Appendix 1: Notes on selective habitat mapping and the GIS-Algorithm "Habtiat-Net"¹

The following pictures show principles of the GIS algorithm 'Habitat-Net': After developing simple ecological model rules (effective distances that indicate ecologically functioning habitat systems for species of different migration abilities) it is possible to process data on the natural inventory in vector-format in order to provide information on existing or restorable habitat networks at regional level.

The data basis regularly available in Germany includes data from selective habitat mapping (selektive Biotopkartierung) in the Federal States, CORINE Land Cover 2000, digital landscape models, CIR – inventories of habitat types and land use types as well as different data on the identification of habitat development potentials (soils, climate) and species-specific data. Due to a frequent lack of comparable data on the occurrence of species, the data of the selective habitat mapping are the most important source of information. For different guilds (representing different demands on habitat type, area size, dispersal distance), respective systems of classified functional areas can be created as habitat networks (e.g. for species of semi-natural woodland, dry grasslands or wetlands).

Altogether, the Federal States of Germany located **1.5 million sites with valuable habitat conditions** (single habitats or habitat conglomerations). Using GIS, these sites are described by 2 million data files. Therefore it's possible to look for the topology of e.g. wetland habitats or habitats of dry grass-lands or of woodlands of special qualities.

¹ Hänel 2007



Fig. A1: Areas identified and described by selective habitat mapping in the surrounding of the Kie-

bitzholm overpass in comparison to the detailed habitat mapping near the overpass



Fig. A2: Results of selective habitat mapping

Left side: Valuable wetlands (blue) between Zeven, Rotenburg and Schneverdingen (the towns as well as other settlement are indicated in reddish colour; forests are represented in green)

Right side (Reck et al. 1996): Most of the mapped habitats are conglomerates or mosaics of different habitats – the respective data files give information on the predominant habitat type and all other included habitat types

The Algorithm "Habitat-Net" looks for the most effective areas for networking, intending to safeguard areas of high connectivity and the most efficient migration areas from further dissection or to mitigate isolation in those areas.



Fig.A3 principle of ecological networks



Supra-regional networks are identified automatically by iterative neighbourhood analysis.

Step 1: Identifying relevant habitats (e. g. valuable dry grasslands).



Step 2: Identifying close habitat systems (low distance, e. g. 250 – 500 m, depending on habitat size and alignment)



Step 3: Regarding irremediable barriers

Step 4: Identifying wide habitat systems (e.g. within distances of 500 – 1000 m depending on habitat size and alignment) and isolated small habitats that cannot be part of an efficient network (small habitats that are not in between larger habitat systems or function areas respectively)



Step 5: Elimination of isolated small habitats from further networking by distance analysis

Step 6: Identifying networks for strong dispersers (e. g. distances between 1000 – 2000 m depending on habitat size and alignment) as well as areas that are suitable for efficient networking



Step 7: Applying further distance analysis (e.g. distances between 1500 – 3000 m depending on habitat size and alignment)

Step 8: Identifying laminary barriers that can be overcome by habitat improvement



Step 9: Identifying linear barriers and priorities for mitigation measures. Overpasses, viaducts etc. should be built in conflict areas where endangered species are severely affected by dissection and/or in areas where close habitat systems are dissected that are part of a supra regional habitat network



Fig.A4: Application between Zeven and Rotenburg ;areas for wetland networks regarding dispersal $\leq 1000 \text{ m}$



Fig.A5: Rebuffering (1000 m type) and additional areas regarding possible dispersal \leq 1500 m



Fig. A6: Area between Zeven and Rotenburg; wetland network and conflict areas with traffic infrastructure(roads with traffic loads of more than 1000 cars/day)

Fig. A7: Results for different habitat types (wetland and dry grassland; clipping from upper Danube river, Fuchs et al. 2008)



*FKZ 3507 82 090, Überwindung v. Barrieren / Wiedervernetzung v. Ökosystemen

Fig. A8: Possible habitat-Network in Germany and its dissection by federal roads

Acknowledgement

We are grateful to C. C. Casper for improving the English

Appendix2: Synopsis of Central European Defragmentation Approaches

The following table is part of a scheme comparing the current European concepts and programmes on connectivity and defragmentation. The scheme is not fixed yet (December 18, 2008) and should, if possible, be used to give a European overview as well as the now intended Central European perspective.

The table has been compiled on the basis of presentations given at the international workshop "De-fragmentation concepts in Central Europe" (Island of Vilm, Germany, September 14–18, 2008) as well as information of IENE members and publications.

Country	Austria	Belgium	Czech Republic	Denmark	Germany	France	Liechtenstein	Luxembourg	The Netherlands	Poland	Switzerland
Country Code	AT	BE	CZ	DK	DE	FR	LI	LU	NL	PL	СН
Surface area ¹ / 1000 km ²	83.86	30.53	78.87	43.09	357.02	551.50	0.16	2.59	41.53	312.69	41.28
Population ² / million	8.33	10.67	10.38	5.48	82.22	63.75	0.04	0.48	16.40	38.12	7.59
Population density / Inhabitants/km ²	99	349	132	127	230	116	221	187	395	122	184
Length of road network ³ / 1000 km											
Motorways	2.1	1.7	0.6	1.0	12.4	10.8		0.1	2.5	0.6	1.4
National roads	10.6	12.6	6.2	0.6	41.0	25.2		0.8	6.7	18.3	0.4
Secondary or regional roads	23.7	1.3	48.8	9.7	178.1	360.0		1.9	57.5	28.4	18.1
Other roads	98.0	136.6	72.3	60.9	413.0	610.0		2.3	59.4	377.3	51.4
Total	134.3	152.2	127.8	72.3	644.5	1005.9	0.4	5.2	126.1	424.5	71.3
Road density / km/km ²	1.6	5.0	1.6	1.7	1.8	1.8	2.4	2.0	3.0	1.4	1.7
No. of existing / planned large-scale overpasses (green bridges and comparable)	6(?) ⁴ / 20 ⁵	4 / 6 ⁶	5(?) ⁷ / ?	2 / ? ⁸	44 / 33 ⁹	56(?) ¹⁰ /?	?/?	?/?	10 / 26 ¹¹	12 / ?12	24 / 1 ¹³
Present / planned overpass density / Green bridges / 1 million inhabitants	0.72(?) ⁴ / 3.12(?) ⁵	0.37 / 0.94 ⁶	0.48(?)/?	0.37 / ? ⁸	0.54 / 0.94 ⁹	?/?	?/?	?/?	0.61 / 2.1911	0.31/? ¹²	3.16 / 3.29 ¹³
IENE Membership	+	+	+	+	+	+	_	-	+	+	+
Participation in COST 341	+	+	+	+	-	+	-	-	+	-	+
National connectivity programmes ¹⁴ (integrative (biodiversity) +++ / focussed on certain ecosystem types or species groups ++ / focussed on single target species +)		15			+++ Grünes Band; Leuchtturm- projekte			?	+++ Ecol. Hoofd- structuur		Öko-Qualitätsver- ordnung, wildtierkorridore
National connectivity concepts ¹⁴ (integrative (biodiversity) +++ / focussed on certain species groups ++ / focussed on single species +)	++	15	+++ TSES		Länderübergrei- fende Achsen des Biotopver- bunds (Fuchs et al. 2007)	Transport Infrastructures Action Plan, National Ecol. Network		?	+++ Nota Ruimte / Robuuste Corridore	ECONET – Poland ++; Ecol. Corridors ++	+++ Landschaftskon- zept Schweiz LKS

As at 2007-01-19. Source: United Nations Statistics Division (UNSD). Online available at http://unstats.un.org/unsd/environment/totalarea.htm [Data retrieved 2008-11-05].

As at 2008-01-01. Source: Eurostat. Online available at http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=0&language=de&pcode=tps00001 [Data retrieved 2008-11-05].

As at 2005. Source: European Road Statistics 2008. Published by the European Union Road Federation, the Brussels Programme Centre of International Road Federation (ERF – IRF BPC). Online available at http://www.irfnet.eu/en/2008-road-statistics/ [Data retrieved 2008-11-07]. Data for Liechtenstein taken from The CIA World Factbook. Online available at https://www.cia.gov/library/publications/the-world-factbook/geos/ls.html [Data retrieved 2008-11-07].

Friedrich Völk (2003): Straße und Wild in Österreich. Online available at http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/naturschutz/Abst-V_lk.doc [Last accessed 2008-11-24].

Instruction GZ.BMVIT 300.040/002-II/ST-ALG/2006 (Dienstanweisung "Lebensraumvernetzung Wildtiere") of the Federal Ministry for Traffic, Innovation, and Technologie (Bundesministeriums für Verkehr, Innovation und Technologie, BMVIT) stipulates the realisation of 20 green bridges along motorways and expressways until 2027. This directive is online available at http://www.bmvit.gv.at/verkehr/strasse/autobahn/umwelt/dienstanweisungen/Lebensraumvernetzung_Wildtiere.html [in German language] [Last accessed 2008-11-30]. Peymen (2008).

Jakub Rímal & S.Rohrböcková: Green Bridges. Contribution to the 2007 workshop of the Czech Technical University of Prague (Czech Republic). Online available at http://workshop.cvut.cz/2007/sbornik.php?sekce=13 [Last accessed 2008-11-17]. Christensen, E. E. M. Nielsen, P. Wind, P. N. Andersen, A. B. Madsen, T. S. Hansen, I. Høst, P. Have, T. Jensen, P. Andersen, & J. Kærgaard (2007): A biological assessment and investigation of the use of fauna passages at the motorway system in Denmark. NERI Technical Report No.

^{631, 172} p. Online available at http://www2.dmu.dk/Pub/FR631.pdf [Last accessed 2008-11-16]. In addition, approximately 60 fauna passages were constructed in Jutland between 1988 and 1994 (COST 341 Denmark 2000). In addition, there are 72 underpasses for game and 176 bridges across rivers and streams carefully designed to allow animals to pass. Source: Böttcher et al. (2008).

France was the first European country to construct green bridges for wildlife and has an extensive network. In this region, there are, in addition, 149 mixed hydraulic passages, 93 mixed agricultural or forestry passages, 11 underpasses for large fauna, and 90 exits from waterways (Bielsa & Pineau 2007).

In addition, there are approximately 600 small underpasses on roads and other fauna passages such as tree bridges and passages along waterways crossed by roads ("ecoduikers"). Source: Homepage of the Dutch Long-term Defragmentation Programme (Meerjarenprogramma Ontsnippering, MJPO). Online available at http://www.mjpo.nl/faunapassages/faunapassages/ [Last accessed 2008-11-16].

In addition, there are 2 overpasses on railways and 263 underpasses on roads: 48 for large mammals (e.g. red deer), 16 for medium-sized mammals (hare, fox, badger), and 70 for amphibians, rodents etc. Source: Wlodzimierz Jedrzejewski & Sabina Nowak: Efforts for defragmentation and connectivity protection in Poland. Presentation given at the international workshop ",De-fragmentation concepts in Central Europe" (Island of Vilm, Germany, September 14-18, 2008).

In addition, there are 2 overpasses on railways, 4 overpasses on creeks, and 11 underpasses on roads. 1 additional road overpass and 1 additional road underpass are in the planning stage. Source: Die Schweizer Wildtierpassagen. Online available at http://www.bafu.admin.ch/jagd_wildtiere/00484/00791/00792/index.html?lang=de [Last accessed 2008-11-16].

On the national level, we distinguish between "concepts" (ideas and action plans which are so concrete that they could be put into action) and "programmes" (concepts that have been put into action or will be put into action; this requires a solid funding to be established).

¹⁵ Nature conservation lies entirely within the legal competence of the three regions (Brussels, Flanders, and Wallonia).

Country	Austria	Belgium	Czech Republic	Denmark	Germany	France	Liechtenstein	Luxembourg	The Netherlands	Poland	Switzerland
Regional connectivity programmes or concepts	Wildökologische Korridore (Steiermark)	+++ VEN & IVON, MINA, SDER	+++ (included in TSES)	Save the Otter	+++	Trame verte	?	?	Veluwe 2000, Heel de Heuvelrug		Kantonale Richtpläne
Cross-border connectivity projects (planned/executed) and their localisation	ALPARC (executed, AT/DE/FR/LI/CH); Alpine- Carpathian Corridor (executed, AT/HU/SK)	?	Carpathian Network of Protected Areas (executed, CZ/PL)	?	ALPARC (executed, AT/DE/FR/LI/CH), Brualer Schloot (executed, DE/NL), Projekt zur Wiederan- siedlung des Rothirsch (concept, DE/NL), F & E "Wolfsschutz" (executed, DE/PL)	ALPARC (executed, AT/DE/FR/LI/CH)	ALPARC (executed, AT/DE/FR/LI/CH)	?	Brualer Schloot (executed, DE/NL); Red Deer Re- introduction (concept DE/NL)	Carpathian Network of Protected Areas (executed, CZ/PL), F & E "Wolfsschutz" (executed, DE/PL); Ecol. Corridors	ALPARC (executed, AT/DE/FR/LI/CH)
National defragmentation programmes ¹⁴ to overcome linear barriers (roads, railways, waterways) and their basis (e.g. neighbourhood analysis) or aim (e.g. large mammals)	Lebensraumver- netzung Wildtiere (game species)	15	Transportation Policy					?	MJOP (integrative biodiversity approach)		Wildtierkorridor- projekt (game species)
National defragmentation concepts ¹⁴ to overcome linear barriers like roads, railways, waterways	Lebensraumver- netzung Wildtiere (game species)	15	In prep.		Lebensraumkorri dore für Mensch und Natur, Bundeswildwege plan (NABU), Wildkatzenwege- plan (BUND); UZVR/UFR				see above		Wildtierkorridor- projekt (game species)
Regional defragmentation programmes or concepts to overcome linear barriers like roads, railways, waterways	?	Misc. LIFE projects	?	?	Defragmentation concepts on state level in MV, TH, BY, RP, SL, BW, BB	Col de Saverne, Fontainebleau forest	?	?	De- fragmentation plans in several provinces	?	?
Prevention measures (e.g. fencing obligations) to be taken in case of construction, expansion, or conversion (always mandatory +++ / mandatory if required ++ / recommended +)	+++	?	+	(+)	++	?	?	?		?	+++ REN
National obligations (by law or binding regulations) concerning connectivity or defragmentation	+	+	(+)?	+	+	+	?	?	+	+	+
Planning aids (handbooks, manuals, technical standards)	+	(+)	+	+	+	+	?	+	+	+	+
Miscellaneous and special features										+	+

For further information see workshop report "De-fragmentation concepts in Central Europe"