

The Successful Reintroduction of the White Stork (*Ciconia ciconia*) into the Alpine Rhine Valley between 1984 and 2018

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Abstract: This study demonstrates that a regionally extinct bird species belonging to the long-distance migrants can be reintroduced under the right circumstances. The article first describes the historic distribution of the white stork (*Ciconia ciconia*) prior to its disappearance from the Alpine Rhine Valley. Furthermore, the study examines the increase in actual population size between 1984 and 2018, mean reproductive success per breeding pair in the Rhine Valley between 2011 and 2018 and compares different types of breeding sites. Finally, the factors facilitating the successful reintroduction of the species are discussed.

Key words: Alpine Rhine Valley, current and historic distribution, reasons for reintroduction success.

1. Introduction

In the last century, the Rhine was still unregulated and the plains of the Alpine Rhine Valley, on an elevation of 400 m, provided a suitable habitat for the white stork (*Ciconia ciconia*) [1]. The floodplains of the Rhine, the lowland moors and the diverse mosaic of extensively used agricultural land provided rich food resources for the synanthropic stork. Even 100 years ago, at least one stork pair bred in each village. Or small colonies existed, like for example a colony made up of six breeding pairs living on the roof of a castle [2].

As a synanthropic species, a symbol for luck and associated with delivering babies, the stork is an important part in cultural traditions in Switzerland. With the decline of the population size of the white stork (*Ciconia ciconia*) in Western Europe in the 20th century [3], the species disappeared as a breeding species from Switzerland in 1950 [4]. In the Alpine

Rhine Valley, the last breeding pairs were recorded in the 1930's [5, 6]. The wet and cold conditions during the breeding seasons in the 1920's and 1930's, in conjunction with an increased mortality rate in the wintering areas are believed to be the reasons for the disappearance of the species from the region [7, 8].

Max Bloesch [9], an enthusiastic amateur ornithologist, started a reintroduction program in 1984 and established the "Storchenstation Altreu", a stork aviary and sanctuary in the Swiss Canton of Solothurn. Between 1955 and 1959, he introduced a total of 292 fledglings from Algeria, in multiple stages. Their descendants, called "project storks" were relocated to different aviaries in Switzerland and later released into the wild. At that time, it was unclear if the reintroduction of the white stork (*Ciconia ciconia*) into the Alpine Rhine Valley would be possible, because many streams had been regulated and land had been turned into an intensively managed agricultural landscape since the white stork disappeared from the region. Especially since the 1950's, agricultural practices had been intensified and urbanisation had increased. Settlements, industrial areas and infrastructure still continue to expand [10].

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It was unclear, if there was still ample suitable habitat available for the white storks, which rely on extensively farmed and temporarily inundated grassland for foraging [11]. There were also concerns, if the descendants of the fledglings from Algeria would be able to adapt to local conditions [12].

This study shows the development of the white stork population in the Alpine Rhine Valley, a region on the periphery of the geographical range of the white stork [13], after the disappearance of the species, using monitoring data and results from ringing of fledglings. A limited number of fledglings was used in the reintroduction project and it was expected that they would, over time, breed with migratory birds.

2. Methods

Over 100 artificial breeding platforms were installed in the Alpine Rhine Valley. Further breeding sites were located on roofs and trees in the project region. All breeding sites were monitored annually from 1984 until 2011. Since 2011, they are surveyed three times a year. During the surveys in the breeding season from March to July, the number of fledged juveniles was recorded. Fledging success in a given region and year is displayed as the number of fledged white storks (*Ciconia ciconia*) per breeding pair.

If the number of fledged storks could not be counted (for example when breeding occurred late in the season), fledging success was given a value of zero. Furthermore, it was investigated, whether the type of breeding site was associated with a change in fledging success and which type of breeding site was preferred, if any. Therefore, breeding success was compared between: trees, roofs, chimneys, artificial platforms on pylons and other breeding sites (silo, crane, transmission tower).

3. Results

The first settlements of white storks (*Ciconia ciconia*) into Eastern Switzerland were recorded in the Canton of St. Gallen in 1966 in Uznach and 1981 in

Mörschwil. In the Alpine Rhine Valley, birds originating from the sanctuary in Mörschwil have been recorded to breed on a telegraph pole since 1984 Hohenems, in neighboring Austria. A second settlement was established in 1988 on a wooden pylon in the Rhine delta in the municipal area of Höchst (Austria) and a further one in 1992 in Wolfurt (Austria). On the 15th of June 1991, in the presence of the Stork-Pioneer Max Bloesch, the stork sanctuary “Rheintaler Storchenhof” was officially opened. The sanctuary was used as an Information and Activity Centre for Stork Reintroduction in the Alpine Rhine Valley. The first breeding success at the site was observed earlier in 1991. Prior to their release, the breeding pairs were kept in an aviary.

Until the establishment of the “Rheintaler Storchenhof” in the Rhine Valley near Kriessern (Switzerland) in 1991, a maximum of three breeding pairs were counted in the region. This number increased to 10 breeding pairs during the active years of the “Rheintaler Storchenhof”. During those years, the storks at the sanctuary were intensely cared for. In the following years, the population continuously increased (Fig. 1) and spread into Vorarlberg (Austria) as well as to other parts in Switzerland.

At the beginning of the 1990's, “project storks” started to breed with storks from other populations. In 1992, only one year after the establishment of the “Rheintaler Storchenhof”, a “project storks” bred with an individual from Germany in Wolfurt (Austria). In 1993 a female paired up with a male from Cleebourg (Alsace/France). The french stork returned to the colony in 1995 to breed with an un-ringed migrating bird. The same year breeding events of seven un-ringed storks and 12 ringed individuals, originating from other Swiss sanctuaries (Möhlin, Brittnau, Staad, Grossaffoltern, Mörschwil, Oetwil am See and Altreu), as well as the individual from Cleebourg (Alsace/France) [5] were recorded at the “Rheintaler Storchenhof” and its vicinity. In the years that followed, further individuals from different populations

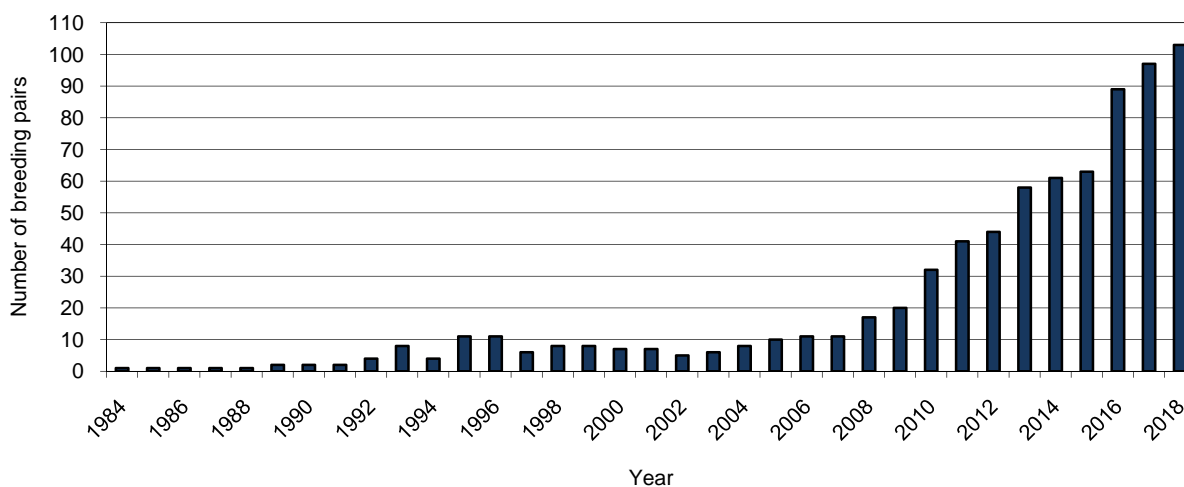


Fig. 1 Population growth of the white stork population in the Alpine Rhine Valley.

were recorded to breed with “project storks” in the Alpine Rhine Valley, with one record showing a breeding event with an individual from Poland, from the Eastern population. While the total population continued to grow due to immigration, the proportion of “project storks” decreased.

The first migratory breeding pair bred in 1995 in the Rhine Valley on an artificial platform in the melioration landscape of the valley. These timid birds that had arrived late in spring had successfully reared their fledglings despite the cool and wet spring. All other pairs had lost their brood.

A further Sanctuary was opened in 1995 at the prison “Saxerriet” in the region of Werdenberg (Switzerland). Similarly to the other sanctuaries, the “project storks” originating from Altreu, were kept in an aviary for a few weeks prior to their release. One pair left the region immediately after their release, while a second pair remained at the site and established a colony that today counts 22 pairs.

In the mid-nineties, the growing population started to spread. In 1996, six pairs bred at the “Rheintaler Storchenhof”. In addition, one pair was recorded in each of the following villages: Wolfurt (Austria), Hohenems (Austria), Montlingen (Switzerland),

Altstätten (Switzerland) and at the sanctuary in Saxerriet (Switzerland). In the following years the first breeding pairs established in Liechtenstein. The first successful breeding event in Liechtenstein was recorded in 2007. In 2009, the population in the Alpine Rhine Valley had reached 20 breeding pairs. Since then, the population size has increased to 103 breeding pairs in 2018 (Fig. 1).

The fledging success in the years investigated was similar across the different parts of the Rhine Valley in Switzerland, Austria and Liechtenstein. Fluctuations in fledging success were observed between 2011 and 2018. During this period, an average of 1.53 ± 1.39 (SD) nestlings per breeding pair was observed. The lowest fledging success was recorded in 2013 with 0.12 ± 0.38 (SD) nestlings per breeding pair, the highest, with 2.32 ± 1.34 (SD) nestlings, in 2018 (Fig. 2). Of 550 broods, most were counted on pylons with platforms (48%), followed by trees (28%), roofs (13%), chimneys (7%) and other sites (4%). Pairs breeding on roofs showed the highest fledging success with 2.10 ± 1.38 (SD) fledglings, followed by 1.55 ± 1.34 (SD) fledglings on trees, 1.46 ± 1.41 (SD) fledglings on artificial platforms, 1.38 ± 1.19 (SD) fledglings on chimneys and 0.92 ± 1.16 (SD)

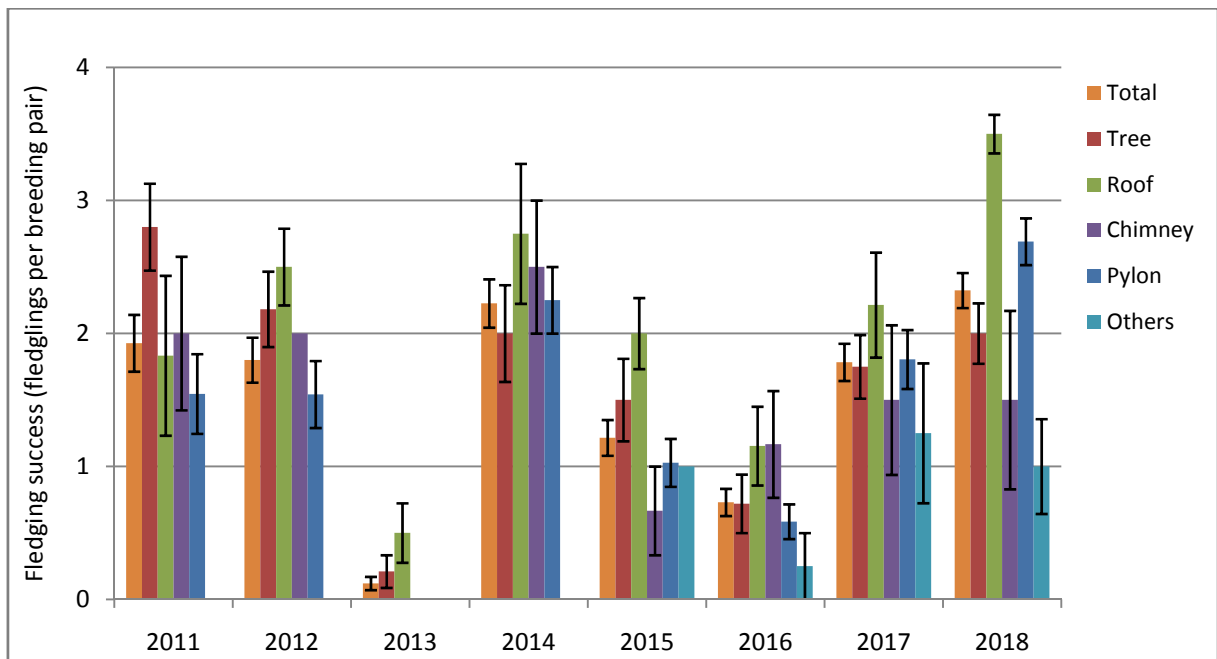


Fig. 2 Fledging success (fledglings per breeding pair) of the white stork population in the Alpine Rhine Valley at different breeding sites (tree, roof, chimney, artificial platforms on pylons or others).

Data are shown as the means \pm standard error.

fledglings on other sites.

4. Discussion

The white stork (*Ciconia ciconia*) has been successfully reintroduced into the Alpine Rhine Valley. With the help of the fledglings from Algeria that started to breed with migratory birds from Western- and Middle-Europe, a viable population could be established. Over the years, migratory birds increasingly displaced the “project storks”. The released birds did not migrate, in contrast to their offspring that did [7, 14].

The results show that despite the suboptimal climatic conditions in the Alpine Region the stork population rapidly increased by 83 breeding pairs between 2009 and 2018. One of the reasons for this surprising development may be the great number of fledglings bred and released in the Alpine Rhine Valley. With the onset of adulthood they returned, partly with partners from other populations (e.g., Southern Germany or France), and successfully reproduced. As a peripheral population this

immigration from surrounding core populations seems essential [8]. Compared to other populations in Europe, fledging success of 1.53 fledglings per breeding pair during the study period is moderate and lies below the mean of 1.65 fledglings per breeding pair measured in Switzerland [14, 15]. Annual fluctuations in breeding success are high, especially in catastrophic years, like 2013.

A favorable factor for the reintroduction success of the species may be the exposition of the Alpine Rhine Valley, which is regularly used as a migratory route by storks. Large assemblies of up to 44 resting storks could be observed in the region, even before the reintroduction of the species [5]. The “project storks” at the sanctuary attracted migrating individuals. As a result, multiple breeding events of “project storks” with migrating storks were recorded on or near the “Rheintaler Storchenhof” between 1991 and 1999 while the sanctuary was particularly active. In the breeding season 2000 the station was closed. In that particular year no breeding events were recorded there, since 2001, one pair breeds at the station annually.

The number and quality of suitable habitats could, thanks to the efforts of different conservation organizations, be increased. Habitat restoration efforts like water logging of meadows and pastures and widening of trenches, lead to a network of additional wetlands and an increase of food resources (Fig. 3) [16]. One particularly successful habitat restoration project, where 10% of agricultural land was converted into wetlands (Hansjakob Reich, project leader, personal comm.), was realized on a government property near the Prison Saxerriet, which was home to 22 stork pairs in 2017/2018. Further habitat improvement measures, like the establishment of wildflower fallows and ecological network projects have led to a higher biodiversity in the valley and have improved stork habitats.

Many marshes have in the past been drained to gain arable land. As a result, grasslands dominate the landscape today. However, the meadows and pastures turn into wetlands in times of high rainfall and provide

rich food resources for the storks. The main prey during the breeding season are small mammals like mice and moles that are common in the region [17]. Also, earthworms are an important resource [18], especially in spring when the storks arrive and earthworms are abundant.

A further factor for the successful reintroduction was the provision of a network of regularly maintained aeries in the form of artificial platforms (pylons) and nesting material on roofs and on chimneys by the Rhine Valley Stork Association [19]. These were well accepted by the storks and made up half of all occupied aeries. These solid aeries were regularly cleaned and repaired if necessary. Nests in trees built by the storks are often unstable and were, if necessary, supported by pylons with platforms (Fig. 4). This did not lead to an increase of casualties. Breeding success on artificial platforms did not significantly differ (as shown) from breeding success on trees, chimneys or roofs.



Fig. 3 This artificial wetland was created by removing the humus layer of a fertile meadow. This wetland in a former marsh is regularly visited by storks and migratory birds for foraging.



Fig. 4 Because nests (a) are often destroyed by storms, the birds were provided with artificial platforms, on pylons or tree stubs (b), in order to facilitate reintroduction.

5. Conclusions

Even though in catastrophic years, as observed for example in 2013, almost no offspring survived, under optimal conditions the mean number of fledglings per breeding pair was observed to be 2.32 and the stork population in the Alpine Rhine Valley continues to grow. The same trend can also be observed in other countries, where the stork occurs. In the Alpine Rhine Valley, ideal breeding conditions, in conjunction with measures like the provision of artificial platforms and diverse food resources provided by meadows, wetlands and marshes, as well as immigration, support population growth.

Given the continuous commitment of the conservation organizations in conjunction with the monitoring of the stork population by the Rhine Valley Stork Association and the “Transnational CICONIA Foundation” based in Liechtenstein, it is expected that a viable white stork (*Ciconia ciconia*) population will persist in the Alpine Rhine Valley.

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