Target Orientation for Ecologically Sound Road Management in Sweden

Andreas Seiler, Anders Sjölund

How can ecological concerns be considered in transport planning? The Swedish Road Adminstration has initiated a target-orientated approach in order to establish objectives and criteria for integrating natural and socio-cultural assets into road management.

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Abstract

Target orientation in road management allows consideration of non-monetary landscape values that have been largely ignored due to lack of assessment tools and insufficient knowledge. We discuss shortcomings in traditional road planning and describe the new Swedish target-oriented approach to integrate natural and socio-cultural assets in road management. The approach is based on tangible environmental targets and criteria that can be enforced.

We emphasize the advantages of the new approach and conclude that target orientation helps to integrate environmental impact assessment into the planning and performance control system. It enhances landscape-ecological concern among planners and strengthens the dialogue between engineers and environmentalists. Target orientation requires an elaborate monitoring system that has roots in a profound ecological understanding. In order to monitor performance and to validate measures mitigating negative effects of landscape fragmentation, further methodological development and applied ecological research are necessary.

Keywords

effect validation, environment, impact assessment, landscape fragmentation, monitoring, performance control, road management, strategic development planning, sustainable development, traffic planning

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Sweden ranks among the European countries that are least fragmented by transport infrastructure (Trocmé et al. 2003). Large unfragmented areas up to 19 000 square kilometres still exist in the mountainous Northwest, and the effective mesh size m_{eff} (for a definition, see Jaeger and Holderegger 2005, in this issue) of the national main infrastructure network is about 7 160 square kilometres. This is more than 20 times greater than the corresponding values in the Netherlands or Germany (see figure in Jaeger et al. 2005, in this issue). 70 per cent of the traffic is confined to a few major trunk roads carrying on average 6 000 vehicles per day (Seiler and Folkeson 2003). Urban areas (defined as having more than 200 inhabitants, ranging from small villages to the largest cities) take up less than three per cent of the Swedish land area (Statistics Sweden 2004). Indeed, most of Sweden is remote from busy cities, noisy highways, and polluting industry.

However, habitat fragmentation due to traffic and infrastructure is a concern and is evoking growing interest even within the transport sector (Seiler and Folkeson 2003). Conventional practice in infrastructure planning and impact assessment has been criticised for not being successful in evaluating and counteracting adverse impacts on landscapes and biodiversity (De Jong et al. 2004). Landscape connectivity, processes and functions did not receive the same concern as air quality or protection of sites and artefacts (Nilsson and Sjölund 2003). Seiler and Eriksson (1997) made first suggestions to integrate landscape-ecological concepts in infrastructure management. Recently, an action plan to remedy barrier effects of infrastructure on people (and animals) in the major urban regions of Stockholm, Gothenburg, and Scania has been published (Banverket 2005). A research programme on integration of ecological and socio-cultural dimensions in infrastructure management has been initiated (Emanuelsson et al. 2005).

Approaches towards defragmentation in Sweden are governed less by acute conservation needs than by the overall endeavour to attain sustainable development (SNRA 2001, Swedish Government 2000). This also implies a sustainable transport system (Swedish Government 2001). An important factor therein is target orientation at all management levels.

Target Orientation in Road Management

The Swedish Road Administration, in cooperation with several other transport and environmental authorities, has been working on a programme entitled *Objectives and Criteria for Consideration of Natural and Socio-Cultural Heritage Assets in the Road Transport System* (Eriksson et al. 2005). Its basic idea is to target-control all management processes – i. e., strategic planning, road project planning, road maintenance and operation – so that protection and development of landscape-ecological functions and natural and cultural heritage assets can be enforced (SIKA 2003). The Swedish Parliament stipulated that 90 per cent of all newly constructed roads and 40 per cent of all maintenance districts must achieve certain quality requirements for natural and cultural heritage assets by the year 2007. By 2010, 15 per cent of the existing road network must meet these requirements as well (Nilsson and Sjölund 2003).

This programme shall be tested in road management and be improved from 2005 to 2007 (SIKA 2003). To further develop it, it is necessary:

1. to identify landscape-ecological functions and environmental values that are affected by transport infrastructure to a degree that impairs sustainability goals;
2. to establish a set of indicators for these values;
3. to define quality criteria that specify the desired quality of the environment and infrastructure network, including mitigation measures;
4. to set up performance targets that state which, when and to what extent quality requirements are to be met;
5. to develop a system for monitoring and quality assurance, allowing validation and calibration of criteria, targets, and mitigation measures.

Environmental Values and Objectives

Which environmental values relate to landscape functioning and quality? What is an "innocuous environmental impact" on these values? There is no simple answer to these questions as the impacts vary between landscapes, species, and types of infrastructure. Objectives and criteria, however, should be simple and suitable to be communicated to and understood by road planners and decision makers (see Schupp 2005, Penn-Bressel 2005, both in this issue). At present, landscape-ecological concern in target-oriented road management is related to the impact on selected indicators that are of special ecological, economic, or legal interest (Eriksson et al. 2005). These indicators include: (1) focal species such as moose *(Alces alces)*, otter *(Lutra lutra)*, and amphibians (as group); (2) specific habitat-related problems such as malfunctioning road culverts and small bridges on streams and rivers that may impose substantial barriers to aquatic and semi-aquatic species moving upstream; (3) infrastructural barriers for animal movement and human outdoor activities, identified and ranked in workshops during 2005 (Banverket 2005). As knowledge progresses, the list of objectives (figure 1) related to these indicators will be optimised, and criteria and targets will be defined more precisely.

FIGURE 1: Amongst other objectives, the new target-oriented road management in Sweden aims at reducing wildlife (picture: wagtail) mortality on roads.

Implementation and Monitoring

Road maintenance: Maintenance of the national road network is carried out by contractors in individual districts. Maintenance tasks are specified in the contract and regulated based on quality objectives defined at national and regional level. These objectives are related to the existing or desired environmental condition in the particular district (see table). They are expressed as performance targets (for example, when and to what degree requirements are to be met) that are followed up in annual reports of the road administration. The focus is to assure the functionality of mitigation measures by adequate maintenance.

Existing roads: The greatest challenge in sustainable road management is continuously adapting and upgrading the existing infrastructure network to match current quality standards and requirements. In order to identify and evaluate discrepancies between existing and desired environmental conditions, in-depth analyses of landscape values, functions, and processes are required, and impacts on these qualities need to be monitored. Mitigation options are to be devised as condition and activity performance targets in action plans for new investments or infrastructure maintenance.

New road projects: Planning of infrastructure is usually initiated when a transport-related problem or task has been recognised. Traditionally, planning has been governed by short-term, often >

non-coordinated projects that focus on minor infrastructure sections and thereby ignore cumulative impacts such as fragmentation of landscapes. Landscape-ecological concerns first entered the planning process in connexion with localisation and project planning and was perceived as an economic cost or practical hindrance to the realisation of an already anticipated development. Target orientation shall help to integrate environmental concerns already at strategic and initial planning levels. Existing as well as desired environmental qualities shall be identified through landscape analysis and expressed as specific project targets that relate to national and regional quality objectives. Project targets will be specified in greater detail during the consecutive planning phases and guide the choice of mitigation measures. The success of each road project is to be monitored and evaluated with respect to the achievement of these targets.

Monitoring: An efficient performance control and calibration system is essential for the success of this approach (figure 2). Criteria for performance control should focus on whether or not measures have been implemented and whether a certain condition or state has been reached. The Road Administration shall control performance annually. At regular intervals, the aspired environmental effects of measures must be validated in order to calibrate performance targets. This requires expertise in ecology and engineering and should be conducted by an external control organisation. No such validation system has yet been developed.

Achievements and Challenges

First tests of target orientation in road management have shown encouraging results (Lisitzin and Ljung 2003): Target orientation enhances awareness for natural and socio-cultural assets, opens up dialogue and interaction among the players and helps achieving a better balance between the different interests in the planning process. The approach does not require a new planning process, but can be integrated into existing routines. New information can be included in the system without need of modification, allowing for continuous refinement and enhancement. Target orientation helps integrating environmental impact assessment into the planning and performance control system. Thus, environmental responsibility is an obligation to be fulfilled by the initiator of an infrastructure project, rather than having to be enforced by external control organisations.

On the other hand, the approach requires that qualities and mitigation needs are expressed as tangible targets and criteria. For this and for performance control and validation, further methodological development and applied ecological research is needed: Knowledge on dose-response relationships and critical thresholds regarding the impact of traffic and infrastructure on species and landscape-ecological qualities must be improved. The efficacy of mitigation measures must be studied in detail so that performance control and validation can be conducted separately. How many fauna passages are required, or how effective must

TABLE: Proposed objectives and quality criteria for roads, to be tested and improved from 2005 to 2007 (Eriksson et al. 2005).

objectives	
A	Quality and natural dynamics of wildlife habitat must be maintained.
B	Wild animals must be able to safely cross roads and move through the landscape as provided by natural conditions.
C	Wildlife mortality on roads must not endanger local populations or harm drivers and passengers.
■ **quality criteria relating to road maintenance**	
A1	Plantations and other measures providing or supporting wildlife habitat are maintained to keep them functional and effective.
B1	Road culverts or bridges do not impose dispersal barriers to aquatic and semi-aquatic species in designated water courses.
B2	Fauna passages, road culverts, and other measures allowing movement of animals across infrastructure are operative and effective.
C	none
■ **quality criteria relating to existing roads (gap analysis)**	
A2	Bays and creeks are not entirely separated by road embankments from the main water body, allowing natural changes in water level.
A3	Road embankments in bays and creeks provide passage for terrestrial animals along the shoreline.
B1	same as above
B3	Animals can safely cross roads with over two lanes or > 8000 vehicles/day. Wildlife passages exist where topography provides opportunities.
B4	Large ungulates can cross fenced roads at least at one spot every ten kilometres.
B5	Wildlife can travel along water courses, valleys, and other natural corridors in the landscape.
C1	Amphibian tunnels are built at places where amphibians migrate and have been killed in large quantities by traffic.
C2	Passages for otters are built at places where otters repeatedly have been killed by traffic.
■ **quality criteria relating to new road projects**	
A4	Habitat patches are of such quality, size, and distribution that they provide suitable habitat context and functions for affected wildlife.
A5	Birds sensitive to traffic noise have good chances to successfully breed in important breeding habitats.
B3 – B5	same as above
C	none

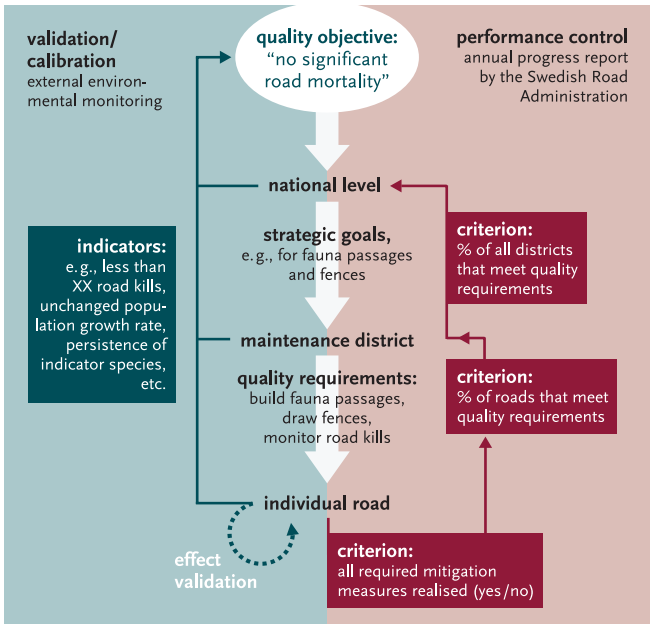

FIGURE 2: The Swedish target-oriented road monitoring system allows validation of effects, calibration of targets, and optimising of mitigation measures concerning landscape fragmentation. Performance control facilitates strategic planning and budget adjustments.

wildlife fences be in order to satisfy the objective "no significant road mortality" (see table and figure)? Are fences and passages the most cost-efficient solution to the problem of wildlife mortality? Where are the critical thresholds in landscape fragmentation due to transport infrastructure (see Frank et al. 2005, Jaeger and Holderegger 2005, both in this issue)? Since many of these questions have not yet been answered, targets initially have to rely on best available knowledge.

Effective methods for functional landscape evaluation need to be developed to support decision making at the early planning stages. There is also uncertainty about how goals and objectives can be linked to or expressed as legal instruments, and what consequences a failure in the achievement of goals should entail for a project or district.

We believe that, at least in Sweden, target-orientated management will successfully define guidelines for the environmental commitment of the transport sector over the next decade.

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