Forest Roads in West Virginia, USA: Identifying Issues and Challenges

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ABSTRACT

Forest roads have long been recognized as the primary source of soil and water disturbance, and other negative site effects, associated with timber harvesting operations. In West Virginia, where slopes are often steep and soils may be unstable, haul and skid road planning, construction, and retirement are particularly important practices. In addition, other challenges related to land ownership and regulations help to form the environment within which forest road practices are performed. However, the scope and relative importance of these challenges have not been studied.

Using a Delphi process, this study pooled the expertise of 10 resource professionals with extensive experience in forest roads, soils, water, and regulations to determine specific challenges and solutions associated with forest roads in the region. Results indicated that among the most significant problems facing forest road construction, as identified by the expert panel, are water management, lack of planning, and topography. Related issues include logger and forester training, adequacy of and compliance with Best Management Practices, constraints on road planning associated with private property boundaries, road costs, and federal and state policies. Results of this study have been used to both guide research priorities and initiate further discussions of important forest road issues.

Keywords: *forest roads, Delphi, Best Management Practices, soil erosion, road planning.*

The Appalachian Mountain region extends from southern Quebec to central Alabama. The construction of forest roads to access timber is unavoidable in the mountainous terrain characterizing much of West Virginia, and the central Appalachian region generally. Despite their necessity, road construction and retirement practices have been controversial. Forest roads have long been recognized as the primary source of potential erosion and sedimentation associated with timber harvesting [1, 2, 3, 4, 5]. Moreover, perhaps more than any other timber-harvesting-related activity, roads represent avenues of public exposure - to hikers, skiers, hunters, motorists, and forestland owners. The impacts of forest roads on forest values like aesthetics and recreation, therefore, come under close, continual scrutiny.

The objective of this study was to collect and synthesize expert opinion on the current challenges and issues facing forest road engineering and construction in West Virginia. This information may be useful in developing both a dialogue on forest roads issues as well as directions for future education and research.

BACKGROUND

Forest roads issues. Much of the research on forest roads in the eastern United States has focused on several issues: Effects on soil and water quality, amount of area required for roads, and roading costs. The role of forest roads as sources of nonpoint source pollution in Appalachian forests, in particular, has been well documented. Kochenderfer [1], for example, posited that forest roads are about the only places on harvesting operations where soils are "dangerously exposed." He proposed several practices that may help to mitigate erosion from forest roads, including logging slash barriers, seeding fill areas, broad-based dips, and daylighting to help roads dry more quickly. In 1976, Patric [2] also suggested that, since infiltration rates of undisturbed forest soils are far greater than average rainfall rates, forest roads are the only source of polluting particulate matter in eastern forests. Corbett et al. [3] agreed, stating that timber cutting alone usually has little effect on stream turbidity and that bare soil exposed during forest road construction was the major source of sediment due to logging. Gravel and grass surfacing as a means of reducing soil erosion from forest roads in southern Appalachia was suggested by Swift [4].

Mitchell and Trimble [5] studied the amount of forest roads necessary to harvest timber. They found that 10-20% of the logging chance areas studied were severely disturbed by road construction and that road networks in West Virginia that were planned by a forester were smaller and had gentler slopes. Kochenderfer [6] found that 10.3% of the skidder-logged area in West Virginia was occupied

The authors are Assistant Professor and Research Assistants, respectively, by roads and landings. In 1984, Olsen and Seifert [7] found that designation of trails before construction lessened the damage to advance reproduction and reduced roaded area by about half.

So-called minimum-standard truck roads, i.e., roads constructed to the lowest standard necessary to provide both utility and protection of the site at a reasonable cost, have been suggested as a cost-efficient alternative to either highly engineered roads or poorly planned roads that result in erosion and too much roaded area (Kochendefer et al.) [8]. The average cost of these roads, excluding gravel, was $8,119. Among the component costs studied were those associated with planning (8% of total costs), excavation (59%), culverts (12%), and labour (12%). Layton et al. [9] compared construction costing methods for central Appalachian forest roads: Group I (hourly rental roads) and Group II (total job bid roads). The authors found that it costs about five times as much to build a road that is bid on in total than when equipment is rented hourly.

The Delphi process. In the early 1950s, Olaf Helmer at the Rand Corporation conducted a forecasting study sponsored by the US Air Force. In that investigation, seven experts were asked their opinion of the probable effects of strategic bombing of industrial sites in the US during a hypothetical conflict with the Soviet Union in 1953 (Dalkey and Helmer) [10]. Participants did not know the identity of the other experts. The process spanned a period of about five weeks, during which a succession of five questionnaires and controlled feedback occurred. Participants were given the opportunity to modify their responses based on the summarized responses of all seven experts. The process concluded when significant convergence of opinion occurred.

This iterative process of questions, controlled feedback, response modification, and consensus, usually executed by mail and framed by participant anonymity, has generally been referred to as the Delphi process. Since its genesis with the Helmer study, Delphi or Delphi-like procedures have been used by many researchers, first in the area of forecasting and, later, more broadly applied to a variety of problem-solving situations for which little or no baseline information was available. The anonymity component eliminates the effects of overly assertive or influential members of the expert panel in dominating discussions and the input of other experts. Expert opinion, therefore, is considered independent and influenced only by each participant's expertise and by controlled, objective feedback.

METHODS

A Delphi method was used to elicit the opinions of 10 individuals considered to have expertise in the areas of forest road planning, construction, and environmental effects. This approach was used in order to offer participants the opportunity to consider and react to the combined inputs of the expert panel. It was felt that this iterative process would (a) provide a forum for a controlled "discussion" of forest roads not available through a survey approach, and (b), as a result, yield results that reflected a thorough consideration of the issues by all participants.

Participants were selected using a networking process that started with a single, easily identifiable expert. This expert was asked to both participate in the study and to identify other potential contributors. These people were also asked to participate in the Delphi process and to suggest other experts. This process continued until 10 experts in forest roads, representing broad backgrounds and professional affiliations (Table 1), had agreed to participate.

Table 1. Professional affiliations of the forest roads Delphi panel.

Professional Affiliation	Number of Participants
Forest industry	3
University faculty/extension	2
US Forest Service Research	2
State forestry	1
US Forest Service Forest Engineering Unit	1
State Environmental Protection - Water Quality	1
TOTAL	10

In the first round, experts were asked by mail to respond to two open-ended questions:

Question 1: What are the five most important *forest road engineering considerations* in West Virginia forests?

Question 2: What are the five most important *issues challenging forest road construction* in West Virginia forests?

Experts were asked to *rank* their responses from one to five, one being the most important and five the least important of the responses provided. Responses to these questions were summarized and reported to the experts for their reaction.

A similar format was followed for the second round. During this iteration, experts were asked to review the round one summary and to react to it by *rating* the importance of each round one response using a five-point Likert scale, a five representing a very important consideration or issue, and a one a consideration or issue that is relatively unimportant.

The entire Delphi process involved two iterations and spanned about three months.

RESULTS

Appendix 1 illustrates the results of the first round as they were presented to the Delphi panel for their review and reaction. Responses related to water quality and management were ranked as very important by many experts. All respondents offered water management and drainage as an important forest road engineering consideration (average rank = 2.55), while seven of the 10 experts said that environmental issues were important (average rank = 2.86).

Round two results were fairly consistent with information provided in the first round. Water management and drainage was rated highest as both a forest road engineering consideration (Table 2) and an issue challenging forest road construction (Table 3). Slope and topography was also rated high for both questions. There were other similarities in responses for both questions, particularly in the areas of road planning (rated 4.3 for both questions) and costs (rated 3.4 in both questions).

Responses for both questions differed most for those considerations and issues that were rated rela-

Table 2. Forest road engineering considerations, rated from 1 (unimportant) to 5 (extremely important) by the Delphi panel in round two.

Consideration	Average Rating
water management and drainage	4.7
slope/topography/terrain	4.7
surface water	4.3
planning and location	4.3
property boundaries	4.0
critical areas	3.9
area/length of road	3.9
cost/economics	3.4
soil type	3.1
design vehicle/ expected usage/useful life	3.1
serviceability	3.1
road retirement	2.6

Table 3. Issues challenging forest road construction, rated from 1 (unimportant) to 5 (very important) by the Delphi panel in round two.

Issue	Average Rating
water management	4.9
lack of planning	4.3
slope/topography	4.1
access	4.1
environmental issues, including endangered species and wetlands	4.0
landowner rights	4.0
maintenance and reclamation	3.9
usage	3.4
cost	3.4
aesthetics and public opinion	3.1
politics and federal and state regulations	3.0
soils issues	2.7
availability of good contractors	2.1

tively low. For example, aesthetics and public opinion (average rating = 3.1) and politics and federal and state regulations (average rating = 3.0) were offered as issues, but not as engineering considerations. Likewise, design vehicle (average rating = 3.1) was offered as an engineering consideration rather than an issue.

IMPLICATIONS AND CONCLUSIONS

Results of this study indicated that principal among *forest road engineering considerations* were treatment of water to avoid erosion and sedimentation, dealing with natural terrain constraints, and proper road planning. Interestingly, these were also considered to be among the most important *issues challenging forest road construction*. Although this may imply that many forest road *issues* are related to engineering considerations, as defined by the Delphi panel, other issues emerged that demand attention. "Aesthetics and public opinion," "politics and federal and state regulations," and "availability of good contractors," although not considered to be as important by the panel, are certainly important issues challenging forest roading.

Such a periodic reevaluation of important issues and challenges facing a discipline serves several purposes. First, the process allows for informed discussion of the issues among recognized experts. The Delphi process employed in this study facilitated this interaction among 10 forest road experts from various backgrounds. It allowed for the distillation of broad ideas captured in the first round into a more structured, prioritized set of important forest road issues and rationales for their significance. Because of the participant anonymity inherent in the process, experts were not influenced either by strong participant personalities or by otherwise overly influential panel members. Rather, "discussion" took place and expert ideas were evaluated strictly on the basis of the perceived merit of those ideas.

Moreover, in developing priorities for forest roads research, it is useful to have a point of departure for evaluating potential study objectives. For example, the combined input of the 10 Delphi participants in this study has contributed to the initiation of a study in West Virginia that aims to describe forest road area as a function of a battery of site and behavioural attributes (e.g., slope, forester involvement, and equipment used). This idea was derived, in part, from results of this study that have indicated a need for mitigating negative impacts of roading through proper planning and construction.

The Delphi process results have also been used as a vehicle for initiating discussions of forest roads issues among students in a class on *Forest Roads* at West Virginia University. Although this study was conducted with central Appalachian forest roading conditions in mind, the results may apply to other regions of North America.

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Appendix 1. Summary of round one responses as presented to the Delphi panel. For each question, items were presented in the order of highest ranking (i.e., closest to 1) to lowest ranking (i.e., closest to 5). Note that average *rankings* from round one were provided to the panel. A ranking of 1 indicated the most important and a 5 the least important of the five considerations offered. This process is reversed for the *rating* process called for in the second round.

Forest Roads Delphi

Summary of the Second Round

The following is a summary of the second round of this process. Please recall that, for the first two questions, you rated each consideration from 1 to 5, 1 a relatively unimportant and 5 a very important consideration. The average rating is reported below for each consideration offered. For question three, the responses of experts to questions they posed during the first round are given in their entirety.

Directions: Please rate each of the following considerations or issues, a rating of 1 being relatively unimportant and a 5 very important.

Question 1: What are the five most important forest road engineering considerations in West Virginia forests?

Consideration		Reason	Rating
1. *surface water*		- All road crossings should be constructed at right angles to streams to minimize sedimentation, and streams should be bridged, culverted, or armoured to minimize impacts.	1 2 3 4 5
avg. rank:	1.50		
# respondents:	4		
		- Minimize sedimentation and stream disturbance and fish habitat disturbance.	
2. *planning and location*		- Roads are permanent and once constructed should provide periodic access to all forest users.	1 2 3 4 5
avg. rank:	1.75		
# respondents:	4	- Roads should be located to avoid bad soils, steep topography, and rock outcropping and to best access timber now and in the future as well as for other resources.	
3. *critical areas*		- Potential impact on streams, wetlands, wildlife, and other critical concerns.	1 2 3 4 5
avg. rank:	2.00		
# respondents:	1		

4. *water management and drainage* avg. rank: 2.55 # respondents 11	- Proper drainage will extend the life of the road, minimize sedimentation and drainage, and the wear and tear on trucks and equipment.	1 2 3 4 5
5. *cost/economics* avg. rank: 3.00 # respondents: 3	- Road construction costs may exceed short- or long-term timber values. - Building desirable forest roads for user access at an affordable cost with nearly year-round utility. - Particularly with West Virginia's topography and small property holdings.	1 2 3 4 5
6. *soil type* avg. rank: 3.33 # respondents: 3	- Influence drainage design, roadbed stabilization, cut-slope design, and road location.	1 2 3 4 5
7. *design vehicle/ expected usage/useful life* avg. rank: 3.50 # respondents: 2	- Influx of tractor-trailer logging trucks results in wider and more costly roads. - Determines type of road, material, allocation of dollars.	1 2 3 4 5
8. *area/length of road* avg. rank: 3.50 # respondents: 2	- Length of road system should be minimized by properly planning layout to get best use.	1 2 3 4 5
9. *slope/topography/terrain* avg. rank: 3.63 # respondents: 8	- Road slopes, both haul and skid roads, should be minimized to avoid excessive erosion and sediment transport. - Slopes affect building and reclamation.	1 2 3 4 5
10. *property boundaries* avg. rank: 4.00 # respondents: 1	- Limits choices of road location, particularly when economics is a factor.	1 2 3 4 5

11. *road retirement*	- Dictates level of maintenance.	1 2 3 4 5
avg. rank: 5.00 # respondents: 2		
12. *serviceability*	- Seasonal or year-round use.	1 2 3 4 5
avg. rank: 5.00 # respondents: 1		

Question 2: What are the five most important *issues challenging forest road construction* in West Virginia forests?

Issue	Reason	Rating
1. *lack of planning*	- Planning is the most important factor to make roads fit the terrain.	1 2 3 4 5
avg. rank: 1.00 # respondents: 1		
2. *availability of good contractors*	- Bad contractors and operators building bad roads.	1 2 3 4 5
avg. rank: 1.00 # respondents: 1		
3. *soils issues*	- Failure to recognize that different soils require different construction practices.	1 2 3 4 5
avg. rank: 2.00 # respondents: 2		
4. *politics and federal and state regulations*	- Determines how roads will be built.	1 2 3 4 5
avg. rank: 2.00 # respondents: 2		
5. *aesthetics and public opinion*	- Public opinion/sentiment can slow or stop construction.	1 2 3 4 5
avg. rank: 2.67 # respondents: 3	- Public views roads as scars on the topography.	

6. *usage* avg. rank: 2.67 # respondents: 3	- Multiple use considerations. - Construction of higher-standard roads than are needed for forest users.	1 2 3 4 5
7. *water management* avg. rank: 2.75 # respondents: 4	- Runoff and crossings: What to use and when?	1 2 3 4 5
8. *Environmental issues, including endangered species and wetlands* avg. rank: 2.86 # respondents: 7	- Consider the Maryland wetland situation - Mud in creeks as potential negative effect on aquatic ecosystems. - Impacts of road building on water quality.	1 2 3 4 5
9. *slope/topography* avg. rank: 3.00 # respondents: 2	- Difficulties imposed by West Virginia terrain.	1 2 3 4 5
10. *landowner rights* avg. rank: 3.00 # respondents: 1	- How far will government go in determining and regulating land use and management?	1 2 3 4 5
11. *cost* avg. rank: 3.33 # respondents: 3	- No one has a good handle on this. - Sharing costs if roads are for multiple uses. - Properly constructed roads will cost more up front.	1 2 3 4 5
12. *access* avg. rank: 3.33 # respondents: 3	- Trespass issues. - The issue of ownership patterns and topography. - Right-of-way considerations.	1 2 3 4 5
13. *maintenance and reclamation* avg. rank: 4.00 # respondents: 2	- Commitment to long-term maintenance and protection.	1 2 3 4 5