Land Use Methods & Metrics Development Outcome

Management Strategy

Introduction

To minimize the extent of and mitigate effects from land conversion, local decision-makers and the land conservation community need to be informed about: 1) land cover/use changes affecting landscapes that provide valued ecosystem and social services; and 2) policy options, incentives, and tools to reduce the rate and magnitude of conversion of those lands. To address the first part of this strategy, the Land Use Methods and Metrics Development Outcome (aka Metrics Outcome) calls for monitoring and reporting on the rates of farmland, forest, and wetland conversion and the rate of impervious surface change at a local scale relevant to land use decisions. The Metrics Outcome will help inform outreach efforts and products developed as part of the Land Use Options Evaluation Outcome which will address the second part of this strategy.

The intent of the Metrics Outcome is to develop a method and metrics to monitor the conversion of valued natural and working landscapes such as forests, wetlands, and farms. These landscapes provide ecosystem services of value to the Chesapeake Bay and its population including water quality and quantity, habitat, recreation, and food production.

I. Goal, Outcome and Baseline

This management strategy identifies approaches for achieving the following goal and outcome:

Goal: Conserve landscapes treasured by citizens in order to maintain water quality and habitat; sustain working forests, farms and maritime communities; and conserve lands of cultural, indigenous and community value.

Outcome: Continually improve the knowledge of land conversion and the associated impacts throughout the watershed. By 2016, develop a Chesapeake Bay watershed-wide methodology and local level metrics for characterizing the rate of farmland, forest and wetland conversion, measuring the extent and rate of change in impervious surface coverage and quantifying the potential impacts of land conversion to water quality, healthy watersheds and communities. Launch a public awareness campaign to share this information with citizens, local governments, elected officials and stakeholders.

Baseline and Current Condition: The temporal baseline for the outcome has not yet been determined but would likely be based on observed landscape changes within the 2007-2015 timeframe and be repeated every 2-5 years. It should be noted that rates of land conversion are responsive to economic growth which peaked in this region around 2006. Because that boom period was an anomaly, baseline assessments initiated post 2006 may more accurately reflect current rates of change.

II. Participating Partners

The following partners have already pledged to help implement this strategy:

- Chesapeake Bay Commission
- Local Government Advisory Committee
- Water Quality Goal Implementation Team
- Habitat Goal Implementation Team
- Healthy Watersheds Goal Implementation Team
- Maryland Department of Environment
- Maryland Department of Planning
- Pennsylvania Department of Community and Economic Development
- USGS Eastern Geographic Science Center
- USGS National Geospatial Program
- The Chesapeake Conservancy

Local Engagement: To assist in quantifying impacts on communities, the CBP Land Use Workgroup will work with the CBP Local Government Advisory Committee to identify local governments interested in playing an active role in quantifying the impacts of land use change on communities and the environment.

III. Factors Influencing

The following are natural and human factors that influence the Partnership's ability to attain this outcome:

1. High-resolution land cover and elevation data availability
2. High-resolution land cover and elevation data costs
3. Sustainability of long-term monitoring
4. Methodology for assessing landscape change with high-resolution data with sufficient precision to inform county-level decisions.
5. Methodology to quantify impacts to communities and the environment
6. Agreement on the temporal and spatial scale at which to assess change

IV. Current Efforts and Gaps

The term "land cover" refers to a wall-to-wall classification of land surface characteristics into categories such as impervious surfaces and tree canopy. Land cover classifications are derived from aerial and/or satellite spectral imagery collected from passive sensors (e.g., cameras). These classifications can be enhanced by incorporating data from active sensors (e.g., those emitting a pulse such as LiDAR). Since the late 1990's, the Chesapeake Bay Program Partners have relied on 30m-resolution Landsat satellite derived land cover data to provide a spatially consistent representation of Bay watershed conditions to inform the suite of models used for management purposes and for tracking changes on the landscape.

Throughout the 2000's and to the present, counties, states, and the USDA's Farm Service Agency have acquired high-resolution (<=2m) imagery to inform transportation, public works, and natural resource decisions. Initially, these data were acquired as natural color images and used as pictures rather than analyzed as data. This practice has gradually evolved through the development of object-based feature extraction software (e.g., Feature Analyst, ENVI, and eCognition) and the acquisition of imagery with a near-infrared spectral band in addition to the three visible bands. The near-infrared band enhances the ability to distinguish vegetation from non-vegetated areas.

At present, US Department of Agriculture-Farm Service Agency (USDA-FSA) collects 4-band leaf-on 1-meter resolution ortho-imagery for each state as part of their National Agriculture Imagery Program (NAIP) every 1-3 years. Collection dates are cyclic and vary due to the availability of state cost-share funds and other factors. The Virginia Institute of Marine Sciences collects and manually classifies black and white aerial photographs along the near-shore areas of the Chesapeake and Coastal Bays to support their annual inventory of Submerged Aquatic Vegetation extent and density. In addition, some states and localities acquire sub-meter leaf-off imagery every 3-5 years to support transportation and planning needs. Leaf-on imagery is better for detecting vegetation and leaf-off imagery is better for detecting impervious surfaces and water features which may be obscured by the canopy during the growing season. Leaf-off imagery is mostly collected during the spring but the collection years often vary by state.

Complete or partial land cover information derived from classifying high-resolution imagery is available only for select counties in the Bay watershed (Figures 1-3). In 2015, tree canopy data will be developed for the states of Pennsylvania and Delaware through a recent NASA grant and tree canopy change will be assessed in Maryland by the University of Maryland and NASA using a combination of high-resolution imagery and LiDAR (Figure 4).

The Metrics Outcome calls for "continually improving the knowledge of land conversion" which requires monitoring land change, not just mapping it once. Assessing and mapping land use/cover change from high-resolution imagery is very challenging but holds great promise for meeting the objectives of this Outcome. Changes in spectral surface properties over multi-date images are influenced by differences in sun-angle, atmospheric conditions, vegetation phenology, infrastructure materials and aggregates, and other factors besides land cover changes that can change from one image tile to another and from one year to another. These problems are largely absent when performing a change analysis on 30m-resolution Landsat satellite imagery. High-resolution change analysis can be done but for the above stated reasons, first-round automated results will likely be noisy and require modification to realize the accuracies needed to detect the average amount of change we expect to observe over a 2-5 year interval.

V. Management Approaches

There are three elements to the Metrics Outcome:

1. Monitor the conversion of forests, wetlands, and farmland to impervious surfaces.
2. Quantify impacts of land conversion on:
    a. Water quality
    b. Healthy watersheds
    c. Communities
3. Communicate results to the public, elected officials, and CBP partners.

The CBP Partners will coordinate and solicit input on user requirements and technical specifications for this outcome. There are three basic technical approaches for monitoring land conversion every 2-5 years: 1) coarse, 30m-resolution wall-to-wall mapping of land cover change from Landsat satellite imagery; 2) high-resolution (<5m) wall-to-wall mapping of land cover change from aerial or satellite imagery; and 3) high-resolution (<5m) stratified random sampling. Each of these options has advantages and disadvantages related to cost, accuracy, spatial and temporal scale, flexibility for management use, adaptability to changing management objectives, and educational value. These attributes will be considered in developing recommendations for monitoring land change over time. Additional options may emerge from discussions with CBP Partners and potential data providers over the coming year. Note, however, that the above options are not necessarily mutually exclusive. For example, monitoring land change with Landsat satellite imagery can inform a stratified sampling framework using high-resolution imagery.

While measuring current rates of land conversion will require use of existing imagery and data which varies in spatial resolution, accuracy, and temporal currency, significant improvements in derived metrics and cost savings to local, state, and federal government agencies could be achieved through a heavily coordinated effort to synchronize the acquisition of imagery and agree on a classification schema and change detection approach.

Quantifying the impacts of land conversion on water quality will be accomplished through close coordination with the CBP Modeling Workgroup and utilize the same sets of assumptions and data used to inform water quality decisions associated with the Bay TMDL. Quantifying impacts to healthy watersheds will be determined through close coordination with the Healthy Watersheds Goal Implementation Team and may involve measures of vulnerability to urban development coupled with hydrologic impact measures associated with stream flow alteration. Assessing the impacts of land conversion to communities is one of the most complicated aspects of this Outcome. Land conversion associated with residential and commercial development provides economic benefits to communities but also involves costs which are not always evident at the time of development. Local participation will be sought to help identify and describe impacts to communities and to develop and implement the communication strategy as described below. Consideration will also be given to putting the rates of land conversion and impacts in context to aid interpretation and understanding, i.e., reporting relative levels of change in addition to absolute rates.

Approaches Targeted to Local Participation

Local participation in developing the methods to assess impacts to communities are needed to ensure the data are useful for informing local-level decisions. The CBP Healthy Watersheds Goal Implementation Team, Citizen Advisory Committee, and Local Government Advisory Committee will work with the CBP Land Use Workgroup and Communications Office to develop a communication strategy and to identify the specific measures used to assess impacts to communities. These groups will further work together to seek additional local government and non-governmental participation and leadership for implementing the communication/outreach strategy, particularly from member's affiliations (MACo, VACo, PSASTS, etc.).

Cross-Outcome Collaboration and Multiple Benefits

Restoration and conservation efforts in the Chesapeake Bay watershed would benefit greatly from the availability of high-resolution land cover and elevation data produced every 3-5 years. The data would inform goals outlined by all of the Partnership's Goal Implementation Teams and inform almost all of the outcomes specified in the 2014 Chesapeake Bay Watershed Agreement—particularly the vital habitats, healthy watersheds, land conservation, and climate resiliency outcomes. Specific benefits include:

- Characterizing, mapping, and tracking of wetlands, riparian forest buffers, forests, and impervious surfaces;
- Characterizing, mapping, and tracking habitat conditions;
- Developing habitat suitability maps;
- Prioritizing and targeting restoration, conservation, education, and public access efforts;
- Understanding the effects of management actions on water quality;
- Verifying riparian buffer and urban tree canopy Best Management Practices;
- Assessing the combined resiliency of the Chesapeake Bay to adverse impacts from land change and climate change;
- Improving the accuracy of nutrient and sediment load estimates; and
- Educating citizens on the value and location of high-functioning landscapes (e.g., landscapes providing ecological services such as nutrient uptake and transformation, sediment retention, and wildlife habitat).

VI. Monitoring Progress

Monitoring for these efforts will focus on ensuring activities are on schedule to complete the new metric by 2016.

VII. Assessing Progress

Progress in developing the methods and metrics will be assessed quarterly by the Land Use Workgroup and will be based on the feasibility and accuracy of the derived metrics and impact measures.

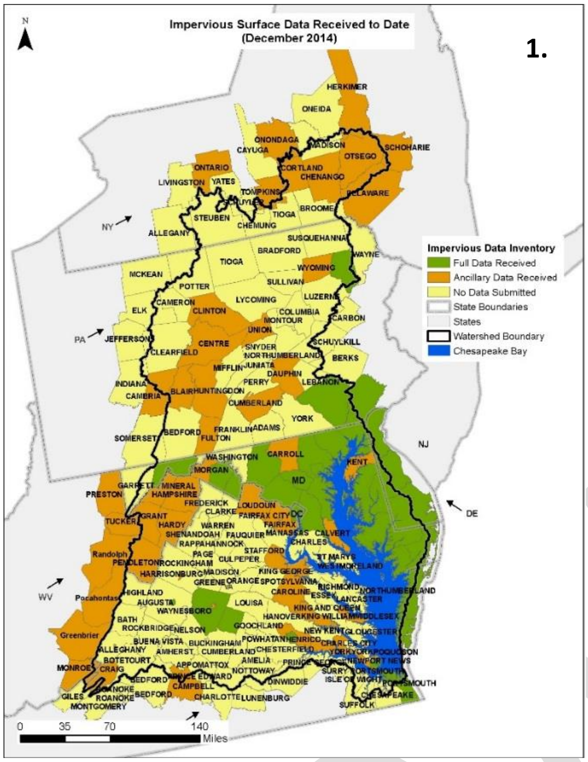
VIII. Adaptively Manage

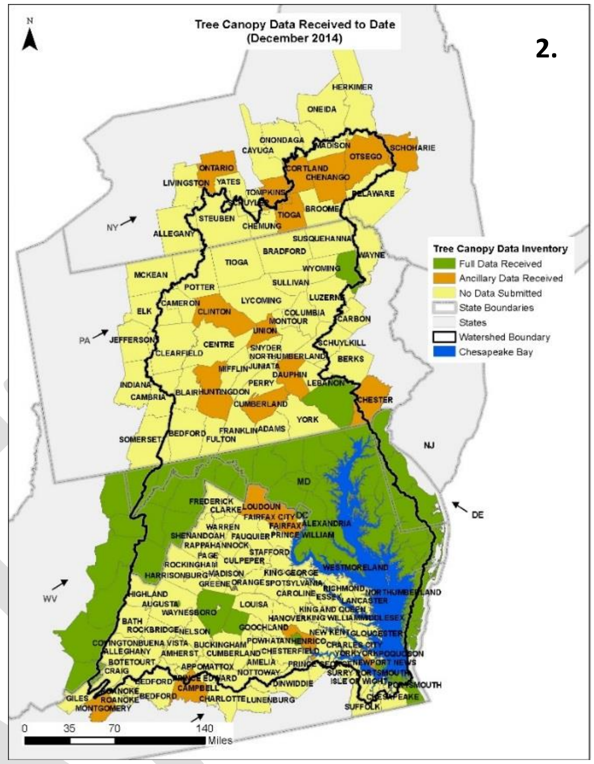
The utility of the metrics and impact assessments for informing CBP decisions will be evaluated at the end of each monitoring cycle and adjusted as needed to improve their utility for local decisions to accommodate changes in technology and/or programs.

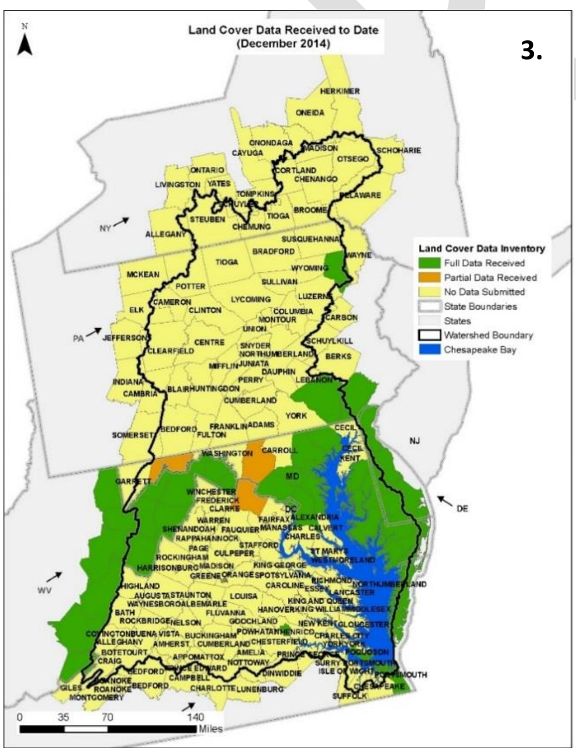
IX. Biennial Workplan

Biennial workplans for each management strategy will be developed by December 2015. It will include the following information:

- Each key action
- Timeline for the action
- Expected outcome
- Partners responsible for each action
- Estimated resources







Figures 1-3. High-resolution impervious surface, tree canopy, and land cover data (multiple classes) produced within the Chesapeake Bay Watershed.

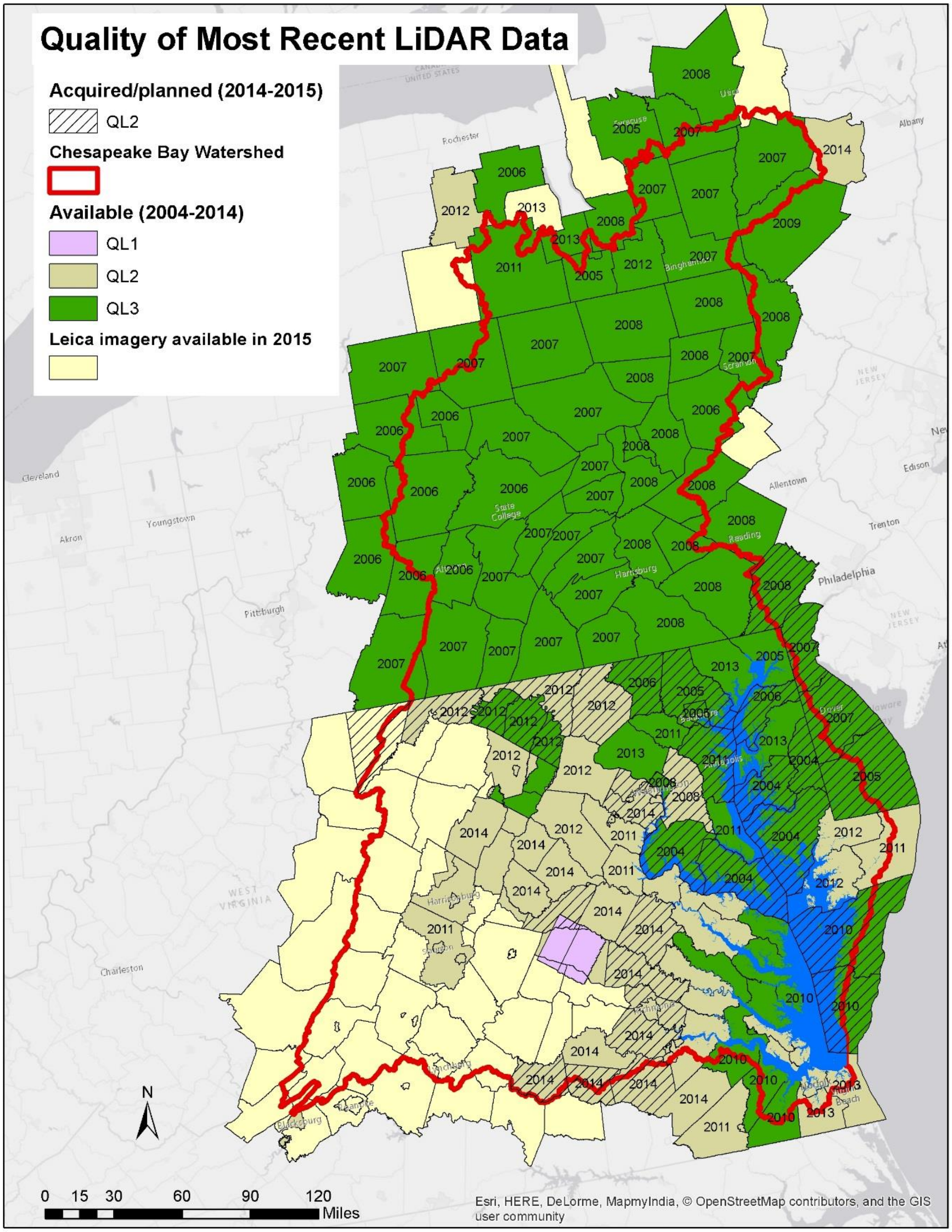


Figure 4. Current and planned availability of LiDAR data.