Research Article

An update on the known distribution and status of the coypu (*Myocastor coypus*) in Austria

Anna Schertler* and Franz Essl

BioInvasions, Global Change, Macroecology-Group, Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, 1030 Vienna, Austria

**Corresponding author*

E-mail: *anna.schertler@univie.ac.at*

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Abstract

The coypu is a semiaquatic rodent, native to South America and introduced to many parts of the world, mainly due to fur farming and as zoo animal. Nowadays, it is widely distributed in Europe, forming many invasive populations; thus, the species is listed as being of European Union concern according to the EU invasive alien species regulation. Here, we provide an update on the known status and distribution of the coypu in Austria since Spitzenberger (2001), presenting known occurrence records and additionally hunting bag data from the federal state of Styria. We derived 197 spatially explicit records, ranging from 1930 to 2021 and covering all nine federal states of Austria. Currently, the coypu is established in at least three federal states (Burgenland, Lower Austria, Styria) and probably also in Vorarlberg, with its main distribution in the lowlands of eastern to south-eastern Austria. We show a significant relationship between annual fluctuations in hunting bag data and the preceding winter temperatures suggesting that harsh winters might have a regulatory effect on Austrian coypu populations. Further, we emphasize the importance of monitoring and field surveys, not only for a detailed assessment of its distribution, but also to clarify potential metapopulation dynamics with occurrences in neighbouring countries. This is essential for future management, especially in the light of its declaration as invasive alien species of European Union concern.

Key words: biological invasions, species distribution, invasive alien species of Union Concern, mammal, nutria, rodent

Introduction

The negative economic and environmental implications of human-assisted species introductions outside their native range (i.e. alien species) are increasing, as a consequence of globalisation and rapid intensification of interconnectedness (Seebens et al. 2017; IPBES 2019). The coypu, *Myocastor coypus* (Molina, 1782), is a large semiaquatic rodent that originates from subtropical and temperate South America and inhabits slow-flowing or standing water bodies, wetlands, swamps and lakes (Woods et al. 1992). It was widely introduced since the 19th century – now being invasive in many regions in Asia, Europe and Northern America (Carter and Leonard 2002; Schertler et al. 2020; Pedruzzi et al. 2022). Reported impacts comprise damage on crops (Panzacchi et al. 2007) and natural vegetation (Baroch et al. 2002; Prigioni et al. 2005; Baker 2006; Meyer and Beatty 2006; Vossmeyer et al. 2016), the undermining of flood protection structures, river banks and dykes (Walther et al. 2011; Harvey et al. 2019), and damaging of wetland bird nests (Bertolino et al. 2011; Angelici et al. 2012) or feeding on native mussels (Nagayama et al. 2020). Fur farming was the primary incentive for the species' import, and the abandonment of fur farms, low hunting pressure due to decreasing market value, combined with mild winters and a scarcity of natural predators, allowed for rapid population increase after escapes or deliberate releases (Carter and Leonard 2002). Harsh winters and freezing events are thought to be a main limiting factor in temperate regions (Gosling and Baker 1989; Doncaster and Micol 1990; Baker 2006; Hilts et al. 2019), nevertheless populations in many areas have strongly increased in the last years (e.g., Greiser et al. 2018; Bonnet et al. 2021).

Schertler et al. (2020) analysed the coypu's distributional patterns across Europe from 1980 to 2018 and, by modelling its potential distribution, found that the coypu is likely to spread further, as many suitable areas remain unoccupied by now. In the past decades, established wild populations occurred in at least 20 European countries (Schertler et al. 2020), and so far only in Great Britain did an eradication program prove successful (Gosling and Baker 1989). The coypu has been listed as invasive alien species of Union Concern (EU Commission 2016), associated with the EU regulation on invasive alien species (EU Commission 2014). Therefore, EU Member States should prevent its spread and implement strategies for early detection, management, or eradication.

The last detailed account on the distribution and status of the coypu in Austria was provided by Spitzenberger (2001). Coypu farms were known to exist since the 1930s, with consequent occasional reports of free-ranging individuals, probably escapees. With the decline of fur farming in the 1980s, larger numbers of animals were released, and sightings became more frequent, especially in the eastern and southern Austrian lowlands, as well as the Austrian Rhine Valley in the west (Spitzenberger 2001).

In this work, we update the distribution of the coypu in Austria and focus on the distributional changes that have taken place in the last two decades. We present a map, depicting spatially explicit records and provide the according occurrence dataset in the Supplementary Material. We further give a textual overview for the nine federal states and compare our findings with the situation in neighboring countries. Moreover, using annual hunting bag data from the Styrian district Leibnitz as a proxy for abundance, we test if winter temperatures are able to explain temporal fluctuations.

Materials and methods

We have done an extensive data compilation of Austrian records of the coypu, by retrieving occurrence records from i) scientific and grey literature, ii) biodiversity platforms, iii) research and conservation institutions and hunting organizations, iv) personal observations, reports from other scientists and citizens. In 2017 and 2018, requests for information on coypu occurrences were sent to a variety of stakeholders (museums, regional hunting associations, national parks, fishing associations, and research institutions) and a public call for citizen's observations was made. This research effort was part of the preparatory work for a previous modelling study (Schertler et al. 2020), as a comprehensive georeferenced dataset was completely lacking for Austria, despite reports of its long presence (see Spitzenberger 2001). Building on this work, we restructured and continuously updated this dataset in subsequent years by adding newly derived records. We also expanded the regarded time span to cover the complete invasion history of the coypu in Austria. In May 2021, we contacted responsive stakeholders again, requesting information about the coypu's status in the respective areas. Moreover, occurrence records were derived from the Austrian biodiversity platform naturbeobachtung.at (Naturbeobachtung.at 2021) and additionally, we downloaded all Austrian occurrences of *M. coypus* from the Global Biodiversity Information Facility (GBIF; GBIF.org 2021), as well as research grade iNaturalist observations (www.inaturalist.org), that were not yet represented through GBIF. District-wise hunting bag data (shot individuals and road kills) from 2005 to 2021 were provided by the Styrian hunting association (Steirische Landesjägerschaft *unpubl. data*). Note, that hunting bag data represents hunting years, which cover the period from April to next year's March.

An occurrence record is defined as the existence of a particular quantity (individual/s, population) of the species at a particular place at a particular time and represents either a single event (observation) or a time span for which occurrence was reported. Occurrence records that did not initially include coordinate information were georeferenced by interpretation of the textual information provided, using the recommendations of Chapman and Wieczorek (2020) as a guideline. We either assigned coordinates and an approximate associated coordinate uncertainty radius or a spatial shape (e.g., a district). All records were transformed to the same spatial reference system (EPSG: 3416 Austria Lambert). The certainty of each record was judged using criteria adapted from Molinari-Jobin et al. (2012): 1 Verified direct records (carcasses, kills, photos); 2 Confirmed data; a) indirect records (feces, tracks, hair) or b) Not verifiable direct or indirect records from experts or skilled personnel (judged as plausible); 3 Not verifiable direct or indirect records from other sources (judged as plausible). Probable escapees (captive animals; described or suspected as escaped from zoos/farms/wildlife parks/breeders/etc. by the source and/or the editor) were flagged and duplicated records removed. The derived records were mapped, and spatiotemporal patterns depicted. Temporal, spatial and occurrence information for the records is given in the Supplementary material (Table S1).

Using a negative binomial regression, to account for overdispersion in our count data, we tested whether fluctuations in the total adjusted annual hunting bag between 2005/06 to 2020/21 could be explained by winter temperatures (average air temperature from December to February of the previous hunting year), the previous year's total adjusted hunting bag as lagged copy of the response and the interaction term of those. We used hunting bag statistics from the district of Leibnitz in Styria, as this currently represents the longest available time series on coypu counts in Austria (2005/06 to 2020/21). Temperature data from the two nearest weather stations ("Graz–Universität" and "Bad Gleichenberg") available on HISTALP (Auer et al. 2007) were derived and averaged. We assume that hunting bag data is a reasonable proxy for population size, as in Styria the coypu can be hunted all year round with no limiting quotas (§59 (2) Stmk LGBl. 23/1986). Due to the territorial hunting system implemented by the state hunting laws (e.g., Stmk LGBl. 23/1986), where the practical right to hunt is bound to hunting areas, the number of hunters in a given area remains rather stable over time. Nevertheless, in order to take into account fluctuations in the number of hunters (e.g., due to administrative changes in the hunting district), we adjusted the hunting bag data by including the number of hunting licenses issued annually as offset variable.

Data manipulation, analyses and visualisation were done in R V.4.0.5 (R Core Team 2021) and RStudio V.1.4.1103 (RStudio Team 2021) using ggplot2 (Wickham 2016), MASS (Venables and Ripley 2002), raster (Hijmans 2020), sf (Pebesma 2018) and the tidyverse package collection (Wickham et al. 2019).

Results

We derived 197 spatially explicit occurrence records; 190 point records represented by coordinates, and hunting bag data representing seven districts in Styria. The dataset spans the time from 1930 to 2021 and covers all nine federal states of Austria. The main distribution is in the lowlands of eastern to south-eastern Austria and the Rhine Valley in the west (Figure 1). Most point records are from Lower Austria (60), Styria (43) and Burgenland (39), notably often clustered in areas of well-known established populations. Fourteen records were explicitly associated with captive animals that presumably escaped from fur farms or wildlife parks. The temporal distribution of records (Figure 2) shows a strong increase within the past decades, with about 70% of records associated with the period from 2010 onwards. Whereas early records were mainly reported in Salzburg and Upper

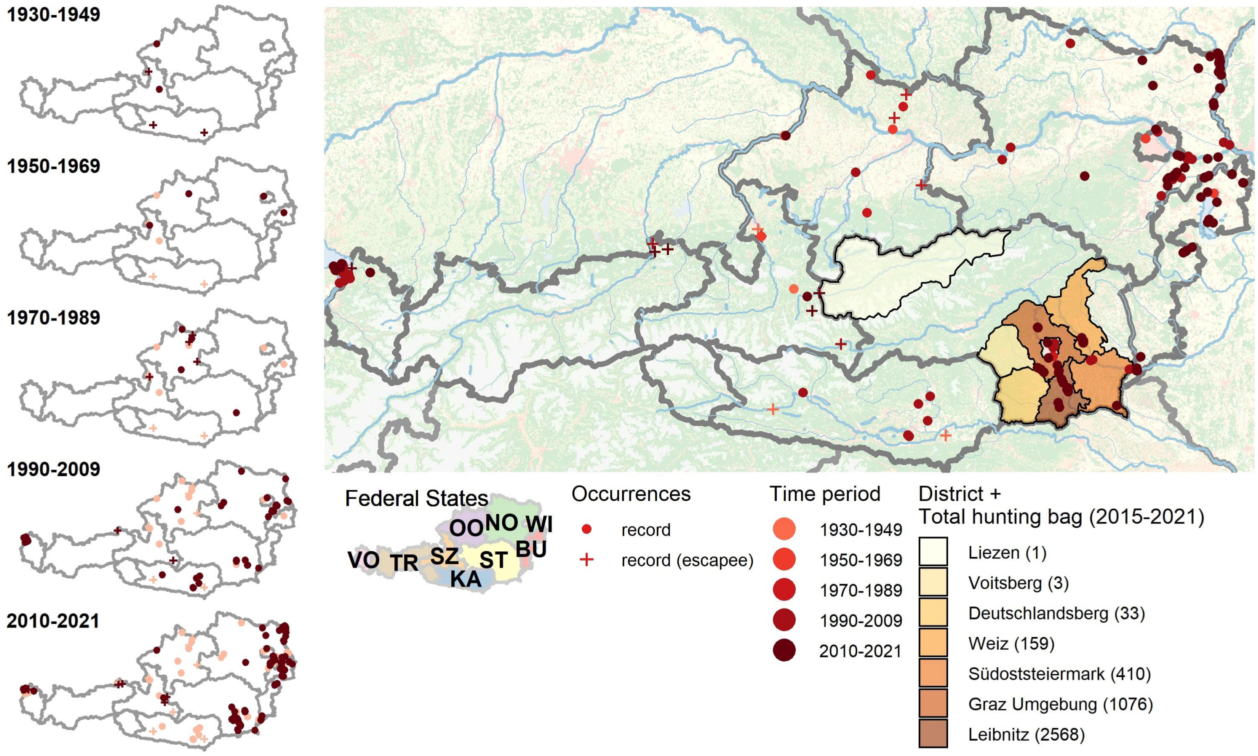

Figure 1. Spatiotemporal distribution of coypu occurrences (n = 197) in Austria from 1930 to 2021. Right: Overview map, showing all records. Data is either associated with a coordinate point (n = 190) or an administrative area (here 7 Styrian districts). Districts are coloured according to the total hunting bag (2015/16–2020/21). Records, explicitly associated with an escaped animal, are indicated by a cross. Federal states of Austria: BU = Burgenland, KA = Carinthia, NO = Lower Austria, OO = Upper Austria, TR = Tyrol, ST = Styria, SZ = Salzburg, WI = Vienna, VO = Vorarlberg. Left: Temporal accumulation of records for point data (n = 190) within 20-year periods. Please note that the last period is incomplete and comprises only eleven years. Red points represent records that fall in the respective time period (either a single date or the start of a time span), while light points indicate records of former periods. Please note, that not all occurrences displayed in Spitzenberger (2001) could be derived.

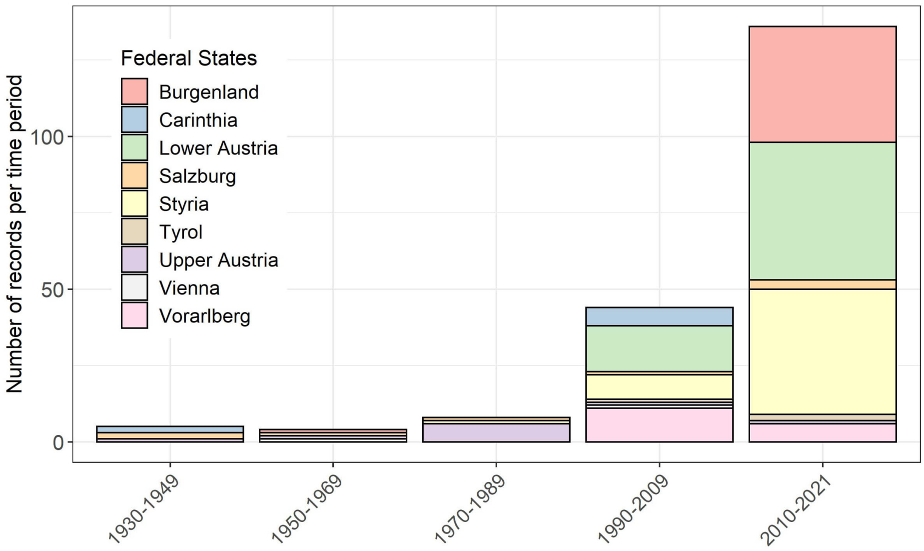

Figure 2. Temporal distribution of records in 20-year time periods (n = 197) coloured after federal state. Please note that the last period is incomplete and comprises only eleven years.

Austria, recent records mostly originate from Burgenland, Lower Austria, Styria, and Vorarlberg (Figures 1, 2).

Currently, the coypu is established in at least three federal states (Burgenland, Styria, Lower Austria) where it is also reported to cause damages

Table 1. Overview on the coypu's status in the nine Austrian federal states. Established = long-term persistence supported by verified direct records; Probably established = probable long-term persistence, but lack of verified direct records; probably absent/casual = occasional sightings, eventually escaped captive individuals, no reports of longer persistence; absent = no sightings or reports of free-living populations in the past decades. Year of last non-captive record (and/or escapee record in parentheses if more recent). Additional information is given on anecdotal reports of reproduction and damages (agricultural and/or river embankments/flood protection structures).

Federal state	Currrent reports (2015–2021)	Year of last record	Status	Reproduction reports	Damage reports
Burgenland	Yes	2021	established	yes	yes
Carinthia	No	1996	absent	yes	–
Lower Austria	Yes	2021	established	yes	yes
Upper Austria	No	2011	probably absent/casual	yes	–
Salzburg	Yes	2014(2018)	probably absent/casual	–	–
Styria	Yes	2021	established	yes	yes
Tyrol	No	– (2014)	probably absent/casual	–	–
Vorarlberg	Yes	2021	unclear; probably established	yes	yes
Vienna	No	1998	absent	yes	–

locally (agricultural, e.g., in corn fields, and along riverbanks) when occurring at high abundances (Schertler A. *pers. observation*; Steirische Landesjägerschaft *pers. comm.*) (Table 1). In Vorarlberg, occasional sightings exist in the Rhine Delta at Lake Constance, but due to the anecdotal (non-verifiable) nature of those records, we currently only classify the species as "probably established". For all federal states except Carinthia and Vienna, the last record available fell into the past decade. Notably, all records from Tyrol are classified as escapees.

Hunting bag data from Styria shows no pronounced increase in the total hunting bag (shot individuals + roadkills) over the recorded years (i.e., Leibnitz: 2005/06 to 2020/21; for the other districts from 2015/16 to 2020/2021) (Figure 3). In seven districts of Styria at least one individual was reported, with the highest counts being from Leibnitz, followed by Graz Umgebung and Südoststeiermark. Since the inclusion of the coypu in the state hunting law and subsequent mandatory reporting of hunting bag numbers, the total hunting bag for Styria amounted on average 708 (sd ± 82.3) individuals annually (Steirische Landesjägerschaft, *unpubl. data*). We found a significant positive effect of the previous hunting year's average winter temperature (December to February) and the adjusted hunting bag count of the previous hunting year on the adjusted annual hunting bag count for the district of Leibnitz (Table 2). There was a negative interaction effect of both predictors, meaning that the strength of the effect of one predictor changes with the other, i.e., with higher adjusted hunting bag in the previous hunting year the effect of winter temperatures gets less pronounced and vice versa. The model explained 48.2% of deviance in the data.

History and situation in the nine federal states:

Burgenland: The earliest individual record dates back to 1961 (NHM Vienna; specimen ID 35557), when a dead coypu was found in a fish trap, at Lake Neusiedl. Although no explicit records are available for

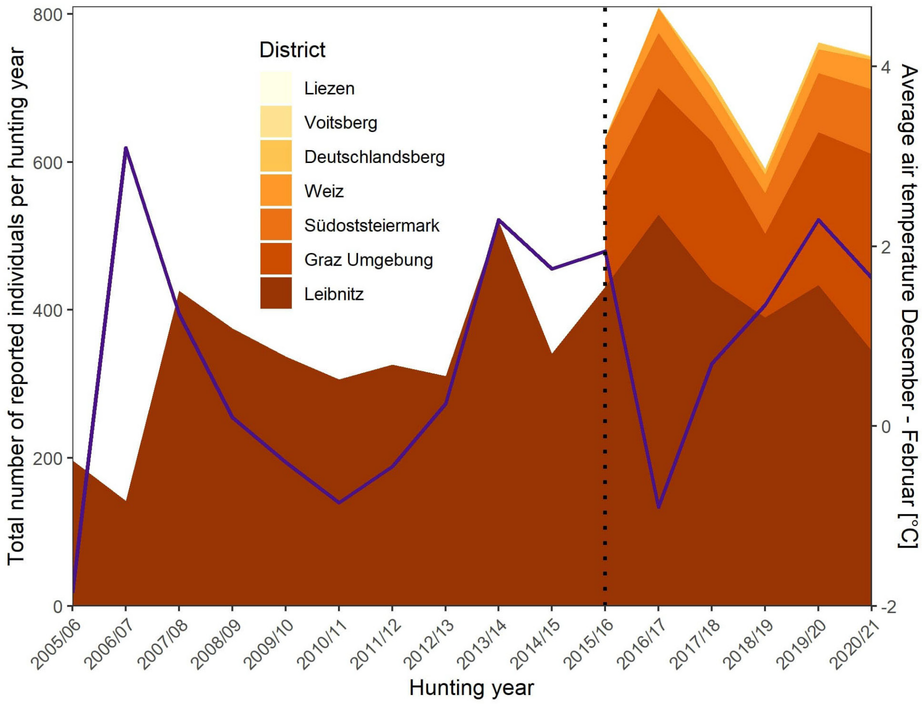

Figure 3. Temporal changes in the total number of reported individuals per hunting year for seven Styrian districts (left y-axis). The blue line represents the average air temperature from December to February (averaged values from the weather stations "Graz-Universität" and "Bad Gleichenberg" (Auer et al. 2007; HISTALP data)); right y-axis. The vertical dashed line represents the inclusion of the coypu in the Styrian hunting law. Note, that for Leibnitz coypu management took place since 2005/06 and hence a longer time series of hunting bag data is available.

Table 2. Results of the negative binomial regression (link = log) relating adjusted annual hunting bag data from 2005/06–2020/21 (N = 15) to the previous year's winter temperature (average air temperature from December to February), the previous year's hunting bag and the interaction of both. The number of hunting licenses issued annually was included as offset variable. Significance levels: *** $p < 0.001$ – highly significant; ** $p < 0.01$ – very significant; * $p < 0.05$ – significant. Null Deviance = 31.24. Residual Deviance = 15.07. Theta = 36.5.

	Estimate	z-value	p	
intercept	4.8094	21.249	< 0.001	***
winter temperature (y-1)	0.3768	4.038	< 0.001	***
adjusted hunting bag (y-1)	0.0026	2.706	0.0068	**
winter temperature (y-1):hunting bag (y-1)	−0.0014	-3.240	0.0012	**

the decades after, from the 2010s onwards, reports were increasing. Sightings are regularly made in the areas around Lake Neusiedl (e.g., "Biologische Station Illmitz", "Warmblutpferdekoppel/Illmitzer Seewäldchen" and at the Northern parts of the lake), and along the river Leitha, which forms the border between Burgenland and Lower Austria. There, a fed population is known from the vicinity of Bruck a.d. Leitha/Bruckneudorf (Schütz B. *pers. comm.*).

Carinthia: The first sightings of escaped individuals date back to 1935 (Spitzenberger et al. 1996). It could not be confirmed whether free-living populations in the Klagenfurt basin, mentioned by Spitzenberger et al. (1996), still exist and no recent occurrence records were derived.

Lower Austria: Although the first mentioning of coypu farming dates back to 1930 (Spitzenberger 2001), explicit occurrence records in the wild are only available from the 1990s, to the best of our knowledge. Current populations are known from the Vienna basin along the rivers Leitha (shared with Burgenland) and Fischa, and more recently from the Morava (germ.: March) and the Morava-Thaya confluence at the border to Slovakia and the Czech Republic. Recently, multiple sightings were made also in the Danube floodplains (Donau-Auen National Park).

Salzburg: Records of single or few escaped individuals date back to the early days of coypu farming in the 1930s, when small coypu farms existed in Salzburg (Stüber et al. 2014). Although those occasional escapees were apparently able to survive in the wild for some time, no wild populations established. The few reports of the past decades are associated with single individuals, probably escaped captive animals (Biodiversitätsdatenbank Salzburg; Haus der Natur 2021).

Styria: Since the 1980s records exist from Graz and the Mur valley south of Graz. Currently feral populations are found along the Mur (districts Graz Umgebung and Leibnitz, Südoststeiermark), in the district Weiz (along the river Raab, e.g., Gleisdorf and surrounding areas; Raith K., *pers. comm.*), and Deutschlandsberg (at the Lahn and Kainach, Griessner F., *pers. comm.*). Due to agricultural and riverbank damages, coypu populations in Leibnitz were already managed since 2005 (Sirowatka K. *pers. comm.*) and by 2015 the coypu was integrated into the state hunting law of Styria (Stmk LGBl. 23/1986). Since then, the total hunting bag for Styria amounted on average 708 (sd ± 82.3) individuals annually (Steirische Landesjägerschaft *unpubl. data*), with the majority of reports coming from Leibnitz.

Tyrol: Only few occasional sightings of single individuals are reported, notably, all from the Lower Inn Valley at the border to Bavaria, Germany (Smettan 2014). Those are probably due to escapes from wildlife parks or breeders; no persisting wild populations are known.

Upper Austria: Currently, there are no known free-living permanent coypu populations in Upper Austria (Plass J. *pers. comm.*), despite its long history of coypu breeding. Feral populations in Upper Austria ("Danube at Ottensheim, Traun, Ybbs") mentioned by Spitzenberger (2001) could not be reconfirmed. The only report from Ottensheim dates to 1954 and is associated with a single individual (Plass 2022). A single record at the river Inn (German-Austrian border) in 2011 (GBIF.org 2021) is the only record that could be derived since the mid-90s.

Vienna: A tame fed colony settled in the Schwarzenbergpark from the 1960s to 1980s (Spitzenberger 2001). One observation was made in

1998 at the Marchfeldkanal (Rückhaltebecken Schwarzlackenau), at the border to Lower Austria (NHM Vienna, *unpubl. data*). Despite recent sightings in the Danube area south of Vienna, no current occurrences are known within the city area itself. One record from 2017 at the northern border of the city area is lacking photodocumentation and therefore unverified.

Vorarlberg: Since the 1990s sightings were made occasionally in the Rhine valley (especially at the Rhine Delta (Lake Constance) and the Rhine) and a small population close to the Swiss border was managed between 1996–2000 (13 individuals shot; Vorarlberger Jägerschaft *pers. comm.*). Unfortunately, recent records are of anecdotal nature only.

Discussion

Despite a long history of coypu farming in many Austrian regions, which has led to recurrent escapes in several federal states (Spitzenberger 2001), the coypu is predominately found in the eastern and southeastern Austrian lowlands and in the Rhine valley in the far most west. Compared to Spitzenberger (2001), the known distribution of the coypu apparently expanded in several regions (e.g., northeastern Lower Austria, in Burgenland at the Lake Neusiedl area and in southeastern Styria) whereas some formerly reported regions of occurrence could not be reconfirmed (e.g., in Carinthia and Upper Austria).

The reported distribution rather closely reflects climatic suitability as only low-lying areas in Austria provide suitable conditions for the coypu (Spitzenberger 2001; Schertler et al. 2020). The essential role of climate—particularly winter temperatures—for the distribution and abundance of the coypu at its cool range margin is also evidenced by the association of low winter temperatures in the preceding winter with hunting bag data in the district of Leibnitz, Styria. Assuming that the hunting bag data derived is a reasonable proxy for abundance—given the Austrian hunting system and shooting regulations for coypu—this is in line with general literature describing cold temperatures as the main limiting factor for coypu populations (Gosling and Baker 1989; Doncaster and Micol 1990; Reggiani et al. 1995; Carter and Leonard 2002; Guichón et al. 2003). Austrian climate has already considerably warmed in the last decades (Auer et al. 2007; Gobiet et al. 2014) and valleys in the Alps are predicted to become more suitable for the coypu (Schertler et al. 2020). Apart from on-going niche filling, this is likely to be an important factor for the recent expansion of the known distribution of the coypu compared to the overview provided by Spitzenberger (2001).

As harsh winters might be less frequent in the future (IPCC 2018; Lorenz et al. 2019), further increases in population size and range can be expected. Hunting bag data for Germany shows a strong increase within the past years, with more than 50,000 shot individuals in 2017/18 (Greiser et al. 2018). Similarly, in Pays de la Loire (Western France) the number of coypus removed per trapper annually, increased by 22% (Bonnet et al. 2021), reaching about 230,000 individuals in 2016. Besides mild winters, insufficient management, favorable conditions in urban areas (e.g. through feeding and thermal pollution) and increased accessibility of resources, are considered main causal factors for population growth (Walther et al. 2011; Greiser et al. 2018). Consequently, besides trapping and shooting, public education and feeding bans could be additional management measures, especially in urban areas, where management of charismatic alien species often proves difficult (Walther et al. 2011; Jarić et al. 2020).

Considering the EU regulation on invasive alien species and the fairly wide distribution of the coypu in many parts of Europe (Tsiamis et al. 2017; Schertler et al. 2020; Tedeschi et al. 2022), international harmonization of monitoring and management is essential, especially to tackle cross-border populations and prevent hampering of management measures, e.g. through re-invasion from adjoining populations spreading from non-managed regions. As semiaquatic animal the coypu spreads along waterways, which often connect different countries or form borders. Notably, many of the recent coypu occurrences are located close to the Austrian border, and, moreover, all neighboring countries (except for Liechtenstein (Broggi 2006)) currently harbor coypu populations (Tsiamis et al. 2017; Schertler et al. 2020). The only recent Upper Austrian record was made at the border to Germany, where the regional occurrence of coypus in Bavaria is evidenced at the Danube and Isar (Scheide 2013; Arnold et al. 2016; Greiser et al. 2018); in the Czech Republic the coypu is widespread (Anděra 2011) and coypus are also reported from Western Hungary and Slovakia (Schertler et al. 2020). It is not clear if and to which extent those populations are connected to the Austrian ones. Such cross-border (meta-)populations should be properly addressed in order to prevent source-sink dynamics that can considerably complicate population management (Prigioni et al. 2005; Oliver et al. 2016).

Importantly, one should keep in mind that this work is based on a variety of different data sources and does not represent a standardized exhaustive field survey. Thus, the coypu might be even more widely distributed than shown in our map. This is supported by the substantial discrepancy of hunting bag counts and the relatively moderate number of reported observations in Styria: since 2015/16 annually on average 708 (sd ± 82.3) individuals for the former vs. 43 records from all other sources combined for the latter. Although those point records also cover longer periods and are partly representative for a whole population, this still indicates that the sole collection of opportunistic records is not sufficient to properly assess the status quo of the coypu. We also take advantage of the—to the best of our knowledge—longest time series on count data available for Austria, providing the first evidence for the significant effect

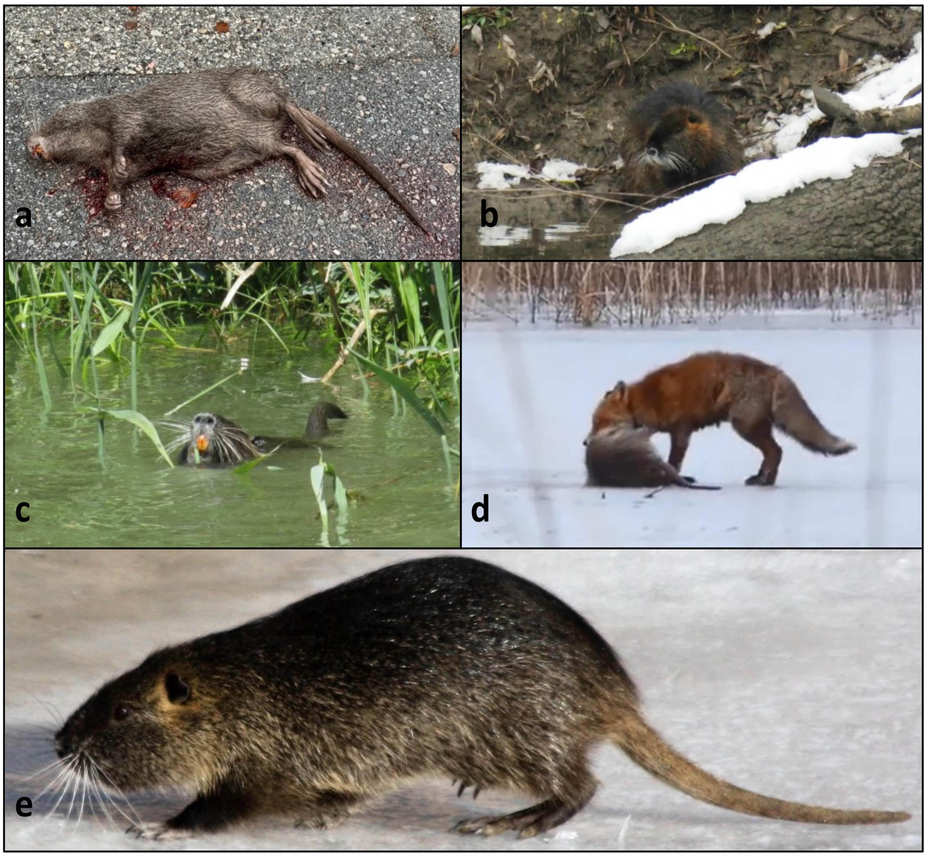

Figure 4. Coypu in Austria. a) roadkill in Ebergassing, Lower Austria, in summer 2019 (© Martens K.); b) coypu at the river Thaya, Czech border, in December 2021 (© Schertler A.); c) a coypu feeds on reed near Regelsbrunn, National Park Donauauen, in July 2021 (© Ruckenbauer N.); d) a fox has successfully preyed on a coypu at Lake Neusiedl in Burgenland, in March 2018 (unknown source) e) coypu walking over frozen river Leitha near Bruckneudorf, Lower Austria/Burgenland, in winter 2017 (© Schütz B.).

mild winters can have on coypu populations in Austria. Although these findings are in line with general literature, our results should be interpreted with caution, due to the relatively small sampling size and the use of hunting data as approximation for population size. The positive relationship between increasing winter temperature and the hunting bag was less pronounced when the hunting bag of the previous year was rather high. This could be due to density effects in the regarded area (e.g. decreased relative reproductive output, increased emigration) (Reeves and Usher 1989; Reggiani et al. 1995), due to hunting capacity limits reached or due to non-linear relationships between hunting bag and population size (i.e. high hunting bag disproportionally decreases the population and results in less individuals that can reproduce). Not only further studies on population dynamics, but also on the interspecific interactions that arise with other semiaquatic mammals (e.g., the European beaver, *Castor fiber*) would improve our understanding on the role of this invasive alien species in Central Europe.

Conclusions

Here, we give the so far most complete update on the distribution and status of the coypu in Austria. We show that population fluctuations are influenced by winter temperatures, and that nevertheless, the coypu seems to expand its range in the Austrian lowlands (Figure 4) – a trend that is likely to accelerate with warming climate. Considering the limitations that come with opportunistic sighting data, our findings may actually even be an underrepresentation of its distribution. This is especially emphasized by the discrepancy of point records vs. hunting bag numbers in Styria. As species of European Union concern, the coypu should be monitored and managed, to prevent its further spread and possible impacts on the native biota should be further evaluated. Proper knowledge of its status quo is essential for successful management, and therefore we emphasize that a standardized national monitoring as well as the clarification of potential meta-population dynamics with coypu populations in neighboring countries is urgently needed. This work can serve as important basis to guide future field surveys to clarify and monitor the distribution of the coypu in Austria.

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Authors' contribution

AS and FE conceived the idea and outlined the study, AS carried out the data collection, visualization and analyses. AS and FE wrote the manuscript.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Occurrence records of the coypu in Austria.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2022/Supplements/BIR_2022_Schertler_Essl_SupplementaryMaterial.xlsx