

# Integrating science and road access management: Lessons from the Northern Continental Divide Ecosystem

Richard D. Mace<sup>1</sup>

Montana Department Fish, Wildlife and Parks, 490 North Meridian Road, Kalispell, MT 59901, USA

**Abstract:** Land management decisions affecting threatened or endangered species are often based on literature reviewed by agency biologists or by the evaluation of empirical data by technical committees. Regardless, it is not often that research can address all of the issues that arise when developing management guidelines. Successful integration of research and management may depend on the effectiveness of technical committees assigned to the task. In the Northern Continental Divide Ecosystem (NCDE) of western Montana, a technical committee was established to develop road access standards for public lands. As a member of this committee, I had the opportunity to observe committee protocol and internal dynamics as they affected committee performance and outcome. In this paper I briefly trace the history of road management in the NCDE and suggest improvements to the performance of interagency technical committees so they will better succeed in developing defensible management guidelines.

**Key words:** grizzly bear, land management, Northern Continental Divide Ecosystem, road access, technical committee, *Ursus arctos*

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Land managers recognize the need to manage forest roads in grizzly bear (*Ursus arctos*) habitat to reduce mortality and physical displacement. To date, most emphasis on road access management has been in areas with legal recovery mandates such as the NCDE, the Greater Yellowstone Ecosystem, and the Cabinet–Yaak–Selkirk Ecosystems. However, road access strategies, developed by interagency committees for these areas, have proved difficult to implement. Common problematic themes among areas include how best to interpret scientific studies, incorporating human dimensions, the assessment of uncertainty and the lack of biological thresholds, the use of peer review, and determining what constitutes the best available data under the Endangered Species Act (ESA; 16 U.S. Code 1531–1544).

An understanding of the evolution of road management in the NCDE may provide those managing small bear populations or reintroduction sites with a useful perspective on how to proceed with population or habitat management plans using interagency committees. The success of an interagency committee, composed of scientists and managers charged with developing road access standards, can be fleeting. Based on the NCDE

experience, I discuss several ways to improve the chance of developing a successful road management program. I include discussions of committee composition, the use of relevant data, analysis protocol, and tools to smooth the integration of results into management.

## Background on road management

Little information was available on the effects of forest roads on grizzly bear behavior or survival when the grizzly bear was listed as threatened under the ESA in 1975. Forest plans for the NCDE adapted road standards developed for elk (*Cervus elaphus*) (Lyon 1983) to the management of grizzly bear habitat.

Several benchmark field studies in the mid-1980s began to explore the relationships between roads, human settlement, and grizzly bears. Mattson et al. (1987) evaluated such effects in Yellowstone National Park, while Archibald et al. (1987) and McLellan and Shackleton (1988) tackled the road–bear issue in areas undergoing high-intensity, short-duration resource extraction activities. Kasworm and Manley (1990) used a sample of instrumented bears in the Cabinet–Yaak Ecosystem to investigate spatial relations among bears, roads, and trails. These studies used univariate statistics and distance to roads as measures of impact to bears. Although conclusions differed among studies, each

<sup>1</sup>rmace@state.mt.us

investigation documented situations under which bears responded negatively to forest road traffic. Differing conclusions among these studies can be attributed to different methods used and probable differences in bear behavior among study areas.

As these studies neared completion, the Montana Department of Fish, Wildlife and Parks initiated a study of grizzly bears in multiple-use habitat in the Swan Mountains within the NCDE. The use of computerized mapping (geographic information systems) was growing during this period, and researchers embraced this technology in their road studies. In particular, biologists used a moving window technique to assess open and total road densities at a 1-km<sup>2</sup> scale. In an early report (R.D. Mace and T.L. Manley, 1993, South Fork Flathead River Grizzly Bear Project, Annual Report, Montana Department Fish, Wildlife and Parks, Helena, Montana, USA), Mace and Manley used this technique to describe the composition of home ranges for female grizzly bears. Using a composite home range of several individuals, the authors found that 46% of the range was either unroaded (>0.5 mile from a road) or unroaded but with trails. Thirty-six percent of the range had a total road density of 0–2 mile/mile<sup>2</sup>, and 18% of the range was >2 mile/mile<sup>2</sup>.

Then a lawsuit changed the face of road management in the NCDE. The first suit in 1989 challenged the 1985 Flathead Forest Plan. This plan addressed road management in grizzly habitat by directing actions toward restricting some activities during certain times of the year and by limiting the density of open roads. Open road density was to be calculated over an area of 5–15,000 acres. In 1994, the 9<sup>th</sup> Circuit Court determined the Forest Service had acted arbitrarily and capriciously in concluding that the plan would not jeopardize species listed under the Endangered Species Act. As a result of this suit and new information developed by the South Fork Grizzly Project, the Forest Service (USFS) amended the Flathead Forest Plan (USFS 1995). Amendment 19 incorporated the results of Mace and Manley (unpublished report 1993) through new standards of open and total road density. Under Alternative 3 of this amendment, approximately 185 km of roads would have to be restricted, reclaimed, or obliterated (USFS 1995).

These interim results of Mace and Manley (unpublished report 1993) became an important source of new information to various public organizations that believed the Forest Service was not adequately addressing the issue of road management in grizzly bear habitat. In this light, a pivotal lawsuit was brought against the Forest Service for a timber sale. Termed the Lost Silver Sale (1993), plaintiffs sought to show that Forest Service road

standards (among other issues) were inadequate to protect grizzly bears and their habitat. Plaintiffs and the U.S. Fish and Wildlife Service relied heavily on the Mace and Manley (unpublished report 1993) report. The Service, in their biological opinion, determined that to avoid a take (any harm or harassment of a species, Endangered Species Act), the Forest Service should implement standards of open and total road density similar to that found in Mace and Manley (unpublished report 1993). This was particularly important, as hitherto there had been no standards for total road density within grizzly bear habitat. Reductions in total road density in the NCDE would require managers to seriously consider closing major arterial forest roads that would have immediate and major impacts on how humans could use the multiple-use forests for recreation and resource extraction.

The issue became so contentious that the Governor of Montana called affected parties to a round-table discussion of solutions. This round-table committee never met again and made no headway toward rectifying perceived conflicts between the new access guidelines and other land uses. At about the same time, the Interagency Grizzly Bear Committee (IGBC, an oversight committee of upper-level managers) called for yet another group to peer review the preliminary research of Mace and Manley (unpublished report 1993). Among other issues, the team determined that the moving window technique was a reasonable and valid approach to evaluating road density. Reviewers also recognized the preliminary nature of the data and called for researchers to investigate the multivariate relationships among grizzly bears, roads, and their habitat. However, there was tremendous momentum to use these data regardless of their interim status. The conclusion of the peer review committee, that data were too premature to help develop guidelines, was usurped by litigation.

During the same period an interagency task force was convened by the IGBC to evaluate state and federal road management programs with the goal of improving consistency of road management among agencies. The resulting report (IGBC 1994) sought to standardize terminology relative to access, standardize the methods to measure road density, develop general concepts for “core area”, and insure compatibility with cumulative effects models. After adjustments for new protocols developed by an interagency task force (IGBC 1994), Mace and Manley’s 1993 findings were adjusted to the following: 19% of the home range had an open road and motorized trail density >1 mile/mile<sup>2</sup>, 19% had a total road density of >2 mile/mile<sup>2</sup>, and 68% of the range would be considered core habitat.

Difficulties arose when land managers began to implement the above “19/19/68 rule”. It had already been anticipated that timber harvest would decline in areas subject to the new road density restrictions (USFS 1995). Implementing this rule would require substantial reclamation of the existing road system.

At the same time, the 19/19/68 rule set was being applied, researchers published findings relative to roads and habitat selection (Mace et al. 1996, Mace and Waller 1997, Waller and Mace 1997). These papers emphasized (1) the multivariate complexity of the issue, (2) that certain habitats were disproportionately selected by bears because of their attractiveness as food sources, and (3) that the degree of displacement by bears from roads depended on traffic volume and habitat quality. By stratifying management subunits strictly on spatial grounds and without respect to habitat, the 19/19/68 rule would allow for areas of low road density in areas of relatively low seasonal value to bears and for the higher road densities in better habitats. Preliminary assessment by research biologists also suggested that road reclamation would occur in concentrated forest lands that were of relatively lower value to grizzly bears.

It was because of these problems, and because the final results represented new data, that the IGBC reconvened the technical committee to assess the applicability of the final research to road management, even though road management was being implemented on the ground through the Amendment 19 process. This re-evaluation of the study had been planned since the first interagency peer review. Applicable information from the study included a multi-variable analysis of grizzly bear habitat and road densities, an improved method to map and evaluate these relationships using GIS (geographical information systems, using resource selection functions derived from logistic regression; Manley et al. 1993), and the use of satellite derived greenness maps as a surrogate for habitat quality. The incorporation of these complex findings became a struggle for the technical committee. After nearly 2 years of working with the empirical data from the grizzly bear study, the committee completed an interim set of road access guidelines. The final proposal detailing the revised set of road access rules was detailed in an IGBC report (IGBC Road Access Task Force, 1998a, Rationale and choices made in the review and development of an access proposal for the NCDE grizzly bear ecosystem, IGBC, Bozeman, Montana, USA). To further explain the history of road access management and to more fully describe the rationale and choices made, the Road Access Task Force also produced a draft document (IGBC Road Access Task Force, 1998b,

Managing motorized access to grizzly bear habitat on multiple-use lands, IGBC, Bozeman, Montana, USA). These 2 documents were released to the public for review. Although there were few initial comments on the new proposal, several environmental groups hired a biologist to evaluate the new road standards. It became clear that these groups were very critical of the proposal.

### **Technical committee protocol: Dealing with empirical data**

Results of scientific studies rarely lend themselves directly and unequivocally to precise management direction actions, especially for low-density species such as bears. This is because the scientific method, used in most studies, tends to narrow the focus of studies by, for example, the use of null hypothesis testing. Studies are also constrained by the difficulty of obtaining large sample sizes and a lack of replication. Management guidelines are further complicated when pertinent publications draw contradictory conclusions. Managers are also required under the ESA to use the best available data, whether published or not, and therefore must accommodate a higher degree of uncertainty than may be found in published information. In the case of developing policy for road management, managers had to look at not only biological ramifications of a particular suite of guidelines, but at the logistical, social, and economic ramifications as well. It is a rare field study that can provide empirical data on all of these important issues.

The challenge becomes, then, how to best integrate the results of scientific studies into standards and guidelines in the face of scientific, biological, and social uncertainty over a landscape of mixed ownerships and management philosophies. In the case of road access in the NCDE, guidelines were developed by an interdisciplinary, interagency committee. I will use my observations as a member of this committee to highlight positive aspects of the process and to suggest avenues where alternative approaches in committee protocol would have improved the process. My comments generally follow the format of Anderson et al. (1999). However, fundamental differences exist between the approach of Anderson et al. (1999), in which science and management were separate, and the more collaborative approach attempted here.

### **Committee composition and dynamics**

Members of a technical committee must be chosen carefully. The success of the committee lies not only in the expertise each member brings to the table, but also in the ability to work as a cohesive unit. The types of

expertise needed should be carefully considered, and the committee should balance these relevant experts. The NCDE technical committee was a mixture of state and federal biologists, most of whom were what may be termed management biologists. The research biologists who provided empirical data on grizzly bear ecology, including relationships to roads, were also committee members. Below, I list of experiences that would be valuable to technical committees of this sort.

**Agency knowledge.** Technical committees should be composed of members that fully understand the opportunities, constraints, policies, and working environment of their respective agency. For example, each agency has mandates and responsibilities for resources other than grizzly bears, and committee members must be cognizant of these issues. It is especially important for members representing dominant land management agencies charged with implementing the road policies to apprise the committee of the legal or logistic feasibility of emerging guidelines. Several instances in the NCDE experience, the committee worked out complex guidelines over several weeks or months only to find that the guidelines were administratively unworkable. This occurred, for example, when the committee developed guidelines for total road density only to find that they could not be met in areas where there was no administrative authority over private and county roads.

**Knowledge of the law.** The technical committee must follow pertinent state and federal law to maintain a legal standing. This legal standing transcends both how technical meetings are arranged as well as the technical aspects of the guidelines. A major issue regarding the composition of the committee is whether meetings are open to the public under state or federal law. Other legal issues may include whether emerging guidelines meet the standard of take under the ESA. At least one member must understand how the standards might best move from inception to implementation, and therefore must have extensive knowledge of the National Environmental Policy Act (42 U.S. Code 4321–4347) and the Section 7 consultation process under the ESA. In the case of the road access committee for the NCDE, this issue became relevant when managers realized that road access standards would be implemented over several national forests. These forests were not on the same time frame relative to revisions of the forest plans, and there were conflicting views on whether separate biological opinions would be necessary for each forest.

**Scientific knowledge.** Biologists are not equally trained in the analysis and interpretation of empirical data. Biologists have various degrees of expertise

regarding the scientific method, theory, hypothesis testing, and the interpretation of statistical tests by virtue of their education and career background. However, a technical committee should be adept in research techniques, and each member should be qualified to contribute scientifically. If possible, the committee should include biologists who collected the empirical data under scrutiny for guideline development. It is the responsibility of these researchers to have their empirical data in a format that is easily retrievable and useful to the committee for evaluation. If empirical data are available, but the primary researchers are not, efforts should be made to include outside professionals that are familiar with data management and analysis techniques.

More experienced members of the committee may have to tutor the remainder of the committee to ensure that all members are comfortable with the techniques being employed. On the downside, tutoring can take an enormous amount of time and preparation.

**Database management.** In some circumstances, the primary researcher serves as manager of the databases. If not, a database manager should be appointed to the committee. Further, if GIS mapping and spatial analyses are a part of the program, a GIS manager is absolutely necessary because of the propensity to build a large number of intermediate and final maps. Database management becomes increasingly important as simple spreadsheet analyses evolve into more numerous and complicated databases. As the committee must return to these databases after months or even years, it is vital that there exist a good record keeping and data retrieval system. Such a retrieval system becomes very helpful during later peer-review processes or in the event guidelines are litigated.

**Knowledge of human dimensions.** The development of effective resource policy always involves several disciplines. Biological knowledge is rarely sufficient. Social scientists are rarely invited to participate in issues that are biologically technical in origin. This is unfortunate, as the success of many conservation initiatives rests on the support of the various publics. The NCDE technical committee did not formally embrace social issues when developing road standards. However, District Rangers were prompted several times to help the committee identify specific areas or roads of high recreation value that would negatively impact the public. Clark and Wallace (1998) outline a process to help identify and include relevant participants through a social mapping procedure. This technique suggests ways to identify participants, perspectives, base values, strategies, and outcomes.

**Other issues.** Aside from the expertise needed from agency personnel on the committee, there are other fundamental issues that need to be addressed when organizing a technical committee. First and foremost is whether to include representatives of the public or interested non-government organizations. There are 2 ways to address this issue. The first is to allow non-voting independent specialists from various groups or professional societies to observe the process and provide ongoing technical support. The second option would be to include outside specialists as full committee members. Perhaps more difficult than deciding the role an outside specialist is to play is determining which organizations to include. One option is to identify several groups or organizations with opposing agendas and have their leadership appoint a committee member. Again, these appointees must be able to bring some technical skills to the table.

It is very important that agencies commit their representative to the committee for the duration of the process and that members regularly attend the meetings. The road access committee for the NCDE, for example, met regularly for several years. During this period, membership changed, and some members chose not to regularly participate in meetings, causing a great deal of back-tracking. Personnel changes are best minimized by completing committee functions quickly.

Committee members must be allowed to work independently from one's own organization so that agency bias can be kept to a minimum. Mid- to upper-managers may try to influence committee decisions on controversial issues. The paradox is that independence for committee members can only be engendered from upper management itself.

Basic strategy and format for the committee should be planned well in advance, making sure there are no surprises that would compromise the committee. One such surprise occurred with the NCDE road access committee. To the surprise of some members, a group of Forest Service District Rangers had been invited to evaluate some rough guidelines and to suggest what roads should be kept open. There had never been a joint decision to solicit the opinion of this group, and certainly no group consensus as to the process by which a subset of roads would remain open to public access on social grounds.

#### **Establish criteria for relevant literature and data**

A technical committee may be charged with analysis of empirical data and the incorporation, interpretation, and

synthesis of technical literature. Specific standards should be developed by the committee that establish the types of data and literature accepted. Empirical data from published studies are of high value. Data from unpublished studies or those with small sample sizes or design flaws should be carefully scrutinized before acceptance.

If possible, the entire raw database on all aspects of bear ecology (verified as error-free) should be at the disposal of the committee. For bears, this may include data on roads, habitat use, home range size, etc. Data should include all observations, even those that may be eventually omitted. These outlying observations or individuals will prove useful in documenting variance and biological uncertainty.

The committee must also read and interpret other published and unpublished papers on the subject. As with empirical data, there must be a process for the committee to filter the value and relevance of these papers. Published literature, if available, should provide more evidence than unpublished work.

The committee should embrace opportunities to integrate the needs of other species into the guidelines. This makes not only good sense logistically and administratively, but multi-species or multi-resource plans may be more acceptable to the public.

Often, the best available data may appear in unpublished papers or agency reports. Best available data still does not mean that they are good data.

#### **Data analysis protocol**

The committee must agree on which databases will be used and whether these databases can be used independently by members or restricted to only committee analyses. The committee analysis process should resemble individual research. Statistical and biological assumptions behind each analysis must be clearly stated. Such assumptions could include statistical independence of observations and, biologically, that the sample of individual bears represents the population.

Committee members need to agree beforehand on the specific analyses to be conducted, allowing for some flexibility during preliminary exploratory analyses. During early phases, the underlying nature of the data may reveal a more appropriate statistical path than previously anticipated. However, the committee must avoid statistical fishing expeditions.

Once the analysis path is determined, members must agree on the interpretation of results. Members must agree on the alpha level (*P* value) for statistical significance and generally stick to their guns. But the committee should also discuss how to use information

when tests are inconclusive. The committee may need to use weight-of-evidence criteria when this occurs.

All decisions made during analysis need to be recorded, including decisions on the types of analyses. Results of all analyses should be included in the final document. Contentious issues should be voted on formally as they arise. Otherwise it becomes difficult to determine whether consensus on an issue has been reached. The NCDE committee did not vote on many outcomes and issues that arose during the analysis of data on grizzly bears and roads. I believe that voting would have helped in several instances when members strongly disagreed.

### **Identify limiting factors**

There is no one-size-fits-all strategy for successful implementation of a road management program. For each area, the strategy needs to reflect the urgency of the problem, based on the current population trend and on the opportunity to affect change. Early on, it is valuable to determine what factors limit the bear population in an area and to evaluate whether more restrictive road management can be expected to improve the situation for bears. I have witnessed time-consuming and expensive lawsuits over road management issues in peripheral areas where bears are absent or exceedingly rare. More emphasis should be on placing bears into an area prior to extensive road management. This leads to an adaptive road management program in low bear density areas. The value of incremental improvements in security through road management could then be assessed. This approach was used in the road management plan for the Cabinet–Yaak Ecosystem, where biologists ranked the relative value of management units to bears and adapted unique standards based on those rankings.

Aside from biological limiting factors, logistical or administrative obstacles may limit progress. Several examples from the NCDE experience highlight the need to identify these limiting factors early. After several months' work, the committee developed preliminary guidelines on total road density only to find they could not be attained in mixed-ownership landscapes. As a second example, the interim guidelines were designed by the technical committee to be applied across several National Forests that administer lands within the NCDE. After the guidelines on road management were completed, managers determined that there was no legal vehicle to implement the standards across administrative boundaries through the NEPA process. Rather each Forest would have to consider the standards as one of several alternatives when their Forest Plan was rewritten.

### **Peer review**

Peer review of committee findings should be an integral part of the process. The review process should be guided by answers to questions such as: (1) what role should the technical committee play in the review process? (2) what are the objectives of the review? (3) who should choose the reviewers? and (4) what type of expertise and affiliations should be included as reviewers?

One of the more difficult challenges faced by the road access technical committee and upper-level managers was how to proceed with peer review. Conceptually, a technical committee should remain as divorced from the review process as possible. Their role should be limited to providing background and technical material needed for a through review. Technical committee members should be at the disposal of the reviewers to answer questions if needed. However the review process for road standards veered from this conceptual process in several significant ways. Most notably, the technical committee itself developed the peer review process. The committee chose the organizations from which the reviewers would be drawn and determined the objectives of the review.

Organizations and individuals must be carefully selected to review committee findings. If qualified representatives from a mix of organizational philosophies are included, the review should be well rounded and retain a balance of philosophies. Reviewers should not be close to the issue, should be objective, and have technical expertise.

A good balance of philosophies was not achieved for the review of road standards in the NCDE. Rather, only organizations with a strong conservation philosophy were chosen. Reviewers were drawn from the International Bear Association, The Wildlife Society, and the Society for Conservation Biology.

The objectives and sideboards of the review should be determined beforehand. Will the review include analyses methods, a critique of conclusions, the underlying body of research, or the operational aspects of the resulting standards? After much deliberation, the NCDE peer review committee was asked to study the 2 approaches to road management (Amendment 19, guidelines developed by the team), comment on the adequacy and correct use of available scientific data, and comment on the assumptions made to develop the 2 alternatives. They were not asked to judge which alternative was best for the conservation of the species.

Despite these guidelines, however, the reviewers went beyond their task and made operational comments and

suggestions dealing with conservation of grizzly bears. They concluded that the interim guidelines were too complex, were based on too many assumptions, and did not provide enough permanent habitat security relative to Amendment 19.

### **Risk assessment**

Risk assessment predicts future outcomes of actions in the face of uncertainty. Risk is most often assessed through qualitative or quantitative models. The consequences of a particular suite of management guidelines can be divided into biological or social consequences. Biological issues that can be quantified include changes in bear behavior toward roads or changes in mortality levels related to roads. Social issues may include general public acceptance or assessment of road closure violations over time. Uncertainty in these types of measures may act independently or interact with one another. Risk assessment and uncertainty can be assessed over the short or long-term. However, short term approaches (1–2 decades) may be sufficient for road standards as the degree of uncertainty increases greatly with time.

Risk is more easily assessed when there are competing models, or in the case of road access, when more than one course of action is provided. Further, the degree of risk one is willing to accept depends greatly on the population level of grizzly bears.

Risk of an undesirable consequence of an action can be assessed and reported by determining the variability in the empirical data (Burgman et al. 1993). Assessing the variability in individual bear behavior relative to road metrics, home range size, seasonal elevation use, and resource selection indices are all important relative to road management scenarios.

### **Conclusions**

I do not necessarily advocate the merger of science and management to solve real world problems as described in this paper. In not all cases can interdisciplinary teams of managers and scientists be expected to effectively forge management standards with complex issues and high levels of uncertainty. The paradigm of keeping research and management separate works best when the underlying research is applied and where uncertainty or variability in animal ecology are clearly expressed. Nonetheless, there will be times when managers and researchers are thrown together to solve a problem similar to the one I presented here. In these cases, these lessons may prove useful.

The probability of a committee succeeding in drafting management standards from empirical data should be greatly increased if several points are adhered to. First, there needs to be a time-frame for product completion. If there is no specified end-point, the process will invariably become drawn out, and an undesirable amount of turnover in committee membership will occur. Second, persons with some expertise in the evaluation of empirical data need to be on the committee. Members must understand the policies of their organization. Although difficult, members must have some autonomy from their parent organization. Third, there must be some vehicle to determine whether the emerging standards can be physically and legally implemented. And finally, the product and underlying analyses must be peer reviewed. The wider the scope the review takes, the stronger the resulting guidelines will be.

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