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Abstract: Results are presented of a North American survey designed to learn how transportation departments mitigate transportation corridors for wildlife and give examples of how wildlife mitigation measures can be incorporated into long range plans and in routine everyday actions. The objective is to promote greater understanding of the potential for incorporating wildlife movement needs into transportation programs and projects. Research results presented include data from a continent-wide telephone survey conducted over a two year period (2004-2006) to learn of accomplishments in wildlife passage and how wildlife and ecosystem needs have been incorporated into the transportation planning process. Telephone interviews were conducted with 410 transportation and ecology professionals in every state and province. Based on research data and the mandates of the SAFETEA-LU legislation the case is made that greater efforts in long term transportation plans and everyday retrofits are necessary to provide for wildlife and ecosystems needs. Some efforts have already been accomplished and can be adapted continent-wide. There are greater than 580 terrestrial and 10,000 aquatic wildlife and fish passages in North America that were specifically built as wildlife and fish crossings, and millions of other bridges and culverts constructed for other purposes but which could be used by wildlife. Placement of these structures has grown so rapidly that over 500 new terrestrial passages are projected to be built in the next 10 years. The almost exponential increase in passage construction each decade is an indication of the growing awareness of the need to mitigate new and existing transportation infrastructure for wildlife permeability. There is also a greater awareness that early planning for wildlife and ecosystems is critical to accomplish these mitigation activities. The inclusion of wildlife and ecosystem needs early in the development of long range transportation plans has not been the traditional paradigm as was learned over the course of the survey. The majority of transportation planners who participated in the survey indicated their state's consideration of wildlife and ecosystems, in the form of consultations with natural resource professionals and referencing Geographic Information Systems (GIS) maps and other data, did not occur until the project development stage. This late consideration does not typically allow adequate time to avoid important wildlife corridors and to install mitigation measures. The majority of those working with transportation and ecological concerns recognized the need to incorporate wildlife mitigation needs early in the programming, planning, and design processes, as learned from the web-based priorities survey. The survey revealed that early planning for wildlife and ecosystem needs was the number one priority in dealing with roads and wildlife. This early level planning has also been mandated in the U. S. SAFETEA-LU Transportation Act of 2005. Examples are presented of instances where long range planning included wildlife and ecosystems needs, and suggest how this can be accomplished on a state and province-wide basis. We also present how everyday opportunities can be used to facilitate wildlife movement over and under roads and railways. Knowledge of successful accomplishments can help build upon opportunities in the movement toward a more proactive transportation planning paradigm.

Introduction

There is an overall consensus among scientists, practitioners, and the general public that roads and their accompanying vehicle traffic pose a serious threat to wildlife and that it is necessary to take action to mitigate those effects (Trombulak and Frissel 2000, Forman et al. 2003, Gunderson et al. 2005, Weigel 2005). Scientists have documented road and vehicular effects from global warming to genetic isolation in insects (Forman 1999, Trombulak and Frissel 2000, Bissonette 2002, Angermeier et al. 2004, Keller et al. 2003). The effects that involve mortality from collisions with vehicles and modifications of animals behavior as described by Trombulak and Frissel (2000) are two effects that can be partially mitigated through alterations of existing road and rail structures and better planning for wildlife in future transportation projects. Traditional transportation planning does not begin to incorporate wildlife and ecosystem needs until late in the planning stages when a specific project has begun the planning and development stages, typically only five years or less to the time of project construction. This later stage of planning allows little time or funding for changes to the proposed projects that would accommodate ecosystem and specific species needs. As a result, transportation system planning, development and construction has in most cases exacerbated the ecological effects of roads, railways, and traffic when in fact there may have been opportunities to help minimize or eliminate these impacts under another planning paradigm.

The new paradigm for transportation planning has begun to develop, due in part to a greater understanding of ecological effects of roads, traditional environmental protection laws such as the U. S. National Environmental Policy Act (NEPA) and the Canadian Fisheries Act, and the recent United States 2005 Transportation Act known as SAFETEA-LU. Traditionally, environmental concerns were viewed as only those related to regulations and laws that required developers of infrastructure to apply for permits and meet specific requirements, such as those pertaining to the U. S. Clean Water Act, Endangered Species Act, and NEPA. With the passage of SAFETEA-LU, long range transportation plans at the state and regional level, which are traditionally set for a 20 to 30 year time frame, are required to be developed in 'consultations with resources agencies, such as those responsible for land-use management, natural resources, environmental protection, conservation and historic preservation, which shall involve, as appropriate, comparisons of resource maps and inventories.' SAFETEA-LU also requires these consultations have 'Discussion of potential environmental mitigation activities and potential areas to carry out these activities, including activities that may have the greatest potential to restore and maintain the environmental functions affected by the plan' (SAFETEA-LU Section 6001). This legislation sets the stage for more open discussions when long range planning is carried out and creates a strong incentive for natural resource agencies to identify natural areas and wildlife populations in greatest need of protection. SAFETEA-LU also instructs states to create participation plans that identify a process for stakeholder

involvement. This early level planning and consultation requires coordination of data sources and working relationships among agencies that may have not been fostered in the past. As states begin to work toward this new paradigm, it would be most instructive to examine examples of how these relationships have been developed in specific projects and places where wildlife mitigation has become a standard option for transportation projects. This paper presents examples of how early planning and coordination among stakeholders across North America has helped ameliorate the effects of existing and future transportation projects. Our objective is to promote greater understanding of the potential for incorporating wildlife movement needs into transportation programs and projects.

Methods

Telephone Survey of Wildlife Crossings

Knowledge of wildlife mitigation activities across North America was largely gathered through a continent-wide telephone survey of transportation and natural resource professionals. The objective of this survey was to learn of state and provincial efforts to mitigate roads for wildlife with wildlife crossings and the process of incorporating wildlife needs into transportation planning (See Cramer and Bissonette 2005 for further details). The survey was carried out from July 2004 through March 2006. Crossings were defined as a new or retrofit passage over or below a roadway that were designed specifically or in part to assist with wildlife movement. Structures in place solely for other purposes such as water flow or recreationists' use that later had fencing attached to them to funnel wildlife to them were not considered wildlife crossings.

Web-based Survey of North American Priority Ranking

North American priorities for the research and practice of transportation ecology dealing with wildlife movement and roads were also used in this research. Our research team of six ecologists and three engineers generated a list of 25 priorities dealing with safely accommodating wildlife movements within transportation systems (Bissonette 2006). The list was then presented in an on-line survey for participants to rate the priorities in April of 2006. Through our contacts generated from the above telephone survey and other transportation-related work, we invited 497 transportation ecology-related professionals to rate the 25 priorities. These priorities were then ranked according to participants' ratings.

Results

Wildlife Crossings

Telephone survey interviews with 410 individuals and ongoing communications with transportation and natural resource professionals reveal there are a minimum of 592 terrestrial wildlife crossings and over 10,000 aquatic wildlife crossings in North America (figure 1). The first well-documented wildlife passages were installed in the 1970's. Since that time each decade has had a doubling in the number of wildlife passages when compared to the previous decade. There are projected to be over 500 new terrestrial passages built for wildlife in the next 10 years. These are intended to mitigate the entire network of approximately 7.2 million kilometers of roads in North America (Forman et al. 2003, Gunderson et al. 2005)

Planning Stages

In order to formally organize the continuous transportation planning process, we segmented the process into long range plans (20-30 years), State Transportation Improvement Plans (5 years), and project plans (near future), based on a similar survey conducted by the U. S General Accounting Office (United States General Accounting Office 2004). Telephone survey participants who were knowledgeable about transportation planning in their state (we present only U.S. individual state results) were asked 1. "How does your state consider ecosystem conservation during the creation of the long-range transportation plans? 2. . . .during the State Transportation Improvement Program (STIP) process? and 3. . . .during Project Development?" The consideration of ecosystem conservation was defined as: A – the incorporation of local plans that have considered ecosystem conservation; B – the use of resource agency personnel as stakeholders in developing transportation plans; C – the consideration of input from environmental interest groups; D - planning agency or resource agency personnel conducting site visits to determine or confirm the location of ecological resources; E – the use of resource agency data to determine mitigation requirements, develop alternative locations, or to avoid planning projects with unacceptably high ecosystem impact; F – the use of geographic information systems (GIS) to determine ecological resource locations; and G - provide funding to ecological impact studies. These actions were taken from those described by transportation agencies in the GAO study (United States General Accounting Office 2004). The majority of respondents representing 28 states indicated their states did not consider wildlife or ecosystem conservation until the project planning phase. Respondents in eight states responded that their planning began considering wildlife and ecosystem conservation at a level equivalent to the State Transportation Improvement Planning process, and respondents in fourteen states stated they began their consideration of wildlife and ecosystem needs at the long range (20 years or more) planning process (table 1). This long range planning was conveyed as not necessarily consistent state-wide long range planning for ecosystem conservation, but also included long range planning for specific road projects or specific geographic areas, specific case studies for future planning models, or new legislation for mandated long term planning.

Priorities

Four hundred and forty-four participants rated the priorities related to roads and wildlife on the April 2006 web-based survey. The number one ranked priority was the need to "Incorporate wildlife mitigation needs early in the U.S. DOT/ Canadian MoT programming, planning, and design process."

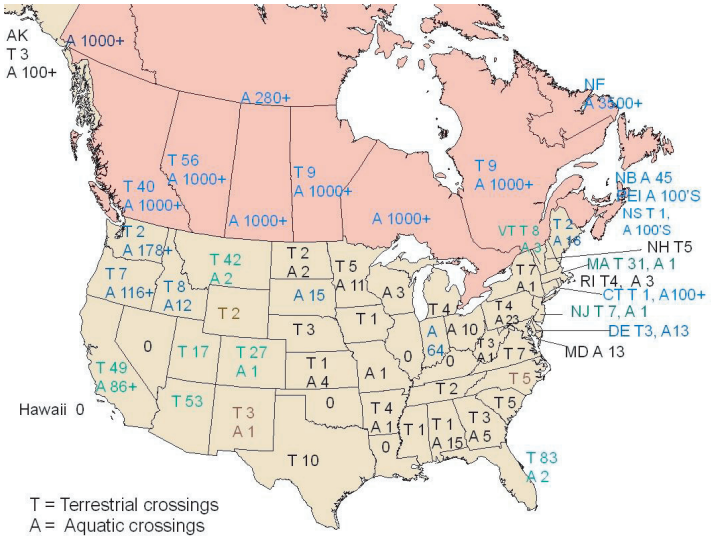

Figure 1. Estimated number of terrestrial (T) and aquatic (A) wildlife crossings in North American states and provinces as taken from NCHRP 25-27 telephone survey.

Table 1: The point in the planning process when telephone survey participants indicated their state began considering ecosystem conservation

Planning Stages		
Long Range (20+ years)	**STIP (5 + years)**	**Project (5 years or less)**
Arizona	Idaho	Alabama
California	Louisiana	Alaska
Colorado	Minnesota	Arkansas
Florida	Pennsylvania	Connecticut
Idaho	Rhode Island	Delaware
Illinois	Wisconsin	Georgia
Indiana	West Virginia	Hawaii
Kansas	Wyoming	Iowa
North Carolina		Kentucky
New Mexico		Massachusetts
Oregon		Maryland
South Carolina		Maine
Vermont		Michigan
Washington		Missouri
		Montana
		Mississippi
		North Dakota
		Nebraska
		New Hampshire
		New Jersey
		Nevada
		New York
		Ohio
		Oklahoma
		Tennessee
		Texas
		Utah
		Virginia
Total = 14	Total = 8	Total = 28

Discussion

Responses to this survey indicate a traditional lack of consideration of wildlife and ecosystems early in transportation planning but also the occurrence of a transition to a new paradigm for transportation planning that is beginning to include these considerations earlier in the planning processes. We learned these planning processes are not as clearly defined as the three stages presented to participants. There is more of a continuum of planning with multiple stages and inputs from a plethora of stakeholders. There are also a multitude of opinions about how states are planning for wildlife and ecosystems. Regardless of our efforts to standardize the questions and predicted answers, the responses were more often a reflection of the individual participant's reality than what may take place across a state. As a result, we present here generalized responses and present examples to better elucidate the new changes to the traditional transportation planning paradigm. This is also a reflection of the nature of planning for long range programs. While long range transportation plans may include statements that the state transportation department would like to be "good stewards of the environment and to follow state and federal NEPA environmental rules," there are typically no definitive statements on specifically how ecological concerns will be planned for or how input from natural resource agency personnel will be incorporated and accommodated in plans. We found that when a specific ecological place such as a more pristine area or transportation corridor is considered, then ecological concerns are more easily defined and accommodated. This is particularly true with large transportation corridors. Corridor planning may be only briefly addressed in the long range plan, but then undergoes a planning process that includes many separate projects over a long span of highway. These plans could be considered a type of long range plan because they occur on 15 to 20 year time frames. As many as a dozen respondents noted this type of corridor planning and indicated that personnel from natural resource agencies are part of the long range planning committees for these corridor plans. If respondents mentioned this type of planning as the first stage that wildlife and ecosystem conservation needs were considered, then their states were classified as beginning ecological planning at the State Transportation Improvement Program stage.

Most states typically began their ecological considerations when planning for the better defined projects. Participants mentioned that wildlife and ecosystems were considered when NEPA requirements began to be taken into account. It appears that provisions of section 6001 of the SAFETEA-LU Act make it much more clear as to at what stage ecological considerations must begin, and exactly what those actions should be.

Another factor in the recording of the transition from traditional to a new planning paradigm was the timing of this survey. It is worthwhile to note the survey was conducted during a transition period where transportation planning was conducted under guidance of the 1998 Transportation Act (TEA 21) to the beginning months of the 2005 Transportation Act, SAFETEA-LU. This was also a critical time when individual states were creating their Comprehensive Wildlife Conservation Plans, which were completed in October of 2005, and later became known as Wildlife Action Plans. As a result, many if not most respondents gave responses that talked of past planning actions and then how the "new" methods were being incorporated into planning stages.

The telephone survey also gave us the opportunity to learn how states deal with transportation planning and ecological concerns over a variety of situations. It may be more instructive to report these exemplary and day to day examples of integrating wildlife and ecological concerns into transportation planning than to give a more academic collection of data and analysis. We present our findings in the form of ten steps. These steps represent processes that are most common to successful mitigation projects and are representative of the newly developing paradigm of transportation planning.

1. **Take stock of state/provincial situation**

   In states where there is an active program of mitigating for wildlife within transportation corridors, a common theme often is a recent event that helped catalyze support among agencies for coordinating efforts. These events are usually workshop-type meetings where members of state and federal agencies, non-profit organizations and zoological parks, consulting companies, academic institutions, and the general public come together to identify wildlife and landscape linkages, zones of connectivity and places where roads bisect those areas, or specific road related mortality workshops to identify the necessary steps to begin to address the issue. Examples of these events include wildlife connectivity-linkage workshops in many western states in the past five years (Utah, Arizona, New Mexico, California, and parts of Oregon, Idaho, and Montana), the Northeast's wildlife and roads bi-annual meetings, and Ontario's recent (2007) Ecopassage Forum to address wildlife mortality province-wide.

2. **Locate or generate databases, maps, and plans that could help with transportation and conservation**

   All states recently completed Wildlife Action Plans which help to identify species in areas that are most in need of protection or sensitive to development, among other priorities. Prior to 2006 when these were finalized, certain states had begun to address these issues in similar documents. Florida is among the leaders in mapping where they believe wildlife and overall landscape linkages should be maintained or restored and made those maps widely available, along with documents of where sensitive species reside and the lands important to their survival. With the use of the State Wildlife Action Plans, connectivity maps of landscape linkages, and accurate and updated Geographic Information Systems (GIS) databases there will be a number of resources for transportation agencies to cross reference at early planning stages.

3. Bridge relationships

One of the common comments participants provided was the lack of communication among agencies until there was an almost crisis situation where the agencies became pitted against one another and sometimes the public. In situations where agencies are working cooperatively together and in conjunction with the public and outside organizations, the common denominator appears to be a proactive effort to communicate and work together long before there is a specific transportation project beginning construction. Vermont Agency of Transportation and Vermont Department of Fish and Wildlife have both a memorandum of agreement and a regular working relationship that involves quarterly meetings, field courses, and other activities to find ways to work together in assisting terrestrial and aquatic wildlife movement regardless of what transportation projects are being planned. We suggest similar avenues for state and federal agencies to build communication and relationship bridges long before there is a specific regulatory reason to do so.

4. Bring data and natural resource professionals into long range planning centered on a specific area or issue

In states where there was an indication that wildlife and ecosystems needs were considered early in the long range planning process, in almost every instance it was when there were specific issues transportation planning could most easily examine, such as a specific ecologically sensitive area (such as the San Diego area of California and Illinois' Critical Trends Assessment identified areas), the availability of distinct GIS layers that could show what the concerns were (such Florida's ETDM planning portal), a demonstration project for future planning (such Colorado's Front Range MPO long range plan), and interagency initiatives such as Oregon's support of the Collaborative Environmental Transportation Streamlining (CETAS) which considers environmental issues relative the larger transportation picture, and the nationwide Eco-Logical approach. Long range plans may be the one common denominator for all states but they are not the only means whereby wildlife and ecosystems concerns can be addressed early on.

5. Begin multi-agency cooperation years ahead of project

If transportation and natural resource professionals can begin cooperating with one another for periods of years ahead of project development, there are multiple opportunities to negotiate differences within the transportation time frames. One common challenge among state transportation departments is the need to move the regulatory permitting process along at a faster pace than the state and federal wildlife agencies can accommodate. An increasingly popular answer to this problem is for state transportation agencies to pay for biological-oriented liaison positions within their state office of the U.S. Fish and Wildlife Service in order to more adequately address their concerns within transportation time constraints. Another approach is for transportation and natural resource professionals and other stakeholders to begin negotiating ecological considerations in large projects five to twenty years ahead of construction. One drawback to this early planning is that many natural resource agency personnel and budgets are already stretched to their limits and cannot afford this early level planning even though it may prevent more time intensive reactions to plans that went on without them. If such agencies could prioritize involvement in transportation planning there may be many more opportunities to mitigate for ecological concerns. An example of a multi-year, multi-partner planning strategy that has become an exemplar of wildlife crossings is the coordinated effort to mitigate for wildlife on US 93 across the Flathead Indian Reservation. The Salish-Kootenai Tribe who owns and resides on the reservation, the Montana Department of Transportation, and U.S. Federal Highways worked together for years in negotiating the plans for an upgrade to the road that will also result in upwards of 42 wildlife crossings.

6. Set up pre-construction and continuous scientific monitoring and coordination

The states with the most successful wildlife mitigation across transportation corridors programs are also the states with strong scientific involvement in these mitigation efforts that result in monitoring and adaptively managing mitigation projects. A critical step in transportation planning is to involve scientists in pre-construction monitoring of the situation and post-construction monitoring to ascertain if the structures were effective. One of the best scientifically documented wildlife mitigation projects is the Payson State Road 260 project across the Tonto National Forest in Arizona. Not only were wildlife biologists involved in planning and pre and post construction monitoring and their results incorporated into an adaptive management scenario to improve on future crossings, but the U.S. Forest Service also supported several engineer positions to oversee the construction of wildlife mitigation structures and the overall construction project to make sure the project was conducted in the environmentally sensitive methods agreed upon.

7. Reach out to non-agency partners

The public and non-profit environmental organizations can also help planning efforts. Citizen scientists are helping to gather data on wildlife moving near the road and wildlife mortality hotspots in places such as Crows Nest Pass on Highway 3 in Alberta, and along State Highway 75 in Idaho. These efforts can help identify specific places in need of mitigation. Non-profit organizations can also help to raise support for transportation projects years before construction such as the I-90 Coalition has done for a series of passage to be built in an upgrade to Interstate 90 across Washington. They can help educate the public on the need for mitigation efforts and even lobby congressional delegates for funding of these efforts such as Colorado's Southern Rockies Ecosystem Project has done for an overpass near Vail, Colorado.

8. **Find everyday opportunities in bridge and culvert replacements**

There are over 200,000 bridges in the United States that will need to be replaced in the next 10 years (MacDonald and Smith 1999) and thousands more culverts that will also need to be replaced. These replacements present opportunities to allow for aquatic and terrestrial wildlife movement. If the states' surveys of culverts and bridges and the long range and STIP transportation plans can be coordinated along with identification of wildlife linkage areas, we can identify hundreds of opportunities in every state where wildlife crossings can be incorporated into projects that are already scheduled. The next logical step would be to make those structures wildlife friendly by such efforts as extending bridges over riparian area's 100-year flood plains to encompass upland for terrestrial movement, and making adjustments to stream culverts to allow a more natural flow to allow for aquatic organisms to travel up and down stream. Minnesota has already begun to do this with their replacement of outdated culverts along Trunk Highway 61 to accommodate terrestrial wildlife along dozens of stream passages that previously did not allow for their movement. Washington and Oregon are involved in ambitious programs which dedicate millions of dollars each year to replace impassable stream culverts with those that allow salmon and other species access to areas they have been restricted from for decades.

9. **Retrofit existing culverts and bridges**

In the web-based priorities survey, participants ranked fifth the need to develop and summarize alternative, cost effective wildlife crossing designs. While it may typically be the goal of natural resource professionals to install major wildlife underpasses and overpasses into future transportation project, everyday efforts may present more opportunities to assist in wildlife movement. Low cost retrofits that can be installed by maintenance crews in their everyday operations ranked eighth in the priorities survey. It is these simple efforts that have the greatest potential to be conducted over the large spatial scale. Simple culvert retrofits include the placement of metal shelves for small and medium wildlife species to move through water filled culverts (Foresman 2003) and the placement of weirs in aquatic culverts to assist in fish movement as has been done in Idaho and other northwestern states as a temporary fix.

10. **Always look ahead to new road improvement projects**

Long range plans and individual transportation projects provide the most probable situations where wildlife mitigation can be placed in a transportation corridor. While wildlife mitigation has been installed solely within its own project, such as was the case with the reptile and amphibian wall and ecopassages along Paynes Prairie in Florida, the majority of wildlife crossings have been established in conjunction with transportation projects. The 50 state long range transportation plans that exist now have taken little to no consideration of wildlife and ecosystem needs. It is within these plans we must begin to work toward such considerations. Those concerned with wildlife and other ecological concerns can begin to promote greater accommodation of wildlife movement by looking to what may become realities in the future and find ways these potential projects must accommodate the natural world. One of the most highly recognized successful wildlife crossing systems in the world is set of 24 wildlife crossings across the Trans Canada Highway in Banff National Park in Alberta. These crossing came about within the context of the twinning project that enlarged the highway. While such projects can be ecologically devastating, early planning for wildlife and ecological needs can be the critical step that makes a tough situation the best it can be for wildlife. Early planning may also help to avoid a transportation project in an ecologically sensitive area, thus preventing the need for mitigation altogether.

The responses from our telephone survey indicate there is a growing awareness of the need to help make the roaded landscape more permeable for wildlife. The results of our web-based priorities survey show that there is a consensus across North America that the top priority for accommodating wildlife within transportation corridors is to incorporate wildlife mitigation needs early in the transportation programming and planning processes. From these research efforts we were able to view the changing paradigm of transportation planning as it develops in response to this greater awareness. Our hope is we help develop a "culture of conservation" in transportation planning across North America that begins to consider and accommodate wildlife and ecosystems across the roaded landscape. From the examples we present, we believe this is not only possible but has been happening across the continent. We look forward to ushering in these changes and the new paradigm.

Biographical Sketches: Patricia Cramer. Patricia (Patty) is a Research Associate with the USGS Utah Cooperative Unit at Utah State University. She is finishing up NCHRP project 'Evaluation of the Use and Effectiveness of Wildlife Crossings, and beginning new research on wildlife use of passages in Utah. Her bachelors, masters, and Ph.D. (University of Florida) degrees are all in wildlife conservation. Her work in road ecology includes membership in the Paynes Prairie Wildlife Coalition which was instrumental in placing a herpetile wall and 4 additional ecopassages for wildlife in Paynes Prairie State Preserve along a state highway in Florida. She has also served as a Visiting Assistant Professor at Montana State University and the University of Florida. Her research interests center on wildlife connectivity in the landscape.

John Bissonette. John is Leader of the USGS Utah Cooperative Fish and Wildlife Research Unit and Professor, Department of Wildand Resources in the College of Natural Resources at Utah State University. His degrees were received from University of Vermont (B.A.), Yale University (M.F.S), and the University of Michigan (Ph.D.). His research interests include landscape ecology, wildlife management, and road ecology. He spent 5 months in Germany in 2002 at the Technic University of Munich as a Senior Fulbright Scholar, and 4 months as a Visiting Professor at the Albert-Ludwigs Universitaet Freiburg in Fall 2005. He was co-author of Road Ecology: Science and Solutions. When not working he rides his horse in the mountains of Utah and his Harley on the back roads of the West.

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