MASTERARBEIT / MASTER’S THESIS

Titel der Masterarbeit / Title of the Master‘s Thesis

„Changes in population size and occurrence of the Little Bittern *Ixobrychus minutus* over a period of 25 years at water bodies embedded in the urbanized landscape of Vienna“

verfasst von / submitted by

Laura Renner BSc

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2022 / Vienna, 2022

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 066879
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Naturschutz und Biodiversitätsmanagement
Betreut von / Supervisor:	Dr. Christian H. Schulze

Abstract

Waterbird populations are declining worldwide with urbanization being a major factor due to habitat destruction and other threats like human disturbances and eutrophication. However, water bodies in urbanized areas can also show an eminently high waterbird diversity if the habitat is suitable for these species. One main distribution area of the Little Bittern *Ixobrychus minutus* in Austria is embedded within the urban region of the capital city, Vienna. Because previous studies indicated a slight decrease of the Little Bittern in Vienna between 1995 and 2006, the current distribution status of the species was assessed again in 2021 and compared with data from previous surveys. Additionally, temporal changes of, different reed bed parameters were analyzed. Our recent survey shows that the species disappeared from a considerable number of waterbodies during the last decades. In contrast, few territories were discovered at sites where the species was previously unknown to occur. Most territories are concentrated along the Old Danube and it's dead channels. It was found that reed beds which are bigger in size are more likely to be occupied permanently. Still, territories could also be found in smaller reed patches. The only reed parameter that declined significantly was the 'largest continuous reed bed' of each water body. The survey of Little Bittern territories in 2021 indicates a weak but continuing population decline of the Little Bittern in Vienna. To prevent an ongoing decline of the Little Bittern in Vienna, the protection and management of even small reed patches is necessary.

Zusammenfassung

Weltweit gehen die Bestände von Wasservögeln durch Faktoren wie Urbanisierung und damit einhergehende Lebensraumzerstörung, Störung durch den Menschen und Eutrophierung von Gewässern, zurück. Trotzdem lässt sich beobachten, dass Gewässer selbst in urbanisierten Gegenden eine hohe Diversität an Wasservögeln aufweisen können, sofern gewisse Habitatansprüche für die Arten erfüllt werden. Ein Hauptverbreitungspunkt der Zwergdommel *Ixobrychus minutus* in Österreich liegt eingebettet in die städtische Region der Hauptstadt, Wien. Vorhergegangene Studien deuten auf einen leichten Rückgang der Zwergdommel in Wien, zwischen 1955 und 2006, hin, weshalb 2021 der aktuelle Bestand erneut erhoben und mit den Daten der vorigen Jahre verglichen wurde. Zusätzlich wurden zeitliche Änderungen bestimmter Schilfparameter analysiert. Unsere jüngste Studie zeigt, dass die Art an einer beachtlich großen Anzahl von Gewässern in den letzten Jahrzehnten verschwunden ist. Im Gegensatz dazu konnten nur wenige neue Territorien an Gewässern, mit keinen zuvor verzeichneten Daten, entdeckt werden. Die meisten Vorkommen konnten entlang der Alten Donau und deren Altarmen festgestellt werden. Ebenso konnte bestätigt werden, dass größere Schilfbereiche wahrscheinlicher von Zwergdommeln dauerhaft besiedelt werden. Dennoch konnten auch in kleineren Schilfbereichen Territorien bestätigt werden. Der größte, durchgehende Schilfbereich jedes Gewässers war der einzige Schilfparameter, der signifikant zurück gegangen ist. Die Bestandsaufnahme der Zwergdommel in 2021 deutet weiter darauf hin, dass sich die Population in Wien zwar gering aber dennoch fortschreitend verringert. Um einen weiteren Rückgang der Zwergdommel-Population in Wien zu verhindern, ist es von großer Notwendigkeit bestehende Schilfbereiche, inklusive kleinen Beständen, zu erhalten und zu fördern.

Keywords: Little Bittern, Austria, Waterbirds, Urban Wetlands, Conservation, Reed Bed Size, Population Trend

Introduction

Waterbirds represent an important indicator for the health of wetland ecosystems, which in turn are essential to humanity because of the many ecosystem services they provide. According to Wetlands International (2012), 38% the world's waterbird populations are declining for many reasons, most of which are anthropogenic, including urbanization.
Urban expansion is one major factor of habitat destruction and therefore affecting an enormous number of species. Although many of them get displaced, some species, mainly generalists, are able to adapt to these circumstances. While urbanization often leads to a higher density of individuals, biodiversity often decreases across the resulting variety of human-dominated habitats (Chace and Walsh, 2006; McKinney, 2008). Even though urban areas can show a higher diversity of waterbird species when cities are surrounded by a landscape with harsh survival conditions, like deserts (Andrade et al. 2018), urbanization also leads to a variety of different threats, like habitat fragmentation, increased nest and chick predation due to higher corvid densities and typical urban predators like rats and cats, human disturbance and collision with utility structures (e.g. power lines) (Chace and Walsh, 2006).
Patches of wetlands remaining embedded in urban areas can represent important refuges for waterbirds. However, many of these wetland species may be negatively affected by human generated barriers like roads and due to traffic noise.

The city of Vienna, the capital of Austria, is a good example that even urbanized regions can have a remarkably high diversity of waterbirds if suitable water bodies are available (Sabathy, 2001). However, it is often unclear to what extent such wetlands embedded in an urban landscape represent ecological traps and how populations develop in the medium and long term. Due to the Birds Directive, all bird species occurring in Austria are under strict protection. In Vienna, 13 of them gained an additional protection status as priority species, including wetland species such as the Little Bittern (*Ixobrychus minutus*). Hence, a special focus of the local government should be on the protection of these priority species and their habitats (Wichmann et al., 2009). Many natural and also anthropogenic water bodies (e.g. gravel pits, fish ponds, etc.) can be found in Vienna. For many wetland species, e.g. dragonflies, amphibians and waterbirds, artificial water bodies like gravel pits can be important as an alternative habitat (Santoul et al., 2009; Frochot and Gordreau, 1995). They often act as stepping stones connecting natural wetlands and are therefore important for rare and/or endangered waterbird species in urbanized areas (Bournaud et al., 1982). An area with outstanding importance for waterbirds in Vienna is the National Park ‘Donau-Auen’ which extends into the adjacent province Lower Austria (Dvorak, 2009).

Because of a significant population decline between 1970 and 1990, the Little Bittern *Ixobrychus minutus* was formerly classified as endangered (EN) according to the IUCN Red List (BirdLife International, 2004) and the Red List for Austria (Frühauf, 2005). However, currently the population appears to be stable (Anselin, 2020). Hence, the species conservation status in Europe was downgraded to least concern (BirdLife International, 2015; BirdLife International, 2021). In contrast, in Austria the species status was only downgraded to vulnerable (VU) (Dvorak et al., 2017). Still, specific conservation measures, especially habitat protection, are necessary to ensure the continuity of the Little Bittern populations in Europe.

The European breeding range of the Little Bittern stretches from the Iberian Peninsula across Central Europe eastwards to Turkey and the southern parts of Russia, with the species’ core areas being located in the central and eastern parts of the region (Anselin, 2020; Voisin, 1991). Originally occupying natural wetland areas like reed swamps and eutrophic lakes, Little Bitterns can also be found now in reedbed patches of anthropogenic habitats like fishponds, gravel pits and post-mining lakes (Cramp and Simmons, 1977). Since the species depends on standing waters surrounded by wide-spread reed beds, it is only locally distributed in Austria. Besides Lake Neusiedl, the biggest known breeding population is centered in the urban matrix of Vienna which sums up to 19.2% of Austria’s Little Bittern population (Wichmann et al., 2009). Between 1995 and 1998, 38-60 breeding territories were detected in Vienna (Sabathy, 1998). During subsequent surveys in 2002 (Wichmann et al., 2009) and 2006 (Scheckenhofer, 2013) 36-40 and 24-38 territories were recorded, respectively, indicating a slight decline over a period of ca. 10 years.

The suitability of a reed bed as breeding habitat is influenced by many factors, like the water depth and vegetation structures (Saunders et al., 1991), area and density of the reed bed patches (Martinez-Vilata, 2002), the distance to terrestrial habitat (Martin, 1993) and presence of small free areas of water within the reed beds (Sabathy 1998). The species adapts to habitats with small and narrow patches of dense and emergent plants, mainly reed (*Phragmatites sp.)* but also bulrush (*Typha sp.)* and even shrubs and trees like willows or alders can be included in its breeding habitat (Martin, 1993). As Scheckenhofer (2013) already pointed out, breeding habitats of the Little Bittern in Vienna are particularly remarkable since a substantial proportion of them represent very small and isolated water bodies, in areas with high anthropogenic disturbance. This indicates a rather high tolerance against human activities. However, besides habitat loss through destruction/fragmentation and habitat degradation due to drainage of wetlands, ongoing water eutrophication decreasing access to fish prey and the intensification of commercial use of water bodies (reed cutting, fish farming, etc.), human disturbance due to recreational activities such as fishing and swimming, is mentioned as one of the major threats at the species' breeding areas (BirdLife International, 2021; Bauer et al., 2006).

The aims of this study were to:

- assess the current distribution and breeding success of the Little Bittern in the urban habitat matrix of Vienna.
- analyze changes in the population size of the Little Bittern in Vienna across the last ca. 25 years by considering previous surveys.
- identify factors being responsible for local extinctions with a particular focus on potential changes in reed bed size and reed bed shape.

Material and Methods

Study area

This study covers the same area surveyed for Little Bitterns by Scheckenhofer (2013) and Sabathy (1998).

In total, 71 study sites (Appendix I) were selected as potential breeding areas (Sabathy, 1998), all located at an elevation between 150-350 m asl. (Fig 1). During the first survey period, water body 50 ('Phönixteich') was found to provide potential habitat requirements for the target species and was located near water body 35 ('Endelteich'), which is why it was also included as a study site.

Water body 50 ('Phönixteich') was also included after the first survey period because it provided potential habitat requirements for the target species. Four additional water bodies (51 – 54), which were not included in this study, turned out to be suitable Little Bittern habitats when data from the observation platform 'ornitho.at' was analyzed after the study period.

A total of 24 water bodies, also considered in former surveys, were either ignored after a few visits because they turned out to be not suitable as a habitat for the Little Bittern anymore (N = 21) or could not be visited because of changes in private property since the last study in 2006 by Scheckenhofer (2013) (N = 3).

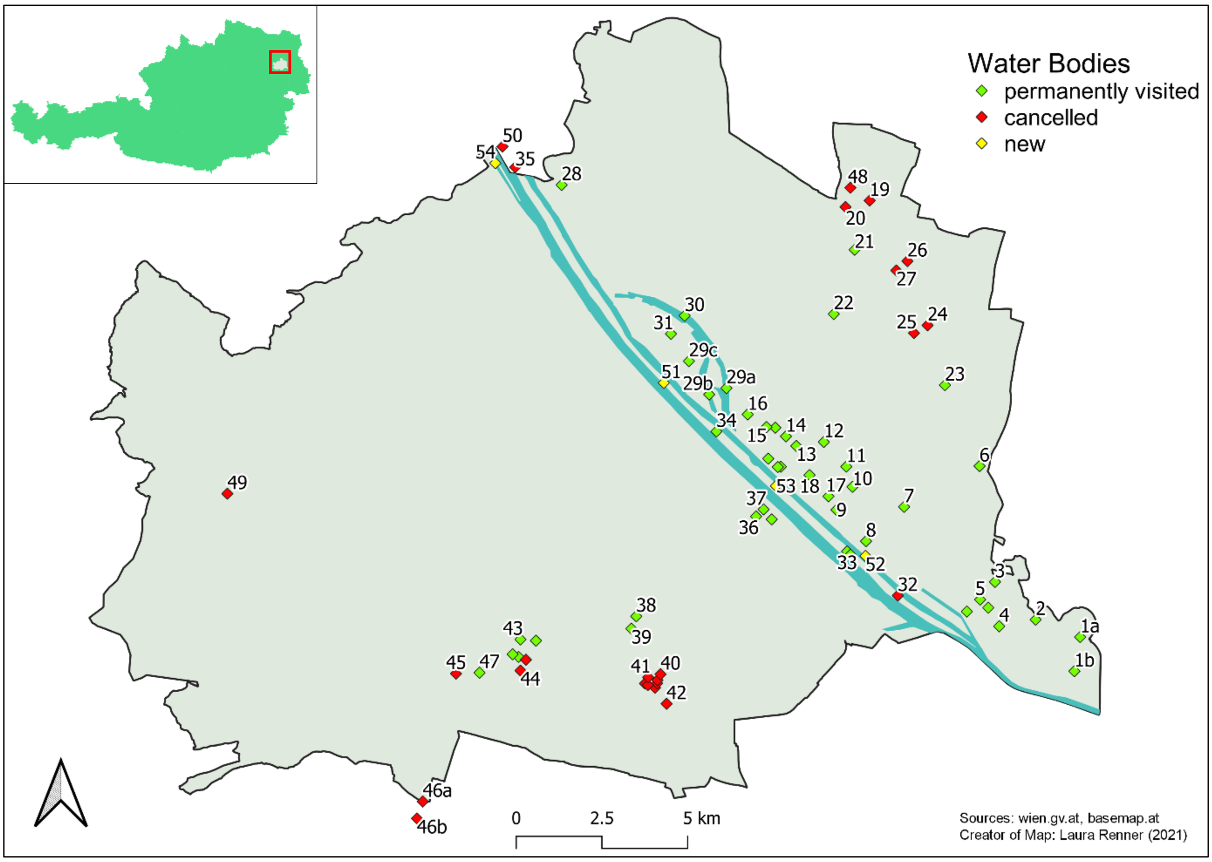

Fig 1: Overview map of all water bodies (with their ID) considered in this study. The green water bodies were visited during all 5 survey rounds, the red water bodies were visited only during the first few survey rounds and the yellow water bodies turned out to be suitable Little Bittern breeding habitats after the study period, through analyzation via data from 'ornitho.at' (https://www.ornitho.at/).

In the previous study from Scheckenhofer (2013) three water bodies in the West of Vienna were omitted due to time constraints. This time, "Wienerflussstaubecken" was included again, the other two sites ("Wilhelminenbergteich" and "Grünauer Teich") were again not visited, because of a low suitability as a breeding habitat with no recorded sightings.

Little Bittern survey

The survey started in 2021 with the arrival of the Little Bittern in Austria from the wintering ground at the end of April and lasted until the end of August, when the species is starting to leave its breeding sites. Because of their secretive behavior and often inaccessible habitat, the Little Bittern is often difficult to observe and easily overlooked (e.g. Anselin, 2020) Especially when they are in potential danger, an upright posture is occupied, which makes them hardly noticeable (Voisin, 1991). Hence, visits of the selected water bodies were done regularly in 5 survey periods (Tab 1). The start of the 5th period is overlapping slightly with the end of the 4th period, due to time constraints.

Tab 1: Survey rounds.

Survey Period	***Date***
1	27/04/21 - 11/05/21
2	12/05/21 - 30/05/21
3	03/06/21 - 29/06/21
4	30/06/21 - 06/08/21
5	02/08/21 - 01/09/21

The occurrence of the Little Bittern was examined through recording calling males, juvenile calls, sightings and foraging flights. Mating calls can be heard up to a distance of 200-300 m and peak in May. Juvenile calls can be heard up to 50-100 m and are expected starting in June (Sabathy, 1998). To avoid potentially negative effects of disturbances, no nest searches were done and no playback used. The observations were concentrated at the peak time of Little Bitterns activity, which is between 6 - 10 AM and 6 - 10 PM (Cempulik, 1994) but were also made between these periods during the day. The observation on each study site lasted at least 15 minutes.

Additionally, citizen science data of Little Bittern sightings from the period 2010 – 2021 entered via the observation platform ‘ornitho.at’ was provided by BirdLife Austria. Particularly for 2021 this data from ‘ornitho.at’ was used to locate territories or sightings that have been potentially missed by our own survey in 2021.

Assessment of reed bed parameters

The following reed bed parameters, which proved being reliable predictors for the occurrence of Little Bitterns in an earlier study (Scheckenhofer, 2013), were assessed:

- Total reed bed area [m^2]
- Area of largest continuous reed bed patch [m^2]
- Total circumference of reed beds [m]
- Shape of total reed bed area quantified as ratio of its perimeter [m] and total area [m^2]

These data were measured using orthophotos, which were provides as Open Government Data by wien.gv.at (2020) and digitalized and calculated with QGIS (Version 3.16 Hannover).

Statistics

To test changes in the ratio of colonized vs. non-colonized water bodies between different study years, a Chi-square test was calculated with the statistical program Past Version 4.03 (Hammer et al., 2001).

Data of reed bed parameters were available from 2006 (Scheckenhofer, 2013) and 2021 (this study). Water bodies that were split up within this study for better Little Bittern detection, were combined again for comparison with Scheckenhofer's (2013) data. To compare colonized with uncolonized water bodies, this study's distribution data was also aggregated to match the water body classification from the previous study. Since all reed bed parameters (total reed bed area, largest continuous reed bed patch, total circumference of reed beds, shape of reed bed) deviated significantly from a normal distribution (all Shapiro-Wilk tests: $p < 0.001$). Pairwise Wilcoxon tests were calculated to detect significant changes of these variables between the survey years 2006 and 2021. For calculations the parameters of a total of 54 water bodies were used (N = 54). Data were not available for every single water body from 2006.

To see if local extinctions at water body are related to changes in reed bed parameters, water bodies with detected territories in 2006 and no observations in 2021 (n = 7) and vice versa (n = 6) were compared. Data of the already mentioned reed parameters were also tested for normality with a following Wilcoxon test to detect significant varieties.

All further tests were calculated with the software SPSS Version 28.01.1 (15). Too see, if water bodies with bigger reed areas are occupied more permanently compared to water bodies with smaller reed areas, a One-way ANOVA was used on the mean reed bed area of the data of the observation years with available reed bed parameters, 2006 and 2021. The homogeneity of variance was checked with a Levene test. In advance, data were log-transformed to approach normal distribution. The occupation of a water body was classified as no occupation (0), infrequently occupied (1), regularly occupied (2) and permanently occupied (3), regularly (2) using the data of all four observation years (1998, 2002, 2006 and 2021).

Since some water bodies were not visited in every year and for other water bodies no reed bed data were available from the last years, only a total of 53 water bodies were considered for analyses. A Tukey HSD was used to detect pairwise differences between survey years.

A logistic regression was calculated for both observation years 2006 (N = 54) and 2021 (N = 71), to see what impact the size of reed beds (log-transformed data) has on the likelihood of occupation and if there was a change in the threshold, at which size an occupation was likely.

Results

Population trend

In 2021, breeding success could be confirmed for the six following water bodies: ‘Panozzalacke/Fasangartenarm’ (site code: 8), ‘Mühl-/Tischwassergebilde’ (10), ‘Oberes Mühlwasser/W Biberhaufenweg’ (12), ‘Großes Schilloch’ (18b), ‘Gewässer SW Kierschitzweg’ (18c), ‘Untere Alte Donau – Arm westlich Gänsehäufel’ (29b).
Additionally, breeding success could be proven for the water body ‘Obere Alte Donau’ (30) via the observation platform ‘ornitho.at’.

All these water bodies are part of the Danube’s dead channel on the northern part of Vienna, where the greatest distance between two study sites is about 9.7 km (Fig 2). Water body 8 and 10 are located in the ‘Obere Lobau’ which is the western part of the National Park ‘Donau-Auen’. The ‘Großes Schilloch’ (18b) is used as a fishing area, water body 18c is not used anthropogenically. The territories at the Old Danube are located either in a highly frequented bathing area (30) or in an area with a lot of visitors passing by very close to the breeding site (29b). Water body 12 is also used as bathing water.

Fig. 2: Water bodies with confirmed breeding success in 2021 (own data: N = 6 water bodies; citizen science data from onitho.at: N = 1).

Most of the observations extracted from 'ornitho.at' over the last 10 years are located on the north-eastern side of the Danube with a noticeable accumulation along the old channels of the Danube (Fig. 3). Additionally, single territories are primarily found in the north-east of Vienna. On the southern side of the city solely the 'Wienerbergteich' stands out with a higher density of observations.

Since 1995-1998, the majority of formerly suitable breeding sites on gravel pits and fishponds in the north-eastern part of Vienna have disappeared. Hot spots along the 'Alte Donau' and other dead channels of the Danube remain as areas with a high density of territories (Fig. 4). Analysis of the provided data from 'ornitho.at' showed 4 additional Little Bittern territories which are all located along the Danube. These areas were not visited in the course of this study but should be included in future surveys. After inspection through satellite pictures, most of these waterbodies seem like suitable breeding sites of the Little Bittern. Still these areas should be examined in the field to see how adequate the conditions are as a breeding habitat for the

species. However, still the data indicate a continuous decline of Little Bittern territories over the entire study period from 1995-1998 till 2021 (Fig. 5).

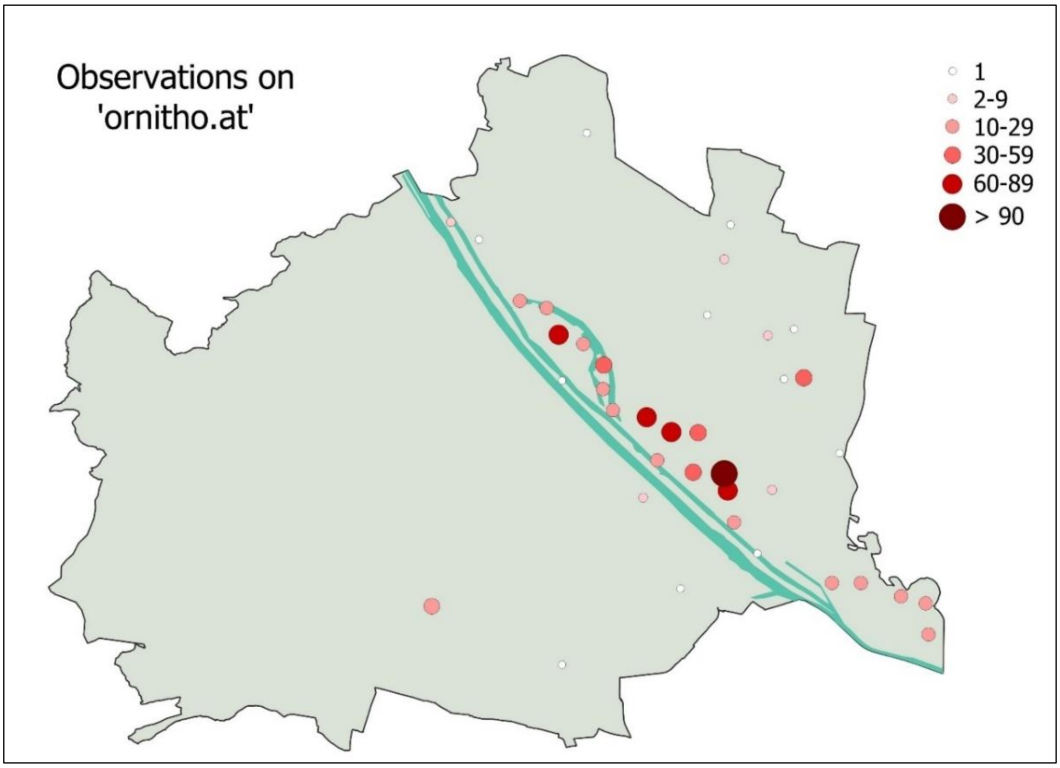

Fig. 3: All clustered entries of Little Bittern sightings in the years from 2011–2021 on the observation platform 'ornitho.at', provided by BirdLife Austria. Most sightings are covering the survey area.

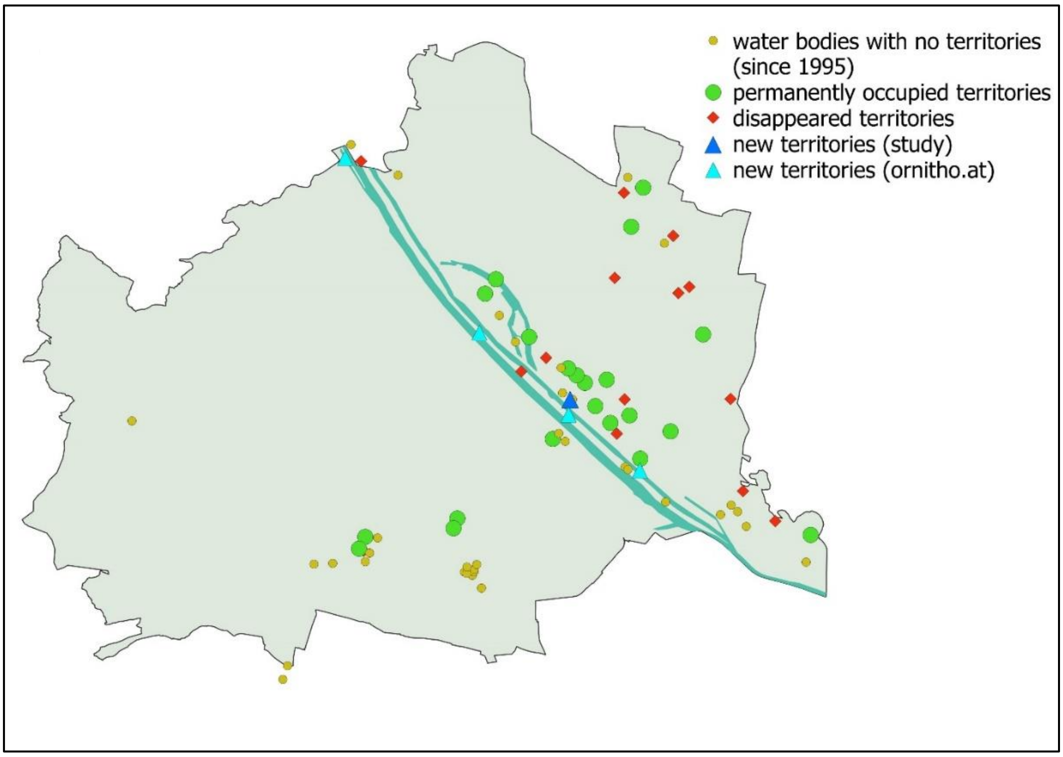

Fig. 4: All records since 1995 with disappeared, permanently occupied and new territories within the study area (N = 79), also including 4 new territories that were detected with data from 'ornitho.at'.

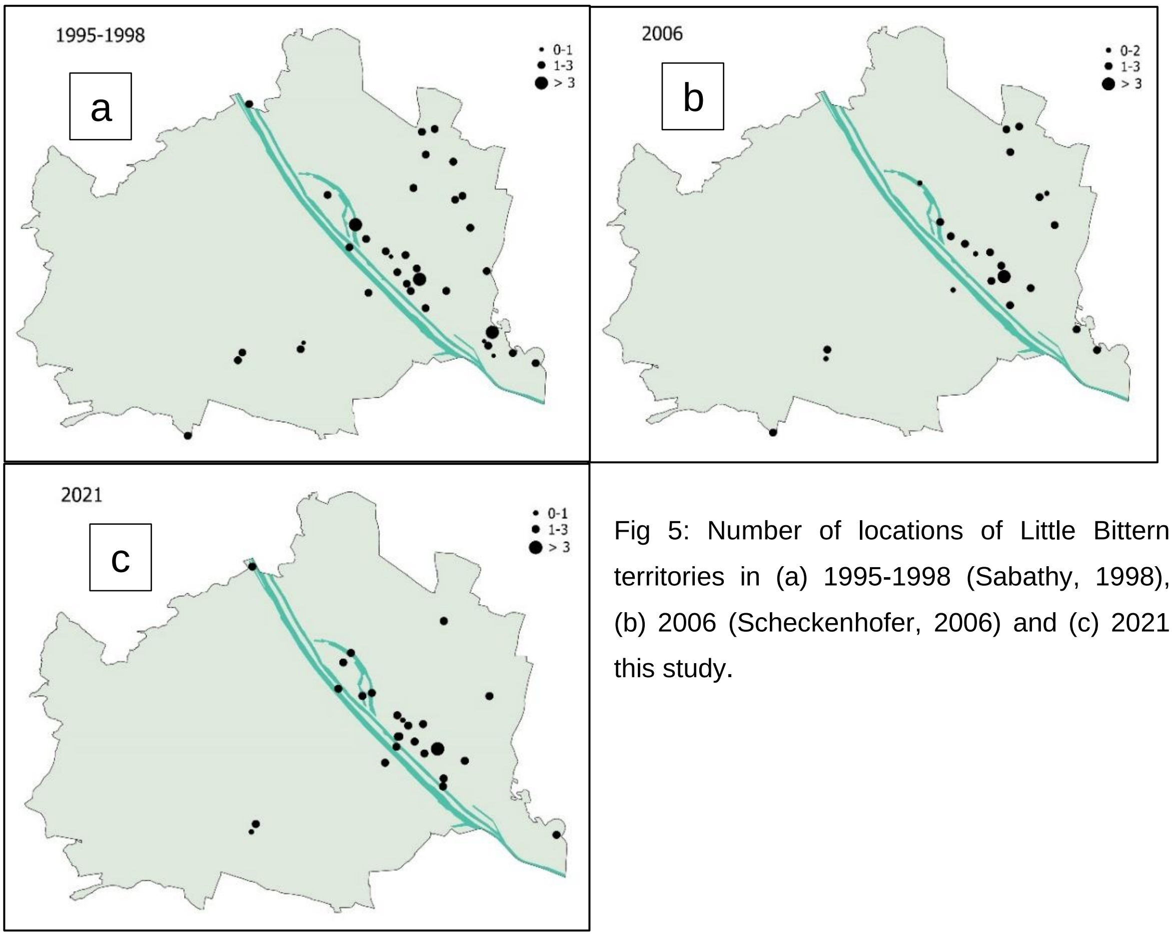

Fig 5: Number of locations of Little Bittern territories in (a) 1995-1998 (Sabathy, 1998), (b) 2006 (Scheckenhofer, 2006) and (c) 2021 this study.

The number territories declined over the years (Fig. 6). Only in 2002, less water bodies were visited due to different methods in that study. Fig. 7 shows that most of total observed territories were covered within this study. Through considering the data from ‘ornitho.at’ it was possible to discover only 4 additional territories of the Little Bittern in Vienna (Appendix I).

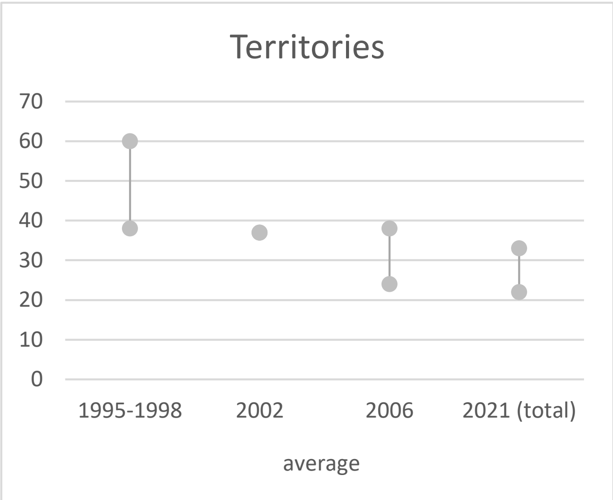

Fig 6: Minimum-maximum number of territories confirmed during the four study periods.

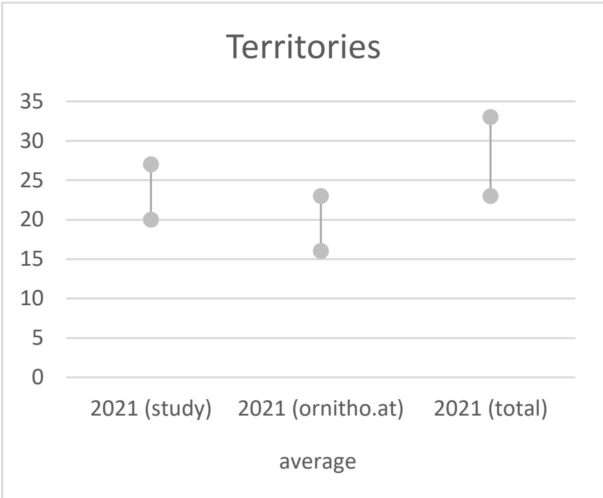

Fig 7: Minimum-maximum number of territories confirmed in 2021 using own survey data, data from the observation platform ‘ornitho.at’ and both data sources combined.

Continuity of occupancy

The proportion of colonized water bodies decreased slightly (Fig 8; χ^2 = 15.996, *df* = 2, *p* = 0.001136). Only in 2002 different observing methods were used and many other species were observed. Therefore, the Little Bittern had not the same priority in this study compared to the others and less water bodies were included.

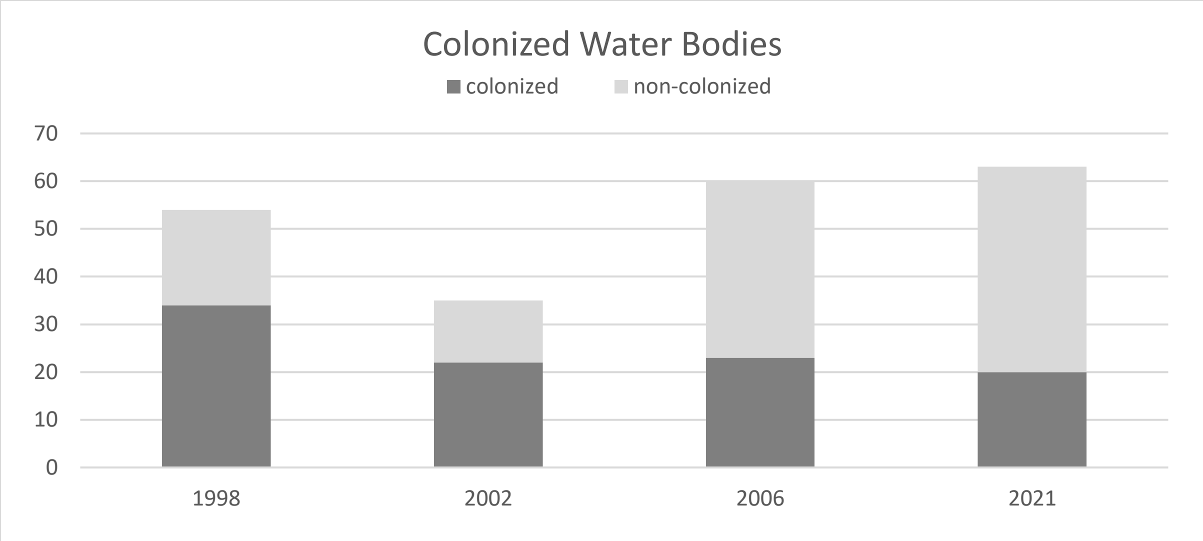

Fig 8: Colonized vs. non-colonized water bodies in each observation year. The number of total number of observed water bodies varies but mostly covers the same area (1998: n = 54; 2002: n= 35; 2006: n = 60; 2021: n = 63, including 4 water bodies, where Little Bittern territories were identified through entries via 'ornitho.at' after the observation periods of this study).

Water bodies which are more permanently colonized by Little Bitterns are characterized by larger reed bed areas (One-way ANOVA: $F(3,49) = 11.279$, $p < 0.001$; Levene test: $F(3,49) = 0.524$, $p = 0.668$). Significant differences were detected with a Pairwise Tukey HSD test between areas with no occupation (0) and regularly occupation (2) ($p < 0.001$), no occupation (0) and continuously occupation (3) ($p < 0.001$) and infrequently occupation (1) and continuously occupation (3) ($p = 0.014$) (Fig. 9).

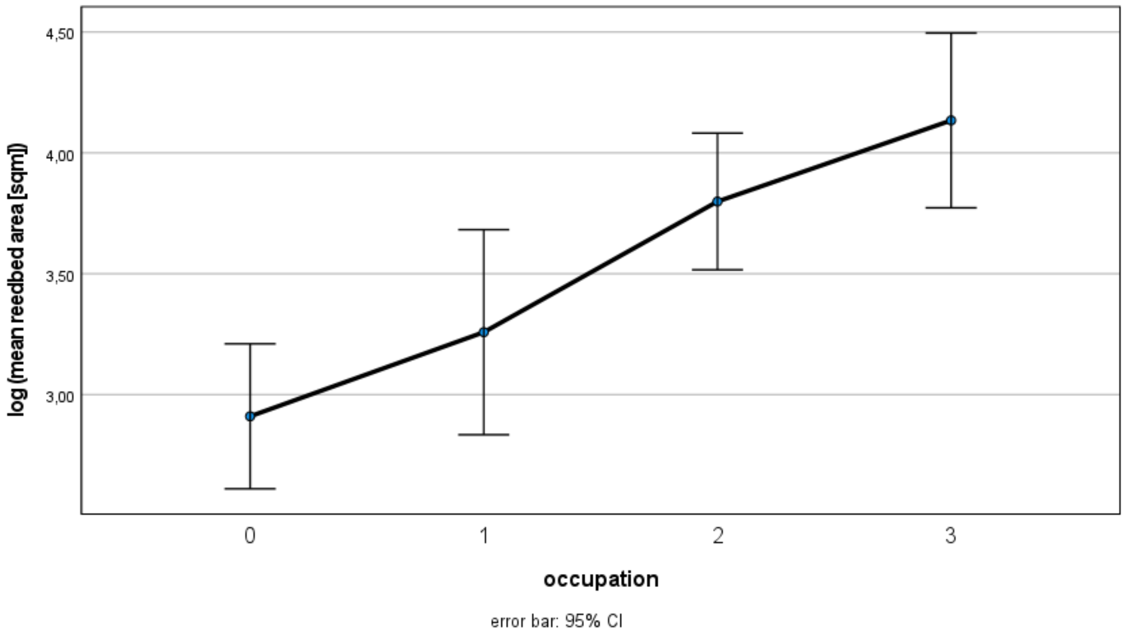

Fig. 9: Differences in mean reed bed area (+ 95% CI) between water bodies with different occupation frequency (0 = no occupation, 1 = infrequently, 2 = regularly, 3 = permanently).

Relationship between reed bed parameters and Little Bittern occupancy

It was also shown that a bigger reed bed area is more likely to be occupied at a certain threshold value (Fig. 5). In 2006 and 2021 reed bed areas were colonized with a likelihood of 50% when they had a size of ca. 3930 m2 and 4180m2 respectively. Further, the sigmoid curve for 2021 shows a less steep increase than the one for 2006 (Fig. 10).

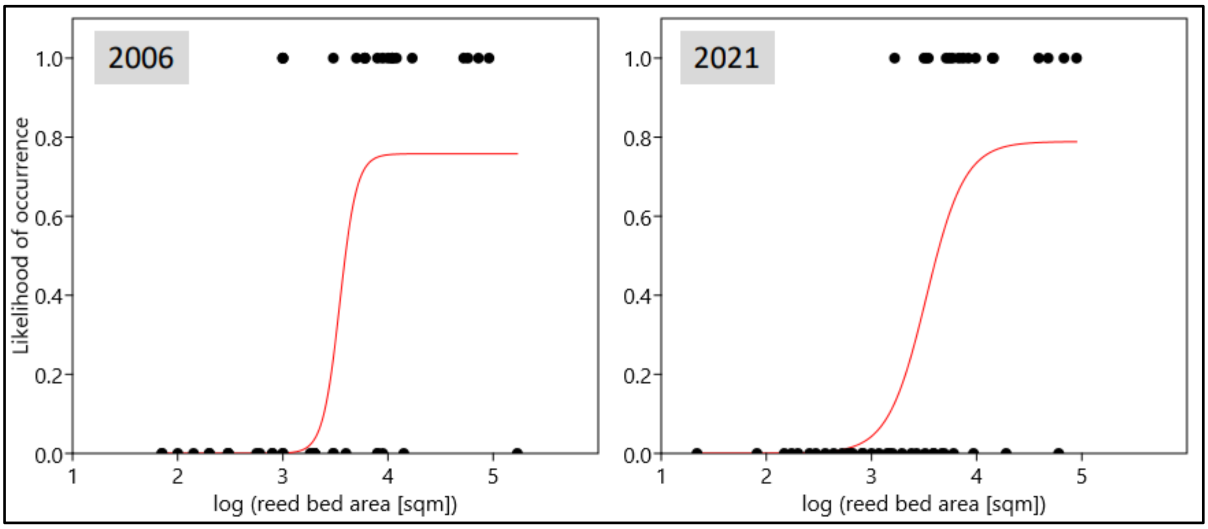

Fig. 10: Likelihood of Little Bittern occurrence with increasing reed bed area, predicted by a logistic regression, separately calculated for the years 2006 (a) and 2021 (b).

No significant difference in the three following reed bed parameters could be detected between 2006 and 2021: Total reed bed area (pairwise Wilcoxon test: z = 0.91, p = 0.36), total circumference of reed beds (z = 1.35, p = 0.19), shape of reed bed (z = 0.11, p = 0.91). However, a significant difference was shown in the size of the largest continuous reed beds (z = 2.57, p = 0,01) between 2006 (*Mdn* = 2000) and 2021 (*Mdn* = 1427) with a high effect size of r = 0.85 after Cohen (1992).

Eight waterbodies with proven territories in 2006 had no Little Bittern observations in 2021. Comparable reed bed data were available for seven of these water bodies (n = 7). No significant differences could be detected (pairwise Wilcoxon tests; total reed bed area: z = 0.51, p = 0.61; largest continuous reed bed: z = 0.34, p = 0.74; total circumference of reed bed: z = 1.69, p = 0.09; shape of reed bed: z = 0.0; p = 1.0). The same results could be revealed for water bodies occupied in 2021, that had no observations back in 2006 (n = 6; total reed bed area: z = 0.31, p = 0.75; largest continuous reed bed: z = 1.36, p = 0.17; total circumference of reed beds: z = 0.52, p = 0.60; shape of reed bed: z = 1,57, p = 0.12).

Discussion

Historical distribution in Vienna

In Sabathy's (1998) three year study 38-60 territories were detected. Dvorak (2003) found 37 territories in 2001-2002. The methods of observation and intensity of work differed from the other studies, therefore these results cannot be treated as equal with the data from the other studies, where specified methods and a high time investment to detect the Little Bittern were used. In Scheckenhofer's (2013) study 24-38 territories could be observed, already implying a slightly decline in Vienna's Little Bittern Population. In this study 22-33 territories could be detected, indicating a further downturn. However, 4 additional territories were shown through citizen science data from 'ornitho.at'.

Breeding success

Breeding success could be detected for 7 water bodies, which are all part of the Danube's dead channels on the northern side of Vienna. Four of these water bodes are facing relatively high human disturbance, three are frequently used for bathing (12, 29b, 30), while one (18b) is used for. The other three water bodies are of no anthropogenic use. Scheckenhofer (2013) already pointed out that Little Bitterns show a high tolerance against human disturbances and it was also shown that there was no significant difference if the waters were used by humans for recreational activities or not.

In the years of 2000 and 2001, successful reproduction in the consecutive years of two breeding pairs could be detected at the 'Tritonwasser' which is located on the 'Donauinsel' (Raab, 2003). No further breeding success could be observed since then, including this study.

The importance of citizen science data

Most observations reported on the platform 'ornitho.at' are located on the north-eastern side of Vienna. This overlaps largely with the species' occurrence documented by our own survey but still some territories were not detected using citizen science data extracted from 'ornitho.at'. This could be related to the fact that the Little Bittern is difficult to observe and easily overlooked. Most observations reported by citizen scientists were made in popular and well-visited areas, such as the 'Alte Donau', an oxbow lake frequently visited by bather and the 'Lobau' as well as the 'Mühlwasser', which attracts many people generally interested in nature. More visitors also mean more observations. However, these observations along the dead channels of the Danube are covering only territories at locations already known to represent suitable breeding sites documented by previous studies.

In contrast, four additional sites with Little Bittern occurrence during the breeding season along the Danube could be identified by observations reported at ‘ornitho.at’. These sites are located in areas not surveyed in this or during previous studies. Hence, it is unknown if these sites were occupied only recently. At least three of these sites seem to meet the requirements as a suitable breeding habitat of the Little Bittern and, therefore, should be considered in future surveys.

Population trend

Compared to previous studies, less territories could be detected. Numerous factors could have an influence on the decline of the Little Bittern in Vienna. The disappearance of the species during the last decades from many water bodies in the northern part of Vienna is particularly noticeable.

This may be caused by a dramatic change in habitat quality of the gravel pits and fish-ponds, which were used as breeding sites in this area (Appendix II). Reed bed areas were fragmented or even destroyed so that these waterbodies were better accessible for human activities. The resulting decrease of reed bed areas may have been the most important factor reducing the suitability of these waterbodies as a breeding habitat of the Little Bittern.

In former studies, 58% of Vienna’s Little Bittern population were located in the ‘Lobau’ (Wichmann et al., 2009). In this study, only 5-7 territories were found in this area, mostly in the ‘Obere Lobau’. Many factors may be responsible for this difference. The Little Bittern is, as already mentioned, a species which is difficult to observe, due to its secretive behaviour. For this reason, it could be possible, that a few territories in the ‘Lobau’ with the largest – and hence difficult to survey – reed bed areas in our study area were overlooked. But even when considering the citizen science data from ‘ornitho.at’, no further sightings of this species were reported. This all points to an actual decline of the Little Bittern in the ‘Lobau’. A current problem in the ‘Lobau’ is the drying up of the whole area, especially the ‘Untere Lobau’. Once the ‘Lobau’ – as part of the Danube floodplains - was a hydrologically highly dynamic area. In the 19^{th} century the floodplains were cut off from the main stream which lead to a lowering of the ground water table since then and therefore an increase in silting up of shallow water zones (Pölz et al., 2014). Additionally, the vegetation indicates a proceeding sedimentation progress as helophytes that accumulate in dry areas are also increasing (MA 45 – Gewässer Wiens, 2015). The study from the MA 45 (2015) mentions that water body 4 (Hansgrund) is severely affected by this process which matches with the fact that no Little Bittern sightings could be made in this area since 1998. Also, water bodies with a high flood inflow like ‘Kühwörther Wasser’ (1a), ‘Mittelwasser’ (2) and ‘Eberschüttwasser’ (4) are characterized by a high nutrient concentration. Nutrient input leads to increased algal production which results in a declining vertical visibility through the water and accessibility of fish prey (Hölzinger, 1987). Eutrophication of water bodies is also a problem in smaller waters like fish ponds and bathing waters. Reckendorfer et al. (2013) state that the ‘Lobau’ lost 93 ha of water area in 56 years due to silting up of the area, 66 ha of which is in the ‘Untere Lobau’.

This processes result in less suitable habitats for the Little Bittern and other reed birds. The apparent widespread disappearance of the species in the Lobau could already be an effect of the drying up progress. Also, the wetland areas in the ‘Lobau’ are facing strong temporal changes in water level. Constant water levels are a beneficial factor for Little Bittern habitat suitability. Therefore, this area does not always meet the habitat requirements of the Little Bittern and its suitability as breeding area differs from year to year (Sabathy, 1998).

Besides a declining habitat quality in the species’ breeding area, changing conditions in wintering and resting areas can also have a negative impact on Little Bittern populations, with the main reasons being increasing drought periods, loss of habitats due to intensification of agricultural land use and direct persecution (BirdLife International, 2010; Bauer et al., 2012). Other long-distance migrants which have to cross vast desert areas and winter in the Sahel zone like Common Redstart (*Phoenicurus phoenicurus*), Bank Swallow (*Riparia riparia*) or Black-crowned Night Heron (*Nycticorax nycticorax*) also suffered from drastic population declines after 1989 (Bauer et al., 2012).

The Little Bittern is also known for high population fluctuations with no recognizable changes in their breeding habitat (Cempulik, 1994; Bauer et al., 2012). Often the reasons for this remain unknown. It is important to continue with a specific monitoring for this species, to find out if the lower number of territories in 2021 is due to population fluctuations or indicating a true population decline in this area.

Reed bed area

The analysis of satellite images showed that the reed bed area did not decline significantly and in the disappearance of the species at individual water bodies could hardly be related to temporal changes of the reed bed.

However, drying up of shallow water zones becomes a greater problem in the past years, as emphasized for the Lobau area. Although, no significant change in the size of reed bed areas could be detected between the two study years 2006 and 2021, it has to be considered that dried up zones at big water bodies are hardly detectable on satellite images. Hence, the real amount of flooded reed beds of big water bodies could not be measured exactly.

However, reed beds seem to suffer from fragmentation since the largest continuous reed bed size decreased drastically. As mentioned before, large and continuous reed beds can be an important precondition for suitable Little Bittern habitats. Even though Little Bitterns also occupy smaller reed beds, this study shows that larger reed beds have a higher chance of being occupied more permanently. Besides the size of the largest reed beds, which decreased significantly over the years, other reed bed parameters did not change significantly.

Continuity of occupancy

In Sabathy's (1998) study the probability of colonization as well as the number of territories increased with bigger reed bed area. The minimum size of occupied reed beds was 0.03 ha (= 300 m^2). On bathing waters, occupied reed bed areas were slightly smaller. The reason for this remains unclear, but it is suspected that a lower predator density due to the higher human activity may be responsible (Sabathy, 1998). Our study also showed that bigger reed bed areas have a higher probability of being occupied. Water bodies occupied continuously throughout the different study years had the biggest reed bed areas. Continuous occupation is an indicator for high habitat quality (Scheckenhofer, 2013). The best conditions for a Little Bittern habitat are large reed beds with at least 0.03 ha in combination with trees and shrubs as well as a minimum water level during breeding and small open water areas within the reeds (Sabathy, 1998). All of these conditions are more likely to occur in larger reed bed areas.

Also the logistic regression models predicting the likelihood of Little Bittern occurrence in relation to the size of reed beds demonstrate the preference for larger reed beds. That the 50% threshold for the likelihood of occurrence is at a higher reed bed size in 2021 and that the regression curve is less steep both may be caused by a smaller population size in 2021. Since reed bed size appears to be one of the most important predictors for habitat quality, larger reed beds may be colonized first at the start of the breeding season and only then smaller ones may be filled. When the population size is decreasing some of the smaller reed beds may remain uncolonized, while in former years they might have been occupied due to the higher 'population pressure' forcing some of the Little Bitterns to select smaller, less suitable reed bed patches when larger ones have been largely occupied. This may also be responsible for the slightly different shape of the logistic regression curves of the two years.

Little Bitterns react very sensitive to changes in habitat conditions (Voisin, 1991). Especially old reed beds have a high importance for Little Bitterns, because they have a very regular structure with only few broken stalks. Nowadays these conditions often cannot be found widespread anymore but only in small spots (Cempulik, 1994). Many reed belts have grown too sparsely and Little Bitterns have a preference for dense vegetation, probably because of better concealment and also lower predation risk (Martin, 1993; Cempulik, 1994). The structure of the reed beds was not analyzed within this study, so a possible change could have an impact on the quality of the reeds as a breeding habitat. In future studies this factor should be included.

Management implications and conclusions

Little Bitterns are the least studied European heron species (Flis, 2016). They are listed in the Annex I of the EU Birds Directive, Annex II of the Bern Convention and Annex II of Convention on Migratory Species (AEWA). Further, the Little Bittern is a priority species in Vienna and under strict protection. Therefore, it is essential to protect reed bed areas and also restore former breeding habitats to match the habitat requirements. Rass (2004) claims that the most significant factors for habitat suitability are structure and age of reed beds and food availability (fish). For that reason formation of small open water areas through reed cutting within the larger reed beds could be done to enhance the habitat quality. To boost fish availability for foraging, eutrophication of water should be minimized or even omitted. All current and historical breeding sites should be protected.

When implementing conservation measurements for the Little Bittern by protecting ecologically valuable reed swamps, many other species which depend on this habitat will benefit, such as Water Rail *Rallus aquaticus*, Great Reed Warbler *Acrocephalus arundinaceus*, European Reed Warbler *Acrocephalus scirpaceus*, Savi’s Warbler *Locustella luscinoides*, etc. But reed swamps do not facilitate species protection, they are also important for bank protection, pollution control, atmospheric humidity and also for groundwater economy (Ostendorp, 1993).

This study indicates an ongoing decrease of Vienna’s Little Bittern population, a continuous monitoring in the future will be necessary, since the species is known for showing pronounced population fluctuations, which may obscure actual population trends.

Acknowledgements

First of all, I want to thank my supervisor Dr. Christian H. Schulze for the scientific supervision, as well as statistical advice and corrections. Special thanks to 'BirdLife Austria for providing data from 'ornitho.at' and also to Vienna's 'Municipal Department 45 – Water Management' for providing reports and data regarding the analyzed water bodies. Lastly I would like to thank my partner, mother and friends for their support during the intensive time of monitoring as well as the writing phase.

Literature

Andrade R., Bateman H. L., Franklin J. & Allen D. (2018): Waterbird community composition, abundance, and diversity along an urban gradient. Landscape and Urban Planning 170: 103–111.

Anselin A. (2020): *Ixobrychus minutus* Common Little Bittern. In: Keller V., Herrando S., Voríšek P., Franch M., Kipson M., Milanesi P., Martí F., Anton M., Klvaňová. A., Kalyakin M.V., Bauer H.-G. & Foppen R. P. B: European Breeding Bird Atlas 2: Distribution, abundance and change. European Bird Census Council & Lynx Edicions, Barcelona: 260-261.

Bauer H.-G., Bezzel E. & Fiedler W. (eds.) (2012): Das Kompendium der Vögel Mitteleuropas. Aula Verlag, Wiebelsheim.

BirdLife International (2004): State of the world's birds 2004: indicators for our changing world. BirdLife International. Cambridge, UK.

BirdLife International (2015): European Red List of Birds. Office for Official Publications of the European Community, Luxembourg.

BirdLife International (2021): European Red List of Birds. Publications Office of the European Union, Luxembourg.

BirdLife International (2021): Species factsheet: *Ixobrychus minutus*. Downloaded from http://www.birdlife.org on 24/03/2021.

Bournaud M., Ledant J. P., Broyer J. & Richoux M. (1982): L'espace eétang dans ses rapports avec l'avifaune en période de nidification. Bulletin d'Ecologie 13: 125–144.

Cempulik P. (1994): Bestandsentwicklung, Brutbiologie und Ökologie der Zwergdommel Ixobrychus minutus an Fisch- und Industrieteichen Oberschlesiens. Die Vogelwelt 115: 19-27.

Chace J. F. & Walsh J. J. (2006): Urban effects on native avifauna: a review. Landscape and Urban Planning 74: 46-69.

Cohen J. (1992): A power primer. Quantitative Methods of Psychology. 112: 155–159.

Cramp S. & Simmons K. E. L. (1977): Birds of the Western Palearctic. Vol. 1: Ostrich to Ducks. Oxford University Press, Oxford: 255-260.

Dvorak M. (2009): Lobau. In: Dvorak M. (Ed.), Important Bird Areas. Die wichtigsten Gebiete für den Vogelschutz in Österreich. Verlag des Naturhistorischen Museums Wien, Wien: 104-115.

Dvorak M. (2003): Bestandserhebung der Wiener Brutvögel – Ergebnisse der Spezialkartierung Gewässervögel 2003. Studie im Auftrag der Magistratsabteilung 22, Wien.

Dvorak M., Landmann A., Teufelbauer N., Wichmann G., Berg H.M. & Probst R. (2017): The conservation status of the breeding birds of Austria: Red List (5th version) and Birds of Conservation Concern (1st version). Egretta 55: 6-42.

Frochot B. & Godreau V. (1995) : Intérêt écologique des carriéres, terrils et mines. Natures Sciences Sociétés 3 (special issue): 66–76.)

Frühauf J. (2005): Rote Liste der Brutvögel (Aves) Österreichs. In: Zulka K. P. (Red.): Rote Listen gefährdeter Tiere Österreichs. Checklisten, Gefährdungsanalysen, Handlungsbedarf. Teil 1: Säugetiere, Vögel, Heuschrecken, Wasserkäfer, Netzflügler, Schnabelfliegen, Tagfalter. Grüne Reihe des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (Gesamtherausgeberin Ruth Wallner) Band 14/1. Wien, Böhlau: 63–165.

Hammer Ø., Harper D. A. T. & Ryan P. D. (2001): PAST: Paleontological Statistics software package for education and data analysis. Paleontologia Electronica 4(1): 9 pp.

Hölzinger, J. (1987): Die Vögel Baden-Württembergs, Bd. 1. Eugen Ulmer, Stuttgart.

Martin T. E. (1993): Nest predation and nest sites - new perspectives on old pattern. BioScience, 43: 523-532.

MA 45 – Wiener Gewässer (2015): Gewässervernetzung (Neue) Donau – Untere Lobau (Nationalpark Donau-Auen). Endbericht. Im Auftrag der MA 45.

Martinez-Vilata J., Bertolero A., Bigas D., Paquet J-Y., Martinez-Vilata A. (2002): Habitat selection of passerine birds in the Ebro Delta reed beds (NE Spain): management implications. Wetlands, 22: 318-325.

McKinney M. L. (2008): Effects of urbanization on species richness: A review of plants and animals. Urban Ecosystems 11: 161-176.

Ostendorp W. (1993): Reed bed characteristics and significance of reeds in landscape ecology. Limnologie aktuell; 5: 149-160.

Pearce C. M., Green M. B. & Baldwin M. R. (2007): Developing habitat models for waterbirds in urban wetlands: a log-linear approach. Urban Ecosystems 10: 239-254.

Pölz E.-M., Funk A., Weigelhofer G., Trauner D. & Hein T. (2014): Ökologie – Fachbericht Vögel. Projekt Gewässervernetzung (Neue) Donau – Untere Lobau (Nationalpark Donau-Auen). Im Auftrag der MA 45, Wien.

Raab R. (2003): Verbreitung und Bestand von sieben ausgewählten Vogelarten auf der Donauinsel in Wien – Ergebnisse flächendeckender Erhebungen aus den Jahren 2000 bis 2002. Denisia 10: 241-273.

Reckendorfer W., Böttinger M., Funk A. & Hein T. (2013): Die Entwicklung der Donau-Auen bei Wien – Ursachen, Auswirkungen und naturschutzfachliche Folgen. In: Beiträge zum 44. Jahrestreffen des Arbeitskreises Hydrologie vom 15.-17. November 2012 in Lunz am See. Band 13. Universität Augsburg: 45-53.

Sabathy E. (1998): Zum Vorkommen der Zwergdommel (Ixobrychus minutus) in Wien unter Berücksichtigung methodischer Aspekte der Bestandserfassung. Egretta 41: 67-89.

Sabathy E. (2001): Verbreitung und Bestand der Brutvögel an den Gewässern in Wien 1995-1999. Egretta 44: 89-138.

Santoul F., Gaujard A., Angelibert S., Mastrotillo S. & Cereghino R. (2009): Gravel pits support waterbird diversity in an urban landscape. Hydrobiologia 634: 107-114.

Saunders D. A., Hobbs R. J. & Margules C. R. (1991): Biological consequences of ecosystem fragmentation: a review. Conservation Biolology 5: 18-32.

Scheckenhofer C. (2013): Habitat preferences of Little Bitterns Ixobrychus minutus breeding in wetlands embedded in an urban habitat matrix: a case study from Vienna, Austria. Diploma thesis. University of Vienna, Vienna.

Südbeck P., Andretzke H., Fischer S., Gedeon K., Schikore T., Schröder K. & Sudfeldt C. (eds.) (2005): Methodenstandards zur Erfassung der Brutvögel Deutschlands. Im Auftrag der Länderarbeitsgemeinschaft der Vogelschutzwarten und des Dachverbandes Deutscher Avifaunisten.

Voisin C. (1991): The herons of Europe. T. & A. D. Poyser, London.

Wichmann G., Berg H.M., Teufelbauer N. & Dvorak M. (2009): Die Vogelwelt Wiens: Atlas der Brutvögel. Naturhistorisches Museum Wien, Wien.

Wetlands International (2012): Waterbird population estimates, 5th edition. Wetlands International, Wageningen, The Netherlands.

Zoufal W., Rossboth D. W., Klemm G., Tekiela B., Dernbauer G., Jaksch G. & Groß F. (2002): Bericht über den Gütezustand stehender Gewässer in Wien, Aufnahme 1993-2001, Wiener Magistratsabteilung 45 – Wasserbau.

Appendix I

	Water body	Visits				
		1st	2nd	3rd	4th	5th
I.	**Untere Lobau**					
1a	Kühwörther Wasser	11/05/21	24/05/21	26/06/21	06/08/21	31/08/21
1b	Gänsehaufenwasser	11/05/21	24/05/21	26/06/21	06/08/21	31/08/21
2	Mittelwasser	11/05/21	24/05/21	26/06/21	06/08/21	31/08/21
3	Eberschüttwasser	11/05/21	24/05/21	26/06/21	06/08/21	31/08/21
4	Hansgrund	11/05/21	29/05/21	27/06/21	06/08/21	31/08/21
5a	Lausgrundwasser Süd	11/05/21	29/05/21	27/06/21	06/08/21	31/08/21
5b	Lausgrundwasser Nord	11/05/21	29/05/21	27/06/21	06/08/21	31/08/21
5c	Lausgrundwasser West	11/05/21	29/05/21	27/06/21	06/08/21	31/08/21
6	Großenzersdorfer Arm-Nord	–	17/05/21	27/06/21	06/08/21	31/08/21
II.	**Obere Lobau**					
7	Oberleitner Wasser	09/05/21	17/05/21	27/06/21	25/07/21	31/08/21
8	Panozzalacke/Fasangartenarm	03/05/21	14/05/21	10/06/21	19/07/21	18/08/21
9	Dechantlacke	03/05/21	14/05/21	10/06/21	19/07/21	18/08/21
III.	**Mühl-/Schillerwasserbereich**					
10	Mühl-/Tischwassergebilde	05/05/21	17/05/21	16/06/21	21/07/21	19/08/21
11	Oberes Mühlwasser/W Lobaugasse	05/05/21	17/05/21	16/06/21	21/07/21	19/08/21
12	Oberes Mühlwasser/W Biberhaufenweg	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
13	Oberes Mühlwasser/W Binsenweg	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
14	Oberes Mühlwasser/W Tamariskengasse	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
15a	Oberes Mühlwasser/W Kanalstraße - Ost	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
15b	Oberes Mühlwasser/W Kanalstraße - West	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
16	Oberes Mühlwasser/N A23	05/05/21	20/05/21	16/06/21	21/07/21	19/08/21
17	Alte Naufahrt	05/05/21	17/05/21	16/06/21	19/07/21	19/08/21
18a	Schillerwasser	05/05/21	20/05/21	16/06/21	19/07/21	19/08/21
18b	Großes Schilloch	05/05/21	20/05/21	16/06/21	19/07/21	19/08/21
18c	Gewässer SW Kierschitzweg	05/05/21	20/05/21	16/06/21	19/07/21	19/08/21
18d	Kleines Schilloch	05/05/21	20/05/21	16/06/21	19/07/21	19/08/21
IV.	**Wien Nord**					
19	Transportbetonteich	–				
20	Meiergrube	09/05/21	12/05/21	20/06/21	25/07/21	28/08/21
21	Biotop Rautenweg	10/05/21	12/05/21	20/06/21	25/07/21	28/08/21
22	Badeteich Hirschstetten	11/05/21	12/05/21	20/06/21	25/07/21	28/08/21
23	Himmelteich	12/05/21	12/05/21	20/06/21	25/07/21	28/08/21
24	Krcalgrube 1	13/05/21	29/05/21	-	-	-
25	Krcalgrube 2	14/05/21	29/05/21	-	-	-
26	Russwasser	15/05/21	29/05/21	-	-	-
27	Paischerwasser	16/05/21	29/05/21	-	-	-
28	Schönungsteich	17/05/21	18/05/21	20/06/21	25/07/21	28/08/21
48	Badeteich Süßenbrunn	18/05/21	12/05/21	-	-	-
V.	**Alte Donau**					
29a	Untere Alte Donau - Arm östlich Gänsehäufel	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21

29b	Untere Alte Donau - Arm westlich Gänsehäufel	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21
29c	Kaiserwasser	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21
30b	Obere Alte Donau	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21
31	Irissee	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21
VI.	**Donauinsel/Prater**					
32	Schwalbenteich	03/05/21	-	-	-	-
33a	Hüttenteich Nord	03/05/21	14/05/21	10/06/21	15/07/21	18/08/21
33b	Hüttenteich Süd	03/05/21	14/05/21	10/06/21	15/07/21	18/08/21
34	Tritonwasser	23/04/21	20/05/21	03/06/21	30/06/21	02/08/21
35	Endelteich	09/05/21	29/05/21	-	-	-
50	Phönixteich	09/05/21	29/05/21	20/06/21	-	-
36a	Lusthauswasser	03/05/21	10/05/21	10/06/21	15/07/21	18/08/21
36b	Mauthnerwasser	03/05/21	10/05/21	10/06/21	15/07/21	18/08/21
37	Krebsenwasser	03/05/21	10/05/21	10/06/21	15/07/21	18/08/21
VII.	**Wien Süd**					
38	Butterteich	27/04/21	13/05/21	09/06/21	15/07/21	11/08/21
39	Blauer Teich	27/04/21	13/05/21	09/06/21	15/07/21	11/08/21
40a	Teichkette 3	27/04/21	13/05/21	-	-	-
40b	Teichkette 2	27/04/21	13/05/21	-	-	-
40c	Teichkette 1	27/04/21	13/05/21	-	-	-
40d	Filmteich WIG74	27/04/21	13/05/21	-	-	-
41a	Seerosenteich West	27/04/21	13/05/21	-	-	-
41b	Seerosenteich Ost	27/04/21	13/05/21	-	-	-
41c	Schwanensee	27/04/21	13/05/21	-	-	-
42	Schilfteich	27/04/21	13/05/21	-	-	-
43a	Wienerbergteich	27/04/21	19/05/21	09/06/21	15/07/21	11/08/21
43b	Großer Lehmteich	27/04/21	19/05/21	-	-	-
43c	Stierofenteich	27/04/21	19/05/21	09/06/21	15/07/21	11/08/21
43d	Kastanienteich	27/04/21	19/05/21	09/06/21	15/07/21	11/08/21
44a	Buttingerteich	27/04/21	19/05/21	-	-	-
44b	Bendateich	27/04/21	19/05/21	-	-	-
45	Steinsee	-	-	-	-	-
46a	Wienerbergerteich	-	-	-	-	-
46b	Heideteich	-	-	-	-	-
47	Teich im Rückhaltebecken Inzersdorf	27/04/21	19/05/21	10/06/21	21/07/21	01/09/21
49	Rückhaltebecken Auhof	10/05/21	30/05/21	29/06/21		
VIII.	**Neue Territorien (ornitho.at)**					
51	Donauinsel/S Reichsbrücke					
52	Neue Donau/S Panozzalacke					
53	Donauinsel/N Windpark					
54	Donauinsel/Blutpretschen-Insel					

Appendix II

a = total area of reed beds (m²) – b = largest continuous area of reed bed (m²) – c = total circumference of reedbed (m) – d = shape total reed bed; n/a = not applicable

orange = cancelled water bodies – green = permanently visited water bodies

	Territories						Water Body Parameters							
				study	ornitho	total	a		b		c		d	
ID	1995-1998	2002	2006	2021	2021	2021	2006	2021	2006	2021	2006	2021	2006	2021
1a	1-3	3	0	1	0	1	169000	89534	151000	36742	24099	10849	0.14	0.12
1b	-	-	0	0	0	0	14000	2706	11000	2045	2041	353	0.15	0.13
2	1-2	3	1-2	0	0	0	92000	59654	91000	26348	7026	6923	0.08	0.12
3	3-6	3	1	0	0	0	n/a	45321	n/a	16302	n/a	8329	n/a	0.18
4	0-1	0	0	0	0	0	n/a	29377	n/a	15508	n/a	3551	n/a	0.12
	?	?	?	0	0	0								
5a	1	-	0	0	0	0	n/a	30042	n/a	15711	n/a	4539	n/a	0.15
5b	0-1	-	0	0	0	0	n/a	22909	n/a	10082	n/a	4011	n/a	0.18
5c	0	-	0	0	0	0	n/a	10299	n/a	8816	n/a	860	n/a	0.08
6	1	1	0	0	0	0	2000	1414	2000	677	203	396	0.10	0.28
7	1	2	1-2	0	1 - 2	1 - 2	73000	67840	73000	54024	5665	6307	0.08	0.09
8	1	2	2	1	1	1	57000	39335	57000	31706	3653	4449	0.06	0.11
9	1	1	0	0	0	0	3000	3221	2000	3267	631	637	0.21	0.20
10	2-5	4	4-6	3 - 4	3 - 4	3 - 4	53000	48235	14000	12400	5697	4691	0.11	0.10
11	1-2	1	1	0	0	0	9000	9375	3000	3709	3021	2231	0.34	0.24
12	1	2	1-2	1	1	1	6000	6732	4000	1696	2034	1803	0.34	0.27
13	0-1	1	0-1	1	1 - 2	1 - 2	6000	8327	3000	3015	1366	1583	0.23	0.19
14	1	1	0	0 - 1	0	0 - 1	3000	5145	2000	1299	1439	1459	0.48	0.28
15a	0	-	1	1 - 2	0	1 - 2	n/a	4220	n/a	1887	n/a	1367	n/a	0.32
15b	0	-	?	0	0	0	4000	5295	4000	2263	2000	725	0.50	0.14
16	1	1	1	0	0	0	11000	18923	3000	5636	3560	3123	0.32	0.17
17	1-2	1	1	1	1	1	3000	5839	2000	1655	1440	1787	0.48	0.31
18a	1-2	2	0	1	1 - 2	1 - 2	8000	3433	2000	683	3759	1681		0.49
18b	?	?	?	1	0	1		1803		802		509	0.47	0.28
18c	0	0	0	1	0	1	560	3333	200	3327	374	356	0.67	0.11
18d	0	0	0	0	0	0	2000	1943	2000	597	538	610	0.27	0.31
19	1-2	2	2	0	1	1	10000	1673	1000	146	3556	1803	0.36	1.08
20	1	0	1	0	0	0	6000	832	6000	789	629	329	0.10	0.40
21	1	1	1	1	0	1	11000	5535	9000	3472	1508	1362	0.14	0.25
22	1	0	0	0	0	0	2000	441	1000	132	885	389	0.44	0.88
23	1	1	2	1	1	1	11000	9839	8000	9839	1860	2013	0.17	0.20
24	1	1	0-1	0	0	0	1000	637	700	324	1227	354	1.23	0.56
25	1	0	1-2	0	0	0	1000	667	400	102	727	756	0.73	1.13
26	1	0	0	0	0	0	700	297	600	55	696	300	0.99	1.01
27	0	-	0	0	0	0	700	259	300	173	557	203	0.80	0.78
28	0	-	0	0	0	0	1400	4903	1200	1206	403	2454	0.29	0.50
29a	4-6	2	1	1	1	1 - 2	17000	14000	9000	5234	4209	4785	0.25	0.34
29b	?	?	?	1	1	1		8392		1130		3409		0.41

29c	?	?	?	0	0	0		1357		177		983		0.72
	?	?	?	-	0 - 1	0								
30	-	-	0-1	1 - 2	1 - 2	1 - 2		6123		1305		2516		0.41
31	1	0	0	1	1	1	9000	7433	9000	4483	2484	2594	0.28	0.35
32	0	-	0	-	0	0	1000	82	700	82	260	101	0.26	1.23
33a	0	-	0	0	0	0	300	1467	200	1467	157	263		0.18
33b	0	-	0	0	0	0		982		982		146	0.52	0.15
34	1-2	1	0	0	0	0	800	3897	400	1688	384	1341	0.48	0.34
35	1	0	0	0	0	0	8000	22	6000	22	1355	29	0.17	1.32
36a	1	0	0-1	1	1	1	12000	14198	6000	6538	2769	2198		0.15
36b	?	?	?	0	0	0		19086		17183		1528	0.23	0.08
37	0	-	0	0	0	0	300	4672	300	4672	168	533	0.56	0.11
38	0-1	0	0	0	0	0	2000	1485	1000	1387	764	484	0.38	0.33
39	1	0	0	0	0	0	1800	595	1300	248	516	321	0.29	0.54
40a	0	-	0	-	0	0	300	174	100	94	266	187	0.89	1.07
40b	0	-	0	-	0	0	600	822	300	774	183	228	0.31	0.28
40c	0	-	0	-	0	0	100	199	70	157	102	122	1.02	0.61
40d	0	-	0	-	0	0	200	0	70	0	127	0	0.64	
41a	0	-	0	-	0	0	n/a	121	n/a	120	n/a	59		0.49
41b				-	0	0		548		359		266	n/a	0.49
41c				-	0	0	600	63	300	30	395	98	0.66	1.56
42	0	-	0	-	0	0	800	522	80	522	308	185	0.39	0.35
43a	1-2	1	1-3	1 - 3	0	1 - 3	8000	14540	4000	3493	3564	3832	0.45	0.26
43b	-	-	0	-	0	0	200	359	200	359	111	177	0.56	0.49
43c	0	-	0-1	0	0	0	1000	1172	500	915	648	799	0.65	0.68
43d	1	0	0	0 - 1	0 - 1	0 - 1	2000	3149	2000	1858	1084	1086	0.54	0.34
44a	-	-	0	-	0	0	2000	995	1000	995	475	360	0.24	0.36
44b	-	-	0	-	0	0	1000	147	200	76	82	128	0.08	0.87
45	0	-	0	-	0	0	2000	2372	2000	2261	301	358	0.15	0.15
46a	1-3	-	1-2	-	0	0	5000	3895	2000	1494	2239	1617	0.45	0.42
46b	-	-	0	-	0	0	4000	6087	4000	3185	1578	2377	0.39	0.39
47	0	-	0	0	0	0	2000	1587	2000	747	685	444	0.34	0.28
48	-	-	-	-	0	0	n/a	818	n/a	641	n/a	270	n/a	0.33
49	-	-	-	-	0	0	n/a	64608	n/a	15705	n/a	4969	n/a	0.08
50	-	-	-	-	0	0	n/a	2298	n/a	1747	n/a	615	n/a	0.27
51					1		n/a	425	n/a	345	n/a	139	n/a	0.33
52					1		n/a	48	n/a	48	n/a	36	n/a	0.75
53					1		n/a	3565	n/a	1676	n/a	917	n/a	0.26
54					1 - 2		n/a	7118	n/a	6045	n/a	1791	n/a	0.25