Breeding season diet of Northern Goshawks *Accipiter gentilis* in the city of Hamburg, Germany

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Each year from 1997-1999, diet composition of a different urban breeding pair of Northern Goshawks *Accipiter gentilis* was investigated in the city of Hamburg, Germany. Nest sites were adjacent to each other and located in a public park, on a hospital ground and on a cemetery, respectively. All three pairs successfully raised young in the year of data collection (3, 3 and 4 juvs., respectively). Goshawk diet was assessed by two methods: (i) radio-tagged males were monitored continuously (and as closely as possible) in an attempt to record all their kills; and (ii) nesting territories of the corresponding pairs were scanned for prey remains at the end of each tracking-session. In total, 324 prey items belonging to 25 vertebrate species were recorded. Prey consisted of birds (21 species; 91.7 % of all individuals) and mammals. Feral Pigeon *Columba livia* f. domestica, Magpie *Pica pica* and Blackbird *Turdus merula* had the largest contributions to total diet. Together, they accounted for 64.5 % of all recorded prey numerically and for 59.4 % in terms of biomass. Rabbits *Oryctolagus cuniculus* comprised 17.4 % of the total biomass recorded for the pair nesting on the hospital ground. Twenty-eight percent of all prey were juveniles (in birds: nestlings and fledglings). The grand mean prey weight was 247 g ± 198 (s.d.). The diets of the three urban Goshawk pairs investigated were characterised by: (i) the dominance of a few avian prey species; (ii) low species richness; (iii) low average prey weight; and (iv) a large proportion of juvenile prey. These observations are consistent with results from other urban study areas. Data are presented in form of the first complete prey list published for Goshawks breeding in a highly-urbanised environment.

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1. Introduction

The Northern Goshawk *Accipiter gentilis* typically prefers large, mature forests as nesting sites and is morphologically adapted for hunting in wooded habitats (Wattel 1973, Fischer 1995, Squires & Reynolds 1997). In Germany, Goshawks living in rural environments primarily prey on Woodpigeons *Columba palumbus* and Feral Pigeons *Columba livia* f. domestica (review in Brüll 1984; see also Looft 1981, Ziesemer 1983, Bezzel et al. 1997), but some local populations have been reported to use other principal prey species (e.g. Jay *Garrulus glandarius*, Kramer quoted in Brüll 1984; thrushes, Schnurre 1973, Bezzel et al. 1997; Pheasant *Phasanius colchicus*, Ziesemer 1983).

During the last 30 years, the Goshawk has colonised urban environments throughout Europe. Breeding populations have been reported for four large cities (Berlin: Behncke & Müller 1991, Altenkamp 2002; Cologne: Würfels 1994, 1999; Moscow: Aparova 2003; Hamburg: Rutz 2001 a) and a couple of suburban habitats (e.g. Saarbrücken: Dietrich 1982; Amsterdam: Müskens 2002; see additional quotations in Fischer 1995). Additional breeding attempts in other urban settings – especially those of pioneer pairs during the early phases of a colonisation process – may have passed unnoticed. Goshawks show a remarkable degree of behavioural flexibility, which allows them to adapt rapidly to urban life (Rutz 2003 b).

Diet composition of urban-breeding Goshawks was investigated in detail in Cologne from 1989 to 1996 (Würfels 1994, 1999). Together, Feral Pigeon and Magpie *Pica pica* numerically accounted for about 50 % of the prey of this population. Pigeons are also the principal prey of Goshawks in the city of Berlin (Altenkamp & Herold 2001) and its suburban periphery (Deppe 1976, Jacob & Witt 1986). The food habits of breeding pairs in metropolitan Hamburg have been studied by means of systematic plucking analysis as part of a long-term population monitoring programme

since 1996 (C. Rutz in prep., C. Rutz et al. in prep.).

In this paper, breeding season diets are reported for three urban Goshawk pairs, nesting in the city centre of Hamburg. The objective of this pilot project was to describe the diets of selected pairs, which were considered to be representative of the study population (see methods), as accurately as possible by combining results obtained by two different field methods: (i) close monitoring of radio-tagged breeding males; and (ii) systematic scanning of nesting areas for prey remains. The material will serve as an important baseline for the interpretation of more quantitative data (C. Rutz in prep.).

2. Methods

2.1 Study area and investigated breeding pairs

The study was carried out in the city of Hamburg (53°34' N, 9°59' E), Germany, from 1997-1999. In each year diet composition of a single urban Goshawk pair was investigated during the breeding season (Table 1). Nest sites were located in an extensively used public park in the city centre, on a hospital ground, and on a large urban cemetery, respectively. They were adjacent to each other (i.e. there were no other Goshawk territories between them) and were considered representative examples of nest stands used by Goshawks in the city of Hamburg, in consideration of: micro habitat composition, proximity to built-up areas, and average degree of human disturbance. A detailed description of nest sites and breeding individuals can be found in Rutz (2001 a). All three pairs reproduced successfully in the year of data collection (Table 1; but see Rutz 2001 c and Rutz et al. 2004, for remarks on the breeding attempts of pair 1). Data on the spatio-temporal organisation of the adult males of all three pairs and on the post-fledging dispersal of the 1997-offspring of pair 1, have been presented elsewhere (Rutz 2001 a, b, 2003 b).

2.2 Radio-tracking

Goshawks were trapped near the nest using spring-net traps ("butterfly traps") baited with live coloured domestic pigeons (Karlbom 1981). Hawks were weighed, measured, ringed and instrumented with 16-g tail-mounted radio-transmitters (model: TW-3 1/2-AA, 150 MHz-band; Biotrack Ltd., Dorset, UK; for tagging-method, see Kenward 1978). Tags had built-in tilt switches that indicated the activity of a bird (inter-perch flight, soaring and plucking) by altering the pulse rate of the radio-signal (Kenward 1987). All radio-fixes were made with a portable M-57 receiver (Mariner Radar Ltd., Suffolk, UK) with earphones, a three-element hand-held Yagi antenna and – when necessary – a mirror compass. Radio-fixes were recorded by either homing-in on the tagged animal or by cross-triangulation (Kenward 1987).

Birds were monitored continuously for half or full days at least once a week. Most of the time, hawks were followed by bicycle, but in cases of long-distance movements (> 1.5 km) they were searched for using a car with a roof-mounted dipole antenna. The remarkable tameness of the birds (Rutz 2001 a, 2003 b) and the urban infrastructure facilitated close monitoring (Fig. 1). Fifty-two percent of all standard fixes (n = 4791) were based on direct observations. Feeding hawks were located accurately enough to find their prey remains after they had flown off (Fig. 2; see also Kenward 1979, Ziesemer 1981, 1983, Widén 1987, Tornberg & Colpaert 2001).

2.3 Plucking analysis

Pluckings were collected by systematically scanning the nesting territory at the end of each radio-tracking session (e.g. Opdam et al. 1977, Brüll 1984, Würfels 1994, 1999, Toyne 1998). During each search, an area of approximately 3 ha (100 m-radius around the nest) was sampled. Data collection was restricted to the time periods of radio-tracking (see Table 1).

Three precautions were taken in order to avoid double-counting of prey items: (i) all remnants were removed or clearly marked after counting (Bijlsma 1997); (ii) main feathers were collected, counted and compared in an attempt to separate scattered feathers of different individuals from the same species (Opdam et al. 1977, Bijlsma 1997); and (iii) bones and pellets were not included in the analysis (Newton 1986, Widén 1987). Further, single feathers were omitted from the analysis as they may have come from moulting birds (Boal & Mannan 1994).

Prey recorded during continuous radio-monitoring sessions were used to quantify potential biases of the standard method of plucking analysis. This methodological aspect of the study has been described in detail elsewhere (Rutz 2003 a).

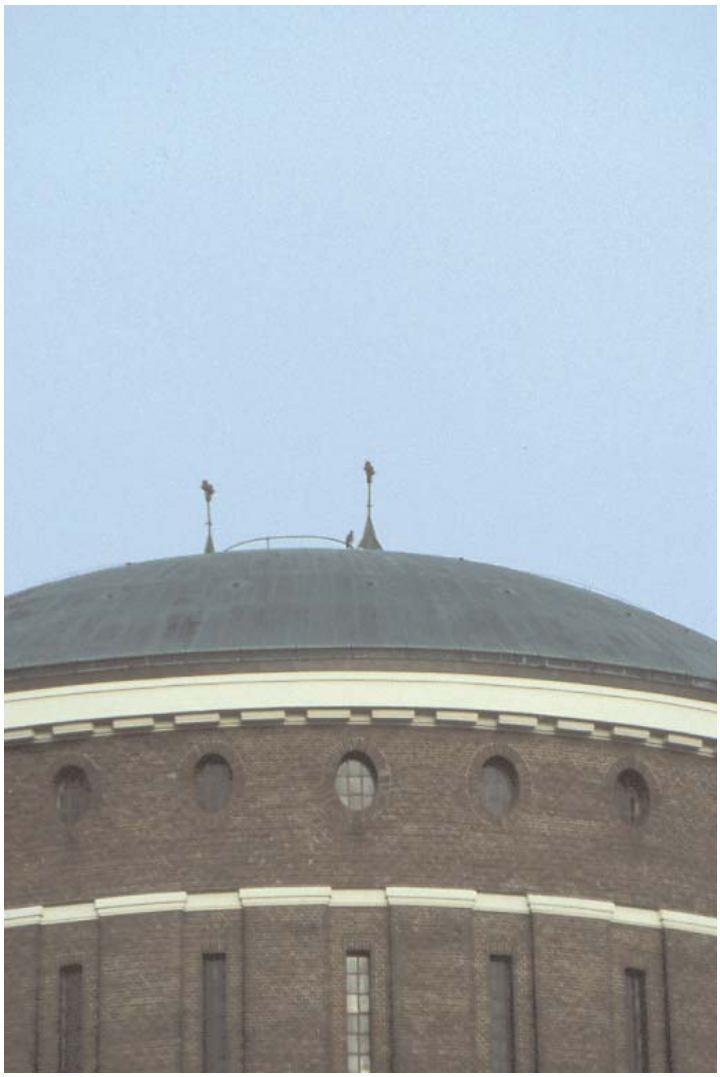

Fig. 1: Not an unusual observation in metropolitan Hamburg: a male Northern Goshawk (male 1) is perched on the roof of a prominent building in the city centre (planetarium). In many regards, the hunting behaviour of urban Goshawks resembles that of city-Peregrines. The photograph was taken during the radio-tracking session on 16.03.1997 at 0752 hours.

Photo: J.-H. Witt-Kükenthal, †

Abb. 1: Kein ungewöhnlicher Anblick in Hamburg: ein Habichtmännchen (Männchen 1) sitzt auf der Spitze eines markanten Gebäudes im Stadtzentrum (Planetarium). Das Jagdverhalten von Stadt-Habichten ähnelt in vielerlei Hinsicht dem städtischer Wanderfalken. Die Aufnahme wurde während der Telemetriesitzung am 16.3.1997 um 7:52 Uhr gemacht.

Table 1: Summary of radio-tracking information for three adult male Northern Goshawks monitored in the city of Hamburg.

Tab. 1: Übersichtstabelle mit Angaben zu drei in Hamburg radiotelemetrisch untersuchten adulten Habichtbrutmännchen.

	Male 1	**Male 2**	**Male 3**
year of data collection	1997	1998	1999
nest-site habitat	public park	hospital ground	cemetery
age of breeding male	4	3	≥ 5
juveniles in year of data collection	3	3	4
radio-tagged	16.02.1997	22.02.1998	16.04.1999
tracking-period	18.02.-12.07.	26.02.-15.07.	25.04.-13.07.
no. of tracking sessions	30	33	14
no. of standard radio-fixes	1980	1940	871

2.4 Prey weights

Average values of prey weights (see Appendix) were taken from Dietrich (1982), März (1987), Collar (1997) and Toyne (1998), and weight classes were adopted from Toyne (1998).

Killed birds were classified as adults, fledglings (young that had just left the nest), and nestlings according to the growth-stage of their feathers (Newton & Marquiss 1982, Toyne 1998). Rabbits *Oryctolagus cuniculus* could be aged by the size of their bones and by the amount of plucked fur when comparatively complete pluckings were found. This was often the case, as the birds of pair 2, which killed the majority of all recorded Rabbits, hunted this species on the meadows next to their nest and transported mainly unprepared individuals to nearby plucking posts. The weight of Rabbits that could not be aged accurately was set at 950 g (= mean of adult weight, 1600g, and juvenile weight, 300g). It is possible that some of these individuals were in fact much lighter juveniles. This may have biased estimates of average prey weights (see also discussion).

Mass of fledglings and juvenile mammals was calculated as being two-thirds of the adult weight (Opdam 1975, Newton & Marquiss 1982, Toyne 1998). Nestlings were assigned an estimated weight of one-third of the corresponding adult weight (see Grønnesby & Nygård 2000). Exceptions from these general rules are explained in the footnotes to the Appendix.

3. Results

At the three Goshawk nest sites investigated, a total of 324 prey items were collected (Appendix), of which more than a third (n = 122) were found by means of radio-monitoring the food-provisioning males (Table 2). During tracking sessions, another 24 items could not be identified, because it was either impossible to enter the back yard where a kill had occurred or the tagged hawk had flown off with its quarry before it could be located precisely enough. These cases were omitted from the analyses.

In total, 25 prey species were recorded. Prey consisted of birds (21 species; 91.7 % of all individuals) and mammals (rest). The pair nesting on the cemetery (pair 3) had the richest diet of the three investigated pairs (18 species). The number of species recorded for a pair was positively related to the amount of park-like habitat within the 100 %-MCP home range of the male (Fig. 3).

Diet was dominated by a few species, the Feral Pigeon being the principal prey of all three pairs (Fig. 4; Appendix). Feral Pigeon, Magpie and Blackbird *Turdus merula* accounted for 64.5 % of Goshawk prey numerically and for 59.4 % in terms of biomass. Rabbits contributed 17.4 % to the total biomass recorded for the pair nesting on the hospital ground (pair 2; Fig. 4).

Pluckings of two exotic escapees (Budgerigar *Melopsittacus undulatus*) were found in the nesting area of pair 3. On 22.04.98, male 2 was observed chasing a green Budgerigar for about 8 min in the inner nesting area. The hawk seriously attacked the bird three times but eventually gave up.

Twenty-eight percent of all prey were juveniles (in birds: nestlings and fledglings; see Appendix). The proportion of juveniles was low for Feral Pigeons (6.7 % of all individuals of this species) but high for Starlings (*Sturnus vulgaris*; 66.7 %) and Magpies (57.7 %). On eleven occasions, tagged Goshawks were observed taking nestling prey out of nests. Another five attempts were unsuccessful because the hawk was either unable to

Table 2: Number of prey items identified for three breeding pairs of Northern Goshawks in the city of Hamburg (1997-99). Numbers of items found by continuous radio-tracking, plucking analysis and both methods combined are given. Average prey weights are reported as arithmetic means ± 1 s.d.. The last column gives data for the pooled datasets of the three pairs.

Tab. 2: Anzahl der über kontinuierliche Radiotelemetrie, Rupfungsanalyse und die Kombination beider Methoden nachgewiesenen Beutetiere innerstädtischer Habichtbrutpaare in Hamburg (1997-99). Die mittleren Beutegewichte sind als arithmetische Mittelwerte ± 1 s.d. angegeben. Die letzte Spalte enthält entsprechende Angaben für die vereinigten Datensätze der drei Paare.

	Pair 1	**Pair 2**	**Pair 3**	**Pooled**
total no. of prey identified	138	109	77	324
found by radio-tracking	69	36	17	122
found by scanning	85	84	64	233
average prey-weight (radio-tracking) [g]	190 ± 103	289 ± 224	220 ± 94	223 ± 153
average prey-weight (both methods) [g]	205 ± 113	323 ± 278	217 ± 148	247 ± 198

reach the nestling (closed Magpie nests!) or it was disturbed during the attack.

The grand mean prey weight was 247 g ± 198 (s.d.) (n = 324; datasets of all three hawks/pairs and both methods pooled; see Appendix). For the distribution of prey of the three pairs across six weight classes, see Figure 5.

4. Discussion

Three bird species – Feral Pigeon, Magpie and Blackbird – dominated the diets of the investigated Goshawk breeding pairs in metropolitan Hamburg. Together, their numerical contribution to total diet was well above 50 %. This is consistent with data for pairs nesting in the cities of Cologne (Würfels 1994, 1999) and Berlin (Deppe 1976, Jacob & Witt 1986, Altenkamp & Herold 2001). All three species are key-members of Hamburg's urban avifauna and reach high local breeding densities in built-up habitats (Mitschke et al. 2000, Mitschke & Baumung 2001). In the city centre, large flocks of Feral Pigeons are associated with railway (underground) stations, shopping centres and public places (see Klemp 1993). Magpies and Blackbirds, on the other hand, are most abundant in gardens and back yards of residential areas (Mitschke & Baumung 2001). In fact, the tagged Goshawks were often observed to scan these different habitat types systematically (see Fig. 6) during their hunting excursions (Rutz 2001 a).

The pair nesting on the hospital ground (pair 2) also preyed on Rabbits, which seemed to be particularly vulnerable to attacks while feeding on the coverless meadows of the park. Rabbits are also an important prey for some Goshawk pairs in the city of Cologne (Würfels 1994, 1999). Woodpigeons were killed infrequently by all pairs investigated in the present study. This is surprising, as the species is abundant in the study area (see Mitschke & Baumung 2001) and extensively used by hawks breeding at the periphery of metropolitan Hamburg (14 % of all prey; Brüll 1984, C. Rutz et al. unpubl. data) and in rural parts of nearby Schleswig-Holstein (17 %; Looft 1981, C. Rutz et al. unpubl. data).

Fig. 2: Adult male Northern Goshawk (male 1) plucking a freshly-killed white Feral Pigeon in a back yard in Hamburg's city centre. The photograph was taken during the radio-tracking session on 23.02.1997 at 1615 hours. *Photo: J.-H. Witt-Kükenthal, †*

Abb. 2: Adultes Habichtmännchen (Männchen 1) rupft eine frisch geschlagene weiße Straßentaube auf einem Komposthaufen in einem innerstädtischen Hamburger Hinterhof. Die Aufnahme wurde während der Telemetriesitzung am 23.2.1997 um 16:15 Uhr gemacht.

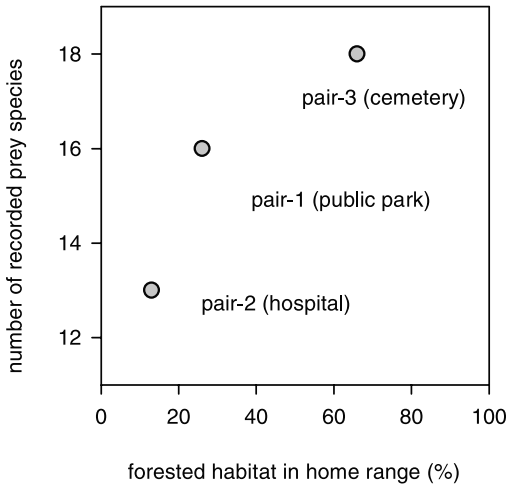

Fig. 3: Diet richness (= number of recorded prey species) of three urban breeding pairs of Northern Goshawks as a function of the proportion of forested habitat (parks) within the 100 %-MCP home ranges of the provisioning males.

Abb. 3: Anzahl nachgewiesener Beutearten von drei innerstädtischen Habichtbrutpaaren als Funktion des Waldanteils im 100%-MCP Homerange des jeweiligen Männchens.

Diet richness (25 prey species for the pooled datasets) was small compared to that found for rural populations in Germany (e.g. 73 species, Opdam et al. 1977; 73 species, Brüll 1984; 94 species, Bezzel et al. 1997). According to a recent breeding bird survey (Mitschke & Baumung 2001), Hamburg's avifauna is remarkably diverse, and comprises some 160 breeding bird species. Thus, the narrow food niche observed in the Goshawk pairs investigated cannot be explained by a low species diversity of their urban hunting ranges. No data on diet richness from other urban Goshawk populations are available for comparisons between cities (neither Würfels 1994, 1999, nor Altenkamp & Herold 2001 reported the number of prey species recorded for Goshawks in their urban study areas). However, only 27, 31 and 38 prey species were found at nest sites of Goshawks breeding in suburban woods in Berlin (Deppe 1976, Jacob & Witt 1986) and Saarbrücken (Dietrich 1982), respectively. At present, it remains unclear whether Goshawks in urban environments indeed have a narrower diet breadth than rural hawks. The preliminary results presented in this paper may also be due to a methodological artefact: the number of prey species found in a diet study is an increasing function of many factors, such as number of investigated pairs, search effort and duration of the investigation. Unfortunately, all studies in urban settings are based on small sample sizes (pairs as well as years) compared to projects in rural habitats.

The positive relationship between diet richness and amount of park-like habitat within the home ranges of the males (Fig. 3) parallels the observation that urban parks tend to have higher avian species diversities than built-up areas (e.g. Hadidian et al. 1997, Fernández-Juricic 2000). Habitat use in urban Goshawks appears to be non-random, i.e. their proportional use of different habitat types does not match the availability of these structures in the environment (Rutz 2001 a, b). The tagged males spent almost 90 % of daylight hours in forested patches but made about half of their kills during short foraging trips into the surrounding matrix of built-up habitat (Rutz 2001 a, b). This suggests that hunting opportunities are best in highly-urbanised areas. Obviously, the degree to which individual hawks have access to high quality habitats (and the resources contained therein) depends on various factors, including habitat composition around the nest site, foraging experience, and competition with neighbours. Detailed studies are needed to further explore the complex interactions between habitat use and prey choice in urban-breeding Goshawks (habitat use vs. habitat availability; prey choice vs. prey availability; habitat use – prey choice).

Almost a third of all prey recorded in this study were juveniles. Studies on rural populations have also shown that juvenile prey can play an important role in Goshawks' diets (e.g. Brüll 1984, Opdam et al. 1977, Goszczyński & Pilatowski 1986, Mañosa 1994, Tornberg 1997, Toyne 1998). Juvenile Magpies made up numerically for 12-18 % in the diet of urban Goshawks breeding in the city of Cologne (Würfels 1994, 1999). In the present

study, the proportion of juveniles was high for Magpies and Starlings but low for Feral Pigeons. This result clearly reflects differences in the vulnerability of juveniles of these species. Tagged males were observed taking Magpie-nestlings out of nests (see also KLUIJVER 1966, TAKAGI et al. 1995) and hunting groups of newly-fledged Starlings. On several occasions, they returned to sites where they had previously enjoyed hunting success. Attacks on nestling pigeons have never been observed directly.

The grand mean prey weight (247 g ± 198) was lower than that reported for most rural Goshawk populations (e.g. 325 g, BRÜLL 1984). Again, estimates for other urban populations are lacking, but values for the populations of Cologne and Berlin will also be well below 300 g, as birds of these populations also primarily prey on pigeons, Magpies and Blackbirds (see above for references). The large average prey weight of the pair breeding on the hospital ground (pair 2; see Table 2) was due to a comparatively high proportion of Rabbits in the diet. As explained in the methods section, this value might be an overestimation due to difficulty in ageing Rabbits.

This pilot study demonstrated that diets of three urban Goshawk breeding pairs in Hamburg were characterised by: (i) the dominance of a few avian prey species; (ii) low species richness; (iii) low average prey weight; and (iv) a large proportion of juvenile prey. These observations are consistent with data from other urban study areas. A comparison with published information on the feeding ecology of this raptor indicates that there might be general differences in the diet choice of urban and rural individuals. Such possible differences, however, remain to be established quantitatively by the analysis of long-term plucking data for larger numbers of urban Goshawk pairs.

5. Acknowledgements

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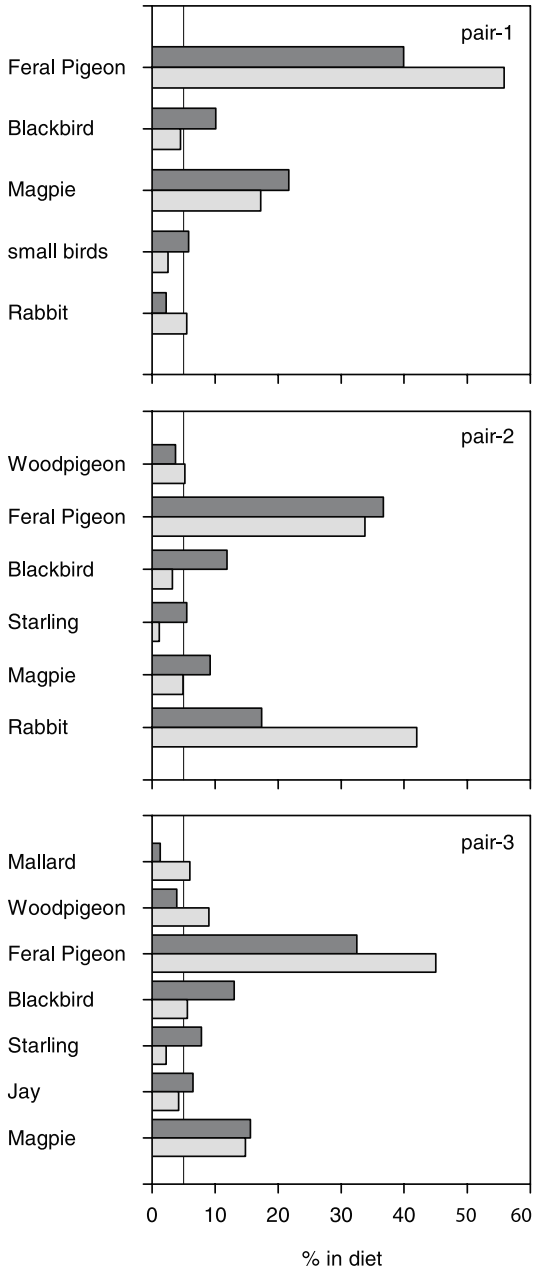

Fig. 4: Principal prey species of three urban breeding pairs of Northern Goshawks in the city of Hamburg. For each pair, prey species are listed that had a contribution of at least 5 % (vertical lines) to total diet numerically (dark grey) or in terms of biomass (light grey).

Abb. 4: Hauptbeutetierarten von drei innerstädtischen Habichtbrutpaaren in Hamburg. Für jedes Paar sind die Arten aufgeführt, die entweder zahlen- oder gewichtsmäßig (dunkel- bzw. hellgrau) einen Anteil von mindestens 5 % (vertikale Linien) an der Gesamtbeute hatten.

Witt-Kükenthal (†) for providing photographs; and the "Studienstiftung des deutschen Volkes", the "Gottlieb Daimler- und Karl Benz-Stiftung" and the "Cecil Rhodes Trust" for funding.

6. Zusammenfassung: Brutzeitbeute urbaner Habichte *Accipiter gentilis* in Hamburg, Deutschland

Von 1997-1999 wurde die Brutzeitbeute von drei verschiedenen, im Stadtzentrum Hamburgs horstenden Habichtpaaren *Accipiter gentilis* untersucht. Die Brutplätze waren benachbart und befanden sich in einem öffentlichen Park, auf einem Krankenhausgelände und auf einem Friedhof. Alle Paare zogen im jeweiligen Untersuchungsjahr erfolgreich Jungvögel auf (3, 3 bzw. 4 juv.). Die Nahrungswahl der Habichte wurde mit zwei verschiedenen Methoden untersucht: (i) die besenderten Männchen wurden ganze und halbe Tage lang radiotelemetrisch auf ihren Jagdflügen durch den urbanen Habitat verfolgt, wobei ihre Beuteschläge möglichst lückenlos erfasst wurden; (ii) zusätzlich wurde am Ende jeder Telemetriesitzung das Horstfeld systematisch nach Rupfungsresten abgesucht. Insgesamt wurden 324 Beutetiere, zugehörig zu 25 verschiedenen Wirbeltierarten, identifiziert. Die Nahrung bestand aus Vögeln (21 Arten; 91,7 % aller Individuen) und Säugetieren. Haustaube *Columba livia* f. domestica, Elster *Pica pica* und Amsel *Turdus merula* machten zahlenmäßig 64,5 % der Gesamtbeute aus und hatten einen Beitrag von 59,4 % zur Gesamtbiomasse. Kaninchen *Oryctolagus cuniculus* waren eine wichtige Beute des Krankenhaus-Habichtpaares (17,4 % der Gesamtbiomasse). Knapp ein Drittel (28,1 %) aller Beutetiere waren Jungtiere (bei Vögeln: Nestlinge und Flügglinge). Das mittlere Beutegewicht betrug 247 g ± 198 (s.d.) für die vereinigten Datensätze. Die Beutezusammensetzung der drei untersuchten Habichtpaare war charakterisiert durch: (i) die Dominanz einiger weniger Beutetierarten; (ii) eine geringe Artenzahl; (iii) ein niedriges mittleres Beutegewicht; und (iv) einen hohen Anteil an jungen Beutetieren. Diese Ergebnisse stimmen mit den Resultaten anderer Studien an urbanen Habichten überein. Die kompletten Beutelisten für die drei untersuchten Paare werden in einem Appendix präsentiert; sie stellen die erste publizierte, vollständige Beschreibung der Nahrungszusammensetzung innerstädtischer Habichtbrutpaare dar.

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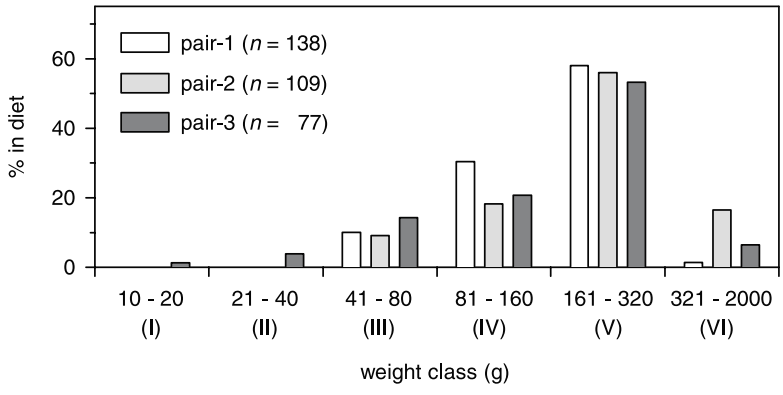

Fig. 5: Distribution of prey of three urban breeding pairs of Northern Goshawks in the city of Hamburg across six prey weight classes

Abb. 5: Verteilung der Brutzeitbeute von drei innerstädtischen Habichtpaaren in Hamburg auf sechs Gewichtskategorien

Fig. 6: Typical hunting habitats of urban-breeding male Northern Goshawks in the city of Hamburg (all photos show locations that were repeatedly visited by male 1 in 1997). Top: Street junction near a public place (market place). Feral Pigeons are often killed close to cars and pedestrians but are then transported to a nearby back yard for undisturbed plucking (in this case behind houses on the right). Middle: Comparatively quiet residential area in the city centre with villas and large back yards (left). Goshawks are systematically scanning this type of habitat for prey (mainly Blackbirds and Magpies) by flying along streets and "jumping" over roofs into back yards (right). Bottom: Blocks of five-storey houses separated by coverless meadows. In this habitat, foraging Blackbirds are attacked by low-quartering hawks. *all photos: N. Dreber*

Abb. 6: Typische Jagdhabitate urbaner Habicht-Brutmännchen in Hamburg (alle gezeigten Orte wurden wiederholt von Männchen 1 im Jahr 1997 aufgesucht). Oben: Belebter Straßenzug in der Nähe eines innerstädtischen Marktplatzes. Straßentauben werden zwischen Autos und Spaziergängern erbeutet, zum Rupfen allerdings meist in einen nahegelegenen Hinterhof transportiert (in diesem Fall hinter den Häusern der rechten Bildhälfte). Mitte: Ruhiges Villenviertel mit geräumigen Hinterhöfen (links). Habichte suchen in diesem Habitattyp systematisch nach Beute (hauptsächlich Amseln und Elstern), indem sie die Straßen in Höhe der Regenrinnen abfliegen, dann über ein Dach schwenken und in einen Hinterhof stürzen (rechts). Unten: Mehrgeschossige Wohnblocks mit deckungsarmen Wiesenflächen. Nahrungssuchende Amseln werden hier von bodennah pirschenden Habichten attackiert.

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Appendix: Diet of three pairs of Northern Goshawks breeding in the city of Hamburg (1997-99). Prey items which were collected by both methods (radio-tracking and remnant-searching in nesting areas) were pooled. Data for the three pairs are given in separate rows. For each species, the top row gives the values for pair 1 (1997), the following row for pair 2 (1998) and the bottom row for pair 3 (1999) (see Mallard for an example). Total numbers of each species are listed and converted into their percentage contribution to Goshawk diet. The number of juvenile prey is given for each species, together with their percentage contribution to overall diet. The next column gives prey masses. Juveniles (juv.; fledglings and juvenile mammals) were assigned a weight of two-thirds of the corresponding adult weight, and nestling-weights (nest.) were set at one-third of the adult weight (ad.; see paragraph 2.4 in the methods section). Exceptions are explained in the footnotes. Biomass (in g) and percentage contribution to total biomass were calculated with the listed masses for each prey species.

Appendix: *Beuteliste für drei innerstädtische Habichtbrutpaare in Hamburg (1997-99). Die Daten der radiotelemetrischen Verfolgung der Männchen und der Rupfungssuche im Horstfeld wurden vereint. Für jede Beutetierart wurden die Daten der drei Paare separat angegeben. In der oberen Zeile stehen die Werte für Paar 1 (1997), darunter die von Paar 2 (1998) und zuletzt die von Paar 3 (1999) (siehe Beispiel-Beschriftung bei Stockente). Angegeben sind die Gesamtzahlen der Beutestücke jeder Art und ihr prozentualer Anteil an der Gesamtbeute des jeweiligen Habichtpaares. Außerdem ist die Anzahl der Jungtiere einer Art und ihr Anteil an der Gesamtbeute des Paares vermerkt. Es folgt die Angabe des Beutegewichtes einer Beutetierart. Für Jungtiere (juv.; Flügglinge und junge Säugetiere) wurden zwei Drittel und für nicht-flügge Jungvögel (nest.), die im Nest erbeutet wurden, wurde ein Drittel des entsprechenden Adult-Gewichtes (ad.) angenommen (siehe Abschnitt 2.4 im Methodenteil). Ausnahmen sind in den Fußnoten erläutert. Die aus diesen Gewichten berechneten Biomassen (in g) und Biomassenanteile an der Gesamtbeutebiomasse eines Paares sind ebenfalls angegeben.*

		Total		**Juveniles**		**Mass**		**Biomass**	
Prey species		**n**	**%**	**n**	**%**	**age**	**(g)**	**(g)**	**%**
Mallard *Anas platyrhynchos*	**pair 1**	0	0	0	0	ad	1000	0	0
	pair 2	0	0	0	0			0	0
	pair 3	1 (♀)	1.3	0	0			1000	6
Sparrowhawk *Accipiter nisus* [1]		0	0	0	0	♀ ad	270	0	0
		1 (?)	0.9	0	0	?	209	209	0.6
		1 (♀)	1.3	0	0			270	1.6
Moorhen *Gallinula chloropus*		0	0	0	0	ad	285	0	0
		0	0	0	0			0	0
		1	1.3	0	0			285	1.7
Woodcock *Scolopax rusticola*		1	0.7	0	0	ad	275	275	1
		0	0	0	0			0	0
		1	1.3	0	0			275	1.6
Black-headed Gull *Larus ridibundus*		0	0	0	0	ad	260	0	0
		1	0.9	0	0			260	0.7
		0	0	0	0			0	0
Woodpigeon *Columba palumbus*		0	0	0	0	ad	500	0	0
		4	3.7	1	0.9	juv	333	1833	5.2
		3	3.9	0	0			1500	9
Feral Pigeon *C. livia* forma domestica		55	39.9	7	5.1	ad	300	15800	55.9
		40	36.7	1	0.9	juv	200	11900	33.8
		25	32.5	0	0			7500	45
Collared Dove *Streptopelia decaocto*		2	1.4	0	0	ad	193	386	1.4
		3	2.8	0	0			579	1.6
		0	0	0	0			0	0
Green Woodpecker *Picus viridis*		0	0	0	0	ad	190	0	0
		0	0	0	0			0	0
		1	1.3	0	0			190	1.1
Great Spotted Woodpecker *Dendrocopos major*		1	0.7	1	0.7	ad	80	53	0.2
		0	0	0	0	juv	53	0	0
		1	1.3	0	0			80	0.5
Blackbird *Turdus merula*		14	10.1	4	2.9	ad	100	1268	4.5
		13	11.9	5	4.6	juv	67	1135	3.2
		10	13	2	2.6			934	5.6
Fieldfare *Turdus pilaris*		1	0.7	0	0	ad	100	100	0.4
		0	0	0	0			0	0
		0	0	0	0			0	0
Song Thrush *Turdus philomelos*		0	0	0	0	ad	70	0	0
		0	0	0	0			0	0
		1	1.3	0	0			70	0.4

Prey species		Total n	Total %	Juveniles n	Juveniles %	Mass age	Mass (g)	Biomass (g)	Biomass %
Mistle Thrush *Turdus viscivorus*		1	0.7	0	0	ad	110	110	0.4
		0	0	0	0			0	0
		0	0	0	0			0	0
European Starling *Sturnus vulgaris*		6	4.3	4	2.9	ad	80	372	1.3
		6	5.5	4	3.7	juv	53	372	1.1
		6	7.8	4	5.2			372	2.2
Jay *Garrulus glandarius*		6	4.3	5	3.6	ad	175	583	2.1
		2	1.8	1	0.9	juv	117	292	0.8
		5	6.5	2	2.6	nest	58	700	4.2
Magpie *Pica pica*		30	21.7	20	14.5	ad	225	4875	17.2
		10	9.2	7	6.4	juv	150	1725	4.9
		12	15.6	3	3.9	nest	75	2475	14.8
Jackdaw *Corvus monedula*		4	2.9	3	2.2	ad	242	725	2.6
		0	0	0	0	juv	161	0	0
		1	1.3	0	0			242	1.5
Carrion Crow *Corvus corone*		0	0	0	0	ad	630	0	0
		5	4.6	4	3.7	juv	420	1470	4.2
		1	1.3	1	1.3	nest	210	420	2.5
Chaffinch *Fringilla coelebs*		0	0	0	0	ad	25	0	0
		0	0	0	0	juv	17	0	0
		1	1.3	1	1.3			17	0.1
Budgerigar *Melopsittacus undulatus*		0	0	0	0	ad	28	0	0
		0	0	0	0			0	0
		2	2.6	0	0			56	0.3
small bird spec. [2]		8	5.8	-	-		90	720	2.5
		4	3.7	-	-			360	1
		3	3.9	-	-			270	1.6
large bird spec. [3]		3	2.2	-	-		200	600	2.1
		0	0	-	-			0	0
		0	0	-	-			0	0
Red Squirrel *Sciurus vulgaris*		2	1.4	2	1.4	ad	325	434	1.5
		0	0	0	0	juv	217	0	0
		0	0	0	0			0	0
Rabbit *Oryctolagus cuniculus* [4]		3	2.2	2	1.4	ad	1600	1550	5.5
		19	17.4	6	5.5	juv	300	14800	42
		0	0	0	0	?	950	0	0
Norway Rat *Rattus norvegicus*		1	0.7	0	0	ad	415	415	1.5
		1	0.9	1	0.9	juv	277	277	0.8
		0	0	0	0			0	0
Wood Mouse *Apodemus sylvaticus*		0	0	0	0	ad	18	0	0
		0	0	0	0			0	0
		1	1.3	0	0			18	0.1
Total	**pair 1**	**138**	**99.7**	**48**	**34.7**			**28266**	**100.1**
	pair 2	**109**	**100**	**30**	**27.5**			**35212**	**99.9**
	pair 3	**77**	**100.1**	**13**	**16.9**			**16674**	**99.8**

1 Calculated as arithmetic mean of weights of adult male (148 g) and adult female (270 g) (both weights from März 1987).

2 Birds ≤ Blackbird in size which were found by radio-monitoring and could not be identified to species level; weight was set at the arithmetic mean of the adult-weights of Blackbird and Starling.

3 Birds > Blackbird in size which were found by radio-monitoring and could not be identified to species level; weight was set at the arithmetic mean of the adult-weights of Magpie and Jay.

4 Following Toyne (1998), 300 g was taken as the weight of juvenile Rabbits; in cases where the age of the Rabbit was unknown (?) an average value of 950 g was used.

[1] Mittelwert aus den Gewichten für ein adultes Sperber-♂ (148 g) und ein adultes Sperber-♀ (270 g) (beide Angaben nach März *1987).*

[2] Über die Radiotelemetrie nachgewiesene Vögel, die nicht näher bestimmt werden konnten, aber maximal Amselgröße hatten; als Gewicht wurde der Mittelwert aus den Adult-Gewichten von Star und Amsel zugrundegelegt.

[3] Über die Radiotelemetrie nachgewiesene Vögel, die nicht näher bestimmt werden konnten, aber größer als eine Amsel waren; als Gewicht wurde der Mittelwert aus den Adult-Gewichten von Elster und Eichelhäher zugrundegelegt.

[4] Für Jung-Kaninchen wurde nach Toyne *(1998) ein Gewicht von 300 g angenommen; war das Alter eines Kaninchens nicht zweifelsfrei bestimmbar (?), wurde der Mittelwert beider Altersklassen (950 g) als Gewicht verwendet.*