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Abundance of red-listed species in infrastructure habitats – "responsibility species" as a priority-setting tool for transportation agencies´ conservation action

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Abstract

Road and railroad verges may contribute to nature conservation by providing habitat for many species, but due to limited resources, there is a need to select the most important road and railroad stretches for adapted management. We explore the responsibility species concept as a tool for the Swedish Transport Administration to make this selection. We propose lists of candidate responsibility species based on relative abundance of conservation priority species in the vicinity of roads and railroads, respectively. Abundance data were derived from crowd-sourced species observations. Species with ≥20 % of observations in infrastructure habitats were included as candidate responsibility species. For roads 32 species were included in the list, for railroads seven species, with an overlap of three species between the lists. We analyzed habitat and management requirements of the listed species to try identifying functional groups. Most of the species require open or semi-open habitats, mainly dry grassland or heathland on sandy or limy soil, un-sprayed crop fields, or solitary trees. Host plants or substrates include broom (genus *Genista*), patches of bare soil, and sun exposed wood. Conservation actions prescribed for the species include, e.g., late or irregular mowing, removal of the field layer, planting of host species, protecting and providing particular substrates, and special protection of certain sites. We argue that road and railroad managers are particularly well suited to conduct most of these actions. We consider the responsibility species concept to be a useful tool for transportation agencies to set priorities for adapted verge management, and the current method to be effective in identifying a first list of candidate species. We discuss the possibility of also identifying responsibility habitats or general management measures based on the results.

Keywords
Infrastructure habitats, Railroad verge, Responsibility species, Road verge, Verge management

Introduction

While the transportation infrastructure has many negative impacts on wildlife, such as habitat loss, disturbance, pollution, mortality and barrier to movements, road and railroad verges may provide important habitat for many species (Way 1977, Forman et al. 2003, Huijser and Clevenger 2006). The sun-exposed grasslands or large trees in roadsides create refuge for many vascular plants and invertebrates that are otherwise in decline due to drastic changes in land use (Eversham and Telfer 1994, Persson 1995, Thomas et al. 2002, Saarinen et al. 2005, Hopwood 2008, Lennartsson 2010). Similarly, railroad switchyards and embankments provide dry, open land often with a diverse flora and invertebrate fauna (Stenmark 2010). Transportation corridors offer a variety of substrates, soil-types and nutrient levels on a small scale, and in agricultural regions, urban areas, and other highly modified landscapes, road and railroad verges may be the only semi-natural habitat that remain (Thomas et al. 2002, Forman et al. 2003, Huijser and Clevenger 2006). Moreover, roads and railroads stretch along the landscape, with a potential to connect remnant habitat patches (Vermeulen 1994, Eversham and Telfer 1994, Tikka et al. 2001, Viles and Rosier 2001, Thomas et al. 2002, Hopwood 2008). As being present in most landscapes, the green network formed by semi-natural strips along roads and railroads has been labelled “a centerpiece of conservation” (Forman et al. 2003).

In Sweden, a large proportion of the state owned road verges has been surveyed for plant biodiversity and some particularly species-rich verges are subject to adapted management, mainly late mowing (Swedish Road Administration 2004). Such species-rich road verges are estimated to cover six per cent of all state owned roads, or a total of 36,000 km, but a long-term goal is to reach ten per cent (Stenmark 2012). Also, some railroad environments, tree rows and large solitary trees along roads have been surveyed (e.g. von Platen 1996, Larsson and Knöppel 2009) and active management to maintain biodiversity has started at some places. Well-designed action for managing species-rich road and railroad verges is essential to keep or enhance habitat quality and to avoid damage to biodiversity during road or railroad maintenance (e.g. mowing, ditching, or spraying) and upgrading (Thomas et al. 2002, Forman et al. 2003). The financial and human resources for such action are however limited, and the Swedish Transport Administration (STA) has asked for means to identify priority road and railroad verges for adapted management.

Here, we explore the possibility of applying the concept of responsibility species (e.g. Dunn et al. 1999, Schmeller et al. 2008) as a priority-setting tool for the transportation agency´s conservation action. A responsibility species is broadly defined as a species for which a large proportion of its entire range or population occurs within the geographic area of an administrative entity (a country, a regional authority etc.). The approach of assigning conservation responsibilities developed in the 1990s, triggered by the shared common responsibility for the protection of global biodiversity agreed in the Convention on Biological Diversity (CBD). National responsibilities for the global conservation of species and habitats is now a developed method for determining conservation priorities, particularly in Europe (Schmeller et al. 2008). Some European countries have also distributed their conservation efforts nationally by assigning responsibility species to county administrations and municipalities (Reck et al. 1996, Larsson 2006, Jooss et al. 2009). However, the concept of responsibility species has to our knowledge not been applied to spatially less coherent administrative units, such as a network of linear infrastructures. Such an approach would support the sectorial involvement in biodiversity conservation required by CBD (article 6b), and we believe that the approach may be fruitful particularly in the case of a national transportation network, where the actors are relatively few and the management decisions centralized.

Over the years, a number of different methods have been used to identify responsibilities for species conservation (Schmeller et al. 2008). Most of these methods combine the species´ conservation status (i.e. red-listing, rarity, or population trend) with a measure of the relative importance of the area in question, based on either distribution or abundance. When dealing with a spatially non-coherent administrative unit, such as a road or railroad network, species distribution can obviously not be used as a basis, due to the coarse geographical level on which distributions are typically defined. Accordingly we used the abundance of a species to investigate the importance of road and railroad sides, and did this for a selection of red-listed species. In order to get the large number of data points needed for this approach, we used databases for crowd-sourced species observations. We propose one method to identify candidate responsibility species for Swedish roads and railroads respectively, and try identifying functional groups regarding habitat and management requirements for the species derived with this method. We discuss the applicability of the responsibility species concept to infrastructure habitats, and the possibility also to identify responsibility habitats or general management measures based on the functional grouping.

Methods

In this quest for responsibility species for the STA, we included only red-listed species subject to a national Swedish initiative for making species-wise action plans (Gärdenfors 2003). Swedish red-listed species have been assigned following IUCN criteria (Gärdenfors 2000), and a sub selection of species for action plans has been done, independently from the present study, by the Swedish Species Information Centre, based on a combination of extinction risk, international responsibility, knowledge level, and susceptibility to management action (Gärdenfors 2003). Hence these species have been identified as priority species by Swedish conservation authorities. Species with action plans also tend to be subject to a larger public interest and therefore better searched for. We excluded species groups that were assumed not to depend on road or railroad verges (fish, mollusks and algae) and species groups that should not be favored near traffic due to the road kill hazard (birds, mammals, reptiles and amphibians).

We derived observational data from the years 1980-2010 from two data bases available within an internet-based platform for voluntary reporting of species observations: the Swedish species observation data base and the Species Gateway (http://www.artportalen.se), both managed by the Swedish Species Information Centre. The two reporting systems are not overlapping with regard to observations and were therefore treated as one dataset. Each observation in these bases contains data on location (with estimated accuracy), date and observer as a minimum; sometimes additional data such as habitat type are given. Only observations with a reported precision <100 m were included. Observations from the same geographical point were reduced to one observation, to exclude double counts.

Of the remaining observations, those within 50 m from state owned roads or railroads (measured from the road or railroad center) were attributed to the infrastructure habitat. This distance was arbitrarily set to cover the entire road or railroad corridor. We are aware that this procedure resulted in some observations outside of the actual corridor being attributed to the infrastructure habitat. We do not see this as a problem however, because it can be argued that species dwelling in such proximity to a road or a railroad may be affected by its management, and may therefore qualify as a responsibility to the infrastructure manager.

Only species with a minimum of three observations were included in the analyses, to avoid the most obvious randomness in results. We calculated the proportion of all observations of each species in infrastructure habitats in relation to the country as a whole. As a cut-off value for inclusion in the list of candidate responsibility species we set 20 %, because it is roughly in line with what has been previously applied to assign responsibility species in Sweden (Larsson 2006) as well as other Scandinavian countries (e.g. Stoltze and Pihl 1998). The Swedish road and railroad network covers roughly 1.5 % of the total land surface (Seiler and Folkeson 2006), so by selecting 20 % as cut-off, we hope to have included only species that are disproportionally often found in infrastructure habitats. Road sides and railroad sides were analysed separately. In order to identify functional groups among the candidate responsibility species, we summarized habitat requirements and management action proposed in the action plans and in species fact sheets linked to the red-list (references given in Table 1–2).

Results

Of the total of 308 species included in the analysis, 197 species (64 %) were reported with at least one observation in road habitat and 53 (17 %) with at least one in railroad habitat. The lists of candidate responsibility species (i.e. ≥20 % of observations in infrastructure habitat) contained 32 species for road habitat (Table 1) and seven for railroad habitat (Table 2). The overlap between species in road and railroad habitats was large; 47 of the 53 species found in railroad habitat were also found in road habitat. Among candidate responsibility species, there was an overlap of three species: the longhorn beetle *Phytoecia nigricornis*, the bee *Anthophora plagiata*, and the leaf mining moth *Phyllonorycter staintoniella*. The total number of candidate responsibility species derived with this method was therefore 36. Among these species, 23 were invertebrates (all seven in railroad habitat), seven vascular plants, and six fungi/lichens (Table 1–2). Among the invertebrate species, *Lepidoptera* (moths and butterflies) were the main taxonomic group, with 12 species.

Almost all of the listed species require some kind of open habitat, such as grassland, heathland, crop field, or a general openness in the surroundings (holds also for species on trees, fence poles and buildings). Nine species on the road list grow in managed grasslands and three in un-sprayed crop fields. Dry or sandy soil (or both) is required by 14 and six species on the road and railroad lists, respectively; limy soil is required by five species on the road list. Ten road species and one railroad species are favored by bare soil during at least part of their life cycle, either through physical disturbance of the field layer (such as erosion, livestock tramping, or driving with vehicles) or in crop fields. Five of the seven species on the railroad list live on broom (genus *Genista*). Large or solitary trees create habitat for seven species on the road list, and processed timber in fence posts or wooden houses is substrate for four species on the same list. A particular preference for warm microclimate (sun exposed sites, such as southern slopes or wood in solitary trees) is described for eight of the species on the road list and four on the railroad list.

In accordance with the species´ requirements described, clearing of shrub in order to keep habitat openness is a common theme in the prescribed management. Many of the species are in need of maintained or adapted (late or irregular) mowing, sometimes in combination with field layer removal (soil scarification or burning). Species growing in crop fields require adapted farming (choice of crop and seed mix, no chemicals, etc.). In some cases, protecting and providing particular substrates (hollow trees, dead branches, unproofed timber) or planting host species is proposed. For species where the remaining sites are particularly few, special protection of these sites, and fine-tuned management in consultation with local conservation authorities, is advised. Sustained or strengthened population monitoring is recommended for all species (therefore not mentioned in Tables 1–2), to keep track of population trends and effects of conservation measures.

Discussion

The importance of certain road and railroad verges as habitat refuges for rare or declining species has been reported from previous research and conservation case studies, both in Sweden (Persson 1995, Weidow 2008, 2009, Stenmark 2010, Lennartsson 2010) and other countries (the Netherlands: Vermeulen 1993, Eversham and Telfer 1994, Van Rossum et al. 2004, Schaffers et al. 2012; Belgium: Tanghe and Godefroid 2000; Great Britain: Thomas et al. 2002; Finland: Koivula et al. 2005; South Africa:

Table 1. Priority species for Swedish conservation (=red-listed species with species-wise action plans) with at least 20 % of the observations nationally in road habitats. Habitat requirements and management described derive from general descriptions, and are not particularly adapted to road habitats. Species in bold are found also in Table 2.

Species	Total no of obs.	% in road-sides	Habitat requirements (substrate, host species, microclimate etc.)	Management requirements	Source
Phytoecia nigricornis (a longhorn beetle)	3	66.7	Dry, sandy soil with *Solidago virgaurea*, sun exposure	Clearing of shrub	1
Sphinctrina anglica (a lichen)	13	61.5	Fence posts, timber houses	Protecting current substrates and providing new	2
Genista germanica (German greenweed)	10	60.0	Dry heaths, sun exposure	Soil scarification, burning, clearing of shrub	3
Andrena labialis (a bee)	31	58.1	Dry, sandy soil with *Fabaceae,* partially bare soil	Adapted mowing, soil scarification	4
Minuartia viscosa (Sticky sandwort)	8	50.0	Dry, sandy, limy soil, sun exposure	Clearing of shrub, soil scarification	5
Senecio erucifolius (Hoary ragwort)	16	50.0	Dry, limy grasslands	Mowing, clearing of shrub	6
Astragalus penduliflorus (Mountain lentil)	125	43.2	Sandy soil	Late mowing, clearing of shrub	7
Eupoecilia sanguisorbana (a moth)	5	40.0	Grasslands with *Sanguisorba officinalis*	Adapted mowing, favouring host species	8
Anthemis cotula (Stinking chamomile)	27	37.0	Edges of un-sprayed crop fields	Adapted farming, no pesticide use, soil scarification	9
Caloplaca furfuracea (a lichen)	47	36.2	Fence posts, timber houses	Protecting current substrates and providing new	2
Rhinanthus serotinus ssp. apterus (a yellow-rattle)	17	35.3	Un-sprayed crop fields	Adapted farming, no pesticide use	9
Andrena batava (a bee)	3	33.3	Solitary willow shrubs, sandy, partially bare soil	Protecting solitary willow, soil scarification	10
Andrena morawitzi (a bee)	3	33.3	Solitary willow shrubs, sandy, partially bare soil	Protecting solitary willow, soil scarification	11
Chlorophorus herbstii (a longhorn beetle)	3	33.3	Tree branches, oak fence posts, sun exposure	Clearing of shrub, keeping dead branches	12
Diploicia canescens (a lichen)	3	33.3	Old, solitary, deciduous trees	Protecting solitary trees and tree rows	13
Agonopterix atomella (a moth)	7	28.6	Dry heaths with *Genista*	Soil scarification, burning, clearing of shrub	3
Coleophora conyzae (a moth)	7	28.6	Limy grasslands with *Inula*, sun exposure	Mowing, clearing of shrub	14
Albatrellus cristatus (a fungus)	8	25.0	Bare, hard soil in beech forest	Protecting beech trees at current sites	15
Anthophora plagiata (a bee)	4	25.0	Bare clay, tiled houses, sun exposure	Protecting current substrates and providing new	16
Phyllonorycter staintoniella (a moth)	4	25.0	Dry heaths with *Genista*	Soil scarification, burning, clearing of shrub	3
Ramaria roellinii (a fungus)	4	25.0	Dry, sandy, limy grasslands with partially bare soil	Soil scarification, clearing of shrub	17
Andrena hattorfiana (a bee)	981	23.6	Dry, sandy grasslands with *Dipsacaceae*	Late mowing, clearing of shrub	18
Eucosma scorzonerana (a moth)	17	23.5	Grasslands with *Scorzonera humilis*	Mowing, clearing of shrub and forest	19

Species	Total no of obs.	% in road-sides	Habitat requirements (substrate, host species, microclimate etc.)	Management requirements	Source
Aethusa cynapium var. agrestis (Fool´s parsley)	44	22.7	Un-sprayed crop fields	Adapted farming, no pesticide use	20
Cyphelium trachylioides (a lichen)	333	22.5	Fence posts	Protecting current substrates and providing new	2
Plebejus argyrognomon (Reverdin's blue butterfly)	76	22.4	Small, sun exposed clearings with *Astragalus glycyphyllos*	Late mowing, planting host species	21
Canthophorus impressus (a true bug)	83	21.7	Dry grasslands with *Thesium alpinum*	Mowing, clearing of shrub	22
Exocentrus adspersus (a longhorn beetle)	33	21.2	Oak branches, sun exposure	Keeping dead branches	23
Lycaena helle (Violet copper butterfly)	105	21.0	Grasslands and springs with *Polygonum viviparum*	Adapted mowing	24
Aphodius merdarius (a dung beetle)	87	20.7	Dry grasslands with horse dung	Mowing, providing new substrate	25
Cheiridium museorum (a pseudoscorpion)	15	20.0	Hollow deciduous tress	Protecting hollow trees, keeping dead wood	26
Triaxomasia caprimulgella (a moth)	5	20.0	Hollow deciduous tress	Protecting hollow trees	27

Sources for descriptions of requirements: 1) Nilsson 2013, 2) Hermansson and Jonsson 2011, 3) Larsson 2007, 4) Karlsson et al. 2011, 5) Mattiasson 2009, 6) Andersson 2006, 7) Grundström 2009, 8) Elmquist 2007, 9) Kloth 2007, 10) Johansson 2012, 11) Johansson 2013, 12) Ehnström 2006, 13) Arup 2006, 14) Lennartsson and Björklund 2014, 15) Svensson and Ryberg 2008, 16) Cederberg 2013a, 17) Nitare 1997, 18) Cederberg 2013b, 19) Björklund and Palmqvist 2007, 20) Aronsson and Jonsell 1996, 21) Elmquist 2010, 22) Karlsson 2011, 23) Franc 2013, 24) Lindeborg 2014, 25) Ljungberg 2007, 26) Sandström 2007, 27) Bengtsson 2011.

Table 2. Priority species for Swedish conservation (=red-listed species with species-wise action plans) with at least 20 % of the observations nationally in railroad habitats. Habitat requirements and management described derive from general descriptions, and are not particularly adapted to railroad habitats. Species in bold are found also in Table 1.

Species	Total no of obs.	% in road-sides	Habitat requirements (substrate, host species, microclimate etc.)	Management requirements	Source
Phyllonorycter staintoniella (a moth)	4	50.0	Dry heaths with *Genista*	Soil scarification, burning, clearing of shrub	1
Syncopacma suecicella (a moth)	4	50.0	Dry heaths with *Genista pilosa*, sun exposure	Soil scarification, burning, clearing of shrub	1
Mirificarma lentiginosella (a moth)	13	38.5	Dry heaths with *Genista*	Soil scarification, burning, clearing of shrub	1
Phytoecia nigricornis (a longhorn beetle)	3	33.3	Dry, sandy soil with *Solidago virgaurea*, sun exposure	Clearing of shrub	2
Scythris crypta (a moth)	11	27.3	Dry heaths with *Genista pilosa*, sun exposure	Soil scarification, burning, clearing of shrub	1
Anthophora plagiata (a bee)	4	25.0	Bare clay, tiled houses, sun exposure	Protection of current sites, providing new substrate	3
Coleophora genistae (a moth)	5	20.0	Dry heaths with *Genista pilosa*	Soil scarification, burning, clearing of shrub	1

Sources for descriptions of requirements: 1) Larsson 2007, 2) Nilsson 2013, 3) Cederberg 2013

Tshiguvho et al. 1999; USA: Hopwood 2008). The present study confirms these results, and consolidates the picture by showing that a number of priority species for Swedish conservation actually have a large proportion of their known sites in or near transport infrastructures. The future conservation status of these species can actually be considered to be in the hands of the road and railroad manager to a large extent. Hence, a certain commitment of the transport administration to the conservation of these species appears crucial. Adopting them as responsibility species would be one way to manifest this commitment, and to help prioritizing among conservation actions.

With the current method, a number of candidate responsibility species were identified for Swedish road and railroad management, respectively, based on the national list of action-plan red-listed species. We acknowledge that the method could be applied differently, for example with a different selection of species to be analyzed (such as all red-listed species, or the inclusion of vertebrates), or using another cut-off level than 20 % for inclusion. A sensitivity analysis of the cut-off level could further inform a future selection of responsibility species and management action. Also the analysis could be applied on subsections of the infrastructure network in order to identify regional or local priorities. What species to finally adopt is a management decision that should be guided not only by the relative abundance in infrastructure habitats, but also by how well the specific requirements can be met by the infrastructure manager. Another aspect is whether certain actions serve several species; then all these species can be adopted, also those with a lower proportion of occurrences in infrastructure habitats. Hence, supplementing methods may be needed to arrive at a final list of species. The ultimate goal should be to find cost-efficient solutions for species conservation on the national level.

Although we did not analyze the habitat and management requirements of our candidate species systematically, we believe that some patterns of relevance to infrastructure management are still evident. Most of the species require open habitats; mainly dry grassland or heathland on sandy or limy soil, or un-sprayed crop fields. Particular open-habitat requirements include *Genista*-heaths, patches of bare soil, and sun exposed trees and fence posts of un-proofed wood. The requirements indicate that a list of responsibility species will help the infrastructure manager in selecting and adapting actions.

The preference for openness among species in infrastructure habitats is indeed not surprising, but it illustrates well that the clearing of shrub encroaching into road and railroad verges that is done for traffic safety also may have a value for species conservation. The same holds for roadside mowing. If minor adjustments of the present road maintenance operations (regarding extent, frequency, timing, machinery, etc.) are needed to reach the specific management requirements stated in the respective management plan, this may be achieved to a small cost. Similarly, soil scarification could be conducted efficiently with diggers engaged for other purposes in road management. In the case of soil scarification however, care must be taken not to facilitate invasion of alien species.

Host plants for insects, for example native broom species (*Genista* sp.), can be planted or promoted in verges near the present sites of the respective species, or even be integrated in standard landscaping programs. Tree management operations in the road environment already focus on creating tree continuity, with planting of new tree rows, gradual tree replacement, and to an increasing extent leaving old trees and dead wood in place or piled in safe places (Stål and Bengtsson 2010). Also here, minor adjustments to match the needs of particular species may be achieved to a small cost. Species growing in un-sprayed crop fields seem less obvious to promote in association with road maintenance, although soil scarification conducted in distant parts of the verge may be of some help for the survival of local populations.

Preferences of responsibility species can also guide the selection of road or railroad sections or regions to focus on for habitat enhancement. For example, our results suggests that roads and railroads going through areas with sandy or limy soils are likely to have better conditions as habitat for rare species, and for the spreading of individuals from and to the surroundings. Another example is that sun exposed slopes generally provide better conditions. The habitat preferences of responsibility species may be translated into a corresponding list of responsibility habitats; such a list is likely to be an equally efficient tool in infrastructure planning. Regional differences in abundance of the responsibility species may further indicate in what management districts habitat enhancement is of higher priority.

Because of the 50 m buffer from the centerline used to define infrastructure habitat, some of the identified species may indeed not occur in the infrastructure corridor as such, but only by coincidence have their last residences near infrastructure. The current method cannot be used to identify these species, but must be complemented by field visits. For such species, the management of the actual verges may not be critical, but rather that special attention is paid during ordinary road or railroad maintenance and upgrading, so that the sites are not spoiled by mistake. Hence, also here the responsibility species concept can potentially aid the choice of action.

When providing habitat for animals in the vicinity of roads and railroads, clearly the risk of creating ecological traps (e.g. Schlaepfer et al. 2002) must be considered. Amphibians and reptiles as well as mid-sized and large mammals can experience high levels of traffic mortality (Fahrig and Rytwiski 2009), and accordingly we have not included vertebrates in our study. Concerning insects however, available research suggests that traffic mortality rarely has effect on the population level (Munguira and Thomas 1992, Hopwood 2008, but see Weidemann and Reich 1995), and that the benefits from infrastructure habitats outweigh the hazard from passing vehicles (Thomas et al. 2002, Hopwood 2013, Skorka et al. 2013), but the matter deserves further study. We suggest that the hazard will be minimized by directing habitat improvement or creation to low traffic infrastructure, or to the parts of the infrastructure corridor that is most distant from the traffic.

One management action required for all the listed species is keeping track of the population development, both in and outside infrastructure habitats. Data on how the relative importance of infrastructure habitats develops with time may justify revision of the responsibility species list, and also give insight in the success of measures taken to conserve the species in different habitats.

Our results illustrate the importance of infrastructure habitats in relation to other habitats in the landscape, and hence points at the necessity for transport administrations to be integrated in nature conservation on the landscape scale. With “the centerpiece of conservation” (sensu Forman et al. 2003) in their hands, infrastructure managers may even function as catalysts for cross-administrational conservation efforts. Effective partnerships are essential. A conservation responsibility should not be misinterpreted as a duty for a single party, or an opportunity for other administrative entities to resign.

In the present case, crowd-sourced species observation appeared to be a useful data source. Despite the obvious drawback of lack of systematic sampling design in this type of data collection, the extensive spatial coverage and large number of observations still make them an interesting potential (Snäll et al. 2011). One limitation in the present study is that the method chosen to identify what may be labeled ”infrastructure species” only took state owned roads into consideration. Privately owned roads add up to more than 75% of all roads in Sweden (Swedish Transport Administration 2014), most of them small, unpaved, and well dispersed in the landscape. Hence, some species not identified as candidate species for the STA´s responsibility may well depend on the management of minor roads (Tikka et al. 2000).

Conclusions

We consider the responsibility species concept to be a potentially useful tool for setting priorities for the STA´s action to contribute in the conservation of endangered species. The described method could be used to point out a number of candidate responsibility species, and to outline important management actions. The most immediate action needs to be directed to and near the remaining sites of a limited number of species. In the longer term, the specific habitat and management requirements of responsibility species may help indicating road or railroad stretches or regions where an adapted management can effectively create new habitat for threatened infrastructure species. Put in a larger perspective, our study points out the crucial role that transportation administrations may have in landscape-scale nature conservation.

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