Habitat Restoration and Conservation Prioritization Tool For the Endangered Species Act

A final report on the USGS LSC project #03057 funded by the U. S. Fish and Wildlife Service

December 16, 2009

Authors:

John Peine, Joshua Albritton, Ryan Wishart, Lyndsay Dawson Mynatt, Sara Malley, Carmel Price, Kay Franzreb, Tom Herbert, Maggie Stevens, and Tom Burley[1]

For more information contact: jpeine@utk.edu 865-974-4056

[1] Report reviewers include Debby Crouse USFWS, John Fay USFWS, Kay Franzreb USFS, Pat Heglund USFWS, Glenn Holcomb USGS, Callie McMunigal USFWS, Elise Lequire UTK, Mike Runge USGS, Rudy Schuster USGS, and Mike Scott USGS who collectively helped correct, clarify and focus the text.

Table of Contents

Abstract

The U.S. Fish and Wildlife Service (FWS) strategic planning efforts continue to identify the need for tools to specifically identify the best locations for on-the-ground habitat actions. This project is designed to fit into the strategies devised by the FWS National Ecological Assessment Team and their evolving program. Development of a Habitat Restoration and Conservation Prioritization Tool focuses on economic and social considerations components within the context of biological considerations. Components of the Prioritization Tool include socio-ecological framework, biological, social, economic and decision making. Each component includes information on its role in the process, goals and objectives, assessment strategies, metrics, the process of making choices, and a look to the future. There are ten case studies included illustrating how these steps in the process have been successfully applied, and the consequences of others where they were not applied. An extensive literature review is included as well. The overarching premise of the project is that by facilitating components of the Prioritization Tool, the potential for evaluating the probability for species/ecosystem sustainability will be maximized thereby reflecting prioritization.

Project Description

Universally, the U.S. Fish and Wildlife Service (FWS) strategic planning efforts continue to identify the need for tools to specifically identify the best locations for on-the-ground habitat actions and equate these actions to a population response at multiple scales for multiple species. The importance to the FWS of this science based, strategic planning is highlighted by the Directorate's formation of a national team (NEAT - National Ecological Assessment Team) to identify how agency leaders can encourage and support this approach to habitat conservation (NEAT 2006). See Figure 1.

Operationally, FWS needs to do a better job of meeting our resource goals and objectives by moving away from a programmatic, opportunistic based approach to habitat restoration and conservation to one that features integrated, landscape-level analysis and planning, and coordinated on-the-ground actions. In order to do this we need tools that readily learn from and educate, communicate, and track stakeholder perspectives and help us to better coordinate our actions and measure our results (NEAT 2006). This project focuses on the critical socio-economic components of that endeavor. See Figure 2.

> **“**Biologists and land managers have one overriding universal question they need answered: What specific lands do we need to restore, protect, and/or manage to most effectively achieve conservation objectives for X species or guilds of species? Our operational dilemma involves issues of scale both spatial and temporal and how we strategically plan and actually take on-the-ground action to achieve maximum results. The focus for this project will be how the socio-economic components of this process of choosing a viable critical habitat and the necessary socio-economic components of the multidisciplinary process. (USFWS RFP)**”**

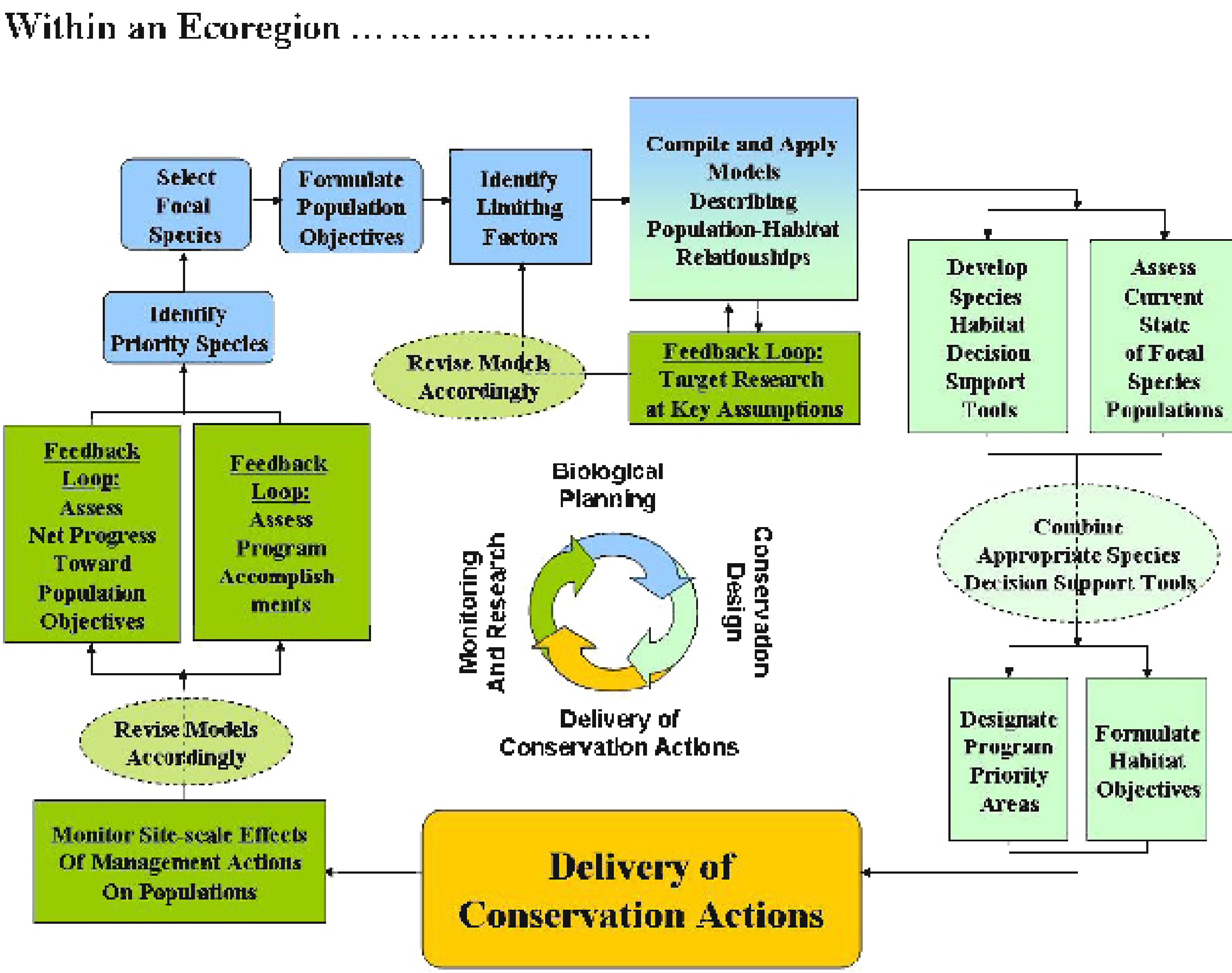

Figure 1. Schematic of the Strategic Habitat Conservation Framework at the landscape scale. Although depicted as a sequential process, some activities may occur simultaneously. (NEAT 2006)

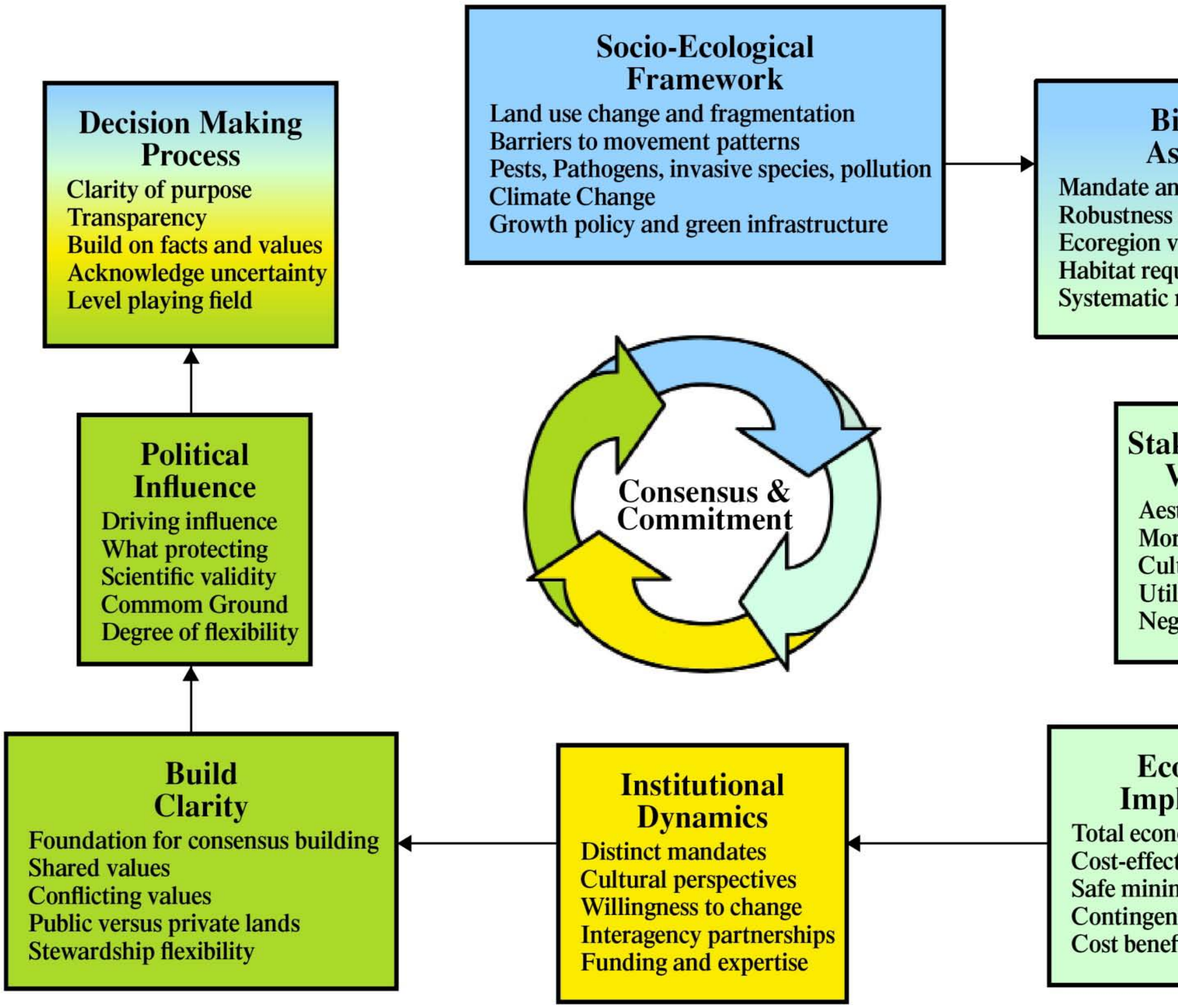

Figure 2. Schematic of the Habitat Recovery and Conservation Prioritization Tool Application Process. Although depicted as a sequential process, some activities may occur simultaneously.

Project Goal and Objectives

GOAL
Development of a Habitat Restoration and Conservation Prioritization Tool for the Appalachian Mountains with focus on economic and social considerations components within the context of biological considerations.

OBJECTIVES
1. Summarize key literature related to the topic and identify experts.
2. Define key components of a socio-economic factors and strategies to ascertain qualitative analysis.
3. Identify and document case studies of socio-economic strategies related to restoration or stabilization of species of concern with a focus on the Appalachian region.
4. Define critical socio-economic steps in a process incorporating all dimensions of the Habitat Restoration and Conservation Prioritization Tool.

ANALYSIS METHODOLOGY
Task 1. Identify leading experts and conduct literature review of key socio-economic dimensions (Raphael and Molina 2007, Dietz and Sterns 2008)
Task 2. Identify indicators reflecting those dimensions. Indicators defined will reflect key components of social-economic factors.
Task 3. Define analysis strategies applying those indicators. Description will be based on real world applications.
Task 4. Conduct analysis of case example applications.
Task 5. Document the value-added by the Prioritization Tool process via the case examples.

<u>Conundrum</u> How can you propose a strategy for a socio-economic assessment process for the Prioritization Tool out of context of evolving biological assessment strategies reflecting the ever changing interpretation and promulgation of the Endangered Species Act? You can't. Therefore a biological component is included in the scope of this project.

This report is in essence an annotated outline for presenting the components of the ESA Prioritization Tool and their suggested sequence of utilization with reference for more detail in the literature review section which follows. Consider it a planning guide for implementation of the Prioritization Guide. The overarching theme throughout is adopting at the beginning of the process the integration of the social and biological sciences in devising habitat restoration and conservation plans for species and/or ecological communities of concern. *The overarching premise of the report is that by facilitating components of the Prioritization Tool, the potential for evaluating the probability for species/ecosystem sustainability will be greatly enhanced thereby reflecting prioritization.*

Navigation guide for resource managers and field biologists

The project is designed to be a navigation guideline for resource managers and field biologists working with sociologists and economists. Managers have a heavy work load and limited time and resources, which must be used efficiently to achieve the demanding job of designing and implementing restoration and conservation strategies for species/ecosystems at risk. Therefore, this report focuses on economic and social considerations within the context of biological considerations as they relate to decision-making. Each component includes information on its role in the process, goals and objectives, assessment strategies, metrics, the process of making choices, and a look to the future. The case examples that follow document the ways in which these considerations have been incorporated successfully in stabilizing species/ecosystems at risk, identify other cases where these components were not well incorporated, and outline the negative consequences that followed.

The intent is to provide a frame of reference for resource managers and field biologists to communicate with social scientists and economists as to alternative tools that might be applied in the analysis and decision-making process.

The challenge is to understand how these dynamics interrelate; the text therefore is succinct and to the point with numerous references so the reader does not to get buried in details and risk missing the larger picture. Ecological and social systems are interrelated and must be considered with equal balance. Both systems are driven by a corollary of structure, process, and function (Peine 2007). Therefore, the social, economic, and decision making components are presented by stating the role of each and its overarching goals, objectives, alternative assessment strategies and related metrics, and integrated decision making strategies. The literature suggests that biologists generally do not seek council from social scientists until they need advice on conflict resolution (Endter-Wada *et al.* 1998). An interdisciplinary team should be formed at the outset of an analysis to maximize efficiency and effectiveness in establishing and maintaining long term sustainability for species/ecosystems at risk. Efficiency in creating, and public acceptance of, recovery plans are critical as we enter a predicted period of dramatic environmental change driven by shifting climate, land use, and other stressors such as pests, pathogens, and pollution (Berkes *et al.* 2003). Therefore, we have provided a process to systematically incorporate social and economic considerations in the decision-making process associated with environmental habitat restoration and conservation practices in a timely manner.

Promulgation and enforcement of the ESA is a moving target

A synthesis of the literature review presented in Appendix B suggests several inconsistencies associated with the prioritization process for listing and management of the habitat recovery and conservation plans as follows:

- Candidate listings, development of recovery plans and 5 year reviews have been inconsistent over the years (Listing *Cf.* Greenwald *et al* 2006, Recovery Plans *Cf.* Davis, Gobel and Scott 2006, 5 Year Reviews *Cf.*…..)
- The adequacy of the science has been frequently questioned to estimate the degree of risk, critical habitat requirements, existing range of species, and population size required to sustain a viable population (Doremus 2006b, Ruckelhaus and Darm 2006).
- The categories of listings such as *candidate species* provide back-door opportunities to indefinitely delay recovery action (Greewald *et al.* 2006).
- Role/value of critical habit designation is contested but is the focus of numerous lawsuits that are usually won by the plaintiff (Patlis 2001, Suckling and Taylor 2006).
- Priority is supposed to be for species with the highest threats and/or highest recovery potential but that premise is often not followed (Restani and Marzluff 2002, Male and Bean 2005).
- Expenditures are skewed to more charismatic species to demonstrate program success (Rolf 1991, Clark *et al*. 2002, DeShazo and Freeman 2006). Funding associated the ESA process is sometimes associated with location in Congressional Appropriations Committee members (DeShazo and Freeman 2006).
- Regulations and management plans often focus mainly on species survival or population stabilization and do *not* adequately address species needs for *recovery* (Rolf 1991, Patlis 2001, Suckling and Taylor 2006).
- The USFWS websites sometimes post conflicting information and are invariably incomplete sources of information. The status of 5 year reviews is a vivid case in point[2]. There is a critical need for creating a universal up-to-date data source for tracking all aspects of the ESA program.
- End of term efforts by the G. W. Bush administration attempted to shift management of T&E species from the USFWS to other federal agencies without requiring consultation with appropriate biologists to interpret policy related to T&E species management. This strategy would result in the ultimate obfuscation of the Prioritization Tool - as previous management failures have occurred due to lack of consultation, even by the EPA (NMFS 2008), have shown (UCS 2008). In addition, the Bush administration forbid wildlife agencies from using global warming as a consideration for endangered species risk analysis as part of the review process (PEER 2009). Fortunately, these policies have been redacted or or are under review by the incoming Obama administration.

The uncertainty, as referenced above, of how and why the species are included in various lists, how the biological assessments are conducted and habitat defined, when and how monitoring is conducted, and overall poor data management, make this project a very challenging assignment. Therefore, it is very difficult to place the socio-economic components of the Prioritization Tool in the invariably changing biological component

[2] Malley, Sara. Research Associate. Ph.D. Candidate, Department of Sociology. University of Tennessee at Knoxville. Personal communication. 2008.

context. That is why a biological component was included in this project. Such is the nature of the beast.

Socio-Ecological Framework Component

ROLE OF FRAMEWORK CONSIDERATIONS: Setting the geographical context for stress assessment and recovery potential analysis. As noted above, the FWS is moving toward an integrated, landscape-level analysis and planning that is coordinated with on-the-ground actions (NEAT 2006). Human societies have generally regarded themselves as *part of nature* rather than separate from it (Berkes *et al.* 2003). Though most challenges to field biologists and natural resource managers tend to be site specific, the drivers of environmental stress are invariably of regional scope and directly or indirectly human related. As a result, there is a fundamental need to understand those dynamics between man and nature at a larger scale. In addition, there is a need to look to the regional framework for solutions to address these challenges. This component identifies framework sources to document and address key stressors and associated databases, as well as example regional ecological assessments, strategies to manage growth, and best sustainability practices that provides socially driven solutions to pervasive ecological problems.

Utilize regional framework perspectives to identify the extent and distribution of perturbations as well as sources of tested best sustainability practices.

GOAL: Place overarching landscape-scale drivers of environmental change and/or stress and sustainability solutions in a bioregional context.

OBJECTIVES: Begin the Prioritization Tool process with a macro-scale assessment of bioregional conditions and stressors which could adversely affect the viability of alternative conservation strategies over the long term as well as related regional ecological assessments, growth management policies, and best sustainability practices to address these issues:

- Define the relevant landscape context of the targeted bioregion or habitat
- Identify associated patterns and trends of land cover and use
- Identify potential stressors affecting that condition in the near and long term
- Define the drivers of those stressors
- Assess the current and potential cumulative affect of the stressors
- Estimate potential constraints posed by these cumulative affects
- Identify potential movement corridor fragmentation where appropriate
- Estimate potential edge effects on critical habitat interior
- Identify best sustainability practices in the region
- Identify strategies in the region to manage growth and create green infrastructure.

ASSESSMENT STRATEGY

Land cover and use assessment

This fundamental characterization and related trend analysis of the landscape condition provides an indicator of the degree of stabilization of the bioregion under consideration. Identifying hotspots of land use change can provide insight as to the degree and spatial pattern of change as well as what is driving change. This assessment facilitates the assessment of potential stressors related to the nature of the land use condition and change taking place. Implications can be characterized via the following categories:

- Critical mass and configuration of habitat required to sustain species or ecosystems of concern
- Movement corridor fragmentation and associated barriers
- Implications of juxtaposed land use
- Boundary edge effects on size of critical habitat.

The noted socio-biologist Edward O. Wilson has cited species fragmentation as a major threat to species richness and diversity, In an April 19, 2004, luncheon address to the National Press Club, titled "The Future of Life", he identified the creation of movement corridors as a means of removing the isolation currently being forced upon many ecosystems (Ely 2004).

Wilson said that "America's species…are trapped in reserves. And even if they somehow could move north, they can't because they're surrounded by farmland or degraded forest or other disturbed habitats. So the solution to this problem… is to pay more attention to the design of natural reserves that are oriented north and south. They're called corridors." (*Ibid*)

A robust example of a regional assessment of ecosystem condition and connectivity at the macro-scale is the Southeastern Ecological Framework (EPA 2002), which will be expanded to encompass the entire country.[3] Numerous databases have been combined to identify concentrations of biological diversity and landscape movement corridors (Durbrow *et al.* 2001). This information represents a rich collection of information that may guide strategies to implement the preservation or restoration of corridors. See Appendix A for a list of data Also see NASA's Land-Cover and Land Use Change websites for trends and data: http://lcluc.umd.edu/.

Another key database is a compilation of protected areas across the United States as displayed in the website: http://gapanalysis.nbii.gov/portal/community/GAP_Analysis_Program/Communities/GAP_Projects/Protected_Areas_Database_of_the_United_States

Water quality, quantity and distribution

The USGS water information system can be accessed at the website: http://waterdata.usgs.gov/nwis. The data categories include real-time data and collection

[3] Durbrow, Rick. EPA Region 4 Policy, Planning and Evaluation Branch. Personal communication 2009.

site information on surface water, ground water, and water quality. Water resource data are collected at approximately 1.5 million sites across the country. The USGS investigates the quantity, quality, distribution, and movement of surface and underground water throughout the 50 states.

Air pollution

Data on air quality, radiation, emissions, and sources can be found at EPA's website: http://www.epa.gov/air/airpolldata.html. Air data categories include Air Compare, air data, air explorer, Airnow, air quality systems (AOS), air trends, AQS data mart, AQS data page, and clean air status and trends network (CASTNET). Emissions data categories include air data, air emission sources data, air emission sources, clean air markets data and maps, greenhouse gas emissions, and national scale air toxics assessment (NATA). An example of a comprehensive website at the national park level is: http://www.nature.nps.gov/air/WebCams/parks/grsmcam/grsmcam.cfm.

Climate change

This is arguably the greatest challenge to endangered species. The International Panel on Climate Change estimates that as many as 20-30% of species on the planet may be at risk of extinction by the end of this century if increases in global average warming exceed 1.5-2.0C (relative to 1980-1999) (IPCC 2007: 54). NASA's Global Change Master Directory: Discover Earth Sciences Data and Services website: http://gcmd.nasa.gov/, provides a wide range of datasets, data services, and portals.

Pests and pathogens

Pests, pathogens, and invasive species seem to progressively increase as does the related complexity of cumulative effects over the long term. See Table 1 below illustrating some major adverse impacts in the Appalachian highlands. The cumulative effects of these perturbations are dependent on their relevance to the species/ecosystems of concern.

Table 1. Pests and pathogens in the Appalachian highlands (Schlarbaum et al. 1999)

PERTURBATION	EFFECTS
American Chestnut Blight	American Chestnut (*Castanea dentata*) loss eliminated primary nut crop at midrange elevation
Gypsy Moth	Defoliates deciduous trees via cycles of varying annual infestation
Balsam Wooly Adelgid	Kills mature Frasier Fir (*Abies frasrei*) affecting high elevation canopy dynamics
Butternut Canker	Butternut *(Juglans cinerea*) populattion devastated

Dogwood Anthracnose	Dogwood (*Cornus florida*) population at high elevations and near water most susceptible
Hemlock Woolley Adelgid	Hemlock (*Tsuga canadensus*) dies within 3 years without chemical or insect treatment
Beech Bark Disease Complex	American beech (*Fagus grandifolia*) in the high elevation most affected
Sudden Oak Death Syndrome	Found in nursery stock in the Southeast but not yet detected in the wild

Exotic invasive species

These species can invade due to disturbance on the landscape from land use conversion or fire providing an opportunity for seedling establishment. For example, of the more than 300 exotic species found in Great Smoky Mountains National Park, 25 are considered to pose significant threats (Schlarbaum *et al.* 1999). The problem-causing species in the Park are pervasive throughout the region. Privet (*Ligustrum vulgare L.*) is an example that is very difficult to control let alone eradicate. The USGS National Biological Information Inventory Invasive Species Information Node is a good source for information http://invasivespecies.nbii.gov/ as is USDA's National Invasive Species Information Center http://www.invasivespeciesinfo.gov/resources/databases.shtml.

Ecological Framework Programs in the Appalachian highlands and beyond

Trans-boundary Planning
http://www.wcscanada.org/wcsc-home/wcsc-main/wcsc_whatwedo/wcsc-northern_appalachians/wcsc-northern_appalachians_transboundary/humanfootprint

The Canadian Wildlife Conservation Society's (WSC) Northern Appalachian Trans-boundary Planning Initiative is a cooperative arrangement that examines the "human footprint" within the Northern Appalachian region.

The complicated issues of interagency and intergovernmental planning are the focus of this initiative. Working among a multitude of boundaries including local, state, and international, WCS Canada hopes to influence policy makers and the public on these key ecological issues with their study on trans-boundary planning.

Maine Ecoregional Conservation Planning
http://denali.asap.um.maine.edu/mcs/?q=node/1169

This study, provided by the Margaret Smith Policy Center at the University of Maine, details the importance of collaboration in conservation planning among the many intergovernmental entities in Maine and includes valuable tables and further resources for the issues of conservation planning in the Northern Appalachians.

Northern Appalachian Ecoregion Conservation Planning Atlas http://www.2c1forest.org/atlas/index.html

This website provides an atlas for facilitating sustainable decision making in the northern Appalachians. This project is meant to aid planners and policy makers in maintaining or restoring the biological integrity of the region. These science-based studies focus on ecological connectivity and provide detailed habitat and land use information to assist in conservation.

Central Appalachians

http://www.nature.org/wherewework/northamerica/states/centralappalachians/files/tnclo_resproof.pdf

This Nature Conservancy project provides a robust example of the recognition of ecological corridors. Working with local, state, and national groups the Conservancy means to protect ecologically sensitive areas within the central Appalachians and maintain viable corridors for the movement of integral mountain species.

Southeastern Ecological Framework

http://www.geoplan.ufl.edu/epa/index.html

This project encompasses eight states in the southeastern region of the United States and intends to assist in the cooperation of local, state, and regional entities with policies and decisions related to conservation. The goals of the project include identification of the essential environmental areas of concern and developing a management program that focuses on these key ecological areas within the parameters of the framework. The ultimate use of the project depends on cooperation between local and state governments, who along with private sector stakeholders can determine the best way to settle conflicts between natural and human systems. The framework includes extensive data compilation using inputs from the U.S. Census TIGER files, U.S. Forest Service, EPA, TVA, and state agencies such as Fish and Wildlife, Highway, and Utilities. These input layers yield analytical and compiled data products relevant to bear habitat, distance from highway or known conservation land layers, among many others. These analytical layers then allow for determination of Priority Ecological Areas and Significant Ecological Areas within the framework.

See report Appendix A which includes two data lists for the SEF Delineation Layers. The first data list represents a brief description of the data sets used in the SEF Delineation process, including input data layers, analytical data layers, Priority Ecological Areas data layers, and Significant Ecological Areas data layers. The second data list includes more detailed information on the methods used to create each layer and their corresponding attribute information[4]

Southern Appalachian Forest Coalition

http://www.conservationgis.org/ctsp/safc/safc.html

This coalition is formed by collaboration among national, regional, and state entities from Alabama to Virginia. The goal of this coalition is to improve conservation policies in the region and work to increase public participation and create new

---

[4] For documentation see the website: `http://www.geoplan.ufl.edu/epa/`

partnerships that influence sound decision making and management polices in the Southern Appalachian region.

Transportation Planning In North Carolina
http://www.southernenvironment.org/

Poorly planned road projects have caused significant damage to North Carolina's air, water, and open spaces while wasting taxpayer dollars. If the region is designated by the U.S. Environmental Protection Agency as a non-attainment area under the Clean Air Act, it will be required to develop a transportation plan that reduces air pollution, or risk losing federal highway-construction money. By filing and winning a lawsuit in district federal court, the Southern Environmental Law Center (SELC), a nonprofit, public interest law firm, was able to force the North Carolina Department of Transportation to reconsider the widening of I-26 in Henderson and Buncombe Counties, North Carolina, and to re-think its long-held pattern of building more and bigger highways without fully considering the profound and irreversible impacts or the applicable environmental laws.

Growth Management Strategies

There is an ongoing effort among policy makers, officials, and citizens nationwide to address the manner in which human footprint expansion and population growth affects the natural environment. This dialogue, and the procedures and methods that derive from these actions, will help facilitate an effective decision-making process where the complicated ingredients of economy, health, and ecology are partnered to ensure success (Berke, *et al.* 2006)[5]. The following concepts include some of the indicators necessary to examine the social and economic impacts affecting growth management policies that offer alternatives to the conventional patterns of land consumption.

Smart Growth
http://www.smartgrowth.org/about/default.asp

Smart growth has been the label given to concepts and policies that provide alternatives to traditional urban sprawl development. These generally municipal efforts attempt to manage future growth patterns. Methods involved include concentrating development in existing urban or suburban development centers, which increases the vitality and value of these central areas. This allows for established infrastructure to be utilized before expanding beyond the reach of municipal capacity. Mixed land uses and compact design also aid initiatives for redevelopment and ultimately allow for ecologically sensitive management plans focused on the preservation of open spaces and key ecological areas. Portland, Oregon has strategies in place, including village scale density and a strict urban growth boundary, to meet the needs of growing populations and shrinking land areas[6]. Regionally, cities and surrounding counties are collaborating on issues of economic growth and environmental protection. One such example is the Power of Ten in Middle Tennessee made up of the 10 counties included in the Nashville

[5] Berke, Philip R. Urban Land Use Planning. p. 35-36.
[6] See website http://www.smartgrowth.org/news/bystate.asp?state=Or&res=1280

Metropolitan region[7]. An excellent resource that compiles national ratings based on analytical data is Smart Growth America. The database includes a number of metrics that determine the sustainable health of a community.[8]

Green Infrastructure
http://cfpub.epa.gov/npdes/greeninfrastructure/technology.cfm

Advances in design and policy that balance economic development with the ecological health of a community are the result of innovations in green infrastructure. These technologies range from upgrades of individual homes to neighborhood scale projects and regional improvements. Rain gardens, green roofs, brownfield redevelopment, riparian restoration, and green streets and highways all are working examples of green infrastructure. These practices can greatly enhance the water quality of developed areas serving the human and natural environments with positive impacts on water treatment and ecosystem vitality. Examples of these projects on the local level include the Portland Green Street Program[9], the Wisconsin Department of Natural Resources Rain Garden Manual[10], and Emeryville, California's Dense Redevelopment Guidelines[11]. An additional study by the Conservation Fund explores the effects of green infrastructure on endangered species[12].

Edge Effects
http://www.habitatauthority.org/lotue.shtml

The increasing conversion of agricultural and natural lands to suburban uses leads to infringement on previously undeveloped areas. The "edge effects" concept urges a process that yields minimal impacts on these marginal areas between wild and settled lands. The continued fragmentation of natural habitat on a local and regional scale prevents normal connectivity or the ability of wildlife to move along natural corridors. One species that has been used to study the effect of infringement impacts is the Wood Thrush. FWS studies revealed that birds occupying nesting areas that were fragmented and covered smaller interrupted land areas were less likely to succeed, being more susceptible to predation[13]. The analysis of these edge effects proves that larger protected areas are necessary for greater diversity of species and for the overall ecological health of an area.

Ecological Corridors
http://www.abcbirds.org/abcprograms/domestic/landscape/apmjv.html

There are numerous environmental challenges associated with conservation and planning among the many local, state, regional, and national jurisdictions that exist in ecologically important migration and movement corridors. The expansion of sprawl

---

7 See Website http://www.cumberlandregiontomorrow.org/Summit
8 See website http://www.smartgrowthamerica.org/sprawlindex/sprawlexecsum.html
9 See website http://www.portlandonline.com/BES/index.cfm?c=44407
10 See website http://learningstore.uwex.edu/pdf/GWQ037.pdf
11 See website http://www.epa.gov/smartgrowth/pdf/Stormwater_Guidelines.pdf
12 See website http://www.conservationfund.org/green_infrastructure_practice
13 See website http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/wood_thrush_model.htm

blocking movement corridors and climate change accelerating the movement process is a pressing concern. The evolving Yellowstone to Yukon corridor is a prime example of a work in progress[14]. The Southeastern Ecological Framework described above is specifically designed to provide a robust dataset for identifying key ecological corridors[15]. The American Bird Conservancy provides an example of one of these complex working partnerships in their Appalachian Mountains Joint Venture.

METRICS[16]

- Ecosystems
    - *USFS EcoRegions*
    - *Regional biodiversity*
    - *Ecosystem services*
    - *Forest density*
    - *Riparian forest*
    - *Riparian Mask*
- Land cover and use
    - *Conservation lands*
    - *Federal lands*
    - *Land values*
- Urban lands
    - *Urban land cover*
    - *Potential for urban growth*
    - *Regional threats*
- Human footprint
    - *Population change*
    - *Invasive species*
    - *Road density*
    - *Permitted pollution release*
    - *Natural systems index by watershed*
    - *Toxic release inventory*
    - *Private land – property rights*
    - *Land values*

MAKING CHOICES: This framework component, from a macro-scale perspective, is the first step in incorporating socio-economic components to an ecosystem assessment. This big picture perspective provides a foundation for beginning the focusing process. Key questions to address include the following:

- What is the geographical extent of the target bioregion?
- To what degree is there connectivity throughout the species/ecoregion range?
- What are the overarching existing or potential stressors to the target species or ecoregion?

---

[14] See website http://www.y2y.net/

[15] For documentation see the website: http://www.geoplan.ufl.edu/epa/

[16] See the Appendix for a list of data layers included in the EPA Southeastern Ecological Framework.

- What is the potential for the cumulative adverse impacts to be adequately reduced at a macro-scale?

Case Example: Socio-ecological lessons learned

The Balsam Mountain Preserve provides a comprehensive model of how a private sustainable development can make a reasonable profit while at the same time conserving critical habitat, encouraging independent science, applying restoration ecology practices *and* operating an environmental education center serving the general public, schools, community leaders, and others in the housing industry.

Bottom line Answers to the above questions will help target key overarching concerns and thereby focus the assessment strategy from a holistic perspective.

A LOOK TO THE FUTURE: The advantage of the macro-scale is its greater potential to track changes of these stressors and their influence on native species over the longer term. As suggested earlier, E. O. Wilson recommends that the long view is the place to start when designing habitat recovery and conservation plans for species and biological communities at risk.

Biological Component

ROLE OF BIOLOGICAL CONSIDERATIONS: Conservation of biodiversity is an important environmental issue. It is a precondition for sustaining natural resources. With only 13% (UNEP 1995) of species worldwide so far scientifically described, conservationists are far from being able to assist everything under threat. Hard decisions will have to be made concerning what and how to conserve. As with all socio-environmental issues, cultural, political, and economical aspects all play an important role in the decision-making process. However, successful biodiversity conservation plans depend upon an understanding of the biology of the organisms under concern.

GOAL: Protect biological diversity, the processes (ecological and evolutionary) that sustain it, and functional landscapes necessary to achieve this.

Congress enacted the ESA to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such . . . species . . . "(U.S. Code 2006*a*). Thus, the ESA sets forth the fundamental goal of protecting, conserving, and restoring U.S. biodiversity, and in doing so reverse the current trend towards species extinction. Critical to this process are several steps including determining threats to species, developing and implementing recovery plans, designating critical habitat for listed species, etc., all of which the ESA requires be done on the basis of the "best scientific data available . . ." (U.S. Code 2006*c*). The principal goal of the biological component of the ESA is to reiterate the need for sound biological criteria, information, and advice upon which conservation strategies, recovery plans, prioritization, and funding can be based.

OBJECTIVES:

- Maximize both representation and persistence across the full hierarchy of biodiversity, including species, communities, ecosystems, and genetic diversity (Moritz 2002; Raphael et al. 2007a).
- Devise, through tradeoffs and setting priorities, practical strategies for revising conflicts between the needs of biological diversity and human societies (Moritz 2002; Failing and Gregory 2003).
- Prioritize major historical (evolutionary) lineages within species for protection. (Moritz 2002).
- Maintain or restore ecological processes (Gavin et al. 2007; Raphael et al. 2007a)
- Protect connectivity across a mosaic of habitats, thus allowing for migratory responses to seasonal and long-term environmental variation (Moritz 2002).

During the last century, our biosphere has suffered enormous degradation (Dayton 2003). Much biotic change is the direct result of various human impacts, and at present, the number of species in danger of extinction far exceeds available conservation resources, (Myers et al. 2000; Burney and Burney 2007). Even more is evidence in the findings of the Intergovernmental Panel on Climate Change (IPCC 2007). The conclusions of the IPCC indicate that it is increasingly likely that the next century will be characterized by changing weather patterns, including changes in temperatures, precipitation, the incidence of extreme climatic events (e.g., hurricanes), and associated disturbances (e.g., droughts, flooding, wildfire). Such changes are projected to have negative impacts on many ecosystems (IPCC 2007). This places a premium on understanding the causes of biotic loss, species to species and species to environment relationships, ecological processes, and how ecosystem integrity is determined (Myers et al. 2000; Dayton 2003).

The science of conservation has continually evolved, incorporating a variety of scientific disciplines including biology, biogeography, ecology, forestry, demography, conservation genetics, environmental management, and economics (Moritz 2002; Lomolino 2006). It also feeds on disciplines concerned with historic and prehistoric life forms including paleoecology and paleobiogeography (e.g., Horn 1993, 1998; Gavin et al. 2007; Willard and Cronin 2007), historical biogeography, and evolutionary biogeography (Lomolino 2006).

Here, we define different approaches found within the ecological and conservation literature related to biodiversity conservation and resource management. The approaches listed below are neither an exhaustive list, nor universally accepted. We offer the following interpretations and ideas in hopes that they will provide some of the knowledge needed for optimal conservation and management of species and ecosystems.

ASSESSMENT STRATEGIES

The trend is to focus on biological communities or eco-regions rather at the individual species level

The key indicators of biological diversity are species diversity and ecosystem diversity (Raphael et al. 2007a). Much debate, however, exists on the relative values of species-based (Simberloff 1998) and ecosystem-based (Marcot and Flather 2007) approaches proposed in conservation planning and strategies (Tracy and Brussard 1994; Lindenmayer et al. 2007; Marcot and Flather 2007; Raphael *et al.* 2007a). The strengths and limitations of either approach are readily distinguishable (see Table 2 below).

Species-Level Strategies for Biodiversity Conservation

Marcot and Flather (2007) defined a species-based approach as one where conservation efforts are focused on the conservation of individual species or a small group of species with similar ecological needs. In reviewing the literature, species-based approaches have principally focused on managing for the viability of individual species or small groups of species (Marcot and Flather 2007). Sometimes, such approaches are targeted at surrogate species, which help to provide for broader elements of biodiversity (Simberloff 1998; Marcot and Flather 2007).

Managing for the Viability of Individual Species or Groups of Species: Conservation efforts directed at individual species focus on providing for a target species or population. Examples of such approaches include efforts to:

- Conserve genetic diversity, including diversity that arises through both adaptive or vicariant[17] processes (Moritz 2002; Rice and Emery 2003).
- Conserve individual species based on concepts of population viability analysis (PVA) (Marcot and Flather 2007).
- Preserve target species in a pre-existing natural environment within their current range, which is often referred to as *in-situ* conservation (MacDonald 2003).
- Reintroduce species to locations outside of its current range but within the recent past range of the species, which is often referred to as *inter-situ* conservation (Burney and Burney 2007).
- Species-based surrogacy approaches (Caro and O'Doherty 1999; Caro 2003; MacDonald 2003; Marcot and Flather 2007)

Table 2. Strengths and Limitations of Species-Based and Ecosystem-Based Approaches to Biodiversity Conservation[18]

CONSERVATION APPROACH	STRENGTHS	LIMITATIONS

[17] This technical term refers to species that share some ancestry (i.e., a related pair of species) that are separated by some geographic barrier, like a mountain range. This barrier results in variation in species (allopatric speciation).

[18] Table adapted from Lindenmayer et al. (2007).

Species-based	- Can show casual processes associated with the decline of an individual species - Has a strong history and methodological basis - Yields information on species-species or species-environment relationships - Research on surrogate species may benefit understanding of entire ecological communities - Charismatic species may foster public support and funding for conservation, which may benefit several other species - May benefit many other species that occupy the same habitat	- There is a lack of detailed information on a number individual species, making assessment difficult and sometimes over-generalized - Charismatic species seem to receive the most attention, which may detract from other species - Species-species or species-environment relationships may be site and/or scale-specific, making generalization difficult - Can produce insights that have limited direct affect - May not address larger-scale causes of decline
Ecosystem-based	- Many species may benefit simultaneously - Often involves species counts, and thus is quantitative - More cost effective to look at many species at one time, especially if detailed information is not required - Some general ecological patterns, and therefore management strategies may broadly apply across landscapes	- There is a lack of detailed information on ecosystem processes, structure, and function - Specialized species (e.g., habitat specialists) may be overlooked - Research on ecosystem-based approaches is relatively new and controversial - Can confuse causation and correlation - Ecological relationships are often site and scale specific

Genetic Variation: A key component of ecosystems required to insure resiliency and adaptability is that of genetic variability among species (Rice and Emery 2003). Rapid environmental change (e.g., climate fluctuations, habitat destruction, air and soils degradation) places a premium on genetic variability and adaptability of species in fragmented habitats (Obioh and Isichei 2007). Populations of species that have been significantly reduced, or have become isolated, are at the inevitable risk of losing much of their genetic variation (Raphael et al. 2007a).

Evolutionary change may be one important mechanism by which species escape extinction. Rice and Emery (2003) have suggested that genetic variation should be included in conservation efforts, and that efforts should address scales of local adaptation, the effects of gene flow on adaptation, and the importance of genetic variation in promoting adaptive response. Fossil records show that rates of evolutionary change occur slowly, and that species have responded to global change primarily through migration (Rice and Emery 2003). Mounting evidence, however, suggests that evolutionary change can occur rapidly, within a few decades, and has occurred in a variety of adaptive responses including morphology, physiology, behavior, among others (Table 3).

Population Viability Analysis: Population viability analysis (PVA) is one tool that can be applied to conservation and management plans. PVA models help predict probability of population (or species) persistence (or extinction risk) within a specified time (Brook et al. 2000). Analysis is based on imputing empirical life history information (e.g., sex ratio, population dynamics, dispersal, disturbance cycles, etc.) and habitat needs of a particular species into computer modeling scenarios with several classes of threats (e.g., environmental, genetic, or demographic stochasticity, catastrophes, economic) (Brook et al. 2000). Such models can provide insights into which environmental factors affect rates of reproduction, mortality, and growth (Raphael et al. 2007a). PVA is also useful in comparing the effectiveness of differing management options and identifying key sites where conservation efforts should be focused (Brooks et al 2000; Kohlmann et al. 2005; Raphael et al. 2007a). Some of the more common PVA packages found in the literature include GAPPS, INMAT, RAMAS Metapop, RAMAS stage, and VORTEX (Brooks et al. 2000).

The predictive accuracy of PVA has, however, come under much scrutiny, mainly because of a lack of validation in real/complex systems, insufficient life history or population data, or short periods (e.g., a few years) of study (Brook et al. 2000; Raphael et al. 2007a). For example, many aspects of plant life history (e.g., plant and seed dormancy periods, episodic seedling recruitment, obligate or strongly mutualistic relationships with for example pollinators) present challenges for PVA analysis (Raphael et al. 2007a). Thus, PVA analyses perform best with data-rich species. Some evaluative studies have shown that PVA predictions are accurate. For example, Brook et al. (2000) evaluated the predictive accuracy of PVA analysis based on ecological studies on 21 wildlife populations (birds, reptiles, mammals, and fish). The authors concluded that the

PVA models were relatively accurate, with good correspondence between simulated and observed rates of decline. Brook et al. (2000) suggested that PVA should, given accurate ecological data, be useful in conservation efforts. Other authors, e.g., Lindenmayer et al. 2000; Raphael et al. 2007a, have suggested that PVA, while potentially useful, are at best uncertain.

Table 3. Examples of rapid evolutionary responses of natural populations to human induced environmental change.

SELECTIVE PRESSURE	ORGANISM	RESPONSE
Harvesting patterns, over harvesting	Various fish species, including Pacific salmon, Atlantic silversides, European grayling	Life history evolution (e.g., juvenile growth rate, age and size at maturity, fecundity)
Industrial Pollution	Pepper moth (*Beston betularia*)	Change in pigmentation
Heavy metal pollution in mine tailings	Various plant species, oligochates (earthworms)	Heavy metal tolerance
Extinction of food source	Hawaiian honeycreeper (*Vestiaria coccinea*)	Selection for shorter bills (access to alternative nectar sources)
Heavy effluent from nuclear reactor deposited into resevoir	Lepomis bluegill	Change in thermal tolerance
Eutrophication of lakes	African cichlids	Reduced coloration and species diversity (via reduction in capacity for mate choice and sexual selection)
Introduction of novel host species through logging and cattle ranching	Checkerspot butterflies (Euphydryas editha)	Diet shift to new host
Global warming	Pitcher-plant mosquito (*Wyeomyia smithii*)	Shift in photoperiodic response
High ozone	Common plantain (*Plantago major*)	Ozone resistance
Introduction of exotic host species	Soapberry bug (*Jadera Haematoloma*)	Change in mouth parts, body size, and development time
Introduction of exotic seed predator (red squirrel, *Tamaisciurus hudsonicus*)	Limber pine (*Pinus flexilis*)	Shift in energy allocation from seeds to cone defenses

Table adapted from Emery and Rice (2003)
See Emery and Rice (2003) for references for above examples

In-situ Conservation: Many conservation efforts are directed towards conserving and/or restoring species in their natural environment within their current range (MacDonald 2003; Burney and Burney 2007).

Restoration of the Florida panther (*Puma concolor coryi*) is one example of an *in-situ* conservation strategy. See the related case example below for more detail. The panther is threatened in large part by habitat fragmentation and a decline in its preferred prey animal, the white-tailed deer *Odocoileus virginianus* (Simberloff 1998). Conservation efforts, directed by the FWS and assisted by several other key partners including Everglades National Park and Florida Department of Natural Resources, include regenerating the population via the introduction of several females, conserving and rehabilitating panther habitat, and securing and maintaining habitat elsewhere within its historic range (habitat range prior to human degradation). To date, the population has increased to an estimated 80 to 100 individuals and much public support for conservation efforts has been fostered.

Inter-situ Conservation: The notion of *inter-situ* conservation is an emerging concept (Burney and Burney 2007). This approach focuses on using the findings of paleoecological studies to reintroduce populations of declining species outside of their current range but within their early historic range (Burney and Burney 2007). Although there is not a consensus definition for "early historic range", in general, it refers to the time period just before European settlement. In the case of globally extinct species, Burney and Burney (2007) suggest that a surrogate species may be substituted, especially if the extinct species is regarded as essential to maintain a process (e.g., providing competition for invasive species, providing food or habitat for other species) critical for ecosystem functionality. Generally, reintroduced species receive some aspect of temporary, but direct care (e.g., weeding, invasive species control, soil amendments, irrigation), with hopes that species will reproduce and recruit successfully (Burney and Burney 2007).

In Kaua′i, Hawaii, paleoecological data have provided detailed information about the former, and much wider ranging distributions of now rare and threatened plants (Burney and Burney 2007). These data have played key roles in conservation planning and implementation at various sites throughout the island (Burney and Burney 2007). For example, pollen and plant macrofossil data reveal that coastal vegetation communities were far more diverse in the past, populated by indigenous and endemic species currently found only in highland, interior forest communities. Ecological restoration efforts at these sites are focused on removing invasive vegetation and planting these once, more wide-ranging and abundant indigenous and endemic species in their place (Burney and Burney 2007). Elsewhere on the island, management sites, some as large as 8 to 12 ha, feature the planting of native plants that were abundant around those sites just prior to European settlement (Burney and Burney 2007).

*Species-Based Surrogacy Approaches***:** Because of limited resources, conservation approaches are often directed at single species as surrogates in hopes that management of these species will both benefit and predict the distribution of other, sometimes lesser-known species occupying the same habitat (Caro and O'Doherty 1999; Caro 2003; MacDonald 2003; Marcot and Flather 2007). Some authors, e.g., Tracy and Brussard (1994), refer to the former approach as a "coarse filter" approach to conservation. Regardless of terminology, in practice, surrogate species should represent a large number of other taxa with similar ecological requirements (Suter et al. 2002).

In reviewing the literature, surrogate species have been used as "umbrella species" to help delineate protected areas (Suter et al. 2002; Caro 2003), and as "flagship species" to help attract public attention (Caro and O'Doherty 1999; Walpole and Leader-Williams 2002). They have also been employed as indicator species to assess several aspects of biodiversity and environmental conditions (Caro and O'Doherty 1999; Lindenmayer et al. 2000; Rooney 2001; Suter et al. 2002; Caro 2003). Unfortunately, as the literature suggests (e.g., Caro and O'Doherty 1999), there exists considerable confusion over these terms, and many, if not all have been used loosely and interchangeably.

Umbrella Species: By definition, an umbrella species is demanding on resources and needs large expanses of habitat, and can therefore be used as a surrogate for many other biodiversity components that have similar but less extensive spatial requirements (Suter et al. 2002; Caro 2003). In practice, given sufficient protected habitat, if significant correlations occur between the geographic distributions of selected umbrella species and other groups of species, it may be possible that the proper management of umbrella species will bring many other species in the same geographic area under protection (Dobson et al. 1997; Caro 2003).

Umbrella species have been used in a variety of conservation strategies and land management plans (Marcot and Flather 2007). In East Africa, population ranges of several large mammal species, in particular elephant (*Loxondonata africana*), lion (*Panthera leo*), and leopard (*Panthera pardus*) have been employed to realign the boundaries of several national parks and reserves (e.g., Serengeti National Park and Masai Mara National Reserve) (Caro 2003). Spotted Owls have been used to help save areas of old-growth forest from logging in the Pacific Northwest, USA (Wilcove 1994). The Florida panther (*Puma concolor coryi*) has been proposed as an umbrella species to help protect wider biodiversity in southern Florida (Simberloff 1998).

A good example of an umbrella species is that of Capercaillie (*Tetrao urogallus*), a large forest grouse species of Central Europe. The Capercaillie resides primarily in structurally diverse coniferous forests that also tend to be high in animal and plant diversity (Suter et al. 2002). Suter et al. (2002) tested the usefulness of Capercaillie as an umbrella species by analyzing the relationship between Capercaillie occurrence and avian biodiversity. Study plots with Capercaillie did not have higher overall avian biodiversity than plots without

Capercaillie. However, there was a positive association between Capercaillie presence and overall richness and abundance of birds restricted to subalpine forests. Several of these bird species also belong to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Suter et al. 2002). The authors concluded that Capercaillie may, at the very least, be used as an umbrella species for birds restricted to subalpine forests of Central Europe.

Flagship Species: Flagship species are those that carry high public interest, and thus have the ability to capture public concern and foster public support for conservation efforts (Caro and O'Doherty 1999; Walpole and Leader-Williams 2002; Marcot and Flather 2007). In general, the success of flagship species as surrogates is determined by whether the awareness and conservation action they promote contributes to conservation goals (Walpole and Leader-Williams 2002). Walpole and Leader-Williams (2002) suggest that this may be as simple as "providing revenues for wider biodiversity conservation in protected areas where flagships reside." In summary, flagship species are used to rally conservation support, usually for high-profile charismatic species.

In Eastern Indonesia, the Komodo dragon (*Varanus komodoensis*) is an example of the value of a flagship species. The Komodo dragon is mostly confined to the islands of the Komodo National Park (KNP). KNP, although established to specifically protect this species, also protects considerable marine and terrestrial biodiversity, including several endangered species (Walpole and Leader-Williams 2002). The Komodo dragon fulfills the role of a flagship species by helping to raise local awareness and support for conservation efforts within the park, thus helping to conserve wider biodiversity (Walpole and Leader-Williams 2002).

The Florida panther (*Puma concolor coryi*) has become a symbol of an entire conservation campaign in southern Florida (Simberloff 1998). The panther is threatened in large part by habitat fragmentation and a reduction in population numbers of its preferred prey animal, the white-tailed deer *Odocoileus virginianus* (Simberloff 1998). The charismatic nature of the panther has attracted significant public support, which helps to fund conservation efforts for both the Florida panther and broader conservation goals (Simberloff 1998).

Indicator Species: In general, neither time nor resources are available to survey the whole of biodiversity, or the effects of management strategies on all species (Caro and O'Doherty 1999). Using species as indicators has been proposed as one possible tool to address this problem (Lindenmayer et al. 2000; Lawler et al. 2003; Smith et al. 2005). Indicator species have also been referred to as ecological indicators (e.g., see Dale and Beyeler 2001), Management Indicator Species (MIS) (e.g., see Smith et al. 2005; Marcot and Flather 2007), and biodiversity indicators (e.g., see Caro and O'Doherty 1999).

Landres et al. (1988) defined an indicator species as "an organism whose characteristics (e.g., presence or absence, population density, dispersion, reproductive success) are used as an index of attributes too difficult, inconvenient, or expensive to measure for other species or environmental conditions of interest." In more general terms, indicator species are species whose population trends are thought to reflect a suite of ecosystem conditions and population trends of other species, and thus the overall health of an ecosystem (Dale and Beyeler 2001; Smith et al. 2005). Although selection of indicator species may vary according to management goals, according to Smith et al. (2005), species with complex life histories are good candidates to be indicator species.

In reviewing the literature, indicator species can be divided into four major types:

- A species whose presence is used to assess the extent of human disturbance (Caro and O'Doherty 1999; Lindenmayer et al. 2000; Caro 2003).
- A species that can be used to assess environmental conditions or trends in condition over time (Dale and Beyeler 2001; Rooney 2001).
- A species whose presence is used to track population trends in other taxa (Caro and O'Doherty 1999; Rooney 2001; Marcot and Flather 2007).
- A species that serves as a biodiversity indicator to help locate areas for conservation prioritization (Dobson *et al.* 1997; Caro and O'Doherty 1999; Lindenmayer et al. 2000; Suter et al. 2002; Lawler et al. 2003; Marcot and Flather 2007).

Most efforts to date have tended to focus on individual species or guilds as ecological indicators (Lindenmayer et al. 2000). A guild refers to a group of species that have similar ecological requirements, and thus share a similar ecological niche. Dale and Beyeler (2001) suggest that because there are various levels in the ecological hierarchy, it does not seem that biodiversity can be simplified or reduced down to a single measure, and thus, ecological indicators are required at a wide range of organizational levels (Table 4) (Heywood and Iriondo 2003).

Table 4. Examples of Ecological Indicators[19]

HIERARCHY	PROCESSES	SUGGESTED INDICATORS
Organism	- Environmental Toxicity - Mutagenesis	- Physical Deformation - Lesions - Parasite Load
Species	- Range expansion or contraction - Extinction	- Range Size - Number of Populations
Population	- Abundance fluctuation, colonization, or	- Age or Size Structure - Dispersal Behavior

[19] Table adapted from Dale and Beyeler (2001).

	extinction	
Ecosystem	- Competitive Exclusion - Predation or Paratism - Energy Flow	- Species Richness - Species Evenness - Number of Trophic Levels
Landscape	- Disturbance - Succession	- Fragmentation - Spatial Distribution of Communities - Persistence of Habitats

Several authors have noted that the use of indicator species in conservation planning is based on assumptions, and thus the theoretical basis for using indicator species as a conservation tool is problematic. For this reason, it is not surprising that several researchers caution against using indicator species in conservation planning. Simberloff (1998) suggested that the use of an indicator species to reflect the health of an ecosystem or other species is, in general, unrealistic. Lawler et al. (2003) noted that, given the difficulty in obtaining detailed information on the ecology and distribution of species and ecosystems, the use of indicator species in conservation planning is not likely to be successful.

Although scientific analyses of the method have shown some positive results, many studies suggest that there is very little correlation between measures of environmental conditions and the indicator species that have been selected (Lindenmayer et al. 2000; Lawler et al. 2003). Smith et al. (2005) tested the assumption that the northern flying squirrel (*Glaucomys sabrinus*) could be used as a Management Indicator Species (MIS) for ecological conditions in temperate rainforests of southeastern Alaska. This assumption was based on previous studies of *G. sabrinus* in temperate forests of the Pacific Northwest, USA, which demonstrate that its habitat use is linked to a suite of old-growth forest characteristics. The expectation was that the ecology of *G. sabrinus* in southeastern Alaska would be similar to populations found in the Pacific Northwest. Smith et al. (2005) found little empirical evidence that supports the use of *G. sabrinus* as an MIS for northern temperate forest in southeastern Alaska, noting important regional differences in habitat use, forest community structure, and diet specificity. Lawler et al. (2003) tested the utility of using at-risk species as an indicator to help select areas for conservation of other at-risk species. Results show that sites selected to protect indicator species provided little protection for other at-risk species not selected as indicators.

Ecosystem-Level Strategies for Biodiversity Conservation

Today, many conservation efforts are focused on ecosystem-based approaches in which the management objective is to conserve the entire biological and physical environment in which species live (Simberloff 1998; MacDonald 2003; Lindenmayer et al. 2007). In reviewing the literature, there does not seem to be a consensus definition of ecosystem-based management. The key feature, however, of ecosystem-based approaches is the focus on ecological processes, and ecosystem structure, function, and composition rather than individual species (Simberloff 1998). It is noteworthy, as Simberloff (1998) points out, that at the level of management, the processes, structure, function, and composition themselves are the valued entities, much like individual species are the valued entities within species-based approaches.

Range of Natural Variability: This approach focuses on managing an ecosystem within a range of historic vegetation and environmental conditions, and is based on an understanding of the long-term environmental history of an ecosystem prior to human disturbance (Heyerdahl 2000; Marcot and Sieg 2007). Many researchers and managers believe that knowledge of past ecosystem conditions, generally provided by paleoecological records of fossil pollen, charcoal, and other proxy indicators such as tree ring records can provide useful information for conservation planning (Horn 1998; Heyerdahl 2000). For example, many researches argue that knowledge of past disturbance regimes (e.g., historic fire regimes) and vegetation history is important for ecosystem management strategies because many of the species present in these ecosystems evolved with the spatial and temporal variability of these disturbances (Horn 1998; Heyerdahl 2000).

Maintaining (or mimicking) natural disturbance regimes is increasingly being recognized as an important part of conservation efforts (Gavin et al. 2007; Marcot and Sieg 2007). Disturbances (e.g., fire or grazing) have been important in shaping the structure and function of various disturbance-prone ecosystems throughout Earth's history (Horn 1998; Willis and Birks 2006; Gavin et al. 2007; Marcot and Sieg 2007). Of particular importance to managers is the variability (e.g., frequency, seasonality) of such disturbances over time and how this variability acted to maintain biodiversity (Willis and Birks 2006; Marcot and Sieg).

Studies of past environmental conditions have increasingly become a more direct part of conservation efforts (Burney and Burney 2007). For example, a number of recent studies have provided direct management information for biodiversity conservation, including recommendations on wildfire, climate change, and management within thresholds of natural variability (e.g., Chambers et al. 1999; Willard et al. 2006; Burney and Burney 2007; Gavin et al. 2007; Willard and Cronin 2007). Horn (1998) examined issues relating to fire management in Chirripó National Park, Costa Rica. Soon after the parks establishment in 1975, a 1976 fire burned significant portions of the Chirripó páramo (Horn 1993). Local media coverage of the event generated concern among observers, and eventually led some officials to regard fire as a major threat to this ecosystem (Horn 1998). Consequently, although the park's management plan raises a number of issues related to fire, the prevailing thought emphasizes the prevention of fire, especially in the high-elevation treeless páramo. Sally P. Horn and collaborators examined pollen and charcoal from sediments from highland glacial lakes to reconstruct the long-term fire and vegetation history of the Chirripó páramo (Horn 1993; League and Horn 2000). Results showed that fire has long been a component of the Chirripó páramo, and that some plants that typify páramo vegetation have been subject to frequent burning (Horn 1998). Her findings highlight the need for park authorities to reevaluate fire management goals (Horn 1998). Horn (1998) suggested that in order to conserve the Chirripó páramo, park managers, rather than preventing fire, may want to focus efforts on maintaining some target fire frequency and controlling fire size

Lindbladh et al. (2003) studied charcoal and pollen from a 2500-year sediment record from a forested wetland site in the Hornsö-Allgunnen region of southeast Sweden. The 200 ha forest site is of concern to local conservation authorities due to its exceptionally large number of endangered species of beetle. Many of these species depend on open forest conditions for survival (Lindbladh et al. 2003). The different size classes of charcoal show large conformity throughout the record. Charcoal analysis indicates frequent and continuous burning until ~AD 1850, when charcoal abundance significantly decreases. The pollen data indicate that the site is more closed today than at any time in the past ~2500 ^{14}C yr BP. The authors concluded that openness of the forest site in the past was a consequence of the long-term occurrence of frequent fires. Open forest conditions remained relatively stable until recent decades after increased land ownership and law enforcement in the middle 19th century resulted in fire suppression. Lindbladh et al. (2003) suggested that in order to conserve beetle assemblages at this site, open forests conditions would need to be restored and prescribed burns would be the most effective way to achieve this.

In the Florida Everglades, human alterations to the natural hydrologic regime and seasonality of freshwater flow through the wetland have changed the distribution of native plant communities throughout the ecosystem (Bernhardt et al. 2004; Willard et al. 2006; Willard and Cronin 2007). This degradation has prompted efforts to restore the natural hydrology and plant communities of the Everglades. Willard and Holmes (1997) and Willard et al. (2001) analyzed pollen from surface samples and deep sediment cores from several sites throughout the Everglades and near Florida Bay. Results of these two studies are consistent. Pollen assemblages indicate that marsh and slough vegetation, primarily sawgrass (*Cladium*) and cattail (*Typha*), were the dominant element of plant communities most of the last two millennia until AD 1950. By ~AD 1960, the abundance of sawgrass pollen and other marsh and slough vegetation had dropped to its lowest levels than anywhere else in the core, with tree pollen becoming more abundant (Willard and Holmes 1997; Willard et al. 2001). Both records provide evidence of major vegetation changes in response to human-induced alterations to the Everglades hydrologic regime, and suggest that water depths were greater and hydroperiods were longer before the onset of water management practices. This evidence plays an important role in determining hydrologic targets for the whole ecosystem (Willard and Cronin 2007). These data also provide important information on how vegetation will respond to planned changes in water management (Bernhardt et al. 2004).

*Species that Play Critical Ecological Roles***:** This concept focuses on conserving species that have large impacts on many others, as well as on the physical environment of which they are a part of (Ernest and Brown 2001; Marcot and Sieg 2007). Often, these impacts are beyond what might have been otherwise expected from a consideration of their abundance or biomass (Simberloff 1998).

Various methods exist for classifying species that play critical ecological roles. Here, we discuss two examples: *keystone species* and *ecological engineers*. Strictly speaking, there is a distinction between the two. The term 'keystone species' refers to any species which helps to regulate local species abundance and diversity. An 'ecological engineer' is a species that has a strong influence over its physical environment, and thus modulates ecosystem structure, composition, and function. (Marcot and Sieg 2007). In practice, the distinction between the two concepts may become blurred, as keystone species and ecological engineers may not be mutually exclusive. For example, if an ecological engineer affects its physical environment, it most likely has a major influence over resources available to other species. Thus, ecological engineers may well facilitate the persistence of many other species that occupy the same habitat. This proposition, however, is a hypothesis rather than a fact. Further, in context of conservation planning, the concept of keystone species has been included in both species-based (Simberloff 1998; Caro and O'Doherty 1999) and ecosystem-based (Marcot and Sieg 2007) approaches. As Simberloff (1998) points out, management of keystone species combines aspects of both species- and ecosystem-based management. For convenience, we have combined the two approaches, and refer to both as keystone species.

Paine (1995), Simberloff (1998), Manning et al. (2006), and other researchers have discussed the concept of *keystone species* as an effective orientation to conservation practice. The concept of keystone species suggests that certain species have a large impact on species diversity at lower trophic levels (Simberloff 1998). As a result, keystones have numerous direct and indirect effects on ecosystem structure and function, such as vegetation composition and energy flow (Ernest and Brown 2001; Rooney 2001). Inherent within this interpretation is that the loss of a keystone species or a change in its abundance (either increase or decrease) will have significant ramifications for the abundance and interactions of many other organisms that occupy the same habitat (Caro and O'Doherty 1999; Ernest and Brown 2001). For example, *coyote* (*Canis latrans*), prairie dogs (*Cynomys* spp.), and kangaroo rats (*Dipodomys* spp.) have been proposed as terrestrial keystones (Ernest and Brown 2001; Marcot and Sieg 2007).

Rooney (2001) studied North American white-tailed deer (*Odocoileus* spp.), and found that they have both direct and indirect impacts on forest structure, including recruitment of some tree species such as eastern hemlock (*Tsuga canadensis*) and white cedar (*Thuja occidentalis*). He also found that they strongly affect forest understory composition. Rooney (2001) suggests that because deer can potentially have a major influence on species composition of forests, effective ecosystem-based management approaches that balance deer management with biodiversity conservation need to be implemented in regions with high deer densities. Deer populations and indicator species, such as ferns, graminoids, or other understory taxa should be monitored. Managers should select indicator species based on their sensitivity to changes to deer density. The indicator species can then be used to establishment management thresholds (Rooney 2001).

The keystone concept can also include structural features. Manning et al. (2006) demonstrated the keystone role of scattered trees in various 'scattered-tree ecosystems', such as the oak-savannas and tundra-boreal forests of North America. For example, at the local-scale, scattered trees influence their environment by providing a cooler and usually wetter microclimate, contributing to an increase in nutrient levels, and providing critical foraging habitat for animals (Manning et al. 2006). At the landscape-scale, they provide greater connectivity for animals, tree cover continuity, and plant genetic connectivity (Manning et al. 2006).

The keystone species concept perhaps has broader implications for conservation efforts. Regarding species extinctions, losses of keystone species are likely, simply by definition, to cause major changes to ecosystem processes and species composition (Ernest and Brown 2001; Manning et al. 2006). This is especially true if surviving local species are unable to compensate for the loss of the keystone (Ernest and Brown 2001). If this interpretation is correct, it presents an urgent need to understand the ecological roles of keystone species (Ernest and Brown 2001).

*Diversity of Habitats and Habitat Conditions***:** This approach focuses on maintaining a diversity of habitats and habitat conditions (e.g., successional stages) across a landscape (Marcot and Sieg 2007). The principal distinction between this approach and that which focuses on managing within a range of natural variability is that this approach focuses on how species use a variety of habitats and habitat conditions, but not from a historical perspective (Marcot and Sieg 2007). The main assumption is that by managing or maintaining a variety of habitats and conditions, this will provide for the diversity of associated species (Marcot and Sieg 2007).

A study by Porej et al. (2004) demonstrates the high sensitivity of amphibian diversity, specifically the presence of forest-associated amphibian fauna such as salamanders (*Ambystoma* spp.), frogs (*Rana* spp.), and newts (*Notophthalmus*), to upland habitat composition, percent forest cover within a core zone (the zone within 200 m radii of the wetland's edge), and forest fragmentation around 54 wetlands in Ohio, USA. Their analyses clearly show that amphibian diversity responds to landscape composition as a whole. In context of conservation planning, results of this study demonstrate the importance of considering multiple habitat types and the effects of landscape composition when devising management strategies. For example, Peroj et al. (2004) postulate that wetlands constructed for mitigation purposes that contain less than 25% forest cover within the core zone are less likely to contain local populations of amphibians. These data may also contribute to on-site preservation of amphibian diversity in and around housing and development projects that retain wetlands on the property for recreational, aesthetic, or biological purposes (Peroj et al. 2004).

METRICS

- Define species' current distribution and natural range
  - *General concepts that underlie analyses of species' ranges:* (see: Gaston 1996, Holt 2003)
    - *Species' niche*
    - *Spatial variation in environments (habitat types)*
    - *Patterns of habitat use*
    - *Dispersal method and barriers to dispersal*
- Define the ecological role(s) played by species in their ecosystems (for example see: Wright *et* al. 2002, Knight *et al*. 2005, Soulé *et al*. 2005, Marcot and Sieg 2007)

- Define interspecies interactions (*e.g.* symbiotic relationships or other associations), especially those that play a significant role in ecosystem maintenance.
  - *Types of species interactions:* (see MacDonald 2003, Soulé *et al*. 2005)
    - *Habitat enrichment*
    - *Symbiotic (e.g., mutualism)*
    - *Predation*
    - *Competition*
- Define the disturbance ecology of species.
- Assess, to the degree possible, how various natural disturbances, such as fire, invasive species, tree-falls, or grazing, interacted with climate fluctuations in maintaining community structure (Swetnam *et al*. 1999, Lafon *et al*. 2005, Marcot and Sieg 2007, Gavin *et al*. 2007, Willard and Cronin 2007)
  - *General attributes of disturbance regimes that need to be assessed:* (see Marcot and Sieg 2007: 175–176)
    - *Type*
    - *Severity*
    - *Frequency*
    - *Seasonality*
- Assess, to the degree possible, anthropogenic impacts
    - *Land use change*
    - *Habitat Fragmentation*
    - *Human alteration to disturbance (e.g., human-altered fire regime)*
    - *Temporal considerations: pre- or post-human influence*
    - *Species' response to human disturbance*
- Determine species' population viability

MAKING CHOICES: A plethora of conservation approaches has been advanced, dealing with statistics, surrogacy, individual species, ecosystems, etc. Many of these approaches were developed to help streamline difficult decisions associated with conservation efforts (Raphael et al. 2007a).

The debate between species- and ecosystem-based conservation approaches has become increasingly important (Lindenmayer et al. 2007). Species-based approaches are considered by many to be inefficient and too costly (Simberloff 1998; Raphael et al. 2007a). The value of individual species, however, cannot be ignored (Dayton 2003). Their life histories, evolutionary contexts, and ecological roles are vital components of ecosystems (Smith et al. 2005). As pointed out be Ernest and Brown (2001), individual species can play key roles, and the loss of such species can bring about major changes to ecosystems. Ecosystem-based conservation approaches are thought to have the benefit of conserving not only the target species, but many other species occupying the same habitat as well, and are thus considered more efficient (MacDonald 2003). This, coupled with the magnitude of biodiversity loss, has meant that conservation efforts are increasingly focused on ecosystem-based approaches (Lindenmayer et al. 2007). Some Key questions to address include the following (Raphael et al. 2007b):

- What is the geographic area of interest?

- What are the species or systems in question?
- What is the level of knowledge about the species of system in question?
- What are the causes of risk or degradation?
- Which conservation approaches are best suited to address conservation concerns?
- What are the advantages/disadvantages of available conservation approaches?
- Which conservation approach supports the most species?
- What are the social and economic considerations?

Case Example: Lessons learned from conserving a variety of habitats

The Clinch, Powell, and Holston Rivers case example provides an example of a conservation program directed towards maintaining a variety of habitats. The management program directed at Clinch Valley, which comprises the watersheds of the Clinch, Powell, and Holston rivers in southwestern Virginia and northeastern Tennessee. These river systems harbor several imperiled aquatic species, along with many rare plants, animals, and birds that live within the diverse suite of habitats and forest types that makeup the Clinch Valley. As part of its "Last Great Places" ecosystem conservation program, The Nature Conservancy, along with local partners and researchers, work to maintain the variety of habitat types and species of concern.

Case Example: Lessons learned from combining biological with socio-economic factors

The Florida Panther recovery initiative is an ambitious and creative example of applying new strategies to restore the population and work closely with the private sector to sustain viable habitat. Translocation of female Texas panthers to Florida prevented the extirpation of the Florida panther. To date, the population has increased to an estimated 80 to 100 individuals and much public support for conservation efforts has been fostered. See the case examples section of this document for more information on these and other case examples.

Bottom line The challenge for resource managers and conservation practitioners is to find a way to meet the needs of all species and systems. However, insufficient time and resources forces managers to make difficult decisions as to where to focus conservation efforts. Addressing the above conservation metrics and questions will help identify an appropriate conservation strategy.

A LOOK TO THE FUTURE: Unprecedented global change and the inevitability of continued human development places a premium on biodiversity conservation efforts. Choosing the most appropriate conservation strategy is imperative. One of the key questions: how can resource managers and conservation practitioners support the most species at the least cost (Myers et al. 2000). This question is at the forefront of conservation planning. By concentrating efforts on areas where there is the greatest need, managers can systematically address the challenge of biodiversity conservation (Myers et al. 2000).

Social Component

ROLE OF SOCIAL CONSIDERATIONS: Incorporating social dynamics in the habitat restoration and conservation planning process is imperative to securing understanding and acceptance of the preferred conservation strategy.

GOAL: Establish a long-term commitment by all sectors of society to maintain a sustainable population of the species/ecosystems of concern.

OBJECTIVES: All of the following are of equal importance in laying the foundation for successful decision-making, leading to a publicly accepted habitat restoration and conservation plan.

- Ensure equitable inclusiveness among stakeholder participation in the planning, analysis, and decision-making process that evaluates alternative conservation strategies to sustain the species/ecosystems of concern (Gregory and Keeney 1994).
- Maintain a holistic and nonpartisan perspective of the social considerations and consequences of alternative species conservation strategies under consideration (Hughey *et al* 2003).
- Maximize an array of social and economic benefits to the degree practical without compromising the species conservation goal (Gregory and Keeney 1994).
- Establish and maintain an institutional framework for sustaining the chosen conservation strategy (Endter-Wada *et al.* 1998).

ASSESSMENT STRATEGY

<u>Social Values</u>

These are the foundations for positions stakeholders take on alternative conservation strategies. Identifying relevant social values, how deeply they are held, by whom, and in what context is a social process (Peine 2007). The human values listed below summarize a broad spectrum. There are five identifiable social values with thirteen subtypes displayed in Table 2. The relative importance of these values will likely vary as to the context of the social process and relevancy to any given species/ecosystem conservation strategy under consideration. Personal values can be quite divergent from collective values held by families, communities, business, and/or political interests. The components of social values briefly described are interrelated to some degree for any given circumstance associated with alternative conservation strategies under consideration (*Ibid*). These values will evolve as the assessment process evolves. Shared and divergent values will be the foundations of collaboration or confrontation. Stewardship and aesthetics tend to be at the top of the list of social values espoused by advocates of species conservation (*Ibid*).

Additionally, understanding both the *conservation* and *preservation* movements related to stewardship can help in understanding different social values and related perspectives of key stakeholders. The conservation discourse advocates for environmental protection and the implementation of natural resource management so that ecosystems may best be utilized for human use (Brulle 1996, Meine 1995). Guifford Pinchot, a leader of the conservationist movement, believed that the deliberate management and scientific manipulation of nature would yield sustainable resources as well as economic benefits (Miller 2001, Meine 1995). He also advocated for government centered resource management, including regulatory practices and legislative protection, and maintained that the benefits of resource development should be distributed equitably (Meine 1995, Simmons 1993).

Social values are the foundation of the decision-making process as structure, process, and function are to ecosystem evolution.

In contrast to *conservation* is the *preservation* perspective whose proponents suggest that nature has intrinsic value and therefore needs preserving for reasons unrelated to human use (Brulle 1996). Preservationists define their relationship with nature not in utilitarian terms, but rather as a deeper spiritual connection (Brulle 1996, Meine 1995). John Muir strongly advocated for the preservation of wilderness and recognized the spiritually rejuvenating aspects of nature (Meine 1995).

Both the *preservation* and *conservation* movements are organized to counter humans' careless destruction of the biophysical environment. In other words, the goals of both movements often overlap, yet in the details differences arise (Meine 1995). The conservationists espouse more scientific and economic values while the preservationists promote more cultural, ethical, and spiritual values (Simmons 1993). Conservationists are ultimately criticized for their over emphasis on utilitarian and market-oriented values, while preservationists are critiqued for having a more hands-off approach to ecosystem management and for often disregarding the needs of humans. David Orr (1993) states the often ignored reality: "The attempt to manage anything carries with it political, social, ecological, and moral consequences."

The ecological-integrity model provides a means to understand how humans affect natural systems and incorporate "human values" in the decision-making process. Humans are too often viewed as deterrents to natural processes rather than interacting elements of ecosystems. However, it has been pointed out that, "humans are intimately connected with and influence ecological systems, and there is growing recognition that understanding those connections is the key to developing an adaptive and effective ecosystem management approach (Endter-Wada *et al* 1998:897)."

Table 5. Social Values

Value	Description	Example

Stewardship	Moralistic	Basic principle of what is right and wrong in terms of the treatment of nature	Cutting plastic soda rings in order to prevent a choking hazard for small animals
	Ecologistic-Scientific	Systematic study of natural processes focusing on the interdependence among species and the structures and process of ecosystems	Role of natural scientists in the recovery plan process for threatened and/or endangered species
Naturalistic	Aesthetic	Reflects the physical appeal and beauty of nature	Advocating species conservation because of the beauty we associate with certain species (i.e. bald eagle).
	Humanistic	Strong emotional attachment and bond with nature	Emotional connection with trees or wild animals; desire to rescue and nurse birds fallen from a nest
	Spirituality	Deep or heritage connection with nature	View of nature as “Mother Earth”
	Solitude	Escape from our everyday routine through opportunities with nature	Communing with nature via sights and sounds
Communal	Family Structure and Lifestyle	Family structure affects relationships with nature and has changed overtime	Generational teaching about and exposure to the outdoors and nature
	Family Traditions and Rituals	Rituals and traditions provide links with nature, changes in rituals may alter relationships with nature	Fishing and hunting traditions have declined overtime
	Community interactions related to nature	Composition of and connection to community affects our relationship with nature	Living near wildlife may result in a better understanding and desire to protect wildlife
Utilitarianism	Welfare	The material benefits of nature and the practical uses of nature as related to our health, prosperity, and general well-being	Job working for a timber company or saw mill
	Safety and Security	Represents survival needs (i.e. clean water, shelter, food)	Clean well water

Dominionistic	Non-sustainable natural resource exploitation	Manipulating and dominating nature (through resource extraction) in ways that ignore resource preservation and conservation.	Mountaintop removal coal mining
	Negativistic	Fears and aversions humans have towards nature and wildlife; often acting in a cruel manner towards nature and causing unnecessary destruction.	Killing wild animals that may threaten surroundings

Stewardship refers to the "responsible use (including conservation) of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society" (Worrell and Appleby 2000). Stewardship is often one of the social values held by those advocating species/ecosystems conservation (Peine 2007).

a) *Moralistic* -the basic principle of what is right or wrong in regards to the nonhuman world; additionally, it represents a basic kinship that binds all living creatures and the natural world together (Kellert 1997).

b) *Ecologistic* - focus on the interdependence among species and natural habitats, as well as the elements of nature and biodiversity. Scientific values also focus on a systematic study of natural processes; however the emphasis is shifted to the physical and mechanical functioning and does not always involve direct contact with nature. Field biologists and other natural scientists have specialized knowledge necessary to this process (Kellert 1997).

Naturalistic emphasize humans' desire to have direct contact with nature. Benefits include relaxation, intellectual growth, increased levels of creativity, sharpened sense of detail, and physical fitness (Kellert 1997). The naturalist social value may be manifested through activities such as hunting (for sport), eco-tourism, visiting a zoo, hiking, and mountain-biking.

a) *Aesthetic* - reflect the physical appeal and the beauty of nature (Kellert 1997). Aesthetics is also one of the social values frequently held by those advocating species conservation. Additionally, beauty looks different for each person, making aesthetics a social value that is subjective and difficult to categorize (Peine 2007).

b) *Humanistic* - represented by a strong, intimate, and emotional attachment and bond with nature. This often manifests itself through companion relationships with pets (Kellert 2005, Kellert 1997).

c) *Spirituality* - a type of heritage association or deep connection that some people have when experiencing the natural environment; however this is not always associated with a formal religious affiliation. While spirituality is an

important social value to consider, it is possibly the least recognized social value associated with species conservation (Peine 2007).
d) *Solitude* - represents the opportunity to become one with nature with minimal distraction, allowing us to recognize our place within nature. Solitude is often described in terms of an escape or a temporary relief from the routine and pressures of everyday life (Peine 2007).

Communal **-** expressed in the context of social interaction and associations such as family and friends, commercial enterprise, voluntary association, public agencies, communities and neighborhoods, and governmental units. Patterns of social behavior, as shaped by our communal interactions, reflect our intellectual and moral faculties (Peine 2007). Family shapes our values and relationship with nature through structure and lifestyles, as well as rituals and traditions.
a) *Family Structure and Lifestyle* - as social shifts in family structure and lifestyle occur (i.e. the traditional nuclear family is evolving, family structure now takes on a variety of forms and personal relationships), alternative relationships with nature develop (Peine 2007). For example, Richard Louv (2008) writes about the effects of 'nature-deficit disorder,' a phenomenon that occurs when children have limited exposure to nature (i.e. video games often replace outdoor activities).
b) *Family Traditions and Rituals* - rooted in history and ancestry, may provide a sense of cultural cohesion and have the ability to cause emotional and symbolic links with specific places in the environment. Changes to traditions and rituals via blended families may shift our relationships with nature (Peine 2007).
c) *Community interactions related to nature* - the composition of one's community (i.e. the degree of rurality, as indicated by the presence of native vegetation, water, open spaces, parks, agriculture, etc…) along with a sense of belonging or connection to one's community (vs. individualism) affects our relationships with nature (Peine 2007).

Utilitarianism - focuses on the material and practical benefits of nature for human use, for example hunting and fishing for food or using timber for constructing shelter. The utilitarian social value allows people to feel connected to the practical uses of nature, giving people the feeling of physical sustenance and security (Kellert 1997).
a) *Welfare* - nature is connected to our welfare because it is connected to our health, prosperity, and our general well-being. Nature may also be entwined in our financial and job welfare (Peine 2007). For example, coal mining companies and oil refineries provide employment opportunities to resource dependent communities. See the Economic Component that follows this section.
b) *Safety and Security* - nature is directly linked to our survival needs (i.e. clean water, shelter, food). When things in the natural world (i.e. heavy pollution, hurricanes, etc directly affect our basic needs in ways that are visible (i.e. increased lung cancer, flooding, etc) then the connections between our physical world and our social world become more evident. Safety and security as a social

value may involve groups or people who would not otherwise be concerned with the natural world based on social values such as stewardship.

Dominionistic - represent the mastery, physical control, and dominance of nature. They often involve mechanical skills, physical capabilities, and the ability to manipulate nature for human use (Kellert 1997).

a) *Non-sustainable natural resource exploitation*.

Non-sustainable natural resource exploitation or extraction is the use of modern mechanics and technology to extract natural resources in ways that ignore wildlife conservation and preservation.

b) *Negativistic* - represent fears and aversions humans have towards nature and wildlife. This is often manifested by people acting in a cruel manner towards nature and consequently causing unnecessary destruction; for example, we are scared of spiders so we kill them (Kellert 1997).

Political Influence

Political agendas, the structure of the decision-making process, and financial resources used to aggrandize a position, can have great influence on whether the dynamics of a process for devising a conservation plan are based on conflict versus compromise (Robbins 2004). Conflicts of powerful economic interests, ideological perspectives regarding property rights, and ethics shape government action. The policy of environmental protection in the United States, beginning in the Progressive Era, has been dominated by large business interests' concerns for economic efficiency more than by a preservationist ethic advanced by popular movements, which are tolerated rather than embraced (Hays 1969, Kolko 1976, Schnaiberg 1980, Gottlieb 2005). The legal status and enforcement of species conservation laws fluctuate with the relative power of these interests over time. Politics can readily override a decision-making process, as illustrated by the Spotted Owl and Florida panther case examples discussed below.

The Endangered Species Act (ESA) provides a poignant example of the influence of politics. The number of new endangered species added varies among presidential administrations reflecting in part the political positions and resources applied to the process (Stinchcombe 2000). When the ESA was amended again in 1982, the two-year deadline for processing listing proposals was abolished and replaced by a purely biological standard for listing. The amendments, along with increased opportunities for the public to facilitate enforcement, were intended to counter layers of economic and administrative reviews the Reagan administration had used to suppress the program (Greenwald *et al* 2006). In 1983 the FWS issued a formal listing prioritization guide[20]. Unfortunately, these aspects of the amendment, designed to facilitate implementation of the act, have not been consistently applied. Echoing Stinchcombe's findings regarding the influence of political party, Deshazo and Freeman (2006) found that under oversight committees with more Democrats, the FWS lists more species. Oversight committees with more Republicans list fewer species by a statistically significant margin despite the clear legislative mandate that listing be based purely on biological considerations. "As it

[20] See Table 5: Recovery Priority Table.

turns out, the FWS is not acting on its own when it deviates from statutory criteria. Rather, the agency's listing and resource allocation decisions respond to legislative principals whose preferences simply contradict what the enacting majority intended when it passed (or reauthorized) the law" (DeShazo and Freeman 2006:71).

One should not draw conclusions too quickly, however, about the greater willingness of Democrats to support species conservation. Stinchcombe's methods, which average species listings across entire presidential tenures, likely obscure a reactionary change in policy midway through the Clinton administration. Today, public petitions account for 54 percent of species listed. Lawsuits have established 39 percent, while agencies list only 29 percent without formal legal pressure (Greenwald *et al.* 2006). A wave of litigation between 1991 and 1995 resulted in more of the multi-species listings recommended by the Inspector General in 1990. However, immediately following over 120 listings in 1994, the highest to date, the Republican Congress issued a one year moratorium on listing. The effect of this moratorium on the FWS's already sizable backlog was the political consequence of Congress's action, which resulted in FWS implementing policies to limit public ability to push enforcement of the ESA, which in turn further slowed down the listing process (*Ibid*). In 1995this was accomplished by ruling that candidate species are not subject to petitions and therefore have no legally enforceable timeline for listing (*Ibid*). , This ruling also rendered "not practicable" the default response to petitions from 1997 on, resulting in delays in the response requirement (*Ibid*). The result has been striking. Between 1997 and 2003 FWS listed only six petitioned species, down from 31 in one year, 1996, alone. As of June 2008, currently two animal and one plant species are proposed for listing. Another 282 species, 144 animals and 138 plants, which have been considered for listing are relegated to the list of candidate species (FWS 2008c).

<u>Steps in the Process to Identify Social Considerations.</u>

Step 1: Content Analysis, Literature Review, and Community Observation [*This provides a foundation to identify potential stakeholders and issues of concern*] - Use of newspapers, magazines, journals, books, unpublished reports, web sites, review of similar cases, and other sources of textual information to help with the identification of appropriate stakeholders and the social dimensions to be considered. This first step may also involve ethnographic research, field observations, community participation, and social network analysis (Krippendorff 1980). Key questions to address include the following:

- What social issues appear to be relevant?
- Who are the central stakeholders and what social values are associated with their perspectives?
- Who are the respected community leaders and influential stakeholders?

Step 2: Interviews with Identified Stakeholders [*Identify respected community leaders representing various stakeholder perspectives*] - Allows all stakeholders *equal opportunity* to identify their values relevant to the conservation issues at hand and their perspectives on alternative conservation strategies under consideration. Once appropriate stakeholders have been identified, interviews should be conducted to understand their social values and vested interests. Look for respected community leaders and willing spokespersons representing key constituencies. Use these initial interviews to determine the following concerning the conservation issue at hand:

- Identify pervasive social values at play
- Determine how they are related to the conservation issues of concern
- Identify distinct constituencies of alternative perspectives
- Identify respected and fair-minded spokespersons representing those constituencies.

Step 3: Focus Groups with Identified Stakeholders [*Focus groups, conducted by social scientists, provide an opportunity to establish dialogue among various stakeholders in a non-confrontational setting*] - This step provides an interactive forum for expressing a variety of perspectives on values and vested interests associated with the conservation issue of concern. Focus groups help to identify where there are shared and divergent values as well as vested interests (values as described in Table 2). Insight gained from this step will provide the foundation for assessing how best to structure an appropriate decision-making process. Keep in mind that the process will always be in a state of flux, evolving as needed. Key tracking perspectives include:

- The evolving set of values and special interests at play
- Determining how those values and special interests are related to alternative conservation strategies under consideration
- Identifying shared and divergent values
- Choosing the most appropriate decision-making process among those described below.

Step 4: Public Forums [*Forums, which unfortunately are often confrontational, can be used as supplementary sources of data but will not provide comprehensive data without the initial 3 steps*] - Public opinion meetings are required as part of the public involvement process (Endter-Wada *et al.* 1998). Social scientists can help make the most of public forums. Potential benefits include:

- Providing documentation of written and oral positions on the proposed conservation strategy under review and an opportunity to observe group dynamics
- Improving the understanding of social values, uses, and concerns
- Encouraging a more collaborative public role; however, care is needed to ensure a forum does not become divisive
- Providing a way to identify communities and groups linked to particular ecosystems
- Helping develop a more focused social science data system.

Step 5: Public Surveys [*Telephone and mail back surveys sometimes have limited value because they represent a broad range of people who may have limited direct knowledge or investment in the issue*] - Public opinion surveys conducted in person, by mail, over the phone, or via email can measure a broader geographic and demographic perspective on values and issues of concern (Endter-Wada *et al.* 1998). In many cases, these surveys of social values related to the conservation of natural resources provide divergent results from those of local interest groups with a greater direct involvement in natural resources utilization.

METRICS:

- Define demographics of stakeholders, examples include:
  - *Sex*
  - *Age*
  - *Level of education*
  - *Profession*
  - *Family structure*
  - *Family income*
- Document social values related to natural resources. examples include:
  - *Stewardship*
  - *Aesthetics*
  - *Spirituality*
- Document cultural values related to natural resources. examples include:
  - *Family outdoor traditions – hunting, fishing, off-road vehicle recreation*
  - *Collinearly traditions – eating fish, game, edible plants*
- Document welfare values such as jobs related to natural resources. examples include:
  - *Renewable natural resource utilization such as flood protection* (Crocker *et al.* 1998)
  - *Non-renewable natural resource utilization*
- Identify land ownership concerns. , examples include:
  - *Public land – shared access utilization*
  - *Private land – property rights*
- Document public agency policy and regulatory promulgation strategies. Examples include:
  - *Degree of flexibility in problem solving*
  - *Degree of political influence in decision-making*

MAKING CHOICES**:** The social dimensions will be fluid during the evolution of the analysis, decision-making, and implementation processes. Tracking changing attitudes provides a benchmark for progress toward defining a viable habitat conservation plan. Key questions to address include the following:

- How well have the social dynamics been identified?
- How are social values monitored as they evolve?
- What are the most influential social considerations to take into account when choosing the most appropriate decision making process?
- What is driving those dynamics?
- What are common values and conservation interests from which to build consensus?

- How have institutional dynamics been manifested; have they influenced the process?
- Is the influence of politics in the process anticipated, and if so what are the likely positions and when will they be applied?

<u>Case Example: Social lessons lost due to a timid biological reintroduction strategy</u>

The reintroduction of the red wolf into Great Smoky Mountains National Park provides a case example where strong public support was generated by an extensive educational effort. The biological component included gathering information on releasing the wolves, but when the actual reintroduction occurred, too few pairs were released on too few diverse locations for the species to become established. This is an example where the social component was fulfilled very well, but the biological component failed in that it underestimated the number of wolves that needed to be released to establish a viable population.

<u>Case Example: Biological linked to social lessons learned</u>

The Florida panther recovery required the unprecedented addition of females to a population of six to 10 remaining males. Translocating female Texas panthers to Florida prevented the extirpation of the Florida panther. Federal and state agencies and NGOs have worked together on this effort. Once approved, the biological component will be enhanced by development of a predictive spatial model assessing the potential impacts of alternative private development plans on panther habitat, which may have dramatic positive effects once tested and evaluated.

<u>Bottom line</u> Answers to the above questions will help in choosing the appropriate decision-making process and the conservation strategy most likely to be supported.

A LOOK TO THE FUTURE: With the inevitable exponential expansion of land use conversion from open lands to a built environment, the options for sustainable habitat will likely be reduced in size and become more fragmented. As a result, the social dimensions will likely become more influential and contentious. Fortunately, there is a growing awareness among a variety of sectors of society for the need for a balance with the natural environment and humankind and for sustainable managed growth on a regional scale (Buttimer 2001). Awareness of these dynamics, identification of advocates, and determining the means to engage them in devising habitat conservation plans are imperative (Endter-Wada *et al.* 1998).

Economic Component – a subcomponent of social considerations

ROLE OF ECONOMIC CONSIDERATIONS: Accurately measure the economic implications, both market and *non-market*, of alternative strategies for the habitat restoration and conservation strategies.

GOAL: Gauge the economic consequences and efficacy of alternative conservation strategies for different stakeholders so as to choose policies that reflect economic dimensions of social values/needs while achieving conservation goals/mandates.

OBJECTIVES: Navigate economic problems, remaining aware of which are questions of quantification of substitutable values and mathematical optimization (e.g. cost-benefit analysis) versus which are questions of political choice between non-substitutable values or ethical considerations (e.g. tradeoffs between risks to future generations of less resilient ecosystems and the needs of current generations) (Sagoff 2005, Spash 2005)[21]:

- Avoid reductionist techniques such as Contingent Valuation that tend to marginalize or distort the incorporation of other social dimensions (Sagoff 2005, Spash 2005, Burkett 2006).
- Estimate the economic consequences, both market and non-market based, for stakeholders, including considerations of environmental justice (Executive Order 12898[22] 1994, Sagoff 2005, Johnson *et al* 2007)
- Efficiently allocate resources for species conservation in order to meet legal requirements within economic constraints
- Determine when compensation assistance with economic adjustment is appropriate for stakeholders economically affected by policies
- Anticipate stakeholder reactions to policy choices and willingness to collaborate.

ASSESSMENT STRATEGY

Framework for Analysis

One of the early pioneers of environmental economics, K. William Kapp, concluded that “Capitalism must be regarded as economy of unpaid costs, ‘unpaid’ in so far as a substantial portion of the actual costs of production remain unaccounted for in entrepreneurial outlays; instead they shifted to, and ultimately borne by, third persons or by the community as a whole” (1950: 231). Environmental externalities are not exceptions to the normal functioning of the economic system, they are “pervasive social costs resulting from the structure and incentives under free markets” (Spash 2005:44). The loss of species can constitute such a social cost. When market

> *The central challenge is to accurately measure the economic implications of both market and non-market values.*

[21] This tension is evident in the rift between the disciplines of environmental and ecological economics (Spash 2005). The goal of *environmental economics* is to estimate the economic consequences, track financial transactions, and measure the benefits and costs of alternative conservation policies within a framework of constrained market capitalism (Raphael *et al.* 2007). This is a distinctly more narrow approach, entailing more *a priori* assumptions, than *ecological economics* which “addresses the relationships between eco-systems and economic systems in the broadest sense” (Costanza 1989: 1).

[22] Executive Order No. 12898 (59 Fed. Reg. 7629 (Feb. 16, 1994)) “FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS”

activities such as resource extraction, agriculture, or industrial/urban development industries cause species to become extinct, those industries receive the majority of the economic benefits, but the costs associated by such extinction are born by society more broadly.

Growing recognition of the pervasiveness of such non-market costs, as well as social benefits that are not bought or sold in markets, has undermined claims of traditional economic models to help "efficiently" allocate scare resources. This, of course, has implications for how resource managers allocate scare resources for species conservation. Some early environmental economists, such as Kapp, stressed that the benefits and costs associated with environmental conservation are too qualitatively distinct and diverse to be successfully reduced to a technical matter of cost-benefit analysis. Such reductionism became the dominant goal of the sub-discipline of environmental economics (Spash 2005). In addition, mainstream (i.e. neoclassical) economics [23], uses models of valuation which *cannot* incorporate fundamental aspects of ecology, except in highly distorted forms (Spash 2005, Burkett 2006). Most goods associated with conservation of species biodiversity are *public, non-market goods* as opposed to the *private market goods* compatible with neoclassical economic models.

Tensions created by this deep incompatibility have kept environmental economics marginalized as a discipline and led to the formation of a new discipline of ecological economics, which does include environmental economics in its pluralistic approach, but is less bound by the problematic axioms of neoclassical theory (Spash 2005, Sagoff 2005). Ecological economists have developed integrative approaches, suggesting that economic choices should not be framed alone, but should include social and biological dimensions. Some of these approaches are discussed in more detail in the decision making component below.

The economic approaches below are divided into two categories. The first allows for the use of democratic deliberative methods to decide policy conservation goals and then evaluate the different paths to achieving that goal based on economic grounds. The second approach uses the economic consequences of conservation to determine the degree of species protection, if any, recommended. These decisions are often based on some measure of the economic value of species. Another point of divergence is whether benefits of conservation are derived from ecology and deliberation or in terms of relativistic consumer preference and personal utility maximization.

Approaches and Relevancy

Below is a brief synopsis of seven common approaches and references for application for each. They are not mutually exclusive.

Approaches evaluating relative economic efficiency between conservation alternatives

[23] "The dominant approach to normative policy analysis is cost-benefit analysis grounded in welfare economics, and ultimately in the rational actor model…Truly rational normative analysis will have to be based on a more realistic model of human ecology than the rational actor model, but it must also be a model that subsumes, rather than discards, the rational actor model" (Dietz 2005:323).

- Safe-minimum standard (SMS): in place of conventional "optimization" SMS takes a precautionary stance toward conservation of ecological resources. This approach takes into account the irreversibility and unpredictability involved in choosing among alternatives. , unless the social costs are deemed intolerable (Ciriacy-Wantrup 1952, Bishop 1978). Social costs are usually calculated using economic impact analysis (see below). SMS is applicable when uncertainty or irreversible outcomes exist and when determining if social costs may require mitigation or compensation (such as required during critical habitat designation) (Berrens *et al* 1999).
- Cost-effectiveness analysis (CEA): finds the least-cost means to meet a conservation objective. CEA is applicable when outputs are measured in non-monetary units, when there are many alternatives to be evaluated, when resources need to be allocated fairly among species in diverse geographic areas, and/or when funds are limited (Hughey *et al.* 2003, Shogren *et al*. 1999). The CEA is also advantageous because it can help balance uncertainty with economic efficiency. For example, the cost to improve the likelihood of survival for the Northern Spotted Owl from 91% to 92% costs an estimated $3.8 billion (Montgomery, Brown, and Adams 1994). The value of the extra one percentage point must be weighed against other resource uses that could be allocated to saving another species.
- Cost-utility analysis (CUA): measures output via utility. CUA is applicable when comparisons must be evaluated between a host of competing alternatives for which outcome data is available (Hughey *et al.* 2003). This could be an important tool for adaptive management of ongoing programs.
- Standards-based system: not an economic technique in itself, it establishes criteria in which habitat conservation can be measured across a species range. It is applicable as a metric for measuring ecological outcomes in conjunction with CEA and CUA. (Hoekstra 2002b).

Approaches focusing on the impact of conservation polices on the economy as a whole

- Economic impact analysis: uses an Input-Output (I-O) model to examine impacts caused by changes in regional economic activity. For example, the I-O model may be used to estimate how increased sales to tourists or a loss of mining jobs has ripple, or "multiplier," effects through the rest of the regional economy. Economic impact analysis is applicable when determining the economic impact of a conservation policy, for instance as required during critical habitat designation. It works best when good statistical data is available to forecast the economic effect (Johnson *et al.* 2007). Care should be taken when setting analysis parameters to be sensitive to distributive issues, not just total aggregate economic effects, so that sub-populations likely to suffer particularly high costs can receive appropriate attention (Berrens *et al* 1999).
- Cost-benefit analysis (CBA): measures the costs and benefits, usually in dollars, in order to determine if a policy creates a net social gain. Contingent valuation is most often used to calculate the benefits of conservation. However, this approach is not recommended as it often conflates *consumer preferences* common in the

marketplace in which people ask "what situation will most benefit me as an individual?" with *citizen preferences* in which people ask "what do we believe is appropriate for us as a society, given our shared principles, beliefs, and commitments?" (Sagoff 2005:274). It has been suggested that using a deliberative forum in which preferences are constructed transparently rather than the traditional CV survey--which often falsely assumes pre-existing, fixed preferences—could avoid some of the problems associated with estimating prices for environmental goods with which to carry out CBA (Sagoff 2005, Dietz 2005). CBA is applicable when there are trade-offs between conservation and competing land-use options (Hughey *et al.* 2003).

- Total economic value (TEV): a common form of contingent valuation that ties together direct and passive use values in order to derive a dollar value for "total social benefits." TEV is applicable when there is a requirement to provide a price value for the species. [Deliberative approaches to estimation are preferred to traditional survey methods for the reasons discussed regarding CBA. This approach requires a team of social scientists because it is a more multidimensional approach that should include "passive" or "existence" economic values species rather than simply the 'active use/consumption" values which revealed preference measures such as the "travel cost" or "wildlife user day" measure (Plottu and Plottu 2007).

Table 6. Economic Approaches and Relevancy

Approach	Relevancy
Safe-minimum standard (SMS)	Applicable when there is uncertainty within risk assessment and when processes may be non-linear or irreversible (such as probability of survival and the possibility of extinction). When sensitive to distributional fairness of costs, this method can be useful for planning mitigation and compensation (Berrens et al 1999). Primarily used for hypothetical projects.
Cost-effectiveness analysis (CEA)	Applicable when there are many alternatives to be evaluated, resources need to be allocated fairly amongt species in diverse geographic areas, and/or when funds are limited. May be used with hypothetical or existing projects.
Cost-utility analysis (CUA)	Applicable when comparisons must be evaluated among a host of currently existing competing alternatives for which outcomes have been measured. May only be used with existing projects.
Standards-based system	Applicable as a metric for measuring

	ecological outcomes in conjunction with CEA and CUA.
Economic impact analysis	Applicable when the goal is to forecast the economic effects of a policy; requires that good statistical data be available. Primarily used to evaluate hypothetical projects, often used to meet requirements of economic consideration during critical habitat designation.
Cost-benefit analysis (CBA)	Although often used in the past, CBA is generally not recommended due to major theoretical incompatibilities with transforming species conservation-related benefits into dollar values. It commonly results in undervaluation or exclusion based on non-market values.
Total economic value (TEV)	Applicable when there is a requirement to provide a price value for the species.

Table 7. Types of Economic Analysis Strategy Options

Approaches	Definition	Strength(s)	Limitations
Safe-minimum standard (SMS)	Preserves a minimum level of resources unless the social costs are deemed intolerable	Includes the possibility of uncertain and/or irreversible circumstances	The threshold of "intolerableness" must be defined politically, and the accuracy of social costs is dependent on the model used by the Economic Impact Analysis
Cost-effectiveness analysis (CEA)	Finds the least-cost means to meet a conservation objective	Helps make efficient use of conservation resources by identifying the marginal costs of protection	Only provides marginal costs
Cost-utility analysis (CUA)	Measures output via utility (utility=improvement of species)	Makes comparisons among a host of competing alternatives; can be applied to multispecies or ecosystem bases	Requires outcomes to be known, so is limited to use in adaptive management comparing different approaches after their implementation
Standards-based system (SBS)	Establishes criteria in which habitat conservation can be measured across a species range	Facilitates economic analysis by providing a system for measuring present and potential biological value	Potential values are based on an anticipated cost that may not be accurate

Economic impact analysis (EIA)	Uses Input-Output (I-O) models to examine impacts caused by changes in economic transactions such as tourism spending	Forecasts environmental effects of economic changes and market and nonmarket outcomes of alternative policies	Does not address the issue of public welfare. The level of analysis (e.g. economic sector, scale of geographic area) can have important implications for detecting distributional justice issues
Cost-benefit analysis (CBA)	Measures the costs and benefits, usually in dollars, to determine the net gain	Offers a transparent tool for decision-making process, increases expediency	Exclusion and/or inaccurate measure of nonmarket values; use of Contingent Valuation Method as a tool for placing value on "priceless" commodities
Total economic value as an economic framework (TEV)	Ties together direct and passive values in order to derive total social benefits; uses WTP and WTA for economic metrics	Includes passive use values in a total economic framework	Reduces all specific ecological values to interchangeable amounts of money and often will not indicate realistic situations when values are elicited from surveys

METRICS

- Market utilization of affected lands and natural resources
  - *Opportunity costs of sequestered natural resources*
  - *Adverse effects on local and regional business opportunities*
  - *Impacts on family income and job security*
- Implications of species or community habitat presence/absence on local economy
  - *Ecosystem services (scenic beauty, air quality, water quality and climate indirectly influence a community's economic health through their influence on business location, job creation, and income levels in a region) (*Johnson and Rasker 1995*)*
  - *Attraction to the area by tourists*
- Define nonmarket values
- Define market values

MAKING CHOICES: Market based economic dimensions will be more formulaic than those of the biological or social components. However, defining the relevant economic factors to utilize will be determined by the social values at play and the attitudes and perspectives of the stakeholders as they assess alternative assessment strategies being proposed. Key questions to keep in mind include the following:

- What are the economic considerations at stake?
- Which stakeholders are most concerned and why?
- Are they in the majority and if so why?
- Does a market exist for the conservation good? Is it a public good?
- How do you account for the non-market related economic values?
- Is the ecological relationship in question linear or non-linear? Reversible or non-reversible?
- How do the economic considerations balance with social and biological considerations?

- Are there alternative conservation strategies in play to potentially minimize the economic concerns?
- How can a balance of perspective be achieved?[24]

Case Example: Economic lessons learned

In the Clinch Valley Program, The Nature Conservancy devised creative local partnerships designed to promote water quality, prevent toxic spills, and enhance forestry and farming practices. *Applying a green economic recovery strategy was the centerpiece of this highly successful program.* Using a landscape-scale ecosystem approach that incorporated three closely connected watersheds, partnerships were forged that helped foster cultural and economic activity without regard to state boundaries. Cooperation among private landowners, government agencies, and NGOs has been critical to its success.

Case Example: Blending economic and social lessons learned

The Southeastern Great Plains Prairie case example is an excellent demonstration of collaboration among biological scientists, resource managers, and industry representatives to strive for a common goal of sustaining natural resource extraction while striving to sustain viable populations of threatened species. Collaborative science and implementation of a reduced footprint of drilling for gas and collaboration on decision-making can be successful among divergent private and public sector interests. The working group, using the fact finding model, identified a biological strategy to achieve a sustainable population, but also worked to accommodate stakeholder interests and to incorporate funding for needed research.

Case Example: Socio-economic framework lessons learned

The Northern Spotted Owl case example represents a situation involving complex interrelated biological, social, and economic factors. There has been extensive legal activity and political action involved in the conservation planning effort for this owl. The Northwest Forest Plan and Northern Spotted Owl Recovery Plan involved intensive and extensive collaboration among state and federal agencies, industry, NGOs and private citizens. While implementation of these plans has helped to minimize reductions in owl populations, additional new risks to owl survival have surfaced.

Bottom line Answers to the above questions will help choose the appropriate assessment strategy.

A LOOK TO THE FUTURE: Economic factors will inevitably play a greater role as competing economic interests grow. The challenge will to be to make stronger cases for non-traditional qualitative economic values as well as the economic advantage of

[24] Whether or not a full impact analysis is needed will be determined by the statutory requirements and the outcomes of stakeholder consultation. It should be noted that large business interests are usually quite adept at understanding and advocating for their economic interests, smaller businesses are less able and may require more assistance from resource managers.

collaboration in facilitating environmental state and federal regulations as illustrated in several of the case examples described in this document.

Decision-Making Component

ROLE OF DECISION-MAKING CONSIDERATIONS: Too often, scientifically valid habitat conservation plans have been sidetracked by the way stakeholders were approached and utilized in the assessment and decision-making process. The challenge is how to minimize the potential for such a derailment during the planning process. Each of the previous components has a final "making choices" section. This component focuses on how to incorporate all of those concepts into an integrated decision-making process designed to increase the likelihood of achieving consensus and long term commitment to species/ecosystem sustainability

GOAL: The decision-making process should be supported with collaborative, broadly based, integrated and iterative analytic-deliberative processes (Dietz and Sterns 2008). When done effectively, participation by the public should be fully incorporated into the process, which improves transparency in the decision-making process and leads to improved quality and validity of the habitat conservation plan. It can also enhance trust, which is the foundation of sustaining stewardship commitments.

OBJECTIVES: The decision-making process should instill the following elements for all stakeholders (Dietz and Sterns 2008):

- Maintain clarity of purpose to sustain the at-risk species/ecosystem in perpetuity
- Maintain transparency at all times unless it risks harm to the species or community of concern
- Promote good-faith communications
- Pay close attention to facts and values
- Analyze alternative strategies to maximize stakeholder values and benefits without compromising the primary goal to sustain viable populations in perpetuity
- Promote explicitness about assumptions and uncertainty
- Level the playing field of influence on the process
- Include independent review of official analysis and conclusions
- Allow iterations based on emerging analysis technology and predictive modeling
- Identify, implement and sustain over the long term a viable implementation strategy.

ASSESSMENT STRATEGY

All the objectives listed above sound good on paper, but keeping the prescribed balance is the greatest challenge. This is why matching the appropriate decision-making strategy to the specific circumstances at hand is so critical. Much of the literature on decision-making focuses on the concept of social learning, which implies that the public is the uninformed sector (Endter-Wada et al 1998). That is an incomplete but pervasive perspective. Biologists need to be better informed of the social dynamics driving habitat degradation so as to devise effective adaptive resource management practices. As stated earlier, the integration of disciplines must be balanced. The decision-making process should be collaborative from the beginning. In most cases, it is a long drawn out process that ebbs and flows with evolving perspectives and shifting concerns and influences. Scientific questions will inevitably be raised requiring analysis. Over time, the challenging drivers of push-back will be identified and if commitment remains, focus will turn to seeking solutions respective of legitimate concerns. These topics collectively represent the enormity of contemporary challenges to create an effective and inclusive decision-making process that leads to effectively defining strategies to sustain populations of threatened species/ecosystem (Peine 2007). Peterson *et al.* (2004) documented the complexity of this challenge. Common flash points are as follows:

> *Decision-making is invariably lengthy and fluid so that several of the strategies listed below may come into play over the course of the process.*

- Encroachment on private land rights
- Threats to family welfare
- Threats to family traditions
- Conflict within alternative public renewable versus non-renewable natural resource utilization
- Institutional rigidity
- Special interest influence
- Corporate profitability and power manifest through politics.

<u>Decision-making Strategies</u>

There is a wide range of alternative decision-making strategies from which to choose. Selecting the best strategy (or strategies) depends on incorporating the social and economic considerations discussed above. Keep in mind that the process will inevitably evolve resulting in the likelihood that several strategies listed below will be utilized over the long term. It is important to be open to the use of multiple strategies for each case, as the alternatives below serve to address only select components of the decision-making process.

Table 8. Processes to Facilitate Integrated Decision-Making

Decision-Making Strategies	Description	Case Examples exemplifying

		the decision-making strategies
Social Network Analysis	Provides a spatial analysis of stakeholders, their roles, social values, and interactions. Can be used to map progress and promote collaboration.	Headwaters of Clinch, Powell, and Holston Rivers – sought out creative local partnerships in order to enhance water quality, prevent toxic spills, and improve farming and forestry practices
Systematic Conservation Planning	Six-step process for spatial planning that provides structure yet flexibility; helps to eliminate bias and cope with uncertainties.	Southeastern Great Plains Prairie, Headwaters of Clinch, Powell and Holston Rivers, and Spotted Owl – all address conservation from a distinct spatial perspective.
Joint Fact Finding	Work together to identify relevant common and divergent values followed by seeking acceptable solutions to reach habitat sustainability goals.	Southeastern Great Plains Prairie – use of collaborative science and decision-making among divergent private and public sector interests to initiate a long term recovery strategy
Learn from Success and Failure	Lessons learned from real-world examples of conservation practices – see case examples.	Red Wolves in Appalachia – extensive public awareness program resulted in widespread acceptance of reintroduction of this predator but not enough pairs were released so the effort failed
Evolutionary Linguistic Model	Recognizes that stakeholders have different rules that influence their decision-making.	Gray Wolves - repatriation in Nez Perce tribal lands where they are sacred versus Yellowstone where they are considered a threat to livestock and big game.
Social Learning	Integrates appropriate social information with biological requirements in decision-making; is a continuous and adaptive process.	Headwaters of Clinch, Powell, and Holston Rivers – partnered with community groups to help preserve the local character, history, and traditions of the region
Contingent Valuation	Designs a hypothetical market for non-market goods and asks	Florida Panther – providing a means to assess tradeoffs between development and

	individuals to assign monetary values to non-market goods.	offsetting habitat protection
Multi-Attribute Utility Theory	A process used to quantify values	Southern strain brook trout – tested alternative recovery strategies to define a cost effective means to achieve a long-term, ambitious conservation goal
Rational Actor Model	Utilizes a cost/benefit analysis approach and expects everyone to follow the rules of the market.	Etowah Watershed – policies within the HCP were structured in a manner saving developers the most money and time
Strategic Perspectives Analysis	Integrates the results of social assessments with ecological management through participatory processes	Spotted Owl – the HCP has changed dramatically with each Fed administration via influences by special interest groups and evolving science
Conflict Resolution	Social scientists are used to manage conflicts. A last resort strategy when impasse occurs.	Spotted Owl – the extent and distribution of critical habitat is controversial and continues to be debated among environmental and forest products interests. Each of the last four federal administrations has changed its predecessor's conservation policy

To be successful, decision making strategies require participation from all stakeholders, not just those in charge of guiding and implementing policy. Without public understanding and support, the best laid plans will be difficult to carry out. The International Association of Public Participation has documented multiple aspects of public participation (Public Participation Toolbox 2008 http://www.iap2.org/associations/4748/files/toolbox.pdf). This analysis of the components and attributes of participation presents a theoretical framework to facilitate cooperation of public stakeholders.

- Social Network Documentation, Mapping and Analysis - Complex ecosystems require an equally complex network of humans engaged in environmental stewardship to ensure sustainability. Network maps and analysis allow people to focus on relationships from a contextual and spatial perspective, and to engage diverse perspectives in the process of conservation planning, decision-making and implementation (Vance-Borland and Halley 2009). Key metrics associated with this process include 1) drawing connections between pieces of the network that might not otherwise be connected, 2) raising awareness of who is in the network and identifying their respective roles, 3) identifying the types of influences at play, and 4) recognizing the degree of integration between the perspectives of various players and the efficiency and effectiveness of their collaborations (Krebs and Holly 2004). Network indicators reflect member roles, which range from facilitating structure to being guardians or innovators, providing needed skills, mentoring, analysis, and implementation *(Ibid).* These indicators, tracked over the long term, provide a means to measure progress, transformation of perspectives, shifting collaborative dynamics, and the degree of continued focus on the conservation goal of concern. This concept provides a methodology for the application of inexpensive spatial analysis technology called Smart Network Analyzer, to define and create a synergistic network of individuals to collectively influence sustainable environmental stewardship (*Ibid*).

- Systematic Conservation Planning -This is a six step approach aimed to eliminate the biased sampling of biodiversity. The steps are as follows: 1) compile spatial data on the biodiversity of the planning region, 2) identify conservation goals for the planning region, 3) review the relevancy of existing conservation areas, 4) select additional conservation areas and identify new places for consideration, 5) decide on the most appropriate form of management to be applied to individual areas, and 6) maintain the required values of conservation areas. Within this approach, conservation goals are set at individual conservation areas, zonings and management actions must be implemented, and key indicators reflecting success must be monitored. Systematic conservation planning provides flexibility and adjustment to better respond to the uncertainties of conservation planning (Margules and Pressey 2000:245).
- Joint Fact Finding - This strategy is based on the premise that all stakeholders collaborate together to gain perspectives from each other through shared participation in the decision-making process (Susskind *et al*. 2000). The process begins with a description of the biological values/resources?? at risk and the reasons they are at risk. Everyone has an opportunity to ask questions as the group explores in detail the alternative conservation strategies under consideration and the potential socio-economic implications of each strategy. The next major step is to identify common interests and values, followed by identification of any divergent perspectives. As the group establishes an identity and group dynamics develop, the building blocks will be laid to establish camaraderie and commitment to problem solving.
- Learn from Success and Failure – This analysis offers a way to take strategiesfrom the abstract to the real world via applications of sustainable practices (as illustrated by the case examples below). Case examples provide an opportunity to go from the hypothetical to real world situations, where stakeholders can learn from the leaders on the landscape. Documentation of these stories is presented on the Best Sustainability Practices website: http://bpappalachia.nbii.gov/portal/server.pt. This website includes

documentation of more than 75 Best Sustainability Practices in the Southern Appalachian Highlands, which represents a wide variety of applications.

- Evolutionary Linguistic Model (ELM) – ELM is a discursive model based on the idea that different stakeholders have different rules that govern their decisions. ELM allows for a conscious, reflective, collective and fair decision-making process and draws on human cognitive and linguistic skills (Dietz 2005). While it incorporates social learning and a collective approach, ELM also has its weaknesses. There is no guaranteed closure and/or agreement on the issue in question, because ELM calls for equal input from all stakeholders. All stakeholders may not hold the same communicative or language skills, which may in-turn limit their power to add to the decision-making process and thus negate the premise of equal input from all (Dietz 2005).
- Social Learning - Social and biophysical components need to be included in ecosystem management; this creates a combination between the social and natural sciences. This process should be one of adaptive management and social learning: analysis that is continuous, used to evaluate the outcomes of present management decisions, and utilized to revise and improve future decisions. While social learning proposes the appropriate incorporation of social dimensions into the recovery planning process, it is important to note that each situation is different and may require necessary adjustments.

  > "Depending on the circumstances, some social science information sources will be critical and others will be marginal or inapplicable. The types of decisions that must go into identifying and collecting relevant social information and the use of the information in ecosystem management must be made in a context of adaptive management and social learning (Endter-Wada *et al.* 1998:899."

- Contingent Valuation (CV) – This model includes a hypothetical market for nonmarket goods, and asks individuals to assign monetary values to non-market goods. The monetary values are assessed on a change in quantity or quality of the good(s) in question. Three distinct weaknesses of this approach have been identified: attitudes rather than behaviors are addressed; important information is omitted; and results are often influenced by cognitive and conceptual bias. Gregory *et al.* (1993) suggest the following five components to be included in the CV model to ensure a successful implementation (*Ibid*).

  Accommodate the multidimensionality of values – a value-elicitation method that is sensitive to the diversity of values
  Minimize response refusals – process will vary by location and relevant stakeholders
  Exclude irrelevancies – including information that is not relevant to the issue at hand
  Separate facts from values – one should not assume respondents have complex, scientific knowledge necessary to make value judgments
  Ask the right question(s) – be sure the questions asked of the respondents are seeking out the appropriate information

- Multi-Attribute Utility Theory – Addresses decision-making analysis and suggests conditions in which one can attach numbers to values. Four conditions are suggested under this theory, ultimately allowing the CV model to run successfully (Gregory *et al.* 1993).
    - *Structure the problem* – be sure to list and organize the problem in a manner that includes all aspects of the problem of value to the stakeholders
    - *Assess utilities* – important to seek input from all spectrums of stakeholders to best eliminate the power differential; also a range of outcomes and trade-offs should be specified and assessed to achieve the best possible outcome
    - *Calculate the total value* – the process of calculating the total utility value for any particular plan, program, or scenario
    - *Perform sensitivity analysis* – once a total utility value is calculated one should recalculate using variations determined while assessing the utilities; this reveals how sensitive the final answer is to such variations enabling the researcher to identify the causes of variations and disagreements among stakeholders
- Rational Actor Model (RAM) - This model identifies a homogeneous environment with only one set of market-based rules that everyone is expected to follow. RAM utilizes a cost/benefit analysis approach, which takes into account current issues but often discounts issues in the distant future. Specifically in reference to environmental issues, discounting the future can be problematic, as environmental effects are often reflected in the long-term. Intergenerational equity also has to be accounted for, as RAM balances the costs and benefits for the present day, neglecting the effects posed to future generations. RAM uses the logic of market values and justifies using market prices for social values.Arguably market prices do not offer an adequate estimate of social values, which are an important component in policy decisions (Dietz 1994; Dietz 2005).
- Strategic Perspectives Analysis – Strategic Perspective Analysis integrates the results of social assessments with ecological management through participatory processes. Existing management techniques are identified followed by relevant stakeholders formulating potential strategies to be considered. A comparison of the existing and potential management alternatives is conducted to identify the best approach for the proposed ecological management plan (Endter-Wada *et al* 1998).
- Conflict Resolution - While biologists are encouraged to include social scientists in ecosystem management processes, it is often not clear what role they should play and how their role should be integrated. The social and political component to ecosystem management has been given some attention in the past. Social scientists are typically viewed as those available to manage conflicts, avoid litigation, improve public participation processes, and provide environmental education. Those working within the natural sciences often view the public as political obstacles to ecosystem management and believe social scientists should be utilized to "educate" the public so that they agree with the goals of the natural sciences. While conflict resolution is important, it is important to recognize the need to avoid conflict throughout the process. Social scientists need to be

involved throughout the total process, rather than simply as conflict managers when problems arise (Endter-Wada *et al* 1998:897).

METRICS

- Synthesize and integrate the metrics from the biological, social and economic considerations
- Customize assessment parameters tracking the dynamics of the process, for example:

  Shared values
  Divergent values
  Temperament differential among stakeholders
  Utilization of leaders in facilitating the process
  Rigidity toward compromise
  Momentum building toward consensus

MAKING CHOICES: This final synthesis step will enhance the probability of achieving desired and sustainable conservation practices. Flexibility will inevitable be necessary.

- Build on the foundation of the biological, social and economic goals and objectives
- Based on that analysis, choose an appropriate decision-making strategy
- Adjust methodology as necessary based on a continued assessment of progress

<u>Case Example - Decision-making lessons learned</u>

The Etowah Habitat Conservation Plan illustrates how local, state, and federal agencies, universities, NGOs, and stakeholders can work together to achieve sustainability of natural resources, growth management, and environmental conservation. *Decisions were based on sound science and provided a one stop shopping strategy for consolidating the environmental review process*. The policies proposed in the HCP were adopted by the local governments in the Etowah basin. The success of this HCP would not have been possible without the inclusive decision-making strategy.

<u>Bottom line</u> Always keep an eye on the goal of restoring and maintaining a sustainable population of at-risk species and/or communities over the long-term.

A LOOK TO THE FUTURE: As natural ecosystems become fragmented by human development, and adverse perturbations increase exponentially, there is a pressing need to incorporate the social sciences into environmental stewardship and restoration. This document suggests a process to incorporate social and economic considerations into the process. The case examples that follow provide documentation of 1) how these considerations have been incorporated successfully in stabilizing species/ecosystems at risk, and 2) how they were not always successful and the negative consequences that followed.

Case Examples Illustrating Application (or Lack Thereof) of the Above Principles

These ten case examples illustrate the positive *and* negative dimensions of the ESA process. They are arguably the most compelling component of the report in that they demonstrate how the principles described above have been applied in the real world and indicate their degree of success.

ETOWAH WATERSHED – Permit criteria protecting aquatic species listed as threatened and endangered for land use change based on sound science adopted by all levels of government and benefiting the private sector.[25]

In 2002, the city and county governments within the Etowah watershed in northern Georgia began working together to develop an HCP pursuant to the federal Endangered Species Act to protect threatened and endangered aquatic species while allowing growth and development to occur in the watershed. Local water authorities, members of the local building and development industry, environmental groups, the University of Georgia, Georgia Department of Natural Resources, the FWS, and other stakeholders also joined the process as HCP partners. The Etowah Habitat Conservation Plan illustrates ways in which local governments; state, regional, and federal agencies; universities; NGOs; and other stakeholders can work together to promote the sustainability of natural resources, growth management, and environmental conservation in the region. The initiative was established to protect 10 imperiled aquatic species known to inhabit the area, while at the same time allowing growth and development in the watershed to occur. .

Species of concern The amber darter (*Percina antesella*) and the Etowah darter (*Etheostoma etowahae*) are federally listed as endangered, while the Cherokee darter (*Etheostoma scotti*) is listed as threatened; both the Etowah and Cherokee darters are endemic to the Etowah. The Coosa madtom (*Noturus munitus*), freckled darter (*Percina lenticula*), holiday darter (*Etheostoma brevirostrum*) and bridled darter (*Percina sp. cf. macrocephala*) are state-listed in Georgia and likely to be considered candidates for federal listing. In addition, the holiday darters of the Etowah are believed to be two separate species, each endemic to a subwatershed of the Etowah. The Coosa madtom of the Upper Coosa is currently being described as a separate species. An undescribed species of Coosa chub (*Macrhybopsis sp. cf. aestivalis*) is also believed to be endemic to the Coosa.

Drivers of declining population Technical committees researched and addressed issues affecting the environment such as storm-water runoff, mass grading, erosion, sedimentation, stream buffers, road crossings, and utility crossings.

Collaboration strategy The HCP planning process is overseen by a steering committee composed of representatives from each of the counties and municipalities within the watershed. The steering committee is assisted by a team of scientists, policy analysts, and educators from the University of Georgia, Kennesaw State University, and the Georgia Conservancy, funded by a grant from the FWS. HCP Advisory Committee members at the University of Georgia and Kennesaw State University have conducted extensive research to support the development of the HCP.

---

[25] This section was adapted from documentation on the Best Sustainability Practices website 2008c.

Conservation strategy The HCP consists of a set of development policies adopted by the local governments of the Etowah basin. These policies have been developed by technical committees made up of experts from within the watershed and staffed by researchers from the University of Georgia.

Benefits and costs The protection of the species at risk is the central benefit. In addition, without a basin-wide HCP, developers and local governments in the Etowah watershed could face long delays and added costs to comply with the ESA, since each potentially harmful project would have to be evaluated individually by FWS. Many of the policies within the plan save developers money and time by encouraging reductions in road infrastructure and the preservation of green space.

Degree of agreement versus divergence of opinion The vast majority of developers comply with the conservation strategy. However, some developers in the region ignore the need to consult with the FWS or to develop HCPs. This provides no protection for listed species and subjects the developers to lawsuits and/or enforcement actions that could include restoration and mitigation of the adverse impacts. State policies prevent local governments from enacting stricter water quality regulations.

Transferability Other communities and cities located within a river watershed could implement planning processes similar to those used in the Etowah HCP in order to protect the threatened and endangered species found in the area while ensuring continued economic growth.

Bottom line Collective interests were achieved based on sound science implemented collaboratively among various levels of government that was a win-win for economic and environmental interests. The key to success was an inclusive decision-making process.

HEADWATERS OF CLINCH, POWELL AND HOLSTON RIVERS – Innovative, holistic landscape/ecosystem/economic-sector multi-scale sustainability strategy devised by an NGO and facilitated via a number of partners.[26]

Spanning 2,200 square miles in the remote mountains and valleys of southwestern Virginia and northeastern Tennessee, the Clinch Valley Program area comprises the watersheds of the Clinch, Powell, and Holston rivers. These last free-flowing rivers of the Tennessee River system harbor more at-risk fish and mussel species than any other rivers in the nation and the highest concentration of imperiled species in the mainland United States. Through its Clinch Valley Program, The Nature Conservancy works to ensure the survival of these fragile lands and waters through creative local partnerships designed to enhance water quality, prevent toxic spills, and improve farming and forestry practices.

Species of concern The Clinch River watershed is the number one hotspot in the United States for imperiled aquatic species. Many rare plants, mammals, birds, and insects live in these watersheds. The Clinch Valley and its rivers alone support 30 federally listed threatened or endangered species.

[26] This section was adapted from documentation on the Best Sustainability Practices website 2008e.

Drivers of declining population Declining water quality, a legacy of coal mining, and unsustainable agricultural and forestry practices are the primary threats to these rivers today.

Collaboration strategy The Nature Conservancy, guided by conservation science, works with a variety of partners to protect the forests, lakes, rivers, wetlands, and unique habitats of the Clinch Valley. The challenge is to develop and promote economically compatible approaches to conservation that not only protect the natural resources, but allow for its sustainable economic use.

- Cooperates with local landowners to improve water quality, helping ensure the survival of rare aquatic species
- Identifies, preserves, and conducts research on rare habitats such as caves that support endangered bat and other cave-dwelling species
- Works with the coal industry and public agencies to tackle the complex issue of cleaning up abandoned mine lands
- Protects and fosters diverse forest types in the project area
- Protects and maintains the diversity of habitat required by endangered terrestrial and aquatic species

Conservation strategy

- In 1983, the Conservancy acquired Pendleton Island in Scott County, Virginia. The Clinch River at this point supports freshwater mussels, including eight species federally listed as endangered.
- Beginning in 1990, The Nature Conservancy targeted the watersheds of the Clinch, Holston, and Powell rivers as part of its "Last Great Places" ecosystem conservation program.
- Currently eight staff members work from field offices in Abingdon, VA and Hancock County, TN.
- The Conservancy owns seven preserves in the valley and plans to acquire critical tracts of land in this area over the next five years.
- In 2004, the Conservancy acquired rights to conduct ecologically sustainable management of more than 22,000 acres of forestland in Tazewell County, Virginia through the Conservation Forestry Program.
- Cooperative Management Agreements were established to help local farmers adopt agricultural best management practices to safeguard the rivers, creeks, and caves on their property from water pollution. The Conservancy has completed 65 such agreements with tobacco and cattle farm owners in Tennessee and Virginia.
- At Kyles Ford, in Hancock County, Tennessee, the Conservancy is using a working farm as a model to show how farming and river conservation can be compatible.
- Purchased the 4,386 acre Brumley Mountain Preserve in Washington County, Virginia

Benefits and costs

Biological:

- 71 percent of habitat is protected for Clinch Valley's 30 federally threatened and endangered species in one of the most biologically diverse areas in the United States.
- 22,000 acres enrolled in the Conservation Forestry Program, promoting private-lands stewardship, compatible forestry, and model working forests. Partnerships promote watershed protection and stream bank restoration.
- Creation of a freshwater-mussel cultivation facility at Cleveland Island Preserve on the Clinch River.

Social:

- Partnerships with community groups to encourage economically, ecologically, and socially sound programs
- Helps preserve the local character, history, and traditions of the region

Economic:

- Promotes sustainable practices in agriculture and silviculture that provide income to landowners while preserving the integrity of the ecosystem
- Provides more opportunities for ecotourism jobs

<u>Degree of agreement versus divergence of opinion</u> Most of the land that lies within the area served by the Clinch Valley Program is privately owned. By far the greatest challenge is forging lasting relationships with private landowners, providing information to support sustainable uses of the lands and waters, and creating cooperative ventures among a variety of individual, governmental, and nongovernmental organizations.

<u>Transferability</u> The Clinch Valley Program views its project area as one landscape-scale ecosystem composed of three closely connected watersheds. This approach helps foster cultural and economic activity that transcends state boundaries and forges partnerships among a variety of private and public interests to achieve its goals. This cooperative approach can serve as a model in other similar regions in the southern Appalachians and elsewhere.

<u>Bottom line</u> this is an example of a radical change by The Nature Conservancy on threaten and endangered species conservation away from an individual species focus to a systems strategy with a focus on promoting sustainability practices at a regional perspective.

SOUTHEASTERN GREAT PLAINS PRAIRIE - Problem solving via a long term partnership between industry and public land managers dedicated to sustain viable populations of listed species.

The multi-dimensional conservation strategy devised on the Great Plains Prairie for two candidate species for federal listing on the threatened/endangered species list was one of the first achievements of its kind addressing multiple candidate species (Bureau of Land Management (BLM) 2005) and remains today an exemplar for collaborative science and decision making among divergent private and public sector interests. State level conservation strategies were not specific enough for local action, which led to forming the New Mexico LPC/SLP Task Force in 2003 to devise and facilitate local action. The goal of the group was to

create a conservation strategy for the management of the shinnery oak and sand sage communities in southeastern and east central New Mexico, recommending a range of specific actions to enhance and insure populations of Lesser Prairie-Chickens and Sand Dune Lizards, so that federal or state listing of these species is not needed, while protecting other uses of the lands." (BLM 2005)
Species of concern. The Lesser Prairie Chicken (LPC) (*Tympanuschus pallidicinctus*) and the Sand Dune Lizard (SDL) (*Sceloporus arenicolus*)

Drivers of declining population Throughout the 19th and 20th centuries, much of the LPC native prairie habitat was lost to agriculture and other uses resulting in the loss of LPC numbers and size of occupied range. Habitat has been lost, degraded and fragmented. In 1998, the FWSe ruled that candidate species for listing was warranted, but as has happened for numerous others, did not establish a Habitat Conservation Plan. For LPC, nest success and brood survival drive population fluctuations.

Collaboration strategy The New Mexico LPC/SDL Working Group met for two years to devise a complex conservation strategy. Members include representatives from seven federal and state agencies; conservation groups; three representatives of the oil and gas industry that supports 28,000 jobs in the region; and one representative of the cattle industry. This case provides an example of successfully engaging divergent stakeholder interests in a joint fact-finding process to devise a successful habitat conservation strategy (Peine 2007).

Conservation strategy The first task was to become familiar with habitat requirements in the shinnery oak and sand sage communities to sustain the two candidate species. The habitat has become greatly reduced and fragmented due to agriculture and mining activity. The group devised nine pathways for sustaining LPC populations related to the variety of threats: maintain quality range for breeding and nesting, address fragmentation of habitat, develop strategies to maintain and improve LPC habitat, focus on long range planning to extend habitat, institute additional measures to address causes of mortality and low nesting success, conduct research and monitoring, provide education and outreach for stakeholders, and fund a permanent position. A similar set of strategies was devised for SDL. These strategies include numerous details about land stewardship policy and practice. Federal and state agencies sat down and worked with industry to protect the candidate species while allowing continuation of the natural resource utilization. The congenial nature of the group allowed them to work together to fix a problem. Key components of the strategy included the following (Peine 2007):

- Establish planning regions and management priorities based on target species' population status
- Create strategic distribution of quality habitat
- Establish conservative grazing practices on these sites with compensation to ranchers
- Enhance management on private lands enrolled in the USDA Conservation Program via reseeding and conservative grazing practices
- Control encroachment of mesquite into targeted grasslands
- Limited control of shinnery oak where overwhelming grasslands

- Minimize habitat loss and modification due to energy development
- Coordinate restoration and reclamation of previously developed areas
- Establish new guidelines for new mineral leasing
- Develop and implement conservation plans for federal, state lands as well as private lands included on the Conservation Reserve Program

And finally, establish via a shared stakeholder financial commitment a research program focused on establishing a greater understanding of the impacts of cumulative stressors and of mitigation resource management strategies

Benefits and costs

- More than 10,000 people are employed in the oil and gas extraction industry and 23,000 are employed in related occupations.
- Much of the economic well-being of the rural counties is tied to royalties generated by petroleum production and related tax revenues. Oil and gas represents 20-25 % of state revenues.
- Ranching is the predominant land use representing a cultural tradition
- Affected land ownership includes approximately 1,183,000 acres owned by the Bureau of Land Management, 1,008.000 acres by the state wildlife agency, 3,787,000 privately owned, and 39,000 in other ownership.

Degree of agreement versus divergence of opinion The following agreement illustrates the degree of commitment among task force members:

- Participants agree that litigation or other legal action could jeopardize the process
- Participants will respect one another's personal integrity
- Members will honor commitments made during negotiation
- Decisions will be made by consensus

Meetings will be open to the public Transferability Although the circumstances are unique, the *process* to 1) identify a biological strategy to create a sustainable population, 2) accommodate stakeholder interests, and 3) incorporate funding for research will collectively improve the probability of success.

Bottom line This is a prime example of successful collaboration utilizing the Joint Fact Finding model including contributions by industry to support research and resource management to address the primary drivers of the reduction in nesting success of the LPC. (*Ibid*)

ROAN MOUNTAIN – An exemplary commitment to sustain grassy balds by volunteers whose efforts are obscured by a lack of focus by federal agencies on a systematic collaborative strategy for interdisciplinary science, predictive modeling of environmental change and risk, and monitoring and data management which is reflected by the lack of science-based cost-effective adaptive management practices.

Roan Mountain is a hotspot of endemic, rare, threatened, and endangered species in the southern Appalachian highlands, a region of convergence of northern and southern species. The rarity of this ecosystem is reflected in the species it contains: seven are currently listed under the U.S. Endangered Species Act (ESA), and an additional species,the Peregrine Falcon, was declared recovered and de-listed in 1998, though it remains on the Watch List. Another 32 species found on Roan are considered Federal Species of Concern by the FWS and 31 of the bird species found on Roan are in the highest priority categories of the National Partners in Flight

Bird Conservation Plans. As a result of these factors, the FWS considers Roan a regional conservation priority. [27] There are at least 26 *rare community types* that occur on the Roan Mountain Massif (USFS 2004). The most general and common community types referred to on Roan are the red spruce-Fraser fir forest, northern hardwood forest, boulder-field forest, early successional scrub, cave, rocky cliffs/outcrops, high elevation seeps, grassy balds and shrub balds (Kenney 1999). The red spruce-Fraser fir forest and grassy balds have been identified among the most endangered ecological communities in North America (FWS & U. S. Forest Service (USFS) n.d.). Roan's grassy balds are the most extensive and highest quality known from the Southern Appalachians (FWS & USFS n.d.).

The flora of Roan Mountain Massif is particularly diverse. The Roan has a greater concentration of rare plant species than any other area of comparable size in the Southern Appalachians (USFS 1991). The current estimate of plant species thought to be present on Roan is approximately 800[28]. "Roan Mountain is unsurpassed in the south for the diversity of 'northern' species, often disjunct many hundreds of miles from habitats in New England and Canada" (USFS 1991). These 'northern' disjuncts are representative remnants of the Ice Ages and have persisted in the cool high elevation climate of the Roan Mountain Massif. For example, the only occurrence of Green Alder south of Pennsylvania is on the shrub balds of Roan. Many of the plant species are dependent on the open conditions characteristic of the grassy balds. "The combination of narrow endemics (several of which are limited to Roan and a few nearby peaks), broader southern Appalachian endemics (distributed in the higher mountains from southern Virginia to northern Georgia), and northern disjuncts make the Roan Highlands richer floristically than any other peak or range in the southern mountains" (USFS 1991). Roan supports federally listed endangered plant species (Spreading Avens , Roan Mountain Bluet, Blue Ridge Goldenrod, and Rock Gnome Lichen (FWS & USFS n.d.), and more than 27 PETS plant species occur on the grassy balds alone (USFS 1991).

It is widely recognized that restoration and maintenance of the high elevation grassy balds of Roan will require long term vegetation management and monitoring to control the invasion of woody plants. This recognition led to the signing of an Environmental Assessment (EA) by the USFS, which prescribed various management activities for the restoration and management of these communities. Implementation of the management techniques described in this EA was preceded by the collection of baseline data on plant community composition along a series of transects and plots established in the late 1980s across the grassy balds of Roan. Historically, management and monitoring of the Roan grassy balds have occurred in an irregular and largely uncoordinated manner in cooperation with the Forest Service, as funding would allow. Because of the many factors listed herein, there has not been a way for the resource managers of Roan to assess the effectiveness of management applied to the area based on documented biological data analysis nor through monitoring.

In addition to these baseline data collected in the late 1980s, there are other inventory and monitoring data that encompass (in whole or in part) the grassy balds that may inform the management of these resources. These data have been collected over a

[28] Donaldson, Jamey. Botanist - private contractor working on Roan Mountain. Personal communication. 2006.

[28] Donaldson, Jamey. Botanist - private contractor working on Roan Mountain. Personal communication. 2006.

period of several years by various individuals, organizations, and agency partners on Roan. With the exception of locality data on species tracked by the North Carolina and Tennessee State Natural Heritage Programs, these data vary widely in their current format (e.g., electronic or hardcopy) and levels of accessibility to current partners that regularly conduct or advise natural resource management activities on Roan. The need for a common repository of management data has been recognized for over a decade[29]; documentation and correspondence on this issue is available in FWS files. However, realization of this goal has failed largely because there appeared to be no mechanism for the collation and exchange of spatial data in a consistent electronic format. A study was conducted in FY 2005-6 by the USGS National Biological Information Infrastructure program concerning data management. During the course of this first project year, it was determined that specific long-term objectives related to evaluating the variable aspects of different types of vegetation management techniques (methodology, defined treatment boundaries, timing, intensity and frequency, etc.) were not sufficiently developed in projects so as to be able to provide specific recommendations for future adaptive management. Without these specific objectives, the specific types of data needed to meet these objectives could not be defined. This also brings in the issue of defined levels of accuracy, completeness, and other aspects of quality control that could not be defined without knowing the specific types of data that were required to meet the specific objectives for adaptive management. The resulting lack of adequate data documentation or analysis monitoring aspects of population sustainability of listed species can not be validated.

Species of concern Spreading Avens (*Geum radiatum Michaux*), Roan Mountain Bluet (*Houstonia montana Small*), Blue Ridge Goldenrod (*Solidago roanensis Porter*) and Rock Gnome Lichen (*Gymnoderma lineare*)

Drivers of declining population The forests are primarily threatened by the invasion of the balsam woolly adelgid, acid deposition, ground level ozone, increased levels of ultraviolet B radiation, and human disturbance, (Donaldson n.d.), and the grassy balds are primarily threatened by woody plant invasion and human disturbance (FWS & USFS n.d.).

Collaboration strategy These partners include the FWS, the USF Se, the Southern Appalachian Highlands Conservancy, The Nature Conservancy, the Appalachian Trail Conservancy, and the NC and TN Natural Heritage programs. Since the Appalachian National Scenic Trail runs through the grassy balds, the National Park Service (NPS), Appalachian National Scenic Trail Park Office also has a vested interest in the oversight of Roan Mountain

Conservation strategy The conservation strategy is not specific nor is there consensus between the Cherokee and Pisgah Nationals Forests nor the FWS field office. There is a fine line between too specific and too general in the management of the grassy balds and/or listed species habitat management. However, $200,000 in federal stimulus funds to Pisgah National Forest have been set aside to clear more land of woody plants.

Benefits and costs This example is unique in that most of the activities on the grassy balds to maintain them by reducing woody plants and conducting environmental

[29] Wells, Carolyn. Botanist - U.S. Fish and Wildlife Service, Asheville N.C. Field Office. Personal communication. 2005.

inventory and monitoring have been conducted by volunteers. The Southern Appalachian Highlands Conservancy has been the primary enabling agency. So in this case, the benefits far out way the costs incurred. The USFS, NPS and FWS have been involved mostly in planning and limited monitoring

Degree of agreement versus divergence of opinion There is consensus that the grassy balds are of national significance by all partners. Where there has a divergence of opinion is the lack of policy nor financial commitment among federal agencies to sustain them or to conduct systematic inventory or monitoring. No federal agency has taken the lead to plan or conduct scientific investigation via predictive modeling to understand the degree and nature of risk to vulnerable species, ecotones and ecosystems.

Transferability The strength of this case example is the extraordinary collaboration in maintaining the grassy balds largely via volunteerism in spite of inadequate funding. The part that serves as a model for dysfunctional science and data management does adequately serve the needs of the management of the listed species.

Bottom line In the case of at-risk species on the Roan, the lack of a clear Habitat Conservation Plan that is based on sound science, effective monitoring, and adequate data management, has resulted in uncertainty of the sustainability of the populations in place. This case example illustrates that shortcomings of the social considerations can be internal to the agency staff and lead personnel to not agree upon or follow standard federal guidelines for data documentation and management. (Burley *et al.* 2007)

SOUTHERN STRAIN BROOK TROUT – An extraordinarily complex recovery effort for the extremely rare southern strain of brook trout in Great Smoky Mountains National Park including extensive genetic analysis, isolating pure strains from encroachment by non-native salmonids, and correlating air pollution with stream health.

The native brook trout (speckled) was originally present in most streams above 2000 feet elevation in the southern Appalachians (King 1937). Genetic analysis has identified the presence of fixed genetic differences between native southern and northern populations, which suggests that diversity of the two groups was distinct before the last glacial retreat. In addition, heterogenity among the southern strain suggests isolation by watershed (Guffey et al. 1999). Extensive logging operations in the early 1900s caused contamination of more than 160 miles of clear mountain streams, eliminating the brook trout from about 50% of its original range. During the same period, rainbow trout were stocked in every major stream for recreational fishing. Non-native brown trout, though stocked only once in the Smokies, migrated from downstream waters in Tennessee and North Carolina. These exotic game fish obtained larger sizes in Park waters and displaced the southern strain of brook trout. The species of concern is limited to hanging on the side of the mountains in second or third order streams behind barrier waterfalls blocking migration for non-native salmonids. They are vulnerable to extreme weather events, such as floods that have washed them down stream, where they encounter more aggressive salmonids, or drought, when low flow rates reduce and fragment spawning sites[30]. Stream acidity is also a concern as a result of air pollution deposition in all forms.

[30] Moore, Steve. Fisheries biologist. Great Smoky Mountains National Park. Personal communication. 2009.

Species of concern Brook trout (*Salvelinus fontinalis*). The distinctiveness of the southern Appalachian brook trout is part of the lore of the region. Known as "speckled trout", they are smaller and have more and brighter spots. Local opinion is that they are livelier when on a fishing line *(Ibid)*

Drivers of declining population Logging, road and railroad construction, land clearing for agriculture, over-fishing, and the introduction of non-native salmonids have all contributed to habitat constriction of the southern brook trout (*Ibid*.). Timber harvest and land clearing change the thermal dynamics and introduce sedimentation, clouding visibility for these visual predators and smothering eggs at spawning sites (*Ibid*). In addition, an aggressive fish stocking program inside and adjacent to the park boundary has been in place for decades. Rainbow, brown, and northern-derived hatchery brook trout were stocked by state and federal agencies. From 1947-1975, an estimated more than 800,000 eggs, fry, fingerlings, and adults of the northern-derived hatchery brook trout were released into 76 park streams. Only 15 streams in the park have no record of stocking (McCracken *et al.* 1993). Just to illustrate how far fisheries management has come, Abram's creek below Abrams Falls was poisoned in 1960 in an attempt to create a prime sport fishery for rainbow and brown trout (Nolt and Peine 1999). Rainbow trout and northern-derived hatchery strains of brook trout out compete the southern stain brook trout; as a result, their presence is confined to second and third headwater streams on the landscape where their fecundity is less and the populations are smaller (Lennon 1967). An additional concern is high acidity in first and second order spring from air pollutions not effected by exposure to acid bearing rock like Anakesta. .

Collaboration strategy In 2004, representatives of state and federal agencies and non-government organizations formed the Eastern Brook Trout Joint Venture, www.easternbrooktrout.org. as a pilot project under the National Fish Habitat Action Plan. Their first task was to identify the distribution of existing populations. The study found that of the 5,560 watersheds studied, 95% were devoid of a healthy population of brook trout. The primary change was agricultural activities that did not adequately protect stream shading and water quality. Unfortunately there was no focus on sustaining the southern strain. (NPS 2008)

However, an effort was initiated with this focus by people and organizations in the Smokies including the American Fisheries Society, Trout Unlimited, Land Between the Lakes, the Great Smoky Mountains Natural History Association, and the National Park Service to raise money for the restoration effort. Artist Lee Roberson created the limited edition brook trout print "Fragile Treasure" with proceeds going directly into the restoration fund. The public can now contribute directly to the restoration of a threatened native Park species.

Conservation strategy The goal is to extend the number of streams with pure southern strains of brook trout. Long term restoration efforts have evolved since the late 1970s. Efforts are underway to study and convert a number of lost streams back to brook trout waters such as the 12 currently without northern-derived hatchery brook trout. Some native brook trout populations are protected from invasion of exotic trout species by barriers like waterfalls. So far, Park biologists know that 40 miles of the 120 miles of pure brook trout streams are protected by functional barriers. Other waterfalls are being studied to determine how high a falls must be to prevent rainbows and browns from migrating upstream over them. The objective of the brook trout program is to expand the range of the native brook trout to produce a self-sustaining natural population which will eventually support angling pressure. In the slightly acidic waters of the Smokies, mayflies, caddisflies, and stoneflies are a part of the life and food chain in the Smokies.

The most cutting edge management strategy is a partnership between the National Park Service and the Tennessee Department of the Environment linking air pollution with stream health in the Smokies. Several streams have been declared non-attainment and have been added to the state's 303d list, which is unprecedented. The goal in part is to document the correlation of air pollution and stream health.

Benefits and costs Stream recovery efforts are labor intensive and therefore costly, but funding has been supported by Trout Unlimited and other NGOs.

Degree of agreement versus divergence of opinion. The controversy focuses on the taxonomy debate as to whether or not the southern strain of brook trout should be listed as a separate species. The biologists in the Park are rightfully treating it as one.

Transferability The methodology to rehabilitate streams is transferable, but there are few instances where brook trout recovery is focused on the southern strain of the speckled trout.

Bottom line This is a prime example of the benefit of long term science and adaptive management collaboration that has patiently documented the extent of the problem and tested alternative recovery strategies to define a cost effective means to achieve a long term ambitious conservation goal.

RED WOLVES IN THE APPALACHIANS – A very successful strategy to engage interest groups and the public creating buy-in for *canid* repatriation which was frittered away by a lack of bold risk taking to create a critical mass of released pairs increasing the probability for success.

The Red Wolf (*Canis rufus*) once ranged throughout the southeastern United States. The FWS first officially recognized the taxon as endangered in 1967. With the enactment of the Endangered Species Act in1973, an ambitious recovery plan, arguably the most complex ever, was initiated. The first step was to establish a foundation breeding stock based on only 14 individuals with adequate taxonomic purity captured from the wild (Norwack 1992). After decades of captive breeding, an experimental release was conducted on Bull Island of Cape Romain National Wildlife Refuge in South Carolina. The release proved to be successful. In 1989, the FWS turned to the southern Appalachians to establish a second population, which is considered necessary to ensure a sustainable population. The site chosen was Great Smoky Mountains National Park.

Species of concern Red Wolf (*Canis rufus).*

Drivers of declining population Indiscriminate killing, bounties, and habitat destruction were the initial drivers of population decline. Further disruption cause by timber harvesting, mining, and agriculture forced Red Wolves into the open, thereby increasing contact and contact with humans and livestock while creating favorable conditions for invasive coyotes. As the number of wolves decreased, coyotes moved in and extensive crossbreeding occurred. A government predator control program exacerbated an already dire circumstance for the wolves.

Collaboration strategy Project partners were the FWS, NPS, and to a lesser degree the USFS and state level fish and wildlife agencies. The Farmers Cooperatives were partners on the education component.

Conservation strategy To gather information and better prepare for potential conflicts, a three phase plan was implemented prior to permanent release which included a coyote study, a public education program, and an experimental release (Lucash et al. 1999).

Education – an extremely successful effort resulting in *very* strong public support

- Park visitors and local citizens were informed of the experimental release program via pamphlets, bumper stickers ("rednecks for red wolves" among others), media stories, school and park ranger programs.
- Public information packages developed by FWS, NPS, WBIR-TV, and the Southern Appalachian Man and the Biosphere Cooperative were distributed free of charge to 800 local schools, media, and resource organizations. The package included a regional Emmy-award winning documentary video "Front-runner", a teachers guide, and wolf activities poster.
- Public meetings hosted by local Farm Bureaus provided a forum for discussion

Wolf release and management program – too few releases to surmount various setbacks

- Experimental pairs were held in acclimation pens for 9 months prior to being released in Cades Cove and Tremont.
- Released animals wore radio tracking collars, and those leaving the park boundaries were returned.
- A fund was created to compensate farms that lost livestock due to kills by wolves.

Benefits and costs

Public acceptance

- Park visitors, local citizens were *very* supportive of the initiative
- People in Cades Cove were thrilled to hear the wolves howl at night and occasionally see them in the wild

Biological challenges

- Para virus was a concern
- Compatibility among pairs was an unknown
- Cross breeding with coyotes occurred
- Wolves roaming beyond the park boundary was a risk worth taking
- There was no critical mass of wolf pairs released to truly test the concept

Degree of agreement versus divergence of opinion.

- The public was overwhelmingly supportive of the initiative to establish a sustainable population of Red Wolves in the national park
- There was considerable procedural disagreement among the biologists and resource managers involved in the project

Transferability.

- The public involvement was a model of success worth emulating.
- The failure of the biological component is important to study for lessons learned

Bottom line. This is a case of where the public involvement component was extraordinary on local and regional levels. The one year effort is worth studying in detail as to why the public readily accepted the repatriation of this *canid* predator. This charismatic species spoke to the people. On the other hand, the capital gained from this acceptance was squandered by a far too conservative repatriation effort that required a critical mass of wolf pairs distributed over a much larger area to fend off coyote competition and a realization that forested lands do not support an adequate prey base to sustain these pairs as they acclimate to the ecosystem. In this case, the social component was better understood and executed than the biological component of the failed repatriation effort.

GRAY WOLF IN THE WEST – a vivid illustration of a culturally based repatriation effort versus one fraught with political conflict and manipulation.

This section compares two case examples of the repatriation of gray wolves demonstrating divergent strategies to achieve public acceptance and what a difference political influence makes. State and federal governments in the U.S. sponsored Rocky Mountain gray wolf formalized population control policy in the 1920s and 1930s by paying a bounty for wolf pelts that led the species to being declared extinct in the lower 48 states (Hardy-Short and Short 2000). That was followed more than 4 decades later by a reintroduction program assessment initiated in 1987. This dramatic turn-around of policy was triggered by the enactment of the 1973 Endangered Species Act and the listing of the gray wolf in the lower 48 states as an endangered species. A heated debate has ensued since centered around the conflict between applying ecological principals for ecosystem management on public lands versus potential mortality of range cattle and adverse impact on outdoor recreation. There has long been a divergence in cultural perspectives from the European Old World hatred of wolves still held by some European Americans to the native Americans reverence and cultural identity with the species (Link and Crowley 1994 from Hardy-Short and Short 2000). Proponents for reintroduction focus on the symbolism associating wolves with wilderness and stewardship and aesthetic values. Opponents from the cattle and outdoor recreation industries are concerned with economic threats via cattle and game species as well threats to human safety.

The first case involved *the Nez Perce Tribe*. In 1995, the FWS entered into a precedent-setting cooperative agreement with the Nez Perce Tribe to restore the gray wolf to Idaho. From a social perspective, the partnership was a good fit since the wolf plays a central feature in tribal culture such as family-centered hunting. The wolf has become a tribal symbol of survival of a tribe that was persecuted and removed from their home lands. This was the first time the Federal government had contracted with a Native American tribe to lead a recovery effort of an endangered species (Mack 1999). The project also included cooperation with the Bureau of Land Management, the USFS and the USDA Wildlife Services. There were two successful translocations in 1995 and 1996 and, as of 1999, there were 115 wolves in 12 known packs *(Ibid).* A key social consideration was to build tolerance for wolves, and the Nez Perce recovery program has brought together proponents and opponents of wolf recovery to find creative solutions. Studies were initiated to determine wolf predation on livestock and big game populations.

This collaborative approach increases the potential for success in the long-term coexistence of wolves and people.

The second case involves *Yellowstone National Park*. Congressman Wayne Owens of Utah introduced legislation to restore wolves to Yellowstone (Owens 1988). Congressmen from neighboring Wyoming and Montana opposed the measure and as a token of protest, requested that that a series of articles on wolves in the Yellowstone distributed by the NPS be withdrawn (Yellowstone Wolf 1990). A compromise bill was introduced in the Senate in 1993 allowing 3 breeding pairs of wolves be introduced and declared them research animals outside the park boundaries allowing ranchers to shoot wolves legally if they threaten livestock. While the planning continued, a number of law suits were filed by ranching and agricultural groups (Hardy-Short and Short 2000). As the debate continued, supporters continued their ecological and stewardship rhetoric but the opponents shifted theirs by using biological research findings concerning genetic analysis suggesting that the animals to be reintroduced were not a pure strain of wolves but had been genetically altered by inbreeding with coyotes and therefore their reintroduction would endanger the genetic integrity of the Canadian wolves to the north (citation). With the change in administration in 1992, the decision was made by Secretary of the Interior Bruce Babbitt to go ahead with the reintroduction of gray wolves in Yellowstone. In March, 2008 the FWS took the gray wolf off the endangered species in the lower 48 states allowing states to determine their management. The agency then approved that each state could remove 500 animals per year. On July 18, 2008, a federal judge ruled that the decision was not sufficiently justified and the FWS then restored the species to the endangered species list. (citation). On January 14, 2009, the Bush administration, (5 days before it ended) overturned that court ruling referring authority back to three states (citation).

<u>Species of concern</u> Gray wolf (*Canis lupus*)

<u>Drivers of declining population</u> Extinction due to active eradication practices

<u>Collaboration strategy</u> The critical distinction is that the repatriation was carried out on tribal lands at the discretional of a culture revering the wolves versus federally owned lands where eradication was carried as a practice and is still championed by many elements of the culture.

<u>Conservation strategy</u> The reintroduction processes were similar via release of pairs into the wild as described above.

<u>Benefits and costs</u> The values at play were very different ranging from cultural verification from the tribal perspective to threats to cattle and big game hunting interests on federal lands.

<u>Degree of agreement versus divergence of opinion</u> The disagreement could not be more striking, a tribal revering the cultural symbolism of the species versus another considering it a threat to the cattle industry and sport hunting.

.<u>Transferability</u> The repatriation procedures are readily transferable but the potential conflicts with public acceptance remain unresolved.

<u>Bottom line</u> The court declared that the science did not justify the delisting decision. This is a classic example of who has the political power to prevail whether if be for repatriation or delisting of a species.

FLORIDA PANTHER – a highly endangered species went from near extinction to biological recovery via the introduction of females from Texas. An innovative public involvement process is being developed including a spatial model assessing the degree of encroachment on habitat of alternative patterns of development allowing tradeoffs to ensure viable sustainability practices.

The Florida Panther is the last subspecies of *Puma* still surviving in the eastern United States. The remaining single breeding group is 80-100 animals in southern Florida that reside in less than 5 percent of their natural range. Panthers are wide ranging, secretive and occur at low density. They require large contiguous areas to meet social, reproductive and pray-base needs. The population is limited by available and fragmented habitat, reduction in prey-base, and human intolerance. The panther is threatened with extinction driven by habitat reduction while recovery is challenged by human intolerance. But there is good news in that several females,introduced from southwest Texas, mated with the remaining 6-8 males resulting in a population increase to an estimated 80-100 individuals. In addition, fines have been set for habitat destruction which have in many cases have been mitigated with the introduction of a spatial model which evaluates alternative development pattern strategies to demonstrate the most cost elective mitigation strategies.

Species of concern Florida panther (*Puma concolor coryi*)

Drivers of declining population Habitat loss, degradation and fragmentation; vehicle strikes; and isolated population have keep the population at a low level. Potential panther habitat throughout the southeast continues to be degraded by urbanization, residential development, conversion to agriculture, and extraction of mining and minerals.

Collaboration strategy Key partners with the FWS are the Florida Fish and Wildlife Conservation Commission, NPS, Florida Department of Environmental Protection, and environmental NGOs (USGS 2008).

Conservation strategy The Recovery Plan includes the following objectives: 1) maintain, restore, and expand the panther population and its habitat in south Florida and expand the breeding portion of the population in south Florida to areas north of the Caloosahatchee River; 2) identify, secure, maintain, and restore panther habitat elsewhere in its historic range, and to establish viable populations of the panther outside south and south-central Florida; and 3) facilitate panther conservation and recovery through public awareness and education. In the early 1970s, the population was estimated to be 12 to 20 animals. Throughout the 1980's the population was estimated between 20 and 30 animals, most of which were collared males whose movements were tracked. In the early 1990s, a captive breading program was under consideration similar to that utilized for the Red Wolf, but was abandoned. Instead, in 1995, a genetic augmentation was initiated via the introduction of eight young females captured in the wild from southwest Texas to successfully reinvigorate the population. Currently there are an estimated 80-100 panthers in southern Florida. In 2004, the Federal Court ruled in favor of the National Wildlife Federation, Florida Wildlife Federation, and The Florida Panther Society, and revoked a Florida Rock Industry mine permit that would have destroyed over 5,000 acres of panther habitat (Defenders of Wildlife 2008).

In October, 2008, the FWS issued panther-people guidelines as the population of both grows. The guidelines include protocols for potential panther-human encounters such as outreach and education, aversive conditioning, or removal of cashed panther prey. If a panther is considered a high risk to human safety, it will be permanently removed from the population by capture or euthanasia (FWC et al. 2007).

The most creative innovation has been the development of a predictive spatial model assessing the potential impacts on panther habitat of alternative development spatial patterns of land use conversion and how those patterns might best be mitigated by preserving alternative habitat. The Florida Panther Habitat Estimator's two main functions are 1) an estimation of habitat value within a user defined polygon and 2) changes in habitat values as a result of changes to the landscape (Thatcher et al. 2008). This tool is designed to facilitate a science-based assessment of alternative development patterns and land use other land use changes.

Benefits and costs The conservation goals are on track and the above mentioned court decision to deny a mining permit on 5,000 acres of critical habitat sets an important legal precedent. In addition the habitat modeling tool provides a means to assess tradeoffs between development and offsetting habitat protection.

Degree of agreement versus divergence of opinion The Recovery Plan has been finalized and signed. It can be found at www.fws.gov/verobeach/panther.htm

Transferability The major success in panther conservation and recovery was genetic restoration. The model has never been used. Eventually, an additional major success may be, if implemented, the predictive model assessing the potential impacts on prime habitat of alternative development spatial patterns of land use conversion and how those patterns might best be mitigated by preserving alternative critical habitat.

Bottom line This is a case where an almost hopeless situation has evolved through introduction of Texas females to the Florida panther population.

NORTHERN SPOTTED OWLS IN THE PACIFIC NORTHWEST This initiative is a precedent setting collaboration among federal and state agencies, industry, and NGOs that resulted in a regional, comprehensive, holistic strategy to conserve northwest forests for the benefit not just of the northern spotted owl but for many ecosystem related species found there. Implementation of the Northwest Forest Plan and Northern Spotted Owl Recovery Plan at times has been hampered by political interference as this is the most costly, controversial, politically charged conservation effort to date.

The historical range of the northern spotted owl *(Strix occidentalis caurina)* extended throughout the coniferous forest region from southwestern British Columbia south through western Washington, western Oregon, and the Coast Ranges of California to San Francisco Bay. It was estimated that of the 17.5 million acres of suitable habitat present in 1800, 7.2 million acres remained by 1990, suggesting that owl habitat had been reduced by 60% (Spies and Franklin 1988, Morrison 1988, Norse 1988). About 70% of the remaining habitat was managed by the USFS, of which approximately 63% was subject to timber harvesting. The Bureau of Land Management (BLM) managed about 11% of remaining owl habitat, of which 82% was considered potentially available for logging.

Because of the potential for enormous economic and environmental consequences engendered in the northern spotted owl issue, all substantive activities by theFWS and land managing agencies were minutely scrutinized and heavily criticized. Numerous actions and decisions were further subjected to legal review through lawsuits and the court system. Details of the criticism and these conflicts are available in Swedlow (2003).

The process by which the northern spotted owl was eventually federally listed was long, arduous, and fraught with controversy. After preparing several status reviews (U.S. Fish and Wildlife Service 1987, 1989), a negative report by the U.S. Government Accounting Office (USGAO 1989), and losing a court battle, the FWS published a proposed rule to designate the northern spotted owl as a threatened species in the *Federal Register* (55 FR 26114-26194, June 26, 1990). The FWS then prepared another update of the status review (FWS 1990), evaluated the 22,000 public comments, and developed the final decision document. Numerous issues were raised, particularly by those associated with the timber industry, in an attempt to refute the data on which the FWS based its proposed rule. After reviewing the status of the northern spotted owl, the FWS concluded that it was at risk throughout its range by the loss and adverse modification of suitable habitat, primarily from timber harvesting and it was listed as a threatened species in 1990 (55 *Federal Register* 26114-26194, June 26, 1990).

Species of concern Northern spotted owl *(Strix occidentalis caurina)*; note that 361 species (5 federally listed, 155 candidates for listing, 30 state listed, 131 special concern, 102 endemics, 194 older forest associates, and 132 riparian associates) associated with forests having old growth characteristics may benefit by actions designed to conserve the northern spotted owl (U.S. Fish and Wildlife Service 1992). If the conservation strategies implemented for the northern spotted owl are successful, the candidate species may also benefit, thus potentially reducing the need to consider formal listing for them.

Drivers of declining population The primary reasons for the decline in the northern spotted owl are the loss, degradation, and fragmentation of suitable habitat throughout its range as the result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms. In addition, competition with or displacement by the barred owl *(Strix varia)* was noted as a potential threat in the final rule. More recently recognized additional potential threats include invasive species, West Nile virus, Sudden Oak Death, and more severe and frequent wildfires.

Collaboration strategy Numerous federal, state, and local government agencies, non-government organizations (NGOs), timber and related companies, and other individuals have been involved in issues and actions related to the northern spotted owl. These actions included the listing process, designation of critical habitat, development of the recovery plan, development of the Northwest Forest Plan, various other plans and reports (e.g., Thomas *et al*. 1990; USDA *et al*. 1993, USDA and USDI 1994), 5-year status review, habitat conservation plans, and safe harbor agreements.

In 1993, President Clinton convened the Forest Conference to examine the federal forests in the Northwest in terms of the human and environmental role that they play. President Clinton then directed that a comprehensive, balanced, and long-term policy be developed that would encompass the 24 million acres of public land. An interagency, interdisciplinary team of scientists, economists, sociologists, and others was formed to craft the Northwest Forest Plan described below (USDA *et al*. 1993).

Conservation strategy To aid in the conservation of the owl, the FWS first designated 6.9 million acres as critical habitat on January 15, 1992 (55 *Federal Register*

1796-1838*)*. The designation of critical habitat resulted in a lawsuit between the FWS and the American Forest Resource Council, Western Council of Industrial Workers, Swanson Group Inc., and the Rough and Ready Lumber Company. On January 13, 2003, the FWS entered into a settlement agreement to revise critical habitat, which would incorporate a new analysis of the possible economic impacts of such a designation. Subsequently, a revision of critical habitat was proposed in 2007 (72 *Federal Register* 32450, June 12, 2007). On August 12, 2008, the FWS issued a final revised designation of critical habitat for the owl, reducing the amount of designated critical habitat to 5.3 million acres of federal land (1.8 million acres in Washington, 2.3 million acres in Oregon, and 1.2 million acres in California) (73 *Federal Register* 47358-47359).

The conservation strategy for the northern spotted owl encompasses a number of plans to help manage the species. Prior to the species being listed, an interagency committee of scientists (Interagency Committee to Address the Conservation of the Northern Spotted Owl) was established by joint agreement among the USFS, BLM, NPS, and FWS to develop a conservation strategy and prepare a plan of action (Thomas *et al*. 1990). This Interagency Scientific Committee [ISC] plan (Thomas *et al*. 1990) provided an in-depth critique of current management practices and recommended the protection of large blocks of habitat (Habitat Conservation Areas) from the Canadian border to Marin County, California, and also proposed a change in the management strategy of both the USFS and BLM (Thomas *et al*. 1990). The ISC plan provided a starting point for the next major planning effort, the Northwest Forest Plan.

The Northwest Forest Plan (USDA *et al*. 1993) was an effort to provide for forest management, economic development, and agency coordination and, as stated above, was prepared at the direction of President Clinton. When the draft environmental impact statement on the forest management and implementation portion of the strategy was released, it generated more than 100,000 public comments. This plan was approved in 1994 and provides a series of standards and guidelines for a new ecosystem approach to deal with the management of competing resources. It signals the first time that the BLM and USFS developed a common approach to managing the land under their control. This is particularly important in the Northwest as there is often a checkerboard pattern of land ownership between these two agencies. In addition to the BLM and USFS, the memorandum of understanding under which the plan is being implemented, includes eight other federal agencies. The goals of the plan were: (1) cooperative planning, improved decision making, and coordinated implementation of the forest management component of the Northwest Forest Plan on federal lands within the range of the northern spotted owl; and (2) improved coordination and collaboration with state, tribal, and local governments who undertake management actions that either support or complement those of the Northwest Forest Plan (USDA *et al*. 1993, USDA and USDI 1994). The Northwest Forest Plan and Northern Spotted Owl Recovery Plan (see below) are strategies to conserve and protect the northern spotted owl while still allowing for appropriate economic growth and use of forest products.

The draft recovery plan for the northern spotted owl was prepared in 1992 to describe the management and conservation actions that were necessary to promote recovery of the owl (FWSe1992). It outlined the primary actions to be implemented by the federal land management agencies and also the state forest management and wildlife agencies in the three affected states. The Secretary of the Interior asked the recovery team to consider other species and economic effects of reducing timber harvesting to the extent allowable by law. Under the ESA, the recovery team could not consider measures short of achieving full recovery of the owl regardless of potential social and economic impacts. The recovery team tried` to find solutions that minimized the loss of timber production and jobs while still achieving recovery of the owl (FWS 1992). If implemented, the recovery plan would have resulted in the reduction in the owl population from the then estimated 3,000 pairs to approximately 2,320 pairs, establishing 196 designated conservation areas (DCAs) to provide about 7.5 million acres of federal forest land as the primary habitat for the northern spotted owl, and in substantial economic impacts (FWS 1992).

At about the time the first draft recovery plan was released, Secretary of Interior Lujan of the G.W. Bush administration released a plan prepared by a small team of Interior Department officials, none of whom were biologists. The Lujan plan called for protecting 2.8 million acres and reduced the number of owl conservation areas from the 196 recommended in the recovery plan to 75, which would likely support a maximum of 1,300 breeding pairs of owls (Foster 1993). To implement this plan, special Congressional legislation would be required as it was counter to the intent of the ESA (Foster 1993). Environmentalists dubbed the Lujan proposal an "extinction plan" and it was never implemented.

After reviewing the comments on the first draft recovery plan, the FWS disbanded the recovery team and did not finalize the draft recovery plan. Subsequently, the FWS established a new recovery team, and eventually issued a revised draft recovery plan in 2007. Recovery team membership in the new team included members from a conservation organization, timber companies, state agencies, and federal agencies. In addition, a series of panels was established to help prepare the plan. The release of the second draft recovery plan resulted in 75,800 public comments. An Interagency Support Team reviewed and responded to comments, summarized the issues that were raised to be resolved in the final plan, and edited the final recovery plan. The preparation of the final recovery plan represented a monumental undertaking that involved significant collaboration and cooperation. The final recovery plan was approved in May 2008 (FWS 2008i).

The conservation strategy in the final recovery plan focuses on federal lands as the major provider of owl habitat. This strategy is based on the conservation areas delineated in earlier reports or plans found in the ISC Report (Thomas *et al*. 1990), draft recovery plan (FWS 1992), Northwest Forest Plan (USDA *et al*. 1993), and on spotted owl population modeling done in the 1990's and revised in 2008 (FWS 2008i). The approved recovery plan focuses on three essential ingredients for recovery: control of barred owls, dry-forest landscape management, and Managed Owl Conservation Areas (MOCAs) (FWS 2008i).

The FWS contracted with the Sustainable Ecosystems Institute (SEI) to prepare the 5-year status review for the northern spotted owl based on a comprehensive compilation of the best available scientific information (Courtney *et al*. 2004). According to the SEI's panel of experts, past habitat loss is still a current threat to the owl because of potential lag effects and synergistic interactions with other factors, but it is less than what was occurring in 1990 when the owl was listed. Because harvest rates on federal lands since the implementation of the Northwest Forest Plan dropped from 1 percent to 0.24 percent, the threat posed by timber harvesting has been greatly reduced (Courtney *et al*. 2004). Habitat fragmentation, the result of historic habitat loss, continuing habitat loss from wildfires and timber harvesting even though at reduced levels, remains a threat in the northern part of the range with little change in intensity; such threat, however, is reduced in the southern parts of the range (Courtney *et al*. 2004). Owl populations have been found to be rapidly declining in Washington and northern Oregon (Anthony *et al*. 2004) and British Columbia (Zimmerman *et al*. 2004) and there is concern that such declines can lead to demographic isolation (Courtney *et al*. 2004). The panel also noted that barred owls were now considered a more serious threat to northern spotted owls (Courtney 2004). After completing its review of the best and most current information, the FWS concluded that the northern spotted owl should remain listed as a threatened species under the ESA (FWS 2004a).

In addition, there have been 18 habitat conservation plans and two safe harbor agreements developed for the northern spotted owl. These agreements allow the "take" of northern spotted owls on private land in pursuit of otherwise legal activities. Suitable mitigation measures must be provided in the agreements, which are subject to review and approval by the FWS.

<u>Benefits and costs</u> It is estimated that the total cost of delisting the northern spotted owl over the 30 year life span of the recovery plan is $489.2 million (FWS 2008i). The benefits will be the maintenance of biologic diversity within these old growth or older growth forests as well as recovering a threatened species and providing additional protection under the umbrella of the northern spotted owl to many other species.

<u>Degree of agreement versus divergence of opinion</u> There has been and will continue to be widely divergent opinions as to whether the northern spotted owl should remain listed as a threatened species, whether there should be any critical habitat designation and whether that already designated is appropriate, and whether the strategy proposed in the recovery plan should be fully implemented. During the entire course of this conservation saga, there has been controversy, turbulence, and delays. Numerous lawsuits have hampered the process and certainly slowed it down. One benefit has been that the final recovery plan has incorporated the efforts of people from a wide spectrum of interests and, hopefully, will gain more public support. One downside has been that the process of the status review, listing, and recovery plan development has been heavily criticized by various entities, but the process did allow for divergent viewpoints to be heard and addressed.

In recent developments, President's Obama's Interior Secretary Ken Salazar has announced that he was reversing the Bush Administration decision to approximately double the amount of timber harvesting in western Oregon's old-growth forest (Barringer, New York Times, July 17, 2009).

<u>Transferability</u> The strength of this case study example is that even with a highly controversial, wide-ranging species, with the potential to have an economic impact reaching billions of dollars, it is still possible to follow the law and provide for the northern spotted owl.

Bottom line In spite of the establishment of reserved areas on Federal lands and a reduction in habitat loss from less timber harvesting, both of which have increased the likelihood of long-term survival, the Northern Spotted owl remains vulnerable. The Northwest Forest Plan, Northern Spotted Owl Recovery Plan, and habitat conservation plans provide a integrated conservation strategy. However, for every risk factor that has improved since listing, another has been identified so that overall the owl's status has not significantly improved. In fact, the potential adverse impacts of barred owls, West Nile virus, Sudden Oak Death, and the higher than usual incidence of wildfires suggest a net increase in risk since 1990 (U.S. Fish and Wildlife Service 2004a). Collaborative efforts to conserve the northern spotted owl have been effective in reducing some of the originally documented risks. However, such efforts must continue and may need to be expanded to counter the additional potential risks that have been discovered, which may have significant adverse effects on owl recovery.

BALSAM MOUNTAIN PRESERVE – Numerous dimensions of sustainable development incorporated that is intended to serve as a model for the housing industry to conserve natural resource and facilitate environmental education while maintaining a viable profit margin.

The Balsam Mountain Preserve, as the concept evolved, is an extension of Chaffin/Light Associates' Spring Island development near Beaufort, South Carolina, adapted to a higher altitude. These developments clearly illustrate the possibility of combining low-density housing and associated facilities and services with the natural environment, while protecting the cultural and physical attributes of the area.

Species of concern Though no at risk species are located on the property, this case example is an exemplary application of the principles of smart growth.

Drivers of declining population The property was owned by the Champion Paper Company for 100 years. The records of their property and forest management have provided an invaluable database that has drawn scientists from nine universities conducting research with several projects from the Smithsonian Environmental Research Center. Experimentation in soil erosion using dams and catch basins has been successful, as has conducting tests with sediment traps that have been used to restore streams.

Collaboration strategy The Balsam Mountain Trust was established to manage and protect the nature preserve and other open spaces; provide educational programs for property owners, guests, and those participating in outreach opportunities; and consult with developers to implement sound developmental plans, land management, and landscaping practices based on science.

Conservation strategy The Preserve contains nearly 4,400 acres of land; approximately 3,000 acres are permanently preserved in a natural state through a land conservation trust and accompanying conservation easements. Growth boundaries have been instituted on the number of residences allowed in the preserve. Only 350 low-density private residences will be built as opposed to the nearly 1,400 residences which would have been permitted based on zoning regulations. Also no homes will be built on the highest ridges and no clear cutting in front of homes is permitted.

Benefits and costs Environmental benefits include erosion control experimentation, which has been successful, and could possibly become state law. The erosion control system contains dams and catch basins which does not allow any soil disturbance within 50 feet of any creek, and provides buffers along some creeks extending to 100 feet on both sides. House sites undergo meticulous planning, including habitat surveys and "see-but-not-be-seen" guidelines regulating square footage, height, color, and outdoor lighting according to compliance procedures combined with periodic inspections to ensure the compatibility between housing and nature. Balsam Mountain Trust continues to construct an ongoing inventory of the natural environment entered in a database from which a species guide with a listing of more than 800 plants and animals is derived. Eighteen water quality-monitoring stations were installed to obtain baseline documentation through monthly water sampling. The practices of sustainable forest management will maintain a healthy environment for the 1,000 species of plants/animals identified so far on the preserve. Green building designs minimizes the electrical needs of the preserve residents. Waste management reduces the amount of rubbish being thrown into the landfill. Environmental education provides a basis for future generations to preserve the natural world continuously. Economic benefits include adding significant tax revenue for Jackson County and ultimately creating approximately 150 jobs, ranging from full-time naturalists to part-time seasonal dining room servers and local construction workers.

Degree of agreement versus divergence of opinion This case example concerns a private development and therefore is not controversial in the public sector.

Transferability This type of land management has already proven to be transferable since eight similar types of planned communities have been developed by Chaffin/Light Associates. Balsam Mountain Preserve hopes to change the current philosophy of home building that disregards the natural environment. Conservation easements provide tax incentives to prevent overdevelopment. In addition, the development of erosion control methods developed by researchers from North Carolina State University are transferable in that they can be utilized in other developments and in fact may become state law.

Bottom line This case example demonstrates the feasibility of sustainable development that clusters development so as to protect 3,300 acres of mountain forests via conservation easements and minimizes the footprint of each house as well as engaging in stream restoration, education on the environment, and sustainable development, and facilitating the conduct of natural science for inventory and monitoring.

Conclusions

There is much to keep in mind to meet the inevitably difficult challenges ahead.

- A sense of urgency – “approximately 20-30% of plant and animals species assessed so far are *likely* to be at risk of extinction if increases in global average temperature exceed 1.5 to 2.5 degrees centigrade” (IPCC 2007).
- Social-ecological Framework considerations

    Become aware of relevant ecological assessment programs and databases at the landscape scale

Identify growth management strategies being practiced in the region that can serve as role models

Look to relevant Best Sustainability Practices and follow those leaders on the landscape

- Biological considerations
  - *Streamline and clarify status declaration implications*
  - *Systematize analysis via predictive modeling when possible of habitat requirements, role of key stressors, monitoring, and restoration and conservation*
  - *Focus on system level conservation strategy where appropriate*
  - *Standardize data management – current system highly flawed*
- Social considerations
  - *Collaboration from the* outset
  - *Inclusiveness is important to achieve legitimacy*
  - *Listen and learn*
  - *Achieve stakeholder buy-in*
- Economic considerations
  - *Biological considerations come first*
  - *Quantify non-market benefits*
  - *Consider total economic values*
- Decision-making considerations
  - *Arguably the most important part of the process*
  - *Flexibility will inevitably be required to meet unforeseen challenges*
  - *Long term commit is the most challenging and important reward*
- Conservation Benefit Indicators. King and Mazotta (2000) developed seven indicators of valuation that display the expected beneficial outcomes from conservation practices. The stages are listed below:
  - *Financial incentives-focuses on eligibility criteria, project ranking criteria, level of funding, allocation of funds, etc.*
  - *Conservation practices-focuses on conservation tillage, wetland restoration, riparian buffers, noxious weed control, manure management, reduced fertilizer/pesticide use, irrigation practices*
  - *Biophysical effects-focuses on reduced sediment, nutrient, contaminant runoff, reduced use of water, energy, manpower; change in mix of seasonal/permanent ground cover, etc.*
  - *State of environment-focuses on improved habitat for fish, birds, fur-bearing animals; increased water/air/soil quality; reduced sedimentation*
  - *Improved environmental functions-focuses on hydrological (floodwater control, groundwater recharge functions), biological (biodiversity, species abundance, ecosystem resilience), and physical functions (chemical and carbon cycling)*
  - *Improved environmental services-focuses on commercial recreational, and other (reduced health risks, aesthetics, etc)*

Socioeconomic benefits-focuses on increased quality of life as measured by WTP for improving environmental services and reducing environmental and public health risks, estimates of the numbers of people who benefit, and illustrations of how people benefit

<u>Bottom line</u> Big challenges can be met with focused and coordinated integrated social and biological sciences addressing the needs of field biologists engaged in the growing challenges of species and ecosystem restoration and sustainabilization.

Appendix A: The ESA Process Shortcomings and Needed Refinements

Congress enacted the ESA to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such . . . species . . . (U.S. Code 2006*a*). Thus, the ESA sets forth the fundamental goal of protecting, conserving, *and restoring* U.S. biodiversity, and in doing so *reverse the current trend towards species extinction*. Critical to this process are several steps including determining threats to species, developing recovery plans, designating critical habitat for listed species, etc., all of which the ESA requires be done on the basis of the "best scientific data available . . ." (U.S. Code 2006*c*).

GOALS OF THE ENDANGERED SPECIES ACT

The fundamental goals of the ESA are: (1) to identify species that are at risk of extinction, and in doing so provide a means for conserving the critical habitat upon which the threatened or endangered species depend, (2) provide immediate protection by prohibiting acts that would further jeopardize listed species and their critical habitats, (3) develop and implement a management/restoration plan, and (4) recover ESA-listed species to the point at which they are no longer threatened by extinction (Carroll *et al.* 1996, Brown and Shogren 1998, Clark *et al.* 2002). The recovery process is flexible, and can be applied to a single species, or to a group of species that share similar habitat requirements. In the language of the ESA, a "species" refers to any subspecies of fish or wildlife, including any invertebrates such as arthropods, reptiles, or amphibians, and plants, including fungi, seeds, or roots. Bird species include any migratory, non-migratory, or endangered bird for which protection is afforded by treaty or other international agreement (U.S. Code 2006*b*). For vertebrates, any distinct segment of a population which shares unique morphological features or genetic traits, or a population that is reproductively isolated from other populations of the same species qualifies as a species (Carroll *et al.* 1996)

The process of listing a species may begin with the FWS or NMFS initiating the action or with a petition from an interested person or agency that a species is either in danger of extinction, or at risk of becoming endangered with extinction. Under Section 4 of the ESA, for a species to qualify for listing it must meet at least one of the following five criteria: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) over-utilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence (U.S. Code 2006*c*).Species which are proposed for listing by the agencies but whose immediate formal listing is "precluded" by higher priorities are added to a list of "candidate species" for which there is no legally binding deadline for listing (Greenwald *et al.* 2006). The USFWS enters into voluntary agreements with other interested parties to try and address issues to ease the costs of listing or prevent the listing of candidate species by pre-emptive actions (Thompson 2006). When the listing of a species is initiated by petition, if practical, a decision about whether listing may be warranted must be made within 90 days. The petition process culminates in one of three outcomes: (1) proposal of federal protection for the species designated as either threatened or endangered, (2) rejection of federal protection (i.e. rejection of the petition that the species is at risk of extinction), or (3) inclusion of the species in the "warranted, but precluded" category, with a final decision for protection to be made within a 12-month time period.

The ESA requires the designation of "critical habitat" for all listed species, with few exceptions. "Critical habitat" is defined as the specific geographical area encompassing all lands and waters which are found to be essential to meet the species immediate needs for survival, or which may require special management considerations essential to the conservation of the species (Taylor *et al.* 2005). The Act requires that designation be done on the basis of the "best scientific data available, and after taking into account the economic impact and any other relevant impact of specifying an area" (U.S. Code 2006*c*).

The ESA provides immediate protection to a species when it is listed. Section 7 of the ESA mandates that any action carried out, authorized or funded by a federal agency *may not jeopardize the continued existence* of a threatened or endangered species, and *may not destroy or adversely modify the critical habitat* upon which the species depends. Therefore, all federal agencies must examine any proposed action to determine whether that action might adversely affect the species or its habitat, and these actions must be evaluated by the USFWS or NMFS (Carroll *et al.* 1996).

Section 7 also deals with "taking". The term "take" refers to any unlawful action or perturbation that might jeopardize the continued existence or recovery of a species. Such actual or attempted actions are defined in Section 3 and may include harass, harm, trap, shoot, wound, pursue, capture, export/import, collect, etc., all of which are prohibited under the Act unless authorized by permit (Harding *et al.* 2001). Take has been interpreted to also include certain harm to the habitat of a species, as well as to a species itself (Carroll *et al.* 1996). "Incidental take" is taking that occurs in the course of otherwise lawful activities (Harding *et al.* 2001).[31]

When a species is listed, the ESA requires that a recovery plan for that species be developed and implemented. The fundamental goal of each recovery plan is to restore

[31] From a USFWS website: http://www.fws.gov/Midwest/endangered/permits/hcp/index.html
Take: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct; may include significant habitat modification degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.
Incidental take: Take that results from, but is not the purpose of, carrying out an otherwise lawful activity.

the species to a viable state in its natural habitat, and in doing so delist the species from being either threatened or endangered. Because habitat loss is a principal cause for species endangerment, and many such species depend on habitat that has been reduced in area or otherwise degraded, habitat preservation is a key element in most recovery plans (Carroll *et al.* 1996).

When a species is recovered to the point at which it is no longer threatened by extinction, the Act provides for delisting the species. Delisted species in cooperation with the states must be monitored for at least five years from the time of removal from the list (U.S. Code 2006*c*).

THE POLITICAL ECONOMY OF ESA PROMULGATION AND ENFORCEMENT

While there are often public calls to make conservation decisions on scientific rather than political criteria, the reality is that political decisions about agency resources and standards inevitably shape the science they perform. "Thus science is not something discrete or apart from the political process. Its purview and its methods are determined by the political process" (Cash *et al* 2001:173). Political agendas, the structure of the decision-making process, and financial resources used to aggrandize a position, can have great influence on whether the dynamics of a process for devising a conservation plan is based on conflict versus compromise (Robbins 2004). Conflicts of powerful economic interests and ideological perspectives regarding property rights, and ethics shape government action. The actual policies of environmental protection in the US, beginning in the Progressive Era, have been dominated by large business interests' concerns for economic efficiency more than a preservationist ethic advanced by popular movements which is tolerated rather than embraced (Hays 1959, Kolko 1977, Schnaiberg 1980, Gottlieb 2005). The legal status and enforcement of species conservation laws fluctuates with the relative political power of institutional interests and social movements over time. However, throughout these fluctuations there is an underlying and consistent coalition of political interests opposing polices, such as species conservation, when they may slow the rate of economic growth (Schnaiberg 1980, Gould, Pellow, and Schnaiberg 2004). Both fluctuations and the underlying trend are visible in the history of species listing under the ESA as well as in our case examples.

PROMULGATION: THE PROBLEM OF CRITICAL HABITAT, SURVIVAL, AND RECOVERY

Critical habitat for a threatened or endangered species is supposed to be designated as:

> ". . . the specific areas within the geographical area occupied by the species . . . on which are found physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and specific areas outside the geographical areas occupied by the species at the time it is listed . . . [*that*] are essential to the conservation of the species (U.S. Code 2006*b*)."

Despite this legal mandate, for the majority of ESA-listed species in the United States, the U. S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), the two federal agencies responsible for administering the ESA, have usually made final determinations that designation of critical habitat was either "not prudent" or "not determinable" (Hoekstra *et al.* 2002*b*). The former determination was made if it was determined that designation would not provide any additional protection for a listed species, and the latter was made if there was insufficient data on a species' distribution or habitat requirements to make a formal designation (*Ibid*). "Not prudent" determinations proliferated because of a "catch 22" whereby agencies have interpreted the "jeopardy" protection afforded by listing and the no "adverse modification" protection extended by critical habitat designations as synonymous- meaning, *by definition designating critical habitat does not provide any additional protection and is therefore never prudent* (Patlis 2001). The ESA does not clearly define either standard but it is fairly clear that they are two separate standards (Patlis 2001, Suckling and Taylor 2006). Critical habitat is defined as habitat "essential to the *conservation* of the species" (ESA sec.3(5)(A), [emphasis by author], and is associated with steps necessary to *recover and delist* the species- the definition of "conservation" under ESAsec.3(3). (Suckling and Taylor 2006:78). The Department of the Interior's argument for collapsing the two standards ("jeopardy" vs. "conservation/recovery") and thereby subordinating recovery hinges on changes in language made in the 1978 amendment to the ESA (Patlis 2001), but as Suckling and Taylor (2006:79) point out, this appears an unfortunate and unnecessary handicap to agency goals:

> "Most legal scholars (e.g. Darrin 2000, Hicks 2000, Armstrong 2002, Senatore et al. 2003) opine that the Interior Department regulation is illegal and its arguments specious. The judiciary agrees. Between 1998 and 2004, at least eight courts (including three different circuit courts of appeals) judged the regulation illegal. Two struck it down. None upheld it. In the most recent appeals court decision, the Ninth U.S. Circuit Court of Appeals stated: **"***This can not be right. If the [FWS] follows its own regulation, then it is obligated to be indifferent to, if not to ignore, the recovery goal of critical habitat"* (Gifford Pinchot Task Force v. United States Fish and Wildlife Service 2004)."

In 1978 Congress amended the ESA to allow the agencies to exclude critical habitat all together based on economic or other grounds (Rohlf 1991). Members of the House Merchant Marine and Fisheries Committee reviewing the bill saw this as problematic and stated: "As currently written, the critical habitat provision is … wholly inconsistent with the rest of the legislation. It constitutes a loophole which could readily be abused by any Secretary of the Interior who is vulnerable to political pressure, or who is not sympathetic to the basic purposes of the [ESA]" (Patlis 2001:155).[32] Rohlf (1991) argues that this marks a significant departure from the Act's biologically based decision-making foundation, and further states that agencies responded to the controversy over critical habitat designation by ignoring the issue all together.

As of 2001, critical habitat had been designated for only around 10% of ESA-listed species in the United States (145 of 1243 species) (Hoekstra *et al.* 2002*b*). Litigation forced the designation of critical habitat for an additional 27% of species (for a total of 37%) between 2000 and 2005 (Suckling and Taylor 2006). However, the USFWS has opposed every case and attaches a disclaimer to every designation it has

[32] Former Secretary of the Interior Bruce Babbitt argues this was the case under the second Bush administration: "There is nothing wrong with the Endangered Species Act. It works," … "The problem is this administration is not enforcing it and it doesn't want it to work. They want it to fail." (Cart 2003).

been forced to make, declaring that the process is redundant and that "'in 30 years of implementing the ESA, the Service has found that the designation…provides little additional protection to most listed species' (US Department of the Interior 2003)" (as quoted in (Suckling and Taylor 2006:76). Several scientific studies have found otherwise (Rachlinski 1997, Taylor, Suckling and Rachlinski 2003, Taylor, Suckling, and Rachlinski 2005) and a 2004 request under the Freedom of Information Act revealed that the Department of the Interior did not have any evidence to support their repeated claims (Suckling and Taylor 2006). There has been little to no change in the percentage of listed species with critical habitat designations since 2005.

As of February 2008, *about* 37% (508 of 1357) of ESA-listed species had critical habitat designations (USFWS 2008c). The majority of ESA-listed species do not have critical habitat designations. To the extent that the ESA permits discretion in habitat designation, Congress intended for decisions to not designate critical habitat to be the exception rather than the norm (Hoekstra *et al.* 2002*b*). Although the primary purpose of the ESA is to "provide a means whereby *the ecosystems upon which endangered species and threatened species depend* may be conserved" (U.S. Code 2006*a*) [emaphasis added], it seems as though this fundamental purpose has been neglected in the past. Designating critical habitat would seem to be an important part in conserving these ecosystems and species, however because the majority of ESA-listed species do not have critical habitat designations, the extent to which such designations have enhanced the recovery process of endangered and threatened species is perhaps difficult to assess.

Hoekstra *et al.* (2002*b*) examined the influence of critical habitat designations on various aspects of the recovery plan process. The primary data used for the analysis came from reviews of ESA recovery plans for 181 listed species, which represents about 20% of all species with ESA approved recovery plans. They found that within their sample, critical habitat had been designated for 32 species (18%), and that designations disproportionately favored vertebrate species. The frequency of critical habitat designation did not vary by the degree of threat to a species or the recovery potential of a species. Also, plans with critical habitat were no more likely to include habitat-based recovery criteria than were plans for species without designated critical habitat. Overall, Hoekstra *et al.* (*Ibid*) concluded that critical habitat designation had only a limited influence on the recovery plan process, but they went on to discuss several possible explanations as for why this seemed to be the case.[33] In contrast, Taylor and colleagues (Suckling and Taylor 2006) found in a more thorough analysis *of all available data* for species[34] that the designation of critical habitat has a significantly positive effect on recovery- independent of length of time listed and recovery plans. In recent years "species with critical habitat were "more than twice as likely to be improving as species without…" (*Ibid*: 88).

[33] First, the recovery plan process may substantially compensate for those species without critical habitat designation, which perhaps suggests that critical habitat designation is redundant (Hoekstra *et al.* 2002*b*). Second, the potential contributions of critical habitat designation to the recovery of a species may be sufficiently handicapped by legislative and regulatory contradictions. In terms of legislative contradictions, for example, the ESA requires that a species biological needs be balanced against human economic interests and the costs imposed by designation (*Ibid*).

[34] 1995-96 (*n*= 701); 1997-8 (*n*= 803); and 1999-200 (*n*=915)

There is also an argument that regulatory contradictions created through the interpretation by the agencies are more serious than legislative ones in limiting the effectiveness of critical habitat designation. Patlis (2001: 198-9) points to a 1999 report by the Congressional Research Service (CRS) finding that critical habitat designation

> "…forces consideration of economic effects, provides guidance to landowners, requires consultation on federal actions, provides an opportunity for judicial review, gives some indication of Section 9 takings, and identifies information for habitat conservation plans, recovery plans, and land acquisition decisions. While the USFWS and NMFS have occasionally recognized all of these benefits, they view them as inconsequential. CRS counters that "these conclusions seem to have resulted from how the USFWS and NMFS have interpreted certain aspects of the ESA."

Further analysis is needed to determine the full effect of critical habitat to the recovery plan process and ultimately to species recovery. However, it does seem fairly certain that current interpretations by regulators *essentially eliminate recovery as a meaningful criterion* (Rohlf 1991, Suckling and Taylor 2006). This occurs in two primary contexts- first by the requirement that a prohibited action threaten both recovery and survival (meaning any action not threatening survival is allowed), and second by the application of this standard to the designation of critical habitat resulting in the interpretation that critical habitat provides no additional protection than that extended to habitat by the jeopardy standard under Section 7 and is therefore never necessary (Rohlf 1991; Patlis 2001, Suckling and Taylor 2006).

ENFORCEMENT: EVIDENCE OF POLITICAL INFLUENCES ON LISTING

The number of new endangered species added varies among presidential administrations reflecting in part to political positions and resources applied to the process (Stinchcombe 2000). Listing provides critical protection under Sections 7 and 9 of the ESA and the speed with which imperiled species are listed is tied to their survival and recovery prospects (Greenwald *et al.* 2006). However, based on estimations by Nature Serve of the species in need of protection, if listing continues at the rate it has between the passage of the ESA and 2003, it would take close to 177 years to list all the species in need (*Ibid*). With a minimum of 42 species having been lost while their listing was pending, the current rate of listing is far too low to meet goals and mandates of the ESA (*Ibid*). The listing process has been plagued by political interference by the executive branch and committees, shifting Congressional preferences, and a consistent lack of sufficient resources and political aggressiveness on the part of the USFWS[35] (Patlis 2001, Greenwald *et al* 2006, DeShazo and Freeman 2006)[36].

Following the passage of the ESA, the annual listing rate steadily increased as the USFWS sought to fulfill its mandate to list all imperiled species through solicitation of petitions and mass listing projects until curtailed by the amendments to the ESA and Regan administration (whose rise to power made 1981 the only year with no new species

[35] "A USFWS biologist stated at the time that the agency did not mount an aggressive listing response to the looming deadline due to "incompetence and ineptitude" and because administrators were "afraid to take the bull by the horns because they worried what would happen politically to the Endangered Species Act itself. We have been so busy saving the act that we are not saving plants and animals" (New York Times 1979 cited in Greenwald *et al* 2006:56).

[36] See Table 3: Current Listing Process Statistics.

listed) (Greenwald *et al* 2006). When the ESA was amended again in 1982 the two year deadline for processing listing proposals was abolished and a purely biological standard for listing along with increased opportunities for the public to facilitate enforcement were implemented to counter layers of economic and administrative reviews the Reagan administration had used to suppress the program (Greenwald *et al* 2006). In 1983 the USFWS issued a formal listing prioritization guide[37].

Unfortunately, these aspects of the amendment designed to facilitate implementation of the act have not been consistently applied. Echoing Stinchcombe's findings regarding the influence of political party, Deshazo and Freeman (2006) found that under oversight committees with more Democrats the USFWS lists more species and under those with more Republicans they list fewer species by a statistically significant margin despite the clear legislative mandate that listing be based purely on biological considerations. "As it turns out, the USFWS is not acting on its own when it deviates from statutory criteria. Rather, the agency's listing and resource allocation decisions respond to legislative principals whose preferences simply contradict what the enacting majority intended when it passed (or reauthorized) the law" (DeShazo and Freeman 2006:71). One should not draw conclusions too quickly about the greater willingness of Democrats to support species conservation as both parties are ultimately committed continuing economic growth at any cost. Stinchcombe's (2000) methods which average species listing across entire presidential tenures likely obscure a reactionary change in ESA policy midway through the Clinton administration.

Today, public petitions are responsible for 54 percent of species listed and lawsuits have established 39 percent, with agencies listing only 29 percent without formal legal pressure (Greenwald *et al* 2006). A wave of litigation between 1991 and 1995 resulted in more of the multi-species listings recommended by the Inspector General in 1990. This civil society pressure to act may have combined with greater agency resources to produce the dramatic increase in listings. However, immediately following over 120 listings in 1994, the highest to date, the Republican Congress issued a one year moratorium on listing. *Greater than the effect on the USFWS's already sizable backlog was the political effect of Congress's action which resulted in Clinton's USFWS implementing policies to restrict the public's ability to push enforcement of the ESA and slow down the listing process* (*Ibid*). This was accomplished, first by the USFWS ruling in 1995 that candidate species are not subject to petitions and therefore have no legally enforceable timeline for listing, and second, by making "not practicable" the default response to petitions from 1997 on in order to delay the response requirement (*Ibid*). The result of these policies has been striking: between 1997 and 2003 USFWS listed only six petitioned species, down from 31 in 1996 alone. As of June 2008, two animal and one plant species were proposed for listing. Another 282 species, 144 animals and 138 plants, which have been considered for listing were relegated to the list of candidate species (USFWS 2008c).

[37] See Table 2: Recovery Priority Table .

ENFORCEMENT: INTIMIDATION AND COERCION OF AGENCY PERSONNEL

Politics can readily override an inclusively executed decision-making process as illustrated by the spotted owl and Florida Panther case examples discussed above. Biologists are likely aware of the political pressures surrounding their work. According to a 2005 survey of USFWS science professionals working in Ecological Services field offices across the country (UCS 2005):

- Nearly half of all respondents whose work is related to endangered species scientific findings (44 percent) reported that they "have been directed, for non-scientific reasons, to refrain from making jeopardy or other findings that are protective of species." One in five agency scientists revealed they have been instructed to compromise their scientific integrity—reporting that they have been "directed to inappropriately exclude or alter technical information from a USFWS scientific document,"
  such as a biological opinion;
- More than half of all respondents (56 percent) knew of cases where "commercial interests have inappropriately induced the reversal or withdrawal of scientific conclusions or decisions through political intervention;" and
- More than two out of three staff scientists (70 percent) and nearly nine out of 10 scientist managers (89 percent) knew of cases "where U.S. Department of Interior political appointees have injected themselves into Ecological Services determinations." A majority of respondents also cited interventions by members of Congress and local officeholders.

In the case of the Florida Panther, in 2005, 20 agency scientists wrote a public letter alleging that their supervisor had ordered agency staff not to object to any development project in Southern Florida no matter how harmful the expected impact on the Panther or the 68 other federally listed species in the region (PEER 2005). This came shortly after the firing of agency biologist Andrew Eller who had refused this order and repeatedly objected to the methods used to evaluate Panther habitat (the agency later admitted these were deeply flawed) for not approving projects quickly enough. In their letter his 20 colleagues wrote:
"We feel a need to voice our collective concerns anonymously over this atrocity [Eller's firing] and others we witness within the Service for fear of similar retribution. In short, we feel that it is not safe to speak out individually…The atmosphere where government employees are afraid to use science, question management, and do their jobs must end."

Appendix B: Southeastern Ecological Framework Data Layers

The following is a list of data layers available in the Southeast Ecological Framework (SEF) (Ely 2004). The meanings of these data layers are not intuitive, so provided is a brief description of each directly from the descriptions in the GeoBook. Also included are the data sources.

Watersheds- Displays watershed boundaries with data from the US Geological Survey data for eight-digit hydrological unit codes (HUCs). These watersheds include all land where water, from rain or runoff, drains to a specific water body.

States- Shows state boundaries and serves as a visual reference to identify natural resources that may cross state lines.

Counties- Shows the county boundaries and a visual reference for identifying locations on the map and navigating around other data sets.

Riparian Mask- Shows different land types within a one-hundred foot buffer along the banks of a particular waterway. This data is from the National Land Cover Data (NLCD) and USGS data. The riparian zones identified are those either in their natural state and need preservation or are under possible threat of alteration or removal.

303D- Identifies impaired waterways within the mapped area. Impairment can be a result of excess nutrients, sediments, chemical pollutants, animal wastes or other forms of contamination. The data identifies the streams that each state considers impaired (standards vary from state to state).

Rivers- Provides coverage of rivers and streams and comes from the USGS's National Hydrologic Data (NHD).

Highways- Shows the Major Highways within the specific map area. One can see where ecological areas are (or will be) being fragmented. This data is from the 1995 Topologically Integrated Geographic Encoding and Referencing (TIGER) system database.

Cities- Shows municipal boundaries for cities and towns that can identify locations where land development is moving away from the city's center and may be threatening water and ecological resources or contributing to habitat fragmentation. It can also be used to design urban greenways and trails that tie into the larger ecological hub and corridor system.

USFS EcoRegions- This data comes from the 1995 USDA Forest Service classification of regional land types.

Land Values- Provides the average estimated market value of an acre of land at a county level. The data is from 1992 Department of Agriculture Census and provides insight to the economic tradeoffs from agriculture and or development land use changes. This can be useful to a county or municipal planner's decision making within the context of economic issues.

Property Taxes- Provides the total of farmland Property Taxes paid in $1,000s within the selected county. The data is from 1992 Department of Agriculture Census and also provides information about tradeoffs made from agriculture/development land use changes within a county.

CRP WRP- This is the total amount of Federal dollars spent in a county for the Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) and is useful when comparing counties. This information comes from the 1992 Department of Agriculture Census.

Fertilized Acres- Provides the total acres of land fertilized in each county. This data is from the 1992 Department of Agriculture Census.

Irrigated Acres- Provides the total acres of irrigated land per county. This data is from the 1992 Department of Agriculture Census.

Ag Sold- Provides the total of All Agriculture Products sold in $1,000s per county. This data is from the 1992 Department of Agriculture Census.

Crops Sold- Provides the total of all crop products sold in $1,000s per county. This information can be used to determine the importance of crop sales to a county's economy. This data is from the 1992 Department of Agriculture Census.

Livestock Sold- Provides the total livestock and poultry products sold in $1,000s per county. This is significant of the importance of livestock sales to a country's economy. This data is from the 1992 Department of Agriculture Census

Land Cover- Shows different types of land cover within the mapped area and an overview of where each land cover type is located within a watershed or county. This data also shows where land uses are encroaching on other land types. This information came from the National Land Cover Data developed by the USGS and the US EPA.

SEF Detail- Identifies the hubs and connectivity of the SEF along with other areas outside the SEF designated as Priority Ecological Areas (PEA) and Significant Ecological Areas (SEA).

Surface Intake- Depicts segments of rivers that are located near surface water intakes. This coverage is important for protecting drinking water for local populations.

Mines- Shows the location of current and past mines and the primary products extracted. Mines can be a source of water pollution.

Railroads- Shows the location of major railroad lines and is useful because abandoned railways have been used to develop greenway trails to connect urban areas to parts of the SEF.

Dams- Shows the location of dams along streams and rivers. This can be useful in finding places where the natural flow of a stream or river may be impeded or altered. Farm ponds created by stream dams is also shown.

TRI_REL- Is the total sum of emissions from facilities reporting under the Toxic Release Inventory. This data is the sum of emissions to air, water, or land as well as emissions off-site or fugitive emissions.

SF Status (Npl_Stat_I)- Identifies the current status of superfund sites in the Southeast.

RCRA- Identifies locations that fall under the Resource Conservation and Recovery Act. The objectives of the RCRA are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

NPDES- The National Pollutant Discharge Elimination System (NPEDS) shows the location of permitted facilities that discharge pollutants into waters of the U.S. The conveyances from the facility are called point sources.

Recreation- Represent sites of recreation such as golf.

Schools- Location of schools from the Environmental Systems Research Institute.

Institute- Provides information on the community resources in your watershed. The data is from Environmental Systems Research Institute and identifies hospitals, schools, and cemeteries. These locations are important when making development decisions.

Airports- Shows the location of municipal and other major airports in the mapped area.

Parks- Represents State and Federal park areas and may overlap with the managed areas database. Parks help make up the hubs in the SEF.

Landmark- Provides information on the location of historic sites or points of interest. This data can assist in the evaluation of potential tourist issues that may be supporting the community's economy.

Lakes- Displays the major lakes and reservoirs in the mapped area.

EJ- The Environmental Justice (EJ) data set shows the location of low-income and minority populations in each county. This information is useful to make sure planning decisions do not adversely impact these populations and to identify diverse members for stakeholder groups. The EJ program ensures that all people are treated fairly with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Population Change- Identifies the change in population between 1990 and 1997. The spatial resolution is based on the census tract level.

Federal Lands (AGBUR)- Shows the location of lands owned by the US Forest Service, Fish and Wildlife Service, National Parks Service, Department of Defense, Tennessee Valley Authority, and Bureau of Indian Affairs.

Forest- Shows the following four forested land cover types: evergreen, upland deciduous; mixed; and forested wetlands. Identification of forest types and locations is a helpful tool for understanding the various habitats in your community. Additionally, each forest type has its own unique role in both providing an protecting natural resources.

Forest Density- Shows the percent of forested land cover within a one kilometer cell. The U.S. Forest Service developed this data from satellite in the early 1990s.

PCT Riparian Forest in HUC- The Forested Riparian data set shows both the percentage of and total acres of froested land within each one-hundred meter wide riparian buffer for a given watershed. This data is from the USGS National Land Cover Data (NLCD).

PCT Forest in HUC- The Forested Watershed data shows both the percentage of and total acres of froested land in each watershed. This data is from the USGS National Land Cover Data (NLCD).

Roads- This layer provides reference for locating specific target areas and identing the principal fragmentation stressor to the landscape and comes from 1995 TIGER database

SEF Mask- Allows the user to see what other layers exist within the SEF for a given location.

Managed Areas- Represents many types of federal, state, and local managed lands. These, too, help make up the SEF hubs.

Conservation Lands- Include various types of management from national parks and forests to local parks and conservation areas.

SEF- Identifies all lands that have been included in the SEF and does not distinguish between hubs and corridors that connect them.

SEF Biodiversity- Assessment relevant to identifying areas that are potentially most important for conserving biodiversity because these areas are most likely to support viable opportunities to conserve biodiversity. This coverage is the regional biodiversity selected for the SEF.

Regional Biodiversity- Assessment relevant to identifying areas that are potentially most important for conserving biodiversity. Additional data on location of species of conservation interest and natural communities and the identification of areas most important for conserving viable populations of those species are important and to be enhanced in future iterations.

SEF Ecosystem Services- Ecosystem (or ecological) services are ecological processes and functions provided by natural and semi-natural areas that help sustain or enhance human life. Primary ecosystem services are water and air protection and purification, flood and storm protection, functional nutrient cycling, etc. This data has been selected for the SEF.

Regional Threats- Assess the threats from intensive land uses and roads that can both negatively affect ecological integrity existing natural and semi-natural lands, and the likelihood that such lands will be converted to residential or urban land uses.

Road Density- Shows the density of roads in miles per square mile of land from the 1995 TIGER database. This information is useful in providing insight to areas that are more accessible to urban sprawl and development pressures.

Potential for Urban Growth- Show the existing urban areas along with areas with the greatest projected potential for becoming urbanized or converted to residential or commercial development. To create this data, mapping analysis was done using 1993 land cover data set looking at an area's distance to roads, distance to urban locations, and the urban density within a one mile and five mile radius from existing urbanized land. This data will be updated using changes in population density between the 1990 and 2000 census.

Urban Land Cover- Three classes of urbanized land are in the National Land Cover Data (NLCD). Low-Density Urban is low-density residential, Medium-Density Urban is high-density residential and light commercial, and High/Industrial class is urban centers and industrialized areas. This layer was created by the USGS satellite photographs from the early 1990's.

Water Bodies- Represents lakes, ponds, and impoundments from USGS National Hydrography Database (NHD).

Flood Zone- These flood zones were delineated by the Federal Emergency Management Agency (FEMA).

Soil Permeability- The soil permeability information is based on STATSGO, the state level soil database. This is important when dealing with potential flooding and non-point source runoff issues that impact the quality and quantity of water resources in the community.

Riparian N-Index- This is the percentage of natural vegetation along riparian areas in a watershed in a natural states. Typically, a low N index percentage indicates possible water quality and quantity issues.

HUC N-Index- Shows the Natural System's Index for Watersheds percentage of land in a watershed that remains in a natural state.

Elevation- Is represented in feet and is important to determine water flows. This data is from the USGS National Elevation Data.

Bibliography

Abbitt, R. J. F. and J. M. Scott. 2001. Examining Differences between Recovered and Declining Endangered Species. *Conservation Biology*, 15(5):1274-1284.

Ackerman, F. and L. Heinzerling. 2004. *Priceless On Knowing the Price of Everything and the Value of Nothing*. New York: The New Press.

Anderson, R.C. and A. J. Kate. 1993. Recovery of Browse-Sensitive Tree Species Following Release From White-Tailed Deer *Odocoileus virginanus* Zimmerman Browsing Pressure. *Biological Conservation* 63:203−208.

Angelstam, P.,G. Mikusiński, B. Rönnbäck, A. Östman, M. Lazdinis, J. Roberge, W. Arnberg, J. Olsson. 2003. Two-Dimensional Gap Analysis: A Tool for Efficient Conservation Planning and Biodiversity Policy Implementation. *Ambio* 32(8):527–534.

Arendt, R. 1999. *Growing Greener: Putting Conservation into Local Plans and Ordinances*. Washington, DC.: Island Press.

Baker, K. H. 2001. “Institutional evolution and environmental amenities.” Ph. D. dissertation. Department of Economics, University of New Mexico, Albuquerque, New Mexico.

Barden, L.S. 1978. Regrowth of Shrubs in Grassy Balds of the Southern Appalachians After Prescribed Burning. *Castanea* 43:238–246.

Barringer, F. 2009. Limits on logging are reinstated. Article in New York Times, July 17, 2009.

Barrett, M.A. 2004. An Analysis of Key Deer herbivory on Forest Communities in the Lower Florida Keys. PhD Dissertation. Department of Biology. University of South Florida. Tampa, FL, USA.

Barrett, M.A. and P. Stiling. 2006*a*. Effects of Key Deer Herbivory on Forest Communities in the Lower Florida Keys. *Biological Conservation* 129:100−108.

Barrett, M.A. and P. Stiling. 2006*b*. Impacts of Endangered Key Deer Herbivory on Imperiled Pine Rockland Vegetation: A Conservation Dilemma? *Animal Biodiversity and Conservation* 29(2):165−178.

Beissinger, S.R. and M. I. Westphal. 1998. On the Use of Demographic Models of Population Viability in Endangered Species Management. *Journal of Wildlife Management* 62: 821–841.

Bernhardt, C.E., Willard, D.A., Marot, M., and Holmes, C.W. 2004. Anthropogenic and natural variation in ridge and slough pollen assemblages. USGS Open File Report OFR 2004–1448: 47 Pp.

Berks, F. , J. Colding, and C. Folke. 2003. Navigating *Social-ecological Systems: Building Resilience to Complexity and Change.* Cambridge University Press.

Berrens, R. P., S. D. Brookshire, M. McKee, and C. Schmidt. 1998. Implementing the Safe Minimum Standard Approach: Two Case Studies from the U.S. Endangered Species Act. *Land Economics*. 74: 2. 147-61.

Berrens, R. P., M. McKee, and M. C. Farmer. 1999. Incorporating distributional considerations in the safe minimum standard approach: endangered species and local impacts. *Ecological Economics*. 30. 461-474.

Berish, C., R. Durbrow, J.Harrison, W. Jackson and K. Riitters. 1999. Environmental Assessments:.The Southern Appalachian Experience. Pp. 117-166 in *Ecosystem Management for Sustainability: Principles and Practices Illustrated by a*

Regional Biosphere reserve Cooperative. New York, ed. J. Peine. New York: Lewis Publishers.

Best Sustainability Practices (BSP). 2008a. http://bpappalachia.nbii.gov/portal/server.pt .

Best Sustainability Practices (BSP). 2008b. County Growth Management http://bpappalachia.nbii.gov/portal/server.pt [accessed April 23, 2009].

Best Sustainability Practices (BSP). 2008c. Etowah Watershed. http://bpappalachia.nbii.gov/portal/server.pt [accessed October 28, 2008].

Best Sustainability Practices (BSP). 2008d. **Headwaters Of Clinch, Powel And Holston Rivers** http://bpappalachia.nbii.gov/portal/server.pt [accessed October 28, 2008].

Best Sustainability Practices (BSP). 2008e. **Headwaters Of Clinch, Powel And Holston Rivers** http://bpappalachia.nbii.gov/portal/server.pt [accessed October 28, 2008].

Bishop, R. C. 1978. Endangered Species and Uncertainty: The Economics of a Safe Minimum Standard. *American Journal of Agricultural Economics*, 60(1):10-18.

Bureau of Land Management (BLM). 2005. Cooperative Conservation Strategies for the Lesser Prairie Chicken and Sand Dune Lizard in New Mexico: Findings and recommendations of the New Mexico LPC Working Group. http://nwcos.org/Resources/LPC_SDL_Conservation_Strategy_CD.pdf [accessed November 6, 2008]

Bradbury, J. 2005. Evaluating public participation in environmental decisions. Paper prepared for the National Research Council Panel on Public Participation in environmental assessments and decision making, Feb 3-5 National Academy of Sciences, Washington, DC. http://www7.nationalacademies.org/hdgc/Bradbury20%pdf[accessed [accessed June 2008]

Brenner, M., M. F. Rosenmeier, D. A. Hodell, and J. H. Curtis. 2002. Paleolimnology of the Maya Lowlands: Long-Term Perspectives on Interactions among Climate, Environment, and Humans. *Ancient Mesoamerica* 13:141–157.

Brook, B.W., J. J., O'Grady, A. P. Chapman, M. A. Burgman, H. R. Akçakaya, R. Frankham. 2000. Predictive Accuracy of Population Viability Analysis in Conservation Biology. *Nature* 404:385–387.

Brown, Jr., G.M. and J. F. Shogren. 1998. Economics of the Endangered Species Act. *The Journal of Economic Perspectives* 12(3):3–20.

Burley, T., N. Schubert, J. Peine, J. Murray, and M. Thompson. 2007. NBII=SAIN FY05-06 Roan Mountain Project Final Report. Knoxville, TN: USGS Southern Appalachian Field Branch.

Burley, T. and J. Peine. n.d.. NBII-SAIN Data Management Toolkit. To be posted on the USGS Publications Warehouse. 130 pp.

Burney, D.A. and Burney, L.P. 2007. Paleoecology and “inter-situ” restoration on Kaua‘i, Hawaii. *Frontiers in Ecology and the Environment* 5(9): 483–490.

Buttimer, A. 2001. *Sustainable Landscapes and Lifeways: Scale and Appropriateness*. Ireland: Cork University Press.

Campbell, S. P., J A. Clark, L. H. Crampton, A. D. Guerry, L. T. Hatch, P. R. Hosseini, J. J. Lawler, and R. J. O’Connor. 2002. An Assessment of Monitoring Efforts in Endangered Species Recovery Plans. *Ecological Applications* 12(3):674-681.

Carlson, P.C., G. W. Tanner, J. M. Wood,, and S. R. Humphrey. 1993. Fire in Key Deer Habitat Improves Browse, Prevents Succession, and Preserves Endemic Herbs. *Journal of Wildlife Management* 57(4):914–928.

Caro, T.M. and O’Doherty, G. 1999. On the use of surrogate species in conservation biology. *Conservation Biology* 13(4): 804−814.

Caro, T.M. 2003. Umbrella species: critique and lessons from East Africa. *Animal Conservation* 6: 171−181.

Carroll, R., C. Augspurger, A. Dobson, J. Franklin, G. R. Orians, W. Reid, R. Tracy, D. Wilcove, and J. Wilson. 1996. Strengthening the Use of Science in Achieving the Goals of the Endangered Species Act: An Assessment by the Ecological Society of America *Ecological Applications* 6(1):1–11.

Cart, J. 2003. The State; Species Protection Act 'Broken'; A top Interior official says the law should be revised to give economic and other interests equal footing with endangered animals and plants. *Los Angeles Times.* Nov. 14, 2003. B6

Chamber, F.M., Mauquoy, D., and Todd, P.A. 1999. Recent rise to dominance of *Molinia caerulea* in environmentally sensitive areas: new perspectives from paleoecological data. *Journal of Applied Ecology* 36: 719–733.

Clark, J. A. and H. Erik. 2002. Assessing Multi-Species Recovery Plans under the Endangered Species Act. *Ecological Applications* 12(3):655-662.

Clark, J.A., J. M. Hoekstra, P. D. Boersma, and P. Kareiva. 2002. Improving U.S. Endangered Species Act Recovery Plans: Key Findings and Recommendations of the SCB Recovery Plan Project. *Conservation Biology* 16(6):1510–1519.

Collen, P. and R. J. Gibson. 2001. The General Ecology of Beavers (*Castor spp.),* as Related to their Influence on Stream Ecosystems and Riparian Habitats, and the Subsequent Effects on Fish – a Review. *Reviews in Fish Biology and Fisheries* 10:439–461.

Costanza, R. and L. Cornwell. 1992. "The 4P approach to dealing with scientific uncertainty." *Environmen*t 34:9, 12-20.

Coulson, T., G. M. Mace, E. Hudson, and H. Possingham. 2001. The Use and Abuse of Population Viability Analysis. *Trends in Ecology and Evolution* 16(5): 219–221.

Courtney, S.P., J. A. Blakesley, R. E. Bigley, M. L. Cody, R. C. Dumbacher, R. C. Fleischer, A. B. Franklin, R. J. Gutiérrez, J. M. Marzluff, and L. Sztukowski. 2004. Scientific Evaluation of the Status of the Northern Spotted Owl. Sustainable Ecosystem Institute. Portland, OR. Pp 1–508.

Crocker, T., S. B. Kask, and J. F. Shogren. 1998. Valuing ecosystems as natural insurance. http.//uwacadweb.edu/Shogren/jaysho/ecosystem.pdf

Crouse, D. T., L. A. Mehrhoff, M. J. Parkin, D. R. Elam, and L. Y.Chen. 2002. Endangered Species Recovery and the SCB Study: A U.S. Fish and Wildlife Service Perspective. *Ecological Applications* 12(3):719-723.

Czech, B, P. R. Krausman, and R. Borkhataria. 1998. Social Construction, Political Power, and the Allocation of Benefits to Endangered Species. *Conservation Biology*, 12(5):1103-1112.

Dale, V.H. and Beyeler, S.C. 2001. Challenges in the development and use of ecological indicators. *Ecologocial Indicators* 1: 3−10.

Davis, F., D. Gobel and J. M. Scott. 2006. Renewing the Conservation Commitment. Pp 296-306 in *The Endangered Species Act at Thirty Vol. 1.,* eds. D. Goble, J. M. Scott and F. W. Davis New York: Island Press

Dayton, P.K. 2003. The Importance of Natural Sciences to Conservation. *The American Naturalist* 162(1):1–13.

Deitz, T. 2005. What Should We Do? Human Ecology and Collective Decision Making. Pp. 316-326 in *The Earthscan Reader in Environmental Values,* eds. L. Kalof and T. Satterfield. Sterling, VA: Earthscan.

Deitz, T and P. Stern (eds). 2008. *Public Participation in Environmental Assessment and Decision Making* in *National Research Council*. National Academic Press. http://www.nap.edu/catalog/12434.html [accessed 23 September 2008].

Defenders of Wildlife. 2008. http://www.defenders.org/programs_and_policy/wildlife_conservation/imperiled_species/florida_panther/background_and_recovery/

DeShazo, J.R. and J. Freeman. 2006. “Congressional Politics.” Pp.68-74 in *The Endangered Species Act at Thirty*, eds. by D. D. Goble, M. Scott and Frank W. Davis. Washington, D.C.: Island Press.

Dickson, J.D. III. 1955. An Ecological Study of the Key Deer. Tech. Bull. 3. Florida Game and Freshwater Fish Comm. Tallahassee. 104pp.

Dobson, A.P., Rodriguez, J.P., Roberts, W.M., and Wilcove, D.S. 1997. Geographic distribution of endangered species in the United States. *Science* 275: 550−553.

Doremus, H.. 2006a. Lessons Learned. Pp.195-207 in *The Endangered Species Act at Thirty Vol.1*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington, D. C.: Island Press.

Doremus, H. 2006b. Science and Controversy. Pp.97-103 in *The Endangered Species Act at Thirty Vol.2*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington, D.C.: Island Press.

Durbrow, B.R., N.B. Burns, J.R. Richardson, and C.W. Berish. 2001. Southeastern Ecological Framework: A planning tool for managing ecosystem integrity. In: Hatcher, K.J., ed. Proceedings of the 2001 Georgia Water Resources Conference. Athens, GA: University of Georgia.

Ellner, S.P., J. Fieberg, D. Ludwig, and C. Wilcox. 2002. Precision of Population Viability Analysis. *Conservation Biology* 16(1):258–261.

Ely, M. A. 2004. Applying Information Technology To Decision-Making: The EPA GeoBook Applied to Greenway Planning. Masters Thesis. University of Tennessee at Knoxville.

Endter-Wada, J., D. Blahna, R. Krannich, and M. Brunson. 1998. A Framework for Understanding Social Science Contributions to Ecosystem Management. *Ecological Applications* 8(3):891-904.

Erlich, P. and A. Erlich. 1996. Of science and reason: How anti-environmental rhetoric threatens our future. Washington D. C.: Island Press.

Ernest, S.K.M. and Brown, J.H. 2001. Delayed compensation for missing keystone species by colonization. *Science* 292: 101−104.

Failing, L. and Gregory, R. 2003. Ten common mistakes in designing biodiversity indicators for forest policy. *Journal of Environmental Management* 68: 121−132.

Flather, C.H., M. S. Knowles, I. A. Kendall. 1998. Threatened and Endangered Species Geography: Characteristics of Hot Spots in the Conterminous United States. *Bioscience* 48(5): 365–376.

Florida Fish and Wildlife Conservation Commission, U.S. Fish and Wildife Service, and National Park Service. 2007. Interagency Florida panther response plan. U.S. Fish and Wildife Service, Atlanta, GA.

Gavin, D.G., Hallett, D.J., Hu, F.S., Lertzman, K.P., Prichard, S.J., Brown, K.J., Lynch, J.A., Bartlein, P., and Peterson, D.L. 2007. Forest fire and climate change in western North America: insights from sediment charcoal records. *Frontiers in Ecology and the Environment* 5(9): 499–506.

Gaston, K.J. 1996. Species-Range-Size Distributions: Patterns, Mechanisms and Implications. *Tree* 11(5):197–201.

Gavin, D.G., D. J. Hallett, F. S. Hu, K. P. Lertzman, S. J. Prichard, K. J. Brown, J. A. Lynch, P. Bartlein, and D. L. Peterson. 2007. Forest Fire and Climate Change in Western North America: Insights from Sediment Charcoal Records. *Frontiers in Ecology and the Environment* 5(9):499–506.

Goble, D. D., M. Scott, and F. Davis. 2006. Conserving Biodiversity in Human-Dominated Landscapes. Pp 290 in *The Endangered Species Act at Thirty Vol. 2.,* eds. J. M. Scott, J. M. Davis and F. W. Davis. Washington D.C.: Island Press

Gerber, R.L. and L, T. Hatch. 2002. Are We Recovering? An Evaluation of Recovery Criteria under the U.S. Endangered Species Act. *Ecological Applications* 12(3): 668–673.

Greene, H.W. 2005. Organisms in Nature as a Central Focus for Biology. *Trends in Ecology and Evolution* 20(1): 23–27.

Greenwald, D. N., F. Kieran, F. Suckling, and M. Taylor. 2006. “The Listing Record.” Pp51-67 in *The Endangered Species Act at Thirty Vol.1*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington, D. C.: Island Press.

Gregory, R., S. Lichtenstein, and P. Slovic. 1993. Valuing Environmental Resources: A Constructive Approach. *Journal of Risk and Uncertainty* 7(2): 177-197.

Gregory, R. and R. L. Keeney. 1994. Creating Policy Alternatives Using Stakeholder Values. *Management Science* 40(8):1035-1048.

Guffy, S., G. McCracken, S. Moore, and C. Parker. 1999. Management of Isolated Populations in *Ecosystem Management for Sustainability: Principles and Practices Illustrated by a Regional Biosphere Reserve Cooperative*, ed. J. D. Peine. New York: CRC Press/Lewis Publishers. Pp 247-266.

Harding, E.K., E. E. Crone, B. D. Elderd, J. M. Hoekstra, A. J. McKerrow, J. D. Perrine, J. Regetz, L. J. Rissler, A. G. Stanley, E. L. Walters, and NCEAS Habitat Conservation Plan Working Group. 2001. The Scientific Foundations of Habitat Conservation Plans: A Quantitative Assessment. *Conservation Biology* 15(2):488–500.

Harvey, E., J. M. Hoekstra, R. J. O'Connor, and W. F. Fagan. 2002. Recovery Plan Revisions: Progress or Due Process? *Ecological Applications* 12(3):682-689.

Hatch, L., M. Uriarte, D. Fink, L. Aldrich-Wolfe, R. G. Allen, C. Webb, K. Zamudio, and A. Power. Jurisdiction over Endangered Species' Habitat: The Impacts of People and Property on Recovery Planning. *Ecological Applications* 12(3):690-700.

Hatcher, C., F.T. vanManan, J. D. Clark. 2008. Estimating Effects of Land Use Change on Florida Panther Habitat. unpublished report. The University of Tennessee at Knoxville.

Heyerdahl, E.K. and V. Card. 2000. Implications of Paleorecords for Ecosystem Management. *Trends in Ecology and Evolution* 15(2):49–50.

Heywood, V.H. and Iriondo, J.M. 2003. Plant conservation: old problems, new perspectives. *Biological Conservation* 113: 321−335.

Hoekstra, J. M., J. A. Clark, W. F. Fagan, and P. D. Boersma. 2002a. A Comprehensive Review of Endangered Species Act Recovery Plans. *Ecological Applications* 12(3):630–640.

Hoekstra, J. M., W. F. Fagan, and J. E. Bradley. 2002b. A Critical Role for Critical Habitat in the Recovery Planning Process? Not Yet. *Ecological Society of America* 12(3):701-707.

Hoffman, J. P. 2004. Social and Environmental Influences on Endangered Species: A Cross-National Study. *Sociological Perspectives* 47(1):79-107.

Holl, K. D. and R. B. Howarth. 2000. Paying for Restoration. *Restoration Ecology* 8:3. 260-267.

Holt, R.D. 2003. On the Evolutionary Ecology of Species' Ranges. *Evolutionary Ecology Research* 5:159–178.

Horn, S.P. 1998. Fire Management and Natural Landscapes in the Chirripó Páramo, Chirripó National Park, Costa Rica, Pp 125–146 in eds. K. Zimmerer and K. Young, *From Nature's Geography. Biogeographical Landscapes and Conservation in Developing Countries.* Madison, Wisconsin: University of Wisconsin Press.

Horn, S.P. 1993. Postglacial Vegetation and Fire History in the Chirripó Páramo of Costa Rica. *Quaternary Research* 40: 107–116.

Hughey, K. F. D., R. Cullen, and E. Moran. 2003. Integrating Economics into Priority Setting and Evaluation in Conservation Management. *Conservation Biology* 17(1):93-103.

Hunter, L.M., J. Beal, and T. Dickinson. 2003. Integrating Demographic and GAP Analysis, Biodiversity Data: Useful Insights? *Human Dimensions of Wildlife* 8:145–157.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007 Synthesis Report, Pg. 48. Adopted section by section at IPCC Plenary XXVII. 12-17 November 2007. Valencia, Spain.

Intergovernmental Panel on Climate Change (IPPC). 2007. Climate change2007: impacts, adaptation, and vulnerability. Summary for policymakers. www.ipcc.ch/. Viewed 10 Nov 2009.

Janzen, D.H. and P. S. Martin. 1982. Neotropical Anachronisms: The Fruits the Gomphotheres Ate. *Science* 215(4528):19–27.

Johnson, R. L., C. S. Swanson, and A. J. Douglas. 2007. Economic Considerations in *Conservation of Rare or Little Known Species*, eds. M. G. Raphael and R. Molina. New York: Island Press.

Johnson, J. D and R. Rasker. 1995. The Role of Economic and Quality of Life Values in Rural Business Location. *Journal of Rural Studies* 11(4):405-416.

Kareiv, P., T.H. Tear, S. Solie, M.L. Brown, L. Sotomayor, and C. Yuan-Farrell. 2006. Nongovernmental Organizations. Pp.176-191 in *The Endangered Species Act at Thirty Vol.1*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Kellert, S. 1997. *The Value of Life: Biological Diversity and Human Society.* Washington D. C.: Island Press.

Kellert, S. 2005. The Biological Basis for Human Values of Nature. Pp.131-150 in *The Earthscan Reader in Environmental Values,* eds. L. Kaylof and T. Satterfield. Sterling VA: Earthscan

King, P.B. 1937. Notes on the distribution of native speckled trout in the streams of Great Smoky Mountain National Park. *J. Tenn. Acad.* 12:351-36.

King, D. M. and M. J. Mazzotta. 2000. Ecosystem Valuation." US Department of Agriculture Natural Resources Conservation Service and National Oceanographic and Atmospheric Administration. http://www.ecosystemvaluation.org [accessed 1 August 2008].

Knight, T.M., M. W. McCoy, J. M. Chase,, K. A. McCoy, and R. D. Holt. 2005. Trophic Cascades Across Ecosystems. *Nature* 437:880–883.

Kohlmann, S.G., Schmidt, G.A., and Garcelon, D.K. 2005. *Ecological Modelling* 183: 77–94.

Kopp, R., J, Alan J. Krupnick, and M. Toman. 1997. Resources for the Future. http://www-sekon.slu.se/~bkr/introtillCBA.pdf. [accessed 25 July 2008]

Krippendorff, K. 1980. *Content analysis: An introduction to its methodology* – second addition. London: Sage Publications.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change: Synthesis Report, IPCC Fourth Assessment Report. http://www.ipcc.ch/ipccreports/ar4-syr.htm [accessed 5 February 2009].

Lafon, C.W., J. A. Hoss, and H. D. Grissino-Mayer. 2005. The Contemporary Fire Regime of the Central Appalachian Mountains and its Relation to Climate. *Physical Geography* 26(2):126–146.

Land Trust Alliance. 1999. Voters Invest in Parks and Open Space, 1998 Referenda Results.

Landres, P.B., Verner, J., and Thomas, J.W. 1988. Ecological use of vertebrate indicator species: a critique. *Conservation Biology* 2: 316−328.

Lang, J.D., L. A. Powell, D. G. Krementz, and M. J. Conroy. 2002. Wood Thrush Movements and Habitat Use: Effects of Forest Management for Red-Cockaded Woodpeckers. *The Auk* 119(1):109–124.

Lawler, J. J., S. P. Campbell, A. D. Guerry, M. B. Kolozsvary, R. J. O'Connor, and L. C. Seward. 2002. The Scope and Treatment of Threats in Endangered Species Recovery Plans. *Ecological Applications*, 12(3):663-667.

Lawler, J.J., White, D., Sifneos, J.C., and Master, L.L. 2003. Rare species and the use of indicator groups for conservation planning. *Conservation Biology* 17(3): 875−882.

Lennon. R. E.. 1967. Brook trout of Great Smoky Mountains National Park. U.S. Fish and Wildlife Technical Paper 15. Department of the Interior, Washington, D.C.

Lindenmayer, D.B., J. Fischer, A. Felton, R. Montague-Drake, A. D. Manning, D. Simberloff, K. Youngentob, D. Saunders, D. Wilson, A. M. Felton, C. L. Blackmore, A. Lowe, S. Bond, N. Munro, and C. P. Elliott. 2007. The Complementarity of Single-Species and Ecosystem-Oriented Research in Conservation Research. *Oikos* 116:1220–1226.

Lindsay, M.M. and S. P. Bratton. 1979a. The Vegetation of Grassy Balds and other High Elevation Disturbed Areas in the Great Smoky Mountains National Park. *Bulletin of the Torrey Botanical Club* 106(4):264–275.

Lindsay, M.M. and S. P. Bratton. 1979b. Grassy Balds of the Great Smoky Mountains: Their History and Flora in Relation to Potential Management. *Environmental Management* 3(5):417–430.

Lindsay, M.M. and S. P. Bratton. 1980. The Rate of Woody Plant Invasion on Two Grassy Balds. *Castanea* 45(2):75–87.

Lopez, R.R. 2001. Population Ecology of Florida Key Deer.Dissertation. Department of Wildlife and Fisheries Sciences. PhD Dissertation, Texas A&M University, College Station, Texas, USA.

Lindenmayer, D.B., Margules, C.R., and Botkin, D.B. 2000. Indicators of Biodiversity for Ecologically Sustainable Forest Manager. *Conservation Biology* 14(4): 941−950.

Lundquist, C. J., J. M. Diehl, E. Harvey, and L. W. Botsford. 2002. Factors Affecting Implementation of Recovery Plans. *Ecological Applications* 12(3):713-718.

MacDonald, G. 2003. Evolution, Speciation, and Extinction. Pg 264 in *Biogeography Space, Time and life,* eds. R. Flahive, P. McFadden, J. Macmillan, and S. Rigby.. New York: John Wiley & Sons, Inc.

MacDonald, G.M. 2003. *Biogeography: Space, Time and Life*. John Wiley & Sons, Inc., NewYork, NewYork.

Macmillan, D. C., D. Harley, and R. Morrison. 1998. Cost-effectiveness analysis of woodland ecosystem restoration. *Ecological Economics*. 27:313-324.

Male, T.D. and M. J. Bean. 2005. Measuring Progress in US Endangered Species Conservation. *Ecology Letters* 8:986–992.

Marcot, B.G. and Flather, C.H. 2007. Species-level strategies for conserving rare or little-known species. In: Raphael, M.G. and Molina, R. (Eds.), *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.* Island Press, Washington, DC, USA, pp. 125–164.

Marcot, B.G. and Seig, C.H. 2007. Systems-level strategies for conserving rare or little-known species. In: Raphael, M.G. and Molina, R. (Eds.), *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.* Island Press, Washington, DC, USA, pp. 165–186.

Marcot, B.G. and Seig, C.H. 2007. Systems-level strategies for conserving rare or little-known species. In: Raphael, M.G. and Molina, R. (Eds.), *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.* Island Press, Washington, DC, USA, pp. 165–186.

Margules, C.R. and R. L. Pressey. 2000. Systematic conservation planning. *Nature* 405: 243-253.

McConnell, C. R. and S. L. Brue. 2005. *Economics: Principles, Problems, and Policies*. Boston: McGraw-Hill.

Main, M. B., M. R. Roka, and R. F. Noss. 1999. Evaluating Costs of Conservation. *Conservation in Practice*. 13(6):1262-1272.

Male, T.D. and M. J. Bean. 2005. Measuring Progress in U.S. Endangered Species Conservation. *Ecology Letters* 8:986–992.

Manning, A.D., Fischer, J., and Lindenmayer, D.B. 2006. Scattered trees as keystone structures – implications for conservation. *Biological Conservation* 132: 311−321.

Marcot, B. G. and R. Molina. 2007. Special Considerations for the Science, Conservation, and Management of Rare or Little Known Species, in. *Conservation of Rare and Little Known species: Biological, Social and Economic Considerations,* eds. M. Raphael and R. Molina. New York: Island Press.

Marcot, B. and C. Sieg. 2007. System-Level Strategies for Conserving Rare and L:ittle-Known Species in *Conservation of Rare and Little Known species: Biological,* *Social and Economic Considerations,* eds. M. Raphael and R. Molina. New York: Island Press.

Margules, C.R. and R. L. Pressey. 2000. Systematic conservation planning. *Nature* 405: 243-253.

McCracken, G.F., C. R. Parker, and S.Z. Guffy. 1993. Genetic differentiation and hybridization between stocked hatchery and native brook trout in Great Smoky Mountains National Park. *Trans, Am. Fish. Soc.*122:533-542.

Miller, M. 2003. Three Decades of Recovery. in *Endangered Species Bulletin,* Vol. XXVIII No. 4. United States Fish and Wildlife Service Endangered Species Program. [This article is available via the internet at http://www.fws.gov/endangered/bulletin/ 2003/07-12/04-05.pdf [accessed on 10 June 2008)].

Moritz, C. 2002. Strategies to protectect biological diversity and the evolutionary processes that sustain it. *Systematic Biology* 51(2): 238−254.

National Ecological Assessment Team (NEAT). 2006. Strategic Habitat Conservation: Final Report of the National Assessment Team. USGS-USFWS. July 2006 http://www.fws.gov/SOUTHWEST/About%20Us/PDFs/SHC%20NEAT_Final_Rpt.pdf

National Marine Fisheries Service (NMFS). 2008. Draft Biological Opinion: Environmental Protection Agency Registration of Pesticides Containing Chlorpyrifos, Diazinon, Malathion. http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biological_opinion_draft.pdf [accessed 25 August 2008].

National Park Service (NPS). 2008. Park Fish Restoration Efforts. http://mms.nps.gov/shen/ncr/docs/factsheets/SHEN_NR_014_Trout_Genetics.pdf [accessed on 8 December 2008].

National Park Service (NPS). 1990. Yellowstone Wolf

Newburn, D., S. Reed, and P. Berck. 2005. Economics and Land Use Change in Prioritizing Private Land Conservation. *Conservation Biology* 19(5):1411-1420.

Nolt, J. and J. Peine. 1999. The Evolution of Land Use Ethics and Resource Management. Pg 41-62 in *Ecosystem Management for Sustainability: Principles and Practices Illustrated by a Regional Biosphere Reserve Cooperative*, ed. J. Peine. New York: CRC Press/Lewis Publishers.

Norwak, R. M. 1992. The red wolf is not a hybrid. *Conserv. Biol.* 6:593-595.

Obioh, G.I.B. and Isichei, A.O. 2007. A population viability analysis of serendipity berry (*Dioscoreophyllum cumminisii*) in a semi-deciduous forest in Nigeria. *Ecological Modelling* 201: 558–562.

Paine, R.T. 1969. A Note on Trophic Complexity and Community Complexity. *The American Naturalist* 103(929):91–93.

Paine, R.T. 1995. A Conservation on Refining the Concept of Keystone Species. *Conservation Biology* 9(4):962–964.

Palmer, M.A., R. F. Ambrose, and N. L. Poff. 1997. Ecological Theory and Community Restoration Ecology. *Restoration Ecology* 5(4):291–300.

Parkhurst, G. M. and J. F. Shogren. 2006. Incentive Mechanisms. Pp.247-58 in *The Endangered Species Act at Thirty Vol.1*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Patlis, J. M. 2001. Paying Tribute to Joseph Heller with the Endangered Species Act: When Critical Habitat Isn't. *Stanford Environmental Law Journal.* 133-217

Public Employees for Environmental Responsibility (PEER). 2009. Lame Duck Soup. Winter 2009 PEER Newsletter. hppt://peer.org

Peine, J. D. 2007. Chapter 9: Social Considerations. Pg. 236-721 in *Conservation of Rare and Little Known species: Biological, Social and Economic Considerations,* eds. M. Raphael and R. Molina. New York: Island Press.

Public Employees for Environmental Responsibility. 2005. "Florida FWS Biologists Ordered to Approve All Development — Panther Called a "Zoo Species"— protecting Wild Habitat Futile". Press Release March 30, 2005. http://www.peer.org/news/news_id.php?row_id=502 [Accessed 16 August 2009]

Peroj, D., Micacchion, M., and Hetherington, T.E. 2004. Core terrestrial habitat for conservation of local populations of salamanders and wood frogs in agricultural landscapes. *Biological Conservation* 120: 399−409.

Perry, S.L., D. P. DeMaster, and G. K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. *Marine Fisheries Review* 61(1):1–30.

Peterson, M. N., S. A. Allison, M. J. Peterson, and R. L. Roel. 2004. A tale of two species: Habitat conservation plans as bounded conflict. *Journal of Wildlife Management* 68:743-61.

Pimm, S.L., G. J. Russell, J. L. Gittleman, and T. M. Brooks. 1995. The Future of Biodiversity. *Science* 269:347–350.

Plottu, E. and B. Plottu. 2007. The concept of Total Economic Value of environment: A reconsideration within a hierarchical rationality. *Ecological Economics*. 61(1):52-61.

Public Participation Toolbox. 2008. http://www.iap2.org/associations/4748/files/toolbox.pdf [accessed 23 September 2008].

Rachlinski, J. J. 1997. Noah by the Numbers: An Empirical Evaluation of the Endangered Species Act. *Cornell Law Review* 82:356-89.

Randall, A. and M.C. Farmer. 1995. Benefits, Costs, and the Safe Minimum Standard of Conservation. Pp. 26-44 in *The Handbook of Environmental Economics*, ed. D. Bromley. Oxford: Blackwell.

Randall, A. and J. Stall. 1983. Existence Value in a Total Valuation Framework. in *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*, eds. R. Rowe and L. Chestnut. Boulder, CO: Westview Press.

Raphael, M. G., R. L. Johnson, J. D. Peine and C. S. Swanson. 2007. Conservation Goals and Objectives. Pg. 17-39 in *Conservation of Rare or Little Known Species*, eds. M. Raphael and R. Molina. New York: Island Press.

Raphael, M.G., Johnson, R.L., Peine, J.D., and Swanson, C.S. 2007a. Conservation goals and objectives. In: Raphael, M.G. and Molina, R. (Eds.), *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.* Island Press, Washington, DC, USA, pp. 17–39.

Raphael, M.G., Molina R., Flather, C.H., Holthausen, R.S., Johnson, R.L., Marcot, B.G., Olson, D.H., Peine, J.D., Sieg, C.H., and Swanson, C.S. 2007b. A process for selection and implementation of conservation approaches. In: Raphael, M.G. and Molina, R. (Eds.), *Conservation of Rare or Little-Known Species: Biological, Social, and Economic Considerations.* Island Press, Washington, DC, USA, pp. 334–362.

Restani M. and J. M. Marzluff. 2002. Funding Extinction? Biological Needs and Political Realities in the Allocation of Resources to Endangered Species Recovery. *Bioscience* 52(2):169-77

Rice, K.J. and Emery, N.C. 2003. Managing microevolution: restoration in the face of global change. *Frontiers in Ecology and the Environment* 1(9): 469–478.

Robertson, Morgan M. 2004. The neoliberalization of ecosystem services: wetland mitigation banking and problems in environmental governance. *Geoforum* 35:361-73.

Rohlf, D. J. 1991. Six Reasons Why the Endangered Species Act Doesn't Work – And What to Do About It. *Conservation Biology* 5(3):273-282.

Ronney, T.P. 2001. Deer Impacts on Forest Ecosystems: a North American Perspective. *Forestry* 74(3):201–208.

Rooney, T.P. and Waller, D.M. 2003. Direct and Indirect Effects of White-Tailed Deer in Forest Ecosystem. *Forest Ecology and Management* 181:165−176.

Rubin, J., G. Helfand, and J. Loomis. 1991. A Benefit-Cost Analysis of the Northern Spotted Owl. *Journal of Forestry*.89(12):25-30.

Rubin, J., G. Helfand, and J. Loomis. 1991. A Benefit-Cost Analysis of the Northern Spotted Owl. *Journal of Forestry* 89(12): 25-30.

Ruckelshuas, M. and D. Darm. 2006. Science and Implementation. Pp.127-49 in *The Endangered Species Act at Thirty Vol.2,*. eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Ruhl, J.B. 2004. Endangered Species Act Innovations in the Post Babbit Era--Are there any? *Duke Environmental Law and Policy Forum* 14(2):419-39.

Sachs, J.L., U. G. Mueller, T. P. Wilcox, and J. J. Bull. 2004. The Evolution of Cooperation. *The Quarterly Review of Biology* 79(2): 135–160.

Sanford Jr., R.L. and S. P. Horn, S.P. 2000. Holocene Rain-Forest Wilderness: A Neotropical Perspective on Humans as an Exotic, Invasive Species. Pp.168-173 in *Wilderness Science in a Time of Change Volume 3: Wilderness as a Place for Scientific Inquiry*, eds. S. F. McCool et al U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station, Ogden, Utah.

Schafale, M.P. and A. S. Weakley. 1990. Classification of the Natural Communities of North Carolina. Third Approximation. NC Natural Heritage Program, Division of Parks and Recreation, Raleigh, NC.

Schlarbaum, S., R. Anderson, and F. Thompson Campell. 199. Control of Pests and Pathogens Pg 291-306, in in *Ecosystem Management for Sustainability: Principles and Practices Illustrated by a Regional Biosphere Reserve Cooperative*, ed. J. Peine. New York: CRC Press/Lewis Publishers.

Scott, J. M., D. D. Goble, L. K. Swancara and A. Pidgorna. 2006. Introduction. Pp.3-15 in *The Endangered Species Act at Thirty Vol.1*., eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Shaffer, M. 1981. Minimum Population Sizes for Species Conservation. *Bioscience* 31(2):131–134.

Shelden, K.E.W., D. P. DeMaster, D. J. Rugh, and A. M. Olson. 2001. Developing Classification Criteria Under the U.S. Endangered Species Act: Bowhead Whales as a Case Study. *Conservation Biology* 15(5):1300–1307.

Schultz, C. and L. R. Gerber. 2002. Are Recovery Plans Improving with Practice? *Ecological Applications* 12(3):641-647.

Shelden, K.E.W., D. P. DeMaster, D. J. Rugh, and A. M. Olson. 2001. Developing Classification Criteria Under the U.S. Endangered Species Act: Bowhead Whales as a Case Study. *Conservation Biology* 15(5):1300–1307.

Shilling, F. 1997. Do Habitat Conservation Plans Protect Endangered Species? *Science* 276(5319):1662-1663.

Shogren, J. F., J. Tschirhart, T. Anderson, A. Whritenour-Ando, S. R. Beissinger, D. Brookshire, G. M. Brown Jr., D. Coursey, R. Innes, S. M. Meyer, and S. Polasky. 1999. Why Economics Matter for Endangered Species Protection. *Conservation Biology* 13(6):1257-1261.

Shrogen, J. F., G. M. Parkhurst, and C. Settle. 2003. Integrating economics and ecology to protect nature on private lands: models, methods, and mindsets. *Elsevier Science Ltd*. 6. 233-242.

Simberloff, D. 1998. Flagships, Umbrella, and Keystones: In Single-Species Management Passé in the Landscape Era. *Biological Conservation* 83(3):247–257.

Smith, W.P., Gende, S.M., and Nichols, J.V. 2005. The Northern Flying Squirrel as an Indicator Species of Temperate Rain Forest: Test of an Hypothesis. *Ecological Applications* 5(2): 689−700.

Soulé, M.E., J. A. Estes, B. Miller, and D. L. Honnold. 2005. Stongly Interacting Species: Conservation Policy, Management, and Ethics. *Bioscience* 55(2):168–176.

Speth, J. G. 2008. *Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability.* New Haven: Yale University Press.

Strittholt, J.R. and R. E. J. Boerner. 1995. Applying Biodiversity Gap Analysis in a Regional Nature Reserve Design for the Edge of Appalachia, Ohio (U.S.A.). *Conservation Biology* 9(5):1492–1505.

Suckling, K. F. and M. Taylor. 2006. Critical Habitat and Recovery. Pp.75-89 in *The Endangered Species Act at Thirty Vol.1*. eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Susskind, L., S. McKearnan, and J. Thomas-Lamer. 2000. *The consensus building handbook: A comprehensive guide to reaching agreement.* Thousand Oaks, CE: Sage.

Suter, W., Graf, R.F., and Hess, R. 2002. Capercaillie (*Tetrao urogallus*) and avian biodiversity: testing the umbrella-species concept. *Consrvation Biology* 16(3): 778–788.

Swetnam, T.W., C. D. Allen, J. L. Betancourt. 1999. Applied Historical Ecology: Using the Past to Manage for the Future. *Ecological Applications* 9(4):1189–1206.

Taylor, M.F.J., K. F. Suckling, and J. J. Rachlinski. 2005. The Effectiveness of the Endangered Species Act: A Quantitative Analysis. *Bioscience* 55(4):360–368.

Taylor, M.F.J., K. F. Suckling, and J. J. Rachlinski. 2003. Critical Habitat Significantly Enhances Species Recovery: Analysis of the Three Most Recent U.S. Fish and Wildlife Biennial Reports to Congress on the Recovery of Threatened and Endangered Species. Tucson, Ariz.: Center for Biological Diversity.

Tear, T.H., J.M. Scott, P.H. Hayward, and B. Griffith. 1993. Status and prospects for success of the Endangered Species Act: A look at recovery plans. *Science* 262: 976–977.

Thatcher, C., F.T. vanManan, and J. D. Clark. 2008. Estimating Effects of Land Use Change on Florida Panther Habitat. unpublished report. The University of Tennessee at Knoxville.

The Nature Conservancy (TNC). 2008. Edge of Appalachia Preserve. The Nature Conservancy. http://www.nature.org/wherewework/northamerica/states/ohio/preserves/art145.html [accessed 27 June 2008].

Thompson, B. H. 2006. Managing the Working Landscape. Pp.101-26 in *The Endangered Species Act at Thirty Vol.1*., eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press.

Tracy, R. and Brussard, P.F. 1994. Preserving biodiversity: species in landscapes. *Ecological Applications* 4(2): 206–207.

Turner, J.C., C. L. Douglas, C. R. Hallum, P. R. Krausman, and R. R. Ramey. 2004. Determination of Critical Habitat for the Endangered Nelson's Bighorn Sheep in Southern California. *Wildlife Society Bulletin* 32(2):427–448.

UCS (Union of Concerned Scientists). 2008. New Endangered Species Act Rules Leave Science Behind. http://www.ucsusa.org/assets/documents/scientific_integrity/ESA-Fact-Sheet-2008.pdf [accessed 25 August 2008].

Union of Concerned Scientists. 2005. "Survey: US Fish and Wildlife Service Survey Summary." http://www.ucsusa.org/assets/documents/scientific_integrity/fws_survey_summary_1.pdf [Accessed 16 August 2009]

United Nations Environment Programme (UNEP). 1995. *Global Biodiversity Assessment*. Cambridge, Cambridge University Press.

U.S. Code. (U.S.C.) 2006*a*. 16 U.S.C., section 1531.

U.S. Code. (U.S.C.) 2006*b*. 16 U.S.C., section 1532.

U.S. Code. (U.S.C.) 2006*c*. 16 U.S.C., section 1533.

U.S. Code. (U.S.C.) 2006*d*. 16 U.S.C., section 1534.

USDA Forest Service. 2004. Land and Resource Management Plan. USDA Management Bulletin R8-M8 115b: USDA Forest Service, Jefferson National Forest, VA. 396 pp.

U.S. Environmental Protection Agency (EPA). 2002. Carr, M.H., T.D. Hoctor, C. Goodison, P.D. Zwick, J. Green, P.Hernandez, C. McCain, J. Teisinger, and K. Whitney. 2002. Final report:Southeastern Ecological Framework. Region 4. Atlanta, GA: U.S.Environmental Protection Agency. http://geoplan.ufl.edu/epa/download/sef_report.pdf [accessed 22 March 2008]

U.S. Department of Transportation (TDOT). 2002. Memorandum to the Federal Highway Administration February 20, 2002 http://www.fhwa.dot.gov/environment/esaguide.html [accessed 16 November 2008]

U.S. Fish and Wildlife Service (USFWS). 2008a. Five-Year Reviews for Federally Listed Species. United States Fish and Wildlife Service Southeast Region. http://www.fws.gov/ southeast/5yearReviews/ [accessed on 11 July 2008].

U.S. Fish and Wildlife Service (USFWS). 2008b. United States Fish and Wildlife Service Endangered Species Program. http://www.fws.gov/Endangered/ wildlife.html #Species [accessed on 25 June 2008].

U.S. Fish and Wildlife Service (USFWS). 2008c. General Statistics for Endangered Species. http://ecos.fws.gov/tess_public/TessStatReport [accessed on 25 June 2008].

U.S. Fish and Wildlife Service (USFWS). 2008d. Habitat Conservation Plans: Section 10 of the Endangered Species Act. http://www.fws.gov/endangered/pdfs/HCP/HCP_Incidental_Take.pdf [accessed on 23 July 2008]

U.S. Fish and Wildlife Service (USFWS). 2008e. The Changing Face of HCPs. http://www.fws.gov/endangered/bulletin/2000/07-08/04-07.pdf [accessed on 23 July 2008].

U.S. Fish and Wildlife Service (USFWS). 2008f. Candidate Conservation Agreements with Assurances for Non-federal Property Owners. http://www.fws.gov/endangered/factsheets/CCAAsNon-Federal.pdf [accessed on 23 July 2008].

U.S. Fish and Wildlife Service (USFWS). 2008g. Safe Harbor Agreements for Private Land Owners. http://www.fws.gov/endangered/factsheets/harborqa.pdf [accessed on 23 July 2008].

U.S. Fish and Wildlife Service (USFWS). 2008h. Endangered and Threatened Wildlife and Plants; Recovery Crediting Guidance. http://www.fws.gov/endangered/policy/june.2008.html [accessed on 8 August 2008].

U.S. Fish and Wildlife Service USFWS). 2006. *Report to Congress on the Recovery of Threatened and Endangered Species Fiscal Years 2005–2006*. United States Fish and Wildlife Service Endangered Species Program. http://www.fws.gov/endangered/ recovery/index.html [accessed on 10 June 2008].

U.S. Fish and Wildlife Service (USFWS). 2005. Habitat Conservation Plans: *Working Together for Endangered Species*. United States Fish and Wildlife Service Endangered Species Program. http://www.fws.gov/endangered/hcp/index.html [accessed on 3 June 2008].

U.S. Fish and Wildlife Service (USFWS) RFP (U.S. Fish and Wildlife Service Request for Proposal). 2007.

US Fish and Wildlife Service and USDA Forest Service (USFWS & USFS). No date. Roan US Fish and Wildlife Service and USDA Forest Service. No date. Roan Mountain Ecological Jewel of the Appalachian Highlands PowerPoint Presentation.

.

U.S. Geological Survey (USGS). 2008. http://www.npwrc.usgs.gov/resource/wildlife/recoprog/states/species/feliconc.htm

Walpole, M.J. and Leader-Williams, N. 2002. Tourism and flagship species in conservation. *Biodiversity and Conservation* 11: 543−547.

Weigl, P.D. and Knowles, T.W. 1995. Megaherbivores and Southern Appalachian Grass Balds. *Growth and Change* 26(3):365–383.

Wilcove, D.S. 1994. Turning conservation goals into tangible results: the case of the spotted owl and old-growth forest. In *Large scale ecology and conservation biology:* 313−329. Edwards, P.J., May, R.M., and Webb, N.R. (Eds). Oxford: Blackwell Scientific.

Wilhere, George F. 2002. Adaptive Management in Habitat Conservation Plans. *Conservation Biology* 16(1):20-29.

Willard, D.A. and Holmes, C.W. 1997. Pollen and Geochronological Data from South Florida: Wilkinson Creek Site 2. U.S. Geological Survey Open-File Report 97–35, pp. 1–28.

Willard, D.A., L. M. Weimer, and W. L. Riegel. 2001. Pollen Assemblages as Paleoenvironmental Proxies in the Florida Everglades. *Review of Palaeobotany and Palynology* 113: 213–235.

Willard, D.A. and T. M. Cronin. 2007. Paleoecology and Ecosystem Restoration: Case Studies from Chesapeake Bay and the Florida Everglades. *Frontiers in Ecology and the Environment* 5(9):491–498.

Willis, K.J. and and J. B. Birks. 2006. What is Natural? The Need for a Long-Term Perspective in Biodiversity Conservation. *Science* 314:1261–1265.

Williams, J.W. and S. T. Jackson. 2007. Novel Climates, No-Analog Communities, and Ecological Surprises. *Frontiers in Ecology and the Environment* 5(9):475–482.

Wright, J.P., C. G. Jones, and A. S. Flecker. 2002. An Ecosystem Engineer, The Beaver, Increases Species Richness at the Landscape Scale. *Oecologia* 132:96–101.

Yaffee, S. J. 2006. Collaborative Decision Making. Pp.208-20 in *The Endangered Species Act at Thirty Vol.1.*, eds. D. D. Goble, M. Scott and F. W. Davis. Washington D. C.: Island Press