Virginia Aquatic Resource Trust Fund
Aquatic Ecosystem Assessment GIS Tools

The Nature Conservancy's (TNC) Virginia Aquatic Resources Trust Fund (VARTF) in-lieu fee (ILF) program identifies priority sites for wetland and stream compensatory mitigation. Using aquatic ecoregional assessments, TNC first identifies important conservation targets and goals within ecoregion-based groupings of watersheds before evaluating targets using a GIS screening tool that rates individual river systems based on land cover composition, dam and water supply, and point source impacts. TNC then facilitates workshops in which groups of experts rigorously review - based on their own professional knowledge of local resource conditions and undocumented data - the identified priorities to produce final maps of conservation priority areas. Within these priority areas, TNC applies field-based assessments to identify finer-scale priorities as part of its conservation action planning process. Because ecoregional assessments have been applied in all 50 states, the transferability of this approach is well established. As applied by TNC VARTF, aquatic ecoregional assessments represent a possible model approach for states seeking to implement aquatic resource restoration and conservation for compensatory mitigation using a watershed approach.

OVERVIEW

Lead developer(s): The Nature Conservancy (TNC), with refinement for use by the Virginia Aquatic Resource Trust Fund (VARTF) in-lieu fee (ILF) program.[1,2]

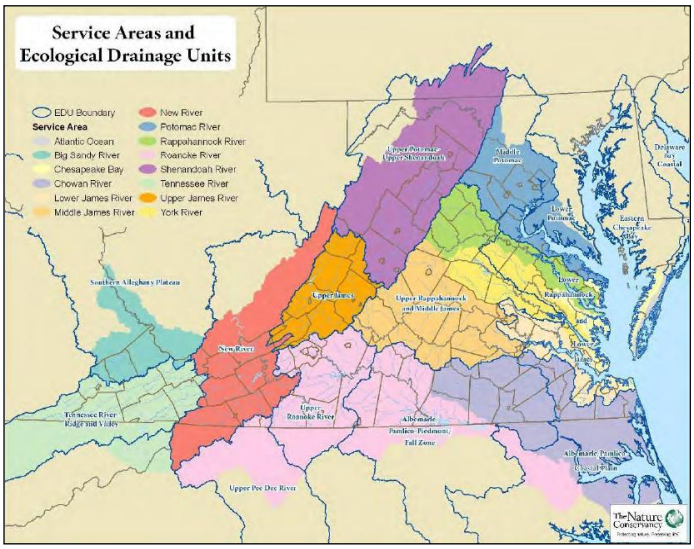

Figure 1. TNC's Aquatic EA used ecoregional planning to identify priority areas within Virginia's 14 EDUs, shown above. Used with permission from The Nature Conservancy.

Year developed: VARTF implemented the approach in 2009, though TNC's use of ecoregional planning began much earlier.[3]

Geographic area: The state of Virginia, at the scale of the ecological draining unit (EDU), excluding the Big Sandy Basin in southwest Virginia (Fig. 1). EDUs are subcomponents of freshwater ecoregions that are composed of multiple HUC-8 watersheds that "share a common zoogeographic history as well as local physiographic and climatic characteristics."[4]

Resource types: Wetlands and streams.

Restoration/conservation: Restoration (reestablishment and rehabilitation), creation, enhancement, preservation/protection, and acquisition with preservation/protection.[3]

Stakeholders: TNC VARTF's ILF program.[4]

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Current status: Priority sites identified by the TNC Aquatic Ecoregional Assessment (EA) are currently applied to inform compensatory mitigation decisions by the VARTF ILF program. However, given the complexities associated with compensatory mitigation, especially restoration work, the use of TNC's Aquatic EA alone is not sufficient to identity the true value or feasibility of any given site. Therefore, any actual projects require site-specific field work. At present, TNC is investing time communicating with regulators and the regulated community about its projects and the compensatory planning framework to encourage them to use VARTF to satisfy their mitigation obligations and achieve good ecological outcomes. It is important to note, however, that many other factors, including federal compensatory mitigation regulations and credit availability, influence whether or not VARTF is an appropriate option for any specific mitigation need.[1]

PRIORITIZATION ANALYSIS

Determination of prioritization objectives: For the Aquatic Ecoregional Assessment, TNC first identified a set of "conservation targets" composed of priority ecosystems, communities, and species identified at both fine scales (e.g., rare and endangered species) as well as coarse scales (e.g., large river systems) within each EDU. TNC then evaluated the "viability" of each conservation target by assessing its target size (abundance/density), condition (quality of its biotic/abiotic factors, structures, and processes), and landscape context (quality of biotic/abiotic factors, structures, and processes in its surrounding landscape). TNC drew upon the GIS factors and data sources listed in Table 1 to evaluate the viability of conservation targets within each EDU. It also held workshops to solicit input from experts familiar with each ecoregion to obtain data for target occurrences that were not readily available. These included data on stocking, channelization, invasive species, non-point source pollution, dam operation, and local water withdrawals.[4]

Table 1. Factors and associated data sources used by TNC to evaluate viability criteria for target species in each EDU as part of its Aquatic Ecoregional Assessment.[4,5]

Factor used in analysis	Data source(s)
Land cover	National Land Cover Dataset
Impervious cover	National Land Cover Dataset
Roads	StreetMap USA (Esri & Tele Atlas)
Dams	EPA
Managed and conservation lands	Multiple state and federal sources
Point source pollution	EPA
Water quality data	VCU INSTAR database, DEQ biological monitoring data, DEQ §303(d) impaired waters list, VDDGIF threatened and endangered waters
Presence of aquatic species	VDGIF aquatic species inventory, VDCR-VDNH aquatic species inventory

VCU = Virginia Commonwealth University; INSTAR = Interactive Stream Assessment Resource database; VDCR-VDNH Virginia Department of Conservation Division of Natural Heritage; VDGIF = Virginia Department of Game and Inland Fisheries; DEQ = Department of Environmental Quality; EPA = Environmental Protection Agency

Within each EDU, TNC also set goals for each conservation target in terms of the number and spatial distribution of on-the-ground occurrences that would be necessary to ensure the target is adequately conserved for at least 100 years. For example, TNC set a representation goal to conserve at least one medium and large high-quality river system within each EDU. In addition, TNC set a connectivity goal to conserve one stream network connecting headwaters to either the coast or a mainstem river.[4]

Landscape prioritization tool(s): After evaluating target viability and setting conservation goals as part of its ecoregional assessment, TNC identified priority conservation areas (PCAs) that its analysis indicated would most efficiently and effectively conserve biodiversity within each EDU. Collections of PCAs, referred to as conservation "portfolios" by TNC, were designed to achieve the goals set for each conservation target by TNC with the smallest total area.[4] In practice, however, many Priority Conservation Areas (PCAs) are actually quite large, since large, unfragmented blocks of habitat are themselves rare and often critical to the maintenance of healthy, intact ecosystem functions and biodiversity.[1]

Aquatic System Integrity GIS model: To develop its portfolio, TNC first applied a GIS screening analysis to rank river systems based on landscape variables known to correlate with the biological integrity of aquatic communities (Table 2). These variables were grouped into three categories: land cover and road impacts (impacts due to roads, urbanization, and agriculture), dam and drinking water supply impacts (impacts caused by altered hydrologic regimes and creation of migration barriers), and point source impacts (potential chemical or nutrient threats due to point sources). By ranking each target river system for each category, TNC was able to identify those river systems that were most intact within each EDU.[4]

Prioritization objectives assessed:

- Aquatic resource condition

Table 2. Factors and data sources used to prioritize for functions/values associated with watershed condition.[4]

Factor in the analysis		**Data source(s)**
Land cover and road impacts	Percentage developed land	National Land Cover Dataset
	Road Density	StreetMap USA (Esri & Tele Atlas)
	Density of road/stream crossings	StreetMap USA and National Hydrography Dataset
Dam and drinking water supply impacts	Dam density	EPA
	Dam storage capacity	EPA
	Drinking water supply density	EPA
Point source impacts	Point source density	EPA

Landscape context GIS model: TNC obtained "landscape context" rankings for each watershed by calculating the percentage coverage of each watershed by three spatial variables: percentage developed land, percentage agricultural land, and total road density per watershed area. TNC applied the criteria listed in Figure 2 to each of these three percentages, using the highest rank

obtained among them to represent each watershed's ranking for overall landscape context. Data sources used to represent each of these criteria are listed in Table 3.[4]

Landscape Context Rankings			
Rank	%Developed	% Agriculture	Road Density (mi.rd./sq.mi. watershed
1	<1%	<3%	<1
2	1-2%	3-6%	1-2.5
3	2-6%	6-10%	2.5-3.5
4	6-15%	>10%	>3.5
5	>15%		

Figure 2 TNC calculated percentage developed, agricultural, and road land use for each watershed, from which three ranks were derived after applying the above criteria. The highest rank for each watershed represented that watershed's overall landscape context rank. Used with permission from The Nature Conservancy.

Prioritization objectives assessed:

- Aquatic resource condition

Table 3. Factors and data sources used to prioritize for habitat quality using the landscape context metric.[4]

Factor in the analysis	Data source(s)
Percentage developed land	National Land Cover Dataset
Percentage agricultural land	National Land Cover Dataset
Total road density per watershed area	StreetMap USA

Validation of the landscape prioritization tool(s): TNC is committed to peer reviewing its assessment methodology and is always working to improve and enhance the accuracy and utility of its conservation planning efforts and products. Ultimately, however, it would be challenging to judge the validity of ecoregional planning efforts based on the success of its compensatory mitigation projects. While TNC is highly confident that their ecoregional assessments direct it to work in areas important to the functionality and diversity of aquatic systems, the success or failure of individual projects depends on a host of variables unrelated to ecoregional planning efforts (restoration site design, for example). Additionally, success criteria for compensatory mitigation projects are more narrowly considered than the overall success of an ecoregional assessment. Thus, while TNC's ecoregional assessment methodology and results have been peer reviewed and supported, TNC is not in a position presently to prove that the success or lack of success of a given project is directly influenced by the ecoregional assessment or vice versa. With additional years of field data, however, TNC may be able to draw some general, but still valuable, conclusions on ways the assessment process could be better refined to serve the purposes of the VARTF.[1]

Refinement of landscape prioritization sites:

Refinement based on data analysis: After applying its landscape prioritization GIS screening analyses (see above), TNC solicited aquatic resource experts from land or resource management agencies, academic institutions, private consulting firms, and local non-profits in a series of workshops to obtain expert feedback on priorities identified. In addition, the experts delineated areas of aquatic biological significance on maps, including written descriptions of the identified areas, based on their professional knowledge of the area. Next, TNC requested that experts identify river systems within each EDU that ranked the highest, in their judgment, for a number of ecological criteria. These included identifying those river systems that were most intact, in best condition, most free from exotic species, contained the highest presence of rare species, contained the most native fish communities, and contained the most stream invertebrates.[4]

Based on this expert input, the results of the GIS screening analysis, and TNC's goals for target representativeness and connectivity within each EDU, TNC was able to prioritize aquatic systems to include in its final portfolio. Guided by TNC, experts selected medium and large river systems and river networks connecting headwaters to coast (in accordance with its goals) to incorporate into TNC's portfolio, expressing their confidence in each selection using a Confidence Code (Figure 3). TNC's expert group also assigned a Portfolio Type Code to each portfolio selection that ranked each selected area in terms of its overall quality as an aquatic system and its connectivity to other aquatic resources (Figure 4).[4]

1	High Confidence. We have high confidence that these expert recommended systems are both important and viable as aquatic conservation targets. Confidence 1 AESs often fall within the optimal condition analysis (% natural cover, road density, dams) as well.
2	Lower Confidence. These occurrences are only *conditionally* in the portfolio. Confidence 2 occurrences require more evaluation before we would take conservation action at these sites. They appear to be good aquatic conservation areas and appear to be necessary additions to the portfolio, but we need more information on these sites.

Figure 3. For each conservation priority experts selected to include in TNC's conservation portfolio, the experts qualified their confidence in the selection using one of the two Confidence Codes, listed above. Used with permission from The Nature Conservancy.

PORT-S1c	Best available example of a stream/river system type and part of a regional or intermediate scale connected stream network
PORT-S1	Best available example of a stream/river system type but disjunct/not part of a focus connected stream network
PORT-S2c	Additional good example of a stream/river system type and part of a regional or intermediate scale focus connected stream network, but not the best example of its system type
PORT-S2	Additional good example of a stream/river system (often included the headwaters in all matrix sites) but disjunct from larger focus connected network
PORT-Sxc	Connector. Not an excellent or additional good best example of a stream/river system. It is considered as part of the portfolio as a connector segment in a focus connected stream network. These connectors usually are the lower mainstem reaches in a focus network that are highly altered but needed for connectivity. This connector occurrence is necessary to meet regional connectivity needs

Figure 4. For each area that experts selected to incorporate into TNC's ecoregional portfolios, they also specified a Portfolio Type Code that rated the area in terms of its overall quality as an aquatic system and its connectivity to other aquatic resources. Used with permission from The Nature Conservancy.

Refinement based on field methods: TNC refined the PCAs identified in its Aquatic Ecoregional Assessment developing a Conservation Action Plan (CAP). A CAP is essentially a series of strategies – including those, like restoration and habitat preservation, pursued by VARTF– that guide TNC's specific conservation actions in or in support of a particular geography.[1] For each PCA, TNC defined primary attributes that determine the biological health for each target within each EDU. If the primary attributes are missing, the target is thought to degrade or be lost over time. For example, an attribute for a stream target may be some measure of water quality – if water quality becomes sufficiently degraded the stream may no longer be viable. For each target, TNC defined the acceptable range of variation of target attributes by establishing a viability rating scale that rates the status of each attribute as "very good," "good," "fair," or "poor." TNC then set goals for each target attribute in terms of these ratings.[4]

TNC also ranked threats (defined as proximate stresses) to targets in terms of their contribution to target impairment and irreversibility. In addition, TNC ranked stresses (defined as impaired aspects of targets resulting from human activities) in terms of their scope and severity of impact to targets. For each of these threat/stress categories (impairment, irreversibility, scope, and severity), TNC collaborated with a team of experts to assign a rating of "very high," "high," "medium," or "low." This process allowed TNC to identify the most critical threats to targets within each EDU.[4]

TNC applied this viability and threat information to data it collected on the ground within PCAs to identify specific locations and strategies for implementing aquatic resource restoration and conservation projects. TNC does not use a standard rapid assessment/intensive method for its field-based assessments, instead relying on a variety of techniques including simple walkthroughs, sophisticated site feasibility analyses, and detailed parcel analyses that identify priority tracts of land. Furthermore, TNC also projected the demand for credits within each service area (service areas are similar to EDUs for the ILF program) to understand where credits could be pooled to enable larger and more effective projects. Using this information, TNC developed strategies for implementing on-the-ground restoration and conservation activities that would meet the goals it had set for each target.[3]

Prioritization products: The prioritization results of the ecoregional assessments are made available to TNC partners as static maps (e.g., Fig. 5) and GIS data and are documented in annual reports that TNC provides to public agencies. These reports identify specific aquatic resource restoration and conservation projects that VARTF plans to complete. However, because certain landowners are sensitive to the identification of their land on a map as a conservation priority, TNC avoids wide distribution of its more spatially-explicit prioritization information.[3,6]

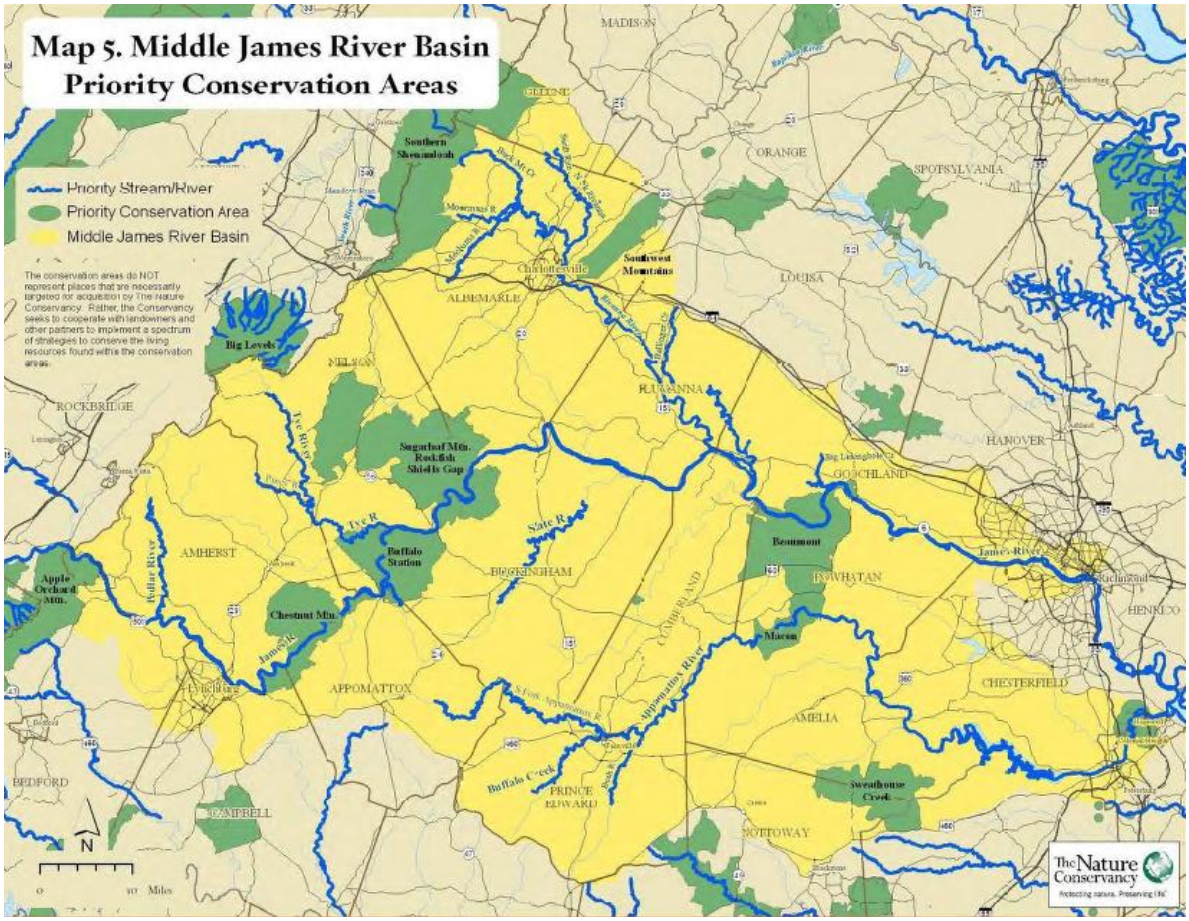

Figure 5. TNC's Aquatic Ecoregional Assessment prioritization process identified Priority Conservation Areas within 14 EDUs, such as those shown above for the Middle James River Basin. Used with permission from The Nature Conservancy.

IMPLEMENTATION

Regulatory/non-regulatory program applications:

- Section 404 wetland compensatory mitigation. Priority sites identified using the TNC Aquatic Ecoregional Assessment, and associated CAP, are used to inform site selection as part of the VARTF ILF program. TNC could also provide information on priority sites to other interested mitigation providers (e.g., mitigation bankers).[3]
    - Watershed approach to mitigation: Because the TNC Aquatic Ecoregional Assessment provides a landscape-scale framework for selecting sites for aquatic resource restoration and protection, it was readily used as the basis for the compensation planning framework required as part of the VARTF ILF program instrument. The VARTF ILF program utilized TNC's Aquatic Ecoregional Assessment methodology as the underlying framework to demonstrate use of a watershed approach to compensatory mitigation.[3]
    - There are currently no formal incentives that promote use of the priorities identified by the Aquatic Ecoregional Assessment for the TNC VARTF program. Absent a detailed examination by regulators of how the watershed approach to compensatory mitigation could be integrated with the mitigation hierarchy in regulatory

decisionmaking, TNC does not favor use of lower mitigation ratios or expedited permit conditions for projects.[7,8]

- Wetland and stream compensatory mitigation required by Virginia Water Protection (VWP) state-level wetland permit program.[3]
- More generally, ecoregional assessments and CAPs have been used to guide aquatic resource restoration/conservation under the following non-regulatory programs:[3]
  - USDA Natural Resource Conservation Service (NRCS) Wetland Reserve Program (WRP): The WRP has favored applicants for wetland restoration or conservation who proposed sites located within CPAs identified by TNC ecoregional assessments.
  - Other federal/state-funded aquatic resource projects (e.g. U.S. Fish and Wildlife).
  - Allocation of land trust funds for restoration/conservation.

Transferability:

- Because ecoregional assessments have been applied in all 50 states, the transferability of this approach is well established.[3]
- The Aquatic Ecoregional Assessment, as applied by TNC VARTF, represents a possible model approach for states seeking to implement aquatic resource restoration and conservation for compensatory mitigation using a watershed approach.[3]

Data gaps:

- A lack of comprehensive datasets for historical wetlands within Virginia that document locations of wetlands that no longer exist or are no longer functional, including information describing factors contributing to these losses and indicating whether restoration is feasible at each site. A National Wetland Inventory (NWI) dataset documenting lost-but-repairable wetlands was once available but is now out of date – an updated version would be very helpful to the ecoregional assessment process.[3]
- An improved §303(d) stream list that, in addition to listing streams with water quality impairments, links stream impairments to specific functional stressors (e.g., channelization, culverts) and details these stressors. This concern may be particularly relevant for impaired streams where Total Maximum Daily Loads (TMDL) have not been developed. Such a dataset would enable TNC to better identify certain degraded, but feasibly restorable sites within PCAs.[3]
- The Virginia Department of Conservation and Recreation Division of Natural Heritage provides data on wetland restorability as part of its Parcel-Based Wetland Restoration, Mitigation, and Conservation Catalog that would be useful to TNC VARTF's efforts.[3]

Barriers:

- Bureaucratic obstacles exist for TNC because many federal, state, and local agencies collect their own datasets but do not necessarily make them readily available.[3]
- TNC would like to invest more effort into gathering better state-wide datasets but is unable due to time and funding constraints. Instead, it generally searches for the necessary datasets on an ad-hoc basis.[3]
- Property rights concerns: Many landowners in Virginia are sensitive to TNC identifying specific locations on a map for restoration/conservation.[3]

Future goals:

- TNC is interested in exploring the use of the Aquatic Ecoregional Assessment and CAP process used for VARTF to support the use of advance mitigation projects in Virginia in collaboration with the Virginia Department of Transportation (VDOT) and other key members of the regulated community, federal and state regulators, mitigation bankers, and other conservation partners.[1] Using TNC's framework, among other tools, these parties could initiate large mitigation projects in advance of projected infrastructure impacts to wetlands and streams, which could help eliminate regulatory uncertainty for permittees.[1] However, obstacles to implementing advance mitigation include:
    - Potential opposition to large-scale, off-site mitigation. For example, to comply with the mitigation rule, TNC or a mitigation banker could plan a highly effective mitigation project within the same service area (i.e., one or more HUC-8 watersheds) to offset transportation impacts. However, local communities near those impacts may oppose these more distant restoration or conservation activities, since local water quality may be impaired and other aquatic resource functions (e.g., biodiversity values or aquatic habitat) may be prioritized over certain water quality improvements.[3]
    - Policy challenges at the federal level (the highway or transportation bill could provide much-improved flexibility regarding authority of states to use advance mitigation).[8]
    - TNC would need all parties to commit time to explore and then implement advance mitigation.[3]

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[1] Feedback received on 5/16/2012 from David Phemister, Director of Federal Government Relations for TNC in Virginia.
[2] TNC developed the Aquatic Ecoregional Assessment methodology and products before TNC developed the VARTF. In 2009, the Aquatic Ecoregional Assessment was modified and refined to fit the VARTF needs.
[3] Interview on 8/12/2011 with David Phemister, Director of Federal Government Relations for TNC in Virginia.
[4] The Nature Conservancy. 2009. The Nature Conservancy's watershed approach to compensation planning for the Virginia Aquatic Resource Trust Fund.
[5] Feedback received on 5/29/2012 from Chris Bruce, GIS Manager at The Nature Conservancy.
[6] It is important to note that TNC, whether through VARTF or its own conservation activities, only works with willing landowners.[1]
[7] "However, there is much that could be done at federal and state levels to ensure that regulators fully implement the mitigation hierarchy at a landscape scale. This hierarchy – avoid, minimize, and mitigate – is often applied at the site level, but for it to be more effective, regulators need to be thinking about mitigation at a watershed level at the front end – project review and approval – and not simply in terms of where they might direct or seek mitigation actions to compensate for damage to aquatic resources. In this scenario, lands of high ecological priority, such as those identified by the Conservancy, would be places where all parties would seek to avoid impacts to the greatest extent possible. Adopting this watershed approach to mitigation will require additional work at the federal and state level beyond the operation of the VARTF itself. Absent that larger examination, TNC would not favor use of lower mitigation ratios or expedited permit conditions for projects that will advance mitigation activities in higher priority areas identified by the VARTF ILF program. While we certainly want to advance mitigation efforts in these priority areas, we have to ensure minimum standards overall are met. Full and consistent implementation of the 2008 federal rule on mitigation will drive better mitigation and improved use of the watershed approach."[1]
[8] Feedback received on 3/26/2012 from David Phemister, Director of Federal Government Relations for TNC in Virginia.