Wildlife Crossings over Roads
Policy and Recommendations for Action

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Science Division Publications

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Description of the Problem

Roads are one of the principal factors in fauna mortality, and it is therefore necessary to relate seriously to the reduction of the ecological and genetic damage caused by them to wildlife populations. In a small country such as Israel, where the habitats are small anyway, nearly every road has the potential to damage natural populations and ecosystems. Entire regions have been fragmented by roads in the past, and it is necessary to do as much as possible to minimize future damage.

Roads affect wildlife in four principal ways (Baki 2000 and the bibliography there; Iuell et al., 2003):

1. Habitat reduction in general, and damage to local, especially rare habitats.
2. Wildlife road accident fatalities.
3. Spatial side effects (noise, lighting, dust, water and air pollution) at significant distances from the road.
4. Physical separation between portions of populations and the effect on their breeding possibilities and genetic fitness.

The major problem caused by the roads is habitat fragmentation and separation of populations. The damage anticipate from this could also take place a long time after construction of the road, together with effect on the vitality of wildlife populations and, accordingly, on the entire ecosystem.

A road can separate a local population in two, however, the effect of the road is often much broader in that it can cut a country into completely separate parts. The ecological corridors plan (Shkedi & Sadot, 2000) points to bottlenecks where expansion of the road systems (and other infrastructure) will lead to the fragmentation of whole land regions (see Appendix). In these bottleneck areas it is necessary to find special solutions that will enable the passage of wildlife.

Structure of the Crossing

Large-bodied species usually require larger crossings than smaller species, while small species will also utilize large passages. Therefore, the large species determine the necessary size of the crossing. However, the mandatory ecological requirements of the various not-so-large species must also be addressed. For instance, crossings for amphibians must be wet (and sometimes even flooded), and with heavy vegetation. On the other hand, passages designated for rodents must be dry (drained) throughout the year. The entrances to the crossing must be planned to enable hidden access into it (by planning and designing the vegetation in the vicinity of the crossing) without concealing the openings into the crossing themselves, far from foci of noise or illumination. In general, it is preferable to construct rectangular crossings (Illustration 1) enabling relatively smooth animal movement. In crossings longer than 20 meters (on broad roads) it is recommended to make an opening in the middle of the passages (between the lanes

at the middle of the road) to enable the entry of light (Baki 2000l; Iuell et al. 2003). Furthermore, it is necessary to maintain a reasonable ratio between the length of the passage and the span, the recommended span being (Baki 2000) :

$$\frac{\text{Width} * \text{Height}}{\text{Length}} = 0.6$$

But of course, such a span cannot be adopted automatically for all roads, and it is necessary to calculate the recommended width according to the cross-section of each road. Adopting such a span is sometimes impossible for an existing road.

Stream beds serve as natural crossings for wildlife, and animals tend to avoid longer passages that are dark and narrow (Baki 2000; Luell et al., 2003). Therefore, it is preferable to build bridge passages on pillars, especially over large streams, than to channel the stream between ramparts under the road (Illustration 2).

Illustration 1: Rectangular crossing. Photo: Steve Homan

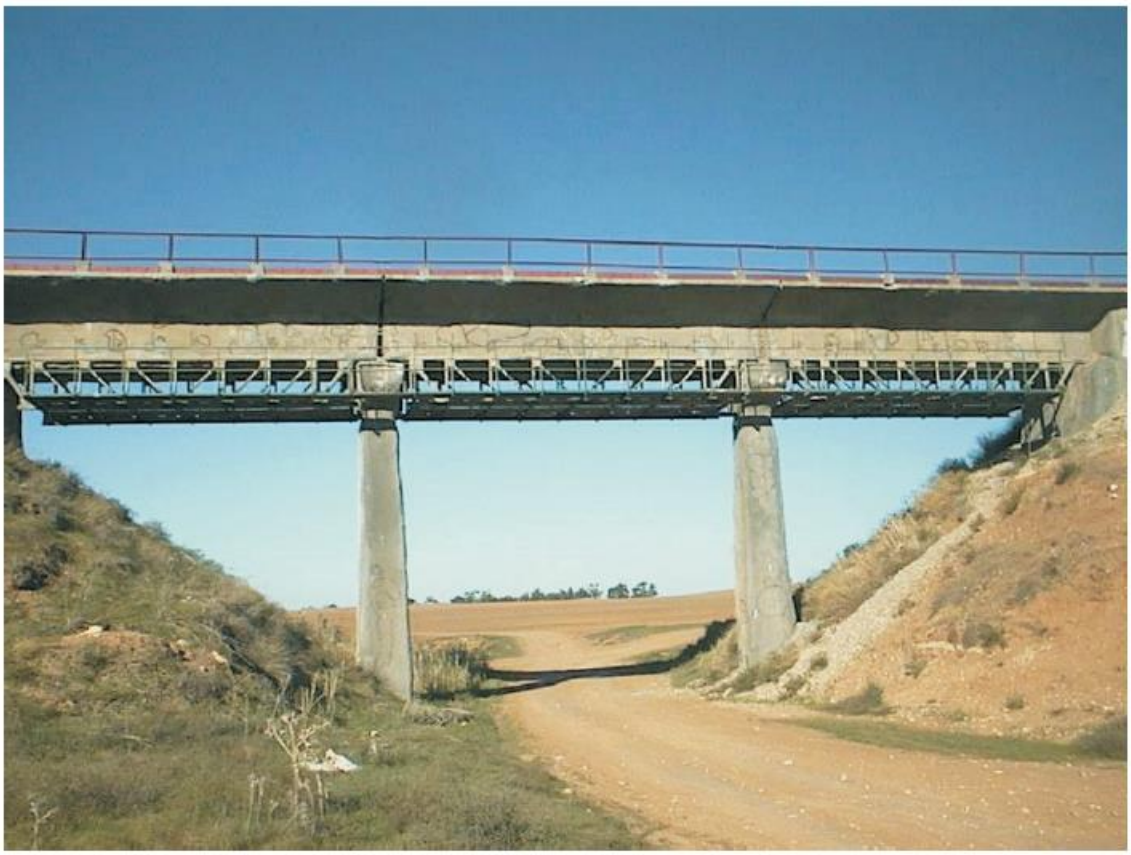


Illustration 2: Bridge enabling comfortable passage for wildlife. Photo: Yehoshua Shkedi

Planning

A very important factor in reducing the road's impact on wildlife is correct ecological planning of the route of the road and location of the crossings themselves. **Correct ecological planning is more significant for the conservation of wildlife than retroactive compensation by constructing fences and crossings, and it could also help to place more effective passages in the future.** It must be remembered that passages, however good they are, are not "miracle pills" for the protection of wildlife populations, and that crossings can never compensate fully for the damage to the continuity of the habitat caused by the construction of the road. This point emphasizes the need to assimilate the issue among the planners community. For that purpose, the Nature and Parks Authority (hereinafter - the "**NPA**") must be involved in the early planning stages.

The passages will serve the species living in their vicinity, and therefore the planning must be suited to the fauna in the vicinity of the road. Accordingly, the recommendation is to examine each road in itself.The guidelines in the table are based on recommendations in other countries (Baki 2000; Luell et al. 2003), as well as the recommendations of a study conducted recently by the Nature and Parks Authority, funded by the national transport infrastructure company and the Ford Environmental Protection Grants Program (Guttman et al., 2000). These recomendations will be updated as additional information from Israel is accumulated.

Species	**Minimum recommended size Height X Width**	**Remarks***
Large herbivores (gazelles, Ibex, fallow-deer, roe deer, wild asses, oryx)	5 x 3 m.	
Large predators (wolves, hyenas, jackals)	1.5 X 1 m.	
Small predators (badgers, mongooses, Marbled Polecat, martens, otters)	1 X 1 m.	In addition to the large crossings, because some of these species prefer small passages
Rodents, reptiles and amphibians	80 X 30 cm.	In addition, and far from water conduits, so that they will not be blocked up in winter (as needed, mainly in the Negev)

* We refrained from recommending the density of the crossings because our principal proposal is to examine each road in itself, mainly because the construction of crossings will not be approved (and rightly so) without individual examination. In this way we shall refrain from recommending the construction of passages in areas where they are unnecessary, or we can have fewer passages in regions which do not require a high density of crossings. At the same time in areas where large herbivores are active, it is recommended to construct suitable crossings at least every 2 kms.

In addition, it is recommended to build small conduits (30 X 80 cm) between the large conduits serving as drains. These conduits have proven effective and they are required

mainly in the Negev where the distances between the conduits are usually great, but not only there (Illustration 3). (See also Luell et al. 2003; Bekker 1998)

In the course of planning each road, and in order to avoid constructing unnecessary crossings, the need for density and size of the passages will be examined in accordance with the inventory of fauna along the road, although it is necessary to take into account that in prominent population concentrations there will sometimes be a need to increase the density.

It is the responsibility of the planners to apply to the NPA, which will collect, in the early planning stages, the following information from every professional entity:

1. Summary of the existing material on the distribution and abundance of species in the vicinity of the road, according to figures from existing data banks, and a review of the number of road fatalities on neighboring roads, in order to adapt the crossings to the species endangered by the road, or to species who avoid crossing the road without crossings or via the small passages.
2. Examination of the effectiveness of the passages planned anyway for drainage purposes, so that they can also serve as crossings for fauna, and recommendations to add passages or change their sizes accordingly.

Illustration 3:
Badgers' passage. The fencing is in order to prevent the badgers from entering the road.
Photographed in Holland, by the Ministry of Transport, Public Works and Water Management.

Crossings at Ecological "Bottlenecks"

In places defined as ecological "bottlenecks", special emphasis must be placed on constructing wildlife crossings. These "bottlenecks" are to be found on existing roads, where it is necessary to ensure that there will be at least one large effective passage. It is desirable that, in such places, the crossings will be in the form of overpasses, and that the road sections in that region will pass under a tunnel (excavation or "cut & cover", accompanied by landscape rehabilitation), because some of the species will not go through passages underneath the road (e.g. gazelles).

Illustration 4 shows a crossing built especially for wildlife. The route of the road was lowered, tunnels were constructed, and vegetation typical of the region was planted on the roof of the tunnel. The road was fenced on both sides so that the animals would be able to cross only via the overpass.

An overpass must be sufficiently wide for the large animals not to hesitate to use it, and the natural habitat that appears in its vicinity must be reproduced. The natural topography can be of help in order to place overpasses, when roads pass through depressed areas in hilly regions. Although not all species traverse the overpasses, e.g. deer refrained from using an overpass 7 meters wide (Keller & Pfister, 1997), but in that study there was a lot of evidence of use by many species of such crossings. For instances, it is important to examine construction of an overpass for wildlife on the Jerusalem-Tel Aviv road at Sha'ar HaGai, that would connect the ridges to the north of the road to those to its south.

Illustration 4: Wildlife Overpass. Photo: Scott Jackson

Maps are attached to this document, in which we indicated points constituting ecological "bottlenecks". **In some of them there are effective wildlife crossings, some require improvement and in some there is no passage at all**. Our proposal is that an effective crossing should be constructed whenever a section of a road at such a "bottleneck" is upgraded or renovated. Such a crossing should preferably be an overpass, and if its purpose is to enable the passage of large herbivores, it is **desirable** for it to be about 50 meters wide (Baki 2000), taking account of the engineering possibilities and the high costs involved in building overpasses, and it must be examined on a cost-benefit basis.

in cases that the construction of such a passage is not possible, a large, effective underpass should be built. Such a crossing can be utilized for additional uses, such as for the passage of agricultural vehicles. The addition of an underpass of a suitable size under a road can have serious engineering significance, such as altering road levels over many kilometers. The enormous cost involved in that work could greatly reduce the cost/benefit ratio - therefore, every road must be examined specifically.

When the topography at the location does not permit the construction of an overpass (it is not possible to build the road in a tunnel), one should try and open a passage on the road surface (separating the lanes). Such a crossing should be broad (200 meters), with no physical partition between the lanes, and hiding places should be created, such as trees or rocks. The shoulders of the road must be level with the terrain. Such a crossing must have clear signs, and the permitted traffic speed must be reduced and the road must not be illuminated (as is presently the case on Road 40 near the Porah Nature Reserve, north of Beit Kamah). It is emphasized that traffic and engineering considerations will dictate the maximum width of the separated lanes road sections.

The contents of the previous paragraph are partially in contradiction to the contents of the section dealing with "Fencing, Barriers and Traffic Islands" (see below). Here we say that when there is no possibility of building an overpass, animals should be enabled to cross on the road surface, and there we say that such crossing should be prevented by means of fencing. The reason is that the crossing of individuals at the ecological "bottlenecks" is of supreme importance in order to reduce genetic separation between populations. Concerning the remaining, and majority of, roads the recommendation is to reduce the possibility of animals reaching the road so as to prevent injuries.

Crossings on Existing Roads that are not "Bottlenecks"

(Water conduits, agricultural vehicles crossings, and others)

It must be remembered that the engineering possibilities on existing roads are relatively limited compared with those of new roads, because it is not always possible to alter the levels of roads already in use.

Some of the existing crossings are not suited for the passage of animals. Therefore, it is recommended that on roads planned to be renovated or upgraded, there should also be plans for the adaptation of crossings for animals' needs, in accordance with engineering possibilities. At crossings that are flooded most of the year (e.g. sewage conduits), a

raised ledge (shoulder) can be built along them so that they can be used by animals even when they are flooded (Illustration 5). The passage's size, density, substrate and design of the vegetation in its vicinity will be determined in accordance with conditions in the area.

In places where there is no need for drainage under the roads, but it is necessary to build animal crossings, dedicated wildlife passages will be built in accordance with engineering and budgetary possibilities.

Illustration 5: Water conduit with a ledge enabling wildlife traffic even when the passage is flooded.

Fencing, Barriers and Traffic Islands

When crossings exist, it is important to fence along the main roads to prevent the entry of wildlife into the road area, and to channel them to the crossings. This will reduce the numbers of road fatalities on the road. The prevention of animals' entry into the roads and channeling them to the crossings is the recommended solution to prevent fatalities, to reduce the separation of populations andto reduce human damage and injury.The fence must be 10X10 cm. or progressive from below upward (smaller rectangles near the ground), anchored into the ground and made of rust-free materials.

On unfenced roads, the "New Jersey" concrete barriers cause a great deal of injury to animals for reasons mentioned above. The small passages presently existing at these barriers are far from useful for animals' crossing, especially since the majority of those animals are large-bodied, such as gazelles (who probably do not enter the underpasses) and various predators. We recommend a reduction in the use of these barriers, or to break up their continuity by using an alternate barrier at intervals. On sections of road longer than 2 kms which are divided by "New Jersey" barriers, alternate types of safety

barrier should be inserted at 2 km. intervals, so that individual animals trying to cross the road will succeed in getting out without staying there for a long time.

The recommendations of this section are in partial contradiction to those appearing in the section dealing with "ecological bottlenecks". Action at "ecological bottlenecks" should be given preference over the contents of this section, see the appropriate explanations given above.

Maintenance

It is necessary to ensure that the passages and fencing at the sides of the road are maintained on a current basis. The animals' sensitivity to the quality of the crossings requires their constant maintenance: cleaning, removing any rocks and tree trunks and branches blocking the passage, pruning vegetation at the entrance, and any other action depending on the condition of the specific crossing. Neglecting the serviceability of the passage and the fences could result in more animal road fatalities, increased risks to drivers and reduced connectivity between animal populations on both sides of the road (Illustration 6).

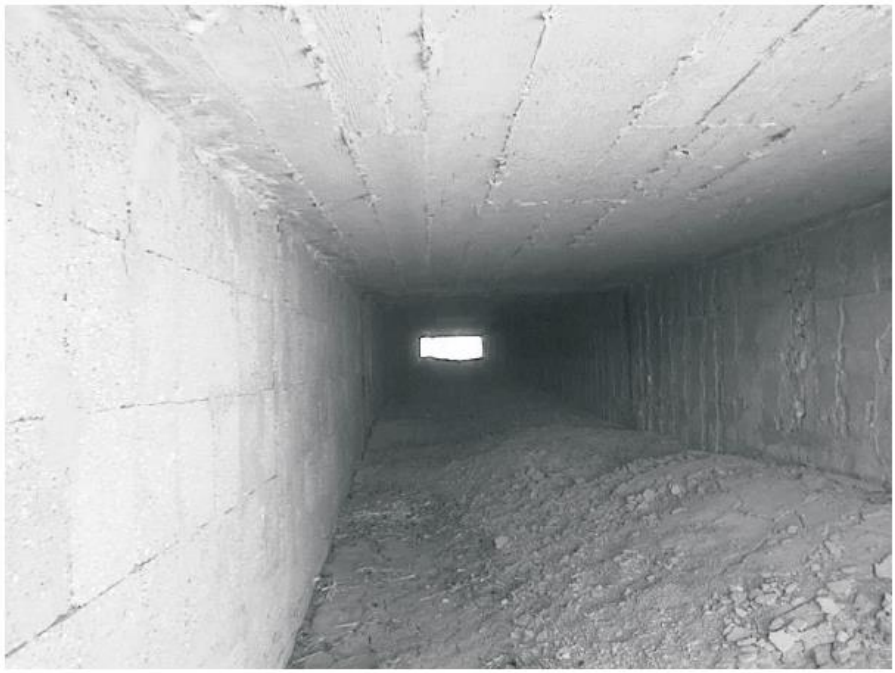


Illustration 6: A water conduit half-blocked by earth and gravel.

Principles of Work vis-à-vis Road Planning Entities

The Nature and Parks Authority will serve as professional consultant for planning road crossings vis-à-vis the planning entities. The NPA will be obligated to provide the

planners with environmental background data concerning the road and its vicinity, and on the need for wildlife passages.

Summary of Recommendations

Bottlenecks: In all bottlenecks large and effective wildlife crossings should be built in accordance with priorities and taking account of engineering constraints.

Structure of the Crossing (subjected to engineering possibilities): Rectangular passages are preferable. In passages flooded most of the year, it is recommended to build a raised ledge to enable traffic even when the majority of the conduit is flooded. For a road crossing a large stream, it is important to build a bridge on stilts, apart from the drainage, and not just a small opening in the earthen bank. In long passages it is necessary to make an opening between the lanes for light to penetrate.

Environmental Planning (subject to possibilities): Planning the vegetation in the close vicinity of the passage must enable screened access to it, but without concealing the crossing itself. The ground at the entrance to the crossing must be similar to the natural ground in its close proximity. The opening must be kept away from centers of noise and artificial lighting.

Fencing: Fencing must be planned so as to prevent the animals' access to the road, and to channel them to the crossing. It is recommended to fence major highways and fast traffic roads, and roads where there is a "New Jersey" barrier.

"New Jersey" Barriers: It is better to make less use of these barriers and to give preference to alternate partitions enabling the passage of wildlife, or to split lanes. On roads with "New Jersey" barriers, the continuity of the barrier should be broken every few hundred meters to enable animals who find themselves in the middle of the road to cross it. It is preferable to locate the openings in the barriers in places where there is a reasonable chance of animals using such openings.

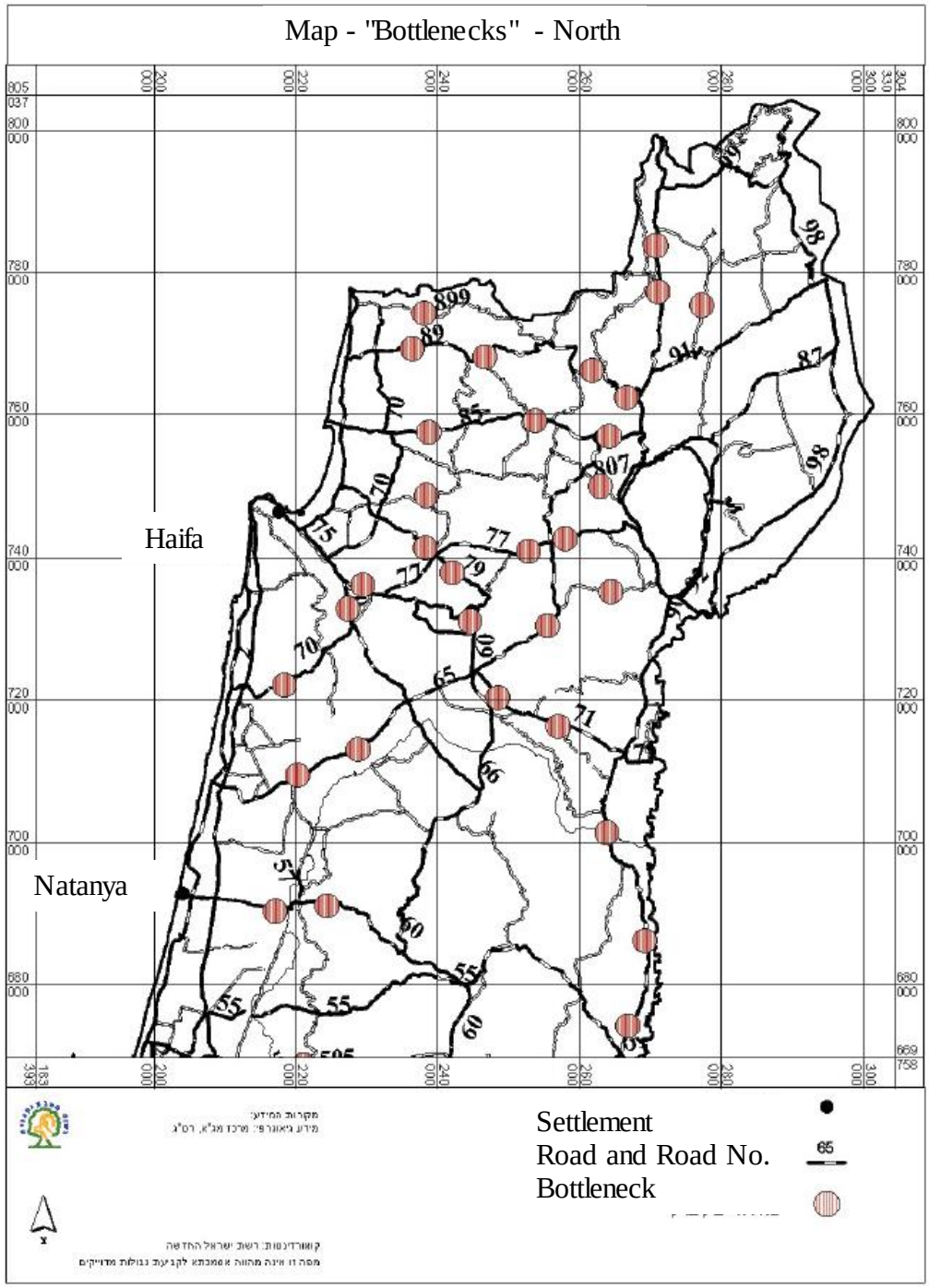
Maintenance: The passages must be kept open. The crossings must be examined and opened every winter, and the fences must be maintained.

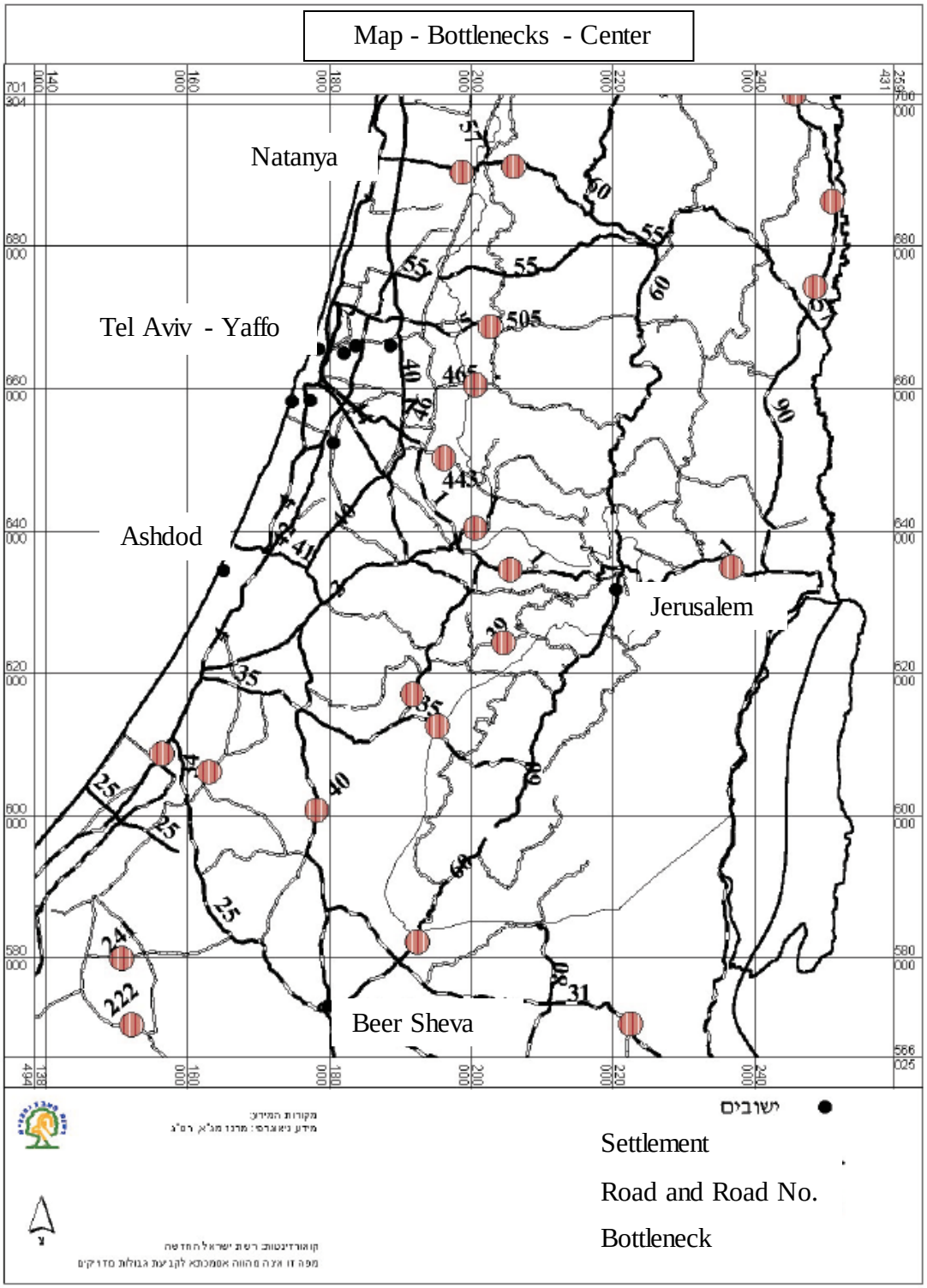
Appendix: Bottlenecks on Existing Roads

List of bottlenecks in ecological corridors requiring special attention (see attached maps). At some of the points, passages suitable for wildlife already exist. **Therefore, this is a list for examination, from which priorities will be derived**. On the other hand, it is reasonable to assume that additional points will be added to this list, as the development and construction of roads continues.

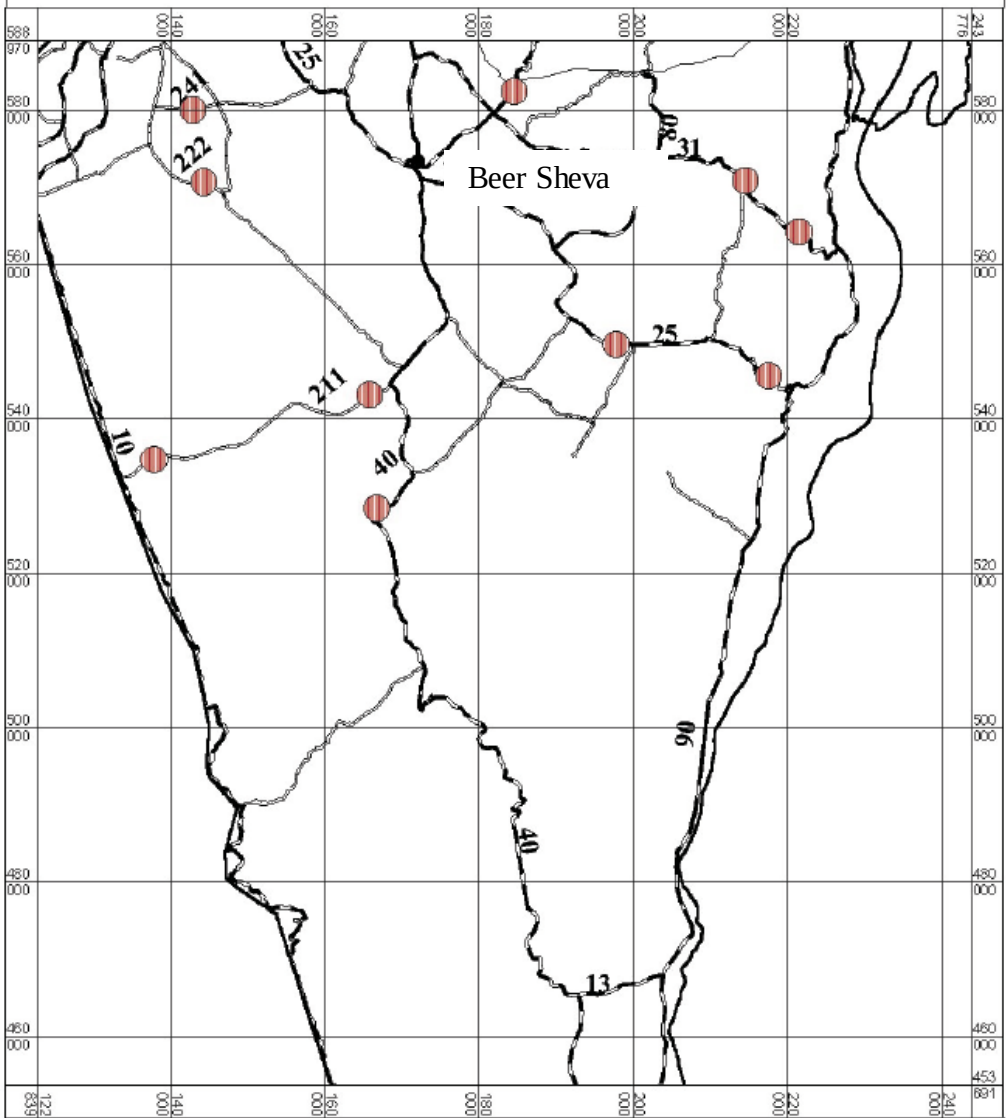
Region	Bottleneck	
North	Road 90 - Koach Junction - Gama Junction Road 90 - Opposite the Hula Reserve Road 918 - Opposite the Hula Reserve Road 899 - East of Ayalon Road 89 - Ein Zeitim Region Road 89 - Mitzpeh HaYamim Hotel Region Road 89 - Alkush Junction Road 89 - Between Ma'alot and Kabri Zefat By-Pass Road Road 85 - Nahal Amud Road 85 - Hananya Junction Region Road 85 - Nahal Hilazon Road 807 - Opposite Mt. Ravid Road 77 - Golani Junction	Road 77 - Golani Junction - Beit Rimon Junction Road 781 - Near Moreshet Juncton Road 79 - Yiftahel Junction - Shefar'am Road 79 - Opposite HaSolelim Forest Road 767 - Bik'at Yavne'el Road 65 - Bik'at Kesulot Road 60 - Near Nazareth South Junction Road 75 - Sha'ar Ha'Amakim fork Road 70 - Sha'ar Ha'Amakim fork Road 70 - Nahal Dalia Road 71 - HaShita Junction - Yissachar Junction Road 71 - Opposite Yizra'el Road 65 - Mai Ami Junction Road 65 - Mishmar HaGvul Junction
Bik'ah	Road 90 - Nahal Bezek Road 90 - Um Zukah	Road 90 - South of Argaman
Center	Road 57 - East of Tul Karem Road 57 -Nahal Alexander Road 5 - Near Oranit Road 465 - Near Rentis Junction Road 443 - Ben-Shemen Forest Road 3 - Near Mevo Horon Road 1 - Shoresh Junction - Sha'ar HaGai	Road 39 - Between Etziona Junction and Mata Road 38 - Massua Road 35 - Near Nechusha Junction Road 40 - Nahal Shikma Road 34 - Near Or HaNer Road 4 - Yad Mordechai Junction
South	Road 60 - Near Meitar Road 31 - Near Taharurim Junction Road 25 - Near Matzad Tamar Road 25 - Nahal Dimona Road 241 - Nahal HaBesor	Road 222 - Nahal HaBesor Road 211 - Nahal HaBesor Road 211 - Nahal Ruth Road 40 - Tzipporim Junction

Map - "Bottlenecks" - North




Map - Bottlenecks - Center
Natanya
Tel Aviv - Yaffo
Ashdod
Jerusalem
Beer Sheva
505
465
443
222
31
ישובים
Settlement
Road and Road No.
Bottleneck

Map - Bottlenecks - South



Settlement

Road and Road No.

Bottleneck

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