AREA 4

Sustainable forestry and biodiversity conservation require management that recognizes and adapts to new information, changing environments, and shifting social priorities.

Finding 4A
Management practices must adapt to evolving knowledge.

Forest landscapes are dynamic—forest uses and types will change. Policy and management must also be dynamic, able to effectively incorporate changing social values, new science, and improved practice. Because so much about how forests work is unknown or unknowable until the future reveals it, adaptive management is often advocated as the best way to advance knowledge while attempting to meet goals or solve problems. Adaptive management requires the full integration of science, management, and stakeholders in a process that treats policies and plans as if they were hypotheses and the forest practice or strategy is the experimental treatment (Holling 1978).

NCSSF Results: When NCSSF and NFF asked forest practitioners, managers, and policy makers what they needed to better address biodiversity and sustainable forestry issues, they identified three broad types of additional information as being of highest potential use. (NCSSF R4: *Users' Needs Survey and Workshops*)

- **Synthesized and highly accessible data** was the top concern for forest managers and forest policy makers, who saw a need to correlate different types and sources of data into an accessible "one-stop shopping" database, or a set of inter-related databases. This would include more common ecological classification systems to improve comparability and understanding, avoiding duplication of efforts.
- **Collaborative assessments**, involving all parties in monitoring and assessments, was a major concern for field practitioners. A more collaborative approach should also be used to make long-term predictions using all available information, with less time spent on legislative process. People also saw a need to include traditional ecological knowledge and recognize its worth.
- **Small-scale and site-specific information** especially on sites of significant value was most often mentioned in conjunction with the need for larger-scale analysis or collaborative work, making it important in the context of other broader types of data, information, tools, and approaches. Also important were better small-scale research on distribution of species and mixed-habitat ranges, and analysis at the micro-level (NCSSF R4).

BUREAU OF LAND MANAGEMENT

Finding 4B
Biodiversity conservation requires traditional forestry and more.

Adaptive management can work only if accompanied by aggressive, adequately funded monitoring programs based on clear working hypotheses that provide a steady flow of data for management decision making.

For example, NCSSF-funded research projects A1 and A4 respectively call for early detection systems for invasives and participatory monitoring and inventorying systems for non-timber forest products. But these systems will only be useful if interactive, up-to-date databases make this information easily accessible.

Thus far, the success of adaptive management has been limited by its inherent need for cultural change in both scientific and management communities (Stankey et al 2003) and the need for all involved to be willing to take risks through bold actions that may create errors or undesired outcomes (Wildavsky 1988). Table 5 indicates some key differences between scientists and policy makers in addressing issues. ■

NCSSF surveyed forestland owners and managers nationwide about their forest management and biodiversity practices, with an eye toward their selection and use of indicators for biodiversity conservation. Several interesting outcomes were identified. Most landowners and land managers surveyed believe the effects of their management on biodiversity are an important consideration. Practices aimed at protecting diversity are strongly influenced by other landowner objectives.

NCSSF Results: Nearly two-thirds of the landowners and land managers surveyed believed their biodiversity program to be successful and sixty percent of respondents felt their biodiversity program was mostly implemented (NCSSF A3). In contrast, the most commonly measured and monitored features of traditional forestry that respondents described as biodiversity indicators are NOT congruent with good indicators for biodiversity as found in the NCSSF A8 project results.

NCSSF researchers believe that to be successful, you need a broader suite of indicators (NCSSF A8).

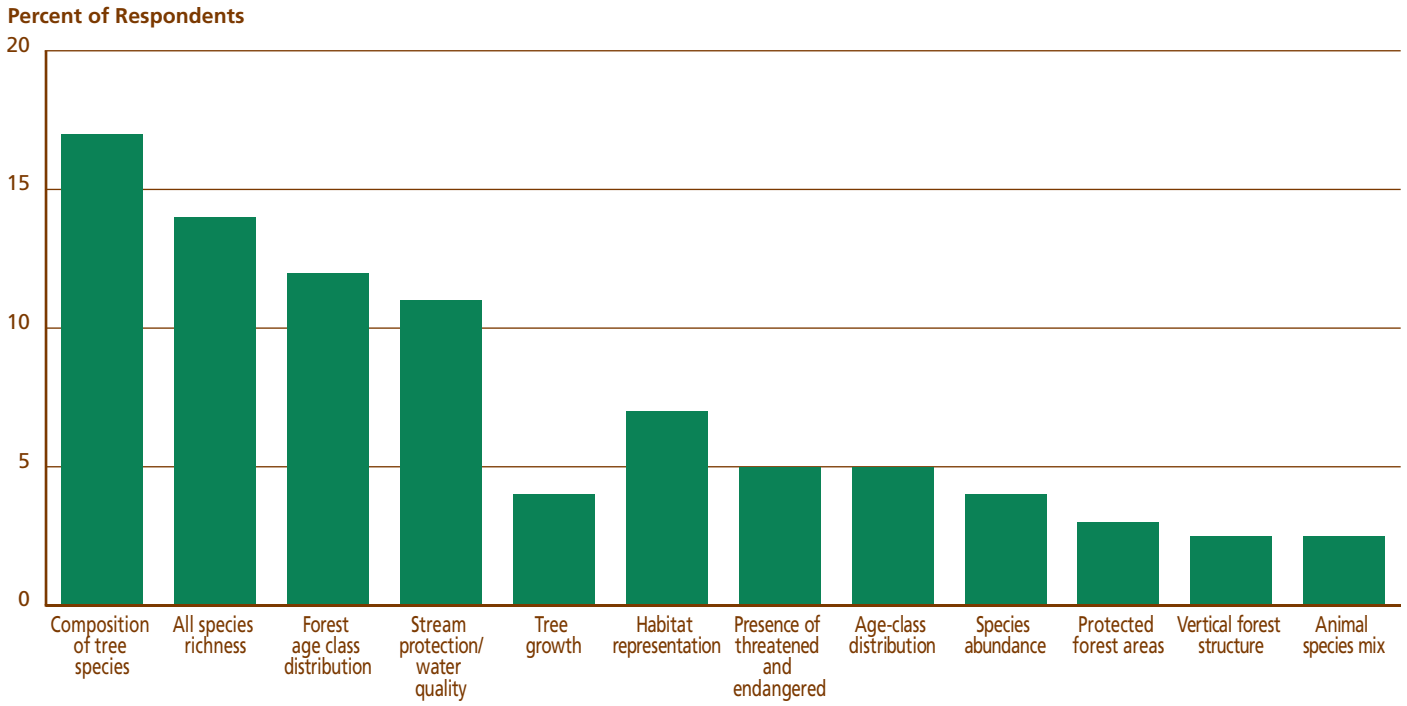
This illustrates the new use of biodiversity indicators in forestry and the general lack of knowledge about effective selection and use of these indicators by forestry practitioners. Respondents most often considered timber inventory, tree species composition, age-class distribution, and stand structure to be important indicators for successful biodiversity programs, as well as ecosystem/habitat protection and protected areas provided by federal and state laws or regulations. Fragmentation wasn't considered to be important. Respondents who believed they had more successful programs tended to use more indicators. Figure 6 shows biodiversity indicators cited as "most important" by survey respondents.

As highlighted in Finding 3, good indicators address pressures and policies related to the resource, in addition to measurable conditions. Good indicators also must be based on composite ecological breadth, practicality, relevance, scientific merit, and usability characteristics. Table 2, "Important Indicators Identified by Functional Characteristics," offers a sampling of indicators across a range of characteristics. Finally, selecting effective indicators requires consideration of clearly stated, specific biodiversity conservation objectives. ■

Table 5
Contrasting Cultures of Scientists and Policy Makers (after Bernabo, 1995)

Science	Policy
Incremental Progress	Deadlines and Crises
Objective Facts	Subjective Values
Proof	Beliefs
Measurements	Perceptions
Theory and Models	Applications and Results

Figure 6
Most Important Indicators Used



Finding 4C
Forest management under different ownership types has implications for biodiversity.

BUREAU OF LAND MANAGEMENT

NCSSF research on land use in the Southeast has identified two different forest management approaches based on whether the owner is economically or conservation oriented.

NCSSF Results: Economically oriented private forest landowners in the South need strong incentives for reducing biodiversity impacts of harvesting and site preparation on more intensively managed stands, and for enhancing non-timber and non-game wildlife attributes of existing forests. Conversely, one of the biggest threats to the forests under conservation or recreation oriented-landowners is development, which is increasing land values and pressures to show economic return.

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Regulatory policies that reduce the uncertainties and risks associated with endangered species protection, such as US FWS Safe Harbor, conservation programs that pay for "set-asides," such as the USDA Conservation Reserve Program, and conservation easements have been effective in encouraging retention of habitats for endangered species (NCSSF B1.2: *Land Use History Impact on Biodiversity: Implications for Management Strategies in the Southeastern US*).

Many economically oriented landowners in the South are actively managing to keep endangered species off their property. The Safe Harbor program provides a mechanism for maintaining habitat for the federally endangered red cockaded woodpecker while guaranteeing landowners use rights for their property. Many landowners in the Carolinas and Georgia participate in this program and view it as a positive response to many negative incentives for endangered species management by private landowners. There was more fear of endangered species among private landowners in Alabama, a state that does not participate in Safe Harbor, than in either Georgia or the Carolinas. For example, the growth of colonies of red cockaded woodpeckers in the Conecuh National Forest in South Alabama has caused many neighboring longleaf pine landowners to alter their management to prevent the woodpeckers from establishing colonies on their land. The introduction of the Safe Harbor program in this area could help in the expansion of red cockaded woodpecker colonies onto private lands. (NCSSF B1.2).

Many conservation- and recreation-oriented landowners are concerned about the long-term sustainability of their efforts to conserve biodiversity. In the Southeast, the life cycle of longleaf pine forests is longer than the human life span. Many landowners who have invested a great deal of time, energy, and money in managing and restoring longleaf pine forests worry about what will happen when they die. Land ownership frequently passes down through several generations, resulting in management by many family members under a variety of arrangements. It almost always takes consensus on management to keep these forests intact. When development pressures build, that consensus is much more difficult to maintain unless a conservation easement is in place. Estate taxes and less conservation-minded heirs can undo decades of work to build and maintain a healthy, diverse forest (NCSSF B1.2).

Although current policies and programs can encourage private landowners to retain endangered species habitat and enhance biodiversity, these incentives do almost nothing to encourage creation of endangered species habitat on private land. ■

Finding 4D

The increasing interest in and gathering of non-timber forest products has both positive and negative implications for sustaining biodiversity.

Non-timber forest products (NTFPs) are a significant part of forest biodiversity. They include thousands of wild or semi-wild forest species that occur throughout the United States on both public and private lands. Few forest managers are equipped to manage NTFPs effectively, as formal guidelines or inventory protocols are not generally available. Many NTFP harvesters have developed a keen awareness of life cycles, habitat, and availability of the products they collect, but this traditional knowledge is usually overlooked as a resource. Wider recognition of the credibility and value of this traditional ecologic knowledge could make it more useful in management strategies.

NCSSF Results: Limited research on the culture and ecology surrounding NTFPs and the general absence of inventory and monitoring programs on state and Federal land hinders conservation of non-timber forest product-related biodiversity. The impacts of removing fruits, cones, mushrooms, and medicinal plants is currently unknown, but could have a transforming effect—positive or negative—on forest biodiversity (NCSSF A4: *Assessment of Knowledge about Non-Timber Forest Products Management Impacts on Biodiversity*).

NTFP species and harvesting locations are declining as a result of development, road building, logging, grazing, and herbicide spraying. The impact of these forest management practices on NTFPs and the people who depend on them should be monitored and addressed. NTFP harvesting should no longer be ignored or considered a minor or special forest use. NTFP management needs more funding and increased staff responsibility and attention.

More research is needed to link the increasing use of NTFPs to forest biodiversity. Participatory inventory and monitoring programs for both direct biodiversity measures and indicators should be developed, implemented, and adequately funded, and the results should be used to determine if desired goals are being met. Effective monitoring may be based on a formal census of target species, or it may use informal tracking and recording of information collected in the course of other activities. In situations where NTFP harvesting adds value to a forest, encouragement of sustainable NTFP harvesting could also be an incentive to maintain working forest landscapes. ■

Finding 4E
Effective management requires access to accurate relevant information and decision support tools.

When NCSSF surveyed forest practitioners, managers, and decision makers, they identified the need for dynamic approaches and predictive tools to address biodiversity and sustainability issues.

Several participants identified the need to look at how forests are changing, and the impact that forest management alternatives, including no action, would have on such a dynamic system.

Both field practitioners and forest managers mentioned the need for predictive models and flexible approaches, such as virtual forest models that could simulate different management alternatives over time and models of relationships or responses of species to forest management.

Forest policy makers tended to mention improved scientific tools.

NCSSF Results: Many existing decision support systems (DSSs) can address components of forest biodiversity, but no DSS exists that is easily accessible and can be used to assess the probable impacts of alternative forest management options on biodiversity (NCSSF A10: *Evaluation of the Needs and Requirements for Decision Support Systems*).

Decision support systems (DSSs) are computer-based tools that can help land managers and other stakeholders simulate, evaluate, and/or optimize management alternatives. NCSSF supported a project (A10) that compiled more than 100 DSSs into an on-line searchable database and compared 30 of them with demonstrated forest-biodiversity applications to a set of decision-making needs identified by a panel of forest biodiversity experts.

The lack of widely accepted problem definitions seriously restricts wider use of traditional DSSs in forest biodiversity decisions. However, this problem could be addressed by incorporating indicator frameworks into DSSs from the Montreal Process and other governmental efforts as well as non-governmental certification systems such as those of the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI).

Most existing DSSs focus either on forest conditions or on wildlife. Linking these two types could provide managers with a broad range of biodiversity indicator classes. However, integration of basic types of information (biophysical, social, and economic) by DSSs is still limited, and few DSS options exist for assessing the effects on biodiversity of climate, biological agents (pests, pathogens, invasives), or fire.

Biodiversity problems span a multitude of ownerships, reflecting the range of the species and ecosystems of interest, but relatively few regional institutions exist that can make decisions at these scales. DSSs could help coordinate decision making at various scales, but few have explicit capabilities to do this or provide options for small landowners. Most DSSs that are most suitable for use in sustainable forest management are still prototypes and aren't easily accessible by managers. ■

Finding 4F
Biodiversity conservation theories require adaptive management to assess their validity.

Although biodiversity conservation theories abound, no single theory serves all biodiversity purposes. NCSSF-funded researchers analyzed and organized theories into the following clusters:

- reserve- and matrix-based approaches, which allocate land to preservation through passive or active management
- "Diversity Begets Diversity" and "Using Nature's Template" models that either undertake a diversity of forest management regimes or mimic patterns created by natural disturbance regimes
- fine filter (focused on species), medium filter (ecosystem elements), coarse filter (ecosystems), and hotspots (areas of high species richness) approaches
- patchworks, networks, and gradients as models of landscape configuration.

NCSSF Results: Given the complexity of conservation strategies, variability in field applications and costs, and challenges in validation and calibration, adaptive management with effective monitoring and evaluation of implementation is the only feasible way to test the designs and applications of various conservation theories. (NCSSF B.2 *Calibration of Conservation Theory and Principles Applied at Various Geographic Scales*).

Each group of conservation theories has sound scientific foundations, and all are being used in the United States. However, few have been validated through field testing, as biodiversity is so complex and variable that it does not lend itself to traditional research methods (NCSSF B.2).

It is very important to evaluate the effectiveness of various theories and combinations of theories in terms of tradeoffs and costs. For example, a common approach to biodiversity conservation is to establish large reserves such as national parks and wilderness areas. But many of these reserves are in places without much biodiversity, some entail substantial tradeoffs to other resource values, all are costly, and it is unlikely that the area and location of such reserves will ever be sufficient to cover all biodiversity concerns. Less costly and more feasible ways to achieve biodiversity might include:

- "micro-reserves" of a few acres
- "meso-reserves" comprising medium-sized areas that provide appropriately managed buffers to protect landscape elements of extraordinary importance to native species and ecosystem processes such as aquatic features
- biological legacies that link past and future systems in working forest landscapes.

Because planning rules and processes and continued contention over federal land purposes impose serious constraints, investments in adaptive management are more likely to yield results on non-federal forestlands. In the meantime, funding a manager's guidebook to conserving biodiversity, incorporating biodiversity conservation into forest resource curricula, and most importantly, promoting adaptive management for outreach and demonstration can foster communication and understanding between conservation scientists and practitioners. Until successful adaptive management programs develop better knowledge about how well each theory works in practice and at what costs, it is also important to include clear descriptions of each theory's known efficacy and limitations for different biodiversity conservation purposes (NCSSF B.2). ■

Implications of Area 4 Findings for Sustainable Forestry

Developing and implementing cost-effective conservation strategies and practices will enhance biodiversity. Biodiversity planning and implementation obviously are constrained by tract size and history, ownership patterns, and overall management goals, e.g., producing wood or maintaining a forest reserve. However, some general features apply across the range of considerations. Most biodiversity plans involve the following steps:

- Clearly articulate land-management objectives and determine what can be accomplished at various scales, e.g., legacies within stands, other aspects of stand structure, landscape, etc.
- Identify a set of relevant biodiversity indicators, using a tool such as the one developed in NCSSF A8. A combination of condition, pressure, and policy response indicators allows decision makers to track performance for sustainability more effectively. Conservation planning can then proceed by (1) delineating features that influence the suitability of a landscape for the indicators, and (2) managing for the features.
  - Identify, delineate, and protect rare plant communities and other areas of high conservation value such as bird nesting areas and colonies of protected species. State heritage programs and NatureServe are good sources of information. Gap analysis and eco-regional planning efforts are useful in identifying areas of high conservation value.
  - Protect landscape legacies and other system elements that maintain stability and resilience, allowing recovery from disturbance without long-term loss of diversity and functional integrity.
  - Protect "special places" such as waterfalls, cliffs, and caves that may harbor rare habitats and be subject to heavy recreational use.
  - Develop and implement streamside management and road construction practices consistent with best management plan (BMP) guidelines, best available science, and local knowledge.
- Determine the role of NTFPs, which can create economic return but may destroy biodiversity without careful management. Support of NTFP species can lead to increased variety in the landscape, and using them culturally can encourage stewardship of native biodiversity. Lack of data and guidelines on what to do or not to do makes NTFP management challenging.
- Use available tools. Great progress has been made in visualization, but few other features for communication and social negotiation have been integrated into DSSs. Such features would increase the usefulness of DSSs in multi-ownership, multi-stakeholder decision processes characterized by lack of agreement on either problems or solutions.
- Monitor results using indicators to determine if desired goals are being met. Effective monitoring may be based on a formal census of target species, or it may use informal tracking and recording of element occurrences encountered in the course of other activities. (An element occurrence is a natural feature of special ecological interest such as a bird rookery or a distinctive habitat such as a cave or sinkhole.)

Landowners and managers in the United States should become familiar with the important elements of biodiversity programs and the most useful options and strategies (NCSSF R2). This won't be easy to achieve. Current funding for research and technology to sustain biodiversity is inadequate. The number of foresters has also decreased in recent years, reducing family forest owners' access to professional advice.

However, several NCSSF projects were begun in 2004 to increase understanding of biodiversity conservation and what should be included in biodiversity management plans and to alert the scientific community to remaining gaps. NCSSF C5, *Assessment of Public Knowledge, Values, and Attitudes toward Biodiversity and Sustainable Forestry*, will emphasize

attitudes about biodiversity versus other forest values such as water quality, wood production, or recreation. NCSSF C4 is developing guidelines for participatory monitoring of sustainable forestry. NCSSF Project A4 (II) will create a professional and academic curriculum for NTFPs, as most current information about NTFPs comes from practitioners' knowledge rather than formal education. And NCSSF Project A10 (II) will develop plans for a state-of-the-art DSS that addresses current DSS weaknesses identified by NCSSF A10.

It is important to recognize that many family forest owners aren't managing their lands. As mentioned earlier, more than 10 million people own 276 million acres of forestland in the United States for non-industrial purposes. Four million people own almost 90% of that land in 10 to 5,000 acre parcels.

While well over half of the NCSSF Project A3 respondents listed nature protection as a reason for land ownership, fewer than 15% of those owners had improved any wildlife habitat in the five years prior to 2002 or planned any habitat improvement in the following five years. Less than half had sought professional advice of any kind.

Knowing everything there is to know about effective biodiversity conservation strategies won't matter if landowners don't see the value in using that knowledge in managing their forestlands. Many family forest owners simply aren't managing their lands for sustainability and biodiversity.