Ecosystem Services and Environmental Management and Conservation on Military Lands

The Nature Conservancy (TNC) &
The Department of Defense (DoD)

Workshop Outcomes

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BACKGROUND

The U.S. Department of Defense (DoD) requires healthy land, water, and air resources (i.e. natural infrastructure) to support mission readiness and success. Over the past 20 to 30 years, the military's natural infrastructure has experienced increasing pressure from threats such as urban development and pollution. At the same time, the military is required to address environmental regulations, base re-alignments, changing needs and new technologies.

Consideration of ecosystem services, the benefits that people derive from functioning ecosystems, is becoming increasingly important in the expanding agenda of biodiversity conservation and in the comprehensive management of lands and waters by the Department of Defense (DoD).[1] The ecosystem services approach provides a comprehensive and policy relevant way of thinking about the values of lands and waters. It can help bring together information inside and outside designated-use areas. It can assist us in:

- conceptualizing and inventorying ecosystem assets;
- identifying how ecosystem goods and services are used, maintained, and enhanced within the boundaries of an installation;
- understanding how flows of ecosystem services from a reserve area to the surroundings, or vice versa, provide benefits or are impacted or sustained by activities within and outside the area;
- mapping installation impact on and impact from the surrounding natural and built environments and communities;
- forecasting changes in services over time that result from different land uses or management practices; and
- understanding how can these benefits be translated into economic terms (markets) that are recognized and shared by a broad array of stakeholders.

A method for incorporating ecosystem services into DoD decision-making currently does not exist, and as a result the military is not able to adequately respond to threats and ensure long-term sustainment of the military mission.

[1] The ecosystem services concept was firmly fleshed out in the 2005 **Millenium Ecosystem Assessment** and has sparked policy and program development globally and throughout the US government. The White House Interagency Committee on Environment and Natural Resources (CENR) recently started a Task Team on ecosystem services in which the DoD participates. Other members of the task team were invited to this workshop to create synergies with programs in other agencies.

Advancing science and policy related to ecosystem services is a major strategic initiative in the Nature Conservancy (TNC) and a focus of management in several units within DoD. TNC and DoD have a long history of productive collaboration and a shared interest in advancing the application of the science of ecosystem services to environmental management and conservation. To bolster this work, TNC and DoD held a workshop to develop an ecosystem-services framework to enhance environmental management and conservation planning.

The Ecosystem Services and Environmental Management and Conservation on Military Lands Workshop was convened April 15-17, 2008, at Eglin Air Force Base (AFB) in Florida. TNC and DoD, together with several federal and state agencies, have been collaborating on environmental management at Eglin AFB for more than a decade. At the workshop, a group of approximately 30 invited TNC, DoD, and other federal and state agency staff and consultants focused on the development of an ecosystem-services framework, its application to planning and management at military installations across the United States, and important research gaps.

The theme of the workshop was "Ecosystem Services Within and Across Boundaries." This theme was chosen because the ability of DoD to achieve its mission within a military area is affected not only by the environment within the area but also by the landscape and human activities "across the fence." Similarly, TNC recognizes that the long-term sustainability of lands under conservation protection depends on the integrity of surrounding areas.

With this in mind, the objectives of the workshop were to: (a) review what is currently being done and what approaches and tools are available; (b) produce a conceptual framework to help identify issues and information gaps; (c) identify priorities for research; (d) determine how ecosystem services can be applied in environmental management and conservation planning; and (e) consider how emerging markets for ecosystem services may affect our activities. In addition, the group discussed potential applications to Eglin AFB as a real world example.

The workshop agenda, discussion notes and participant list can be found in the appendix of this report. Workshop materials, including the agenda, presentations, participant list, and discussion notes, are available at the following web site: http://www.serdp-estcp.org/workshops/ecosystems/index.cfm. At this site, links can be found to a variety of additional materials and related sites, including Conserve Online, which contains ecosystem services presentations, references and other materials from several different TNC workshops.

The main outcome of the workshop was the identification of seven research priorities for using ecosystem services approaches to improve environmental management and conservation planning on military lands. The research priorities identified included:

1. Inventorying ecosystem services
2. Incorporating ecosystem services into military decision-making processes
3. Operationalizing environmental management

4. Forecasting ecosystem services
5. The importance of an ecosystem service valuation process to military planning
6. An ecosystem services-based decision support system
7. An accounting framework for ecosystem services

These priority research areas are described in this report, along with their significance and recommendations for their next steps.

II. ECOSYSTEM SERVICES AND MILITARY LANDS: RESEARCH PRIORITIES

During the workshop, seven research priorities were identified as essential for effectively incorporating ecosystem services into military environmental management decision-making and conservation planning. These seven research priorities were: (1) inventorying ecosystem services; (2) incorporating ecosystem services into military decision-making process; (3) operationalizing environmental management; (4) forecasting ecosystem services; (5) the importance of an ecosystem service valuation process to military planning; (6) an ecosystem services-based decision support system, and (7) an accounting framework for ecosystem services. The workshop concluded that a more complete understanding in each of these areas was essential for an ecosystem services approach to succeed.

To fully capture the issues associated with each research priority, teams of workshop participants volunteered to write brief reports on each research priority, including background information, issue significance, and recommendations for next steps. These reports are summarized below. It should be noted that there is some overlap in the research requirements for each areas. These overlaps should be acknowledged when the actual research is designed in order to avoid duplication of effort.

1. Inventorying Ecosystem Services

Authors: Marc Hewitt, Dan Friese, Len Hirsch, Bill Tate

Background

Ecosystem services management provides an additional tool to the Department of Defense's ability to sustain mission requirements and protect the environment. Understanding the different ecosystem services (grouped as: **provisioning services** such as food and water; **regulating services** such as regulation of floods,drought, land degradation, and disease; **supporting services** such as soil formation and nutrient cycling; and **cultural services** such as recreational, spiritual, religious and other nonmaterial benefits)[2] and how they are perceived, managed, and used in and around installations is the first step for effective management. Managing these services can allow DoD to mitigate or prevent the impacts of encroachment on installations. Leveraging ecosystem credits or assets such as wetlands can create buffers against encroachment or provide flexibility to meet new and changing mission requirements. **Knowing what services are available on or around an installation and how those services interact with mission and community requirements is essential to being able to manage them.**

[2] Millennium Ecosystem Assessment Conceptual framework.

1.2 Significance

DoD cannot effectively manage ecosystem services/assets without a full understanding of what or how much it has and how it fits into the larger ecosystem. DoD's installations and ranges must be able to meet current and future mission requirements. Encroachment pressures will continue to grow at the same time as mission requirements evolve and new weapon systems are developed and fielded. DoD needs to know what ecosystem services are where, how much are needed for particular missions, what the mission dependencies are, and what the testing/mission impacts on ecosystem services are. Accurate decision making, management, and forecasting cannot be accomplished without a baseline inventory of ecosystem service assets.

Increasing pressure from encroachment and development of rural lands has stimulated military installations to establish buffers and wildland or rural corridors to maintain mission capabilities within and among installations. Understanding the ecosystem services required to effectively manage lands within installation boundaries will aid in (a) acquisition decisions for buffer or corridor lands, (b) creation of management or landowner partnerships, and (c) efficient utilization of resources to more effectively maintain mission flexibility and future needs.

Inventorying ecosystem services will provide critical input for the other six research areas.

1.3 Recommendations

- Define ecosystem services/assets based on the Millennium Assessment approach
- Identify current methods for identifying and tracking ecosystem services/assets
- Research and list the methods DoD is currently using, and provide a high-level analysis of their effectiveness
- Perform a systematic survey of other organizations'/agencies' ecosystem services inventory methods and what ecosystem services they are trading, including other federal, state, local, or non-governmental organizations – understand what they are doing and what lessons can be learned
- Identify objectives of a desired inventory and how it would be used
- Perform gap analysis to identify focus areas for improvement – gap analysis should look at the differences between the current inventory and tracking methods and the objectives of a desired inventory method
- Design recommended architecture, including data elements, data definitions, and data relationships – identify where data comes from, what processing is required, and who is responsible for what
- Utilize 1-3 environmentally diverse/unique pilot installations for development of inventory tracking
- Test the recommended architecture to see how well it functions and whether it supports the desired inventory objectives
- Assess ease of implementation and use of the recommended architecture

2. Incorporating Ecosystem Services into Military Decision-making Processes

Authors: Elizabeth Keysar, Vernon Compton, Debbie Keller, Bert Bivings

2.1 Background

Due to the complex nature of decision-making and difficulty inventorying and quantifying ecosystem services, the contribution of ecosystem services to sustaining the military mission is often not fully incoporated into DoD decision making. Loss of ecosystem services both within the military and in the outside communities may compromise the long-term sustainability of the military mission.

The decision-making context is influenced by a matrix of factors including:

- Present and potential future mission requirements
- Compliance with federal laws
- Fiscal constraints in current and out years
- Political ramifications of either land or easement acquisition
- Negative perception of environmental requirements
- Lack of needed scientific data
- Poor definition of how military needs are supported by ecosystem services

2.2 Significance

In order to ensure realistic training to mission readiness over the long term, successful maintenance of critical built and natural infrastructure is required. The natural infrastructure includes important ecosystem services that are related to the condition of air, land and water resources, as well as the availability of noise and smoke buffers, frequency spectrum and air space. Installation training, land use, and conservation decision makers must navigate a complex milieu of training requirements, scientific data, legal and fiscal constraints and stakeholder interests. The ability to successfully incorporate ecosystem services into this context requires a better understanding of these factors in order to enable the prioritization of investments and improve long-term outcomes for the mission, community and environment.

2.3 Recommendations

The recommended research will "map" the decision-making context at a sample of installations to describe the context and identify which factors are the most critical in relation to incorporation of ecosystem services. The research objective will be to identify and prioritize areas where improvements can be made to this system such as: 1) addressing critical data gaps (what are the ecosystem services, what is the condition, etc.); 2) modifying existing polices or creating new policies to address the value of ecosystem services, 3) forming partnerships with outside stakeholders for improved relationships and information sharing, and 4) improved articulation of mission requirements for stakeholders outside of the training community. It is important to note here that overlaps with the inventorying ecosystem services research priority and other research priorities will require some coordination.

The research will collect data to advance the awareness and appreciation of critical decision-making processes that impact ecosystem services at the installation and regional scale to include both internal and external processes. The research will answer questions such as:

- How will the concept of ecosystem services be incorporated? What value will this add to supporting the mission?
- How will understanding of ecosystem services help in fiscal allocation decisions?
- Who are the key decision makers and in what format do they need the information?
- How can transparency of the critical decisions be ensured?
- What steps can be taken to improve the process and thus the outcomes?

Research method may be a case-study format at one installation from each Service, for a total of 4, selected with input from Regional Environmental Officers. Findings will be briefed back to the case study locations as well as to key DoD stakeholders in the ranges, environmental and planning functional areas.

Success will depend on institutional knowledge of long-term civilian employees and military personnel that have constrained schedules. Many of the important study participants may have already retired, or moved on to other roles within the military or private sector. Outside-the-fence line input will require coordination through respective Service HQ and the Office of the Secretary of Defense.

3. Operationalizing Environmental Management

Authors: Tom Heffernan, Elizabeth Keysar, Disel Hinkle

3.1 Background

Cultural and language gaps exist between the Range Commanders at DoD installations and the scientific community that performs research in support of the military readiness activities these Commanders support. As a result of these gaps, institutional knowledge of past successes and failures is not passed on to new leadership and Range Commanders do not benefit from past experience. Another problem is that the importance of ecosystem services to supporting the mission is not articulated in a manner that can be understood and applied. As a possible consequence, short-term decisions may be made that could jeopardize the long-term sustainability of ranges supporting military readiness activities.

3.2 Significance

Range Commanders are held accountable to their headquarters and range customers to provide a safe, efficient and highly capable test and training infrastructure, available when and where needed to support the ever-changing needs of our war fighters. Scientists are held accountable to peers in their specific disciplines to follow solid and defensible research methods that test theories, develop data and gather knowledge that can be used to address specific questions, particularly those related to military readiness activities (test and training). Both of these skill

sets and cultural foundations are needed to successfully support, schedule and conduct military readiness activities on DoD ranges and installations. As is the case with any highly specialized functional roles, there are challenges in communicating information between these subject matter experts. A common language is needed to bridge the gap between the operational commanders and the natural resource scientists such that mission needs are communicated to scientists in a manner they can integrate into their assessments and inventories. Likewise, a common language is needed so that scientists may communicate indicators of ecosystem health to operational commanders in a manner that enables comprehension and application of this data to benefit sustainment of the range. These ecosystem service observations must be couched in terms that the range commander can take and operationalize, i.e. boots on the ground, rubber meets the road, pass the "so what" test.

3.3 Recommendations

Effective communication will rely on generating "bi-lingual" professionals with diverse backgrounds that allow them to pass seamlessly between the two communities, speaking their language, exhibiting their customs, and objectivity contributing to discussions on range use at installations. These professionals will also need access to information that can link military readiness activities to ecosystem services in a manner that "speaks to" both communities.

Critical research gaps that should be addressed include:

- *Characteristics of the "bi-lingual" professional in the DoD:* Do these professionals already exist? Where are they? How did they successfully emerge into this cross-functional role? If they do not exist, how can DoD develop these professionals in the future? Why are there so few of them?

- *Case-study information:* What are some of the important "lessons learned" related to this cultural and language gap? What/where are cases when effective communication across these barriers improved outcomes? Likewise, what/where are cases when communication did not occur and outcomes were less favorable? What is the most effective way to relay this case study information to the desired audience once the case studies have been assembled?

Implementation of research should include:

- Survey to identify "success stories" – these should lead to the "bi-lingual professionals" (or other factors that enabled success) – Alternatively, focus on one major installation over time; this will get at both the good and not-so-good cases
- Detailed data collection at relevant locations
- Develop database and populate
- Present findings at several installations, conferences, etc. "Get the information in the right hands"

It must be noted that collecting information on the "less than favorable" cases is difficult; we would not want to compromise the installation staff and/or leadership by reporting on

"failures." Yet it is from these hard lessons that the some of the best data for improvement can be obtained. Success will depend on institutional knowledge of long-term civilian employees and military personnel engaged at the time. Many of these may have already retired, or moved on to other roles within the military or private sector.

4. Forecasting Ecosystem Services

Authors: Doug Bruggeman, Tim Hayden, Jesse Borthwick

4.1 Background

Rigorous forecasting models will be required to estimate the benefits of sustaining ecological structure and function on and near military installations to achieve military readiness and environmental sustainability. Land use decisions will have impacts on ecosystem services at local (e.g., water quality), regional (e.g., biodiversity), and global (e.g., carbon sequestration) scales. Predicting the influence of land use decisions on ecosystem services at multiple temporal and spatial scales represents a significant challenge. An equal challenge, but more critical task, will be making forecasting models available to decision makers.

4.2 Significance

The primary purpose of military installations is to provide the land, water and air spaces necessary to support DoD's training, testing and deployment missions. From a mission perspective, sustainable natural environments on DoD installations provide realistic training opportunities, buffers for weapons deployment, and mitigation of impacts on external communities. A secondary outcome of providing sustainable natural environments in support of mission activities is the protection of natural resources. Military installations significantly influence local economies that also rely upon sustainable natural resources. Enhanced capabilities to forecast the dynamic interactions of ecosystem services as a function of external and internal environmental, economic and social factors will help inform DoD natural management and policy decisions that affect the sustainability of military installation mission support functions.

4.3 Recommendations

A landscape-scale approach will be required to forecast the interactions among military training, commercial/residential development, and the provisioning of ecosystem service. A landscape can be described as a geographic unit including "multiple and interacting ecosystems" (Crow, 2002, pg 353). The fundamental unit of a landscape is a patch, which can be characterized based on vegetative communities present (e.g. emergent wetland, prairie, or Longleaf pine-wiregrass savannah) (Liu and Taylor, 2002). Landscape structure (pattern) results from the interaction of the size, shape, arrangement, and composition of patches within the landscape (Crow, 2002). The level of interaction among patches determines the quality of landscape functions, which include the flow of energy, materials, genes, and organisms across space (Crow, 2002; Liu and Taylor, 2002).

Models used for forecasting must be complex enough to simulate changes in landscape structure over time but simple enough to inform policy decisions. For example, model feedback loops should be specified such that: (a) the change in ecosystem structure and/or function in one patch effects ecosystem function and/or structure in another patch -- multiple models should be used to determine which feedback loops are important and which can be safely ignored, and to assess level of uncertainty in model forecasts (Grimm et al, 2005); and (b) the change in land use in one parcel affects the economic value, contribution to training, or ecosystem function and structure of another parcel.

Armsworth et al (2006) use an ecological-economic model to describe how protection of habitat increases the real estate value of land. However, the ecological component of the model was simple and did not include dynamic feedback mechanisms between changes in biodiversity at one patch and changes in biodiversity in other patches over time. Specifying feedback loops is critical for evaluating policy decisions that change landscape structure over time. The response of landscape function to changes in structure will often depend upon past events (Tillman et al., 1994). Therefore, researchers should demonstrate how they will build models to reflect landscape history, how the models will be verified with existing data, and how they can be validated with new data collected as policy decisions are implemented and landscapes change (Walters 1986).

Similarly, models incorporating feedback between ecosystem services the market value of land (Armsworth et al. 2006) impart realism needed for policy evaluation. An analogous issue for military lands is that the protection of ecological services within military boundaries and adjacent lands will often contribute to sustaining military readiness. For example, replicating natural fire cycles through prescribed burning on southeastern U.S. installations supports maintenance of biodiversity while enhancing access to lands for military training. Incorporating feedback mechanisms between military readiness, local economies, and ecosystem services should lead to resilient patterns of human and natural capital across the landscape.

5. The Importance of An Ecosystem Service Valuation Process to Military Planning

Authors: Mike Applegate, John Fittipaldi, Len Hirsch

5.1 Background & Significance

Disparate national, multi-agency policies and historical local and regional land-use decisions have resulted in encroachment around Defense bases and installations. The ecosystem services approach may provide additional leverage and opportunities to build long-term strategic plans for installation support and survival. It can help to answer questions like:

- What methods does the Secretary have to ensure that the integrity of DOD National level training areas are not piecemeal leased or loaned away to local communities and state government by local commanders

- What is the 50 year strategy for such training areas?
- How are environmental and natural resources factored into the local decisions and how does that coincide with national policy?
- What is the affect on natural and managed ecosystems, species diversity and endangered species management under the Integrated Natural Resource Management Plan?

5.2 Recommendations

1. Determine the effects of selected past decisions on present day and future missions to "excess" or lease range and installation lands. (For example, there are currently national policies, letters, instructions and other directives for installations to avoid encroachment, yet there are also policies directing or authorizing commanders to implement enhanced use leasing on a 50 year lease basis to non governmental entities to obtain cash flow at the installation to supplement underfunded installation budget requirements.)
   - Use aerial imagery and maps to view encroachment and land losses
   - Use past practices to build a model predicting the effects of disparate land use policies on out year strategic military range requirements
   - Determine the strategic implications by comparing potential future weapons systems anticipated land requirements
   - Determine what processes are in place for installation commanders/other decision makers who are on short term assignments to factor in long range future national requirements on their local decisions

2. Assess how natural resource (asset) management is factored in decisions determining which lands are underutilized and available for lease and whether the ecological services should be a factor in lease decisions. Understand the implications to endangered species, mission flexibility, Sikes Act managed resources, public access to natural resources of privatization from enhanced use leasing.

3. Determine how best to convey these issues to the non-biological scientist decision maker and assess the opportunities for stacking ecosystem services.

6. Ecosystem Services-Based Decision Support System

Authors: Analie Barnett, Elizabeth Keysar

6.1 Background

The DoD owns or manages over 30 million acres of land which includes installations, test and training ranges, and auxiliary fields. This land is important and valuable to the military mission, environment, and neighboring communities. Management of the military's natural resources entails the assessment of trade-offs between mission requirements (e.g., airspace availability), regulatory constraints (e.g., Endangered Species Act, Clean Water Act), and the

needs of neighboring communities (e.g., noise abatement, water supply). With mounting pressure on the military's natural infrastructure from encroachment and other threats, shortcomings in the military's current approach to natural resource management decisions are evident.

First, decisions are often made at a small spatial and temporal scale. Natural infrastructure management often occurs at the installation and range scale, is opportunity-driven, and fails to consider the larger regional military context and a long-term perspective. Second, natural infrastructure decisions are made using a cost-benefit approach that rarely captures the value of ecosystem services. In order to sustain DoD access to natural resources at the installation, regional, and national scales in the face of growing threats such as encroachment, the military needs a large-scale, long-term, and strategic approach that incorporates ecosystem services to inform future natural infrastructure decisions.

Such an approach could be captured in a web-based spatially-explicit decision support system (DSS) that would enable military decision-makers and natural resource managers to inventory a core set of ecosystem services at multiple scales, account for the value of multiple services, weight different services and incorporate this information into subsequent cost-benefit analyses to illuminate hidden benefits as well as hidden costs (e.g., lost access). Important scales available for analysis in the DSS would be the installation and surrounding areas (e.g., installation buffers), regional level (e.g., air and ground space corridors), and the national level (e.g., existing natural infrastructure capability and future needs). For example, military decision-makers might submit the spatial location of proposed air corridors for the southern US into the DSS, and then overlay priority conservation areas from nongovernmental organizations (NGOs) and state environmental agencies to align ecosystem services and military needs. The value of the ecosystem services captured in the potential air corridors could be a key factor in evaluating the different routes in a cost-benefit approach. Data to populate the DSS would consist of nationally-available free spatial data (e.g., National Land Cover Data (NLCD), conservation assessments, National Hydrography Dataset (NHD), LandFire, National Elevation Datasets, GAP Analysis Data, etc.), satellite imagery (Landsat Thematic Mapper), and would be supplemented by military and conservation spatial data available at local and regional levels. The DSS would ultimately allow the military to use ecosystem services to help prioritize acquisitions, protection efforts, and weigh the trade-offs of different decisions.

6.2 Significance

A multi-scale, spatially-explicit, and ecosystem-services accounting DSS would inform the military's long-term strategic planning and decision-making regarding natural infrastructure, thus helping to sustain military missions into the future while also protecting valuable natural resources. It would strengthen military partnerships with state and federal environmental agencies as well as national, regional, state, and local conservation organizations. In addition, such an approach would help identify additional funding sources and likely increase funding opportunities. For key military personnel, the DSS would better link natural resource

management to mission success and provide a common language with which to communicate to the public and internally. In addition to maintaining existing ecosystem services, it could be used to identify promising ecological restoration opportunities. If available to the public or impacted communities, the DSS would promote stakeholder and community involvement in military decisions and illustrate the importance of provide ecosystem services to local communities.

6.3 Recommendations

a) Research Gaps

i. Identify core set of ecosystem services common to military installations and applications
   - How to inventory these services using readily available spatial data and satellite imagery
   - How to appropriately capture the value of core ecosystem services using
   - Readily availably spatial data (e.g. relative value, EBI, benefit transfer analysis)
   - Multiple services that operate at different scales
   - Determine how to stack
   - Develop weighting system to evaluate tradeoffs (e.g. manage for RCW or for C sequestration)
   - How to forecast changes in the delivery of ecosystem services due to land use changes, climate change and other threats
ii. Research existing ecosystem services tools and new tools being developed to learn how others are approaching the above questions

b) Partnering opportunities

- National, state, and local conservation organizations
- State and federal natural resource management agencies
- Universities
- DoD and Service-level Research and Development agencies (i.e. ERDC/CERL)

c) Implementation steps

i. Address research gaps
ii. Convene a workshop with upper level military staff and potential partners to identify key information to be delivered by the decision support system
   a. Draft workflows – how users will interact with the DSS
   b. Identify desired functionalities
   c. Identify desired DSS outputs
   d. Define users and access community
iii. Develop the framework for the web-based spatially-explicit decision support system; propose how the system would be maintained over time, who would 'own' the system, and how it would be populated and paid fo

iv. Conduct a pilot study – populate the DSS for a given region to demonstrate and validate the system. This system will be expensive to operate and maintain, so it will be necessary to demonstrate the cost-savings or cost-avoidance that can be achieved through its use

7. Accounting Framework for Ecosystem Services

Authors: Richard Pinkham, Bill Goran, Len Hirsch, Kelly Burks-Copes

7.1 Background

For some years, public and private institutions have worked to expand the concept of the "bottom line" to encompass environmental and social results of policies and decisions in addition to the financial/economic bottom line. Others have modified this so-called "triple bottom line" framework to encompass other goals. For instance, the U.S. Army promotes a triple bottom line concept defined by mission, environment, and community (Army Strategy for the Environment, 2004). Operationalizing these concepts has been difficult because the biophysical, economic, and social accounting systems to track the multiple values provided by ecosystem services are poorly developed. Accounting frameworks and systems are needed that adequately and efficiently encompass the full range of values provided by ecosystem services.

7.2 Significance

Effective policy mechanisms to protect and enhance ecosystem services are contingent upon proper accounting of the values the services provide. Without good measurements of value, policy design rests on theory rather than empirical results. This is particularly a concern for market mechanisms that incentivize landowners to preserve, enhance, restore, or create certain environmental conditions. One important issue is the inability of current approaches to account for multiple values in order to determine the appropriateness of "stacking" multiple types of environmental credits on single parcels of land. For instance, a wetlands restoration project might also produce a restored stream channel, reductions in nutrient enrichment of water bodies, new or improved endangered species habitat, and carbon sequestration. These benefits might justify award of credits under wetlands mitigation banking, water quality trading, stream mitigation banking, habit conservation banking, and carbon trading programs. At present, regulations either prohibit stacking or are vague on its permissibility, in part because of policy issues regarding "double-dipping," and also because weaknesses in ecosystem service accounting reduce certainty in benefit measurement.

The lack of clear and practical ecosystem service accounting standards limits DoD's ability to: a) measure the impacts (positive and negative) of its actions on ecosystem service values, b) make sound trade-offs between mission, economic, environmental, and social implications of decisions, and c) obtain full credit for actions that protect or enhance multiple ecosystem service values. Missed opportunities to gain credits result in increased costs to mitigate future impacts, or loss of income generation potential from the selling or leasing of credits.

7.3 Recommendations

DoD and its contractors and partners should follow closely the ongoing developments in the fields of environmental accounting and environmental indicators. This would include follow-up to a workshop on development of national environmental accounts convened by GAO and the National Academy of Sciences in 2007, and the June 2008 announcement by OMB, CEQ, and the White House OSTCP of a joint directive to Federal Agencies charging them to pilot test water quality/quantity programs designed to generate environmental status and trend indicators. Developments in these fields will have direct relevance to environmental accounting for ecosystem services, including some overlap into economic and social accounting. In addition, DoD could pursue or participate in resolution of a number of key research and development questions:

- How can ecosystem services be linked to mission capability and mission success? What accounting framework is needed, and what indices or other metrics of ecosystem service flows can be tracked to determine the contribution of different services to mission success and the impacts of DoD actions on services? What metrics provide the best predictive power and therefore the best handles for assessing future impacts of current decisions?
- What types of decisions are most important to address with a "triple bottom line" approach? Design of frameworks and metrics may be best driven by application to the most pressing decision making needs.
- What sources of data can be used? This should include data DoD currently gathers or has access to, and other readily available sources that could be tapped.
- How can non-economic values be incorporated into DoD's methodologies for analysis of alternatives?
- What methodologies for multi-objective decision making are practical for DoD, or could be adapted to meet DoD requirements?

III. CONCLUSIONS AND NEXT STEPS

The initial goals of the workshop were: (a) review what is currently being done and what approaches and tools are available; (b) produce a conceptual framework to help identify issues and information gaps; (c) identify priorities for research; (d) determine how ecosystem services can be applied in environmental management and conservation planning; and (e) consider how emerging markets for ecosystem services may affect our activities. To varying degrees, the workshop was able to achieve all of these objectives. During the first day we reviewed current work and available approaches and tools. We were able to take that information and discuss it within a conceptual framework in order to identify issues and information gaps. This enabled us to identify priorities for research to determine how ecosystem services can be applied in environment management and conservation planning on military land. The research priority areas include consideration of how emerging markets for ecosystem services may affect activities on military lands.

The identified research priorities, as described in this report, identify the next steps for determining how the military can incorporate ecosystem services into every day decision-making. There is much overlap amongst the identified research priorities and therefore it is important that they are part of an overall research strategy. Further design of each research priority will require an assessment of overlap with the other research priority areas. In particular, the "Inventorying Ecosystem Services" research priority provides critical inputs to the other six research priority areas. As a broader research program is designed, the objectives of the program should reflect how each research priority area contributes to the higher goal and complements the work of the other research priority areas.

IV. REFERENCES

Armsworth PR, GC Daily, P Kareiva, et al (2006) Land market feedbacks can undermine biodiversity conservation. Proceedings of the National Academy of Sciences 103: 5403-5408

Crow, T.R. 2002. Putting multiple use and sustained yield into a landscape context. Pages 349-365 in J. Liu and W.W. Taylor (eds.) Integrating landscape ecology into natural resource management. Cambridge University Press, Cambridge

Grimm V, E Revilla, U Berger, et al (2005) Pattern-Oriented Modeling of Agent-Based Complex Ecosystems: Lessons from Ecology. Science 310: 987-991

Liu, J., and W.W. Taylor. 2002. Coupling landscape ecology with natural resource management: Paradigm shifts and new approaches. Pages 3-19 in J. Liu and W.W. Taylor (eds.) Integrating landscape ecology into natural resource management. Cambridge University Press, Cambridge, UK

Tilman, D., R. M. May, C. L. Lehman, and M. A. Nowak. 1994. Habitat destruction and the extinction debt. Nature 371:65-66.

Walters, C. 1986. Adaptive management of renewable resources. The Blackburn Press, Caldwell, New Jersey, 374 pp.

APPENDIX 1: WORKSHOP AGENDA

April 15: The Framework

8:30 – 8:45 **Welcoming comments:** Mike Applegate, John Hall, Belinda Morris

8:45 –9:45 **The conceptual foundation of ecosystem services** (Belinda Morris, coordinator)

- Ecosystem services overview: What are ecosystem services, the Millennium Ecosystem Assessment, and attempts to value ecosystem services (Matthew Wilson) (20 min)
- The science: What do we know and what do we need to know (Analie Barnett) (20 min)
- Market-based approaches, opportunities, and challenges (Belinda Morris) (20 min)

9:45 – 10:00 Break

10:00 – 11:00 **The DoD context** (Bill Goran, coordinator)

- Military mission priorities as they relate to land use and land stewardship (Marc Hewett) (15 min)
- Mission priorities at Eglin (current and transforming) and relationships to ecosystems (Jesse Borthwick) (15 min)
- Ecosystem services: how the military are starting to approach emerging markets and ecosystem services concepts, plus barriers for the military in engaging with ecosystem service markets (Elizabeth Keysar) (15 min)
- DoD Natural Infrastructure Management initiative – relationship of capability assessments and valuation to ecosystem services (Richard Pinkham) (15 min)

11:00 – 11:45 **The TNC context** (Belinda Morris, coordinator)

- How are ecosystem services being incorporated into TNC's conservation planning? (Belinda Morris) (20 min)
- Some specific examples: Eglin AFB and the Lower Mississippi River (Analie Barnett) (25 min)

11:45 – 12:45 Lunch

12:45 – 1:30 **How are other agencies viewing and using ecosystem services?** (Bill Goran/Richard Pinkham, coordinators)

- EPA (Virginia Engle) (10 min)
- US Fish & Wildlife Service (Richard Gooch) (10 min)
- Corps of Engineers (Kelly Burks-Copes) (10 min)
- Smithsonian Institution, Federal Interagency Ecosystem Services Task Team (Leonard Hirsch) (10 min)

1:30 – 3:00 **What tools are available to assess and value ecosystem services?** (Richard Pinkham, coordinator)

- Mapping ecosystem services using benefits transfer data (Matthew Wilson) (15 min)
- Ecological Benefits Indicators (Richard Pinkham) (15 min)
- Tools being applied in the Coastal Carolinas (Dorsey Worthy) (15 min)
- Tools applied along the Rio Grande in New Mexico (Kelly Burks-Copes) (15 min)

- National scale wetlands ecosystem services tools under development by EPA (Virginia Engle (15 min)
- NatCap Project tools (Belinda Morris) (10 min)

3:00 – 3:20 Break

3:20 – 4:15 **Some specifics on Eglin AFB and its surroundings** (Mike Applegate, Jesse Borthwick, and Vernon Compton)

4:15 – 4:45 **A conceptual framework to help identify issues and information gaps and enable hypothesis testing** (John Hall)

4:45–5:15 **Discussion and background for tomorrow's field trips**

April 16: The Realities

1. Field trips to areas in and around Eglin AFB, focusing on how ecosystem services are produced and distributed and the benefits to multiple stakeholders. Details are attached.

2. Reconvene in late afternoon to share impressions, begin the identification of emerging issues and insights, and provide questions for folks to think about as they drift off to sleep.

April 17: Pulling It All Together

(John Hall, Bill Goran, Richard Pinkham, Belinda Morris/Analie Barnett, coordinators)

8:00 – 9:45 **The Local Context**

- Presentation of three issues at Eglin AFB as starting point for discussing the needs and opportunities for applying the ecosystem services concept at Eglin and other installations

9:45 – 10:00 **Break**

10:00 – 12:00 **Identification and prioritization of research needs**

- Identify and expand upon key themes that emerged from the local context discussion
- Prioritize research needs

12:00 – 1:00 **Lunch**

1:00 – 2:00 **Refinement of the conceptual framework, development of an implementation plan, and next steps**

2:00 **Adjourn**

APPENDIX 2: WORKSHOP SUMMARY

Day 1

Many informative presentations were delivered that generated interesting questions and set the stage for subsequent discussions during the workshop. PDF files of the presentations can be downloaded at the following web site:
http://www.serdp-estcp.org/workshops/ecosystems/presentations.cfm

Day 2

Participants chose from two different field trip options to observe the variety of ecosystem services provided by Eglin AFB. In addition to enjoying beautiful weather, participants continued the first day's discussion regarding the issues and challenges associated with incorporating ecosystem services into military decision-making and environmental management.

Day 3

The third day was broken into three major sessions.

Session 1:

In the first session, Jesse Borthwick of Eglin AFB presented the following three issues specific to Eglin, as starting points for discussion.

1. How to determine Return on Investment (ROI) and value of ecosystem services within AFB boundary as it relates to mission?
2. How to get the highest ROI for protecting buffers?
3. How to prioritize protection of airspace and groundspace corridors at the regional scale?

During the discussion, participants were asked to keep the following questions in mind.

1. What do we know?
2. What do we need to know?
3. What can we do next?

Session 2:

The following six key thematic areas emerged from the Session 1 discussion and were further discussed by participants during the second session.

1. Ecosystem services accounting
2. Stacking of multiple ecosystem services
3. Forecasting
4. Scenarios
5. Tools
6. Linkages (i.e., communication translation, decision-making process)

Session 3:

Based on the discussions in Session 2, each participant was asked to identify and expand upon what they thought was the most important research priority. The following seven key priorities were established by the group:

1. Inventorying ecosystem services
2. Incorporating ecosystem services into military decision making process
3. Operationalizing environmental management
4. Forecasting ecosystem services
5. Show importance of ecosystem service valuation process to military planning
6. Ecosystem services-based Decision Support System (DSS)
7. Accounting framework for ecosystem services

APPENDIX 3: LIST OF PARTICIPANTS

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