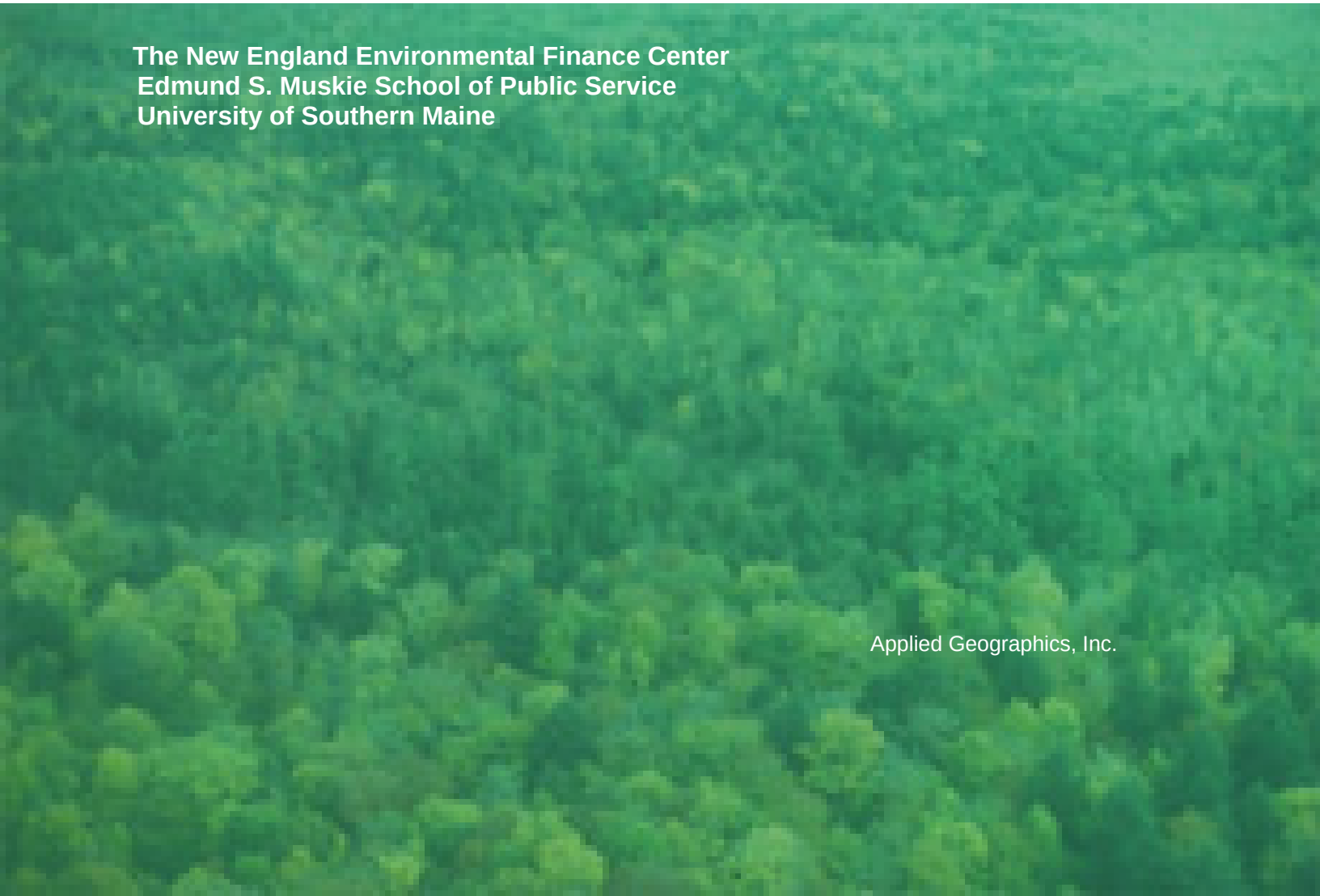
March 2006

Standardizing Geospatial Information for New England Conservation Lands

Data Capture Methods + Technology



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Standardizing Geospatial Data for New England Conservation Lands

Data Capture Methods + Technology Report

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The New England Environmental Finance Center wishes to acknowledge and thank the numerous individuals who have assisted in this project. These include federal, state, local and land trust officials, private sector software and data vendors, planners and private citizens who have contributed their time and expertise as the project has evolved since preparation of the initial Conservation Lands Feasibility Study in 2002.

Ongoing project status as well as extensive analysis information may be accessed from:
http://www.appgeo.com/clients/efc/

Additional project information as well as other EFC initiatives may be accessed from:
http://efc.muskie.usm.maine.edu/

Executive Summary

It is a commonly held misconception that a mature, complete and accurate system of digital land records exists in the United States. Because property taxes always seem to be effectively assessed and ownership records of real estate parcels don't frequently become orphaned or lost, it is frequently assumed that no work remains to be done in the area of land records management. Information technology has made such enormous advances so quickly that universal lot-level, map-based access to land records data seems an entirely reasonable expectation.

In fact, the technical capabilities of modern information technology have advanced significantly ahead of application of these tools to access and update land information in a consistent way over large areas and multiple jurisdictions. Relational databases and geographic information system (GIS) technologies have been evolving steadily since the 1960s. Thousands of different users at all levels of government and within the private sector employ these spatial tools to manage and analyze property records. But while most users work within a small number of common software platforms and practice similar data maintenance techniques, no consolidated system has yet evolved to query and extract uniform and meaningful content from the disparate repositories; there is a conspicuous absence of tools to "Google" for available spatial data and produce results quickly and dependably for a chosen location.

This is very much the case in the Northeast United States regarding protected open space data. Many federal, state, local and private officials and analysts in this region utilize conservation lands data frequently and with a wide array of objectives. Municipalities track protected lands data to assess future build patterns and growth limitations, as well as in management of their tax base. Land trusts are increasingly interested in seeing an accurate picture of property holdings in their own as well as adjacent jurisdictions, for purposes of evaluating existing resource loads, and future acquisition strategies. State agencies depend on these data for accurately integrating with large area wildlife and recreation planning, and the federal government and multi-state agencies require inter-jurisdictional consistency to evaluate future protection or asset liquidation involving vast watersheds or bioregions. The specific locations, dimensions and characteristics of protected open space properties represent a vital inventory for informing most planning and development initiatives, and these data need to be consistent, accurate, uniform and up-to-date if such initiatives are to yield dependable results. But partly because New England is so politically Balkanized, partly because protected open space traditionally falls *outside* of tax rolls, and partly due to the large number and dynamism of the status of such properties, the data falls well short of a mature, complete set.

In 2002 The New England Environmental Finance Center and Applied Geographics issued the *Feasibility Study for a GIS Inventory of New England Conservation Lands*[1] describing the conservation lands data status throughout EPA Region 1 (New England). This report identified stakeholders and technologies participating in the maintenance of conservation lands data within this region.

In the four years since that initial report dramatic changes have occurred in the technical means by which geographic data are delivered from their respective repositories. These changes have been most pronounced and obvious in the area of web mapping services. Web mapping services are software utilities by which diverse and frequently unrelated geographic data sets are structured and symbolized

[1] Available for download at http://efc.muskie.usm.maine.edu/gis_feasibility_study.pdf from the EPA New England Environmental Finance Center

for consumption by remote clients through the Internet. In a more general sense, these represent a kind of democratization of access to digitally mapped data, by providing tools and content (often free) from remote servers that can be consumed by an end user with only a web browser or a small software download (and with little or no technical expertise). This method of delivery is in striking contrast to the preceding era in GIS evolution where all data and tools were closely held and generally inaccessible by dint of their expense and technical complexity.

Web mapping opens up opportunities to quickly and easily access the largest digital repositories without the burden of maintaining large, complex data layers or expensive software on the desktop. Such services range from extremely general and lightweight consumer products as provided by Yahoo, Microsoft or MapQuest that serve millions of users daily, to very specific, highly tailored applications that municipalities use to manage and visualize local assets and that might only be queried a few times per week. Within this range the number and variety of new applications is exploding. Over the past year the public release of programming interfaces for products by Microsoft and Google has created a flurry of novel application deployment, where different feeds of data are 'mashed up' to produce accurate and useful map-based content has never been accessible before.

Unfortunately, as land records data lags back on the information technology curve, so do spatial data capture techniques fall well behind the now ubiquitous ability to display and interrogate maps through the web. An axiom of cartography is that the map is always least accurate in the area where the user is most knowledgeable. Nowhere is this truer than in publicly available open space data. The conservation lands layer may contain an impressively large number of identified features, but around the local neighborhood of the well informed user of the data, how accurate are they? Typically, not very. More importantly, when the user identifies inaccuracies in the data, what mechanisms are available to report this useful information back into the system in order to flag or correct the problem for the next release of the data layer?

This sort of feedback system, where data are exposed to a broad user base for contribution and vetting[2], has not yet appeared in the area of conservation lands geospatial data management.

In a few areas such capabilities are indeed beginning to arise, albeit in a rudimentary way. Recently, and typically at the state level, the set of layers deemed essential to homeland security applications has been enhanced and evolved using input from distributed, local participants through a web interface. Features pertaining to first responders, critical infrastructure, natural hazards and vulnerable assets are being tracked dynamically and accurately this way now. The process remains cumbersome however, and even in geospatial sectors as actively well-funded as Homeland Security such efforts are very much exceptions rather than the rule.

Digital land records representing protected lands represent only a small subset of the overall cadastral[3] set, but accurately characterize most problems of digital lands records management in microcosm. Tracking land records with dimension and ownership information is a more complex exercise than logging location points of fire stations or fuel tanks. Thus, in addressing the complications of

[2] This concept is generally known to the web as a *wiki*. The purpose is to provide a secure, stable framework that allows for universal input of content by anyone, providing overall completeness through countless small data inputs to strengthen specific areas of weakness. While there are now thousands of wiki implementations for sharing knowledge and data in specific niche areas, the primary implementation is wikipedia, accessible from http://en.wikipedia.org/wiki/Main_Page

[3] **ca·das·tral** data includes public record records, surveys, or maps of the value, extent, and ownership of land, typically as a basis of taxation.

maintenance of conservation lands data for multiple states to local scales, EFC is grappling with spatial data capture and distribution problems of much more universal applicability.

The solution to present problems of inconsistency, inaccuracy and lack of access are straight forward in concept:

- All stakeholders producing and consuming spatial conservation lands data should have access to a technical framework that provides minimum friction in data exchange and cross-border analysis.
- They should not be restricted to any software or data format, or from data sources that are publicly available but inaccessible due to technical shortcomings or incompatibilities, and
- Anyone possessing information about any site, property or document who wishes to contribute this to the overall knowledge base must be able to do so with the minimum investment of time and technology.

Achieving this solution, unfortunately, is not nearly so simple or straight forward. This report, an extension of the 2000 *Feasibility Study*, identifies the current state of data capture technology among data stakeholders within EPA Region 1 and identifies areas where further technical and staff resources might be best applied to advance this vital data layer in the direction of these goals.

Data Acquisition Inefficiencies

In the overall supply chain of conservation lands data, there are a large number of stakeholders and active participants, and many methods of performing edits and updates. From field and document research to data digitizing and database updating, innumerable opportunities exist for using various tools to do similar things differently. However, the bulk of inefficiencies in existing systems of conservation lands data acquisition and maintenance concentrate around two specific friction points. These are, at one end of the data supply chain, an inability to collect the data from its various local sources, and at the other, inadequate resources to vet and process the data properly.

Capture Inadequacy

Local Capture Inadequacy is characterized by an inability to properly pass local knowledge of land dimensions and attributes through digital channels to a centralized data repository. All New England states currently maintain digital information pertaining to conservation lands. While the digital data are aggregated and distributed from the state level, almost always the most accurate data pertaining to these parcels are collected and maintained by the stewards and administrators of the properties themselves, locally. Modifications to property lines or parcel characteristics do not broadcast their changes automatically at the time of a transaction. But in a smoothly functioning data supply chain such changes should become generally available shortly after local officials have logged them for their internal use.

One of the approaches EFC has investigated for addressing capture inadequacy is the production of a web-based geographic markup tool[4] (GMT). The strategy of deploying such a tool is to demonstrate feature capture of detailed local information freely and simply to as large an audience as possible across the entire New England landscape. As part of this technology evaluation EFC developed a base GMT to assess application requirements and technical stumbling blocks in pursuit of these objectives.

Most of the base data for this application were assembled from existing web services hosted by state repositories. Base web services are currently hosted by nearly all state repositories, though

[4] Available online at: http://dev.appgeo.com/efc/ .

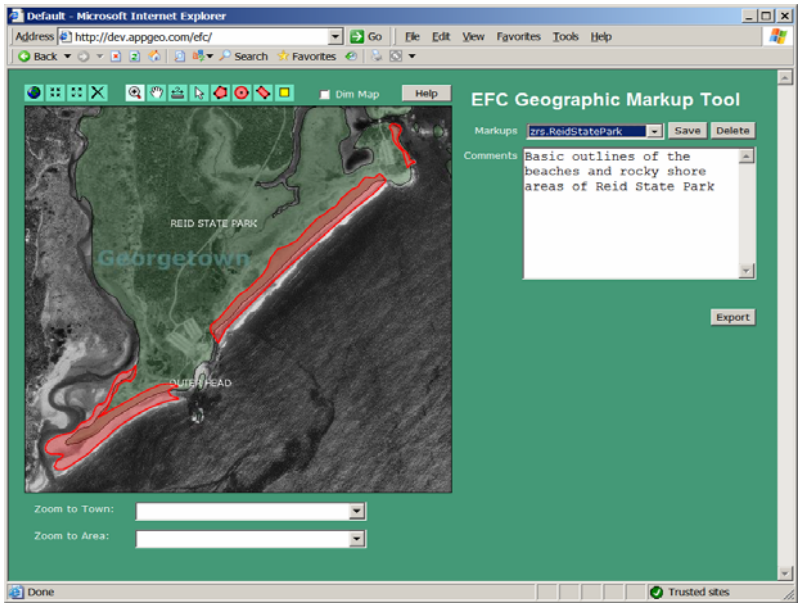
complications frequently arise when these are brought together in a single application. Web services are presently all ESRI Internet Mapping Service (ArcIMS) applications, published in ways that permit easy integration through independent applications such as the GMT. ESRI was early to market in this area and provided many of the foundation components very effectively to agencies and organizations who had previously only been able to distribute data as individual files for download. This ESRI de facto standard has made integration easier in many ways, though in the future it is unlikely that ESRI will retain such a monopoly over such services. Open source GIS has created a robust toolbox for performing many of the same functions, and fortunately standards are in place that allow open source and proprietary systems to integrate in a single application.

EFC Action Opportunity: Coordinate basic properties of all participating web services to ensure coordinated display irrespective of the web client used to access them.

To provide conservation lands context within its GMT, EFC hosted an overlay layer that can be used for reference and query. The GMT allows users to navigate to a property or area, create a sketch over the ground, and post this sketch up for review by others. This sketch may also be saved to the local machine as an ESRI Shapefile for integration with a multitude of other GIS packages.

Users of a functional GMT are be able to save their marked sketches as named entities within the application as well as export them to formats for exchange and integration with other GIS packages. This provides as simple and accessible a solution as possible to provide a spatial data capture option for local experts without access to editable GIS technology. .

The EFC Geographic Markup Tool graphic displayed below shows a sample screen of this application. Using a standard Internet browser with a small plug-in[5], users are able to create and share sketches that are accurately pinned to real geographic locations.



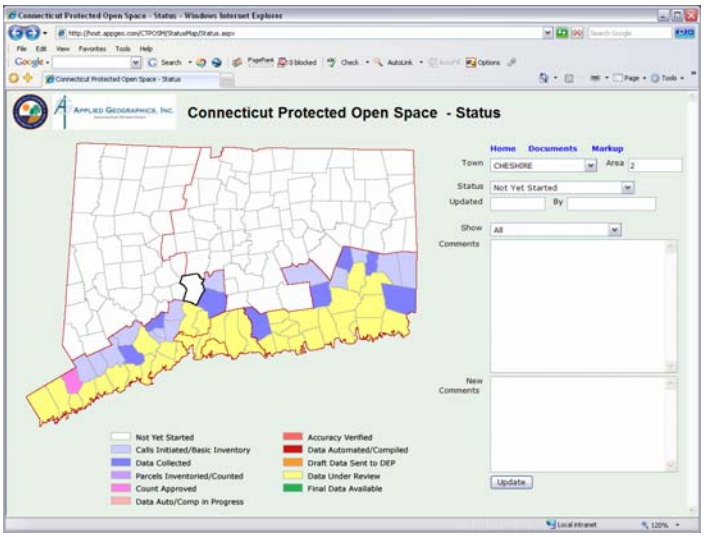
NE/EFC Geographic Markup Tool. Screen capture shows polygon markup, user comments and existing conservation lands area.

[5] The plug-in used by the GMT to provide vector sketching is a Scalable Vector Graphics (SVG) tool, freely available from Adobe (www.adobe.com/svg/viewer/install).

Providing the technology to scribe lines and areas over aerial photographs does not constitute the complete picture of a working distributed conservation lands data capture network, however. Property boundaries are highly specific in definition, surveys frequently exist, and a large number of attendant documents may be required to correctly characterize the property in question.

A functional data capture mechanism must therefore also include some capacity to upload and integrate these documents along with the marked up base map.

The State of Connecticut, currently in the midst of a high accuracy protected open space data inventory, is employing a version of such a tool. The illustration at right shows one interface screen of this application, functionally similar in many ways to the EFC GMT[6].



The Documents tab at the top opens a page which permits users to navigate to documents on their local system and upload these to the project server. This permits various resources such as photos and surveys to be combined with the other project data in a directory structure to organize and consolidate relevant information for evaluation and authentication by project staff.

While this is a project specific application and as such is designed to be available only during the duration of the statewide data capture, it provides many of the features that a persistent tool or tool suite would need to support perpetual conservation lands data maintenance. Building such a tool to meet the needs of multiple states, even multiple counties, necessarily introduces complications due to inconsistent practices of records tracking in separate jurisdictions. But a platform that facilitates robust data acquisition, including markups, attendant documents and text from many local sources will be essential for land information data management.

Authentication Pinch

The other primary point of friction in conservation lands data capture, *authentication pinch*, arises when acquisition of data occurs with a volume or frequency that exceeds the ability of a central point of validation to process it. Since this problem implies an active flow of incoming data, this is preferable to a supply chain choked by capture inadequacy: the system is feeding itself. But it is not digesting the input efficiently, and thus is just as crippling to the ongoing maintenance of the data repository as capture failure.

[6] The CT POSM data capture tool as well as the EFC Geographic Markup Tool share common software architectures. There was a strong benefit to this, as components that were pioneered as part of the GMT could be repurposed with slight modification into the CT toolkit to provide markup and memo functions.

Evidence of the success at distributed data capture is apparent in Massachusetts at MassGIS where the volume of data arriving for inspection and check-in through the single validation point continues to produce a considerable backlog. This should come as no surprise. Even with a mature and heavily regimented work process in place, many details must be checked manually and in a large percentage of cases digital automation – the actual scribing of property lines on the GIS basemap – occurs for the first time at this validation node. Successfully processing a single, relatively simple property into the database may consume hours of staff time. Consider the magnitude of this commitment: Massachusetts maintains in excess of 30,000 parcels in its open space data layer.

It is very difficult to alleviate authentication pinch through strictly technical means. Many steps may be taken at the validation point to optimize data structures and simplify inputting of records and document review. And where data arrives in large collections from GIS-savvy contributors carefully checked and pre-validated by state agencies or land trusts, much of the check-in may be automated to some extent. But where the inputs come from potentially hundreds of contributors in very small quantities, the process will slow to a crawl.

Even in the most advanced of the state data repositories, data validation ends up being a manual, time consuming exercise of interacting with a large array of contributing individuals, referring to paper documents and digitizing lines by hand.

Web-based Data Capture Tools

A growing number of technologies are available for use and modification to assist in the view, query and capture of conservation lands data features and documents. A subset of these was assessed for pertinence to ongoing EFC/conservation lands data capture initiatives as a component of this project. These include Microsoft's Live Local oblique imagery tools, DeLorme web and desktop products, Google's Maps and Earth offerings, NASA's World Wind, smaller, independent software such as FlashEarth and GAIA, as well as various offerings by the Environmental System Research Institute.

Environmental Systems Research Institute

Since the opening days of the age of web mapping, ESRI has been the undisputed front runner providing tools and services to extend the capabilities of its vast population of traditional desktop users. There have been other large commercial vendors in this arena, but in the Northeast they have proven a dominant force: every state data agency uses ESRI for data maintenance, display and query.

ArcGIS offers three server software products—ArcSDE, ArcIMS, and ArcGIS Server.

ArcSDE is an advanced spatial data access server, providing a gateway for storing, managing, and using spatial data in a DBMS for multiple client applications (e.g., ArcIMS, ArcGIS Server, or ArcGIS Desktop). Most state GIS data repositories in the Northeast have already moved their spatial data warehouse into this format, as it has traditionally provided the most secure and accessible framework for very large data sets.

ArcIMS is a scalable Internet Map Server. It is widely used for GIS web publishing to deliver maps, data, and metadata to many distributed users. For example, ArcIMS provides browser-based access to many GIS catalog portals that enable users to publish and share geographic knowledge widely.

ArcGIS Server is a comprehensive GIS toolkit for enterprise and web application developers. It is used to build distributed and multi-tier enterprise information systems and consists of a large and complex object library that will permit elaborate spatial processing to be built into web applications.

These products combine to provide the backbone of much of the customized, technical level web mapping that exists today. EFC's GMT utilizes ArcIMS to manage requests from users and generate maps at the browser. ArcSDE is the storage framework where the GIS data resides, both in the state servers providing imagery data as well as at AppGeo where the conservation polygons are hosted.

ESRI continues to refine and evolve their products. Most recently they have announced **ArcWeb Explorer**, which provides Flash-based access to high quality mapping products and may be integrated with commercial services. Data storage, maintenance and updates are all handled by ESRI, providing the benefit of offloading all complicated hosting responsibilities but severely limiting flexibility of product development over time. ArcWeb services are also sold on a credits-based model that is not conducive to wide user access at low cost.

ESRI will continue to lead the way in spatial data storage and maintenance for the foreseeable future, though a tremendous amount of competition is developing in the area of content delivery via the web. The largest, best funded and most innovative companies in the software industry have undertaken to deliver an accurate model of the earth with speed and efficiency and traditional GIS companies will have a difficult time keeping up.

Google Earth

The rapid ascent of Google to a must-have utility for effective use of the Web was well established by 2005. The company's strategy of making useful, web-based software available for free, supported only by targeted advertising revenues has provided a useful collection of tools that hitherto had been of inferior quality or only available at a stiff premium. One application of particular interest to the geospatial community is Google Earth (GE). Google purchased the company (Keyhole) just prior to Google's initial public stock offering in early 2005. GE provides a highly performance-tuned base map covering the entire world with aerial imagery at varying resolutions. Google is committed to increasing the quality of this imagery and has enhanced the relatively coarse base imagery over some areas of New England. Massachusetts, as the most accurately covered state, is entirely available at sub-meter imagery, using data from the MassGIS repository. For selected communities (i.e., Cambridge) even higher quality data are presently hosted through GE. The figure at left shows some of the variability of the base imagery however; green areas are the standard EarthSat satellite imagery, while the darker swatches constitute places where higher accuracy (in some places as great as 4" pixels) has been integrated.

Because the product works well, is free or very low cost, and removes much of the burden of base data assembly and maintenance from the spatial data capture equation, it is noteworthy in this context.

Base access to the GE product is free; users need only download the software and install it on their local machines. Most of the product's functionality is available at this level, although more advanced licensing options provide tools useful for conservation lands capture. The Google Earth Plus license costs $20 and allows users to add vector polygons as GE features to be used and saved within the GE

environment. Google uses a simple XML-based format (called KML) that allows conversion to conventional GIS formats through widely available utilities.

As higher quality imagery is integrated, GE holds promise for filling a role in the area of conservation lands data management. The software provides many functions that distributed users would need in order to mark up changes in property configurations and share these with a broader community. As is possible with the GMT, users are able to navigate to a particular location and mark the map with geographically anchored tags. Georeferenced vector and raster data may also be integrated over the base. There are even rudimentary image registration tools included.

EFC Action Opportunity:
Work with key web application providers (Google and others) to accelerate deployment of the highest quality public imagery available throughout EPA Region 1 to support GMT/capture applications.

The application programming interface (API) for this product is limited, but the data format and ubiquity of base map data provide significant opportunities for enhancement and modification. In short, the tool can not be modified to provide specific interface and functional objectives; any additional functionality would need to be carefully constructed around GE's rigid structure. But the performance is unmatched and if ground coverage of imagery continues to expand and improve the product provides enormous cost savings in providing a basemap and navigational platform to build from.

Google Maps

Google provides more traditional web access to maps through http://maps.google.com . This product does not require an independent software download and works with all major varieties of web browsers. While this is a much simpler application than Earth, it has become enormously popular as a modifiable application since the API was published by Google in 2005. Literally thousands of 'mash-ups' have been developed to spatially enable everything from crime locations to exotic bird sitings. The licensing agreement requires that these combinations of independent tabular data with Google's dependable mapping framework be available for general public access. While this makes virtually everything created available for use and evaluation, it limits the ability to build a business model that requires even minor restriction of access to the mapping data.

Google.maps utilizes the same base imagery and roads data as GE, though resolution limits are more severe (users are not able to zoom in as far). This will present a difficult hurdle for anyone looking to use this as a base upon which to automate accurate property lines.

Microsoft Live Local

Microsoft's mapping technologies over recent years have been aggregated under the MapPoint brand, both for desktop and web use. In 2006 the software giant altered its web mapping strategy by integrating georeferenced photographic elements and all internet mapping services under the name Live Local. Microsoft provides Live Local with an API that allows for development of individualized applications, but, even more than with Google maps, these options are limited. Live Local brings oblique imagery to a wide user base through its licensing arrangement with Pictometry Corporation, and this content can be extremely useful for viewing the ground from varying perspectives. However, the area presently covered by this data source is limited primarily to large urbanized areas and their immediate environs. For clarifying boundary, line of sight, connectivity or context issues for conservation land parcels Live Local holds significant potential, but only in the urban areas where it is available. No schedule has been released for extending coverage to an area that would satisfy the needs of regional conservation lands mapping.

Open Source Tools

Enormous advances have occurred over the past couple of years in the area of open geospatial systems. There are hundreds of applications[7] currently available that provide particular tools or geospatial access to data over particular areas. Some of these with existing or potential value to the region are briefly assessed here.

Perhaps the best known open webservices development environment is **MapServer**, which was originally developed by the University of Minnesota, MN Department of Natural Resources and NASA beginning in 1994. It has subsequently been adopted by thousands of applications developers worldwide and has a robust development team and an avid user base.

Autodesk has recently introduced the new version of MapGuide Open Source, its MapServer-base web mapping software, and made this available through the newly formed Open Source Geospatial Foundation. MapGuide Open Source is a web-based platform that enables users to quickly develop and deploy web mapping applications and geospatial web services. The software features an interactive viewer that includes support for feature selection, property inspection, map tips, and standard GIS operations such as buffer, select within, and measure. MapGuide includes an XML database for storing and managing content, and supports most popular geospatial file formats, databases, and standards. The MapGuide platform can be deployed on Linux or Microsoft Windows, supports Apache and IIS web servers, and offers extensive PHP, .NET, Java, and JavaScript APIs for application development. MapGuide Open Source is free, open source software licensed under a general public use license.

The implication of this and similar products is clear: developers will be able to build large, robust GIS implementations without being held hostage to annual licensing and maintenance fees from vendors. These have traditionally amounted to tens of thousands of dollars annually. As far as conservation lands data management is concerned the end users will likely not care or know whether the software and data structures they are using and their end are proprietary or open source. But open source is truly invaluable in flexible systems where modifications to an interface or utility can be designed and realized by a technically capable user without having to pay the tithe of a license or royalty. In conservation lands data capture it is conceivable that tool development of this nature could strongly enhance the quality of data acquisition and validation over time: tools produced by one GIS office or agency could be generally distributed for use or modification by others to both add efficiency and conform to specific local needs.

[7] OpenSourceGIS.org currently identifies 220 products conforming to open source as defined by the Open Source Initiative or the stricter definition of the Free Software Foundation

Data Capture Status: State Level Summaries

Conservation lands data layers are consolidated at the state level for all six New England states. The means by which data make their way into these respective repositories differ significantly, but the state level results are similar in many technical aspects.

Most data update and storage is handled using ESRI products, though, as discussed above, this may begin to change as open source products become more ubiquitous and dependable. Features are presently stored in Shapefile, Coverage or Geodatabase formats and data are distributed through the web in .shp or .e00 formats with metadata of varying quality. Metadata permits the data to be queried for its contents and quality as an index item, and it has become more generally available and standardized thanks to efforts by the Federal Geographic Data Committee. In Maine and Vermont metadata are presented in strict FGDC format, which can be useful for technical professionals with parsing tools and familiarity with the rather arcane structure and syntax. Others like Massachusetts and New Hampshire present less formal descriptions. Almost all maintain FGDC internally or are in the process of migration.

Data are also distributed in numerous cases through web services which provide instant user access to display and query features in context with other hosted base and analytical layers. Massachusetts is a leader in this area with a large number of services as well as a customized viewer (OLIVER) for display and query of essentially the entire MassGIS spatial data repository. Conservation lands are available not just as a simple layer but with numerous symbology variants to address particular queries. New Hampshire has a highly effective and customized Conservation Lands viewer and the webservices supplying it are accessible through other enabled software products such as ArcGIS.

All states maintain accurate records of federal and state properties. Vermont declares its open space datalayer “essentially complete” though due to the dynamic nature of easements and land transfers completion is a rather fluid term. Massachusetts has by far the largest and most complex inventory with tens of thousands of polygons addressing not just fee-owned properties but also those in a number of easement protections. New Hampshire is undertaking to acquire a large number of additional properties at the easement level, beginning with coastal communities. Likewise Connecticut is in the second phase of a 3-phase statewide map down that will result in essentially all fee and easement properties in its repository when complete. Maine has only federal and state properties in its repository at present with neither plans nor resources to complete collection down to the local level or to integrate easement lands.

The information technology used to capture and process conservation lands data varies between states as well, though in all cases it is underdeveloped or underutilized. Massachusetts has plans to develop a distributed capture application through the web though these are currently on hold. Connecticut has a web-based toolset working as part of its ongoing POSM project. New Hampshire is pursuing grant money to develop such a capability. The remaining states rely upon traditional means of data submission.

In the following sections, individual state data feeds as well as current and planned technologies used to maintain geospatial conservation lands data are described in some detail.

Maine

In Maine, geospatial data pertaining to conservation lands have been historically captured and consolidated by Maine State Planning Office. This role was performed for almost the entire evolution of the layer by a single individual, Richard Kelly, who retired from state government in 2004.

After a brief fallow period, Janet Parker was hired in the Maine State Planning Office to continue development on this as well as other SPO data. This has resulted in an updating of some data maintenance procedures, such as editing within ArcGIS desktop rather than through the antiquated command line interface and utilizing Shapefiles rather than ArcInfo Coverages. Janet currently accesses her ESRI licenses via the MeGIS Citrix server.

High quality data for federal and state holdings are included in the layer, with more than 3200 properties available as digital polygons. The data are distributed out of the Maine Office of GIS (MeGIS) and are fully FGDC metadata compliant as of 2005.

Many contributing state, federal and NGO stakeholders supply data to this layer, though there is no regular mechanism for securing updates or capturing change. Data are primarily supplied to Maine SPO in hardcopy form for compilation into the repository. Currently the resources allocated to care of this layer barely appear adequate to track changes to properties already contained in the repository. As there are many thousands of properties held by municipalities, land trusts and individuals in the state that must be documented to complete the set, a formidable condition of capture inadequacy exists.
.
No municipal or trust lands are included in the repository. A municipal layer exists, but it has only been fleshed out with real data in an exploratory way over a small number of communities and is not included in the MeGIS distributed version. Any initiative aimed at capturing significant quantities of these parcels would require far more staff and resources than are currently available. Maine's nearly 500 municipalities, 10 million acres of unorganized territory (within which conservation lands are most completely mapped down) and more than 100 land trusts represent an unwieldy collection of stakeholders to federate into a working group, even while the local expertise of most would be essential to exhaustively inventorying the area.

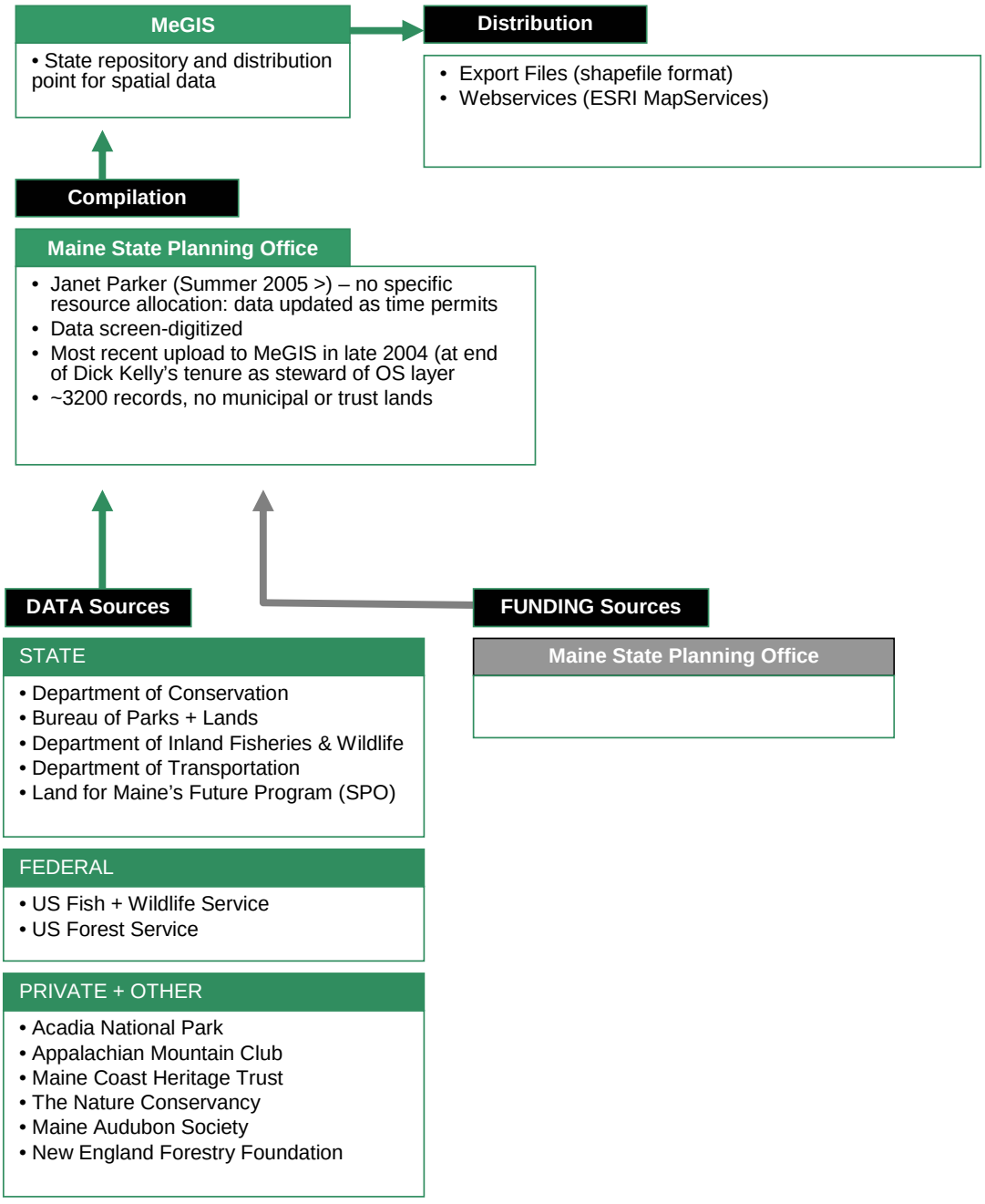
Maine is a strong candidate for deploying a web-based data capture application. The primary inefficiency in the state's collection network is capture inadequacy, and since there is such a vast amount of land and large base of stakeholders no traditional system of capture will likely be practicable. The EFC GMT demonstrated access to high quality orthoimagery statewide and markup ability through a simple, low technical threshold tool. A number of users in varying capacities and jurisdictions used the application to experiment with markup and geographic data exchange.

With responsibility for management of this layer firmly established within the State Planning Office it is unlikely that funding will be forthcoming to advance technology toward capture of the full set of conservation lands data in the near term. Demands are high, available resources are low, and few within the SPO perceive the need or even value in acquiring information on the many small parcels that would complete this inventory. To assist efforts such as Beginning with Habitat or to augment information associated with the increasing number of growth area boundaries or Smartgrowth initiatives, accurate protected lands data will be essential.

EFC Action Opportunity:
Provide staff + technical assistance to the Maine State Planning Office to capture and process municipal or trust lands data to augment the existing federal and state properties layer.

Maine Data Feeds

Maine



Rev. 2006.01

New Hampshire

The primary source of capture friction for New Hampshire conservation lands data is inadequacy of input and submission tools. A large percentage of current data are passed through the Society for the Protection of NH Forests, though municipal sources are presently scarce and in many cases undependable.

A current capture initiative is being funded by the NH Estuaries Project to enlist the assistance of conservation commissions of coastal towns in order to upgrade their protected lands layer. These data will be compiled by Chris Phaneuf (Conservation Lands Manager, UNH|GRANIT) as they arrive. It is likely that most of the submissions will be in hardcopy format. The Conservation Lands Manager spends roughly a quarter of his time (2005) managing and updating this layer. The Society for the Preservation of New Hampshire Forests is the largest single annual data contributor. Submissions arrive on mylar sheets which are digitized, re-plotted and sent back to SPNFF annually.

Most data submission is in hardcopy form. UNH|GRANIT only requires that data are submitted in a "decent hardcopy format" and that a Tract Sheet attribute form is filled out for each property.

The working database is housed in ESRI Coverage format due to the legacy benefits and ease of data manipulation that this provides. This is becoming an increasingly outdated editing environment and it is recognized that a port to a more current format (probably GeoDatabase) will be required within the next few years, though no specific plans for this migration have been established.

Database updates are passed to the GRANIT website four times a year, and data are made available as ESRI export (E00) file or Shapefile (SHP) format to the public at large. No access restrictions are currently applied to data in the Conservation Lands export dataset. All features and attributes are available for download from the GRANIT site.

Web Capture Potential:

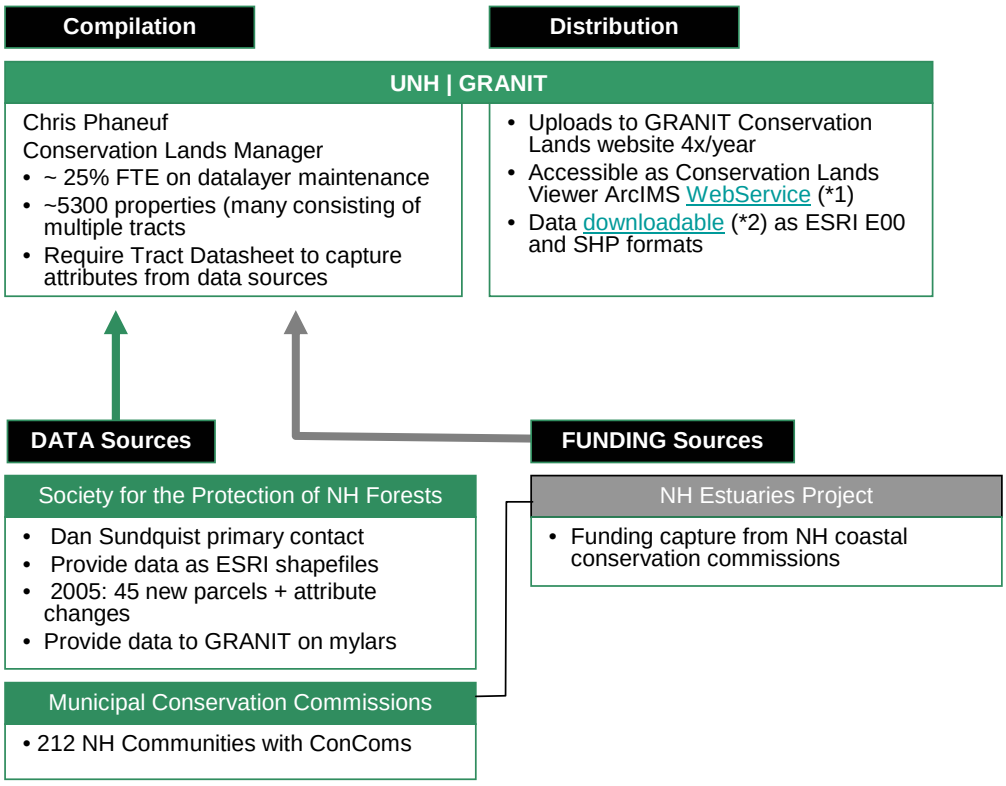
New Hampshire is a strong candidate for deploying an advanced GMT application. An existing web-based conservation lands data application developed by Northern Geomantics is well utilized and effective and there is a mature and efficient capture point established at UNH|GRANIT.

While the Conservation Lands Viewer will be phased out (probably during 2006) the intent is to replace it with a more generic version that will integrate a larger set of spatial data layers.
New Hampshire (through UNH|GRANIT) is currently evaluating plans for deploying redlining/markup capabilities to work in concert with their generic spatial data viewer application. The intent of this application would be to provide web-based markup capability to an authenticated base of users that would streamline data submission and open up access to a larger base of primary contributors. The core of this user base is anticipated to be municipal conservation commission officials, probably beginning with the NH coastal communities that are participating in the ongoing NH Estuaries Project. If GRANIT is successful in the current bid to develop web tools in order to ease its present local capture inadequacy, this could provide a solid template application for data capture in northern New England, or at least for Maine. Maine's data specification remains minimal and fairly loosely defined, and collaborating with or piggybacking on a New Hampshire model could provide a useful economy of scale as well as foster interstate communication.

EFC Action Opportunity:
Monitor and advise New Hampshire's Open Space web capture initiative to ensure compatibility and promote integration with a similar tool to meet Maine's needs

New Hampshire Data Feeds

New Hampshire



*1 http://granitweb.sr.unh.edu/clv_phase1/viewer.jsp
*2 http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/database/index.hml

Rev. 2005.11

Massachusetts: MassGIS

Capture Status:

Beginning with a pilot project on Cape Cod in the early 1990's and expanding out to the state as a whole, an ambitious town-by-town census was conducted that brought the content of this data layer to its current status as the giant of open space layers in New England. At the peak of the statewide map down in the mid nineties, more than a dozen individuals were committed to the task through the MassGIS office and this team was interfacing with liaisons from all of the 351 cities in towns. MassGIS maintains a very high quality state level conservation lands data repository, including federal, state, municipal, trust and non-fee simple agricultural/open space (Chapter 61) lands data.

Even with the large investments and commitment over time, the complexity of the task is highlighted by gaps in the data in various areas and and the perennial difficulty in keeping the data current. While the primary, bulk data capture was completed a decade ago, the size of the maintenance tail is daunting to the point that it overwhelms the staff allocated to it.

The primary friction in open space lands upkeep in Massachusetts is the authentication pinch: the flow of arriving data is such that it consistently exceeds the ability of available MassGIS staff to stay ahead of it. The effort is managed by Scott Costello from the MassGIS office in Boston, with assistance provided by a changing array of part time interns.

Massachusetts currently has the most highly developed conservation lands data model in New England and maintains and ESRI ArcSDE versioned database that meets the needs of a multitude of varied data users. But the data capture remains to a large extent paper-based. Some regional planning agencies and trusts provide data in digital form, but most changes are submitted as paper surveys or descriptive documents and these data are compiled and automated into the open space layer at the MassGIS authentication node.

EFC Action Opportunity:
Work with MassGIS and NH/GRANIT developers to transfer technology and promote synchronization and compatibility between services and tools.

MassGIS will soon be initiating its own web-based conservation lands capture initiative, however. This will make full utilization of the complex existing data structure and allow users to submit both vector polygons as well as attendant tabular data to describe changes and updates. Details are incomplete as of spring 2006, but deployment of this application is expected within the current calendar year.

Additionally, there are efforts underway in Massachusetts to integrate parcels data with Deeds Registry data maintenance. In at least one case (Bristol County) the Registry itself is undertaking responsibility for parcel automation and update for member towns that have not yet managed to digitize their own property boundaries. Parcels will be automated to an established MassGIS standard and become part of the MassGIS repository. With their linkage to the Registry data this will make the data set eligible for ownership queries that provide the final keystone to a mature land records management system. This is a small and isolated example at present, but is important as a possible harbinger of the future shape of lands records infrastructure in New England.

Connecticut:

Capture Status:

Connecticut is currently in the second of three phases of its Protected Open Space Mapping Project (POSM). This multi-year initiative aims to capture virtually all conservation and recreational lands statewide, down to sub acre urban parcels and consolidate these into a single spatial database. The first phase covered the coastal towns and some inland municipalities.

EFC Action Opportunity:
Provide outreach to assist low technology towns in Connecticut in contributing lands data to the state's Protected Open Space Mapping Project.

The concentration of the current phase is acquisition of data from municipalities with existing digital parcels and integration into the open space database. Because the State of Connecticut both records deeds and maintains parcels at the municipal level, all parcels being assembled into the set are being captured with both map/lot (assessor) as well as book/page (deed registry) identification.

While this is a substantial undertaking spanning numerous years, it is being undertaken essentially as a snapshot; no maintenance protocols or schedules have been established for updating the layer in an ongoing fashion into the future. The aim of the project is to replace the 1997 layer that currently serves as the primary open space data resource. A consequence of this strategy is that by the time the inventory has geographically covered the entire state, the communities that were contacted first may have experienced significant changes in their conservation lands holdings.

The initiative is being undertaken by the Connecticut Department of Environmental Protection, and the one exception to the data maintenance freeze is the class of parcels actually under the physical ownership or management of DEP. These are being updated perpetually to support DEP activities. Maintenance is managed using traditional paper compilations submitted for automation at DEP.

Rhode Island:

Conservation lands data in Rhode Island is distributed over nine different data layers, segregated by source and managed by different entities. Massachusetts is currently advising Rhode Island regarding and integration plan for these data and potentially the state will adopt a data model similar (though likely less complex) to the Massachusetts model. Since the number of Rhode Island cities and towns is so small (39) and a significant percentage of these currently have their parcels digitized, this state provides a potential microcosm for managing these data statewide as an extracted set of an independently maintained layer. Any fully mature conservation lands management system will exist as a subset of a comprehensive framework that includes all lands as digital parcels linked to deeds and registered survey information. While this is some years off for most states, because of Rhode Island's size and current state of digital parcel automation it is likely to happen here first. Synchronization would need to be managed among the five counties and significant efforts would be required to solidify and enforce standards, but these are not unreasonable hurdles. An approach of this nature would eliminate much of the confusion in the existing fractured system of open space data management by providing ownership information for all state parcels through database queries.

Rhode Island, which has not typically been a leader in this area, would lunge immediately to the front of the pack through sound, integrated lands data management that would not merely serve conservation lands purposes but support all real property focused efforts. From this perspective it seems well worthwhile to undertake an itemization of potential beneficiaries in an effort to identify up front funding for this valuable statewide objective.

Vermont:

The Vermont Conserved Lands Database (CLD) contains parcels owned by Municipal, State, and Federal entities. It also includes a small number of privately-owned lands for which public access is mandated by easement. Public lands with natural-resource features are included regardless of their conservation designation, but parcels dedicated to schools, garages, or other non-natural facilities are not included. The public lands included in this layer are considered likely to be maintained with at least a minimal degree of protection from land conversion, but may allow multiple uses such as logging and recreation access. The minimum size for most parcels is two acres, with exceptions for critical natural areas and state public access areas. This public-lands version of the database is distributed through the Vermont Center for Geographic Information (VCGI).

A version containing both public and private lands is available only through the University of Vermont, Spatial Analysis Laboratory (SAL); distribution of the complete dataset is strictly limited to persons or organizations with an approved research or conservation focus. Copies of the private lands section of the Conserved Lands Database (CONSPRI) may be obtained by contacting David Capen, Director of the Spatial Analysis Lab.

The public-lands extract of the Vermont Conserved Lands Database (CLD) is a GIS coverage of parcels that are currently protected from development through public ownership. This layer was designed to facilitate land-conservation planning in Vermont and is intended to include all publicly-owned parcels greater than two acres in area that are expected to remain protected from development or land conversion.

The Vermont Conserved Lands Database (CLD) was designed to be continuously updated and improved with the availability of improved data. It has developed as follows:

- 1997, March: The pilot phase of the project, which concentrated all research efforts on the southern four counties of Vermont, was completed. . This phase of database development included approximately 90% of the known conserved acres within the southern four counties of Vermont.
- Post March, 1997: the University of Vermont, Spatial Analysis Laboratory (SAL) has worked in cooperation with the Vermont Agency of Natural Resources, the Vermont Housing and Conservation Board, the Vermont Land Trust, the Vermont chapter of The Nature Conservancy, regional planning commissions, Vermont municipalities, and other conservation organizations to complete the database for the entire state of Vermont.
- 1999, April: maps depicting the database were sent out for review by cooperating government agencies and conservation organizations, Vermont towns, and regional planning commissions.. New or improved data on conserved parcels is continually added to the database.
- Post April 2000 release of the CLD: Primary emphasis was adding new properties protected by the Vermont Land Trust and The Nature Conservancy. Significant additions also included updated Green Mountain National Forest boundaries, and new parcels protected by Vermont Housing and Conservation Board, Green Mountain Club, and Lake Champlain Land Trust.
- 2002, July: release of the database adding internal administrative boundaries to state-owned lands in the northern Green Mountain region; these administrative boundaries were drawn to differentiate areas with varying management practices and objectives. As part of this effort, a new attribute item, ANRPROTLEVEL, was added to the database to provide specific management criteria mandated by the Vermont Agency of Natural Resources. Comparable

administrative boundaries will ultimately be added to state-owned properties in other parts of the state.

- 2004, December: Data release where Vermont Land Trust lands were again the primary focus of database revisions. Other significant updates included lands conserved by the Vermont Department of Fish and Wildlife (wildlife management areas), The Nature Conservancy, Green Mountain National Forest, National Park Service, Green Mountain Club, Richmond Land Trust, and Tinmouth Land Trust. In addition, the Windham Regional and Bennington County Regional Planning Commissions provided updates for conserved lands in their districts. Note, however, that this public-lands version of the CLD contains only parcels conserved by Municipal, State, or Federal entities. The only exception to this rule is a small number of privately-conserved properties for which public access is guaranteed by easement.

Currently, the Conserved Lands Database is divided into three different GIS coverages. The CONSPUB coverage includes information about public lands and is publicly available through the Vermont Center for Geographic Information (VCGI). CONSPRI complements CONSPUB and is distributed to users who agree to certain limitations about its uses and distribution. CONSPRO contains some proprietary information about selected projects, and is distributed only to project cooperators, such as those organizations represented on the steering committee. New information and corrections to existing information are continuously added to the CLD, and new versions of the three coverages are periodically announced.

The Conserved Lands Database was declared "essentially complete" in April 2000. At that time, the three versions of the database were prepared for distribution. CONSPUB was provided to VCGI for public distribution. CONSPRI and CONSPRO are kept on a secure server in the SAL and distributed, either by CD or on a public FTP site, to qualified users.

The database now comprises more than 1,150,000 acres, about 20% of the area of Vermont. Information on approximately 1500 conservation projects is included, and there are more than 4554 separate polygons in the GIS database.

Data have been captured using traditional paper-based submissions and this will likely continue into the foreseeable future.

Action Items

If resources were not limited and all of the necessary technical and political stakeholders were committed to fully modernizing lands data, the path to producing a fully integrated system of perpetual conservation lands data management over EPA Region 1 would be clear. This process is underway now, and it is not restricted to conservation lands. The mature solution, when available, will be an extension of an overall digital property management framework that will exploit current information technology to bring the land records inventory to a condition that includes all properties, is generally accessible and is current to the most recent transactions.

Components of this network will include:

- Automation of all property parcels throughout all of New England based on state or market defined geospatial standards. Statewide standards currently exist in at least half of the New England states and are of such quality as to permit cross border integration with little difficulty. Still, only a minority percentage of New England communities maintain digital parcels accurately and regularly; at the current rate of automation, regional completion is unlikely before 2015. This timetable is based on current state efforts to promote and fund in line with coordinated standards. Left to local initiatives the process will take considerably longer.
- Integration of parcel property line data for all of New England with corresponding Deeds Registry information (book/page) to provide exhaustive and definitive conveyance and survey-level information for all deeded land. This process is complicated by the fact that the parcels/deeds relationship differs throughout the region; some states maintain deeds at the county level and parcels locally (ME, MA, NH), while others record deeds at the municipal level (CT, RI, VT)[8]. Exploratory efforts are being taken in this direction in Massachusetts and Maine, and with universally available digital parcels the transition will probably happen quickly. In locally recorded states this book/page link is easily integrated, as evidence by its inclusion with parcel records in the conservation lands data sets maintained by Vermont and Connecticut.
- Perpetual maintenance of a master list of properties throughout the region that enjoy some form of protection as open space or conservation lands. With the above two components of the lands network fully in place, GIS may be de-emphasized from this step of the process. Responsibility for boundary maintenance will be accomplished either by standardized parcel maintainers, either at town or county levels or by proxy. When any parcel in the region may be digitally interrogated for its status and attributes, isolating those under fee or easement protection will have been reduced to writing a database query to an appropriate web service.

Of course resources are not unlimited. A lot level map down of all New England states, integrated with deeds registries and continually updated, remains many years away. In the meantime, there are important steps that may be taken in specific areas to ensure that maximum utility is squeezed from available data. These steps should be pursued in such a way that moves the process consistently forward so as to harmonize with a regional digital lands network as this begins to develop. Some of these steps have been mentioned in context boxes throughout this document. EFC and other organizations may undertake these steps to produce short term benefits as well as harmonize with the greater overall future trend:

- Coordinate basic properties of all regionally and thematically pertinent web services to ensure coordinated display and access irrespective of web clients used to access them. This applies to

[8] These three states are the only ones in the entire United States that maintain this method of deeds recording.

incipient conservation lands data capture services being undertaken in Massachusetts and possibly New Hampshire, but also base services operated by the states, municipalities, the federal government and large philanthropic and trust organizations.

- Work with high performance, high quality commercial and public web application providers to accelerate deployment of top quality public imagery available throughout EPA Region 1 to support GMT applications. Standing on the shoulders of well funded, carefully engineered products and data resources provides huge advantages over assembling capture tools from scratch.

- Monitor and advise ongoing web based data capture tool developments in the leading states and help to accelerate technology transfer to states with less access to software and data development resources.

- Continue to foster discussion and interaction between state level data stewards to promote harmonization of data repositories to ensure feature and attribute compatibility and elevate all datalayers to similar standards of accuracy.

- Enhance the capabilities and resources of personnel at the state level data validation nodes through development of optimized extraction, transformation and loading routines. Help to vet or train support staff to assist primary data validation work.

- Provide outreach to assist low technology towns or counties to assist them in their contributions to statewide data capture efforts. This may entail information infrastructure enhancement such as enhancing access to broadband internet access or training in use of the data capture tools made available by specific states.

The cost of continuing to push the different conservation lands data streams into closer alignment will be comparatively very low. Small investments in appropriate areas may be used to tighten integration of capture and distribution processes among capture entities and state level validation officials. Short descriptions of some of these follow.

- Provide seed funding to states to ensure that all Region 1 web services work together. This should be an easy modification for states with existing web services.

- Provide financial support or direct intern assignments to ease pressure on validation node bottlenecks at state level data centers.

- Work with land trusts to pool ESRI and other spatial software buys/licensing in order to minimize product outlays and reduce aggregate purchasing/leasing

- Continue to support EPA Region 1 conservation lands portal to simplify data access for interstate/wide area data consumers

- Support ongoing property parcel automation in the interest of harvesting protected open space features from these data sets

- Encourage buildout analysis efforts and development of municipal/watershed scale analytics that create demand pull for more accurate conservation lands data.

- Sponsor or host ongoing forum discussions among core data stewards, technicians and large consumers of these data throughout the region to synchronize efforts, exchange best practices and foster interpersonal trust among participants.

Contacts: Primary State Level Conservation Lands Data Stewards

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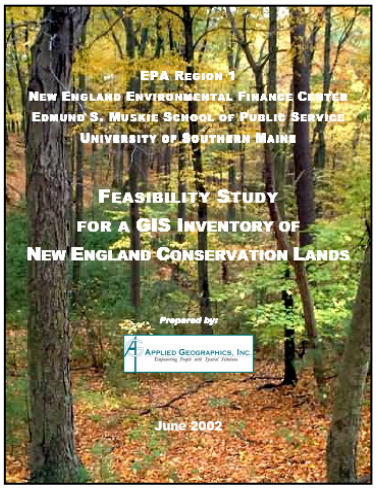
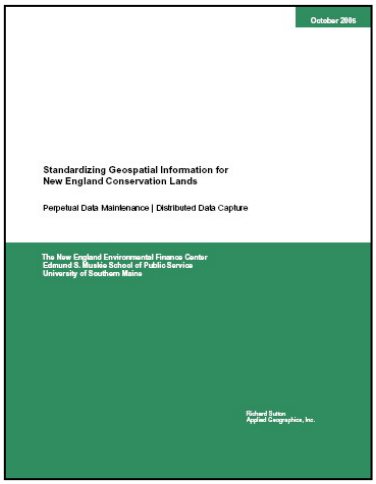
Associated Documents



Feasibility Study for a GIS Inventory of
New England Conservation Lands
June 2002

An inventory of activities and stakeholders utilizing conservation lands data EPA Region 1 (New England).

http://efc.muskie.usm.maine.edu/gis_feasibility_study.pdf



Standardizing Geospatial Information for
New England Conservation Lands:
Perpetual Data Maintenance | Distributed Data Capture
October 2005

A brief overview of the opportunities in and impediments to development of uniform digital protected open space data for New England.

http://efc.muskie.usm.maine.edu/docs/StandardizingGeospatialInfomation.pdf

Standardizing Geospatial Information for
New England Conservation Lands
Data Capture Methods + Technology
March 2006

A review of technical capabilities and assessment of ongoing and future initiatives of conservation lands data clearinghouse nodes in New England.

About the EFC/NE:
The purpose of the New England Environmental Finance Center is to further the joint goals of the U.S. EPA and the Muskie School of researching, publishing, and extending creative approaches to environmental protection and management, especially respecting the associated "how-to-pay" questions. In particular, the Center works to advance the understanding and practice of Smartgrowth throughout New England; to build local capacity to deal with related issues; and to develop and apply techniques that go "beyond compliance" with government regulations.

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