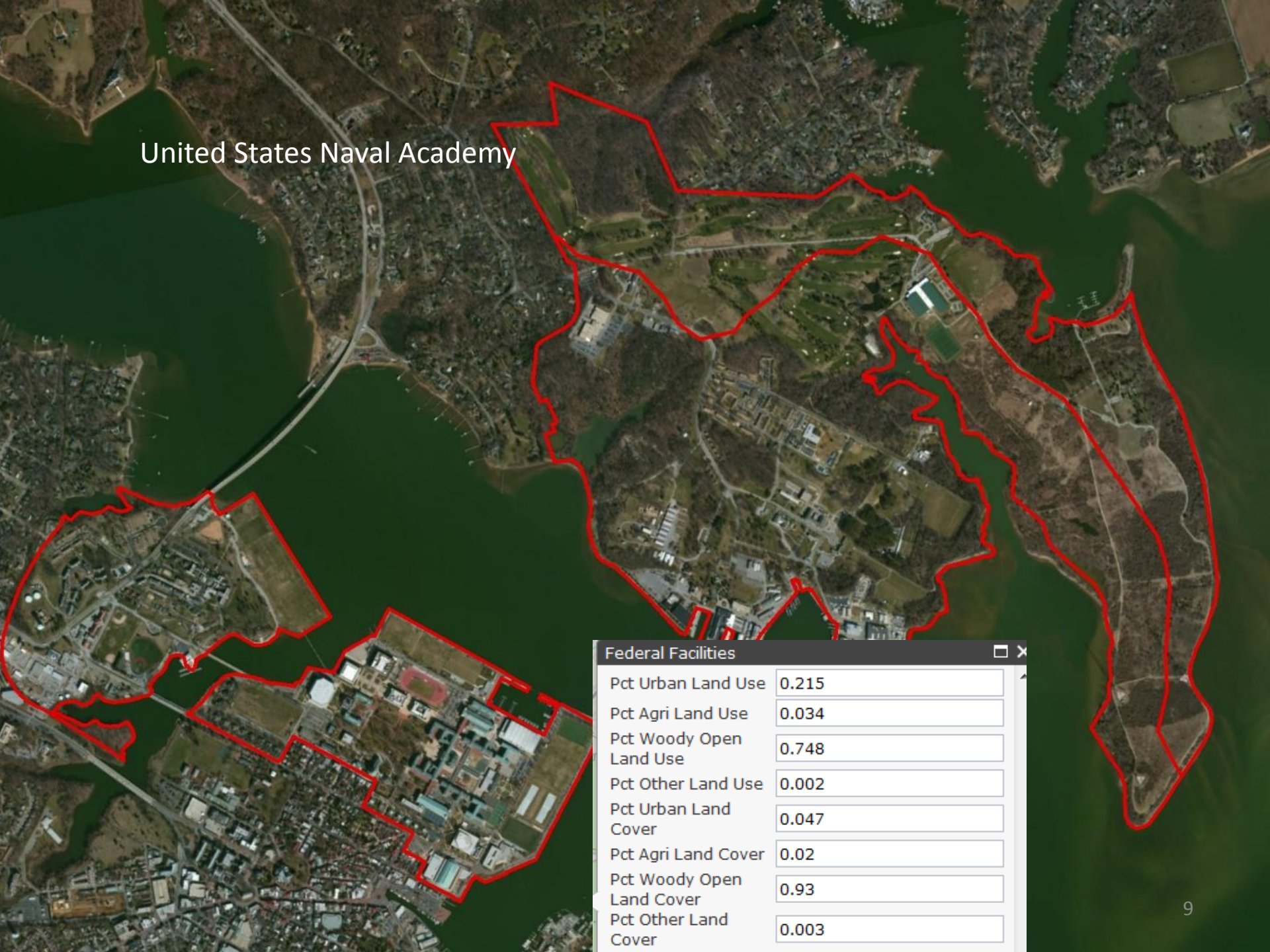
Pennsylvania:
Lycoming County
Snyder County
Wyoming County

Virginia:
Caroline County
King George County
Spotsylvania County
Stafford County
City of Fredericksburg

Federal Facilities Editor Tool

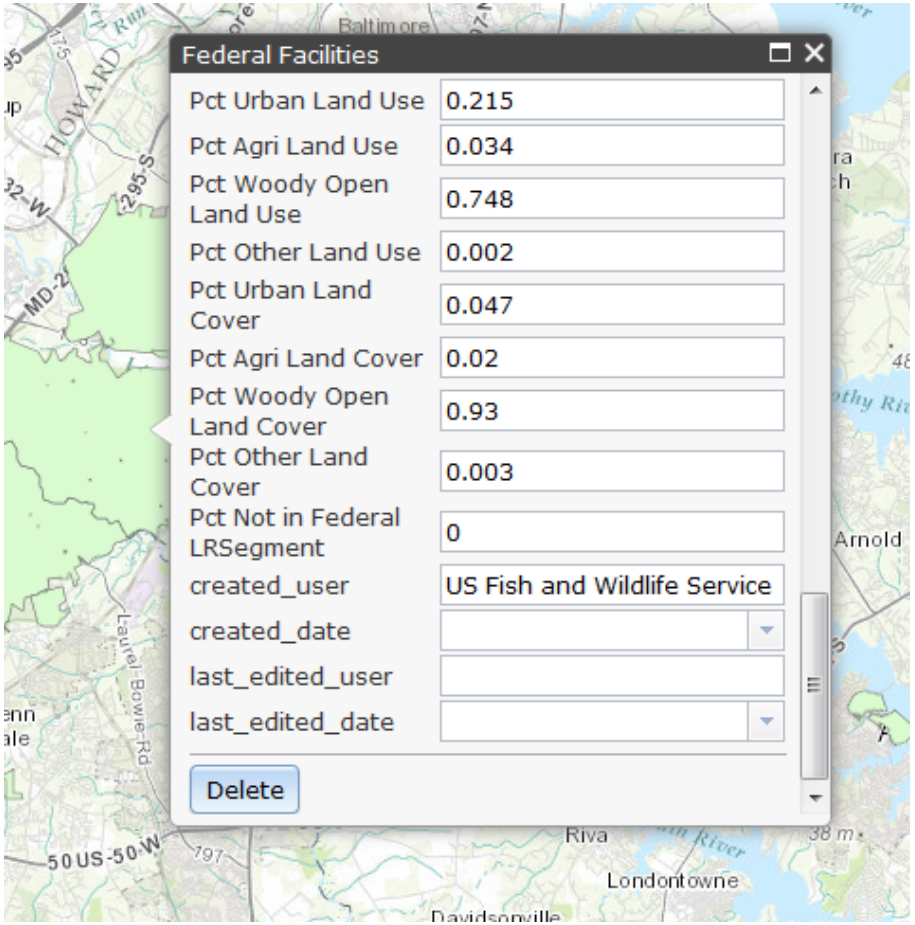
- Currently exists as a prototype
- Allows managers of Federal facilities to manage land use data for their facilities
- Simplifies data management for CBP staff, while improving data quality




United States Naval Academy
Federal Facilities
Pct Urban Land Use 0.215
Pct Agri Land Use 0.034
Pct Woody Open Land Use 0.748
Pct Other Land Use 0.002
Pct Urban Land Cover 0.047
Pct Agri Land Cover 0.02
Pct Woody Open Land Cover 0.93
Pct Other Land Cover 0.003

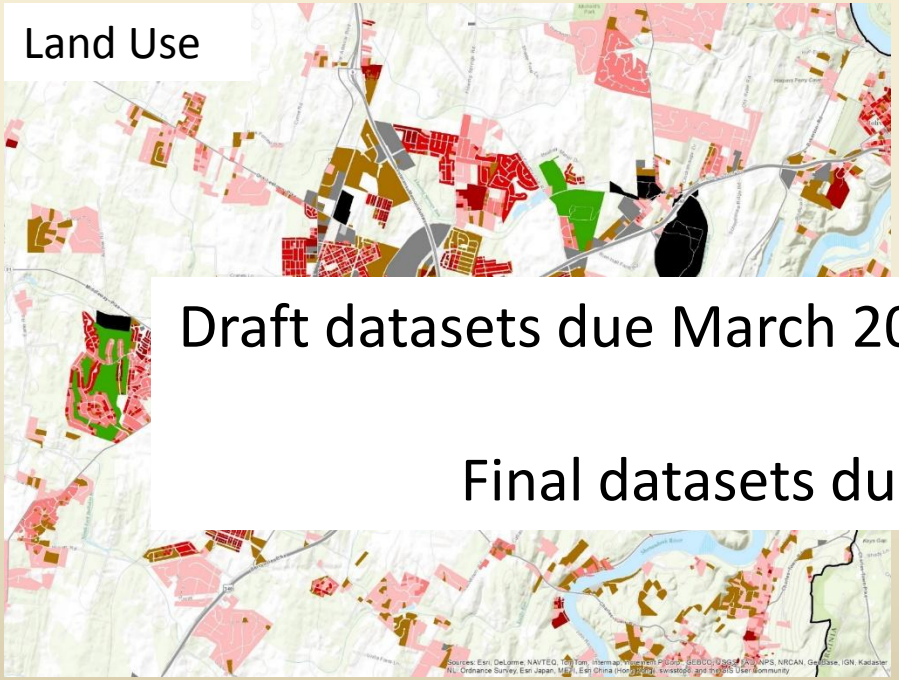
Federal Facilities Editor Tool

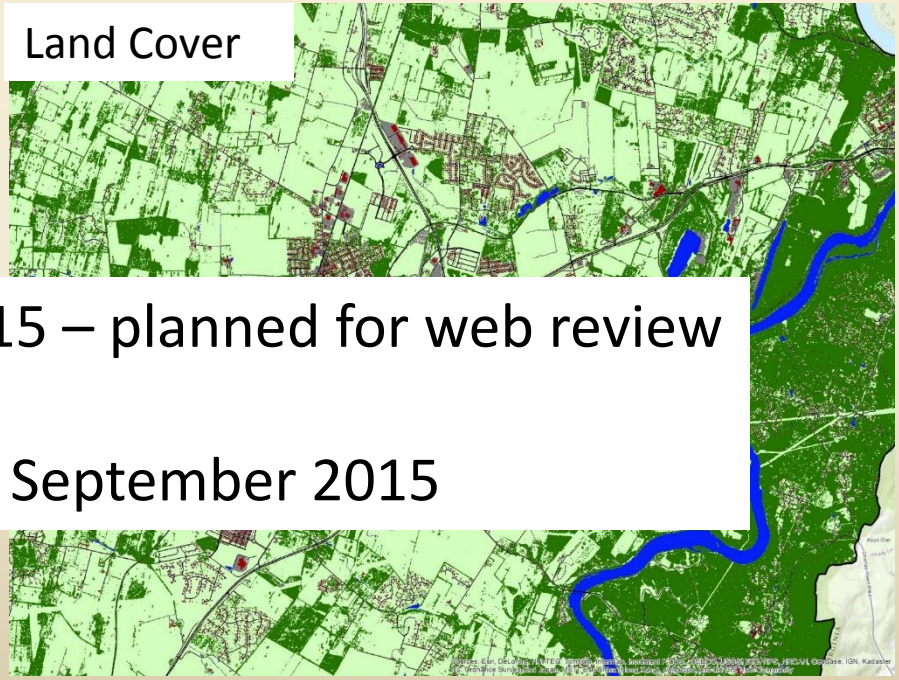
- Land use data is edited directly in a CBP database via a map-based interface, and used as an input to the watershed model
- The initial release will include a simplified interface for editing data
- Future enhancements may include the ability to upload new facility boundaries



Building a 2012 Phase 6 Land Use Raster Database

1. Phase 6 Land Uses
2. Regulated Areas (MS4s/CSOs)
3. Federal Lands
4. Riparian Zone with effectiveness weights
5. Stream corridors with (Stream Source Ratio proportions)





Draft datasets due March 2015 – planned for web review

Final datasets due September 2015

Improving Forecasting and Backcasting Methods

Current Approach

- Synthesize information on land cover change, land use, extractive lands, regulated areas, and housing change in GIS.

- Use spreadsheets to integrate and extrapolate data forward and back through time from 2006 baseline to:

  1984 < 1992 < 2001 < **2006** > 2010 > 2015 > 2020 > 2025

Issues:

- Not transparent
- Challenging to error check
- Time consuming to update for Progress and Milestones
- Deterministic: one set of assumptions = one outcome

Improving Forecasting and Backcasting Methods

Proposed Approach

- Synthesize information on land cover change, land use, extractive lands, regulated areas, and housing change in GIS.

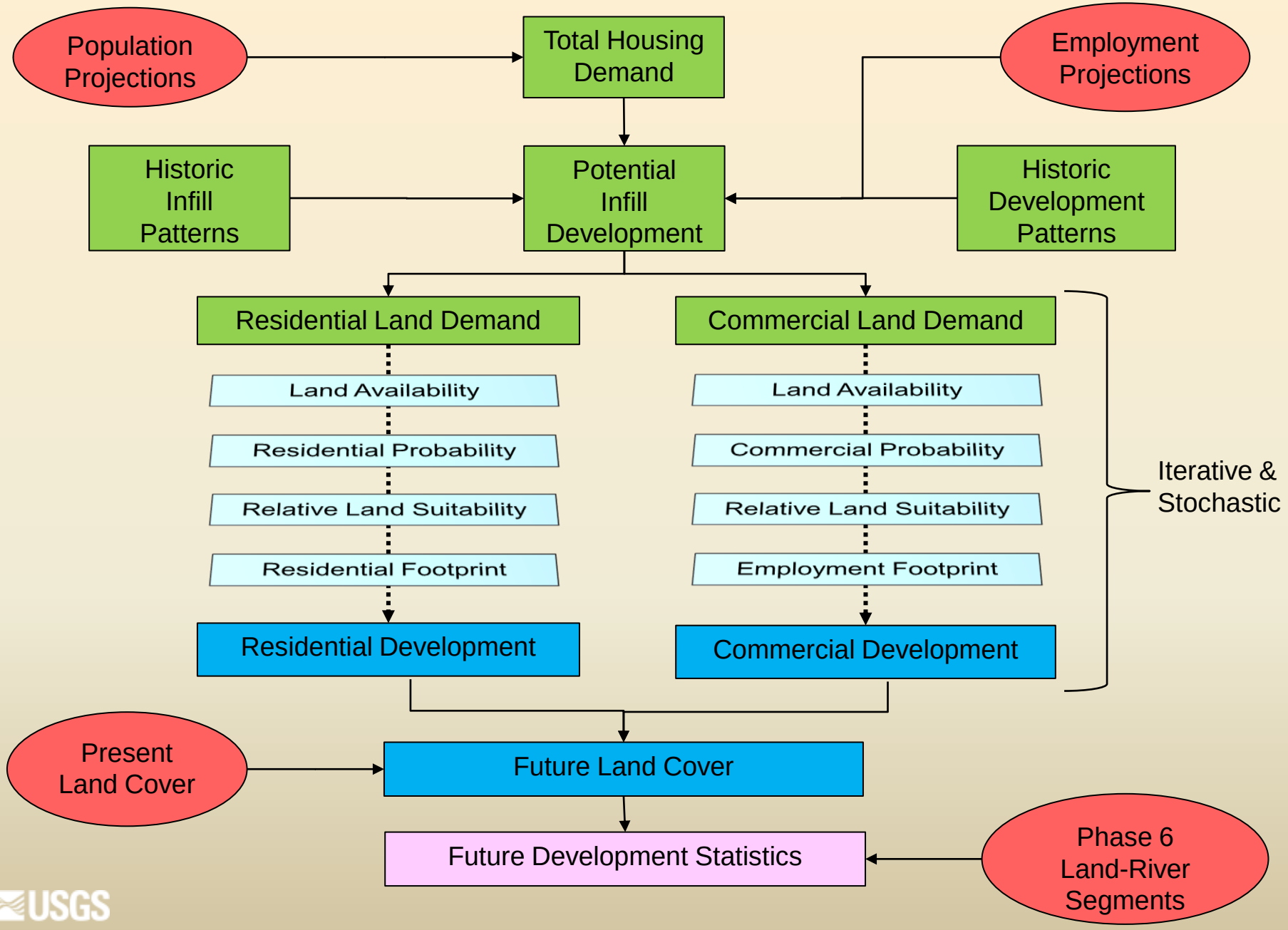
- Use a stochastic spatial simulation model to forecast and backcast land use change from **2012** baseline.

- Ensure LUWG and scientific peer-review of modeling assumptions and methodology.

Benefits:

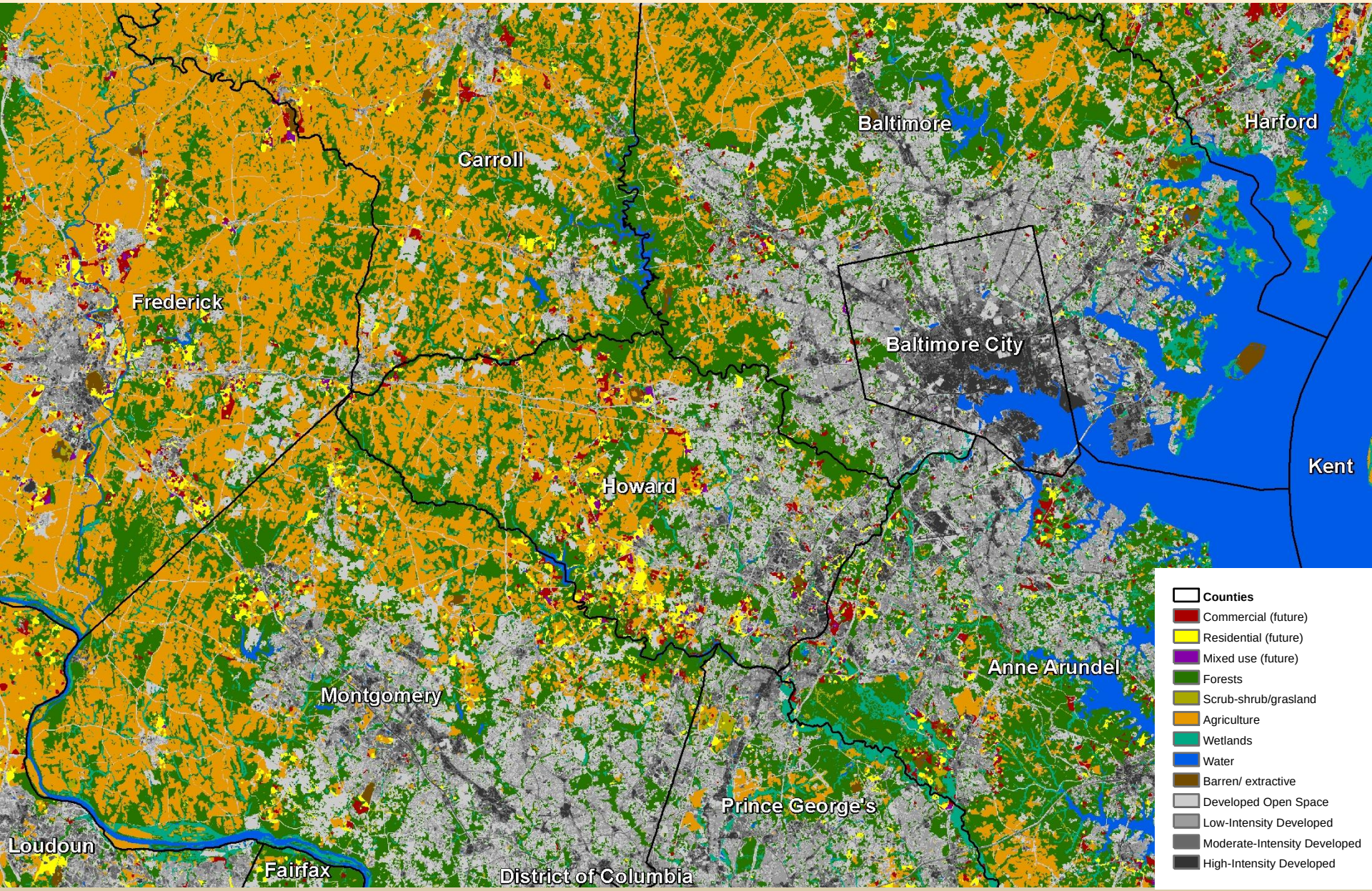
- Transparent and intuitive
- Coded with integrated error checks
- More easily updated with new information
- Stochastic: one set of assumptions = range of plausible outcomes

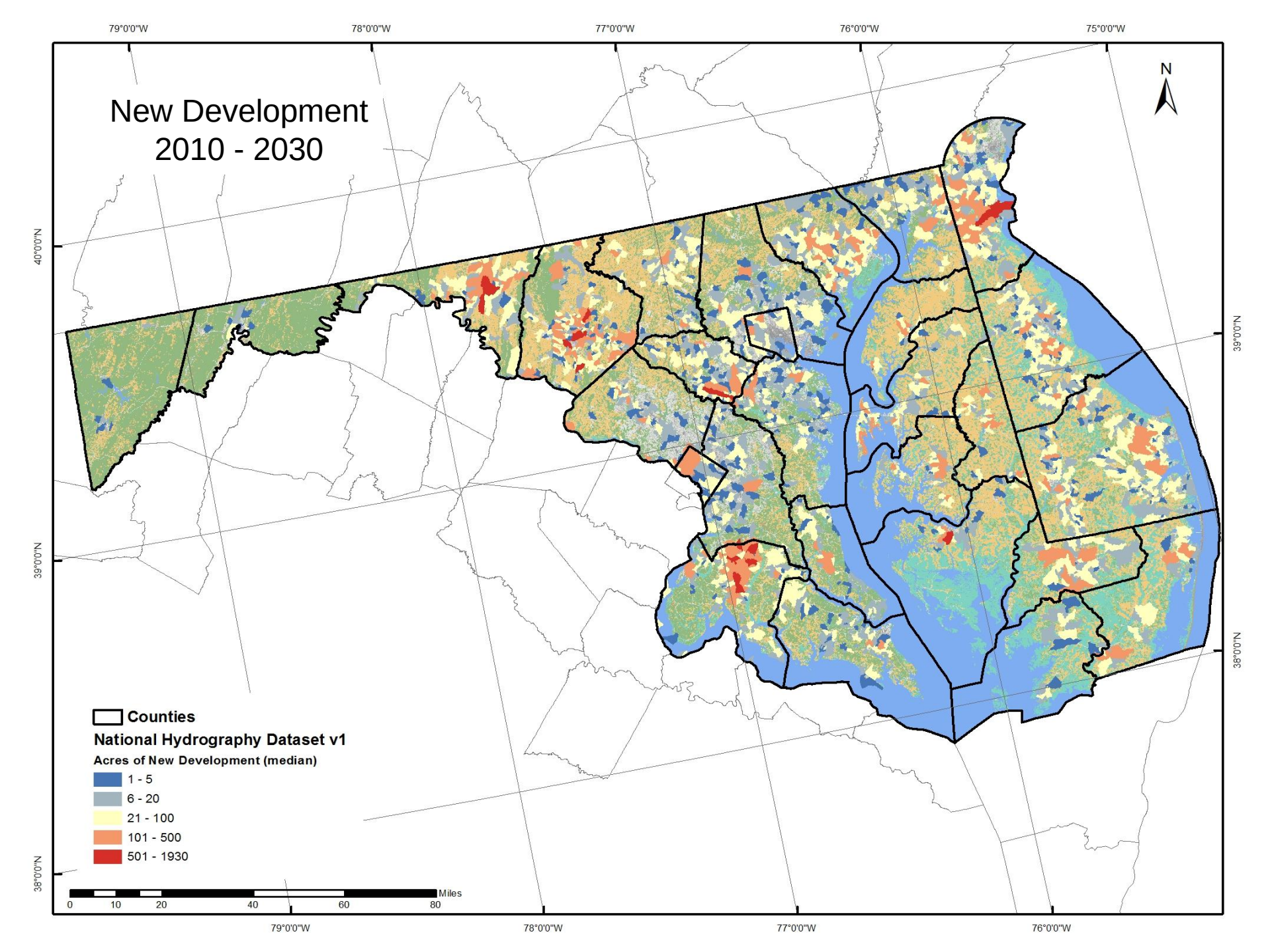
Chesapeake Bay Land Change Model v3a

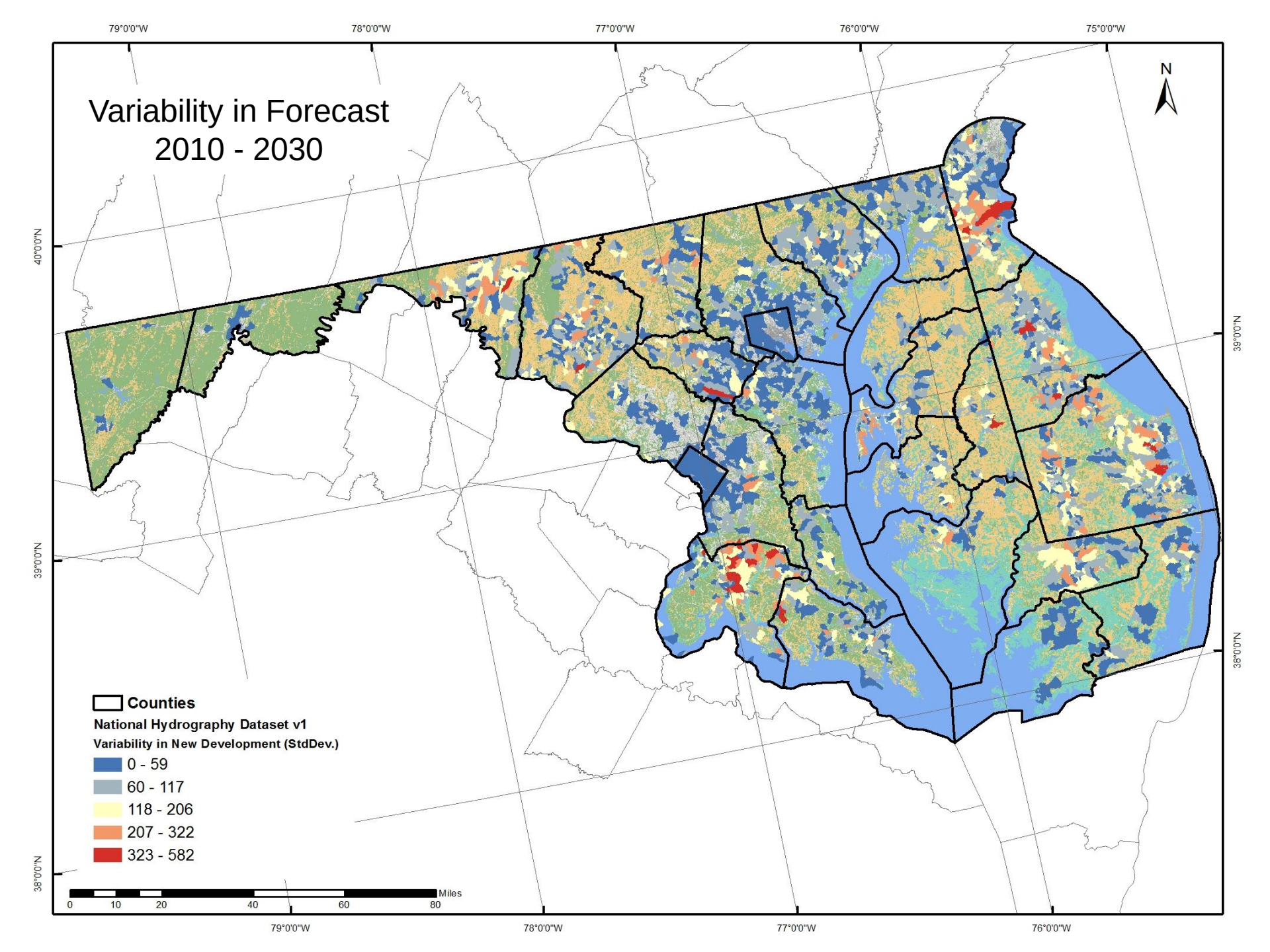


USGS

Forecasted 2030_v4 Development




New Development
2010 - 2030
N
79°0'0"W
78°0'0"W
77°0'0"W
76°0'0"W
75°0'0"W
40°0'0"N
39°0'0"N
38°0'0"N
Counties
National Hydrography Dataset v1
Acres of New Development (median)
1 - 5
6 - 20
21 - 100
101 - 500
501 - 1930
0
10
20
40
60
80
Miles


Variability in Forecast
2010 - 2030
79°0'0"W
78°0'0"W
77°0'0"W
76°0'0"W
75°0'0"W
40°0'0"N
39°0'0"N
38°0'0"N
N
Counties
National Hydrography Dataset v1
Variability in New Development (StdDev.)
0 - 59
60 - 117
118 - 206
207 - 322
323 - 582
0
10
20
40
60
80
Miles

Timeline for Completing 2025 Chesapeake Bay Land Use Forecasts

January 2015: Publish Chesapeake Bay Land Change Model, v3a; LUWG to explore pros/cons of setting TMDL on a future land use.

March 2015: Simulate Trend Scenario for all Chesapeake Bay Watershed States

May 2015: Complete LUWG review of Trend Scenario and draft alternative future scenarios. LUWG presents recommendations to WQGIT.

July 2015: Complete simulation of all scenarios through 2030 (five year increments)

Summer 2015: WQGIT decision on setting TMDL on future land use.

What about back-casting: 2010 >>> 1984?

Options:

1. States submit change in developed lands by Land-River segment for given time intervals.

2. Adapt CBLCM v3a to stochastically “subtract” urban land through time tied to population, housing, and historic land cover data.

3. Hard-code Phase 5.3.2 methodology (similar to #2 but deterministic and not spatially explicit).

Phase 6 Proposed Land Uses*

- Phase 6 proposed land uses = 27
  - Urban 7
  - Agricultural 13
  - Natural 7
- Phase 5 land uses = 25
  - Urban 4
  - Agricultural 17
  - Natural 4

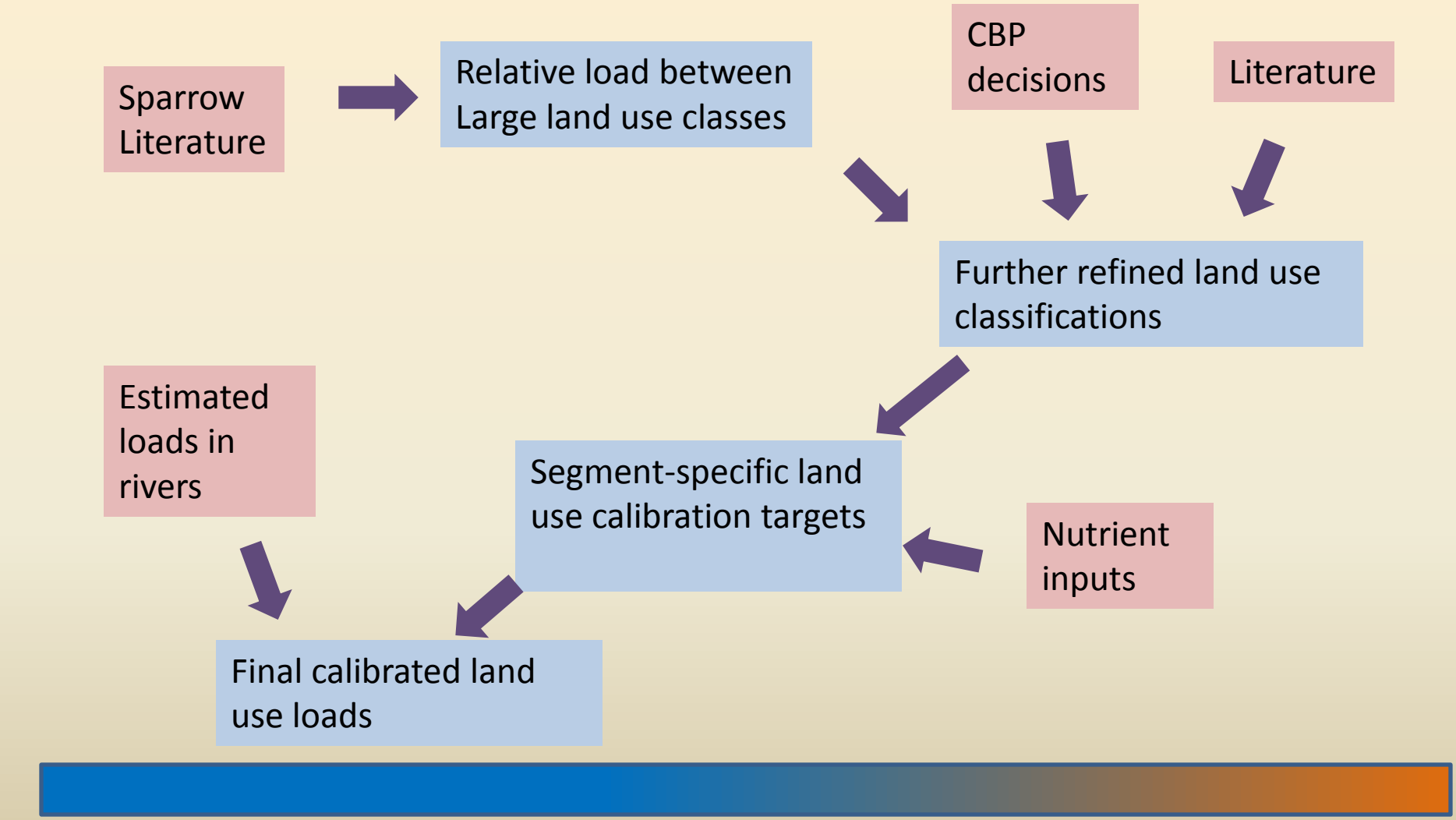
It may be that the loading rate data do not support differentiation among some land uses or that other issues may preclude incorporation into the model

***Land uses are also attributed using overlays of federal properties, MS4s, CSOs, and riparian zones.**

Reasons to differentiate land uses

- Distinct land use loading rates from literature, models, other data sources
- BMPs are exclusive to one type of land use (e.g.: stream corridor buffers or fencing)
- Helps jurisdictions for planning and reporting purposes. In this case, there would not be a different loading rate.

Land Use Load Decisions – Phase 6



Role of Workgroups in Proposing Land Uses, Setting Target Loads

- Propose land use subdivisions based on data showing differential load impacts
- Provide critical pieces of information in addition to the full literature review that is already underway.
- Panel, workgroup documents and recommendations, and available literature are critical sources of data
- Modeling Workgroup approves the target loads for final Phase 6 model

Timeline

- December 31, 2014 - Sparrow and literature review results for draft land uses
- February 28, 2015 - draft targets for draft land uses
- April 30, 2015 - Final land uses and targets approved by Modeling Workgroup
- Oct 1, 2015 - Finalize targets using a Sparrow update, final sensitivities, and other information.

Proposed Developed Phase 6 Land Uses

Phase 6	Phase 5.3.2
Roads Buildings, parking lots, etc.	Impervious surfaces
Turf grass Tree canopy* “Open space”	Turf grass (pervious)
Construction Extractive	Construction Extractive

* provisional, pending further work on loading differences and model fitness

Proposed Agricultural Phase 6 Land Uses (from Ag Workgroup and Ag Modeling Subcommittee)

Phase 6

Corn
Soybeans
Small grains
Alfalfa
Non-legume forage
Pasture
Vines
Low cover specialty
High cover specialty
Impervious CAFO & AFO farmsteads
Impervious non-animal farmsteads
Pervious CAFO & AFO farmsteads
Pervious non-animal farmsteads

Phase 5.3.2

Hightill w/ & w/o manure
Lowtill with manure
Nutrient management hightill w/ & w/o manure
Nutrient management lowtill
Alfalfa
Hay w/ & w/o nutrients
Nutrient management alfalfa
Nutrient management hay
Pasture
Nutrient management pasture
Nursery
AFOs
CAFOs
Degraded riparian pasture

Proposed Natural Phase 6 Land Uses

Phase 6	Phase 5.3.2
Forests	Woody/open
Harvested forest	Harvested forest
Disturbed forest	
Tidal emergent wetlands	
Fresh emergent wetlands	
Non-tidal woody wetlands	
Water*	Water

* Will expand water coverage to include 1:24K National Hydrography Dataset waterbodies and possibly Landsat derived “persistent” water features.

Proposed Phase 6 Sources and Overlays

Phase 6	Phase 5.3.2
Population on sewer	Population on sewer
Population on septic*	Population on septic
Stream corridors**	
Riparian zone	
MS4 areas	MS4 areas
CSO areas	CSO areas
Federal properties***	

* Loads may be adjusted based on findings from Advanced Onsite Systems Panel
** Provisional, pending further work on loading differences and model fitness
*** In Phase 5.3.2, federal properties were incorporated into the segmentation. In Phase 6, federal properties will be treated as an overlay.

Urban Tree Canopy

Options:

1. Treat as a land use

   (i.e., map it. Areas with less than 1-acre of contiguous interior tree canopy are assigned unique loads- distinct from turf and forest).

2. Treat as a BMP

   (i.e., the presence of tree canopy in urban areas modifies loads from impervious cover and/or turf grass)

Stream Corridors as Sediment Sources in Phase 6

Goals:

- More explicitly account for stream corridors as sources of sediment
- Modify Sediment Delivery Factors in Phase 6 based on fluvial geomorphic conditions
- Develop model relationships between upland runoff reduction and stream restoration BMPs.

Estimating Sediment Source Ratios (SSRs) for Urban Streams

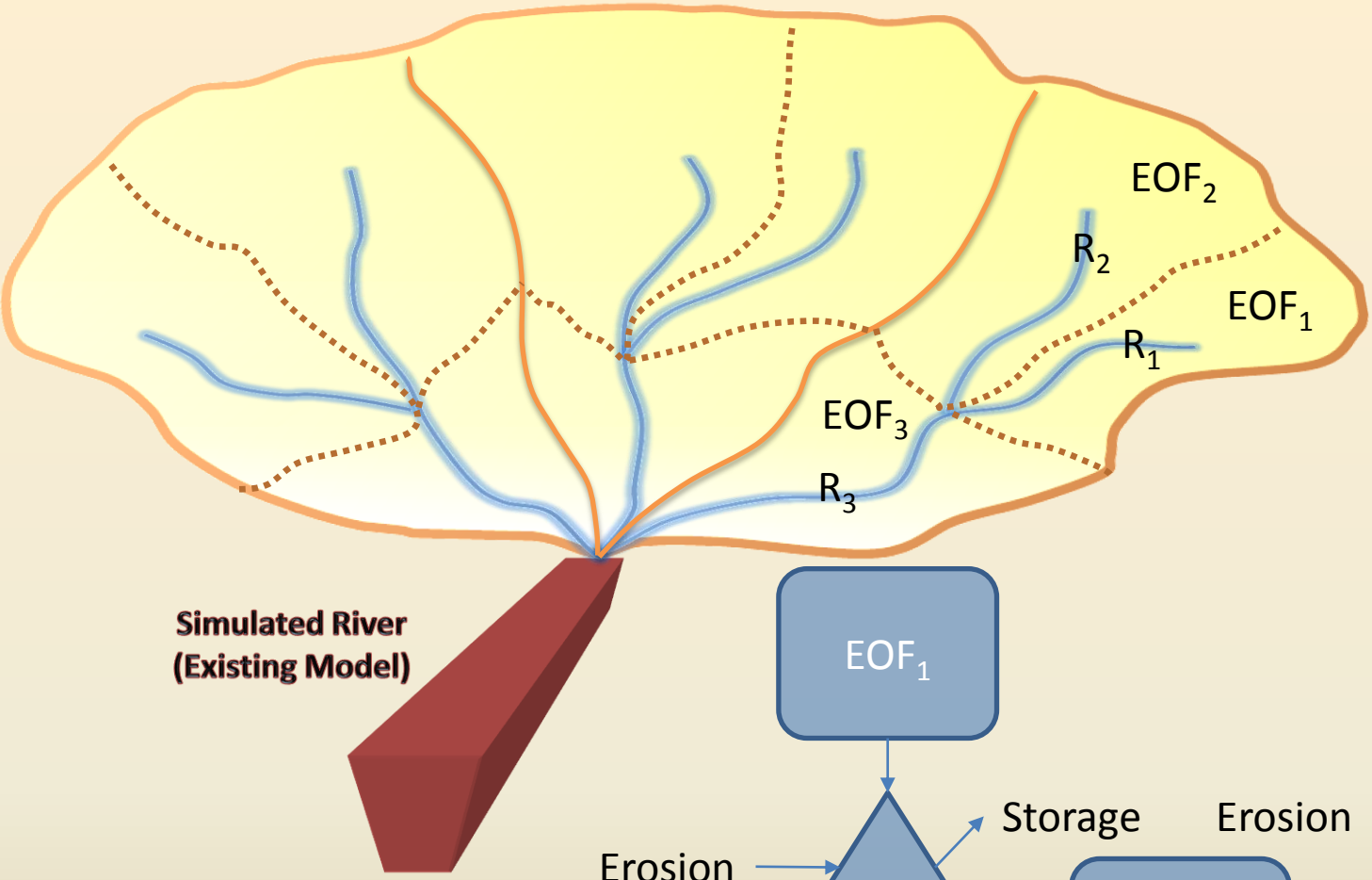
SSR =
ratio of sediment originating from bank/bed erosion to total sediment budget

- Develop a database of outfall and in-stream sediment monitoring data.
  - Use stormwater outfall and in-stream monitoring data
- Develop database of watershed and stream corridor characteristics
  - Use high-resolution digital elevation models (e.g., LiDAR) and high-resolution land cover
- Perform stepwise multiple regression to predict SSRs from watershed and stream corridor characteristics
- Apply relationship to all urban stream corridors.

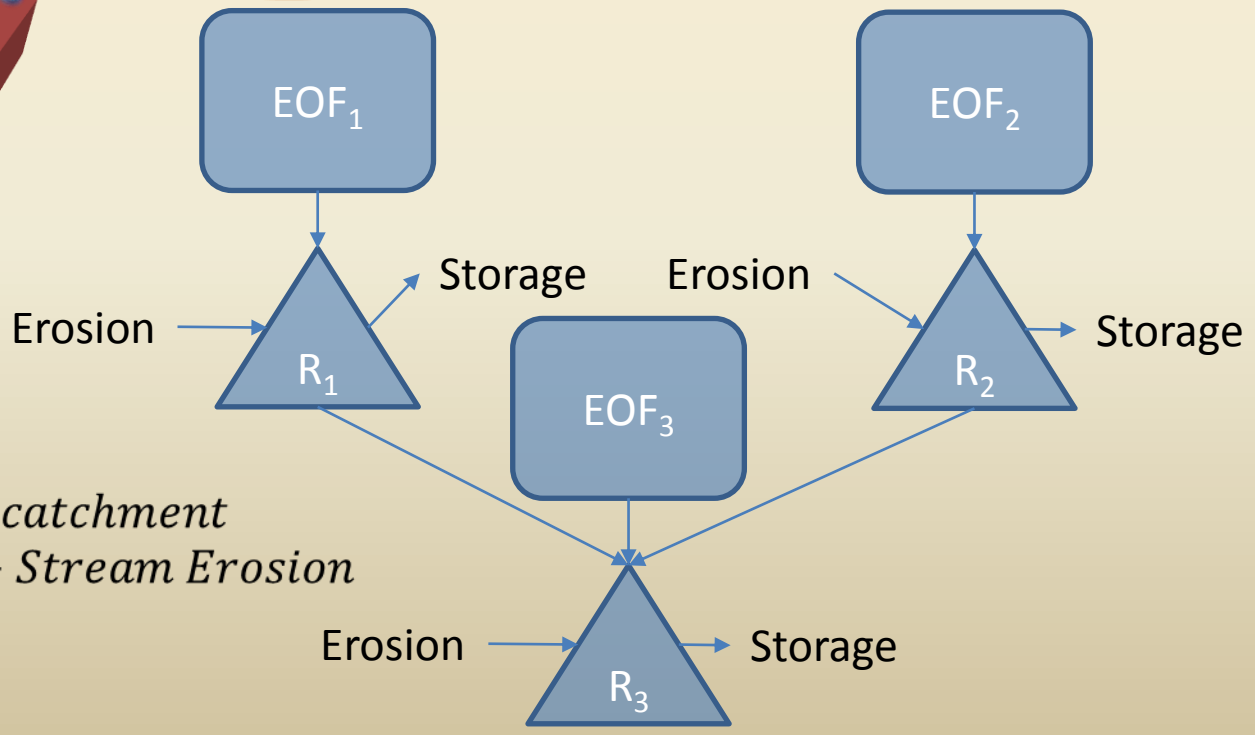
Potential stepwise regression parameters for SSR

Catchment data – variables affecting sediment budget	
Parameter	Data Source
Impervious cover	Local data – planimetric; NLCD
Storm drainage density	Local/ MS4 data; connectivity indicator
Density of outfalls	Local/ MS4 data
Forest Cover (watershed)	Anderson Level II (from State e.g. MDP)
Riparian land cover/buffers	Local data
Soil type	SSURGO
BMP implementation	Local/MS4 data; % IC treated or other
Stream density	Connectivity indicator
Stream corridor – variables affecting sediment budget	
Sinuosity	Derived
Floodplain width	USGS
Bank height	USGS
Channel slope	Derived
Source/sink	USGS-Schenk method

Drainage Network

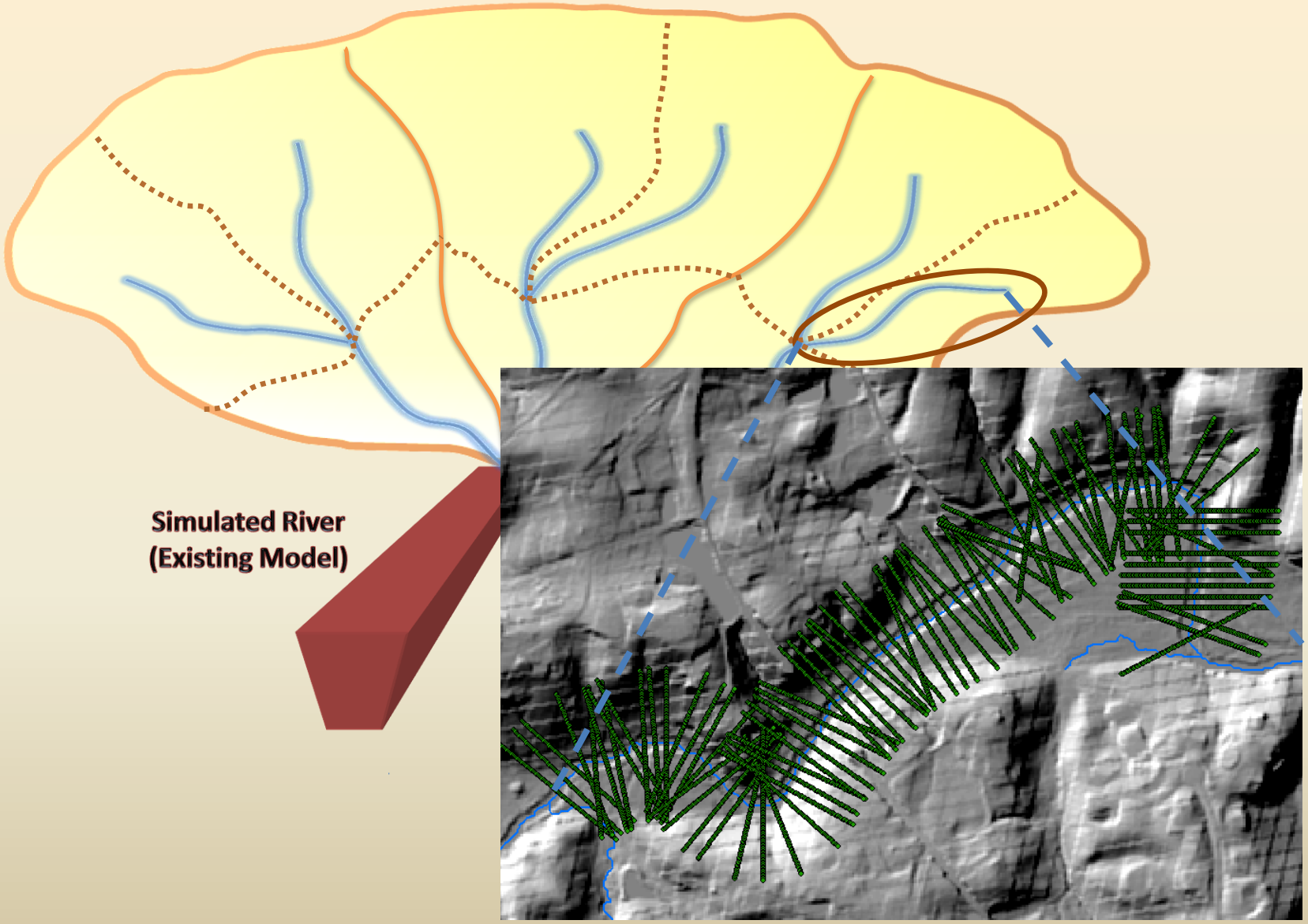


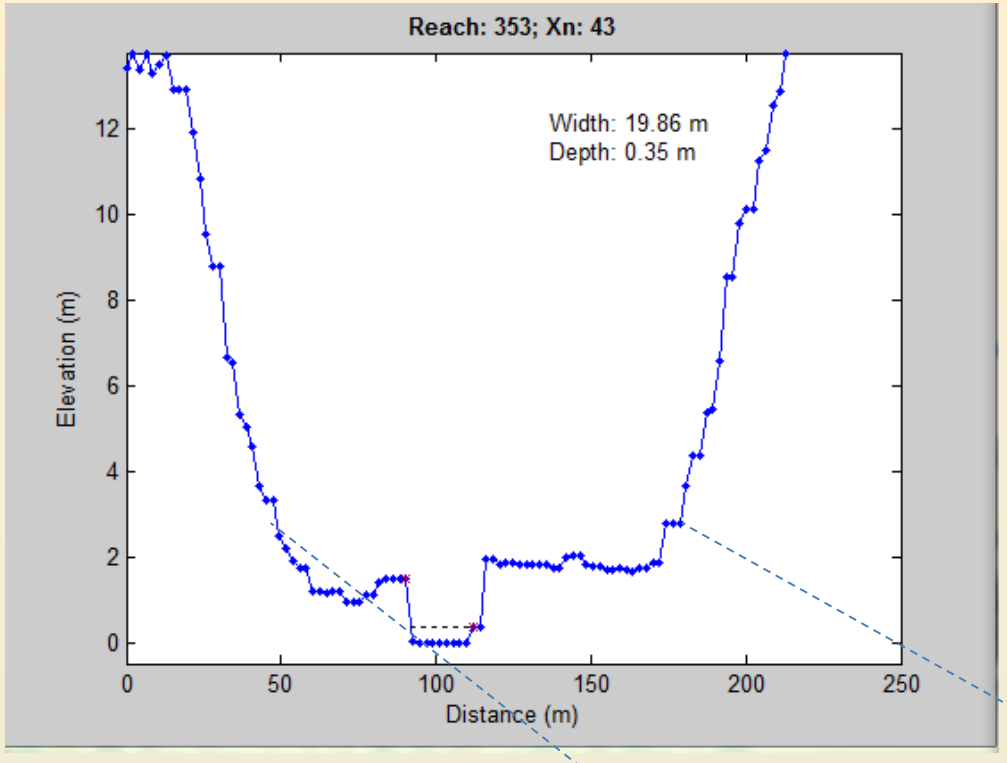
Simulated River
(Existing Model)

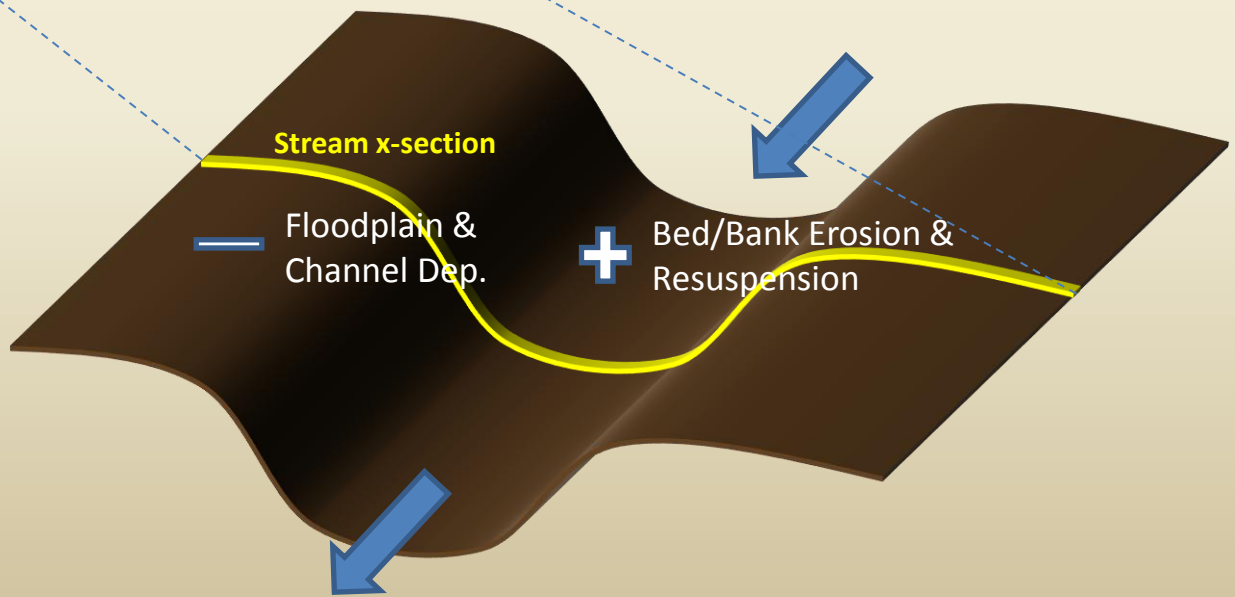


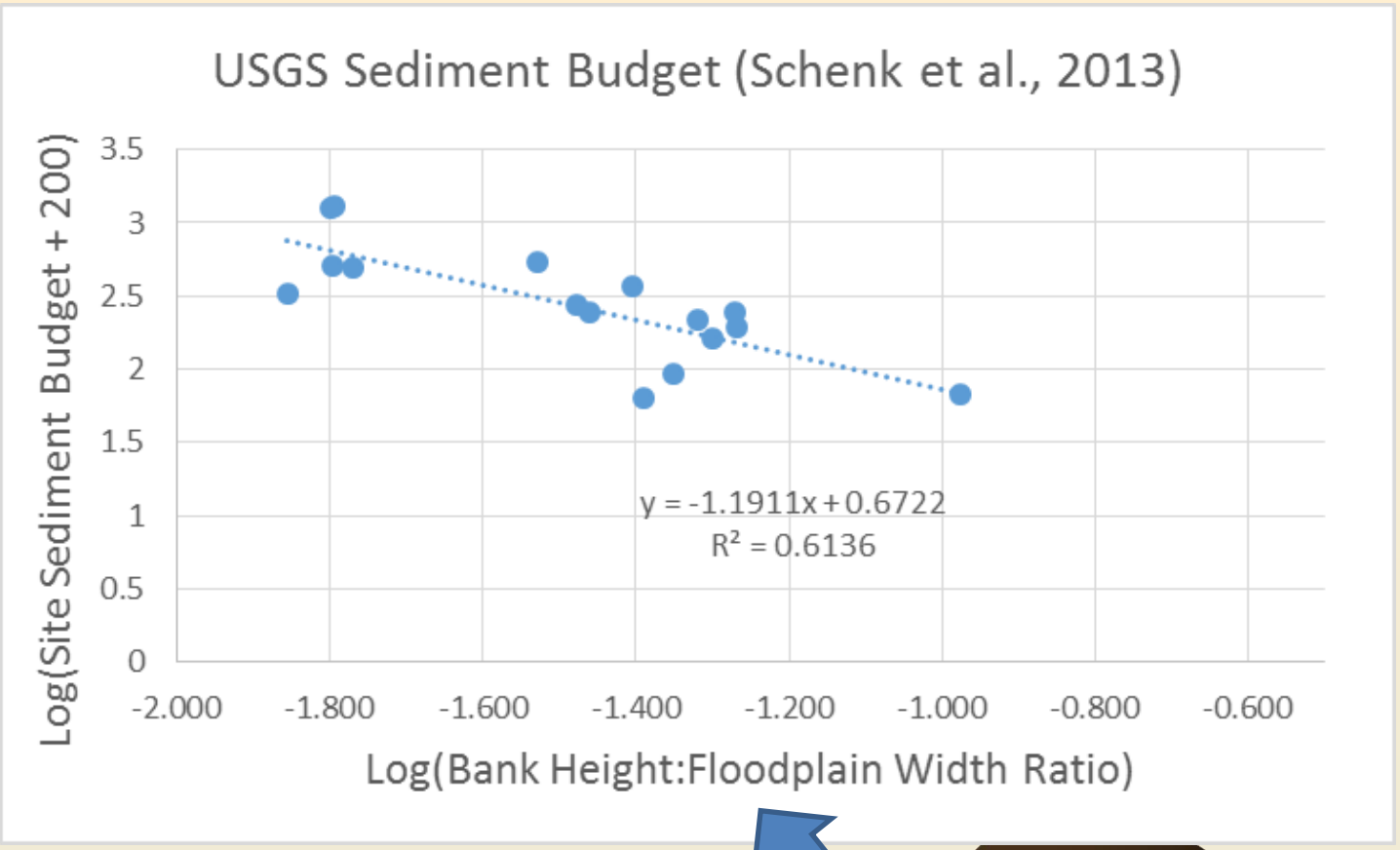
$$Sediment\ load\ at\ outlet\ of\ catchment = EOF - Stream\ Storage + Stream\ Erosion$$

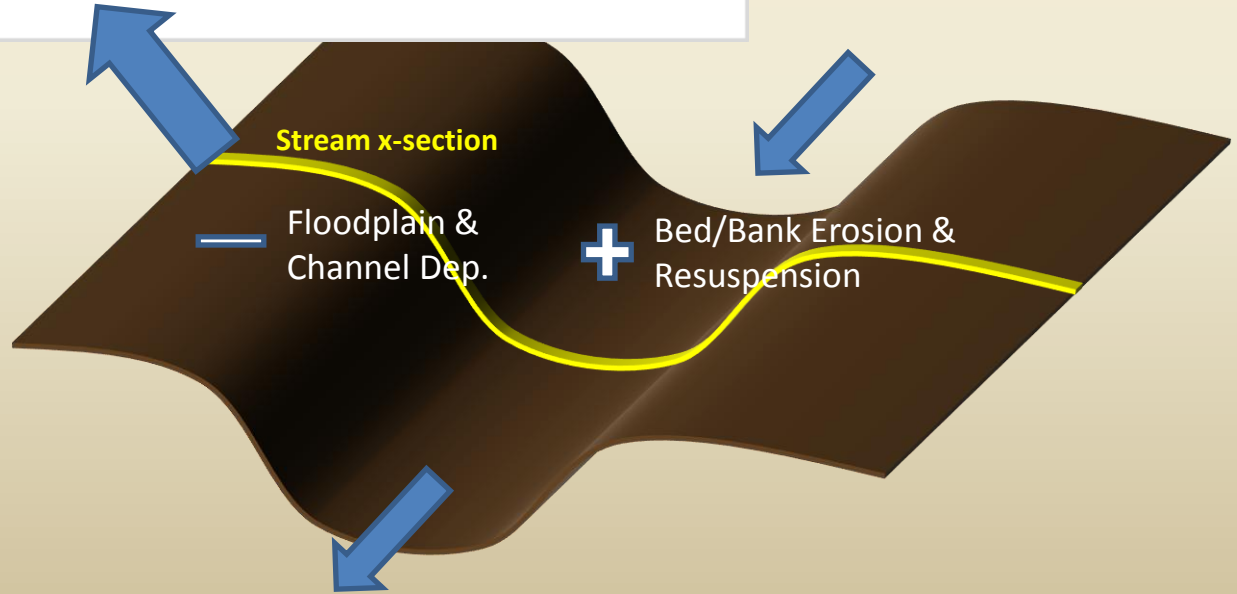
Drainage Network



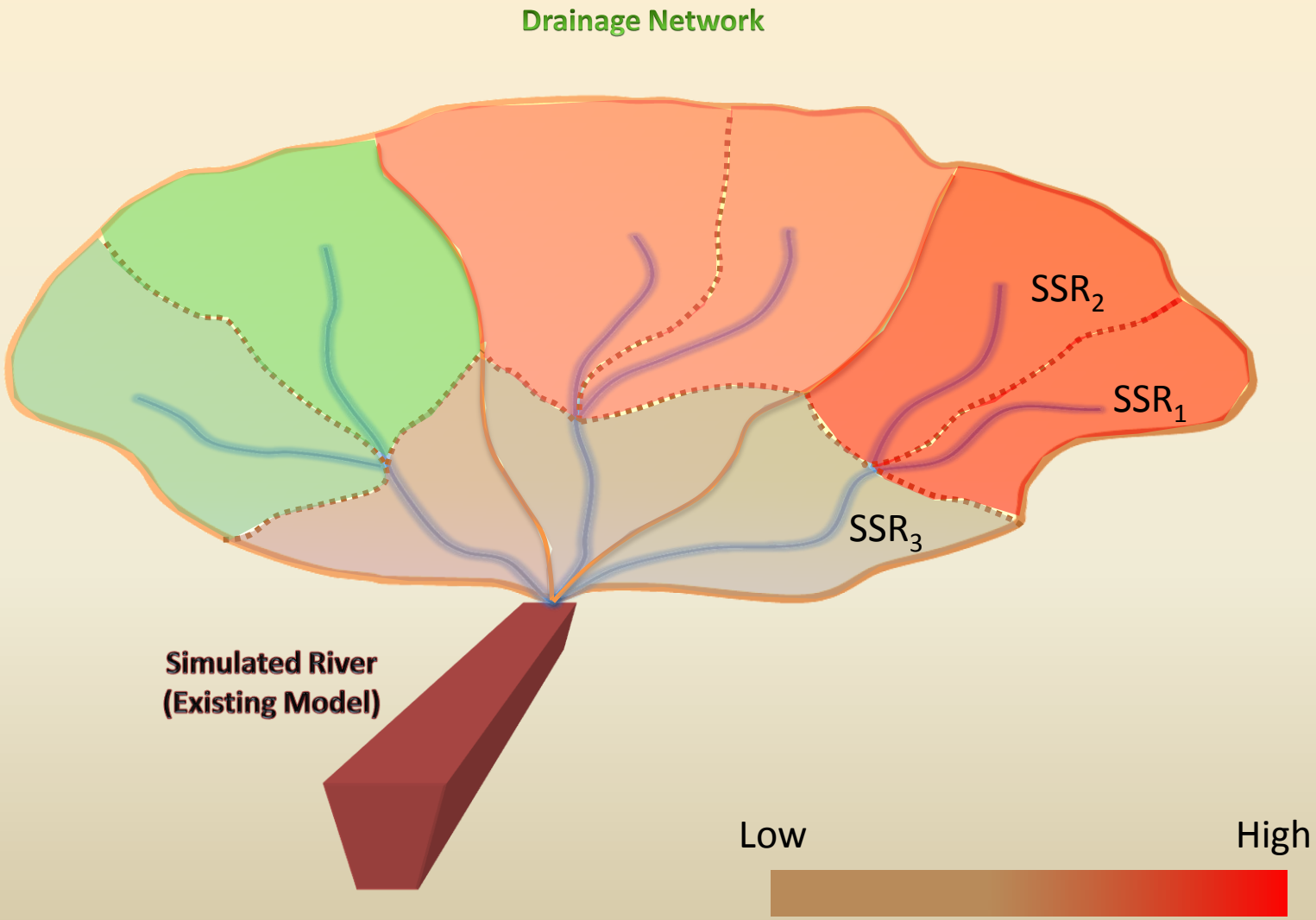

Reach: 353; Xn: 43
Width: 19.86 m
Depth: 0.35 m
Elevation (m)
Distance (m)
0
2
4
6
8
10
12
0
50
100
150
200
250


Stream x-section
Floodplain &
Channel Dep.
Bed/Bank Erosion &
Resuspension


USGS Sediment Budget (Schenk et al., 2013)
Log(Site Sediment Budget + 200)
3.5
3
2.5
2
1.5
1
0.5
0
-2.000
-1.800
-1.600
-1.400
-1.200
-1.000
-0.800
-0.600
y = -1.1911x + 0.6722
R² = 0.6136
Log(Bank Height:Floodplain Width Ratio)


Stream x-section
Floodplain & Channel Dep.
Bed/Bank Erosion & Resuspension

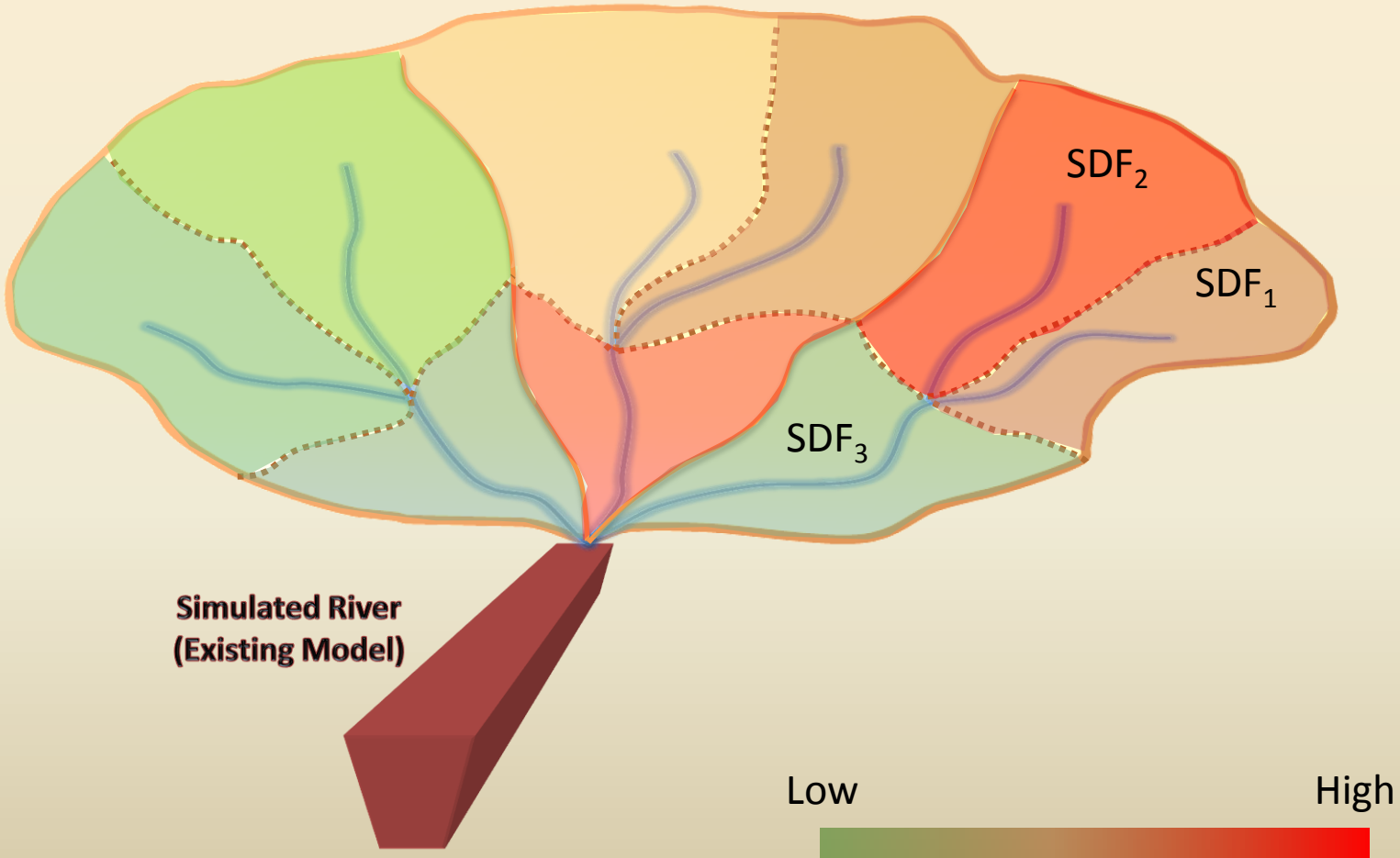
SSR Result


Drainage Network
SSR2
SSR1
SSR3
Simulated River
(Existing Model)
Low
High

SDF Result

Drainage Network

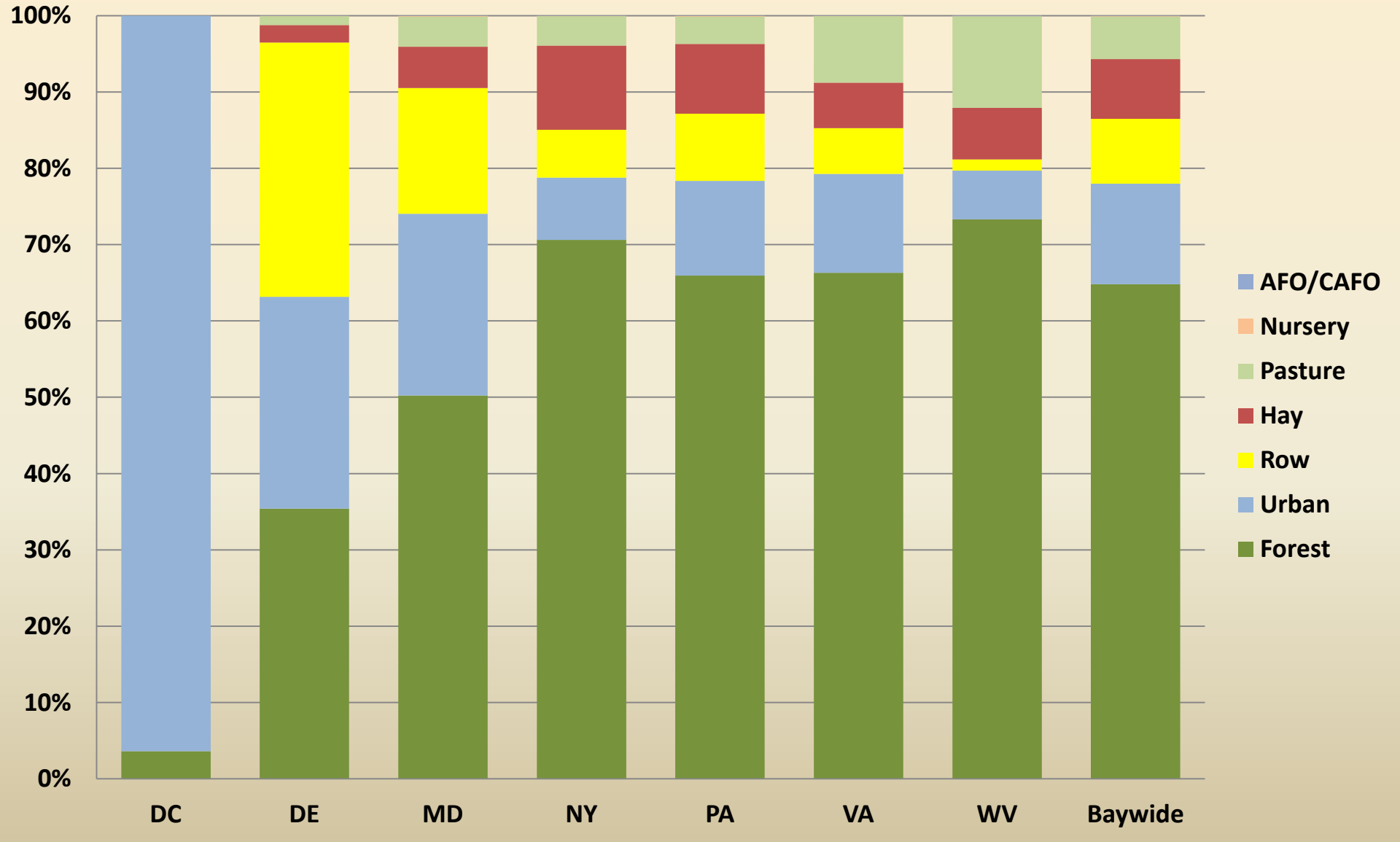
$$SDF = \frac{Sediment\ Delivered}{Sediment\ Generated}$$



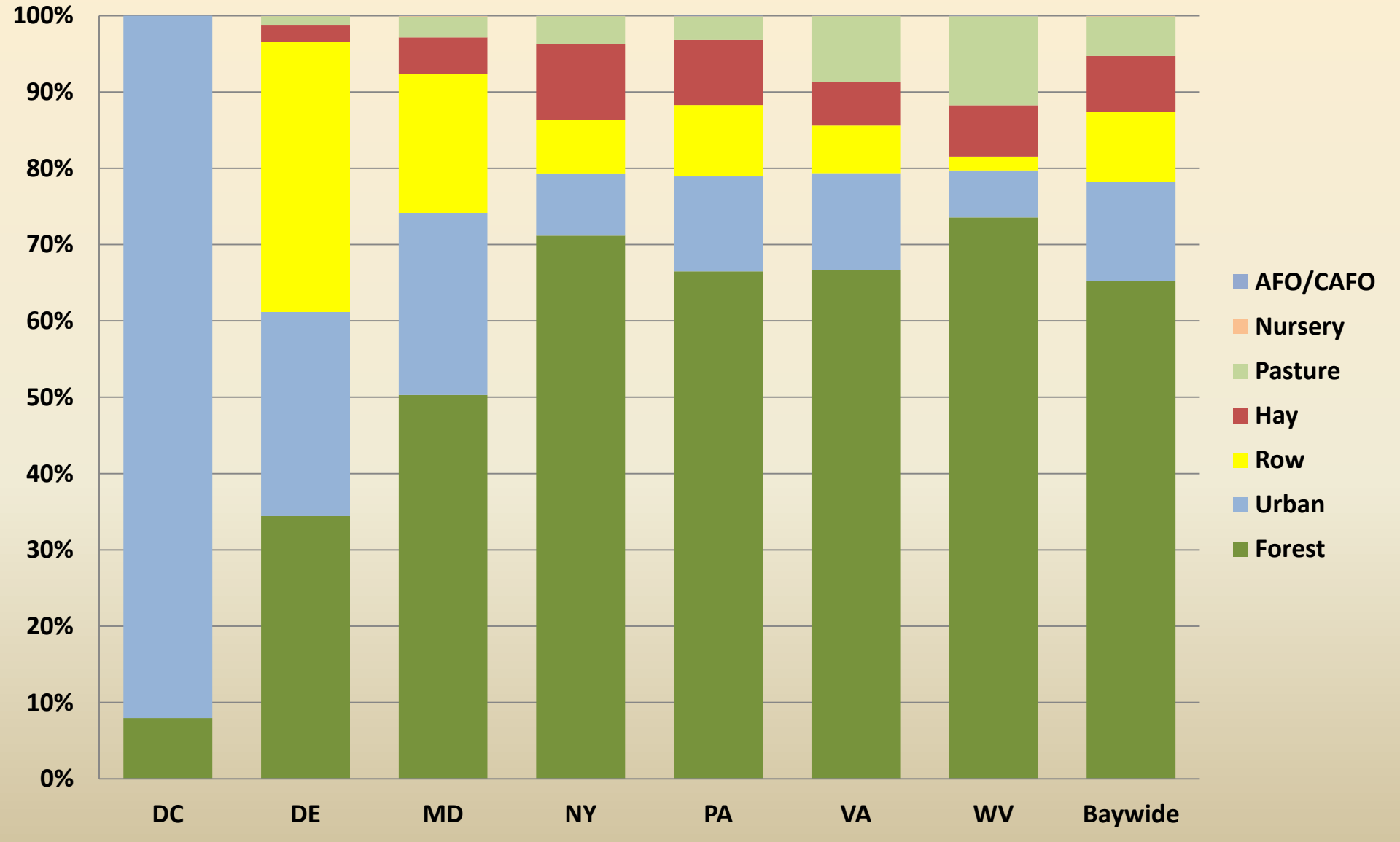
2014 Progress Land Use: New Data Sources

- Agriculture Data
  - Crop Acres and Animal Populations updated based on 2012 Ag Census.
  - Crop Acres distributed to better match overall Harvested Acres and Pasture trends reported in Ag Census.
  - States updated estimates of animals within CAFO operations.
- Urban Land Uses
  - Population projections for PA (March, 2014), MD (July, 2014) and WV (March, 2014) used to update urban lands and population.
  - 2011 National Land Cover Dataset used to update land uses and future populations on sewer vs. septic.
  - WV and MD localities provided updates for sewer service boundaries.
  - Method for capping total urban acres in a county was corrected (error found in November, 2013 version).
- Construction
  - States provided permitted, disturbed acres
- Harvested Forest
  - States provided permitted, harvested forest acres

2014 Relative Acres
(November, 2013 Version)



2014 Relative Acres
(October, 2014 Version)



Percent Change in 2014 Relative Acres

State	AFO/CAFO	Hay	Row	Pasture	Nursery	Forest	Urban
DC	0.00%	0.00%	0.00%	0.00%	0.00%	4.36%	-4.36%
DE	0.00%	-0.10%	2.08%	-0.01%	0.00%	-0.98%	-0.99%
MD	0.00%	-0.64%	1.76%	-1.20%	-0.03%	0.07%	0.04%
NY	0.01%	-1.04%	0.71%	-0.22%	0.00%	0.55%	-0.01%
PA	0.01%	-0.61%	0.54%	-0.51%	-0.02%	0.56%	0.03%
VA	0.00%	-0.26%	0.23%	-0.07%	0.00%	0.33%	-0.23%
WV	0.00%	-0.07%	0.38%	-0.32%	0.00%	0.22%	-0.22%
Baywide	0.01%	-0.54%	0.64%	-0.38%	-0.01%	0.39%	-0.09%

Percent Change in 2014 Animals

State	Poultry	Cattle/Dairy	Swine	Other
DE	-18.07%	-3.10%	280.32%	0.79%
MD	-11.60%	21.16%	-18.04%	-2.83%
NY	23.68%	-3.16%	-7.25%	13.01%
PA	-1.02%	5.04%	-23.52%	0.94%
VA	-38.65%	1.85%	-27.53%	8.09%
WV	2.28%	1.31%	-30.76%	1.29%
Baywide	-16.62%	3.20%	-23.59%	3.74%