Report of
Research Workshop
26-28 Jan 1999
Vicksburg, MS

Ecosystem Characterization and Monitoring Initiative (ECMI)

Strategic Environmental Research and Development Program Ecosystem Management Project (SEMP)

US Army Engineer Research and Development Center

Environmental Laboratory, Vicksburg, MS

Construction Engineering Research Laboratory, Champaign, IL

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INTRODUCTION

The objective of the SERDP Ecosystem Management Project (SEMP), Ecosystem Characterization and Monitoring Initiative (ECMI) is to design a baseline ecosystem monitoring program suited to defense installations in the southeastern United States (U.S.) and demonstrate this program at Fort Benning, GA. As part of the design process, a series of workshops have been conducted to solicit input from several interest groups regarding the types of data to be included in the monitoring program. The five primary interest groups included in the design process are: 1) military land managers and trainers, 2) research scientists and academicians, 3) ecosystem model developers, 4) currently funded SEMP ecosystem work units, and 5) other established long-term monitoring programs.

Input from the military land managers and trainers was acquired in a meeting with Fort Benning staff on 11-12 January 1999 that identified information requirements to support installation natural resource management and environmental conservation goals. Results of that workshop were reported in a document dated 5 February 1999 (USAERDC 1999).

This report documents the second in the series of workshops, held 26-28 January 1999 at the Waterways Experiment Station, Vicksburg, MS. This workshop involved selected members of the research and academic communities conducting environmental research, the SEMP researchers, and staff from Fort Benning. Participants in the workshop included representatives from five laboratories in the U.S. Army Engineer Research and Development Center: Coastal and Hydraulics, Construction Engineering Research, Cold Regions Research and Engineering, Environmental, and Geotechnical; the University of Florida; the Fort Benning Directorate of Public Works, Environmental Management Division; and the Directorate of Operations and Training, Range Division. Appendix A lists the workshop participants and includes a photograph. Appendix B is the agenda for the workshop.

This document was prepared as a compilation of notes from the workshop for further use. Additional analysis of input from all sources is occurring.

WORKSHOP ORGANIZATION

This workshop was structured to accomplish five objectives:

- Develop a complete and highly relevant list and definition of ecological processes to meet ECMI objectives.
- Provide a rationale to explain the selection of the above processes.
- Develop a complete and highly relevant list and definition of variables that will describe the above processes.
- Provide a rationale to explain the selection of the above variables.
- Provide recommendations on stratifying the installation for measurement.

The meeting was organized around five elemental and key ecosystem sectors: soil and sediments, water, aquatic biota, terrestrial biota, and landscapes. Meeting participants were selected based on their expertise in at least one of these key ecosystem sectors and assigned to a sector (Table A2). While recognizing the interrelated nature of all sectors, we began with the individual ecosystem components to assure coverage of the basic elements.

The Process

The workshop was divided into six main parts. First, participants were given an overview of the ECMI and natural resources at Fort Benning. Second, five breakout groups corresponding to ecosystem sectors were tasked with identifying ecosystem processes relevant to the ECMI. These were reported to the group at large. Third, participants went back into breakouts and were tasked to identify and define variables associated with processes identified in the first breakout session. Fourth, after session reports in plenary, participants discussed and refined a list of 21 candidate selection criteria as identified by ECMI staff, to guide final selection of variables. The refined list of 19 was voted on by participants, who were given five colored dots to place by the criteria they believed most important to the ECMI.

The fifth part of the workshop occurred in sector breakouts, at which time the previously identified variables were ranked against the four highest priority selection criteria as identified by votes (the high priority selection criteria were; ability to detect changes or relationships; relevance to training and land management; cost effectiveness; potential for multiple uses). Finally, in plenary discussions the last day, participants provided additional insights on other aspects of implementing the monitoring program. Topics included themes and assumptions of ECMI, stratification, reference conditions, stewardship and sustainability, and monitoring infrastructure.

General Results

Table 1 shows a gross summary of categories of variables that each sector identified as important. One cannot read too much into the table, especially where the cell is empty, because the breakout groups all worked somewhat differently. For example, the soil sector recognized the role of vegetation in soil-forming processes and in erosion control, but left vegetation for the other sectors such as terrestrial biota to address. Even so, one can see a large amount of similarity among sectors and the breadth of factors that must be considered in design of the ECMI.

A list of variables for each sector and associated rankings are provided as Table 2. The list and voting results for selection criteria are shown in Table 3. Points from the discussion of other aspects of ECMI are recorded in Table 4.

WORKSHOP RESULTS

Most of the time was spent on deliberations by breakout groups to identify ecological processes and potential monitoring variables associated with each ecosystem sector. This section provides a brief summary of the key findings of each ecosystem sector group, to be considered in combination with Table 2.

Soils. The soils group began by redefining the scope of their activities to include five aspects of earth science; soils, sediments, geomorphology, geology, and topography, with topography being defined as a result of geomorphology. While the characterization of geology and topography is an important component of the ECMI, the group recommended that monitoring not consider geology and topography.

The group then developed a framework for thinking about the monitoring program. Humans define **characteristics or conditions**, which support **ecological functions or processes.** Mindful of those processes, we plan and conduct **ecosystem management**, which is intended to result in **sustainable land use**. One useful distinction is that conditions (e.g., major landform) will not change during the time frame of our program, processes (e.g., erosion) will exhibit changes.

Thoughts on earth sciences functions are below:

Soil ecological functions:	*Sediment ecological functions:*
1. Direct support to training Physical condition and safety Mobility and trafficability Training realism 2. Water source and sink Storage Transport Helps determine quality Quantity 3. Nutrient source and sink Storage Transformations Nutrient production Transportation 4. Habitat for flora and fauna Quality Quantity	1. Direct support to training Characteristics of streambeds e.g., crossings 2. Water Quantity Quality (facilitates contaminant transport) (suspended or unsuspended condition) 3. Nutrient source and sink Storage Transformations Nutrient production Transportation 4. Habitat for flora and fauna Quality Quantity

Soil Geochemical Processes:	Geomorphology, considered as soils and sediments in the landscape:
1. Erosion/detachment wind water mass movement biologic 2. Transport/entrainment wind water mass movement biologic 3. Deposition wind water mass movement biologic 4. Weathering physical chemical	1. Direct support for training OCOKA (observation, cover and concealment, obstacles, key terrain, and avenues of approach) Maintenance of land base Training realism 2. Production or determination of landforms, at 2 scales: ecotones, drainages, drainage patterns, habitat soil pedogenesis

Water. This group organized water processes and parameters associated with precipitation, evapotranspiration, soil-water dynamics, streamflow, groundwater, lakes, wetlands, sediment transport, and biogeochemical processes. Within each category they described why the topic was important, i.e., by what it "controls". In addition the group identified the roles and impacts of each water process on other ecosystem processes and installation training and land management functions. Of additional value was presentation of water-related variables by topics of meteorology, vegetation, soil-water dynamics, streamflow, groundwater, water bodies, and erosion/sediment transport, with comments on space and time.

Other comments were that watersheds are the traditional breakout of water studies, and that it is necessary to consider all scales from landscape to a single plant. Water-related processes are most closely linked to aquatic biota, but critical in all other sectors as well; "The River Runs Through It."

Aquatic Biota. This group began with the premise that in-stream aquatic biota indicate the cumulative effects of land use and management practices in the watershed. The group identified five assumptions on which further deliberations were based:

a) longitudinal stream gradations are important in variables
b) order 6 streams make a lateral contribution to productivity/respiration ratios
c) zonation occurs in terms of stream hydraulics, substrate, and slope

d) sediment input is the main stressor; others include bank destabilization, turbidity, and bank erosion
e) environmental improvements result in faunal recolonization and recovery.

The group assumed that an installation management goal would include some form of aquatic biotic diversity (i.e., number, abundance, and type of species in relation to their environment). Type of species could include functional feeding groups, guilds, and special species such as exotic, threatened and endangered, and indicator.

The importance of aquatic biota as linked with physical, chemical, and biological processes was emphasized in the selection of key processes affecting aquatic resources. Three processes were identified:

organic matter dynamics,
sediment dynamics, and
nutrient dynamics.

These processes were selected because of their effects on food webs, habitat quality, and primary producers. Organic and nutrient dynamics should be characterized in terms of source, processing, and transport dynamics. Sediment dynamics should be characterized in terms of input, and retention and transport of inorganic sediments. The group recommended that aquatic biotic diversity be monitored in the context of the state of these three processes. The three most important categories of biotic variables identified were fish collections, substrate organic content, and macro-invertebrate collections. The three most important categories of abiotic variables were water quality, stream gauge stations, and stream crossectional profiles.

Terrestrial Biota. This group initially identified 48 "processes" potentially associated with terrestrial biota at Fort Benning, such as predator-prey relationship, fecundity, dispersal, and vocalization. Next, broad categories of processes were identified which were particularly relevant to research and management associated with ECMI. Specific processes were selected that were considered as "minimum requirements" for which variables should be identified and monitored. Eight processes including succession, productivity, energy flow, nutrient cycling and dynamics, biological interactions, and pathogens were associated with disturbance regimes. For each item it was recommended that measures be made of amplitude, frequency, duration, and timing (seasonality). In addition, measures of the distribution and abundance of flora and fauna were recommended. The following variables were identified as the highest priority among each variable category evaluated:

Vegetation floristics and physiognomy (cover at all levels)
Vegetation productivity (physical damage, growth rate)
Distribution and abundance of species and plants
Fauna as species occurrence, distribution, and abundance
Vegetation and faunal historical data

Landscape. This group deliberated on a variety of issues and identified processes addressed by other groups. However, the processes were described at the landscape scale. Two major landscape processes were erosion, with sediment deposition and transport mechanisms, and disturbance patterns; of concern is their effect on the distribution of plants and animals. Erosion processes have landscape, watershed, and field scale components; natural recovery processes in soil and vegetation occur at the field scale.

One possible organizing principle is the source of processes, whether natural or cultural (human). However, they should be considered together, so perhaps a better way of organization is by management objectives.

Part of the planning for monitoring must be defining the extent and scale of each process, then the specifications for each variable. One set of breakouts includes:

watersheds vegetation communities migration and movements of animals land use categories	geology and soils pollutants, contaminants, and nutrient flows natural disasters

The group agreed that the region considered in the ECMI should be defined in terms of the extent to which the installation influences the surrounding region in political, economic, and environmental terms. Both landscape level natural and cultural processes were identified and divided into four categories; physical, chemical, biological, and landscape pattern development. The group identified 42 individual landscape scale variables or categories of variables that could be potentially monitored under the ECMI.

Precipitation and water quality were identified as most important in characterizing water erosion processes. Precipitation and stream flow were identified as most important to characterize hydrologic processes. Hardwood understory and temperature were identified as being key to describing fire processes. Water quality and soil-related variables were identified as most important in characterizing nutrient cycling processes.

Eleven additional biological and landscape pattern development processes were ranked according to their relative importance to the ECMI. Secondary vegetative succession, military training, stewardship, and animal population dynamics were identified as the most important additional landscape processes to consider in the monitoring program.

SUMMARY AND FOLLOW-UP

This report captures the results of the second in a set of five interest groups being included in the design of the ECMI baseline ecosystem monitoring program. The workshop documented here provided a comprehensive view of information needed to understand and monitor fundamental ecosystem processes and properties.

As expected, the extent of needed information is much more than resources will allow. Two challenges for the ECMI are to build a design that (1) balances what we want with what we can obtain, and (2) can be adapted as data become available from SEMP focused research, Fort Benning activities, and analysis of ECMI outputs. The next document will provide the selection of variables, their rationale for inclusion, and their spatial and temporal scale of measurement for implementation of characterization and monitoring at Fort Benning.

LITERATURE CITED

U.S. Army Engineer Research and Development Center. 1999. SERDP Ecosystem Management Project, Ecosystem Characterization and Monitoring Initiative: Report of Land Managers and Trainers Workshop, 11-12 Jan 1999, Fort Benning, Ga. Environmental Laboratory, USAERDC Waterways Experiment Station, Vicksburg, MS.

Table 1. Category of Variable Identified by Each Sector, and Sector Defined

Category of Variable	Sector				
	Soil	Water	Aquatic Biota	Terrestrial Biota	Landscape
Landform	x	x	x		x
Soil structure	x	x			x
Soil-water relationships	x	x	x		x
Sediment transport	x	x			x
Streamflow, channel morphology		x	x		x
Water quality	x	x	x		
Litter, debris		x	x		
Microbial action	x		x	x	
Vegetation		x	x	x	x
Nutrients	x	x	x		x
Fauna			x	x	x

SOIL — Soil, sediments, geology, topography, geomorphology; all systems; physical, chemical, and biological elements

WATER — Surface and ground water; collection, storage, discharge; all systems; physical, chemical, and biological elements

BIOTA — Plants and animals. Growth, reproduction, maintenance; fitness. Include wetland flora and fauna. Levels from genetic or individual to species to populations to communities

LANDSCAPE — Plants and animals and interactions with the land; spatial arrangement of components; connections; all systems. Community to ecosystem levels of organization, including metapopulations

Table 2. Variables Identified by Each Sector for Monitoring at Fort Benning and Their Weighted Rank Using the Top Four Variable Selection Criteria.

Soils Sector	Weighted Rank
SOILS	
Standard Agricultural Soil Test Package	1
Soil Hydraulic Properties	3
Horizon Characteristics	5
Soil Gases	4
Soil Biology/Microbiology	2
SEDIMENTS	
Sediment Mass Transport	1
Physical Characteristics	5
Chemical Measurements	4
Nutrients	2
Biological	3
GEOMORPHOLOGY	
Hydraulic Geometry (Channel)	1
Floodplain Parameters	2
Upland	3

Water Sector	Weighted Rank
STREAM FLOW	**2**
hydrograph	
cross sectional area	
Q = discharge	
baseflow	
peak discharge	
OTHER IMPACTS	**1**
out take	
temperature	
oxygen	
TSS/TDS	
alkalinity	
chlorophyll / biomass	
light penetration	
THM precursors	
contaminants	
discharge	
velocities	
scouring	
structures	
aspect/slope topography	
stream, lake & wetland morphology	
suspended load	
grain size characteristics	
bed load	
load-sediment balance	
carrying capacity	
rainfall	
soil type	
training	
micro-hydraulic parameters	
soil moisture	
organic content	
bulk density	
porosity	
texture	
permeability/infiltration rate	
hydro conductivity	
depth to water table	
landscape features	
topographs and Digital Elevation Models	
canopy interception	
canopy density and land cover	
stem flow	
subcanopy meteorological variables	
litter layer characteristics	
depth	
fetch/area	
landscape position	
sediment characteristics	
inflow/outflow discharge	
management processes e.g., dredging	
recharge	
from vados zones	
from streams	
discharge to streams	
pieziometer Head mapped	

Water Sector	Weighted Rank
permeability	
porosity	
transmissivity	
geology	
boundary conditions	
rainfall	
humidity	
wind speed	
wind direction	
barometric pressure	
back radiation insolation	

Aquatic Biota Sector	Weighted Rank
BIOTIC	
PRIMARY PRODUCERS	
Riparian Plant Cover	4
Substrate Organic Content	2
Algae	5
P/R ratio	7
MACRO-INVERTEBRATE COLLECTIONS	**3**
FISH COLLECTIONS	**1**
DECOMPOSERS	**6**
Leaf Litter Decomposition Rate (bag)	
ABIOTIC	
STREAM CROSS SECTIONAL PROFILES	**3**
STRUCTURAL	**4**
Land Use Classes	
Substrate	
Log/debris	
WATER QUALITY	**1**
Hydrolab Package	
Turbidity	
Total Suspended Solids and Organics	
STREAM GAUGE STATIONS	**2**

Terrestrial Biota Sector	Weighted Rank
VEGETATION	
FLORISTICS	
Species Composition	1
Genetics	2
PHYSIOGNOMY	
Cover (all levels)	1
Biomass (leaf/root)	5
Diameter (diameter breast height)	4
Number of individuals	2
Abundance	3
PRODUCTIVITY	
Presence/absence of disease	2
Photosynthetic rate	8
Respiration	7
Leaf area index	3
Normalized Difference Vegetation Index	6
Biomass	5
Physical damage	1
Growth rate	4
DISTRIBUTION	
Presence/absence spatially	1
Contagion/connectivity (patterns)	2
HISTORICAL DATA	
all above (pre-Army/pre-settlement)	1
FAUNA	
SPECIES COMPOSITION	
Spatially/Temporally	1
Relative Abundance	2
DEMOGRAPHICS	
age class	2
sex ratios	3
age specific fecundity	4
age specific survivorship	5
population density	1
HISTORICAL	
MICROBIAL	
Biomass	2
Functional Diversity	1

Landscape Sector	Weighted Rank
PHYSICAL PROCESSES	
WATER EROSION	
Vegetation Cover	1
Precipitation	2
Slope (1 Time)	6
Soil Type	5
Turbidity	4
Water Quality	3
Soil Depth	7
WIND EROSION (Not important)	
HYDROLOGY	
Precipitation	2
Stream Flow	4
Soil Moisture	5
Wetland Vegetation Species	3
Changes In Land Use	1
FIRE	
Temperature	2
Wind Speed	1
Humidity	3
Fuel Load (Connectivity)	6
Precipitation	2
Topography/Fire Breaks (1 Time)	5
Hardwood Understory	7
Patchiness of Controlled Burns	8
SOIL FORMATION (SAME AS WATER EROSION)	
WEATHER	
Temperature	1
Precipitation	2
Climate Variables, Typical Weather Station	4
Damage From Catastrophic Events	3
CHEMICAL PROCESSES	
NUTRIENT CYCLING	
Water Quality	1
Soil and Plant N, C, & P	3
Air Quality	2
BIOLOGICAL PROCESSES	
SECONDARY SUCCESSION Vegetation map, updated regularly	**1**
Structure	
Composition	
Productivity	
ANIMAL POPULATION DYNAMICS	**4**
Map Observations - Spatial Tag	
PESTS	**5**
Distribution	
LANDSCAPE ALTERATION PROCESSES	
TRAINING	**2**
Type, Location, Duration, Frequency & Timing	
COMMODITY SALES	**10**
Timber Harvesting	
Recreational Land Use	
Agricultural Outleasing	
STEWARDSHIP	**3**
Map Management Activities	
ROADS & TRAILS	**7**
Map Changes In Roads/Trails and Drainage Patterns	
INFRASTRUCTURE	**9**
Map Changes In Ranges, Facilities & Utilities	
POLITICAL/LEGAL CONSIDERATIONS	**6**
Map Constraints That Can Be Reflected Spatially	
SOCIAL & ECONOMIC ISSUES	**8**
Map Constraints That Can Be Reflected Spatially	
SPATIAL PATTERN OF LANDSCAPE FEATURES	**11**
Landscape Metrics	

Table 3. Candidate Criteria for Selecting Variables for ECMI

1. Ability to detect change & relationships	Sufficiently sensitive to register a change in the subject, but robust enough to not show false change or to emphasize short-term variability
2. Accuracy can be attained	Desired accuracy can be specified and reached, to match measurement limitations
3. Amenable to measurement by instrumentation	Can be measured with sufficient accuracy and precision using instruments installed and left in place
4. Amenable to measurement by remote sensing	Can be measured with sufficient accuracy and precision using satellites, aerial photographs, or other air-borne sensors
5. Availability of prior data	Complements or expands existing LCTA and other data collected at Fort Benning
6. Comparable to other monitoring programs	Parameters are similar to those in use in other long-term monitoring programs across the country
7. Cost effective	An acceptable amount of information is produced, in relation to the cost in dollars and time spent in collecting the information
8. Explainable	Rationale for measurement can be articulated and explained to decision-makers or people unfamiliar with Fort Benning
9. Flexible	Able to accommodate new techniques of measurement or analysis and not lose old information
10. Hierarchical	Some form of the variable can be collected, aggregated, or disaggregated within a hierarchy of scales or organization levels
11. Logistics of data collection	Data are relatively easy and quick to collect. Data collection without disturbing ongoing activities at Fort Benning is a given.
12. Part of an aggregation	Must be combined with other data to allow maximum use, e.g., site classification using landform, soil, and vegetation; Index of Biotic Integrity
13. Precision can be attained	Desired precision can be specified and reached, to match measurement limitations
14. Process- or function-related	If this variable is appropriately measured, then perhaps combined with other variables, the process or function will be described
15. Multiple uses	Variable has wide applicability, or can be used for multiple purposes

(Continued)

Table 3 (Concluded)	
16. Relevant to current or future models	Variable is contained within models currently in use or under development; models used in land management or training activities
17. Relevant to both training and land management	Data will be used directly for concerns of both training and land management, e.g., sustaining adequate vegetation and soil cover on training areas, maintaining training realism
18. Repeatable	Results of measurement are consistent over time or over space with the same or with different observers
19. Single indicator	Direct and only measure required. Need not be combined with other measures to answer the question

Criteria	Landscapes	Water	Terrestrial Biota	Aquatic Biota	Soils	TOTAL	GIVEN*
1.	2	1	4	7	4	**18**	
2.							**5**
3.		1	1			**2**	
4.	1	1				**2**	
5.	1					**1**	
6.			3	1		**4**	
7.	3	1	3	1	5	**13**	**1**
8.			2	2	2	**6**	**3**
9.						**0**	
10.	2		1	1	1	**5**	
11.	1		1		1	**3**	**3**
12.						**0**	
13.							**3**
14.			3	1	2	**6**	**5**
15.	3	1	1	3	1	**9**	
16.	1		1		3	**5**	
17.	5		3	3	4	**15**	**2**
18.	1		2	1	1	**5**	**2**
19.					1	**1**	

*In addition to placing dots, participants could write a “G” indicating that a criterion was given, or assumed.

Table 4. Thursday Morning's Discussion

Themes and Assumptions for ECMI

1. Everything is connected to everything else.
2. Water goes downhill (e.g., see Aquatic Biota sector notes on longitudinal gradients and zonation; stabilize uplands first in land rehabilitation).
3. Vegetation often indicates cumulative effects of management.
4. Military land use activities are compatible with land stewardship. An important corollary is that sustainment of military training is contingent upon land stewardship.
5. We will be able to identify a smaller number of variables to measure, in future years.
6. Cause and effect. The following was submitted: "Information accumulated through SEMP and ECMI will elucidate critical ecological cause and effect relationships as a basis for enhancing efficiency and effectiveness of stewardship, in support of the military mission and environmental conservation goals". Reactions to that sentence were that the statement of cause and effect is too strong, that cause and effect is just one component, and that the perspective of "enabling" or "facilitating" statements of critical ecological cause and effect relationships is more appropriate.
7. Basic environmental information is essential to land use decisions and to research initiatives and results. A written comment: Integrate ECMI results into the decision - making process for training and stewardship at Fort Benning.
8. Look at possible linear relationship - environmental information (e.g., ECMI) ➜ research (e.g., SEMP) ➜ natural resource management (e.g., Fort Benning land stewardship) ➜ training (highest user).
9. ECMI should provide a knowledge base to understand dynamics.
10. Supply Fort Benning with full technical transfer. This means how to use and how to interpret technologies, tools, analyses, and mechanisms.

What is Good Stewardship?

1. Sustainability (of resources).
2. Sustain current conditions, or restore to previous conditions.
3. Goal - oriented (sustain what levels, or restore to what point?)
4. Include practices that contain or limit impacts.
5. Thresholds are implicit (e.g., rate and trajectory of soil loss).

(Continued)

Table 4 (Continued)

Stratification

1. What can be used?
   a. Watersheds
   b. Soil type (e.g., erodibility)
   c. Physiographic provinces
   d. Vegetation type
   e. Training areas
   f. Training type/intensity (e.g., high, light)
   g. Land use (e.g., managed vs unmanaged forestry)
   h. Forestry
   i. Landscape position (e.g., floodplain, upland)
   j. Aspect
   k. Wildlife, or habitat (e.g., tortoise)
   l. Carrying capacity
   m. Ecogroup (The Nature Conservancy)

      Ecological groups are either terrestrial or aquatic ecological systems that represent a combination of broad mappable vegetation types, aquatic ecosystem characteristics, or specific environmental settings and ecoregions. They are aggregations of community types that tend to occur in similar environmental settings at the same scales and have similar dynamic processes associated with them. They encompass community types that may be exposed to similar threats and have similar management needs. Source: John Hall, Conservation Planner, The Nature Conservancy, Fort Benning, 4 Feb 99.
2. Questions to ask -
   a. What is the smallest level we can get?
   b. How to deal with changes over time?
3. Why do we stratify -
   a. Summarize for decision - makers
   b. Extrapolate
   c. Identify homogeneity
   d. Organizing units
4. Major points:
   a. Consider strata changes over time
   b. Stratify by structure vs function
   c. What is projected (year 2018) land use, so we can maximize future use of data (e.g., where will training areas be, what agronomic practices will be in place)
   d. Make sure strata will aggregate
   e. Look at LCTA allocations
   f. Watersheds do nest and allow hierarchical analysis

(Continued)

Table 4 (Concluded)

Reference conditions

1. Points to consider:
    a. Depends on strata (scale)
    b. Specific to objectives
    c. Specific to variables
    d. Look at relative rate of change
    e. Treatment effects
2. Types:
    a. Historic
    b. Regional
    c. Fort Benning - specific scenarios e.g., commercial vs installation forestry; with or without military activities

Monitoring Infrastructure

The most basic information needed to conduct the ECMI was characterized by 12 items from the 5 sectors:

1. Meteorology
2. Stream gauge stations
3. Topographic survey
4. Soil survey
5. Location grid
6. Watershed nomenclature
7. Training information
8. Geology
9. History, 1826 forward
10. Land use, e.g., water and land cover
11. Imagery
12. Maps and database structures

Other Comments

1. What is analysis level of ECMI?
2. Quality control, i.e., error propagation of raw data, errors in storage.

APPENDIX A

Table A1. Research Workshop Participants

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Trame, Ann-Marie	CERL-LL-N	800-872-2375 ext. 5498 217-373-4570	P.O. Box 9005 Champaign, IL 61826- 9005	a-trame@ cecer.army.mil	Ms.
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Table A2. Research Workshop Participants by Sector for Breakout Groups

SECTOR	SOILS	WATER	AQUATIC BIOTA	TERRESTRIAL BIOTA	LANDSCAPES
Participants:	DeBusk	Barko	Kasul	Anderson	Hamilton
	Fredrickson	Hains	Killgore	Krzysik	Peyman
	Gebhart	Rao	Madsen	Palazzo	Riggins
	Price, Richard A.	Seal	Payne	Swiderek	Trame
	Smith			Martin	Davo
Location:	NRD conf. room, no. 255	EED conf. room, no. 270	PMO conf. room, no. 248	ERD conf. room, no. 107	EL conf. room, across from 204
Facilitator, Recorder:	O'Neil/Tingle	Seal/Lord	Jackson/Jackson	Passmore/Mitchell	Price, David/Dunn

Figure A1. Environmental Charaterization and Monitoring Initiative Research Workshop, Vicksburg, MS, 26-28 Jan 1999

kneeling: Richard A. Price, Herb Fredrickson, Linda Peyman, Jean O'Neil, Lawson Smith, Tony Krzysik, Theresa Davo, Scott Jackson, Bob Riggins;
1st row: Rose Kress, Wade West, Bob Dunn, Dick Kasul, Dick Gebhart, Alan Anderson, Barry Payne, John Tingle;
2nd row: John Hains, Roger Hamilton;
3rd row: Jack Killgore, R. Suresh C. Rao, Tony Palazzo, Wilma Mitchell, Pete Swiderek, Chester Martin;
Back: Dave Tazik, Bill Debusk, Ann-Marie Trame, Rebecca Seal, David Price, John Madsen;
(**not pictured:** John Barko, Renee' Caruthers, Elizabeth Lord, Mike Passmore)

APPENDIX B

WORKSHOP FOR RESEARCH INPUT TO THE ENVIRONMENTAL CHARACTERIZATION AND MONITORING INITIATIVE (ECMI)

OBJECTIVE: The purpose of this workshop is to obtain input from the research perspective on baseline information and monitoring data requirements in the ECMI. Using the results of this workshop and other input, the highest priority and most relevant ecological processes and parameters will be identified for measurement.

26-28 JAN 1999

Building 1006
ENVIRONMENTAL LABORATORY Vicksburg, Miss.

DAY	HOURS		SUBJECT	LOCATION	FACILITATOR
	FROM	TO			
TUE	0830	0910	Introductions; Overview of ECMI; Workshop Objectives	EL Conf Rm	Dave Tazik
	0910	0930	Regional and Local Geography of Fort Benning	EL Conf Rm	Rose Kress
	0930	1010	Training, ITAM, and LCTA at Fort Benning	EL Conf Rm	Theresa Davo
	1010	1025	Break		
	1025	1100	Natural Resource Management at Fort Benning	EL Conf Rm	Pete Swiderek
	1100	1130	SERDP Ecosystem Management Project (SEMP) Research Emphasis and Activities	EL Conf Rm	Dave Tazik
	1130	1150	Organization of Breakout Sessions	EL Conf Rm	Jean O'Neil
	1150	1200	Group Photo		
	1200	1300	Lunch		
	1300	1630	First Breakout Session: Identification and description of key ecological processes	Breakouts*	Participants and Facilitators
	1630	1700	Summary and Report Preparation by Each Group	Breakouts	Participants
	1830		Dinner and Social (optional)	Walnut Hills Restaurant	

* Breakout Locations:
- Orange - NRD Conf Rm 255
- Blue - EED Conf Rm 270
- Yellow - PMO Conf Rm 248
- Red - ERD Conf Rm 107
- Green - EL Conf Rm

WORKSHOP FOR RESEARCH INPUT TO THE ENVIRONMENTAL CHARACTERIZATION AND MONITORING INITIATIVE (ECMI)

OBJECTIVE: The purpose of this workshop is to obtain input from the research perspective on baseline information and monitoring data requirements in the ECMI. Using the results of this workshop and other input, the highest priority and most relevant ecological processes and parameters will be identified for measurement.

26-28 JAN 1999		Building 1006 ENVIRONMENTAL LABORATORY Vicksburg, Miss.

DAY	HOURS FROM	HOURS TO	SUBJECT	LOCATION	FACILITATOR
WED	0815	0930	Group Reports to Plenary on Key Processes	EL Conf Rm	Participants
	0930	1000	Summary of Relevant Models	EL Conf Rm	David Price
	1000	1200	Second Breakout Session: Identification and Description of Monitoring Variables for Key Processes	Breakouts	Participants and Facilitators
	1200	1215	Summary and Report Preparation by Each Group	Breakouts	Participants
	1215	1315	Lunch		
	1315	1430	Group Reports to Plenary on Variables	EL Conf Rm	Participants
	1430	1530	Discussion and Prioritizing of Variable Selection Criteria	EL Conf Rm	Facilitator
	1530	1550	Break		
	1550	1700	Application of Criteria to Variables	Breakouts	Participants
THU	0815	0900	Integration and Prioritization of Key Processes Across Sectors	EL Conf Rm	Facilitator
	0900	1000	Integration and Prioritization of Monitoring Variables Across Sectors	EL Conf Rm	Facilitator
	1000	1015	Break		
	1015	1115	Stratification of Fort Benning	EL Conf Rm	Facilitator
	1115	1145	Summary, Follow-on Actions, Adjourn	EL Conf Rm	Dave Tazik