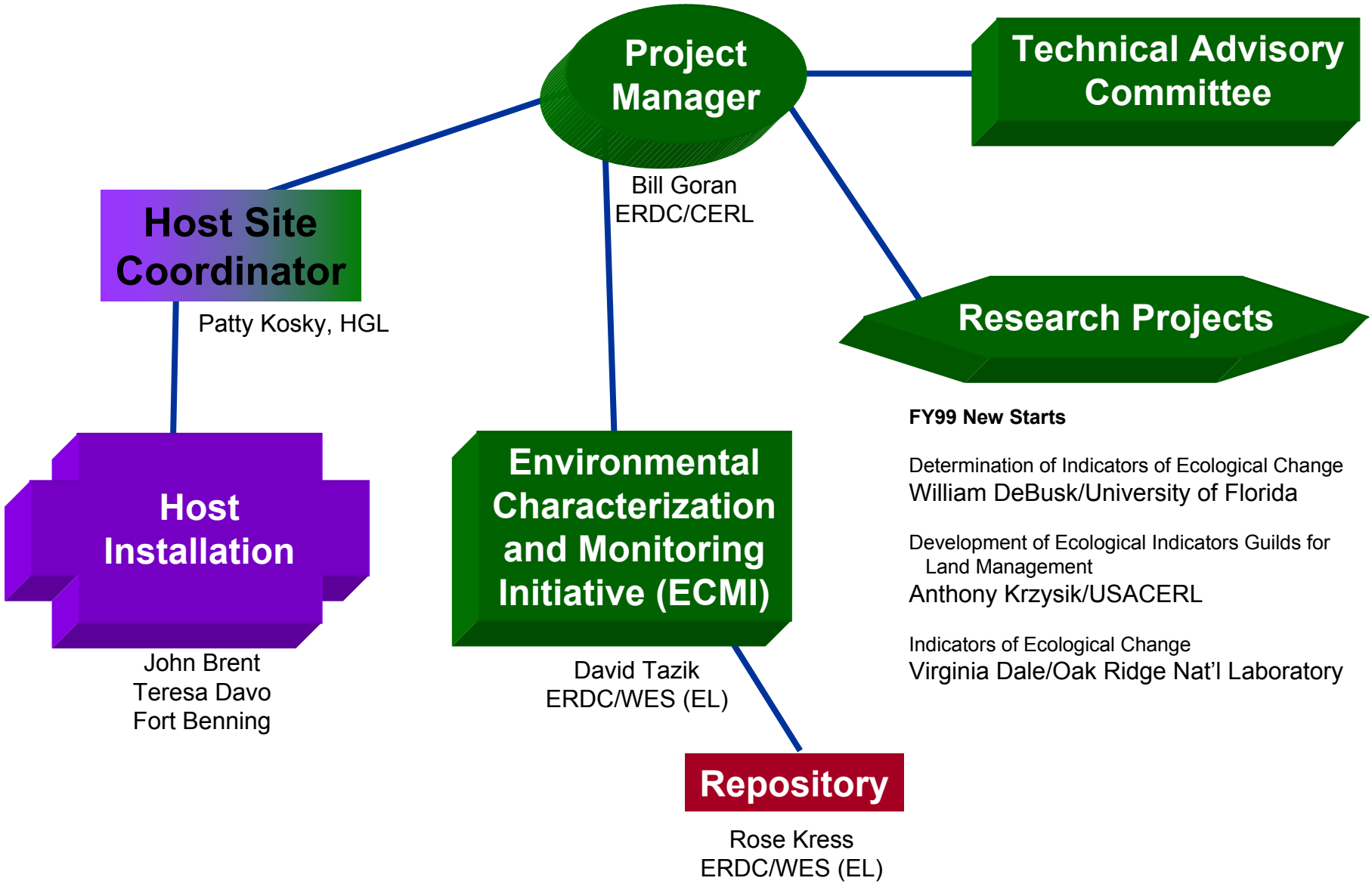
The SERDP Ecosystem Management Project
CS-1114/7

William D. Goran
U.S. Army Engineering Research and Development Center (ERDC)
U.S. Army Construction Engineering Research Laboratory (USACERL)

SERDP In-Progress Review
26 April 1999

SEMP Organization Chart



Technical Advisory Committee for SEMP

- Mr. Peter Boice, Director of Conservation Programs, Deputy Undersecretary for Defense, Environmental Security
- Dr. Roger Dahlman, Program Manager, U.S. Department of Energy
- Dr. Penny Firth, National Science Foundation
- Mr. Richard McWhite, Natural Resources Chief, Eglin Air Force Base
- Ms. Kim Michaels, Army Environmental Center, Conservation
- Dr. Sam Pearsall, Science Advisor, North Carolina Nature Conservancy
- Dr. Doug Ripley, Headquarters, Air Force
- Dr. James Spotila, Chief Environmental Scientist, Assistant Sec. of the Army (IL&E)
- Dr. J. Whitfield Gibbons, Savannah River Ecology Lab and University of Georgia
- Ex Officio Members from SERDP, ERDC and Fort Benning

The Problem

Understanding of Ecosystem Management

- How does the ecosystem function?
- How do mission and protected resources interact?
- What are the thresholds of degradation?
- How might beyond-the-fenceline dynamics impact the mission?

Knowledge Gaps

Guidance for Ecosystem Management

- DoD Guidance
- Services Guidance
- SIKES Act/Regs
- Endangered Species Act/Regs
- Public Concerns

Adaptive Management

Ecosystem Management Practices

- Use Management
- Habitat Protection
- Habitat Restoration
- Controlled Burning
- Planting/Harvesting
- Invasive Species Controls
- Species Population Controls
- Erosion Control
- Sediment Management

1997 Ecosystem Research Workshop Identified Research Themes for "Knowledge Gaps"

- Indicators of Ecosystem Status
  - Ecosystem health
  - Signals of change
- Ecological Thresholds
  - Disturbance beyond unaided recovery
  - Population/habitat size
  - Species, ecosystem and landscape diversity
  - Critical zones along biogeochemical gradients

D. Botkin, P Megonigal, R. Sampson, *Management-Scale Ecosystem Research: Findings and Recommendations*, The Center for the Study of the Environment, August 1997.

1997 Ecosystem Research Workshop Identified Research Themes for "Knowledge Gaps"

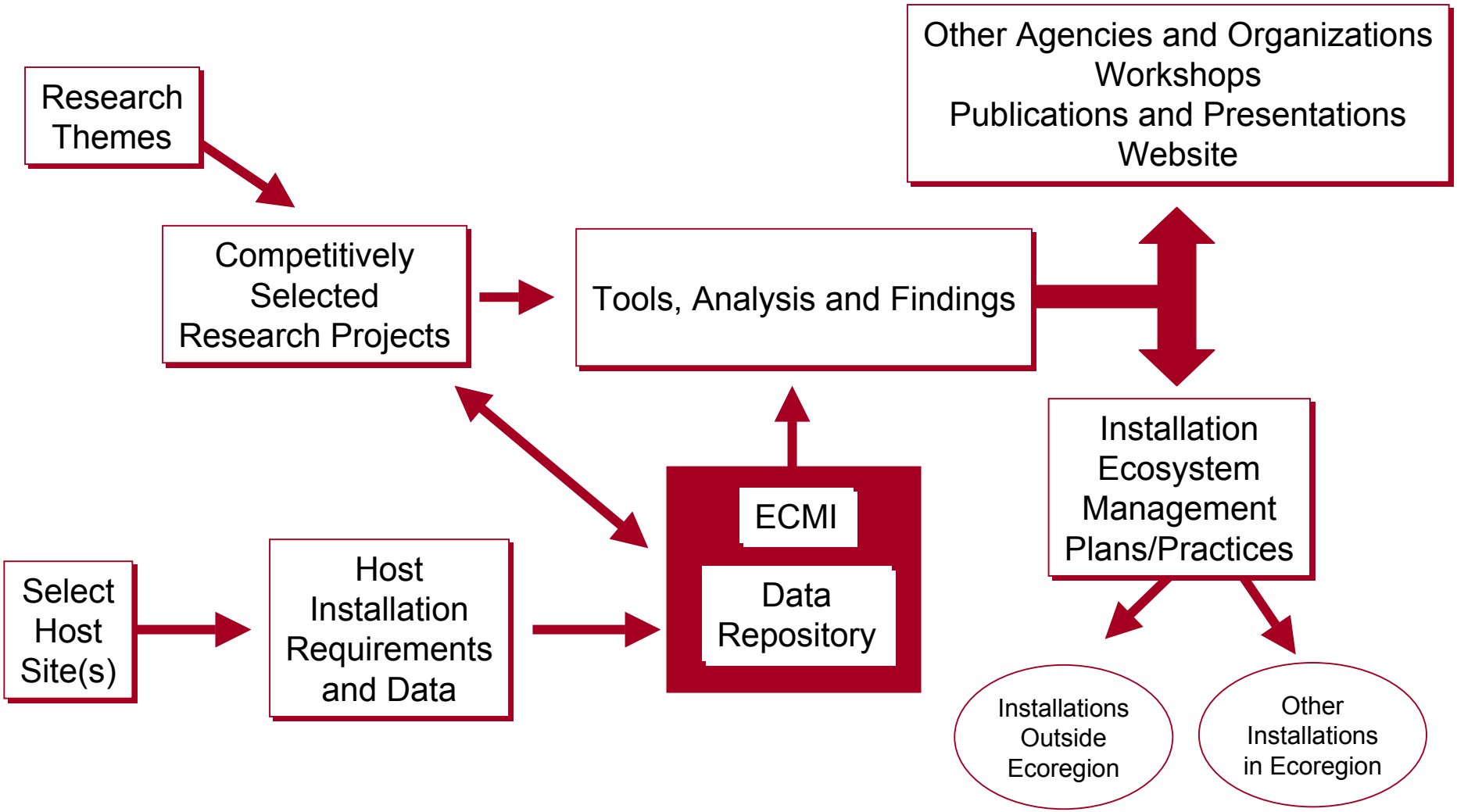
- Role of Manipulating Biogeochemical Cycles
  - To favor one species over another
  - To promote sustainability of ecological processes
  - To promote biodiversity
  - To promote recovery
- Important of Spatial/Temporal Scales
  - In the disturbance/recovery cycle
  - In off-post/on-post relationships
  - Relationship between landscape patterns and ecosystems processes/dynamics

D. Botkin, P Megonigal, R. Sampson, *Management-Scale Ecosystem Research: Findings and Recommendations*, The Center for the Study of the Environment, August 1997.

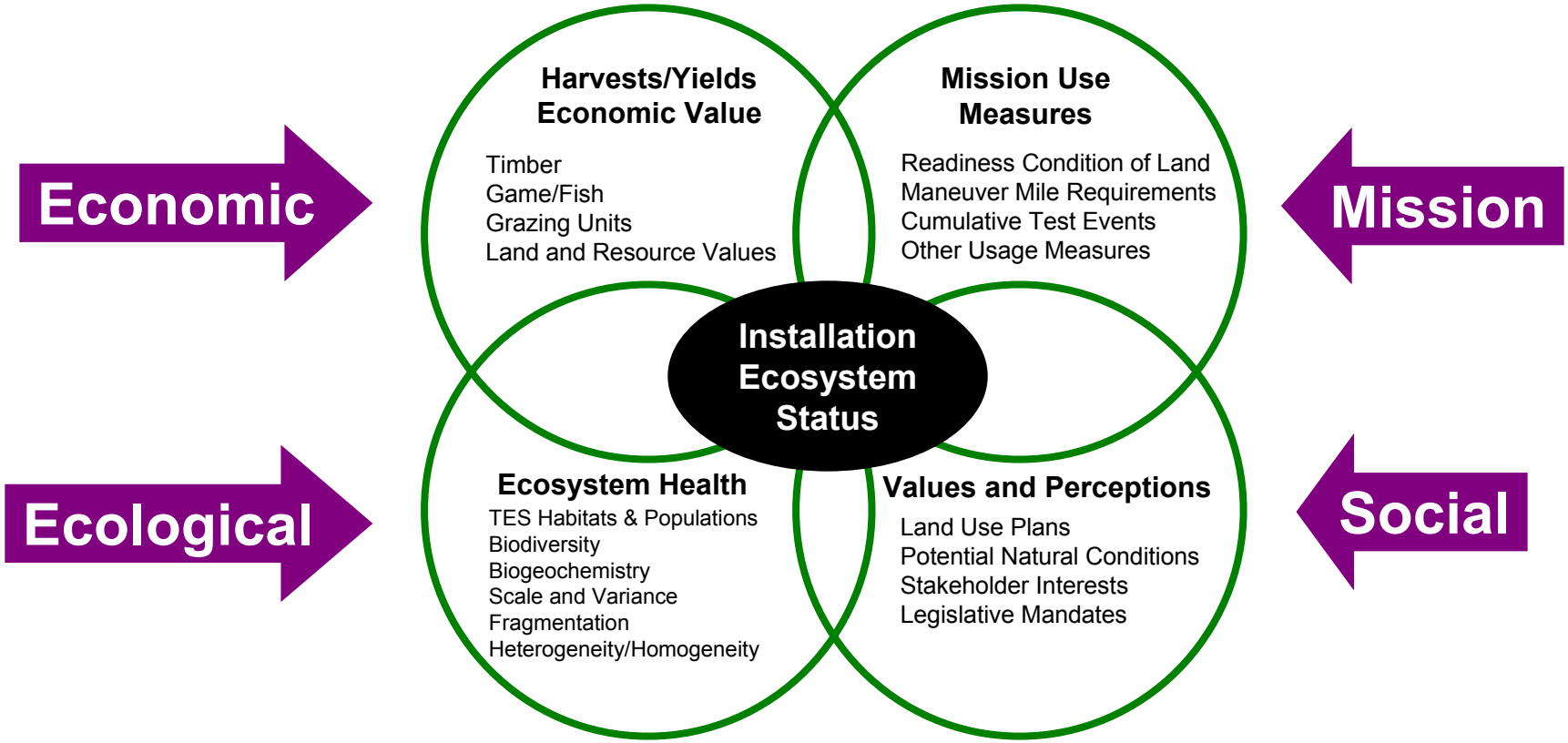
Technical Objectives

- To Address DoD Requirements and Opportunities in Ecosystem Management Research (as identified by the 1997 SERDP Ecosystem Science Workshop)
- To Establish a Long-term Research Site (or sites) on DoD Lands for DoD Relevant Ecosystems Research
- To Conduct Ecosystem Research and Monitoring Activities Relevant to DoD Requirements and Opportunities
- To Facilitate the Integration of Results and Findings of Research into DoD Ecosystem Management Practices

Technical Approach



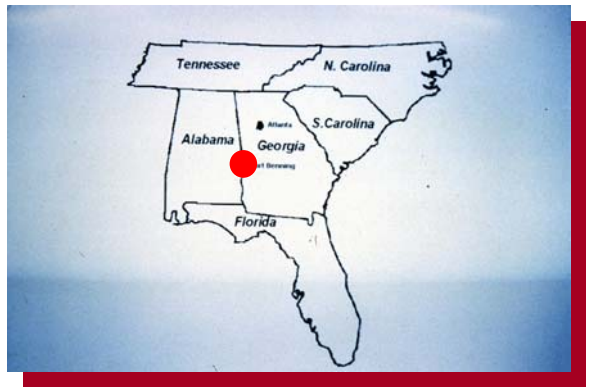
Military Installation Ecosystem Current and Potential Measures



Why Fort Benning?

- Large: 182,000 acres
- Enduring: Category 1 ITAM
- Home to: Multiple TES Species
- Extensive Data Sets: LCTA +
- Proactive Response to SEMP
- Numerous Military Use Stresses

Region of Interest: Southeast



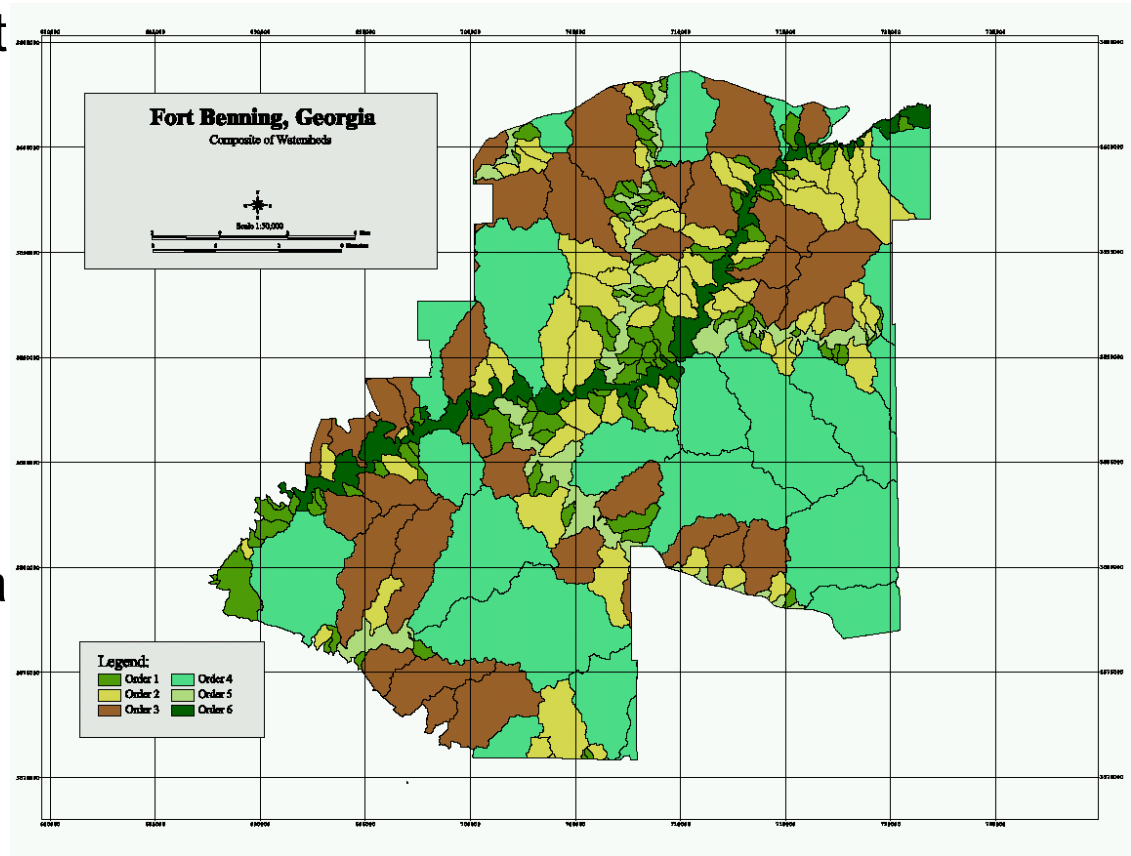
- Many DoD Installations
- Ecosystem Constraints to Mission

Land Resource Areas

Home of Infantry

ECMI Approach

- Inventory and Document Existing Data and On-going Monitoring Programs
- Design the Baseline Monitoring Program
- Implement the Baseline Monitoring Program
- Establish and Maintain a Data Repository
- Adapt the Monitoring Program



SERDP Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

US Army Corps of Engineers

SERDP Ecosystem Management Project

Ecosystem Characterization and Monitoring Initiative

David J. Tazik, Environmental Laboratory
USAERDC, Vicksburg, MS

SERDP In-Progress Review
26 April 1999, Arlington, Virginia

Environmental Characterization and Monitoring Initiative (ECMI) Team

- Dr. David Tazik, EL (WES), lead
- Mr. Scott Jackson, EL (WES)
- Dr. Rose Kress, EL (WES)
- Mr. Robert Lozar, USACERL
- Dr. Jean O'Neal, EL (WES)
- Dr. David Price, USACERL
- Mr. Wade West, EL (WES)
- Dr. Adeyami, Clark-Atlanta University

Repository

- Dr. Rose Kress, EL (WES), lead
- Ms. Kelly Dilks, USACERL

ECMI -- Goal

- Design, develop and demonstrate an ecosystem characterization and monitoring concept
  - Baseline data
  - Research and land management applications
  - Demo at Fort Benning
  - Adaptable regionally and nationally

SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

US Army Corps of Engineers

Objectives

- Characterize biotic and abiotic elements and associated processes and properties in support of ecosystem-based research and management
- Assess both spatial and temporal dynamics within aquatic, riparian, and terrestrial communities

Approach

- Inventory existing data and monitoring
- Design the baseline monitoring program
- Implement the baseline monitoring program
- Establish and maintain a data repository
- Adapt the monitoring program

1. Document Existing Data and Monitoring Programs

Milestone/Product	Date
On-site inventory	Dec 98
Regional inventory	Feb 99
Monitoring programs	Mar 99
P: Tabular Report	Apr 99

2. Design Baseline Monitoring Program

Milestone/Products	Date
Document data & info needs	Jan 99
Variable selection criteria	Feb 99
Select variables	Mar 99
Draft sampling design & protocols; submit for external review	Jun 99
Revised design & protocols	Jul 99
P: Interim: Variable Selection	Apr 99
P: Draft: Design & Protocols	Jun 99
P: Final: Design & Protocols	Aug 99

3. Implement Baseline Monitoring Program

Milestones/Products	Date
Site suitability reconnaissance	Mar 99
Initial acquisition and procedures	Jun 99
Initial deployment & testing	Jul 99
Phase 1 implementation	Oct 99
P: Phase 1 Implementation Plan	Aug 99

4. Establish & Maintain Data Repository

Milestone/Product	Date
Repository Design	Aug 99
Phase I Repository	Oct 99
QA/QC Planning	Feb 00
P: Design Document	Sep 99
P: Phase I Repository On-line	Nov 99
P: QA/QC Plan	Mar 99

5. Adapt Monitoring Program

Milestone/Product	Date
Evaluate first year data	Dec 00
Assess adaptation recommendations	Feb 01
Implement adaptations	Apr 01
P: First year data report	Dec 00
P: Documented changes to monitoring plan	Annual

Design Considerations

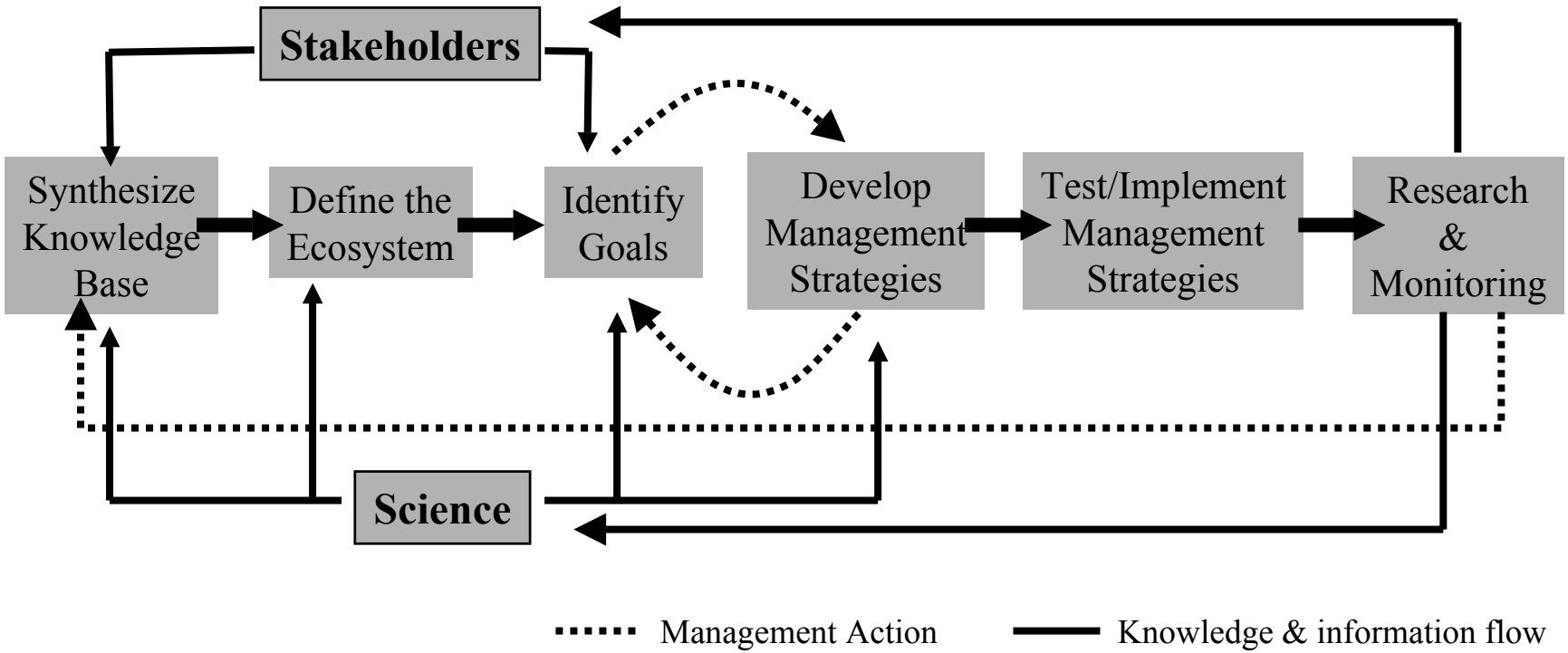
- Ecosystem Management Protocol
- Link Science, Land Management, & Data/Information Requirements
- Adaptive Monitoring
- Others

Scientific Basis of Ecosystem Management

"…management driven by goals,
executed by policies, protocols, and practices, and
made adaptable by ***monitoring and research***
based on our understanding of the ecological
interactions and processes
necessary to ***sustain***
ecosystem composition, structure, and function."

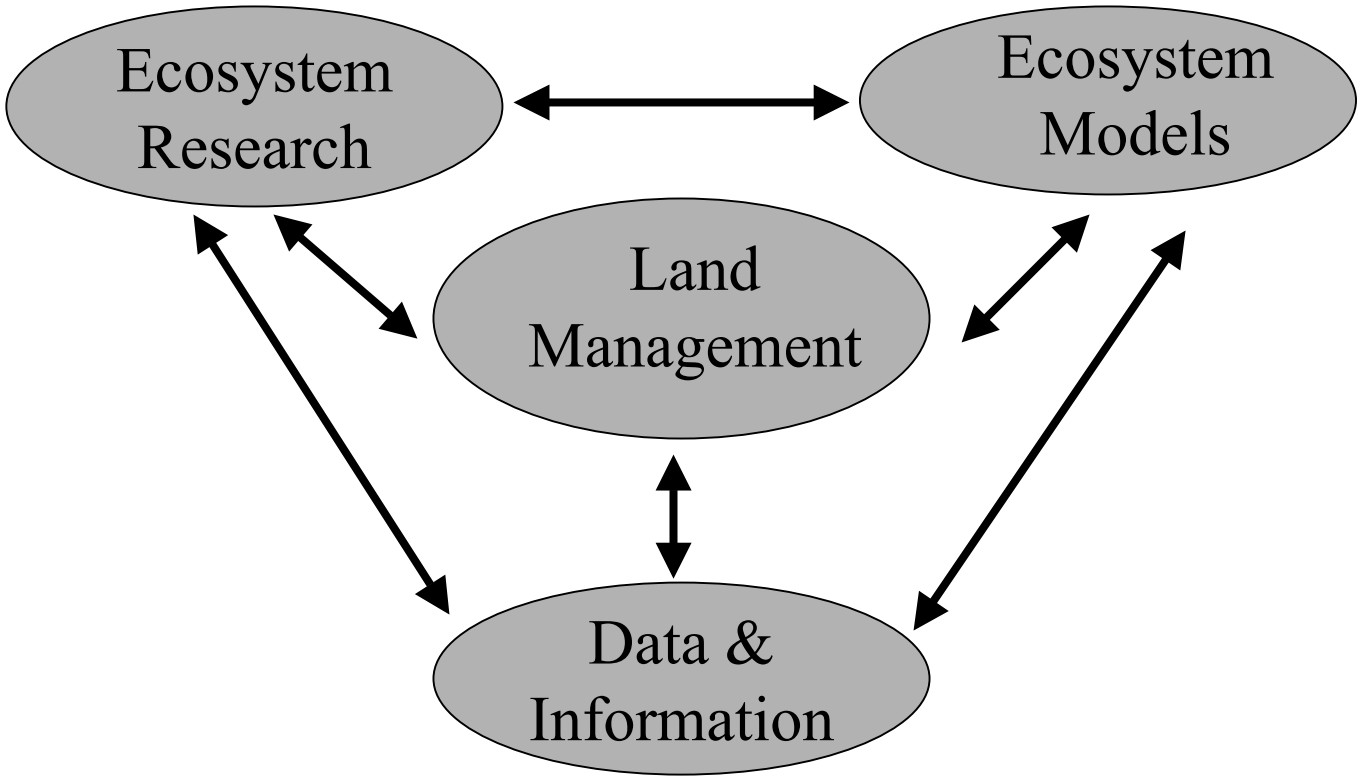
N.L. Christiansen et al. 1996. The report of the Ecological Society of America Committee on the Scientific Basis for ecosystem management. *Ecological Applications* 6(3):665-691.

Ecosystem Management Protocol



after J.A. Stanford and G.C. Poole. 1996. A Protocol for Ecosystem Management. Ecological Applications 6(3): 741-744.

Linking Science, Land Management, and Data & Information



Adaptive Monitoring

- Uncertainty re: system dynamics
- Logistical challenges
- Incorporating new knowledge (e.g. models)
- Technical and Institutional barriers
  - Qualitative objectives
  - Methodologies
  - Uncertain characteristics of environmental features
  - Priorities partially understood

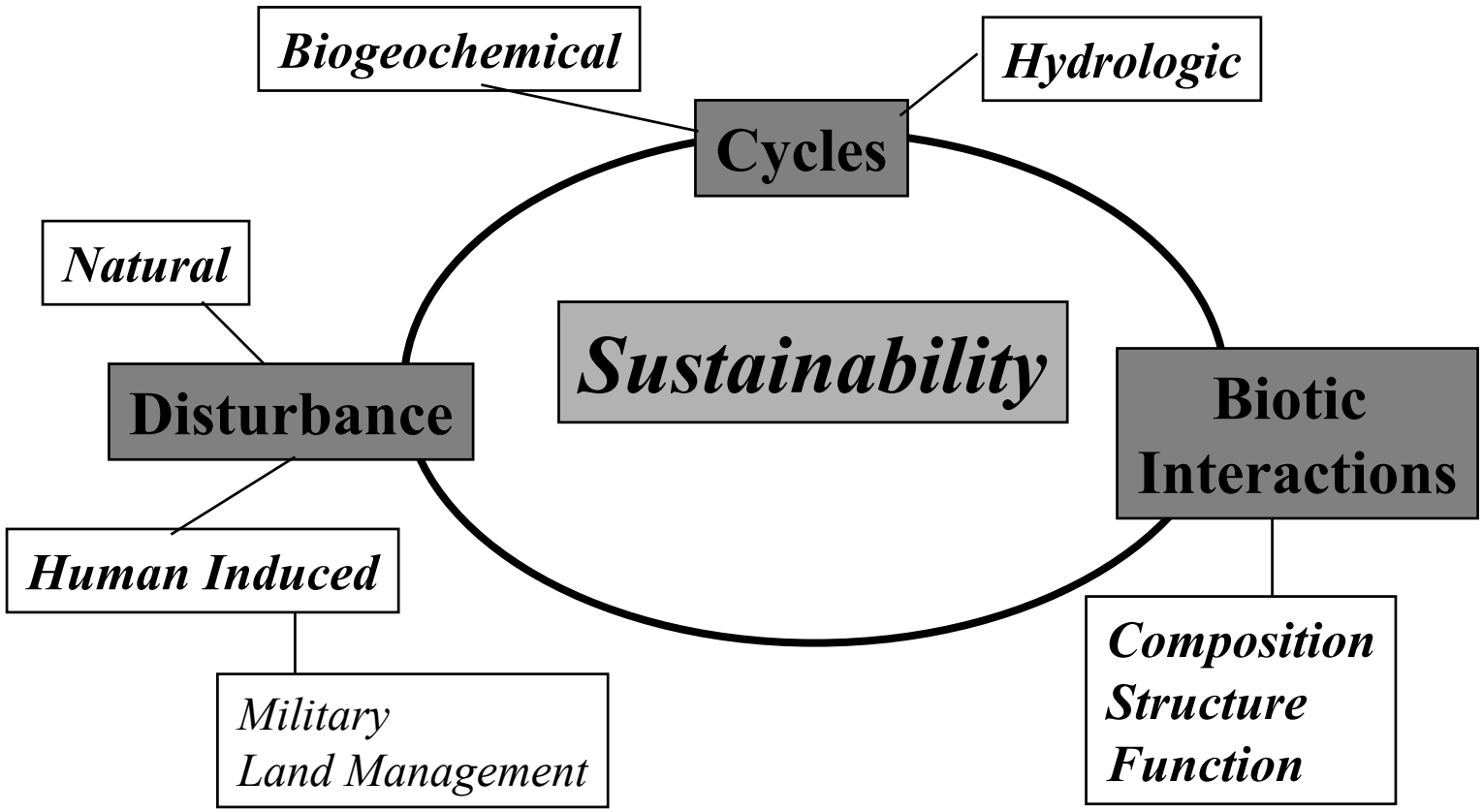
Adaptive Monitoring

- Extended design phase
- Phased implementation
  - Number of variables
  - Number of sampling units
  - Number of models addressed
- Incorporate research results
- Evaluate research and management utility

Additional Considerations

- **Scale**
  - species versus ecosystems
  - ecosystem and business processes
- **Technology**
  - minimize impact on host organization
  - rapid turnaround/accessibility
  - efficient QA/QC protocols
- **Host organization**
  - Leverage existing data collection
  - Provide value-added to installation
- **Long term commitment**
  - value of the data increases with time
- **Keep it simple & cost effective**
  - longevity inversely proportional to complexity and cost

Conceptual Framework



Variable Selection Process

- Land Managers workshop
- Researchers workshop
- Ecosystem models
- SEMP research projects
- Other monitoring programs

Priority Selection Criteria

- Ability to detect change or relationships
- Relevance to mission and land management
- Cost effectiveness
- Potential for multiple uses

Design Components

- Thematic
- Spatial
- Temporal
- Adaptive

Variable Themes

- Meteorology
- Surface Water
- Ground Water
- Soil
- Fauna
- Flora
- Land Cover
- Land Use
- Landscape Characterization
- Remotely Sensed Data

Key Process Applications

	MET	SW	GW	Soils	Fauna	Flora	Land Cover	Land Use	Land-scape	RS
Hydrologic	X	X	X				X		X	X
Biogeochem		X		X			X			
Disturbance		X		X			X	X		X
Biotic					X	X	X	X		X
Landscape Dynamics							X	X	X	X

Phased Implementation Near Term

	FY99				FY00				FY01
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q
Meteorology			C		M				
Surface Water				C	M				
Ground Water					C	M			
Soil			C						
Fauna				C		M			
Flora				C		M			
Land Use/Cover			C			M			
Landscape Characterization		C			M				

Initial Deployment & Characterization

- Meteorology
  - Temperature
  - Humidity
  - Barometric pressure
  - Precipitation
  - Wind speed & direction
  - Radiation (photosythetic)
  - Evaporation
- Surface Water
  - Stage/depth/velocity
  - Temperature
  - Precipitation
  - pH
  - Turbidity
  - Dissolved oxygen
  - Conductivity
  - NH_4, NO_3, CL
  - Suspended solids

Phased Implementation
Phase I

- 1999: Design & Charac-terization
  - Inventory
  - Framework
  - Draft design & testing
  - Initial characterization
  - Focused research
- 2000: Characteriza-tion & Implementation
  - Characterization
  - Monitoring year
  - QA/QC
  - Functional repository
  - Research data flow
  - Data evaluation

Phase II-III

- II 2001-2002: Main-tain & Adjust
  - ECMI data stream
  - Conservative change
  - Imagery calibration
  - Research data stream
  - Evolving repository
- III 2003-2005: Incorp-orate Research Results
  - Potential major adjustments
  - Additional resarch attracted to site
  - Cross-site comparisons possible

Phase IV-V

- IV: 2006-2010: Adapt to Land Management Experiments
  - Research results transferred to land management
  - Adaptive land management influences monitoring program
- V: 2011-….. Continued Monitoring

Next Steps

- **June**
  - Design and protocols report for external review
  - Acquire, deploy and test met and surface water stations
- **July/August**
  - Finalize design and implementation plans
  - Additional characterization work
- **August**
  - Brief Technical Advisory Committee
  - Repository design
- **September/October**
  - On-going characterization work
  - Phase 1 monitoring implementation
  - Phase 1 repository

Change Indicators
SON 99 Solicitation

- Identify and Test Potential Indicators of Change
- Define Historic Range of Variation in Indicators
- Develop Methods for Determining Change
- Identify Factors Leading to Change

Determination of Indicators of Ecological Change

Team Lead Dr. William F. DeBusk
University of Florida, Gainesville

Team Member Name	Task/Topic	Institution
W. F. DeBusk	Soil/Sediment/Water Quality	Univ. of Florida
K. R. Reddy	Soil/Sediment/Water Quality	Univ. of Florida
A. V. Ogram	Molecular Microbial Ecology	Univ. of Florida
D. L. Miller	Vegetation ecology	Univ. of Florida
G. W. Tanner	Vegetation ecology	Univ. of Florida
J. Jacobs	Surface Water Hydrology	Univ. of Florida
P. S. Rao	Vadose Zone Hydrology	Purdue Univ.
W. Graham	Synthesis/Modeling; Hydrology	Univ. of Florida

Determinations of Indicators of Ecological Change

William DeBusk, University of Florida

- Technical Premise
  - Soil serves as central ecosystem component linking terrestrial and aquatic habitats
- Technical Objective
  - Evaluate a suite of parameters related to properties and processes in the understory vegetation, soil and surface hydrology as potentially sensitive indicators of ecosystem integrity and ecological response to natural and anthropogenic factors

Determinations of Indicators of Ecological Change

William DeBusk, University of Florida

Technical Approach

- Within a Watershed, Measure and Model Dynamics Between Vegetation, Soils and Soil Micro-organisms, Water Quality and Sediment Loads Relative to Natural and Anthropogenic Factors
- 5-year Effort

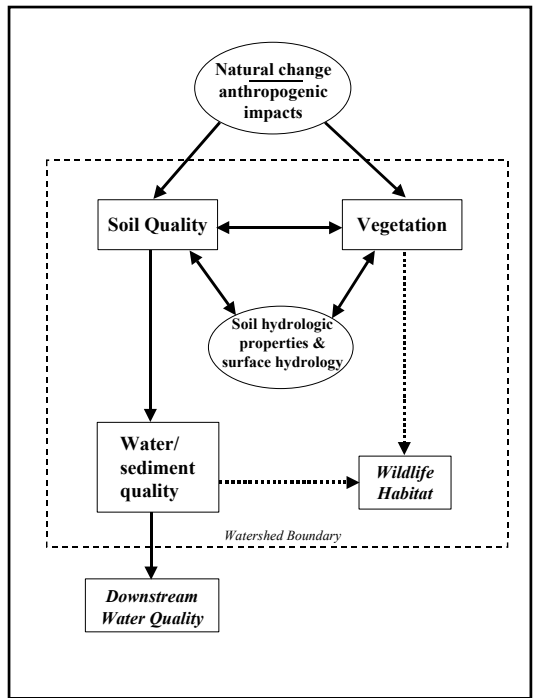


Fig. 1. Flow chart and conceptual diagram for proposed evaluation of ecological indicators at the Ft. Benning study site.

Determinations of Indicators of Ecological Change

William DeBusk, University of Florida

- Parameters to be Sampled
  - Soil/sediment physical & chemical properties
  - Enzyme activity
  - Microbial biomass
  - Microbial respiration rate
  - Vegetation
  - Hydrology
  - Stream water quality

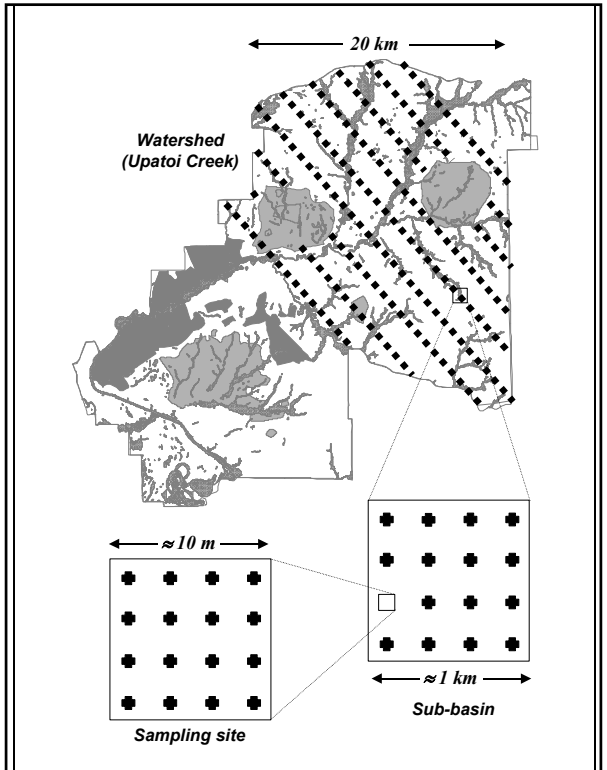


Fig. 2. Conceptual design of nested sampling scheme for ecological indicators. Replication within sampling sites applies to measurement of soil indicators.

Upatoi Creek Watershed
Selected Sub-basins

Determinations of Indicators of Ecological Change

William DeBusk, University of Florida

Milestone	Completion Date (after funds distribution)
Project Work Plan	4 months
Installation-Wide Sampling	12 months
Low-Order Watershed Sampling (6 sites)	42 months
Intensive Sampling Along Local Gradients	42 months
Follow-up Installation-Wide Sampling	50 months
Synthesis and Modeling	56 months
Final Report	60 months

Indicators of Ecological Change

Team Lead Dr. Virginia Dale
Oak Ridge National Laboratory

Team Member Name	Role	Institution
Virginia Dale	Landscape Ecology	ORNL
Thomas Foster	Historic Land Cover	Penn State Univ.
David White	Microbiology	Univ. of Tennessee
Pat Mulholland	Aquatic Ecology	ORNL
Katherine Eddins	Technology Transfer	The Nature Conservancy
John Hall	Technology Transfer	The Nature Conservancy
Teresa Davo	Impact Experiments and T2	Ft. Benning DOT

Indicators of Ecological Change

Virginia Dale, ORNL

- Technical Concept
  - "biological integrity" or "system wholeness"
- Key Elements
  - Species Diversity
  - Landscape Diversity
  - Ecosystem Function
  - Ecosystem Structure
- Technical Approach
  - Historic Trends Analysis
  - Measure changes in biological integrity of
    - terrestrial ecosystem using a focal species approach
    - aquatic systems (land/water interactions and stream biological communities and processes
    - soil microorganisms as a measure of the below-ground aspect of integrity
  - Perform "Impact" Experiments (with Ft. Benning)
  - Analyze Results in Terms of "Indicators"
  - Develop Tech Transfer Plan

Indicators of Ecological Change

- The technical concept, “biological integrity” or “system wholeness,” incorporates the concepts in the report from the Ecological Society of America Land Use Committee entitled, *Ecological Principals and Guidelines for Managing the Use of Lands*.

Indicators of Ecological Change

Virginia Dale, ORNL

Components of Biological Integrity

Hierarchy	Elements	Processes	Suggested Indicators
Taxonomic	Species	Range expansion or contraction	Range size
		Extinction	Number of populations
Ecological	Population	Abundance fluctuation	Age or size structure
		Colonization or extinction	Dispersal behavior
	Assemblage	Competitive exclusion	Number of species
		Predation or parasitism	Species evenness
		Energy flow	Number of trophic levels
		Nutrient cycling	Elements of redundancy
	Landscape	Disturbance	Fragmentation
		Succession	Number of communities
			Persistence

Indicators of Ecological Change

Virginia Dale, ORNL

6-Year Effort

Milestone	Completion Date
Development of candidate indicators	Nov 99
Preparation of digitized land cover and historic disturbancy map for Ft. Benning	Mar 00
Definition of focal elements at Ft. Benning	Mar 00
Report on how historical trends affect candidate indicators	Nov 00
Implementation of experiment	Nov 01
Report on critical attributes of land/water interface	May 03
Report on key soil microorganisms at Ft. Benning	Mar 03

Development of Ecological Indicator Guilds for Land Management

Team Lead Dr. Anthony J. Krzysik, U.S. Army CERL

Team Member Name	Task/Topic	Institution
John M. Emlen	Theoretical Ecology	U.S. Geological Survey
D. Carl Freeman	Plant Ecology & Physiology	Wayne State University
John H. Graham	Population Genetics	Berry College
David A. Kovacic	Ecosystem Ecology	University of Illinois
Lawson M. Smith	Geomorphology/Geology	Geotechnical Lab, WES
Ann-Marie Trame	Plant Populations	USACERL
John C. Zak	Soil & Microbial Ecology	Texas Tech University

Development of Ecological Indicator Guilds for Land Management

Anthony Krzysik, U.S. Army CERL

Technical Objective

Develop "Ecological Indicator Guilds" based on ecosystem relevant design criteria and landscape scales, for the purpose of monitoring biological viability, long-term productivity, and ecological sustainability of military training and testing lands.

Technical Approach

- Identify Ecological Indicator Guilds Based Upon Assessment of:
  - Indicator Species
  - Ecofunction Groups
  - Geomorphic Indicators
  - Developmental Instability and Plant Stress
  - Nutrient Flux
  - Microbial Functional Activity

response to stressors

along gradient of military use intensity

Development of Ecological Indicator Guilds for Land Management

Anthony Krzysik, U.S. Army CERL

Nested Sampling Sequence

Hierarchy	Sample Frame	Variance Contrasts
Ecoregion	Sites	controls, gradient of disturbance
Ecosystem	Plots	uplands, riparian, lotic aquatic
Macrohabitat	Strata	habitat mosaics: patches, environmental gradients
Microhabitat	Samples	replicates

Development of Ecological Indicator Guilds for Land Management

Anthony Krzysik, U.S. Army CERL

Milestone	Completion Date (after funds distribution)
Selection of study sites and plots	2 months
Selection of ecological indicators	8 months
Pilot study completed	12 months
Data assessment on military impacts on SE ecological systems	30 months
Use of Ecological Indicator Guilds for military land mgmt in southeastern United States	50 months
Applications of Ecological Indicator Guilds to southwestern, northwestern and northeastern ecoregions	60 months

Accomplishments and Deliverables
FY99 Milestones

HOST INSTALLATION ACTIVITIES		
MOU and license for facilitating work at study site	03/15/99	✓
SON ACTIVITIES		
FY99 SON (Change Indicators)		
Evaluation of proposals complete	11/30/98	✓
Solicitation and Review of FY00 SON (Disturbance Thresholds)	08/30/99	
TAC ACTIVITIES		
Hold session of TAC for review of project plans	12/15/98	✓
Hold second TAC session for review of FY00 SON topics	08/15/99	
ECOSYSTEM CHARACTERIZATION & MONITORING ACTIVITIES		
Complete monitoring status report for Fort Benning, GA	04/15/99	✓
Develop plan for new monitoring activities at study site	06/15/99	
Data repository design and access protocol	09/15/99	
Acquisition and fielding of new monitoring equipment/stations	09/15/99	
OTHER ACTIVITIES		
Plan and implement SEMP Website	03/31/99	✓

Memorandum of Understanding

- Facilitate SEMP Teams Working On-Site at Fort Benning
- Institutional Support by Installation and MACOM to SEMP
- Signed by the Fort Benning Garrison Commander; Assistant Deputy Chief of Staff for Base Operations Support, HQ TRADOC; and USACERL Director
- 10-Year Time Frame
- Requires On-Site Coordinator at Fort Benning

1st TAC Session

- Met at Fort Benning on November 18 and 19
- Reviewed Seven Proposals Forwarded from the Peer Review Group
- Accepted the Following Three Proposals
  - Determination of Indicators of Ecological Change
  - Indicators of Ecological Change
  - Development of Ecological Indicator Guilds for Land Management

Review Process for FY99 SEMP Proposals

SERDP Program Office Review

Determination of Indicators of Ecological Change

Received: 15
Rejected: 2

7

6

Peer Review (Sept, Oct)

SUBGROUP A
Ecosystem -- Terrestrial Focus
Proposals Reviewed by PRP: 7
Proposals Forwarded to TAC: 4

SUBGROUP B
Ecosystem -- Aquatic Focus
Proposals Reviewed by PRP: 6
Proposals Forwarded to TAC: 3

TAC Review (Nov)

TAC Reviewed: 7
Forwarded: 3

November 98 TAC Workshop

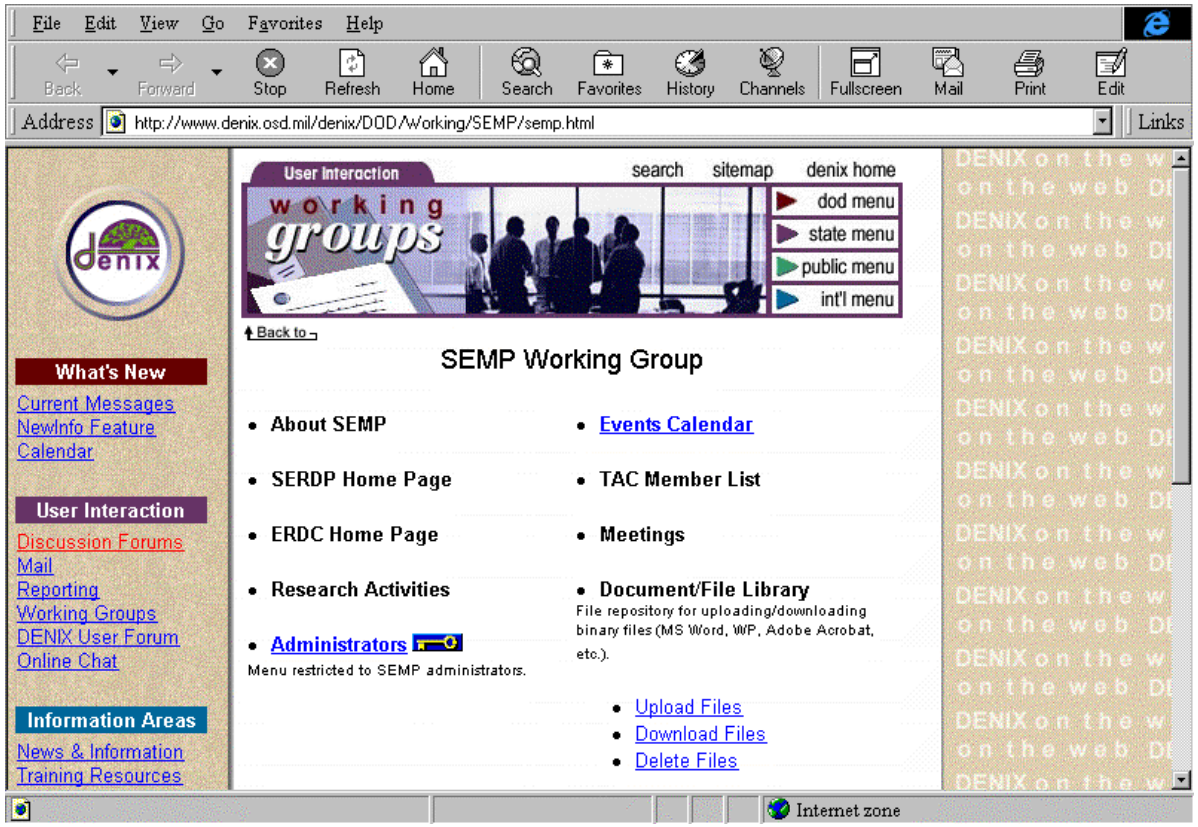
Dale	**terrestrial**
DeBusk	**aquatic**
Krzysik	**terrestrial**

1. Document Existing Data and Monitoring Programs

Milestone/Product	Date
On-site inventory	Dec 98
Regional inventory	Feb 99
Monitoring programs	Mar 99
P: Tabular Report	Apr 99

SEMP Website Through DENIX

http://www.denix.osd.mil/denix/DOD/Working/SEMP/semp.html



How to obtain a DENIX logon:

- Accessing on-line registration through DENIX Home Page (http://denix. osd.mil)
- Contact Kim Grein at (217) 373-6790, FAX (217) 373-7270

Response to Action Items

- Consider Appropriateness of Imminent DOE Sites Already in Place
  - DOE Savannah River site conducts relevant work
  - Whitfield Gibbons is a member of the SEMP TAC and a lead scientist at Savannah River
  - Other DOE Involvement (TAC and research projects) Will Help Ensure SEMP Project Incorporates Information and Approaches from Other DOE Sites

Response to Action Items

(Relationship to On-going SERDP Projects)

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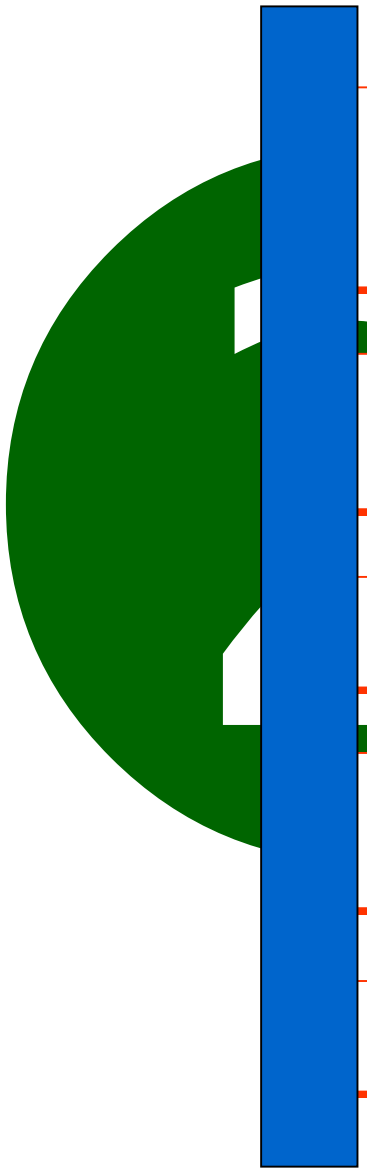
SERDP Ecosystem Management Project (SEMP)



- Emerging and Contemporary Technologies in Remote Sensing for Ecosystem Assessment and Change Detection on Military Reservations
  - **Collaborative Techniques**
- Assessment of Training Noise Impacts on the Red-Cockaded Woodpecker
  - **Expanded RCW and Mission Impact Knowledge/Models**
- Scenario-Based Planning Effort for the Mojave Desert
  - **Ecological "Forecasts" for Mgmt Options; Approach Relevant for SE "forecasts"**
- Predicting the Effects of Ecosystem Fragmentation and Restoration: Mgmt Models for Animal Populations
  - **Threshold Issue -- Collaborative Knowledge and Techniques (different ecoregion)**
- Threatened, Endangered and Sensitive Resources
  - **Focus on Southeast; SEMP Building Upon this Investment for Research and ECMI**

Program Plan

Description	FY99	FY00	FY01	FY02	FY03	FY04
Management	182	200	200	200	200	200
Characterization, Monitoring and Repository	938	700	350	300	300	300
Developing Ecological Indicator Guilds (CERL)	392	382	388	388	368	
Determination of Indicators of Ecological Change (Univ. of FL)	400	405	409	400	401	
Indicators of Ecological Change (ORNL)	400	400	400	400	400	400
Host Site Coordinator	70	70	72	75	75	75
Disturbance Thresholds (FY00 SON)		400	400	400	400	
FY02 SON				400	400	400
Lessons Learned Report/Analysis/Workshop			150			150
FY04 SON						650
Total Funding	**2382**	**2557**	**2369**	**2563**	**2544**	**2175**

SERDP
Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

US Army Corps of Engineers

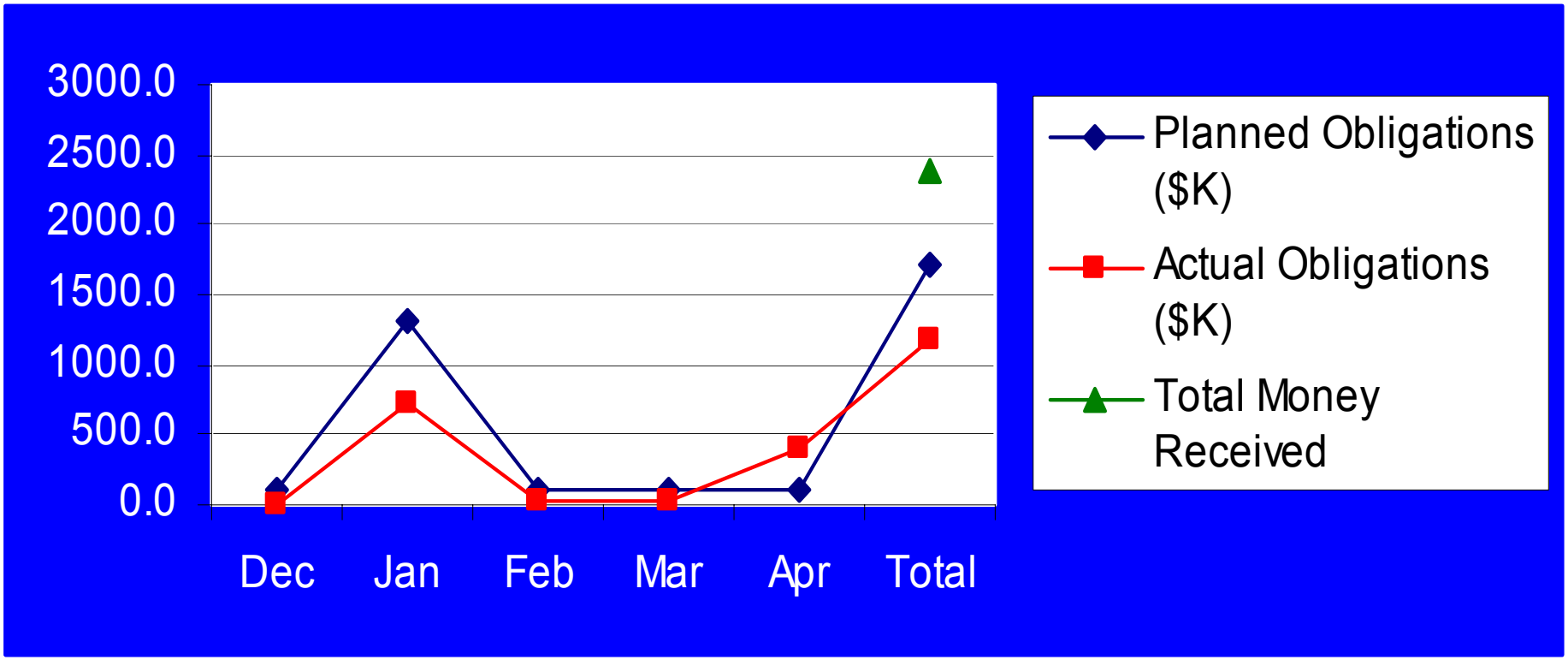
Program Status

Description	Status
Management	On Schedule
Characterization, Monitoring and Repository	On Schedule
Developing Ecological Indicator Guilds (CERL)	In Progress; Cooperative Agreement
Determination of Indicators of Ecological Change (Univ. of FL)	Close to Award
Indicators of Ecological Change (ORNL)	Funds Just Received at ORNL
Host Site Coordinator	On Board 04-21-99

Deliverables

- Every 3 Years (01, 04, 07)
- Year 2 (with revisions in later years)
- Every Year
- As Planned
- Continuous Updates
- Lessons Learned Reports and Workshops
- Monitoring and Repository Plans
- Annual Monitoring and Repository Summary and Analysis
- Reports and Deliverables from Specific Research Efforts
- Website

Planned vs. Actual Obligations



Planned vs. Actual Expenditures