III. Information Management and Technology

A. Information Management Philosophy and Objectives

The general philosophy for Andrews LTER Information Management (IM) is that all LTER research data will be archived and openly available for the indefinite future. The primary goals are 1) to preserve high-quality and well-documented data collections that are both secure and accessible, 2) to serve the Andrews and broader community through the development and management of informational products and tools, and 3) to participate and provide leadership at the LTER Network level. The following objectives illustrate how aspects of the primary goals are achieved.

- Assure data preservation through the direction and maintenance of a long-term data repository, the Forest Science Data Bank (FSDB), assure high quality metadata and data products through adherence to LTER best practices for data quality assurance and management, and provide security through regular maintenance and backup procedures.
- Assure the public availability of Andrews data through commitment to a data release and access policy, which generally provides access to data within two years of collection.
- Provide web access to Andrews data and publications, research programs and projects, site and personnel information, education and outreach programs, community events and other information through development and maintenance of the Andrews LTER web pages and interfaces.
- Assure service to the Andrews community through IM Team participation and reporting at Andrews LTER monthly meetings, the inclusion of IM Team representation on the Andrews Executive Committee, and regular interactions with community members.
- Provide leadership to the LTER Network through participation or leadership roles in the development of network information systems that promote the discovery, use, and integration of LTER data, both within the network and globally.

B. People and Institutions

Information Management is an essential component of the Andrews LTER program and benefits from an institutional partnership between the Oregon State University College of Forestry (COF) and the USFS Pacific Northwest Research Station (PNW). The current Andrews LTER Information Management Team reflects this long-term partnership:

- Don Henshaw (Team Leader, PNW)
- Suzanne Remillard (Database/Web Developer, LTER/COF)
- Theresa Valentine (GIS Specialist, PNW)
- Fred Bierlmaier (Andrews Forest System Administrator, LTER/COF)

Two other field technicians (1 PNW, 1 LTER/COF) serve IM roles in supporting data loggers and field computers used in routine data collection, describing collection methods, and providing data. A PNW administrative assistant tracks Andrews publications and maintains the LTER bibliography. NSF supplements are used on occasion to contract for specific application development.

C. The Andrews LTER Information Management System

Information System: The Andrews LTER Information Management Team has developed an information system to support the collection, management, and curation of a rich and diverse collection of environmental data. The Forest Science Data Bank (FSDB) is a long-term data repository, which is supported by the LTER in partnership with the PNW and COF, and is the central component of the information system. The FSDB includes over 200 active and legacy study databases and features a highly-structured metadata database. Other components of the information system include a generic, metadata-driven quality control system, an administrative interface for LTER members, data submission tools, and dynamic web pages for discovery and access to data and informational products. The information system manages study databases and research publications, and extensions to include the image library and Andrews-related museum collections are being considered.

FSDB study data and metadata: The FSDB contains "signature" and other LTER-related data sets from the Andrews Forest. All LTER data sets are routinely placed on-line based on the terms of our data access policy (section III.D). The FSDB has also opportunistically captured other important data sets from OSU and the Forest Service, and continues to house significant legacy data collections that are not available on-line, due to priority status or quality control issues.

Metadata are established in compliance with the LTER metadata standard, the Ecological Metadata Language (EML), and follow LTER "best practice" recommendations. Software tools are used to map elements from the relational metadata database into EML, and similarly map ESRI metadata from the FGDC spatial standard into EML. EML metadata are regularly harvested from the Andrews LTER into the central metadata repository (Metacat) at the LTER Network Office (LNO), which assures that Andrews data is available for network-wide data searches. EML files are easily mapped into the NBII Biological Data Profile metadata standard using stylesheet software at the LNO and discoverable through the NBII clearinghouse.

Quality control system: This system consists of a set of simple procedures that provide generic metadata-driven data validation. A desktop control program reads the relevant metadata for validating any given data table and generates appropriate validation code. The control program executes the generated code and records any problems in the metadata description of the data table in an error report. Validation includes checks of the primary key for nulls and duplicates (entity integrity), checks versus listed numeric ranges or enumerated codes (domain integrity), and database rules. Rules are typically specific to individual databases and often have been "discovered" with the help of database owners. Generic rules are employed in time-series contexts, but most rules are only shared occasionally. A working group within the LTER Network is currently using a similar approach to construct an "EML congruency checker" that could ultimately provide EML-driven metadata and data validation.

Administrative interface: An improved administrative interface has been implemented that allows interactive site member submission of study metadata, managing of personnel profiles, and managing research projects including an online project application form. This interface is designed to improve the efficiency of IM operations by reducing the amount of staff time dedicated to the update of study metadata and personal information. Planned extensions of the interface will allow the entry of publication citations as well.

Data submission: The IM team has developed a web page to provide instructions and other references to facilitate submission of study data from site PIs, graduate students, and other researchers. Instructions are available to assist a data provider in entering study metadata using the administrative interface and describing spatial entities. A spreadsheet template is also provided to capture specific entity and attribute information. Desktop software tools allow the import of the template (Excel) into the metadata framework and allow additional editing of the metadata. The information system draws upon a local controlled vocabulary for both place and theme keywords and a reference list of common units of measurement to promote consistency of data set descriptions and to avoid redundant descriptions of site locations.

Web pages: Andrews LTER personnel maintain and update extensive web pages describing the Andrews Forest, ongoing LTER and related research, research collaborations with management, over 160 data bases, bibliography (including pdf documents for many publications), education and outreach activities, arts and humanities, and personnel. Web pages are dynamic using ColdFusion software with navigation bars and page templates provided through the production database (SQLServer). A web site search engine is employed and a web interface permits searching for data and publications by person, theme keyword, simple search strings and other options.

The metadata database is accessed dynamically to build web pages for describing individual study databases and creating text files for download. Caching of large datasets has been implemented to increase the performance of the download process. Downloads are tracked through a user registration system. Web page development has been an important activity for our site as it provides integration of our many research products and provides a primary source of site information for users within and outside our research community.

System Administration:

System administration and hardware at Oregon State: The COF Forestry Computing Resources (FCR) provides system administration support for LTER campus computer servers through agreements with LTER and PNW. Production and development web servers (IIS, UNIX, and LINUX), production and development database servers (MS SQLServer), shared file server directories, and two tape backup servers are directly used by the LTER and supported through FCR. Refer to the FCR description of network systems (http://helpdesk.forestry.oregonstate.edu/about-our-network).

System administration and hardware at the Andrews site: The on-site Andrews LTER system administrator maintains the site Local Area Network (LAN), local web server, wireless LAN, spread spectrum and radio telemetry communication network, telephone communications, and local personal computers. A wireless LAN is installed with access points linking the conference room and classroom, dormitories, cafeteria, shop, and director's residence to the wired LAN with a wireless bridge.

*Backup policies***:** General backup procedures are maintained and implemented through agreements with OSU College of Forestry. In general, campus web servers (including IIS, UNIX, and Linux used by LTER) and file servers (Windows) are backed up nightly. For these systems a full backup is done once each month, and a "level" backup is done once a week. A level backup catches what changed since the last full backup. Then, on all remaining days, an incremental backup is performed. Backups are kept for 6 months. See the COF backup policy at http://helpdesk.forestry.oregonstate.edu/policy-system-backups-and-recovers-0. A T1 line to OSU campus allows nightly backup of Andrews on-site web and file servers to COF. On-site servers are also mirrored to provide an immediate local backup.

Legato NetWorker's backup module for SQL Server is used to backup MS SQL Server databases. A full backup is performed on a regular schedule every night. Additionally, space is provided for DB managers to perform SQL backups as needed throughout the day. For example, if a database was undergoing a major change, the DB manager could use the SQL Backup Tools within MS SQL Server to backup the database by hand, before making the change. We also have the ability to perform a backup using NetWorker's tools at any time. Backups are kept for 2 months.

The backup server is a Dell 2900 system with a RAID to store backup indexes. Backups are routed to a Qualstar XLS tape library that holds 245 tapes, and each tape holds 1.5 Terabytes native. Inside the library are 6 LTO-5 tape drives. Backups are grouped according to our network design (home directories, group directories, web servers, database servers, email, UNIX servers, and special backup needs. COF is currently in the process of reviewing backup strategies to address changes in storage architectures, such as Storage Area Networks.

Non-electronic storage: Paper record storage is greatly reduced from historic levels, but raw data collection records including field and lab data forms, check sheets, and recording charts are stored in the FSL fire-proof vault. Legacy documents, charts, computer printouts, and individual scientist storage boxes are also stored here. While all chart recorded data has been digitized, scanning of these long-term paper documents into digital formats is ongoing. Similarly, a publication reprint library is being reduced in scope and all LTER publications have been scanned. Original photographic slides and aerial photos are inventoried and stored in six fire-proof cabinets, and scanning will proceed when resources are available.

D. Data Access Policy and Online Data

The Andrews LTER data access policy (http://andrewsforest.oregonstate.edu/data/access.cfm?topnav=98) is modeled after the LTER network data policy (http://www.lternet.edu/data/netpolicy.html) and includes three sections: the release policy for data products, user registration requirements for accessing data, and the licensing agreement specifying conditions for data use. Excerpts from this policy follow.

Data and information derived from publicly funded research in the Andrews Experimental Forest, totally or partially from National Science Foundation LTER funds, or Partner Agency or Institution funds where a formal memorandum of understanding with LTER has been established, are made available online with as few restrictions as possible on a nondiscriminatory basis. Andrews LTER scientists make every effort to release data in a timely fashion and with attention to accurate and complete metadata.

Types of data:
Type I - data are to be released to the general public within 2 years from collection and no later than the publication of the main findings from the dataset and,
Type II - data are to be released to restricted audiences according to terms specified by the owners of the data. Type II data are considered to be exceptional and should be rare in occurrence.

Data Prioritization: While the intention of the Andrews LTER policy is to promote maximum availability for ecological data, resource constraints have led to establishing criteria for prioritizing data for release. Primary observations collected for core research activities directly supported by LTER funding receive the highest priority for data release. Data collected with partial LTER support or where the LTER program has added value to resulting data products will also receive high priority for release. Other types of data including student thesis data, schoolyard LTER data, or non-LTER data that was acquired for LTER research may be ranked at a lower priority. Legacy data will be released as resources become available.

Online data: Here is a summary of LTER online databases

- Currently 160 LTER databases are online representing 950 data tables or spatial entities
- Nearly half (78 databases) are long-term data collections (>10 years)
- 13,350 LTER data tables have been provided or downloaded over 25 years (1986-2010)

Table III.1. This table tracks Andrews LTER data use over 25 years. The IM Team believes that increasing numbers of data downloads are primarily due to easier data access and greater demand for this data, however increased downloads also reflect greater numbers of online data tables and improved data use tracking. IM Team downloads for checking or testing are excluded.

Research Area	Number of Fulfilled Requests/Downloads of LTER Data Tables (1986-2010)				
	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010
Climate	15	150	200	1030	3050
Hydrology	10	50	130	755	2090
Vegetation	15	30	60	640	1150
Carbon/Nutrients	5	5	40	420	740
Biodiversity	0	5	55	395	670
Soils	0	0	15	255	450
Disturbance	5	10	25	160	415
Stream-Forest	0	5	15	70	235
Total Downloads	**50**	**255**	**540**	**3725**	**8800**
LTER Databases online	**0**	**20**	**50**	**130**	**160**

Data use: Tracking of data set use has been ongoing since the mid-1980s (see Table III.1). The following summarizes the nature and scope of data use tracking.

- 1987-1994: Data requests are received via email and data is handled manually and sent through email or paper mail. A desktop software program and tracking database were developed in 1991 to easily track requested data sets, requestor and date, and intended use.
- 1994-1996: The first data was placed online in fall 1994 and approximately 20 data sets are placed online by 1996. Requests are still primarily handled through email and tracked through the desktop program.
- 1996-2001: A voluntary registration form is established on the web page, and form data is hand entered into the tracking database. Data downloads are likely under estimated during this period due to the “voluntary” forms, and some tracking documentation is incomplete.
- 2002-2005: A user registration system is employed to track downloads of data sets. Users must agree to the terms of the Data Use Policy and a one-time user registration is required. Some data sets were still tracked through voluntary registration forms until all data set migration into the new information system was completed in 2005.

- 2006-2010: A web page tracking and registration system automatically documents all data downloads in the production database server**.**

E. Andrews IM Accomplishments and Activities in LTER6, 2008-2010

Data set creation and updates: Thus far in the LTER 6 funding cycle, the IM team has placed over 20 new study databases online including new LTER 6 databases, newly documented spatial databases, and legacy data sets that have been migrated into the information system. The new web pages now feature the ability to browse on "signature" data sets (see Table III.2), which represent long-term core research. Several signature climate, hydrology, and vegetation data sets are specifically maintained and updated by the IM Team and technical staff. Some examples of recent data product development of note are:

- The USGS streamflow record has been reconstructed from old strip chart and punch tape records from 1949 to 1986 at hourly time steps. This entire hourly record (1986-Present) will be placed online in summer 2011 (as part of study HF004).
- The long-term stream chemistry record has been enhanced to include value-added entities for mean monthly nutrient concentrations and monthly nutrient outflow (flux).
- A series of long-term tree remeasurement and mortality study and under-story vegetation study databases from the Andrews and throughout the PNW region are under redesign. The redesign will standardize database entity structures, attribute names, and biomass and primary production calculation for five or more existing FSDB databases. This redesign will allow the integration of vegetation data collections and the use of standard applications to create the derived and value-added data required by site scientists.

Bibliography: The Andrews bibliography has been migrated from legacy Procite software into the metadata database where it can be directly managed from the administrative interface and easily searchable through the web interface. All LTER publications and library documents have been scanned (into pdf files) for online access, and scanning of remaining Andrews publications is underway. Additionally, publication abstracts are now searchable to improve discovery of Andrews publications.

Information system development: The Andrews LTER web pages have been updated and redesigned into a modern style. A new search interface for databases and publications was written (in LINQ) to be faster and more efficient. A web-based tool, the administrative interface, was designed and implemented to allow researchers and site members to update and edit study metadata and manage their personnel information. This interface also provides project registration forms, which are required for conducting research at the Andrews site. The interface was coded (ASP.NET) through a contract with Business Solutions Group (BSG) at OSU who hire and train student programmers and development engineers.

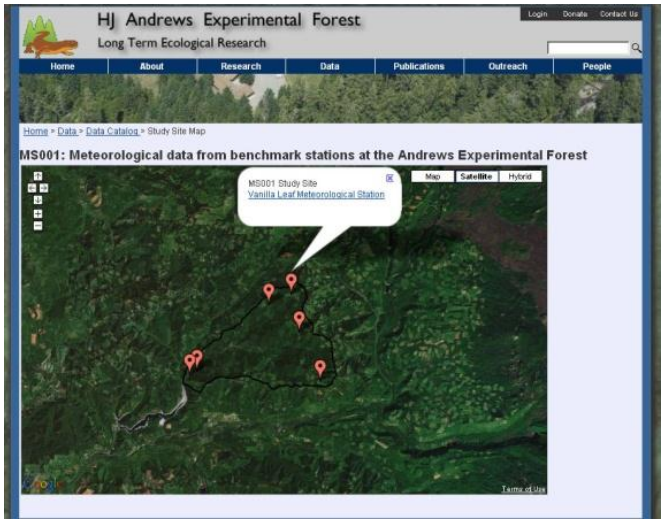
A web-based tool that generates the metadata standard EML from the SQLServer metadata database has been greatly enhanced to better conform to LTER best practices for EML. The tool uses style sheet transformations (XSLT) to convert SQL native-XML into EML and was originally described in DataBits (http://databits.lternet.edu/spring-2007/generating-eml-relational-database-management-system-rdbms). This is an important improvement for Andrews metadata to ensure compliance with PASTA architecture being developed at LNO, and particularly new LNO tools for checking congruency of site data with their EML description. This work was funded through the special 2010 LTER supplement for information management.

Data is increasingly being collected using radio telemetry to stream high-temporal resolution data to the Headquarters base station. As the wireless communication capabilities expand, so does the need for better management of streaming data. Currently much of the climate station and stream gauging station data is put online “as is” on an hourly basis, and provisional data tables are made available daily. Standardizing the capture and quality screening of all streaming data will allow the system to provide immediate access to many additional data streams. SQLServer procedures have been developed (2011) to pull streaming climate data from four benchmark weather stations, provide initial data limits checking, and place in archival entity structures. These procedures serve as the prototype for handling streaming data and efficiently providing access without information manager intervention.

Other previously developed tools are still maintained including a lodging and conference room use reservation system, streamflow summary tool (FLOW), climate data summary tool (GLITCH), analytical lab management system (CCAL), and multiple online forms for registration, reservations, and requests.

Spatial data activities: The GIS data have been converted from coverage to shape file format and projected from NAD27 datum to NAD83 datum. This process was necessary to meet US Forest Service GIS data standards, to provide data readable by Open Source software, and to keep current with ESRI software products. Providing data in the NAD83 datum was necessary to match existing data with the new LiDAR data and to integrate with on-line data sources for imagery (Google Maps and Bing Maps). Data downloads will now contain both NAD27 and NAD83 datasets, along with FGDC and EML metadata.

A “place keyword” table provides coordinate, elevation, and descriptive information for all Andrews study sites, and serves as a means to search databases by location. Recently, this data table has been enhanced through programs developed to extract this information from GIS systems. A Google Maps application (see figure) was developed to dynamically display site locations associated with databases through pop-up windows and imagery.



Annual GPS sorties have also been used to improve study site and infrastructure spatial coordinates and elevations at the Andrews site. These sorties occur over a 2 to 3 day period when optimal satellite coverage is available, and participants use precision GPS units and take digital photographs at each site. Retiree volunteers have been invaluable in locating and documenting historic measurement sites. The resulting data have been critical in conducting analysis in conjunction with LiDAR data, and in assuring documentation and protection of sites.

A new Andrews paper map and brochure is currently in press and also available as a map service. Detailed LiDAR information provided an opportunity to correct and update out-of-date topography, roads and streams, and replenish supplies of maps. The back of the map is designed as a brochure, with information about research, local points of interest, and recreational opportunities. Web users can view GIS information with the map as a backdrop in ArcGIS, or print a custom map on the new site plotter.

Planning: The Andrews IM advisory committee includes the IM Team, the site manager, the administrative coordinator, and a signatory PI. The committee serves as a means to provide annual reviews of IM activities and reports to the HJA Exec committee. The committee has been active the past two years in guiding IM efforts to improve efficiency, prepare for the 2011 site review, address the data access and release policies, and identify and prioritize signature data for update and placement online. An ad hoc web content and design committee has also been active to guide the redesign of the web site.

Technology: LiDAR was flown for the Andrews in 2008. Products include processed point clouds, both 1-meter bare-earth and vegetation Digital Elevation Models (DEM), and intensity grids. Several researchers and students are integrating LiDAR data into their projects.

A wireless communications network is under development (http://andrewsforest.oregonstate.edu/pubs/pdf/pub4433.pdf) and two radio towers will be constructed at the Roswell Mountain and RS20 Ridge locations. One acre of second-growth forest was cleared at RS20 Ridge to provide line-of-site to Roswell Mountain and back to the Andrews Headquarters (HDQTRS). The radio towers will be the backbone for site wireless communication and support pairs of direct line-of-site 5.8 GHz radios with Ethernet bridges between HDQTRS and RS20 and RS20 and Roswell. Two additional radio pairs are planned from RS20 to WS1 treetop and Ws1 treetop to WS1 Airshed tower. The WS1 Airshed tower will support an 802.11 Wi-Fi access point. The RS20 tower has been constructed and Roswell Tower will be built once access is open in summer 2011. The radios will be battery-powered by a 2.5 kW solar array (12 210-watt panels) to assure enough power to allow for year round operation even at the seasonally inaccessible Roswell Mountain site.

The new communication network will improve efficiency and bandwidth to the existing radio telemetry network. The existing network includes four benchmark weather stations and several stream gauging stations linked to headquarters via radio telemetry. Measurement data is transmitted hourly, displayed graphically online, and provided as provisional data for download. This original telemetry system is based on FCC-licensed VHF radios operating at 151 MHz, but will no longer be supported for Campbell dataloggers. A telemetry system based on 900 megahertz spread spectrum radios is also in use at the WS1 “cyber watershed”. The new network will provide more efficient streaming of data and internet access near the Airshed Tower, and opens the possibility for additional internet access points throughout the forest.

The last three years have seen the upgrade and enhancement of existing technology tools:

- New web server is now Apache/2.2.15 (Linux/SUSE) with PHP 5.3.3 and ColdFusion 9
- LTER database has been migrated from SQLServer2005 to SQLServer2008
- Web Applications have been migrated to new IIS servers running windows7
- Version 10.0 of ArcGIS is a major upgrade for desktop and server applications. This upgrade required the deprecation of ARCIMS applications and a new metadata system. An image servicer is added allowing web services to provide LiDAR DEM products directly to ArcGIS applications.
- Social media is added as interested users can become a fan of the Andrews Facebook page or subscribe to the RSS news feed.
- Technology at the field site has been enhanced through a series of OSU Technology Resources for Students (TRF) grants. New lab computers, a rugged laptop for field work, high precision GPS unit, a large scale plotter, a laser for collecting tree heights and distances, and Video Teleconference (VTC) equipment have been acquired for the site, 2007-2010.

F. LTER Network-level Activities

Andrews Information Managers are active at the LTER network level with Henshaw (co-Chair IM Committee, 2009-Present), Valentine (chair GIS subcommittee, 2003-2010), and Remillard (IM Executive Committee, 2008-Present). A summary of network-level activities follows:

- Henshaw co-chairs the annual IMC meeting, Kellogg (2010) and Santa Barbara (Sep 2011).
- Henshaw participates on the LTER Synthesis Committee and was co-author of a network-wide prospectus for LTER legacy data
- Henshaw organized an LTER All-Scientist Meeting (ASM) workshop, *Sensor network technologies: Recent innovations and tools for management and analysis of sensor data* (http://asm.lternet.edu/2009/workgroups/sensor-network-technologies-recent-innovations-and-tools-management-and-analysis-sen).
- Valentine led the development of LTERmapS, an all-LTER-site mapping interface tool and conducted a related post-ASM workshop to successfully migrate LTERmapS to the LNO. Valentine is recently funded by LNO for LTERMapS Phase 2 product-oriented workshop.
- Valentine chaired a workshop on Visualization at ASM 2009. Valentine leads GIS working group activities at annual IMC meetings that focus on improving GIS technology and data at LTER sites, and organized a workshop hosted at the Andrews site on "Preparing spatial data documentation for EML (ESRI2EML)" in Nov 2010 (http://intranet.lternet.edu/im/news/committees/working_groups/gis_data/gis_eml).
- Remillard served as the ClimDB administrator (2002-2010) and assisted migration of this system to the LNO in 2010 for long-term stewardship. Remillard assisted in training the new LNO data administrator on its operation. The ClimDB/HydroDB data harvester and data warehouse was developed at the Andrews as a cross-site and cross-agency webpage and data resource.
- Bond served on the LTER Network Information System Advisory Committee (2008-2011). Henshaw formerly chaired NISAC (2003-2007)
- Other LTER working group and committee activities include participation on IMC web design (Remillard and Valentine), controlled vocabulary (Henshaw), web services (Remillard), EML best practices (Valentine), and Network Information System (NIS) Tiger Teams to provide testing and feedback of new system components to NIS developers (Remillard and Henshaw).
- The IM Team regularly contributes to the LTER DataBits newsletter.

The Andrews also populates network-wide databases. EML for all on-line data sets is harvested to LNO on a regular schedule into the NIS metadata catalog. ClimDB/HydroDB is updated at least annually for several climate and gauging stations. PersonnelDB, SiteDB, and the All-site Bibliography are updated episodically. All units of measurement in use within Andrews data are now part of the Units dictionary and web service.

G. Impact

Perhaps the greatest impact is demonstrated through the persistence and growth of the Forest Science Data Bank. The FSDB was established in 1980 and has been largely funded and operated by LTER personnel since the mid-1990s. The FSDB has opportunistically acquired non-LTER data and includes well over 250 databases with more than 170 databases on-line (mostly LTER). A stable computing environment and information system with desirable features such as adherence to national metadata standards have allowed the FSDB to expand its LTER data resource holdings into a regional data center. Holdings now include key US Forest Service Research data (e.g., Research Natural Areas and Experimental Forests), USFS campaign data (e.g., Demonstration of Ecosystem Management Options

(DEMO) and Mount St. Helens), National Forest System data (Young Stand Study), OSU CoF data (e.g., OSU MacDonald Forest), and the Long-Term Permanent Vegetation Plot Network (OSU, PNW, UW). NSF-funded grants in ecosystem informatics such as the IGERT and summer institute (EISI) programs have broadened campus-wide perspectives on information management and cyberinfrastructure issues, and Andrews data has been essential in student projects (e.g., quality control of high-volume streaming data, visualization software on species diversity). There have been over six thousand documented downloads of data from FSDB in the past three years.

The IM Team has recently participated in writing data management plans for proposals or in working with funded grants to establish IM protocols or take use of the FSDB. Examples include the NSF-funded exploratory Portland-Vancouver ULTRA, NSF-funded Willamette Water 2100, USDA-funded Regional Approaches to Climate Change in Pacific Northwest Agriculture (REACCH), and other proposals including NSF Macrosystems Biology. The IM Team has participated in DataONE, NEON, and ILTER workshops, and have served on NSF review teams.

The Andrews IM Team was the primary developer for the ClimDB/HydroDB data harvester and warehouse. The Andrews was well-suited to establish the hydrology component and combine the early ClimDB prototype LTER climate data with 15 additional USFS sites with streamflow data. The impact of ClimDB/HydroDB is evident in participation from 44 sites (LTER, USFS, Taiwan) contributing over 11 million daily measurement values and over 20,000 documented downloads or graphical views since 2003. The web page, http://climhy.lternet.edu/, averages over 25 visitor sessions per day.

Other recent demonstrations of impact are as follows:

- The Andrews IM team conducts yearly training and outreach to graduate students, IGERT, and Eco-Informatics Summer Institute students. The team meets one-on-one with students to help them understand the importance of managing their data and contributing to the long-term records of the Andrews LTER. Team members have conducted training and outreach internationally and nationally at conferences and workshops.
- The Andrews LTER received ARRA funding to assemble a stream chemistry database, StreamChemDB, which originally will include 10 USFS sites but will be being expanded to include several LTER sites. The early prototype will be explored in an LNO-sponsored workshop this fall.
- Valentine leads a local Spatial Data Committee, which meets monthly with USFS, USGS, EPA, and OSU participants to present and discuss current GIS issues.
- Other outreach and training:
    - Valentine demonstrated LTERmapS at the 2010 ESRI International User Conference in the Forest Service booth and at the Andrews Annual LTER Symposium.
    - Henshaw was an instructor and participant in the ILTER East Asian Pacific "2nd *Analytical Workshop on Dynamic Plot Database Analysis"* in Kuala Lumpur, Malaysia, July 19-22, 2010. Participants included international students and researchers from Malaysia, Vietnam, Korea, and Taiwan.
    - Henshaw was a guest speaker at the Coastal and Estuarine Research Federation's 20th Biennial Conference in Nov 2009 and participated with the Salmon Data Access Working Group to present lessons learned in LTER Information Management and current IM activities and innovations.

Table III.2. Andrews LTER Signature Data

CODE	TITLE	BEGIN	END
Biota and diversity			
AS006	Aquatic Vertebrate Population Study, Mack Creek, Andrews Experimental Forest	1987	Present
SA001	Invertebrates of the Andrews Experimental Forest: An annotated list of insects and other arthropods	1971	Present
SA015	Spatial and temporal distribution and abundance of moths in the Andrews Experimental Forest	1994	2007
SA016	Spatial and temporal distribution and abundance of butterflies in the Andrews Experimental Forest	1994	1996
SA024	Bird Arrival and Activity Phenology at the Andrews Experimental Forest	2009	Present
SA025	Insect Activity Phenology at the Andrews Experimental Forest	2009	Present
TP041	Post-logging community structure and biomass accumulation in Andrews Experimental Forest Watershed 10	1973	Present
TP073	Plant biomass dynamics following logging and burning in the Andrews Experimental Forest Watersheds 1 and 3	1962	Present
TP091	Ecosystem dynamics in a mature and an old-growth forest stand (WS02, HGBK)	1981	Present
TP114	Plant biomass dynamics following logging, burning, and thinning in watersheds 6 and 7 at the Andrews Experimental Forest	2002	Present
TP115	Plant biomass dynamics in old-growth watersheds 8 and 9 at the Andrews Experimental Forest	2003	Present
TV010	Tree growth and mortality measurements in long-term permanent vegetation plots in the Pacific Northwest (LTER Reference Stands)	1910	Present
TV019	Cone production of upper slope conifers in the Cascade Range of Oregon and Washington	1959	Present
TV075	Vegetative Phenology observations at the Andrews Experimental Forest	2009	Present
Climate			
MS001	Meteorological data from benchmark stations at the Andrews Experimental Forest	1957	Present
MS005	Reference Stand air and soil temperature network at the Andrews Experimental Forest	1971	Present
MS007	Snow depth and snow water equivalent measurements along a road course in the Andrews Experimental Forest	1978	Present
MS029	Mean monthly maximum and minimum air temperature spatial grids (1971-2000), Andrews Experimental Forest (GIS)	2002	2002
MS033	Radiation spatial grids, Andrews Experimental Forest (GIS)	1995	2002
MS036	Cold air drainage mobile transects in the Andrews Experimental Forest	2002	Present
MS041	Snow study on Watershed 7 in the Andrews Experimental Forest	2006	Present
MV001	Airshed tower data in Watershed 1 in the Andrews Experimental Forest	2005	Present
TW006	Ecohydrology and Ecophysiology in Watershed 1 at the Andrews Experimental Forest	2005	Present
Landuse			
GI010	LIDAR flown 10-11 August 2008 for the Andrews Experimental Forest	2008	2008
TP054	Andrews Experimental Forest management history	1980	2009

Disturbance			
DF028	Age structure and fire regime characterization of Douglas-fir/western hemlock forests in the central western Cascades of Oregon (Tepley)	2006	2010
GE012	Landslide inventory (1953-1996), Andrews Experimental Forest and vicinity (GIS)	1953	1996
GS002	Stream cross-section profiles in the Andrews Experimental Forest and Hagan Block RNA	1978	Present
HS004	Bedload data from sediment basin surveys in small gauged watersheds in the Andrews Experimental Forest	1957	2009
TV025	Ecosystem responses to the creation of tree-fall gaps in the western Cascades of Oregon and Washington (Experimental Gap Study)	1990	2006
Hydrology			
GS006	Dynamics of large wood in streams: Tagged log inventory, Mack Creek, Andrews Experimental Forest	1985	2008
HF004	Small watershed streamflow summaries at the Andrews Experimental Forest	1949	Present
HF006	Small watershed storm history with peak flows (derived from HF04 summaries) at the Andrews Experimental Forest	1953	1998
HT004	Stream and air temperature network at the Andrews Experimental Forest	1976	Present
HT006	Stream and air temperature within the phenology network at the Andrews Experimental Forest	2009	Present
Nutrients and detrital dynamics			
CF002	Long-term stream chemistry concentrations and fluxes: Small watershed proportional samples in the Andrews Experimental Forest	1968	Present
CP001	National Atmospheric Deposition Program (NADP site OR10): Precipitation chemistry at the Andrews Experimental Forest	1980	2009
CP002	Long-term precipitation and dry deposition chemistry concentrations and fluxes: Andrews Experimental Forest rain collector samples	1968	Present
TD012	Dimensions and volumes of bark and wood from logs, snags, and stumps from multiple forests in the United States and Mexico	1984	2006
TD014	Long-term log decay experiments at the Andrews Experimental Forest	1985	Present
TD017	Comparison of terrestrial versus aquatic decomposition rates of logs at the Andrews Experimental Forest	1985	Present
TD018	Nitrogen fixation and respiration potential of conifer logs at Andrews Experimental Forest	1987	2005
TD021	Dimensions and volumes of bark and wood from logs, snags, and stumps from multiple forests in the United States and Mexico	1989	2007
TD023	LTER Intersite Fine Litter Decomposition Experiment (LIDET)	1990	2002
TD024	Fine woody detritus volume and mass from line transect inventory	2002	2006
TD028	Mass of forest floor litter from cores in reference stands and inventory plots in the Pacific Northwest	1992	2006
TD030	Fine woody debris inventory data from reference stands and inventory plots in the Pacific Northwest	1992	2000
TD031	Decomposition of Fine Woody Roots: a Time Series Approach	1995	2006
TD032	A chronosequence of woody root decomposition in the Pacific Northwest	1995	1997
TD035	Coarse woody debris volume and mass from line transect inventory from reference stands and inventory plots of the Pacific Northwest	1997	2006
TN025	Nutrient Concentrations of Vegetation in Small Watersheds at H. J. Andrews Experimental Forest	2005	2007