Upper Chattooga River Visitor Capacity Analysis
Data Collection Reports

The Forest Service is conducting a Visitor Capacity Analysis and is employing a modified "Limits of Acceptable Change" (LAC) planning framework for evaluating visitor use and potential impacts on the environment. Several types of information and analyses were needed as part of this analysis, as described in *Upper Chattooga River Visitor Capacity Analysis Implementation Plan for Data Collection Methods* (USFS, 2006). This document describes one element of those efforts, the ***Literature Review Report*** - *a* review and summary of information from existing studies on the Chattooga River or studies /planning from other similar settings.

A summary and integration of key findings from these collective efforts is provided in *Assessing Capacity and Conflict on the Upper Chattooga River* (CRC, 2007). Information from these efforts will be incorporated into the LAC effort to assess visitor capacity decisions on the Upper Chattooga. At the conclusion of the LAC effort, the Forest Service plans to develop a proposed action and alternatives for review through a National Environmental Policy Act (NEPA) process prior to implementation.

This document is one of several describing methods and findings from the data collection efforts. It serves as one of several "supporting reports" to the *Capacity and Conflict Report*. The complete list of reports includes:

- ***Chattooga River History Project, Literature Review and Interview Summary*** *(Tetra Tech, 2006)* – a history of Chattooga recreation decision-making that documents the basis for the 1976 boating ban and similar issues in order to help frame issues in the current analysis.

- ***Capacities on other Wild and Scenic Rivers: seven case studies*** *(Diedrich, 2007)* - a review of capacity issues on seven W&S with similarities to issues on the Upper Chattooga. This report provides examples of how other planners have interpreted laws and mandates, conducted analyses, or arrived at capacity decisions on other rivers.

- ***Use Estimation Workshop Summary*** *(Berger and CRC, 2007)*– summary of workshop conducted with resource agency personnel to help consolidate and summarize use information by capitalizing on extensive agency knowledge as well as some existing user surveys and creel surveys.

- ***Limited Use Monitoring Summary*** *(Berger, 2007)* – summary of data collected through the use monitoring conducted by the public, Forest Service and contractor of vehicle counts within selected access locations along the Chattooga River Corridor.

- ***Literature Review Report*** *(Louis Berger, 2007)* – Literature review and summary of information from existing studies on the Chattooga or studies /planning from other similar settings; includes the following components:

  - *Recreation-Related Social Impacts and Standards* **-** information related to the relationships between use and impacts and the "evaluative side" of the social impacts issue, including which impacts are most important, tolerances for those impacts, and which management actions tend to be used and supported to address them.

  - *Recreation Related Trail/Site Impacts* - information about relationships between use and biophysical impacts, potential standards for those impacts, and the acceptability of management actions to address them.

  - *Recreation-Related Wildlife Impacts* - information about relationships between recreation use and wildlife impacts, potential standards for those impacts, and the acceptability of management actions to address them.

  - *Recreation Related Flow Preferences* **-** information about opportunities and flow preferences, particularly related to other rivers similar to the Chattooga.

- ***Proxy River Information*** *(USFS 2007)* – summary of management and flow related information for "similar-type" rivers to the Chattooga River as identified through public input.

- ***Biophysical Monitoring Information on the Chattooga River*** *(USFS 2007)* **-** information about current conditions in the corridor, including maps of existing trails, and a summary of other biophysical-related information that is relevant to Chattooga River capacity issues.

- ***Hydrology Issues on the Upper Chattooga River*** *(USFS 2007)* **-** This report summarizes recreation-relevant hydrology information for the upper river, including (1) rating curves and basin areas for staff gages at all bridges; (2) relationships between the Burrells Ford gage and the USGS Highway 76 gage; (3) summary hydrology for the period of record at the Highway 76 gage; and (4) extensions to the Burrells Ford gage.

- ***Expert Panel Field Assessment Report*** *(Louis Berger, 2007)* – report for the expert panel field assessment conducted to gather information about boating and angling opportunities on the upper Chattooga River, with particular attention to boater and angler flow preferences for these flow-dependent activities.

CHATTOOGA RIVER

PHASE I DATA COLLECTION

LITERATURE REVIEW REPORT

Submitted to:

USDA National Forest Service
Sumter, Chattahoochee, and Nantahala National Forests

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March 2007

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Appendix A - Identified Terrestrial Wildlife and Aquatic PETS, MIS and LR Species for the Upper Chattooga River Watershed

1.0 INTRODUCTION AND PURPOSE

The Chattooga River is located within Macon and Jackson Counties, North Carolina, and within Rabun County, Georgia, and Oconee County, South Carolina. In 1974, the Chattooga River was designated a Wild and Scenic River for its "outstandingly remarkable" fish, wildlife, recreation, scenic, and historic values. The 57-mile, 15,432-acre corridor, along the upper reaches of the Chattooga designated as *Wild and Scenic* includes 40 miles designated as wild, 2 miles as scenic, and 15 miles as recreational[1]. The Chattooga River corridor is bordered by three National Forests: the Nantahala in North Carolina, Chattahoochee-Oconee in Georgia, and Sumter in South Carolina. In addition, a portion of the river is bordered by the 8,724-acre Ellicott Rock Wilderness. Day-to-day management of the Chattooga River falls under the responsibility of the Sumter National Forest.

The initial management plan (1976) divided the riverway into different geographic and management zones employing the Recreation Opportunity Spectrum approach and consequently closed the upper portion of the riverway above Highway 28 Bridge to boating. Subsequent revisions to the forest management plan maintained this restriction. The current revised Sumter National Forest Land and Resource Management Plan (LRMP) (USFS, 2004) continued the 1976 restriction on boating use upstream of Highway 28 Bridge. On April 15, 2005, American Whitewater filed an appeal of 2004 LRMP boating restriction. On April 28, 2005, the Forest Service in the decision on the appeal directed the Sumter National Forest to conduct a Visitor Capacity Analysis to reassess its decision to exclude boating as part of broader examination of visitor capacity issues on the upper Chattooga River.

For the Visitor Capacity Analysis, the Forest Service is employing a modified "Limits of Acceptable Change" (LAC) planning framework for evaluating visitor use and potential impacts on the environment. This report documents various literature review components of the Phase I Data Collection Efforts associated with the LAC process. Please refer to the *Upper Chattooga River Visitor Capacity Analysis Implementation Plan for Data Collection Methods* (USFS, 2006) for more detail regarding Phase I Data Collection Efforts.

Management of wilderness or park areas in terms of carrying capacity often include the identification of indicators and standards of quality for biophysical conditions and for the visitor experience as part of a management framework. Indicator variables can be monitored over time to determine if the identified standards of quality are in

[1] Definition of classifications under the 1968 National Wild and Scenic Rivers Act (P.L. 90-542, as amended): w*ild river areas* - Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted; s*cenic river areas* - those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads; *recreational river areas* - those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

danger of violated and if so, whether management actions are necessary (Manning, 2003). Management factors include both social and ecological impacts and can involve descriptive and evaluative components. The descriptive component includes measures to identify specific conditions that result from recreational use, such as trail or site impacts, based on factual, objective data. The evaluative component involves assessment of how much impact or change in the recreation environment is acceptable, such as the number of visitor encounters (Vaske, et al, 1993; Manning, 2003).

To assist with the identification of management indicators and standards, various literature review topics were identified as part of the Phase I Data Collection Process, and as discussed in the *Implementation Plan* (USFS, 2006). The primary purpose of the literature review is to provide a summary of various relevant studies and management actions associated with these topics in other similar settings to the upper Chattooga River in order to help provide context and potential guidance to resource and management decisions for the upper Chattooga River. The literature review topics discussed in this report and key objectives are summarized below:

- ***Recreational Use Social Conflict Impacts and Standards*** - The objective of this literature review topic was to provide illustrative examples of studies where use/social impact relationships have been established and to provide illustrative examples of standards developed from studies or capacity analyses on other rivers. The focus of this literature review was on issues associated with recreational user type conflicts and also threshold assessments of user tolerances and user preferences, and impact standards.

- ***Recreational Use Flow Preferences*** - The objective of this literature review topic was to review a sample of flow/recreation studies on rivers with characteristics similar to the upper Chattooga as a general check on expert assessments of flow ranges for different activities. This assessment included the review and assessment of optimal flow ranges for whitewater boating, wading-based fly angling, and other types of fishing as identified by the flow assessment studies.

- ***Recreational Use Effects on Trail and Site Resources*** - The objective of this literature review topic was to provide information on trail and site impacts of recreation use from other rivers and assess whether current types and levels of use (or potential increased or new uses) are likely to noticeably increase those impacts on the upper Chattooga River corridor. Literature was reviewed related to trail and site impact studies, particularly those from the southeast, and general findings are summarized about how use levels affect these impacts, and typical ways that managers address them.

- ***Recreational Use Effects on Wildlife and Aquatic Resources*** - The objective of this literature review topic was to review literature related to possible wildlife impacts from recreation use in river corridors and assess whether current types and levels of use (or potential use increases or new uses) are likely to noticeably increase those

impacts on the upper Chattooga. Literature was reviewed related to wildlife impacts from river recreation activities and summarize general findings about how use levels affect these impacts and typical ways that managers address them.

For each of the literature review topics included in this report an overview or background regarding the identified literature topic is provided, a summary of various studies conducted within or in settings/circumstances that are similar to the upper Chattooga River corridor is discussed, and a summary is provided of potential management considerations and management standards, indicators, and actions based on the findings of the literature review. This information can provide input to decision makers so that they can make informed judgments in the establishment of management standards, indicators and actions related to recreational use within the Chattooga River corridor.

Requests to several Forest Service or other fish biologists have not produced any literature addressing the effects of passing boats on population viability, fish behavior, or fishing success. Idaho's Upper Main Salmon River is closed to boating during Chinook spawning periods to prevent boating disturbances over shallow gravel bars. One Idaho biologist noted "informal administrative results" showing that passing boats can "disturb and displace spawning Chinook salmon if the interactions occur at close proximity," although "we have no idea at what level these disturbances affect their reproductive success" (Moulton, 2007).

2.0 RECREATIONAL USE SOCIAL CONFLICT AND IMPACTS STANDARDS

Several elements can contribute to social conflicts within a recreational setting. Recreational use conflicts can be influenced by user type, the number, type and location of encounters, and user experiences and expectations. Conflict can arise when different types of uses and different types of desired experiences and outcomes occur. Conflict can also occur when expectations about the type and amount of use, such as anticipated encounters, are not what experienced. In addition, place bonding, such as desire to maintain the area under the existing conditions due to familiarity and other emotional bonding factors, can play a role in expectations for the desired recreational experience at a particular location.

This literature review section provides an overview of the potential influences of recreation activity on social conflict. The purpose is to review how specific types of recreation activity and behavior may affect social interactions, and further consider potential impacts that may be relevant to recreational use and potential conflicts that may occur within the Chattooga River corridor. The review is not intended provide a discussion of social conflict theory or specific conflict that may be occurring within the Chattooga River corridor. However, the intent is to identify factors that contribute to the occurrence of social conflicts, discuss potential impacts and considerations that could result from increased recreational use, and provide insight as to the types of indicators,

standards, and management strategies that have been used or recommended to address conflicts in other settings. In addition, section focuses on a literature review of several key elements associated with recreational user social impact preferences and tolerances (also know as standards).

This literature review section is organized in several parts. Section 2.1 provides an overview of social conflict impacts associated with recreational use activities or behaviors. Section 2.2 provides a summary of various related studies and Section 2.3 focuses more specifically on studies that have been conducted within the Chattooga corridor related to social conflict and standards. Section 2.4 provides a summary from other studies regarding potential management strategies associated with social conflict impact and standards. Finally, Section 2.5 summarizes key findings and makes recommendations for social impact indicators and standards for the upper Chattooga River corridor.

2.1 Overview of Social Conflict and Impact Standards

2.1.1 Influences of Type of Recreational Use

Marcouiller et al (2005b) states that there is a wide range of possible interactions among recreational users and groups and that conflict occurs when the interaction leads to negative outcomes for at least some of the participants. Conflict interaction can be categorized along a spectrum of four basic categories (see Table 2-1): complementary, supplementary, competitive, and antagonistic (van Kooten 1993, as cited in Marcouiller, et al, 2005b). The first two represent beneficial or neutral outcomes while the latter two represent conflict or negative outcomes. Also, after some threshold point, complimentary and supplementary interaction types can turn competitive, and therefore, there is a need to understand both relative interactions and the extent, or range, in which interaction types exist. Marcouiller et al (2005b) also state that recreational use conflict is often asymmetrical amongst different user groups, a finding that pervades conflict research. For example, bird watchers may experience significant conflict as a result of interactions with all terrain vehicle users, yet the all terrain vehicle users may view bird watching as generally supplemental to their activity.

Table 2-1. Interaction Types and Outcomes
(Source: Marcouiller, et al, 2005b)

Interaction Type	Key Characteristics	Outcome	Example
Complimentary	Increasing rates of return with increased use	No conflict	Canoeing and fishing
Supplementary	Neutral interaction	Minor conflict	Snowmobiling and ATV use
Competitive	Decreasing rates of return with increased use	Conflict	Fishing and jetskiing
Antagonistic	Any activity of one drives the other to zero	Strong conflict	Wilderness camping and ATV use

Recreation experiences can also be influenced by expectations, (e.g., social values conflict). Vaske et al (2006) conducted a study of cross country skiers and snowmobilers at two Colorado locations to assess the potential effects of interpersonal and social values conflict between the user groups. The results of the study indicated an asymmetrical relationship between skiers and snowmobilers, with skiers experiencing more conflict. For the skiers, 36 percent reported no conflict, 30 percent noted a conflict in social values, and 34 percent experienced interpersonal conflict. By comparison, 81 percent of snowmobilers indicated no conflict, 0 percent social values conflict, and 19 percent interpersonal conflict.

Vaske et al (2006) provide a distinction between interpersonal conflict and social values conflict. Interpersonal conflict occurs when the presence or behavior of an individual or group interferes with the goals of another individual or group. Social values conflict occurs between groups who may not share similar norms and values about an activity and the conflict can occur even when there is no direct contact between the groups.

Marcouiller et al (2005b) state there is a growing body of research that has documented the prevalence of coping behaviors amongst outdoor recreationists. "Coping behaviors are a mechanism that individuals have for avoiding or minimizing the negative experiences of crowding or conflict" (Gramann 1982; Hammitt and Patterson 1991, as cited in Marcouiller, et al, 2005b). Examples of types of coping behavior can include displacement to other recreation sites, within the recreation site itself or to other times of the day, week or season; or changes in an individuals expectation or alteration of activity more in line with current conditions.

2.1.2 Recreational Use Encounters and Crowding

Vaske and Donnelly (2002) describe the four concepts associated with recreational use interactions: actual density, reported encounters, crowding and norms. *Actual density* refers to the number of people per unit area, and it is measured by counting the number of people and measuring the space they occupy. *Reported encounters* refer to the number of other people in a recreation setting that visitors recall seeing and these perceptions of encounters can be influenced by characteristics of the resource, activity, visit and the visitor. *Crowding* is a negative evaluation of the number of people the individual remembers seeing and involves a value judgment that the number of people encountered is too many, where the individual compares the condition they experience with their perception of what is acceptable. *Norms* are standards that individuals use for evaluating activities, environments or management proposals and define what people think behavior and conditions should be.

Influences of Recreational Use Encounters

Recreational use encounters are often measured to better understand the relationship between user densities or perceptions of density with privacy, coping behaviors, satisfactions, and social carrying capacity (Hammitt and Patterson, 1991;

Hammitt and Rutlin, 1995; Manning, 1999; Lah, 2000, as cited in Dawson and Alberga, 2003). Vaske, Donnelly, Heberlein, and Shelby (1982) theorize that participants in consumptive activities (e.g., hunters and anglers) differ from those in non-consumptive activities (e.g., motorized and non-motorized boaters) in terms of the specificity of their recreation goals and their control in achieving those goals. Encounters can play a different role in different types of recreational activity. For example, some hunters view deer hunting as a solitary experience and thus prefer few encounters (Vaske, et al, 1993). Others believe that the presence of additional hunters help move deer, thereby increasing the likelihood of seeing game. For this group, a large number of encounters may be preferable. The same logic applies to non-consumptive recreation. Individuals who are motivated by solitude may find the presence of others disruptive. Alternatively, large numbers of people on a beach are often expected and may enhance the quality of the social experience.

Influence of Perceptions of Crowdedness

Crowding can be defined as a negative evaluation of density and involves a value judgment that the density or number of encounters with other visitors is too many and often the term perceived crowding is used to denote the evaluative nature (Desor, 1972; Stokols, 1972; Altman, 1975; Schmidt & Keating, 1979, as cited in Vaske, et al, 1998). Crowding can arise between user groups or more commonly within user groups (intra-activity conflict). Crowding can result from a combination of increased visitation, relatively stable facility or transportation infrastructure, and changes in visitor use patterns such as bus tours (Lime, et al, 1995, as cited by Kakoyannis, 2002). User's perception of crowding can be affected by several variables such as the numbers of other users within a specific place, the numbers of large groups, distance between users, encounter norms, experience expectations, and perceived encounter levels. Sometimes geographic area can influence encounter tolerance. Perceptions of crowding can influence visitor perceptions and satisfaction with the wilderness experience (Dawson and Watson, 2000).

2.1.3 Encounter Norms

Norms can be defined as evaluative standards that individuals evaluating acceptable behaviors, activities or conditions within a given environment or context (Vaske and Donnelly, 2002; Donnelly, et al, 2000). In the recreational setting, norms have typically been evaluated in terms of social encounter norms, by assessing personal/individual norms and then aggregating this information to describe the "social" encounter norm (Donnelly, et al, 2000). Encounter norms are determined by asking individuals to indicate the highest number of encounters, or number of other people in a recreation setting that visitors recall seeing, that they would tolerate before their experience became unpleasant (Vaske, et al, 1986). Social conflict or perceived crowding levels can occur when the actual encounters exceed the visitors encounter norm (anticipated or "tolerated" levels of encounters) (Vaske and Donnelly, 2002).

Characteristics associated with encounter norms that have typically been studied include: optimal number of encounters, range of tolerable encounters, level of agreement, intensity, and prevalence (or percent of people willing to state a norm). The literature identifies both experiential, such as type of resources, type of activities and type of encounter, and methodological variables, such as variations in survey format, associated with the willingness of individuals to identify an encounter norm (Donnelly, et al, 2000).

Vaske et al (1986) and Shelby et al (1996) describe a means to present encounter norms through encounter norm curves, based on Jackson's (1965) return potential curve (or impact acceptability) curve model. Encounter norm curves denote the optimum condition, the range of tolerable contacts, the intensity of the norm, and the crystallization of the norm. The high point of the curve denotes the optimum condition, or situation that receives the most positive evaluation. The social norm defines the boundaries of acceptable behaviors for that activity and the range is in part dictated by the group's ability to achieve desired goals. The range of tolerable encounters represent the number of encounters that an individual or group find acceptable and are depicted by the evaluations that are above the neutral line of the curve. The intensity of the norm is the distance from the neutral line at each point on the contact norm curve to either direction of the evaluation (i.e., favorable or unfavorable). When the range of tolerable encounters for a particular activity is narrow, the intensity of the norm may be increased. Norm crystallization is defined as the amount of agreement about a norm and can be measured by computing the standard deviation for each point on the curve. A small standard deviation implies that the social norm is crystallized and denotes a high degree of agreement on the encounter contact levels (Vaske, et al, 1986; Shelby, et al, 1996).

2.1.4 Influence of Use Experience and Place Attachment

Place attachment can play a role in recreational use experience. Place attachment is a developing concept and place attachment theories suggest that over time and with increased exposure recreationists form emotional and functional bonds with a specific resource (Hammitt, Backlund, and Bixler, 2003; Moore and Graefe, 1994; Williams and Patterson, 1996)). Therefore, the greater an individual is attached to a resource the less willing they are to make a substitution. Resource place bonding occurs after repeated experiences with a place and through transitional people-place interactions, therefore allowing the place to take on an identity of its own.

Hammitt et al (2003) state that experience use history (EUH) refers to the amount of past experience, usually measured in terms of years and frequency per year of participation with an activity and/or resource (Hammitt and McDonald, 1983; Schreyer, Lime, and Williams, 1984, as cited in Hammitt, et al, 2003). EUH has been shown to have multiple dimensions; specific past experience with a particular study site, and past experience with other similar sites. The bonding component of recreation resource use can become a main concern with resource specific activities because the resource users are commonly experienced individuals who have developed a strong bond with resource

places over time. Repeat-use areas commonly become "special," "favorite," and even "one of a kind" places for bonded recreationists.

2.2 Findings from Studies Regarding Social Conflict and Impacts

The following section summarizes some of the key findings from other studies related to social conflict and perception.

2.2.1 Influences of Type of Recreational Use

Moore and Sideralis (2005) conducted a study of the West Branch of the Farmington River, a designated Wild and Scenic River, located in west central Connecticut. The study included the assessment of the recreational use and users; a comparison of the two primary river users, anglers and boaters; and provided recommendations for river management and policy.

Participants were quite satisfied with their river experiences regardless of the particular activities they were engaged in during their visits, with a mean satisfaction rating of 7.5 on a 10-point scale with 10 being "the best possible trip." There was little difference in the crowding ratings between the two groups, with the angler group average of 7.5 and the angler group average rating of 7.8, measured on 9-point scale with 9 being "extremely crowded." Moore and Sideralis speculated that this was due to the fact that most tubers concentrated on the last 2.5 miles of the segment, well below the area most popular with anglers.

Respondents were also asked to rate the importance of 22 different possible motives for visiting the river that day. Both anglers and floaters had the same three most important reasons for visiting, all of which had to do with the quality of the natural resources available at or along the river. Five of the motives were significantly more important to the anglers than they were to the floaters. They were: "to use my equipment", "to experience solitude", "to think about my personal values", "to be on my own", and "to be away from the family for a while." Two motives were significantly more important to the floaters than the anglers: "to do something with my family" and "to take risks."

Moore and Sideralis (2005) conclude that the most important reasons people visited the West Branch of the Farmington River were to enjoy the views, experience the river itself, and be close to nature and the most important benefits they felt the river has for surrounding communities were fish and wildlife habitat, aesthetic beauty, and preserving undeveloped open space. Moore and Sideralis also conclude that management actions should therefore emphasize protection of high quality resource values and provide measures to diligently monitor the quality of natural resources and user experiences.

2.2.2 Recreational Use Encounters and Crowding

Influence of Perceptions of Crowdedness

Vaske, Donnelly, Whittaker and Shelby (1998) conducted an evaluation of 88 studies and 156 different settings and activities to summarize existing studies on perceived crowding from 1975 to 1996; to examine multiple ways to report perceived crowding; to assess factors that influence crowding; and to re-evaluate the crowding standards. They found that based on their analyses perceptions of crowding can vary by:

- *Specific types of use* (e.g., motorized boating, nonmotorized boating, big game hunters, and small game hunters) - such differences might be attributed to differences in the resource and/or recreationists' characteristics.
- *Type of resource* (i.e., backcountry versus frontcountry) - respondents in frontcountry evaluation contexts report higher levels of crowding than those visiting backcountry settings.
- *Region* - the highest crowding scores were reported by respondents in the northwest and Alaska regions and west region respondents reported the lowest crowding mean.
- *The year the study was conducted* - the time period 1975 to1981, shows a high-normal level of crowding and the time period 1992 to1996 has the lowest crowding mean of all the time periods.

The analyses also indicated that crowding <u>did not</u> vary by:

- *General types of use* (i.e., consumptive versus non-consumptive) - consumptive versus nonconsumptive categories of activities are too broad to take into account the differences that exist within specific activities.
- *Types of use* (salmon anglers versus general anglers) – although a small sample size the analyses found no difference in crowding ratings between salmon anglers and general anglers.
- *Method of data collection* (e.g., onsite versus follow-up mail and phone survey) - crowding is not influenced by survey methods, despite the difference in asking a respondent during, just after, and months after the experience.

<u>*Influences of Recreational Use Encounters*</u>

Dawson and Alberga (2003) surveyed hikers in three wilderness areas of New York's Adirondack Park and one wilderness area of the White Mountain National Forest regarding encounter levels associated with wilderness experiences. The locations included both higher us density wilderness areas and lower use density areas. Respondents were asked to indicate the number of hikers that was acceptable to them to meet on the trail each day, and fifty percent or more of the respondents in the higher density use areas reported that 20 encounters or less was acceptable, while fifty percent or more of the respondents in the lower density use areas reported that 10 encounters or less was acceptable. Respondents were also asked to indicate the number of large groups of hikers (i.e., 10 or more people) that was acceptable to them to meet on the trail each. Fifty percent or more of the respondents in the higher density use area reported that two large group encounters or less was acceptable, while fifty percent or more of the respondents in the one higher use and two lower density use areas reported that one large group encounters or less was acceptable.

Respondents were asked to indicate whether the number of user encounters experienced was less or more than expected during their trip in a given area. The largest percentage of respondents reported that what they experienced was what they expected. Respondents were also asked to indicate whether they felt crowded by other visitors during their trip in a given area, and over 50 percent of respondents in all areas reported that they did not feel crowded. When testing for a correlation between feelings of crowding and visitor expectations for encounters, Dawson and Alberga found that when encounters were less than expected there was a higher likelihood that there was no perception of crowding and, conversely, when visitor expectations were exceeded there was a greater likelihood that there was perceived crowding from a moderate to extreme problem (Dawson and Alberga, 2003).

2.2.3 Encounter Norms

Encounter norm curves were first applied in the Brule River where canoers were asked how they felt about seeing other canoers, tubers and fishermen (Heberlein and Vaske, 1977). The results indicated that encounter norms were held with different intensities depending on the type of use encountered. Encounters with tubers resulted in the highest intensity, encounters with fishermen resulted in reactions nearer to the neutral line, and intensity for encounters with canoers was in between. Crystallization for all three encounter norms was fairly comparable (Vaske, et al, 1986).

Donnelly et al (2000) conducted an assessment of 30 different studies that included 56 different types of norm evaluation contexts (specific situations where one type of user encounters another). Four predictor variables were examined: (1) type of resource, (2) type of activity, (3) type of encounter, and (4) question response format. The results indicated that norm prevalence varied by type of resource (backcountry or front country), type of encounter - (no conflict versus conflict), and question response format, and there was no relationship between type of activity (consumptive or non-consumptive) and norm prevalence. In terms of type of encounter, the assessment confirmed the existence of asymmetrical relationships among activities and that in conflict situations, encounter norms were more prevalent. For the assessment of the variation in consumptive versus non-consumptive activities, Donnelly et al stated that the categorization of non-consumptive versus consumptive activities was too broad a category to differentiate norm prevalence. In terms of type of resource, the assessment indicated that for visitors in a front country setting the tolerance limits was more variable and that individuals generally were more willing to tolerate that presence of other visitors as compared to those in backcountry settings (Donnelly, et al, 2000).

Table 2-1 provides a summary of median acceptable encounter levels from previous studies that include similar type of activities to what could occur in the Chattooga River corridor. The table is comprised of extracted relevant portions of a summary table provided by Vaske et al (1986) where they provided a synopsis of findings from previous studies of encounter norms. The table also summarizes findings from several other more recent studies that included encounter norm assessment

(Whittaker and Shelby, 1998; Roggenbuck, et al, 1991; Whittaker, et al, 2000). The studies were conducted in a variety of settings/contexts and used different methodologies for conducting the data. However, there are some similarities between some of the identified encounter norms. For example, the encounter norms for wilderness area trips as compared to more recreational or social type of trips were lower. Typically, the average boating norm encounter levels were around 10 boats per day.

Martinson and Shelby (1992) conducted a study to assess encounter and proximity norms for salmon anglers in California and New Zealand. As part of this study, Martinson and Shelby summarize other study key findings related to angler norms and indicate that the angling experience may differ by the type of species pursued, fishing intensity, technique, equipment, season, and resource setting. They also surmise that the trout angling experience may be more dependent on the recreational resource than on the species. The following bullets present some of the other literature summaries as provided in Martinson and Shelby (1992):

- "In a study of four Vermont rivers, Manning (1979) found that anglers showed a lower tolerance for encounters than did river users engaged in swimming and boating; anglers reported that satisfaction decreased markedly after only two contacts with any other river users. Anglers also were significantly more sensitive to setting attributes (e.g., water quality and access) when evaluating experience quality, and anglers perceived the most conflict (often one-sided) with other users."

- "A study on the Bois Brule River in Wisconsin (Heberlein and Vaske, 1977) found that trout anglers were less tolerant of contacts with people floating the river in canoes or on inner tubes, and they preferred contacts with other anglers or other recreationists whom they perceived to be most like them. The tolerable range of encounters was zero to seven other anglers per day."

- "In their study of Colorado anglers, Harris and Bergersen (1985) found that trout anglers are motivated by the quality of the natural setting, the presence of native fish, and the absence of other recreational activities that interfere with fishing. Such anglers are more likely to seek resource settings where they expect to encounter few others who would affect their experience."

- "In a review of fisheries management techniques, Barnhart (1989) found that on certain trout waters, when fishing use significantly increased, user satisfaction declined."

Table 2-1. Summary of Acceptable Encounter Levels based on Findings from Previous Studies (Sources: Vaske, et al, 1986; Whittaker and Shelby, 1998; Roggenbuck, et al, 1991; Whittaker, et al, 2000)

Citation	Study Area	Study Population	Norm for Meeting:	Median Acceptable Encounter Level
Stankey (1973)	Boundary Waters Canoe Area	Wilderness visitors	Paddling canoeist parties	3.5
	Three Western Wilderness Areas	Wilderness visitors	Backpacker parties	2.5
Stankey (1980)	Desolation Wilderness	Wilderness visitors	Backpacker parties	9.5
			Large (>12) parties	2.6
			Other camps within site or sound	2.4
Vaske (1977)	Bois Brule River	Fishermen	Fishermen	9.0
			Canoers	7.0
			Tubers	0.0
		Canoers	Fishermen	9.0
			Canoers	7.0
			Tubers	30
		Tubers	Fishermen	9.0
			Canoers	7.0
			Tubers	15
Shelby (1981)	Rogue River	River users	Wilderness area encounters/day	1.5
			Semi-wilderness area encounters/day	2.9
			Undeveloped recreation area encounter /day	4.4
	Rogue River	River users	Wilderness area encounters/day	.7
			Semi-wilderness area encounters/day	2.0
			Undeveloped recreation area encounter /day	2.7
Roggenbuck and Bange (1983)	New River Gorge	All river users	Boats seen/day	15.0
		Commercial river users	Boats seen/day	10.0
		Private river users	Boats seen/day	25.0
		All river users	Boats seen floating past lunch stop	10.0
		Commercial river users	Boats seen floating past lunch stop	9.0
		Private river users	Boats seen floating past lunch stop	15.0
		All river users	Boats seen floating past campsite	4.0
		Commercial river users	Boats seen floating past campsite	4.0

Table 2-1. Summary of Acceptable Encounter Levels based on Findings from Previous Studies (cont.) (Sources: Vaske, et al, 1986; Whittaker and Shelby, 1998; Roggenbuck, et al, 1991; Whittaker, et al, 2000)

Citation	Study Area	Study Population	Norm for Meeting:	Median Acceptable Encounter Level
Roggenbuck and Bange (1983)	New River Gorge	Private river users	Boats seen floating past campsite	5.0
		All river users	% of time in sight of boats from other trips on Wilderness whitewater trip	10.0
			% of time in sight of boats from other trips on scenic whitewater trip	25.0
			% of time in sight of boats from other trips on social recreation whitewater trip	50.0
Shelby and Stein (1984)	Klamath River	River floaters	Wilderness area encounters/day	3.0
			Semi-wilderness area encounters/day	2.5
Whittaker and Shelby (1988)	Deschutes River	River user	Hours in sight of other users	1.8-2.2
		Anglers	Number of boats per hour	4.0-4.7
		Campers	Number of camp encounters	1.4-1.9
Roggenbuck, Williams, Bange, and Dean (1991)	New River	River users	Acceptable number of boats seen - wilderness whitewater	10.1
			Acceptable number of boats seen - scenic whitewater	20.4
			Acceptable number of boats seen - social recreation	33.4
			% of time in sight of boats from other trips on Wilderness whitewater trip	18.3
			% of time in sight of boats from other trips on scenic whitewater trip	32.3
			% of time in sight of boats from other trips on social recreation whitewater trip	48.1
Whittaker, Vaske and Williams (2000)	Gulkana River	River floaters	Encounter with non-motorized boaters	5.0-10.0
			Encounter with motorized boaters	0.0-5.0
			% of time in site of others – floaters	24-30
			% of time in site of others – powerboaters	54
			% of time within site/sound of campsites	18-38
			% of time within sight of ATV users	5-12
		Anglers	% of time fishing sites passed up	25-30

Whittaker (1993) in a study of five moderate to high density south central Alaska rivers found that competition impacts appeared to have greater negative effects than just encounter impacts. Whittaker suggests that encounters alone may not be as important as the way encounters occur, or the place where they occur. For example, having to share a camping site, a fishing hole, or a boat launch can have greater negative effects than just seeing other users. Whittaker also found that users oriented toward primitive recreation opportunities were generally more sensitive to impacts than users oriented toward less primitive opportunities (Whittaker, 1993).

2.2.4 Perceptions of Wilderness and Solitude Experiences

Many studies have examined standards for social impacts in wilderness settings. A representative sample of review studies or studies from settings with similarities to the Upper Chattooga are discussed below.

Roggenbuck et al (1993) conducted a study to compare user perceptions of appropriate indicators and standards in several wilderness areas, including the Cohutta (located in Georgia), Caney Creek (Arkansas), Upland Island (Texas), and Rattlesnake (Montana) wilderness areas. The study found that wilderness visitors have high shared agreement in what influences visitors wilderness experience. Littering and damage to trees in campsites, noise (adverse impacts) and seeing wildlife (a positive impact) were all viewed as important adverse influences on wilderness experiences. Camping within sight or sound of other people had a greater adverse impact on overall experience quality than trail encounters. Any stated differences seemed instead to be related to the type of use the area receives.

Roggenbuck et al also suggest that wilderness conditions that influence perceptions of wilderness quality are more often related user behavior, such as noise and type of activity, rather than specifically the amount of use. In one example, they discuss how a very small proportion of people who litter can have large effects on wilderness quality perceptions and many littering studies suggest that setting cues are better determinants of the amount of litter than the number of people using an area. The point is that managers may be able to reduce impacts more effectively through shaping user behavior than by limiting use, through appropriate application of education, persuasion, and rewards and incentives.

Hall (2001) conducted a study of wilderness hikers within the Shenandoah National Park through open-ended interviews with 117 groups of hikers. The purpose of the study was to investigate wilderness hikers' experiences of solitude, to understand what factors contributed to those experiences, and to understand the extent to which encounters with other groups detracted from the sense of solitude. Table 2-4 provides a summary of the key factors that hikers indicated affected their wilderness and solitude experience. The study results indicated that 85 percent indicated that encounters detracted from the sense of solitude, but only 25 percent indicated that few or no encounters were a critical element in their definition of wilderness experience.

Table 2-4. Summary of Key Factors Contributing to Wilderness and Solitude Experience of Hikers in the Shenandoah National Park
(Source: Hall, 2001)

Elements	Percent
Factors Contributing to a Feeling of Wilderness (41 groups)	
Natural setting features (trees, scenery, rocks, water, wildlife)	51
People (seeing no one, seeing few others, not being crowded)	44
Human influences (unmanaged, no developments)	27
Access (challenging trails, remote, rugged)	22
Experiences (escape, peace, harmony)	15
Sounds (water, wind, natural sounds)	12
Factors Detracting from a Feeling of Wilderness (46 groups)	
Access (not remote, trail too developed or maintained)	83
People (too many people, crowded, large groups)	52
Experiences (too safe, easy hike, too short)	26
Sounds (sounds of cars)	20
Human influences (evidence of people, developments)	15
Elements in Personal Definitions of Wilderness (100 groups)	
Lack of human influence (no developments, untouched, uninhabited)	60
Natural setting features (trees, scenery, rocks, water, mountains)	53
Wildlife	47
Experiences (solitude, peace, harmony)	37
Access/Location (remote, difficult access, large area)	36
People (few encounters, no people)	25
Factors Contributing to a Sense of Solitude (91 groups)	
Presence of people or encounters	68
Saw few people	39
Saw no one else	24
During times away from people	24
Quiet/natural sounds	42
Natural setting	32
Personal experiences	28
Being still/observing	16
Being away/remote	11
Didn't hear people	3
Factors detracting from a Sense of Solitude (34 groups)	
Presence of people or encounters	85
Saw a lot/too many people	62
Talking amongst selves	12
Own group size	9
Experiences (easy, short)	15
Sounds (cars)	12
Management setting	6

Hall stated that that many hikers felt solitude during episodes in which they were away from others, even if they had experienced many encounters across the entire trip, suggesting that the pattern of encounters may have more influence than just the number. For example, many encounters all at one time, followed by long periods of seeing no one, might be more likely to promote a sense of solitude than relatively evenly spaced encounters through the day. Hall also found that the relationship between solitude and crowding was generally strong among Shenandoah hikers; however, individual factors (past experience and expectations) influenced perceived crowding more than solitude. Hall concludes that management implications of this finding may support a monitoring approach that evaluates solitude opportunities that include other indicators, such as "the longest period of time without seeing others" rather than just the number of encounters per day.

2.3 Findings from Studies within the Chattooga River Corridor Regarding Social Conflict and Impacts

The following section summarizes some of the key findings of social conflict and perception studies conducted within the Chattooga River corridor.

2.3.1 Influences of Type of Recreational Use

Vagias, Morais, and Dziubek (2005) conducted a study of whitewater boating participants on Section III and Section IV of the Chattooga River to assess motivations to participate in a wilderness whitewater rafting trip. Section III is characterized by Vagias et al as "relatively mild mannered and contains primarily Class I, II and III rapids and numerous large, deep pools," and Section IV, "as one of the most difficult and dangerous rivers commercially rafted in the United States, with steep, often violent, with numerous natural hazards inherent to the river."

Data was collected during May through June 2004 and included 202 respondents with 98 Section III participants and 104 Section IV participants. Section III respondents were evenly distributed between genders, and Section IV respondents were comprised of 66 percent males and 34 percent females. Of Section III respondents, 78 percent were between 35-54 years of age with the most frequent distribution being individuals 45 to 54 years of age, and of all Section IV respondents, 58 percent were between the ages of 25 to 44 (Vagias, Morais, and Dziubek, 2005).

Vagias et al (2005) found that perceptions of the amount of risk involved in the rafting trip decreased significantly from pre to post measurements in both river sections and that perceptions of the amount of risk involved in the rafting trip was significantly higher for Section IV participants than for Section III participants. Also, Section IV participants were significantly more motivated by "allure of danger/risk/challenge" than Section III participants. Finally, the most important motivations for participation in a rafting trip for participants of both groups were "interacting with family and friends" and "wilderness and "enjoyment of nature/pleasure."

2.3.2 Recreational Use Encounters

Hammitt and Rutlin (1995) conducted a study to investigate the relationship between wilderness use encounters and degree of privacy for visitors in the Ellicott Rock Wilderness during the fall of 1992 and the spring, summer, and fall of 1993. For this study, Hammitt and Rutlin sampled a total of 607 visitors with a response rate of 71 percent through use of an initial on-site contact survey conducted at one of four trailheads within the Ellicott Rock Wilderness area and a follow-up mail questionnaire. The mail questionnaire included topics such as: current visit characteristics, past use history, low-impact behavior, campfire use and attitudes, wilderness use encounters, wilderness privacy, and visitor background characteristics.

Rutlin (1995) summarized key visitor characteristics based on the study data, including: the average age of the visitors was 35 years; most visitors were from urban areas; the majority (62 percent) of the visitors were residents of South Carolina; about half (43 percent) indicated that it was there first visit to the wilderness area. The average group size was 4.5 people and primary activities included: hiking (88 percent), sightseeing (50 percent), wildlife observation (45 percent), camping (38 percent) and fishing (34 percent). Most of the visitors entered the wilderness area through Burrell's Ford (48 percent) and Chattooga (42 percent) trailheads and most use was concentrated along the trail corridor between these two trailheads. The average number of visits per year was 4.3 and the use was evenly distributed between the spring, summer and fall periods.

Wilderness use encounters were defined for respondents as "number of other groups (parties) you saw regardless of size, or type of activity." Respondents were asked to report the number of groups encountered at three specific locations: trailhead, along the trail, and at campsite or other wilderness destination. Table 2-3 summarizes the reported ideal, actual and maximum group encounters for the three locations.

Table 2-3. Ideal, Actual and Maximum Group Encounters at Three locations within the Ellicott Wilderness Area
(Source: Hammitt and Rutlin, 1995)

Location	**Encounter (Mean)**		
	Reported Encounter[1]	**Preference**[2]	**Tolerance**[3]
At Trailhead	5.71	3.76	8.68
On Trail	4.12	3.19	6.58
At Destination Site	2.24	1.03	2.46
All Three Sites Combined	4.12	2.67	5.94

[1] Actual number of groups seen at each location.
[2] Maximum number of other groups visitors could tolerate before desired level of privacy is lost.
[3] Ideal number of groups visitors would like to see at each location.

Rutlin (1995) found that factors related to the degree of privacy achieved were most heavily influence by the relationship between privacy achieved and between the actual number of encounters, particularly for individuals whose actual encounters exceeded their ideal and maximum visitor encounter tolerance preferences. The amount of privacy desired was of greater importance for the overnight visitors than for the day use visitors, and overall privacy was found to be less important than what might be expected for a wilderness area.

2.3.3 Influence of Use Experience and Place Attachment

Several studies and assessments of EUH have been conducted for certain types of recreational use within the Chattooga River corridor (Backlund, 2005; Cavin, 2004; Hammitt, Backlund and Bixler, 2005; Vagias, Powell and Haynie, 2006). Table 2-2 provides a summary of key findings related to EUH. Backlund (2005) conducted a study of trout anglers and whitewater boaters who used the Chattooga National Wild and Scenic River in 2000 to examine the relationship between place attachment and resource substitutability. Backlund surveyed 292 trout anglers (with a response rate of 71 percent) drawn from members of the Rabun and Chattooga chapters of Trout Unlimited (TU) and 447 whitewater boaters (with a response rate of 64 percent) drawn from a stratified random sample of whitewater boaters who completed self-administered permits in 2000. Study participants were asked to report the number of alternative rivers they felt would provide a similar experience as participating at the Chattooga, and to name and rate the equivalence of a river in the Southeastern United States they thought was the best substitute for the Chattooga.

Table 2-2. Experience Use History Summary for Chattooga River Campers, Anglers and Whitewater Boaters
(Source: Cavin, 2004; Vagias, Powell and Haynie, 2006).

Previous Experience Category	**Camping**	**Angling**		**Whitewater Boating**	
	Mean	**N**	**Mean**	**N**	**Mean**
Years participating in activity	NA	188	31.5	238	13.0
Years participating in activity within the Chattooga River area	6.5	188	14.7	237	10.5
Years participating in activity at other local areas	9.5	188	17.5	231	10.8
Times participating in activity in the previous year within the Chattooga River area	1.4	185	9.8	237	13.8
Times participating in activity in the previous year at other areas	2.4	181	20.8	233	23.2
Total times participating in activity within the Chattooga River area	10.8	161	142.5	229	145.5

TU members named 40 different rivers and the whitewater boaters named 37 different rivers they perceived as potential substitutes for the Chattooga River, with about 14 percent of the TU members and 44 percent of the whitewater boaters reporting having no substitutes. The mean number of substitutes reported by the TU members was 5.9 and 1.8 for the whitewater boaters. TU members tended to rate their substitutes as equivalent or better with a mean rating of 4.5, while whitewater boaters tended to rate their substitutes as equivalent or not as good with a mean rating of 3.4. The degree of place attachment was generally lower for the TU members, with a mean place identity rating of 3.5 and a mean place dependence rating of 2.5 as compared to the whitewater boater ratings of 4.2 for place identity and 3.5 for place dependence (Backlund, 2005).

Hammitt, Backlund and Bixler (2005) conducted further assessment of the trout angler responses (associated with their assessment of Experience Use History) and Vagias, Powell and Haynie (2006) provided additional assessment of recreational use in the Chattooga River drawing primarily from Backlund (2005) data. The mean number of total years that participants trout fished anywhere was 32 years and the mean total years trout fishing at the Chattooga River was 15 years. The average number of times that the participants fished the Chattooga River was 10 times and spent an average number of 21 trips to other local streams during the previous year. The surveyed anglers fished an average of eight streams during the previous year in addition to fishing on the Chattooga River (Hammitt, et al, 2005). In comparison, the average number of years whitewater boating for the boater group was 13 years and an average of 10 years boating experience on the Chattooga River. The average number of times that the participants boated on the Chattooga over the previous year was 14 times and an average number of 23 trips were conducted on other rivers by participants in the previous year (Vagias, et al, 2006).

In their assessment of the relationship between the amount of experience use history (EUH) and the degree and character of place bonding behavior of trout anglers for the Chattooga River, Hammitt, Backlund and Bixler found an overall fairly high degree of place bonding. The rating was based on a 7-point scale of 1 being weak to 7 being strong, with the mean rating of the veterans group of 5.54, the locals group of 5.86, the beginners rating of 4.44, and the visitors rating of 4.32. The veterans were classified as anglers with high EUH on both the Chattooga and other rivers, locals were classified as anglers with high EUH on the Chattooga but low EUH on other rivers, beginners were classified as anglers with low EUH on both the Chattooga and other rivers, and visitors were classified as anglers with low EUH on the Chattooga River, but high EUH on other rivers (Hammitt, Backlund and Bixler, 2005).

Cavin (2004) conducted a study of campers within the Andrew Pickens District of the Sumter National Forest, including the Cherry Hill developed campground, Burrell's Ford walk-in campground and the Ellicott Rock Wilderness area. Cavin conducted a survey of 506 campers (and received a response rate of 84 percent) during May through October 2003. In terms of EUH, Cavin found that the average number of years respondents camped at the campground sites were 6.5 years with the total number of times camping at the sites at an average of almost 11 times. Considering all three camping areas, the average length of stay was 3.1 days and the average group size was

4.8 people. The activities respondents participated in while visiting the area included: camping (90 percent), viewing scenery (68 percent), day hiking/walking (65 percent), fishing (52 percent), backpacking (33 percent), picnicking (32 percent), photography (27 percent), nature study (16 percent), boating/kayaking (5 percent), mountain biking (2 percent) and other (12 percent).

2.4 Findings from other Studies of Potential Management Strategies

This section includes a discussion of several management considerations and actions that are typically used to address social conflicts and impacts in a recreational use setting.

2.4.1 Identification and Selection of Indicators

In recreation management, indicators identify what conditions will be monitored and standards define when those conditions are acceptable or unacceptable. Before developing a standard, it is necessary to choose an appropriate indicator. Recreation impact frameworks encourage selection of the most important and relevant impacts for indicators, generally because managers can not afford to measure, monitor, and manage every social or environmental impact that may affect recreation opportunities (Stankey, et al, 1985; Shelby and Heberlein 1986; Graefe, et al, 1990, as cited in Whittaker and Shelby, 1993). Whittaker and Shelby (1993) identify key considerations in the selection of indicators:

- Specificity -indicators should refer to specific conditions.
- Measurability - indicators should be easily and reliably measured in field situations.
- Sensitivity - indicators should be sensitive to changes in impact over a relatively short period of time.
- Correlation and Responsiveness - indicators should reflect impact changes which are related to human-caused activities, and which can be affected by alternative management actions.
- Integration - indicators should consider multiple types of impacts to be most effective.
- Significance - indicators should represent significant impacts.

Whittaker and Shelby also state that good standards should be like good objectives: quantifiable, time bounded, attainable, and output-oriented.

Management decisions require both descriptive information, such as affects of use resulting in ecological impacts, and evaluative information, such as the identification of

specific standards and management objectives (Manning, 2003; Vaske, et al, 1993). Shelby et al (1996) summarize key sources for evaluative information, including: *decision makers* – opinions and experiences of decision makers who are responsible for managing the resource; *expert opinion* – assessment and provision of input for management strategies from "experts" in the resource topic area; *organized interest groups* – influence of organized groups on evaluative judgments; *user groups* – evaluative judgments and input from users of the resource, and *general population* – broader source of input from the general population. This information can be obtained through site specific surveys, assessment, and documentation, and/or through the review and assessment of applicable literature and studies conducted in comparable settings and/or circumstances. For example the literature reviewed in this document can provide valuable information to decisions makers in making "informed" evaluative judgments in the development of standards and indicators for the management of the Chattooga River corridor.

Roggenbuck et al (1993) state that "the limits of acceptable change planning framework recognizes that forest managers must decide what indicators of wilderness conditions best represent resource naturalness and high-quality visitor experiences and how much change from the pristine is acceptable for each indicator. Visitor opinions on the aspects of the wilderness that have great impact on their experience can provide valuable input to selection of indicators. Roggenbuck et al state that this commonality in the pattern of response across areas suggests that not all wilderness areas need intensive visitor surveys to implement LAC management. They state the need to study intensively a few areas with great diversity in use and user characteristics, in order to cover the typically high range in visitor opinions about acceptable conditions, and apply these findings to comparable user groups in other areas.

2.4.2 Use Limits

Monz et al (2000) surveyed managers of all 624 areas in the National Wilderness Preservation System (NWPS) to gather information on the role of group size limits as a visitor management technique for wilderness areas. The key questions asked included:

1) What is the percentage of all wilderness areas in the NWPS that currently have group size limits, and what is the maximum allowable size?
2) What justifications do managers give for their group size limits?
3) Do wilderness managers have plans to alter their group size regulations, and if so, why and how?

Monz et al (2000) found that overall about 52 percent of wilderness areas have established some type of group size limits. The results indicated that the implementation of group size limits varied by type of agency with 73 percent of the Forest Service, 68 percent of the National Park Service, 17 percent of the Bureau of Land Management, and 11 percent of the Fish and Wildlife Service managed areas applying size limits. The results also indicated that only 10 areas (1.9 percent) were closed or inaccessible (with 8 of these being managed by the Fish and Wildlife Service). Group size limits ranged from 6 to 60 with a median of 12 and an average of 10.

In terms of reasons for establishing group size limits, environmental impact was the most frequently listed reason (81 percent), followed by "to be consistent with neighboring wilderness areas" (50 percent), "conflict between groups" (47 percent), overall high use of the area (42 percent), facility/site constraints (39 percent), and public constraint/pressure (24 percent). In terms of future plans for alteration of group size limits, 77 percent of the areas did not plan to change group size limits, and about 17 percent did plan to change group size limits within the next 5 years (Monz, et al, 2000). Monz et al (2000) also state that in wilderness areas with limits, the trend appears to be toward reducing maximum allowable group size; comparing their findings of most common group size limit of 10, as compared to past studies (Cole and others, 1987) that indicated a common party size limit of 25.

Monz et al (2000) state that it is not clear how successful group size limits has been in limiting ecological and visitor experience impacts, with the exception of eliminating very large groups and their associated impacts. They state that other factors such as visitor behavior, overall visitor numbers, geographic and temporal separation of groups and site size and durability may be more effective in minimizing impacts than limiting group size. Monz et al (2000) also state that while measurements of biophysical and social conditions are invaluable aids in decision making, they cannot be the sole determinants for management decisions and that careful, value-based decisions must often be made in defining visitor limits and for management actions. They state that planning frameworks such as Limits of Acceptable Change (LAC) (Stankey, et al, 1985) and Visitor Impact Management (VIM) (Graefe, et al, 1990) are based on this premise and, to date, represent the most effective efforts to maintain a high standard of resource and social conditions.

Landres et al (2005) provided recommendations for management of the A.T. trail and campsite areas developed through the case study review and input from land managers, scientists, ATC staff, and club members. In terms of campsite encounters, hikers reported that they preferred to see an average of three other parties of people camped within sight and sound of them and that nine other parties were the maximum that should be allowed. Landres et al recommend that overnight visitation be managed within specified maximum capacities and that managers evaluate the desirability of increasingly social overnight experience and if found to be undesirable, consider the specification of overnight capacities that vary by A.T. zone.

2.4.3 Other Factors

Marcouiller et al (2005a) summarize various approached for managing recreational use conflict in outdoor recreation. These strategies include: (1) managing recreation areas based on social and environmental carrying capacity; (2) separating uses in either time or space; (3) educating users and managers about the issues; (4) being clear about the goals of management; and (5) providing a spectrum of different recreation opportunities.

Identification of Visitor Norms

There is a recent focus on using visitor norms to set standards of quality or management targets (Shelby and Vaske, 1991; Shelby, et al, 1996; Manning, 1999, as cited in Marcouiller, et al, 2005a). In this approach a management standard can be set based on the social norm for a certain element, such as the number of people encountered on a trail or type of facilities required. A social norm can be defined as "the sum of individual norms for a certain variable and can be graphed as a curve with range of acceptability on the vertical axis and the variable graphed on the horizontal" (Vaske, et al, 1986, as cited in Marcouiller, et al, 2005a).

Use Zoning

Vaske et al (2006) states that zoning incompatible users to different locations can be an effective method of managing conflict that stems from interpersonal conflict. Furthermore, when the source of conflict is a difference in values, education may be required. There is a recent focus on using visitor norms to set standards of quality or management targets. In this approach a management standard can be set based on the social norm for a certain element, such as the number of people encountered on a trail or type of facilities required (Shelby and Vaske, 1991; Shelby, et al, 1996; Manning 1999, as cited in Marcouiller, et al, 2005a).

Roggenbuck et al suggest a potential option of zoning the wilderness for different experience opportunity classes and establishing different condition standards within each. Roggenbuck et al state "managers could then provide information to potential visitors to help them find the zone that best meets their experience requirements. If the wilderness area is so small that defining and managing for distinct experiences in separate zones within the wilderness is unfeasible, as might be the case for many eastern areas, then the manager might attempt to shape user definitions of appropriate wilderness conditions through consensus-building or small group discussions. Another strategy might be to manage a wilderness for one clientele group, use that group's standards for acceptable conditions, and provide information on nearby wildernesses and backcountry areas where other clientele groups could go to find their desired conditions."

2.5 Key Findings and Management Considerations

The following section provides a summary of the key considerations associated with social impact standards based on the literature review. In addition, potential indicators, standards and actions, including both monitoring and management implementation actions are provided for consideration in the future development of management actions.

2.5.1 Summary of Key Findings

- *Recreational use interactions* - there is a wide range of possible interactions amongst recreational users and conflict occurs when the interaction leads to

negative outcomes for at least some of the participants. Recreational use can be complementary, supplementary, competitive, and antagonistic and often the conflict is often asymmetrical amongst different user groups. Also, recreation experiences are often influenced by expectations, which managers may be able to influence with good information about conditions users are likely to experience.

- *Type of use considerations* - Asymmetrical relationships of social experience (and social conflicts) can occur between recreational user types; e.g. tubers can be more tolerant of higher level of encounter levels than anglers. Also, competition impacts can lead to a greater negative effect than just encounter impacts alone. In developing indicators managers may need to determine different indicators and standards based on the type of user group.

- *Encounters* - recreational use encounters are often measured to better understand the relationship between user densities or perceptions of density with privacy, coping behaviors, satisfactions, and social carrying capacity. Perceptions of encounters are relative; individuals who are motivated by solitude may find the presence of others disruptive. Alternatively, large numbers of people on a beach are often expected and may enhance the quality of the social experience.

- *Crowding* – perceptions of crowding are primarily based on the density or number of encounters and the visitor's assessment of whether the number of encounters are too many (perceived crowding), which are often linked to visitor's expectations. Also, perceptions of crowding can influence visitor perceptions and satisfaction with the overall wilderness experience

- *Place attachment* – place attachment typically occurs when visitors become emotionally bonded to specific places over extended use of the area. The greater an individual is attached to a resource the less willing they are to make a substitution and the more likely alternative resources seem less suitable for the activity and/or the experience can be perceived as being of lower quality.

- *Encounter norms* - Encounter norms vary depending on type of use: *recreation use category* (e.g., hiking, camping, boating, angling) can influence the type of experience desired and expectations; *size of group* – larger group, social versus more solitude; *setting* – in more wilderness, less developed setting fewer encounter levels are tolerated than less remote more developed area; and *expectations* – if actual use exceeds the encounter norm (or level at which encounters are tolerated) conflict is more prevalent. Managers need to consider these aspects in the development of standards and indicators for the management of a wilderness area.

- *Group size limits* - Large group size limits have moderate beneficial effects - primarily that of groups over 10 or more. However, other factors, such as visitor behavior, overall visitor numbers, geographic and temporal separation of groups,

and site size and durability, may be of more important consideration in the development of standards and indicators for the management of a wilderness area.

- *Management strategies* - As recreational use conflict is an outcome of the recreational use experience, management actions should emphasize protection of high quality resource values and provide measures to monitor the quality of natural resources and user experiences. Specific types of management actions can include providing a range of recreation opportunities, separating conflicting types of uses by temporal or spatial restrictions, or educating users about potential sources of conflict and appropriate behaviors. Management techniques can include factors such as recreational use zoning (separating uses in either time or space); and educating users and managers about the issues. Also, management indicators should identify what specific conditions will be monitored and standards should specifically define when those conditions are acceptable or unacceptable.

2.5.2 Management Considerations

Potential Indicators

The following are a list of general potential indicators. Indicators are typically more definitive and would need to be developed based on the specific resource objective. For example, for the general indicator of increase in site/trail degradation, the specific indicator applied may be "no more than *X* percent increase in litter than what occurs under existing conditions of *X* percent occurrences reported as the baseline." Potential general indicators associated with social impact standards could include:

- Average number of encounters per day.
- Increase in recreational use conflict.
- Increase in site/trail degradation (e.g., litter, site/trail erosion).

Potential Standards

- Less than 7 encounters per day (on average).
- Minimal/no increase in recreational use conflicts.
- Minimal/no increase in other perceived social impacts (e.g., litter, site/trail erosion).
- Minimal increase in encounter levels above the determined encounter norm.

Potential Management Implementation Actions

Monitoring Actions

- Monitor number, type and location of recreational use.
- Conduct user surveys to determine encounter norm preferences, social encounter conflicts, and other social impacts perceived by recreational users specific to the resource area.

Regulation/Education Actions

- Group size limits.
- Recreational use restriction zoning by location and/or type of use.
- Redirect use from high use areas – through trail or site facility closures or modifications.
- Zoning for type, level and location of recreational use.
- Education of recreational users concerning management actions and user interaction expectations (e.g., location/type of use if zoning is applied).

3.0 RECREATIONAL USE FLOW PREFERENCES

Instream flow, the amount of water in a river, is a fundamental determinant of recreation quality in most river settings. Flows determine whether a river is boatable, swimmable, or fishable, and flows may affect other attributes such as the challenge of whitewater, the efficacy of different fishing techniques, or the aesthetics of the "riverscape" (Brown, Taylor, and Shelby, 1992; Whittaker, et al, 1993). Due to the large number of flow-regulated rivers (from dams, diversions, or other water development), considerable research has examined flow preferences for different recreation activities.

Most of these studies have focused on flow ranges for whitewater boating, which is particularly sensitive to flows, but at least a dozen have assessed ranges for fishing or other activities with similar precision. The following literature review section is designed to summarize generalizations about different flow needs for these activities as context for discussion of the possibility of natural "zoning" between boating and other uses on certain kinds of rivers. The findings also provide a "check" on flow preferences for different activities that will be developed through the "expert panel" element.

This literature review section is organized in several parts. Section 3.1 reviews flow-recreation concepts and methods, and then suggests how those may apply to flow-related issues in the Chattooga corridor. Section 3.2 summarizes key findings from published studies of boating, fishing, and other studies. Section 3.3 summarizes additional information about boating flows on southeastern or other rivers based on guidebook or webpage information. Section 3.4 summarizes overall findings from the review and suggests implications for capacity issues.

3.1 Overview of Recreational Use Flow Preferences

3.1.1 Recreation Flow Preference Assessment Concepts and Methods

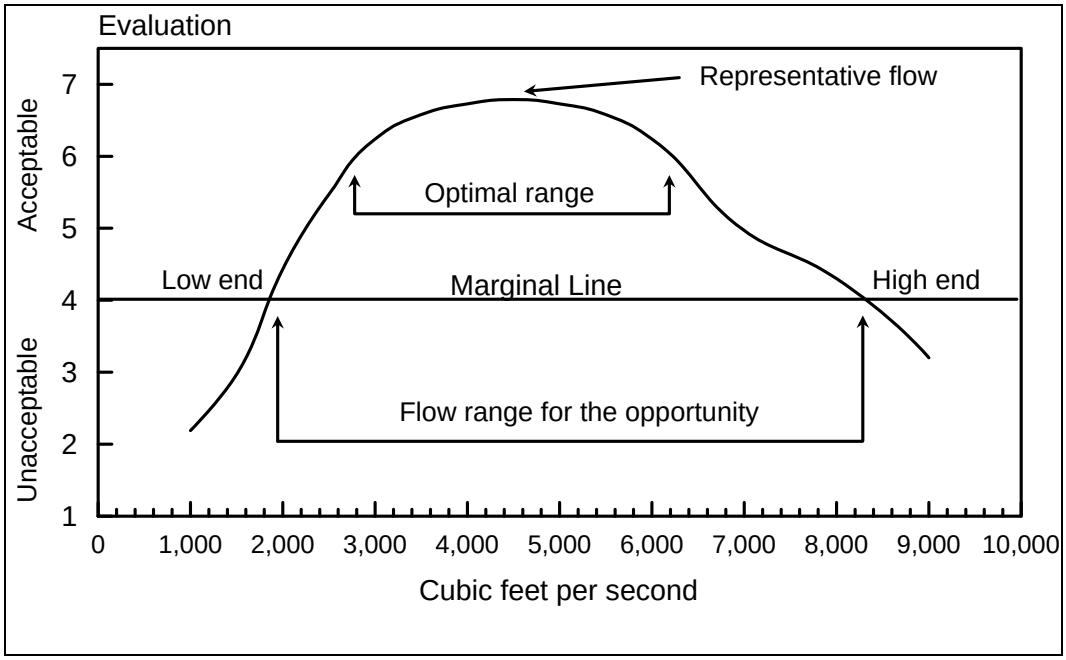
The field of recreation flow assessment has developed over the last 20 years with numerous studies and field manuals (Whittaker, et al, 1993; Whittaker and Shelby, 2002; Whittaker, et al, 2005a). Some key concepts and methods associated with this research are summarized in the following section.

The amount of water in the river, flow, can have immediate or direct effects (e.g., boatability, whitewater challenge, fishability) or long-term and indirect effects (change the geomorphology or riparian vegetation, which in turn may affect fisheries or the size of beaches, which are important recreation attributes). The physical characteristics of the river channel (slope, exposed substrate, sinuosity, riparian vegetation, etc.) affect how flow behaves through various reaches in both of these time scales. When examining direct effects, flows may be further examined in terms of its hydraulics through a reach, which may include measuring depths, velocities, size of waves, wetted perimeters, etc. as indicators of quality for various recreation activities or other resource values (Whittaker and Shelby, 2002). Most studies have been specifically tailored to address specific questions related to water adjudications, dam licensing, or navigability proceedings.

It is useful to distinguish recreation activities that are "stream-flow dependent" from those that are "stream-flow enhanced." Dependent activities may include boating, wading, swimming, and fishing, because it may be impossible to engage in them without flows in certain ranges. In contrast, activities such as hiking, camping, walking, biking, wildlife observation, photography and similar riverside recreation can often occur along a river regardless of the flow, but flows may enrich the experience with aesthetic benefits (Brown, 1991; Whittaker, 2002).

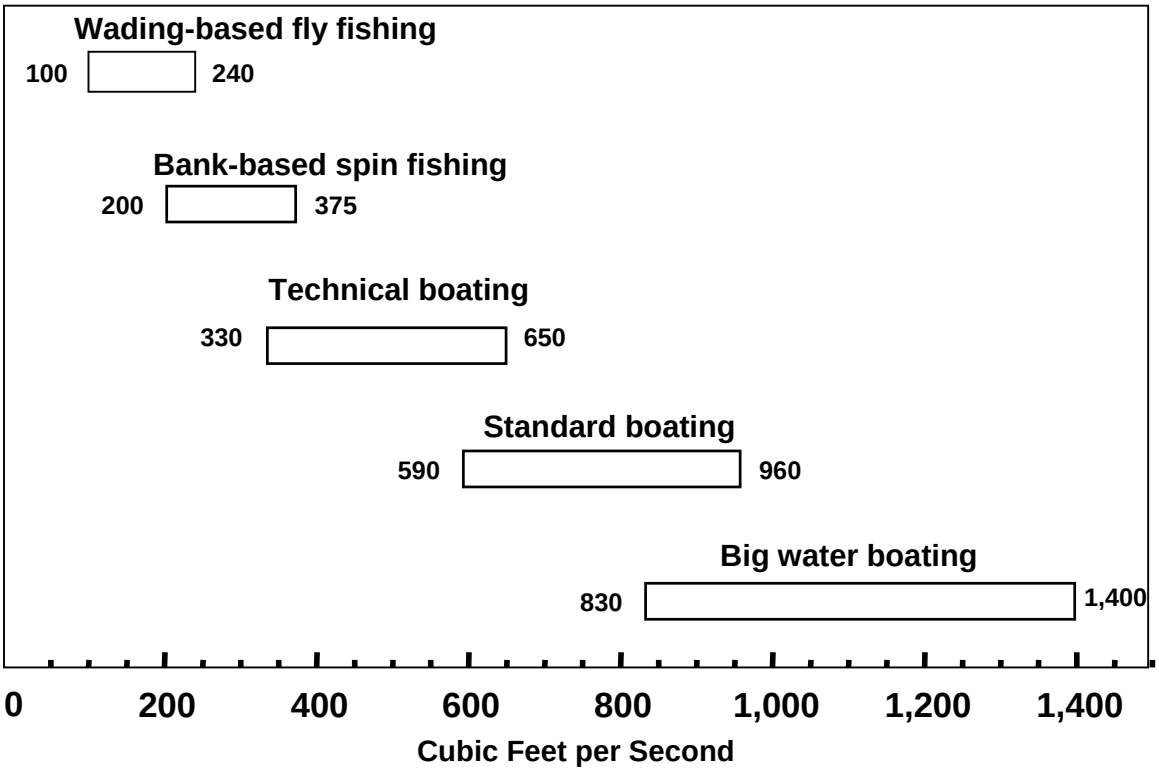
Flow-recreation studies recognize that flows generally affect recreation incrementally, and have often shown this through "flow evaluation curves" for different opportunities. These curves show flow along the x- or horizontal axis and recreation quality (usually on an acceptable-unacceptable scale) along the y or vertical axis; they typically are an inverted bell, indicating that some flows are too low for an activity, while others are too high. In most cases, the curves are developed from surveys of recreation users who have evaluated a series of flows on the acceptability scale (the curve connects the mean responses). With this type of data, the places where the curves cross the "marginal line" define an acceptable flow range, and the relatively flat part of the curve at the highest ratings defines an "optimal range." In some cases, the peak of the curve may be described as the optimal flow or the best "representative flow" for that type of opportunity. A hypothetical flow evaluation curve is shown in Figure 3-1.

Figure 3-1. Example of a Flow Evaluation Curve for a Recreation Opportunity
(Source: Whittaker, 2006)



Several studies have documented that different recreation opportunities occupy different "niches" of the hydrograph; there can even be differences within an activity type (e.g., rafters may prefer different flows than kayakers on a whitewater reach, or spin anglers may prefer different flows from wading-based fly anglers). In essence, there may be many curves for a river reach corresponding to different types of recreation. To simplify presentation of these multiple opportunities, researchers sometimes show a "range bar" graph that identifies acceptable and optimal ranges across opportunities and illustrates the "niche" concept (see Figure 3-2 for an example from California's Upper North Fork Feather River). Because optimum streamflow varies by activity, it is important for research studies to examine the relation between flow and various water-based recreational activities (Kakoyannis, 2002).

Figure 3-2. Example of a "Range Bar" Graph for Different Opportunities
(Source: Whittaker, 2006)



In studies related to "flow-dependent" recreational activities, recent literature suggests that methods be tailored to three levels of assessment: Level 1 – desk-top options; Level 2 – limited reconnaissance; and Level 3 – more intensive studies. Level 1 assessments are helpful to develop and compile existing information about existing recreational opportunities, access and physical characteristics of the river as it relates to flow. For the Level 1 assessment, information can include: literature reviews- obtain information from existing literature about the flow-dependent recreation opportunities and flow preferences; hydrology summary – obtain information and assess the specific river hydrology and flow regimes; and structured interviews – obtain information regarding recreational opportunities and potential effects of flow on these opportunities from experienced users of the river (Whitaker, et al, 2005a).

Often, the assessment will require more precise and site-specific information about flow effects and require on-site field assessment. Level 2 includes limited reconnaissance options, such as an on-land feasibility assessment, on-water assessment, and expert judgment (or expert panel) assessments. These types of field assessments provide the opportunities to assess the potential and type of recreational opportunities and flow regime effects on these opportunities. These field assessments can provide information regarding the specific river physical characteristics, feasibility and type of recreational opportunities and assessment of flow ranges/preferences for various recreational opportunities (Whitaker, et al, 2005a).

Level 3 assessments typically include more intensive study options associated with multiple flow reconnaissance assessments for situations where controlled flow, such as below dams, may occur. These assessments allow for more precision of estimated flow ranges for recreation opportunities by conducting multiple flow reconnaissance assessments and controlled flow studies of multiple flow ranges (Whittaker, et al, 2005a).

Four basic survey methods are commonly used to assess social evaluations of flows for recreation: focus groups, present flow surveys, flow comparison surveys, and controlled flow assessments (Whittaker and Shelby, 2002). Shelby et al (1992) note that using expert panels is a common method of recreational flow assessment. Brown et al (1991) also states that the expert panel approach is a viable study methodology, especially on reaches where use levels are low so user surveys are infeasible. Brown et al (1991) states that systematic assessment by a small sample is a powerful approach and expert judgment is efficient and probably the most commonly used approach in flow assessments. However, Brown et al (1991) note one criticism of expert panels includes the potential for "bias" (responses from participants that purposely disguise their actual evaluations in order to influence the study results in favor of an advocacy position). Larger sample user surveys can help avoid some of these problems.

Whittaker et al (2005b) cautions that fishability assessments at a single flow may be able to demonstrate whether a flow provides fishable water, but they are unlikely to provide precise flow ranges for different opportunities (unless the range is narrow and a flow in that range was assessed).

3.1.2 Flow-Recreation Issues in the Chattooga Corridor

Many flow-recreation studies are conducted on regulated rivers where dams, diversions or other water development affects the type of recreation that is provided. In other cases, flow-recreation studies have been conducted to assess navigability or to help establish water rights for different beneficial uses. In most of these cases, the goal is to determine the flow needs because flows are or might be manipulated in the future. In contrast, the Upper Chattooga is an unregulated river (no dams or diversions), and flows change naturally with seasonal or daily weather patterns (they cannot be substantially modified). In this case, the question at hand is whether "natural" flow preferences would tend to separate different types of uses (if several different uses were allowed). The degree to which natural variation in flows separates different groups will affect the degree to which different groups may interact and potentially impact or conflict with each other.

In addressing this issue, it is important to also note that the Upper Chattooga River is high in the watershed and has a small catchment area. Accordingly, the river tends to have "flashy" hydrology (rain events cause the river to rise very rapidly and they also decline relatively quicker than lower gradient sections of larger or downstream rivers. With this kind of hydrology, higher flows may only exist for short time periods and recreation opportunities dependent on those high flows will have to be opportunistic.

Similarly, opportunities that are constrained by high flows will generally not be affected for longer periods.

This is important because un-regulated and flashy hydrology, in turn, may constrain the types of methods that can be used to assess flow preferences. By being unregulated, it is not possible to conduct "controlled flow studies" that manipulate flows for accurate assessments. Similarly, with its flashy hydrology, scheduling multiple flow assessments (where research capitalizes on natural flow variation) is challenging on the Upper Chattooga, particularly since flows are likely to vary even within a few hours when the assessment is occurring. In these situations, careful attention to hydrology changes through the assessment and having the target recreation opportunities assess the exact same flows at the same times and segments are critical.

3.2 Findings from Studies Regarding Flow Preferences

3.2.1 Boating Flow Preferences

At a minimum, boating requires enough water for the boat to float and move (Brown, 2003). Once the minimum flow is achieved, boaters can recreate within the river and the river is said to be floatable. Brown (2003) defines *floatability* as the capacity of the river to support boating without excessive hits, stops, drags, and portages and that minimum flows on any river differ by type of craft and boater skill level. Brown (2003) also states that minimum flows are not necessarily optimum flows and that floatability and the quality of the experience is also influence by the other factors such as the number and type of rapids, rate of travel, and safety. Brown (2003) makes some general distinction about the type of flow related to stream type, stating: (1) above average flows are needed in smaller streams for boatable flow, indicating that the boating season is limited to above-average runoff times of the year; (2) more water is required for boating whitewater streams (streams characterized by cobles rocks and boulders as compared to silt, sand, or small gravel); and (3) there is considerable variation in minimum flow among rivers of the same average flow, thus leading to the need for on – site study if more precision regarding flow ranges is needed.

In a review of boating preferences from 9 rivers where flow preferences were "standardized" as a percentage of mean annual flow (which allows comparisons between rivers of different sizes), boating flow preferences ranges varied considerably by reach (Whittaker, 2006). The lowest acceptable flow for "technical" (low flow) trips ranged from 26% percent of MAF (Middle Fork Salmon, ID) to 172% (Pit River 4, CA). Similarly, the start of optimal "standard" trips ranged from 60 percent (Hells Canyon on Snake River, ID/OR) to 383 percent (Pit 4) on these same rivers. Taken together, these findings suggest that boating flows may occur at a wide range of flows, and simple "desk-top" formulae for estimating such ranges on any given river are unlikely to work (Shelby and Jackson, 1991). The general conclusion is that case by case studies are needed to develop these ranges for individual rivers.

Table 3-1. Summary of Whitewater Boating Flow Preferences
(Source: Whittaker, 2006)

		Lowest acceptable flow for "technical" trips		Start of optimal range for "standard" trips	
	Mean annual flow	**Flow in cfs**	**% MAF**	**Flow in cfs**	**% MAF**
Pit River 3	520	300	58%	750	144%
Pit River 4	477	819	172%	1,425	299%
Pit River 5	646	850	132%	1,367	212%
North Umpqua	1,476	590	40%	1,500	102%
Lower Lochsa	2,847	2,572	90%	5,222	183%
Selway	3,748	1,940	52%	5,975	159%
MF Salmon	1,473	387	26%	1,665	113%
Main Salmon	11,198	3,400	30%	7,600	68%
Hells Canyon	20,813	6,896	33%	12,500	60%

However, this review also shows that good boating flows (optimal standard trips) are typically larger than 100% (the average annual flow of a river), except on the two largest rivers in the review (Main Salmon and Snake through Hells Canyon). The conclusion here is that the best whitewater boating occurs at flows that tend to be in the upper half of a river's annual hydrograph.

Numerous other flow-boating studies have been conducted as part of relicensing efforts, navigability adjudications, or water rights adjudications. This does not include a comprehensive list of studies and findings nor "standardized" results by calculating preference ranges in terms of mean annual flow; however, Table 3-2 provides a summary of about 30 river segments with some similarities to segments of the Chattooga for general comparisons. The table includes the minimum acceptable flow for technical kayak trips and the low end of the optimal range for standard trips. These two flows (as in Table 3-2) help characterize when boating becomes possible and when it becomes optimal. The rivers are arranged from lowest to highest boating flows. Also, in section 7.0, *Proxy River Information*, we also provide a summary of whitewater flow ranges for the various identified proxy rivers.

Table 3-2. Summary of Boatable Flows from Various Studies
(Source: Whittaker, 2006)

River(s) and State	Study purpose	Low end of acceptable range for technical trips	Low end of optimal range for standard trips	Class	Gradient
Clear Creek whitewater park, CO	Water rights	100	300	III	
Talachulitna Creek, AK	Water rights	150	300	I-II	
Kroto Creek/Deshka, AK	Water rights	150	300	II	
Shepaug River, CT	Water rights	150	350	II-III	
Nantahala Cascades, NC	Relicensing	175	350	IV	186
Bedrock Canyon, Dolores River, CO	Water rights	200	1,200	II+	11
Little Susitna, AK	Water rights	200	450	II	10
Chelan Gorge, WA	Relicensing	200	275	V-VI	480
Whiskey Flat, West Branch Feather, CA	Relicensing	200	370	IV	56
Upper Nantahala, NC	Relicensing	250	350	III	84
Smith River, OR	Relicensing	250	350	IV	135
Hamilton Branch, CA	Relicensing	250	350	IV	156
Satan's Kingdom, Farmington, CT	Relicensing	250	540	III	
Slickrock Canyon, Dolores River, CO	Water rights	250	1,200	III-IV	24
DeSabla Bypass, Butte Creek, CA	Relicensing	270	400	IV-V	141
The Drag run, Butte Creek, CA	Relicensing	270	460	III-IV	53
Clackamas, OR (Oak Grove Fork)	Relicensing	300	350	IV-V	185
Lower Carmen, Mckenzie River, OR	Relicensing	300	500	IV-V	240 (gorge)
Below Centerville, Butte Creek, CA	Relicensing	300	600	III	33
Upper North Fork Feather, CA (Seneca)	Relicensing	350	450	IV-V	
Upper North Fork Feather, CA (Belden)	Relicensing	350	600	III-IV	
Lower Kern , CA	Relicensing	400	1,150	II-III	28
Hells Corner reach, Klamath, OR	Relicensing	700	1,400	IV-V	70
West Fork bypass, Tuckaseegee, NC	Relicensing	200	260	III-IV	140
Dillsboro segment, Tuckaseegee, NC	Relicensing	540	815	II	15
Whittier segment, Tuckaseegee, NC	Relicensing	800	1,000	II+	18
Service-Clarno, John Day River, Or	Navigability	600	900	II-III	8
Clarno-Cottonwood, John Day River, Or	Navigability	600	850	II-III	11
Virgin River Gorge, AZ/NV	Water rights	400	700	III-IV	
Gulkana River, AK	Water rights	1,200	2,000	II-III+	20 to 50 feet

First, for the rivers reviewed here, the lowest acceptable boating flows typically require at least a couple hundred cfs, with some notable exceptions: very small headwater streams (e.g., Talachulitna Creek, Kroto Creek), very steep streams (e.g., Chelan Gorge, Nantahala Cascades), a modified channel (e.g., Clear Creek whitewater park), and a couple of flatter canoeing streams (Little Susitna, Bedrock Canyon on Dolores River).

Second, optimal flow ranges for standards trips (the kind of flows that whitewater boaters prefer) are usually substantially higher than minimum flows to get down the river. On steeper rivers, the differences tend to be more narrow (e.g., Chelan Gorge, Seneca Reach of Upper North Fork Feather), but on less steep rivers, it is the volume of water that creates good whitewater (Slickrock Canyon on Dolores River, Lower Kern).

3.2.2 Angling Flow Preferences

Instream flow affects biophysical habitat for aquatic species and "angler habitat" or "fishability" for people who fish. The quality of fishing depends on healthy fish populations, aquatic habitat (temperature, substrate, cover, food supply, etc), turbidity and availability of locations for fishing (Brown, 2003). In addition, while high quality fishing may start with good habitat and a healthy fishery, other factors and broader experiential benefits such as "exploration" or "experiencing natural environments," or the "challenge of fishing" or "experience of the catch" may be as important as simply catching fish (Knopf, Driver, and Bassett, 1973; Fedler and Ditton, 1994, as cited in Whittaker, et al, 2005b). Fishability evaluations appear to be influenced by type of river segment (regulated, bypassed, or unregulated), target species (e.g., trout, sturgeon), and angling approach (bank, wading, boat) (Whittaker, et al, 2005b). The direct effects of water flows on fishing include those on access, fish activity, and safety (Brown, 2003).

Whitaker et al (2005b) conducted an assessment of results from normative flow evaluations for fishability on segments of Pacific Northwest rivers. Table 3-3 shows median flow ranges for fishability on all study reaches. Acceptable and optimal flow ranges were expressed as percentages of that river's mean annual flow (MAF) in cubic feet per second (cfs), allowing comparisons across rivers and broad consideration of flow needs for different types of rivers. Fishability flow ranges showed considerable diversity across the studies with acceptable flow ranges from 13 percent (Klamath anglers) to 221 percent MAF (Selway anglers), to optimal flows ranges from 20 percent (Klamath anglers) to 120 percent MAF (powerboat sturgeon anglers on the Snake). The study found that the range of optimal and acceptable flow ranges indicated that that office based "rules of thumb" for fishing flow preferences are insufficient and comprehensive assessments on a case-by-case basis are needed. Also, based on the data, the study found that anglers generally rated lower flows better than higher ones (Whittaker, et al, 2005b).

The data suggested that *anglers generally rate lower flows better than higher ones*, supporting the common anecdotal advice to fish when "water is low and clear" and "fish are concentrated." In general, the most positively evaluated fishing flows on these rivers were below (sometimes substantially below) 100% of MAF. Data also suggested that some flows were "too low" for good fishing, supporting the concept of a inverse U-

shaped "flow evaluation curve" for the activity, as predicted by Whittaker et al (1993) and commonly found for other recreation opportunities (Whittaker and Shelby, 2002).

Table 3-3. Summary of Angler Flow Preferences
(Source: Whittaker, et al, 2005b).

River / opportunity	Mean annual flow	Period of record	Acceptable range (cfs)		Optimal range or flow (cfs)		Acceptable range (% of MAF)		Optimal range (% of MAF)	
Pit River 3	520	1970-1999	150	250	155	217	29%	48%	30%	42%
Pit River 4	477	1957-2001	150	350	200	300	31%	73%	42%	63%
Pit River 5	646	1970-1999	150	300	160	250	23%	46%	25%	39%
North Umpqua	1,476	1950-2001	600	1500	800	1,200	41%	102%	54%	81%
Upper Klamath	1,813	1959-2001	240	1120	370	670	13%	62%	20%	37%
Lower Lochsa	2,847	1911-2000	792	4598	2370		28%	162%	83%	
Selway	3,748	1930-2000	1793	8287	4,023		48%	221%	107%	
MF Salmon	1,473	1974-2000	387	2444	1,040		26%	166%	71%	
Main Salmon	11,198	1911-2000	3188	10750	5,655		29%	96%	51%	
Hells Canyon: Floaters										
Steelhead	20,813	1966-2000	Not available		7,000	18,000	Not available		34%	87%
Trout					6,000	18,500			29%	89%
Bass / Crappie					6,000	20,000			29%	96%
Sturgeon					6,000	24,500			29%	118%
Hells Canyon: Powerboaters										
Steelhead	20,813	1966-2000	Not available		7,000	15,000	Not available		34%	72%
Trout					6,000	15,000			29%	72%
Bass / Crappie					6,000	15,000			29%	72%
Sturgeon					7,500	25,000			36%	120%

3.2.3 Comparison of Angling and Boating Flow Preferences

Assessment of studies conducted on flow preferences indicate that *typically fishable ranges tend to be much lower than boating ranges on the same reaches.* (Whittaker, et al, 2005b). For example, the best fishing flows on the Pit 4 reach were about 42% to 63% of current regime MAF (200 to 300 cfs). In contrast, optimal whitewater boating occurs from 299% to 383% (1,400 to 1,800 cfs). Even though boating and fishing ranges overlap on some larger rivers (e.g., Hells Canyon, the Idaho Wild and Scenic rivers), flow ranges for these activities are different. Data from the Middle Fork Salmon, for example, showed that acceptable fishing occurs from about 26% to 166% of MAF (400 to 2,400 cfs), whereas optimal whitewater boating is from 113% to 331%. (1,700 cfs to 4,900 cfs). This suggests that fishing and whitewater boating have different "prime seasons" and niches in the hydrograph (Shelby, et al, 1997), so "designed flows" in a regulated reach will rarely provide both at the same time.

Ultimately, *flow preferences may differ by size and type of river, species pursued, or tackle and techniques used*. The task for researchers is to assess these differences systematically. This is parallel to research efforts regarding flows and whitewater boating quality, where stark differences have been shown between users of different crafts (e.g., rafts, kayaks, canoes), boater skill levels (e.g., Class III, Class V), or types of experiences (e.g., technical, "big water" trips) on the same river (Whittaker and Shelby, 2002). Similar distinctions between fishing opportunities will need to be developed. As studies with these variables accumulate, it may be possible to begin the process of generalizing and explaining relationships between flows and fishability.

3.2.4 Aesthetics

Finally, in assessing flow preferences, most studies focus on flow-dependent rather than flow-enhanced opportunities (with their emphasis on aesthetics of different flows). A complete review of aesthetics literature related to flows is beyond the scope of this document. However, findings from a few studies suggest interesting generalizations. In a study from the Virgin River downstream of Zion National Park, for example, respondents were shown video footage ranging from 0 to several thousand cfs (Shelby, Whittaker and Ellingham, 1994). At low flows, small increments offered dramatic improvements in aesthetic quality; once the bottom of the channel was filled, however, there was little improvement from medium to high flows. Professional judgment curves (based on onsite reconnaissance and user interviews) for Connecticut's Shepaug River suggested similar findings Shelby and Whittaker, 1999). In this small stream, even a 5 cfs dam release improved aesthetics, and above 50 cfs, additional water provided little aesthetic improvement.

Other studies have evaluated paired photographs (Land and Water Associates, 1992), or compared evaluations among several photographs after controlling for other scenic features such as vegetation, sky, and canyon walls (Brown and Daniel, 1991). In

general, very low and very high flows were rated lower, although differences were small. Computer-manipulated images now offer opportunities to control other scenic features in photographs, so evaluations can focus solely on flow elements.

3.3 Summary of Key Findings

Following are key considerations and conclusions associated with recreational flow preferences based on the literature review:

- *Acceptable flow ranges* - Results from flow preference studies on other rivers suggest acceptable flows for boaters and anglers typically do not occur at the same time which would minimize potential conflicts between user groups. Angler optimal flow preferences typically range at less than 100% MAF, while boater optimal flow preferences were typically higher than 100% MAF, and often substantially higher. This suggests that fishing and whitewater boating can have different "prime seasons" and niches in the hydrograph.

- *Factors contributing to flow preferences* - For anglers flow preferences may differ by size and type of river, species pursued, or tackle and techniques used. Anglers typically rate lower flows more optimal for criteria such as access, wading, fishability, as compared to higher flows. For whitewater boaters, flow preference may differ by size and type of river, boating experience, boat type and techniques. Whitewater boaters typically rate the higher flows as providing better challenges and boating experiences.

- *Assessment methodology* - Much of the literature related to instream flow and recreation research has been developed on regulated river reaches where the flow (the variable that can be controlled) is evaluated with respect to boatability and fishability. Because the Upper Chattooga is unregulated, controlled flows studies are not a realistic option in evaluating the recreation flows. Field assessments, such as an on-land feasibility assessment, on-water assessment, and expert judgment (or expert panel) assessments, can provide information regarding the specific river physical characteristics, feasibility and type of recreational opportunities and assessment of flow ranges/preferences for various recreational opportunities.

- *Flow-dependent versus flow-enhanced opportunities* - Most flow assessment studies focus on flow-dependent (i.e., fishing and boating) rather than flow-enhanced opportunities (i.e., aesthetics of different flows). Aesthetic flow studies typically find that at low flows, small increments of increased flows offered dramatic improvements in aesthetic quality; once the bottom of the channel was filled, however, there was little aesthetic benefits resulting from higher medium to high flows.

- *Regulated versus regulated system* - Potential users of the Upper Chattooga are limited to the opportunities presented by natural flows and currently by the

existing Forest Service management policy. For the Upper Chattooga, the unregulated nature of the river may provide a situation where natural processes and responsiveness to rain events naturally isolate flow preferences of anglers and boaters.

- *Information to assist management decisions* - Understanding the reaches hydrology, hydraulics, and user group's flow preferences can help in developing and implementing appropriate recreation management policy. Specifically, the development of recreational flow relationship curves for the Upper Chattooga would help managers in developing appropriate recreational policy for the reach.

4.0 RECREATIONAL USE EFFECTS ON TRAIL AND SITE RESOURCES

Recreational trail and site impacts are a major management focus in many backcountry recreation settings because they can have important effects on biophysical resources and visitor experiences. Understanding how these impacts may be caused by different types and quantities of recreation use is the key to developing strategies that reduce or mitigate them. Within the upper Chattooga River corridor, there are both designated campsite areas and hiking trails, as well as self-selected campsites and user-created trails. Currently, the Forest Service is assessing existing biophysical conditions in the corridor, including trail conditions, number and condition of campsites, amounts of litter, and water quality. The biophysical conditions monitoring effort focuses on conditions in the corridor on Forest Service managed lands from Grimshawes Bridge to Tugaloo Lake, including the West Fork. Additional information on this monitoring effort is available at http://www.fs.fed.us/r8/fms/forest/projects/Appdef.pdf.

This literature review section provides an overview of the potential influences of recreation activity on trail and site impacts. The purpose is to review how specific types of recreation activity and behavior may affect trail and site conditions, or visitor perceptions of those conditions and related broader evaluations (e.g., litter may make people feel crowded). This literature review is not intended to provide an exhaustive analysis of potential trail and site impacts in the Chattooga River corridor (a separate monitoring program addresses that goal). However, the intent is to narrow the list of potentially important trail and site impacts, focus attention on the likely critical impacts, and provide insight as to the types of indicators, standards, and management strategies that have been used or recommended in other settings.

This literature review section is organized in several parts. Section 4.1 provides and overview of potential site and trail impacts of recreational use and summarizes more specific impacts from certain types of recreation behaviors based on findings from other areas. Section 4.2 focuses on potential monitoring and management strategies for addressing these types of impacts, and Section 4.3 summarizes key findings and makes recommendations for recreation-wildlife indicators and standards for the upper Chattooga River corridor.

4.1 Overview of Recreational Use Effects on Trail and Site Resources

Effects of recreational use can lead to trail and site impacts on soil vegetation, water and wildlife resources (see Section 5.0, *Recreational Use Effects on Wildlife Resources,* for more information regarding direct effects on wildlife impacts). These biophysical components are interrelated and therefore a recreation impact on one of these elements can result in impacts on multiple components (Leung and Marion, 2000; Hammitt and Cole, 1998). In general, recreational use trail and site impacts: (1) can be direct or indirect; (2) are often interrelated; (3) have both a spatial and temporal component; (4) can vary (the severity and type of impact) with the type of recreational activity; (5) can vary with the type of visitor behavior; (6) are influenced by environmental factors (type of vegetation, slope, soil type, etc.); and (7) usually cause greater changes in impact during "pioneering" (initial) use, with the marginal change in impact decreasing as additional use occurs (Hammitt and Cole, 1998; Leung and Marion, 1996).

According to Leung and Marion (2000) direct effects of recreational use in wilderness settings can include: *soil* - soil compaction, loss of organic litter, loss or mineral soil; *vegetation* – reduced height and vigor, loss of ground cover, fragile species and trees and shrubs, tree trunk damage, and introduction of exotic species; and *water*- introduction of exotic species, increased turbidity, nutrient inputs and levels of pathogenic bacteria, resulting in altered water quality. Leung and Marion also summarize potential indirect impacts, including: *soil* – reduced soil moisture, reduced soil pore space, accelerated soil erosion and altered soil microbial activities; *vegetation* – change in composition, altered microclimate, and accelerated soil erosion; and *water* – reduced health of aquatic ecosystems, composition change and excessive growth.

Marion (2003) states that recreation visitation has the potential to degrade both biophysical conditions and the experiences of other visitors, particularly along trails, at overnight campsites and shelters, and at day-use recreation sites like scenic overlooks and waterfalls, where visitor use and associated resource and social impacts are concentrated. Marion (2003) provides a summary table of potential impacts of high recreational visitation (see table 4-1).

Table 4-1. Potential Resource Impacts caused by High Visitation
(Source: Marion, 2003)

Vegetation Changes	Soil Changes	Additional Concerns
Loss of Vegetation Cover	Loss of Organic Matter	Littering
Alteration of Composition	Erosion	Threats to Water Quality
Loss of Species	Compaction	Threats to Human Health
Damage to Trees	Reduction in Soil Moisture	Threats to Cultural Resources
Exposure of Tree Roots	Impacts to Soil Fauna	Threats to Wildlife

Cole (2004) summarizes several key characteristics regarding ecological (site and trail) impacts of recreational use, including: (1) impact is inevitable with repetitive use; (2) impact occurs rapidly, while recovery occurs more slowly; (3) often impact increases more as a result of new places being disturbed than from the deterioration of areas that have already been impacted; (4) the magnitude of impact is a function of frequency of use, the type and behavior of use, season of use, environmental conditions, and the spatial distribution of use; and (5) the relationship between amount of use and amount of impact is usually curvilinear (asymptotic). However, while these general distinctions can be made potential effects of recreational use on site and trail impacts, the type and extent of impacts can vary on a case by case basis, depending on the site characteristics, type of use, etc.

4.2 Findings from Other Studies Regarding Recreation Impacts

Following are some more specific discussions of potential impacts by type of impact (i.e., trampling and trail impacts, site or camping impacts, visitor perceptions of impacts) that can be caused by various types of recreational uses. For example, trampling impacts can be caused by hiking, fishing, camping, boating, and most other types of wilderness recreational activities. Camping, as discussed below, can lead to some more specific type of site and trail impacts. Boating and fishing can both result in trampling and trail impacts as a result of gaining access to the waterway (river and/or lake). For example, for boating use, the most prominent areas of impact are typically along the banks of the lakes and streams where individuals camp, picnic, fish and boats are taken in and out of the water (Hammitt and Cole, 1998). A similar statement can be made for angling use, for cases where boats are used, and in cases where boats are not, the other effects of waterway access and associated recreational use can still occur. Typically the extent of impact is a result more of the intensity, type of actions, and location of use, rather than linked to a specific recreational "activity" (e.g., fishing, hiking, boating, etc.).

4.2.1 Trampling and Trail Impacts

Cole (2004) states that trampling can result in abrasion of vegetation, abrasion of organic soil horizons and compaction of soil. Trampling effects on vegetation can result in loss of vegetation or reduction of plant vigor and reproduction. At moderate levels of trampling, some species can increase in abundance due to decreased competition or a change in microhabitat. At more intense levels of trampling generally plant cover and biomass is reduced and species composition can be altered. Cole (2004) also states that effects of trampling can result in soil compaction, reducing porosity, and the water-holding capacity and infiltration rates of soil, leading to increased runoff and erosion. Also, compacted soils can inhibit seed germination and plant growth.

Cole (2004) states that it is difficult to separate the impacts of hiking on trails from the impacts associated with trail construction and maintenance, and that except where hiking use is extremely high, it is probably rare for the impacts of hiking on trails to exceed the impacts caused by trail construction. Potential impacts of trail construction

and maintenance can include opening up tree and shrub canopies, soil compaction, changes in drainage patterns, or habitat changes.

By making a designated trail, managers are essentially defining the acceptability of impacts from that trail (where soils are compacted, vegetation growth is discouraged, and treads may be side-cut into a hill or have non-natural features such as water boards, steps, non-native tread surfaces, etc. to improve durability, reduce erosion, or make them easier to travel. While most users do not think of trails as "impacts," they clear are a change from a pristine environment. The question is what level of impact is acceptable for what type of trail and setting. For example, a 10 foot wide paved trail may be unacceptable in a backcountry setting but quite acceptable in a front country access area. Similarly, a 1 foot wide trail with steep gradients may not make sense for an urban greenway, but is perfect for a wilderness backpacking trail.

Leung and Marion (1996) state that environmental factors are an important determinant of the type and severity of trail degradation caused by recreation use. For example:

- *Climate and geology* - affects trail degradation primarily through their influence on other factors, although the effects are typically indirect and can be mediated by elements such as vegetation and soil characteristics;

- *Vegetation* – resilience and type of vegetation, e.g., dense understory and trailside vegetation can inhibit trail widening;

- *Topography* - numerous studies have documented strong positive relationship between trail slopes and soil loss (steep slopes increase erosion from trails);

- *Soil and surface characteristics* - poorly drained soils increase trail widening because users often seek to avoid muddy areas, while soils with a high rock or gravel content have been found to be less susceptible to soil erosion;

- *Proximity to groundwater discharge or streams* - can increase the susceptibility of trail widening and erosion due to excessive wetness and periodic flooding of trail; and

- *Alignment of the trail to the prevailing slope* - trails that directly ascend tend to be more degraded, usually because more water is channeled down the trail.

- *Trail design* – can substantially mitigate many environmental factors that increase the likelihood of recreation use impacts, but some options may be expensive or inappropriate for some settings.

4.2.2 Camping and Site Impacts

Camping can include the effects of trampling, as well as more extensive elimination of vegetation and soil compaction at the location of the site and extensive damage or felling of trees at the site (Cole 2004). The most common off-site impacts associated with camping are informal trailing (between the campsite and water sources, other campsites or the main trail) and impacts caused by the collection of wood to be burned in campfires. Hall and Farrell (2001) documented 25 to 63 percent reductions in abundance of small woody material on and around campsites.

Studies have consistently found that impacts typically occur rapidly during pioneering use (the first few groups that camp in an area). After a site has seen consistent use, additional parties camping on the site induce relatively little change. For example, Marion and Cole (1996) studied the impacts of camping on soil and vegetation at the Delaware Water Gap National Recreation area, including evaluation of change over a 5-year period. They found that soil and vegetation conditions changed rapidly when campsites were initially opened to use and changes were less pronounced on the long-established campsites. In the trampling experiments, impact varied greatly with trampling intensity and between vegetation types. They also found that an open-canopy grassland vegetation type was much more resistant to trampling than a forb-dominated forest vegetation type.

Marion (2003) conducted an assessment of camping impact management along the Appalachian National Scenic Trail (A.T.) in response to agency and Appalachian Trail Conference (ATC) management concerns regarding the resource and social impacts of increasing overnight visitation, particularly in high use areas. Study findings and recommendations were primarily based on site investigations at 17 problem areas (including 11 shelters and 6 campsites) selected by A.T. clubs and ATC staff, and examination of relevant A.T. legislative, agency, and organization guidance and visitor impact management knowledge derived from research and management experience. Marion identified various trail and site impact problems based on this assessment and following is a summary of the key findings related to trail and site impacts:

- *Campsite proliferation* - A proliferation of visitor-created campsites is occurring due to increase in visitors and a greater number of visitors that are camping outside of the established shelters. Without guidance, visitors often select and develop campsites that are poorly located with respect to resource protection and visitor experience considerations. Visitor created campsites are often located on the banks of water bodies, in fragile vegetation, and in areas with a high potential for expansion or are close to shelters, other campsites, or the A.T. Many campsites are created during peak use periods yet are used with sufficient frequency on a rotating basis that they rarely recover.

- *Campsite expansion* - There is a tendency for campsites to expand in size over time, often growing together with adjacent campsites to form exceptionally large

impacted areas. Once a new campsite is pioneered, subsequent visitors enlarge it by camping in different areas on different nights. Campsite expansion is a particularly prevalent problem when camping occurs in flat terrain and open vegetation.

- *Vegetation, soil, and water resource impacts* - The most common impacts occurring on campsites included loss of original vegetation cover, loss of organic litter, and exposure, compaction and erosion of mineral soil. Fragile plants are often replaced by more resistant species so an evident change is species composition in the groundcover was seen in many areas. Generally all shrubs and tree regeneration (seedlings and saplings) were lost on campsites and physical damage to trees from broken or cut limbs and axe scarring was common in both areas that permitted campfires and those that prohibited fires. There was evidence of eroded soils from campsites and trails finding their way into water bodies, either through sheet erosion off of trampled areas or from gully erosion along trails, contributing to water turbidity and sedimentation. Improper dish washing practices next to or in water bodies were a common occurrence.

- *Campfire site proliferation and impacts* - For those areas where campfires are permitted, the proliferation of visitor-created campfire sites is often a perennial problem. Visitors frequently established new fire sites in a different location or moved existing sites, enlarging campsites by creating different traffic patterns and core use areas. Firewood collection impacts were also significant around some of the sites and illegal campfires in areas where fires are prohibited were also commonly cited as a problem, particularly during the off-season.

- *Proliferation of visitor-created trails* - Visitor-created trails were often numerous in the vicinities of high-use shelters and campsites. Trails are created by visitors to access the A.T., a shelter, another campsite, water source, viewpoint, firewood collection areas, bear bag hanging tree/cable, and toilet or bathroom area. Even when prepared trails exist to these features, visitors often created their own alternate routes, with many being poorly located from both a resource protection and social perspective. Some occur on steeper slopes and a few, such as those to water sources, directly descend slopes and contribute eroded soils to water bodies.

- *Human waste management* - The management of waste at the more popular shelters and camping areas was a significant issue with high use resulting in the need to relocate pit toilets every one to two years. Trash and food thrown into the toilets by visitors was a commonly cited problem. Bad smells and flies associated with well-used toilets also caused visitors to attempt cat-holing which often lead to improper surface deposition of wastes and toilet paper.

- *Large groups* - Research and management experience indicated that visitors traveling in larger groups (groups with 10 or more individuals) have the potential to cause a disproportionate amount of biophysical impact (as well as recreational experience impacts on other visitors).

Marion and Leung (1999) assessed the conditions of 377 campsites within the Great Smoky Mountains National Parks. As part of this assessment, Marion and Leung identified three general factors that can require targeted management strategies. The first factor, *area of disturbance*, was related to campsite size, fire sites and social trails. The size of a campsite was identified as potentially the most commonly used indicator of camping disturbance on a landscape. The level of off-site disturbance and the potential for campsite expansion and proliferation was inferred in part by the number of social trails radiating from a campsite. Leung and Marion also stated that the number of fire sites were indicative of the extent of land scarring and associated soil damage caused by campfires. The second factor, *soil and groundcover,* was related to trampling loss of vegetation groundcover and soil exposure and erosion. The three indicators included in this factor are trees with exposed roots, absolute groundcover loss and exposed soil. The third factor, *tree-related damage*, included indicators related to the percentage of on-site trees that are damaged (tree damage) and that are cut (stumps). Both of these impacts were linked to depreciative visitor behavior.

4.2.3 Visitor Perceptions of Site and Trail Impacts

Manning et al (2004) state that recreational use can lead to aesthetic consequences due to soil compaction and erosion, trampling and removal of vegetation, and other related factors, and that this can ultimately lead experience quality degradation. Visitor surveys at Acadia National Park in Maine found that trail conditions were important factor in affecting the quality of the recreation experience. However, Manning et al noted that managers may be more sensitive than and less tolerant of recreation-related resource impacts than visitors (a finding that has been duplicated in other studies), so planners need to decide whether they are managing for a more stringent "managers' tolerance standard" or a less stringent "users' tolerance standard." In addition, managing for a more stringent standard may require more regulation or tighter use limits, which have other consequences on experiences and access, a trade-off that is not always acknowledged (Cole and Hall, 2000). Many visitors may be willing to accept restrictions on visitor use in order to maintain acceptable levels of resource impacts, but others will not. Finally, Manning et al and others (Shelby, Vaske, and Harris, 1988), state that in some cases visitors may prefer some impact on trails and at campsites because they facilitate activities (hiking, camping, fires and cooking) and cue people where to do these activities.

Martin et al (1989) conducted a study to investigate different aspects of visitor and manager perceptions of campsite impacts. Bare ground, tree damage, and fire rings impacts were chosen for the evaluation due to being amongst the most prevalent type of impacts occurring at wilderness sites. Bare ground and tree damage were determined to be representative of soil and vegetation impacts that are widespread at campgrounds. Fire rings were chosen to represent a visitor development type of impact with both biophysical and aesthetic impacts. The results of the study found that visitors perceived greater amounts of fire ring and tree damage impact, while managers perceived greater amounts of bare ground impacts. Both visitors and managers found bare ground to be the

least acceptable impact, while fire rings were the most acceptable. In comparing evaluations of interior and peripheral campsites, Martin et al found some indication toward perceptually zoning wilderness (e.g., campsites can be more acceptable in the periphery but unacceptable in the interior).

Marion (2003) identified various visitor experience issues at selected A. T. sites. These included:

- *Crowding, solitude, and natural quiet* - High densities of A.T. visitors camping within shelters and on campsites were reported to lead to crowding and noise issues. Also, the occurrence of trailside campsites, even when unoccupied, were identified to contribute to the sense of crowding and diminished solitude for hikers.

- *Conflicts* - Site visits revealed relatively few examples of direct conflicts between visitors. The A.T. is not open to horse riders (with at least one exception) and motorized visitors, resulting in a fairly homogenous group of either day-use or overnight hikers. Somewhat more significant occurrences of conflict were described between small and large-group visitors.

- *Litter* - The presence of litter was a commonly cited problem at nearly all of the study sites. Litter was most prevalent at the shelters and campsites closest to roads. Litter included cans and bottles, damaged camping gear, and various food items left in shelters for others. Fire pits were also common receptacles for litter, including non-burnable trash, broken bottles, and partially burned food.

- *Visitor safety* - Visitor safety was a significant concern at two locations that were in close proximity to campers and taller cliffs. Wildlife issues included bears, rodents and other wildlife that might bite visitors or damage personal property. The transmission of disease through insects from improperly disposed fecal material or through water bodies was also a concern.

4.3 Findings from other Studies of Potential Management Strategies

4.3.1 Establishing Indicators and Monitoring Programs

Colistra and Flood (2005) state that an effective monitoring program is essential in any management program and should include measures that identify accurate indicators, provides information on existing resource conditions, provides measures to alert managers of when standards have been reached or exceeded, and provides feedback on the effectiveness of the implemented management actions. Marion (1995) describes three functions of recreation monitoring programs: (1) to document the condition of campsites and trails; (2) to evaluate human impacts and to suggest effective management interventions; and (3) to evaluate the subsequent success of implemented management actions.

Hammitt and Cole (1998) state that a monitoring system should generally involve: (1) evaluating system needs and constraints; (2) reviewing and selecting monitoring approaches and impact evaluation protocols; (3) testing and refining protocols; (4) documenting protocols and training evaluators; (5) developing field collection procedures; and (6) designing data analysis and reporting procedures. In addition, Hammitt and Cole state the importance of deciding how the monitoring data will be applied, before deciding on a system and the need to allocate sufficient time to training.

Landres et al (2005) state that a successful monitoring program is composed of four necessary components: (1) monitoring goals need to be established, with a clear explanation of how these are derived and their relevance to management; (2) these goals drive the selection of what will be monitored, allowing managers to evaluate accomplishment toward the goals; (3) standardized methods (data collection) need to be developed and tested for how these indicators will be monitored; and (4) standardized methods need to be developed and tested for analyzing, reporting, and using the resulting data.

McEwan and Cole (1997) state that primarily three categories of site monitoring approaches have been developed, including: (1) photographic systems – those based on repeat photographs taken at permanently established photo points; (2) condition class systems – those based on descriptive visual criteria of general site conditions; and (3) multi-parameter systems – those based on individual measurements and/or appraisals of different types of resource impacts (Cole, 1989; Marion, 1991, as cited in McEwan and Cole, 1997; Marion and Leung,1999). Condition class rating systems determine which of several descriptive classes best characterize a campsite's overall condition. A multiple-indicator approach uses a system of discrete ratings or actual measurements to obtain data on individual impact indicators, such as campsite size or soil erosion. Marion and Leung also state that some programs combine both approaches to provide a more comprehensive approach.

4.3.2 Management Strategies

According to Cole (1990), there are five primary strategies for minimizing impacts to campsites: (1) reducing the amount of use on campsites; (2) educating to change user behavior; (3) shifting use to more durable campsites; (4) containing and/or hardening sites; and (5) closing and rehabilitating sites. Cole (2004) also states that there are certain general characteristics of durable campsites and other nodes of concentrated use, including either lack of groundcover vegetation or presence of resistant vegetation, an open rather than closed tree canopy, thick organic soil horizons, or a relatively flat but well-drained site.

Marion (2003) provides recommendations for management of the A.T. trail and campsite areas developed through the case study review and input from land managers, scientists, ATC staff, and club members. Some of the management-related recommendations which may be applicable to the Chattooga corridor include the following:

- *Refine guidance on site management and facilities* - Evaluate the appropriateness of site management and facility actions and establish policy and more specific guidance to ensure trail-wide consistency in their use. Site management actions and facilities are powerful management tools that can limit the areal extent and severity of camping-related resource impact by spatially concentrating visitor activities, creating travel patterns that limit off-site traffic, and focusing use on durable or previously disturbed surfaces.

- *Manage overnight visitation within specified maximum capacities* - Implement management efforts to restrict overnight visitation to the specified capacities.

- *Discourage trailside camping* - Discourage trail-side camping through education, site closure and rehabilitation, and site selection and construction efforts.

- *Manage large groups* - Evaluate and select educational and site management actions for resolving large group resource and social impacts. This recommendation focuses on encouraging all outdoor enthusiasts to learn and practice low impact skills, regardless of their group affiliation or size. Marion states that to a large extent, resource and social impacts are primarily a function of visitor behavior rather than group size, and that an educational focus recognizes and avoids or reduces the significant visitor-related costs associated with group size regulations.

- *Resolve human waste management problems in high use areas* - Evaluate and select from management options in the recently published "Backcountry Sanitation Manual" (ATC, Green Mountain Club, 2002). Improve education on the "cat-hole" disposal method.

- *Reduce proliferation of visitor-created trails* - Create guidance for trail managers to evaluate visitor-created trails. Describe procedures for their closure or improvements needed to protect natural resources and visitor experiences. Continued use of unnecessary trails can be deterred through a consistent program of blocking them with logs, brush, rocks, or shrub transplants. Alignments parallel to slopes should be rerouted to side-hill alignments. Improved campsite designs and configurations, including the layout of constructed access trails, can often deter the development of visitor-created trails.

Leung and Marion (2000) state that recreation impact problems may be addressed through an array of management strategies and tactics, including the following:

- *Modification of use-related factors* - Managers can control or influence amount of use, density of use, type of use, and user behavior. The type of visitor action contributing to the management problem is an important consideration.

- *Modification of environmental factors* - Managers can influence or control the location of visitor use in wilderness and manage the trails and campsites that sustain that use. For example, resistant plant communities and environments may be targeted for camping, while fragile communities may be avoided or identified for closures to camping.

- *Site maintenance* - Trail maintenance programs exist in most wilderness areas, and many excellent manuals have been developed to guide this work.

- *Site facilities* - Site facilities are not always visitor conveniences, and many serve important safety and resource protection functions.

- *Site closures* - Camping closures represent a final resource protection strategy, generally most appropriate for protecting sensitive environments, rare flora and fauna or fragile historic .

- *Site selection and development* - Knowledge of the environmental resistance and resilience of vegetation and soil types can be applied to select new and relocated trails and campsites. Management options include educating visitors to improve site selection, marking resistant sites to encourage their use and designating resistant sites.

4.4 Key Findings and Management Considerations

The following section provides a summary of the key findings associated with recreational use effects on trail and site impacts based on the literature review. In addition, potential indicators, standards and management actions, including both monitoring and implementation actions, are provided for consideration in the future development of management actions.

4.4.1 Summary of Key Findings

- *Impacts are inevitable* - Recreation use will cause impacts. Key issues are defining what impacts matter (picking indicators), setting standards (how much is too much), and then using an array of actions to reduce impacts to acceptable levels.

- *Environmental factors affecting impacts* - Environmental factors, such as topography, type of vegetation, trail alignment and design, geology, and proximity to groundwater discharge or streams, influence the type and severity of trail degradation caused by recreation use.

- *Use factors affecting impacts* - Typically the extent of impact is a result more of the intensity, frequency, type of actions (e.g., walking along trails, creating new user trails, etc.) and the location of use, rather than linked to a specific recreational "activity" (e.g., fishing, hiking, boating, etc.), with the exception of

camping which has some specific types of use related impacts. Therefore, many "types" of recreational activities can result in similar types of impacts.

- *Camping impacts* - Camping can result in vegetation, soil, and water resource impacts as a result of campsite proliferation and expansion, campsite expansion, campfire site impacts and wood collection for campfires, visitor created trails, human waste management, and trampling.

- *Timing and event of impacts* - Studies have consistently found that impacts typically occur rapidly during pioneering use (the first few groups that camp in an area), and after a location has seen consistent use, additional use induces relatively little change.

- *Impact perceptions* - Managers may be more sensitive than and less tolerant of recreation-related resource impacts than visitors. In some cases visitors may prefer some impact on trails and at campsites because they facilitate activities (hiking, camping, fires and cooking) and cue people where to do these activities.

- *Management strategies* - Many management strategies include trail and site monitoring efforts. Potential management strategies can include measures to control the location and extent of visitor use, such as zoning or group size limits, trail, site and facility maintenance and/or redesign, trail, site and facility closures or relocation, or visitor education.

4.4.2 Management Considerations

Potential Indicators

- Increased number of user created trails and campsites.
- Miles of user and designated trails in different condition classes.
- Numbers of camps in different condition classes.
- Condition trends.

Potential Standards

- No increase in user trails.
- No increase in user created campsites.
- No changes (downward trend) in condition class of trails and campsites.
- Reduce overall number (miles) of user trials
- Reduce number of trails and campsites in poor condition classes.

Potential Management Implementation Actions

Monitoring Actions
- Systematic monitoring of campsites and trails.
- Monitoring of type of use occurring.

Regulation/Education Actions
- Close camps with more than *X* bare ground, remove and appropriately size fire rings; dead and down wood limits in depleted areas, etc.
- Trail and site design to encourage regular use patterns.
- Group size limits.
- Periodic camp closures for rehabilitation.
- Education programs to alert users to impacts/best practices.

5.0 RECREATIONAL USE EFFECTS ON WILDLIFE RESOURCES

Recreational use impacts on terrestrial wildlife resources are influenced by the type, timing and location of recreation-related uses and the type and response of the wildlife being affected (Knight and Cole, 1995; Hammitt and Cole, 1998). Potential recreational impacts can be direct or indirect, and can occur at the individual, population, and community levels (Wright, et al, 2006). Understanding differences among these types of impacts is critical for developing management strategies that minimize them (DeLong, 2002).

This literature review section provides an overview of the potential influences of recreation activity on terrestrial wildlife. The purpose is to review how specific types of recreation activity and behavior may affect wildlife in river corridors, and further consider potential impacts that may be relevant for species occurring in the Chattooga River corridor. The review is not intended provide an exhaustive analysis of potential sensitive species or specific impacts from recreation management alternatives that have yet to be defined for the upper Chattooga River corridor. However, the intent is to identify sensitive and indicator wildlife species within the Upper Chattooga River corridor, discuss potential non-site specific impacts and considerations that could result from increased recreational use, and provide insight as to the types of indicators, standards, and management strategies that have been used or recommended to address impacts in other settings.

This literature review section is organized in several parts. Section 5.1 reviews overall types of recreation impacts on wildlife and more specific impacts from certain types of recreation activities or behaviors. Section 5.2 discusses potential species of interest in the Chattooga corridor. Section 5.3 discusses potential management strategies, and Section 5.4 summarizes key findings and makes recommendations for recreation-wildlife indicators and standards for the upper Chattooga River corridor.

5.1 Findings from other Studies of Recreation Influences on Terrestrial Wildlife

5.1.1 Overview of Potential Causes of Wildlife Impacts

Knight and Cole (1995) identified six factors of recreational disturbances that can influence wildlife responses: (1) type of recreational activity; (2) behavior of recreationists; (3) predictability of events and behavior; (4) frequency and magnitude of disturbances; (5) timing of disturbances; and (6) location of disturbances. Hammitt and Cole (1998) state that the effects of human-wildlife interactions can be influenced more by the frequency of human presence than by the amount of total recreational use or number of people present at any one time. In addition to these factors, the effect of recreational disturbance on wildlife can be influenced by the type of animal, group size, age and sex composition of the animal type. For example, species with specialized food or habitat needs are more vulnerable to disturbance.

The influence of recreation on wildlife can occur as a result of direct impacts, such as effects on animals caused by primary disturbance and interactions; or indirect impacts, caused by secondary results of disturbances to habitat and other factors as a result of recreational use (Hammitt and Cole, 1998). Cole and Landres (1995) state that indirect effects of recreational use on wildlife can be the result of disturbances to soil, vegetation, water, habitat and food sources. In addition, indirect effects generally occur over long periods of time, are long-lasting, and the timing of recreational activities has less influence on indirect impacts as compared to direct impacts. Kuss, Graefe and Vaske (1984) state that larger game species tend to be more susceptible to direct impacts or contact with people while smaller species may be more affected by indirect impacts. Cole and Landres (1995) also state that indirect effects are more likely to have more substantial of an impact on invertebrates, amphibians, reptiles, small birds, small mammals, and fish than direct impacts of recreation.

5.1.2 Potential Influences of Recreation Activity Type and Behavior

Anderson (1995) and Cole and Landers (1995) state that virtually all types of recreational activity can have an impact on wildlife and effects on wildlife can include altered behavior, increased stress, changes in productivity or diet, and habitat, and can result in the alteration in the size and distribution of the wildlife populations. Wildlife can respond to recreationists and people in general based on the number and outcome of human-wildlife interactions (Whittaker and Knight, 1998). Many of the potential effects are related to how fast people move, the method of movement, predictability of movement, the number of people, the distance between the animal(s) and the people, the location of the interaction (DeLong, 2002). These factors, rather than the specific type of recreational activity, are the key issue in determining the extent of impact. However, some general statements can be made about potential impacts on wildlife from different types of recreational use that may occur within the Chattooga River corridor.

The following discussion focuses on potential negative impacts of recreational use. As noted previously, all of the categories of recreational use can also have indirect

beneficial effects on wildlife resources, such as through greater appreciation and understanding of wildlife resources as a result of recreational experience within a wilderness setting.

Hiking

Effects of hiking and walking can result in soil compaction, increased erosion potential, and trampling of vegetation (see also Section 4.0, *Recreational Use Effects on Trail and Site Resources*). Impacts to vegetation can occur quickly and with moderate levels of use and can vary by the type of plant species (some species are more resistant to trampling). This can lead to changes in plant diversity, which has been shown to increase with slight use and decrease as use intensifies (Leung and Marion, 2000; and Liddle, 1997, as cited in Wright, 2006). These impacts can result in modification of wildlife habitats and food sources. Unpredictable movements, such as dispersed use, can result in a greater flight response to birds than more predictable movement, such as use that follows a distinct path (Gabrielsen and Smith, 1995). Leung and Marion (2000) state that visitors hiking on trails can disturb wildlife by displacing them from trail corridors during times of heavy use (temporal displacement) or permanently (spatial displacement).

Wildlife Observation and Photography

Wildlife observation and wildlife photography can negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat. Such activities can occur during sensitive times of the year (e.g., nesting, hibernation), and often involve close approaches to identify or photograph the wildlife, having a greater potential for impact to the wildlife (Purdy, et al, 1987; Knight and Cole, 1995, as cited in DeLong, 2002).

Fishing

DeLong (2002) states that fishing can affect bird distribution and abundance, reproductive success, predation rates, and foraging. The process of getting to the fishing site can also cause disturbance, similar to that associated with hiking and walking. Other effects from recreational fishing can include waterfowl fatalities resulting from entanglement with trotlines and trammel nets and degradation of wildlife habitat (Liddle and Scorgie, 1980, as cited in DeLong, 2002). Also, a debate in the literature has been made about the potential effects of stocking fish, particularly introduced or non-native species, and the potential to alter aquatic ecosystems, particularly as related to potential effects on native species (Liddle, 1997, as cited in Leung and Marion, 2000).

Boating

Boating activities can be grouped into non-motorized and motorized boating categories. Motorboats may have the greatest disturbance potential because they involve both faster movement and noise, whereas non-motorized boating involve slower speeds and less noise and are probably less disruptive to most wildlife (Knight and Cole, 1995).

In areas where waterfowl are nesting, however, canoes and rowboats have the potential to cause disturbance to nesting waterfowl as they can travel into the shallows and therefore cause disturbance (Speight, 1973, as cited in DeLong, 2002), and some non-motorized users may specifically use those craft to approach wildlife for viewing or photography. Kaiser and Fritzell (1984, as cited in DeLong, 2002) reported that green-backed heron activity declined on three of four survey routes when canoes and boat use increased on the main river channel of the Ozark National Scenic Riverway (Knight and Knight, 1984, as cited in DeLong, 2002) found that bald eagles perched in trees along the Skagit River, where boat-based angling was common, flushed less often when approached by a canoe than eagles along the Nooksack River, where there was little boating activity. This suggested that eagles can habituate to boating activity.

Camping

Camping activities can impact vegetation in ways similar to hiking and walking, such as trampling of vegetation and soil compaction. Use of a campsite as infrequently as one night per year can cause measurable impacts in many vegetation types, but typically results in height reduction rather than cover loss. Visitors often spend more time at their campsite than anywhere else during their visit, which can potentially result in a source of pollution (litter) and bacterial contamination (Hendee, et al, 1990; Cole, 1995, as cited in DeLong, 2002).

5.1.3 Potential Wildlife Response and Impacts

Knight and Cole (1991) state there are three general wildlife responses to human disturbance: avoidance; habituation; and attraction. The type and magnitude of avoidance can be influenced by: the type, distance and duration of disturbance; timing, such as time of day or year; weather influences; access to food and cover, and reproductive status of the wildlife. Habituation (factors that can influence the degree to which wildlife may tolerate disturbance or influence the degree of response) can be related to familiarity or proximity to human settlements, the distance and the movement pattern of the disturbance, and access to cover. For example, most animals appear to tolerate disturbance better in woodland than open terrain, and they appear to have a greater defense response to humans moving unpredictably in the terrain than to humans following a distinct path (Gabrielsen and Smith, 1995, as cited in DeLong, 2002). In certain circumstances wildlife may be attracted to human presence, such as instances where wildlife may be seeking food (DeLong, 2002).

An example of wildlife attraction resulting from recreational-related use is illustrated by one of the findings in an assessment conducted by Marion (2003) of camping impact along the Appalachian National Scenic Trail (A.T.) and associated resource and social impacts of increasing overnight visitation, particularly in high use areas. They found that wildlife are obtaining human food in all of the study sites visited, leading to attraction behavior (scavenging and begging) for a variety of species including rodents, squirrels, birds, skunks, raccoons, deer and bear. Most of the feeding is

unintentional, associated with spilled food during preparation, eating or cleaning and improper food storage.

The effects of recreational use can potentially impact wildlife on three levels – individual, population, and community. If enough individuals are negatively affected by recreation, impacts at the population level can occur and if impacted wildlife populations have important interactions with other species, community impacts are possible as well (Wright, et al, 2006). Purdy et al (1987) and Pomerantz (1988) described six categories of impacts to wildlife as a result of visitor activities. They include: (1) direct mortality: immediate, on-site death of an animal; (2) indirect mortality: eventual, premature death of an animal caused by an event or agent that predisposed the animal to death; (3) lowered productivity: reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site; (4) reduced use of refuge: wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity; (5) reduced use of preferred habitat on the refuge: wildlife use is relegated to less suitable habitat on the refuge due to visitor activity; and (6) aberrant behavior/stress: wildlife demonstrating unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates.

The literature suggests that direct mortality and effects on nesting/breeding are the impacts of greatest concern with regard to recreation use. The most substantial impacts on wildlife related to recreational use typically results from either direct or indirect mortality, often as a result of direct interaction, such as hunting, or a high level of indirect impacts, such as habitat destruction as a result of larger scale development. Other more indirect effects, such as increased user trails or campsites, can lead to increased disturbance of wildlife, and reduced habitat and productivity rates. Most of these more indirect effects can be mitigated through management of the location and type of recreational use and education of recreational visitors regarding potential impacts and appropriate behavior in terms of wildlife interaction.

While recreational use can cause impacts on wildlife, the literature acknowledges there are also beneficial aspects of recreational use on wildlife resources, such as greater appreciation for wildlife associated with wildlife observation. Also, trails and campsite areas created for recreational use can establish new and more diversified habitat areas if properly designed. For example, in a study along backcountry trails in Shenandoah National Park, Virginia, Hall and Kuss (1989) found changes in groundcover and increased species diversity closer to trails and they attributed it to environmental alterations along trail corridors (Hall and Kuss, 1989, as cited in Leung and Marion, 2000). The literature also demonstrates that wildlife habituation can play a role in how wildlife responds to recreational use, and that wildlife can adjust to recreational use when regular recreational use patterns and interactions occur, leading to fewer occurrences of impacts to wildlife populations.

Finally, in the assessment of potential impacts of recreational use on wildlife, other factors and their influence on the wildlife impacts should also be considered. Wright et al (2006) state that assessing the significance of recreational impacts to wildlife

can be difficult and that in addition to recreational use, other factors that can influence wildlife behavior (such as habitat features, weather, age and sex of animal) should also be considered. In addition, cumulative impacts, threshold levels, time lags, and interactions among disturbance variables may also be considered in the assessment (Gutzwiller and Cole, 2005; Harris, 1988, as cited in Wright, et al, 2006).

5.2 Wildlife and Aquatic Species in the Chattooga Corridor

Understanding the resource, conducting an inventory of what species are present and location, and understanding the potential visitor influences (level, type and location where visitation occurs) are important in identifying the potential effects and the development of management strategies. Gutzwiller and Cole (2005) state that managers initially can use existing information to identify species that require special consideration (Wright, et al, 2006).

Environmental assessments of potential effects on wildlife and aquatic resources requires specification of potentially endangered, threatened and sensitive species (PETS), management indicator species (MIS), and locally rare species (LR). There are several non-game and game terrestrial wildlife and aquatic species within the Chattooga River Basin that could be potentially affected by increased recreational activity in the area. Appendix A provides a list of PETS, MIS and LR species that may potentially occur in the project area and/or may have a potential impact from increased recreation within the Chattooga River Basin. The assessment of potential affects of any alternatives developed associated with recreational use on wildlife within the Chattooga River corridor will be conducted as part of the National Environmental Assessment Act (NEPA) review.

5.3 Findings from other Studies of Potential Management Strategies

The following section describes general management considerations identified in the reviewed literature related to addressing recreational impacts on wildlife.

Cole and Landres (1995) state management strategies for managing indirect impacts of recreational use on wildlife can include measures to restrict the amount, type, and spatial distribution of use, and measures to enhance site durability. While management strategies, such as measures for visitor education and temporal restrictions, are more effective on direct impacts than indirect impacts. Vaske et al (1995) identified classifications of visitor use management strategies which include indirect strategies: *physical alterations*, such as improved or neglect access and campsites; *information dispersal*, such as advertising area attributes, identifying surrounding opportunities, and providing education on minimum impacts; and *economic constraints*, such as charging fees. Vaske et al (1995) also identified direct strategies, including: *enforcement*, such as increased surveillance or fines; *zoning*, such as separating incompatible users; *rationing use intensity*, such as limiting use via access point or campsite, rotating use or requiring reservations; and *restricting activities*, such as restricting the type of use, limiting size of group, limiting length of stay, restricting camping practices, and prohibiting use at certain times.

DeLong (2002) describes the following measures that can be implemented to help manage the effects of human disturbance on wildlife:

- Increase predictability of public use patterns to habituate wildlife to non-threatening situations, such as encouraging hikers and anglers to use designated trails, avoid bushwhacking or creating new trails, or establishing areas or zones where no users go (perhaps only at certain sensitive times).

- Encourage slow moving and quiet activities, such as through regulating the number of users and vehicles, prohibiting motorized boats and off-road vehicles.

- Minimize area influenced by human activities, such as establishing use zones, minimizing roads, prohibiting off-road vehicles, establishing trails along habitat edges (increases diversity of wildlife viewed and minimizes impact to more sensitive interior species).

- Design facilities to conceal visitors and to protect natural resources, such as through the use of vegetation, topography, blinds, etc., and through spatial and temporal zoning to protect sensitive species and habitats during critical periods, such as board walks to protect sensitive areas.

- Encourage behavior that demonstrates respect for people, fish, wildlife, and plants, such as encouraging slow moving and quiet behavior; designing trails that approach wildlife tangentially; increasing public awareness of disturbance issues through environmental education, signs and interpretive displays.

Knight and Gutzwiller (1995) discuss general categories for managing for coexistence between recreation visitors and wildlife, including: *spatial* - isolate recreation visitors from sensitive wildlife habitat locations; *temporal* - restrict recreation visitors from the sensitive habitat locations during the time of year when nest sites, feeding sites, or roosting sites are being used; and *behavioral* - restrict certain behaviors or certain recreational use types if they are more disruptive to key wildlife species.

5.4 Key Findings and Management Considerations

The following section provides a summary of the key findings associated with recreational use effects on wildlife based on the literature review. In addition, potential indicators, standards and management actions, including both monitoring and implementation actions, are provided for consideration in the future development of management actions.

5.4.1 Summary of Key Findings

- *Assessment* - Review suggests that recreation can have impacts on wildlife, but the key to addressing them is to: identify the wildlife species of concern; identify the type of behavior/use occurring; identify the impacts use is having; and identify how much change or impact is acceptable. The process for this is to identify sensitive species first, consider what is known about how people cross paths with that species, assess potential effects, and then explore potential mitigation measures.

- *Effects of recreation behavior* - The type, timing, location and predictability of recreational activity and behavior of visitor influence wildlife responses and impacts. These impacts can vary by species depending on the animal type, size, age and habitat preferences. Larger game species tend to be more susceptible to contact with people while smaller species may be more affected indirect impacts associated with recreational use, such as impacts to soil, vegetation, water, habitat and food sources.

- *Wildlife response* - Wildlife can respond to human disturbance by avoiding encounters, being attracted to locations where use occurs, such as scavenging for food, and/or adjusting behavior. Depending on the wildlife species and location (e.g., woodland area versus open terrain), many types of wildlife are able to adjust to human interaction (i.e., habituation) over time.

- *Potential impacts* - The most substantial impacts on wildlife related to recreational use typically results from either direct or indirect mortality, often as a result of direct interaction, such as hunting, or a high level of indirect impacts, such as disturbance of nesting sites. Other more indirect effects, such as increased user trails or campsites, can lead to increased disturbance of wildlife, and reduced habitat and productivity rates. The literature suggests that direct mortality and effects on nesting/breeding are the impacts of greatest concern with regard to recreation use. Habitat destruction caused by larger scale development is also a concern, but not an issue in the Upper Chattooga.

- *Potential benefits* - All effects of recreational use on wildlife resources are not necessarily detrimental. Beneficial aspects of recreational use can occur, such as greater appreciation for wildlife associated with wildlife observation. Trails and campsite areas created for recreational use can establish new and more diversified habitat areas if properly designed.

- *Site specific issues* - Key sensitive and indicator species are identified for the Upper Chattooga corridor (Appendix A). Most potential impacts of increased recreational use within the Upper Chattooga corridor are likely to relate to disturbance at sensitive periods and locations rather than direct mortality or substantial habitat destruction. Most of these impacts can be mitigated by

establishing buffers and trail design to direct visitors away from sensitive habitat locations.

- *Management strategies* – management actions can include directing recreational use to occur in specific areas away from sensitive habitats, zoning or use restrictions, encourage use of existing trails and discourage user-created trail, education of visitors regarding potential effects of recreational use on wildlife and benefits of appropriate use behavior.

5.4.2 Management Considerations

Potential Indicators

- Population levels or trends for sensitive and indicator species.
- Disturbance events (e.g., bears disturbed in their dens)
- Number and location of nesting locations.
- Number of wildlife feeding incidents.
- Disturbance of sensitive habitat locations.

Potential Standards

- No downward trend in population due to recreation impacts.
- No disturbance of nesting locations due to recreation impacts.
- No disturbance of sensitive species habitat locations.
- No additional habitat fragmentation as a result of increased user trails.
- Enhanced protection of sensitive species habitat by restricting use to sensitive habitat locations.

Potential Management Implementation Actions

Monitoring Actions
- Monitor wildlife population trends and effects.
- Monitor sensitive habitat locations.

Regulation/Education Actions
- Trail design to encourage regular use patterns and reduce user created trails.
- Campsite designations to avoid camping near sensitive habitat.
- Limited use levels during sensitive seasons (must be specific).
- Education programs to alert users to impacts/best practices

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APPENDIX A

Identified Terrestrial Wildlife and Aquatic PETS, MIS and LR Species for the Upper Chattooga River Watershed

Definitions

Definitions are taken from the Federal Register, Vol. 56, No. 225, November 21, 1991(50 CFR Part 17), unless otherwise noted. Federally listed Endangered and Threatened species are protected under the provisions of the Endangered Species Act of 1973, as amended through the 100th Congress. This status is designated by the US Fish and Wildlife Service.

Federally Endangered: A taxon which is in danger of extinction throughout all or a significant portion of its range (Endangered Species Act, Section 3).

Federally Threatened: A taxon which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (Endangered Species Act, Section 3).

Forest Sensitive Species: Those plant and animal species identified by the USFS Regional Forester for which population viability is a concern as evidenced by significant current or predicted downward trends in population numbers or density; or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Sensitive Species include Natural Heritage Network species ranks of G1, G2 and G3.

Management Indicator Species: An animal or plant species selected for use as a planning tool in accordance with 1982 NFMA regulations (36 CFR 219.19). These species are used to help set objectives, analyze effects of alternatives, and monitor plan implementation. They are chosen because their population changes are believed to indicate the effects of management on selected biological components. Management indicators refer to communities (all the plants and animals that represent that community) that serve the same function.

Locally Rare Species: Those species that are considered locally rare; usually ranked by the state Natural Heritage Program as S1 or S2 or designated as a state threatened or endangered species.

Table A-1. Federally Threatened, Endangered and Proposed Wildlife and Aquatic Species and Region 8 Forest Sensitive Wildlife and Aquatic Species (PETS)

Chattooga River Corridor - Sumter National Forest (SNF), Chattahoochee Oconee National Forest (CONF), Nantahala National Forest (NNF)

Species	Ranking	Forest	Habitat
Bald eagle *Haliaeetus leucoocephalus*	Federally Threatened	SNF CONF	Perennial rivers and lakes; nesting in dominant or codominant pines 3 km or less from open water.
Peregrine falcon *Falco peregrinus*	Sensitive	NNF CONF	Known to use cliffs associated with Whiteside Mountain in the upper Chattooga River watershed.
Northern saw-whet owl-Southern Appalachian population *Aegoliius acadicus*	Sensitive	NNF	Associated with spruce-fir forests or mixed hardwoods and spruce-fir forests for nesting during breeding season only.
Olive-sided flycatcher *Contopus cooperi*	Sensitive	NNF	One known occurrence in upper Chattooga River watershed; typically associated with montane conifer forests.
Rafinesque's big-eared bat *Corynorhinus rafinesquii*	Sensitive	SNF CONF	Restricted to the mountains, sandhills, and coastal plain physiographic regions. May be found in hollow trees or behind loose bark near streams, caves, mines, or human-made structures.
Rafinesque's big-eared bat-Mountain subspecies *Corynorhinus rafinesquii rafinesquii*	Sensitive	NNF	Known to roost in hollow trees, old buildings and beneath bridges; usually near water.
Eastern small-footed myotis *Myotis leibii*	Sensitive	SNF CONF	At southern terminus or range in the mountains of SC; known from Moody Creek near Lake Cherokee. May commonly roost in hemlock trees near streams in summer.
Diana Fritillary *Speyeria diana*	Sensitive	SNF CONF	Violets are larval host plant; occupy open areas for nectar sources in summer; mountains.
Eastern woodrat- Southern Appalachian population *Neotoma floridana haematoreia*	Sensitive	NNF	Utilizes rocky sites in mixed forests in the upper Chattooga River watershed.
Timber rattlesnake *Crotalua horridus*	Sensitive	NNF	Rocky hillsides and river valleys.
Southern Appalachian salamander *Plethodon teyahalee*	Sensitive	SNF	Mature Mesic Hardwood Forests.
Oconee stream crayfish *Cambarus chaugaensis*	Sensitive	SNF CONF NNF	Fast-moving, rocky tributaries of the upper Savannah River.
Brook floater *Alasmidonta varicosa*	Sensitive	SNF CONF	Small streams with gravel bottoms; known from Chattooga, Turkey and Upper Stevens Creek watersheds.
A dragonfly *Macromia margarita*	Sensitive	NNF	Rivers in Macon, Swain and Transylvannia Counties.

Table A-2. Management Indicator Species (MIS) and Management Indicators (MI): Wildlife and Aquatic Species

Chattooga River Corridor - Sumter National Forest (SNF), Chattahoochee Oconee National Forest (CONF), Nantahala National Forest (NNF)

Management Indicators and Communities	Forest	Habitat
Mgmt. Indicator Species		
Hooded warbler	SNF CONF	Mesic deciduous forests with dense understory and mid-story structure.
Scarlet tanager	SNF CONF	Oak forests.
Pine warbler	SNF CONF NNF	Pine/pine-oak forests.
Acadian flycatcher	SNF CONF NNF	Riparian forests.
Brown-headed nuthatch	SNF	Mid and late successional pine and pine/oak forests.
Prairie warbler	SNF CONF	Early successional forests.
Swainson's warbler	SNF CONF	Canebrakes and other early successional riparian habitats.
Field sparrow	SNF CONF	Woodland/grassland/savanna habitats.
Wood thrush	CONF	Deciduous and mixed forests.
Ovenbird	CONF NNF	Large Contiguous Forest Areas.
Chestnut-sided warbler	CONF	Mid successional deciduous forests.
Rufous-sided towhee	NNF	Early-successional Forests.
American woodcock	SNF	Early successional riparian habitats.
Pileated woodpecker	SNF CONF NNF	Old Forest Communities.
Northern bobwhite	SNF	Brushlands and open woodlands.
Ruffed grouse	NNF	Early-successional Forests.
Eastern wild turkey	SNF	Open forests.
Black bear	SNF CONF NNF	Old Forest Communities.
White-tailed deer	CONF NNF	Early-successional Forests.
Brook, brown and rainbow trout	NNF	Coldwater streams.
Blacknose dace	NNF	Coldwater streams.
Management Indicators		
Cold Water Communities	SNF	Chattooga River tributaries; Brook trout, rainbow trout and brown trout, aquatic insects, crayfish and mollusks.
Cool Water Communities	SNF	Chattooga River main stem; Trout and other fish species, aquatic insects, crayfish and mollusks.

Table A-3. Locally Rare Species (LR): Wildlife and Aquatic

Chattooga River Corridor - Chattahoochee Oconee National Forest (CONF) and Nantahala National Forest (NNF)

SPECIES	RANKING	FOREST	HABITAT
Hellbender *Cryptobranchus alleganiensis*	LR	NNF	Rivers and large streams in Tennessee and Savannah River systems.
A caddisfly *Rhyacophila amicis*	LR	NNF	Mountain rivers.
A caddisfly *Matrioptila jeanae*	LR	NNF	Streams and rivers.
A caddisfly *Micrasema burksi*	LR	NNF	Mountain streams.
A caddisfly *Micrasema sprulesi*	LR	NNF	Streams and rivers.
Oconee crayfish ostracod *Cymocythere clavata*	LR	NNF	Symbiotic on crayfish in mountain streams and rivers in the Savannah River system.
Whitewater crayfish ostracod *Dactylocythere prinsi*	LR	NNF	Symbiotic on crayfish in mountain streams and rivers in the Savannah River system.
Ski-tailed emerald *Somatochlora elongate*	LR	NNF	Slow to moderate streams
Zebra clubtail *Stylurus scudderi*	LR	NNF	Rivers.
Yellowfin shiner *Notropis lutipinnis*	LR	NNF	Savannah and Little Tennessee River systems.
Turquoise darter *Etheostoma inscriptum*	LR	NNF	Large streams in Savannah River system.
Redeye bass *Micropterus coosae*	LR	NNF	Savannah River system.
Habrophlediodes mayfly *Habrophlediodes spp*.	LR	NNF	Very small streams.
William's rare winter stonefly *Megaleuctra williamsoni*	LR	NNF	Streams and rivers.
Eastern Woodrat - Southern Appalachian population. *Neotoma floridana haematoreia*	LR	NNF CONF	Rocky places in deciduous or mixed forests, in southern mountains and adjacent Piedmont
Long-tailed shrew *Sorex dispar*	LR	NNF	High elevation forests with talus or rocky slopes
Cerulean warbler *Dendroica cerulean*	LR	NNF CONF	Mature hardwood forests; steep slopes and coves in mountains [breeding season only]
Appalachian yellow-bellied sapsucker *Sphyrapicus varius appalachiensis*	LR	NNF	Mature, open hardwoods with scattered dead trees [breeding season only]
Warbling vireo *Vireo gilvus*	LR	NNF	Groves of hardwoods along rivers and streams [breeding season only]
Green salamander *Aneides aeneus*	LR	NNF CONF	Damp, shaded crevices of cliffs or rock outcrops in deciduous forests (southern forests)

Table A-3 Locally Rare Species (LR): Wildlife and Aquatic (cont.)

SPECIES	RANKING	FOREST	HABITAT
Golden banded skipper *Autochton cellus*	LR	NNF	Moist woods near streams; host plant-hog peanut (*Amphicarpa bracteata)*
Dusky Azure *Celastrina nigra*	LR	NNF	Rich, moist deciduous forests; host plant-goat's beard (*Aruncus dioicus*)
An undescribed Nesticus spider *Nesticus species 1*	LR	NNF	Habitat not indicated (known only from Jackson and Transylvania counties, NC and Oconee county, SC)
Least flycatcher *Empidonax minimus*	LR	CONF	Deciduous forests.
Willow flycatcher *Empidonax trailii*	LR	CONF	Brushy habitats in wet areas, pastures and meadows.
Red-breasted nuthatch *Sitta canadensis*	LR	CONF	Northern and sub-alpine conifers.
New England Cottontail *Sylvilagus transitionalis*	LR	CONF	Dense cover of montane woods and thickets.
Red squirrel *Tamiasciurus hudsonicus*	LR	CONF	Coniferous, mixed coniferous and deciduous forests.
Northern pine snake *Pituophis m.melanoleucus*	LR	CONF	Dry upland pine forests and ridges in burrows, under leaf litter or in natural cavities.
Whitetail shiner *Cyprinella galactura*	LR	CONF	Clear upland creeks and rivers.
Tennessee shiner *Notropis leuciodus*	LR	CONF	Small creeks to large rivers.