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Major Objectives for Road Ecology to Benefit Transportation and Society

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Abstract: Pinpointing major objectives as a vision for transportation and society provides a cost-effective framework for numerous detailed solutions along the road network. Three major objectives, with road ecology a central player, are highlighted: (1) improve the natural environment close to the entire road network; (2) integrate roads with a sustainable emerald network across the landscape; and (3) integrate roads with near-natural water conditions across the landscape. These are briefly described along with examples of possible key steps ahead. In effect, this big picture or vision is a cost-effective route to achievement and benefit for transportation, the environment, and society.

Background

The world's transportation infrastructure, a remarkable engineering accomplishment, was basically built before the rise of modern ecology. Now in an era of new scientific information and new societal objectives, transportation, science and the public have all moved well ahead. Enhancing the natural environment increasingly stands alongside safety and efficiency in transport as transportation's central goal for the public.

Not surprisingly, along with this major development, the science of "Road Ecology" has emerged, focusing on plants, animals and water related to roads and vehicles (National Research Council 1997, Forman et al. 2003, Forman 2004). Decreasing the apparent drumbeat of public calls for environmental sensitivity in transportation plans and projects, planners, engineers, and managers increasingly find existing solutions, tested options, and solid ecological science readily available for application. Potential partners...transportation departments, natural resource agencies, academics, nonprofit organizations, and the informed public...are discovering common interests and opportunities for a new era of accomplishment. Project by project, countless locations along our road network ecologically improve, and environmental objectives increasingly receive emphasis in transportation plans.

Yet the big picture has yet to coalesce and capture our attention. The greatest environmental gain and the greatest cost benefit for transportation and society are achieved by keeping our eye on the big picture—the major objectives—while we work project by project, location by location, and solution by solution. Three major objectives effectively tie the detailed solutions together in context, and provide the primary gain for transportation and society (Forman 2007a). Road ecology is central to all three.

The Three Major Objectives

1. Improve the natural environment close to the entire road network.
2. Integrate roads with a sustainable natural emerald network across the landscape.
3. Integrate roads with near-natural water conditions across the landscape.

The first objective is a flexible trajectory rather than an end point, with different solutions in different locations. The second effectively meshes road networks with the land's most-valuable large natural areas connected by major wildlife corridors to establish a combined sustainable pattern for the future. The third objective integrates road networks with the land's water-bodies, groundwater/surface-water flows, aquatic ecosystems, and fish populations, so that an effective infrastructure and relatively natural surrounding water conditions are both sustained.

The major objectives constitute a vision appealing to many potential partners and interested parties. The vision cannot be accomplished by the transportation community alone; collaboration with partners is essential, providing planning, project, policy, and public-relations values. Indeed, diverse interested parties with a common vision are an unbeatable recipe for powerful, cost-effective environmental accomplishments for transportation and society. Therefore, consider the three objectives more closely.

Improve the Natural Environment Close to the Entire Road Network

This objective emphasizes a trajectory of improvement rather than identifying and targeting a specific end product with success or failure. The rate of improvement varies from place to place. Location-by-location solutions along a road are appropriate (Bekker et al. 1995, Trocme 2003, Iuell et al. 2003, Forman et al. 2003, van Bohemen 2005). Road-segment-by-road-segment solutions may often be more effective and cost efficient. Road-network-by-road-network approaches are likely to be especially valuable. The types of improvement stretch the imagination---habitat enhancement, vegetated stormwater-pollutant depressions, wildlife underpasses/overpasses, less-intensive mowing regimes to reduce invasive species, diverse deicing approaches, reduced air pollutants, aesthetic noise-attenuation techniques, and much more. Intriguing solutions for all of these currently operate in different nations. In essence, this objective can be accomplished with ample flexibility for transportation and great environmental gain for society.

Integrate Roads with a Sustainable Natural Emerald Network across the Landscape

This second objective emphasizes the most important solution known to protect and sustain biodiversity in a landscape with roads and vehicles, even in the face of urbanization and anthropogenic climate change. The central

component is to identify (even create) and protect emeralds, the most-valuable large natural patches or areas on land, in locations and forms undegraded by roads, traffic, and other human effects (Forman 1995, 2007b). However, significant added value is achieved by effective connections for species movement, and also walkers, among the emeralds. Highways with traffic fragment habitats and are major barriers to effective movement between natural areas. Identifying, creating in some places, and protecting major wildlife corridors emerges as the key to converting a group of large natural patches into an effective functioning emerald network, which can be sustained for the future. Planning road networks hand in hand with landscape ecology is a key to achieving this objective.

Integrate Roads with Near-Natural Water Conditions across the Landscape

This third objective highlights water as the other major flow that crosses a landscape with roads and traffic present. Water is normally a key variable in road construction and, almost always, surrounding wetlands, streams, ponds, groundwater, other water-bodies, and especially water flows are significantly altered (Bekker et al. 1995, Forman et al. 2003, van Bohemen 2005). Thereafter culverts/bridges and roadside ditches are key determinants of water conditions in surrounding areas, and therefore are major "handles" for improvement and attaining the objective. For example, ongoing maintenance and rehabilitation/upgrading projects are cost-effective opportunities to reduce water-flow problems and the water transport of pollutants, including heat, mineral nutrients, heavy metals, and hydrocarbons from roadsides, road surfaces, and vehicles. Wide stream-corridor vegetation has double value, addressing both the second and third objectives (Forman 1995). Achieving near-natural conditions in essentially all water systems of the surrounding landscape provides many important societal benefits, from flood control and less-scarce-and-costly clean-water-supply to biodiversity, aesthetics, and happy fishermen.

The three objectives focus on the existing infrastructure on which we all depend. For new road construction, incorporating the objectives into planning can eliminate the later need to address them, an environmentally salutary and cost-effective accomplishment.

Promising Steps Ahead

How do we get from here to there? Think big. Large areas are a surrogate for long term. Planning and improving whole landscapes and road networks is effectively long-term thinking, and is likely to produce sustainable patterns that persist. Or, achieve success in a small area, and replicate it flexibly in similar form so that it spreads widely across the road system. The first objective above is especially amenable to inexorable incremental progress, while the second and third objectives fit progressive steps logically into a framework or vision.

An array of important ecological steps is readily available for use in transportation, as the following examples emphasize (Bekker et al. 1995, Forman et al. 2003). Ongoing bridge and culvert replacement or upgrading is a cost-effective opportunity to combine benefits for water, wildlife, and other societal goals. Identify and map the major water flows and species movements across landscapes, to identify potential conflict points with the road system (Forman et al. 2003). Wildlife underpasses and overpasses are the best way for animals in major wildlife corridors to cross highways (Trocme 2003, Iuell et al. 2003, Forman et al. 2003, van Bohemen 2005). Roadside woody vegetation in distinct wildlife-crossing zones is also effective for animal crossing of roads (Forman and McDonald 2007). Determine and apply the ecologically and travel-optimum road network form and its underlying principles (Forman 2004). The road-effect zone, combining engineering and landscape ecology perspectives, is particularly valuable for transportation planning (Forman et al. 2003, van Bohemen 2005).

Indeed, appoint a respected blue-ribbon panel of transportation, engineering, ecology, planning, and other experts to critically evaluate the objectives, and outline the trajectory and timetable to success. Establish high-profile pilot projects (with monitoring) widely across the land. Continue attracting the cutting-edge scholars in road ecology, and fund high-quality scientific research (National Research Council 1997, Forman et al. 2003, Roedenbeck et al. 2007). Accomplish steps in the context of other major concerns or crises, such as greenhouse gases/climate change, urbanization-spread patterns, and water scarcity. In short, lots of promising approaches await our leadership, stepping forward to accomplish the three major objectives—the vision—for transportation, for the environment, and for society.

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