Desired Future Conditions of Riparian Areas on Southeastern National Forests

by

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(ABSTRACT)

Development of goals (desired future conditions (DFCs)) based on substantial public involvement is critical to the success of ecosystem management on public lands. I evaluated DFCs of riparian areas on national forests in the southern Appalachian mountains and evaluated a process for involving the public in development of DFCs for riparian areas on the Jefferson National Forest. First, I identified the major components, structures, and functions that are essential to riparian health through a literature review. Second, I examined how the key components, structures, and functions identified in the literature review were addressed in the DFCs and standards and guidelines for eight southeastern national forest management plans. In reviewing forest plans, I found a clear shift from emphasizing water quality in older forest plans to a more comprehensive incorporation of the values and functions of riparian areas in more recent plans. Riparian attributes included in DFCs varied widely and disparities between DFCs for forest plans and measurable criteria in the standards and guidelines often occurred.

Finally, I designed, tested, and evaluated a public involvement process that identified public values for use in the development of DFCs for riparian areas on the Jefferson National Forest. I used a combination of alternative dispute resolution techniques and the Analytic Hierarchy Process (AHP), a participatory decision-making tool. I used surveys before and after the riparian meetings to evaluate the effectiveness of the public involvement process. Survey respondents generally were middle-aged, well-educated, high-income males who were long-time residents of the area. Riparian meeting participants indicated that the DFC for riparian areas on the JNF should strongly emphasize water quality and quantity, protection of riparian-dependent species and their habitats, and maintenance of the integrity of the relationship between riparian areas and the surrounding environment. Participants indicated recreational and commodity uses of riparian areas could occur as long as they did not negatively affect the other, more highly valued characteristics of riparian areas. Participants felt that the meetings were fair, that diverse interests were represented, that they had enough information to participate in the process, and that it was a wise use of their time.

GRANT INFORMATION

Coldwater Fisheries Research Unit, USFS
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DEDICATION

This dissertation is dedicated to my grandmother, Elizabeth Milliken Reed, who instilled in me at an early age a strong belief in the power of education.

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CHAPTER 1. DISSERTATION INTRODUCTION

National forest planners face two major problems: integrating ecosystem management into forest plans and incorporating public input into the planning process in a manner that is equitable to all parties involved. Ecosystem management attempts to manage ecological systems through a melding of ecological knowledge, public input and values, and adaptive management (Grumbine 1994; Salwasser 1994; Yaffee 1999). Public involvement has continually been a key component of forest planning but has gained importance as conflicting stakeholders voice their increasing dissatisfaction with the forest planning process.

Ecosystem management places an emphasis on developing objectives for forest planning that describe the desired future conditions (DFCs) of forest resources. The DFCs define the overall characteristics of national forests as well as characteristics specific to management areas identified within national forest plans (USDA 1993; Committee of Scientists 1999). The DFCs strongly influence all other forest planning products, such as standards and guidelines that are used to make on-the-ground management decisions (Committee of Scientists 1999). The DFCs for management areas represent an important tool for resolving disputes between conflicting uses.

In conjunction with increased emphasis on public involvement and ecosystem management, forest managers increasingly recognize the importance of riparian areas to watershed health. Riparian areas occupy a narrow, linear portion of a watershed, yet are essential in protecting water quality, providing habitat for terrestrial and aquatic organisms, and providing recreational, resource, aesthetic and cultural values for humans (Brinson et al. 1981; Gregory et al. 1991; Naiman and Decamps 1997). The varied resources of riparian areas make them potential hot spots for conflict. Therefore, riparian areas represent a good small-scale test for evaluating methods to improve the forest planning process.

Currently, several southeastern national forests are revising forest plans and struggling with implementing ecosystem management and involving the public effectively in the planning process. Incorporating riparian areas into ecosystem management is a challenge in that forests must switch from a traditional approach of managing for one or a few resources (e.g., water quality) to addressing all attributes of riparian areas. Recognition of the key components, structures, and functions that contribute to riparian health is essential for ecosystem management of riparian areas. Identifying public values for riparian areas would provide guidance to planners about the importance of different resource values associated with riparian areas.

Despite legal mandates for public involvement, the national forest planning process is viewed as ineffective in the face of changing public values and uses of national natural resources (Wondolleck 1988). The forest planning process has been criticized for being slow, ineffective, costly, and irrelevant by the time it is completed (Wondolleck 1988; Ellefson 1992). Effective public involvement is critical to implementation of successful forest plans (O'Connell 1982; Wondolleck 1988). The Forest Service would benefit by increasing public participation in the development of forest plans because public values could be incorporated into DFCs in addition to the recommendations of technical experts.

Understanding the impacts of management decisions on riparian areas requires input from a variety of specialists including hydrologists, fisheries and wildlife biologists, economists, silviculturists, and sociologists. Integrating the opinions of a variety of professionals is a time-consuming and cumbersome process. Typically, in the forest planning process, stakeholders are presented with a range of alternatives, developed by technical experts. However, stakeholders often are not involved in the initial stages of outlining DFCs or potential alternatives. This approach reinforces a common criticism of forest planning that public input occurs too late in the process. Incorporating stakeholders earlier in the planning process may help to reduce the legal, political, and jurisdictional battles that frequently accompany planning. Including all parties in decision analysis from the beginning helps to establish trust and open communication between stakeholders and managers (Wondolleck 1988).

Forest planners could accomplish several goals through incorporation of the public values in DFCs for riparian areas. The public would be involved early in the planning process which can increase trust between resource interest groups and forest planners. Forest planners would receive guidance from the public about resource values that need clear management guidelines while interested publics would receive technical information about managing resources. In addition, conflicting resource values in riparian areas would be identified.

This dissertation is arranged around three major themes. The first theme is identification of the components, structures, and functions that are essential to riparian health in the southern Appalachians through a literature review (Chapter 2). The second theme is examination of how southeastern national forests currently manage riparian areas (Chapter 3). Questions that were addressed include: What are the current desired future conditions for riparian areas in southeastern national forests? How well do the standards and guidelines reflect the DFCs for a given forest? How well are the key components, structures, and functions identified in the literature review addressed in management plans? The third theme is identification and prioritization of public values for riparian areas on the Jefferson National Forest, a southern Appalachian forest that is currently revising its forest plan (Chapter 4). A public involvement process for identifying public values for riparian areas on the Jefferson National Forest was developed, tested, and evaluated. A synthesis chapter summarizes the major findings (Chapter 5).

STUDY OBJECTIVES

The specific objectives of this project were to:

1. Review and synthesize literature to identify available knowledge on southern Appalachian riparian areas. Identify the important disturbance processes and the physical, chemical, and biological components that contribute to the diversity and structural complexity of riparian areas in forested southern Appalachian Mountains.

2. Review existing management guidelines for riparian areas in southern Appalachian National Forests. Examine how well ecosystem management concepts are addressed and examine how well standards and guidelines represent the intention of the DFCs for riparian areas.

3. Design, test, and evaluate a decision-making technique for incorporating diverse user groups into the National Forest planning process when determining DFCs for riparian areas.

4. Identify and prioritize public values that should be reflected in the desired future condition of riparian areas on the JNF.

CHAPTER 2. LITERATURE REVIEW OF FORESTED SOUTHERN APPALACHIAN RIPARIAN AREAS

Introduction

In the southeastern United States, much of the federally owned land is concentrated within the Appalachian Mountains, an area with high species diversity, steep and highly variable topography, high hydrologic runoff, and numerous stream channels. Water running off of the southern Appalachians is a major source of drinking water for much of the southeast (Southern Appalachian Man and the Biosphere (SAMAB) 1996b). The quality of riparian habitat plays an important role in maintaining water quality, protecting instream resources, and supporting riparian dependent species (Pringle 2000). Other resource values associated with riparian areas include recreation, food and fiber production, floodplain hydrology, and aesthetics (Meehan et al. 1977; Brinson et al. 1981; Cubbage et al. 1991). The importance of riparian areas has increased the emphasis on riparian area management in recent national forest planning efforts.

Cold, headwater streams represent at least half of the stream types found on national forest lands in the southern Appalachians. Riparian areas have a relatively greater area of influence on smaller streams than on larger streams. Effective management of riparian areas for small headwater streams requires a firm understanding of functional processes, species composition, and structural diversity associated with riparian areas. The intent of this literature review is to identify key structures, processes, and components of headwater streams.

There has been far less research on riparian areas in the southeast than in other areas of the country, such as the Pacific Northwest. The approach in this literature review was to supplement existing information on riparian areas in the southeast with research from upland areas in the southeast or western literature, if applicable. For instance, research conducted on salamander habitat use in upland areas may be transferable to habitat needs in riparian areas. Therefore, when relevant, literature on that topic were included. I reviewed the available literature to identify: 1) how riparian areas are defined and classified, 2) the disturbance processes that are important in riparian areas, 3) the physical, chemical, and biological components that contribute to the diversity and structural complexity of forested southeastern riparian areas, and 4) briefly, the human impacts on riparian areas. This information should aid managers in identifying the functional processes, species composition, and structural diversity associated with riparian areas in the southern Appalachians.

Southern Appalachians

For the purposes of this literature review, the southern Appalachians include portions of Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia (SAMAB 1996c). The Southern Appalachian Mountain region encompasses the Blue Ridge, Ridge and Valley, and Appalachian Plateau physiographic provinces. The Blue Ridge includes elevations ranging from 600-1000 meters while the Ridge and Valley includes elevations ranging from 300-900 meters (Isphording and Fitzpatrick 1992). The southern Appalachians have great species diversity, which is attributed to several factors: 1) high geological complexity, 2) mild climate with warm summers and moderately cool winters, 3) high annual precipitation, resulting in humid, moist conditions and 4) lack of glaciation (SAMAB 1996a; Morse et al. 1997).

Definition of Riparian Areas

Riparian areas, the zones of direct interaction between terrestrial and aquatic environments, help protect instream resources (Gregory et al. 1991; Welsch 1991). The spatial zone of influence of riparian areas extends outwards to the limits of flooding, upwards into the canopy, and longitudinally along the stream (Gregory et al. 1991). Increasingly, riparian areas are appreciated not only for the services they provide (e.g., filtering sediment) but also for their unique combination of biological components, physical structures, and functions. Riparian areas include seeps, streams, rivers, lakes/ponds, beaver ponds, bogs and fens, and ephemeral pools (Pauley et al. 2000). For the purposes of this discussion, the primary focus will be riparian areas associated with small streams (first- to fourth-order, Strahler 1964) in forested areas.

Within the Southern Appalachian Assessment (SAA) area, 65% of riparian areas are forested, with almost 80% of riparian areas occurring on private lands (SAMAB 1996c). The SAA is comprised of 83.8% public lands, 12.2% national forest lands, 2.2% national park lands, 1.5% state owned lands and 0.3% other federal lands. Riparian areas are 97% forested on national forest land, 94% forested in national parks, 84% forested on state lands, and 60% forested on private lands. The riparian area estimates are based on satellite data with 30m resolution on larger watercourses. Most of the second- and third-order streams, nearly all first-order and all intermittent streams were omitted from the SAA river and stream data base for this estimate (SAMAB 1996c).

Disturbance Processes

Riparian areas are extremely dynamic and influenced greatly over time by disturbance and geomorphic processes (Gregory et al. 1991). The southern Appalachians are characterized by high rainfall, mountainous terrain interspersed with valleys, high species diversity, and a history of intensive human use. Disturbance processes that influence riparian areas in the southeast include fires, drought, flooding, wind, gravity, ice storms, insects, disease, and human activities. Many natural disturbances are episodic and occur randomly across the landscape (Swanson 1994). Undisturbed locations act as refuges and provide source material to recolonize disturbed areas. The effect of the disturbance is dependent on the size, length, and intensity of the disturbance (SAMAB 1996c). The influence of human activities will be discussed at the end of this review.

Fire

The influence of fires on the composition, structure, and functioning of many ecosystems within the southern Appalachians is well recognized (Van Lear and Waldrop 1989; Sharitz et al. 1992a; MacCleery 1994; Cole and Landres 1996; Ford et al. 1999). Fires are short-term events that have lasting influence on the vegetation structure and distribution of wildlife (Cole and Landres 1996).

Fires in the Appalachians (Van Lear and Waldrop 1989) are fueled by environmental stressors such as drought, insect infestation, disease outbreaks, windthrow, and global climate change (Rogers 1996). Lightning starts approximately 15% of fires in the SAA area (SAMAB 1996c). Fires started by lightning may be infrequent in the southern Appalachians because of the high annual precipitation (Delcourt and Delcourt 1997), however, drier slopes facing southeast to southwest are more likely to have fires (SAMAB 1996c).

Humans have been purposefully starting fires for eons. Aboriginal inhabitants, including Cherokee, Shawnee, Creek, and Cawtaba Indians, burned forests annually to improve game habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, enhance conditions for berries, and drive game (MacCleery 1994). European settlers continued the practice of using fires to clear the land and hunt for game (Van Lear and Waldrop 1989). In the 1920s, fire suppression policy was put into effect by federal and state agencies (Van Lear and Waldrop 1989). Research in the 1950s highlighted the importance of fires and currently prescribed burns are used to help maintain ecosystems, although the benefits for the hardwood-dominated forests of the Appalachians are less clear (Van Lear and Waldrop 1989).

Pine communities are fire dominated but account for less than 10% of southern Appalachian forests (Ford et al. 1999). Pine communities have experienced declines because of fire suppression policies (Sharitz et al. 1992a), as well as problems with drought and southern pine beetle (*Dendroctonus frontalis*) (Ford et al. 1999). The important question for managing riparian areas is "what role do fires play in riparian areas in the southern Appalachians?" Swanson (1994) suggested that fire may be less important in riparian areas compared with upslope areas because microtopography conditions (soil moisture, coolness of streams) prevent high intensity fires. High intensity, prescribed fires can control fire-intolerant plants such as rhododendron (*Rhododendron maximum* L.) and mountain laurel (*Kalmia latifolia*) (Ford et al. 1999). However, it may be difficult to obtain high-intensity fire conditions in riparian areas because of the microclimate conditions. For example, a prescribed community restoration fire in North Carolina had negligible influence on the understory density and overstory mortality of rhododendron-dominated riparian area, although there were significant effects on the upslope areas (Ford et al. 1999). Baker and Van Lear (1998) speculated that historically, during drought conditions, fire may have killed the tops of the rhododendron and allowed other faster growing woody species to overtop rhododendron.

Fire could have a negative impact on leaf litter, which would be harmful to some amphibians and reptiles (Ford et al. 1999). Ford et al. (1999) found that a community restoration fire of riparian areas and upslope areas on the Nantahala National forest, North Carolina had no significant effect on herpetofauna. However, the burn resulted in negligible changes in the overstory mortality and understory density for midslope and riparian areas.

Flooding and Drought

Wetland plant communities are among those communities most affected by changes in precipitation (SAMAB 1996a). Year-round and abundant (>40" annually) precipitation, combined with localized rain patterns, can result in large variation in rainfall in the southern Appalachians (Hack and Goodlett 1960). Flash floods are normal phenomena in areas of high relief in the southern Appalachians (Hack and Goodlett 1960). Flooding transfers materials downstream, forming floodplains. Flooding also scours the active channel and adjacent areas, which discourages the growth of new vegetation (Gregory et al. 1991). Large floods provide canopy openings, changing the vegetation species composition (Hack and Goodlett 1960).

Drought can reduce the importance of mesic species, increase mortality of some trees, weaken others that are then susceptible to disease and insect infestations (SAMAB 1996c) and increase the incidence of fires (Rogers 1996). Drought conditions can reduce instream flows, which will in turn, influence riparian vegetation.

Gravity

Gravity governed disturbance mechanisms include mass wasting (landslide and mudflows), fluvial processes, and avalanches (Rogers 1996). Material introduced into the stream channel is carried downstream and deposited in lower streams, rivers, and oceans. Episodic disturbances such as landslides can convert bedrock reaches to alluvial reaches (Montgomery et al. 1996). Debris avalanches are episodic events that may have an occurrence rate of once every 100 to 200 years (Hack and Goodlett 1960), yet are an important component of the erosional process. The combination of above-normal antecedent moisture, heavy rainfall, steep slopes, and thin soils induces debris avalanches (Neary and Swift 1987). Debris flows can change the substrate composition, eliminate riparian vegetation, and remove instream and terrestrial biota. Debris avalanches influence long-term erosion rates and formation of some of the more productive forest soils (Neary and Swift 1987). Examples of documented debris avalanches include an intense rainfall in 1949 that resulted in over 100 landslides with an average length of 15 meters along the Little River in Virginia (Hack and Goodlett 1960) and in 1995, a catastrophic debris flow along 1.9 km of Staunton River in Shenandoah National Park, Virginia (Roghair 2000).

Ice Storms

Ice storms commonly cause damage to trees in eastern deciduous forests in North America (Whitney and Johnson 1984, Boerner et al. 1988, Warrillow and Mou 1999, Mou and Warrillow 2000). Excessive weight of ice on tree limbs can result in broken limbs, bent and deformed trees, crown reduction, and toppling of trees (Warrillow and Mou 1999). In the central and southern Appalachians, ice storms influence the distribution and dynamics of local forest vegetation primarily through the creation of canopy gaps (Whitney and Johnson 1984, Mou and Warrillow 2000).

The extent of damage to forests is a function of ice storm severity, topographic features, and forest structure (Mou and Warrillow 2000). Severe ice storms occur in the Appalachian region on average once every 20 years (Whitney and Johnson 1984). Ice storm severity is increased by ice accretion (ice deposition greater than 1 cm radius, or less with wind), high winds, and low temperatures (Boerner et al. 1988). For example, after heavy ice deposition, 60-78% of sampled tree stands in Virginia were severely damaged (Whitney and Johnson 1984). Topographic features such as elevation, aspect, slope, and slope position affect ice damage on trees by modifying tree canopy exposure as well as microclimate, soil, moisture, nutrient, light and temperature conditions (Warrillow and Mou 1999, Mou and Warrillow 2000). For instance, Mou and Warrillow (2000) found that gap size was 7 to 14 times larger on steep slopes than other slopes in southwestern Virginia. In areas with complex topography, such as the Ridge and Valley region, all areas may be exposed to wind and ice damage (Warrillow and Mou 1999).

Forest structure features such as tree species composition and forest condition including density, size structure, and canopy features determine susceptibility to ice damage (Warrillow and Mou 1999, Mou and Warrillow 2000). Tree characteristics such as age, crown geometry, and wood tensile strength influence the damage to individual trees (Boerner et al. 1988, Warrillow and Mou 1999).

Influence of ice storms on riparian areas has not been documented. In the Appalachians, many riparian areas are found in variety of topographic condition, running through steep slopes as well as low gradient areas, thus the influence of ice storms could be highly variable. In some regions, ice storms may contribute coarse woody debris (CWD, diameter $\geq$10cm) to streams as well as modify streamside vegetation structure.

Wind

Winds have the potential to provide CWD to streams, open the canopy surrounding streams, cause short-term changes in the canopy structure, create rooting sites for seedlings from windthrow trees, and introduce sediments to the streams if erosion from landslides occurs (Rogers 1996). Intense windstorms may rapidly destroy healthy vegetation (Rogers 1996). High winds damage larger trees (Sharitz et al. 1992b) and ice-laden trees (SAMAB 1996c). For instance, in a North Carolina stream, Hurricane Hugo doubled the load of CWD, from 76 to 186 pieces per kilometer of stream channel (Dolloff et al. 1994). Some trees such as oaks and pines appear more vulnerable to wind damage, possibly because of wind resistance from foliage and rooting characteristics.

Large-scale episodic events such as storms are a normal process in the southeast, however, the effects tend to be strongest close to the coastline. Hurricanes and tornadoes can strongly influence stand composition and patch dynamics (Sharitz et al. 1992b). Sharitz et al. (1992b) found that Hurricane Hugo (1989) affected invading bottomland or transitional species more than the community dominants, resulting in reduced aquatic community diversity. High winds, combined with soil saturation, caused by heavy precipitation or snowmelt, can increase windthrow and landslides, especially on thin soils (SAMAB 1996c). Hurricanes can affect instream characteristics by changing the ratio and abundance of pools and riffles, changing substrate size, and loading CWD into streams (Dolloff et al. 1994).

Insects and Disease

Riparian areas in the southern Appalachians are influenced by the introduction of some insects, such as the hemlock wooly adelgid (*Adelges tsugae*) and the European gypsy moth (*Lymantria dispar* L.), as well as past influences of diseases such as the chestnut blight (*Cryphonectria parasitica*). Hemlock wooly adelgid is a serious pest of the eastern hemlock (*Tsuga canadensis*), and is currently spreading throughout the southern Appalachians. The eastern hemlock is an important riparian tree that provides shade, contributes nutrients through litterfall, and winter shelter for wildlife (SAMAB 1996b). Mortality of the hemlock usually occurs within 5 years of infestation (SAMAB 1996b).

The chestnut blight removed the American chestnut (*Castanea dentata*) from much of the Appalachians and the East (Spurr and Barnes 1973). Before the blight, chestnuts made up to 25-50% of hardwood stands (SAMAB 1996b). Now the chestnut is only able to grow to shrub height from root sprouts before the top is killed by the blight. Historically, the chestnut was an important riparian species that served as an important source of CWD for streams, as well as providing wildlife habitat and forage and shade for streams (Hedman et al. 1996).

After the demise of the chestnut, oak species became one of predominant replacement species (Smock and MacGregor 1988). Oak species are experiencing decline in response to defoliation by the gypsy moth and a combination of tree age, stress-inducing site factors, root disease (e.g., Armillaria root disease), and opportunistic insect pests (SAMAB 1996c). Gypsy moth defoliation of oak species' spring vegetation introduces further stress. Oak decline is a naturally occurring phenomenon but currently appears to be occurring at a rate higher than normal (SAMAB 1996c). Replacement species for the oak appear to be red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), and other shade-tolerant species (SAMAB 1996c).

Riparian Components and Structures

Physical Components

Geomorphology and Hydrology

Riparian areas are influenced by geomorphic and hydrologic processes such as slope and morphology of the stream; drainage pattern; frequency, magnitude, timing and duration of flooding; sediment transport and deposition; streamflow-groundwater interactions; and the extent and texture of alluvium and adjacent hill-slope soils (Gregory et al. 1991; Kattelmann and Embury 1996; Kondolf et al. 1996; Huggenberger et al. 1998). The diversity of southern Appalachian geology strongly influences the geomorphic processes such as drainage basin shapes, hydrologic regime, slope, and substrate composition. Most of the headwater streams are groundwater fed with relatively stable flows, and originate at elevations greater than 450 meters (Medlin 1999). Southeastern streams can be characterized as having steep gradients with stable banks and boulder-rubble dominated substrates. Although, low-order, headwater streams account for most of stream length within a drainage basin (Beschta and Platts 1986) these streams are typically not measured or accounted for in riparian inventories. For example, only 30 percent of the total length of flowing streams in the upper slopes of the southern Appalachians are represented in the SAA database (SAMAB 1996b).

Stream gradient is the slope of the channel in any given reach and influences the stream width, water depth, and water velocity (Hupp 1982). Small streams in more mountainous areas have higher gradients, narrower channels, more resistant parent rock and thin soils (Hupp 1982). During low flows, water is usually constrained to the active channel, the portion of the stream that undergoes active erosion and deposition (Huggenberger et al. 1998). High annual precipitation results in many smaller streams being perennial (Morse et al. 1997). Adjacent to the active channel is the active floodplain that is inundated periodically (Huggenberger et al. 1998). In small, headwater streams, riparian vegetation will extend to the edge of the active channel. During high flow events, erosion and deposition may reshape the active channel and floodplain (Huggenberger et al. 1998).

Floods in higher gradient stream reaches periodically disturb stream channels and floodplains which, in turn, increases deposition and erosion, creating new locations for vegetation to become established (Hupp 1982). High velocity flows can prevent establishment of woody vegetation in the channel through scouring of seedlings and selects for plants tolerant to flooding conditions. Erosion and deposition of alluvial materials can create new habitats for plant colonization. Riparian forests are more xerophytic (drier, upland) in steeper stream gradients and more mesophytic (wetter, bottomland) in gentler gradient, mature streams (Hupp 1982).

Stream-groundwater interactions help maintain base flows and maintain a high water table (Kondolf et al. 1996; Huggenberger et al. 1998). Permeable sediments allow rapid exchange between stream and groundwaters (Huggenberger et al. 1998). The three types of relationships between groundwater and stream water (losing, gaining, and flow-through) are determined by the hydraulic gradient and permeability of the sediments (Huggenberger et al. 1998). Losing reaches discharge water from the stream into the bank when channel stage is higher than the adjacent water table. Streams recharge water from the adjacent water table when the stream stage is lower than the adjacent water table. Finally, in flow-through systems there is no net gain or loss between the stream and adjacent water table. Fine sediments and biological activity can reduce the permeability of stream substrates and the rate of exchange between stream and groundwater. Flood events can flush fine sediments out of the system (Huggenberger et al. 1998).

Geologic setting also influences the supply of inorganic nutrients available to terrestrial vegetation and streamwater chemistry (Yeakley et al. 1994). Channel morphology, depth and extent of near-stream soil saturation, and timing and duration of rainfall are important geomorphic controls for nutrients (Yeakley et al. 1994).

Coarse Woody Debris

By the early 1900s, much of the timber in the Appalachian Mountains was harvested (Dolloff 1994a). During this period, streams were modified to facilitate extraction and transportation of timber (Maser and Sedell 1994; Dolloff 1994a). Riparian vegetation was cleared, logs were flushed downstream, and roads and railroads were built along or in stream channels. These practices resulted in the removal of CWD, excessive erosion and sedimentation of the stream channel, and rerouting of stream channels (SAMAB 1996b). Removal of CWD would facilitate the erosion of the streambottom down to bedrock (Montgomery et al. 1996). Stream channels that are worn to bedrock could reflect past management activities where instream structures such as CWD were "cleaned out" resulting in loss of alluvium. A deposit of CWD in stream channels produces a step profile that captures material and dissipates stream energy (Bilby 1980; Debano and Heede 1987).

Functions of CWD include routing of sediment and water, dissipating stream energy, creating habitats, retaining organic and inorganic matter, and serving as substrate for in-stream biological activity (Bisson et al. 1987; Maser et al. 1988; Wallace et al. 1996b). In small mountain streams, CWD plays a critical role in slowing down and rerouting water flow, creating habitat for instream organisms, and accumulating food sources. The loading of CWD in streams is influenced by transport power of streams, decay rates of tree species, amount of CWD in the stream, and the amount of CWD added by adjacent stands (Harmon et al. 1986; Bisson et al. 1987; Maser et al. 1988). Hedman et al. (1996) in a study of the Blue Ridge Mountain province of North Carolina found that decay-resistant chestnut and hemlock were the dominant CWD species. Without the carry-over debris from the chestnut and hemlock, debris loading would have been extremely low in mid-successional streams (~50-70 years). Variations in loading across streams were highly variable and influenced by vegetation species assemblage, land-use and disturbance histories, and impacts of chestnut blight (Hedman et al. 1996). Coarse woody debris has more direct influence in headwaters than large rivers (Harmon et al. 1986).

Chemical Components

Water Quality

Riparian vegetation influences water quality by providing shade to help maintain the temperature regime, filtering sediments and uptaking nutrients, and adding plant materials and insects that fall into the stream which provide chemical energy and nitrogen compounds (Lynch et al. 1975; Bormann and Likens 1979; Brown 1980; Martin et al.

1986; Webster et al. 1990; Kattelmann and Embury 1996). Temperature affects recreational use, water supply, and most importantly, biotic processes with streams (Brown 1980; Hornbeck and Kochenderfer 2000). Changes in temperature can affect instream primary and secondary productivity (Kattelmann and Embury 1996; Richards and Hollingsworth 2000). Aquatic organisms have specific temperature tolerances; deviations from required temperatures can affect community structure. For example, in Hubbard Brook watershed, New Hampshire, larval two-lined salamanders (*Eurycea b. bislineata*) were eliminated from a headwater stream after clearcutting of an adjacent watershed increased temperatures and removed organic debris (Burton and Likens 1973).

Riparian vegetation filters sediments and nutrients entering the stream channel (Gregory et al. 1991; Welsch 1991). Riparian areas filter sediment by minimizing overland transport, stabilizing stream channels, and slowing the velocity of overbank flow, which results in deposition of some of the sediments in riparian vegetation (Adams 1989; Gilliam 1994; Rabeni and Smale 1995). Healthy riparian areas have abundant leaf litter and organic horizons that facilitate water infiltration even during high precipitation events, which in turn prevents erosion (Hornbeck and Kochenderfer 2000). Erosion from adjacent lands can result in increased sedimentation and turbidity to the stream. Sediments can smother eggs, food sources, and habitats and directly damage fish, invertebrates, and crayfish (Clark 1985). Sediments can increase turbidity, which negatively affect drinking water quality and recreational experiences such as fishing (Clark 1985). Nutrients attached to sediments can stimulate algae growth, which can, in turn block sunlight. Pesticides and other contaminants can harm instream life. Nutrients within the deposited sediments can be immobilized or assimilated by riparian vegetation (Adams 1989; Gilliam 1994). For instance, Gilliam (1994) estimated that greater than 90% of sediments and nitrate were removed by vegetation. Phosphorus removal is not as efficient as nitrogen removal in riparian vegetation. Gilliam (1994) concluded that riparian vegetation removed phosphorus attached to sediments but not dissolved phosphorus.

The filtering capacity of riparian areas can vary with dominant tree species, flooding frequency, sediment load, surface roughness, riparian ground cover, and infiltration conditions (Adams 1989; Sykes et al. 1993). Tree species vary in their ability to take up and store nutrients (Sykes et al. 1993). Deciduous trees along streams are more effective nutrient filters than conifers (Sykes et al. 1993). For example, oaks require more potassium and nitrogen than spruce and pine (Sykes et al. 1993). Therefore, species composition can affect nutrient uptake by riparian areas.

Acid Deposition

The biota of streams along the Appalachian Mountain chain is at risk from acid deposition because of poor air quality (a byproduct of sulfur dioxide emissions from coal-fired power plants) and low buffering capacity of geologic formations (SAMAB 1996b). Acid deposition is detrimental to streams when chronic or episodic lowering of stream pH raises aluminum concentrations to toxic levels. Acidification effects can range from reduced aquatic biodiversity to elimination of living organisms. Acid precipitation and pollution are associated with amphibian declines in the Appalachian Mountains and northeast (Pauley et al. 2000).

Forested watersheds with shallow acidic soils and rapid, shallow subsurface flows are most vulnerable to acid deposition (SAMAB 1996b). Stream sensitivity to acid deposition is determined by the buffering capacity of soils. In the southern Appalachians, soil composition is determined primarily by bedrock geology. Soils derived from quartz sandstone have limited buffering capacity while soils derived from limestone readily buffer acidic deposition (SAMAB 1996b). Within the Southern Appalachian Assessment Area, 54% of stream miles have high sensitivity to acid deposition (SAMAB 1996b). The George Washington National Forest monitoring program, based on aquatic macroinvertebrate sampling, indicates that 60% of streams are acidified (SAMAB 1996b). There may be a substantial lag time between a reduction in sulfur dioxide emissions coal-fired power plants and acidity levels decreasing in streams. In a study of 58 brook trout streams over a 12-year period, only 15 streams exhibited a decrease in acidity levels and the remainder of the streams increased despite a 40% reduction in sulfur dioxide emissions (Webb et al. 2000).

Biological Components

One approach to assessing ecological integrity of an ecosystem is the use of focal species (Committee of Scientists 1999). The abundance, distribution, health, and activity over time and space of the focal species is indicative of the functioning of the ecosystem (Committee of Scientists 1999). The status of a focal species can reflect the conditions of key components of riparian ecosystems. Focal species is an inclusive term that encompasses terms such as indicator species, keystone species, ecological engineers (e.g., beaver), umbrella species (e.g., black bear), link species (e.g., salamander), and species of concern (Committee of Scientists 1999). In floodplain ecosystems, four ecological attributes are important to animals: composition and structure of woody plant communities, presence of corridors for dispersal and migration, the presence of surface water and soil moisture, and habitat diversity (Sharitz and Mitsch 1993). The structure and complexity of riparian vegetation has a strong influence on the quality of riparian habitat, and therefore, will be discussed first. Following will be a discussion of the life history requirements of organisms associated with southeastern riparian systems.

Vegetation

Function and Structure

Riparian vegetation provides shade, habitat and influences microclimate, stream bank stabilization, coarse woody debris and leaf litter, and food for macroinvertebrates (Vannote et al. 1980; Brinson et al. 1981; Webster et al. 1999). The quantity and type of riparian vegetation directly affects stream temperatures, terrestrial nutrient uptake and cycling, bank stability, and input of organic material (Vannote et al. 1980). In smaller streams, riparian vegetation has a greater influence on channel processes and aquatic habitats than in larger streams (Vannote et al. 1980). The root system of riparian vegetation helps to maintain streambank integrity by binding and holding sediments in place (Beschta and Platts 1986; Tang and Montgomery 1995) and preventing erosion (Gregory et al. 1991). Stabilization of streambanks by roots facilitates the colonization of additional riparian vegetation (Beschta and Platts 1986).

Riparian literature tends to focus on the western United States where there is often a more pronounced difference between riparian vegetation and upland vegetation. Within the southeastern riparian literature, much of the research is focused on bottomland forests (Mitsch and Gosselink 1993). However, there have been recent attempts to characterize eastern upland headwater riparian systems (e.g., Hedman and Van Lear 1995; Hedman et al. 1996; Hupp and Osterkamp 1996; Williams et al. 1999).

World wide, the spatial pattern and successional development of riparian vegetation is influenced by geomorphic and other disturbance processes such as fire, wind, plant disease, and disease outbreaks as discussed above (Gregory et al. 1991). In the Appalachians, riparian vegetation is extremely diverse due to the topography and soils (Teskey and Hinkley 1977). For instance, in the headwaters of the Shenandoah River, patterns in the vegetation, the landforms, and soil texture were closely linked (Hack and Goodlett 1960). The frequency, duration, and intensity of flooding is an important controlling factor in the distribution of riparian species in the humid East (Hupp and Osterkamp 1996). Inundation from flooding creates soil anoxia and selection for plants tolerant under those conditions; flooding increases the soil moisture (Kondolf et al. 1996; Teskey and Hinkley 1977). In the Coweeta watershed North Carolina, riparian vegetation such as tulip poplar, rhododendron, and eastern hemlock were associated with soils having high organic matter content and deep A-horizons (Elliot et al. 1999 see Table 2.1 for scientific names).

Within a small section of a riparian area, microtopographical shifts in soil saturation and composition creates a corresponding diverse array of riparian vegetation (Gregory et al. 1991; Hupp and Osterkamp 1996). Southeastern riparian vegetation typically has multiple plant canopies with under-story, mid-story, and over-story components. The structural complexity provides multiple niches for a variety of organisms.

In the southern Appalachians, the distinction between structural and vegetation characteristics of the riparian and nonriparian zones is less pronounced than in arid regions (Laerm et al. 1997). In the headwaters of the southern Appalachians, the vegetation shift from riparian areas to upland areas is subtle and moves along a gradient determined by soil, landform, aspect, and flooding. This pattern may be reflective of the nature of the headwater streams, where in constrained reaches, with low frequency of overbank flooding and poorly developed floodplains, riparian plant boundaries are

Table 2.1. Examples of vegetation associated with headwater riparian areas in the southern Appalachians.

Scientific Names	Common Names	Source
Betula sp.	Birch	Flebbe & Dolloff 1995 Hedman & Van Lear 1995
Castanea dentata L.[a]	American Chestnut	Hedman & Van Lear 1995
Cladrastis lutea	Yellowwood	Flebbe & Dolloff 1995
Fagus grandifolia	Beech	Flebbe & Dolloff 1995
Kalmia latifolia	Mountain Laurel	Flebbe & Dolloff 1995
Liriodendron tulipifera	Tulip Poplar	Flebbe & Dolloff 1995 Hedman & Van Lear 1995
Magnolia fraseri	Fraser Magnolia	Flebbe & Dolloff 1995
Pinus strobus	White Pine	Hedman & Van Lear 1995
Prunus serotina	Black Cherry	Hedman & Van Lear 1995
Quercus sp.	Oak species	Flebbe & Dolloff 1995 Hedman & Van Lear 1995
Rhododendron maximum L.	Rhododendron	Yeakley et al. 1994 Flebbe & Dolloff 1995 Hedman & Van Lear 1995
Tilia sp.	Basswood	Flebbe & Dolloff 1995
Tilia heterophylla	White Basswood	Hedman & Van Lear 1995
Tsuga canadensis	Eastern Hemlock	Flebbe & Dolloff 1995 Hedman & Van Lear 1995

[a]Historically important, currently limited in size and distribution

narrow and closely resemble upslope forests (Brinson et al. 1981; Gregory et al. 1991; Schlosser 1991).

In a study of southern Appalachian riparian forests, Hedman and Van Lear (1995) characterized the vegetation of early-, mid-, and late-successional riparian forests. Riparian forests represented mixed mesophytic and eastern hemlock forests and transitions between these types in the southern Appalachians. Early- and mid-successional forests were dominated by an overstory of pioneering shade-tolerant species (tulip poplar, birch, white basswood, and black cherry) with an even-aged structure. Late-successional and old-growth forests were predominantly shade intolerant (hemlock, white pine, and oak) or moderately tolerant overstory species with an uneven age-distribution (Hedman and Van Lear 1995, see table 2.1 for scientific names). Rhododendron dominated understory canopy layers and appeared to inhibit vegetation diversity.

Loss of the once abundant overstory tree species and the spread of rhododendron thickets raises concerns about the future vegetational diversity of some riparian areas

(Baker and Van Lear 1998). Historically, the American chestnut was the dominant overstory species in southern Appalachian forests. With the loss of the chestnut to the chestnut blight, other species such as the eastern hemlock, oaks, and tulip poplar have become the predominant overstory species in different riparian communities. Now there are concerns that the hemlock and oaks are in decline because of biological and environmental stressors. Additionally, the rhododendron has increased its range and abundance in response to loss of the chestnut, landuse practices, and exclusion of fire (Baker and Van Lear 1998). The growth of potential overstory and understory vegetation is limited by the ability of the rhododendron to limit light conditions, compete for moisture and nutrients, and create leaf litter that is acidic and possibly allelopathic (Baker and Van Lear 1998). Long-term concerns include losing sources of overstory trees for CWD in streams, decreasing vegetation diversity, and corresponding effects on riparian-dependent organisms.

Leaf Litter

Production of leaf litter across a broad geographic region is a function of climate (latitude) and vegetation type (Benfield 1997). Within riparian zones, leaf litter production is higher, decomposition is faster, and litter redistribution is greater than upslope areas (Xiong and Nilsson 1997). Magnitude and timing of flooding, soil moisture, and soil fertility largely control litter production as well as net primary production in the riparian zone (Xiong and Nilsson 1997). Leaf litter decomposition rates are a function of invertebrate activity, moisture, and plant species. Conifers leach less than deciduous species and younger leaves break down faster than older leaves (Xiong and Nilsson 1997). Accumulated leaf litter affects the structure and dynamics of plant communities by burying them, chemically adding nutrients and phytotoxins, and biologically by adding seeds (Xiong and Nilsson 1997). Leaf litter is an important food source for detritivores and decomposers. Leaf litter in riparian zones provides habitat for small mammals, amphibians, reptiles, and invertebrates.

Leaf litter plays an important role not only within the riparian zone but also within the stream channel. Leaves and other organic material from streamside vegetation are important foods for aquatic invertebrates that are in turn food for many fishes (Murphy and Meehan 1991). Leaf litter is very influential in smaller streams, where allochthonous materials provide most of the base of the aquatic food chain (Vannote et al. 1980; Kattelmann and Embury 1996; Wallace et al. 1997). Within a river basin, leaf litter input increases with decreasing stream order (Benfield 1997). Leaf litter can enter streams directly during the fall, during major storms or laterally from stream banks. Under normal conditions, the yearly input of leaf material can exceed that of wood (Webster et al. 1995; Dolloff and Webster 2000).

Coarse Woody Debris

An important product of riparian vegetation is CWD produced from standing dead trees, fallen trees, and decomposing large roots (Stevens 1997). Coarse woody debris can be defined as "sound and rotting logs and stumps, and coarse roots in all stages of decay, that provide habitat for plants, animals, and insects and a source of nutrients for soil structure and development" (Stevens 1997:2). Coarse woody debris loadings are dependent on inputs from tree breakage, tree mortality, and tree losses from decomposition and fires (Van Lear 1996). The ecological roles of CWD include enhancing forest productivity, provision of habitat and structure to maintain biological diversity, a future source of CWD for streams, long-term carbon storage, and slope stability (Stevens 1997). Forest productivity is enhanced when CWD adds organic matter and nutrients to soils, provides habitat for decomposers, retains moisture, and in some systems acts as a site for regeneration of conifers (Stevens 1997). In terrestrial systems, down wood provides nesting, cover, and forage sites for invertebrates, amphibians, reptiles, insects, and wildlife as well as providing amphibians and reptiles with retreat sites during environmentally stressful times (e.g., low moisture). Current forest management practices contribute to low loadings of CWD in southern forests because fiber that would contribute to CWD is harvested or salvaged for timber production (Van Lear 1996).

Migration Corridors

Riparian zones are recognized as corridors for movement of plants and animals (Gregory et al. 1991; Naiman and Decamps 1997). Open habitats in floodplains may have been one of the original habitats for weedy plants (Gregory et al. 1991). Riparian corridors can function as migration corridors for wildlife, defined as passageways between similar habitat types (Simberloff et al. 1992). The ability of a corridor to function as a migration route is dependent primarily on the life history of the animal(s) using it (Noss and Harris 1986). Habitat structure within the corridor, corridor width, and position of the corridor relative to habitat patches in the landscape are all important components of corridors. Migrating animals need cover from predators and food sources if the corridor is very long relative to the migration rate of the organism. Noss (1987) suggested that corridor width is dependent on human-use patterns around the area. Harrison (1992) suggested that corridors must be wide enough for an organism to live in the corridor if necessary.

Wilson and Willis (1975) proposed that corridors should be maintained between refuges as a logical consequence of the equilibrium theory of island biogeography. In theory, maintenance of corridors would increase the immigration rate and maintain a higher number of species. The extinction rate should decrease because species would be "rescued" by reciprocal immigration from other sites (Brown and Kodric-Brown 1977). Small populations, that are frequently part of a larger metapopulation, are vulnerable to demographic stochasticity; chance events can lead to the local extinction of isolated populations. The concept of a metapopulation implies that adjacent populations can restore locally extinct populations, via migration. In theory, migration corridors should facilitate movement between the populations. Increased migration to a reserve should increase or maintain species richness and diversity and it could increase population sizes of particular species and decrease probability of extinction ("rescue effect") (Noss 1987). In the southern Appalachians, corridors may facilitate re-establishment of locally extinct populations in areas disturbed by episodic events such as debris flows, flooding, fires, and human activities.

Aquatic Fauna

Southern Appalachian streams have high faunal diversity for several reasons: 1) the mountains were never glaciated, 2) a relatively mild climate results in high biological activity even in higher elevations, 3) the streamside vegetation provides shade seasonally and thus most of the energy is allochthonous (from outside the channel) leaf and wood debris, 4) high annual precipitation results in extended stream networks, 5) high natural complexity of the streams provides diverse cover and protection for instream fauna, and 6) the high physio-chemical variability of streams as a result of flooding and variable seasons results in abiotic controls of the streams (Morse et al. 1993, 1997). All factors combine to create extremely complex and diverse stream environments. There is a correspondingly diverse aquatic fauna, especially of macroinvertebrates, in smaller mountainous streams.

Invertebrates

Aquatic macroinvertebrates are strongly influenced by thermal conditions, sedimentation, nutrients, and allochthonous input from riparian areas (Ward 1984). Temperature serves as a cue for life-cycle responses and can influence distribution of species as well as the outcome of competitive interactions (Ward 1984). Riparian areas can filter sediments and nutrients that may be detrimental to invertebrates or change the community structure. Leaves and other organic material from streamside vegetation are important foods for aquatic invertebrates that are, in turn, food for many predators (Murphy and Meehan 1991). The quality and diversity of vegetation will influence the invertebrate community structure because allochthonous sources of food are an important energy source in small streams (Vannote et al. 1980, Ward 1984).

In small, forested streams, the structure of the community is highly dependent on and structured by leaf input (Cummins et al. 1989; Wallace et al. 1996a). Invertebrate shredders (also called detritivores) process conditioned leaf litter and convert it to fine particulate organic matter (FPOM) (Cummins et al. 1989). The FPOM is further processed by collector-gatherers. The dependence of detritivores on the quality, quantity and timing of riparian vegetation means that changes in riparian vegetation can cause shifts in the invertebrate population and community. For example, in a study of the effects of a stonefly species raised on a diet of oak, hickory, or chestnut leaves, those raised on chestnut leaves had higher specific growth rates and adult body mass than those raised on other diets (Smock and MacGregor 1988). The researchers suggested that the demise of the chestnut could have resulted in subtle changes in the population or community structure (Smock and MacGregor 1988).

The southern Appalachians have high aquatic invertebrate diversity and a large number of endemic species (Morse et al. 1997). Mayflies, stoneflies, and caddisflies

(Ephemeroptera, Plecoptera, and Trichoptera or EPT) have been the primary focus of research because of their sensitivity to stream disturbances (Wallace et al. 1996a; Morse et al. 1997) and vulnerability to extirpation in the southern Appalachian Mountains (Morse et al. 1993; SAMAB 1996b). The EPT are vulnerable to sedimentation, poor forest management practices, acid rain, changes in precipitation, and development (SAMAB 1996c). Biological monitoring programs based on EPT indices have been used successfully in southern Appalachian headwater streams as indicators of degradation and recovery in streams (Wallace et al. 1996a; SAMAB 1996b). On the George Washington National Forest, EPT indicators have been used to identify acidified streams and streams with high concentration of fine sediments (SAMAB 1996b).

Fish

Status of Fishes

The composition of fish communities across the Appalachians varies considerably, however, drainage and physiography can explain much of the variability across the region (Angermeier and Winston 1999). Over smaller spatial scales, variability is commonly explained by stream size, elevation, and channel gradient (Angermeier and Winston 1999). Etnier (1997) subjectively classified habitat preference for southeastern freshwater fish species. Headwaters (first- to second-order streams) and creeks (third- to fourth-order streams) were preferred habitat for 3% and 51% (respectively) of southeastern fishes, but contained only 4% and 35 % of the jeopardized species of the region (Etnier 1997).

Within southern Appalachian streams, fish assemblages are classified on an overlapping scale according to coldwater ($<70^{o}$ F), coolwater (transitional between cold and warm water) and warmwater ($>70^{o}$ F) criteria. Most headwater streams contain a simple coldwater fish assemblage consisting of salmonid, cyprinid, cottid, catostomid or percid species depending on the drainage basin, elevation, and latitude (Burton and Odum 1945; Flebbe 1994, see Table 2.2 for scientific names). Brook trout are historically associated with headwaters in the southern Appalachians and are currently restricted to higher stream elevations (Larson and Moore 1985; Flebbe 1994). Two introduced fishes, rainbow trout and brown trout, typically occur further downstream (Larson and Moore 1985; Flebbe 1994).

Table 2.2 Fish species associated with coldwater streams in the southern Appalachians.

Taxon	Common Name	Distribution	Source
Campostoma anomalum	Central Stoneroller	Cherokee NF	Medlin 1999
Catostomus commersoni	White Sucker	Nantahala-Pisgah NF (cool streams)	Medlin 1999
*Clinostomus funduloides**	Rosyside dace		Etnier 1997
Cottus baileyi	Black Sculpin	George Washington, Jefferson NF	Medlin 1999
Cottus bairdi	Mottled Sculpin	George Washington	Medlin 1999
Cottus sp.	Sculpins	Nantahala-Pisgah NF Cherokee NF Chattahoochee NF	Medlin 1999
Hemitremia flammae	Flame Chub	Alabama NFs	Medlin 1999
*Nocomis leptocephalus**	Bluehead chub		Etnier 1997
Oncorhynchus mykiss	Rainbow Trout	George Washington NF Jefferson NF Chattahoochee NF Cherokee NF Sumter NF	Medlin 1999
*Phoxinus oreas**	Mountain redbelly dace		Etnier 1997
Rhinichthys atratulus	Blacknose Dace	AL, GA, NC, SC, TN, VA, WV George Washington NF Jefferson NF Nantahala-Pisgah NF Chattahoochee NF Cherokee NF Sumter NF	SAMAB 1996 Medlin 1999
Rhinichthys cataractae	Longnose Dace	George Washington NF Sumter	Medlin 1999
Salmo trutta	Brown Trout	George Washington NF Jefferson NF Chattahoochee NF Cherokee NF Sumter NF	Medlin 1999
Salvelinus fontinalis	Brook Trout	GA, NC, SC, TN, VA, WV	SAMAB 1996
Semotilus atromaculatus	Creek Chub	Chattahoochee NF	Etnier 1997, Medlin 1999
Thoburnia rhothocea	Torrent sucker	George Washington NF	Medlin 1999

*classified by Etnier (1997) as associated with creeks

While fish have been used extensively as indicators of stream health (Karr et al. 1986), they are probably not reliable indicators in small headwater streams because species diversity is naturally low and fish population densities of first-order and ephemeral streams vary widely. Angermeier and Winston (1999) included third-order streams and larger in characterizing fish community diversity across Virginia landscapes. In larger stream systems, reliance on a single indicator species is inappropriate. The Index of Biotic Integrity (IBI) is more widely used to assess stream health. The IBI is a multi-metric index that incorporates community structure, trophic status, and fish condition to assess biotic integrity (Karr et al. 1986).

Across the southeast, most of the jeopardized fish species are disproportionately represented by the Ictalurid catfishes (i.e., madtoms) and percids (i.e., darters) (Etnier 1997). Degradation and fragmentation of benthic habitat (Warren et al. 1997) and nonpoint source pollution (i.e., sedimentation) (Etnier 1997) are strongly associated with jeopardized southeastern fishes. Cumulative impacts upstream contribute to downstream declines of fish species (Warren et al. 1997). One of the more important functions of forested riparian vegetation in headwater streams for southeastern fish may be to ameliorate cumulative impacts of sediments and nutrient inputs downstream.

Importance of Riparian Areas to Headwater Fish Assemblages

Cool temperatures are especially important to the headwater fish assemblage (Burton and Odum 1945; Flebbe 1997). Riparian vegetation shades streams, producing cooler stream temperatures and moderating temperature fluctuations (Brinson et al. 1981). Increased temperatures can increase disease, decrease competitiveness, and change the timing of migration.

The species in smaller, cooler streams are adapted to relatively extreme changes in physical conditions and food supply (Burton and Odum 1945). Fish are especially sensitive to changes in habitat complexity and timing of water flows (Richards and Hollingsworth 2000). The quality and quantity of fish habitat is a product of streamflow, channel morphology, and sediment transport (Heede and Rinne 1990; Richards and Hollingsworth 2000). Riparian vegetation strongly influences the quality and quantity of instream structures that aid fish in surviving stochastic and daily events. Roots of riparian vegetation provide bank stability and cover (Brinson et al. 1981). Coarse woody debris plays an important role in creating diversity in depth, substrate, and current in small streams (Schlosser 1991). Loss of CWD in streams changes the ratio of pools and riffles as well as the water and sediment storage capacity (Dolloff 1994b). Streams with higher quantities of CWD have more pools and higher numbers of trout (Flebbe 1999). CWD facilitates the creation of pools that serve as rearing habitat for juvenile fish and provide cover during high flows and from predators (Bisson et al. 1987).

Much of the research on effects of sediments on salmonids has been conducted in the Pacific Northwest. Research on effects of sedimentation on fish in the Appalachians has been limited (Tebo 1955; Tebo 1957; West 1979; West et al. 1982; Dechant and West 1985; England 1987) and there is a need for further research (Waters 1995). Sublethal effects of sediment on fish include behavioral avoidance of turbid waters, loss of visual capability (which leads to reduced feeding and depressed growth), respiratory impairment, and reduced tolerance to disease and toxicants (Waters 1995). Sedimentation affects reproductive success of fish by filling in spawning substrate and smothering eggs and larvae (Rabeni and Smale 1995; Waters 1995). In looking at effects of fine sediments on community characteristics, Rabeni and Smale (1995) found that herbivores, benthic insectivores, and simple lithophilic spawners were most sensitive to siltation. Paradoxically, many fish need sediment for spawning substrate, yet too much fine sediment is harmful - there is a need to strike a balance on input of desirable sediment and detrimental sediment. Riparian vegetation reduces instream sediment additions by stabilizing streambanks, trapping sediment in overland flow, and contributing CWD to the stream channel.

The linear nature of streams and riparian areas influences the ability of fish to migrate and recolonize areas. Some fish migrate long distances; the stream sections traversed while migrating are influenced by the quality of riparian vegetation (Brinson et al. 1981). Brook trout are strongly associated with headwater streams yet have declined compared to their historical distribution (Larson and Moore 1985; Nagel 1991; Flebbe 1994). Brook trout declines are attributed to competition from introduced rainbow trout, habitat destruction, and habitat fragmentation (Larson and Moore 1985; Nagel 1991; Flebbe 1994). Refuges of undisturbed fish populations help to recolonize decimated areas. For example, in 1995, a debris avalanche eliminated all fish (brook trout and blacknose dace) from a 1.9 km stretch of the Staunton River, a second order stream (Roghair 2000). Within 3 years, the disturbed stream section was recolonized with fish abundance and density exceeding the pre-disturbance levels (Roghair 2000).

Food

Food sources for fish include aquatic invertebrates, terrestrial invertebrates that drop into the stream, other fish, and eggs of other organisms (e.g., amphibians) (Tebo 1955, Brinson et al. 1981). For example, in western North Carolina streams, benthic macroinvertebrates accounted for over 80% of the rainbow trout diet and during the summer and fall, terrestrial invertebrates were a major diet item (Tebo 1955). The CWD traps vegetation input from riparian vegetation that, in turn, acts as a food source for invertebrates that are food source for fish. Seasonally, floodplains may be a source of food for fish as well as refuge from high flow conditions (Brinson et al. 1981; Pert 1993).

Terrestrial Fauna

Traditionally, wildlife species abundance and richness is considered greater in riparian areas than the upland areas (Stauffer and Best 1980; Brinson et al. 1981; Dickson and Warren 1994). However, recent research indicates that species diversity or abundance may not be higher in riparian areas that are structurally similar and contiguous to upland areas (Murray and Stauffer 1995; Whitaker and Montevecchi 1997). Riparian habitats that support unique species are important to the regional biodiversity (Whitaker and Montevecchi 1997). Many plant and animal species depend on the unique characteristics of riparian areas and wetlands to fulfill most of their life history functions (Brinson et al. 1981). Still other species rely on the relative security of riparian areas for nesting or rearing young or to facilitate movements and migrations among habitats (Sharitz and Mitsch 1993). The three major factors that influence use of riparian areas are vegetation structure, water regime and connectivity, and extent of riparian forest (DeGraaf and Yamasaki 2000).

Vegetation structure is generally more important than composition to riparian dependent wildlife (Brinson et al. 1981; DeGraaf and Yamasaki 2000). Structural complexity is comprised of the herbaceous, shrub, and canopy layers (Brinson et al. 1981). Some wildlife species have very specific habitat requirements such as closed canopy, shrubby understory, or cavities in large dead trees (Brinson et al. 1981; DeGraaf and Yamasaki 2000). Composition of vegetation may be important if upland and riparian vegetation differs, especially for food values such as mast production or invertebrates associated with riparian vegetation (Brinson et al. 1981).

Proximity to water, type of water body, and interconnectedness strongly influence riparian fauna. For example, riparian species associated with lakes and large ponds (e.g., bald eagles) would be very different from those associated with swiftly flowing water (e.g., Louisiana waterthrush) (DeGraaf and Rudis 1986). Water regime influences microhabitat conditions such as soil moisture, vegetation structure, and food availability. The four types of habitats having distinct species groups or assemblages associated with water bodies in the Southern Appalachian Assessment were: 1) mountain bogs, 2) fen or pond wetlands, 3) seep, spring, or streamside and 4) bottomland forests. Wildlife management concerns for the SAA associated with seep, springs or streamside include maintaining bald eagle nest and roost sites, maintaining canopy openness of sand and gravel bars, and reducing human disturbance to sites (SAMAB 1996b).

The degree of difference between aquatic and upland habitats will strongly influence any differences between the two communities. The interface, or edge, of two highly different habitats is credited with increasing species richness and abundance (Whitaker and Montevecchi 1997). For instance, in the arid west, the moist conditions and structural diversity of riparian zones contributes to higher diversity and abundance of wildlife (Brinson et al. 1981).

Amphibians and Reptiles

Amphibians and reptiles perform an important function in the flow of energy within riparian areas (Pauley et al. 2000) because they move between the aquatic and terrestrial environments. The quality of both habitats will influence their distribution, abundance, and overall health. Amphibians may be important indicators of environmental change (Orser and Shure 1972) because many species have life stages in both the aquatic and terrestrial environments, they are ecothermic (which makes them susceptible to environmental changes), many hibernate in soils, many species of salamanders lack lungs and use their skin as respiratory organs, and they are both predators and prey within the foodweb (Pauley et al. 2000). Pauley et al. (2000) estimated that 71 amphibians and 50 reptiles out of 143 amphibians and reptiles in the continental forests of eastern North America use riparian areas sometime in their lifetime.

In the southern Appalachians, salamander taxonomic diversity, density, and biomass is unequaled worldwide (Cohn 1994; Petranka et al. 1994). Burton and Likens (1975) estimated that salamander biomass can exceed the biomass of all other small vertebrate species in a given area. Some salamanders are efficient at converting ingested energy, with an average protein concentration of 50% (Burton and Likens 1975). Snakes, birds, small mammals, and other salamanders prey on salamanders (Brodie and Howard 1973; Pough 1980) although their skin secretions may cause avoidance by some predators (Brodie et al. 1979). The Environmental Monitoring and Assessment Program (EMAP) identifies salamanders, frogs, and turtles as highly useful indicators of the quality of multiple resource categories (Hunsaker et al. 1990). The primary focus of this section will be on salamander requirements because of their diversity and abundance in the southern Appalachians.

Habitat

The majority of amphibians use aquatic habitats for reproduction and overwintering (Brinson et al. 1981). Many amphibians' primary residence is in riparian areas (Brinson et al. 1981). Reptiles are not as restricted to riparian areas but some species such as turtles, skinks, and snakes are associated with riparian areas (Brinson et al. 1981; Pauley et al. 2000).

Important aspects of riparian areas for salamanders include microclimate (temperature and moisture) (Harper and Guynn 1999), leaf litter and coarse woody debris, soil pH (Wyman and Jancola 1992) and soil compaction (Pauley et al. 2000). Harper and Guynn (1999) found that salamanders prefer moist microhabitats and that microsite conditions seemed to be a better indicator of terrestrial salamander density than availability of prey. Moist site conditions are required by salamanders because their skin is highly permeable and, therefore, prone to desiccation (Petranka et al. 1994).

Moist site conditions are determined by elevation, aspect, slope location, soil type, canopy and understory cover, and tree species. Northern and eastern exposures and lower portions of slopes in the higher elevations of the southern Appalachians are more conducive to moist site conditions (Harper and Guynn 1999). Forest vegetation and structural features play an important role in providing the temperature, moisture and acidity required by amphibians (DeGraaf and Yamasaki 1992; Harper and Guynn 1999). Salamanders are found in higher numbers in deciduous forests than coniferous forests or forests with abundant ericaceous shrub (e.g., *Kalmia latifolia or Rhododendron maximus*) because deciduous leaf litter stays moist longer than coniferous leaf litter (DeGraaf and Yamasaki 1992; Harper and Guynn 1999) and is associated with a more favorable pH in the surrounding soils and leaf litter (Harper and Guynn 1999). Deeper leaf litter retains moisture longer (Harper and Guynn 1999) and can vary with slope, microtopography, time of year, site, and time of last major disturbance (DeGraaf and Yamasaki 1992). Low soil pH, between 3.5 and 4, may restrict salamander distribution and can be lethal (Wyman and Jancola 1992). Mountain laurel and rhododendron foliage creates a more acid environment. Leaf litter provides habitat for foraging, higher prey density, and protection from desiccation and predation (Orser and Shure 1972; Pough et al. 1987). Herbaceous understory provides perch sites for foraging (Duffy and Meier 1992) and refuge from predatory salamanders. Many species of salamander use other animal burrows, root tunnels, and interstices between rocks in subsurface retreats during the day (Petranka et al. 1994) and during adverse conditions.

Within the stream channel sediment loads, temperature, current velocity, volume of flows, and oxygen levels will influence amphibian populations (Orser and Shure 1972; Pauley et al. 2000). Increased runoff and streamflows results in higher erosion and scouring of stream channels as well as physical displacement of amphibians and their eggs (Orser and Shure 1972). High sediment loads can smother amphibian eggs. The physical stability of instream substrate will influence salamanders that burrow in aquatic environments (Orser and Shure 1972). For example, the *Desmognathus* populations in the southern Appalachians appear to be limited by stream substrate (Kleeburger 1984). The salamander community structure will be influenced by the presence or absence of aquatic breeding sites (Petranka et al. 1994). Species that have an aquatic larval stage (i.e., *Desmognathus, Eurycea,* and *Gyrinophilus*) are often found within the immediate vicinity of streams and seepages that are used as breeding sites (Petranka et al. 1994). *Desmognathus* are aquatic or semiaquatic species that lay their eggs in or near streams and seepages (Petranka et al. 1994).

Riparian types most common to the southern Appalachians would probably include headwater wetlands and seepages and streamside riparian zones (Pauley et al. 2000). Spring rains create flushing effects that help to keep headwater wetlands less acidic than some other wetlands (Welsch et al. 1995). Several amphibians are associated with headwater wetlands and seepages (Pauley et al. 2000) including northern dusky, four-toed, spring, and northern red salamanders (see Table 2.3 for scientific names). The larvae are aquatic and the juveniles and adults are highly aquatic (Hairston 1987). Fish normally are absent in these systems, increasing the survival rate of amphibian larvae. Approximately 30 species of salamanders, 7 species of frogs, 3 species of turtles, 2 species of lizards, and 3 species of snakes occur in headwater wetlands of continental forests of eastern North America (Pauley et al. 2000).

Riparian habitats associated with larger streams, such as second- and third-order streams, provide habitat for nesting, larval development, foraging, and refuge for several genera of salamanders (Pauley et al. 2000). Some turtles use these areas for overwintering, while snakes forage for fish and amphibians along the edge (Pauley et al. 2000). Approximately 38 species of salamanders, 16 species of frogs, 13 species of turtles, 3 species of lizards, and 25 species of snakes riparian habitat associated with larger streams (Pauley et al. 2000).

Diet

The main prey of salamanders is detritivores (Harper and Guynn 1999), small invertebrates such as insects, worms, snails, slugs, and spiders, and other salamanders (Cohn 1994; Harper and Guynn 1999). Aquatic salamanders eat fish, crayfish, leeches, salamander larvae and adults, and frog eggs (Cohn 1994). Salamanders play an important role in maintaining the diversity of invertebrates and facilitate increased leaf litter decomposition (Harper and Guynn 1999). Terrestrial salamander foraging occurs primarily in the forest floor litter at night after rainfall or high humidity conditions (Harpole and Haas 1999). Streamside species (*Eurycea*, *Desmognathus, Pseudotritons*) forage at night around the stream edge (Hairston 1987).

Table 2.3 Reptiles and amphibians found in the southern Appalachians. Occurrence is shown, where the information was available.

Scientific Names	**Common Names**	**Occurrence/Notes**	**Source**
Salamanders			
Ambystoma jeffersonianum	Jefferson	VA	SAMAB 1996
Ambystoma talpoideum	Mole	GA, NC, TN	SAMAB 1996
Ambystoma tigrinum tigrinum	Eastern tiger	AL, TN, VA	SAMAB 1996
Aneides aeneus[b]	Green	TES	SAMAB 1996
Crptobranchus alleganiensis[b]	Hellbender	TES	SAMAB 1996
Desmognathus aeneus[a]	Seepage	NC	SAMAB 1996 Harper & Guynn 1999
Desmognathus fuscus	Northern dusky		
Desmognathus imitator[a]	Imitator	NC, TN	SAMAB 1996
Desmognathus ochrophaeus	Mountain dusky	AL, GA, NC, SC, TN, VA, WV	SAMAB 1996 Ford et al. 1999
Desmognathus quadramaculatus[a]	Blackbelly	GA, NC, SC, TN, VA	SAMAB 1996
Desmognathus santeetlah[ab]	Santeetlah dusky	TES	SAMAB 1996
Desmognathus welteri[a]	Black mountain	TN, VA	SAMAB 1996
Desmognathus wrighti[a]	Pigmy	NC, TN, VA	SAMAB 1996
Eurycea aquatica[a]	Dark-sided (Brownback)		SAMAB 1996
E. cirrigera/bislineata			
Eurycea junaluska[ab]	Junaluska	TES	SAMAB 1996
Eurycea longicauda longicauda	Longtail	AL, GA, NC, TN, VA, WV	SAMAB 1996
Eurycea lucifuga	Cave	AL, GA, TN, VA	SAMAB 1996
Eurycea wilderae	Blue Ridge two-lined	GA, NC, TN, VA	SAMAB 1996 Ford et al. 1999
Gyrinophilus porphyriticus danielsi	Blue Ridge spring	NC, TN	SAMAB 1996
Gyrinophilus palleucus[b]	Tennessee cave	TES	SAMAB 1996
Hemidactylium scutatum	Four-toed	AL, GA, NC, SC, TN, VA, WV	SAMAB 1996
Leurognathus marmoratus[a]	Shovelnose	GA, NC, SC, TN, VA	SAMAB 1996
Necturus maculosus	Mudpuppy	AL, GA, NC, TN, VA	SAMAB 1996
Plethodon jordani[a]	Jordan's	NC	SAMAB 1996 Harper & Guynn 1999
Plethodon kentucky[a]	Cumberland Plateau		SAMAB 1996
Plethodon yonahlossee[a]	Yonahlossee		SAMAB 1996
Pseudotriton ruber nitidus	Blue Ridge red	NC, TN, VA	SAMAB 1996
Pseudotriton ruber schencki	Blackchin red	GA, NC, TN, VA	SAMAB 1996
Pseudotriton ruber ruber	Northern red		
Turtles			
Apalone spinifera spinifera	Eastern spiny softshell	AL, NC, TN, VA	SAMAB 1996
Clemmys guttata	Spotted	VA	SAMAB 1996
Clemmys inscultpa	Wood	VA, WV	SAMAB 1996
Clemmys muhlenbergii[b]	Bog	TES	SAMAB 1996
Graptemys geographica	Map	AL, GA, TN, VA	SAMAB 1996
Graptemys pulchra	Alabama map	AL, GA	SAMAB 1996
Psedemys rubriventris	Redbelly	VA, WV	SAMAB 1996
Sternotherus minor peltifer	Stripeneck musk	AL, GA, NC, TN, VA	SAMAB 1996

[a] = associated with seeps, springs and streamsides
[b] = TES

Birds

In the forested southern Appalachians, riparian dependent birds include the Acadian flycatcher and Louisiana waterthrush that use habitats near streams having well-developed overstory and understory canopy layers with relatively open ground layers (See Table 2.4 for scientific names, Triquet et al. 1990; Murray and Stauffer 1995). Bird communities are generally associated with vertical foliage layers, total foliage volume, habitat patchiness, and stand successional stage (Dickson and Warren 1994). The Acadian Flycatcher is primarily an insectivore (moths, caterpillars, beetles, wasps, bees, and some wild berries) that builds hammock-like nests in tree forks (8 to 20 feet above the ground) and near water (DeGraaf and Rudis 1986). The Louisiana Waterthrush prefers wooded streams with swiftly flowing waters. Nests are typically built on the ground in streambank cavities or among upturned tree roots. The Louisiana waterthrush gleans dragonfly and cranefly larvae, beetles, bugs, ants, caterpillars, scale insects, spiders, and mollusks from sandy margins of streams (DeGraaf and Rudis 1986).

The bald eagle and American woodcock were identified as species associated with seeps, springs, or streamsides in the Southern Appalachian Assessment (SAMAB 1996c). However, these species are associated with much larger bodies of water or habitats than are typically found in forested headwaters. The bald eagle forages near large bodies of water, primarily for fish, and nests in large, living trees with unobstructed views of the surrounding terrain (DeGraaf and Rudis 1986). The American woodcock prefers early-successional moist woodlands, brushy edges of woods, dry open woods or fields for breeding habitat and winters along rivers and streams (DeGraaf and Rudis 1986). Nesting sites are on the ground in forests or abandoned fields, near a habitat edge. Primary food items include earthworms, beetle larvae, flies, and other insects (DeGraaf and Rudis 1986). Woodcock populations are low in the Southern Appalachian Assessment area; one possible explanation is loss of agricultural lands (SAMAB 1996c).

Management indicator species for riparian areas mentioned in forest planning documents across the southern Appalachians include osprey, wild turkey, wood duck, and pileated woodpecker (Table 2.4). These species are not satisfactory indicators of headwater riparian areas because they are associated with larger bodies of water, have

Table 2.4 Birds and mammals associated with riparian areas in the southern Appalachians.

Scientific Names	Common Names	Source
Birds		
Aix Sponsa	Wood Duck	George Washington Forest Plan
Dryocopus pileatus	Pileated Woodpecker	Chattahoochee Forest Plan
Empidonax virescens	Acadian Flycatcher[a]	SAMAB 1996c
Haliaeetus leucocephalus	Bald Eagle[a]	SAMAB 1996c, Chattahoochee Forest Plan
Meleagris gallopavo	Wild Turkey	Chattahoochee Forest Plan
Pandion haliaetus	Common Osprey	Chattahoochee Forest Plan
Scolopax minor	American Woodcock[a]	SAMAB 1996c George Washington Forest Plan
Seirus motacilla	Louisiana Waterthrush[a]	SAMAB 1996c George Washington Forest Plan
Mammals		
Castor canadensis	Beaver[a]	SAMAB 1996c
Corynorhinus rafinesquii	Rafinesque's Big-eared bat[a]	SAMAB 1996c
Lutra canadensis	River Otter	George Washington Forest Plan
Mustela vison	Mink	Nantahala-Pisgah Forest Plan
Myotis grisescens	Grey Bat	Nantahala-Pisgah Forest Plan
Myotis sodalis	Indiana Bat[b]	SAMAB 1996c Chattahoochee Forest Plan
Procyon lotor	Raccoon [a]	SAMAB 1996c, N-P, Chattahoochee Forest Plan
Sciuris carolinensis	Grey Squirrel	George Washington Forest Plan
Sorex cinereus	Masked Shrew	Ford et al. 1999
Sorex fumeus	Smoky Shrew	Ford et al. 1999
Sorex palustris punctulatus	Southern Water Shrew[a]	SAMAB 1996c
Ursus americanus	Black Bear	Chattahoochee Forest Plan

[a] = species from the seeps, springs and streamside species group for the southern Appalachian assessment area
[b]= Cave species but associated with riparian areas for summer nursery colonies (Brack 1989)

broad habitat requirements, or are restricted to certain regions. For instance, the turkey's ideal habitat is a mixture of open fields and forests yet it nests near water (DeGraaf and Rudis 1986). Near altered landscapes, riparian forests are important habitat for wild turkey that use them for travel corridors, foraging sites, and roosting sites (Dickson and Warren 1994). The pileated woodpecker is associated with mature forests with large dead or dying trees preferably located in rivers or wooded swamps (DeGraaf and Rudis 1986). Waterfowl, such as the wood duck, are associated with shallow waters, ponds, or lakes as are found in southern flooded forests (DeGraaf and Rudis 1986; Dickson and Warren 1994). Osprey can be found near large bodies of water such as lakes or rivers but are much more common along the coast (DeGraaf and Rudis 1986). These species may be important riparian indicator species in some parts of national forests but most likely not in the headwaters.

Mammals

It appears that only a few mammals are associated with riparian areas in forested, headwater streams. A lack of structural and vegetation distinctions between the riparian and nonriparian zones in the southern Appalachians may explain this trend (Laerm et al. 1997). In a study of small mammal communities in riparian zones and upland areas around seeps, first-, second-, and third-order streams in North Carolina there was no significant difference in species richness, diversity or evenness (Laerm et al. 1997). Mammals associated with seeps, springs, or streamsides include southern water shrews, beavers, Rafinesque's Big-eared bats, and raccoons (SAMAB 1996c). In general, shrews have high habitat moisture requirements that could explain their association with riparian areas (Ford et al. 1999). Water shrew are associated with wet areas, cold water, and favor cover in boulders, tree roots, and overhanging banks (DeGraaf and Rudis 1986). They are primarily insectivorous, feeding on aquatic macroinvertebrates, but also consume small fish, snails, and flatworms (DeGraaf and Rudis 1986).

Other species that are partially riparian dependent include the Indiana bat and other shrew species. The Indiana bat, an endangered species, uses riparian areas in the summer for nursery colonies located in dead trees with exfoliating bark (i.e., hickories) and foraging along perennial streams with mature, overhanging trees (Brack 1989). However, the SAA classifies the Indiana bat as associated with caves because over 50% of the population hibernate in 2 caves (Brack 1989). In an assessment of community restoration fires in Wine Spring Creek ecosystem in North Carolina, masked and smoky shrews were found in higher numbers in riparian areas than in upslope areas (Ford et al. 1999). Neither of these species were listed as species found in the SAA (SAMAB 1996c).

Other species such as beaver, river otter, mink, grey bat, gray squirrel, raccoon, and black bear are identified as management indicator species for riparian areas in some national forest plans. These species are associated with larger bodies of water or use water for some life stages. The beaver, a keystone species, can have a profound effect on riparian terrestrial and aquatic plant communities and structure (Johnston and Naiman 1990; Stock and Schlosser 1991). Beaver ponds modify nutrient and carbon cycling, nutrient availability, decomposition dynamics, and water characteristics (Snodgrass and Meffe 1998). Historically in decline, the beaver has been restored to much of its former range (Dickson and Warren 1994). In low-order, blackwater streams beaver ponds increase fish species richness (Snodgrass and Meffe 1998). The effect of beaver ponds on fish species richness in low-order, montane streams is unclear. The river otter is being introduced to several southeastern states and is strongly dependent on stream resources (Dickson and Warren 1994). The mink is associated with riparian and aquatic habitats in some regions of the Appalachians such as on the Nantahala-Pisgah National Forest. The grey bat requires caves located near rivers and forested areas. The gray squirrel is widely distributed in the SAA and inhabits small riparian forests to mature contiguous forests (Dickson and Warren 1994). The raccoon uses acorns and other hard mast found in mature-forested habitats and is strongly related to riparian areas and wetlands. In some regions, streamside zones provide key habitat to black bears (Dickson and Warren 1994), however, through much of the SAA, black bear abundance and distribution appears to be linked to acorn production of oak forest, forested habitat, and protection efforts (SAMAB 1996c).

Anthropogenic Influences

Riparian areas have been adversely modified through human activities such as agriculture, mining, deforestation, dams, channelization, and development, and through natural disasters such as hurricanes, floods, forest fires, insect outbreaks (i.e., gypsy moth) and disease (i.e., American chestnut blight). In the southern Appalachians, the primary anthropogenic influences on forested headwater riparian resources include past land use, acid precipitation, timber production, and recreation. Harding et al. (1998) found that past land use was a better predictor of present diversity of invertebrates than current conditions of riparian and watershed land use. Past land use activities include timber extraction, clearing of land for subsistence agriculture, and mining. The federal government has acquired large tracts of southeastern forest land to restore the forests, primarily for water quality purposes. Modifying the effects of acid precipitation is beyond the scope of most land managers. The primary influences that will be discussed here are recreational and silvicultural effects on riparian resources.

Recreation

Recreational users are often attracted to riparian areas for such diverse activities as bird watching, wildflower walks, hiking, hunting, mountain biking, boating, camping and fishing (Rasmussen and Padgett 1994). The primary attraction is proximity to water and associated benefits such as cool temperatures, shade, and aesthetics (Rasmussen and Padgett 1994). Principal recreational impacts that can occur in riparian areas are associated with trails, campsites, and access points (Fleming et al. 1996) and can influence adjacent physical and biological resources (Cole 1994). Human disturbances associated with recreation include littering, pollution by human waste and other foreign substances, accidental fires, wood cutting, campfire effects, trampling, erosion, exotic plant introduction, and removal and disturbance of wildlife and vegetation (Cole 1994, Rasmussen and Padgett 1994, Cole and Landres 1996, Fleming et al. 1996).

Trails affect high-use recreational areas, such as along river corridors (e.g., Cascades Trail), however, the effect of recreational activities on aquatic systems and animals is poorly understood and in need of further research (Cole 1994; Lanehart 1998). The two types of effects on fauna and flora are direct and indirect impacts (Hammitt and Cole 1987). Direct impacts include removal or destruction of species (i.e., hunting and fishing), harassment of wildlife, and feeding animals (Lanehart 1998). Access to streams provided by trails along the riparian zone may increase fishing pressure that will in turn influence fish abundance (Marschall and Crowder 1996). For example, Flebbe and Dolloff (1995) found fewer trout in pools in Little Santeetlah Creek, North Carolina that were accessible by foot traffic than in pools in Right Fork Creek that had low angling pressure.

Indirect impacts include unintentional feeding, habitat disturbance, and resource degradation (Lanehart 1998). For example, Blakesly and Reese (1988) found that avian nesting substrate, cover, and foraging substrate were reduced in riparian campground areas in Utah. In response to this vegetation change, the bird species primarily nested in trees while species found in noncampground areas nested on the ground, in shrubs, or small trees (Blakesly and Reese 1988). Riparian vegetation that is found in the southern Appalachian region (i.e., broad-leaf plants) is more sensitive to trampling than shade intolerant plants such as grasses (Lanehart 1998). Loss of leaf litter, coarse woody debris, and vegetation could affect moisture dependent-species such as shrews and salamanders.

Trampling alters soil composition, reduces the infiltration capacity of soils, increases sedimentation in streams, and reduces vegetation abundance (Cole 1994). The pattern of influence for trampling is first to modify groundcover, then soils, and finally larger vegetation such as trees and shrubs (Lanehart 1998). Loss of groundcover reduces the cycling of organic matter into soils which in turn reduces moisture-holding capacity and increases bulk density (Reid 1993).

Erosion from trails adjacent to and crossing streams can increase stream width and sedimentation, reduce water depth, reduce shade, and change habitat diversity (Rasmussen and Padgett 1994). In the a study of the effect of trails on high gradient trout streams in the Great Smoky Mountains National Park, there appeared to be no effect of sediment from trails on stream sediment, benthic macroinvertebrates, or trout populations (Fritz 1993). However, downstream invertebrates and fish stocks may have been affected (Fritz 1993).

In wilderness settings, attempts to manage recreational impacts can change the wilderness experience of users. For example, building facilities to reduce damage from human waste or access points will diminish the primitive nature of an area (Cole 1994). Other potential impacts of recreational use on riparian areas include inhibiting management activities such as leaving dead wood on the ground because it may be "ugly" or visually unpleasant to recreationists. Coarse woody debris in streams may act as barriers or hazards to anglers and boaters (Reid 1993; Richards and Hollingsworth 2000).

Timber management activities can increase recreational use because logged areas create habitat favorable for game that attracts hunters. Logging roads also are used by mountain bikers and off-highway vehicle (OHV) users. Logging roads increase access to previously undisturbed areas (Reid 1993).

Recreational use of southeastern national forests is projected to increase, however, current budgets for maintenance of trails and facilities are inadequate (Morton 1997).

Insufficient funding has resulted in inadequate maintenance of trails and existing facilities, and degradation of resource conditions (Morton 1997). For instance, in a study of three backcountry trails located near streams on the Jefferson National Forest, all three trails exhibited signs of impacts, including excessive width, root exposure, and multiple trails resulting in soil erosion, wet soils, and water on the trail (Lanehart 1998). Degradation was attributed to heavy use, poor trail location, or improper maintenance. For example, hikers, mountain bikers, and horses caused impacts on a heavily used trail, while impacts on a lightly used trail were the result of steep slopes (Lanehart 1993). Lack of adequate drainage features contributed to trail impacts in all locations (Lanehart 1993). Existing research on the impacts of trails in riparian areas is deficient (Lanehart 1993).

Management strategies to reduce recreational impacts on riparian resources include: 1) identifying sensitive or critical areas through field assessments of use and condition, 2) locating new trails and facilities outside of riparian zones, 3) proper design and maintenance of existing trails, 4) seasonal or permanent closure of heavily used areas, 5) barriers and structures to redirect use and 6) public involvement and education (Lanehart 1998, Rasmussen and Padgett 1994).

Forest Management

Past timber activities may have allowed complete removal of riparian timber to often increase water quantity and for the value of the timber. However, riparian areas are now used as buffer strips between timber harvesting activities and stream channels. Some activity frequently is allowed in the riparian areas or streamside management zone. Primary impacts on riparian areas from timber management are from road building and vegetation removal.

Roads

Transportation systems associated with logging (i.e., roads, skid trails, landings) account for more sediment than all other forestry activities (Patric 1976). Roads located on steep slopes, erodible soils, or stream crossings can cause the most harm to water quality (Mattson et al. 2000). Surface erosion from roads near ephemeral channels can increase the transportation of fine sediments into the main stream channel. Roads crossing streams can modify channel morphology by eroding streambanks (Reid 1993; Mattson et al. 2000).

Other impacts from roads include increasing the transmission of pathogens and exotic species, increasing blowdown on adjacent forests, introducing chemicals into adjacent areas, creating unstable landforms, and increasing water flow (Reid 1993). Roads may introduce chemicals into surrounding areas from sources such as 1) oil products leaked from vehicles on road surfaces 2) salt used to de-ice roads, 3) herbicides used to control roadside shrubs, 4) toxic chemicals spilled in transport, and 5) runoff from surface materials such as limestone-gravel can increase pH (Reid 1993). Poorly designed, located, and constructed roads can create cut or fill slopes that are more unstable than the original landform, which increases the occurrence of mass wasting (i.e., landslides, debris avalanches) (Reid 1993). Roads increase water flow that can increase scouring and bank erosion in headwater streams.

Because of the potential influences of roads on watersheds and water quality, BMPs are established to prevent and control negative impacts from roads. In general, roads are kept out of streamside management zones and stream crossings are limited with strict construction guidelines where and when they must be built. Best Management Practices are designed to divert water and sediment from roads to the surrounding forest floor and away from the stream channel (Richards and Hollingsworth 2000).

Silvicultural Practices

In addition to the removal of timber, other silvicultural activities need to be considered such as thinning, planting, and slash treatment (McKee 1994). Important riparian functions that can be modified by silvicultural activities include organic matter input to water, shading, bank stability, regulation of sediment, water, nutrient movement, and wildlife habitat (Palik et al. 2000). Changes in vegetation composition can modify the quantity and timing of CPOM input into stream channels and, in turn, modify instream benthos (McKee 1994). Removal of large trees can result in a loss of structural complexity, influence stream shading, reduce the availability of coarse woody debris for instream uses, and reduce stream stability (Gregory et al. 1991). A reduction in or removal of streamside vegetation can increase solar radiation to the stream and increase instream productivity (McKee 1994). Removal of timber on upslope areas can result in increased peak runoff and erosion (Kondolf et al. 1996). Changes in vegetation structure and composition can influence the nutrient filtering capability of riparian areas. Timber harvesting practices can cause rutting and compaction of soil (Crow et al. 2000), which influences groundwater recharge, surface and subsurface flow, and vegetation regrowth.

Although microclimate conditions are important to riparian dependent organisms, there is little research on the width of buffer strips required to maintain microclimate conditions within the buffer strip. The Forest Ecosystem Management Assessment Team (FEMAT) guidelines recommend an additional zone of one tree height upslope from the riparian buffer to maintain microclimate conditions although the data to support this recommendation appear limited (O'Laughlin and Belt 1995).

Management activities that increase the surface runoff could have negative effects on amphibian populations (Orser and Shure 1972). Increased runoff increases instream flows and erosion rates which will decrease instream habitat and increase scouring and erosion, which would be harmful to instream organisms (Orser and Shure 1972). Management activities that increase siltation in streams can have a negative impact on salamander species that use rocks for cover, because the interstitial spaces are filled in and surface cover is reduced (Petranka et al. 1994).

Harvest strategies such as group selection, shelterwood, leave-tree, and clearcutting has a negative impact on local salamander abundance and diversity (Petranka et al. 1994, Harpole and Haas 1999). Vegetation removal degrades forest-floor microhabitats for salamanders by reducing shading, decreasing leaf litter, and increasing soil surface temperature and moisture (Ash 1995, Petranka et al. 1994). Timber harvesting could potentially alter the genetic composition of populations (Stiven and Bruce 1988) and trigger hybridization between closely related species(Kraus 1985, Hairston et al. 1992). Replenishment of adequate organic matter could take up to 65 years (Likens et al. 1978) which would require a longer rotation of timber harvesting (Petranka et al. 1994).

Summary

In the southeastern Appalachians, the geomorphology, hydrology, and periodic disturbances (i.e., wind, flooding, pest, debris flows, and fire) play an important role in the structure and function of riparian areas (Table 2.5). The high annual rainfall, high stream density, and steep terrain create a dynamic system subject to flooding and distribution of materials. The ecological attributes of forested southern Appalachian riparian areas were summarized (Table 2.6). Important components are the geomorphic complexity, vegetation structure and composition, depth and composition of leaf litter, composition of soils, coarse woody debris, microclimate, and stream-groundwater interface. Retaining these primary features should provide the microclimate, habitat, and food essential to riparian dependent organisms as well as protecting water quality and instream resources. Given the high variability of the physical and biological components of the Appalachians, specific management goals should be based on the unique attributes of a watershed.

Table 2.5. Influence of geomorphology, hydrology, and disturbance processes on riparian communities in the southern Appalachians (Adapted from Kondolf et al. 1996)

Variable	Attribute	Ecological Importance
Geomorphology	Channel pattern, slope and morphology of stream, Geology	Sediment transport and deposition Extend and texture of alluvium and adjacent hill-slope soils Influences pH buffering capacity of streams
	CWD	Route sediment Dissipate stream energy Create habitats Retains organic & inorganic matter, acts as a substrate for biological activity, shortens nutrient spirals Increase species diversity and abundance
Hydrology	Frequency, magnitude and duration of flooding	Inundation, high-velocity flows, deposition
	Stream-groundwater interactions	Maintain base flow Recharge alluvial table Maintain water table
Periodic disturbance		
Fires	Modify vegetation composition Reduce leaf litter Mineralize soils Disturb wildlife	Modifies species diversity Creates new habitats
Flooding	Scours vegetation Saturates soils & creates soil anoxia Moves instream materials & substrate Displaces organisms Erodes streambank	Modifies species diversity & habitat patchiness Creates new habitats Influences leaf litter accumulation
Drought	Reduce baseflow, soil and leaf litter moisture	Increases disease, fires, insects Modify vegetation composition
Debris flows	Transfers sediments and CWD into stream	Creates new sites for vegetation Displace organisms Introduce sediment & nutrients to stream channel
Wind	Open and modify vegetation structure; Increase CWD	Create new sites for vegetation Contribute CWD to streams
Insects/Disease/Pest	Modifies vegetation structure Increase CWD	Contribute CWD to streams

Table 2.6. Summary of ecological attributes and importance for forested southern Appalachian riparian areas (Adapted from Kondolf et al. 1996).

General Attribute	Specific Attribute	Ecological Importance
Structural complexity	Vegetation structure and composition, vertical foliage layers, total foliage volume, dead snags	Creates multiple niches Influences ability to take up and store nutrients Influences nutrient filtering capacity
	Leaf litter	Facilitates water infiltration Influences soil acidity & composition Influences plant communities Provides habitat & food Moderates soil temperature and moisture
	CWD	Enhance forest productivity Provide habitat & food Source of instream CWD Long-term carbon storage Slope stability
Moisture Availability	Shallow water table Evapotranspiration and shading increases humidity; Moist environment	Increase invertebrates, amphibian and reptile abundance Influences leaf litter composition
Food Resources	Diverse vegetation supplies diverse foods Diverse habitat harbors prey Open water available for wildlife	Increase species diversity
Linear nature	Edge effect: ecotone Migration corridors	Increase species diversity & predation Help recolonize disturbed areas Maintain metapopulations
Microclimate	Shaded, cool, moist in summer Protected in winter, overwintering habitat	Increase species, esp. amphibians
Influence on aquatic habitat	Shade Contributes CWD Contributes plant material and terrestrial insects Filters sediments and nutrients Stabilizes stream banks	Adds chemical energy and nutrients Creates habitats Increases instream species diversity Moderates stream temperatures Improves water quality

CHAPTER 3. MANAGEMENT GUIDELINES FOR RIPARIAN AREAS IN SOUTHERN APPALACHIAN NATIONAL FORESTS: EXAMINING THE LINK BETWEEN DESIRED FUTURE CONDITIONS AND STANDARDS & GUIDELINES

Introduction

In the last two decades, riparian area management on national forests has received increased interest and emphasis. Three factors help to explain this trend: an increased focus on abating nonpoint sources of pollution to improve water quality, an increased appreciation for the complexity and importance of riparian areas to watershed health, and the adoption of ecosystem management on national forests (Gregory et al. 1991; Kondolf et al. 1996; Pringle 2000).

National forests have managed riparian areas to comply with the 1987 Water Quality Act, which was designed to improve water quality by reducing nonpoint sources of pollution. On national forest land, one approach to protecting and improving water quality from the adverse effects of forestry activities has been the adoption of Best Management Practices (BMPs) for forested wetlands (Aust 1994, Phillips et al. 2000). The Environmental Protection Agency, which is responsible for approving forestry-related water quality programs, defines BMPs as any method, measure, or practice designed to reduce water pollution (Lickwar et al. 1990). By design, BMPs addressed only water quality concerns but increasingly there is recognition that other functions and values of riparian areas need consideration (Phillips et al. 2000).

Riparian areas occupy a relatively small portion of a watershed yet are essential in protecting water quality, providing habitat for terrestrial and aquatic organisms, and providing recreational, resource, aesthetic and cultural values for humans (Brinson et al. 1980; Gregory et al. 1991; Naiman and Decamps 1997). Riparian ecosystems have ecological impacts that extend well beyond their spatial extent (Committee of Scientists 1999) and may be the ecosystems most sensitive to environmental change (Naiman et al. 1992). In attempts to manage whole watersheds to address large-scale issues such as water quality, management of riparian areas has gained increasing attention (Naiman and Decamps 1997).

At the same time that recognition of the importance of riparian areas increased, the Forest Service adopted the concept of ecosystem management for management of national forests (Kessler et al. 1992; Wood 1994). Increased emphasis on ecosystem management highlighted the importance of riparian area management on national forests, as these areas are critical to maintaining watershed health (Kondolf et al. 1996). Central to the ecosystem management approach on national forests is the concept of the Desired Future Conditions (DFCs) that define overall characteristics of national forests as well as characteristics specific to management areas identified within national forest plans (USDA 1993; Committee of Scientists 1999). The Desired Future Condition describes what a forest would look like to a visitor in the future (Voth et al. 1994). The DFC is used not only to describe what the landscape should look like in the future, it also serves as the central reference point for planning and management (USDA 1993; Committee of Scientists 1999). Standards and guidelines developed from the DFCs are used to guide daily management activities.

I reviewed the DFCs for riparian areas on southeastern national forests and I also investigated how they are translated to operational standards and guidelines. It is not the intention of this paper to review state best management practices that are used by southeastern national forests, as this has been done elsewhere (Aust 1994). At present, many southeastern forest plans are out of date and under revision. The DFC concept is relatively new and may not have been an important component of a particular plan at the time that it was written. The specific objectives of this paper are 1) to compare and contrast desired future conditions and standards for riparian area management across southeastern forests and 2) to identify areas that differ among forests so that clear and consistent guidelines can be developed across forests. The process of reviewing existing forest management guidelines for riparian areas should highlight areas that need standardization and illustrate where further research is needed to help develop consistent management guidelines across southeastern national forests.

Concepts and Definitions Pertinent to Riparian Management on National Forests

To better understand the legal, managerial, and ecological mandates that guide national forest management, I reviewed key concepts and definitions pertaining to southeastern riparian areas including 1) the legal mandates governing riparian management on national forests, 2) the concepts of ecosystem management and cumulative watershed effects as applied to national forest planning, 3) the critical components and functions of southeastern riparian areas, 4) the terminology for delineating and defining riparian areas, and 5) the riparian characteristics used for assessing management objectives.

Legal Mandates

Regulations designed to protect water quality are extended to riparian areas (Braun 1986; Mitsch and Gosselink 1993). Numerous federal and state laws address water quality, however, for the purposes of this paper, only the major laws that influence riparian areas will be discussed (for more comprehensive reviews see SAMAB 1996a and Sierra Nevada Ecosystem Project (SNEP) 1996). For example, most riparian regulations stem from amendments to the Federal Water Pollution Control Act of 1972, aimed at controlling nonpoint source pollution (Brown et al. 1993). States are responsible for developing water quality regulations and BMPs (SAMAB 1996a). The National Environmental Policy Act of 1969 (NEPA) requires that national forests comply with state water quality regulations.

National forests are mandated to provide recreation, timber, and range, and to protect watersheds, wilderness, wildlife, and fish (Multiple-Use Sustained Yield Act 1960). National Forests are required to manage fish and wildlife habitat to maintain viable populations of native species; to protect streams, streambanks, lakes, wetlands, and other bodies of water; and to consider environmental impacts before decisions are made (Forest and Rangeland Renewable Resources Planning Act (RPA) as amended by the National Forest Management Act of 1976 (NFMA)). National forests also must protect any species listed as threatened or endangered (Endangered Species Act of 1973).

Ecosystem Management

Many attempts have been made to define ecosystem management, all with slightly different emphases, however, each definition has fundamental elements in common (Forest Ecosystem Management Team 1993; Grumbine 1994; Wood 1994; Christensen et al. 1996; Yaffee 1999). Elements of ecosystem management include incorporating sustainability, clearly articulating goals, maintaining a sound basis in ecological models and knowledge, appreciating the complexity, connectedness, and dynamic character of ecosystems, consideration of spatial and temporal scales, incorporating humans as ecosystem components, and implementing adaptability and accountability (Christensen et al. 1996).

The Committee of Scientists was convened in 1997 to make recommendations for national forest planning to the Forest Service (Committee of Scientists 1999). The Committee had several recommendations regarding forest planning, however, the focus in this paper will be on the primary recommendation that the overriding goal for forest management should be ecological sustainability. The fundamental scientific principles for ecological sustainability include recognizing temporal and spatial scales, maintaining biological diversity and structural complexity, recognizing that ecosystems are dynamic in space and time and acknowledging that uncertainty, surprise, and limits to knowledge are a given (Christensen et al. 1996). The Committee of Scientists recommended a three-pronged strategy for achieving ecological sustainability: 1) maintain conditions necessary for ecological integrity, 2) provide the ecological conditions for viability of selected focal species and 3) monitor the effectiveness of this approach. Ecosystems with ecological integrity maintain the composition, structure, and processes expected under the natural environmental conditions and disturbances in a region (Committee of Scientists 1999).

How the Forest Service will translate the Committee of Scientists' recommendations into ecosystem management or general forest planning is unclear. In this era of uncertainty in planning guidelines, a conservative approach would be to use elements that are common to ecosystem management principles and the Committee of Scientists report as a template for developing desired future conditions and standards and guidelines for riparian management. Elements common to both approaches include sustainability, setting clear goals (desired future conditions), public involvement, collaborative planning, species diversity, consideration of spatial and temporal scales, recognition that ecological systems are dynamic and interconnected, and use of adaptive management with an emphasis on monitoring.

The elements of ecological sustainability consist of species composition structure, and function (or process). Persistence of species over time is the single best metric of ecological sustainability (Committee of Scientists 1999). Composition is defined by the biodiversity of an ecological system, including genetic, species, and landscape diversity (Committee of Scientists 1999; Schramm and Hubert 1999). To assess composition, planners need tools to assess habitat conditions and population dynamics (Committee of Scientists 1999). Structure is the configuration of biologic, geologic, and chemical attributes present in an ecosystem (Committee of Scientists 1999; Schramm and Hubert 1999, see Table 3.1). A few examples of structure associated with riparian areas include coarse woody debris, large trees, above ground complexity, unconstrained rivers, and cover types (Committee of Scientists 1999). In assessing structure, planners must consider current condition, biological potential, and historical legacy in the context of the larger physical landscape (Committee of Scientists 1999). The adaptability of species to environmental variability also must be considered (Committee of Scientists 1999). Functions are the actions, changes, or processes essential to the maintenance of a system (Committee of Scientists 1999; Schramm and Hubert 1999). Examples of ecological functions include nutrient cycling, water movement, and soil processes (Committee of Scientists 1999).

Cumulative Watershed Effects

To implement ecosystem management, techniques are needed that assess current land conditions, landscape capabilities and capacities, and integrate that information with planning (Montgomery et al. 1995). In order to set and reach desired future conditions, a clear understanding of current conditions is critical (Montgomery et al. 1995). The NFMA requires that all national forests develop a land and resource management plan (Hornbeck and Swank 1992). In addition, NEPA requires that cumulative effects be considered when conducting an environmental analysis (Berg et al. 1996). Resource managers need information that will help them prepare plans that are based on current conditions with an understanding of the influence of past and current management activities.

Table 3.1 Sustainability attributes by scale (adapted from Committee of Scientists 1999) for the southern Appalachians riparian areas.

Scale	Composition	Function	Structure
Region	Metapopulations	Landscape connectivity	Land Cover
		Landscape pattern	Geology
Watershed	Streamsides	Energy flow	Habitat distribution
	Species	Nutrient cycling	Vegetation distribution
		Disturbances (Fire, wind, flooding, drought, debris flows)	Soil distribution
			Drainage pattern
Site	T&E species	Growth	Vegetation structure
	Obligate species	Pollination	Vegetation composition
	Facultative species	Reproduction	Standing dead vegetation
		Mortality	Leaf litter
		Competition	CWD
		Predation	Soil physical properties
		Energy flow	Soil chemical properties
		Nutrient cycling	Water quality
		Disturbances	Microclimate

There are myriad approaches to assessing cumulative watershed effects (see Reid 1993 and Berg et al. 1996 for review). "Cumulative watershed effects are those impacts accruing from more than one incident or activity that have combined to affect a stream or riparian areas" (Menning et al. 1996:35). Watershed analysis is one approach for assessing current conditions of a watershed and incorporating that information into current planning efforts (Montgomery et al. 1995; Berg et al. 1996). Effective watershed analysis identifies current condition, feasible future conditions, strategies to achieve desired conditions, and methods or criteria by which to assess progress toward these objectives (Berg et al. 1996).

Riparian Terminology

Delineating riparian areas is difficult because, as with wetlands, classification frequently depends on the perspective of the classification scheme. Two common classification schemes are technical and functional. The technical classification, which is the most frequently used, uses a set distance from the stream bank based on criteria such as slope and soil erodibility (Woodman and Cubbage 1994). In the southeast, SMZ widths can range from 6.1m (20 ft) in Georgia to 50.3m (165 ft) in Kentucky and West Virginia (Aust 1994).

The functional classification includes ecological functions of the riparian area and, therefore, can incorporate a highly variable width (Ilhardt et al. 2000). Functional classifications could be based on a combination of hydrologic, topographic, vegetative, and soil functions (Gregory et al. 1991; Ilhardt et al. 2000). Recent functional definitions recognize that riparian areas are ecotones that extend from the aquatic systems into the upland areas (Ilhardt et al. 2000). Variable widths that consider function of the riparian area and value of the aquatic resource would probably be more ecologically effective in protecting instream resources than fixed-width SMZs (Castelle et al. 1994), however, they are difficult to implement and thus potentially less effective.

Riparian areas are known by many names, including buffer strips, streamside management zones (SMZ), erosion strips, filter strips, vegetated filter strips, and shade strips. Each name places emphasis on specific functions that may not reflect all of the values of riparian areas. Many agencies, including the US Forest Service, use SMZ, which are vegetated strips along streams, to protect water quality by restricting the types of management activities that can occur within these areas. Streamside management zones may contain erosion strips, filter strips, shade strips, and buffer strips. Erosion strips adjacent to stream channels are designed to provide protection from major soil disturbing practices (e.g., roads, log landings) (Chattahoochee-Oconee National Forests Land and Resource Management Plan 1987). Filter strips are designed to filter sediment and pollutants between areas of severe soil disturbance and streams (Jefferson National Forest Land and Resource Management Plan 1985). Shade strips help maintain instream water temperatures, moist habitats, and provide CWD and habitat (Jefferson National Forest Land and Resource Management Plan 1985). The term buffer strip is all encompassing and includes filter strips, leave strips, shade strips, and SMZ (O'Laughlin and Belt 1995). Consistently classifying and delineating riparian areas is a first step towards managing riparian areas for varied resource values and functions.

Southeastern states and national forests do not agree on either classification or delineation of riparian areas. According to Castelle et al. (1994), four criteria should be used to determine the adequate size of SMZ widths: 1) resource functional value, 2) intensity of adjacent land use, 3) buffer characteristics, and 4) specific buffer functions required. Rarely is more than one of the four criteria used to determine width of riparian areas. Examples of criteria used in the southeast include stream type (perennial, intermittent, or ephemeral), physiographic province, topographic classes, steepness of adjacent slopes, erodibility of soil, stream width, or in the case of Virginia, presence or absence of trout (Aust 1994). At least two southern states, Georgia and Alabama, break riparian areas into primary and secondary zones (Aust 1994). The primary zone typically is a minimum disturbance zone immediately adjacent to the stream and the secondary zone can have a more liberal harvest but should not have the site mechanically prepared (Aust 1994).

Riparian Characteristics for Assessing Management Objectives

A variety of characteristics can be measured and assessed to determine status and health of riparian areas. To identify the key characteristics that could potentially be measured, I used several sources including suggested biological indicators for riparian areas (Brooks et al. 1998), the habitat assessment parameters for the modified Rapid Bioassessment Protocols (Barbour and Stribling 1993), the management objectives for riparian areas in the Sierra Nevada Ecosystem Project 1996 (Moyle et al. 1996), and the management objectives for riparian areas Pacific Northwest old-growth forests (SAT 1993) (Table 3.2). These sources were selected because they were relatively recent attempts to integrate state-of-the-art knowledge regarding riparian areas.

Several of these variables reflect specific management concerns in the southeastern Appalachians. For instance, EPT metrics and pH values will aid in assessing the extent and influence of acid precipitation. Changes in the distribution and abundance of key plant species (i.e., eastern hemlock and rhododendron) should be monitored. The high diversity of salamanders and their strong association with moist, cool habitats has the potential to make some salamander species reliable indicators of riparian health.

Table 3.2. Riparian characteristics and specific attributes measured in forest plans or indices of health.

Characteristic	Attribute	Reference:
Water Quality	Water temperature	SAT 1993
	Sediments - timing, volume, and character of inputs/transport	SAT 1993
	Nutrients	SAT 1993
	pH, conductivity, total alkalinity, total nitrogen, total phosphate	Brooks et al. 1998
Water Quantity		SAT 1993
	Timing of events	Virginia DOF 1997
	Runoff ratios	Virginia DOF 1997
	Channel flow status	Barbour and Stribling 1993
	Velocity-depth regimes	Barbour and Stribling 1993
Channel Characteristics		
	Existing CWD	Moyle et al. 1996, SAT 1993
	Channel gradient	Moyle et al. 1996
	Adjacent hillslope gradient	Moyle et al. 1996
	Pool frequency	Moyle et al. 1996 Barbour and Stribling 1993
	Riffle frequency	Barbour and Stribling 1993
	Sedimentation (% embeddedness, accumulation rates)	Brooks et al. 1998 Barbour and Stribling 1993
	Bottom substrate	Brooks et al. 1998
	(Epifaunal substrate)	Barbour and Stribling 1993
	Bank conditions	Barbour and Stribling 1993
	Pfankuch stability rating	Moyle et al. 1996
	Width/depth ratio	Moyle et al. 1996
	Riffle stability index	Moyle et al. 1996
	Habitat complexity	SAT 1993
	Stream habitat assessment (relative scores, wetted perimeter/mean depth ratio, proportion of riparian wetlands)	Brooks et al. 1998
	Channel alterations	Barbour and Stribling 1993
Aquatic habitats	Types present	Moyle et al. 1996
	Integrity/health of each	Moyle et al. 1996
	Instream cover	Barbour and Stribling 1993
Riparian Vegetation		
	%canopy cover	Moyle et al. 1996
	Distribution and abundance of sensitive plant species	Moyle et al. 1996
	Plant communities/seral stage present	Moyle et al. 1996
	Trees (site potential height/ role as CWD)	Moyle et al. 1996
	Vegetation disturbance	Barbour and Stribling 1993
	Bank Vegetation	Barbour and Stribling 1993
Connection to surrounding area	Width of 10 yr. flood plain	Moyle et al. 1996
	Continuity of corridor (patchiness)	Moyle et al. 1996
	Erodibility of watershed (condition of upland portions)	Moyle et al. 1996
	Riparian width	Barbour and Stribling 1993
Biota		
	Basic inventory of plants/animals present	Moyle et al. 1996
	Riparian widths needed by rip dependent animals, esp. amphibians	Moyle et al. 1996
Macroinvertebrate	Biomass and community composition	Brooks et al. 1998
Amphibian	Distinct species assemblage	Brooks et al. 1998
	Presence/absence data	Brooks et al. 1998
Avian	Richness, diversity, response guilds	Brooks et al. 1998
	Habit metrics from survey points	Brooks et al. 1998
	Landscape assessment	Brooks et al. 1998
	Louisiana Waterthrush (productivity, density, abundance)	Brooks et al. 1998
Habitat Recovery Rate		SAT 1993
Watershed Conditions/		SAT 1993
Human Impact	Number of stream crossings	Moyle et al. 1996
	Length/% of bank that is severely altered	Moyle et al. 1996
	Equivalent roaded area	Moyle et al. 1996
	Subjective or quantitative scales to rate impacts of mining, dwellings/urbanization, roads, recreation, grazing, pollution, logging, and others	Moyle et al. 1996

Methods

I contacted eight southeastern national forests (NF) and requested copies of their forest plans and any other information relevant to riparian management. Five of the eight forests sent a complete forest plan, appropriate amendments and/or decision notices related to riparian management (Nantahala and Pisgah National Forest Land and Resource Management Plan Amendment 5 1994; George Washington National Forest Final Revised Land and Resource Management Plan 1993; Jefferson National Forest Land and Resource Management Plan; Sumter National Forest Land and Resource Management Plan; Chattahoochee-Oconee National Forests Land and Resource Management Plan 1987). The Monongahela, Cherokee, and Daniel Boone NFs sent photocopies of the relevant materials from their respective forest plans, amendments, and decision notices. I reviewed the information to identify DFCs and standards for southeastern riparian areas. After summarizing the information, I sent the information back to the appropriate national forest for review of accuracy and completeness of material. The Sumter and Cherokee NFs responded with updated information. Any suggested changes were incorporated into this review.

All forest plans contain water quality goals, however, to be included with the riparian area goals in this review there had to be a statement linking water quality goals to riparian area management. To meet state, local, and federal water quality standards, forest plans must address issues of temperature, sediment, and nutrient inputs, even if not explicitly stated in the DFCs or goals. This review did not focus on specific water quality standards and guidelines such as temperature, sediment, and nutrient inputs from roads and timber harvesting activities because the forests met state BMPs and water quality goals. Additionally, the state BMPs and water quality have changed since the plans were written. However, timber-harvesting activities that addressed sustainability issues, such as vegetation structure and composition or soil compaction, were included.

Results

Format of Forest Planning Documents

Each forest plan had a general direction statement that contained the goals (desired future condition), objectives, management requirements and standards and guidelines (S&G). The plans also included desired future conditions, objectives, and S&G for specific resources (e.g., soils, waters, facilities, recreation, riparian areas). A variety of sources contained riparian management directions, including common standards for fisheries, facilities, management indicator species, range, recreation, recreational water, soil, timber, wildlife, and water (or water quality) and for separate management areas. Riparian areas were consistently identified as Management Area 18 in the forest plans that had separate management areas. Amendments to the plans addressed riparian management issues not covered adequately in the original plans.

Forest Plan Background Information

Three southeastern national forests (George Washington, Nantahala-Pisgah, and Cherokee) had recently revised their forest plans or contained amendments specifically regarding riparian areas. These forests treated riparian areas as separate management areas (Table 3.3). With the exception of Monongahela NF, riparian areas were estimated to be 95% forested (SAMAB 1996b). There were large differences in the number of estimated acres in riparian areas between a specific forest's values and SAA estimates (Table 3.3). For example, the George Washington NF estimated that there were 21,000 acres in riparian areas while the SAA estimated there were 50,353 acres on the forest (SAMAB 1996b). The Nantahala-Pisgah NF plan identified twice as much riparian area as the SAA (Table 3.3). Variability in estimates may be attributed to the width of riparian areas used in the estimate and the type of stream included (i.e., perennial and/or intermittent).

Definitions for perennial, intermittent, and ephemeral streams (if they were defined at all) differed slightly between forests. In general, perennial streams had year-round flow or flow at least 90% of the time, the channel was below the water table, and the channel was scoured. Intermittent streams flowed seasonally between10% and 90% of the time and received flow from groundwater in wetter seasons. Ephemeral streams flowed less than 10% of the year, only in direct response to precipitation, the channel was above the water table, and had scoured or unscoured channels.

Table 3.3. Summary of the southeastern national forest plans and criteria used to delineate riparian areas and streamside management zones (SMZ). Shown are the dates of the original plan and relevant amendments, states, whether riparian areas were treated as a separate management area or not (if a forest did not have a separate management area for RAs then the forest-wide goals and general direction statements for other sources in the forest plan were used) , recognized components of SMZs such as Erosion Strips (ES), Filter Strips (FS), Shade Strips (SS), and Vehicle Exclusion Zones (VZ) and stream type - perennial (P), intermittent (I), and ephemeral streams (E).

	----------NATIONAL FOREST----------							
	George Washington	**Jefferson**	**Chattahoochee**	**Monongahela**	**Nantahala-Pisgah**	**Cherokee**	**Sumter**	**Daniel Boone**
State	VA, WV	VA, WV	GA	WV	NC	NC,TN	SC	KY
Year of Plan/Amendments	1993/1994	1985/-	1985/1995	198?/1994	1987/1994	1986/1994	1985/-	1985/1990
Estimated Area (acres)	21,000	-	47,490	-	100,000	23,400	13,407	12,500
from SAA[a]	50,353	32,131	37,595	3,094	50,620	37,621	4,851	N/A
% in forest cover[a]	98%	98%	98%	82%	95%	96%	97%	N/A
Management Area	Separate	None	None	None	Separate	Separate	None	None
Riparian Delineation Criteria								
Stream Type	P,I	P,I	P,I	P,I,E	P	P	P	P
Width	Variable	100'[b]	100'	100'	100'	100'	100'	100'
Classification Criteria								
Vegetation	X	-	X	X	X	X	X	X
Soils	X	-	-	X	-	-	X	X
Water regime	-	-	-	X	-	-		-
Landform	X	-	-	X	-	-	-	-
Floodplain	100 yr.	-	100 yr.	-	100yr	-	-	100 yr.
SMZ Delineation Criteria								
SMZ stream type	P,I	P,I	P,I	P,I,E	P,I	P,I	P	P,I
SMZ width (min-max)	33'-200'	30'-290'	10'-160'	20'-250'	30'---	15'-290'	20'----	30'-290'
SMZ components	FS, SS, VZ	FS, SS	ES, SS, VZ	FS, SS	SS	FS, SS		FS, SS
SMZ width criteria								
Fish	-	X	X	-	-	-	-	-
Slope	X	X	X	X	X	X	-	X
Soil Erodibility	-	X	X	X	-	X	-	X
Stream Width	-	-	X	-	-	X	-	X
Stream Temperature	X	-	-	-	-	-	-	-
Watershed Area	-	-	-	X	-	-	-	X

[a] (SAMAB 1996)

[b] 100' on perennial streams, 50' on intermittent

The riparian area classification criteria included ecological components and the SMZ width was determined by variables that were sensitive to management activity (Table 3.3). Classification criteria for riparian areas could have included vegetation, soils, water regime, landform, and floodplain (Table 3.3). The two most commonly used criteria to delineate riparian areas were vegetation and soils. Width of the riparian zone could be determined by any combination of the presence/absence of fish, slope, soil erodibility, stream width, stream temperature, and watershed area. The two most common criteria for determining width were slope and soil erodibility. The two primary components of SMZ were filter or erosion strips to prevent material sediments from entering the stream and shade strips to maintain ambient temperature. The George Washington and Chattahoochee NFs also had vehicle exclusion zones (VZ). All forests had SMZ guidelines for perennial streams, most had guidelines for intermittent streams (except Sumter NF), and the Monongahela NF had criteria for ephemeral streams.

Desired Future Conditions for Riparian Areas

In general, the DFCs were broad, sweeping statements about what riparian areas should look like with descriptors such as maintaining natural, diverse, or healthy. The DFCs generally included specific attributes such as water quality, aquatic organisms, wildlife, and vegetation structure (Table 3.4). Recently updated forest plans were more likely to have measures of sustainability, such as vegetation structure and habitat requirements of obligate species, as well as recognition of riparian areas as ecotones with unique values (George Washington and Nantahala-Pisgah NFs).

Table 3.4. Desired future condition attributes in riparian areas for the George Washington (GW), Jefferson (Jeff), Chattahoochee (Chat), Monongahela (Mono), Nantahala-Pisgah (N-P), Cherokee (Cher), Sumter, and Daniel Boone (DB) national forests. (X = mentioned in the DFC or goal statement).

	---------------------National Forest------------------------							
Desired Future Condition	**GW**	**Jeff[a]**	**Chat[b]**	**Mono[a]**	**N-P**	**Cher**	**Sumter[c]**	**DB[a]**
Riparian	X	X	X		X	X	X	
Natural/Unique		X	X		X			
Productive	X					X		
Diverse	X							
Healthy	X							
Surface Water	X	X	X		X	X	X	X
Quality	X	X	X		X			
Quantity of Flows					X	X		
Timing of Flows					X			
Ground-water Resources					X			X
Channel Morphometry				X	X			
Streambank Stability				X	X			
Coarse Woody Debris	X				X			
Aquatic Organisms	X	X	X	X	X		X	X
Habitat	X	X	X	X	X			X
Food	X							
Wildlife	X		X	X	X		X	X
Habitat	X		X	X	X			
Food	X				X			
Vegetation Features	X			X	X		X	X
Structure	X				X			
Diversity	X							
Habitat	X			X				
Rehabilitation/restoration	X				X			X
Microclimate/Moist Habitat								
Soil Resources							X	
Cultural Resources	X		X		X			
Aesthetics & Visual Mgt.					X			
Recreation	X		X		X			
Consideration of Connectivity to Adjoining Management Area	X				X			
Monitoring	X							

[a] no DFC statement for riparian areas, used appropriate forest-wide goals
[b] no DFC statement for riparian areas, used appropriate goals for forest-wide, water, and MA 11 (recreation waters)
[c] no DFC statement for riparian areas, used appropriate forest-wide, soil, and water goals

Standards and Guidelines for Riparian Areas

Water Quality, Water Quantity, and Timing of Flows

All forests had S&Gs for water quality and were required to meet state water quality standards (Table 3.5). Standards and guidelines for maintaining timing and quantity of flows were not addressed, with one exception. The Nantahala-Pishgah required protection of the natural hydraulic and hydrologic functions of the stream channel.

Aquatic Organisms and Habitat

The primary physical and chemical variables used for S&Gs of aquatic organisms were sediment and temperature. Other variables, such as alkalinity or hydrogen sulfides, reflect conditions of particular concern to a given forest (Monongahela and Cherokee NFs respectively). Half of the forests had S&Gs for features that influence channel morphometry, such as CWD and fish habitat improvement structures. Aquatic modifications that would change the flow patterns (i.e., impoundments) were restricted on the George Washington and Jefferson NFs. Instream disturbances from equipment or other activities were discouraged or seasonally restricted to avoid disturbing spawning trout.

The S&Gs for aquatic habitat varied widely between forests. For example, the Sumter NF required provision of stream shading while the George Washington NF specified ambient water temperature, dissolved oxygen levels, CWD loadings, and sedimentation rates as measured by the Environmental Protection Agency Rapid Bioassessment Protocol (EPA RBP II).

Wildlife and Habitat

In general, the S&Gs for wildlife were either nonexistent (Sumter, Daniel Boone) or very general, e.g., provide habitat for riparian dependent species (George Washington, Cherokee) and/or management indicator species (Nantahala-Pishgah, Cherokee). In one instance the DFC for riparian wildlife included providing thermal cover, foraging areas, and hiding, resting, breeding, and rearing opportunities for wildlife (George

Table 3.5 Standards and guidelines for surface water, aquatic and terrestrial species in riparian areas for the George Washington (GW), Jefferson (Jeff), Chattahoochee (Chat), Monongahela (Mono), Nantahala-Pisgah (N-P), Cherokee (Cher), Sumter, and Daniel Boone (DB) national forests. (X = mentioned in the DFC or goal statement).

	---------------------National Forest-------------------------							
Standards and Guidelines	**GW**	**Jeff**	**Chat**	**Mono**	**N-P**	**Cher**	**Sumter**	**DB**
Surface Water	X	X	X	X	X	X	X	X
Quality	X	X		X	X	X	X	X
Flow Quantity					X			
Flow Timing					X			
Aquatic Components	X	X		X	X		X	
Physiochemical:								
Alkalinity				X				
Dissolved Oxygen	X							
Hydrogen Sulfides						X		
pH	X					X		
Sediment	X			X	X			
Temperature	X			X	X	X	X	
Channel Morphometry:	X	X		X	X			
Banks		X			X			
Pools		X		X				
CWD	X	X		X	X			
Aquatic Modifications								
Hatchery Stocking	X	X	X	X				
Impoundments	X[a]	X[a]						
Fish Habitat Improvement Structure	X	X	X	X				
Instream Disturbances	X[b]	X[b]		X[b]				
Wildlife	X	X	X		X	X		
Riparian Dependent Sp.	X		X			X		
Amphibians		X	X					
Birds		X	X		X			
Insects		X						
Mammals		X	X		X			
Reptiles			X					
Wildlife Habitat	X	X	X	X	X	X		
Snags		X	X	X				
Thermal Cover								
Foraging Areas			X	X				
Hiding & Resting				X				
Breeding & Rearing			X	X	X			
Travel Corridors								
Rehab/manipulate Vegetation				X				
Caves	X							

[a] - prohibited on wild trout streams [b]- seasonal restrictions

Washington). While the S&Gs simply state that management activities are conducted to enhance riparian-dependent species. A few forests had specific guidelines about what vegetation structure should be or look like after timber harvesting. Examples of habitat structures included were number of snags larger than 18' dbh, den trees per square mile, and dead, hollow or loose-bark trees.

Soils

Soils were rarely mentioned in DFC statements, however, there were clear S&Gs for ground disturbing activities. Ground disturbing activities are a primary source of erosion and all of the forests followed state BMPs that addressed these activities. Examples of permitted ground disturbing activities include felling of timber, cable skidding, timber stand improvement, skyline yarding, and prescribed burns. Undesirable ground disturbing activities included use of wheel and crawler vehicles, roads, log landings, skid trails, and mechanical site preparation. All forests used filter/erosion strips between areas of disturbance and streams. To assess soil disturbance, most forests used percent bare soil (usually 15%). However, the George Washington NF based soil disturbance on the presence of litter layer, topsoil, and root mass. The Jefferson, Chattahoochee, and Nantahala-Pisgah NFs identified compaction as a condition to be avoided in SMZs. All forests used mitigation measures of revegetating the disturbed area within a certain time frame and/or installing sufficient surface drainage to prevent concentrated water movement or implementing temporary measures. The Jefferson and Cherokee NFs required discing or ripping of compacted riparian soils.

Timber and Vegetation Management

All of the forests, except for the Nantahala-Pisgah NF, allowed some timber harvest within the SMZ (Table 3.6). The George Washington and Monongahela NFs allowed timber harvesting primarily to enhance riparian values. Riparian areas located in municipal water supplies were not suitable for harvesting. It was difficult to determine whether riparian areas were included in the timber base, however, where indicated, inclusion in the timber base appeared to be dependent on the management directions for adjoining areas. If the adjoining area was considered part of the timber base then the

Table 3.6. Standards and guidelines for timber and vegetation management in riparian areas on the George Washington (GW), Jefferson (Jeff), Chattahoochee (Chat), Monongahela (Mono), Nantahala-Pisgah (N-P), Cherokee (Cher), Sumter, and Daniel Boone (DB) national forests. (X= Found in standards and guidelines of the forest plan). Guidelines provided for stream type - perennial (P), intermittent (I), and ephemeral streams (E). (X = mentioned in the DFC or goal statement).

	--------------------National Forest------------------------							
Standards and Guidelines	**GW**	**Jeff**	**Chat**	**Mono**	**N-P**	**Cher**	**Sumter**	**DB**
Timber/ Vegetation Management								
Suitable for Timber Production	X^R	X^A	X^R	X^R	No	X^R	X^R	X^R
Stream Type Requirement								
Harvest Method Specified	PI	PIE	PIE	PIE				
Harvest Level Specified	PI	PI	PIE	PIE				
Vegetation Structure	X		X	X			X	
Ground Disturbing Activity	X^R	X^A	X^R	X^R	X^R	X^R	X^R	X^R
Site Prep			X^R		X			X
Equipment limits	X	X	X^R			X	X	X
Mitigation/Rehabilitation	X	X	X	X	X	X	X	X
Logging Debris		X	X					X
Salvage Sale Operations	X^R		X^R					
Herbicides	X	X^P	X					X^P
Aerial application	200' ^{Z}		100' ^{Z}					
Ground application	30' ^{Z}		25' ^{Z}					
Fertilizers				25-50' ^{Z}				

^{R}=Restricted, allowed conditionally.
^{A}=Allowed but mitigate and avoid if soils sensitive or highly erodible.
^{Z}= Restricted zone

riparian area was also included. Timber harvest allowed in SMZs had restrictions in type of regeneration method used (e.g., clear-cut, small group selection, shelterwood) and in the level of harvest taken (e.g., % basal area (BA), % canopy) dependent on the stream type (i.e., perennial, intermittent, or ephemeral). There was no consistent pattern in regeneration method used between forests other than clear-cuts were not preferred.

Four of the forests provided guidelines for how vegetation structure should look after timber harvesting. For example, changes in vegetation structure were not permitted or a minimum of 50 square feet per acre BA of dominant and co-dominant tree species were required after harvest. The Jefferson NF required that all virgin Hemlock be preserved to protect riparian areas. Only two forests addressed salvage sale operations. In the case of the George Washington NF, salvage sales were allowed if riparian values were maintained and for the Chattahoochee NF they were allowed if insect, wind, disease, or fire damage had occurred.

Three forests provided S&Gs for herbicide use (George Washington, Jefferson, and Chattahoochee NFs). The distance from the stream channel for herbicide use was dependent on the application method; aerial spraying S&Gs required a distance of 100 feet from the stream. The Monongahela NF provided S&Gs for fertilizer use and soil amendments in timber and range management, applications were not allowed in areas of limestone geology.

Other Management Actions

Integrated pest management designed to control pest and disease outbreaks could be considered to prevent unfavorable impacts on riparian areas for a majority of the forest plans (Table 3.7). Specific S&Gs for distance from stream for aerial and ground application of pesticides and insecticides in riparian areas were given on two forests. The Monongahela NF restricted pesticide application near endangered bat foraging areas.

Prescribed burning and firelines for wildfires were generally allowed only when essential (Table 3.7). Approaches to protecting water quality with prescribed fires included retaining litter layers, not mineralizing the soils, or not killing shade trees. The Nantahala-Pisgah NF required use of handtools for firelines in riparian areas unless they were deemed ineffective.

Standards and guidelines for minerals, utilities, and range generally recommended exclusion from riparian areas unless unavoidable. Surface disturbing mineral activities were excluded or restricted from all forests that had S&Gs for minerals. New leases were not allowed for surface occupancy. Other activities (oil & gas) were allowed if facilities were located outside of the riparian area. Range animals had restricted or controlled accessed to streams and other water bodies. Utility S&Gs were addressed only on the Chattahoochee NF in MA 11 (major recreational waters), all new installations were required to be underground.

Table 3.7 Standards and guidelines for management actions other than timber management in riparian areas on the George Washington (GW), Jefferson (Jeff), Chattahoochee (Chat), Monongahela (Mono), Nantahala-Pisgah (N-P), Cherokee (Cher), Sumter, and Daniel Boone (DB) national forests. (X = Found in standards and guidelines of the forest plan).

Standards and Guidelines	GW	Jeff	Chat	Mono	N-P	Cher	Sumter	DB
Other Management Actions								
Integrated pest mgt.	X	X		X		X		X
Pesticides/Insecticides	X^P			X^B		X		
Storage	X^P							
Aerial	200'^{Z}					100'^{Z}		
Ground application	200'^{Z}					50'^{Z}		
Minerals		X^P	X^P		X^P	X^P		
Oil & gas	X^P					X^P		
Other	X^P	X^P	X^P					
Prescribed Burning	X^P		X^P		X^P	X^P	X^P	X^P
Wildfire	X^P			X^P	X^P	X^P		X^P
Range	X^P	X^P	X	X				
Utility			X^U					

B-avoid in bat foraging habitat
P-prohibited or restricted with some exceptions
Z- restriction zone
U-underground

Other Cultural Resources

Visual quality objectives (VQO) were designed to protect scenic attributes of the landscape by defining the degree of acceptable change allowed by a management activity (George Washington National Forest Plan 1993). For instance, on the Cherokee NF, roads, trails, and campsites had VQOs of retention and partial retention (Table 3.8). On the George Washington NF, timber salvage in riparian areas had a VQO of retention. Visual quality objectives of retention attempt to avoid visual evidence of management activities and VQOs of partial retention keep "management activities visually subordinate to the characteristic landscape" (Nantahala -Pisgah National Forest Land and Resource Management Plan Amendment 5 1994). Visual quality objective requirements influence a variety of site characteristics including the type of vegetation removed, opening shapes and sizes, slash removal, timing of regeneration cutting on adjacent areas, and road and landing designs (to mention a few examples). Four of the forest plans required VQOs of retention and two also required VQOs of partial retention in some situations.

Facilities included structures such as boat ramps, docks, bridges, fords, culverts, stream structures, buildings, campsites, and roads. Forests with S&Gs for facilities in riparian areas recommended that new facilities be located outside of riparian areas unless essential (i.e., boat ramps, stream structures). Existing facilities had to be compatible with management objectives.

Seven of the eight forests have S&Gs for recreation in riparian areas, yet only four of the eight had specific guidelines for trails and campsites, both of which can impact riparian areas if not designed carefully. If adverse impacts occurred, S&Gs required either restoring the site or, if necessary, closure and rehabilitation of the site. New recreation sites were discouraged in riparian areas. Four forests had S&Gs for off-highway vehicle (OHV) use. Stream crossing restrictions were the most common component of OHV use in riparian areas.

Table 3.8 Standards and guidelines for cultural resources located in riparian areas on the George Washington (GW), Jefferson (Jeff), Chattahoochee (Chat), Monongahela (Mono), Nantahala-Pisgah (N-P), Cherokee (Cher), Sumter, and Daniel Boone (DB) national forests. (X = Found in standards and guidelines of the forest plan).

Standards and Guidelines	**GW**	**Jeff**	**Chat**	**Mono**	**N-P**	**Cher**	**Sumter**	**DB**
Aesthetics & Visual Resource Mgt.	X[R]		X[R]	X[I]	X[R,PR]	X[R,PR]		
Adjoining mgt. area objectives	X[R]				X			
Trails, roads, skid trails					X			
Facilities	X[P]	X[P]	X[P]		X	X[P]		X[P]
Recreation	X	X	X	X[P]	X[P]	X[P]		X
Adjoining mgt. area objectives	X							
Recreation opportunity class	X		X			X		
Vehicle use	X[P]				X			
Trails &Campsites	X[P]	X			X	X		X
Near Appalachian Trail	X[P]							
Off-highway vehicles	X		X[P]		X[N]	X[P]		
Barrier free recreation				X				

I-limits of visual quality on instream structures
N-emphasize nonmotorized recreation
P-prohibited or restricted with some exceptions
R,PR-visual quality objectives of retention or partial retention

Discussion

The goal of national forests is to maintain ecological sustainability of forest ecosystems (Committee of Scientists 1999). National forests are mandated to develop desired future conditions for riparian areas based on public values, technical expertise, and ecological limits. The variability in management direction across southern forests for riparian areas indicated a limited understanding of riparian functions, conditions, and structures needed to meet desired future conditions. Examples of these limitations include lack of a clear and consistent definition of riparian areas, lack of consistent criteria to classify riparian areas, and variability in the resource values included in the management directions for riparian areas across national forests. There was a trend from the older to newer forest plans of increasing emphasis on multiple resource values for riparian areas. The primary emphasis in older forest plans was water quality, which is reflective of the concerns at the time of their creation. Recent forest plans and amendments incorporated a more holistic view of riparian areas and recognized the many functions and values provided by these areas.

The link between desired future conditions and measurable criteria in the standards and guidelines was frequently weak across southern national forests. For example, on many forests, the soil characteristics received only cursory attention in the riparian goal statement, yet there was extensive coverage of soil-disturbing activities in the standards and guidelines. On the other hand, habitat for wildlife was frequently highlighted as a desired value but few structural features were identified in the standards and guidelines to meet those values. In some cases, the requirements for aesthetics and visual resource management contained more specific structural components than many of the wildlife guidelines. Many of the forests did not consider condition of soils, water table elevation, timing and magnitude of flows, amphibians, macroinvertebrates, channel morphometry and integrity, connection of the riparian area to the surrounding area, condition of the upland portion of the watershed, or availability of CWD. These are just a few of the potential features that are important to riparian areas and need careful consideration in forest plans.

Limited knowledge of riparian areas and/or a lack of resources, time and personnel to identify criteria due to limited funding for land management may contribute to variability in detail across the forest plans (Committee of Scientists 1999). For instance, the recently revised George Washington NF plan included specific standards and guidelines for the aquatic component and very general guidelines for the terrestrial component. This may reflect the lack of information on terrestrial riparian species and their habitat needs in southeastern forested headwaters. Southern brook trout (*Salvelinus fontinalis*) are well studied and have clear habitat requirements (Larson and Moore 1985, Dolloff 1994a, Flebbe 1994). This research was translated into detailed guidelines for aquatic habitat in the forest plan. The literature identifies only a few terrestrial species that clearly associate with headwater riparian areas, including some salamander species (Petranka et al. 1994) and some avian species such as Acadian flycatchers (*Empidonax virescens*) and Louisiana waterthrushes (*Seiurus motacilla*) (Murray and Stauffer 1995).

The larger issue is what structural features and biological components are reliable measures of sustainability in riparian areas. Identification of these features will aid in translating desired future conditions to measurable variables. Assessing every aspect of riparian functions would be costly and unrealistic. Effective tools are needed to assess health of riparian areas. Some promising approaches are being developed including watershed analysis to assess current conditions (Montgomery et al. 1995), use of biological indicators to assess riparian health (Brooks et al. 1998), as well as the traditional approach of using focal species and their habitat requirements (Committee of Scientists 1999). The high variability of riparian systems indicates that a suite of species and/or metrics may be required to reflect different riparian habitats across the Appalachians, similar to those used in Indices of Biotic Integrity (Karr et al. 1986). Inventories of riparian areas and existing status are needed to assess riparian condition. This information will aid in monitoring and evaluating how well the DFCs are being met through the standards and guidelines. This is an expanding area of knowledge and will require flexibility in forest planning.

Adaptive management will be needed to provide flexibility in responding to information gained on the effectiveness of standards and guidelines in reaching DFCs (McLain and Lee 1996, Walters 1997). Many riparian areas face current and future problems such as a current lack of CWD in some streams and a potential future loss of the eastern hemlock, a key riparian tree species in some areas. Recreational use is expanding on national forests across the U.S. How will recreational impacts on riparian areas be identified, assessed, and resolved? What will be the effect of increased abundance and density of rhododendron on riparian ecosystems? How will these effects be addressed? If fire management strategies to control the distribution and abundance of rhododendron are employed, what are the effects of fire on the stream systems, soils, and riparian organisms? Will trees in the riparian area that are damaged by insects or disease be salvaged or left on the forest floor? Leaving the damaged trees could provide important ecological benefits but could be visually unpleasant as well as posing forest health and fire hazard concerns. These are just some of the riparian concerns that will require flexibility in management strategies to meet desired future conditions.

Revision of forest plans should focus on improving several aspects of riparian guidelines. First, there should be a clear link between the DFCs and standards and guidelines. The standards and guidelines should adequately address all aspects of the DFCs. Standards and guidelines should have outside peer review to assess how well they address the DFCs. Second, tools should be implemented or developed to aid in assessing the health of riparian areas. If there is currently limited information to assess riparian health and status, areas needing further research should be identified and steps taken to fill in knowledge gaps. Third, standard definitions for riparian areas and streamside management zones should be used across national forests. Fourth, a standard format, glossary, and index should be used across national forests to aid not only the personnel on different forests in exchanging information but also to make the information more accessible to the public. Currently, forest plans are very difficult to review because each forest has a different format and few of the formats are user-friendly. Finally, riparian areas should be treated as separate management areas to highlight their importance and make information on management guidelines more readily available to the reader.

Several southeastern forests (Jefferson, Cherokee, Chattahoochee, Sumter, and Alabama national forests) are concurrently revising their plans to develop common guidelines for resource issues that must be considered at various scales and across boundaries. While a daunting task, this is an important step in improving the quality of forest plans and more specifically, riparian management.

Chapter 4. PublicValues of Riparian Areas on the Jefferson National Forest

Introduction

National Forest Management

In the past three decades, public involvement in forest planning has increased and changed substantially. Historically, national forest managers were recognized as scientific experts and their recommendations for management of national forests were accepted (Carr et al. 1998). Starting in the 1960s, the public became increasingly dissatisfied with how public lands were managed (Wondolleck 1988). In response to these concerns, important legislation concerning forest planning and public involvement were passed including the National Environmental Policy Act of 1969 (NEPA), Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), and the National Forest Management Act of 1976 (NFMA) (Erickson 1980; Hogan 1995).

The National Environmental Policy Act mandates public involvement in the preparation of environmental impact statements (Irland and Vincent 1974; Sabatier et al. 1996; Steelman 1999). The RPA calls for a resource assessment, centralized planning at the national level, a policy statement, and annual statements identifying progress and financial considerations (Ellefson 1992; Hogan 1995). In the NFMA planning phase, the Chief of the Forest Service uses the RPA information to set national objectives for resource outputs for long-term planning. Each regional forester develops standards and guidelines to achieve their objectives and resource output allocation specified in the national plan. Next, each national forest develops a forest plan to meet the regional guidelines. The NFMA requires the Forest Service to complete land management plans every 10-15 years (Gericke et al. 1992; Steelman and Ascher 1997), to use a more interdisciplinary approach in decision making than previously used by the Forest Service (Steelman 1999) and to "provide for public participation in the development, review, and revision of land management plans" (16 USC 1600, Sec. 6(d)).

National forests are encouraged to solicit public opinion at all phases and even before the planning process begins. After standards and guidelines are developed for individual forests, public comment is again solicited and can be incorporated into the standards and guidelines. Public opinion is also solicited for the regional plan and the accompanying Environmental Impact Statement.

Despite these efforts, Forest Service constituents still express dissatisfaction with attempts to involve the public in decision making (Steelman and Ascher 1997). The current system of decision making in resource agencies does not adequately incorporate the concerns of diverse stakeholders and can result in legal battles (Wondolleck 1988). This can be seen in the increase in litigation during the past two decades and has affected the Forest Service decision-making process (Jones and Taylor 1995). The era of scientific analysis substituting "for public involvement, debate, deliberation, and conflict over the management and use of natural resources has proven unfounded and unworkable in the present-day social milieu" (Bengston 1994:70). Forest planning decisions are no longer left to local or regional Forest Service officials, instead external factors such as Congress, the Forest Service Washington Office, litigation, and interest groups play an expanding role in forest planning (Sabatier et al. 1996). Significant amounts of time and money can be spent on litigation. The Forest Service receives clashing mandates from Congress such as conflicting legislation, unrealistic budget appropriations, and political pressure (Jones and Callaway 1995). To avoid excessive congressional meddling and litigation, the Forest Service must be aware of, receptive to, and responsive to the opinions of the Congress and the public.

In 1992, Chief Dale Robertson officially changed the concept of forest management from multiple use to ecosystem management (Robertson 1992). This change had long been coming as public demands for noncommodity uses and ecological sustainability increased (Bengston 1994; Gorte 1999). Forest Service personnel liberally use the term ecosystem management, yet its definition and implementation remain elusive. For the purposes of this discussion, I will use Wood's (1994) definition of ecosystem management, the "integration of ecological, economic, and social principles to manage biological and physical systems in a manner that safeguards the ecological sustainability, natural diversity, and productivity of the landscape." It should be noted that the definition of ecosystem management means different things to different people and is evolving as people attempt to implement it (Yaffee 1999). However, there are consistent elements within different definitions of ecosystem management. These elements are: "systems thinking, deeper understanding of the complexity and dynamism of ecological and social systems, more extensive consideration of different spatial and temporal scales, ecologically derived boundaries, adaptive management to deal with uncertainty, and collaborative decision making" (Yaffee 1999:714). Recent attempts to incorporate ecosystem management into the national forest planning process have not been without problems (Kessler et al. 1992; Wood 1994). An inability to smoothly integrate ecosystem management into national forest planning has increased the difficulty of managing national natural resources.

For the purposes of this discussion, I would like to focus on the collaborative planning and goal setting component of ecosystem management (Yaffee 1999). Implementing ecosystem management entails understanding human values and choices (Grumbine 1994; Salwasser 1994; Yaffee 1999). Socially defining goals and management objectives is an important component of ecosystem management (Steelman & Maguire 1999). With implementation of ecosystem management in national forest management, there is increased emphasis on identifying public values that will guide development of the desired future conditions (DFC) for national forests. The Forest Service uses the concept of DFCs to define overall characteristics of national forests as well as characteristics specific to management areas within national forest plans. Desired future conditions are typically broad statements, including goals and objectives, that describe what a forest would look like at some future time (Voth et al. 1994). The DFC incorporates the dynamic nature and natural variability of forest ecosystems. The DFC serves as "the central reference point for planning and management" (Committee of Scientists 1999). Desired future conditions are important because they influence all other phases of the forest plan, such as developing standards and guidelines, monitoring, and evaluation of the forest plan. The end goals of forest plans are typically used to resolve disputes between conflicting uses in management areas. Therefore, incorporation of diverse stakeholders in determining the DFC is critical to the development of a successful forest plan.

Public Values

Emphasis on ecosystem management and a need for more effective involvement has made it critical for the Forest Service to identify public values that will shape the development of DFCs (Carr et al. 1998). Forest managers have the technical expertise to develop standards and guidelines to help guide day-to-day management decisions. However, the values that determine the DFC of management areas should reflect public values, not the values of Forest Service personnel (Tipple and Wellman 1989).

What a value is and how it is defined in the context of natural resource management as been discussed extensively in the literature (Brown 1984; Bengston 1994; Hetherington et al. 1994; Manning et al. 1999). Two broad categories of values are preference-related value and nonpreference-related values (Brown 1984). Preference-related values are where one thing is viewed as better than another thing because of a "notion of betterness" (Brown 1984). In this case a "thing" can represent "a concept (e.g., wilderness, beauty), object (e.g., timber, watershed), or activity (e.g., recreation, conservation)" (Hetherington et al. 1994). A nonpreference-related value is defined as representational ("some physical property or characteristics"), obligatory ("the necessity of something to someone"), or functional ("biological or physical relationships of one entity to another") (Hetherington et al. 1994). Hetherington et al. (1994) argue that in the context of trying to identify public values for forest management and applying that knowledge to forest ecosystem management, the public's preference-related values should be the focus of researchers.

Preference-related values have three realms: the conceptual, the relational, and the object realms (Brown 1984). "The conceptual realm deals with the basis of preference, the relational realm deals with the act of preferring, and the object realm with the result of the preference" (Brown 1984). The conceptual realm is considered to include *held* values, which are "modes of conduct, end-states, or qualities, which could possibly be desirable" (Brown 1984). Another component of the conceptual realm of preference-related values is the ability to designate the relative importance of one object to another, called the *assigned* value (Bengston 1994). Held values provide a basis for the assigned value (Brown 1984).

Public Involvement

The range of forest management issues, diverse interests groups, and scope of legal mandates requires wise decisionmaking (Wondolleck and Yaffee 1994). To effectively manage natural resources, managers must have a solid understanding of the social issues involved (Grumbine 1997). Currently, the management and planning teams wind up dominating the planning process (Sabatier et al. 1995). To avoid excessive external influence (i.e., congressional meddling, litigation, and interests groups) and to understand the importance of public values, it would benefit the Forest Service to effectively involve the public in forest plan development. Value based information is more difficult to manage and respond to, yet traditionally, this is the type of information the Forest Service receives in written and verbal comments (Steelman 1999). The Forest Service must adapt strategies to use the information provided by the public (Steelman 1999).

The approaches to public involvement are as varied as the types of resources problems that exist. Some public involvement efforts have been successful and many others have not. The type of public involvement effort used varies with the complexity of the issue, the number of parties involved, the available data, and the time frame for making a decision. Tuler and Webler (1999) reviewed public involvement literature and found there is no consensus on good principles of a public involvement process. However, there are common elements of effective public involvement, including identification of all interested stakeholders, early involvement of stakeholders, clear goals and problem statement, ground rules for the process, joint information gathering, a process to help structure the problem, and using the input from stakeholders in the final decision (Erickson 1980; Creighton 1981; Blahna and Yonts-Shepard 1992; Selin and Chavez 1995; Glicken 1999).

Including all parties in the decision-making process from the beginning helps to establish trust between stakeholders and managers. From the start of a decision-making process, the problem should be clearly defined and the desired goals clearly stated. Clear and mutually agreed upon ground rules provide a fair environment for all participants. Joint information gathering provides participants with an opportunity to exchange ideas, perceptions, and knowledge. An increased appreciation for the perceptions of others and an increased understanding of the issue facilitates reaching an agreement (Kearney et al. 1999). The decision-making process must clearly show what assumptions were used to reach a final decision.

It is important that the process be perceived as fair to all participants. A process that is overly complex or technical may not be acceptable to all participants. Technical expertise will not be equal among all participants. If some participants perceive that they are being swamped in incomprehensible technical detail, there could be mistrust of the entire process. Researchers have found that information can be provided to participants to make sure all involved have the necessary information. Exchanging information between participants can dispel misinformation and bring up the level of understanding of all participants. In the case of ecological systems, the participants will need guidance from experts to identify the ecological constraints and limits. Where there is disagreement about data or current state of knowledge the parties involved should work together to gather the necessary information. Equally important, the final decisions should be legally defensible if all assumptions and decision criteria are clearly stated throughout the analysis. A common complaint of participants who have been involved in past public involvement exercises is a reluctance to participate in future efforts because it is unclear how their input was used in the final decision. To maintain credibility and good public relations it is essential that agencies use the information participants provide in final decisions.

Frequently, natural resource agencies use some form of alternative dispute resolution when involving the public in management decisions (Manring 1998). Alternative dispute resolution is an umbrella term used for a "variety of conflict management approaches, including collaborative problem solving, joint fact-finding, negotiation, facilitation, and mediation" to name a few of the approaches (Manring 1998:275). Despite a profusion of terms for techniques that refer to alternative dispute resolution approaches most incorporate "voluntary, face-to-face, consensus-based, problem-solving techniques" (Manring 1998:275). Alternative dispute resolution techniques encourage finding common ground, focus on identifying underlying interests of the group, use creative thinking techniques, and use objective criteria for decision making (Fisher et al. 1991).

Alternative dispute resolution techniques "lack a formal structure for identifying critical sources of disagreement in complex disputes; decision analysis can provide that structure" (Maguire and Boiney 1994:33). Researchers have found that combining decision analysis and alternative dispute resolution techniques works well for complex decisions (Maguire & Boiney 1994; Schmoldt and Peterson 2000). Decision analysis provides a structured format for making decisions. It allows participants to scrutinize assumptions, incorporates uncertainty, and ensures that the process is fair for all involved. It should allow participants to explore alternative scenarios when there is uncertainty in the data or potential outcomes. Alternative dispute resolution techniques help the process managers provide an environment where people with differing views can work together.

Project Goals

I propose that early involvement of stakeholders will be an effective approach but that it must focus on the appropriate tasks - identification of the values that will guide development of the forest plan. I wanted to evaluate an approach that consisted of the characteristics listed above and combined alternative dispute resolution techniques with decision analysis. To test this theory, I held a series of public meetings in the spring of 1997 to identify values for the DFC of riparian areas on the Jefferson National Forest (JNF), specifically in the Ridge and Valley Provinces (Blacksburg, Newcastle, and Wythe Ranger Districts).

I chose to study public involvement in management of riparian areas because of the potential for conflict among stakeholders who may have opposing, but legitimate interests. Riparian areas border streams, lakes, and other bodies of water and are areas that attract high amenity and commodity use as well as having diverse ecological values. Recreational uses, for example, may conflict with certain wildlife, timber, or fisheries uses. Legal mandates (such as the Clean Water Act) designed to protect water quality also influence management of riparian areas. Managers of riparian areas must integrate public demand for various uses with sound ecological information to meet multiple-use objectives mandated by law. Riparian issues must now be considered on multiple spatial scales and resource planning must incorporate the concerns of diverse publics.

Steiner et al. (1994) identified several features of successful wetland and riparian management programs. These features included policies for the present, clear goals for the future, and procedures for the decision-making process. The authors suggest that "clear goals should provide the bridge between the purposes and delineations and the actions and strategies needed to achieve water quality." These criteria seem straightforward, yet many agencies face difficulties in developing goals and policies that are acceptable to the public because of the multiple uses and functions of riparian areas.

Involvement of the public in identifying values for use in the development of DFCs for management of riparian areas will provide clear goals for the future. Through the involvement of diverse citizen groups, I hoped to develop DFCs for riparian areas in the Ridge and Valley provinces. People who had an interest in riparian areas were identified from the George Washington and JNF mailing list. The goals of this project were:

1) To design and test a decision-making process that could be used to incorporate public values into national forest management decisions.
2) To identify public values that should be reflected in the DFC of riparian areas on the JNF.
3) To assist the stakeholders in prioritizing the identified riparian values.
4) To evaluate the public stakeholders' satisfaction with the process and results.
5) To evaluate whether the participants were representative of others that have been involved previously in forest planning.

Methods

Identification of Stakeholders and Development of Mailing list

The JNF covers a diverse area that runs for more than 321 kilometers (200 miles) along the Appalachian Mountains in southwestern Virginia. The forest contains 287,168 hectares (709,593 acres) and three ecological subsections, based on the National Hierarchical Framework of Ecological Units (USDA 1996). The subsections included in the JNF are the Ridge and Valley, the Northern Blue Ridge Mountains, and the Pine and Cumberland Mountain subsections. I chose to work in the Ridge and Valley subsection for several reasons: 1) this is the largest ecological subsection within the JNF; 2) I wanted to work in one subsection rather than several so that the management issues were similar; and 3) I wanted to test a process of public involvement on a portion of the forest rather than the entire JNF. After I began this project, the Blacksburg and Wythe ranger districts were combined into a single, and as of yet, unnamed ranger district. However, I continued to treat the three areas as separate ranger districts for the convenience of local participants.

I used several sources of information to identify the participants for this project. The primary source of information was the JNF mailing list of any person or organization that has written or contacted the JNF, as well as people in governmental offices. Planning personnel from the JNF helped to narrow down the mailing list to people who either lived in one of the three ranger districts, had an interest in forest-wide issues, or were specifically interested in riparian area management issues. I then sorted the names of people on the modified list into three separate mailing lists - one for each ranger district. This sorting was based on zip code. People who did not live within the zip codes of any of the ranger districts were then sorted into the ranger district closest to their homes. After the first meeting, I realized that people who did not live in or near any of the ranger districts but were very active in forest planning may possibly be interested in participating even though it may have meant traveling a great distance. These names were added to the mailing list and a letter was sent to them explaining what had occurred at the first meeting. District rangers of each ranger district supplied the names of other potentially interested individuals. I added names from a separately maintained New

Castle Ranger District mailing list. Wythe Ranger District personnel compiled a list of individuals they thought would be interested in riparian area management. The Blacksburg Ranger District did not maintain a separate mailing list.

I identified other local groups that may have had an interest in riparian management, but who were not on the JNF mailing list, through several other sources. First, I scanned newspaper articles in the Roanoke Times and the New River Free Press to identify interest groups. Second, I scanned a list of local citizen groups that the Town of Blacksburg maintained on a World Wide Web site. Third, I put an announcement in the forest newsletter seeking expressions of interest. Fourth, I placed a poster at the JNF open house in October of 1996 explaining the upcoming riparian meetings and requesting interested parties to contact me. Finally, I solicited recommendations of other people who should be involved from all of the people I identified by other methods. Using all of the sources listed above I was able to develop a mailing list for each ranger district. There were 150, 121, and 90 names on the Blacksburg, New Castle, and Wythe mailing lists respectively.

Process and Structure of the Series of Public Meetings

The Federal Advisory Committee Act of 1972 (FACA) was designed to address the serious problem of special interest groups controlling and blocking public access to federal advisory committees (Wondolleck and Yaffee 1994; Frentz et al. 1997). Currently, a series of administrative requirements must be met for federal advisory committees to be formed, resulting in a very time consuming process that discourages the formation of official advisory committees for most public involvement activities (Wondolleck and Yaffee 1994; Frentz et al. 1997). It is unclear exactly how FACA applies to public involvement efforts within the Forest Service (Wondolleck and Yaffee 1994; Selin et al. 1997). Until the role of FACA in forest planning is clarified, the Forest Service "adheres to the spirit of FACA by ensuring an open process and balanced participation" (Frentz et al. 1997).

As mentioned previously, the common elements of effective public involvement include identification of all interested stakeholders, early involvement of stakeholders, clear goals and problem statement, ground rules for the process, opportunities for joint information gathering, a process to help structure the problem, and using the input from stakeholders in the final decision (Erickson 1980; Creighton 1981; Blahna and Yonts-Shepard 1992; Selin & Chavez 1995; Glicken 1999). To meet these requirements, I designed a decision-making process that allowed participants to meet multiple times, that was open to all, run by a facilitator to provide a fair environment, and had a clear agenda. Meeting multiple times allowed participants time to review material developed at previous meetings and obtain feedback from others that could not attend the meetings. I used a decision-making tool, the Analytical Hierarchy Process, to help structure the meetings and rank the values identified by the participants.

Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), a participatory decision-making tool used for prioritizing alternatives in complex situations (Saaty 1980; reviewed in Schmoldt et al. 1994) has been used successfully in a variety of fields, including National Park Service resource management planning (Peterson et al. 1994), economics and planning, conflict resolution, project selection, education, and politics (Zahedi 1986). Application of the AHP for decision making is very useful when the problem includes qualitative as well as quantitative elements (Zahedi 1986). The strengths of the AHP process include the ability to structure a complex decision into a hierarchy, to incorporate different types of data, and to make decisions based on existing knowledge. Once a problem is identified and defined, there are four steps to the AHP process: 1) structure the problem into a decision-making hierarchy, 2) collect data by pairwise comparisons of the decision elements within the hierarchy, 3) use the "eigenvalue" method to estimate the relative weights of the decision elements, and 4) aggregate the relative weights of selection choices to develop ratings of the alternatives (Saaty 1980; Zahedi 1986).

The first step is one of the most important aspects of AHP (Zahedi 1986) and consists of structuring the problem into a hierarchy, which helps to clarify components of the problem and to identify possible inconsistencies (Schmoldt et al. 1995). The hierarchy has several levels reflecting the components of the problem. A simple form of the hierarchy would consist of three levels: a goal, the criteria, and the alternatives. Other possible levels may include objectives, scenarios, events, and outcomes (Schmoldt et al. 1994).

An example will help illustrate the steps of this process. Suppose a team of recreational specialists was trying to decide on what type of new trail to build. First, they would develop a hierarchy listing the desirable attributes of the trail types under consideration (Figure 4.1). At the top of the hierarchy is the goal of increased recreational opportunity, in the form of a new trail (New Trail). Below that are the criteria used to evaluate alternative trail proposals (Location, Appeal, Impact, and Users). The location of the trail is the proximity of the trail to the target population. The appeal of the new trail includes features such as scenic beauty and interesting features such as historic relics or natural features. The impact criterion is the effect of construction of the trail on the surrounding environment and biota. The users include the type of people who would potentially use the trail such as mountain bikers, hikers, horseback riders, anglers, and large groups. The lowest level contains the alternative trails (A, B, C) being considered.

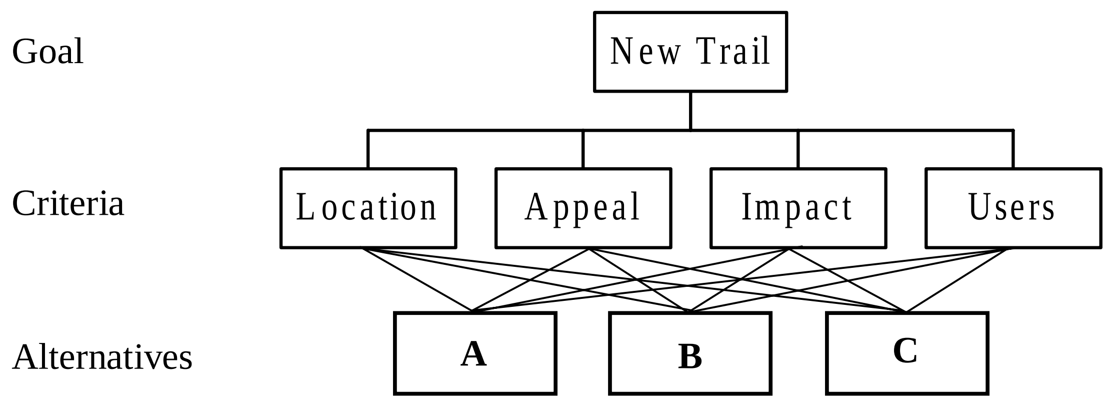


Figure 4.1. Hypothetical hierarchy for selection of new trail type. Shown are the goal, the criteria, and the alternatives.

The second step in the AHP is to collect data for making pairwise comparisons. For pairwise comparisons, participants are asked to determine the relative importance of two criteria (i.e., which is more important). Pairwise comparisons are made between all possible combinations of criteria. The scale used for comparisons is 1 to 9, where a value of 1 represents items of equal importance, a value of 3 indicates one item is moderately more important than the other, a value of 5 indicates one item is strongly more important than the other, a value of 7 indicates one item is very strongly more important than the other, and a value of 9 indicates one item is extremely more important than the other. When multiple people are involved in making pairwise comparisons, it is important to agree upon the rules used to obtain a single judgement, i.e., such as a majority vote or calculating the mean. There should be an opportunity for people to discuss any difference in judgements made for pairwise comparisons.

In this hypothetical example, I assume that the recreational team received many comments from the public requesting a trail that is close to the local community, has fishing access, and has facilities for group picnics. Local people are interested in a trail that provides a natural experience without having to hike long distances. The recreational team is also concerned that the trail not harm the surrounding environment. Using these criteria, the team members make pairwise comparisons between each of the criteria (impact, location, users, and appeal) relative to the importance of the goal (Table 4.1). Since there were several people on the recreational team, they decided to use the mean of all individuals' judgement for each pairwise comparison. Where there were extreme differences in the judgements the group discussed the reasons for differences.

Table 4.1. Example sheet of the pairwise comparison made between each criterion relative to the importance of the goal of choosing a hypothetical trail location. The numbers that are in bold, italicized with a double strikethrough indicates selected importance. A estimate of 1 is equally important, 3 is moderately more important, 5 is strongly more important, 7 is very strongly more important, and 9 is extremely more important. In the first row, Impact is 4 times as important as Location.

1	Impact	9	8	7	6	5	~~***4***~~	3	2	1	2	3	4	5	6	7	8	9	Location
2	Impact	9	8	7	6	5	~~***4***~~	3	2	1	2	3	4	5	6	7	8	9	Users
3	Impact	9	8	7	6	5	~~***4***~~	3	2	1	2	3	4	5	6	7	8	9	Appeal
4	Location	9	8	7	6	5	4	3	~~***2***~~	1	2	3	4	5	6	7	8	9	Users
5	Location	9	8	7	6	5	4	~~***3***~~	2	1	2	3	4	5	6	7	8	9	Appeal
6	Users	9	8	7	6	5	4	3	~~***2***~~	1	2	3	4	5	6	7	8	9	Appeal

After the pairwise comparisons are made of each element (Location, Appeal, Impact, and Users) with respect to the goal, a matrix (Matrix *A*) of the comparisons of elements is formed (Table 4.2). Expressed as:

$$A = (a_{ij}) = \begin{bmatrix} 1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & 1 & \dots & w_2/w_n \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ w_n/w_1 & w_n/w_2 & \dots & 1 \end{bmatrix}$$

Where:

A = matrix of pairwise comparisons
a_{ij} = wi/wj represents the importance ratio
w_i = the weight of the decision element in row i
w_j = the weight of the decision element in column j
n = the number of decision elements to be compared

In the matrix A, $a_{ij} = 1/a_{ji}$ so that the lower triangle half of the matrix is the reciprocal of the upper triangle half. Elements compared to themselves have equal importance or a value of one. Priorities are developed for each criterion based on the judgements made by the team (Saaty 1980; Schmoldt et al. 1994). Saaty (1980) developed the mathematics for making the comparisons and commercially available computer programs simplify the process of developing the hierarchy and calculating priorities. The AHP mathematics is based on linear algebra and graph theory (Saaty 1980). To summarize the calculation process, an "eigenvalue" method is used for estimating the relative weights (Zahedi 1986: 99):

> "The matrix A is defined as:
>
> $$AW = nW$$
>
> Where W = (w_1, w_2, ..., w_n) is the vector of the actual relative weights, and n is the number of elements. In matrix algebra, n and W are called the eigenvalue and the right eigenvector of matrix A.
>
> AHP posits that the evaluator does not know W and, therefore, is not able to produce the pairwise relative weights of matrix A accurately. Thus, the observed matrix A contains inconsistencies. The estimation of W (denoted as $\hat{W}$) could be obtained from:
>
> $$\hat{A}\hat{W} = \lambda_{max} \hat{W}$$
>
> Where $\hat{A}$ is the observed matrix of pairwise comparisons, λ_{max} is the largest eigenvalue of $\hat{A}$, and $\hat{W}$ is the right eigenvector. $\hat{W}$ constitutes the estimation of W."

Table 4.2. A matrix of the relative importance scores of the four criteria (Location, Appeal, Impact, and Users) for selecting a hypothetical trail location. The value, a_{ij}, in the matrix, A, represents how much more important the value in row heading i is to the value in column j.

		j Location	Appeal	Impact	Users
	Location	**1**	3	1/4	2
i	**Appeal**	1/3	**1**	1/4	1/2
	Impact	4	4	**1**	4
	Users	1/2	2	1/4	**1**

In this example, the priority vector for Table 4.2 would be W=[.216,.089,.560,.135] with a Consistency Ratio of 0.05. The Consistency Ratio is a measure of how consistently the comparative judgements were made among the different criteria. Consistency ratios of less than 0.10 are considered acceptable. Inconsistencies in judgements are expected since humans are making the judgements and the comparisons are relative. The formula for the Consistency Ratio (CR) is:

CR=100(CI/ACI)
Where:

CI=$(\lambda_{max} - n)/(n-1)$
λ_{max}= largest eigenvalue of $\hat{A}$
n=number of elements
ACI= the average consistency index of randomly generated comparisons, which varies functionally with the size of the matrix (Saaty 1980; Kangas 1994).

The result of the AHP is a priority weight assigned to each criterion. In this example, the priorities were Location (0.216), Appeal (0.089), Impact (0.560), and Users (0.135). The priority weights for all criteria within a level must sum to 1.

The next step for the recreation team was to assess how well proposed trails meet the criteria. This was done by making pairwise comparisons for each of the proposed trail locations (A, B, and C) with respect to each of the criteria (i.e. Location, Appeal, Impact, and Users). Using these data, the priority value for each alternative were calculated. For example, under the criterion Appeal, a table was created from the judgements entered for Trail A versus Trail B with respect to Appeal, as well as for all other possible combinations. This process was repeated for each of the criteria. Four new tables were created representing the criteria. The priority vectors created for each of the tables were:

$W_{Location}$ =[0.400(a_L), 0.200(b_L), 0.400(c_L),] with a Consistency Ratio of 0.0.
W_{Appeal} =[0.044(a_A), 0.019(b_A), 0.026(c_A)] with a Consistency Ratio of 0.05.
W_{Impact} =[0.128(a_I), 0.595(b_I), 0.276(c_I)] with a Consistency Ratio of 0.01.
W_{Users} =[0.122(a_U), 0.648(b_U), 0.230(c_U)] with a Consistency Ratio of 0.0.

A partial score is calculated for Trail A with respect to Location by multiplying the priority of Location with respect to New Trail (L) by the score for Trail A with respect to Location(a_L). For each of the trail locations, a total score is the sum of each partial score with respect to each criterion (Schmoldt et al. 1994). The overall rank of the Trail A location would be:

Trail A= $a_L L + a_A A + a_I I + a_U U$
Trail A=(0.400*.216) + (.044*.089) + (.128*.560) +(.122*.135)
Trail A = 0.086 +0.051 + 0.072 + 0.016
Trail A = 0.225
Where:
L = the priority of Location with respect to the goal, New Trail.
A = the priority of Appeal with respect to the goal, New Trail.
I = the priority of Impact with respect to the goal, New Trail.
U = the priority of Users with respect to the goal, New Trail.
a_L = the partial score for Trail A with respect to Location.
a_A = the partial score for Trail A with respect to Appeal.
a_I = the partial score for Trail A with respect to Impact.
a_U = the partial score for Trail A with respect to Users.

The same calculations for Trails B and C result in final scores of 0.477 for Trail B and 0.297 for Trail C. Trail B received the highest score and was chosen by the recreation team as the new trail location. In this instance, the Trail B clearly met the criteria the best. However, if the values were similar for two of the trails the recreation team could discuss the relative merits of each trail and use consensus agreement or some other approach to make the final decision. In this instance, the AHP served as a tool to help structure the problem so that trade-offs could be carefully examined.

Meeting I

My goal for the first two meetings was to develop a decision hierarchy of public values for management of riparian areas on the JNF. I first had to identify riparian values and next structure them into a hierarchy. I used alternative dispute resolution techniques such as face-to-face discussion of participants, clear ground rules for behavior, and a facilitator to moderate discussion.

I held the first meetings in spring 1997. A JNF representative, usually the JNF Revision Team Leader, attended all meetings. Three to four weeks before the meeting, I sent an announcement to all people on the mailing lists for all ranger districts explaining the purpose of the meeting, location and time of meeting, and inviting anyone interested to attend (Appendix A contains mailing dates of meeting announcements, meeting dates and locations, and number of participants). The meetings were held on weekday evenings and usually lasted for two hours. I began the first meeting by giving people a questionnaire to collect socioeconomic and demographic information and to assess their attitudes towards forest planning and riparian areas. The survey also asked if the attendees knew anyone who should be attending the meetings who weren't there. At the start of the meeting, I explained that everyone would have an opportunity to express their interests and asked that people be respectful of others. A facilitator conducted the meeting to provide structure, to maintain a cordial and inclusive atmosphere, and ensure a consistent process.

The goal of the first meeting was to identify riparian values. I used a nominal group technique to address the brainstorming question “What values should drive management of riparian areas?" Participants were given a few minutes to think about the question and silently record their responses on a piece of paper. Next, in round-robin fashion, participants stated one idea at a time and the ideas were recorded on a flipchart so that everyone could see the list of ideas. This continued until everyone's ideas were posted on the flipchart. The list of ideas were discussed and clarified. The meeting was wrapped up by reviewing the comments on the flipcharts and verbally summarizing the results. Participants were told they would be sent written summaries of the meetings.

Meeting II

I announced the second meeting by mail two to three weeks before the meeting. The announcement summarized the previous meeting and included the grouping of all comments into nine value categories. The initial nine value categories acted as a starting point for discussion with the participants. The purpose of the second meeting was to review the value groups and to reorganize them into groups acceptable to the participants. This would allow us to develop the structure of the decision hierarchy for the AHP. Because only two participants attended the Blacksburg meeting, it was cancelled.

During the meeting, attendees reviewed and discussed the groupings. To facilitate the discussion, I put paper sheets on the walls around the room that explained each value group and its components. The sheets also contained comments that illustrated the value groups. I encouraged participants to review the paper sheets to see how the comments were grouped. A facilitated discussion of the relevancy of each value group to the mission of the meetings led to the removal or reorganization of inappropriate value groups. The discussion continued until people were satisfied with the reorganized value groups.

Meeting III

I sent a meeting announcement to all people on the mailing list for each ranger district two weeks prior to the third and final meeting. Following the low attendance problem for the second Blacksburg meeting, I used phone calls and email messages to encourage attendance. I cancelled the New Castle meeting due to low attendance. Therefore, people who could not attend mailed in information.

At the third meeting, I explained and reviewed the value groups again. I then asked the group to prioritize the groups of values using the AHP. Based on previous meeting results, I structured the values into a decision hierarchy, completing the initial steps of the AHP process. At the third meetings, I asked participants to make the pairwise comparisons of the decision elements within the hierarchy (15 comparisons)(Figure 4.2). The remaining two steps, using the "eigenvalue" method to estimate the relative weights of the decision elements and aggregating the relative weights of selection choices to develop ratings of the alternatives, were facilitated by use of a software program.

The goal of the third meeting was to develop a riparian hierarchy with a single level consisting of values for the DFC of riparian areas. During the third meeting, I asked the attendees to make pairwise comparisons between every possible combination of the six value groups. I entered data on a laptop computer using commercially available software (ECPro™ for Windows, developed by Expert Choice™, Inc) and projected the composite results with a LCD Projector for attendees to see. I posted a scale (0 to 1) for each value group on the wall using a large sheet of paper. I placed a blue dot on each scale for each participant for all six value groups. Some people could not attend the meetings but had mailed in results; I also displayed those priorities on the charts. Consequently, attendees could easily see the range of values for each value group.

I discussed the distribution of the priorities for the value groups, especially when there was a wide range. In each case, meeting participants decided to use the mean value of priorities for each value group. Estimates time for the required to implement this process are given in Appendix B.

1=Equal 3=Moderate 5=Strong 7=Very Strong 9=Extreme

1	Aesthetic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Biodiversity
2	Aesthetic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Commodity
3	Aesthetic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Ecosystem
4	Aesthetic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Recreation
5	Aesthetic	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water
6	Biodiversity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Commodity
7	Biodiversity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Ecosystem
8	Biodiversity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Recreation
9	Biodiversity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water
10	Commodity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Ecosystem
11	Commodity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Recreation
12	Commodity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water
13	Ecosystem	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Recreation
14	Ecosystem	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water
15	Recreation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water

Figure 4.2. Example of pairwise comparison sheet given to participants. Participants were asked to make judgements on each pairwise comparison by circling the response that best represented their opinion of the relative importance of one item to the other.

Evaluation of the Process

I evaluated success of the riparian meetings by assessing participants' satisfaction with the process and results. Measures of success included: 1) public stakeholders' satisfaction with the final outcome, 2) public stakeholders' satisfaction with involvement in the decision-making process, 3) representation and involvement of a diverse range of stakeholders in the decision-making process, 4) public stakeholders' satisfaction with exchange of and quality of information used to make decisions, and 5) ability to develop a consensus agreement for values that should be used in the development of DFCs in riparian areas on the JNF.

The evaluation included pre- and post-questionnaires administered to participants to assess their opinions, expectations, and perceptions of the decision-making process. In addition, I asked the post-process participants to evaluate the effectiveness of the riparian meetings. I also surveyed nonparticipants to assess whether people who participated in the process were representative of people who had been previously involved in forest planning on the JNF. The questionnaires consisted primarily of multi-item scale questions and an open-ended question for respondents to make additional comments. The three surveys had four objectives in common: (see Appendix C for copies of the questionnaires)

1. To determine if participants and nonparticipants differed with respect to socioeconomic and demographic variables.
2. To assess citizens' attitudes and activities regarding forest planning.
3. To determine if participants and nonparticipants differed with respect to environmental values.
4. To determine if participants and nonparticipants differed with respect to the importance of riparian area features and the effect of management activities on riparian areas.

Socioeconomic and demographic information included year of birth, length of residence, gender, highest level of education, gross family income, current place of residence, residence of respondent's upbringing, and occupational status. For highest level of education, gross family income, current place of residence, and upbringing residence, respondents could check only one box whereas, for occupational status, they could check multiple boxes. For comparability with 1990 census data, highest level of education was collapsed from nine to four categories and gross family income categories were reduced from eight to seven categories.

For Objective 2, respondents were asked questions to assess: 1) how active they have been in forest planning, 2) what were their forest resource interests, 3) where did they obtain their forest planning information, 4) what was their level of interest in forest planning, and 5) whether they were satisfied with JNF public involvement efforts. Activity level in forest planning was assessed through questions identifying types of activities in which respondents participated, number of hours spent on planning, and organizational membership. Respondents were asked to identify the most important interests to them or the group they represented. New categories were created based on the interest groups written in by respondents. If a person listed several interests as their most important interest, a random number generator was used to choose one of the interests indicated. Level of interest in forest planning was assessed by asking respondents if they felt forest planning was a wise use of time, if they were planning to participate in upcoming forest planning, and what were their reasons for involvement in forest planning.

To assess effectiveness of public involvement activities on the JNF, pre-process respondents were asked a series of questions regarding importance and effectiveness of public involvement activities by JNF, use of and effectiveness of public involvement activities by respondents and how much influence organizations had with the JNF. The questions about JNF public involvement activities consisted of two-parts; respondents were asked to rate the importance of an activity and how well JNF was performing the activity. In addition, the respondents were asked a series of two-part questions asking how likely they were to participate in an activity and how effective that activity is in conveying their opinion to the JNF. Pre-process respondents complained about the length of the survey and especially the difficulty of answering the questions with two-parts. In response to these complaints, I simplified the survey by dropping these questions from the nonparticipation and post-process respondents' questionnaires (see Table 4.3).

Table 4.3. Riparian management survey questions by objectives. Shown are the response format, data type (ratio, nominal, ordinal), scale used (i.e., years, 5-point satisfaction scale, or hours), number of answers allowed (#), Survey Groups (Pre, Post, Non) and associated significance tests (Sig. Test). An X indicates which questions were given to a given survey group (Pre=Pre-process respondents, Post=Post-process respondents, Non=Nonparticipants). S=Single answer, M=Multiple answers, O=open ended.

Objectives	**Response Format**	**Data Type**	**Scale**	**#**	**Pre**	**Post**	**Non**	**Sig. Test**
Objective 1 - Sociodemographic Information								
Length of Residence	Open-ended	Ratio	Years	S	X	X	X	ANOVA[a]
Residence	Open-ended	Nominal	Zip code	S	X	X	X	N/A
Age	Open-ended	Ratio	Year born	S	X	X	X	ANOVA[a]
Gender	Checkbox list	Nominal	Male/Female	S	X	X	X	Chi-square
Education levels	Checkbox list	Ordinal	9 options	S	X	X	X	Chi-square
Occupational status	Checkbox list	Nominal	6 options	M	X	X	X	Chi-square
Family income	Checkbox list	Ordinal	8 options	S	X	X	X	Chi-square
Current residence	Checkbox list	Ordinal	7 options	S	X	X	X	Chi-square
Upbringing residence	Checkbox list	Ordinal	7 options	S	X	X	X	Chi-square
Additional comments	Open-ended	Nominal		O	X	X	X	
Objective 2 - Forest Planning Activities & Attitudes								
Participation in public involvement methods	Checkbox list	Nominal	17 options	M	X	X	X	Chi-square
Participation in forest planning on GWNF	Checkbox list	Nominal	Yes/No/Unsure	S	X	X	X	Chi-square
Participation in forest planning on other forests	Checkbox list	Nominal	Yes/No/Unsure	S	X	X	X	Chi-square
Member of an organization	Checkbox list	Nominal	Yes/No	S	X	X	X	Chi-square
Represent personal or organizational interests	Check box	Nominal		S	X	X	X	Chi-square
Hours spent on planning activities	Open-ended	Ratio	Hours	S	X	X	X	ANOVA[a]
Interest categories	Checkbox list	Nominal	22 options	M	X	X	X	Chi-square[b]
Most important interest	Open-ended	Nominal	write in	S	X	X	X	Chi-square[b]
Sources of information	Checkbox list	Nominal		M	X		X	Chi-square
Reasons for participation in forest planning	10 reasons	Ordinal	4-pt Importance	S	X		X	Chi-square
Forest planning is a wise use of time	Checkbox list	Nominal	Yes/No/Unsure	S	X	X	X	Chi-square
Plan to participate in the upcoming forest planning	Checkbox list	Nominal	Yes/No/Unsure	S	X	X	X	Chi-square
Satisfaction with JNF public involvement	Circle answer	Ordinal	5-pt Satisfaction	S	X	X	X	Chi-square
Importance of forest planning	Circle answer	Ordinal	5-pt Importance	S	X	X	X	Chi-square
Importance of JNF public involvement components	8 reasons	Ordinal	5-pt Importance	S	X			
How well the JNF is performing each component	8 reasons	Ordinal	5-pt Performance	S	X			
Use of Forest Service planning activities	18 activities	Ordinal	5-pt Use	S	X			
Effectiveness of Forest Service planning activities	18 activities	Ordinal	5-pt Effectiveness	S	X			
Influence of organizations with the Forest Service	21groups	Ordinal	5-pt Influence	S	X			
Objective 3 - Environmental Values								
Relationship between humans & the environment measured by the NEP Scale	Set of 12 items	Ordinal	4-item Agreement	S	X	X	X	N/A [b]
Objective 4 - Riparian Areas								
Importance of management of riparian areas	Checkbox list	Ordinal	4-pt Importance	S	X	X	X	Chi-square
Importance of riparian features	11 features	Ordinal	5-pt Importance	S	X	X	X	Chi-square
How well the JNF is maintaining these features	11 features	Ordinal	5-pt Performance	S	X			
Impact of management activities on riparian areas	14 activities	Ordinal	5-pt Impact	S	X	X		Chi-square
Effectiveness of JNF managing riparian activities	14 activities	Ordinal	5-pt Effectiveness	S	X			
Objective 5 - Evaluation of Riparian Meetings								
Number of riparian meetings attended	Checkbox list	Ordinal		S		X		
Stopped attending meetings, because:	Checkbox list	Nominal		M		X		
Treated fairly at the meetings	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Attending meetings a wise use of time	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Enough information to participate	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Willing to attend a series of meetings again	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Participate in future riparian meetings	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Agreement can be reached for riparian area DFC	Checkbox list	Nominal	Yes/No/Unsure	S		X		
Satisfaction with the meeting outcome	Circle Answer	Ordinal	5-pt Satisfaction	S		X		
Diverse range of interests represented	Checkbox list	Nominal	Yes/No/Unsure	S		X		
List any groups that were not represented:	Open-ended	Nominal		O		X		

[a] Tukey's HSD used for multiple comparison test
[b] Sample size too small to calculate test statistic

For objective 3, I used the New Environmental Paradigm (NEP) scale (Dunlap and Van Liere 1978) to measure environmental values. The NEP is a 12-item scale that was originally developed to measure an endorsement of a pro-environmental worldview and more specifically, primitive beliefs about humans' relationship with nature (Dunlap et al. in press). The NEP scale has been used to measure environmental attitudes, beliefs, and values (Dunlap and Van Liere 1978; Albrecht et al. 1982; Geller and Lasley 1985; Noe and Snow 1990; Shetzer et al. 1991; Widegren 1998). There are three dimensions of environmental values measured by the NEP: limits to growth, balance of nature, and humans over nature (Dunlap and Van Liere 1978). Agreement with 8 of the 12 items indicates acceptance of the NEP (pro-NEP) and disagreement with the remaining four items (anti-NEP) indicates acceptance of the NEP. The NEP uses a 4-point Likert scale that ranges from 1="Strongly Disagree" to 4="Strongly Agree." Reverse scoring of the anti-NEP items was used for statistical analysis and calculation of means. There was also a "no opinion" response option. For calculation of the NEP score, the sample mean was assigned for the missing item(s) if three or less of the twelve items were missing (Riley Dunlap, Boeing Distinguished Professor of Environmental Sociology, Washington State University, personal communication).

The original NEP scale was intended to be unidimensional, however, subsequent research has found the scale to have 1-4 dimensions depending on the study group (Albrecht et al. 1982; Geller and Lasley 1985; Noe and Snow 1990; Shetzer et al. 1991; Widegren 1998). Therefore, Dunlap et al. (in press) recommended validating internal consistency of the scale before using the results. I used Cronbach's alpha, which indicates how much items in an index are measuring the same thing (Vogt 1993), and high loadings on the first unrotated factor derived from factor analysis as measures of internal consistency, as per the authors recommendations (Riley Dunlap, Boeing Distinguished Professor of Environmental Sociology, Washington State University, personal communication).

For Objective 4, respondents rated the importance of management of riparian areas and the importance of several riparian features. These features included wildlife habitat, food sources for wildlife, shade for streams, water quality, flood control, erosion control, large woody debris for streams, production of high quality timber, protection of stream stability, diversity of vegetation types, and aesthetic appeal.

Pre-process Survey

I asked all participants at the beginning of the first meeting in each ranger district to complete a pre-process questionnaire. In addition to the objectives listed above, this survey assessed the following perceptions of the participants:

1) The importance and performance of the JNF with different components of public involvement programs.
2) The participation in and perceived effectiveness of different types of public involvement activities by the participants.
3) The influence of different interest groups with the JNF.
4) The impact and effectiveness of management activities on riparian areas.
5) The importance and performance of different features of riparian areas.

I pretested the questionnaire with three graduate students to ensure that the format and questions were clear.

Importance-Performance (I-P) analysis is a technique used initially in marketing and then expanded to other fields to evaluate the effectiveness of programs and services (Martilla and James 1977; Siegenthaler 1994; Hammitt et al. 1996). The technique identifies which features of a program are important to participants, how important those features are, and how well an agency is performing those features (Siegenthaler 1994; Hammitt et al. 1996). This information is then used to identify areas that need improvement.

A matrix is formed with the importance of features on the Y-axis and the performance of features on the X-axis (Figure 4.3). I plotted the mean scores of the performance and importance attributes on the I-P matrix. The middle point of the scale was used for the cross hairs of the I-P matrix. Where a feature or attribute falls on the grids provides information on the course of action to be taken for that feature. For example, if a feature falls in quadrant A, "Concentrate Here," then managers should concentrate on improving that feature.

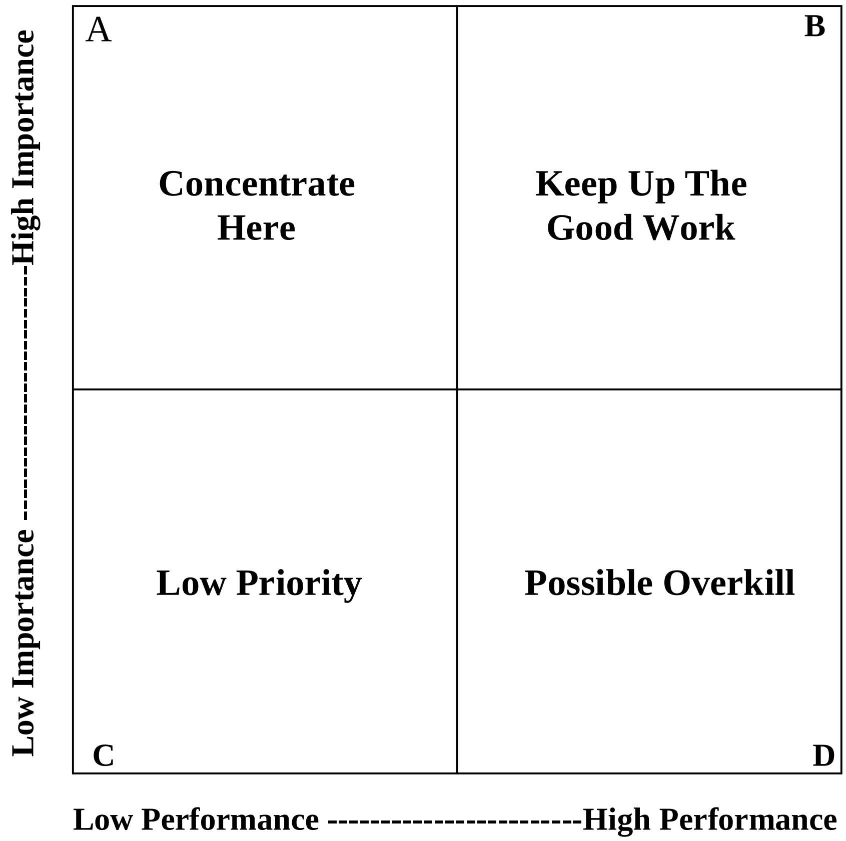


Figure 4.3. Example of an Importance-Performance analysis matrix (Martilla and James 1977). The X-axis displays how well a given task is being performed and the Y-axis displays the importance of the task.

I used Importance-Performance analysis to assess how well the JNF was performing public involvement by asking participants about the importance of public involvement components and how well the JNF was performing those components. These components included informing the public about planning issues, informing all citizens equally, usefulness of information for making planning decisions, opportunities for the citizens to influence planning decisions, engaging diverse citizens in planning, consideration of citizen recommendations, long-term commitments to planning decisions, and equal consideration to all opinions. I also used the I-P analysis to assess the importance of riparian area features and how well the pre-process participants perceived the JNF to be managing those features.

I adapted the I-P analysis to assess the Use-Effectiveness (U-E) of public involvement activities and Impact-Effectiveness (I-E) of riparian management activities. Among the public involvement activities listed were attending Forest Service presentations, private meetings with JNF personnel, signing a petition, and filing a lawsuit. Riparian management activities included use of herbicides, campsite locations, and stream crossings. Instead of evaluating the importance and performance of a feature in the matrix, I evaluated the use of public involvement activities by participants and the participants' perceived effectiveness of the activities and the impact and effectiveness of management activities on riparian areas.

Post-process Survey

I mailed self-administered questionnaires to citizens who participated in the riparian public meetings, including people who attended meetings and those who sent written comments. The survey was administered according to a modified Dillman's (1978) Total Design Method. I mailed a postcard reminder one-week after the initial mailing. A duplicate questionnaire was mailed three weeks after the initial mailing to all nonrespondents.

In addition to the general objectives listed above, this survey evaluated the effectiveness of the riparian meetings. I asked participants about how many meetings they attended, reasons for no longer attending (if applicable), their satisfaction with meetings, whether they had the information they needed to participate, if they were treated fairly, if the meetings were a wise use of their time, their willingness to participate in future meetings, and whether they felt that agreement could be reached for the development of DFCs. As with the pre-process respondents, a suite of questions were asked about the impact of several JNF management actions in riparian areas.

Nonparticipants Survey

I surveyed people who did not participate in this process but were previously active in forest planning (nonparticipants) to assess whether people who participated in this process were representative of JNF planning participants. To identify nonparticipants, I subsampled the JNF mailing list. To avoid potential bias, I excluded everyone who received information on the riparian meetings regardless of whether they attended the meetings or not. Addresses of libraries, news organizations, historical societies, colleges, legislative assistants, and other entities that did not have a single contact person were removed from the sample. This shortened the list from 2,173 names to 1,575 names in my sampling frame.

To determine the sample size, I used data from the pre-process survey and calculated the number of replicates needed to detect a difference between two means with α=0.05, n=51, and a detectable difference of 0.1 for 23 of the survey questions (Sokal and Rolhf 1981). The number of replicates needed ranged from 8 to 961, with an average of 233 and a median of 152. It was not financially feasible to mail out 961 surveys. However, a sample size of about 300 surveys would be adequate to detect differences for most of the questions and was financially realistic. To adjust for an anticipated return rate of 65-70%, I randomly selected 456 names.

I used 1990 U.S. Census Bureau data available on the Internet (http://www.census.gov//datamap/www/51-2.html) to obtain sex ratios, education level, and income data from counties that were in the Blacksburg-Wythe (Giles, Montgomery, Pulaski, Wythe, Bland, Tazewell, Smythe counties) and New Castle Ranger Districts (Botetourt, Roanoke, and Craig counties). These data were compared to the survey data to determine if forest planning participants were representative of people who lived around the JNF.

Statistical Analyses

All statistical analysis was completed using SPSS for Windows release 8.0.0 (December 22, 1997).

Data for AHP Results from Riparian Public Meetings

I used the conservative, distribution-free Friedman's test to detect differences in priorities for riparian value groups among ranger districts and to detect differences in priorities among riparian value groups. The null hypothesis was that there was no systematic variation in the priorities across ranger districts and that there was no systematic variation in the priorities across riparian value groups.

__Data for Surveys Evaluating the Process__

I used the Pearson chi-square test to detect differences among the pre-process, post-process, and nonparticipation survey groups (α=0.05) for (see table 4.3 - table with survey questions and tests used):

- sociodemographic information
- member of an organization
- represent personal or organizational interests
- types of public involvement activities
- participation in and attitude towards forest planning
- most important interest and areas of interest
- reasons for participation in forest planning
- satisfaction with JNF public involvement efforts
- importance of riparian area management
- importance of riparian features

I also used the Pearson chi-square test to detect differences among the pre-process respondents vs. nonparticipants for sources of information to learn about forest planning and reasons for participation in forest planning. The Pearson's chi-square test was used to detect differences between pre-process and post-process participants' assessment of the impact of management activities on riparian areas.

I performed a one-way Analysis of Variance (ANOVA) on hours spent on forest planning by pre-process participants, post-process participants and nonparticipants. Values greater than 50 hours/month were recoded as 50 (three cases met this criterion). I also used one-way ANOVA to detect significant differences in age and length of residency for all participants. If significant differences were detected, I used Tukey's HSD test to determine which groups differed significantly.

The gross family income categories on the survey were less than $15,000, $15,000- $24,999, $25,000-$34,999, $35,000-$44,999, $45,000 - $54,999, $55,000-$99,999, $100,000 -$119,999, and greater than $120,000. To allow comparisons of my survey data and 1990 census data, the last two income categories were combined into "More than $100,000." For statistical analyses, I coded "don't know" responses as missing values in order to avoid the inclusion of categorical data in calculations of the mean.

Meeting Results

Meeting I

Wythe

Fifteen participants, three Forest Service personnel, and three researchers attended the first meeting in the Wythe Ranger District. Most of the participants were associated with a state or federal agency. Other interests represented included horseback riding, environmental, timber interests, and the general public. The meeting focused on technical aspects of riparian management. However, there was general agreement that it was not the function of the group to set technical standards but rather to identify the values that can provide guidance to the Forest Service. Participants discussed the meaning of a value at length. They settled on a definition of what basic property, characteristic, function, or quality of riparian areas was important to the participant.

The technical ideas discussed at the meeting included: 1) how are riparian areas classified; 2) what information is available on riparian areas; 3) upon what information are management actions and ideas based; 4) what types of strategies are used to manage riparian areas; and 5) how can riparian areas remain accessible to all users and not be set off limits (see Appendix D for specific comments). Specific values that were discussed included concern for endangered species, human ecological responsibility to habitat - on and off site; improvement of water quality and habitat diversity, capturing the value of all resources (i.e., recreational, aesthetic), and maintenance of pasture-stream interfaces for better nutrient filtering.

New Castle

Eight public stakeholders participated in the New Castle meeting representing state agencies, environmental groups, timber interests and general citizenry. Having learned from the previous meeting in Wythe, I more carefully focused the participants on discussing values by posting the definition of values on a flipchart and discussing it (see definition above).

Nevertheless, some comments touched on management issues rather than values (see Appendix D). In general, these comments included how riparian areas are classified (inclusion of seeps, springs, waterholes and width of buffer strips) and how riparian areas are managed. Specific management comments included support for management of riparian areas, rather than preservation, appropriate federal and state designation of streams, use of interpretative signs to improve the public's knowledge, and management plans that are developed in concert with other multi-disciplinary planning on the forest and adjacent lands. The general groups of values included: enjoying the unique beauty of riparian areas; maintaining the biodiversity of riparian areas by providing quality instream habitat, managing for dependent species, and controlling pest species (e.g., Hemlock wooly adelgid (*Adelges tsugae*)); pro or con statements about commodity uses such as livestock, mining, power, and timber; recreational use of riparian areas; protecting and maintaining the quality and quantity of water; and looking at riparian areas as part of the surrounding ecosystem.

Blacksburg

Thirty participants, six Forest Service personnel, and four researchers participated in the Blacksburg meeting. The participants included a large component of people associated with Virginia Tech, as well as people who represented state, local, and federal agencies, environmental groups, recreational groups, timber interests and general citizenry. Because this was such a large group, I split the group in half for the brainstorming process and then brought everyone back together for the final summary. As with the New Castle group, I tried to focus on identifying values rather than management issues by posting the definition of values on a flipchart and discussing it.

The Blacksburg group favored environmental protection and the general attitude was against commodity use of riparian areas. Specific values mentioned for riparian areas included the beauty and spiritual value, biodiversity of aquatic and terrestrial areas, limit or ban all impacts on riparian areas by humans and domestic animals, maintain water quality and quantity, provide diverse recreational opportunities, and maintain or restore the many functions of the riparian ecosystem.

The Blacksburg group did not focus on specific management issues (see Appendix D). Some general management topics that were brought up included: classification of riparian areas (maintain wide buffer zones defined on solid science), educational use and benefits of riparian areas, developing monitoring protocols such as establishing reference areas, management strategies, and planning at a bioregional level.

Summary of Initial Meetings

Each ranger district meeting had a distinct character, yet the underlying themes brought up in each location were very similar. Therefore, it seemed reasonable to combine the comments from all three locations. One of the suggestions from the first meeting in New Castle was to include comments from the scoping letters. The public wrote the scoping letters in response to proposed management actions as part of the first phase of the forest planning process. These responses had been entered into a JNF database and coded for each resource category (water, timber, riparian, etc). Another suggestion was to combine comments from all three meeting locations and the scoping comments so that a single comprehensive list was created. Participants at each location were interested in the outcome from the other locations and were amenable to using a combination of comments from all three locations plus the scoping comments. Thus, using input from the meetings in Wytheville, Blacksburg, and New Castle plus comments related to riparian issues from the scoping process, I compiled a list of over 190 comments.

Meeting II

The purpose of the second series of meetings was to review all values that had been identified and to organize all the values identified into groups. To facilitate this process, I combined all 190+ comments into nine groups prior to the meeting. The nine groups (listed alphabetically) were:

Aesthetic. The Aesthetic group included the beauty and spiritual aspects of riparian areas as well as a desire to protect the viewshed. The concern was to maintain the beauty of riparian areas for others to see and enjoy, now and in the future.

Biodiversity. The Biodiversity group included the values of maintaining the genetic and habitat diversity of riparian areas. These values centered on a desire to maintain the different types of plants, animals, and habitats associated with riparian areas. The physical features that make riparian areas unique were considered essential to maintaining biodiversity.

Classification. The Classification group addressed the question, “what is included as a riparian area?" Participants wanted to know how riparian areas are defined, if federal and state designations for streams are applied on the JNF, and what type of criteria are used determine the width of riparian areas. Other riparian classification questions were: "Are seeps, springs, bogs, and waterholes included?" and "Are ephemeral, intermittent, and perennial streams included?"

Commodity. This group included resources that can be extracted from riparian areas. The four subcategories were livestock, mining, power, and timber. The livestock subcategory included the influence of domestic animals on streams and riparian areas. While participants felt there should be mechanisms for local farmers to water their livestock and protect riparian areas, they also felt that if riparian areas are used for grazing it should be part of a total grazing system for proper management.

The mining subcategory included concerns about mine drainage entering streams, as well as withdrawing riparian zones from leasing for mining areas. The Wythe meeting participants clearly indicated that large-scale surface disturbing activities would be unacceptable. The focus of all three groups was on large-scale surface disturbances related to mining activity; further investigation would be needed to clarify people’s reactions to other types of mineral and gas extraction.

The power subcategory included a range of values from no powerlines in riparian areas to allowing powerlines in riparian areas where appropriate. Participants distinguished between a transmission line paralleling a riparian area versus one that crosses a riparian area, there seemed to be preference for the second scenario. Participants felt that planning for riparian areas must be in concert with forest-wide planning. If forest-wide planning includes utility corridors and other linear facilities, then transmission and powerlines that cross riparian areas may be unavoidable on the forest. Participants appeared to be in consensus that maintaining instream flows should have a higher priority than hydropower.

The final subcategory was timber. This included a range of values from no logging in riparian areas to selective logging for high value species to timber harvest being the focal point of riparian areas with all other considerations secondary. Other concerns included the potential negative impacts of not logging in riparian areas and appropriate storm damage clean up. The scoping comments included several concerns related to the appropriateness of logging in steep headwater and intermittent streams. Comments ranged from absolutely no timber removal in headwater streams to allowing any harvesting system. For example, one scoping comment indicated that harvest systems such as shelterwood, small clearcut, and thinnings could be conducted in riparian areas without adverse environmental impacts.

Ecosystem. The Ecosystem group stressed looking at riparian areas in relation to their surrounding environments. Participants felt managers should examine the role of riparian areas in the entire watershed and how they are connected to adjacent areas. The six subcategories in this category were connectivity, drainage basin, environmental stability, human responsibility, multifunctional and natural. The connectivity subcategory valued continuous, linear riparian systems that integrate streams and terrestrial areas while recognizing their role as part of Southern Appalachian ecosystems. For example, some wildlife use riparian corridors to facilitate movement from one area to another. The drainage basin subcategory encouraged management of waterways that encompass whole drainage systems (including headwaters). The environmental stability subcategory was based on the idea that environmental stability supports species diversity, native flora, and native fauna. There should be balance between ecological destruction and repair, i.e., repair of riparian areas should be equal to or greater than the rate of destruction. The human responsibility subcategory recognized that humans have an ecological responsibility to habitat both on and off site. The multifunctional subcategory stressed the need to maintain all values and functions of riparian resources, including human use of riparian areas. The natural subcategory included maintenance of naturally functioning ecosystems or restoration of native structure and processes where appropriate.

Health: The health group included a desire to manage riparian areas so that stream and riparian area health is optimized. This included concerns about monitoring impacts of management activities, maintaining a buffer zone to minimize impacts, and a desire to lime streams that have been affected by acid deposition. Participants perceived a need for information to assess stream health and to develop strategies for restoring degraded streams. They also felt forest managers should evaluate and develop management and protection options to deal with pest species.

Management of Riparian Areas: This group focused on management strategies and approaches for riparian areas. For example, how will DFCs be reached and maintained? The management group included the following six subcategories: 1) Education - riparian areas as areas for education, as well as good examples for private lands; 2) Legislation - meet federal and state standards; 3) Monitoring - develop monitoring programs, identify model or reference streams, involve volunteers, use aquatic macroinvertebrates stream sampling program; 4) Planning - riparian area management should fit into a bioregional plan (at a minimum defined as a drainage basin) - don't look at riparian areas in isolation (on national forests); 5) Restoration - restore degraded riparian habitat; and 6) Strategies/Approaches - this included the approach the USFS uses in meeting DFCs - how to recognize which areas should be managed or left alone. What criteria are used to make management decisions? When should “action” be taken and who makes that decision? Other management characteristics that were expressed by the participants included a flexible, hands-off and practical approach to management of riparian areas.

Recreation: This group included recreational interests such as biking, angling, horseback riding, hunting, hiking, and camping. The primary concern for recreation was access, safety, and impact of trails in riparian areas.

Water: This group included concerns about water quality and quantity. Participants desired to maintain water quality from an ecological perspective (nutrients, sediment, and temperature) and to protect water quality for municipal water supplies. Concerns about water quantity included aquifer/groundwater replenishment, flood control, instream flows, and municipal water supplies.

Summary of Second Series of Meetings

At the second meeting, participants reviewed and modified the groups. The participants agreed that the DFC should only contain items directly related to goals or values for riparian areas. Participants decided that the Management and Classification groupings were really not values but management actions and elected to remove those groups (see Appendix E). The Health group was dismantled with its components shifted to other value groups; the component relating to acid deposition was moved to the Water group, the component relating to knowledge/information was moved to the Management group, and the remaining component of dealing with control of pest species was moved into the Biodiversity group. The groups Biodiversity, Ecosystem, Recreation, and Water were not otherwise significantly modified.

The Aesthetic group was not modified. There was some discussion by the New Castle participants about whether the term "aesthetic" really captured the intent of this category, including the emotional and sensory experiences that may occur in riparian areas. For example, a spiritual experience would not necessarily be classified as aesthetic. Other possible titles, such as cultural attachment, were suggested. However, the participants decided to retain the name Aesthetic.

The Commodity group was kept as is, however, the New Castle participants discussed whether the name should be changed to Economics, Consumptive, Land Use, Economic Uses, or Societal Benefits. Consensus was not reached on a potential new name. Some names such as Land Use or Societal Benefits would also cover groups such as Recreation and did not seem appropriate. Some participants expressed concern that Commodity should not be described as an extractive resource. However, the Wythe group, and later the Blacksburg group, discussed the name and felt that it adequately described the value group.

The meetings in New Castle and Wytheville were held independently of each other, yet the results were very similar for how the values were grouped. As mentioned above, the second meeting in Blacksburg was cancelled due to low participation. Many of the Blacksburg participants were on an academic schedule and were preparing to leave town at the end of the semester. Therefore, it was not feasible to reschedule a second meeting and have time for a third meeting in Blacksburg. Because the outcomes from the New Castle and Wytheville meetings were similar, I decided to use these revised value groups for the Blacksburg participants. This decision allowed us time to schedule a third meeting in Blacksburg. The final six value groups are explained below (Appendix F).

Water (Quality and Quantity)

There was strong concern that management of riparian areas should protect water quality and quantity on the JNF. Specific issues regarding water quality included protecting municipal and private water supplies, as well as providing quality water for recreational uses and stream health. Issues regarding stream health included maintaining appropriate stream temperatures, preventing excessive nutrients from entering the stream, avoiding high sediment loads in the stream channel, and minimizing the effects of acid deposition.

Water quantity issues included: 1) the role of riparian areas in aquifer/groundwater replenishment and flood control, 2) providing adequate supplies of water for municipal sources, 3) providing adequate flows for fish passage and to remove fine sediment, and 4) concerns about diverting instream flows for agricultural and other uses. Participants also felt that hydropower dams no longer used for hydropower should be removed.

Biodiversity

This group of values addressed participant concerns about species and their associated habitat. It included the value of maintaining the genetic and habitat diversity of riparian areas. Participants placed emphasis on issues related to biological integrity such as species diversity, the return of native species to historical ranges, and restoration of areas damaged by exotic insects, diseases, species, plants, etc. The participants expressed a preference for biological rather than chemical control of pest species. In addition, participants preferred preventing further damage to riparian areas.

Values for aquatic habitat included protection of riparian areas to maintain stream channel stability, to provide shade, moderate stream temperatures, and to filter sediments. Participants highly valued native species and in some cases nonnative trout species; their goal was to provide quality instream habitat for these species. Values specific to terrestrial habitat included providing wildlife corridors, use of native plant species to vegetate disturbed areas, protecting or enhancing wildlife habitat, and managing or improving habitat for single species such as providing wood duck boxes. Participants also mentioned reestablishing beaver populations for flood control and to provide natural structure and function of habitats associated with beaver. Wildlife was defined by the participants as including mammals, birds, fish, and reptiles along with invertebrates such as butterflies.

Ecosystem

This group of values dealt with spatial scales and the relationship between riparian areas and the surrounding environment. Management of riparian areas should include consideration of the entire watershed, understanding important connections between riparian areas and adjacent areas, and understanding the role riparian areas play in the Southern Appalachian ecosystem. In addition, meeting participants valued providing for environmental stability to support species diversity and native plants and maintaining the natural function of riparian areas. They also felt riparian areas should be managed for multiple use, while avoiding degradation of riparian areas.

Participants expressed concern that headwater, intermittent and ephemeral streams should be included in the definition of riparian areas and the effect they have on downstream areas should be considered, i.e., that management of waterways should encompass whole drainage basins.

Recreation

This group included recreational interests such as mountain biking, angling, horseback riding, hunting, hiking, camping, off-highway vehicle use, and bird watching. The primary concern for recreation was access, safety, and effect of trails in riparian areas. Participants felt that recreational areas should include a range of accessible sites from remote, difficult-access sites to sites easily accessible for the elderly, young, and handicapped. While hunting was considered important there was a concern about safety in heavily used areas.

The issue of trails was important to participants. They generally agreed that some trails are heavily used and degraded. Participants agreed that trails should be provided for access points to rivers for boating, swimming, and fishing uses as well as biking, hiking, off-highway vehicle use, and horseback riding. However, there should be careful recreation site and trail design and management. Location of trails adjacent to streams and in riparian areas should be planned carefully and take into consideration other recreational users, such as anglers who may be disturbed by trails located very close to streams. Related to high trail use is the impact of campsites located within the riparian areas on the quality of the area.

Commodity

The Commodity group of values included resources that typically can be removed from riparian areas. The four subcategories were livestock, mining, power, and timber. Issues associated with livestock included minimizing impacts from domestic animals, grazing rights, and mechanisms to help farmers keep cattle out of streams. Mining issues included leasing rights in riparian areas and damage to streams from mine drainage. Power issues included hydropower relicensing and powerlines crossing through riparian areas. Timber issues included harvesting or not harvesting timber from riparian areas and the repercussions of either option.

Aesthetic

This group of values included the beauty and spiritual aspects of riparian areas as well as a desire to protect the viewshed. The goal would be to maintain that beauty for others to see and enjoy, now and in the future. Participants felt that the unique beauty of riparian areas should be preserved.

Meeting III

The goal of the third and final meeting was to prioritize each of the new groups of values. Prior to the meeting, the groups of values associated with riparian areas were structured into a DFC hierarchy to facilitate the participants' ability to see the relationship between the different values (Figure 4.4). The hierarchy served as a visual reminder to the participants of the key value groups of the riparian DFC. To facilitate the prioritization of values, I used the AHP (see methods section for explanation).

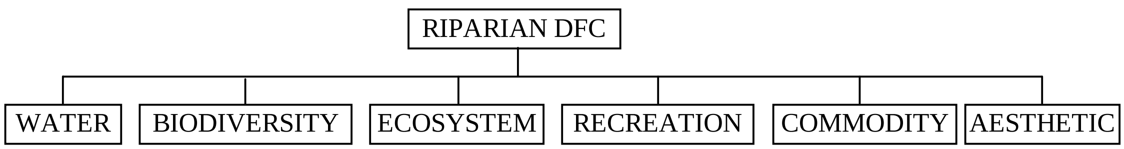


Figure 4.4. Desired Future Condition hierarchy for riparian areas on the Jefferson National Forest.

A few people were uncomfortable with quantifying or assigning ranks to qualitative values. However, the Forest Service will need quantitative ranks for qualitative values to make difficult decisions about management of riparian areas. Quantifying values allows the public to provide guidelines about the relative importance of values, rather than leaving that decision up to the Forest Service. Another concern was that the Ecosystem and Biodiversity groups both represented biological values and that putting them into two groups might split their importance.

Participants in all three districts prioritized Water, Biodiversity, and Ecosystem values as two to five times more important than Recreation, Commodity, and Aesthetic values. There were significant differences among the priorities for the riparian values groups (Friedman test, X^2=12.3, df=5, P=0.030). Among the lower priority groups, Recreation was ranked the highest, followed by Commodity and Aesthetic.

Overall, New Castle and Wythe had more similar priorities than Blacksburg (Table 4.4). While there were not significant differences among the ranger districts (Friedman test, X^2=1.00, df=2, P=.607), the Blacksburg ranger district prioritized Water, Ecosystem, and Biodiversity as equally important and New Castle and Wythe prioritized Water as clearly more important. Blacksburg had lower priorities for commodity and water and higher priorities for ecosystem and recreation than the other two locations. The three ranger districts had a similar range of priority values for Recreation and Aesthetic. However, for the other four values there was a wide range of priorities reflecting the diversity of the participants.

Table 4.4. Descriptive statistics of the riparian value group priorities for each ranger district (Blacksburg, New Castle, and Wythe) and for all ranger districts combined (Combined). S.D. = Standard Deviation

Location	**Blacksburg**		**New Castle**		**Wythe**		**Combined**	
Sample Size	15		7		9		31	
Value Groups	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Water	.237	.112	.366	.081	.314	.156	.288	.129
Biodiversity	.250	.080	.193	.062	.220	.141	.228	.098
Ecosystem	.242	.089	.170	.084	.160	.080	.202	.092
Recreation	.119	.124	.065	.019	.105	.063	.103	.093
Commodity	.057	.060	.135	.150	.127	.106	.098	.103
Aesthetic	.094	.052	.071	.034	.074	.043	.083	.046

Survey Results

Response Rates and Sample Size

All of the 52 people who attended the series of first meetings completed the pre-process questionnaire. Sixty-seven of 81 people responded to the post-process survey, a response rate of 82.7 percent. The post-process survey included people who attended any of the three meetings as well as people who sent in written comments. The nonparticipants' survey had a response rate of 67.1 percent with a total sample size of 420 and 282 returned samples. Rubin and Babbie (1997) indicate a response rate of at least 60 percent is good and a response rate of 70 percent is very good. Dolsen and Machlis (1991) found that for a homogeneous population of recreationists, a response rate of 65 percent indicated a minimal nonresponse bias. My population of respondents is probably more homogeneous than the general population because they consist of individuals who have a strong interest in issues on national forests.

Profile of Participants and Nonparticipants

My goal was to design and test a process that could be used to incorporate public values into forest management decisions. I hoped to develop and evaluate a public involvement process that would be applicable for forest management issues beyond riparian areas. I wanted to evaluate whether the meeting participants were representative of people who participate in forest planning. If the participants were representative of people involved in forest planning, and the process was successful, then it would be feasible to use this technique for other issues. To assess whether the participants were representative, I asked both the participants and the nonparticipants a series of sociodemographic questions, types of forest planning activities they participate in, where they obtained information on forest planning, environmental attitudes, knowledge of and attitude toward riparian issues. Post-process respondents were asked questions assessing their attitudes towards and satisfaction with the riparian meetings.

Sociodemographic Characteristics

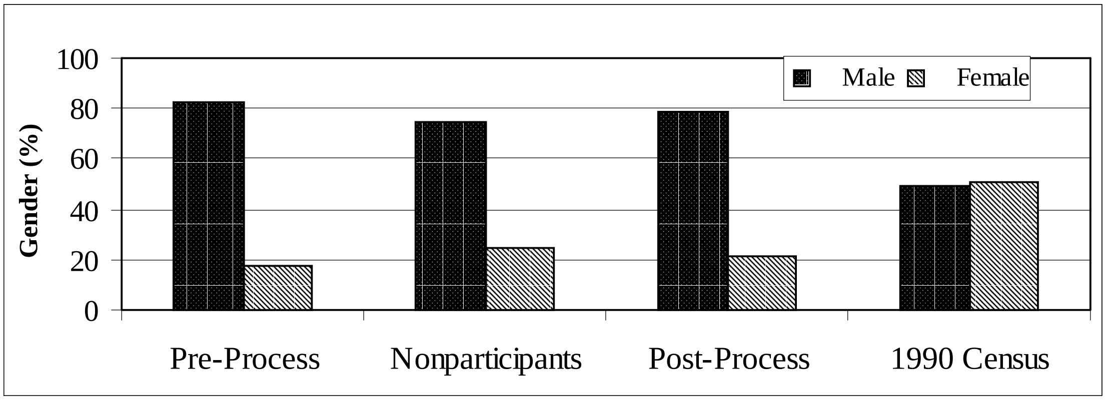
The average respondent was a middle-aged male, had lived in the area for over 18 years, was highly educated, and had a high income (Table 4.5). Participants were similar to nonparticipants except for the following categories: 1) nonparticipants were significantly older than participants; 2) retired people were more likely to participate in some form of forest planning other than these meetings; 3) people who attended the meetings were more likely to be from a rural area or small city while a higher percentage of nonparticipants lived in large cities or metropolitan areas; and 4) a higher percentage of students participated in the meetings than were involved in forest planning as a whole. For the post-process respondents, I was concerned that participants who did not attend meetings but sent in comments may be different from those who did attend meetings. Therefore, I re-examined the sociodemographic data by removing respondents who had attended no meetings from the pre-process respondent database. There were no appreciable differences between the pre-process respondents with or without people who had attended meetings.

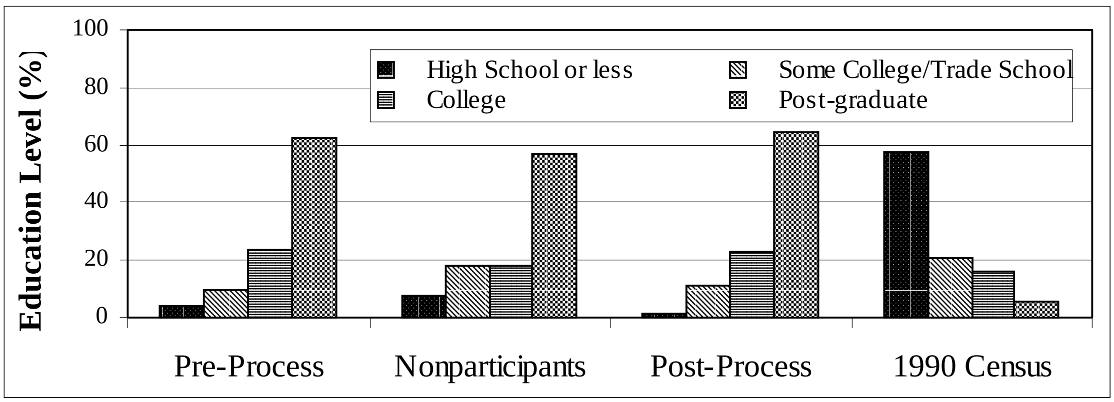
Participants in forest planning were more often male, more educated, and had a higher income than 1990 census data for the average residents of counties in the Wythe, Blacksburg, and New Castle ranger districts (Figures 4.5, 4.6, 4.7).

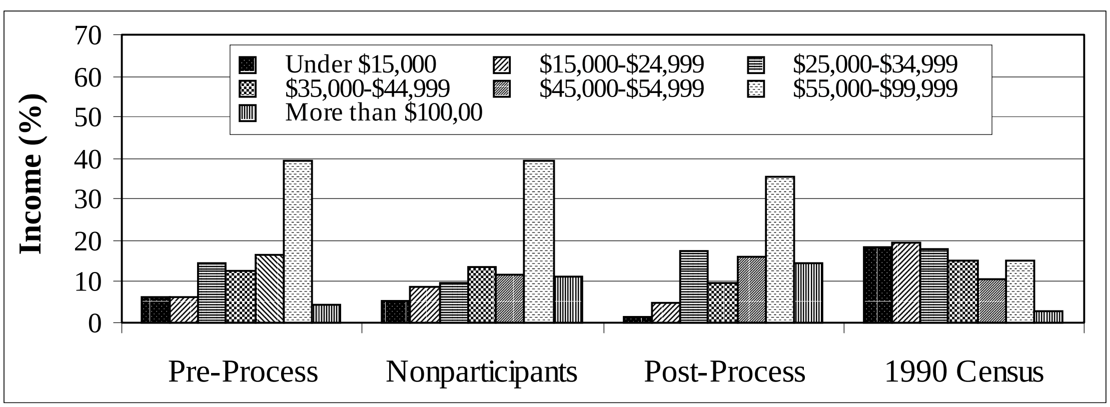
Table 4.5. Sociodemographic profile of pre-process, post-process, and nonparticipant survey respondents as well as of residents in counties surrounding the JNF using 1990 Census data.

	Survey Group			
	Pre-Process	Nonparticipants	Post-Process	1990 Census
Age (Years)[a]	47	52	49	-
Length of Residence (Years)	18.9	23.1	20.9	-
	--------------------------(percent of respondents) --------------------------			
Gender				
Male	82.4	75.0	78.5	49.1
Female	17.6	25.0	21.5	50.9
Education Levels				
High School or less	3.9	7.8	1.5	57.5
Some College/Trade School	9.8	17.8	10.8	21.0
College	23.5	18.2	23.1	16.1
Post-graduate	62.8	56.6	64.6	5.3
Family Income				
Under $15,000	6.3	5.5	1.6	18.7
$15,000-$24,999	6.3	8.7	4.8	19.5
$25,000-$34,999	14.6	9.8	17.7	18.1
$35,000-$44,999	12.5	13.8	9.7	15.2
$45,000-$54,999	16.7	11.8	16.1	10.7
$55,000-$99,999	39.6	39.4	35.5	15.1
More than $100,00	4.2	11.0	14.5	2.7
Current Residence[b]				
Farm/Ranch	13.7	14.5	9.5	-
Rural Area	35.3	32.2	42.9	-
Town	13.7	9.8	7.9	-
Small City	23.5	8.7	14.3	-
City	5.9	9.4	11.1	-
Large City	7.8	12.3	9.5	-
Metropolis	0.0	13.0	4.8	-
Upbringing Residence				
Farm/Ranch	17.6	18.5	19.0	-
Rural Area	19.6	21.2	14.3	-
Town	25.5	15.0	20.6	-
Small City	13.7	13.8	15.9	-
City	7.8	10.0	11.1	-
Large City	9.8	11.5	9.5	-
Metropolis	5.9	10.0	9.5	-
Employment Status				
Self-employed	7.8	17.9	16.9	-
Employed for someone else	68.6	57.7	70.8	-
Unemployed	2.0	0.4		-
Retired[c]	13.7	26.5	13.8	-
Full-time student[d]	11.8	1.4	6.2	-
Full-time homemaker	2.0	3.2	1.5	-

[a] significantly different (one-way ANOVA, F=4.22, df=2, P=0.015)
[b] significantly different (Chi-square=23.55, df=12, P=0.23)
[c] significantly different (Chi-square=7.547, df=2, P=0.23)
[d] significantly different (Chi-square=15.01, df=2, P=0.001)







Figures 4.5,4.6,4.7. Gender, educational level, and income of the three survey groups (pre-process, nonparticipants, and post-process) and the 1990 Census population for the counties surrounding the Wythe, Blacksburg and New Castle Ranger Districts. Shown are percentages for each group.

Resource Interests

Areas of Interests

I created 13 new interest categories, in addition to the original 22 categories, from written comments. The 35 interests were grouped into four categories: ecological, recreation, commodity, and others. Most respondents indicated an interest in ecological and recreational categories while only about a third of the respondents expressed an interest in the commodity category (Table 4.6). Eighty percent or more of all respondents were interested in environmental protection (Figure 4.8). About 50% or greater of people in all groups were interested in water, wildlife, hiking, and native plants. The water area of interest included people who checked the "water quality related" box and people who wrote in "water " or "water quantity" or "river relationships." People who attended the riparian meetings (both the pre- and post-process participants) generally were more interested in recreation and significantly more interested in other recreational interests than nonparticipants (Pearson Chi-square, X^2=6.0, df=2, P=0.049). The other recreational interest category included written responses such as photography, canoeing, tubing, and respondents who checked the other recreational interest box. Participants had a much lower interest in hiking and camping and a higher interest in water issues, horseback riding, hunting, angling, and forestry than nonparticipants.

Table 4.6. Percent of respondents, for each survey group, who checked an interest for the JNF. Respondents could check multiple boxes. Interests were grouped according to four major categories: ecological, recreation, and commodity, and other.

Interest Categories:	Pre-Process (n=46)	Nonparticipants (n=205)	Post-Process (n=61)	X^2	df	P
	(percent of respondents)					
Ecological[c]	95.7	93.7	91.8	0.6	2	0.722
Environmental Protection	89.1	83.9	80.3	1.5	2	0.469
Water	73.9	65.9	78.7	4.1	2	0.126
Wildlife	69.6	66.3	63.9	0.4	2	0.830
Native plants	54.3	52.7	49.2	0.3	2	0.849
Fish	50.0	39.0	44.3	2.1	2	0.355
Biodiversity[b]	2.2	2.0	0.0	1.2	2	0.536
Ecosystem integrity[b]	2.2	0.0	0.0	5.8	2	0.055
Old growth/wilderness[b]	0.0	3.4	0.0	3.7	2	0.154
Forest preservation[c]	0.0	1.5	0.0	1.6	2	0.454
Landscape management[b]	0.0	0.5	1.6	1.3	2	0.515
Recreation[c]	87.0	82.9	83.6	0.4	2	0.800
Hiking	54.3	67.8	54.1	5.6	2	0.061
Camping	47.8	57.1	44.3	3.7	2	0.155
Hunting	39.1	27.3	34.4	3.0	2	0.218
Angling	37.0	29.3	34.4	1.4	2	0.509
Other Recreational Interests[a]	30.4	22.4	37.7	6.0	2	**0.049**
Horseback Riding	21.7	14.1	21.3	2.7	2	0.254
Mountain Biking	17.4	16.1	19.7	0.4	2	0.806
Off-highway Vehicle Use	8.7	14.6	18.0	1.9	2	0.392
Trails[b]	4.3	1.0	0.0	4.4	2	0.113
Commodity[c]	39.1	37.1	36.1	0.1	2	0.947
Forestry Combined[d]	33.3	20.3	26.2			
Private, non-industrial forestry	23.9	15.6	18.0	1.8	2	0.399
Industrial forestry	21.7	16.6	21.3	1.1	2	0.566
Other timber related interests	10.9	8.3	14.8	2.2	2	0.325
Grazing	13.0	9.8	18.0	3.2	2	0.207
Mining	10.9	13.7	9.8	0.8	2	0.684
Business	8.7	5.4	13.1	4.3	2	0.118
Rural development/tourism[b]	2.2	2.0	1.6	0.0	2	0.979
Corridor planning/management[b]	0.0	1.0	0.0	1.1	2	0.591
Other[c]	28.3	36.6	26.2	2.9	2	0.235
Other personal interests[b]	21.7	19.5	21.3	0.8	2	0.916
Native American	13.0	16.6	6.6	4.0	2	0.139
Media	4.3	7.3	8.2	0.7	2	0.720
Education[b]	4.3	1.0	1.6	2.7	2	0.258
Multiple-Use[b]	2.2	1.0	3.3	1.7	2	0.429
Spiritual[c]	2.2	0.5	0.0	2.2	2	0.339
Historic sites[b]	0.0	0.5	1.6	1.3	2	0.515

[a] Significantly different (Pearson's Chi-square α=0.05)
[b] Signifies categories created based on written comments.
[c] Percentages for major categories were based on the selection by respondents of any interest within that category.
[d] Combined industrial forestry, private non-industrial forestry, and other timber related interests.

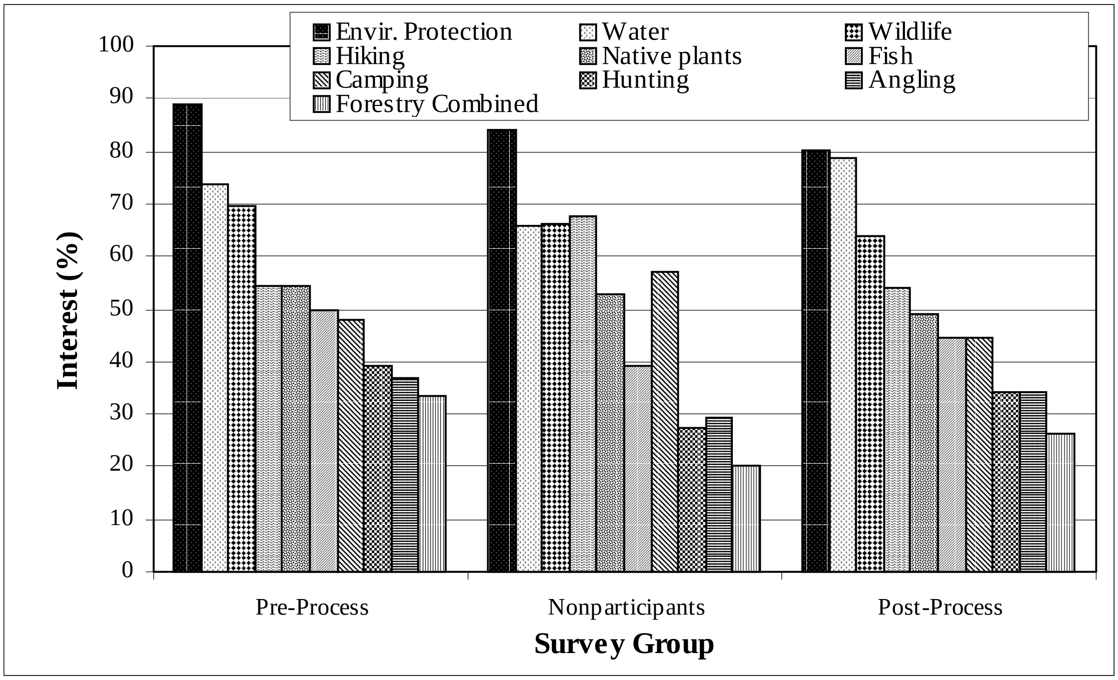


Figure 4.8. Top ten areas of interests on the JNF for pre-process, nonparticipants, and post-process respondents. Shown are percent of respondents who indicated an interest in a category.

Most Important Interest

In addition to asking respondents which categories were of interest to them, I also asked them which was the most important. The trend was for the majority of all three survey groups to rate ecological concern as the most important followed by recreation, commodity, and other interests in decreasing order of importance (Table 4.7). Pre-process, post-process, and nonparticipant respondents all held similar views of importance among the four interest categories. Environmental protection was, by far, the most important interest for all three groups (Figure 4.9). Within the ecological category, participants indicated that water, wildlife, and fish in that order were the next most important interest. Nonparticipants indicated that wildlife, old growth/wilderness, and water, respectively, were their most important ecological interests.

Recreational interests, the next most important category, were highly variable (Figure 4.10). Trails were more important to pre-process participants and horseback riding was more important to post-process participants while hiking, hunting, and off-highway vehicle use were more important to nonparticipants. Trails covered interests such as protecting old trails and making new ones, protection of the Appalachian Trail, trail riding and camping, trail use in Semi-Primitive Non-Motorized (SPNM) and Roaded Natural (RN) areas. Although angling was included among the recreational interests, no one checked it as his or her most important interest.

The third most important category was commodity with slightly more than ten percent of the respondents indicating it was important. By combining the three forestry groups (industrial forestry, private nonindustrial forestry, and other timber interests) into a single forestry category, it is clear that forestry is more important to the participants than the nonparticipants (Figure 4.9). Respondents wrote in the multiple-use category and almost ten percent of the post-process respondents indicated that it was their most important interest.

Table 4.7. Percent of survey respondents indicating the most important JNF interest of an individual or group for each of the survey groups (pre-process, nonparticipants and post-process). Interests are grouped into four major categories: ecological, recreation, forestry, and other.

Most Important Interest	Pre-Process (n=45)	Nonparticipants (n=200)	Post-Process (n=60)
		(percent of respondents)	
Ecological[b]	60.0	66.0	53.5
Environmental Protection	31.1	45.0	26.7
Water	11.1	4.0	11.7
Wildlife	6.7	6.5	6.7
Fish	6.7	1.0	5.0
Ecosystem integrity[a]	4.4	0.5	1.7
Biodiversity[a]	0.0	1.0	1.7
Forest preservation[a]	0.0	1.5	0.0
Landscape management[a]	0.0	0.5	0.0
Native plants	0.0	1.0	0.0
Old growth/wilderness[a]	0.0	4.5	0.0
Riparian areas[a]	0.0	0.5	0.0
Recreation[b]	17.7	19.5	21.7
Trails[a]	6.7	0.5	3.3
Hiking	4.4	5.0	1.7
Camping	2.2	0.0	1.7
Hunting	2.2	5.5	1.7
Horseback Riding	0.0	2.0	5.0
Mountain Biking	0.0	1.0	1.7
Off-highway Vehicle Use	0.0	3.5	3.3
Other Recreational Interests	2.2	2.0	3.3
Commodity[b]	11.0	10.5	15.1
Industrial forestry	4.4	3.0	5.0
Other timber related interests	2.2	2.0	6.7
Private, non-industrial forestry	2.2	1.0	0.0
Rural development/tourism[a]	2.2	1.5	1.7
Corridor planning/management[a]	0.0	1.5	1.7
Mining	0.0	1.5	0.0
Other[b]	8.8	4.0	10.0
Multiple-Use[a]	4.4	1.0	10.0
Education[a]	2.2	0.5	0.0
Spiritual[a]	2.2	0.5	0.0
Historic sites[a]	0.0	0.5	0.0
Native American	0.0	0.5	0.0
Other personal interests	0.0	1.0	0.0

[a]Signifies categories written in by respondents

[b] Percentages for major categories were based on the selection by respondents of any interest within that category.

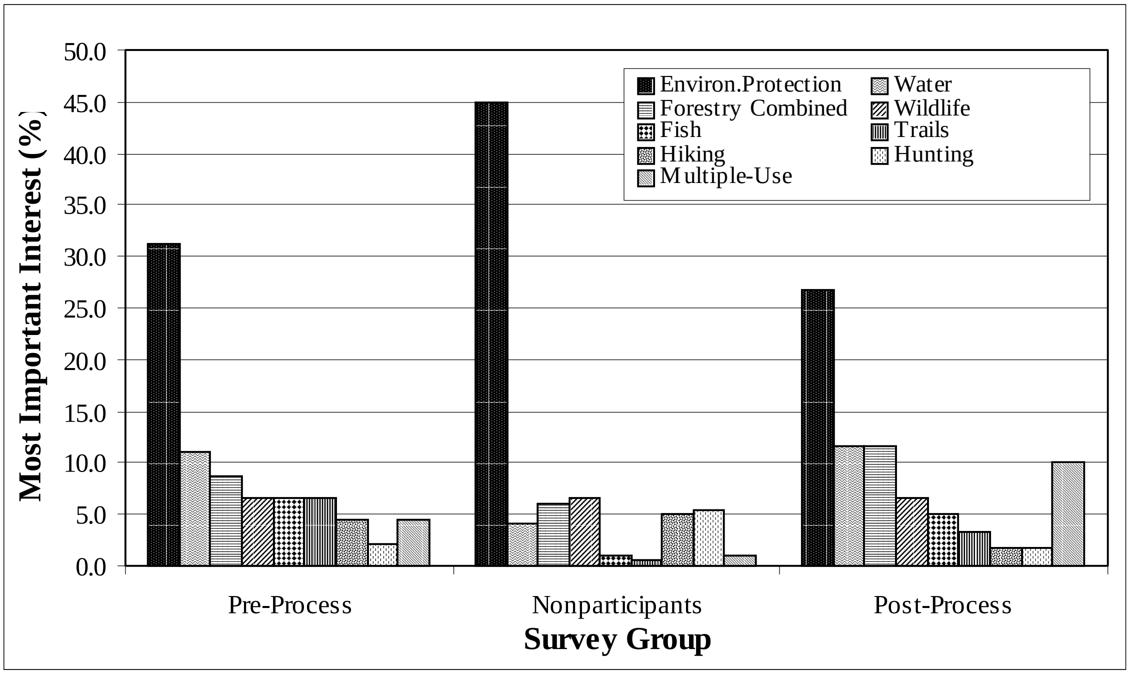


Figure 4.9. The nine most important interests categories on the JNF identified by pre-process participants, nonparticipants, and post-process participants. To be included, at least five percent of one of the survey groups had to indicate that the category shown was the most important interest. The combined forestry category includes industrial forestry, private non-industrial forestry, and other timber interests.

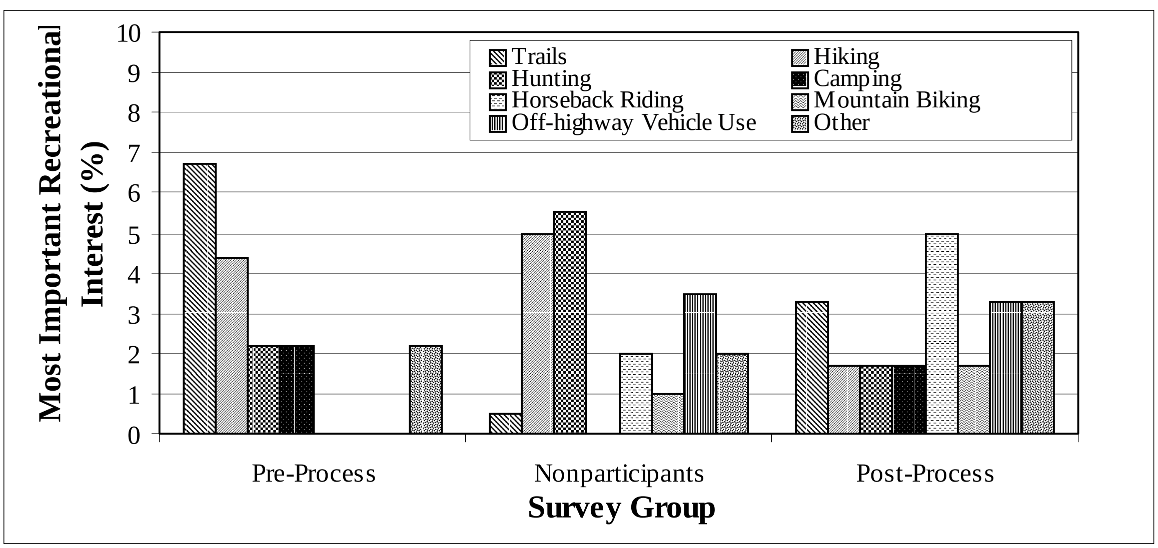


Figure 4.10. Percentages of recreational categories on the JNF that were the most important to the pre-process, nonparticipating, and post-process survey respondents.

Environmental Values

A majority of respondents for all survey groups agreed with the pro-environmental items on the NEP scale (Items 1, 2, 5, 7, 8, 9, 11,12 in Table 4.8, mean>3.0). A majority of respondents disagreed with three of the four anti-environmental items on the NEP scale (Items 3, 4, 6, 10, mean >3.0 with reverse scoring). Over 50% of the nonparticipants strongly agreed with the items measuring "Balance of Nature" (Items 2,5,8,12 in Table 4.8) while the pre-process and post-process respondents did not show a similar trend.

To test the internal consistency of the scale, I estimated Cronbach's alpha and analyzed how well all items loaded on the first unrotated factor of a principal factor analysis. Cronbach's alpha was 0.787 for the pre-process, 0.836 for the nonparticipants, and 0.882 for the post-process respondents. Values higher than 0.7 are considered acceptable (Dunlap et al. in press).

The factor analysis indicated that the first unrotated factor accounts for 32.3% of the variance for the pre-process, 38.0% of the variance for the nonparticipants, and 44.3% of the variance for the post-process respondents. All items loaded highly on the first factor for the post-process and nonparticipants. For the nonparticipants the loadings ranged from .440 to .805 and for the post-process respondents the loadings ranged from .544 to .804. However, for the pre-process group, 10 of the 12 items loaded highly on the first factor with loadings that ranged from .414 to .887 and the remaining two items loaded with values greater than 0.30. These results indicate the NEP scale has internal consistency for all survey groups.

The mean total score for the NEP scale for pre-process respondents was 39.4, for the post-process respondents it was 37.9, and for the nonparticipants it was 40.1. All scores were high and indicated acceptance of the NEP scale. A score of 48 would indicate complete acceptance. There appeared to be no overall difference between the three survey groups. These findings showed JNF forest planning participants had higher environmental values than the mean score of 35.6 for respondents surveyed in the Southern Appalachian Assessment (SAMAB 1996).

Table 4.8. Percentage distribution, sample size (N) for percentage calculations, mean values, and standard error (S.E.) are shown for NEP scale items from pre-process respondents (PRE), post-process respondents (POST), and nonparticipants (NON). Agreement with items (except 3,4,6, and 10) indicates Pro-NEP responses[a].

			Percent (%)						
			Agree		Disagree		No		
NEP Item	**Group**	**N**	**SA**	**MA**	**MD**	**SD**	**Opinion**	**Mean[c]**	**S.E.**
1. We are approaching the limit of the number of people the earth can support	PRE	51	33.3	45.1	13.7	3.9	3.9	3.1	.12
	POST	65	38.5	32.3	16.9	9.2	3.1	3.0	.12
	NON	276	46.4	25.4	15.6	5.8	6.9	3.2	.06
2. The balance of nature is very delicate and easily upset	PRE	51	45.1	23.5	27.5	2.0	2.0	3.1	.13
	POST	65	32.3	36.9	24.6	6.2	0.0	3.0	.11
	NON	280	58.9	27.5	9.3	3.2	1.1	3.4	.05
3. Humans have the right to modify the natural environment to suit their needs[b]	PRE	51	3.9	33.3	37.3	23.5	2.0	2.8	.12
	POST	65	12.3	41.5	24.6	21.5	0.0	2.6	.12
	NON	279	7.9	31.5	28.3	31.2	1.1	2.8	.06
4. Humankind was created to rule over the rest of nature [b]	PRE	50	6.0	12.0	16.0	62.0	4.0	3.4	.14
	POST	65	13.8	9.2	15.4	47.7	13.8	3.1	.15
	NON	280	12.1	13.9	13.9	55.0	5.0	3.2	.07
5. When humans interfere with nature it produces disastrous results	PRE	50	32.0	38.0	26.0	4.0	0.0	3.0	.12
	POST	64	32.8	39.1	26.6	1.6	0.0	3.0	.10
	NON	280	50.4	27.5	16.4	4.6	1.1	3.2	.05
6. Plants and animals exist primarily to be used by humans[b]	PRE	49	2.0	14.3	26.5	53.1	4.1	3.4	.12
	POST	65	7.7	20.0	15.4	55.4	1.5	3.2	.13
	NON	277	7.6	12.6	26.4	50.2	3.2	3.2	.06
7. To maintain a healthy economy we will have to develop a "steady-state" economy where industrial growth is controlled	PRE	49	30.6	36.7	12.2	6.1	14.3	3.1	.14
	POST	65	32.3	29.2	13.8	10.8	13.8	3.1	.14
	NON	275	40.0	38.5	12.0	3.6	5.8	3.2	.05
8. Humans must live in harmony with nature in order to survive	PRE	50	66.0	26.0	2.0	4.0	2.0	3.6	.11
	POST	65	64.6	23.1	9.2	3.1	0.0	3.5	.10
	NON	277	78.7	17.7	1.8	1.1	0.7	3.8	.03
9. The earth is like a spaceship with only limited room and resources	PRE	50	62.0	28.0	8.0	2.0	0.0	3.5	.10
	POST	65	68.8	22.2	3.2	3.6	2.2	3.5	.10
	NON	279	61.5	26.2	7.7	3.1	1.5	3.6	.04
10. Humans need not adapt to the natural environment because they can remake it to suit their needs[b]	PRE	50	2.0	6.0	28.0	62.0	2.0	3.5	.10
	POST	65	0.0	18.5	20.0	56.9	4.6	3.4	.10
	NON	277	1.8	4.7	21.7	69.0	2.9	3.6	.04
11. There are limits to growth beyond which our industrialized society cannot expand	PRE	50	64.0	22.0	6.0	2.0	6.0	3.6	.10
	POST	65	53.8	16.9	15.4	3.1	10.8	3.4	.05
	NON	277	54.9	29.6	4.3	5.4	5.8	3.4	.12
12. Humankind is severely abusing the environment	PRE	50	52.0	32.0	8.0	6.0	2.0	3.3	.13
	POST	65	41.5	30.8	15.4	9.2	3.1	3.1	.13
	NON	279	65.2	23.3	7.2	3.6	0.7	3.5	.05

[a] SA=Strongly agree (coded 4), MA=mildy agree (coded 3), MD=mildly disagree (coded 2), and SD=strongly disagree (coded 1).
[b] Reverse scoring applied to responses.
[c] Mean scores calculated without "no opinion" values.

Citizen Involvement in Forest Planning

Level of Interest in Forest Planning

Pre-process respondents, post-process respondents, and nonparticipants did not differ significantly in organizational membership (Pearson's Chi-square=2.71,df=2, P=0.258) or if they represented personal or group interests when participating in forest planning (Pearson's Chi-square=5.83,df=2, P=0.054). Sixty-seven percent of the pre-process respondents, 55% of nonparticipants, and 62% of post-process respondents said they were members of an organization. Fifty-one percent of the pre-process respondents, 62% of nonparticipants, and 45% of post-process respondents said they represented personal interests when participating in forest planning activities.

When asked whether forest planning was a wise use of time, the majority of the respondents said yes (Table 4.9). Very few participants said forest planning was not a wise use of time. Despite answering that participation in forest planning was a wise use of time, fewer people were willing to participate in forest planning activities. Over one quarter of the respondents were unsure whether they would participate in forest planning. The three respondent groups did not differ significantly in terms of planning being a wise use of time (Pearson's Chi-square=3.35, df=2, P=0.187) or plans to participate in upcoming forest planning (Pearson's Chi-square=5.85, df=2, P=0.054).

Table 4.9. JNF survey respondents response to whether planning is a wise use of time and plans to participate in forest planning.

		Pre-Process	**Nonparticipants (percent of respondents)**	**Post-Process**
		(n=46)	**(n=201)**	**(n=60)**
Is forest planning a wise use of time?	yes	76.1	82.6	68.3
	no	2.2	4.0	8.3
	unsure	21.7	13.4	23.3
		(n=46)	**(n=200)**	**(n=61)**
Do you plan to participate in forest planning?	yes	73.9	61.5	60.7
	no	0.0	10.5	11.5
	unsure	26.1	28.0	27.9

Forest planning was important to all survey respondents. The majority of participants and nonparticipants indicated that forest planning scored importance of 4 or 5 indicating high importance to them (Table 4.10). There were no significant differences between the three respondent groups (Pearson's Chi-square=14.89, df=8, P=0.061)

Table 4.10. Importance of forest planning to JNF survey respondents.

Respondent Group	N	Mean	Level of Importance (%) Low<---------------------------------->High				
			1	2	3	4	5
Pre-Process	45	4.33	0.0	0.0	8.9	48.9	42.2
Nonparticipants	201	4.30	1.0	1.0	15.4	32.3	50.2
Post-Process	61	4.13	0.0	6.6	18.0	31.1	44.3

Reasons for Involvement

The most important reason pre-process respondents and nonparticipants listed for being involved in forest planning was to preserve the forest for future generations (Table 4.11). Other top reasons for participation included influencing forest planning decisions, learning more about issues on the JNF and having an opportunity to express opinions. Nonparticipants identified preserving the spiritual value of the forest as significantly more important than pre-process respondents (Table 4.11). The least important reasons for forest planning involvement included defending economic interests and defending a way of life.

Table 4.11 Reasons for pre-process and nonparticipants participation in JNF planning. Results shown for Pearson Chi-square test and frequency distribution.

				----------------	**Percent Agreement (%)**			-----------------		
Reasons for Participation	**Respondent Group**	**N[a]**	**Mean[b]**	**Not Needed**	**Somewhat Important**	**Important**	**Very Important**	**Don't Know**	X^2	**P**
To learn more about issues on the Jefferson National Forest	Pre-Process	46	3.2	2.2	13.0	50.0	34.8	0.0	2.8	0.588
	Nonparticipants	199	3.3	0.5	13.6	41.7	43.7	0.5		
To have an opportunity to express my opinion(s)	Pre-Process	46	3.1	4.3	21.7	34.8	39.1	0.0	1.0	0.904
	Nonparticipants	194	3.2	3.6	17.0	34.0	44.8	0.5		
To influence forest planning decisions	Pre-Process	45	3.2	2.2	15.6	37.8	44.4	0.0	3.1	0.541
	Nonparticipants	196	3.4	2.6	13.8	26.5	56.1	1.0		
To defend my economic interests	Pre-Process	46	1.6	65.2	19.6	6.5	8.7	0.0	6.0	0.201
	Nonparticipants	185	1.9	51.9	16.2	11.9	14.1	5.9		
To defend my recreational interests	Pre-Process	45	3.0	8.9	20.0	35.6	35.6	0.0	1.2	0.887
	Nonparticipants	188	3.1	6.3	20.5	32.1	40.0	1.1		
To fulfill my civic responsibilities	Pre-Process	45	2.6	15.6	26.7	35.6	22.2	0.0	6.0	0.199
	Nonparticipants	188	2.9	10.6	17.0	37.2	28.7	6.4		
To preserve the forest for future generations	Pre-Process	46	3.7	2.2	4.3	17.4	73.9	2.2	3.9	0.414
	Nonparticipants	197	3.8	1.0	1.5	10.7	85.3	1.5		
To preserve the spiritual value of the forest[c]	Pre-Process	44	2.8	25.0	9.1	22.7	43.2	0.0	23.2	**<0.001**
	Nonparticipants	190	3.3	4.2	11.6	25.3	51.1	7.9		
To defend my way of life	Pre-Process	43	2.3	34.9	20.9	20.9	23.3	0.0	8.9	0.063
	Nonparticipants	182	2.6	17.6	24.7	23.1	26.4	8.2		

[a]Sample size (N) shown for percentage calculation
[b]Means calculated with "don't know" values coded as missing.
[c]Significantly different (Pearson's Chi Square, α=0.05)

Sources of Information

Over 50% of the pre-process respondents and nonparticipants obtained information on forest planning from newspapers, the JNF newsletter, organizational meetings, and JNF personnel (Table 4.12). Post-process respondents were not asked this question. A significantly higher percentage of pre-process respondents received information from academic sources, communication with forest service personnel, and Forest Service publications (i.e., other forests' newsletters, technical literature, and Forest Service studies). A significantly higher percentage of nonrespondents received information from organizational literature such as magazines and newsletters from conservation and scientific organizations.

Table 4.12. Sources of information on forest planning for pre-process and nonparticipant respondents. Shown are results from Pearson's Chi-square analysis.

Sources of Information to learn about forest planning:	**Pre-Process (n=46)**	**Nonparticipants (n=206)**	X^2	**df**	**P**
	(percent of respondents)				
Newspaper	65.2	60.7	0.3	1	.567
JNF Newsletter	63.0	54.4	1.1	1	.284
Organizational Meeting[a]	60.9	40.8	6.1	1	**.013**
JNF Personnel[a]	52.2	31.6	7.0	1	**.008**
Friends	47.8	37.9	1.6	1	.212
Radio[a]	37.0	20.9	5.4	1	**.021**
TV	26.1	29.1	0.2	1	.680
Other Categories Specified by Participants:					
Academic Sources[a]	6.5	1.0	6.0	1	**.015**
Communication w/ agency personnel[a]	4.3	0.5	4.8	1	**.028**
Internet	0.0	1.5	0.7	1	.410
Organizational literature[a]	2.2	21.8	9.8	1	**.002**
Professional contacts	0.0	2.9	1.4	1	.241
USFS Planning documents or participation in planning	8.7	4.4	1.4	1	.230
USFS publications[a]	13.0	1.5	14.7	1	**<.001**

Forest Planning Activities

Hours Spent on Forest Planning

Time spent on forest planning differed among pre-process respondents, post-process respondents, and nonparticipants (One-Way ANOVA F=10.09, df=2, p<=0.001). Multiple comparison tests (Tukey's HSD test) revealed that pre-process and post-process respondents spent similar amounts of time on forest planning (p=0.348). By contrast, nonparticipants spent significantly less time on forest planning than pre- and post-process respondents (pre v. non p<0.0001, post v. non p=0.018). Pre-process respondents spent a mean of 8.6 hours per month and post-process respondents spent a mean of 6.3 hours per month on forest planning. The majority (76%) of nonparticipants spent less than one hour per month on forest planning, with a mean of 2.6 hours per month.

Involvement in Forest Planning Activities

The top forest planning activity for all survey groups was reading a forest plan (Table 4.13). Forest planning activities that required more time were significantly different among the pre-process respondents, post-process respondents, and nonparticipants (Table 4.13). In all cases, significantly fewer (Chi-square P<0.05) nonparticipants than either pre- or post-process responded engaged in these activities: 1) had a telephone conversation with Forest Service personnel, 2) attended a Forest Service presentation to a civic organization, 3) attended a private meeting with Forest Service personnel, 4) involved in the scoping process, 5) attended a workshop, 6) attended an openhouse, 7) attended an annual conference, 8) helped prepare an organizational report which addressed forest planning, and 9) helped draft a resolution which addressed forest planning.

Sixty-three percent of the post-process respondents said they completed and returned a response form compared to 41.3% of the pre-process respondents. This increase may indicate that post-process respondents possibly were including the survey I gave them in this category. Therefore, this number should be viewed with caution.

Respondents who were members of an organization that was participating in JNF planning and had participated in this series of meetings (pre-process and post-process

Table 4.13. Percent of pre-process participants (Pre), post-process participants (Post) and nonparticipants (Non) who were or were not members of an organization (Member) and their participation rates in public involvement activities on the JNF. Results are shown for Pearson's Chi-square tests.

Public Involvement Activities	**Member**	**Pre (n=45)**	**Non (n=200)**	**Post (n=60)**	X^2	**df**	**P**
Read a forest plan	**Total**	**63.0**	**59.3**	**60.3**	**0.22**	**2**	**.894**
	Yes	79.3	62.6	73.7	3.68	2	.159
	No	42.9	65.1	43.5	5.01	2	.082
Telephone conversation with JNF personnel	**Total**[a]	**58.7**	**38.6**	**49.2**	**7.52**	**2**	***.023***
	Yes[a]	69.0	42.1	63.2	9.4	2	*.009*
	No	42.9	41.0	26.1	1.82	2	.402
Personal letter sent to JNF	**Total**	**54.3**	**52.3**	**47.6**	**0.58**	**2**	**.748**
	Yes	69.0	67.3	65.8	0.08	2	.963
	No	35.7	47.0	21.7	4.92	2	.085
Attended a JNF presentation	**Total**[a]	**54.3**	**28.6**	**36.5**	**11.81**	**2**	***.003***
	Yes[a]	65.5	31.8	47.4	11.62	2	*.003*
	No	35.7	26.5	21.7	0.87	2	.646
Attended a private meeting with JNF personnel	**Total**[a]	**52.2**	**25.7**	**38.1**	**14.12**	**2**	***.001***
	Yes[a]	72.4	31.8	52.6	17.16	2	*<.001*
	No	21.4	28.9	17.4	1.41	2	.494
Involved in the scoping process	**Total**[a]	**50.0**	**22.8**	**54.0**	**30.15**	**2**	***<.001***
	Yes[a]	65.5	35.5	71.1	18.33	2	*<.001*
	No	28.6	15.7	30.4	3.18	2	.204
Attended a workshop	**Total**[a]	**47.8**	**12.9**	**55.6**	**62.84**	**2**	***<.001***
	Yes[a]	48.3	17.8	52.6	21.32	2	*<.001*
	No[a]	57.1	7.2	60.9	39.09	2	*<.001*
Attended an openhouse	**Total**[a]	**43.5**	**15.8**	**33.3**	**22.06**	**2**	***<.001***
	Yes[a]	55.2	15.9	47.4	24.65	2	*<.001*
	No	28.6	15.7	13.0	1.71	2	.426
Completed and returned a response form	**Total**	**41.3**	**51.9**	**63.5**	**5.40**	**2**	**.067**
	Yes	55.2	54.2	73.7	4.56	2	.102
	No[a]	21.4	60.2	52.2	7.31	2	*.026*
Attended an annual conference	**Total**[a]	**39.1**	**9.1**	**39.7**	**45.63**	**2**	***<.001***
	Yes[a]	55.2	11.2	57.9	41.72	2	*<.001*
	No[a]	14.3	6.0	13.0	1.90	2	*<.001*
Prepare a forest planning organizational report	**Total**[a]	**28.3**	**13.3**	**27.0**	**10.48**	**2**	***.005***
	Yes	41.4	25.2	42.1	5.23	2	.073
	No	7.1	4.8	4.3	0.16	2	.922
Attended a fieldtrip	**Total**	**26.1**	**15.8**	**22.2**	**3.55**	**2**	**.170**
	Yes	27.6	20.6	26.3	0.94	2	.625
	No	28.6	8.4	17.4	5.06	2	.080
Signed a petition	**Total**	**23.9**	**30.3**	**19.0**	**3.50**	**2**	**.174**
	Yes	27.6	32.7	23.7	1.18	2	.555
	No	21.4	28.9	13.0	2.53	2	.283
Helped draft a forest planning resolution	**Total**[a]	**10.9**	**7.9**	**20.6**	**8.60**	**2**	***.014***
	Yes	17.2	14.0	31.6	5.79	2	.055
	No	0.0	3.6	4.3	0.58	2	.750
Attended a planning picnic	**Total**	**8.7**	**4.1**	**9.5**	**3.55**	**2**	**.169**
	Yes	10.3	6.5	13.2	1.70	2	.430
	No	7.1	1.2	4.3	2.13	2	.344
Signed a form letter	**Total**	**6.5**	**14.1**	**7.9**	**3.30**	**2**	**.191**
	Yes	10.3	21.5	13.2	2.66	2	.285
	No	0.0	4.8	0.0	1.85	2	.398
Other	**Total**	**13.0**	**12.4**	**6.3**	**1.97**	**2**	**.373**
	Yes	13.8	13.1	2.6	3.45	2	.179
	No	14.3	13.3	13.0	0.01	2	.993

[a] Significantly different (Pearson Chi-square test, α=0.05)

respondents) were significantly more likely to participate in the following activities: 1) telephone conversation with Forest Service personnel, 2) attend a Forest Service presentation to a civic organization, 3) attend a private meeting with Forest Service personnel, 4) be involved in the scoping process, 5) attend a workshop, 6) attend an openhouse, 7) attend an annual conference (Table 4.13). Participants who were not a member of an organization and did not participate in these meetings (nonparticipants) were more likely to complete and return a response form and less likely to attend a workshop.

These results indicate that people who participated in the meetings were more likely to belong to an organization and be involved in forest planning activities that required a commitment of time and energy.

Importance-Performance Analysis of Forest Planning Components

Pre-process respondents were asked a series of questions about the importance of JNF public involvement processes and how well the JNF is performing those processes (Table 4.14). The most important component was an opportunity to influence forest-planning decisions. The least important component was equal consideration to all opinions in the current forest planning process. The highest performance was for the extent to which JNF engages diverse groups of citizens in the planning process. The lowest performance was for long-term commitment to forest planning decisions. Almost one quarter of the respondents were unsure how well the JNF was engaging diverse citizens, considering citizen input when making forest planning decisions, giving equal consideration to all opinions, and making long-term commitments to current planning decisions (Table 4.14)

The Importance-Performance Analysis indicates that the JNF is performing well in all areas (Figure 4.11). All the features fell within Quadrant II (Keep Up The Good Work) of the Importance-Performance matrix which contains features the pre-process participants viewed as important and in which the JNF is performing well.

Table 4.14. The importance of JNF public involvement activities (Importance) and how well JNF is performing each activity (Performance) for pre-process respondents. Descriptive statistics shown include the mean, percent unsure, and percent agreement for each public involvement activity.

	Importance							Performance						
		Low<---------------->High							Poor <-------->Excellent					
	Mean	1	2	3	4	5	Unsure	Mean	1	2	3	4	5	Unsure
Long-term commitments to current planning decisions	4.33	0.0	2.3	9.3	39.5	46.5	2.3	3.23	2.4	14.3	23.8	26.2	4.8	28.6
Opportunities for citizens to influence JNF planning decisions	4.32	0.0	0.0	15.9	36.4	47.7	0.0	3.69	0.0	9.5	28.6	35.7	19.0	7.1
Usefulness of public information programs to prepare citizens to make informed decisions about forest planning	4.16	0.0	2.3	15.9	45.5	36.4	0.0	3.29	0.0	21.4	31.0	28.6	9.5	9.5
How JNF employees inform you about issues related to forest planning	4.12	0.0	0.0	20.5	43.2	31.8	4.5	3.49	0.0	7.0	41.9	32.6	9.3	9.3
The extent to which the JNF engaged diverse groups of citizens in the planning process	4.05	0.0	2.3	29.5	22.7	38.6	6.8	3.79	2.4	4.8	23.8	23.8	23.8	21.4
The consideration of citizen recommendation by the JNF when making decisions concerning forest planning	4.02	0.0	4.5	22.7	36.4	34.1	2.3	3.52	2.4	4.8	31.0	31.0	9.5	21.4
For the JNF to equally inform all residents about plans and emerging issues	3.93	4.5	2.3	15.9	50.0	27.3	0.0	3.42	0.0	9.3	37.2	30.2	7.0	16.3
Equal consideration to all opinions in the current forest planning process	3.59	4.5	11.4	27.3	34.1	22.7	0.0	3.63	2.4	0.0	28.6	38.1	7.1	23.8

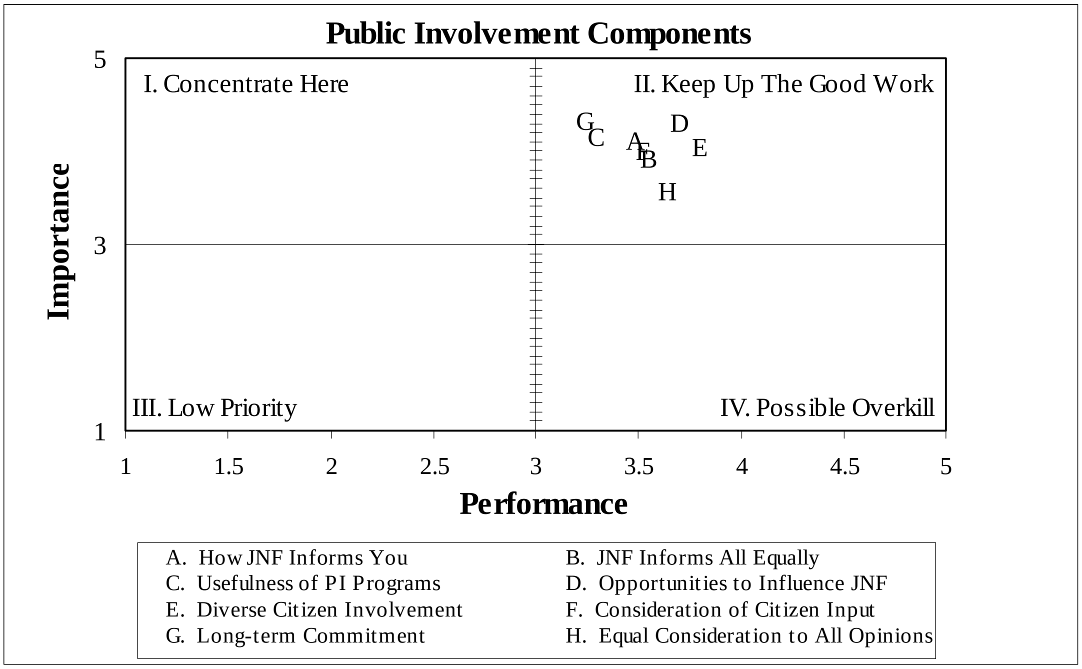


Figure 4.11. Importance-Performance Matrix for importance of public involvement activities and how well the pre-process respondents perceive the JNF to be performing each activity. Scale ranges from low (1) to high (5) on both axes.

Participation in and Effectiveness of Public Involvement Activities

I asked pre-process respondents to indicate how likely they were to participate in a forest planning activity and how effective they thought that activity was in conveying their opinion to the JNF (Table 4.15). The five activities participants were most likely to use were complete and return a response form, attend a FS presentation, attend a workshop, send a personal letter and attend a private meeting with JNF personnel. The respondents perceived the five most effective forest planning activities to be attending a private meeting with JNF personnel, preparing an organizational report, sending a personal letter, attending a Forest Service presentation, and completing a response form (which tied with draft a resolution). High percentages (44%) of the respondents were the unsure about the effectiveness of sending a Freedom of Information Act Request to the JNF.

Table 4.15. Pre-process respondents' use of JNF public involvement activities (Use of Activity) and the perceived effectiveness of the activity (Effectiveness) in conveying the respondent's opinion to the JNF. Descriptive statistics shown include the mean, percent unsure, and percent agreement for each public involvement activity.

	Use of Activity							Effectiveness						
		Low<---------------------->High							Low<---------------------->High					
	Mean	**1**	**2**	**3**	**4**	**5**	**Unsure**	**Mean**	**1**	**2**	**3**	**4**	**5**	**Unsure**
Complete and return a response form	3.8	2.3	9.1	18.2	45.5	22.7	2.3	3.5	0.0	11.4	34.1	34.1	13.6	6.8
Attend workshop	3.7	0.0	4.5	36.4	34.1	18.2	6.8	3.5	2.3	4.5	29.5	45.5	4.5	13.6
Attend Forest Service presentation	3.7	0.0	6.8	38.6	31.8	20.5	2.3	3.6	2.3	6.8	31.8	38.6	11.4	9.1
Private meeting with JNF personnel	3.5	13.6	13.6	4.5	38.6	27.3	2.3	4.1	4.5	2.3	15.9	31.8	38.6	6.8
Send personal letter to JNF	3.5	6.8	13.6	20.5	36.4	20.5	2.3	3.7	2.3	6.8	29.5	31.8	20.5	9.1
Attend openhouse	3.3	6.8	18.2	34.1	15.9	20.5	4.5	2.9	6.8	27.3	34.1	13.6	6.8	11.4
Telephone JNF personnel	3.1	13.6	20.5	25.0	18.2	20.5	2.3	3.4	14.0	7.0	18.6	32.6	18.6	9.3
Attend annual conference	3.0	13.6	22.7	18.2	18.2	15.9	11.4	2.6	15.9	13.6	36.4	6.8	4.5	22.7
Prepare organizational report which addresses forest planning	2.9	29.5	9.1	15.9	20.5	18.2	6.8	3.9	2.3	4.5	18.2	29.5	25.0	20.5
Help draft a resolution which addresses forest planning	2.4	31.8	15.9	20.5	15.9	4.5	11.4	3.5	7.0	2.3	23.3	32.6	9.3	25.6
Contact elected representative to intervene	2.4	34.1	20.5	20.5	9.1	11.4	4.5	3.0	20.5	9.1	11.4	27.3	11.4	20.5
Sign a petition	2.3	40.9	22.7	9.1	4.5	18.2	4.5	2.2	29.5	18.2	25.0	11.4	0.0	15.9
Attend JNF picnic	2.2	36.4	27.3	9.1	6.8	9.1	11.4	2.3	22.7	11.4	29.5	6.8	0.0	29.5
Participate in administrative appeal of the plan	2.0	40.9	27.3	6.8	11.4	4.5	9.1	3.0	15.9	11.4	13.6	22.7	11.4	25.0
Send a form letter to JNF	1.7	53.5	20.9	16.3	2.3	2.3	4.7	1.8	34.9	32.6	16.3	2.3	0.0	14.0
Send a Freedom of Information Act Request to JNF	1.6	58.1	11.6	2.3	4.7	4.7	18.6	2.8	18.6	7.0	7.0	11.6	11.6	44.2
File a lawsuit against the forest plan	1.4	72.1	11.6	2.3	2.3	2.3	9.3	2.9	25.6	12.8	7.7	12.8	20.5	20.5
Other (please specify)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Use-Effectiveness Analysis of Public Involvement Activities

The means of the use and effectiveness of JNF public involvement activities were plotted on the Use-Effectiveness grid (Figure 4.12). Quadrant I (Concentrate Here) contains features that participants are likely to use but don't perceive as being very effective in conveying their opinions. Two activities fell into this quadrant: attending an openhouse and attending an annual conference. Quadrant II (Keep Up The Good Work) includes activities that respondents are likely to use and are perceived as being effective in conveying their opinion such as completing a response form, attending a workshop, attending a Forest Service presentation, attending a private meeting with JNF personnel, sending a personal letter, and telephoning JNF personnel. Quadrant III (Low Priority) contained features that received low effectiveness and low use scores by the respondents. Two of the activities in this quadrant, administrative appeal and lawsuit, would be time consuming and contentious actions. The other three actions would be relatively easy for stakeholders to complete; these activities were sign a petition, send in a form letter, and attend a JNF picnic. Quadrant IV (Possible Overkill) included forest-planning activities that received high effectiveness ratings but relatively low use. Some of these activities were aggressive such as contacting an elected official, filing an administrative appeal or filing a lawsuit, which may explain why these activities are not used as often. The other activity that fell in Quadrant IV, drafting a resolution, was not used as much as its effectiveness would indicate which might be a function of the technical expertise and time commitment required. Participants tended to use more often forest-planning activities that they perceived as being effective in influencing forest planning.

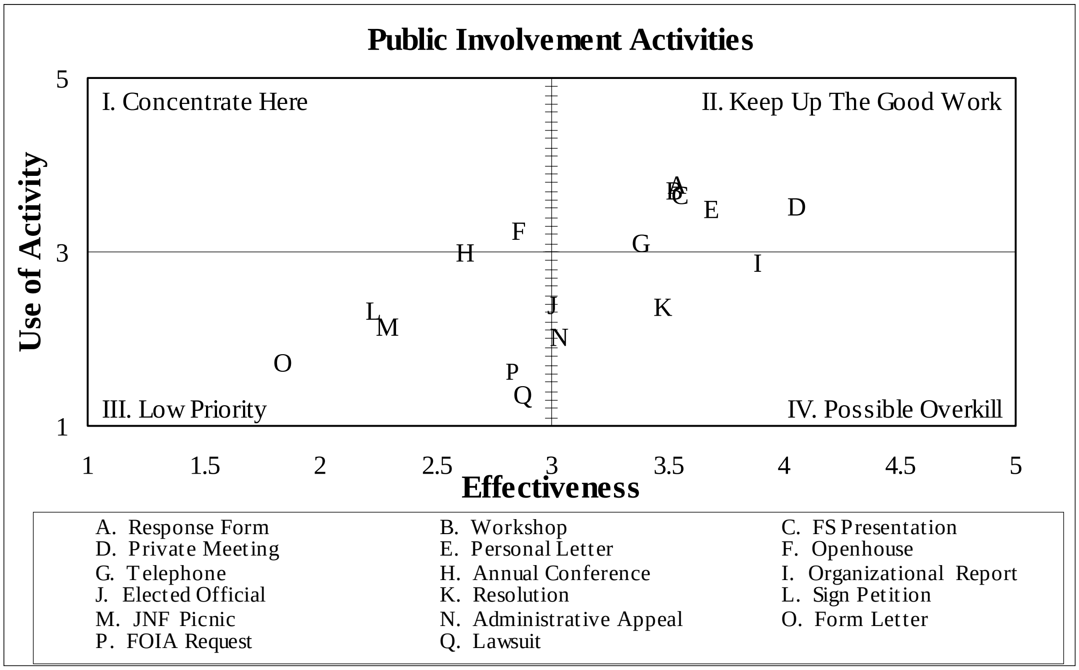


Figure 4.12. Use-Effectiveness Grid for likeliness of use (Use of Activity) of forest planning activities and perceived effectiveness of forest planning activities (Effectiveness) in conveying respondents' opinion to the JNF. Scale ranges from low (1) to high (5) on both axes.

Satisfaction with JNF Public Involvement Efforts

Pre-process respondents and nonparticipants were moderately satisfied with public involvement efforts by the JNF, post-process respondents appeared to have slightly higher levels of satisfaction (Table 4.16). However, the groups did not differ significantly (Pearson Chi-square=12.716, df=8, P=0.122).

Table 4.16. Satisfaction of respondents with public involvement efforts of the JNF in forest planning.

Respondent Group	N	Mean	Level of Satisfaction (%) Low<------------------------------------>High 1	2	3	4	5
Pre-Process	45	3.05	7.0	20.9	39.5	25.6	7.0
Nonparticipants	201	2.83	12.2	20.1	43.4	21.2	3.2
Post-Process	61	3.23	10.0	13.3	31.7	33.3	11.7

Perceived Influence of Interest Groups

Pre-process respondents were asked to rate the influence of organizations involved in forest planning with the JNF. Natural resource agencies such as the U.S. Fish and Wildlife Service (USFWS), Department of Forestry, Virginia Department of Game and Inland Fisheries, Environmental Protection Agency (EPA) and industrial forest interests were perceived as the most influential. Organizations representing recreational or environmental interests were the next most influential. The least influential groups were business, private forestry, and recreational groups such as mountain bikers and off-highway vehicle groups (Figure 4.13).

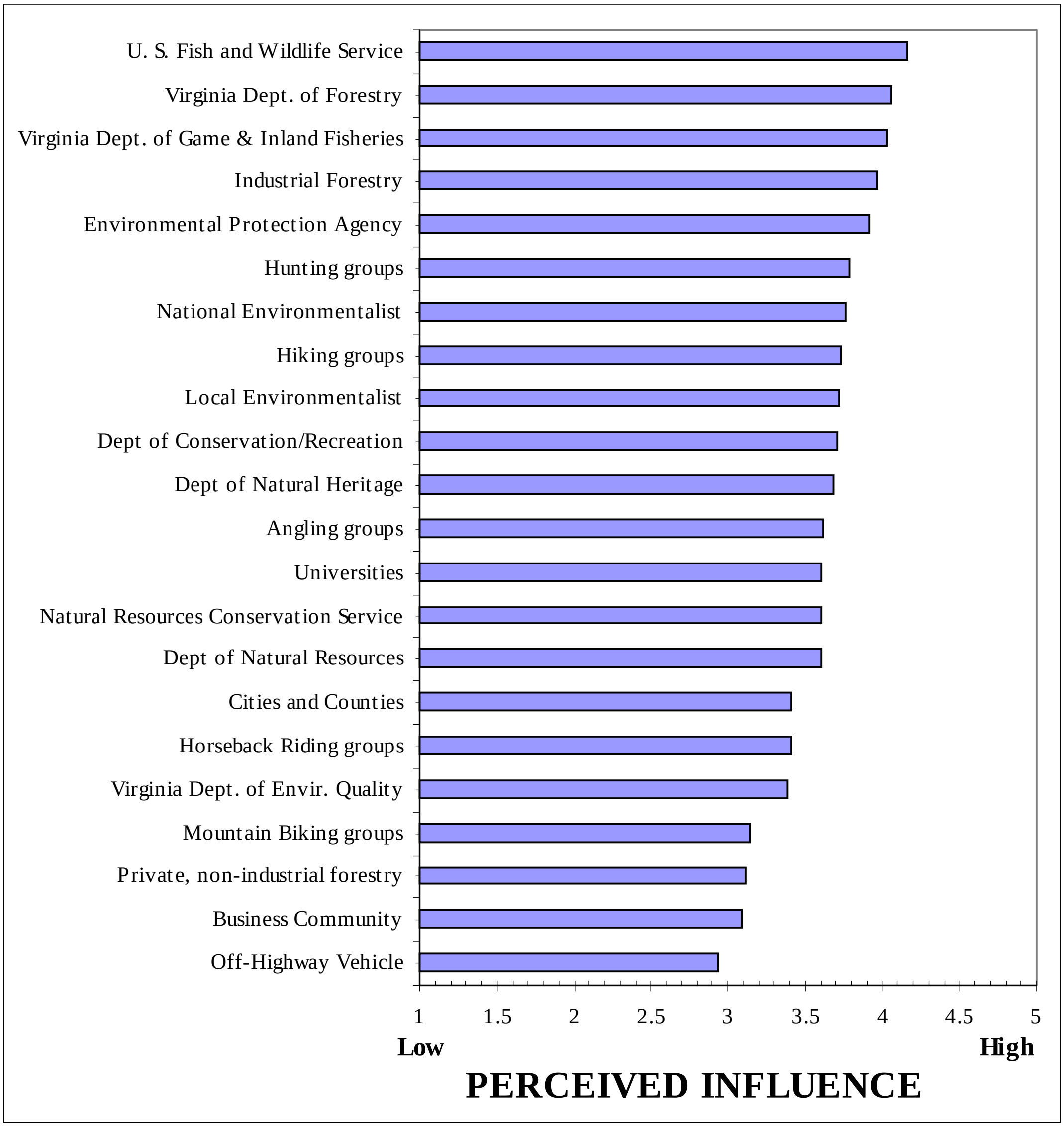


Figure 4.13. Pre-process respondents perceived influence of organizations that are involved in forest planning on the JNF. Values graphed represent the mean influence on a scale of 1 to 5 (low to high).

Participation in Forest Planning on GWNF and Other Forests

All groups had equal rates of participation in forest planning on the George Washington National Forest but differed significantly in rate of participation on other forests (Pearson chi-square, p=0.009). This may be because respondents from the nonparticipation group, who are not locally based, are involved in forest planning in several areas. Forty percent of pre-process respondents, 41% of post-process respondents, and 44% of nonparticipants had participated in forest planning activities on the George Washington National Forest. Twenty-two percent of pre-process respondents, 21% of post-process respondents, and 38% nonparticipants had participated in forest planning activities on other national forests.

Riparian Areas

Importance of Riparian Areas and Riparian Features

The pre-process respondents, post-process respondents and nonparticipants did not differ significantly in their attitude towards the importance of management of riparian areas (Pearson Chi-square=10.94, df=6, P=0.09). Riparian areas were highly valued by all respondents with 98% of the pre-process respondents ranking management of riparian areas as very important (Table 4.17).

Table 4.17. Importance of management of riparian areas on the JNF to respondents for all three surveys on a 4-point scale (1=not needed to 4=very important).

			----------------------Level of Importance (%)-----------------------				
Respondents	**N**	**Mean**	**Not needed**	**Little Importance**	**Somewhat Important**	**Very Important**	**Don't Know**
Pre-Process	50	3.98	0.0	0.0	2.0	98.0	0
Nonparticipants	255	3.80	0.0	1.5	16.0	79.8	2.7
Post-Process	63	3.86	0.0	0.0	14.1	84.4	1.6

The three survey groups did not differ significantly on the relative importance of any of the riparian resources (Table 4.18). Water quality received the highest rating from all survey groups. The next cluster of highly rated features included wildlife habitat, food sources for wildlife, protect stream stability, erosion control, and stream shade. Aesthetic value, flood control, diversity of vegetation types, and provide large woody debris for streams were rated as quite important. The production of high quality timber was rated lowest with a mean value of 2.7 for all survey groups.

Table 4.18. Descriptive statistics for the importance of riparian features to the pre-process participants (Pre), nonparticipants (Non), and post-process participants (Post). Shown are the results of the Pearson's Chi-square test.

Importance of Riparian Features	Survey Group	N	Mean	Level of Importance (%) Low<----->High 1	2	3	4	5	Don't Know	X^2	df	P
Water Quality	Pre	51	4.84	0.0	0.0	2.0	11.8	86.3	0.0	5.32	4	.256
	Non	276	4.73	0.0	0.0	2.9	21.4	75.4	0.4			
	Post	65	4.72	0.0	0.0	6.2	15.4	78.5	0.0			
Wildlife Habitat	Pre	51	4.71	0.0	0.0	5.9	15.7	74.5	3.9	5.24	8	.732
	Non	277	4.58	0.4	1.1	5.1	27.4	65.7	0.4			
	Post	64	4.58	0.0	0.0	7.8	26.6	65.6	0.0			
Protect Stream Stability	Pre	51	4.70	0.0	0.0	5.9	17.6	74.5	2.0	9.48	8	.303
	Non	275	4.46	0.4	1.8	5.5	35.3	55.6	1.5			
	Post	65	4.56	0.0	0.0	6.2	30.8	61.5	1.5			
Erosion Control	Pre	51	4.66	0.0	0.0	5.9	21.6	70.6	2.0	3.74	8	.879
	Non	275	4.48	0.4	1.5	7.3	31.3	58.5	1.1			
	Post	65	4.50	0.0	1.5	7.7	29.2	60.0	1.5			
Food Sources for Wildlife	Pre	51	4.51	0	0.0	9.8	27.5	58.5	3.9	4.83	8	.776
	Non	275	4.55	0.4	1.1	5.5	29.5	63.3	0.4			
	Post	64	4.50	0.0	0.0	10.9	28.1	60.9	0.0			
Shade for Streams	Pre	51	4.58	0.0	0.0	5.9	27.5	60.8	5.9	4.75	8	.784
	Non	274	4.37	0.7	0.7	13.9	28.1	53.3	3.3			
	Post	64	4.46	0.0	0.0	14.1	25.0	59.4	1.6			
Diversity of Vegetation Types	Pre	51	4.38	0.0	2.0	15.7	21.6	54.9	5.9	9.63	8	.292
	Non	274	4.27	1.8	2.2	12.0	32.8	47.8	3.3			
	Post	63	4.18	0.0	1.6	23.8	28.6	44.4	1.6			
Aesthetic Appeal	Pre	51	4.24	0.0	2.0	19.6	27.5	47.1	3.9	12.07	8	.148
	Non	270	4.15	2.6	4.4	11.1	37.0	43	1.9			
	Post	64	4.16	1.6	3.1	23.4	25.0	45.3	1.6			
Flood Control	Pre	51	3.88	2.0	11.8	19.6	27.5	37.3	2.0	5.73	8	.678
	Non	273	4.09	2.2	6.2	18.3	24.9	46.5	1.8			
	Post	64	3.93	3.1	4.7	21.9	29.7	34.4	6.3			
Provide Large Woody Debris for Streams	Pre	50	4.02	0.0	6.0	22.0	26.0	36.0	10.0	10.04	8	.262
	Non	262	3.73	3.4	5.3	30.9	18.3	28.6	13.4			
	Post	63	3.71	3.2	12.7	22.2	23.8	30.2	7.9			
Production of High Quality Timber	Pre	50	2.94	26.0	12.0	22.0	14.0	22.0	4.0	4.37	8	.822
	Non	270	2.69	29.3	17	22.2	16.2	14.1	1.1			
	Post	64	2.52	34.4	15.6	25.0	14.1	10.9	0.0			

Pre-process survey respondents were asked not only about the importance of riparian features but also how well the JNF is maintaining these features (Table 4.19). The mean performance scores were lower than the importance scores for all items except production of high quality timber. The highest performance scores were for wildlife habitat, shade for streams, and food sources for wildlife. The lowest performance scores were for production of high quality timber, erosion control, and provide large woody debris for streams. For all items, there were large percentages of unsure for performance. Respondents were most unsure about the importance and performance of large woody debris for streams, indicating that participants were not familiar with the importance of large woody debris in streams.

Importance-Performance Analysis

The Importance-Performance Analysis indicates that the pre-process participants perceive the JNF as performing well in all areas of management of riparian features (Figure 4.14). All the features except one fell within Quadrant II (Keep Up The Good Work) of the Importance-Performance matrix which contains features the pre-process participants viewed as important and in which the JNF was performing well.

Table 4.19 Importance of riparian features and how well the JNF is maintaining those features (Performance) for pre-process respondents.

	Importance							Performance						
		Low<-------------------->High							Low<-------------------->High					
	Mean	1	2	3	4	5	Unsure	Mean	1	2	3	4	5	Unsure
Water Quality	4.84	0.0	0.0	2.0	11.8	86.3	0.0	3.50	0.0	6.1	32.7	38.8	4.1	18.4
Wildlife Habitat	4.71	0.0	0.0	5.9	15.7	74.5	3.9	3.78	0.0	0.0	28.0	42.0	10.0	20.0
Protect Stream Stability	4.70	0.0	0.0	5.9	17.6	74.5	2.0	3.47	2.1	4.2	27.1	39.6	2.1	25.0
Erosion Control	4.66	0.0	0.0	5.9	21.6	70.6	2.0	3.32	4.0	4.0	36.0	28.0	4.0	24.0
Shade for Streams	4.58	0.0	0.0	5.9	27.5	60.8	5.9	3.68	0.0	3.9	25.5	43.1	7.8	19.6
Food Sources for Wildlife	4.51	0.0	0.0	9.8	27.5	58.8	3.9	3.58	0.0	4.1	28.6	40.8	4.1	22.4
Diversity of Vegetation Types	4.38	0.0	2.0	15.7	21.6	54.9	5.9	3.57	0.0	2.0	34.7	32.7	6.1	24.5
Aesthetic Appeal	4.24	0.0	2.0	19.6	27.5	47.1	3.9	3.56	0.0	4.1	34.7	38.8	6.1	16.3
Provide Large Woody Debris for Streams	4.02	0.0	6.0	22.0	26.0	36.0	10.0	3.33	2.0	10.0	22.0	28.0	4.0	34.0
Flood Control	3.88	2.0	11.8	19.6	27.5	37.3	2.0	3.40	2.0	2.0	32.7	34.7	0.0	28.6
Production of High Quality Timber	2.94	26.0	12.0	22.0	14.0	22.0	4.0	3.03	8.0	12.0	24.0	22.0	4.0	30.0

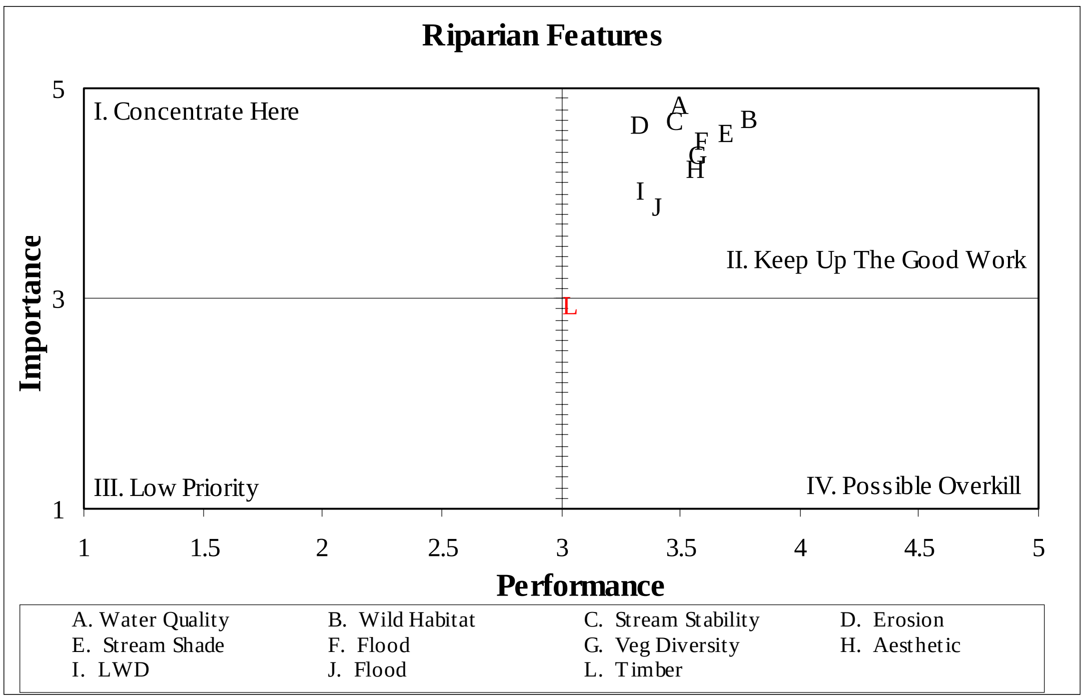


Figure 4.14. Importance of riparian features and how well the JNF is maintaining those features (Performance). Data is for pre-process respondents. Scale ranges from low (1) to high (5) on both axes.

Impact of Management Activities on Riparian Areas on the JNF

The pre-process and post-process respondents indicated that roads and erosion had the highest impact on riparian areas (Table 4.20). Over 50% of the pre-process respondents rated 11 out of 14 management activities in riparian areas as having a high impact on those riparian areas (Table 4.20). Both respondent groups perceived control of tree diseases and prescribed burning as having low impact on riparian areas. The post-respondents had a wider range of response with over 25% rating activities such as trails and use of herbicides has having a low impact on riparian areas. The pre-process respondents had significantly higher perception than the post-process respondents of impact for the following activities: use of fertilizers, location of campsites, mineral/gas leases, stream crossings, vehicle or equipment exclusion, and prescribed burning (Table 4.20).

Impact-Effective Analysis

Pre-process respondents were also asked to rate how effectively the JNF was managing riparian areas (Table 4.21). There was high response of unsure, for example over half of the respondents were unsure how well the JNF was managing use of herbicides, fertilizers and prescribed burning; controlling pest insect species and tree diseases; and managing mineral/ gas leases and prescribed burning. For all categories, except prescribed burning and control of pest insect species, respondents indicated the JNF was managing less effectively than the perceived impact. However, all categories except Roads fell in Quadrant II (Keep Up The Good Work) (Figure 4.15). The category "Roads" fell on the line between Quadrant I (Concentrate Here) and Quadrant II indicating that pre-process participants believed roads could be more effectively managed by the JNF.

Table 4.20. Participants perceived impact of management activities on riparian areas on the JNF. Descriptive statistics shown include sample size (N), mean, percent agreement with level of impact for management activities, and percent "Don't Know" responses. Shown are results from Pearson's Chi-square analysis.

Activities	Respondent Group	N	Mean	Level of Impact (%) Low---High 1	2	3	4	5	Don't Know	X^2	df	P
Roads	Pre-process	49	4.50	2.0	0.0	6.1	24.5	57.1	10.2	8.23	4	0.084
	Post-process	65	4.05	1.5	4.6	20.0	24.6	38.5	10.8			
Erosion	Pre-process	50	4.40	0.0	2.0	14.0	22.0	56.0	6.0	5.91	3	0.116
	Post-process	65	3.95	0.0	10.8	20.0	18.5	36.9	13.8			
Mineral/gas leases[a]	Pre-process	49	4.34	0.0	4.1	10.2	10.2	40.8	34.7	10.28	4	**0.036**
	Post-process	64	3.56	6.3	4.7	12.5	17.2	15.6	43.8			
Timber Harvest	Pre-process	49	4.29	0.0	2.0	16.3	22.4	44.9	14.3	7.29	4	0.121
	Post-process	65	3.71	7.7	7.7	20.0	15.4	33.8	15.4			
Stream Crossings[a]	Pre-process	50	4.27	0.0	4.0	10.0	32.0	42.0	12.0	12.68	4	**0.013**
	Post-process	65	3.53	3.1	16.9	21.5	18.5	24.6	15.4			
Vehicle/Equipment Exclusion[a]	Pre-process	49	4.23	0.0	4.1	8.2	32.7	34.7	20.4	11.12	4	**0.024**
	Post-process	64	3.43	12.5	10.9	7.8	17.2	25.0	26.6			
Location of Campsites[a]	Pre-process	50	4.22	0.0	4.0	14.0	32.0	42.0	8.0	16.58	4	**0.002**
	Post-process	65	3.42	7.7	6.2	32.3	32.3	13.8	7.7			
Timber Salvage	Pre-process	50	4.03	2.0	2.0	20.0	22.0	32.0	22.0	7.66	4	0.105
	Post-process	64	3.34	9.4	9.4	21.9	20.3	17.2	21.9			
Use of Fertilizers[a]	Pre-process	50	3.97	4.0	8.0	6.0	20.0	32.0	30.0	13.48	4	**0.009**
	Post-process	65	3.04	13.8	10.8	23.1	10.8	15.4	26.2			
Use of Herbicides	Pre-process	50	3.81	6.0	8.0	8.0	22.0	28.0	28.0	8.63	4	0.071
	Post-process	65	2.93	16.9	10.8	15.4	12.3	13.8	30.8			
Trails	Pre-process	50	3.72	2.0	10.0	20.0	42.0	20.0	6.0	6.29	4	0.178
	Post-process	65	3.20	6.2	21.5	24.6	30.8	10.8	6.2			
Prescribed Burning[a]	Pre-process	49	3.47	4.1	10.2	16.3	26.5	12.2	30.6	10.64	4	**0.031**
	Post-process	65	2.62	13.8	23.1	18.5	10.8	6.2	27.7			
Control of Tree Diseases	Pre-process	49	3.35	4.1	14.3	20.4	24.5	12.2	24.5	6.56	4	0.161
	Post-process	65	2.78	16.9	12.3	18.5	12.3	9.2	30.8			
Control of Pest Insect Species	Pre-process	50	3.24	10.0	12.0	16.0	22.0	14.0	26.0	1.99	4	0.737
	Post-process	65	3.14	10.8	10.8	16.9	10.8	15.4	35.4			

[a]Significantly different (Pearson's Chi Square, α=0.05)

Table 4.21. Impact of activities on riparian areas (Impact) and how effectively the JNF is managing these activities (Effectiveness) for pre-process respondents.

	Impact							Effectiveness						
		Low<--------------->High							Low<---------------->High					
	Mean	1	2	3	4	5	Unsure	Mean	1	2	3	4	5	Unsure
Roads	4.50	2.0	0.0	6.1	24.5	57.1	10.2	3.00	2.0	20.4	32.7	16.3	4.1	24.5
Erosion	4.40	0.0	2.0	14.0	22.0	56.0	6.0	3.25	0.0	10.2	38.8	20.4	4.1	26.5
Mineral/gas leases	4.34	0.0	4.1	10.2	10.2	40.8	34.7	3.50	2.0	2.0	18.4	10.2	8.2	59.2
Timber Harvest	4.29	0.0	2.0	16.3	22.4	44.9	14.3	3.21	4.1	12.2	22.4	22.4	6.1	32.7
Stream Crossings	4.27	0.0	4.0	10.0	32.0	42.0	12.0	3.47	2.0	4.0	30.0	30.0	6.0	28.0
Vehicle/Equipment Exclusion	4.23	0.0	4.1	8.2	32.7	34.7	20.4	3.25	2.0	12.2	16.3	22.4	4.1	42.9
Location of Campsites	4.22	0.0	4.0	14.0	32.0	42.0	8.0	3.14	4.0	18.0	26.0	16.0	10.0	26.0
Timber Salvage	4.03	2.0	2.0	20.0	22.0	32.0	22.0	3.24	2.0	8.2	26.5	18.4	4.1	40.8
Use of Fertilizers	3.97	4.0	8.0	6.0	20.0	32.0	30.0	3.40	0.0	4.0	20.0	12.0	4.0	60.0
Use of Herbicides	3.81	6.0	8.0	8.0	22.0	28.0	28.0	3.63	0.0	4.1	14.3	12.2	8.2	61.2
Trails	3.72	2.0	10.0	20.0	42.0	20.0	6.0	3.34	2.0	10.0	30.0	28.0	6.0	24.0
Prescribed Burning	3.47	4.1	10.2	16.3	26.5	12.2	30.6	3.86	0.0	2.0	10.2	24.5	8.2	55.1
Control of Tree Diseases	3.35	4.1	14.3	20.4	24.5	12.2	24.5	3.13	2.0	8.2	20.4	14.3	2.0	53.1
Control of Pest Insect Species	3.24	10.0	12.0	16.0	22.0	14.0	26.0	3.30	0.0	8.0	18.0	18.0	2.0	54.0

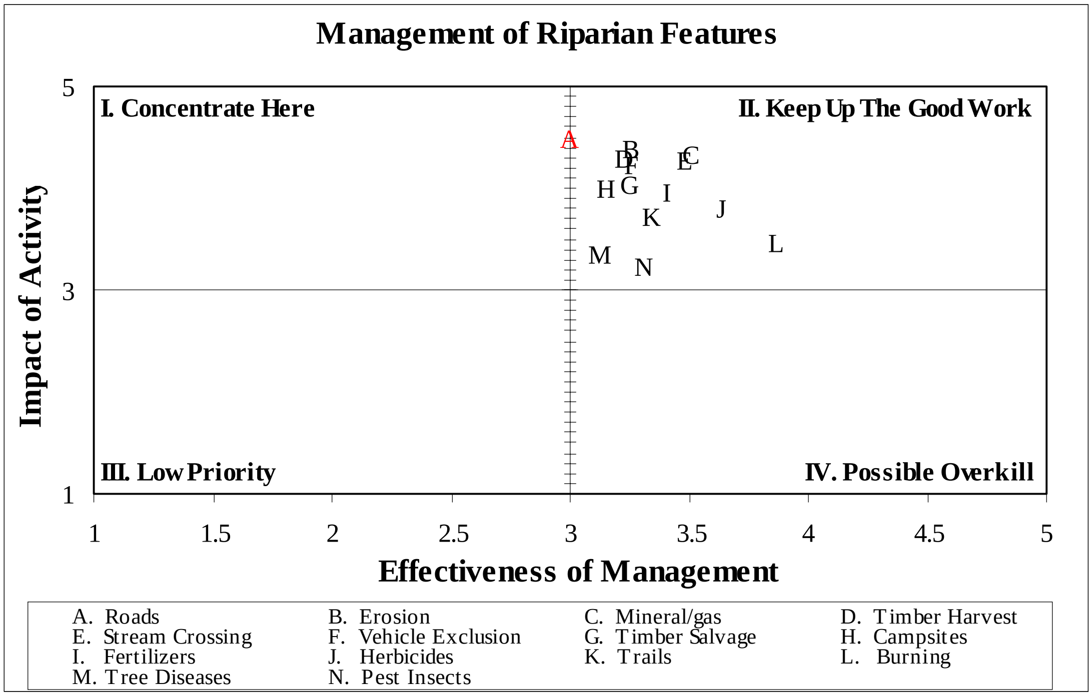


Figure 4.15 Pre-process respondents rating of the importance and effectiveness of riparian management activities. Scale ranges from low (1) to high (5) on both axes.

Evaluation of Riparian Meetings

Meeting Attendance

Conflicts with other activities, the time commitment required, and the cancellation of one meeting in two of the ranger districts made it difficult for people to attend all three meetings. Only 6.2% of the survey respondents attended all three meetings while 27.7% attended two meetings and 69.2 % attended one meeting. Fifteen individuals (23%) never attended any meetings but were considered involved in the process if they had sent in written comments, called, or filled out the value ranking sheet. There were several reasons why people stopped attending meetings. Four people said they were either notified too late or gave up after a meeting was cancelled. Three people stopped because they felt they had contributed all that they could or that they felt the USFS would take the environmentally sensitive management approach to riparian areas. Five people commented on the questionnaire that they stopped out of frustration with the process. They felt preservationists controlled the meetings or that the USFS would do what it wanted regardless of public input or that the process was too lengthy and too elementary. Finally, two people did not attend because they were out of town or too busy.

Assessment of Meetings

Nearly all people felt they were treated fairly and approximately 4 out of 5 people felt that they had enough information to participate and that diverse interests were represented at the meetings (Figure 4.17). It is encouraging to note that 75% of the participants were willing to participate in such a time consuming process again. About 65% of the participants felt that attending meetings was a wise use of time and 63% thought agreement on the DFC could be reached. However, a relatively high percentage of respondents were unsure of whether an agreement could be reached. Uncertainty in the ability to reach an agreement may be reflective of the ongoing nature of the current forest planning efforts. Participants are probably unsure of how the information from the meetings will actually be used in the revised forest plan. Sixty-one percent were willing to participate in meetings related to riparian management again while 29% were unsure if they would be willing to participate. Forty-five percent of the participants rated their satisfaction with the meeting as 4 or 5 (with a 5 being the highest) (Figure 4.18).

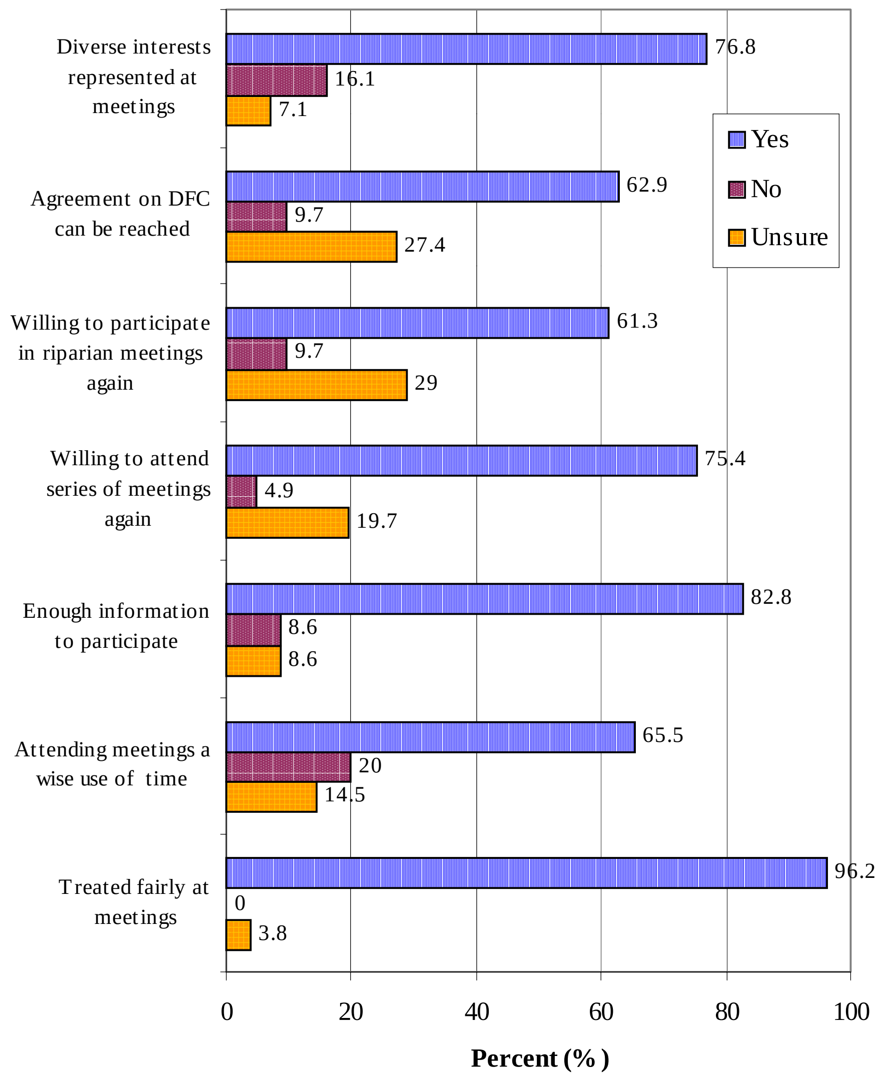


Figure 4.17. Post-process respondents assessment of the riparian meeting process, effectiveness, and outcome.

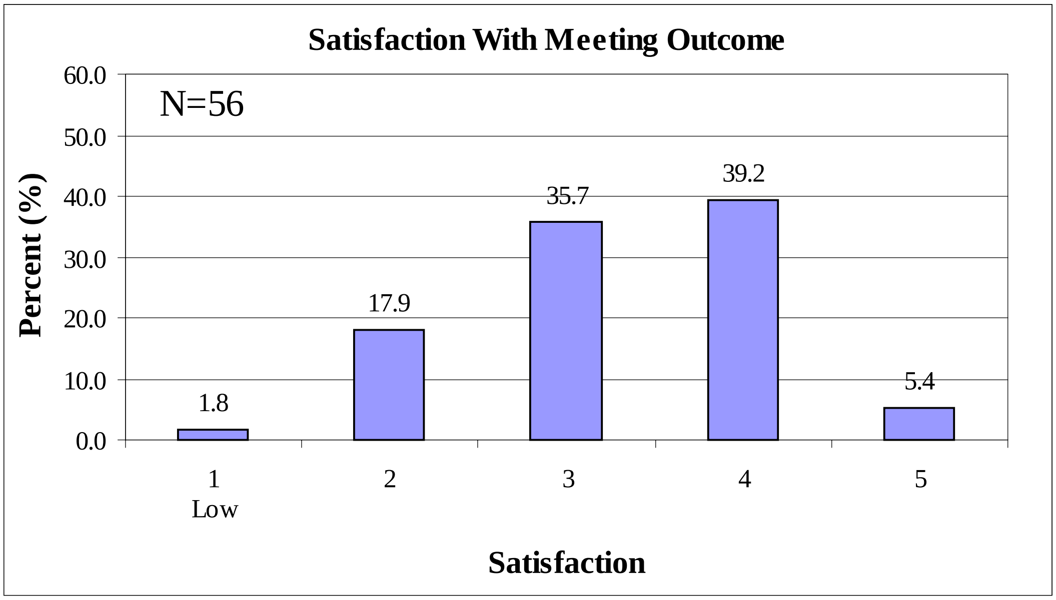


Figure 4.18. Satisfaction of post-process respondents with the outcome from riparian meetings (N=56). Scale ranges from low (1) to high (5).

Summary of Survey Results

Sociodemographic characteristics

- Survey respondents could be characterized as middle-aged, well-educated and high-income males who had lived in the area for a long time.
- Nonparticipants were more likely to be from a large urban area, older and correspondingly, more likely to be retired and less likely to be students.

Resource Interests

Areas of interest

- Participants and nonparticipants indicated similar interests in the ecological, recreational, and commodity interest categories. Ecological and recreational interests had the highest percentage of respondents.
- Most survey respondents had a strong interest in environmental protection, recreation, water, wildlife, and native plants on the JNF.
- Participants had a higher interest in water issues, horseback riding, hunting, angling, and forestry than nonparticipants.
- Participants were less interested than nonparticipants in hiking and camping.

Most Important Interest

- Participants indicated that environmental protection, water, wildlife, and fish in that order were their most important ecological interests.
- Nonparticipants indicated that environmental protection, wildlife, old growth/wilderness, and water, respectively, were their most important ecological interests.
- Participants had slightly more consumptive interests than the general forest planning population because more participants than nonparticipants indicated that types of forestry interests or multiple-use was their most important interest.

Environmental Values

- There were no differences in environmental values, as measured by the NEP scale.
- Environmental values of all survey respondents were higher than environmental values of residents of the Southern Appalachians as measured by the Southern Appalachian Assessment study.

Citizen Involvement in Forest Planning

Level of Interest in Forest Planning

- The three groups of survey respondents did not differ significantly in organizational membership or if they represented personal or group interest when participating in forest planning.
- The majority of respondents rated forest planning as important, indicated that participation in forest planning was a wise use of time and that they planned to participate in forest planning.

Reasons for Involvement:

- The primary reason for involvement in forest planning was to preserve the forest for future generations.
- Other top reasons for involvement were to influence forest-planning decisions, learn more about issues on the JNF, and to have an opportunity to express an opinion.
- The only significantly different reason for forest planning involvement was that nonparticipants rated preserving spiritual involvement as more important than pre-process respondents did.
- All survey respondents were moderately satisfied with public involvement efforts.

Sources of Information:

- The primary sources of information for forest planning were the newspaper, JNF newsletter, organizational meetings, and JNF personnel.

- A significantly higher percentage of participants than nonparticipants received forest-planning information from the academic sources, communication with forest service personnel, and Forest Service publications.
- A significantly higher percentage of nonrespondents received information from organizational literature.

Forest Planning Activities

- Nonparticipants spent less time on forest planning and were more likely to have been involved in forest planning on other national forests.
- The top forest planning activity for all survey groups was reading a forest plan.
- Participants were more likely to be involved in forest planning activities that required time or interaction such as telephoning or having a private meeting with Forest Service personnel; attending a meeting, workshop, openhouse, or annual conference; or helping prepare an organizational report or drafting a resolution which addressed forest planning.
- Pre-process respondents were most likely to complete a response form, attend a presentation, attend a workshop, send a personal letter, and attend a private meeting with JNF personnel.
    - The most effective activities were attending a private meeting, preparing an organizational report, sending a personal letter, attending a FS presentation, and completing a response form.
- The Use-Effectiveness analysis indicated that:
    - Participants participated in openhouse and an annual conferences but didn't perceive those activities as being very effective in conveying their opinions.
    - Respondents were likely to use and perceived as being effective in conveying their opinion completing a response form, attending a workshop, attending a Forest Service presentation, attending a private meeting with JNF personnel, sending a personal letter, and telephoning JNF personnel.

Forest Planning Components

- Pre-process participants viewed an opportunity to influence forest planning decisions as the most important forest planning component.
- The Importance-Performance analysis shows the JNF is doing a good job of involving the public in forest planning.

Satisfaction with JNF Public Involvement Efforts

- Pre-process respondents and nonparticipants were moderately satisfied with public involvement efforts by the JNF, post-process respondents appeared to have slightly higher levels of satisfaction.

Perceived Influence of Interest Groups

- Natural resource agencies and industrial forest interests were perceived as having the most influence with the JNF.

Riparian Areas

Importance of Riparian Areas and Riparian Features

- Riparian areas were highly valued by all respondents with 98% of the pre-process respondents ranking management of riparian areas as very important.
- The most important riparian resource was water quality, followed by wildlife habitat, food sources for wildlife, protection of stream stability, erosion control, and stream shade.
- The production of high quality timber was rated the least important feature of riparian areas.
- The Importance-Performance analysis indicates that pre-process respondents were satisfied with how well the JNF is managing riparian features.

Impact of Management Activities on Riparian Areas on the JNF

- Pre-process and post-process participants rated roads and erosion as having the highest impact on riparian areas.
- Greater than 20% of the respondents did not know how management activities affected riparian areas.
- Pre-process respondents were asked to rate how well the JNF was managing activities in riparian areas. Over 40% of respondents were unsure how well the JNF was managing 9 of 14 activities.
- However, for the Impact-Effectiveness analysis, all categories except roads fell in Quadrant II (Keep Up the Good Work). Participants believed that roads could be more effectively managed.

Evaluation of Riparian Meetings

- The riparian meetings were perceived as fair, a representation of diverse interests, and provided enough information to participate.
- Many participants were willing to participate in the process again, felt that attending the meetings was a wise use of time, and were satisfied with meetings' outcome.
- Sixty-two percent of the respondents felt that agreement on the DFC for riparian areas could be met, however, 27% were unsure.
- The majority of participants were only able to attend one of the three meetings.

Discussion

My goal was to involve stakeholders in identifying the values that should drive management of riparian areas on the JNF rather than focusing on technical aspects of riparian management. A classic mistake for resolving conflicts is to address technical fixes before there is a full understanding of the issue. The participants in the meetings quickly recognized that some of the values being reported were actually technical approaches to reaching goals and decided to focus on identifying values while setting aside technical issues.

I asked participants to identify their held values by asking them to identify "what basic property, characteristic, function, or quality of riparian areas" was important to the participant. This definition closely matches definitions used by other researchers who have defined public values of natural resources as something of use or desirable to humans (Mitsch & Gosselink 1986; Richardson 1994; Manning et al. 1999). I further asked participants to assign relative values to the values identified using the AHP process. In the following paragraphs, I will first discuss the values identified and then the quantification of those values.

The six groups of values identified by the respondents in our study were: 1) protection of water quality and quantity (Water), 2) protection of species, their habitats and biodiversity (Biodiversity), 3) maintenance of a healthy ecosystem (Ecosystem), 4) provision of recreational opportunities (Recreation), 5) opportunity for commodity uses such as timber, mining, livestock, and power (Commodity), and 6) the desire to protect the beauty and spiritual values of the forest for present and future generations (Aesthetic). Participants prioritized Water, Biodiversity, and Ecosystem values as two to five times more important than Recreation, Commodity, and Aesthetic values. Thus, they indicated that the DFC for riparian areas on the JNF should strongly emphasize water quality and quantity, protection of riparian-dependent species and their habitats, and maintenance of the integrity of the relationship between riparian areas and the surrounding environment. Participants indicated that activities such as recreational uses and commodity uses could occur but that they should not negatively affect the other, more highly valued characteristics of riparian areas.

The values identified in this study correspond closely to values identified by other researchers for national forests. Researchers have identified public values for national forests using several techniques, including surveys (Shindler et al. 1993; Steel et al. 1994; Mohai and Jones 1995; Manning et al. 1999; Stein et al. 1999), individual interviews (Maguire 1995; Steelman and Maguire 1998), focus group interviews (Stein et al. 1999), cognitive mapping (Kearney et al. 1999), content analysis of news media (Bengston et al. 1999) and content analysis of public comments on a forest plan (Proctor 1998). Bengston et al. (1999), through content analysis of online news media stories regarding national forest management, identified four categories of values that were similar to those identified in this study: recreation, commodity, ecological, and moral/spiritual/aesthetic. Mohai and Jakes (1996) surveyed Forest Service employees nationwide and identified seven areas of interests for the USFS in regards to forest management: wildlife and fish, recreation, wilderness, water, minerals, timber, and grazing. In a study of stakeholder values of forested wetlands in the eastern coastal plain of North Carolina, Steelman and Maguire (1998) identified habitat, water quality, natural heritage/biodiversity, water storage, and recreation as values that were common to all stakeholders. Other values identified but not held by all stakeholders included property rights, training marines, economic benefits, and fiber production. In a survey of the values, ethics, and attitudes of Vermont respondents concerning the Green Mountain National Forest, Manning et al. (1999) identified eleven categories of values: aesthetic, ecological, recreation, education, moral/ethical, historical/cultural, therapeutic, scientific, intellectual, spiritual, and economic.

The most notable difference between the values identified by the participants in our study and other studies is an emphasis on biodiversity and water quality as separate from ecosystem values. This is probably a function of our focus being specifically on riparian areas while other studies focused on forest-wide values. Steelman and Maguire (1998) examined wetland values and found that water quality and water storage were identified as well as biodiversity and habitat. Riparian areas are sensitive areas that are intricately linked to and dependent on adjacent bodies of water and are viewed as critical habitat to some species. It would therefore follow that there would be more emphasis in our study on biodiversity and water quality values than in a study of forest-wide values.

In addition, some of the people involved represented agencies or organizations such as Trout Unlimited, Virginia Department of Game and Inland Fisheries, and USDA Natural Resources Conservation Service, that have a strong interest in water-related issues.

Despite different resource interests of the study participants, they had similar values for riparian areas. For instance, approximately 54% of post-process respondents identified ecological interests as their most important interest while 22% identified recreation and 15% identified commodity as their most important interests. Yet over 96% of all respondents, regardless of their most important interest, indicated that management of riparian areas was important. Not surprisingly, the participants reached agreement on the relative importance of the values that they identified. Mohai and Jones (1995) surveyed commodity stakeholders, noncommodity stakeholders, and forestry schools and found that all three groups included watershed management and recreation in the top-five of priority uses for national forests. Kearney et al. (1999) explored the perspectives of three stakeholder groups (Forest Service employees, timber industry, and environmentalists) using cognitive mapping. The participants entertained stereotypes about each other that proved to be inaccurate. For instance, the environmentalists were perceived as being concerned primarily with recreation and habitat preservation when in fact they displayed "a relatively high degree of concern for economic issues and a relatively low concern for human factors" (Kearney et al. 1999). The authors suggested that if stakeholders have an increased understanding of each other's perspectives, there is a higher probability of reaching agreement.

The relative importance of public values has been identified by ranking of values (Steelman and Maguire 1998), by participants indicating the degree of importance or agreement for specific value statements (Steel et al. 1994; Manning et al. 1999; Stein et al. 1999), and by incidence of topics covered in news media over time (Bengston et al. 1999). It is difficult to compare relative priorities assigned to values in my study to other studies because of differences in techniques used to quantify values. However, it is possible to compare the relative order of values in other research to my research. Bengston et al. (1999) examined the reporting of values through content analysis of media articles. Recreation was the most frequently expressed value, with commodity, ecological, and moral/spiritual/aesthetic the next most frequently expressed values. From

1992 to 1996 interest in recreational and moral/aesthetic values increased while interest in commodity values decreased. In general, content analysis indicated a high level of concern about protecting the environment and ecosystem. Bengston et al. (1999) noted that because this was a study based on media reports, which are reflective of "newsworthy" situations, they are more likely to reflect conflicts. They further indicated that stories about recreational conflicts are more likely to be reported than stories about ecological conflicts.

Steelman and Maguire (1998) organized 27 respondents into stakeholder groups: forestry/industry, nonprofit organizations, state agencies, and federal agencies. Although all respondents identified habitat, water quality, natural heritage, water storage and recreation values, fiber production and habitat were viewed as most important by most of the respondents. Fiber production was the most important value for forestry/industry stakeholders and habitat was the most important for state and federal agencies. Nonprofit organizations did not identify a single most important value. Shindler et al. (1993) surveyed Oregon and national public attitudes towards federal forest management. Most respondents indicated that environmental and economic considerations should be given equal weight. Vermont residents indicated that aesthetic and ecological values were most important and economic values were rated as least important concerning management of the Green Mountain National Forest (Manning et al. 1999). Respondents favored nonmaterial benefits, including protection of ecological integrity, and tended to favor managing for multiple benefits.

The values expressed in this study reflect a national trend of public values shifting from an anthropocentric (or utilitarian) to a biocentric (or ecosystem) basis (Shindler et al. 1993; Proctor 1998; Bengston and Fan 1999). Increasingly the public has placed more emphasis on ecological, moral, spiritual, and aesthetic qualities rather than economics and utilitarian qualities (Stein et al. 1999; Bengston 1994, Bengston and Fan 1999). Steel et al. (1994), in a study of Oregon and national publics, found strong support for "less commodity-based, more environmentally and ecologically sensitive, holistic, and multi-valued approach to federal forest management."

Quantitative values assigned by the participants in our study should aid the JNF in understanding what aspects of riparian management are most critical to stakeholders.

Quantifying values allows managers to clearly understand the relative importance of each value. Also, the process of forcing stakeholders to quantify values provides a forum for discussion of conflicting objectives (Hillborn and Walters 1977). The high assigned values for water, ecosystem, and biodiversity indicated high preference for management strategies that place ecological functions as the primary value. However, the participants were willing to accept commodity uses in riparian areas as long as key values were protected. Alternative management scenarios could be assessed relative to the assigned values for riparian areas to determine how well values for a DFC are met.

The values of Forest Service employees appear to be reflective of national values, although the management priorities are slower to change. Brown and Harris (1992) examined the attitudes and values of Forest Service employees towards resource management issues and found that although Forest Service employees preferred an ecosystem management approach they perceived the Forest Service position to be "oriented towards traditional silviculture" (Brown and Harris 1992). Cramer et al. (1993) surveyed value orientation and management priorities of Forest Service employees nationwide and found that employees valued moving towards uses such as recreation and wildlife even though they indicated current management priorities favored timber. In a survey of USFS employee perceptions and views, Mohai and Jakes (1996) found that employees felt the emphasis of the Forest Service should be on wildlife and fish, recreation, and water interests but that the actual emphasis was on timber output. These studies reinforce the perception of the Forest Service placing higher priority on timber interests. However, Farnham et al. (1995) reviewed Forest Service statistics and found that noncommodity resources (i.e., recreation, wildlife, fish habitat) received more emphasis and funding. Furthermore, a survey by Farnham and Mohai (1995) indicated that timber output had declined in the past decade. The Forest Service's movement away from a primary focus on commodity resources and towards an emphasis on ecosystems and recreation indicates a convergence of professional and public values.

Representation of Forest Planning Participants

The overall characteristics of the participants in the riparian meetings were similar to the people who did not participate in the riparian meetings but who do participate in other forest planning activities. The respondents could be characterized as middle-aged, high-income, well-educated males who had lived in the area for a long time. Forest planning and management of riparian areas was important to both participants and nonparticipants. Pre-process, post-process, and nonparticipant respondents all held similar views of importance among the ecological, commodity, and recreational interests.

There were some expected differences between the nonparticipants and participants. For instance, a higher percentage of participants held water issues as their most important interest and a lower percentage held interest in environmental protection. In addition, participants were more likely to be involved in forest planning activities that required time or personal contact with Forest Service personnel. There were differences in the percentages of people interested in specific recreational interests among the three survey groups, however, a diverse range of recreational interests were represented by both participants and nonparticipants.

Some of the differences in the meeting participants and nonparticipants can probably be attributed to meeting location and the topic of the meetings. We held the meetings in rural towns so that they would be accessible to people who live near the forest but this also entailed a longer trip for people who lived in the larger cities. People who lived further away would have needed a strong interest in riparian areas to make the one hour or more drive. The meetings held on the Virginia Tech campus in Blacksburg attracted more students. Nonparticipants were more likely to have been involved in forest planning on other forests and from urban areas, which are indicators of people who are interested in forest planning on a national level. Therefore, some nonparticipants may not be motivated to attend time-consuming meetings on a very narrow topic.

One or two participants expressed concerns that environmental interests were over represented. However, a higher percentage of participants than nonparticipants identified forestry and multiple-use interests as their most important interests. Although some participants were slightly more commodity-oriented than nonparticipants, the majority identified ecological interests as the most important value.

The profile of forest planning participants for the JNF was similar to other national forests (Force and Williams 1989; Holthoff 1993; Shindler et al. 1993). Citizens who participate in forest planning were characterized as well educated, high income, older, and long-time residents (Force and Williams 1989; Holthoff 1993; Shindler et al. 1993). Traditionally, researchers discuss two types of forest planning participants: those with timber interests and those with environmental interests (Force and Williams 1989; Steel et al. 1994). However, our research shows there is clearly a third group that represents recreational interests. The JNF will increasingly encounter and need to respond to a growing national interest in recreation.

The high environmental values identified by the NEP scale reflect a national trend towards stronger national ecological values on national forests. There is increasing public support for federal forest management that emphasizes ecological values and multiple values and incorporates the public in decision making (Shindler et al. 1993; Steel et al. 1994; Manning et al. 1999).

Effectiveness of Process

Many aspects of the riparian meetings were successful. A high percentage of the participants felt that that they were treated fairly, that they had enough information to participate and that diverse interests were represented at the meetings. The majority of participants felt that the meetings were a wise use of time, that agreement on the DFC could be reached, and that they were willing to participate again in a similar process.

The meeting process had several components that led to its success: identification of varied stakeholders, the use of some alternative dispute resolution techniques, and use of the AHP. Stakeholder representation was diverse because participants were identified from an array of sources rather than relying strictly on the JNF mailing list. For example, we had several key individuals who were not on the forest mailing list but were recommended by other participants or were contacted because of membership in an organization. These people contributed greatly through either discussion of values or representation of different resource interests.

The use of alternative dispute resolution techniques such as defining the goal of meetings, clearly established and agreed upon ground rules and procedures, and use of a facilitator helped provide an environment where people felt comfortable identifying and discussing key values. A facilitator and clear ground rules prevent a single interest group or individual from dominating the process. Most of the participants felt the process was fair which can affect the satisfaction with process (Lawrence et al. 1997). Key elements of a fair process are an opportunity to express views and feedback to participants (Lawrence et al. 1997). A convenient location made it possible for most of the participants to attend the meetings. The small group sizes provided the participants with an opportunity to express their values and allow others to hear potentially conflicting values, an important component of a public involvement process (Gericke and Sullivan 1994; Bengston et al. 1999; Smith et al. 1999). In addition, summaries of all meetings were sent to all participants in a timely manner. This information was sent to all people on the mailing list, so that even if someone had to miss a given meeting they could still understand what had transpired at the meeting.

The AHP provided the structure for organizing and prioritizing the values. The flexibility of the AHP facilitated the fusion of a qualitative task such as identifying riparian values with the quantitative task of prioritizing those values. I was able to take a large list of values and group those values into categories that were acceptable to the participants. The participants were then able to use the AHP to identify the relative importance of riparian values. Projecting the results of the AHP with the LCD system and posting the scores on flip chart graphs increased the credibility of the process with the participants.

Concerns About The Process

Participants identified several common concerns about our approach to public involvement, including representation, learning process, and usefulness of information gained. A key criticism was representation and group size. Some participants felt that too few or too many people participated. If there were too few participants, the concern was that a single interest could dominate the group and the outcome. If there were too many participants, the concern was that the process was too unwieldy and little would be accomplished. Others felt agency or environmental interests dominated the groups. One person wanted to know how the values of the silent majority would be identified. The variety of comments was reflective of the difference in the meetings at the three ranger districts.

All of these viewpoints addressed a central theme of adequately representing the interests of forest stakeholders. It is essential to ensure that all resource interests are well represented. Based on our survey data, participants represented all resource interests in proportion to the general forest planning population, which was represented by the nonparticipant survey. Participants' resource interests were identified on the basis of what participants indicated was their most important resource interest on the surveys. However, it would have been useful to ask participants on the survey not only what resource interest was the most important but also which resource interests they were representing. It was the role of the facilitator to ensure that no single individual or interest group dominated the process. The strength of this process was that everyone was treated fairly and given an opportunity to express their opinion. Because there were three meeting locations, people at one location may have been unaware of the interests represented at other meeting locations. The three ranger districts had different characteristics, which was reflected in the participants. I wanted to encourage people to attend the meeting by making the meeting locations convenient. This was a drawback in that everyone was not in one location and did not benefit from hearing all perspectives.

Identifying the silent majority and their associated values is problematic to public involvement on national forests. Some researchers have been able to identify and sample the silent majority through personal interviews (Maguire 1995). This process is very time consuming and beyond the scope of this project. One suggestion to address this issue was to attend organizational meetings and gain information from people that way. One comment indicated that participation may have been reduced because a few people may have felt that this was just a research project and not worth their time. It would have been better to play down the research aspect and emphasize that the JNF was interested in the results of the process.

The second concern addressed a lack of learning about riparian ecosystems and the perspectives of the different participants. Learning more about riparian ecosystems could have modified some attitudes and helped build consensus on management. Through learning about and discussing each other's perspectives, people would have gained more insight and understanding about each other. This could have also helped build consensus. This problem seemed to be identified by people who were not able to attend more than one meeting or who had missed the first meeting. People who attended two or three meetings had more opportunity to discuss values and gain understanding of other participants' perspectives. At the first meeting, we reviewed information about riparian ecosystems on the JNF, however, some participants missed this first meeting. Unfortunately, time constraints limited opportunities to discuss riparian ecosystems. My primary objective was to identify the values of the stakeholders.

The third and final concern was uncertainty regarding how the information gained through this process would be used by the JNF. Some participants felt that the JNF should have already identified these issues and they were not clear how prioritizing the values would aid the JNF. These concerns point to a general mistrust of the JNF when it comes to public involvement. It may be difficult for participants to fully commit to the process if they are unclear how the public input will be used (Steelman and Ascher 1997). Forest planning participants may be less willing to participate in future public involvement efforts if they do not see tangible results from their past activities. These people will feel that their opinions are not being heard or viewed as important, causing them to forego future participation. The pre-process survey data suggest that people are not inclined to use administrative appeals or lawsuits nor do they feel such drastic measures are very effective. The results could indicate that people who do use more extreme approaches to forest planning did not attend these meetings.

The JNF commitment to this process was demonstrated by the presence of a forest service representative, usually the JNF Revision Team Leader, at every meeting. The JNF also provided support for the meeting mailings and helped to arrange the meeting locations. One goal of this project was not only to provide people with an opportunity to understand others' perspectives but also to provide the JNF with specific information on the relative importance of those values. Quantitatively prioritizing values provides clear information to the JNF personnel about future management of riparian areas.

A final concern that was not mentioned in the comments but became increasingly clear by declining attendance was that this type of approach was very time consuming.

This is a problem common to collaborative planning; external partners can find the process very time consuming (Carr et al. 1998). Participants must have a high level of commitment to make the process successful. My approach was to keep the process fluid and flexible by allowing people to attend meetings when feasible. The problem with this approach stems from a potential loss of continuity if participants varied widely from one meeting to the next. The strength of our process was that meetings could continue if there was enough overlap in the participants attending.

A better format, perhaps, would have been to hold one evening meeting in three locations and then a single longer workshop meeting in one central location where everyone could work together to prioritize values and discuss any differences. For example, Schmoldt and Peterson (2000) successfully used the AHP in a two-day workshop format to identify and prioritize research needs for large-scale fire disturbances. Peterson and Schmoldt (2000) reviewed the process for using the AHP in a workshop setting and suggested that a highly structured workshop will efficiently elicit a large amount of information in a short time period.

Although beyond the scope of this project, there are serious concerns about how some of the recommendations will be funded. Many of the desired values require tools to inventory the status of riparian areas, tools to assess the health of riparian areas, tools to develop and implement best management practices, and resources to develop strategies for reaching the goals. Restoring riparian areas, maintaining trails and facilities, and educating the public are all activities that require adequate funding. In addition, there is potentially lost revenue if land is removed from the timber base. Strategies need to be developed for reaching these goals including consideration of implementing user fees for some areas.

Another concern regarding funding is that the budget process is not well integrated with the management planning process (Sample 1992; Farnham 1995). Currently, funds are appropriated by Congress and not closely linked to the forest planning process (Farnham 1995). If the appropriation process does not reflect the planning process, then there is less incentive for the public to spend time on forest planning. It may be more effective for resource interest groups to lobby Congress than to participate in forest planning (Sabatier et al. 1995). However, in reviewing funding levels by Congress and budget requests from the Forest Service from 1983 to 1992, Farnham (1995) found that recreation, soils, and wildlife and fish were funded at levels similar to the Forest Service requests. In fact, funding levels increased substantially during that time frame. The budgeting process should be integrated with the strategic planning and program management, working together toward a clear goal (Sample 1992). Otherwise, the time and effort spent on the forest planning process is negated.

Summary

The results of this study demonstrate that combining the AHP with more traditional public involvement techniques facilitates successful public involvement. In this study, stakeholders with different resource interests were able to identify and prioritize their riparian values as a group. Participants prioritized water quality and quantity, protection of riparian-dependent species and their habitats, and the maintenance of the ecosystem as two to five times more important than recreation, commodity, and aesthetic interests. Participants in this process were representative of the people involved in JNF forest planning but probably not representative of all of the people who live around the forest. This process suggests that stakeholders can aid in making decisions concerning values while leaving the more technical decisions to the resource professionals.

Key components of this process include early involvement and identification of all interested parties, a clearly defined goal, clear ground rules, and use of a highly structured process such as the AHP that is fair and transparent. A process that is well managed and transparent "gives the decisionmaker sufficient grounds to defend a decision, while remaining accountable to the public"(Glicken 1999, p. 323). This technique requires participants who are highly committed and willing to spend the time to reach a goal.

Participants appeared to be clear on their preference for riparian management criteria, however, the real test of how well public preferences were identified will be when management decisions are implemented. This approach may be used to set guidelines that are more specific for developing DFC statements. Incorporating the results from this study, and other ongoing public involvement efforts, into the revised forest plan by the JNF will be critical to successful future public involvement efforts. Forest planning participants may be less willing to invest so much time and energy if they perceive the JNF as ignoring their input.

Public land-management agencies use adaptive management strategies to manage uncertainty in ecosystem management (Yaffee 1999; Committee of Scientists 1999). Adaptive management is not only a learning process about how to manage ecosystems when dealing with uncertain outcomes. It is also a process of incorporating the stakeholders and using consensus building to reach complex management decisions (McLain and Lee 1996). Decision-making tools that facilitate information flow between participants, that allow incorporation of different perspectives, and allow exploration of different alternatives are more likely to succeed (McLain and Lee 1996). Forest planners need to be flexible, take risks, and incorporate multiple perspectives (McLain and Lee 1996). Successfully incorporating public values into forest planning will continue to challenge forest planners. A variety of public involvement tools are needed to involve different publics and encourage dialogue. This study should help in public involvement challenges by illustrating that the combination of qualitative and quantitative techniques can bring together people with different resource interests to reach agreement on management issues. The techniques used in this study would be a useful addition to a public involvement professional's toolbox.

Management Recommendations

Use of AHP in Forest Planning

- Forest planners should consider use of the AHP in a workshop setting for resource issues that require public involvement, a high quality decision, and are potentially contentious. Although time consuming, the strength of the AHP is that it brings people together so there is an opportunity for education about and understanding of different viewpoints. Participants will have ownership in the final decision. Participants felt that the AHP process was fair and many were willing to participate in this process again. I would recommend streamlining the process by changing the format with the goal of increasing participation by decreasing the number of meetings. Regardless of the structure of the revised format, there should an opportunity for learning through discussion between participants and some presentations by "experts" on a given subject. Forest planners must be careful to focus on interaction and not just presentation of ideas, to avoid the impression of swaying people to a certain perspective. The role of forest service personnel should be to provide technical expertise on the ecological and legal limits of resource issues.

Possible formats for a revised AHP process:

1) Meeting/Workshop: Organize one meeting in each ranger district to identify and discuss key issues on a particular subject. Summarize the information into an AHP structure as a "straw" document for starting point in discussion. Organize a workshop in one location for the entire forest with all interested stakeholders. This would allow everyone to hear all the viewpoints and work together to modify the structure and prioritize the components.

2) Workshop: Identify the components of the issue prior to meeting through surveys, personal contacts, and/or analysis of written comments. Compile the information into a "straw" document, review and prioritize components in a full-day workshop. Participants would have an opportunity to interact,

gain understanding of different perspectives, and help develop the final product.

- The AHP would also be a useful tool for in-house decisions. It takes time to structure the decision but once done it would be clear what types of tradeoffs are being made and would move away from the BOGSAT (Bunch of guys/gals sitting around a table) style of decision making (Schmoldt et al. 1995)

Recommendations for Riparian Management

- The values identified by the participants are similar to the goals of ecosystem management.

- In developing a desired future condition for riparian areas, primary emphasis should be maintaining the functions, structures, and components of riparian areas that contribute to the quality, timing and magnitude of water flows; the biodiversity, and the interconnectedness and integrity of riparian areas to the surrounding watershed which includes processes such as water, energy and nutrient flow.

- Participants also valued using riparian areas for timber production and other commodity uses as well as recreation if the primary values of riparian areas were not impaired. There is a clear need to determine what level of management activities can occur before these values would be impacted.

- Use the AHP to further identify what types of management strategies are acceptable to the public. The different attributes of riparian areas (soils, vegetation, etc.) could be incorporated into the AHP model for riparian areas. Using the public inputs on the relative importance of values and the Forest Service experts' inputs on the contribution of riparian attributes to the values, it would be possible to identify desired attributes of riparian areas. In addition, management activities could be modeled into the hierarchy and technical expertise of forest professionals could be used to predict the effects of given management activities on riparian attributes. Public values could then be used to identify the appropriateness of different management strategies in riparian areas. There is a strong need for more detailed information on exactly what types of management activities can occur in riparian areas and under what situations (e.g., timber extraction for salvage, restoration, profit, access trails for anglers, boaters).

Public Involvement:

- In reviewing the Importance-Performance analysis, it appears that the forest is doing a good job in involving the public in the forest planning process.

- A variety of public involvement techniques are required to involve different segments of the forest planning population. People who have the time and commitment will attend meetings, call JNF personnel, write letters, and otherwise participate in forest planning. Forums were there is dialogue between stakeholders is preferred for resolving complex issues. However, people who have little time will use other outlets such as response forms or completing surveys. Many people are busy and don't have the time to attend a series of meetings but may have time to briefly attend an openhouse. A nonparticipant commented that they appreciated receiving the survey because they were too busy to attend meetings or other events and it was the first time someone reached out and asked them their opinion.

Disseminating Information To The Public

- The majority of people received their information from the newspaper, the JNF newsletter, and organizational meetings. The JNF should continue or even expand use these formats to transfer information to people and to ask for opinions on specific subjects. It is likely that JNF personnel could arrange for print news media to do a monthly/weekly series on forest issues.

- There is a strong need for a venue to convey the status of riparian areas on the JNF: What sort of condition are they in? How are they defined? Why are they important? What are important features of riparian areas? What percentage of the forest are they? What are the management concerns for riparian areas? Over 40%

of participants were unsure how effectively the forest was managing riparian areas. This lack of knowledge could be attributed to the public being uninformed, however, this was a well-educated group that had a strong interest in riparian management. If they don't know how the JNF is doing managing riparian areas, who would? Nonparticipants had higher interests in hiking and camping. High use areas would be a good place to post forest planning information and general information about natural resources such as riparian area.

Validating Public Involvement and Public Confidence in the Forest Service

- There is uncertainty about how recommendations made by the public will be used in the forest planning process. There needs to be clear link between information gathered in public involvement efforts and how it is translated into forest planning documents. There seems to be a lack of trust on the part of the public that the JNF is really responding to the public demands and desires for resource management on the JNF. To address these concerns the planning process should be fair, acceptable, and legitimate for all interested parties. The Forest Service must continuously involve all interested stakeholders throughout the planning process, maintain a fair and open planning process, and clearly articulate the criteria used to make decisions. The decisions made should reflect public values. By involving the public throughout the planning process and carefully identifying public values the Forest Service will be able to provide the technical expertise to implement those values. Forest plans that integrate public values and Forest Service expertise will help to regain public trust and credibility.

Chapter 5. Synopsis

Managers of national forests are guided by the concept of ecosystem management (Robertson 1992; Wood 1994). There are many definitions and interpretations of the ecosystem management concept, however, all have elements in common (FEMAT 1993; Grumbine 1994; Wood 1994; Christensen et al. 1996; Yaffee 1999). These elements include sustainability, setting clear goals (desired future conditions), public involvement, collaborative planning, species diversity, consideration of spatial and temporal scales, recognition that ecological systems are dynamic and interconnected, and use of adaptive management with an emphasis on monitoring (Yaffee 1999). This research project investigated the public involvement, goal setting, and ecological sustainability components of ecosystem management for riparian areas in the southeastern national forests. My specific goals were to: 1) identify the attributes that contribute to ecological sustainability in riparian areas associated with forested headwater streams through a review of current scientific literature; 2) review current southeastern national forest plans to identify and assess current DFCs to determine how they address ecological sustainability, and to evaluate the translation of DFCs to standards and guidelines; and 3) design and evaluate a public involvement process that identifies public values for use in the development of DFCs for riparian areas on the Jefferson National Forest.

In the literature review, I emphasized headwater streams because they represent over half of streams found on national forest lands in the southern Appalachians (Chapter 2). The complex geology, hydrology, and periodic disturbances (i.e., fires, flooding, drought, debris flows, high winds) found in the southern Appalachians create a highly complex environment with diverse fauna and flora. Vegetation directly affects stream temperatures, terrestrial nutrient uptake and cycling, bank stability, input of organic material, and wildlife habitat. Coarse woody debris plays an important role in structuring the instream habitat and fauna. Important structural components of riparian areas are the geology and soils, vegetation structure and composition, leaf litter composition and depth, coarse woody debris, water quality, and microclimate.

In reviewing current southern forest plans, I found a clear shift from emphasizing water quality in older forest plans to a more comprehensive incorporation of the values and functions of riparian areas (Chapter 3). However, the riparian attributes included in the DFC varied across national forests. Many of the older forest plans did not consider key structures of riparian areas in their DFCs. For instance, condition of soils, water table elevation, timing and magnitude of flows, amphibians, macroinvertebrates, channel morphometry and integrity, connection of the riparian area to the surrounding area, and condition of the upland portion of the watershed were all variables that were poorly represented in the forest plans.

There was a disparity between the DFCs for forest plans and the measurable criteria in the standards and guidelines. For instance, when wildlife habitat was identified as a desirable feature of riparian areas there were not corresponding guidelines identifying the required critical structural features. This lack of clear guidelines for riparian species habitat may reflect limited knowledge of riparian areas or a lack of resources, time and personnel to identify criteria due to limited funding for land management (Committee of Scientists 1999). Other areas that should be addressed by the Forest Service in revising forest plans include developing clear and consistent definition of riparian areas and consistent criteria to classify riparian areas across forests. The Jefferson, Cherokee, Chattahoochee-Oconee, Sumter, and Alabama National Forests are currently revising their forest plans. As these forests develop DFC statements for riparian areas, they will need to inventory the status of riparian areas and tools to help them assess the health of riparian areas. These tools and inventories will also help future monitoring and evaluation of meeting the DFCs through the standards and guidelines.

Adaptive management will be needed to provide flexibility in responding to information gained on the effectiveness of standards and guidelines in reaching DFCs (McLain and Lee 1996; Walters 1997). Southern national forests will need to develop strategies to handle potential resource problems in riparian areas. For example, the eastern hemlock (*Tsuga canadensis*), an important overstory tree, is currently threatened by the hemlock wooly adelgid (*Adelges tsugae*). Loss of overstory trees will influence recruitment of CWD in streams and modify vegetation diversity with corresponding effects on riparian-dependent organisms. Many of the decisions managers encounter reflect not only the ecological limits of riparian systems but also public values. Forests will need guidance from the public in determining the desired future condition of riparian areas and the appropriate pathways to reach those goals (Committee of Scientists 1999). For instance, if there is high mortality of eastern hemlock in riparian areas, will the timber be salvaged or left in place? Tradeoffs include the ecological benefits of CWD and the increased risk of fire hazards and decreased forest health. Forest Service professionals can provide the technical expertise to identify the influence of different strategies on riparian areas while the public may need to provide information on the relative importance of different values in developing a management strategy.

On the Jefferson National Forest, stakeholders from three ranger districts in the Ridge and Valley Provinces identified and prioritized public values for riparian areas. I used a combination of alternative dispute resolution techniques and the Analytic Hierarchy Process (AHP), a participatory decision-making tool (Maguire & Boiney 1994; Schmoldt and Peterson 2000**)**. The AHP has been successfully used for prioritizing alternatives in complex situations that include qualitative and quantitative elements (Zahedi 1986; Saaty 1980; Schmoldt et al. 1994). Strengths of the AHP process include the ability to structure a complex decision into a hierarchy, to incorporate different types of data, and to make decisions based on existing knowledge.

I used surveys before and after the meetings to evaluate the effectiveness of the public involvement process. I also surveyed people who were involved in forest planning but did not attend the riparian meetings to determine if the participants in the riparian meetings were representative of forest planning participants in general (nonparticipants). Survey respondents were characterized as middle-aged, well-educated and high-income males who were long-time residents. People who participated in the meetings were more likely to belong to an organization and to be involved in forest planning activities that required a commitment of time and energy. Participants and nonparticipants indicated similar resource interests (ecological, recreational, commodity). The most important interest for participants and nonparticipants was environmental protection, a subcomponent of ecological interests.

The riparian meeting participants indicated that the DFC for riparian areas on the JNF should strongly emphasize water quality and quantity, protection of riparian-dependent species and their habitats, and maintenance of the integrity of the relationship between riparian areas and the surrounding environment. Participants approved of recreational and commodity uses of riparian areas as long as they not negatively affect the other, more highly valued characteristics of riparian areas. The values identified closely mirror the components that are important in ecological sustainability of riparian areas.

I surveyed meeting participants to assess the effectiveness of the AHP decision-making process for public involvement. Participants felt that the meetings were fair, that diverse interests were represented, and that they had enough information to participate in the process. Many participants were willing to participate in the process again, felt that it was a wise use of their time, and were satisfied with the meeting outcome. A majority felt that agreement could be reached on developing a DFC for riparian areas on the JNF.

If DFCs for riparian areas were to be developed for forest plans, the next step would be to use the AHP decision-making process to prioritize public values for riparian areas across southern national forests. The AHP may be used to structure the important components, functions, and structures in riparian areas. A strength of the AHP decision-making process is the ability to incorporate uncertainty into the model - a given when managing riparian areas and other ecosystems.

Because the decision-making process used in this study is very time and labor intensive, anyone considering its use must weigh the costs and benefits. To determine if the process is worthwhile, managers must consider the level of public interest, the information available to make a quality decision, the need for a quality decision, and the need for public acceptance of the decision (McMullin 1996). Issues with high public interest, variable information, and a need for a quality decision warrant an intensive public involvement process (Wondolleck 1988; McMullin 1996). Spending time initially to involve the public in a critical resource management decision may help to reduce time and resources spent defending or litigating a decision that is unacceptable to the public (Steelman 1999). Managers need tools to reach a robust decision when dealing with complicated issues. The AHP is a useful tool for structuring complex resource issues that contain a mixture of qualitative (public values) and quantitative (resource attributes) data, require a fair and transparent process, and involve multiple interest groups (Schmoldt et al. 1994).

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