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Nesting habitat selection of Peregrine Falcons *(Falco p. peregrinus)* in Eastern Germany – the state of knowledge

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Abstract After the disappearance of the Peregrine Falcon during the DDT era, the re-colonization of Eastern Germany from 1981 was accompanied by colour-ringing of a high percentage of juveniles and systematic identification of these individuals on their later nest-sites. Before that period there were two geographically distinct subpopulations: tree-breeders in the north, and cliff-breeders in the south. We were able to restore the tree breeders' tradition by imprinting nestlings at stick nests in forests. Today, besides cliff- and tree-breeders there are also nest-sites on buildings and lattice structures. The population is increasing including all nest-site types. Here, we analyse nesting habitat choice with respect to the natal habitat of birds. The exchange between the four nest-site types is limited. Habitat fidelity was high in birds fledged on cliffs (95%) and on buildings (81%). The sample size for lattice structures is still too low for deeper analyses. The fixation towards trees was stable only in 56% of birds, and higher for males than for females. The influx from other habitat types is very limited and hardly supports the tree breeders' subpopulation. A growing number of tree-breeders go along with higher habitat fidelity which is stabilizing their sub-population.

Keywords: Peregrine Falcon, habitat selection, eastern Germany, tree-breeders' project

Összefoglalás A vándorsólyom DDT használat következtében történő eltűnése után 1981 óta ismét megjelent Németország keleti részén. Azóta nagy számban jelölik a fiatal egyedeket színes gyűrűvel, hogy a fészekelőhely-választásukat később meghatározhassák. Korábban két, földrajzilag jól elkülönülő alpopulációja volt ismert a fajnak: fán költők északon és sziklán költők délen. A visszatelepítési programoknak köszönhetően a fán fészkelő populáció újra megjelent a terület erdeiben. Napjainkban már nemcsak fákon vagy sziklákon, hanem emberi építményeken fészkelő párok is előfordulnak. Az állomány növekedésnek indult minden fészkelőhely típusnál. Jelen tanulmányban a vándorsólyom fészkelőhely-választását vizsgáljuk, különös tekintettel a fajra jellemző, eredeti élőhelyekre. A megkülönböztetett négy fészkelőhely típus közötti váltás korlátozott. A sziklaormokon és épületeken fészkelő egyedek fészektípushoz való hűsége magas (95% és 81%, ebben a sorrendben). A fán fészkelés iránti hűség is nagy, de az előzőkhöz képest alacsonyabb (56%), a hímek esetében magasabb, mint a tojóknál. Más típusokból való bevándorlás elég csekély, ami nem segíti a fán fészkelő populáció növekedését, azonban a fészkelőhelyek iránti hűségük stabilizálja azt.

Kulcsszavak: vándorsólyom, élőhelyválasztás, Kelet-Németország, „fán fészkelő" program

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Introduction

In 1973, the Peregrine Falcon became extinct in eastern Germany, the former GDR area. Before the extinction in the context of the pesticide crash, there were exclusively two habitat types in the breeding area: 1) rock areas in the low mountain ranges with nest-sites in vertical cliffs including quarries, and 2) forests in the lowlands with stick nests of other large bird species on trees *(Figure 1)*. An area of about 50 to 100 km between tree breeders in the north and cliff breeders in the south was free of peregrine broods with the only exception of annually 1-2 cliff broods on the chalk coast of the island of Rügen. From the past, it is known that the two subpopulations differed not only from their nest type but also with regard to their nesting habitat as a whole, their breeding ecology, nest-site defence, hunting strategy etc. There is no evidence for genetic differences (Kirmse 1987).

Only a little number of Peregrine Falcons was ringed until then, and there was no colour ringing in order to get more insight into questions such as individual habitat choice and habitat fidelity. From today's point of view, we can only theoretically estimate the behaviour of the breeding birds in this respect.

The restoration of the population began in 1981 with the arrival of falcons released in West Germany and first breeding pairs in the Harz and Thuringia mountains near the inner German border. The recovering population was intensively monitored from the beginning and managed in order to optimize each nest-site. Just a few years later, released Peregrine falcons also occupied artificial buildings at industrial sites and in cities, first 1983 in Sangerhausen, and 1985 on a church in the centre of Berlin. An increasing number of broods like these stepwise covered both of the former habitat types and as well the area between.

However, there was no spontaneous repopulation of the forests in the North-east German lowlands. Before the extinction, the majority of the East German peregrine population lived here with several hundred pairs in earlier decades. "Each pine forest in Brandenburg has its Goshawk and its Peregrine", wrote Schuster (1932). Furthermore, the population covered the whole lowland range from the Netherlands in the West to the Ural Mountains in the East (Kirmse 2004). The lack

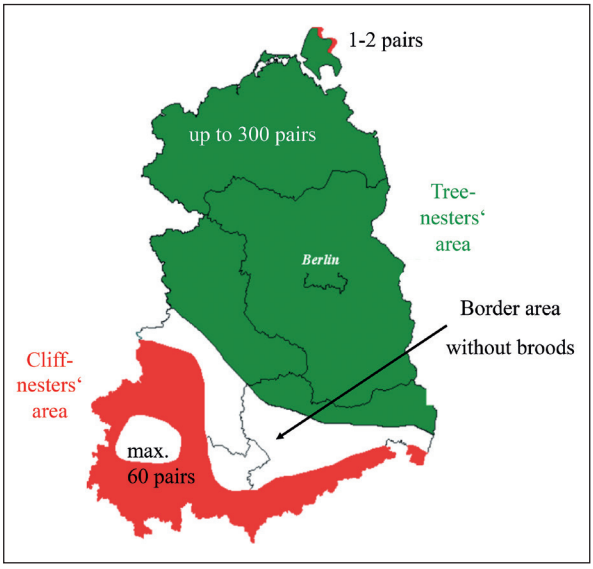

Figure 1. Historical ranges of tree-breeders and cliff-breeders in our study area in eastern Germany (Kleinstäuber *et al.* 2009)

1. ábra A fán, illetve sziklán fészkelő vándorsólyom populációk történelmi elterjedése a vizsgálati területe, Németország kelet részén (Kleinstäuber *et al.* 2009)

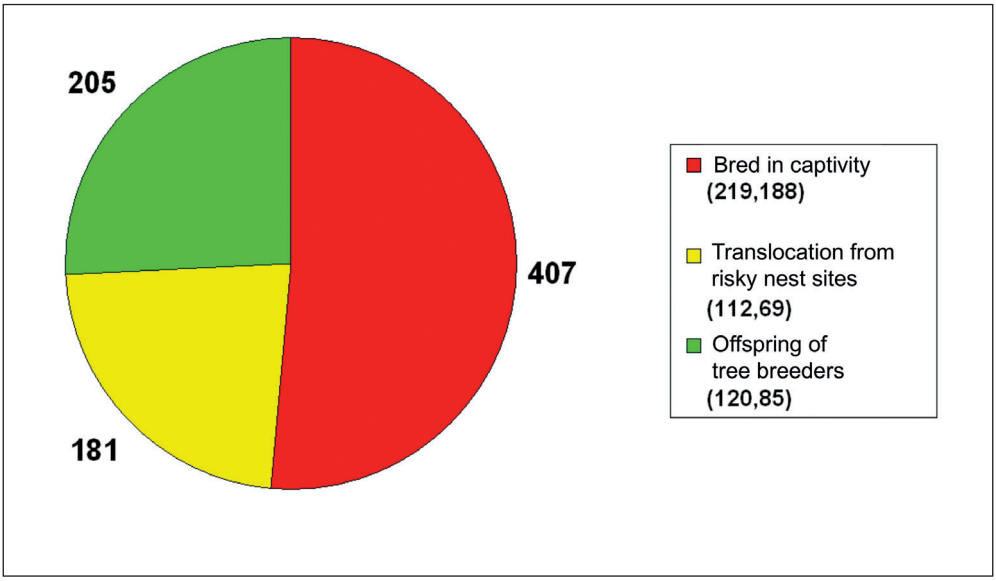

Figure 2. Origin from peregrines fledged in trees in eastern Germany 1990–2009 (Kleinstäuber 2013)
2. ábra Németország keleti részén, fáról kirepült vándorsólymok származási helye 1990–2009 (Kleinstäuber 2013)

of a spontaneous come back of the tree breeders was in accordance with our hypotheses: The recovery of the cliff nesters population will not automatically lead to a re-colonisation of the tree nesters' range as tree nesting needs imprinting on tree nests and the respective landscape in the juvenile period (Kirmse 1991, Kleinstäuber & Kirmse 2001). According to this assumption a reintroduction project for the tree-breeders' population was started in 1990, after pilot releases in the former West Berlin by C. Saar (overview Kleinstäuber 2013). Six years later, a first breeding pair established in northern Brandenburg with a successful brood in 1996 (Langgemach *et al*. 1997). From 1990 till 2009, 793 peregrines fledged in trees – 51.3% bred in captivity, 22.8% released after rescue translocation from risky nest-sites, mainly on buildings and industrial sites, and 25.9% as offspring of the growing tree-breeders' subpopulation *(Figure 2)*. After the successful end of the release project in 2011 the tree breeders' subpopulation comprised 37 breeding pairs and continued to increase up to 64 pairs in 2017.

After starting the reintroduction of tree-breeders, peregrine falcons spontaneously settled for the first time on steel lattice towers in nests of ravens and ospreys (cf. Kirmse 2001). These structures might resemble high dead trees and could be interpreted as a substitute nest-site for a tree brood – as buildings could be seen as artificial rocks. But is it actually the same? In this manuscript, we analyse individual nest choice and habitat fidelity of peregrines of the East German population with the four different nest-site types: cliff, tree, building, and lattice tower.

Material and methods

The re-colonisation after complete extinction provided a unique opportunity to quantify the emerging population and to document the life history of individuals by appropriate marking. Beginning in 1990, all released juveniles and the offspring from wild broods were individually marked, from 1992 onwards according to the so-called "Wachberg protocol" *(Figure 3)*: The left legs are fitted with a coloured ring of the ringing centre Hiddensee, the so-called "habitat ring", with red for rocks, yellow for buildings, and green for trees. From 2003 on different habitat rings have been fitted to birds from lattice structures, since 2015 black coloured rings. The right legs are fitted with the "identity ring" for remote identification with silver or aluminium, respectively, for juveniles from unmanaged wild broods and black for juveniles released via hacking or fostering.

Till 2010, nearly the whole East German population was ringed, and – even more important – the majority of the breeding birds were identified, at least their habitat colour. Only later, with growing population size, the percentage of birds not ringed and not identified increased, as the capacities of the essentially voluntarily working team are limited.

Identification of individuals took place by high-resolution spotting scopes with a magnification of 100 to over 200x. Individuals were recognized by their identity rings, but additional information was gained by birds which were merely identified by their colour rings, i. e. their

Figure 3. Ringing scheme in the eastern German Peregrine population since 1992. Black as an additional habitat ring colour has been used only from 2015 on – for birds fledged on lattice structures

3. ábra A keletnémet vándorsólyom állomány gyűrűzési sémája 1992 óta. A fekete szín 2015-től kezdve került a rendszerbe, a nagyfeszültségű távvezeték oszlopokról kirepülő példányok jelölésére

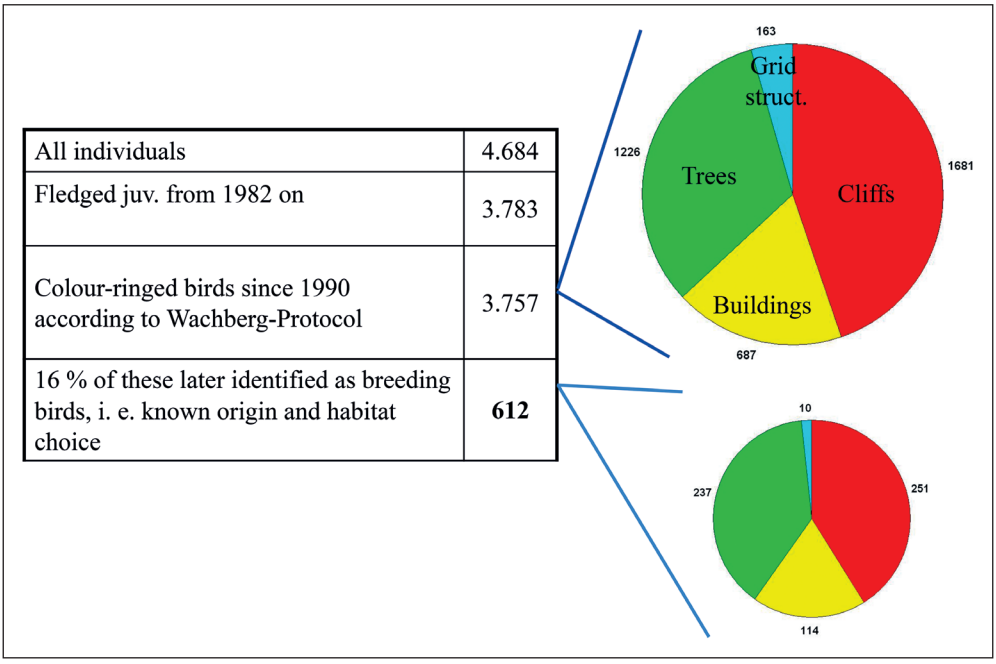

Figure 4. Database of the "Arbeitskreis Wanderfalkenschutz e. V." from 1981 to 2014
4. ábra Az „Arbeitskreis Wanderfalkenschutz e. V." (Vándorsólyom-védelmi Munkacsoport) adatbázisa 1981-től 2014-ig

Table 1. Database of the "Arbeitskreis Wanderfalkenschutz e. V." from 1981 to 2014, continued
1. táblázat Az „Arbeitskreis Wanderfalkenschutz e. V." adatbázis 1981 és 2014 között

Ringed birds identified as breeding birds since 1981 (since 1992 according to Wachberg-Protocol), corrected because of possible double-counting	600
From these 6% individuals of other origin (Western Germany, Poland, Czech Republic)	35
Individual code identified for habitat and individual analysis (59% from 600)	355
Colour ring identified for habitat analysis (41% from 600)	245

origin habitat. From 1992 to 2014, a database for 355 exactly identified individuals was built up, of which many were seen over several years. The origin and settlement of an additional 245 individuals was identified by recognising merely their colour ring but not their identity ring.

Figure 4 and *Table 1* give an overview about the database of the "Arbeitskreis Wanderfalkenschutz e. V." from 1982 to 2014.

Results

Population trend; trend and distribution of the four nest-site types

Figure 5 shows the development of the East German Peregrine population from 1981 to 2014 with respect to the four different nesting and habitat types. After spontaneous settling of released birds on rocks (1981) and buildings (1983, see above), the first tree brood was in 1996,

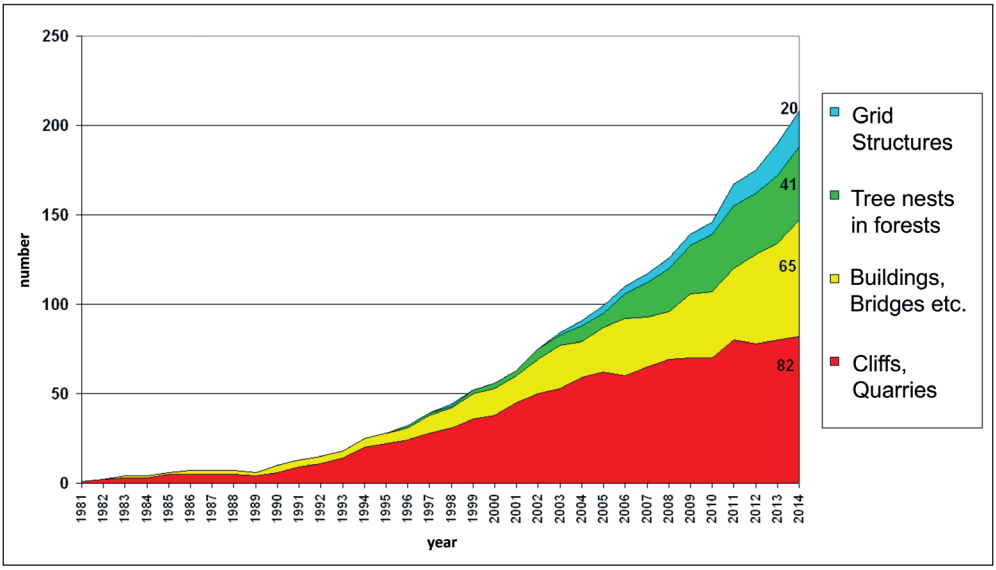

Figure 5. Trend of the Peregrine population in Eastern Germany with respect of the four different habitat types, 1981–2014

5. ábra A vándorsólyom-állomány változása Németország keleti részén a négy különböző élőhely-típusban, 1981 és 2014 között

followed by first broods on lattice masts: in 1998 near Rheinsberg by a pair imprinted on tree-nesting*, and 2003 (near Vockerode) by a male from a building and a tree-born female.

The regional distribution of the occupied territories 33 years after the start of the recovery in 1981 is shown in *Figure 6*. Compared to the historical situation (small map in the corner) several things are conspicuous:

– cliff breeders re-occupied most of their former range and even found the chalk cliff far away on the Baltic sea coast; and one single, isolated nest-site in a quarry north of the mountains;
– tree breeders are in the process of restoration of their former range with one large core area were the reintroduction project began, and more scattered sites mainly around the other release areas except the two south-westernmost;
– the former gap between the two sub-populations is now occupied by Peregrines breeding on buildings and lattice towers, but again not by tree breeders;
– as well, buildings and lattice towers are increasingly occupied in the two historical ranges but not in their core areas (mountains: Saxon Switzerland, Upper Harz, and Thuringian Forest, lowlands: South Mecklenburg and North Brandenburg);
– altogether, there is still the separation between tree breeders' and cliff breeders' range known from the past, but a regional co-existence of the new site types with both, except the core areas.

* First (unsuccessful) brood of a newly established pair on a lattice mast in the core of an extended forest area; thereafter breeding exclusively in pine trees nearby – one of the very few exceptions of switch to another nest-type and come back to tree-nesting in the next year.

Habitat choice of Peregrines depending on their natal habitat

Earlier results showed that the decision for one of the different nest-site types is made with the first breeding attempt. This decision is for the whole life of a bird (Sömmer & Kirmse 2013), with very few exceptions, described by Kirmse & Sömmer (2015). This is important for the understanding of the following paragraphs on habitat choice.

According to *Figure 7*, habitat fidelity is highest on cliffs – the inherent nest-site type of Peregrines (95%). Only very few (3%) birds fledged on cliffs later chose buildings as nest-sites, whereas trees and lattice towers may be considered as exceptions.

Also on buildings ("artificial rocks") the habitat fidelity is rather high – 81% of the birds later came back to buildings to breed there, followed by 11% that changed towards cliffs pronouncing again rocks as the inherent nest site type. A slightly higher shift towards lattice structures (5%) and trees (3%) compared to birds from cliff nests may suggest that the bond to buildings is smaller than that to rocks.

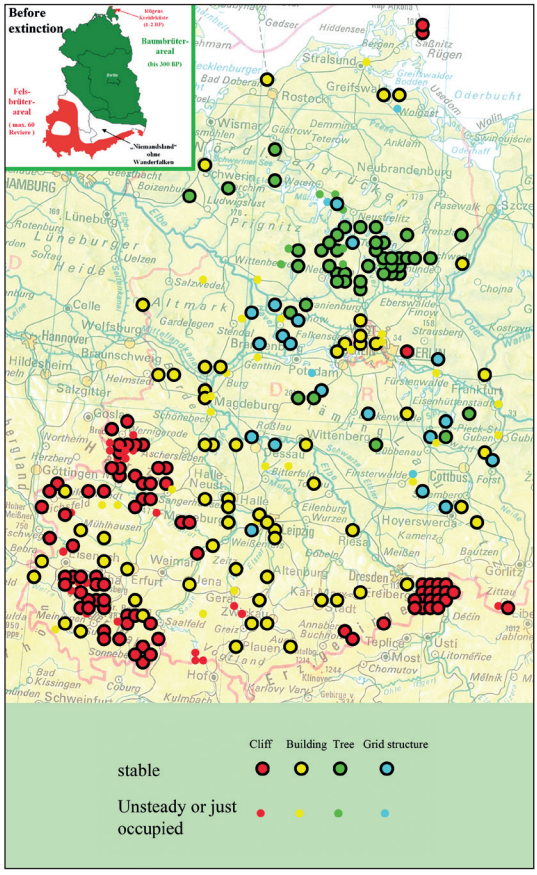

Figure 6. Regional distribution of the occupied Peregrine territories in 2014, 33 years after the start of the recovery in 1981; historical situation above left for comparison

6. ábra A foglalt vándorsólyom revírek regionális eloszlása 2014-ben, 33 évvel a visszatelepedés kezdete, 1981 után; a korábbi állapotot balra fent ábrázoltuk, az összehasonlítás kedvéért

The probability for Peregrines fledged on trees to breed on trees later is much lower (57%). There is a marked shift towards buildings which are regionally closest (26%), followed by cliffs and lattice structures (each 9%). The latter are abundant in proximity and offer plenty of nests from ravens and ospreys, however, the tradition to breed there is very young from evolutionary point of view. The growing tendency towards lattice towers in recent years is evident *(Figure 5)*, showing the attractiveness of this nest-site type. At least 9% changed from trees to rocks which are much more distant than other nest-site types.

The number of birds fledged on lattice structures is still too low for deeper analyses. Even though this nesting type started to establish in 2003, the increase was slow. Also the number of later re-sightings is lower than expected, which needs further investigations. Nevertheless, there is a markedly increasing number and percentage of respective broods in recent years.

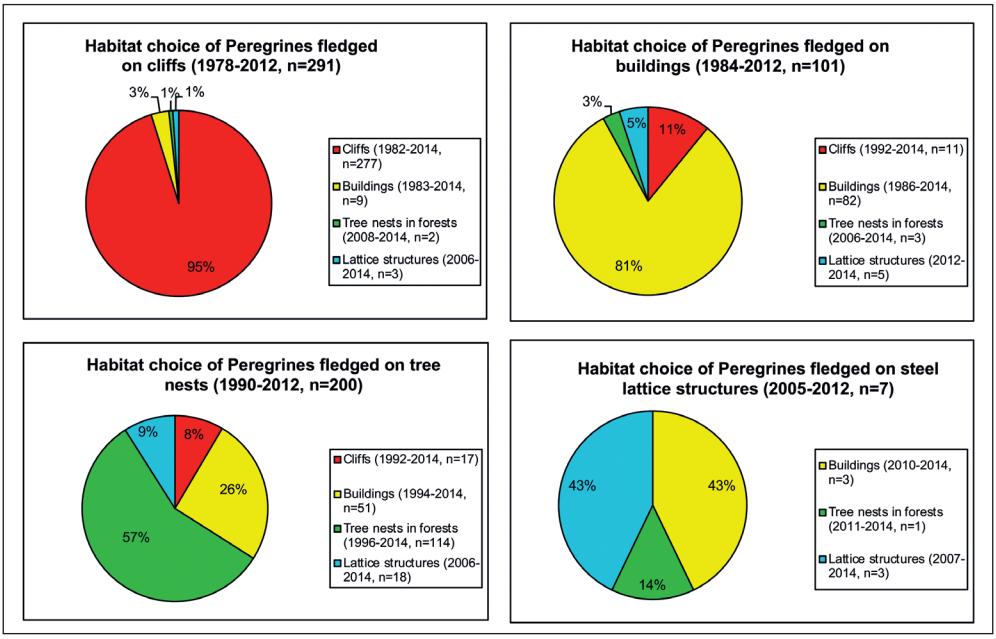

Figure 7. Habitat choice of Peregrine Falcons in eastern Germany, depending on their natal habitat. Years in the boxes mean year of registered settlement, therefore differences to the time span of fledging years in the respective title. An additional bird (female) from a cliff settled as a ground-breeder on a North-Sea island

7. ábra A vándorsólymok élőhelyválasztása Németország keleti részén, a kikelési helyük függvényében. A szövegdobozban lévő évszámok a regisztrált megtelepedés évét jelentik, ettől eltér a kirepülési évek időintervalluma, ami a megfelelő címsorban található. Egy szikláról kirepült (tojó) példány egy északi-tengeri szigeten telepedett meg és a földön fészkelt

Origin of Peregrines breeding on cliffs, trees, buildings and lattice towers

More insight into the mechanisms behind may be gained by looking from the other side: Where do the birds that breed on cliffs, trees, buildings and lattice towers come from?

Most of the cliff breeders (91%) come from cliffs, only a smaller percentage from trees (5%) and buildings (4%), and so far none from lattice towers *(Figure 8)*.

There is a mixed figure in Peregrines breeding on buildings: 57% are of the same origin, but not less than 35% originally fledged on trees, and at least some on cliffs (6%) and lattice towers (2%). The shift from trees to buildings was highest in the first decade of the tree-breeders' project when the chance to meet a partner in the tree-breeders' range was still low.

The tree breeders recruit mainly by themselves (95%), and only single birds (altogether merely 5%) come from the other habitat types. In conjunction with the low habitat fidelity shown previously, that makes the tree-breeders the group which is most vulnerable to shift towards the other nest-site types – an additional indication for the lacking genetic fixation of the phenomenon.

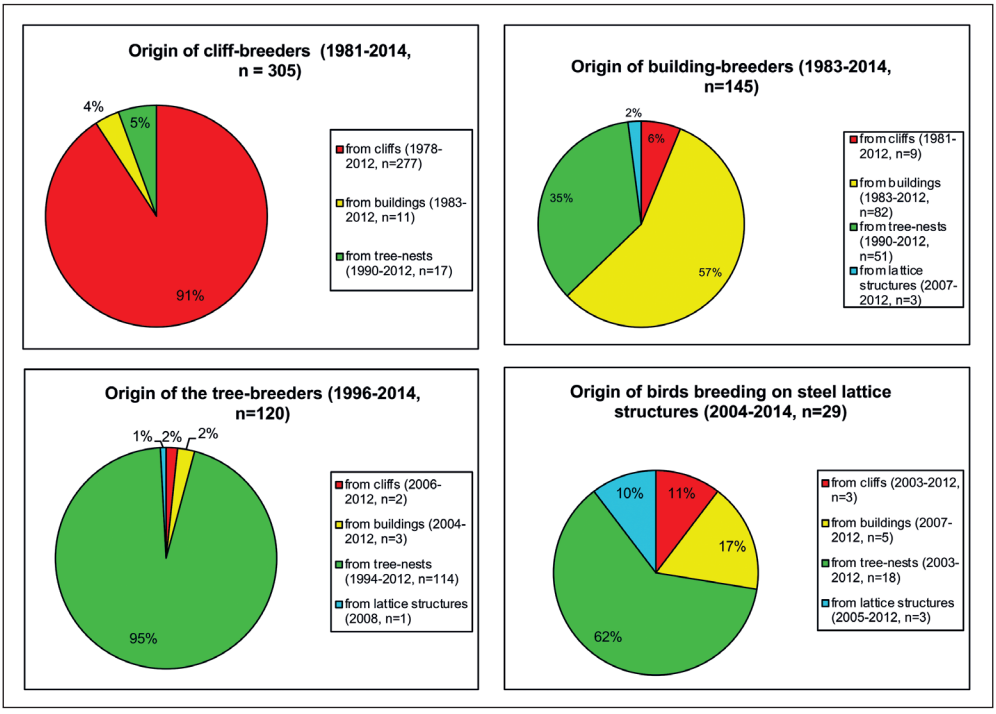

Figure 8. Natal habitat of East German Peregrines breeding on cliffs, trees, buildings and lattice towers
8. ábra Sziklán, fán, épületen és távvezeték oszlopon fészkelő kelet-németországi vándorsólymok származási élőhelytípusa

The number of 29 ringed birds breeding on lattice towers compared to 7 analysed above is a sign of the increasing tendency towards this nest-site type. The majority of them (62%) hatched and fledged on trees (see previous paragraph), but nests on lattice towers attract Peregrines from cliffs (11%) and buildings (17%) as well. The latter includes industrial sites many of which were abolished during the last years. Surprisingly, there is only a small recruitment from the same nest-site type (10%). Nevertheless, available nests on lattice structures seem to be a very attractive resource for Peregrines as shown by an updated analysis (Kleinstäuber unpubl.): The number of occupied territories increased from 20 in 2014 (cf. *Figure 5*) to 49 in 2017. Altogether 38 ringed breeding birds were identified meanwhile regarding their original habitat: Still, most birds (55%) came from trees, 8% from cliffs, and 29% from buildings. Compared to 2014 *(Figure 8)*, there was not a single additional bird coming from a lattice structure, resulting in merely 8% for these three identified birds.

Habitat fidelity towards trees depending on the release method / natural fledging

As the tree-breeders show the least habitat fidelity it is a question of conservation concern to compare the offspring of natural broods with juveniles which were brought by artificial management into the population (cross-fostering with other species as a method tested in Poland

was not used in the German project). In the course of the tree-breeders' project we analysed this for the years 1996 (first tree brood) to 2009. The generally high juvenile mortality has to be kept in mind, and the fact that many birds got lost towards other habitat types. *Figure 9* shows that hacking as the starting method – the release of nearly fledged juveniles from captive breeding – has the lowest return rate: 7% of the released birds were identified later as birds breeding in tree nests. The results are slightly better (11%) with birds from translocations, i. e. juveniles from urban or industrial nest sites with known mortality risk that were taken from the nests and released in trees via hacking. Even better did the birds from captive breeding or translocation after fostering by wild pairs in trees: 15% were found later breeding in tree nests. It should be mentioned that translocations took place at an earlier age than the transfer of captive bred juveniles to the release site. Furthermore, translocations were preferably managed in the surroundings of the release sites. These aspects are considered to be relevant for the better success compared to the hacking method. Offspring of naturally breeding birds on tree nests are doing best – 18% were found later as tree breeders. Summarizing, it is unavoidable to start with methods of comparatively low prospect of success. However, as soon as possible the chance of improvement by switch to the fostering method should be used (as happened in our project). A growing number of tree breeders released an increasing number of juveniles with a higher return rate into the subpopulation. This is part of the explanation of the ongoing increase after the stop of the release in the end of 2011.

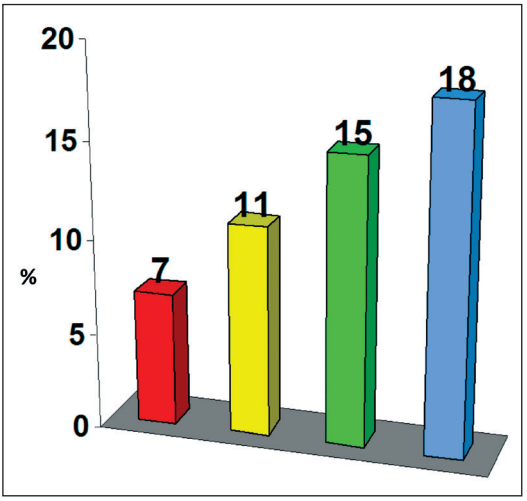

Figure 9. Percentage of habitat fidelity within the tree-breeders' project depending on the release method or natural fledging respectively, 1996–2009.
Red: Release of nearly fledged juv. from captive breeding via hacking (26 settled in forests from 378 released birds);
Yellow: Release of nestlings from translocations via hacking (14 settled in forests from 124 translocated birds);
Green: Release of small nestlings (captive bred or translocated) via adoption in wild broods (9 settled from 60 adopted birds);
Blue: Own offspring of wild breeding birds (23 settled from 124 fledged birds)

9. ábra Az élőhelyhűség százalékos bemutatása a fán fészkelő vándorsólymokkal foglalkozó project kapcsán, a visszatelepítési módszer vagy természetes szaporulat függvényében, 1996 és 2009 között
Piros: Tenyésztett, kirepülés előtt álló fiatal vadröpítése (26 telepedett meg erdőben a 378 elengedett madárból)
Sárga: Más fészekből áthelyezett fiókák vadröpítése (14 telepedett meg erdőben, a 124 áthelyezett példányból)
Zöld: (Tenyésztett, vagy természetes szaporulatból származó) kis fiókák adoptálása természetes fészekaljakba (9 telepedett meg a 60 madárból)
Kék: Természetes szaporulat (23 telepedett meg a 124 kirepült fiatalból)

Table 2. Comparison of the breeding performance of Peregrine Falcons of the four different nest-site types in Eastern Germany (2014 as an example)

2. táblázat A vándorsólymok költési sikerének összehasonlítása a négy fészkelőhely típusban, Németország keleti részén (az adatok 2014-ből származnak)

Habitat-Type	N breeding pairs (BP)	Successful BP	Fledged juv.	juv. per BP	juv. per successful pair
Cliffs	82	38 (46%)	105	1.3	2.8
Buildings	65	40 (62%)	109	1.7	2.7
Tree nests in forests	41	36 (88%)	96	2.3	2.7
Grid structures	20	14 (70%)	36	1.8	2.6
altogether	208	128 (62%)	346	1.7	2.7

Breeding performance of Peregrines depending on their nesting habitat

In *table 2* we show the markedly different breeding performance of Peregrines breeding on cliffs, buildings, trees, and lattice structures in the East German population. It is evident that the number of juveniles per successful pair is rather similar, with cliff nests ranking highest and nests on lattice towers lowest. However, the percentage of successful nests and consequently juveniles per territorial pair is by far the highest in tree nests and much higher than the lowest value among the habitat type. This results just from cliff broods which virtually are the inherent breeding strategy of Peregrines. The main reason for this low rate of successful pairs is predation and nest-site competition by eagle owls. For tree-breeding, on the other side, it is demonstrably that it cannot be seen as an "artefact" in the breeding ecology of Peregrine falcons, much more as a prospering alternative strategy to extend the range towards lowlands without rocks.

Discussion

This article refers to selected aspects of the colour ringing programme: the habitat choice depending on the original habitat, and in tree breeders depending on management methods vs. natural broods. Many more aspects comprise inter alia settlement distance from the place of birth, influence of the sex, duration of the occupation of territories, life reproduction, partner change, mortality etc. some of which are published in earlier papers (e. g. Kleinstäuber *et al.* 2009a,b, Kleinstäuber 2013).

Concerning the habitat choice depending on the habitat of origin, the results demonstrate convincingly that there is no free exchange of Peregrines between the different habitat types, as could be expected. Instead, we found strong habitat fidelity in birds resulting from cliff nest-sites, and – slightly reduced – in birds fledged on buildings, which form the nest type most similar to cliffs. This habitat fidelity may be related to the inborne nesting scheme of the Peregrine. In this respect, the tree-nesters differ much from cliff- and building-nesters in as far as their habitat choice depends fundamentally on the individual experience with that habitat type in the period of growing up and fledging. The relevant imprinting period

for a nestling obviously is the time between first active orientation (ca. 14 days) and the first weeks after fledging (Kirmse & Sömmer 2015). That makes the imprinting effect most stable in natural tree broods compared to all kinds of management *(Figure 9)*.

This individual experience or imprinting competes with the inherent nesting scheme of the species and is able to overwhelm it at a rate of nearly 60% following our results with tree-nesters. This rate seems to be positively correlated with the size of the tree-nesters' subpopulation and the increasing chance to meet a partner for a tree brood – i.e. the higher the number of occupied territories in tree habitats, the bigger the probability for a bird to breed later in a tree nest. The males play a crucial role in this context as they are the sex that is responsible for the choice and occupation of a nest site. With 90%, their habitat fidelity is much higher than that of females. Additionally, males settle markedly closer to their place of origin than the females – after an earlier analysis 26 km (100 males) vs. 114 km (86 females) (Kleinstäuber 2013, Kleinstäuber *et al.* 2009a). That may be the reason why the core areas of the cliff-breeders in the mountains and the tree-breeders in the lowlands are still largely free of broods on buildings and pylons.

Our data could prove that tree-nesters recruit nearly exclusively from themselves, and they hardly benefit from the other nest site types (the very few cases are described by Sömmer & Kirmse 2013). That has important implications for management and conservation. Most relevant, with respect to the restoration of the tree-breeders' population in Central and Eastern Europe, is to avoid any support of broods on buildings, industrial sites, and lattice towers in the tree-breeders' range. Nest site management has exclusively to focus on tree nests in order to stabilize the tree-nesting tradition in this subpopulation. In cases of new potential tree-breeder pairs in suitable surroundings additional "guidance" may be taken in consideration, e. g. from a fire watchtower (blocking of suitable niches) to trees (nest basket in optimal position). Large forest areas free of cliffs and high buildings are most promising for the establishment of new tree-breeders' territories.

Outside the tree-breeders' range, single breeding attempts on trees or even successful broods have been reported during the last decades (e. g. Wegner 2013, Brauneis 2017). The respective territories usually sustain no longer than one or two years. Only exceptionally cases of longer existence of a tree-nest territory outside the tree-breeders' range have been reported in Central Europe (e. g. Preusch *et al.* 2018 in Southwest Germany), however never a starting increase of their numbers in the surroundings.

A new artificial nest-site type is steel lattice constructions such as pylons of high-voltage powerlines, big cranes, broadcast towers etc. They offer new nesting opportunities as there are plenty of stick nests available, mainly from ospreys, ravens, and carrion or hooded crows. Due to long-term cooperation with the electricity companies, natural osprey nests are usually stabilized after the first brood with artificial nest constructions making these nests even more stable and attractive to Peregrines. In our population, Peregrines started to use this nest type in 1998, and in spite of a very low rate of comeback in our database, this new tradition is spreading increasingly, mainly in farmland areas but also within forests, or mixed habitats. For the tradition of tree-nesting this is detrimental because of the evident shift of tree-born Peregrines towards lattice structures. The former hope pylon-breeders could be a source for the tree-breeders did not fulfil and had to be corrected. The opposite is

true: the shift from trees towards lattice towers is increasing (compared to "stable" towards cliffs and buildings).

The re-colonisation of the tree-breeders' range may be slowed down by the shift to lattice structures but it is not really threatened by that. The subpopulation of the tree-breeders is still growing, last but not least due to intensive nest site management in many of the existing territories – artificial nests, nest protection zones, and co-operation with the forestry – resulting in the best breeding results among the four nest-site types. In farmland areas in the lowlands were no Peregrines used to exist before the pesticide crash, today lattice structures with stick nests of ospreys, ravens and to some extent even crows, enable the spread of the species into these new habitats.

Finally, we want to stress the interesting fact that the first nest-site choice is very stable, and there are only few cases of a later change. After our experience changes of an established pair towards another nest-site type are usually triggered by an emergency situation, and in all known cases of our investigation the pair stayed in the near surroundings of the former nest-site. In fact, the birds keep up their habitat and merely change the nest-site.

We suppose that single tree-broods outside the tree-breeders' range as described by Wegner (2013), Brauneis (2017) and others have a comparable background. This is confirmed by case studies from Wegner (2013). For that reason they are not stable and cannot be the foundation of a population of tree-breeders' or even a mixed population of tree-breeders and cliff-breeders which in fact cannot and does not exist in Central Europe. Our assumption is that also reports about tree-broods in other countries refer more to single events than to the existence of "hidden" populations of tree-breeders.

Outlook

In total, we expect a further increase of the Peregrine population in East Germany. However, there will be differences between the four nest-site types due to different ecological conditions, resulting differences in breeding performance, and as well due to shifts between the four groups as described in the results.

Nest-sites on rocks increasingly reach the limits of their availability and have a low breeding success, mainly due to eagle owl predation and competition. There are limited opportunities for a marked increase of Peregrines breeding on rocks or quarries. Likewise, there is hardly any population pressure from the other nest-site types.

There is some potential for additional nest-sites on buildings and industrial sites, however, breeding performance and survival of the juveniles are limited there. Without nest-site management even former strongholds loose their importance, such as in Berlin after the decision to stop nest-site management on buildings there in favour of the tree-breeders in the surroundings of the city.

The subpopulation of the tree-breeders is still far from their historical size. The availability of stick nests from ravens, ospreys and white-tailed eagles today is much higher than before the extinction of Peregrines in the 1970s. Combined with a good breeding performance we expect a further increase over the next decade even if the tree-breeders continue to loose birds towards the other nest-site types. Gradually, this shift may decrease as a thriving

tree-breeders' population *per se* is attractive to Peregrines in preparation of their first brood. If offspring of tree-breeders switches to other nest-site types, this will happen increasingly towards steel lattice structures, first of all electricity pylons.

With their huge supply of stick nests, steel lattice structures will more and more outpace buildings and industrial sites with respect to their attractiveness. Situated in the whole area of cliff-breeders, tree-breeders and the space between, the shift towards these structures is quite easy for Peregrines from other nest-site types. Therefore, broods on lattice structures are supposed to increase further, more due to shifts than due to own reproduction. The annual removal of corvid nests by the energy companies could slow that gradually down and lead to more spatial dynamics; on the other side that could be outbalanced by artificial nests provided routinely by the energy companies for Ospreys.

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