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A GIS-based spatial decision support system for tourists of Great Smoky Mountains National Park

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Abstract

Great Smoky Mountains National Park (GSMNP) is filled with an abundance of ecological diversity, historical significance, and recreational opportunities for visitors to explore and experience. The wide range of potential activities available in the park also present a major challenge for park visitors to plan activities that will better meet their preferences and constraints. With the large amounts of spatial and non-spatial data associated with the diverse resources and activities in the park, it is a logical choice to use geographic information systems (GIS) for storing, managing, analyzing, and visualizing the data. Nevertheless, GIS functions alone are insufficient to facilitate activity planning for park visitors. This paper presents a GIS-based spatial decision support system (SDSS) application that integrates GIS functions and SDSS designs with easy-to-use graphic user interfaces to help visitors of GSMNP choose and plan their activities more effectively to match their personal preferences and constraints.

Keywords: Geographic information systems; Spatial decision support system; National park; Tourism

1. Introduction

Great Smoky Mountains National Park (GSMNP) is a national treasure filled with an abundance of ecological diversity, historical significance, and recreational opportunities waiting to be discovered by those who come to explore within its boundaries. GSMNP, which has something for everyone to experience and enjoy in the park, attracts more than twice as many visitors as any other US national park. However, many visitors are new to the park and do not know where to begin exploring the vast number of options they are presented within the GSMNP. Even for visitors who know what they would like to do during their visits, they often do not know where the best places to fulfill their desires are. Repeat visitors to the park may also want to explore new areas of the park that they have not yet encountered, but know little about the park beyond the most popular destinations. Most park visitors stay along the main roads, trails, and popular attractions of the park and do not venture to the equally attractive but lesser known areas. The 308 sq km GSMNP has something to offer everyone who comes to the park and having a memorable trip to the park is a matter of matching the wishes of the visitors to the resources within the park.

The spatial aspect in a problem of this nature lends itself well to applications of geographic information systems (GIS) and spatial decision support systems (SDSS). This paper presents a GIS-based SDSS application that assists the park visitors in discovering various hidden treasures in GSMNP and matches their personal interests to the abundant resources available in the park. Such a GIS-based SDSS will not only offer park visitors with a useful tool to facilitate their activity planning but also increase their satisfaction from the matched personal interests and park resources.

The remaining sections of this paper are organized as follows. Section 2 presents the background information of GSMNP, GIS, and SDSS. Section 3 describes a GIS-based spatial decision system designed to assist the visitors of GSMNP in discovering and planning potential activities in the park. An example is included to illustrate how the

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GIS-based SDSS application can be used to recommend the trails that best match the interests of a park visitor. The paper is concluded with suggestions of future development of the current system and the potential of using GIS and SDSS in other applications related to retailing and consumer services.

2. Background

GSMNP was established in 1934 and is the second largest national park in the eastern United States (Fig. 1). It is known throughout the world for its extraordinary biodiversity with over 100,000 plants and animals estimated to live in the park. Over 70% of the park is forested, providing the largest extent of forested landscape in the eastern USA. Elevation in the park ranges from about 204 m in the park's southwest corner to Clingman's Dome, which at 1830 m is the third highest peak in the eastern United States and the highest point in Tennessee. The peaks, ridgelines, and valleys offer breathtaking vistas around every corner. Geologic formations such as the Anakeesta outcrops of "Charlies Bunion", "The Chimneys", and "Needle's Eye" offer a unique character to the park that leaves a lasting impression on those who visit these sites.

The altitudinal range of GSMNP resembles the latitudinal extent one would experience traveling from Georgia north to Maine. For example, in the lowlands, trees typical of the south, such as sweet gum (*Liquidambar styraciflua*), are in abundance while higher elevations contain species like mountain ash (*Sorbus americana*), which are normally found in northern habitats. Hiking and driving in low elevations is a completely different experience in regard to vegetation, fauna, and climate than exploring the high elevations of GSMNP. Wildflowers cause the mountainside to come alive starting in early spring. Many visitors plan their trips around the colors of the park, whether it is the plentiful colors of the spring and summer wildflowers or the exquisite fall leaves that explode with color in September, October, and November. Waterfalls are another favorite attraction of the park and can be found in most every region and elevation of the park. Abrams Falls and Laurel Falls attract the most attention, as they are the easiest to access, while more dramatic falls such as Spruce Flats Falls and Forney Creek Cascades often go unnoticed by casual visitors.

There are over 528 km of maintained trails and 3300 km of streams and rivers that cover the majority of the park's geographic extent. The fauna of the park ranges from small insects to large mammals such as white tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and black bear (*Ursus americanus*). The park boasts the most diverse population of salamanders in the entire world with over 30 different species found in the park. With the rich abundance found in GSMNP, encounters with some sort of wildlife are almost guaranteed. Fishing is another major attraction of the park. While brook trout (*Salvelinus fontinalis*) are the only native species to the park, rainbow (*Salmo gairdneri*) and brown (*Salmo trutta*) trout are caught in large numbers in the cold mountain streams.

In addition to the tremendous biodiversity and topographic diversity, the park offers a rich history of early frontier life in Appalachia. Areas such as Cataloochee in the northeast corner of the park and the popular Cades Cove in the southwest offer a unique insight into early life in the park through a number of restored structures such as

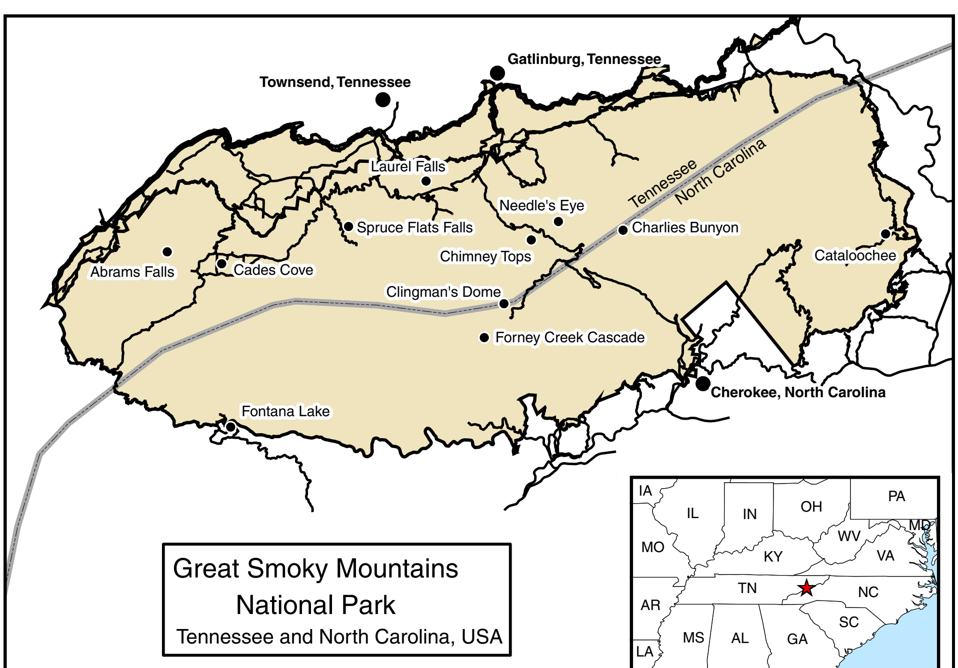

Fig. 1. Map of Great Smoky Mountains National Park.

cabins, churches, barns, mills, and schools. Smaller settlements with mills, barns and houses can be found in several lowland areas of the park. Cemeteries marking the men and women who once called the Smoky Mountains home can be found throughout the park. Many visitors are fascinated with life on the frontier and spend their time exploring the human history that abounds in GSMNP.

GSMNP provides an idyllic setting to enjoy solitude for the individual, a place for families, and a retreat for groups of friends. Both backcountry campsites and developed campsites for recreational vehicles and campers are available for the visitors. Some visitors enjoy the relaxation of a bike ride through Cades Cove while others are looking for a challenging hike to one of the many heath balds and mountain peaks in the park. Fly-fisherman and kayakers enjoy the rushing waters of the mountain streams while boaters and skiers enjoy the recreational opportunities of Fontana Lake. Many national parks cater to the interests of certain types of visitors while GSMNP has something to offer almost anybody that comes to explore within its borders. Given its beauty and location, it is not surprising that GSMNP attracts over nine million visitors annually. However, the wide range of potential activities available in GSMNP also presents a major challenge to the park visitors in planning activities that will best meet their personal preferences.

2.1. GIS and tourism

Roger Tomlinson first coined the term of GIS in 1963 when he was in charge of the national natural resource inventory for Canada (Tomlinson, 1998). GIS, however, did not begin to surface as a cognate field and commercial GIS software was not available until the late 1970s and 1980s (Longley and Batty, 2003). What distinguish GIS from other information systems are their abilities of representing, storing, managing, analyzing, and visualizing spatial and non-spatial data in an integrated environment. GIS, as spatial information systems, have found many possible applications in various fields, including business (e.g., Longley and Clarke, 1995; Grimshaw, 2000; Boyles, 2002), retail location planning (e.g., Birkin et al., 1996; Benoit and Clarke, 1997; Cowen et al., 2000), territory planning (e.g., Birkin et al., 2002), retail (e.g., McMullin, 2000; Beitz, 2001), real estate and insurance (e.g., Castens, 2003), among others.

GIS are equally useful in tourism, which consists of a wide variety of aspects including facilities, activities, services, and industries to deliver a travel experience. Spatial data plays an important role in evaluating and planning these different aspects. GIS can be used to determine the best sites for a new tourist destination while trying to maintain a sustainable natural area in the presence of tourism (Butler, 1993). GIS also can be a valuable tool for investigating specific questions that pertain to tourism development including location, condition of the area, trends and changes, routing to and through the site, and patterns associated with resource use. For example, Boyd et al. (1994) used GIS to help identify the areas for ecotourism in northern Ontario. Elliott-White and Finn (1997) reviewed the role of GIS for tourism marketing in the United Kingdom. There also have been studies of GIS applications in tourism planning (e.g., Savitsky et al., 1999; Mejia et al., 2000) and on delivering tourism information via the Internet (e.g., Du and Gabay, 2002). The US National Park Service, for example, maintains an Internet GIS web site known as Interactive Map Center (http://www.nps.gov/gis/index.html) that allows users to find information about national park locations and navigation to and within the national parks. Environmental Systems Research Institute (ESRI, Redlands, CA) also hosts an Internet GIS tourism site for San Diego, California (http://maps.esri.com). The growing interest in tourism and recreation studies will be able to benefit from the GIS technology by developing more useful and efficient applications.

2.2. GIS-based SDSS

A SDSS is defined as an interactive, computer-based system designed to support a user or a group of users in achieving a more effective decision by solving a semi-structured spatial problem (Malczewski, 1997). Spatial decision problems often involve a large number of decision alternatives, each evaluated on the basis of multiple criteria. Some of the criteria are qualitative while others are quantitative and all are subject to the preferences of the decision maker. Simon's (1960) seminal book suggests that most decision problems fall on a continuum from completely structured (i.e., the decision maker is able to fully identify all elements of a decision situation) to unstructured decisions (i.e., the decision maker is unable to structure the decision problem or the problem cannot be structured on the basis of a relevant theory). In real-world spatial decision making situations, it would be hard to find examples of either a fully structured or unstructured problem (Malczewski, 1999, Chapter 9). Most real-world spatial decision problems involve some elements that are hard to be fully structured; therefore, they are known as semi-structured problems.

Due to the large amount and variety of spatial data involved, GIS provide useful functions in helping solve these spatial decision problems. However, GIS alone are insufficient to solve the semi-structured spatial problems. When different people are faced with the same spatial decision problem, they are likely to place different values on variables and relationships and select and use information in different ways (Densham, 1991). Standard GIS software is not designed to handle these situations. On the other hand, SDSS can facilitate such decision situations through an implementation that allows users to specify their decision criteria and preferences interactively. An SDSS also includes an easy-to-use interface for users to explore possible options, as well as analytical functions, to generate feasible solutions based on user-specified criteria and preferences. Users can change their criteria and preferences and repeat the analysis process as many times as they wish. In other words, an SDSS includes the integration of a geographic database management system with analytical modeling capabilities, a visualization component, and a user-friendly decision making interface for users to reach a more effective decision to a semi-structured spatial decision problem.

Although many GIS-based SDSS have been developed for various spatial decision problems in the environmental domain (see Clarke et al., 2002), there are only a few SDSS developed for applications related to retailing, consumer services, and tourism. Cowen et al. (2000) presented two SDSS applications focusing on real estate site evaluations. The first application developed Avenue scripts of ArcView GIS to assess comparative values of a chosen real estate site against other sites based on user-selected criteria. The second application used ArcView grid-based Spatial Analyst extension and spatial interaction models to generate a probability surface reflecting the market potential of a specific site under the existing competition. One example of GIS-based SDSS for tourism is the *Tour*Plan, which was designed to assist in the decisions of site selection and impact evaluation for tourism planning in small island states (Feick and Hall, 1999). Two key modules were developed for the *Tour*Plan SDSS to guide users through the decision-making process and to manage their access to the spatial modeling and analysis procedures. The first module, called the "Site Selection Assistant", allows users to specify scenarios of alternate tourism land use patterns to be developed. The second module, known as the "Multiple Criteria Analysis (MCA) Assistant", determines the criteria weightings from the user input and computes the rank of each alternative scenario. Evaluation results are then displayed in both map and tabular forms for users to make their final decision.

3. TrailFinder: a GIS-based SDSS

Based on the above review, a GIS-based SDSS becomes the logical choice to develop an application that can help the visitors of GSMNP plan their recreational activities. First of all, there exists a wide range of potential activities with different characteristics that are distributed across the park for visitors to choose from. In addition, each visitor is likely to have specific preferences in terms of what he/she would like to experience in GSMNP. Matching an individual's interests and preferences with the opportunities available in GSMNP therefore is a semi-structured spatial decision problem that will benefit from a GIS-based SDSS application.

Most first time visitors to GSMNP have a limited knowledge of the park, while many repeat visitors come looking for new areas of the park to explore. It is a challenging task for the visitors to plan their activities effectively and efficiently, such that they can explore the beauty and unique attributes of the park to best fulfill their interests during their visit. Most visitors simply stay to the main roads and popular, accessible trails because they are not aware of other options that may better fit their interests. This section presents a GIS-based SDSS application, named TrailFinder, which assists park visitors in selecting among the many trails available in GSMNP according to their specific preferences and constraints. The system was designed and developed by a graduate level GIS project management class in the Department of Geography at The University of Tennessee, Knoxville (Lafrenz et al., 2003). Based on the preferences and constraints selected by the user, the GIS-based SDSS then retrieves all relevant data from various GIS layers and performs the necessary analyses to identify the trails that meet the user-specified criteria and constraints. Information on the recommended trails is presented in both map and text formats for users to make their decision.

3.1. Creation of GIS databases

A first step in developing the TrailFinder SDSS was to collect various data sets of physical features (e.g., roads, streams, trails), park amenities (e.g., waterfalls, lookouts, historical sites, balds), and park facilities (e.g., visitor centers, campgrounds, ranger stations, shelters) in GSMNP. Most of the data sets were obtained from the National Park Service GIS personnel. This project chose the ArcGIS software (Environmental Systems Research Institute, Redlands, CA) as the development platform mainly because of its ArcObjects open development environment. ArcObjects can be used with any Microsoft component object model (COM) compliant programming languages to develop customized GIS applications (Zeiler, 2001). This customization capability is critical to the development of customized analysis procedures and graphic user interfaces in a GIS-based SDSS.

The data sets were organized into a geodatabse of ArcGIS as separate feature classes (equivalent to GIS map layers; see Zeiler, 1999). Each separate feature class represented either a factor or a constraint to be used within the SDSS analysis. Additional attributes were entered into some feature classes to more effectively support the analysis. For example, a wildflower attribute was added to the trails feature class to give users an option of specifying spring, summer, or fall wildflowers among the criteria. Trails were ranked either excellent, great, good, or poor based on the chance of encountering wildflowers. Due to the seasonal nature of wildflower viewing, this option is disabled for winter. Each trail was also given a difficulty rating of easy, moderate, hard, or strenuous to offer users with an option of specifying how much exertion they wish to put forth. These values were derived from the elevation gain, trail slope, and the personal experience of the system developers. Wildlife probability models for deer, elk, and black bear were used to give users another option to assess the chances of encountering wildlife on different trails.

3.2. System design

SDSS lend themselves well for solving spatial decision problems that arise in the TrailFinder application. The analysis results depend not only on the geographic distributions of various features and attributes, but also on the value judgments involved in the decision making process reflecting the user's personal influence. The SDSS framework allows users to explore a variety of alternatives to help support their decision making process. Since each park visitor may have different constraints (e.g., physical condition or time constraint) and preferred activities (e.g., horseback riding, fishing, camping, seeing wildflowers or wild animals), it is important to include in the system design a comprehensive set of constraints and factors that may be considered in the decision making process of park visitors. In addition, the system must allow users to specify the importance of various factors to their decisions. These constraints, factors, and importance levels specified by the user are used in an algorithm developed for the TrailFinder SDSS to rank the trails and then recommend a list of trails that best meet the user's criteria. A flow chart of the system design is presented in Fig. 2.

Designing a user-friendly interface, which guides the users through the application in an intuitive and informative manner, was an important consideration during the application development. The user interface should let "users do what they want to do and that it is relatively easy

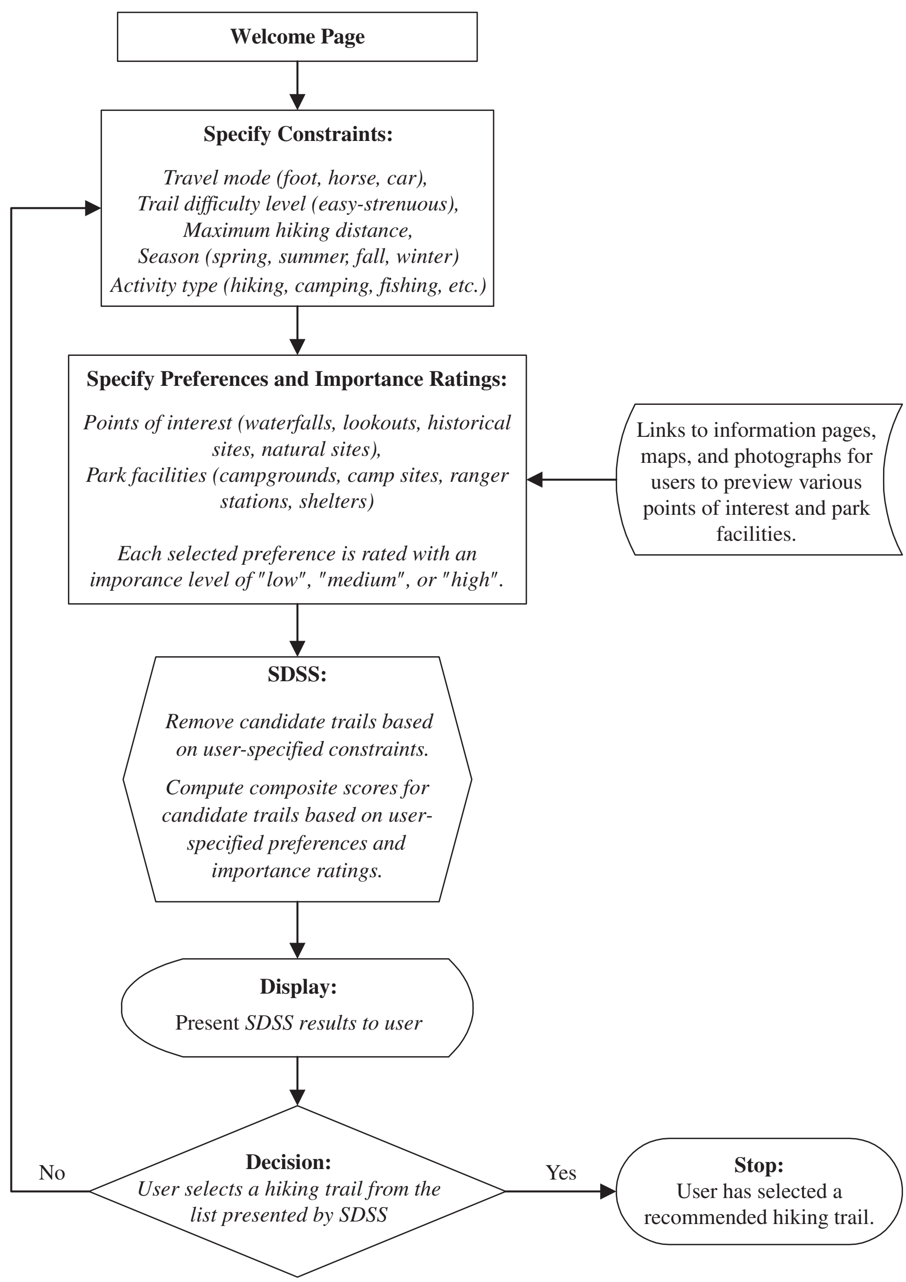

Fig. 2. Flow chart of the system design.

to communicate these needs to the system'' (Densham and Rushton, 1987, p. 77). Custom Visual Basic programming with the ArcObjects open development environment was used to design easy-to-follow dialog windows and analysis procedures for this TrailFinder SDSS application. The graphic user interfaces were designed in a manner that required no prior GIS knowledge on the user's behalf to utilize the system.

When users start the TrailFinder SDSS application, they will first see a welcome dialog window with an introduction to the system. A set of constraints is presented in this dialog window for users to choose (Fig. 3). The first constraint offers the user a choice of the mode of travel among the three options of foot, horse, or car. If a user chooses foot, all trails will be included in the analysis. If a user specifies horse, only horse trails will be analyzed. If car is selected, only roads open for automobile traffic will be considered. Users also can click the ''View Trail Map'' link to view a map containing all foot trails, horse trails, and roads in GSMNP. Next the user selects the trail type they would like to experience. They choose a trail difficulty level of easy, moderate, hard, or strenuous and specify how many miles they would like to travel round trip. Decision support analysis in the TrailFinder application will be performed only on those trails that meet these criteria. The user then selects the season when they are visiting the park. Certain roads and trails are not accessible in the winter months and will not be included in the output if winter is chosen. Also certain trails have wildflowers blooming only in spring, summer, or fall. The season selected by a user sets another constraint on which trails would be considered. The final constraint is to indicate whether or not the user is interested in a particular activity that requires specific facilities or resources in the park. For example, only trails that have shelters or backcountry campsites should be included in the analysis if visitors are interested in a backcountry hiking/camping trip. If the user checks the fishing activity box, only trails within a 20-m buffer of fishable streams would be evaluated in the analysis. The constraints selection user interface narrows the number of trails to be considered in the SDSS application based on the information provided by the user.

The constraints dialog window also includes an advanced search option. If the user knows a particular feature in the park they would like to see, they can directly query the data for that feature. The user simply enters the feature name and the system will display a map of the feature as well as a list of trails that access it. For example, the user could type in ''Charlie's Bunyon'' and the system output would include a map zoomed to the area and a list of trails,

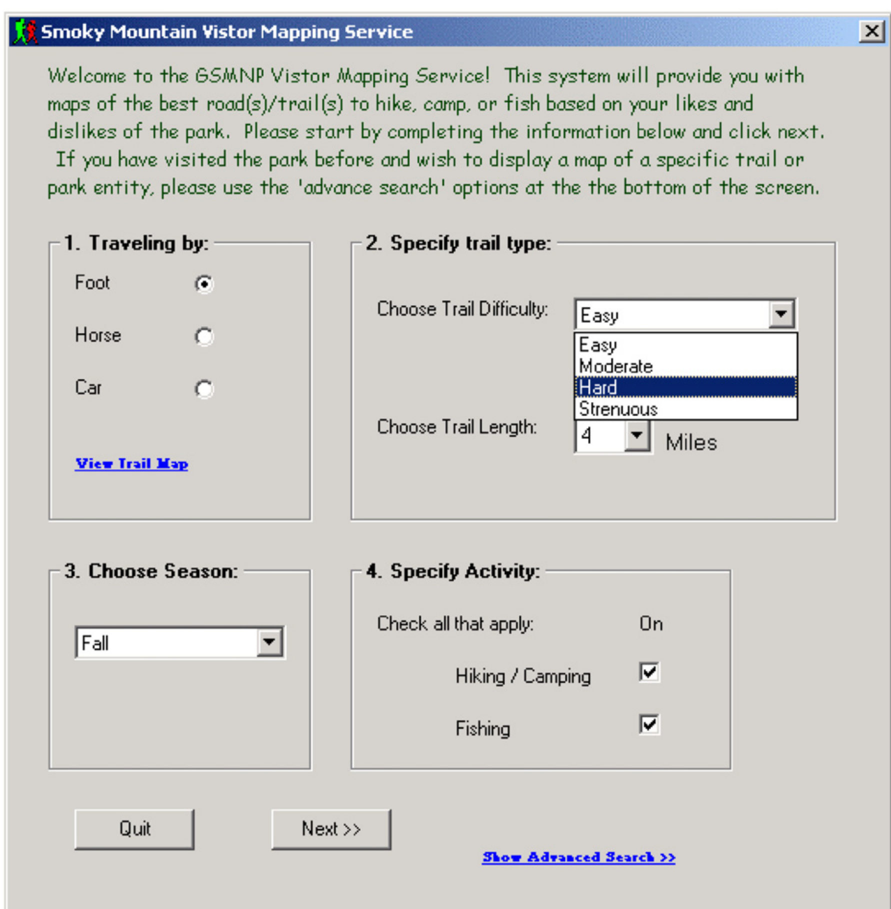

Fig. 3. Introduction and constraints selection dialog window.

including "Appalachian Trail, Sweat Heifer, The Boulevard Trail, Dry Sluice Gap Trail", that access this feature. This function is useful when users know what they would like to see, but do not know where the feature is located.

The next dialog window allows the user to specify the importance of various physical and cultural features to his/her excursion in GSMNP (Fig. 4). There are two pages of different factors for the user to rank. All factors start with a default importance ranking of "Low". If a particular factor is of higher interest to the user, he/she could change the importance level to "Medium" or "High". The factors are further broken down into categories. The first category, points of interest, includes waterfalls, lookouts, historical structures, and natural sites. The park facilities category includes factors that may be of interest if the user plans to have an extended stay or picnic at a campground, or visit a ranger station while they are in the park. Another category ranks the biology of the park and allows the user to rank certain flora and fauna factors including wildflowers, elk, deer, and black bear. Additional factors can be easily added to the user interface as more data becomes available about the diverse biology of the park.

Many visitors to the park have little knowledge about these park amenities and do not know what to base their ranks on. The TrailFinder system design therefore includes a link for each factor to other information pages that give the user a chance to investigate the amenities before specifying the importance ranking for a factor. Each factor is hyperlinked to a map showing the spatial location of the relevant features in the park as well as descriptive information about each. For example, the waterfall factor is linked to a map showing the location of all major waterfalls in the park (Fig. 5). Users can also view a picture of each waterfall via a simple click on the map (e.g., picture of Abrams Falls shown in Fig. 5). The campsite factor is linked to a map of all backcountry campsites with reservation information, rules and regulations for backcountry camping, as well as individual campsite pictures for users to view.

For the analysis module of the TrailFinder GIS-based SDSS, the application includes two major sets of customized programs. The first set of programs reads the constraints specified by the user and then uses the spatial search and database query functions in ArcGIS to identify a set of candidate trails that meet the user-specified constraints. The second set of programs evaluates these candidate trails according to the factors and their importance rankings selected by the user. The importance rankings of various factors are translated into numerical weights assigned to the factors. A factor with a high

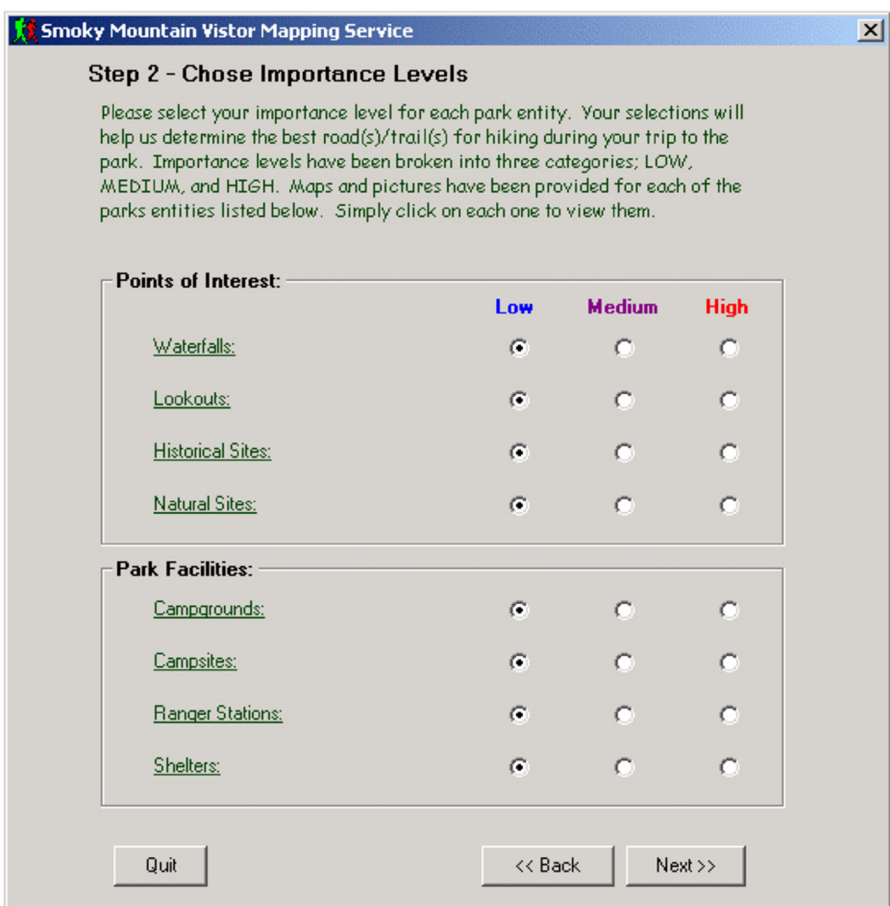

Fig. 4. Factor ranking dialog window.

Fig. 5. Map and information page of waterfalls in the Great Smoky Mountains National Park.

importance ranking receives a greater weight than other factors. Each candidate trail is evaluated by the combination of all factors weighted by their respective importance rankings as specified by the user. A composite score is then generated for each candidate trail. For example, if the user ranks waterfalls and black bears high, wildflowers, campsites, and lookouts medium, and takes the default for the remaining factors, greater emphasis would be given to trails that have waterfalls along their path and travel through an area with high probability for black bear occurrence. Trails that meet these criteria and also contain wildflowers, campsites, or lookouts would receive a higher score than other trails. If no trails have both waterfalls and black bears, the trails with the highest combination of high and medium factors will be reported based upon their composite scores.

When the analysis is completed, the system displays a map and a report of the recommended trails. These recommended trails are highlighted on the map and the user is provided with easy-to-use tools to explore the results. The user can zoom-in and zoom-out on the map, pan around, and interactively retrieve information about a specific feature by clicking it. The report includes a list of recommended trails and summary information for each trail. The user can interactively explore each recommended trail on the map display using the tools described above before making a final choice. Users also have options to modify their constraints and preferences and use the system to re-evaluate the trails based on the modified criteria. Once a final decision is made, the user then indicates which park entrance he/she will enter the park. The system will automatically find the best route from the entrance to the selected trailhead for the user.

3.3. *An example of using the TrailFinder GIS-based SDSS application*

Let us look at an example for a first time visitor to the park and walk through the TrailFinder application to illustrate the entire process. The visitor first starts the application by double clicking the TrailFinder icon on a computer located at a visitor center. The instructions and constraints selection dialog window comes up on the screen. The visitor decides that she would like to hike and chooses foot as the mode of travel. She then selects strenuous for the difficulty level and 10 miles for the roundtrip hiking distance. These choices reflect the highest difficulty level and the maximum hiking distance she is physically capable to take for a hiking trip. She is visiting the park in the spring and chooses that as the season. This visitor is not interested in camping or fishing so she leaves those constraint options blank. Next, she starts to rank the factors. The visitor really wants to see waterfalls and wildflowers so she checks these two factors as a high

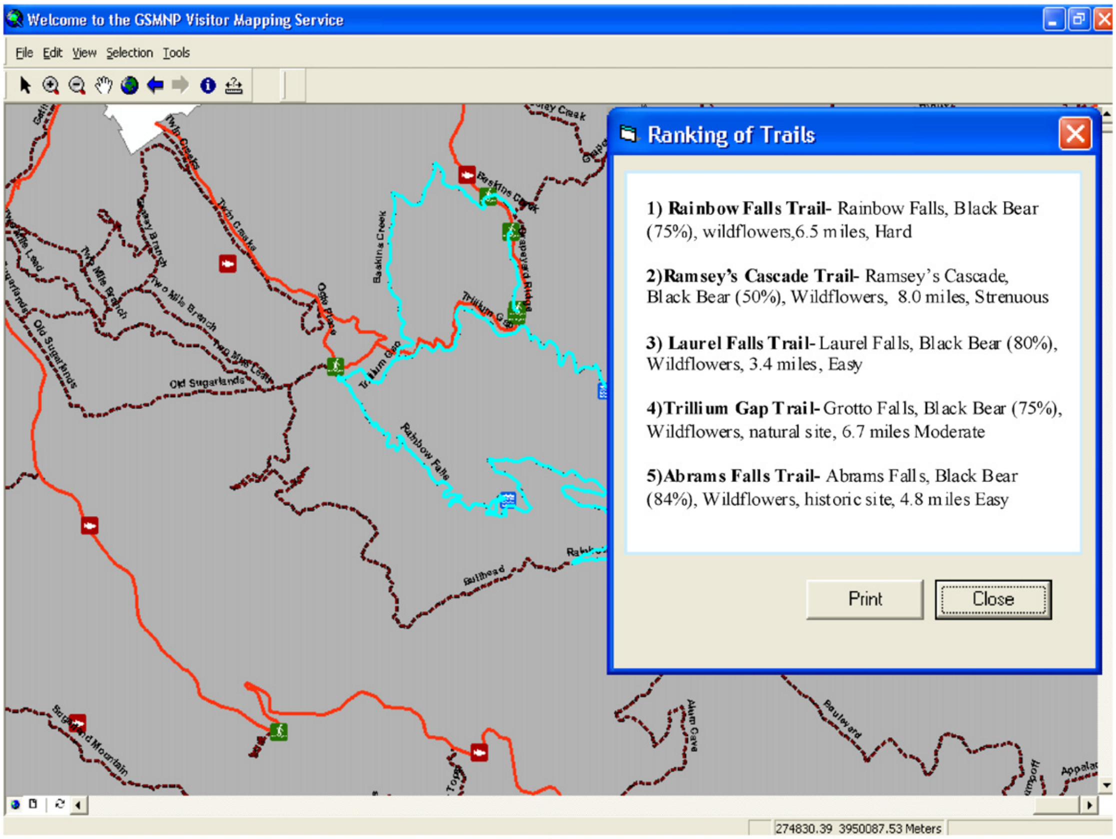

Fig. 6. Output of the TrailFinder spatial decision support system.

priority. She also would like to see black bears but not as much as the other factors and marks it as a medium priority. All other factors are left at their default setting of low. She clicks the ‘‘Finish’’ button and awaits the results.

The system presents her a map of the park, which highlights the recommended trails that best meet her interests (Fig. 6). A separate report window with some key information of the recommended trails is also displayed. Based on the constraints and preferences specified by this user, the system recommends five trails that all offer waterfalls, wildflowers, and a good chance of seeing black bears. The report also lists the difficulty level and the length of each trail. The user can then use the zoom, pan, and identify tools available in the map window to further explore each of these recommended trails. After a decision is made, she indicates her current location and the system uses the routing tool to map her way to the trailhead.

4. Conclusions

This study demonstrates the power of integrating GIS with SDSS for a tourism application. GIS-based SDSS provide useful tools to help tackle many semi-structured spatial decision problems that we often encounter in the real world. For the visitors of GSMNP, there are many resources and activities awaiting them to explore and experience. However, most visitors have no or very limited knowledge about these possibilities. It, therefore, presents a challenging task for the visitors to plan their activities in the park to deliver the experiences they are looking for. Since different visitors often look for different activities and experiences based on their personal preferences and constraints, it is not feasible to find one optimal plan for everyone. The GIS-based SDSS application of TrailFinder presented in this paper shows how we can develop an easy-to-use and flexible system to assist GSMNP visitors in choosing the trails that better match their personal interests and give them a more satisfying experience during their visits. To help assess the effectiveness of this application, a survey could be conducted in the future to evaluate if the system improves the tourist's experience in the park.

This GIS-based SDSS application for GSMNP represents a starting point for future systems to be developed. Initially, this application was designed to be available at visitor centers. The next step would be to migrate the system to a web-based GIS application where it could be accessed from anywhere in the world. This would allow visitors to plan trips from their home before they come to the park and would allow them to optimize their time spent in the park. A web-based application also opens new possibilities such as linking the system to online routing tools and park resources already available on the Internet. It could route a user from anywhere in the United States to the park. Online weather information also could be linked to enhance the system. For example, a 5-day weather forecast could be used to rank the trails based on their flooding potential or accessibility levels during sever weather. As more data become available on the flora and fauna of the park, additional wildlife options could be added to the system. This information could be useful for visiting scientist coming to study particular species. They could easily identify which trails would give them a greater chance of finding their target species based on the habitat probability maps utilized by the system. This system also could be expanded to include other parks within the National Park System. The expanded system then will be able to suggest particular national parks for visitors to enjoy based on their preferences and constraints.

This system also can be further developed to benefit retail businesses surrounding the national parks. With online links to hotels, restaurants, shopping places, and other recreational opportunities in the surrounding area, this system can help retail businesses to reach their potential customers. For example, a family plans to stay in the Gatlingburg area outside GSMNP for three nights and would like to find a hotel that charges $70 per night or less and is as close to a seafood restaurant as possible. This GIS-based SDSS can help find the hotels and the restaurants that meet the family's criteria. In addition, local outfitters could be linked to the system to offer guide services within a particular region as well as clothing, equipment, and other retail options that would meet the different needs of individual visitors. Matching customers' preferences with the available services is an important business consideration. This paper illustrates that a GIS-based SDSS can offer significant benefits to tourism as well as other retail businesses to improve the experience and satisfaction of their customers. The power of GIS-based SDSS becomes especially apparent when the decisions involve choices of opportunities (e.g., hiking trails, hotels, restaurants, retail stores) at different locations in space.

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