APPENDIX 2: CAMPING MANAGEMENT PRACTICES

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Camping Management Practices[1]

Decision Making and Management Constraints

This new century will undoubtedly see a continuing escalation in visitation along the A.T. and a renewed focus on the management of associated recreation-related resource impacts. This Appendix is provided to review the range of potential management responses for preventing and minimizing camping-related resource and social impacts. It is intended to serve land management agency staff and A.T. club members (collectively referred to as "managers" in this Appendix) as a reference document to guide camping management planning, decision making, and fieldwork.

Camping management can be proactive or reactive. Proactive management anticipates a problem and seeks to minimize the likelihood of it occurring before its emergence. Reactive management responds to problems after they occur, often when unacceptable resource or social conditions have developed that are difficult or expensive to rectify. Professional management should always attempt to be proactive. Selecting and maintaining a resistant campsite is always better than reconstructing or relocating, closing and rehabilitating a poorly located site. The importance of supporting actions, evaluations of project success, and sustained management are also critical elements of successful camping management programs.

The identification and selection of effective management interventions requires knowledge of the impacts that are occurring, their underlying causes, and the role of various influential factors (e.g. environmental resistance). Hammitt and Cole (1998) and Leung and Marion (2000) review and summarize this knowledge and its implications for management decision making. Ideally, such knowledge should be integrated with current management expertise and monitoring data (if available) in a careful problem analysis prior to the identification and selection of management actions.

Decision frameworks such as Limits of Acceptable Change (LAC) (Stankey and others 1985) and Visitor Experience and Resource Protection (VERP) (NPS 1997a; NPS 1997b) can also be applied to provide formal decision processes to guide and evaluate the success of management decision making. These decision making frameworks transform management goals into prescriptive objectives that are implemented and evaluated with standards defining the limits of acceptable resource and social conditions. Monitoring permits periodic comparisons of conditions to standards. If standards are exceeded, a problem analysis evaluates causal factors to aid in selecting appropriate and effective management intervention(s). These models provide dynamic decision processes; future monitoring evaluates the success of implemented actions, so managers can select and implement additional actions if unacceptable conditions persist.

Informal decision making may also benefit from the guidance provided by these frameworks. For example, what are the management objectives for the area according to land management agencies, the ATC and local clubs and interests? What are the current conditions within the area and how do these differ from the desired future conditions? What criteria will be used to select new management strategies and actions? What do visitors want and how will proposed actions affect them? Management decisions

[1] Sections of this Appendix were taken or adapted from Leung and Marion, 2000.

must always strike a balance between protecting resources and providing for appropriate recreational opportunities. Successful management requires a thorough understanding and consideration of the diverse array of factors that control and influence that balance.

There are also a number of management constraints that must be considered during the selection of management actions. These include funding and personnel constraints, and policy limitations imposed by Congressional laws or agency and organizational guidance. As discussed in the Recommendations Chapter, federal management planning guidelines link the type and number of visitor facilities to land zoning classifications. The presence of facilities and the materials used to construct them generally vary across land management zones ranging from frontcountry, to backcountry, to wilderness. More latitude in the use and construction of facilities is permitted in frontcountry settings in contrast to wilderness, where an unmodified and undisturbed natural environment assumes a greater prominence.

The Wilderness Act (P.L. 88-577) defines wilderness as "undeveloped" lands "without permanent improvements" which "has outstanding opportunities for solitude or a primitive and unconfined type of recreation," and where "the imprint of man's work is substantially unnoticeable." Furthermore, it states that "except as necessary to meet minimum requirements for the administration of the area ... there shall be no ... structure or installation." In light of this mandate, managing agencies have generally adopted what has become known as the minimum tool rule to guide their wilderness management actions (Hendee and others 1990). This rule directs managers to apply only the minimum tools, equipment, device, force, regulations or practice that will accomplish the desired result.

This guidance is frequently interpreted as a need to first select and attempt indirect management actions, such as Leave No Trace educational practices or improved trail and site design and maintenance before more direct controls such as limitation of use or regulations. However, if indirect methods fail to resolve resource protection problems, managers must be prepared to apply more restrictive measures. It has been argued that managers must not hesitate to employ direct controls, even as initial actions, when long-term or irreversible resource degradation is occurring (Dustin and McAvoy 1982).

Decisions about the use of site hardening and facility development actions in wilderness are particularly difficult. A constructed and maintained trail is a permanent wilderness facility designed both to facilitate wilderness travel and protect resources. Such facilities can involve vegetation disturbance, soil excavation and deposition, and the potential disruption of surface water movement. However, a properly managed trail system limits the areal extent and severity of recreation impacts by concentrating traffic on resistant tread surfaces. The absence of formal trails in popular locations would lead to a proliferation of poorly located and heavily impacted visitor-created trails. Similarly, although less common in wilderness, designated campsites can be located, constructed and maintained to substantially reduce the areal extent and severity of camping impacts. The Wilderness Act clearly permits managers to employ such facilities, although their use must be justified as the minimum means for managing sustainable visitation.

Management Strategies and Tactics

Recreation impact management problems may be addressed through an array of management strategies and tactics. Strategies are broad approaches that address underlying causes of problems. Tactics are the means used to implement a strategy, often involving one or more specific management actions. To illustrate, consider the problem of excessive campfire-related impacts. Following a careful problem

analysis, an educational strategy is identified as the most appropriate first course of action. A tactic might be to develop a Leave No Trace program for the area to communicate low impact campfire and firewood collection practices. Specific actions might include distribution of the brochure at trailheads and by ridge-runners and club staff in the field.

The most common management strategies and tactics, which are presented and briefly reviewed in this section, are described in more detail in Anderson et al. (1998), Brown et al. (1987), Cole (1989), Cole et al. (1987), Hammitt and Cole (1987), Hendee et al. (1990). Readers are encouraged to access these references for more detailed information.

The most recent review by Anderson et al. (1998), employs a handbook approach with worksheets to guide managers through the process of defining unacceptable resource and social impacts and identifying and selecting from a range of strategies and tactics. Visitor use problems and alternative solutions are evaluated through a five-stage decision process: (1) problem awareness, (2) problem specification, (3) strategy and tactic selection, (4) plan implementation, and (5) monitoring. The manual also includes descriptions of 25 management tactics organized into five categories: (1) site management, (2) rationing and allocation, (3) regulations, (4) deterrence and enforcement, and (5) visitor education. Management tactic descriptions include information on their potential costs to visitors and managers, their effectiveness, and references for further information.

A comprehensive problem-oriented review of wilderness management strategies and tactics (Table 6) is provided by Cole et al. (1987), including information on their advantages and disadvantages, costs to visitors and management, effectiveness, and references for further information. Applicable strategies and tactics are highlighted for a set of common management problems, including: (1) trail deterioration, (2) campsite deterioration, (3) litter, (4) crowding and visitor conflict, (5) packstock impact, (6) human waste, (6) wildlife and fishery impacts, (7) water pollution. These management problems are also described, including information on potential causes relevant to the selection of strategies and tactics.

Management interventions seek to avoid or minimize recreation impacts by manipulating either use-related or environmental factors. Use-related factors, particularly the redistribution or limitation of visitor use, have received more research and management attention. However, research has increasingly demonstrated the importance of environmental factors, such as focusing use in environmentally resistant locations or increasing resource resistance through the use of facilities like trails and campsites (Cole, chapter 16, in Hendee et al. 1990; Leung and Marion 2000; Marion and Farrell 2002). The modification of user behavior through educational and regulatory actions is another increasingly applied strategy.

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 often an important consideration (Cole 1990a). For example, impacts from visitors knowingly engaging in illegal actions require a law enforcement response. Careless, unskilled or uninformed actions are often most appropriately addressed through visitor contacts and educational responses (Lucas 1982). Unavoidable impacts are commonly reduced by relocating visitation to resistant surfaces or by limiting use.

Table 6. Strategies and tactics for managing camping-related resource and social impacts.

I. REDUCE USE OF PROBLEM AREAS

a) Inform potential visitors of the disadvantages of problem areas and/or advantages of alternative areas
b) Discourage or prohibit camping in problem areas
c) Limit number of campers in problem areas
d) Encourage or require a length-of-stay limit in problem areas
e) Make access to problem areas more difficult and/or improve access to alternative areas
f) Eliminate facilities or attractions in problem areas and/or improve facilities or attractions in alternative areas

II. MODIFY THE LOCATION OF USE WITHIN PROBLEM AREAS

a) Discourage or prohibit camping on certain campsites and/or locations
b) Encourage or permit camping only on certain campsites and/or locations
c) Locate campsites on durable surfaces
d) Concentrate use on campsites through facility design and/or information
e) Separate campers from each other and trails

III. MODIFY THE TIMING OF USE

a) Encourage use outside of peak use periods
b) Discourage or prohibit use when impact potential is high

IV. MODIFY TYPE OF USE AND VISITOR BEHAVIOR

a) Teach *Leave No Trace* camping practices
b) Discourage or prohibit campfires, axes, or saws
c) Encourage or require certain behavior, skills and/or equipment
d) Encourage or require a group size limit
e) Discourage or prohibit pets

V. MODIFY VISITOR EXPECTATIONS

a) Inform visitors about appropriate uses
b) Inform visitors about negative resource or social conditions they may encounter

VI. INCREASE THE RESISTANCE OF THE RESOURCE

a) Create or strengthen campsites
b) Shield the site from impact

VII. MAINTAIN OR REHABILITATE THE RESOURCE

a) Maintain campsites
b) Close and rehabilitate unnecessary or impacted campsites

Adapted from Cole et al., 1987.

Amount of Use. Amount of use is perhaps the most studied use-related factor. Earlier studies have consistently found a nonlinear asymptotic relationship between amount of use and amount of impact (Cole 1987b). Most forms of camping impact occur rapidly with initial and low levels of use (up to 10 nights/year), then begin to level off as near-maximum impact levels are reached at moderate to high use levels. This use-impact relationship has been corroborated by recent trampling studies for most impact parameters with a few exceptions (such as exposure of mineral soil) (Cole 1987; Cole 1993; Kuss and Hall 1991).

The curvilinear use-impact relationship reduces the potential effectiveness of use limitation for addressing recreation impacts (Strategies I & II, Table 6). Substantial use reductions would be necessary to achieve even modest improvements in resource condition on heavily impacted trails and campsites. Use reductions can lead to pronounced improvements at lower use levels, where use and impact are more strongly related (although slow recovery rates prevent rapid improvements) (Cole 1995). Use reductions during peak use weekends (Strategy III) can also be very effective in preventing the establishment of new campsites. Peak use is often dramatically higher than normal use, so visitors frequently create new campsites during peak periods that are kept from recovering by subsequent occasional use during the rest of the year. Use reductions during peak periods reduces the number of campsites needed and the total area of camping disturbance. For example, visitors could be encouraged to avoid the A.T., or at least popular sections, during peak use weekends. Tactics for rationing use are reviewed in Anderson and others (1998) and Cole and others (1987).

Density of Use. How much visitation is concentrated spatially affects both the areal extent and severity of resource impacts (Marion and Cole 1996). Educational programs and regulations may be used to shape visitation density, generally through one of two strategies: visitor dispersal, which spreads use sufficiently to avoid or minimize long-term impacts, and visitor containment, which concentrates use to limit the areal extent of impact (Cole 1992; Leung and Marion 1999). Containment, as evidenced by the development and maintenance of formal trail systems, has a long tradition of use in wilderness. Its application to camping management is less common, but a variety of options are now in use (Marion, et al. 1993). In contrast, dispersal is rarely applied to reduce hiking impacts except for remote low-use areas. Its application to camping management is more common, although many factors thwart the success of this strategy.

When camping is unregulated, visitors are free to choose any existing campsite or create new ones. This policy can result in many poorly located campsites (Cole 1993a; Leung and Marion 2000b; McEwen et al. 1996). For example, wilderness campsites in the Jefferson National Forest of Virginia were frequently located on trampling-susceptible herbaceous groundcover in areas that readily permit site expansion and proliferation (Leung and Marion, 2000). Campsites were also located close to trails and other campsites, enhancing the potential for visitor conflicts and reducing solitude for both campers and hikers.

A successful application of dispersal and containment strategies can reduce camping impacts. Consider three campsites that receive intermediate amounts of use (10-20 nights/year) under an unregulated camping policy (Figure 2). Aggregate resource impact for these sites would be three times the “a” amount of impact. Under the purest form of dispersed camping, these sites would be closed and their use distributed across 45 pristine sites, each receiving only one night of use/year. Most vegetation types can sustain such light camping with no permanent impact visible the following year. More resistant surfaces, like grassy groundcover, sand, gravel and rock, can accommodate many more nights of use

without permanent impact. The low camping densities under a dispersal strategy also resolve problems with crowding and conflicts.

In contrast, a containment strategy could be implemented by closing two of the three original sites and distributing their use to the third. Due to the curvilinear use-impact relationship, impact on this third site would increase only marginally, from "a" to "b" (Figure 2). Aggregate impact would decline substantially, from three sites with an "a" level of impact to one site with a "b" level of impact. Application of this strategy was largely responsible for a 50 percent reduction in the total area of disturbance from river camping at Delaware Water Gap National Recreation Area (Marion 1995). Furthermore, in addition to favoring resistant sites, site selection criteria emphasized the closure of sites within dense clusters, addressing crowding and conflict problems by maximizing intersite distances.

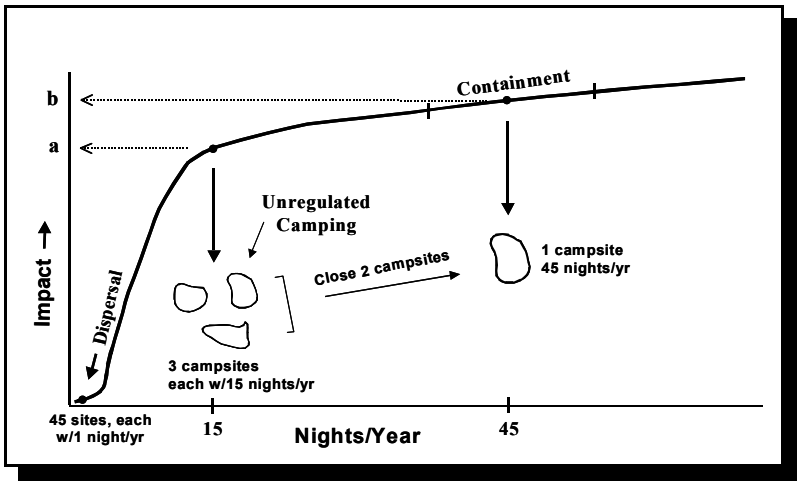

Figure 2. A generalized use-impact curve illustrating the intended locations of typical or average campsites under dispersed and containment strategies.

While these strategies may seem straightforward, additional issues often complicate their implementation. Achieving the level of camping dispersal necessary to prevent impacts has proven exceptionally difficult. In most vegetation types more than a few nights of camping will quickly create lasting impacts -- that is, permanent campsites (Cole 1995). Mountainous topography, dense vegetation, and availability of water frequently limit the number of potential camping locations, and few of these contain resistant surfaces (Williams and Marion 1995). Furthermore, most visitors prefer camping on established sites close to trails, water and popular features (Lucas 1990). Generally, a dispersed camping strategy will be effective only in areas that receive low levels of use, have numerous potential camping locations that are resistant and/or resilient, and where visitors are willing to learn and apply LNT camping practices (Leung and Marion 1999). See the following publications for more in-depth reviews of LNT practices: Cole 1989; Cole and Benedict 1983; Hampton and Cole 1995; http://www.LNT.org, and McGivney 1998.

Successful containment strategy requires concentrating camping activities on the smallest number of sites needed to accommodate the intended level of use (Leung and Marion 1999d). Reserved, designated site camping permits the smallest number of campsites and aggregate impact. However, fixed itineraries are difficult to follow and entail a substantial loss of visitor freedom (Stewart 1989). Restricting camping to designated sites (signed on the ground and marked on maps) without a reservation system allows greater flexibility. Visitor use surveys or direct observation can provide information for matching campsite numbers and locations to visitor use patterns, or entry point quotas can restrict use based on available campsite numbers (Lime and Buchman 1974). To avoid excessively large inventories of campsites, use surveys should be conducted during average high use periods rather than peak use periods. If limited to only a couple of peak use weekends, overflow camping in pristine areas will not likely result

in the establishment of new campsites. However, in comparison to areas with site reservation systems, somewhat larger numbers of campsites are necessary to avoid the "musical chairs" dilemma of too many visitor groups and too few campsites. For example, a system with fixed itineraries could achieve 100% occupancy rates during high use periods but a system with designated sites with unfixed itineraries would require occupancy rates around 70% to avoid the need for visitors to conduct extensive walking and searches for an open campsite.

An educational approach, asking visitors to camp only on informal well-established campsites (not signed or marked on maps), may also be used (Leung and Marion 1999). This less regimented "established site camping" option allows visitors greater latitude in seeking out informal campsites that meet their needs. Implemented at Shenandoah NP in 1999, this option targeted campsite proliferation problems which, in some areas of park, had resulted in occupancy rates as low as 10-20%. Managers applied site selection criteria to identify and concentrate future use on sites that were resistant and promoted solitude. Numerous poorly located sites were then closed, increasing site occupancy rates to the 50-70% range. Research and monitoring to gauge the effectiveness of this new strategy are nearing completion.

Often a combination of camping policies provide the most effective strategy (Leung and Marion 1999). The new backcountry camping management policies at Shenandoah NP provide an example (NPS 1998). The previously described established site camping option applies to the majority of the backcountry. Dispersed camping on pristine sites is permitted only when all available campsites are occupied. In high-use areas, such as at A.T. huts, visitors are required to camp on a limited number of marked designated campsites on a first-come, first-served basis. A few areas containing sensitive cultural and natural resources or that accommodate high day use are closed to camping. While more complex, such combined strategies offer substantial flexibility in balancing resource protection and recreation provision objectives.

Type of Use. Types of uses that result in greater or disproportionate impacts are often subject to special regulations or educational programs (Strategy IV). Use along the A.T. is relatively homogenous due to prohibitions on motorized, horse, and mechanical (mountain bike) uses. There are some differences in impacts between day and overnight use and between weekend vs. long-distance hikers but differential management of these groups related to reducing resource impacts at campsites and shelters is a largely unexplored topic. Targeting day use and weekend campers with introductory LNT information and practices focused on the predominant impacts or problems will often be the most effective action. Long distance hikers can be targeted with more comprehensive or "advanced" LNT information - these individuals are important because of their substantially greater number of camping nights and because they serve as role models during their numerous interactions with short-term A.T. hikers.

Large groups are perhaps the most important type of use that require special management attention. Organized commercial groups are often easier to target and manage than unorganized and/or non-commercial groups. Management of large groups was previously addressed in the Recommendations chapter under "Manage Large Groups," much of it is included here for easy reference.

Organized groups present A.T. managers with some unique opportunities. Most outdoor enthusiasts are introduced to the out-of-doors by some type of group-related outdoor program. The organizations that operate these largely novice and youth-oriented programs can be efficiently targeted, allowing cost-effective education of large numbers of public land visitors. Young, inexperienced visitors tend to be

more receptive to adopting Leave No Trace practices, providing an opportunity for instilling life-long LNT skills and ethics. Group leaders are receptive to educational literature and outreach efforts and are also skilled in teaching their members outdoor practices. An LNT pamphlet that specifically targets LNT practices for large groups has recently been developed (http://www.LNT.org).

Many agencies have established group size limits, particularly for wilderness, to address resource and social impact issues. However, few studies have examined the relationship between group sizes and resource or social impacts, nor is it expected that they could they provide specific guidance for selecting a meaningful size limit. Decisions about group size limits require subjective judgements and a limit of 10 is unlikely to be any more "correct" or "appropriate" than 6 or 14. There is no magic "best" number. Furthermore, while large groups create larger campsites than small groups, splitting them up may require more campsites and greater aggregate impact (Cole 1987b; Cole and Marion 1988). Matching group size with site size is therefore a significant management challenge.

To a large extent, resource and social impacts are primarily a function of visitor behavior rather than group size. Thus, the core land management challenge lies in encouraging all outdoor enthusiasts to learn and practice low impact skills, regardless of their group affiliation. An educational focus recognizes and avoids or reduces the significant visitor-related costs associated with group size regulations. The safety of group members, particularly in remote settings, may be compromised. Volunteer, non-profit and commercial organizations are also significantly disadvantaged by group size limits, which necessitate additional leadership. Smaller staff/participant ratios translate into higher costs for participants which reduces the economic viability of outdoor education programs or displaces them from public lands. A.T.-specific education efforts targeting organized groups have already been pioneered and implemented in the northern states.

Site management actions offer a final option to address large-group impacts. Group-use campsites have been designated in some areas and could be developed in others. Accommodating groups of up to 12 on carefully selected sites would likely involve less resource impact than splitting them up to camp on separate sites. Informal or formal reservation systems may be needed to facilitate site use by organized groups.

User Behavior. Many impacts are avoidable, often caused by uninformed or careless behavior (Lucas 1982). Education and regulations developed to modify visitor behaviors are effective methods for avoiding or minimizing resource and social impacts associated with overnight visitation (Strategy IV). Common avoidable camping-related resource impacts include littering, creating new campsites and trails, moving or building new fire sites, improper disposal of human and food waste, enlarging campsites, cutting or damaging trees, and feeding wildlife. Management efforts can also minimize unavoidable impacts, such as vegetation disturbance caused by foot traffic.

Generally visitor education should be given an opportunity to resolve problems before regulations are imposed, unless impacts are severe or long-term. An incremental management approach ensures that visitor freedoms are not unnecessarily restricted. For example, excessive tree damage related to firewood gathering might begin with LNT educational messages that encourage stove use over campfires. When campfires are desired they should be built small with dead and down wood that can be broken by hand. These messages might be conveyed on signs at trail heads and shelters, with LNT pamphlets or flyers, or through personal contacts by caretakers and club members. If subsequent evaluations reveal that the problem was not resolved an action such as prohibiting axes and saws might be added to the educational

program. The educational program might also be intensified by targeting groups known to be part of the problem. Finally, if these actions are ineffective campfires could be prohibited.

LNT camping practices have been developed to address every common camping management problem (Cole 1989b; Hampton and Cole 1995), along with alternative education techniques for conveying such practices to visitors (Doucette and Cole 1993). The list includes selection of resistant campsites away from streams, trails, shelters, and other occupied campsites, confining activities within core use areas to avoid enlarging sites, using stoves and low impact campfire practices, proper food storage and cleanup, proper human waste disposal, and practices to avoid impacts to wildlife and the recreational experiences for other visitors. These practices are taught in LNT training courses offered by a variety of organizations, including the National Outdoor Leadership School, the Appalachian Mountain Club, federal land management agencies, and the ATC. A variety of publications (1-800-332-4100) and a comprehensive web site (http://www.LNT.org) are also available.

Although more restrictive to visitor freedom and experiences, regulations offer another option for altering visitor behavior to reduce impacts (Lucas 1982). Examples include requirements on the location of camping, such as restricting camping to designated sites or prohibiting camping in certain areas or within a set distance from trails or streams. Axes, saws, or campfires may be prohibited or campfires may be restricted to designated fire rings. Proper food storage may be required and feeding wildlife may be prohibited. Interventions may employ both educational and regulatory responses. Finally, managers must consider their ability to enforce regulations. The remote nature of the trail environment and declining agency budgets make it difficult to enforce regulations along the A.T. While volunteers can remind visitors of regulations, they cannot and should not try to enforce them.

Environmental Factors and Site Management

Managers can also influence or control the locations where visitors camp (Strategy II) and manage the sites that they use (Strategies VI and VII). Both the areal extent and severity of camping impacts can be reduced through careful site selection, design, construction and maintenance. The location and spatial arrangement of campsites also determine the social conditions for visitors who use them.

Primitive campsites have rarely been planned and developed through careful evaluations of their expected ability to sustain use while preserving high quality natural conditions and social experiences. Most backcountry campsites, even those that have been formally designated, were originally visitor-selected and created. Examples abound in many backcountry areas of poorly located campsites that are severely degraded or offer little opportunity for solitude and natural quiet. However, scientific knowledge and managerial experience have provided improved information for selecting campsites able to sustain heavy recreational traffic with far less resource and social impact than most existing campsites. Improved site design, facilities, and maintenance also contribute substantially to the avoidance and minimization of impacts.

Site Selection. Flat, dry ground near water and the trail have been the traditional requirements for a good backcountry campsite. However, research and management experience have shown that these are often poor locations for low-impact campsites. Large flat stream benches, gaps, and ridge tops may offer many potential camping locations but they also offer little resistance to campsite proliferation and expansion and promote high-density camping that degrades visitor experiences (Figure 3). Campsite monitoring has revealed that large flat areas often support several times the number of campsites needed for typical high use periods, with some that merge to form mega-sites exceeding 4000 ft^2 in size.

Campsites developed near streams, ponds, and springs often experience sheet erosion that drains down water access trails to add turbidity and sediments to pristine water sources. Finally, camping along or near trails reduces the opportunity for solitude for both hikers and campers, whose experiences are degraded by seeing campsite after campsite and their close proximity to other visitors.

Figure 3. Large barren area due to high-density camping at Slaughter Gap, Georgia.

Knowledge of the environmental resistance and resilience of vegetation and soil types can also be applied to select the most durable campsites (Hammitt and Cole 1998). Management options include educating visitors to improve their site selection, marking resistant sites to encourage their use and designating resistant sites. Topography and other environmental attributes such as rockiness and vegetation density can also be considered to select locations that minimize impact severity and area of disturbance.

Research has demonstrated considerable variability in the trampling resistance of different vegetative growth forms and plant communities (Cole 1987; Kuss 1986). Open forests and dry meadows support grassy ground cover that is substantially more resistant to damage from trampling than herbs growing under closed forest canopies. Grasses have flexible stems and leaves that are well-adapted to trampling pressures and they recover more quickly following damage. Other alternatives include durable non-vegetated surfaces, such as rock or gravel, or other locations where ground vegetation is minimal, such as dense shade. For example, campsites are less obvious when located under dense forest canopies that shade out most ground vegetation yet yield substantial organic matter to cushion heavy foot traffic. Avoid fragile vegetation, like ferns or tall broad-leafed herbs, and vegetation that recovers slowly, like high elevation plants or woody shrubs. Resistant plant communities and environments may be targeted for camping, while fragile communities may be avoided or identified for closures to camping.

Similarly, soils vary in their resistance to trampling degradation, as influenced by texture, organic content, and moisture. Dry, somewhat organic soils with a wide range of particle sizes (e.g., sandy-clay loams) are preferred. Smaller silt and clay particles promote soil cohesion while larger sand particles promote soil drainage. Soils with a narrow range of particle sizes, particularly those high in silt and fine sands, are most prone to erosion (Hammitt and Cole 1998). Erosion is accelerated by the absence of vegetation and organic litter, and slope is a critical determinant of erosion potential. Highly organic soils (peats and mucks) retain water long after rains, creating mud.

Knowledge of the relative resiliency (ability to recover) of different environments and vegetation types may also be used to direct camping to areas that will recover quickly after trampling disturbance. Resiliency varies among plant species but is also strongly related to environmental factors that influence plant growth, including soil properties (fertility, moisture, and texture) and length of growing season. Environmental resilience is a more important consideration in low-use areas where dispersed camping is promoted, than in higher-use areas where a concentration strategy is employed (Cole 1995). This is because campsite impact rates are far greater than recovery rates (Marion and Cole 1996). On higher-use campsites, visitor traffic is sufficient to permanently remove most vegetation cover. However, vegetation

and environments that are highly resilient can still help to restrict campsite sizes and disturbance in surrounding areas.

Information to promote the selection campsites that are resistant and protect solitude can be communicated to and applied by visitors. The *Leave No Trace* program provides information focusing on this issue through it's second principal: "Travel and Camp on Durable Surfaces". Site selection information can be communicated in maps and guidebooks, but also through LNT brochures and direct visitor contacts. Alternately, in areas where a containment strategy is used, resource and social selection criteria can be developed and applied by managers to evaluate either existing or new campsites.

Experimentation by backcountry managers in parks and forests has revealed that site selection is the single most important factor in developing a campsite that sustains heavy use while remaining small and in good condition. Camping management should begin with a thorough assessment of existing or proposed campsites to evaluate their potential for sustaining use while protecting the quality of resource and social conditions. An illustration of draft campsite selection procedures adapted for the A.T. are included in Table 7 and discussed below.

Table 7. Campsite selection criteria. Adapted from Shenandoah NP procedures (Williams and Marion 1995).

Points	Campsite Selection Criteria
	1. Campsite Location
2	Campsite is located greater than ½ mile from a road or permanent building (other than shelters); 50 yards from the A.T. or a shelter; and 30 yards from another campsite. (Record actual distances for each element)
1	Campsite is located out-of-sight (summertime) from the A.T.
1	Campsite is located out-of-sight (summertime) from shelters or other campsites.
1	Campsite is located >30 yards from any water source
	2. Expansion Potential
2	Poor expansion potential: Off-site areas are completely unsuitable for any expansion due to topography, rockiness, dense vegetation, and/or poor drainage.
1	Moderate expansion potential: Off-site areas moderately unsuitable for any expansion due to the factors listed above.
-1	Good expansion potential: Off-site areas are suitable for campsite expansion, features listed above provide no effective resistance to campsite expansion.
	3. Campsite Slope
2	Most campsite areas have gentle slopes (3-4%), or they can be easily created.
	4. Vegetation Groundcover
2	Ground vegetation around the campsite is predominantly grasses or sedges, as opposed to broad-leafed herbs, ***or*** off-site vegetation cover is very sparse (less than 20%).

Campsite location -- These criteria ensure adequate separation from developed areas, the A.T., shelters, campsites and water resources. Points are awarded to favor campsites that are adequately separated or preferably out-of-sight from the A.T., shelters and campsites to enhance the solitude of both hikers and campers. A separate criterion is included to ensure the protection of water resources.

Campsite expansion -- These criteria emphasize selection of sites that have inherent constraints on expansion potential due to steep or uneven topography, rockiness, dense vegetation, or poor drainage. The objective is to identify sites that are unable to expand under heavy use within areas that will also deter campsite proliferation.

Campsite slope -- This criterion favors sites with gentle 3-4% slopes that facilitate drainage yet minimize erosion potential. Flat or cupped sites will develop drainage problems and more steeply sloped sites are prone to soil erosion. While cut-and-fill work can create campsites in more steeply sloped terrain, this criterion favors selection of sites that can be used without such work.

Vegetation groundcover -- This criterion favors sites with impact-resistant vegetation or areas with sparse vegetation cover. The most resistant campsites are those under nearly open tree canopies that support grassy groundcover. Alternately, vegetation loss can be minimized by selecting sites under dense forest canopies, which often have less than 20 percent vegetative groundcover. Campsites in these areas have less vegetation cover to lose, are not visually obvious, and have thick organic layers and heavy litter production to minimize trampling disturbance.

Additional factors, such as proximity to potable water, visitor attractions, hazardous areas (e.g., cliffs), cultural sites, or rare, threatened and endangered species, should also be evaluated and considered. Area attractiveness for camping is also an important consideration - campsites established in areas with little appeal may go unused. Selection criteria should be periodically reviewed and modified, particularly as management experience or monitoring data reveals how different campsites stand up to intensive or long-term use.

Field reconnaissance surveys must be conducted during summer months and can be applied to identify and rank existing or potential campsite locations. As a general rule, twice the number of desired new site locations should be identified and rated to ensure the search is thorough and that the most highly rated sites are selected. A form that includes rating data and descriptive information about locational attributes and resource conditions (e.g., distance to water or A.T.) will aid the ranking and decision making process.

An important decision is whether camping should be continued on existing campsites or shifted to new sites. Existing sites should be used when possible when they score highly for the selection criteria (Figure 4). However, existing campsites frequently have one or more significant limitation, such as close proximity to the trail, water, or other sites and the shelter. Sometimes the closure of some sites and construction or maintenance work on others can

Figure 4. Natural topography constrains expansion on this campsite.

adequately address deficiencies to make them usable (see following sections). This option may be favored as the areas are already impacted and their effective closure may be difficult to achieve. Shifting use to new sites can alleviate deficiencies in existing campsites. This may allow the selection and/or construction of smaller sites that will resist expansion and greater separation of campsites to improve social conditions.

Site Design. Resource and social conditions on campsites can also be substantially influenced by site design considerations and construction techniques. Site design relates to both capacity (number of campers) and site configuration (arrangement of sites in relation to shelters, other sites, and topography).

Site Capacity – Camping capacity is dependent on a variety of factors, including desired resource and social conditions, local demand for camping, topography, availability of water, and environmental resistance. The process of determining camping capacity should begin with a review and consideration of management objectives and desired future condition statements (which often vary by land management zone). What level of overnight visitation is most appropriate for the area? Given the desired social conditions, how should overnight visitation be structured and arranged in relation to the A.T., shelters, and other campsites? What are the maximum capacities for specific campsite/shelter locations? All other considerations ought to be secondary to these strategic factors.

Objective evaluations of other factors are also essential, beginning with documentation of existing use within the area. This will normally require field surveys to record overnight visitation by location, groups and group size on a representative sample of typical high use weekends. For example, ridge-runners or club staff might hike the trail to check all camping areas during the evening or early morning hours on four to six good-weather weekends during the most popular season(s). Data on peak use weekends would also be useful but should not be used for capacity decisions because visitation is often substantially higher. Land managers generally agree that facility capacities should not be designed to accommodate peak use periods. Evaluations of this data in relation to the desired future conditions prescriptions will reveal the acceptability of current use levels and the ability to accommodate future growth. It is important to note that capacity decisions are inherently subjective, they cannot be derived from scientific research or objective formulas.

Due to the decentralized management of the A.T. and its numerous entry points, use rationing will likely be rare and the primary goal will generally be to accommodate increasing demand over time. While this may be the case, managers can still manipulate where overnight visitation occurs and how much will occur at any single location. Critical decisions include the acceptability of co-locating camping with shelters and the maximum number of campers permissible within a single area. Capacity guidance can and probably should be established for management zones to ensure consistent management decisions along the A.T. For example, maximum campers per single location might be set at 40 for a Frontcountry zone, 30 for a Backcountry zone, and 20 for a Wilderness zone. Planning for site capacities above 20 to 30 need to carefully consider options for avoiding bottlenecks at communal facilities such as water sources, toilets, and food storage devices. Water sources with multiple accesses and multiple toilets and food storage devices can alleviate crowding at these locations when larger capacities are planned. Severe limitations for any of these factors should initiate considerations for shifting overnight use to other locations.

Next, other factors should be examined to determine if the preferred level of camping use can or should be sustained within the area. Topography and the availability of dependable water are important

considerations. Flat ground need not be a limiting factor, however, as techniques described in the following section require sloping terrain. Terrain that naturally limits site expansion is preferred, as are more open forests that support substantial grass cover.

Additional guidance on site capacity decision making, particularly related to shelters, is provided by Leonard et al. (1981).

Site Configuration – In areas where a containment strategy is used, campsites may be configured singly, in small clusters, or in large groupings depending on desired conditions, campsite demand and availability of space. On individual sites, the area of camping disturbance can be minimized by identifying one to three tent sites that are close to one-another (Figure 5) and promoting their consistent use through site construction and maintenance practices (described in a following section). The objective is to encourage all campers to consistently tent and cook on the same sites so that camping activities and disturbance are spatially concentrated (Leung and Marion 1999, Marion and Farrell 2002).

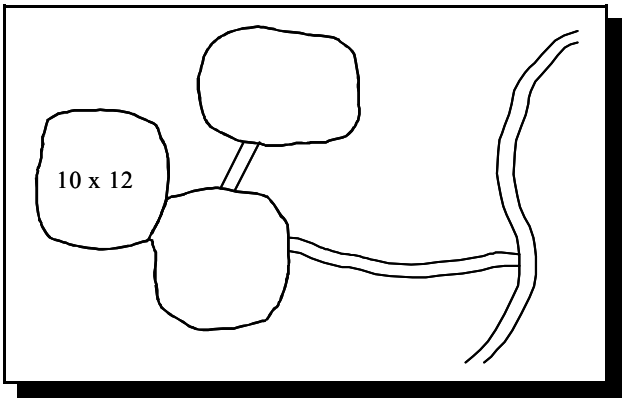

Figure 5. A campsite with three tent sites.

Access trails should also be designed, constructed and marked to promote use of preferred or designated campsites and to avoid the development of numerous and poorly located visitor-created trails. Individual campsite access trails, generally 50-150 feet long, should branch off this trail when multiple campsites are provided, so that campers do not walk through or around the edge of other visitor's campsites when traveling to their own site. These trails could be marked with small camping symbol signs or paint blazes and should exit the park trail in a perpendicular fashion to discourage the creation of "short-cut" trails. Ideally, this unique symbol or blaze should be standardized for the entire A.T.

Careful thought should also be given to the spatial arrangement of campsites relative to resource features such as streams or water sources, other campsites, shelters or tent platforms, and communal facilities like toilets and food storage boxes or devices. This is particularly critical when larger numbers of overnight visitors are grouped within a single area. Travel patterns within the area should be anticipated so that intended use areas can be linked by a limited number of carefully designed and constructed trails rather than numerous visitor-created trails. Figure 6 illustrates some preferred arrangements; many other arrangements are possible. Where possible, a linear arrangement of sites and facilities promotes traffic along a single trail, protecting surrounding areas from trampling (Leornard et al. 1981). Spacing sites a minimum of 100 feet apart protects visitor privacy; conversational voices generally become unclear beyond this distance.

Site Construction. Much of the expertise gained in constructing and maintaining trails can be extended to campsites. For example, like side-hill trails, campsites can be constructed in sloping terrain (10-15% slopes) using standard cut-and-fill practices to create small benches for tenting and cooking areas (Figure 7). Rock, or less preferably, rot-resistant logs, should be used for cribbing to shore up fill material. Tent sites should be crowned or sloped to promote water drainage and free of rocks, stumps, and roots.

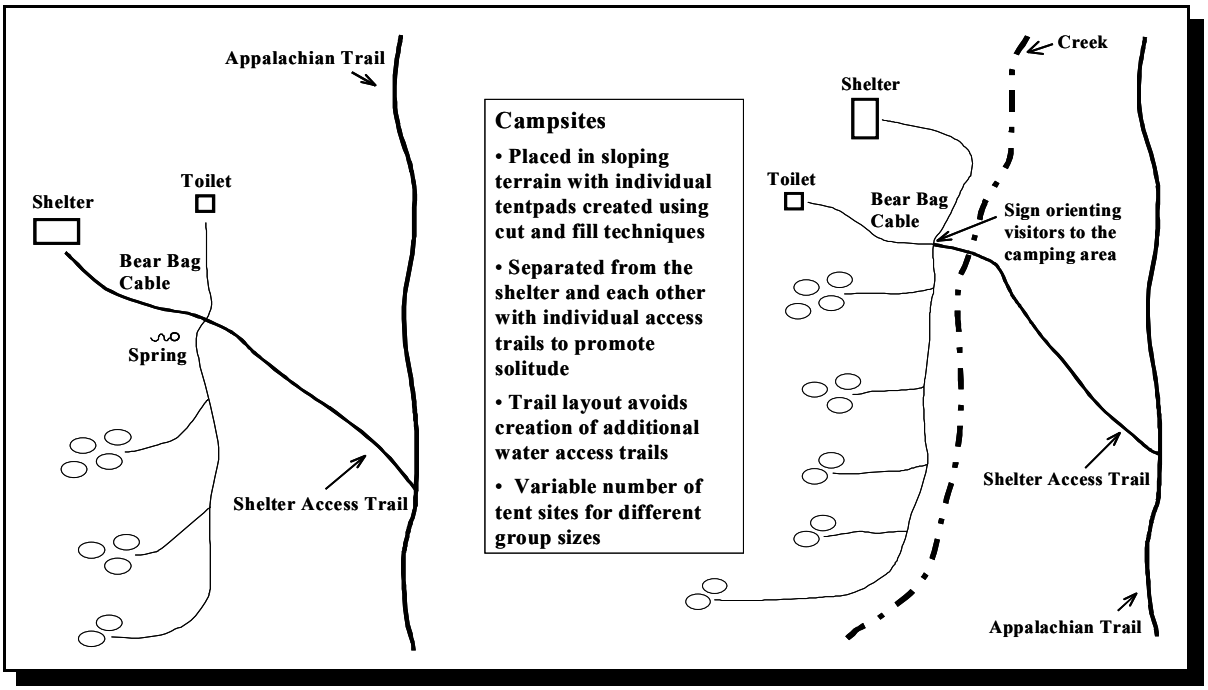

Figure 6. Examples of preferred campsite/shelter site configurations that minimize resource impact and promote visitor solitude.

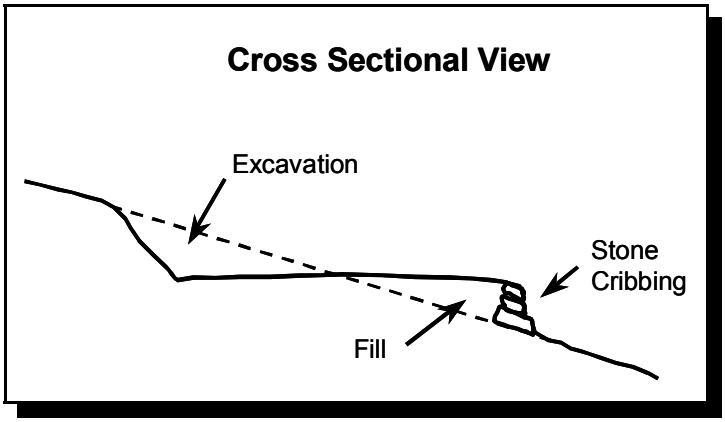

Figure 7. Cross sectional view of a side-hill constructed tent pad. Surface should be slightly crowned in all directions for water drainage.

Scout the sloping terrain to look for spots that meet all the site selection criteria (preceding section) and that will minimize the amount of excavation. During excavation work it is best to remove all organic litter and soils to piles located along the contour on either side of the pad. Then find rock and build the stone cribbing along the downhill sides to contain fill material. Excavate uphill and fill in behind the cribbing, any rocks in the soil can be placed deep and filled over with mineral soil (at least five inches of soil to cover all rocks). Lower the slope of uphill excavations by digging further uphill - a steep slope will be prone to erosion and may not revegetate. Avoid making tent pads in precise geometric shapes (squares, rectangles, circles) due to their artificial appearance, uneven sinuous boundaries are preferable. The even, well-drained tent pad surface should be sufficient to promote consistent selection and use. Compact, smooth and gently crown or slope the fill material and dig a shallow drainage dip around the uphill side of the tent pad to collect and drain water. Finally, place the organic soil and litter on the cut slope uphill from the tent pad. This will naturalize the excavation work and promote natural recovery. Annual maintenance of tent pads to keep the surfaces even and well-drained will further promote their use and limit expansion and off-site impact.

The number of tent sites should accommodate the typical range of group sizes for the area, generally one to three pads, up to five for group sites. A separate smaller pad can be created for cooking and a campfire ring in areas where they are permitted. Placement or a flat "stove/kitchen table rock" in the intended cooking area will help to attract kitchen activities to this location. Use of a large heavy rock will help discourage visitors from moving it around and disturbing different areas. Fire rings or grates can be anchored using a chain or aircraft cable down to a post-holed coffee can filled with cement. Fire rings no larger than two feet in diameter will encourage the building of smaller campfires using smaller-diameter wood.

At Isle Royale NP the construction of such "side-hill" campsites has yielded exceptionally small campsites in spite of their intensive visitation (Farrell and Marion 2002). Experience there has shown that visitors confine their activities to the flat intended use areas, resulting in sharp campsite boundaries and pristine vegetation in adjacent off-site areas. A principal advantage of side-hill campsites is that the topography, rather than educational messages or regulations, encourages campers to concentrate their activities on a limited number of "intended" use areas (Figure 8). Furthermore, placement of these sites away from trails, shelters, and other campsites protects the quality of visitor experiences.

Figure 8. A constructed side-hill campsite at Springer Mountain, Georgia.

The area of disturbance will always be greater when camping must be accommodated in flat terrain but a number of site construction practices can help to define camping disturbance. Begin by applying the site selection criteria and site configuration recommendations to identify the approximate site locations. Look for specific site locations that have relatively few good tent sites, perhaps due soils with protruding roots (note that rocks can be removed or soil added to improve tent sites). The least intrusive technique is to construct campsite access trails to each intended campsite, identified by a camping sign or post. It may be necessary to line the access trails and campsites with rocks or logs, at least for the first year. Firmly anchored fire rings or grates have also been effective for marking campsites and concentrating visitor activities in flat terrain.

Another effective but more artificial technique for use in flat terrain is to construct slightly raised rock- and root-free tent pads. These can be made more visually obvious to attract use by lining their edges on two or three sides with embedded rocks or rot-resistant logs. Experience has shown that logs must be drilled so that rebar rods can be hammered through to anchor them (Figure 9). Nearby locations that could or have been used for tent sites should also be ruined (see site ruination practices in the Site Maintenance section). An effective regulatory approach is to erect 4x4 campsite posts engraved with the words "Camp within 5 yards" on each side. Most visitors will adhere to such regulations so that creation/ruination of tenting sites should be unnecessary.

Figure 9. Tent pad logs should be embedded and anchored with rebar or visitors may pull them out for firewood.

Care should be taken to accomplish all site development and maintenance work in close cooperation with land management agency staff. Soil and vegetation disturbance often require environmental assessments and archaeological surveys and approvals, activities that can be expensive and time-consuming. In addition, construction work should strive to use native, rustic materials and be carefully blended to match natural conditions (Marion and Sober 1987). Avoidance of straight lines or perfect geometric shapes in marking campsite and tent site boundaries is one of the easiest ways to accomplish this. Using rock or short rot-resistant timbers rather than pressure-treated dimensional lumber is another. There is a fine line between making the intended use areas sufficiently obvious so visitors will consistently use them and artificial or visually obtrusive so that natural values are degraded. However, more artificial work may be justified in high use areas or on particularly troublesome sites.

Site Facilities. The installation of most facilities serving backcountry and wilderness campsites are justified on the basis of protecting natural resources or visitor safety, though most facilities also provide some kind of visitor convenience. For example, bridges along trails are built to safely transport trail users across deep or dangerous currents and to protect sensitive riparian areas from vegetation damage and soil erosion on steep slopes. Placement of small, firmly anchored steel fire rings can be used to identify preferred or legal campsites, spatially concentrate visitor activities to reduce site size and limit resource impacts by focusing fire-related activities at only one spot (Marion 1995). Pit toilets address problems with improperly disposed human waste, particularly on high-use campsites where the volume of waste poses a threat to human health.

The primary disadvantage of site facilities is the issue of their appropriateness in backcountry and wilderness settings. Facilities are artificial developments that can detract from the natural environment. U.S. federal land management planning guidelines link the type and number of visitor facilities to land zoning classifications. Facilities such as shelters, picnic tables, and toilets are appropriate and common in accessible frontcountry settings but are viewed as less appropriate or inconsistent with backcountry settings. NPS Management Policies (NPS, 2001, Section 8.2.2.4) state that backcountry facilities "will be limited to the minimum necessary to achieve a park's backcountry management objectives and to provide for the health and safety of park visitors."

The appropriateness of installing various facilities should be carefully considered, particularly in wilderness. The U.S. Wilderness Act defines wilderness as "undeveloped federal land retaining its primeval character and influence, without permanent improvements." Exemptions include essential administrative facilities and resource or visitor protection facilities. NPS wilderness management guidance (NPS 1999) directs managers to evaluate whether a facility: "is required to preserve wilderness character or values, not considerations of administrative convenience, economy of effect, or convenience to the public or park staff." Pre-existing shelters are generally permitted but picnic tables are specifically

disallowed. Federal wilderness management agencies have developed Minimum Requirement/Minimum Tool guidance (Arthur Carhart National Wilderness Training Center 2000) to assist managers in evaluating whether an action is the "minimum necessary requirement for the administration of the area..."

Guidance varies by agency and park or forest so local consultations with land managers regarding facility decisions in wilderness should be initiated early in the process. However, there are numerous precedents for facilities such as fire grates and pit toilets on wilderness campsites, justified as the minimum tool necessary to accomplish important resource protection objectives.

Even in backcountry settings the provision of facilities like picnic tables is a subject of some debate. Tables have traditionally been considered a visitor amenity or convenience facility. However, a study at Isle Royale NP found that backcountry and wilderness sites with picnic tables were significantly smaller and had less exposed soil than those lacking tables (Marion and Farrell 2002) (Figure 10). This was attributed to the activity concentration effect of tables, which attracts visitors to them and focuses trampling disturbance to their immediate vicinity.

Figure 10. Picnic table on a campsite at Isle Royale NP.

The following sections on facilities and issues is offered to help decision makers evaluate the utility and acceptability of various facilities.

Campfire Rings/Grates - Campfires can be an essential element of a high quality camping experience for many visitors. Unfortunately, problems related to campfire use, including the development of multiple fire sites and large trash-and food-filled fire pits, mounds of charcoal and halfburned logs, tree damage and felled trees, off-site vegetation trampling and wood removal, and the threat of forest fires, have caused an increasing number of managers to prohibit campfires. Campfire rings or grates can help and could be tried along with educational efforts before campfire bans are considered. Many managers have had success in keeping campfires small and contained to a single location by firmly anchoring small steel fire rings or grates on campsites. Such facilities can also be used to identify preferred or designated campsites and have been shown to attract and concentrate visitor use to their vicinity, thereby minimizing site size and expansion. The trend is towards smaller fire rings, a six-inch tall 18 inch diameter ring is sized to encourage small, low-impact campfires that most effectively burn fuel that can be broken by hand (Great Smoky Mountain NP managers have a source for these). Anchoring the fire ring restricts campfires to a single permanent site. One easy anchoring method is to bolt a heavy chain to the fire ring (damage bolt threads to prevent removal), dig a hole as deep as possible and pour a gallon of cement in the bottom with the chain embedded. Large "ice-berged" rocks can be used to anchor rock fire rings.

Food Storage Devices - A fed bear is a dead bear. Unfortunately fed shelter mice do the opposite, they reproduce exponentially... The attraction of bears to campsites when they are successful in obtaining

food all too frequently ends with threats to human safety and the removal or shooting of the bear. Visitors to the backcountry are just that - we visit nature to see wild animals in their habitat. They should not have to pay any price for our recreational pursuits. Proper food storage, including smaller "micro-garbage," is key to preventing wildlife behavioral changes for a variety of wildlife species, including bears, skunks, squirrels, rats, mice, and birds. Tree damage and trampled vegetation associated with repeated bear bag hanging can be avoided through the provision of food storage hoisting cables, poles, or food lockers.

Cable systems can be installed with thick aircraft cable stretched between two trees spaced 30 feet apart at a height of 20 feet. Visitors can throw their own ropes over this to pull food bags up, taking care to hoist it at least 10 feet high and more than six feet from any tree. Alternately, pulleys and smaller cable or rope can also be installed for hoisting food, particularly in areas where visitors may not be carrying their own rope. Ground vegetation and organic litter under such cables will be quickly trampled and lost so it is important to locate such facilities in relatively flat terrain to prevent soil erosion. Contact Great Smoky Mountain NP for information on cable system construction.

Bear poles that resemble 15 foot tall coat racks with multiple arms and hooks for hanging food bags can also be effective. These should be sufficiently strong and anchored in cement for stability. A 10foot lifting pole with a hook on the end is provided for placing and retrieving food bags. The lifting pole should be secured to the bear pole with a six-foot length of chain or cable to prevent its loss. The capacity of this system is less than that of cable systems so more than one may need to be provided for larger capacity camping areas.

Food storage lockers are steel boxes with a hinged door and latch that bears cannot manipulate. Doors should also fit tightly to prevent access by mice. A common disadvantage of food lockers is that visitors leave trash and spilled food in them.

Toilets - Cat-holing is generally considered an effective human waste disposal practice only in areas where visitors are knowledgeable and overnight use is relatively low. Carry-out options are also increasingly possible due to the development of lightweight toilet kits that have been approved by the EPA for landfill disposal. Areas of concentrated overnight use generally require toilet facilities. The determination of when to place a toilet could be made based on monitoring the extent of improperly disposed human waste sites in the vicinity of shelters and camping areas. Low use shelters, particularly in wilderness, may not require toilets. A variety of pit toilet designs have been developed, ranging from simple fiberglass cone-shaped models that lack privacy walls to the more elaborate "Sweet Smelling Toilet" (SST) developed by the USFS. Simpler, more rustic models are cheaper and more appropriate in backcountry settings, though larger venting pipes and fly-proofing can be important features to ensure their consistent use by visitors. A variety of composting toilets have also been developed. Facilities such as stainless steel bin composting containers should be hidden from view by visitors and/or painted to make them less obtrusive. The new ATC "Backcountry Sanitation Manual" (ATC, Green Mountain Club 2002) is an authoritative source of information and guidance on toilets and their management.

Picnic Tables - Some managers question the necessity of picnic facilities at shelters, both as a visitor convenience facility that is considered inappropriate in backcountry and because they might attract greater day use to shelters. However, picnic tables are considered by many to be a traditional facility at shelters and they do concentrate resource disturbance associated with cooking and eating activities. If provided, they should only be placed at shelters, not on campsites. Their use in wilderness is disallowed by NPS management policies.

Shelters - The provision of shelters is a long and strong tradition for the A.T. Studies have shown that these structures concentrate visitor activities to the extent that areal measures of disturbance are substantially lower than for a similar number of visitors camping in tents. However, some managers question their necessity or appropriateness in backcountry and particularly in wilderness environments. They are artificial permanent structures; many use dimensional lumber and non-traditional roofing materials, a few are large and elaborate, and some even have modernistic circular concrete footers. A number of issues regarding use of shelters require considerable further debate and will not be addressed here: When shelters are replaced should larger capacity designs be used? Are multiple shelters at a site appropriate (instead of a single large shelter)? Should additional shelters be placed between existing shelters to increase camping capacity?

Tent Platforms - These are wood decks constructed from pressure-treated dimensional lumber. Such facilities have been built in flat terrain but are most useful in rugged rocky areas where smooth ground suitable for tenting cannot be found, or in areas of sensitive vegetation. Platforms do appear to be effective in concentrating camping activities and are cheaper to construct and maintain than shelters. Disadvantages include their high cost of materials and construction, maintenance requirements (painting, protruding nails, splintered wood), and artificial appearance. Erecting tents or tarps that require stakes is also problematic. In general, platforms should not be used in backcountry and wilderness environments where tent pads on soil can be located or constructed with cut and fill techniques or in flat terrain.

Spring Improvements - Trampling along the banks of springs and streams causes significant damage to vegetation and organic litter and can lead to muddiness, soil erosion, and contamination of drinking water sources. These impacts can be effectively minimized by installing some rock-work around the spring source and/or providing a pipe to speed the filling of water containers. While such a facility does protect the water source it is also artificial and could lead visitors to wrongly assume that the water is safe to use without purifying first. A general precaution when pipes are used is to ensure that educational information stress is provided clearly stating that water must be purified before use.

Site Maintenance. As discussed in the Density of Use section and Site Selection sections, some existing campsites that are poorly located for resource or social considerations should be closed and rehabilitated. The remaining campsites, including well-established visitor-created campsites, can benefit from routine maintenance, just as trails. This section describes maintenance practices that can be applied to keep campsites open and in good condition.

Much of the expertise gained in maintaining trails can be extended to maintaining campsites, although the appropriateness of such work in wilderness has been questioned (Cole 1990). Managers can perform maintenance work on campsites to reduce their size, protect visitor safety, minimize erosion, and address campfire-related impacts (Hammitt and Cole 1998; Marion and Sober 1987). Formal or informal site impact evaluations can reveal what problems require maintenance actions. For example, excessive site size may be addressed by subtly improving tenting locations in core use areas. If you maintain perfect tenting sites visitors will naturally choose and use them consistently (Figure 11). Where necessary, remove protruding rocks or redistribute soil to slightly crown tent pads and improve drainage or smooth over exposed roots (see Site Construction section for procedures).

Site ruination work on unnecessary, peripheral use areas can also be highly effective in concentrating activity and reducing site sizes. Ruin adjacent unnecessary tenting areas by ice-berging large rocks - this works best when rocks are buried at least three-quarters so that visitors cannot kick or pull them free

(Figure 12). Digging shallow soil scrapes and mounding the soil to create uneven terrain is an alternate practice. However, until the soil settles and compacts, visitors may kick it back into the depressions so this is a less effective technique. Brushing out alternative tent sites and use areas with felled trees, large logs, tree branches and organic litter should also be done to help close these areas but this action alone is rarely effective unless large materials are used.

Figure 11. The perfect tent site.

Hazardous trees can be a significant safety hazard, campers have been killed by falling limbs and trees. Hazardous trees should be identified and removed, often providing a good source of logs to line an expanding campsite's boundary. Check with land management agencies for current guidance on identifying hazardous trees (not just standing dead trees). Their removal is a legal liability issue for all shelters, tent platforms, and designated campsites.

Figure 12. Club members ice-berging rocks to close this tent-site and shift use to adjacent constructed tent-pads near Maupin Field shelter, Virginia.

Examine how water drains across a campsite and look for evidence of erosion. Reshape the soil to disperse or shunt water to areas where erosion will not occur. In particular, make sure that water is filtered through ground vegetation and organic litter before entering streams or other water resources. This requires a dispersed flow of water through at least 10 feet of undisturbed vegetation and litter. Well-placed rocks or a large log along the low side of a campsite and a redesigned water access trail that doesn't drain water can help protect riparian vegetation and allow it to filter campsite runoff.

The management of campfires can be a particularly vexing problem. Visitor surveys have shown that campfires can be an important element of a high quality camping experience, yet resource studies show that campfire wood collection and burning create significant damage to soils and vegetation (Cole and Dalle-Molle 1982). Due to the long-term nature of resource impacts where campfires are built, managers should select the best spot on a campsite and encourage use of only that spot. Some managers have followed a practice of removing all fire sites, even within areas where campfires are permitted. This practice encourages fire scars in multiple sites and should be avoided, except in remote areas where dispersed camping is encouraged. To the extent possible, managers should try to retain the same "fixed" fire site on each campsite and only dismantle new fire sites. Choose a good site that is not close to trees,

tree roots, or boulders and is away from the best tent sites (sparks will melt through tent fabrics). Making this spot the "permanent" fire site without using permanently anchored fire rings, grates, or ice-berged rocks will require reliance on field notes or site photographs. A strong educational message to visitors that encourages use of existing fire sites and discourages construction of new fire sites is critical.

Another important reason for keeping a fire site location fixed over time is that it attracts visitors to a common spot for camping activities and spatially concentrates use. Multiple fire sites create multiple locations of camping activities; different groups use different parts of a site, which grows larger over time. Breaking up all but the intended single fire site will effectively concentrate activity in the same place over time, reducing the area of camping disturbance.

A second fire site management issue is the use of rock rings, some managers have advocated the use of simple fire sites without rocks. Here are some advantages and disadvantages of using rock rings. Rocks shelter the fire from winds that may blow coals or sparks out of the fire, possibly when campers aren't looking. Rocks help to contain the fire, physically separating it from nearby flammable organic litter. Older agency literature recommended clearing to mineral soil a 10 foot circle around a campfire. This size of a cleared area is no longer advocated because of the soil disturbance involved so the risk of catching nearby leaves on fire is an important concern. Rocks also provide containment to charcoal and ash that might spread over the campsite from rain, wind, and foot traffic. Finally, rocks provide greater "permanency" to the fire site's location, the site is more "official" looking and less likely to be moved.

Some disadvantages are that visitors will "mine" surrounding areas for rocks, which provide habitat for aquatic organisms in water and for salamanders, reptiles, and insects on land. Visitors sometimes get carried away and build unnecessarily large rock rings. Rocks become permanently blackened by soot - an aesthetic eyesore for visitors. Wet rocks can explode from heat, a safety issue. Rocks make it difficult for managers or visitors to clean out the charcoal and ash. Rocks could provide campers with a false sense of security and be more likely to leave a fire burning unattended.

The maintenance of simple rock fire rings in commonly used camping areas is a preferred option. Rocks help to "designate" the intended fire site more effectively and permanently than just a fire scar, particularly after it has been cleaned of coals by visitors or managers. Permanency of the fire site is key to attracting camping activities to a common area - thus minimizing area of disturbance. Rocks also help to contain campfires from wind and organic debris. The chief difficulty lies in determining which areas should have fire rings and which shouldn't (those managed for dispersed use). The educational message for visitors is simple, however, avoid having a campfire or use only pre-existing fire sites. Never construct a new fire site (other than temporary mound fires) or add rocks to an existing one.

Managers can also modify environmental resistance to reduce camping impacts. The construction and use of campsites frequently opens forest canopies, allowing greater sunlight penetration that enhances the survival and spread of trampling-resistant (but shade intolerant) grasses, sedges and herbs (Figure 13). In some heavily used frontcountry areas it may be appropriate to thin forest canopies to promote the growth of native grasses, or to fertilize grasses to encourage expanded growth, particularly on eroding slopes. Seeding grasses, using locally obtained pure sources of native species in another option. Agricultural extension specialists can be contacted to locate companies in the region that provide weed-free sources of native grasses. Soil amendments, including a variety of organic materials, can be added to retain soil moisture and improve soil fertility. Although most commonly applied to restore closed campsites, these techniques can also be used on open campsites to close unnecessary areas and

reduce their size (Marion and Sober 1987). Gravel could also be placed in front of shelters or camping could be restricted to tent platforms. While use of these techniques may be common and acceptable in frontcountry settings, some are less appropriate in backcountry and inappropriate in wilderness.

Figure 13. The forest canopy opening at this shelter in Great Smoky Mountains NP allows sufficient sunlight to support trampling resistant grasses that minimize soil exposure.

Formal and well-placed visitor-created trails that access campsites, shelters, and water sources also require routine maintenance. The objective is to promote consistent traffic patterns within camping areas on well-designed and maintained footpaths and to close and rehabilitate unnecessary and poorly located routes (Figure 14). Many excellent trail maintenance manuals have been developed to guide this work (Birchard and Proudman 2000; Demrow and Salisbury 1998; Hesselbarth and Vachowski 1996; Hooper 1983). Active trail maintenance reduces impacts by providing a durable tread able to accommodate the intended traffic while minimizing problems with tread muddiness, erosion, widening and multiple tread development.

Figure 14. A visitor-created trail closed by logs and ice-berged rocks.

In areas where dispersed camping is practiced, routine maintenance consists of locating and removing all fire sites and renaturalizing site conditions to avoid repeated use of the same sites. Refer to the Campsite Closure and Rehabilitation section for specific management practices. In these areas visitors should avoid building campfires or use LNT campfire practices, such as mound fires.

Site Closure and Rehabilitation. Camping closures represent a final resource protection strategy, generally most appropriate for protecting sensitive environments, rare flora and fauna or fragile historic sites (Cole 1990; Hammitt and Cole 1998). Camping closures around popular features such as waterfalls, cliffs, ponds and lakes may be appropriate to separate overnight campers from intensive day use. Closures of popular highly impacted campsites are often ineffective and inappropriate unless clearly marked alternatives are provided. Little recovery will occur unless all use is removed, and new campsites with greater aggregate impact are frequently created in nearby areas (Cole and Ranz 1983). Generally, closures of high-impact sites or areas are warranted only when use is shifted from impact-susceptible locations to impact-resistant locations, although social considerations (crowding, conflict or visitor safety) may also provide justification (Cole and Ranz 1983).

A common scenario is to shift camping from locations next to streams, trails, shelters or large flat areas to more carefully located sites selected to protect natural resources and visitor experiences. For example, a dense cluster of campsites next to a stream in front of a shelter might be shifted to newly constructed sites in sloping terrain arrayed along a campsite access trail. Successful closure of the old sites can be enhanced by making the new sites more attractive than the old (e.g., improved tent sites), clearly signing the access trail, conducting renaturalization and site ruination work on the old sites, and temporarily signing them as closed to use.

Site closure work can also follow an incremental or phased process. Phase 1 might include renaturalization by dragging woody debris and spreading organic litter across the site. A few larger rocks and partially rotted logs placed across tenting sites or felling large dead trees across the site are also helpful. The objective is to hide the site and make it appear natural. Several attempts at Phase iwork are often necessary, be sure to check and redo such work immediately after busy or peak use weekends so that reused sites are quickly restored.

Phase 2 work involves placing a "No Camping" post or sign on sites that receive consistent repeat use. These signs should be relatively vandal-proof, such as a firmly anchored post with the words "No Camping" routed into the sides. Other alternatives include signs with messages like "Campsite Closed - Please allow this site to recover." Western land managers have had success in closing campsites by tying nylon string around them, wrapped around trees or temporary posts.

Phase 3 work consists of more active site ruination work and/or enforceable regulations. These generally require land management agency actions and approval so be sure to plan ahead and allow time for rule-making processes. Site ruination techniques are described in the Site Maintenance section. Vegetation transplanted from adjacent areas or native vegetation appropriate for the area may also be planted in a random fashion around the site, see Hanbey (1992) and Little and Mohr (1979) for guidance. Watering during dry spells is necessary to improve survival. Shrubs and tree seedlings or saplings will help to fill in the area, particularly after a few years growth. Phase 1 and 2 work should also be done to enhance the effectiveness of these more intensive actions. In addition, or as an alternative, enforceable regulations that prohibit camping at the closed sites and/or require camping at the alternative sites may also be enacted.

Effective site closures are often difficult to achieve so managers must be committed to many repeat visits and follow-up site work. The bulk of this work will occur during the first three years when the closed areas still resemble campsites and traditional use patterns must be altered. Occasional use may continue years after an effective closure so vigilance is necessary.

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