横浜国大環境研紀要 23：47－62（1997）

総 説

都市におけるバイオトープ地図化

1．東京都および横浜市の都市集中域におけるパイロットスタディ

Biotope Mapping and Nature Conservation in Cities-Part 1: Background and Methods as Basis for a Pilot Study in the Urban Agglomeration of Tokyo (Yokohama City)*

Norbert MÜLLER**

Synopsis

Progress in urban ecology in the last 30 years has shown that also many plants and animals live in urban agglomerations and are adapted to the specific ecological conditions in urban areas. Nature conservation in cities focuses on protection of their biotopes (habitats) as a basis for a direct contact between urban dwellers and the natural elements of their surroundings, and in order to preserve biodiversity as well as to mitigate the extremes of urban climates and water regimes.

Fifteen years ago, investigations started in Germany in order to inventory the habitats of flora and fauna which are important for nature conservation in cities. The investigations, which became famous as "biotope mapping", focused mainly on floristic and phytosociological features. Additionally,some animal groups were selected. In principle, two methods of biotope mapping can be distinguished:

1) Selective mapping investigates only biotopes worthy of protection.

2) Comprehensive mapping raises biological data representative of all land-use types and biotopes.

The advantage of comprehensive mapping is that it provides a broader basis for later utilisation of the results. The disadvantage is that it requires a great deal of money, time and staff. Therefore, in most German cities, until now selective mapping was employed.

For the city Augsburg, where both methods were used biotope maps are shown. Their application in nature conservation and city planning are explained.

In contrast to most European countries, where meanwhile biotope mapping is an important basis for nature conservation, similar standardised investigations so far do not exist in Japan. Therefore, in the urban agglomeration of Tokyo-Yokohama, a pilot study was started in the summer of 1996 in order to test this method in Japan.

* Contribution from the Department of Vegetation Science, Institute of Environmental Science and Technology, Yokohama National University.

** Department of Vegetation Science, Institute of Environmental Sccience and Technology, Yokohama National University.

(1996年12月10日受領)

1. Introduction

The latest forecast for world population growth is predicting that by the year 2025 65% of the total population will live in urban areas (compare Fig. 1). This means a further increase in population density in cities and the further growth of urban settlements. Therefore it is important that technical environmental protection as well as biological environmental protection (nature conservation) be improved in urban areas.

The basic science for environmental protection in cities is urban ecology. In contrast to other branches of ecology this part of ecology is a young discipline. In the 19th century we can already find first single studies in urban ecology, e. g. Howard (1833) described the differences of the climate in London and its surrounding. In the tradition of nature history, at first the interest was also focused on flora and fauna (e. g. Nylander 1866: "Lichens of Luxembourg").

Since the middle of this century we can observe an increase of specific ecological investigations in urban areas e. g.: "The urban vegetation of Berlin" (Sukopp 1973), "The fauna of Vienna" (Künelt 1955). These first studies showed a surprising variety of habitats, plants and animals, typical for urban areas.

The first entire studies of urban areas developed from the UNESCO project "Man and Biosphere 11" (e.g. Hongkong - Boyden & al. 1981, Tokyo-Numata 1981). These studies have their origin in human ecological problems and deal with questions of human health as well as culture and nature in cities.

Today urban ecology is well advanced in central Europe, where Sukopp & Wittig (1993) have given in recent times a detailed overview of the actual scientific stage. An overview is also published in Japanese in a short form Ermer & al. (1994).

The advantages of urban ecology in Japan, mainly of projects of Tokyo and Chiba Bay-Coast are presented in Numata (1990, 1991).

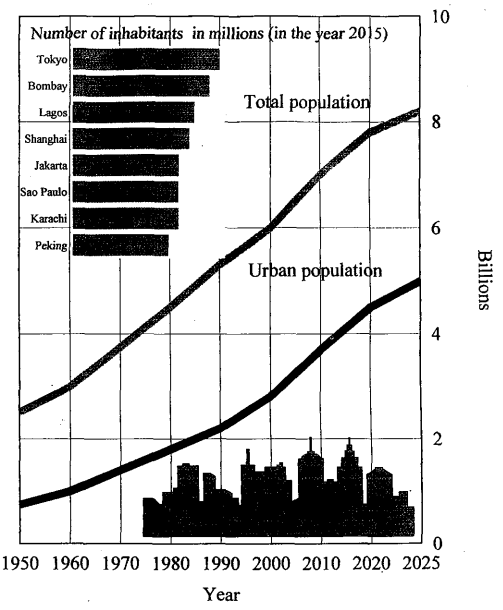

Fig. 1: Growth of the urban population and the biggest cities of the world in future (Source: World demographic estimates and projections 1950-2025, United Nations and UNFPA)

The first projects which developed out of urban ecology and which focused on nature conservation in cities started in Germany in the 1980s. Called "biotope mapping", a method was developed in order to investigate habitats in urban areas which are important for nature conservation (Starfinger & Sukopp 1994, compare chapter 3). Since then this method has been well developed and is used in most cities.

In Japan assessments of green natural environments have been done based on the map of actual vegetation (e. g. Miyawaki & al. 1989, 1991). They are used for concepts for conservation, restoration and management of green environments under the term "Functional vegetation map" (Fujiwara & Miyawaki 1989, 1991). But until now there has been no standardised method for the investigation of biotopes in urban areas.

Especially because Japanese cities grow very fast - e.g. in future the urban agglomeration of Tokyo will be the biggest city of the world (compare Fig. 1) - knowledge about the

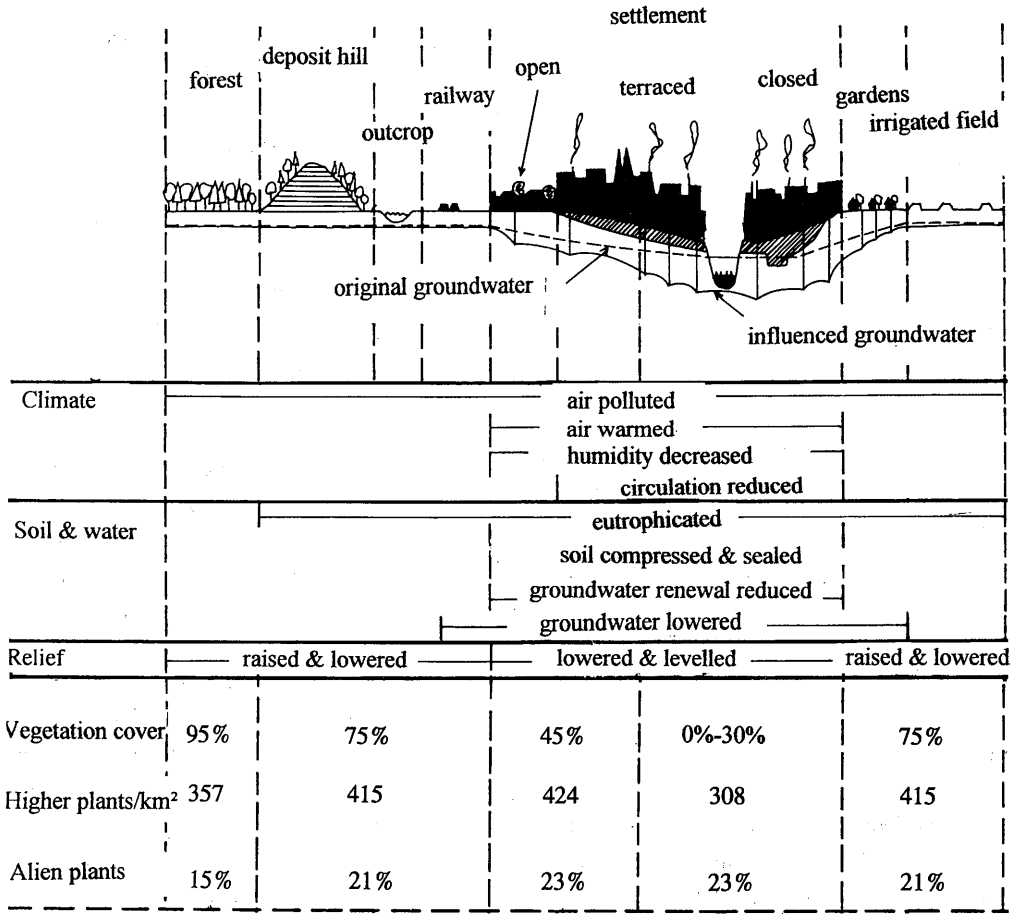

Fig. 2: Ecological characterisation of a city (after Sukopp 1990, slightly modified)

distribution of biotopes is very important for nature conservation and infrastructure planning. Therefore a pilot study was started in Japan in the summer of 1996 to test the European method in Japan for the first time. The testing area lies in the urban agglomeration of Tokyo-Yokohama.

In this paper background and methods of biotope mapping in urban areas are described in general, on a basis for a pilot study in Tokyo-Yokohama. In a further contribution the results of this study will be shown.

2. Characterisation of cities

Severe changes of the ecosphere are connected with the concentration of people and the agglomeration of buildings, which are described in detail by the example of Berlin (compare Fig. 2).

Compared to the surroundings, changes in the local climatic conditions are characteristics of the urban climate (after Horbard & al. 1983):

-higher air pollution

-altered radiation

-lower relative humidity, reduced wind speed, increased annual mean precipitation.

The ecologically most important result of these effects is a rise in temperature.

The essential characteristics of urban soils are compression and accumulation of nutrients. In the centre of cities most soils are sealed. Urban soils were investigated and classified systematically for the first time in

Berlin (e. g. Blume 1989).

In general ground water is lowered in cities, due to the high amount of drainage and sealed areas. The pollution of groundwater as well as the water of rivers is also typical.

Tab. 1: Extinct and endangered plants (Pterido- and Spermatophyta) in the former Federal Republic of Germany and two cities

	investing. area km²	species No.	extinct or endangerd	references
Augsburg	200	1119	39%	Müller 1985
Berlin	480	1008	54, 3%	Auhagen & Sukopp 1982
Former Republic Germany	248620	2476	35%	Blab & al. 1984

Within the urban area the original habitats are destroyed or changed seriously. In consequence the share of extinct and endangered plants is higher than in the surrounding country. Extinction is higher in big cities than in small ones (compare Tab. 1). Native species and especially those of wet and nutrient poor sites show a high decrease. However, urban agglomerations have a high number of species compared with the surroundings. This is because there are a lot of different habitats. An increasing number of alien species mainly of neophytes, meaning species which were introduced by men since the year 1500, is also typical. The proportion of alien species is correlated with the size of the city population, which is shown by example of Berlin (Fig. 3).

Most alien species in European cities have their origin in warmer areas of the world. Their growth is possible because of the warmer climate of urban areas. Another group of alien plants can be summarised as species with a high possibility of regeneration and show in their original country as well as in urban areas a fast distribution, due to the increasing impact of men, caused by nutrition and disturbance. Impressive examples are ruderal plant communities in urban areas all over the temperate zone which are dominated by the north American plant *Solidago gigantea*. Cosmopolitan species which are adapted to regularly disturbance such as *Poa annua*, are also typical for a lot of urban habitats. The aliens build up typical urban plant communities together with the native plants.

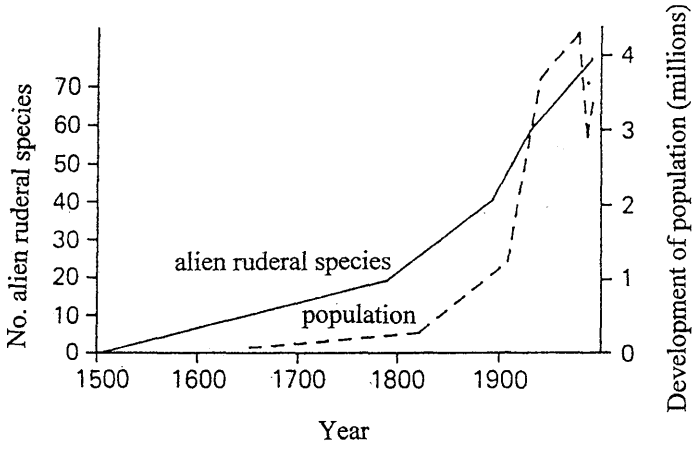

Fig. 3: Population development of Berlin related to the number of alien ruderal species (neophytes) introduced since the year 1500 (from Sukopp et al. 1979)

Many investigations into the flora, vegetation and fauna of European cities have shown that the distribution of species and their communities is highly correlated to the actual landuse types (Sukopp & al. 1980). Different landuse types show different species richness (comp. Fig. 4). Because each type of landuse has its own characteristic abiotic factors, the land use types are used as ecological units in urban areas. A detailed description of the different landuse types in urban areas and their specific ecological conditions is given by Gilbert (1989) and Sukopp & Wittig (1993).

Fig. 4: Number of higher plant species from different types of land use in the city of Augsburg (number of investigated areas) (from Müller 1990)

3. The aims and history of nature conservation and biotope mapping in cities

In principle the aims of nature conservation in cities and the open landscape are the same, and are to protect and develop nature and landscape in order that:

-the capacity of the nature household
-the utilisation of the natural goods
-the plants and animals
-the biodiversity, peculiarity and beauty of nature and landscape as a basis for the human beings are saved as sustainable.

Nature conservation in cities has its roots in Europe in the protection of old and rare trees and leads back mainly to the 19th century. With the general increase in importance of nature conservation in the beginning of this century, it focused also on rare and endangered species and their biotopes (habitats) in the surroundings of cities. But until that time the main objects of nature conservation were species and habitats of the open landscape such as forests or wetlands.

With the development of urban ecology and increased knowledge about the specificity of urban plant- and animal communities, nature conservation also focused on protection of specific urban biotopes.

The first studies in cities to specially estimate the areas which are important for nature conservation started in Germany in the 1980s and became famous as "biotope mapping". This systematic investigation of biotopes was at first limited to the open landscape and focused on habitats for rare and endangered species (Kaule 1975). In contrast "biotope mappings of urban areas" are oriented towards the special tasks of urban nature conservation as which are to protect or develop nature in cities as a basis for a direct contact between urban dwellers and the natural elements of their surroundings (Sukopp & al. 1980). Biotopes in urban areas are important:

-as refuges, dispersal centres and corridors for species
-for environmental protection and ecological balance (hydrological cycle, water resources and hygiene, climate, air hygiene, noise protection),
-for the aesthetic quality of the urban landscape, especially for structuring and enlivening the townscape,
-for providing low key recreation opportunities,
-as informal playgrounds for children,
-as demonstration and experimental areas for educational purposes,
-as bioindicators for environmental changes and pollution,

-for fundamental research into urban ecology

The first biotope mappings in urban areas were conducted in Berlin (Sukopp & al. 1980), Augsburg (Bichlmeier & al. 1980, Müller & Waldert 1981) and Munich (Brunner & al. 1979). As of today biotope mappings were done in 175 German cities (Sukopp 1994).

In 1978 a working group called "Biotope Mapping in Urban Areas" was established. The annual meetings are held in different cities at first in Germany and then also in other countries with German language. The aims of the meetings are to exchange experiences about the methods and results of mapping as well as its application in ecological city planning. For example the working group published recommendations for a basic program for biotope mapping in urban areas (Arbeitsgruppe "Methodik der Biotopkartierung im besiedelten Bereich" 1993).

In addition to the meetings a bibliography of research on nature conservation in urban areas is published regularly (compare Sukopp 1994).

The results of these studies were quickly recognised as basic information for nature conservation and infrastructure planning in cities. They found their application in programs e. g. "Program of protection the species and biotopes of Berlin" (Arbeitsgruppe Artenschutzprogramm Berlin 1984), and plans e. g. "Landuse and Landscape Plan Augsburg") (Müller 1982) as well in the daily practise of management of green spaces (Müller & Schmidt 1981). Meanwhile the results are basic information for "ecological city planning" in many European cities, especially in Germany.

4. Methods of biotope mapping

In general biotope mapping is focused on floristic and phytosociological features as it is relatively easy to study plants as compared with animals. It cannot be concluded, however, that from the particular value of a given site as a habitat for plants the site will be also be valuable for animals nor vice versa. But for the most part sites valuable for plants are also valuable for animals. Furthermore, biotope mapping in urban areas focuses on the aims of nature conservation in urban areas, which means more than the conservation of species as shown in chapter 3.

In principle two methods of biotope mapping in urban areas can be distinguished (Sukopp & Weiler 1988): the selective mapping and the comprehensive mapping.

Selective mapping investigates only habitats worthy of protection. This presupposes a framework of evaluation for biotopes worthy of protection and thus of mapping.

This method was developed from a method for biotope mapping the open landscape in Germany (Kaule 1975) which investigated the natural and semi-natural vegetation according to a key describing biotopes which are endangered (e. g. natural and secondary forests, wet and dry grasslands etc.). This key was extended for mapping in urban areas with the specific worthful urban biotopes such as urban forests and shrubs, old ruderal vegetation, extensive used meadows, abandoned or extensive used allotments etc. (Müller & Waldert 1981).

In the first step, those areas which show a high amount of vegetation and low influence of human impact are chosen with the help of aerial photos. These areas are then visited and evaluated. Biotopes are mapped when they show one or more of the following criteria:

-typical spectrum of species on the specific site (e. g. typical species of ruderal vegetation or of secondary forests)

-a high variety of vegetation age and structure

-rarity with the regard to the presence of specific plants and animals of the specific vegetation

-age and possibility of replacement (e. g. old

urban forests need a long time to develop)

The biotopes are described in maps. The written description take place in a special computerised form. The basis for the uniform description is a code plan used e. g. in Bavaria all over the country.

Comprehensive mapping investigates all landuse types e. g. settlements, industrial areas, waste lands etc. (Sukopp & al. 1980). Since normally it is not possible to carry out highly detailed study over the entire city area, sample areas for all landuse types are chosen, in order to identify the complete spectrum of different biotope types (comprehensive-representative mapping). The floristic and phytosociological studies consist the following steps:

-inventory of wild plant species (excl. woody species),

-inventory of woody species (spontaneous and planted) and

-inventory of vegetation

Afterwards the biotopes worthful for nature conservation are selected.

In addition to the mapping of flora and vegetation, investigations in some selected animal groups are done by selective mapping as well as by comprehensive mapping. The aim is, to get information about the value of sites which are not important from the view of vegetation e. g. large areas with bare ground which can be important for specific animal groups (e. g. grasshoppers) (Plachter 1980). Important groups which shall be investigated are (Arbeitsgruppe "Methodik der Biotopkartierung im besiedelten Bereich" 1993): birds; selected groups of mammals e. g. bats, shrews and hedgehogs; amphibians and reptiles; grasshoppers; butterflies (*Macrolepidoptera*); beetles (*Carabidae*); dragonflies; spiders (*Araneae*) and wild bees (*Apoidea*).

In comparison with selective mapping, comprehensive mapping gives a broader base for later interpretation. Besides the selection of areas which are especially important for nature conservation it is possible to do e. g.:

-an evaluation of the different landuse types as corridors

-choose the plants which shall be used for green space planing e. g. trees along roads, species for meadows etc.

-to document the changes of flora and vegetation exactly after a second investigation.

The disadvantage of comprehensive mapping is that it means a great deal of money, time and qualified personnel, so it was done only for a few cities. In contrast, selective mapping has the important advantage of being done quickly, with less demands on personnel and money. It can provide quick results for nature conservation and infrastructure planning. However the dates can hardly be used for further interpretation unlike those from comprehensive mapping.

Due to its fast results and as a second step of the investigation of the open landscape the selective method has been used in most German cities until today (comp. Fig. 5). In a lot of countries exist a standardised documentation of the dates, which is organised by the ministries of environmental protection. This ministry also supports the cities by the investigation, in form of guidelines and money for the investigations. In some countries of Germany the researchers get a special education for mapping.

For a wider interpretation of the dates from biotope mapping the working group "Methods of biotope mapping in built up areas" (Arbeitsgruppe "Methodik der Biotopkartierung im besiedelten Bereich" 1993) has recommended 1986 and al last 1993 a basic program for biotope mapping which shall include at least:

-overall mapping of landuse types (by aerial photos)

-mapping of areas which are potentially rich biologically or worthy for preservation

-mapping of biotope complexes

-mapping of flora and vegetation on selected sites

-mapping of animal groups on selected sites

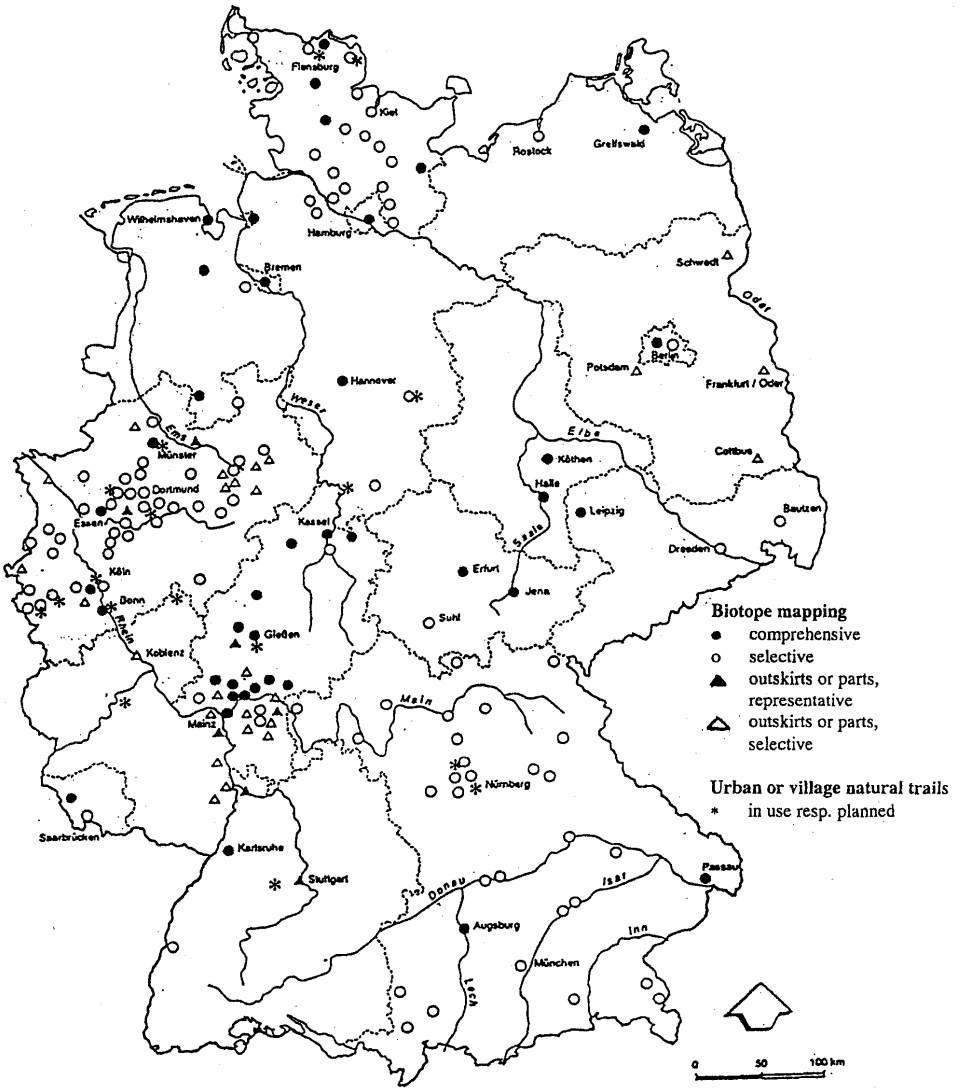

Fig. 5: Urban biotope mapping in populated areas, urban or village nature trails in Germany (from Starfinger & Sukopp 1994)

5. The example - biotope mapping in the city of Augsburg

In the city Augsburg both methods were tried (Müller & Waldert 1996). The results are shown by a series of maps (compare Fig. 6, 7, 8). First a selective mapping was done in order to get dates for infrastructure planning in a short time. In a second step, a comprehensive mapping was done for the settled areas. Additionally investigation in the following groups of animals were done: birds; selected groups of mammals e. g. bats, shrews and hedgehogs; amphibians and reptiles; grasshoppers; butterflies (*Macrolepidoptera*); beetles (*Carabidae*); dragonflies; spiders (*Araneae*) and wild bees (*Apoidea*).

To sum up, one can say that for basic dates for infrastructure planning (e. g. which areas shall be protected and not touched by the planning of roads or settlements) selective mapping is very useful, due to its quick

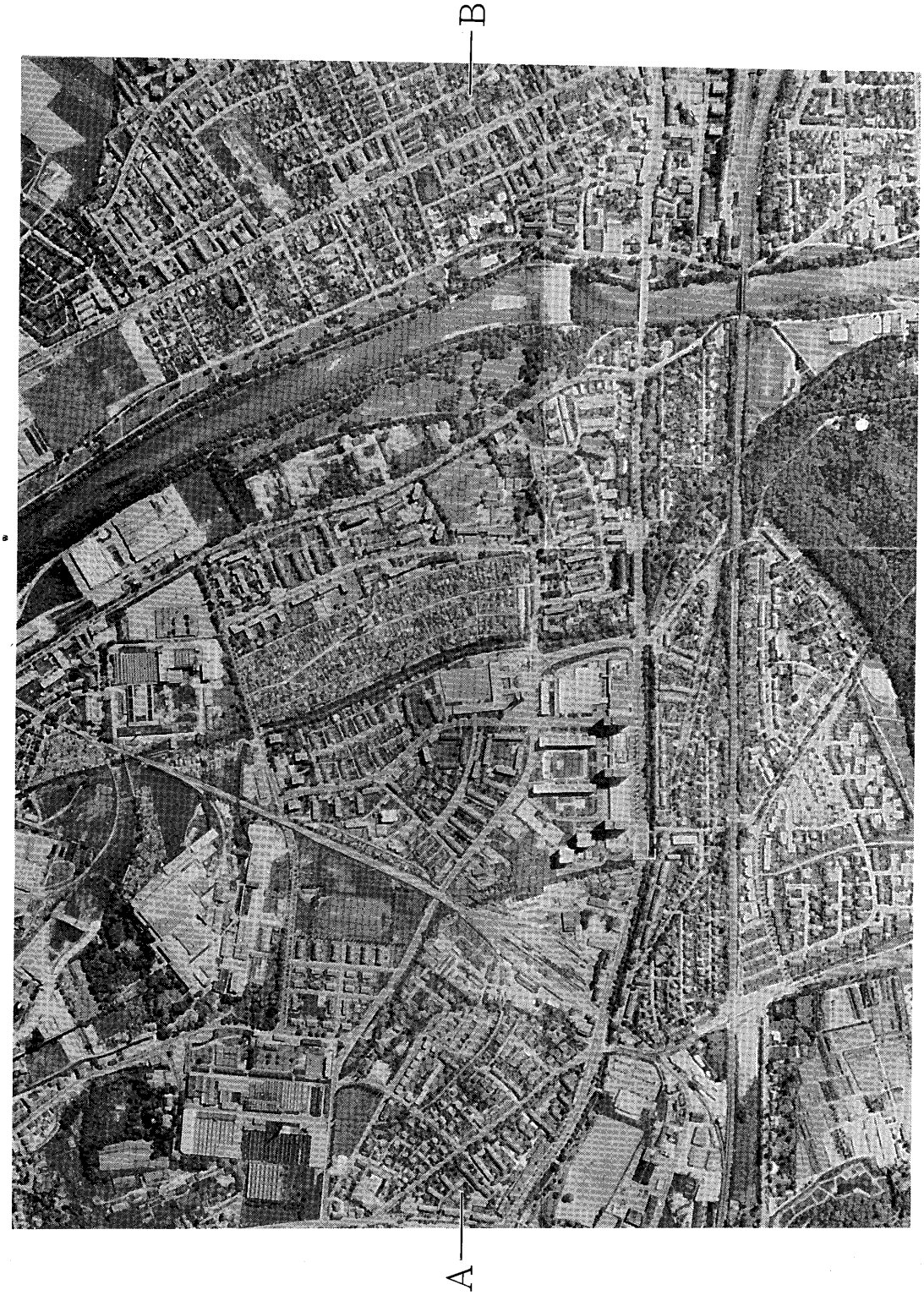

Fig. 6: Aerial photos are basic information for biotope mapping (extract of the urban area of Augsburg, compare fig. 7 & 8).

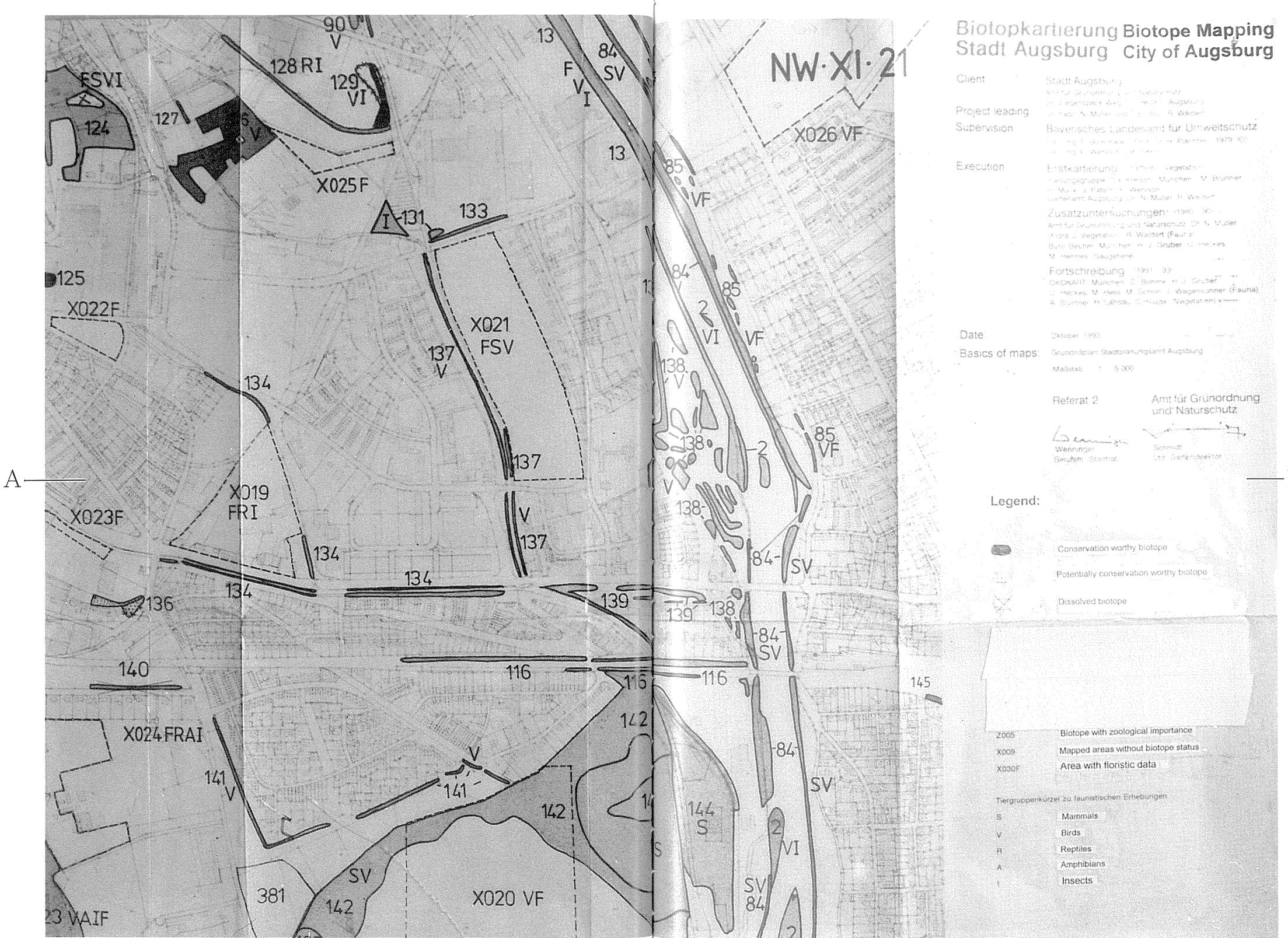

Fig. 7: Selective biotope mapping - only habitats, important for nature conservation, are investigated (extract of the urban area of Augsburg).

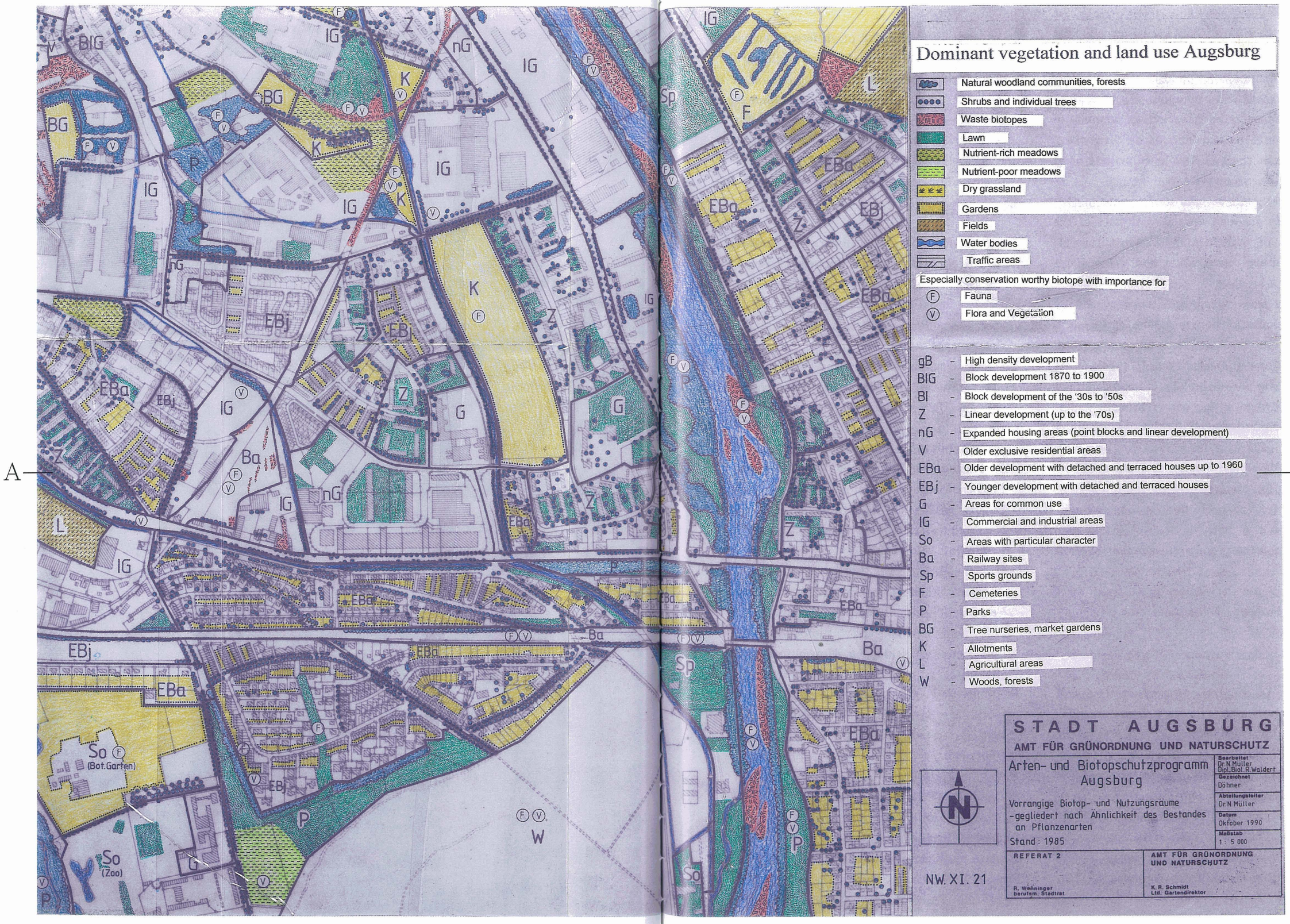

Fig. 8: Comprehensive biotope mapping - all dominant types of vegetation and land use are investigated and described. Afterwards biotopes worthful for nature conservation are selected (extract of the urban area of Augsburg).

investigation. On the other hand the dates produced by comprehensive mapping are a fundamental information for landscape planning as part of infrastructure planning e. g.:
-which landuse types have a high amount of trees and gardens and function as corridors,
-which areas shall be developed with special regard to green planning,
-which trees shall be used along roads

The dates are also an essential part of the evaluation of daily demands in a public office for nature conservation and green planning e.g.:
-where are trees which shall be protected by the construction of houses
-which plants shall be used for constructing new parks or settlements.
-which public parks shall be managed with a higher regard to nature conservation

As a result of the comprehensive mapping a lot of programs and following projects have been developed (Müller & Waldert 1996):
-programs for management of public parks
-program for the protection endangered animal species e. g. bats
-program for the protection endangered plant species

Especially for the protection of trees there has been developed a law under the city.

6. Forecast

In order to get dates in a short time and due the low amount of staff (the investigation were done by the author, the main time in frame of an exercise at the university), the pilot study in the urban agglomeration of Tokyo was done only in two testing areas.

a) area 1 around the campus of the National University Yokohama
b) area 2 around Yokohama Station

The selection of the areas depended on two reasons:
-for the university campus exists already actual dates of flora and vegetation (Okuda 1994, Tohma & al. 1994)
-the areas include a lot of different landuse types, which are typical for the agglomeration of Tokyo-Yokohama.

A basic programme of biotope mapping was used, which will be explained in a further contribution as well as first results of the pilot study.

Thanksgiving:

I thank Prof. Dr. K. Fujiwara for hints at Japanese literature and productive discussion.

7. References:

Arbeitsgruppe Artenschutzprogramm Berlin (1984) Grundlagen für das Artenschutzprogramm in drei Bänden. - Landschaftsentw. u. Umweltforsch. 23, Berlin, 993 S. u. Karten

Arbeitsgruppe "Methodik der Biotopkartierung im besiedelten Bereich" (1993) Flächendeckende Biotopkartierung im besiedelten Bereich als Grundlage einer am Naturschutz orientierten Planung - Natur & Landschaft 68: 491-526

Auhagen, A. & Sukopp, H. (1982) Auswertung der Liste der wildwachsenden Farn- und Blütenpflanzen von Berlin (West) für den Arten- und Biotopschutz - Landschaftsentwicklung u. Umweltforschung 11: 5-19

Bichlmeier, F., Brunner, M., Patsch, H., Mück, H. & Wenisch, E. (1980) Biotopkartierung Stadt Augsburg - Garten & Landschaft 7: 547-556

Blab, J. & al. (1984) Rote Liste gefährdeter Tiere und Pflanzen in der BRD - Kilda, Greven, 4. Aufl.

Blume, H.-P. (1989) Classification of soils in urban agglomerations - Catena 16: 269-275

Boyden, S., Miller, S., Newcombe, K., O'Neill, B. (1981) The ecology of a city and its people. The case of Hongkong. Australian National University Press, Canberra

Brunner, M., Duhme, F., Mück, J., Patsch,

H. & Wenisch, E. (1979) Kartierung erhaltenswerter Lebensräume in der Stadt - Gartenamt 28: 1-8

Fujiwara, K. & Miyawaki, A. (1989) Functional vegetation map of Koganei City in: Miyawaki, A., Fujiwara, K. & Takanami, Y. (1989) Vegetation of Koganei City, Tokyo metropolitan area - Bulletin of the Yokohama Phytosociological Society 59: 1 map

Fujiwara, K. & Miyawaki, A. (1991) Functional vegetation map of Oiso Town - in: Miyawaki, A., Fujiwara, K. & Terada, J. (1991) Vegetation of Oiso Town - Bulletin of the Yokohama Phytosociological Society 61: 1 map

Gilbert, O. L. (1991) The Ecology of urban habitats - Chapmann & Hall, London Horbert, M., Kirchgeorg, A. & v. Stülpnagel, A. (1983) Ergebnisse stadtklimatischer Untersuchungen als Beitrag zur Freiraumplanung. - Umweltbundesamt, Berlin. Texte 18/83

Kaule, G. (1975) Kartierung schutzwürdiger Biotope in Bayern - Verh. Ges. Ökologie 3: 257-260

Kühnelt, W. (1955) Gesichtspunkte zur Beurteilung der Großstadtfauna (mit besonderer Berücksichtigung der Wiener Verhältnisse) - Österr. Zool. Z. 6: 30-54.

Miyawaki, A., Fujiwara, K. & Takanami, Y. (1989) Vegetation of Koganei City, Tokyo metropolitan area - Bulletin of the Yokohama Phytosociological Society 59

Miyawaki, A., Fujiwara, K. & Terada, J. (1991) Vegetation of Oiso Town - Bulletin of the Yokohama Phytosociological Society 61

Müller, N., (1982) Biotopkartierung im besiedelten Bereich und ihre Bedeutung für die Stadtplanung - Inf. Raumentwicklung 10: 812-835

Müller, N. (1985) Rote Liste gefährdeter Farn- und Blütenpflanzen in Augsburg und ihre Auswertung für den Arten- und Biotopschutz - Ber. Nat. wiss. Ver. Schwaben 89: 2-24

Müller, N. (1990) Charakteristik von Flora und Vegetation in Städten - Schriftenr. Bayer. Landesamt für Umweltschutz 107: 30-40

Müller, N. & Waldert, R. (1981) Erfassung erhaltenswerter Lebensräume für Pflanzen und Tiere in der Stadt Augsburg - Stadtbiotopkartierung: Natur & Landschaft 56: 419-429

Müller, N. & Schmidt, K. R. (1982) Stadt Augsburg - Blumenwiesen, Entwicklung von artenreichen und biologisch aktiven Grünflächen - Pflegeprogramm Siebentischpark - Das Gartenamt 31: 23-30

Müller, N. & Waldert, R. (1996): Stadtökologische Grundlagenerhebungen in Augsburg - Deren Umsetzung in Planung und Praxis - Stadt & Grün 45: 622-624

Numata, M. (1981): Integrated Ecological studies in Bay-Coast-Cities. II. Seibunsha, Chiba

Numata, M. (1990) Urban ecology in the broader context of ecological science - Nat. Hist. Res. 1: 1-10

Numata, M. (1991) Urban ecosystem studies in the Tokyo Metropolitan area - Memoirs Shukutoku University 25: 41-53.

Plachter, H. (1980) Tierbestände im Siedlungsbereich und ihre Erfassung im Rahmen von Biotopkartierungen - Garten & Landschaft 90: 569-576

Sukopp, H. (1973) Die Großstadt als Gegenstand ökologischer Forschung. Schr. Verbreitung naturwiss. Kenntnisse in Wien 113: 90-140

Sukopp, H. (Edit.) (1990) Stadtökologie: das Beispiel Berlin - D. Reimer, Berlin

Sukopp, H. (1994) Stadtforschung und Stadtökologie in Vergangenheit und Gegenwart-Geobot. Kolloq. 11: 3-16

Sukopp, H., Blume, H. P., Elvers, H., Horbert, M. (1980) Beiträge zur Stadtökologie von Berlin (West). Landschaftsentwicklung und Umweltforschung 3, Inst. Ökol. Techn. Univ. Berlin, Berlin.

Sukopp, H., Elvers, H. & Mattes, H. (1982) Studies in urban ecology of Berlin (West). - Zwiezete w swieci zurbanizowanym osslineum: 115- 130.

Sukopp, H., Kunick, W. & Schneider, Ch. (1980) Biotopkartierung im besiedelten Bereich von Berlin (West) Teil II: Zur Methodik von Geländearbeit und Auswertung - Garten & Landschaft 90: 560-564

Sukopp, H. & Weiler, S. (1986) Biotopkartierung im besiedelten Bereich der Bundesrepublik Deutschland - Landschaft und Stadt 18: 25-38

Sukopp, H. & Wittig, R. (1993) (Edit.) Stadtökologie - Gustav Fischer, Stuttgart, Jena New York

Starfinger, U. & Sukopp, H. (1994) Assessment of urban biotopes for nature conservation- in: Cook, E. & v. Lier, H. (Edit.) Landscape planning and ecological networks: 89-115, Elsevier, Amsterdam

Tohma, H., Ishii, S. & Fujiwara K. (1994) Actual Vegetation in the Yokohama National University Campus - Vegetation change over the last 25 Years - Bulletin Inst. of Environmental Science and Technology, Yokohama National Univ. Vol. 20, No. 1, Yokohama: 31-96.

Yokohama City (1993) (Edit.) Local environmental characteristic maps