Possible extinction of the globally threatened Western Hazel Grouse *Tetrastes bonasia rhenana* in Luxembourg

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Zusammenfassung: **Mögliches Aussterben des weltweit bedrohten Westlichen Haselhuhns *Tetrastes bonasia rhenana* in Luxemburg**
Zwischen Ende März und Anfang April 2018 wurde in Luxemburg eine intensive Suche nach dem Westlichen Haselhuhn *Tetrastes bonasia rhenana* durchgeführt. Eine Kernzone von ca. 8.800 ha, welche auf Grundlage von Haselhuhnmeldungen der letzten fünf Jahre (2013-2017) abgegrenzt worden war, wurde flächig bearbeitet und alle darin enthaltenen potenziellen Haselhuhnhabitate nach Hinweisen auf *T. b. rhenana* abgesucht. Des Weiteren wurden in einem ausgedehnteren Gebiet von ca. 42.000 ha, welches einen Großteil der früheren Verbreitung der Art in Luxemburg umfasst, potentiell geeignete Flächen lokalisiert und anschließend abgesucht. Es wurde kein Hinweis auf ein aktuelles Vorkommen des Westlichen Haselhuhns in Luxemburg gefunden. Neuere Meldungen von *T. b. rhenana* betreffen größten Teils wahrscheinliche oder nachweisliche Verwechslungen mit anderen Vogelarten. In Verbindung mit schwerwiegenden Lebensraumdefiziten und dem Fehlen handfester Beweise (Losung, Federn) für ein Vorkommen in jüngerer Zeit, lässt dieses Ergebnis nur einen sinnvollen Schluss: Das Westliche Haselhuhn ist in Luxemburg wahrscheinlich ausgestorben. Dennoch sollte zur Sicherheit zunächst weitergesucht werden. Es werden Vorschläge für weitere Suchen und Monitoring gemacht und Anforderungen an avifaunistisch einwandfreie Nachweise von *T. b. rhenana* in Luxemburg formuliert.

Résumé : **Disparition possible au Luxembourg de la sous-espèce *Tetrastes bonasia rhenana* en danger critique d'extinction.** Une recherche intensive de *Tetrastes bonasia rhenana* a eu lieu entre fin mars et début avril 2018 au Luxembourg. Une région de ca 8.800 ha, délimitée sur base de tous les signalements de la Gélinotte des bois des cinq dernières années (2013-2017), a été entièrement prospectée, tout en recherchant des traces de présence de *T. b. rhenana* dans tous les biotopes potentiellement favorables. Un secteur plus étendu de ca 42.000 ha, incluant l'essentiel de l'aire occupée antérieurement par *T. b. rhenana* au Luxembourg, des biotopes potentiellement favorables furent localisés et examinés par la suite. Aucun indice concernant la présence actuelle de *T. b. rhenana* au Luxembourg n'a pu être trouvé. Des signalements récents de *T. b. rhenana* concernent essentiellement des confusions probables ou certaines avec d'autres espèces. Ce résultat, associé à une inadéquation caractérisée des biotopes et à l'absence de preuves tangibles (fientes ou plumes) lors de recherches et monitorings récents, nous incite à conclure que la population de *T. b. rhenana* est probablement éteinte au Luxembourg. Par précaution, les recherches ne devraient cependant pas encore être abandonnées. Une ligne de conduite pour d'autres actions est proposée. Les exigences concernant des preuves incontestables de présence de *T. b. rhenana* au Luxembourg sont formulées.

Abstract: At the end of March / beginning of April 2018, a two weeks intensive search for Western Hazel Grouse *Tetrastes bonasia rhenana* was carried out in Luxembourg. It comprised the full survey of a core area of c. 8,800 ha, identified from recent Western Hazel Grouse reports (2013-17), in which all potential Western Hazel Grouse habitats were searched in detail for signs of the species' presence. Furthermore, in a wider area of ca. 42,000 ha, representing the core of the former Western Hazel Grouse distribution in Luxembourg, suitable habitat patches were examined closely. No evidence for the continued presence of Western Hazel Grouse in Luxembourg was found. Recent reports of Western Hazel Grouse in Luxembourg largely involve likely or demonstrable confusions with other bird species. This result, combined with major habitat deficiencies and all previous recent surveys failing to produce any hard evidence (droppings, feathers) for the presence of Western Hazel Grouse in Luxembourg, only leaves the conclusion that *T. b. rhenana* is probably extinct in Luxembourg. However, to be on the safe side, surveys should continue for now. Suggestions for further searches and monitoring are made and requirements for sound records of Western Hazel Grouse in Luxembourg are formulated.

The Western subspecies *rhenana* of Hazel Grouse *Tetrastes bonasia*, in the following referred to as Western Hazel Grouse *Tetrastes bonasia rhenana* following Schreiber et al. (2015), is morphologically (Bauer 1960, Glutz v. Blotzheim et al. 1973/1994, Bergmann et al. 1996, Schreiber in press; furthermore: Kleinschmidt 1917, 1941, 1944a, 1944b, 1949, 1952, Keve 1948, Verheyen 1941, 1950, all cited and reviewed in Schreiber et al. 2015), genetically (Nowak et al. 2012; indirectly, also Rozsa 2011) and with regards to habitat selection (Glutz v. Blotzheim et al. 1973/1994, Bergmann et al. 1996, Schreiber et al. 2015) distinct. This means that *T. b. rhenana* is a valid taxon and it differs in these traits from all other subspecies of Hazel Grouse worldwide.

A recent revision of the latest status information on *T. b. rhenana* was made in the frame of an international expert meeting in Bad Dürkheim, Germany, in December 2017. The meeting brought to light that the taxon is critically endangered and faces extinction in its entire global range in France, Belgium, Luxembourg and Germany (Pfeffer in press for the Vosges – the only area where *T. b. rhenana* is currently confirmed to be present with few remaining territories; Pfeffer pers. comm., pers. obs.; Dronneau in press for northern France, Paquet in press for Belgium, Felten & Bastian in press for Luxembourg, Dietzen & Handschuh in press for Germany); according to these authors and to ongoing surveys throughout the range of *T. b. rhenana* that are failing to find the taxon, the figures from regional and national bird atlases and Red Lists that were recently cited by Herkenrath et al. 2017, are outdated and too high (also see Dietzen & Handschuh 2018, Lieser 2015, 2017).

T. b. rhenana is endemic to western Central Europe. Being the most threatened bird taxon in Central Europe and one of the most threatened bird taxa in Europe, *T. b. rhenana* is the taxon of highest conservation concern amongst our birds. The four global range states, namely France, Germany, Luxembourg and Belgium, carry the global responsibility for the survival and conservation of this taxon (Schreiber et al. 2015, Schreiber in press).

Hazel Grouse *T. bonasia* is also listed in Annex I of the Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds which legally binds member states to conserve the species.

During the international expert meeting in Bad Dürkheim it has become obvious, and was therefore unanimously endorsed by all participants, that to save *T. b. rhenana* from global extinction, two main approaches must be taken:

- Intensive searches by species experts throughout its range and wherever the taxon may be found, immediate implementation of emergency measures (mainly habitat improvement; also, mammalian predator and ungulate management as required).

- Establishment of an internationally coordinated conservation breeding programme: The global population of *T. b. rhenana* is on an extremely critically low level and split into very few, tiny, isolated population kernels. Only in captivity, genetic management and exclusion of unbeneficial chance events are feasible. Both are crucial for small population management and unfeasible in the wild. Furthermore, habitat improvement and mammalian predator and ungulate management measures take time to be planned, implemented and then take actual effect on the last few known individuals. This time is not available any more for this short-lived bird that is on the verge of global extinction. Therefore, as additional safety measure, the establishment of a conservation breeding programme is indispensable (IUCN 1987). Because *T. b. rhenana* is not yet represented in captivity, this conservation breeding programme is to be initiated with founder eggs collected from the wild and hatched in captivity. Collection of eggs from Galliformes does not harm the wild source population because soon after nest loss females lay a replacement clutch (Glutz v. Blotzheim et al. 1973/1994). This is also true for Hazel Grouse in the wild (Montadert & Léonard 2011a) and in captivity where hens regularly even lay several replacement clutches (Nappee pers. comm., Wilmering pers. comm.). The fact that most bird groups lay replacement clutches after nest loss is long known amongst ornithologists with the respective background, bird species recovery specialists, zoos, aviculturists and game bird breeders. The so-called "double-clutching" (and even triple and multiple clutching) technique is standard in bird recovery and conservation breeding programmes worldwide and has been used many times to bring bird species back from the brink of extinction (Sutherland et al. 2004, Jamieson 2016, Copsey et al. 2018). Therefore, fears of the public or of conservationists who lack the required expert knowledge, are unfounded. Some of the founder eggs were to be collected in Luxembourg where a genetically globally important relict population of *T. b. rhenana* was suspected to persist (Felten & Biver 2009, Felten & Bastian in press).

A special volume of the journal *Pollichia* on the Bad Dürkheim meeting, detailing the points outlined above, is in preparation and expected to be available by the end of 2018 (A. Schreiber pers. comm.).

Spearheaded by Centrale ornithologique du Luxembourg (COL) of natur&ëmwelt, in an internationally commendable way, the Grand Duchy of Luxembourg promptly assumed its global responsibility for *T. b. rhenana* and proposed a rapid survey of Western Hazel Grouse in late winter / early spring 2018.

In this frame, the author was assigned to visit suspected Western Hazel Grouse territories with recent reports of *T. b. rhenana* and identify and survey further potential sites in northern Luxembourg in order to confirm whether the taxon is still present or not. The article at hand is based on the respective project executive report to natur&ëmwelt Centrale ornithologique (Handschuh 2018a).

Methods

In order to get an overview over the study area and over the record types and quality, prior to field work, all reports of Western Hazel Grouse since 2013 were sighted. The reports had been collected on behalf of COL and were provided to the author in an annotated ESRI shapefile format. The five-year period 2013-17 was chosen because Hazel Grouse is short-lived (i.e. few years; Swenson 1991a, Lieser 1994, Bergmann et al. 1996, Montadert & Léonard 2003, Mulhauser 2003, Montadert 2005, Scherzinger 2007, Mulhauser & Zimmermann 2008, 2014) and in Luxembourg, as in the entire Rhenish Massif, it mainly inhabits relatively short-lived coppice habitats (Glutz v. Blotzheim et al. 1973/1994, Faber 1987, Ledant 1990, Ledant & Devillers 1991, Lieser 1990, Moes 1991, Bergmann et al. 1996, Aarbechtsgrupp Beschhong 1997, Felten & Biver 2009, Felten & Bastian in press). Therefore, the sites with the latest reports were most important and promising with regards to confirming the continued presence of Western Hazel Grouse in Luxembourg.

Field work was carried out between 26/03/2018 and 06/04/2018, at the end of the winter and just before the start of the vegetation period. This time was chosen because during the winter Hazel Grouse is restricted to suitable winter locations (see below) which usually significantly reduces the total area that has to be searched to find the species, particularly in broadleaved forests. Furthermore, at this time of the year, Hazel Grouse winter territories contain the maximum amount of winter droppings that are unmistakable proof of the species' presence. Each Hazel Grouse individual produces a dropping about every 10 min (Potapov & Sale 2013) and each dropping lasts for weeks to months (pers. obs.). Therefore, at the end of the winter, there are usually sufficiently large amounts of winter droppings present in each Hazel Grouse territory and before the vegetation growth, the droppings are usually also visible enough so that a surveyor with species knowledge and a well-developed search image can find them. Also, at this time of the year, male Hazel Grouse may respond to song playback (Bergmann et al. 1996, pers. obs.).
At the beginning of the field work, meetings were held with the Western Hazel Grouse monitoring personnel (A. Johnston and P. Thelen; K. Klein and C. Felten were also present) to discuss previous reports and gather their opinion on where the currently best areas may be located, and to inspect some sites in the field together.

In order to complete the subsequent survey work within the given time frame, it was carried out at two levels of spatial scale and accuracy (Fig. 1):

- Based on the recent reports of Western Hazel Grouse and discussions with previous field workers (A. Johnston and P. Thelen), a Western Hazel Grouse core area was crudely determined. This area (sum of three large blue areas in Fig. 1: c. 8,800 ha) was delimited in more detail after the survey, based on the GPS points and notes taken in the field. The core area also contained most of the Western Hazel Grouse reports in the recent years prior to 2013 and the area was located entirely within the core area of the former distribution of *T. b. rhenana* in Luxembourg (Faber 1987, Ledant 1990, Ledant & Devillers 1991, Moes 1991, Felten & Biver 2009, Felten & Bastian in press). The core area was surveyed in its entirety and all supposed record sites 2013-17 as well as all suitable Western Hazel Grouse habitat patches contained in this area, identified visually on foot or from the car, were searched in detail.
- It was only possible to cover such a large area because a) the general area and its forests are easily accessible via a dense network of roads and forest tracks, b) the proportion of suitable Hazel Grouse habitat is low (see results), c) the topography of the area with hills and valleys is convenient in that potentially suitable habitat patches can often be seen from a distance, especially at the chosen time of the year when deciduous trees were not yet foliated and d) I had been introduced to the area by A. Johnston and P. Thelen.
- A wider area, largely representing the entire former distribution range of *T. b. rhenana* in Luxembourg (Faber 1987, Ledant 1990, Ledant & Devillers 1991, Moes 1991, Felten & Biver 2009, Felten & Bastian in press), was only coarsely surveyed by driving roads and large forest tracks by car (black area in Fig. 1: ca. 42,000 ha, also delimited after the survey) and locating promising sites by sight (sum of small blue areas in Fig. 1: c. 160 ha). At the sites seen from the car,all patches of suitable Western Hazel Grouse habitat were searched in detail. This method was crude because only the main roads in this large area were driven and thus not all of the forested areas could be seen entirely from the car. However, this still provided a good overview over the forest in general and the proportion of potential Western Hazel Grouse habitat.

Two sites with previous reports of Western Hazel Grouse were not searched in detail: One site south of Winseler because it had already been sufficiently checked and was considered unsuitable by A. Johnston, and another site because it was located in Germany close to the border where there have not been any certain records since 2010 (Handschuh 2017).

I did not determine the number and extent of all patches of suitable Western Hazel Grouse that I found and searched because they were numerous and mostly small. To quantify the habitat patches was beyond the scope of this rapid survey, whose goal was to find Western Hazel

Grouse. The blue outlines in Fig. 1 do therefore not delimit suitable Hazel Grouse habitat, but areas that were considered promising to find Western Hazel Grouse based on previous reports and the extent / proportion of suitable habitat contained in them. In these areas, all actually suitable habitat patches were searched in detail.

To navigate in the field, I used photocopies of topographical maps on which I also took notes, a handheld GPS (Garmin GPSMAP 62s) and Google Maps on a smartphone.

Hazel Grouse is a cryptic bird species that is difficult to observe and survey and requires detailed species knowledge to be found reliably (Zbinden 1979, Bergmann et al. 1996, Südbeck et al. 2005, Scherzinger 2007).

My detailed searches included the inspection of habitat patches and forest stands suitable for Hazel Grouse, according to my own experience and to various authors, mainly Pynnönen (1954), Eiberle (1974), Wiesner et al. (1977), Zbinden (1979), Asch und Müller (1989), Swenson (1991a, 1993a, 1995a, 1995b), Swenson and Angelstam (1993), Swenson et al. (1994), Lieser et al. (1993), Lieser (1990, 1994), Kämpfer-Lauenstein (1995), Klaus (1995), Bergmann et al. (1996), Åberg et al. (1995, 2000, 2003), Sachot et al. (2003), Montadert (2005), Mathys et al. (2006), Scherzinger (2007), Müller et al. (2009), Schäublin und Bollmann (2011), Kajtoch et al. 2012, Klaus und Ludwig (2015); specifically for *T. b. rhenana* also: Glutz v. Blotzheim et al. (1973/1994), Handschuh (2004). Habitat patches were searched on foot and locations that are favoured and frequented by Hazel Grouse during winter or all year round for feeding, resting and roosting, were thoroughly inspected. Such locations mainly included:

- Single individuals or groups of conifers (mainly Spruce *Picea abies* and Fir *Abies alba*) with low vital branches important as cover (especially during the winter), in forest stands dominated by deciduous tree species,
- vital single individuals or groups of soft woods whose buds / catkins are important as winter food (mainly Alder *Alnus sp*., Birch *Betula sp*., Hazel *Corylus avellana* and Rowan *Sorbus aucuparia*) in conifer-dominated forest stands,
- edges between pure stands of conifers and pure deciduous stands containing winter food trees,
- outer and interior edges of dense deciduous shrubbery (mainly Blackthorn *Prunus spinosa*),
- the interior of dense conifer stands, being potential night roosting sites where clusters of winter droppings, often with pale ends, can be quite conspicuous on the dark underground of conifer needles,
- edges of winding forest tracks or grass tracks with good cover,
- edges in the terrain in cover,
- tree stumps, fallen logs and rocks in cover,
- under and next to low life branches of conifers.

The ground at such locations was scanned for winter droppings and feathers. Furthermore, suitable locations (Bergmann et al. 1996, Scherzinger 2007, pers. obs.) were inspected for the presence of dust bathing sites that may be used in all calendar months (Lieser 1994). At promising or inaccessible locations, lure whistles were used to imitate the song of male Hazel Grouse and calls of female Hazel Grouse which may stimulate male Hazel Grouse to respond with song or wing purring or both sexes to approach the observer (Bergmann et al. 1996, pers. obs.).

Results and discussion

Persistence of *T. b. rhenana* in Luxembourg?

Despite the intensive searches outlined above, I found no evidence for the continued presence of *T. b. rhenana* in Luxembourg.

To put this negative finding and the effort undertaken into context: At the same time the survey in Luxembourg was carried out (April 2018), I followed up on a recent supposed sight record of Hazel Grouse ("Alpine Hazel Grouse" *T. b. styriaca*) on a forest track in the Swiss Jura where

Hazel Grouse is known to occur. I knew the sighting location with a precision of c. 50 m and after getting to the place and starting to search, it took me less than one minute to find the first droppings in one of the first promising looking spots (see above in Methods) next to the forest track. Subsequently, during c. four hours of searching in the wider surroundings, I found more than 150 winter droppings and some small feathers (Fig. 2) at c. 25 feeding, resting and roosting locations as well as a dust bathing site with old droppings of Hazel Grouse (and fresh feathers of European Blackbird *Turdus merula*). Furthermore, after an hour or so, I heard the territorial male singing spontaneously, probably because it was irritated by me rummaging around back and forth in its territory, and when I carefully approached the suspected location I got a rare nice view of the territorial pair feeding on young leaves in a large beech tree *Fagus sylvatica*.

Although this pair had a relatively small core area within a wider area that contained several Hazel Grouse territories and thus there was much evidence present per unit area and also close to the record site, this gives an impression of the amount of unambiguous hard evidence that can be found relatively quickly by an experienced observer when Hazel Grouse is present.

Western Hazel Grouse is no exception. About a month after the survey in Luxembourg (May 2018), within a couple of hours of searching in occupied habitat in the Vosges Mountains in France, J.-J. Pfeffer, C. Felten and I confirmed *T. b. rhenana* via droppings and two dust bathing sites with droppings (Fig. 3). We did not search as intensely and concentrated as I did in Luxembourg. Thus, being rare and globally threatened still does not make Western Hazel Grouse a phantom or ghost whose existence cannot be proven with hard evidence.

Apart from producing a dropping about every 10 min (Potapov & Sale 2013), each individual Hazel Grouse also has c. 10.000 feathers (Bergmann pers. comm.) that it moults annually.

With regards to the survey in Luxembourg, this means that methodological insufficiencies or inability of the author to find Hazel Grouse in the field, or Western Hazel Grouse being exceptionally hard to find, can all be ruled out.

Concerning reports of Western Hazel Grouse in Luxembourg during 2013-17, many of the supposed record sites are located in unsuitable habitat, also at the time of the record and often including the wider surroundings of the record site. Unsuitable habitat was mostly characterised by an unfavourable forest age or structure and / or tree species composition resulting in insufficient vertical and horizontal cover, and this mostly also in combination with habitat patches being too small for a pair of Western Hazel Grouse to set up a territory.

Hazel Grouse is strictly forest-dwelling and all studies on the species' ecology and habitat selection stress the species' narrow ecological niche and special habitat requirements, especially the vital importance of cover (e. g. Swenson 1991a, Lieser 1994, Bergmann et al. 1996, Montadert 2005, Klaus & Ludwig 2015, Scherzinger 2007; also see photographs in Guillet 2018).

Therefore, in any Western Hazel Grouse range state, when accidental suspected or supposed records of the taxon are located in unsuitable habitat, they are most likely based on confusion with other bird species. Confusion is even more likely if there are few observations in typical habitat and in typical situations and no hard evidence for Hazel Grouse presence is ever found, neither by chance, nor when looking for it. This is the case in Luxembourg in recent years.

Judging from the habitat at the record sites and in their surroundings and / or the observation circumstances described, most of the recent supposed sight records of Western Hazel Grouse in Luxembourg likely involve confusions with Pigeons *Columba sp.*, Thrushes *Turdus sp.* (especially Mistle Thrush *T. viscivorus*) and, in particular, Woodcock *Scolopax rusticola*. This is also the case in Germany (Dietzen & Handschuh in press; also see Klaus & Bergmann 2004, Lieser 2015).

Recent supposed sound records of Western Hazel Grouse in unsuitable habitat and / or when only nondescript high pitched calls were heard, are likely based on confusion with other bird spe-

cies, such as Goldcrests *Regulus sp.* (in particular Firecrest *R. ignicapilla* can produce calls, call series or untypical (sub-) songs that can resemble Hazel Grouse; pers. obs.), Tits (Paridae; especially Marsh Tit *Parus palustris* and Willow Tit *P. montanus* – which observer is familiar with the subsong / high frequency contact call / female begging call of the latter species?), Treecreepers *Certhia sp.* (in particular Eurasian Treecreeper *C. familiaris*), and the generalised (air attack) alarm call uttered by various bird species. Inferred or assumed sound records must not be considered as valid records of Hazel Grouse because even sounds apparently occurring in response to the Hazel Grouse lure whistle do not automatically stem from Hazel Grouse (and never so if the alleged call has not been described for Hazel Grouse or has been heard at night, both of which was reported in Germany; Lieser 2015, pers. obs.); various bird species can respond to the Hazel Grouse lure whistle, also repeatedly and also reproducibly (pers. obs.). In Luxembourg, in recent years, only on one occasion, one single apparent male Hazel Grouse song strophe was heard in or close to suitable Western Hazel Grouse habitat following the use of the lure whistle (Johnston 2016, Johnston pers. comm.).

All of the recent findings of supposed Hazel Grouse droppings in Luxembourg are demonstrable confusions with faeces of other bird species (in particular Woodpeckers Picidae; pers. obs., Johnston pers. comm.) and recent findings of footprints are demonstrably or possibly (one incident of footprints in snow) based on confusion with Woodcock or Pigeons (pers. obs., Johnston pers. comm., Montadert pers. comm.).

All of the potential confusion bird species listed were encountered regularly to abundantly at all potential, suspected or former Western Hazel Grouse sites in Luxembourg.

Most importantly, I flushed a total of c. 20 Woodcocks during the detailed searches. Some of these Woodcock encounters very much resembled Hazel Grouse encounters and occurred in situations and locations in which there is a definite high potential for confusion, especially by observers who are not very familiar with both species. These two elusive and hard to see species have a high confusion potential due to similarities in behaviour and plumage. In dense habitat and with brief, unexpected observations, the potential for confusion is even higher when observers are (unavoidably) influenced in their perception of what they see or hear by the "perceptual set" that Hazel Grouse is supposed to occur at a site (pers. obs.).

Situations with high confusion potential during the current survey included:

- Flushing a Woodcock in a patch of suitable dense Western Hazel Grouse habitat after having used the Hazel Grouse lure whistle and then carefully moving a few steps further. This suggested that the bird had been attracted by the lure whistle and thus was a Hazel Grouse.
- Flushing two Woodcocks together in a very good patch of Western Hazel Grouse habitat (Hazel Grouse usually live pairwise and Woodcock does not).
- A Woodcock flushed in a very dense potential Western Hazel Grouse habitat patch that then flew c. 7 m straight up and seemingly landed in the closest dense spruce tree, while in reality the bird continued its flight through the tree unseen and soundless.

In all of these situations, as it is often the case in the dense potential Hazel Grouse habitats, the Woodcocks were only seen briefly and not very well plus wing sounds were clearly audible. This may lead an inexperienced observer to believe that the bird must have been Hazel Grouse; subsequently, a suspicion may become a fact. However, in all of these cases mentioned, I was able to exclude Hazel Grouse with certainty by fresh feathers and / or faeces of Woodcock found at the flushing locations (Fig. 4).
The high potential for confusion stresses the need to immediately search the surroundings for indirect signs after a suspicious observation occurred. Unmistakable signs can be found in most instances. On those occasions when even after a very thorough search of the wider surroundings (both Woodcock and Hazel Grouse can run surprisingly fast, also unnoticeably in cover and before they flush; pers. obs.) nothing can be found, the respective observation must not be reported as a record of Hazel Grouse (also see below).

Conclusion: Current situation of *T. b. rhenana* in Luxembourg

Considering:

- that population declines of *T. b. rhenana* in Luxembourg have been reported for decades (Faber 1987, Ledant 1990, 1991, Moes 1991, Aarbechtsgrupp Beschhong 1997, Schmidt & Heidt 1997, Felten & Biver 2009, Johnston 2016, Felten & Bastian in press) and Hazel Grouse is not a species that is able to persists at low densities for years and decades without being embedded in a supra-regional, self-sustaining population (Handschuh 2018b) and
- that already for decades, extensive habitat improvement measures have been considered urgent in order to conserve the taxon in the country (Faber 1987, Ledant 1990, Ledant & Devillers 1991, Moes 1991, Aarbechtsgrupp Beschhong 1997, Schmidt & Heidt 1997, Felten & Biver 2009, Johnston 2016, Felten & Bastian in press), but the proposed measures have never been implemented, as shown by the habitat deficiencies found in the course of the present survey and
- that the most efficient and sustainable forestry practices available to eradicate Hazel Grouse (in particular strong thinning of young forest stands with removal of low conifer branches and soft woods; also, harvester-made industrial-scale clear-cuttings) are common practice in Luxembourgish forests (Handschuh 2018b) and
- that in addition to habitat deficiencies that alone may explain the absence of *T. b. rhenana*, there are also other grave problems for the taxon in Luxembourg (very high densities of ungulates and mammalian predators; Handschuh 2018b) and that these have already been active for some time and
- that most of the recent reports of *T. b. rhenana* in Luxembourg are likely based on confusion with other bird species and
- the effort undertaken by the author during this survey that has not even produced a single piece of evidence for the presence of even one single individual, although a) the survey involved consultations with the previous surveyors (A. Johnston and P. Thelen), b) the survey took place at two levels of search intensity and spatial scale, including in the core area of the former distribution of *T. b. rhenana* in Luxembourg (with relict occurrence of the taxon outside of the wider survey area being unlikely), c) basically all of the recent reports were followed up, and d) the survey was carried out at a time of the year when unambiguous signs of Hazel Grouse can usually be found reliably where the species is present, and
- that all efforts undertaken by previous field workers (A. Johnston and P. Thelen) during repeated surveys in recent years have never revealed any hard evidence for Western Hazel Grouse presence either, although the surveyors looked for indirect signs and regularly found faeces and feathers of other bird species (Johnston pers. comm., Thelen pers. comm.), and
- that even in declining, small relict populations, in the end Hazel Grouse often still occurs in the form of last sub-population kernels with several territories clumped (Pfeffer pers. comm. for the Vosges, Asch pers. comm. for the Black Forest), making it unlikely that such an area remains unknown, especially in an easily accessible region with a well-developed infrastructure, or that such an area is not found during an intensive survey as the present one; the observed clumping of last remaining territories also further decreases the chance of *T. b. rhenana* persisting in Luxembourg because there is not enough habitat at one location for a population kernel to exist,

the only reasonable conclusion is that there is no regular breeding population of *T. b. rhenana* present in Luxembourg anymore and that the taxon is probably extinct.

It is questionable if single, widely spaced individuals, that by chance have never been found, persist since both scenarios would be untypical for Hazel Grouse. However, this cannot be ruled out with absolute certainty at this point. It is certain though that if such single “last Mohicans” still exist somewhere in Luxembourg at this moment, without rapid and massive intervention they have zero chance to survive and will disappear rapidly.

Recommendations for further surveys and future monitoring of *T. b. rhenana* in Luxembourg

The search for and monitoring of Western Hazel Grouse in Luxembourg should be continued for the time being because single individuals still persisting cannot be ruled out with absolute certainty at this point. Certainty is only possible after further surveys and a number of further years without any unmistakable Western Hazel Grouse record in Luxembourg.

Another reason for further surveys is that if such single "last Mohicans" still exist, they must be found very quickly because without rapid emergency intervention they have no chance to survive. Handschuh (2018) makes detailed suggestions regarding possible future surveys and monitoring, summarised in the following.

Continued regular monitoring for the next 5 (-10?) years:

- At the best sites found during the present survey, because offspring and single adult individuals in search of partners may well turn up there and only at those sites they are likely to survive any length of time and not get predated quickly.
- If applicable, at further sites with > 10 ha and better even much more of contiguous high-quality habitat in the wider survey area (black outline in Fig. 1) that might have been missed during the present survey or that may be located outside of the wider survey area.

These sites should be surveyed 3-4 times per year: At the end of the winter for droppings or singing birds; in summer for moulted feathers and dust bathing sites; after new snowfall occurred, to look for footprints and subsequently for droppings (footprints in snow can be a good way to find Hazel Grouse, but because often footprints cannot be safely distinguished from Woodcock, tracks must then be followed and the wider surroundings be searched to find droppings of Hazel Grouse or Woodcock). If indicated, another optional survey may be organised in autumn to search for singing birds and subsequently droppings.

Further dedicated short-term searches:

- Rapid repeat survey, especially in the wider survey area (Fig. 1) and perhaps even outside of it, in the next upcoming promising period (end of the winter 2018/19).
- Interview survey amongst foresters and hunters in Luxembourg, similar to Faber (1987), also concerning the location of young unkempt mixed forest stands of > 10 ha in size, and subsequent follow-up at those sites.
- In addition (but not as replacement), searches using trained dogs that are proven to find single Hazel Grouse occurring at extremely low density, may be considered (see Böcker 2018).

A longer-term monitoring option may also be the large-scale deployment of nest boxes for small birds that, depending on the species, may use Hazel Grouse feathers to insulate their nests. Those feathers can be found when emptying the boxes in autumn and examining the nests. It may also be promising to locate nests of Long-tailed Tit *Aegithalos caudatus*, Chiffchaff *Phylloscopus collybita* and Goldcrests *Regulus spec*. (i.e. species that use a lot of feathers for nest building) in potential Western Hazel Grouse habitats and examine the nests for Hazel Grouse feathers after failure or fledging (pers. obs.).

If Western Hazel Grouse was to be confirmed in Luxembourg at any point in the future, then a country-wide detailed survey involving several species experts must be carried out without delay.

Requirements for field records of *T. b. rhenana* in Luxembourg

Hazel Grouse is cryptic (Zbinden 1979, Bergmann et al. 1996, Südbeck et al. 2005, Scherzinger 2007) and in many situations can easily be confused with various other bird species by sight and sound (see above and Handschuh 2017). Western Hazel Grouse has become extremely rare in its entire global range and faces imminent global extinction (Pfeffer in press for the Vosges, Dronneau in press for northern France, Paquet in press for Belgium, Felten & Bastian in press for Luxembourg, Dietzen & Handschuh in press for Germany).

Therefore, and in order to warrant avifaunistically sound documentation and record keeping (also see Klaus & Bergmann 2004, Lieser 2015, Dietzen & Handschuh 2018) of an EU birds directive

Annex I species for which there is a legal obligation for correct reporting, it is essential to evaluate each future report of Western Hazel Grouse in Luxemburg within a set framework and against rigorous objective criteria.
All future reports must be promptly followed up in the field by a species expert, in order to be critically assessed and double-checked on site and, if applicable, to secure hard evidence.

After follow-up by a species expert in the field, the further evaluation of reports should follow an adaption specific to *T. b. rhenana* of the scheme by Braunisch and Suchant (2006) that was originally developed for the monitoring of *T. b. rupestris* in the Black Forest. According to Handschuh (2017) and Dietzen and Handschuh (2018), only the following verifiable records of *T. b. rhenana* are certain:

- Feathers or droppings documented in the field and collected. If there is any doubt regarding the origin of such evidence (i.e. escaped or illegally released birds, or evidence placed in an attempt to deceive), it must be confirmed via genetic analysis to belong to *T. b. rhenana*; such evidence should also be used for individual identification using DNA to evaluate if more than one individual is involved
- Clearly identifiable photo or video recording of a life specimen that has been confirmed to stem from the postulated location and time and by a species expert or taxonomist to belong to *T. b. rhenana*
- Specimen captured alive and sufficiently documented or dead body collected. If there is any doubt regarding the origin of such evidence, it must be confirmed by a species expert or taxonomist, and remains via genetic analysis, to belong to *T. b. rhenana*

All other potential record types of Western Hazel Grouse (e. g. footprints, sound recording) are uncertain and may only be used as an indication that must be confirmed with hard evidence. Hazel Grouse is highly sedentary and even during dispersal, it usually only moves short distances (Swenson 1991b, Bergmann et al. 1996, Montadert & Léonard 2006). Thus, if a timely follow-up of an uncertain record, including the thorough search for indirect signs by a species expert during a suitable time of the year, does not produce confirming evidence, then the foregoing uncertain record does most likely not involve Hazel Grouse.
In the future, only reports that have been evaluated and confirmed to be certain records according to the above-mentioned criteria should be cited as records of Western Hazel Grouse in Luxembourg. Furthermore, since *T. b. rhenana* will likely become globally extinct in the near future (unless conservation breeding is started rapidly), all of the evidence of the taxon should be documented thoroughly and be permanently stored.

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in December 2017; the present survey is also a direct consequence of this meeting. To persons who may become upset, or hopefully motivated, by my suggestion that Western Hazel Grouse is extinct in Luxembourg, I would like to say: Many people, including myself, would be extremely happy and excited if the taxon was to be found in Luxembourg or anywhere else outside of the Southern Vosges; if you believe the small forest grouse is present in your area, then please do go out into the forest tomorrow and search for hard evidence – the bird is not a phantom and proof of its continued existence is desperately needed throughout its global range. I am also happy to be contacted at any time for discussion, help or advice and the "Western Hazel Grouse task force" is a network of experts for all aspects of saving this gem from global extinction.

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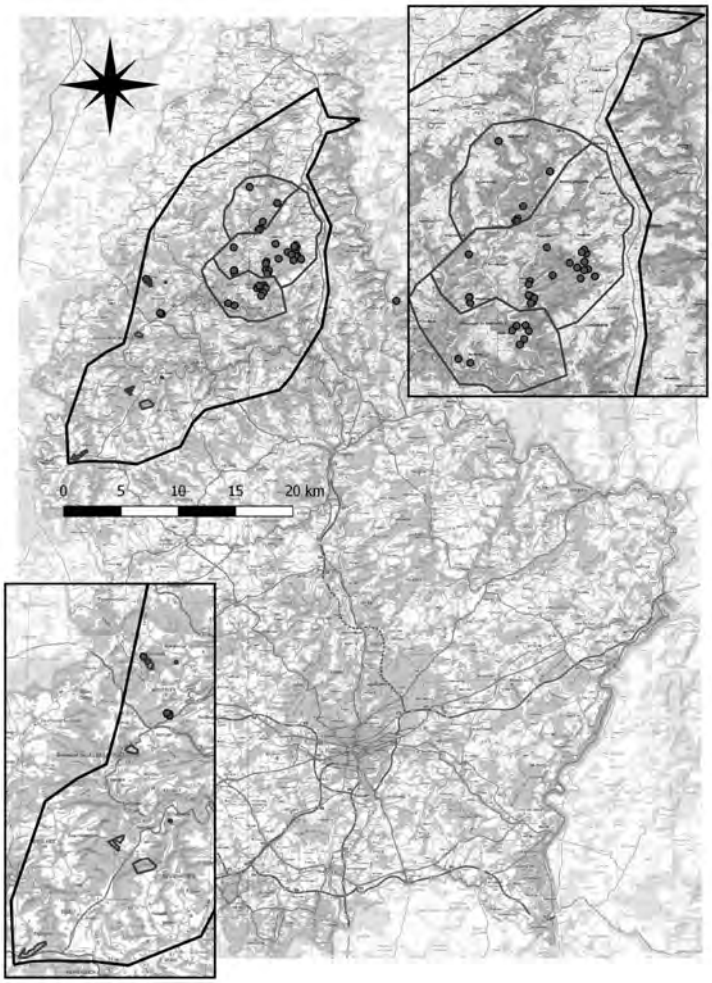

Figure 1: Map of Luxembourg and overview over the wider survey area (black outline: c. 42.000 ha), areas searched in detail (inner outlines; sum of the three large areas: c. 8.800 ha; sum of the seven small areas: c. 160 ha) and reports of *T. b. rhenana* 2013-2017 (dots). The map insets show details of the north-eastern (top right) and southwestern (bottom left) part of the wider survey area. The scale refers to the map of Luxembourg only. Note: The inner outline is not the actual extent of potentially suitable Western Hazel Grouse habitat found and searched, but it marks areas that were considered promising to find Western Hazel Grouse based on previous reports and the extent / proportion of suitable habitat contained, and in which then all suitable habitat patches were searched in detail. Map prepared using QGIS (QGIS Development Team 2018).

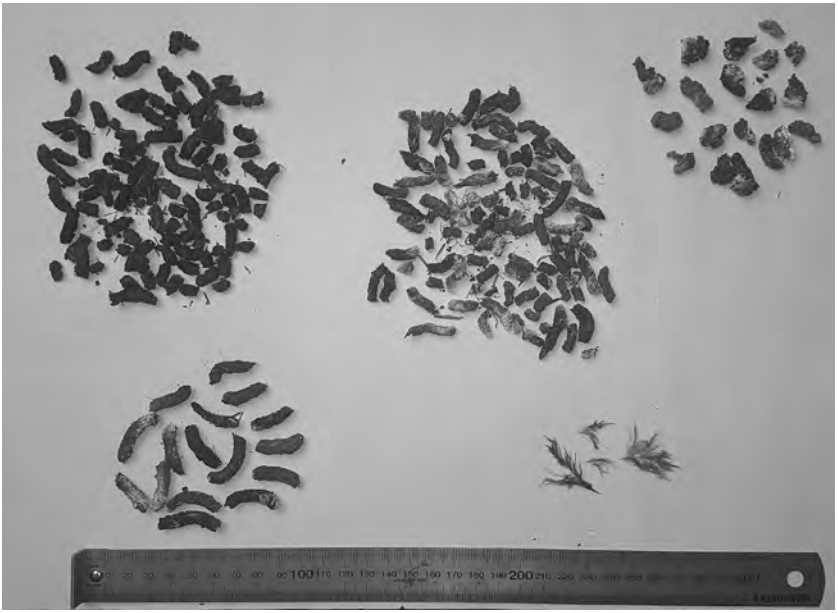

Figure 2: If Hazel Grouse is present in an area, then proof of it can be found: Result in terms of unambiguous hard evidence of a 4 h follow-up in the field in April 2018 on a previous supposed sight record of Hazel Grouse ("Alpine Hazel Grouse" *T. b. styriaca*) in Switzerland: More than 150 winter droppings and some small feathers of Hazel Grouse found at c. 25 feeding, resting and roosting locations and at a dust bathing site on c. 4 ha around the record site. The droppings at the top left stem from a previous snow refuge and were wetter than the other droppings, thus the dark colour. Swiss Jura, April 2018.

Figure 3: If present, Western Hazel Grouse can be confirmed with hard evidence, too: Dust bathing site of *T. b. rhenana* (centre left) in the Vosges Mountains, on the underside of the overgrown root plate of a fallen Fir *Abies alba* tree, confirmed by droppings to be used by Hazel Grouse (and not only by other bird species that also occur in Hazel Grouse habitat and regularly bathe in the dust). In the Vosges, Western Hazel Grouse also inhabits higher altitudes where Fir occurs naturally, as opposed to other parts of the taxon's range where originally there were no conifers (SCHREIBER et al. 2015). Vosges, France, May 2018.

Figure 4: Faeces (slightly to the left of bottom centre, on Oak *Quercus sp.* leaf) and small feathers of Woodcock found within a suspected Western Hazel Grouse territory in suitable habitat, at a spot where a Woodcock had been flushed. Luxembourg, April 2018.