

ISWS Miscellaneous Publication 72

**LONG TERM ECOLOGICAL RESEARCH  
DATA MANAGEMENT WORKSHOP  
HELD AT URBANA-CHAMPAIGN, ILLINOIS  
NOVEMBER 22-23, 1982**

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Long Term Ecological Research  
Data Management Workshop  
Held At Urbana-Champaign, Illinois  
November 22-23, 1982

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## SUMMARY

The LTER (Long Term Ecological Research) Data Management Workshop was conceived with the idea of giving the eleven LTER site data managers and others who wanted to attend an opportunity to exchange ideas and thoughts concerning the management of ecological data, along with the chance to talk about any problems that any site data managers were having and were willing to share with the group.

The workshop was composed of two general sessions and two working committee sessions. The first general session was held so each site data manager could present his or her data management program in an overview fashion. This gave everyone the opportunity to become familiar with everyone else's background and current data management activities.

There were two working committees: Data Administration, chaired by Carl Bowser, and Data Documentation, chaired by Ken Lubinski. The two working committees spent a long half-day working up the ideas and recommendations that are contained in this report.

The second general session of the workshop was for the two committees to meet jointly to approve and discuss the recommendations and ideas put forth at the separate working committee sessions. Good agreement was found on almost all issues. About five weeks after the workshop, a rough draft copy of the report was sent to all participants for their comments and review.

The editor has found that the feedback that has been received has been nothing but positive concerning the feelings of the participants about the workshop in general and what was accomplished. So often people go away from a meeting or workshop feeling that their time was wasted or their missions were unfulfilled. From the feedback that has been received on the workshop, this is not true in this case.

## Brief Summary of Some of the Recommendations

1. Each LTER site will prepare a new site report. These will be expanded and updated reports of the ones prepared for the Kellogg workshop held in May 1982.
2. Each site will prepare LTER data set abstracts which will be sent to Walt Conley so he can create an LTER abstract database.
3. Each site will establish quality assurance standards.
4. Each site will establish archiving policies and procedures.

5. Each site will have data access arrangements for intersite data exchange.
6. Each site will have guidelines for acknowledgment of data.
7. Site reports should describe each facility's computer hardware and software capabilities.
8. Each site will update the LTER data set documentation annually.
9. The two working committees did not recommend common data set formats among sites.
10. All LTER sites will work together toward intersite compatibility in the areas where common desires and interest exist.
11. The two working committees recommended that the LTER data managers should meet annually so intersite cooperation and discussions can be continued.

#### RECOMMENDATIONS OF DATA ADMINISTRATION COMMITTEE

As a general policy the Data Administration Committee members do not recommend any degree of internal consistency across the various LTER sites. Rather the committee has set goals that it recommends for all sites. The way in which they attain these goals is left to the individual sites, as they are in the best position to efficiently allocate their resources in the most expedient and efficient way to facilitate reaching these goals. No one on the committee felt any need to dictate specific tasks and/or assignments to individual sites.

Two levels of guidelines were established at the Workshop by the Data Administration Committee: a minimum level of action or support, and an optimum level of action or support.

Generally anything considered minimum level refers to LTER-supported data only. Optimum level of attainment would imply attainment for all data at the specific site, whether LTER-related or not. Additionally the term "all data" does not imply literally all data, but only that judged meaningful in terms of criteria set by the database group at each site.

All sites agreed to prepare an upgraded, expanded, updated site report following the guidelines set forth for the site reports prepared for the NSF-sponsored Workshop on Database Management at Biological Field

Stations held at the Kellogg Biological Station in May 1982. The guidelines for preparation of the report are listed below. Each of the sites agreed to review the draft site reports that were sent out as part of the preparation for the LTER Data Management Workshop (November 22-23, 1982) and to prepare a revised site report that:

1. Reflects recent changes at specific sites since preparation of the earlier site report.
2. Represents more uniformity of style with other site reports.
3. Adds specific additional information as described in more detail in the following paragraphs.

Relative to the second point it is suggested that everyone use an extended outline form using subheadings the same as in the outline. If possible data on such things as hardware and software capabilities should be put in tabular form.

All site participants agreed to have the updated documentation prepared and submitted to Dick Marzolf before January 1, 1983. That would allow him time to duplicate the documentation and to send it to all participants of the LTER Steering Committee before the mid-January meeting.

#### ADDITIONS TO SITE REPORTS

The following items should be added to each site report. In some cases the added material can be placed in the body of the site reports.

#### Quality Assurance

All sites will provide a description of the means of quality assurance used at the database management level. The scope of quality assurance as used herein refers only to that necessary for database management, including such things as data entry verification techniques, transfer from one data medium to the other, and techniques used for data screening (checks for outliers, statistical verification programs, etc.). The data managers will only assume responsibility for accurate transcription of the "data" they receive. The quality assurance of the data received is NOT the data manager's responsibility. It is the responsibility of the P.I. to make sure that the data are correctly collected and truly represent the phenomenon being studied. Quality assurance at the Principal Investigator level includes such things as the use of accepted or established methodology, and proper recording

and verification of the accuracy of the data. The data managers are not responsible for the soundness of the statistical design or the integrity of the scientific enquiry. They are, however, responsible for the accurate transmission and transcription of the data, sustained accessibility, and maintenance of the data integrity.

### Archiving

All sites will describe the means used for archiving of data at their site. In addition the committee recommends that all sites store data in at least two different sites. For the purpose of archiving, the committee proposes that raw data be stored in original form for a period of one to two years. Afterwards the committee considers that the term "raw data" would include such storage forms as microfiche, microfilm, or other such means of recording raw data in untranscribed form. (The meaning of "raw data" varies with different investigators, and rather than specifically describe the meaning it was felt that raw data should mean any form of data as collected-or minimally reduced by the site investigator. Common sense generally determines the meaning of the term.)

### Data Access

Responsibility for access to data and established procedures for obtaining data vary from site to site. Sites will describe procedures used for obtaining data access. Generally the committee feels that within reason the LTER data should be publicly available within constraints set by specific P.I.'s and the lead P.I. at the site. It is not the database manager's responsibility to decide on such matters, only to help in the transfer of data once agreed upon by the researcher who is responsible for the data and the person making the request.

### Data Acknowledgment

Guidelines for the proper acknowledgment of data should be listed. Forms of citation will vary in accordance with the nature of the data and type of investigation. If you have established means of acknowledgment for various types of data please include them. Other sites will likely learn from the good ones.

## Hardware/Software

(a) Hardware - Sites will list the various types of computer systems available for LTER projects. Tabulation should include a brief description of LTER site hardware (micros, minis, mainframes(?), terminals, printers, disk systems) and the campus mainframe system available. In this latter case you do not need to do an elaborate writeup. For the University of Wisconsin system they will provide a couple of short writeups from their campus computing group. It should be tremendously valuable to those who plan to exchange data through their campus computer facilities. Also indicate (diagram or text) the various computer linkages you have available: cable, telenet, modem (baud rate), etc.

(b) Software - List general types of software used, and specific commercial programs/packages used. If available list software packages you have access to through your campus facility (SPSS, SAS, SIR, etc.) Again, if available, use one of the listings from your computer center.

(c) Data Exchange Media - Describe (or tabulate) the various data exchange media available to you (tape, floppies, calcomp plotter output, color graphics, microfiche, paper, etc.). In the case of tape output indicate what number of tracks, bit density, and whatever other types of special formatting requirements you have.

(d) System Critique - Include any comments you might have about system capabilities that are particularly useful, bad, etc., that you feel would be of use to other site data managers who might have to exchange data with your site via computer.

(e) Applications - Briefly describe computer applications particularly useful to your LTER project that would be of value to the other sites.

## RESEARCH ABSTRACTS

Walt Conley (Jornada site) has volunteered to put on his computer system data set abstracts of the main LTER research projects. Each site needs to send him a one-page abstract of the specific research project and how it relates to the five "core areas" of the original LTER proposal guidelines. It is suggested that the sites use their own abstract form, but that each abstract should include:

- (a) Investigator(s)
- (b) Project title
- (c) Brief descriptive abstract of research
- (d) Key words to describe the research, data types, etc.
- (e) An indication of which of the five core research areas the project addresses.

The core research areas are:

- (1) Primary Production
- (2) Population Dynamics
- (3) Organic Matter
- (4) Nutrients
- (5) Disturbance

Natural

Anthropogenic

Each site will get the abstracts to Walt Conley within six months (May/June 1983). He will see that the abstracts are typed and available on computer file. Each site will be able to utilize the file in either of two ways: (1) requested paper output, or (2) directly through phone modem. (Walt presumably will provide all the sites with the appropriate information for using the file.)

This is a first attempt at preparing LTER data set abstracts. The idea was conceived with the idea of giving all sites the opportunity to become familiar with each other's data and to see what interesting problems or situations presented themselves. (A sort of testing the waters approach.) This will give the researchers a chance to use the LTER data set abstracts information base to determine what is of value and what changes or additions need to be made.

#### USAGE HISTORY LOGS

Sites need to keep usage logs of the LTER data by date, type of data requested, and person(s) who request data. (At present this is a level II recommendation for the sites, although some sites currently have usage history logs set up.)

#### INTERSITE EXCHANGE OF DATA

##### Role of the Database Administrator/Manager

The role of the database manager is principally to facilitate the availability of data used for research at the LTER sites, especially as it relates to core LTER research questions. One of the primary functions of the database manager is to provide access to the LTER dataset, and the systemization and proper documentation of the data help to facilitate the research process. The database manager responds to needs and priorities set by the P.I.'s. As needs arise the database manager also serves to aid in intersite research by assisting with the data exchange process.

For collaborative research at both the intrasite and intersite level the database manager should be directly involved with the researchers to aid in such tasks as setting up proper databases, establishing units of recording of data, helping to design data recording forms that make the raw data to archived data transcription process efficient and accurate, and setting reasonable guidelines for data recording times and updating, etc.

#### Data Request Procedures

The individual sites will each develop guidelines for routing requests for data from the other site investigators. It is not within the authority of the database manager to set policies for the availability of data unless directed by the P.I. responsible for the data collection.

#### ADDITIONAL DATA ADMINISTRATION COMMITTEE RECOMMENDATIONS

We DO recommend that an annual meeting be held of representative database managers from each site. The meetings should be held at one of the sites. We request that the LTER Steering Committee plan accordingly in preparation of the budget for the next Intersite Steering Committee proposal. A draft outline of the next proposed meeting of the LTER data managers, that will be submitted to the Steering Committee in January 1983, is as follows:

The LTER data managers should meet together once annually, preferably at one of the LTER sites, to:

1. Review and evaluate progress toward quality site-specific data management.
2. Conduct the first iteration of work on inventories of data at sites.
3. Continue discussions on the convergence of systems of coordinated database management for intersite exchange.
4. Consider potential projects as might arise from intersite research ideas generated by site P.I.'s.
5. Respond to NSF review of summer 1983 (vis-a-vis data management).

We DO NOT RECOMMEND:

1. Common formats for data among LTER sites.
2. Forcing consistency of database management among sites.
3. Common hardware and software for all sites. (A remarkable convergence on types of hardware and software seems to be taking place among sites as they find out what kinds of database "tools" are available to the other sites.)
4. Common exchange media. "Keep it simple" is the idea. The researchers, the types of data they are collecting, the specifics of the research questions, the size of the data that need to be exchanged, and the willingness and interests of the P.I.'s is what will determine the nature of the exchange process for now.
5. That all sites put ALL data into their respective database systems. Priority needs are for data that are core to LTER research ongoing at the site and are of such a volume that computerized databases are necessary.

#### LTER SITE DATA DOCUMENTATION PROCEDURES

Comprehensive data documentation is necessary within any research institution to insure that scientific procedures can be duplicated and results correctly utilized. Since a primary objective of the LTER program is to synthesize data and develop ecological concepts among sites, there is an even greater need to maintain uniform high quality data documentation procedures at individual sites. As a result, a special work session was convened at the LTER Data Management Workshop to formulate recommendations to be followed at each site. Recommendations emphasized essential and optional documents and procedures. Less emphasis was placed on how the documents (or their elements) should be structured, and no effort was made to standardize documents or procedures based on one system.

#### Data Documentation Objectives

The following objectives were recommended to guide documentation procedures at each site. The objectives could also apply to other data management activities.

1. To maintain the integrity and immediate and long-term

usability of data collected at the site as part of the LTER program.

2. To facilitate the intersite exchange of data and their synthesis into ecosystem concepts applicable among sites.

#### Recommendation Criteria

Several criteria were identified and used to rate the necessity or usefulness of the documents and procedures considered. The criteria were also ranked in order of priority (high to low).

1. Is the procedure (document) necessary to maintain the scientific integrity and usability of the site data?
2. Is the procedure necessary to insure intersite exchange of data?
3. Is the procedure necessary or useful to establish an efficient data management system at the site?
4. How costly is the procedure in terms of dollars needed for salaries, training, hardware, or software?
5. How costly is the procedure in terms of the time required for training and implementation, or the time that would have to be contributed by researchers at the expense of their research?
6. How convenient is the procedure? Are all or most of the sites already complying or planning to develop the procedure regardless of LTER recommendations? Are hardware/software systems (if any) required for the procedure commonly available?

#### DATA DOCUMENTATION DEFINITIONS

The use of uniform definitions for data documentation terms at the LTER sites was considered critical. The following terms were defined specifically for their intended use within the LTER program:

**Data Base Management-** A term that covers a broad range of activities, including construction, documentation, verification, manipulation, and maintenance (particularly long-term storage) of data base elements.

**Data Base-** The available information at each site that is specifically collected and used as part of the LTER program. Each LTER data base

should be composed of at least three elements: a collection of documented data sets, a data set catalog, and a set of supplemental archived material (i.e., maps or museum collections) that is typically not suited for management with data sets.

Data Set- A one- or multi-dimensional, internally uniform array of data or record types that describes selected ecological information.

Documentation- Necessary information about data sets or other archived material. Documentation descriptors for a single data set should describe its origin (i.e., location, investigator, methods) and structure (i.e., variable names, units of measurement, field lengths).

Data Set Catalog- A set of comprehensive and detailed descriptions of the data sets in the data base. The descriptions should be ordered by data set name, subject, or keywords. The function of the catalog is to provide all of the documentation necessary for any data set to be correctly utilized by future researchers who are unfamiliar with it.

Data Set Directory- A subset of the data set catalog that contains information regarding the location of each data set and how it can be accessed. The function of the directory is to tell an investigator where and how to access a data set once he/she has identified it.

Data Set Inventory- A subset of the data set directory which contains the names (or acronyms) of each of the datasets in the data base. The primary function of the inventory is to present a list of the available data sets at each LTER site.

Data Set Index- A list of data set names organized by one or more data descriptors. Commonly used indexes are those that are organized by keywords, variable names, or taxa, or by collection period, location, or method. The function of an index is to identify one or more data sets that share selected characteristics.

#### LTER SITE DATA DOCUMENTS AND PROCEDURES

Each LTER site should develop, maintain, and regularly update three key documents: a data set catalog, a data set directory, and a data set inventory. Figure 1 illustrates how the inventory is a subset of the directory, which in turn is a subset of the catalog. The essential and optional data descriptors that should be included in these documents are outlined in Table 1.

Data set indexes should also be developed, but these present additional problems. Their use is more dependent on the sophistication of the data management system at a site than is the use

of the documents recommended above. In addition, their use among sites must be preceded by the development of a uniform set of keywords (see Other Data Documentation Recommendations section). As a result, data set indexes are presently considered optional LTER site data documents.

The three documents recommended above should facilitate the exploration of a site's data sets by a non-resident scientist in addition to the actual exchange of data. A typical exchange should start with the non-resident scientist requesting a copy of the data set inventory and directory from the data manager at the site of interest (with copies of all correspondence going to principal investigators at both sites). Using these two documents, the researcher could identify the data sets of interest to him and determine how to access them. He could then request the complete data set descriptions from the data set catalog at then site. If then data appeared appropriate, he could then request a complete copy of the data set .

#### IMPLEMENTATION OF DATA DOCUMENTATION

Figure 2 shows how the LTER site data documents should be developed through time. Since the sites are presently at different stages in this process, no absolute time periods could be placed on the vertical scale. The LTER Steering Committee, however, should review the site data management reports now in preparation and determine uniform deadlines by which all sites will reach the first three stages identified in Figure 2.

Stage 1 is marked by the completion of the site data inventory for all current and historical data sets that will specifically be used in the LTER program. Stage 2 is marked by the completion of the site directories and data set descriptions for all current data sets and selected historical data sets. This will, in effect, complete the site data set catalog. However, any use of the catalog will be limited until it can be conveniently searched using index terms. Stage 3 therefore combines the site catalog with the development of uniform index terms that have been generated through combined efforts of all researchers at the site and preferably among sites. The use of index terms will also be linked to the sophistication of the data management system used at the site. A high degree of computerization will probably be required. As a result, Stage 4 will conclude with the establishment of a searchable computerized site data catalog.

## OTHER DATA DOCUMENTATION RECOMMENDATIONS

While the LTER sites develop the data documents described above, efforts should also be made to develop an intersite thesaurus of index terms that can be used to search all LTER data bases. As a preliminary step, an exchange of keyword lists now in use at the individual sites is suggested. In order to facilitate the eventual exchange of data, network type hardware and software systems should be explored. These may include standard hardware devices that could be purchased for all sites, and networking systems that are already in place and provided by outside businesses.

Table 1. Essential and optional data descriptors to be included in LTER site data documents.

LTER site data document	(E)ssential or (O)ptional	Descriptor	No.	Comments
Data set inventory	E	Data set title	1	Titles should identify the unique characteristics of the data set but be as brief as possible
	O	Data set code	2	A code or acronym used to symbolize the data set for organizational purposes
*****				
Data set directory	E	Descrptrs. 1-2		Descriptors 1-2 above are both essential items in the directory
	E	Contact person	3	The individual at the site that is most familiar with the data set and the research project that generated it
	E	Security restrictions	4	An indicator of any access limitations to the data set
	E	Data file names	5	Necessary if the data set is subdivided into files
	E	Data file content description	6	A brief description of the differences between the files
	E	Data storage location	7	Physical location of the data set
	E	Data storage medium	8	Disk, tape, hardcopy, field data sheets?
	O	Data type	9	Raw, transformed, condensed, extracted from literature, derived?
	O	Size/length	10	Total records, characters per record, fields per record
	O	Entry verification	11	An indicator of the level of verification and error checking followed during data entry

Table 1. Continued.

LTFR site data document	(E)ssential or (O)ptional	Descriptor	No.	Comments
Data set directory (cont'd.)	0	Data set status	12	An indicator of whether data will be added to the data set in the future
	0	Latest update	13	
	0	Latest archive date	14	
	0	Documenta- tion status	15	An indication of the completeness of the documentation for the data set
*****				
Data set catalog	E	Descriptrs. 1-15		Descriptors 1-15 above should be essential in the data set catalog
Physical structure descriptors				
	E	Variable names	16	The full written variable names as they would be described in a publication (i.e., ash-free dry weight)
	E	Variable codes	17	Variable abbreviations used in or with the data set (i.e., AFDW).
	E	Columns	18	The columns in which the data values occur in the record (fixed-field format)
	E	Variable number	19	A number representing the order of the variable in the record (free-field format)
	E	Variable format	20	Numeric, alphanumeric, decimal places?
	E	Units of measurement	21	
	E	Missing data	22	Blanks, -9.0's, system defaults?

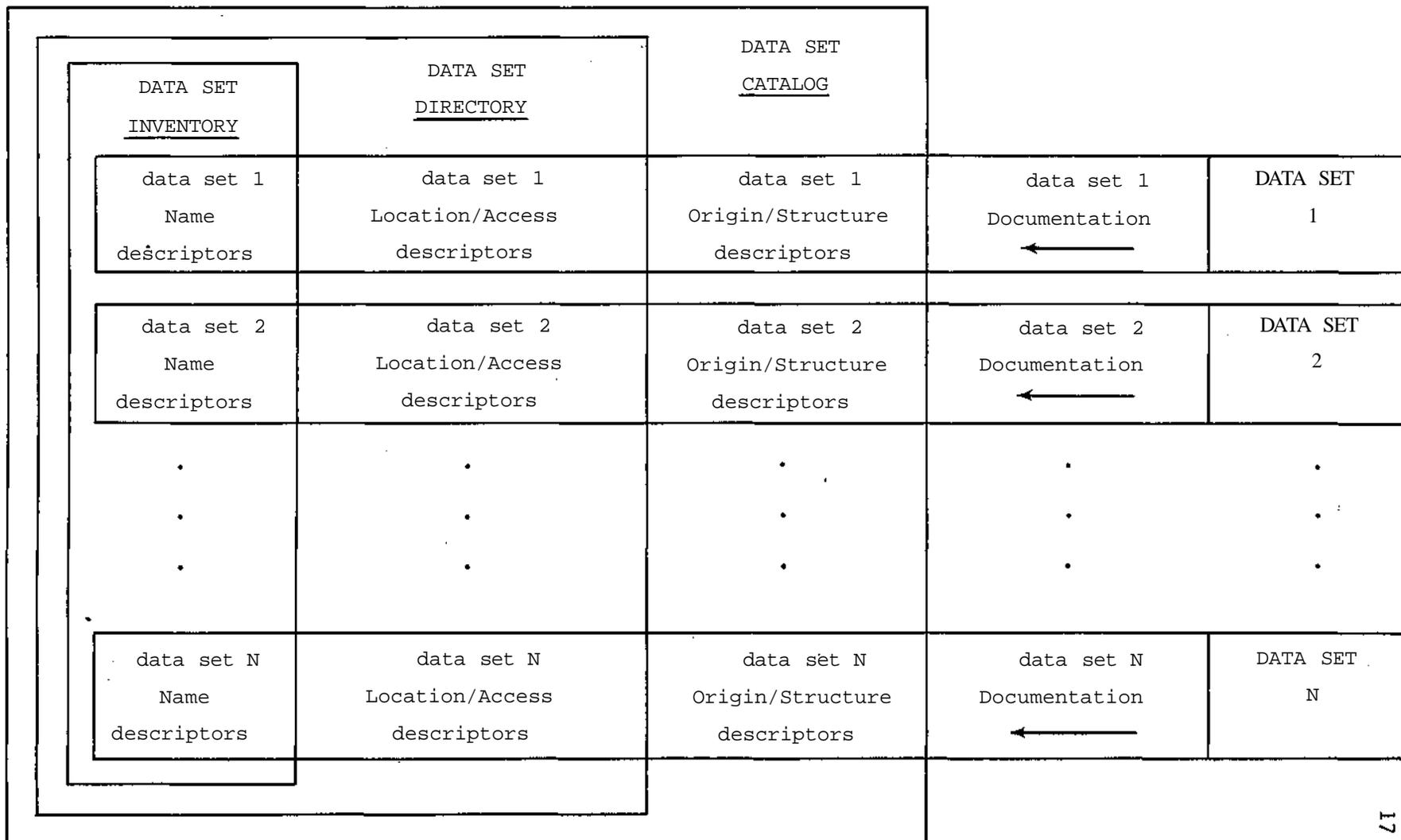
Table 1. Continued.

LTERR site data document	(E)ssential or (O)ptional	Descriptor	No.	Comments
Data set catalog (cont'd.)	E	Coded variable indicator	23	A symbol that indicates if a code has been used in assigning variable values
	E	Variable code definitions	24	
	E	Data anomalies	25	A description of any factor that may have resulted in non-uniform data values(beyond those considered in the research design). This descriptor is particularly necessary for potential future hypothesis testing beyond the scope of the original research.
	0	Measurement precision	26	
	0	Rounding-off standards	27	
	0	Sorting hierarchy in the data set	28	
	0	Relational key indicator	29	Specification of the combination of columns or variable values which uniquely identify each row of data
Research origin descriptors				
	E	Data collection period	30	
	E	Research site location	31	

Table 1. Concluded.

LTERR site data document	(E)ssential or (O)ptional	Descriptor	No.	Comments
	E	Principal investigator	32	
	E	Study purpose (summary)	33	
Data set catalog (cont'd.)	E	Site character (summary)	34	A description of key features of a site controlled or selected to accommodate study goals
	E	Experimental design (summary)	35	
	E	Research methods (summary)	36	
	0	Assoc iated researchers	37	
	0	Related supplemental materials	38	Available materials which may be valuable to persons who seek to utilize or review the data set
	0	Related computer programs	39	
	0	Data set index terms	40	Keywords, selected variables, taxa, community or habitat types, location, etc.

Figure 1. Organization of LTER site data documents. Each site should maintain a data set inventory, directory and catalog. The inventory and directory are subsets of the catalog.



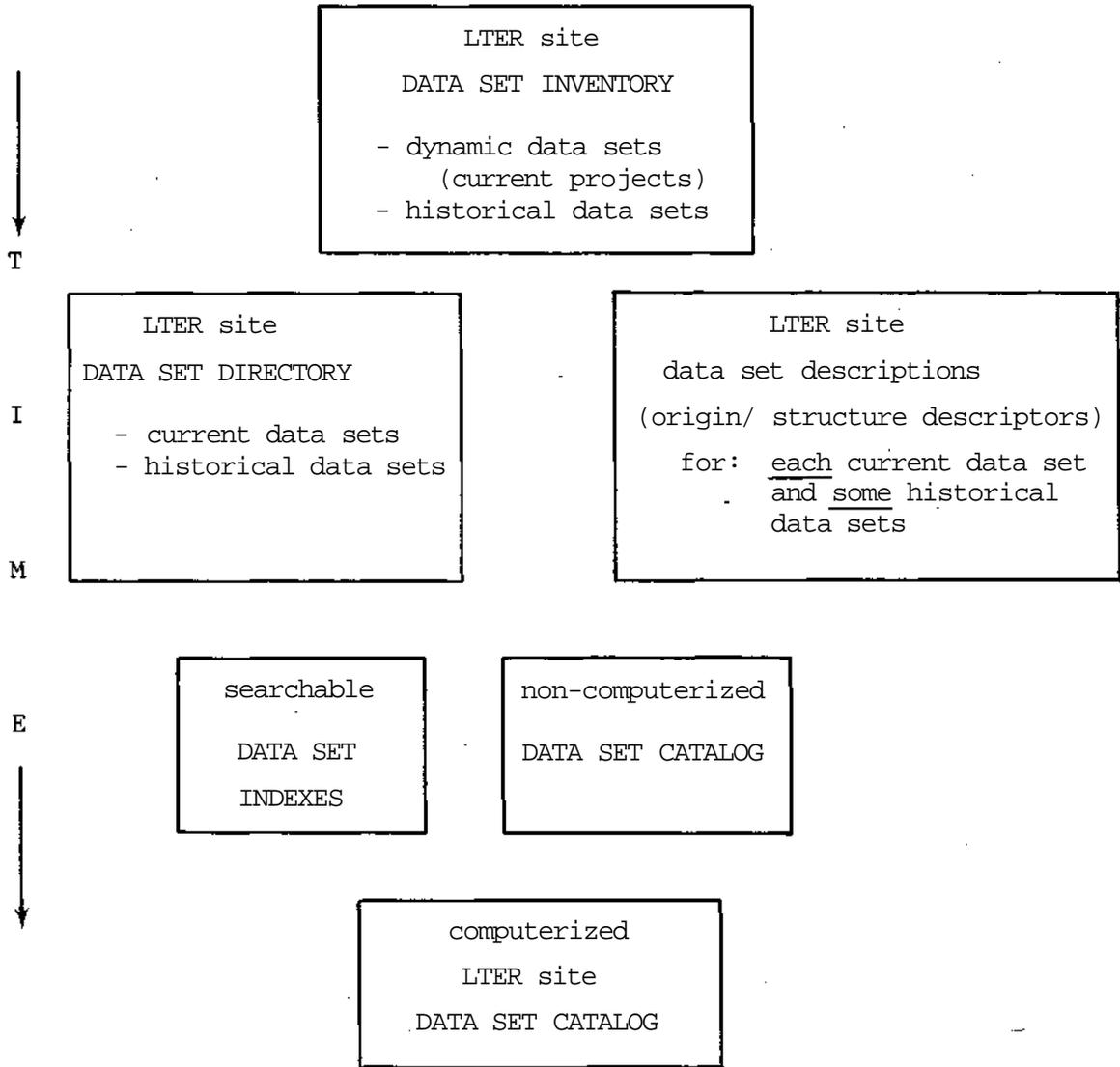


Figure 2. Recommended implementation plan for LTER site data documents.

APPENDICES

Data Management Workshop Roster  
November 22-23, 1982

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Data Management Workshop Roster  
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Data Management Workshop Roster  
November 22-23, 1982

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- (2) Chairman of the Data Documentation Committee
- (3) Member of the Data Documentation Committee
- (4) member of the Data Administration Committee
- (5) Workshop Chairman and Report Editor

Sources of Information  
on Data Management

National Handbook of Recommended Methods for Water-Data Acquisition

Contact: Porter E. Ward, Chief  
Office of Water Data Coordination  
United State Department of the Interior  
U. S. Geological Survey  
Mail Stop 417  
Reston, Va. 22092  
Tele. (703) 860-6931

U. S. Environmental Protection Agency STORET Water Quality  
Parameter Codes Listings (numeric and alphabetic)

Contact: Stuart C. Ross, ADP Systems coordinator  
USEPA Region V  
230 South Dearborn Street  
Chicago, Illinois 60604  
Tele. (312) 353-0299

The Production and Distribution of Knowledge in the  
United States

Author: Fritz Machlup  
Princeton University Press  
1962 - 416 pages

Environmental Data Management

Authors: Carl H. Oppenheimer, Dorothy Oppenheimer,  
and William B. Brogden  
Plenum Press - New York and London  
1976 - 244 pages

HISARS - Hydrologic Information Storage and Retrieval System

Contact: Edward H. Wiser  
Professor of Biological and Agricultural Engineering  
North Carolina State University  
Box 5905  
Raleigh, North Carolina 27650  
Tele. (919) 737-3121

Sources of Information  
on Data Management

NAWDEX - National Water Data Exchange

Contact: Program Office  
U. S. Geological Survey  
421 National Center  
Reston, VA. 22092  
Tele. (703) 860-6031  
      FTS 928-6031

Strategic Data Planning Methodologies

Author: James Martin  
Prentice-Hall, Inc.  
Englewood Cliffs , New Jersey 07632  
1982

SIR - Scientific Information Retrieval

User's manual (Version 2)  
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Data Dictionaries and Data Administration

Author: Ronald G. Ross  
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135 West 50th Street, New York, N.Y. 10020  
1981 - 454 pages

BIO-STORET (Biological Data Management System)

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