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Recommendations for the documentation and assessment of golden jackal (*Canis aureus*) records in Europe



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Recommendations for the documentation and assessment of golden jackal (*Canis aureus*) records in Europe

Authors:

Jennifer Hatlauf¹, Felix Böcker²

Advisory:

Fridolin Zimmermann & Florin Kunz (KORA - Predator Ecology and Wildlife Management)
Gesa Kluth (LUPUS Institute for Wolf Monitoring and Research in Germany)

Editor:

DI Dr. Ursula Nopp-Mayr, IWJ

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¹ Department for Integrative Biology and Biodiversity Research (DIB),
Institute for Wildlife Biology and Game Management (IWJ),
University of Natural Resources and Life Sciences, Vienna, Austria.

² Forest Research Institute Baden-Württemberg,
FVA Wildlife Institute, Freiburg, Germany.

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Department for Integrative Biology and Biodiversity Research (DIBB)
University of Natural Resources and Life Sciences, Vienna
Gregor-Mendel-Strasse 33
A 1180 Vienna

Foreword

For some years now, an expanding species has become relevant in the monitoring of European carnivores. The golden jackal is colonizing new habitats where it has not been recorded before. This has created a new situation in many areas, posing a new challenge for recording and monitoring. The European legal situation and the increasing social and political interest make a structured and comparable monitoring increasingly necessary. Today, established monitoring standards for wolves, lynx and bears allow consistent comparisons of data collected among many European countries. Only standard monitoring rules and forms of presentation make it possible to provide reliable and comprehensible data across political borders. In order to meet these requirements for the further monitoring of golden jackal occurrence in Central Europe, recommendations for the monitoring of the golden jackal are formulated in the following. The aim is to create a monitoring basis for Central European and other neighbouring countries to ensure transparency and comparability in golden jackal monitoring. The monitoring standards "Monitoring of wolves, lynx and bears in Germany" (Reinhardt *et al.*, 2015) served as an essential orientation for the formulation of the recommended criteria for the monitoring of the golden jackal.

Addition for the English translated version: *in the meantime, there has been proof of reproduction in Germany, so this was added compared to the German version. Furthermore, if you have any specific questions concerning the suggested monitoring in practical use, we are aware that some terms and concepts are mostly influenced by the monitoring concepts in Germany, Austria or Switzerland – however, most of the general concepts will be easy to implement in other countries.*

Jennifer Hatlauf & Felix Böcker



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1. INTRODUCTION

Monitoring of large carnivores in Europe has recently gained in importance and has been advanced through contributions of many experts. The recent expansion in geographic distribution of lynx, wolves, bears and golden jackals in many areas has motivated these rapid developments. The species is expanding its range in areas of Eastern Europe where it was previously intensively hunted until the 1950s. In regions where the golden jackal did not formerly occur, such as in central, western, and northern Europe, new evidence of their presence is increasingly being recorded. Long distances between known occurrence areas and new colonization make an international exchange between European countries advisable to ensure an adaptive process and knowledge transfer. Consequently, there is a growing desire to apply uniform standards to collecting and confirming evidence as is already the case for lynx, wolves and bears in many places.

In the following, proposals for a uniform procedure and assessment of evidence in the monitoring of the golden jackal are described in agreement with experts from Germany, Austria and Switzerland. If necessary, these standards will be further developed and adapted at regular international meetings. The standards are mainly based on the monitoring standards for lynx, wolves and bears (Molinari-Jobin *et al.*, 2003, Reinhardt *et al.*, 2015). Several ideas from the first proposals for practicable criteria specifically for golden jackals from Hatlauf *et al.* (2016) were expanded and practical experiences of the consulted experts were integrated.

2. CURRENT SITUATION IN EUROPE

The golden jackal has increasingly appeared in Western and Central Europe, since the end of the 19th century. The possible causes of the spread of the golden jackal are manifold and are debated among scientists. A combination of factors in recent centuries is suspected: changes due to climate change, abandonment of small farms or intensification of agriculture - land-use changes and previous decimation of Europe's wolf populations in recent centuries (Krofel *et al.*, 2017; Spassov & Acosta-Pankov, 2019). In addition to the known range, records in regions further west and north in Europe have been recorded for the past decades. Golden jackals are dispersing to new habitats on their own and migrating to regions where they have not been before. For example, there have been repeated reports in western and central European countries such as Germany (since 1997), the Netherlands (since 2016), France (since 2017), Switzerland (since 2011), the Czech Republic (since 2006), Estonia (since 2011) and Poland (since 2015) (Hatlauf *et al.*, 2021a). Even from Scandinavia, individual records of golden jackals were confirmed (Denmark 2015, Finland 2019, Norway 2020). The closest known areas to these new records, where reproduction has been detected are in Poland, the Czech Republic, Austria and Italy (Arnold *et al.*, 2012; Hatlauf & Hackländer, 2016a; Jirku *et al.*, 2018; Kowalczyk *et al.*, 2020; Hatlauf *et al.*, 2021a).

The first golden jackals in Austria were documented between 1987 and 1995 (Hoi-Leitner & Kraus, 1989; Bauer & Suchentrunk, 1995; Zedrosser, 1995). Until 2007, there were a total of 17 observations of individual animals (Humer, 2006; Plass, 2007). In 2007, reproduction was confirmed for the first time at the Neusiedl-Seewinkel National Park (Herzig-Straschil, 2008). In 2016, further reproductions were officially confirmed for the first time by bioacoustic surveys (Hatlauf & Hackländer, 2016b). Since then, there have already been records of individual animals in all federal provinces except Vorarlberg and Vienna (Hatlauf, 2021).

In Germany, a golden jackal was first recorded in Brandenburg in 1997 (Möckel & Podany, 2015). After further isolated detections in 2007 (Brandenburg), 2012 (Bavaria) and 2014 (Mecklenburg-Western Pomerania), the number of detections of golden jackals in Germany has been steadily increasing in recent years (Böcker *et al.*, 2020; Tillmann, 2020). Except for the federal states of Berlin, Bremen, Hamburg, Rhineland-Palatinate, Saarland and Saxony-Anhalt, individual golden jackals have now been detected in all federal states. The repeated detection of golden jackals in certain regions shows that individuals are settling and living territorially in Germany.

In Switzerland, a golden jackal was registered for the first time in 2011 via camera traps in the Alps of northwestern Switzerland. In 2015, another camera trap detection followed in the canton of Graubünden and shortly afterwards a jackal was shot because as mistaken for a fox. In March 2016, another severely weakened golden jackal was shot in the canton of Schwyz. Since July 2017, there have been repeated detections in the Linth Plain. In August 2017, a golden jackal was detected via saliva traces on a killed sheep near Arosa, and in 2018 in the canton of Geneva (Zimmermann & Kunz, 2021).

3. BIOLOGICAL BASICS

The golden jackal is a medium-sized canid known mainly from south-eastern Europe and south-east Asia. It lives in small family groups (about two to seven animals). It generally has a shoulder height of up to 50 cm, a body weight of 10-11 kg (sometimes up to 15 kg) and a body length of about 100 cm. This makes it slightly larger than the fox, but significantly smaller than the wolf. A description of the characteristics can be found in chapter 7.

3.1 HABITAT

The golden jackal is very flexible in its habitat choice and shows few preferences. Although it now occurs in many European countries, its exact habitat requirements and needs are little studied. However, the golden jackal is not adapted to higher altitude habitats with long-lasting snow cover or heavily human-populated (urban) areas (Spasov and Acosta-Pankov 2019). It migrates independently to new regions. The absence of the wolf - a natural predator, changed climatic conditions (milder winters) and also changes in agricultural use can favour dispersal (habitat structure, extensive farming). This often takes place along rivers; the riverine vegetation provides both protection and sufficient food. An important element in its habitat is above all good cover (Figure 1), which can be used during the day and for rearing young. Shrub vegetation, reed beds or small forests in agricultural areas also provide shelter and adjacent fields provide sufficient food (Šálek *et al.*, 2013; Hatlauf *et al.*, 2015; Torretta *et al.*, 2020; Selimovic *et al.*, 2021).



Figure 1: Typical habitat with shrub structures and small forests, next to water-bodies (Source: J. Hatlauf)

3.2 FOOD

The golden jackal is a food generalist and opportunist that can adapt very well to the season, habitat and available resources. Thus, the main diet differs according to region and availability. Primarily, small to medium-sized mammals (such as mice and rats; or small hoofed game species) are on its menu, which is incidentally very similar to that of the fox (Lanszki *et al.*, 2006; Lanszki *et al.*, 2018). Similarly, it feeds on birds, amphibians, insects, fish and often carcasses. It also consumes fruits and other plant foods and, in some regions, anthropogenic resources (such as slaughterhouse waste) (Lanszki *et al.*, 2018). In stomach content analyses, we found specimens with over 95% cherries or even pears (unpublished data). In heavily hunted areas, the golden jackal may use as main food left-behind break-up (hunting term for offal of killed game) or carrion of not found ungulates. In 2020, for the first time in Austria, killed farm animals (young sheep) could be detected and confirmed by DNA samples. In Germany, sheep killed by the golden jackal were confirmed for the first time in 2017. In Switzerland, also in 2017, a killed sheep was attributed to the golden jackal for the first time (Zimmermann & Kunz, 2021). Data are currently lacking to examine the impact of the golden jackal on livestock. So far, no systematic data are collected regarding livestock attacks in most countries. General patterns of kills and spatial use are also hardly known, which makes it difficult to design efficient collection of the necessary data.

4. LEGAL STATUS

As the golden jackal follows a natural expansion, its distribution is not comparable to that of species introduced by humans, which is also reflected in its protection status. The Fauna-Flora-Habitat Directive (FFH - "Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora") regulates the conservation of habitats and wildlife. The aim of this directive is to promote the conservation of biological diversity, taking into account economic, social, cultural and regional requirements. A favourable conservation status of species and habitat types of Community interest is thus to be restored or maintained. In Austria and Germany, the requirements of the Habitats Directive are implemented through the hunting and/or nature conservation laws of the Länder. In other neighbouring countries, this is handled differently (see Figure 2). The golden jackal is listed in Annex V as a species of Community interest. Unlike the raccoon or the raccoon dog, it is not considered an alien species (European Commission, 2016). Similar to other species, transboundary management of golden jackals is probably more effective than management strictly following political boundaries.

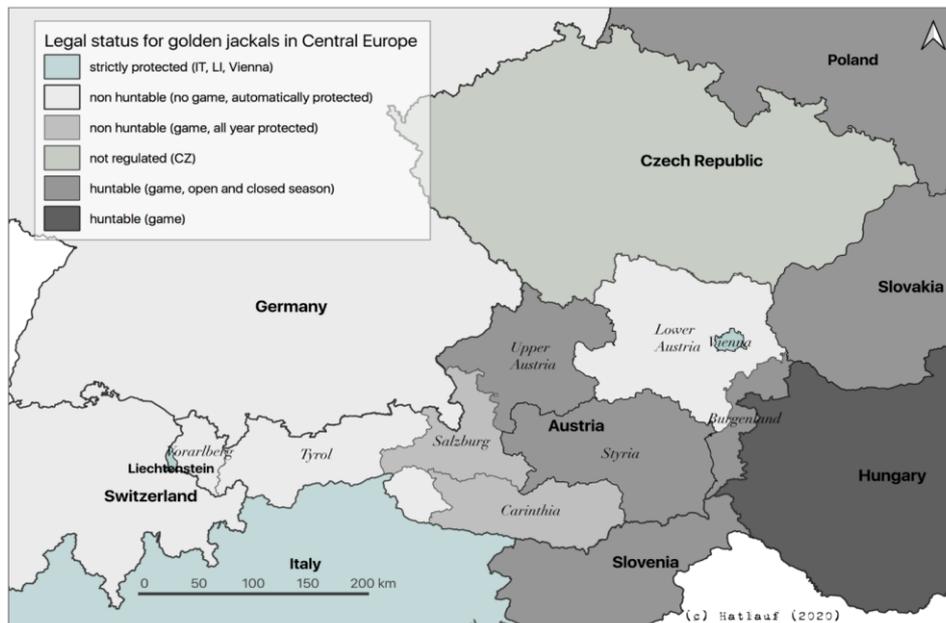


Figure 2: Legal status in Central Europe from: "New rules or old concepts? The golden jackal (*Canis aureus*) and its legal status in Central Europe" Hatlauf et al. (2021)

- In Austria (see Table 1) the status of the golden jackal varies among the federal provinces. Currently (February 2021) it is listed as huntable game in four provincial hunting laws: Upper Austria, Styria and Burgenland (closed season 16 March to 30 September) and Salzburg (protected all year round). In the remaining federal provinces, it falls automatically or specifically (strictly protected in Vienna) under the Nature Conservation Act (Hatlauf *et al.*, 2021a).
- In the Czech Republic, the golden jackal is not mentioned in any specific law, which indicates that killing is not prohibited, but it can be allowed by the nature conservation authority.
- In Germany, the golden jackal is not listed in the Federal Hunting Act and therefore cannot be hunted.
- In Hungary, golden jackals can be hunted all year round, and incentives are payed.
- Italy lists the golden jackal as a specially protected species.
- In the Principality of Liechtenstein the golden jackal was already a protected species even before the first individual sighting was confirmed in 2018.
- In Poland, the golden jackal has been listed as huntable game in 2019 with a hunting season from 1 August to the end of February. The maximum quota of 1,270 animals for the 2019/20 hunting season may not be exceeded.
- In Slovakia, the golden jackal has been listed in the hunting law since 2013 with an official hunting season from 1 August to the end of February.
- Since the beginning of 2020, the golden jackal has had an annual quota in Slovenia, following years of coordinated monitoring.
- In Switzerland, the species is specially protected because it is not listed in the Federal Hunting Act.

Table 1: Overview of the legal status of the golden jackal in Austria at international, national and regional level shows the diverse legal status within only one country (from Hatlauf et al., 2021).

	National status				Provincial status			
	international and regional			national	Hunting Acts/Hunting Regulations		Nature Conservation Acts	
	CBD ¹	Bern Convention	Habitats Directive	Austrian Animal Welfare Act	spared timely	spared all year	strictly protected	in NCA
Burgenland	basic regime <i>no species named especially</i>	basic regime <i>golden jackal not listed in Appendix II or III</i>	Annex V <i>'species of Community interest'</i>	protection if non-huntable due to provincial status <i>§ 3 (4)</i>	since 2019 § 1 (1) par. j	<i>up from</i> 2017 § 3 (1) <i>no. 1</i>		
Carinthia						since 2018 § 4 par. a		
Lower Austria								§ 17 (3)
Upper Austria					since 2012 <i>Annex I</i> par. a			
Salzburg						since 1993 § 4 no. 1		
Styria						since 2014 § 2 (1) par. d		
Tyrol								§ 5 (2)
Vienna							<i>Annex I</i>	
Vorarlberg								§ 6 (1)

¹ Convention on Biological Diversity

5. MONITORING – PRINCIPLES & CONSIDERATIONS

Molinari-Jobin *et al.* (2003) published standards that made the monitoring of lynx in the Alpine region categorisable. They thus created better possibilities to compare and summarise monitoring data across areas. This approach was subsequently adopted in other places and established in modified form for other animal species. Thus, in Germany, Austria and other countries, the monitoring of bears and wolves is largely based on uniform standards, the principles of which can be found in the works of Molinari-Jobin *et al.*, (2003) and Reinhardt and Kluth (2016), among others. The original name for the categorisation "SCALP" (Status and Conservation of the Alpine Lynx Population), introduced by Molinari-Jobin *et al.*, (2012), was retained. In 2016, participants of the Golden Jackal Informal Study Group in Europe (GOJAGE) drafted standards for monitoring the golden jackal in Europe (Hatlauf *et al.*, 2016), which, however, are not applied consistently across Europe and we have therefore supplemented these within this text.

The standardised assessment of golden jackal records is also intended to enable the large-scale creation of occurrence maps, based on the SCALP criteria for lynx, wolf and bear. As with the above-mentioned species, the 10x10 km EU grid (EU-EEA-grid²) will be used to map golden jackal presence and reproduction. A 10x10 km grid cell is considered occupied by the golden jackal if at least one C1 detection has been achieved in the current monitoring year. The monitoring year is based on the temporal definition of the monitoring year of wolf, lynx and bear, especially since the rutting and reproduction period of the golden jackal corresponds to that of the wolf. The monitoring year of the golden jackal thus extends from May 1st to 30th of April of the following year.

In the monitoring of golden jackals, a number of monitoring methods that are known from the monitoring of related species have proven to be helpful in the past decades (i.e. camera trapping, genetic sampling). In recent years, more methods have been added, so that today different methods are combined to find out more about local occurrences of golden jackals or to detect individuals. A fundamental distinction must be made between active and passive monitoring. In passive monitoring, traceable evidence such as photographs or reports of dead animals by citizens can play an important role. Sighting reports without visual material should be considered, but with caution. Experience shows that especially in regions where golden jackals are not yet widespread, very few reports are likely to be golden jackals. Foxes are often mistaken for golden jackals. Exotic animals (potentially also golden jackals) are sometimes found not only in zoos and game parks, but also in private homes. Therefore, in case of detection, it should always be taken into consideration whether jackals could have escaped from a holding in the vicinity. After the first verified reports from passive monitoring, monitoring in the respective region should be intensified in order to obtain further information on territoriality, migration behaviour and for genetic monitoring. The prerequisite for active monitoring is that several indications or evidences suggest that at least one animal stays in a certain region for a longer period of time and that this indicates territorial behaviour. In active monitoring, various methods are used to find out more about the occurrence of the species and specific scientific questions are addressed. The search for signs (e.g. tracks, scat, killed prey) plays an important role in determining presence of large carnivores. For example, clues such as tracks or scats of wolves are often easy to find, recognise and to document. The risk of confusion of golden jackal signs with those of other species is very likely and thus active searching should only be carried out under certain circumstances (case specific, if nothing else will work) or as preparation for further investigation measures (e.g. camera traps). An exception is the search with the help of trained wildlife detection dogs, as dogs can smell the differences between jackal scats and other species (Hatlauf *et al.*, 2021b).

² <https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2>

In the regions where golden jackals may be hunted, further analysis of hunting bags is also appropriate in addition to the methods mentioned (Banea *et al.*, 2018; Hatlauf *et al.*, 2018; Raichev, 2020). Taking into account other influencing factors, number of individuals harvested can also reflect the development of local golden jackal abundance. In addition to golden jackals that have been hunted, the investigation of other mortalities, such as road kill, should be considered.

5.1. BIOACOUSTIC MONITORING (BAM)

Acoustic stimulation is a widely used method for the detection of canids and is often chosen for presence determination in golden jackal research (Giannatos *et al.*, 2005). A species-specific call from one or more animals, depending on the situation, is played at selected points, each several kilometres apart (on average, about 3 km can be expected). Golden jackals that have already settled in the study area are thus animated to respond. Through their unique, melodic howling, the presence of golden jackals in the area can thus be confirmed by experienced individuals. However, the absence of a response is not evidence of the absence of golden jackals. It is possible that individual territorial golden jackals react more reservedly than pairs or groups. If golden jackal responses are documented, other parameters such as the compass direction of the response, the weather, the presumed distance and the number of responding animals can be noted. Recording devices can also be used for later estimation of the distance. These data can also be used for calculations and modelling of group numbers (Graf & Hatlauf, 2021). The creation of a spectrogram is not mandatory, but it shows typical well-recognisable formations of the group calls (Figure 3).

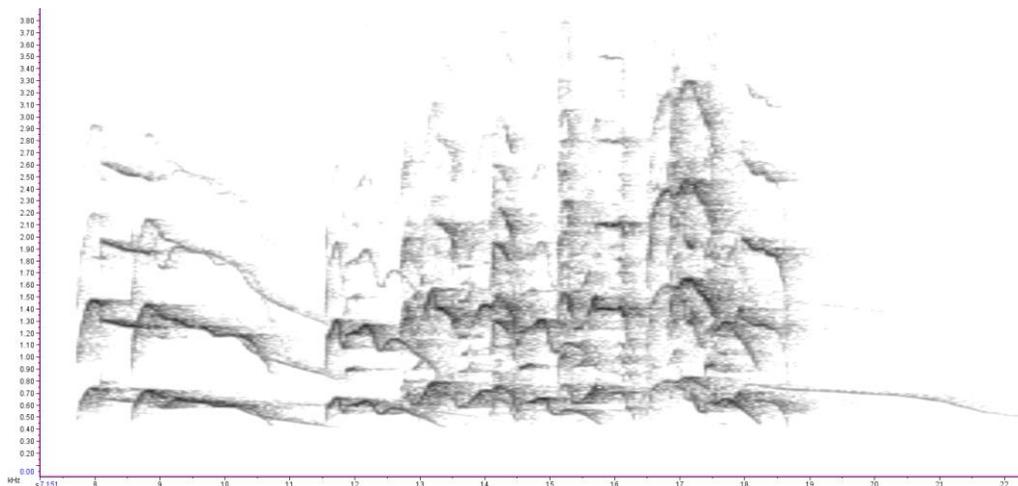


Figure 3: Spectrogram of a golden jackal group call from Hungary.

5.2. CAMERA TRAPS

Camera traps (Figure 4) have become indispensable in wildlife research and monitoring. With the automatically triggering cameras it is also possible to detect golden jackals and find out more about their behaviour. Wildlife cameras can play a role in both passive (random recordings from cameras installed for another purpose) and active monitoring. The use of wildlife cameras in certain situations can help to obtain the conclusive information (e.g. on a snatched prey animal). In active monitoring, wildlife cameras can help both in confirming presence on a regular basis and in answering further questions about the specific and spatial behaviour of individuals, groups or the species in general. In active golden jackal monitoring, wildlife cameras should always be positioned along paths or crossings. An alignment at knee height at an acute angle to the path allows the best recordings and reduces motion blur.



Figure 4: Photo trap in the reed area near Lake Neusiedl (Source: J.Hatlauf)

5.3. SPECIES DETECTION DOGS

Species detection dogs are now increasingly used in various wildlife research, monitoring and conservation projects. Specially trained dogs can help to detect specific animal species or their clues. Trained dogs are also able to distinguish between signs of related species. The use of species detection dogs in golden jackal monitoring allows the search for scat, hairs or urine of the animals in order to examine them genetically (see also Hatlauf *et al.*, 2021b). Therefore, their use is generally recommended for special projects to study golden jackals or for local monitoring.

5.4. TELEMETRY

Telemetry is a method that offers a wide range of possible applications, but which goes far beyond standard monitoring. This requires the capture of golden jackals, which are then observed with the help of GPS and/or VHF collars. This can be used, for example, to study space use and migration behaviour (Lanszki *et al.*, 2017; Fenton *et al.*, 2021). Territory sizes can be determined and monitoring results calibrated. For a generally valid statement, it is necessary to transmitter many animals (Reinhardt *et al.*, 2015). Otherwise, we are dealing with examples and anecdotal insights into the life of single individuals. Telemetry is not to be considered a classical monitoring method, but can provide complementary information.

5.5. GENETIC MONITORING – DEAD ANIMALS

In order to enable medium- and long-term studies on the relationships and lineages at local, regional and international level, genetic samples should also be taken from dead golden jackals, archived and, if possible, analysed. International cooperation and coordination of the relevant laboratories are recommended for this purpose (Alvares *et al.*, 2019; Krofel *et al.*, 2021).

5.6. GENETIC MONITORING - KILLS

In Germany, genetic wolf and lynx monitoring is carried out on behalf of the federal states via the Senckenberg Research Institute. Samples with suspected golden jackals are also increasingly examined here. In Austria, there has already been genetic evidence of golden jackals in livestock killings, which was collected within the framework of the respective monitoring of killings by the Provinces. In Switzerland, opportunistic genetic analyses of golden jackals are also carried out as part of KORA's monitoring of the development of predator populations at the Laboratory for Conservation Biology in Lausanne.

6. EXPERIENCED PERSON

An experienced person in the sense of these assessment recommendations has several years of experience in dealing with monitoring and research of the golden jackal in Europe or adjacent regions. In addition, there is regular exchange with experienced persons from Germany and abroad on this and related topics. A certain level of experience and regular practical experience should be assumed for persons assessing clues. Previous experience in applying assessment criteria of other species (bear, lynx, wolf) is an advantage.

7. EVALUATION OF GOLDEN JACKAL RECORDS

- Evidence of golden jackals can be classified according to different criteria that reflect the plausibility of the evidence (Table 2).
- Only those indications that are assessed as C1 evidence (C = "category") are designated as reliable evidence such as photos or dead finds.
- In contrast to the species wolf, lynx and bear, C2 evidence (evidence confirmed by experienced persons) is NOT recommended for the golden jackal due to the high risk of confusion of tracks (footprints, scats, kills). C3 clues cannot be conclusively verified or refuted.
- When assessing C3 evidence of the golden jackal, an internal sub-categorisation ("C3a - probable", "C3b - possible" and "C3c - unlikely") is recommended when examining the circumstances and considering potential expertise.
- Reports where a golden jackal can be excluded with certainty are assessed as "false".

ATTENTION!
Due to the high risk of confusion with other species, C2 records do NOT apply to the golden jackal.

Reports for which too little information is available or can be collected to assign them to one of the above categories are assessed as **"no assessment possible (nap)"**. The basis for an assessment of indications is documentation that enables traceability with the help of noted and photographed information. For an assessment to be as plausible as possible, each case must therefore be documented in such a way that third parties can also understand the situation. Indications that are not or not sufficiently documented can thus not be assessed as evidence.

Attention!

Besides the assessment categories C1 and C3, all possible record reports can also be concluded as "false" if it can be excluded that they are related to a golden jackal.

Cases in which the given information does not allow a closer assessment (e.g. skeleton of a prey animal that no longer allows a statement on the cause of death) can be concluded as "no assessment possible (nap)". This also applies to all possible clue types.

Since these two assessment categories apply generally and do not differ for the clue types, they are not listed again below for the individual clue types.

Table 1: The SCALP categories adapted for the assessment of golden jackal records

SCALP category	description	Possible hints
C1 (color representation for maps = red)	Reliable evidence	Photo, video, dead find, live catch, genetic evidence (e.g. solution, urine, hair), howling (BAM sound recording)
C3 (color representation for maps = yellow)	Notice that the golden jackal cannot be confirmed or excluded	Sightings without picture credits, all traces, utterances without sound recording and notes that cannot be confirmed in more detail
false	All indications in which a golden jackal can be safely excluded	All types of clues
No assessment possible (nap)	Insufficient information to assign the note to one of the categories mentioned	All types of clues

In order to be able to assess indications and to ensure the traceability of the reports, they should be recorded with the help of suitable protocols. The protocols should contain information on the date, place and contact persons. Depending on the type of tip, specific details should be recorded. Photographs of the situation are also necessary for traceability. Protocols specifically designed for monitoring golden jackals can be used, or those used in wolf monitoring.

7.1. DESCRIPTION

An important distinguishing feature of the golden jackal is, among other things, the rather short tail (20-30 cm) in relation to the body. Its coat is yellowish-grey (to reddish), dark in the area of the back and the tip of the tail and golden on the sides and legs. The back of the ears is inconspicuously coloured, a good visual distinguishing feature from the fox, which has distinctive black markings there. Its brown facial mask is marked by white markings around the mouth and on the neck (cf. also figures 5 and 6; Demeter & Spassov, 1993).

When evaluating photos and videos of suspected golden jackals, typical characteristics of the animals depicted must be considered (Table 3; depending on the position of the observed/photographed animals and the angle of observation, characteristics of the animals described may vary).

TYPICAL FEATURES:

- the short tail
- the typical drawing (contrasts, patterns on the head or body) and
- a typical head or body structure

In order to confirm a golden jackal with certainty, it is necessary that an experienced person (see chapter 6) identifies the animal as such, that a confusion with another animal can be excluded and that at least two typical characteristics of a golden jackal are clearly recognisable.

When assessing photo trap images, it may be necessary to have comparative camera images of other animals or created scales in order to correctly assess the size of the suspected golden jackal and to exclude confusion with another animal (e.g. wolf).



Figure 5: Golden jackal in winter fur (Source: J.Hatlauf)

Table 3: Comparisons of red fox, golden jackal and wolf - dimensions given according to Hunter and Barrett (2012) (image sources: F. Böcker, J.Hatlauf).

Features	Red fox	Golden jackal	Grey wolf
Head front			
Head side			
Body from side			
Body from behind			
Mask / muzzle / neck	Light muzzle and neck	Light muzzle and neck	Light muzzle and neck
Tail	Long (28-49 cm), light-colored tip	Short (20-26 cm), dark tip	Short (35-50 cm), dark tip
Tail length: head-trunk length ratio	approx. 1: 1.6-1.8	approx. 1: 3.7-4.0	approx. 1: 2.5-2.6
Head-to-ear ratio	Large ears in relation to the head	Small ears in relation to the head; little pronounced "stop" (transition forehead to nose)	Small ears in relation to the head; more pronounced "stop"
Head-body proportion	Slim head, slim body	Small, short head in relation to the body	Big, tall skull
Back of ears	Usually black	Usually bright	Usually light / reddish
Runs front	Usually black	Usually light, sometimes black / dark stripes	Usually light, sometimes black / dark stripes



Figure 6: Red fox, golden jackal and wolf. Direct comparison of body proportions with pictures at the same location (Source: J. Hatlauf)

7.2. SIGHTING

Observations of golden jackals are seldom successful and usually happen by chance. Due to the high risk of confusion with other dog species, an observation can only be used as C1 evidence if there is a picture documentation of the observation (photo or video) that meets certain minimum requirements and is confirmed by experienced persons. The behaviour of the observed animal, the stature, the size, the colouring as well as the circumstances of the observation should be asked for. In the case of picture evidence, particular attention should be paid to authenticity (location and season). False reports do occur.

Table 4: SCALP assessment for golden jackal sighting reports.

SCALP category	Description	Documentation
C1	<p>Observations with image documentation are considered C1 if at least two typical features³ are recognizable. Wolf, fox and dog are to be excluded</p> <p>AND</p> <p>The animal is identified as a golden jackal by an experienced person</p> <p>AND</p> <p>No open doubts or features of the observation or the recordings suggest a forgery. If necessary, an on-site check is recommended for verification</p>	Protocol and if possible, image / video material
C3	Observations of golden jackals with pictures of poor quality or without picture material do not allow a final confirmation	

³ See Chapter Fehler! Verweisquelle konnte nicht gefunden werden. "Typical features"

7.3. FOTO/VIDEO

Photo and video recordings (e.g. Figure 7) from automatic camera traps play an important role in both passive and active monitoring of golden jackals. In passive monitoring, recordings of suspected golden jackals are often reported by hunters. In active monitoring, game cameras are mostly used where there is already a suspicion of (territorial) golden jackals. Recordings from fixed surveillance cameras (infrared, thermal image or true colour) can also play a role in monitoring. Recordings made by hand-held cameras are assigned to a sighting report and can substantiate it accordingly (see chapter 7.1)

Table 5: SCALP score for photos and videos of golden jackals.

SCALP category	Description	Documentation
C1	When at least two typical features can be identified AND the animal is identified as a golden jackal by an experienced person (confusion with dog / fox can be ruled out) AND no open doubts or characteristics of the recordings indicate falsification. If necessary, an on-site check is recommended for verification	Protocol and image / video material
C3	if golden jackal cannot be excluded but also cannot be confirmed with certainty	



Figure 7: Photo trap of a golden jackal in winter fur (Source: J.Hatlauf)

7.4. HOWLING

The vocalisations of golden jackals are very typical and have a high recognition value. In contrast to the vocalisations of wolves, they are easier to identify. This type of cues is therefore more important in the monitoring of golden jackals. Furthermore, howling animation is a frequently used method for presence detection of the golden jackal (Bioacoustic Monitoring "BAM"). It does not matter for identification whether a single animal howls, a pair or a multi-member group.

Table 6: SCALP assessment for howling reports of golden jackals.

SCALP category	Description	Documentation
C1	if typical jackal howl was recorded qualitatively (melodic howl) and precisely documented (confusion with dog / fox can be excluded) AND experienced person golden jackal confirmed AND no open doubts or characteristics of the observation or recordings suggest a forgery	Audio recording and protocol "BAM"
C3	if golden jackal cannot be excluded, but also cannot be confirmed with certainty, or complete documentation is not available	

Table 2: Audio example of typical howls of golden jackals.

	<p>Howling-recordings of golden jackal calls can provide a first clue when directly comparing documented calls. Sample recordings of a golden jackal group and an individual animal can be played via this link.</p> <p>www.goldschakal.at/kriterien/</p>
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7.5. SCAT

The scats of golden jackals are difficult for humans to identify. Its appearance is variable over a wide food spectrum. As a food opportunist, the scat can contain remains of hunted prey, but also those of carrion or slaughterhouse waste. The diet of the golden jackal is not limited to small and medium-sized mammals, but may also include amphibians, reptiles, fish, birds or invertebrates. Vegetable ingredients are also very commonly part of the golden jackal's diet. Furthermore, plastics or other materials from municipal waste can be found in the droppings. Golden jackal droppings often resemble those of wolves, dogs or foxes and vary in size. Mean values of measured scats of wild golden jackals from Hungary are 15.8 cm in length and 2.2 cm in diameter (Hatlauf *et al.*, 2020). A reliable identification of golden jackal scats is therefore only possible by genetic analysis. Specially trained dogs can be used to detect the scats.



Figure 8: Genetically confirmed scats of the golden jackal in Hungary (Source: F. Böcker)

Table 8: SCALP assessment for lots with suspected golden jackal.

SCALP category	Description	Documentation
C1	Golden jackal droppings are considered C1 if confirmed by genetic analysis	Minutes of solution find with photos
C3	Solution with suspected golden jackal without confirmatory genetic testing	

7.6. TRACKS

The track marks of adult golden jackals typically measure 5-6 cm in length and 3-4 cm in width (Černe *et al.*, 2019), but are difficult to distinguish from the tracks of other canids due to their size and shape. The typical fused middle toe pads of the golden jackal (which can also occur in wolves and some dog breeds) are often not visible in the track pattern. In some cases, the different surfaces and behaviour of the jackals do not allow for clearly recognisable features in the footprints. In addition, there is a high risk of confusion with the tracks of foxes. Therefore, it is not possible to evaluate them as reliable evidence (C1) or confirmed evidence (C2).



Figure 1: Footprint of a jackal (Source: F. Böcker)

Table 9: SCALP assessment for tracks and footprints with suspected golden jackal.

SCALP category	Description	Documentation
C3	C3 if golden jackal cannot be ruled out	Protocol and photos

7.7. KILL

Golden jackals, like related species, can prey on game or livestock up to the size of a sheep or a deer. However, self-hunted prey of this size makes up only a small proportion of the golden jackal's diet. A specialisation on wild ungulates as it exists in the wolf was not studied up-to-date. Golden jackals generally feed on smaller prey. In different regions, however, they can show different preferences. Due to these circumstances, very individual kill- and utilisation behaviour can arise. The kill pattern on prey killed by the golden jackal can accordingly be ambiguous (Černe *et al.*, 2019). As is typical for wild canids, golden jackals can cause injuries to the captured animal by biting the legs, abdomen, thorax and neck or head. The use of the captured animal is probably comparable to that of the fox and can also be very variable. Therefore, in order to prove the impact of a golden jackal on a killed prey animal, genetic verification of samples taken from the kill bite on the neck of the prey animal is necessary. A kill bite is when haematomas are also detectable, proving that the bites were inflicted while the injured animal was still alive. If the golden jackal is genetically proven by samples taken from carcass bite marks, a kill by a golden jackal cannot be proven with certainty - In such cases, it may be the after-use of an already dead animal and does not have to be related to capture by a golden jackal (Chapter 7.7). In these cases, bite marks (tooth distance between the canine see Figure 10) that are not based on haematomas are also often visible, proving that the bites occurred after the death of the animal. These circumstances must be considered when evaluating kill sites. However, in both cases, after genetic verification, it is evidence that proves the presence of a golden jackal. Recordings from e.g. game cameras alone, which show golden jackals on animal carcasses, also only prove use, but not killing.

Table 10: SCALP assessment for crack reports with suspected golden jackal.

SCALP category	Description	Documentation
C1	genetic examination confirms golden jackal (Attention! Consider whether it proves a real kill or scavanging. Where were samples taken (killing bite or traces of eating)?	Protocol examination of carcasses, photo documentation
C3	If golden jackal cannot be excluded, but also cannot be confirmed with certainty	



Figure 10: The mean tooth distance of the canini from 70 measured golden jackal skulls was on average 24.8 mm (+- 1.87) for mandibles and 27.7 mm (+- 1.90) for maxillae (picture source: J. Hatlauf).

7.8. SCAVANGING

In addition to cases where golden jackals are suspected of having killed prey, there might also be cases where it seems likely that a golden jackal was not responsible for the killing of an animal, but used the carcass as food. In these cases, one must speak of after-use, whereby this must be clearly distinguished from laceration cases. Farmed animals are also repeatedly found in food analyses. In most cases, however, this is due to the fact that anthropogenic resources are not properly disposed of and are thus available as a food source for wild animals. Naturally, dead animals are also a preferred food source for the golden jackal. A reliable differentiation between animals killed by the golden jackal and carcasses that the golden jackal did not kill but scavenged on (e.g. Figure 11) is in some cases only possible through a professional veterinary pathological examination.

Table 11: SCALP assessment for feeding or use tracks with suspected golden jackal.

SCALP category	Description	Documentation
C1	genetic examination confirms golden jackal (Attention! Consider whether it proves a kill or scavenging. Where were the samples taken (killing bite or traces of feeding)?	Protocol examination of carcasses, photo documentation
C3	If golden jackal cannot be excluded, but also cannot be confirmed with certainty	



Figure 11: The remains of a scavenged mufflon (Source J.Hatlauf)

ATTENTION!

An animal carcass that was only scavenged can look very different from a real kill.

7.9. DEAD ANIMAL

Golden jackals found dead (Figure 12) may have died from natural causes as well as from anthropogenic impact (e.g. shooting (legal or illegal), poisoning, traffic accident). Findings are generally documented and investigated in a uniform manner. Interpretations of the cause of death are sometimes only possible through veterinary pathological examinations. A photo documentation is made and samples are secured for genetic analyses and further examinations if necessary. It is advisable to examine genetic samples for genetic monitoring. Hair, saliva, blood or tissue samples are suitable. Which samples are suitable is to be agreed with the examining laboratory. In contrast to footprints and tracks of the golden jackal, the typical feature of the fused middle pads of the toes is also easily recognisable in dead finds and live captures.

Table 12: SCALP assessment for dead finds with suspected golden jackal.

SCALP category	Description	Documentation
C1	if the animal is identified as a golden jackal by an experienced person based on the animal's body or photos OR genetic tests confirm that it is a golden jackal	Protocol of dead animal, photos
C3	If golden jackal cannot be excluded, but also cannot be confirmed with certainty	

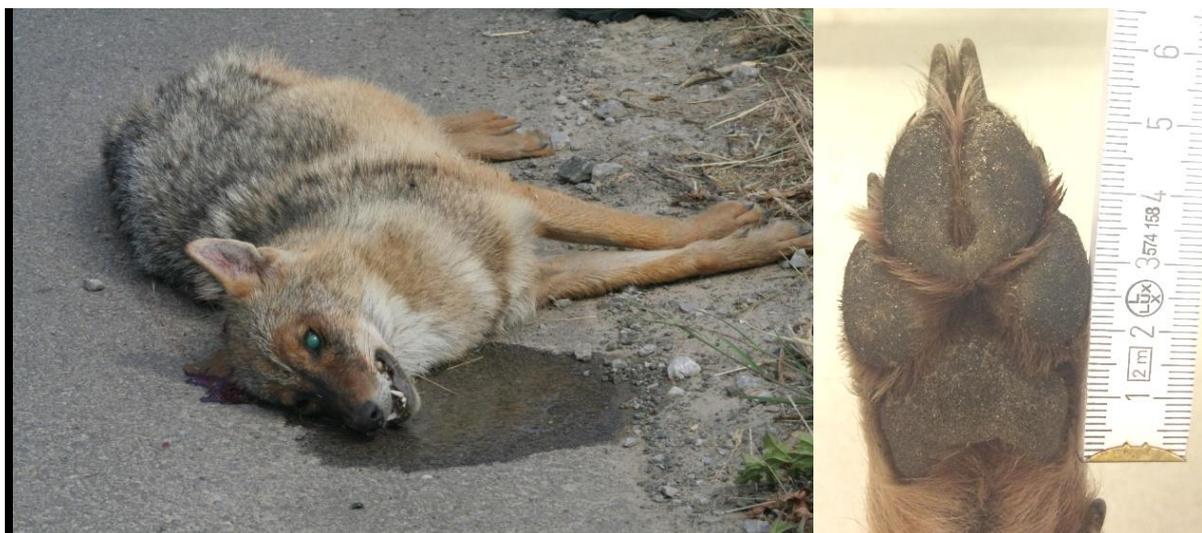


Figure 12: In dead golden jackals, the characteristic fused middle pads of the toes can be clearly visible (Source: F. Böcker; J. Hatlauf)

7.10. LIVE ANIMALS

Live animals can be golden jackal individuals captured for a research project (e.g. collaring), as well as injured or sick golden jackals or orphaned pups taken into human care. In general, it is desirable to clarify the origin of the individual genetically. Live-caught golden jackals are handled according to a protocol. Photo documentation is taken and samples (blood, or if none can be taken, hair or saliva) are secured for genetic analysis.

Table 13: SCALP assessment for reports, captures and finds of live animals suspected of being golden jackals.

SCALP category	Description	Documentation
C1	if the animal itself or photos of it are identified as a golden jackal by an experienced person OR genetic tests confirm that it is a golden jackal	Protocols and images
C3	If golden jackal cannot be excluded, but also cannot be confirmed with certainty	

7.11. OTHER (URINE/BLOOD/HAIR/BONES)

Further evidence such as urine (marking behaviour see Figure 13), oestrus blood, hair, bones or saliva can also only be reliably assigned to the golden jackal by means of a positive genetic examination and thus be evaluated as C1 evidence.

Urine can be genetically tested if the sample is collected and stored correctly. Here, a good agreement on the correct sample handling with the examining laboratory is necessary. However, urine markings should only be examined genetically if further evidence points to a golden jackal as the causative agent. The trace of a golden jackal on the mark or the sighting of a marking animal, for example, may make an examination useful.

Oestrus blood can usually be found together with urine on tracks of female individuals during the rutting season. In rare cases, injuries to jackals may also make it possible to examine blood samples. To enable the finding of urine or blood samples, a snow cover is usually necessary.

Hair can be collected from fences, thorny plants or resting places and can also be examined genetically. Often other clues such as tracks also point to places where hairs can be found. Bone finds that could come from dead golden jackals can also be examined genetically, if necessary. The possibilities of examinations should be coordinated with the examining laboratories in individual cases.



Figure 13: Golden jackal (male) urinating/marketing (Source: J. Hatlauf)

Table 14: SCALP assessment for other clues (urine, blood, hair, bones) with suspected golden jackal.

SCALP category	description	documentation
C1	Genetic examination is a prerequisite for C1	Protocol and photo documentation
C3	If golden jackal cannot be excluded, but also cannot be confirmed with certainty	

8. DETERMINATION OF TERRITORIALITY, DISTRIBUTION AND PRESENCE

Whether the presence of golden jackals indicates migratory animals or territorial jackals cannot be determined from individual records. Only repeated detections can provide information about territoriality. In wolf monitoring, an individual wolf is considered territorial if it is detected in the same area for at least six months (Reinhardt *et al.*, 2015). A prerequisite for this is that the individual is genetically individually identified or otherwise unmistakable.

In contrast, the individual identification of single golden jackals is a major challenge. Kills (of livestock or wild ungulates) suspected to be caused by the golden jackal are relatively rare and the identification of golden jackal scats is very difficult for humans with a high risk of confusion. Therefore, the focus of the monitoring of the golden jackal is suggested not be on individuals, family groups and territoriality, but only on presence and reproduction at the spatial level of the EU EEA grid (10x10km). A grid cell is thus considered occupied by the golden jackal if the presence of the species is detected in the current monitoring year (see examples in the appendix). The presence of identified territorial individuals, pairs or family groups should be documented if possible, but is not relevant for the annual mapping of the situation and in many places not feasible. If reproduction is detected within an occupied grid cell (pups or bitch with udder), this is documented accordingly and mapped grid cells are marked accordingly. If there are no further detections within a grid cell in the next monitoring year, it is no longer considered occupied.

In summary: The difficulties and risks of confusion in the study of golden jackal signs make it clear that a detailed consideration of territories, status and individuals in the golden jackal is difficult. It is therefore recommended to limit the annual information to be documented to a presence record. Only proven reproduction should be documented and presented in addition. A grid cell (10x10 km) is considered occupied if at least one C1 detection has been documented within the monitoring year to be mapped. C3 evidence does not imply confirmation of presence. Further information on territories, group sizes and individuals should be provided within the framework of supplementary projects or stratified monitoring.

9. PROOF OF REPRODUCTION

Proof of reproduction basically proves the mating of two golden jackals. As a rule, the proof of cubs is provided by footage from hand-held or camera traps. The capture or (dead-)finding of golden jackal pups can also prove reproduction. In addition, the detection of a lactating female (e.g. wildlife camera image showing visible teats) can prove reproduction. Genetic testing of samples is generally recommended to obtain individual information. In order to prove reproduction, the corresponding documentation must be of C1 quality.

10. INTERNATIONAL COOPERATION

International, cross-border cooperation in research and monitoring of animal species with a high dispersal allows to create new knowledge and to observe population development across broad extents. The cooperation of authorities and persons that conduct monitoring or work in genetic laboratories of different countries regularly proves to be valuable and essential. The dispersal movements of golden jackals, which are increasingly being detected in western and northern Europe,

display also data gaps and motivate the need to find out more about this species. The origin and migratory routes of jackals are rarely known in the newly colonized regions. Furthermore, answers to questions about the impact of this new species to ecosystems where it has not been found before are still lacking. Uniform criteria in the monitoring of golden jackals can therefore serve as a first step and improve knowledge exchange between areas with comparable data. The cooperation of genetic laboratories in wolf and lynx monitoring has already proven the added value of such cooperation. Such cooperation should also be sought in the genetic monitoring of the golden jackal (Alvares *et al.*, 2019).

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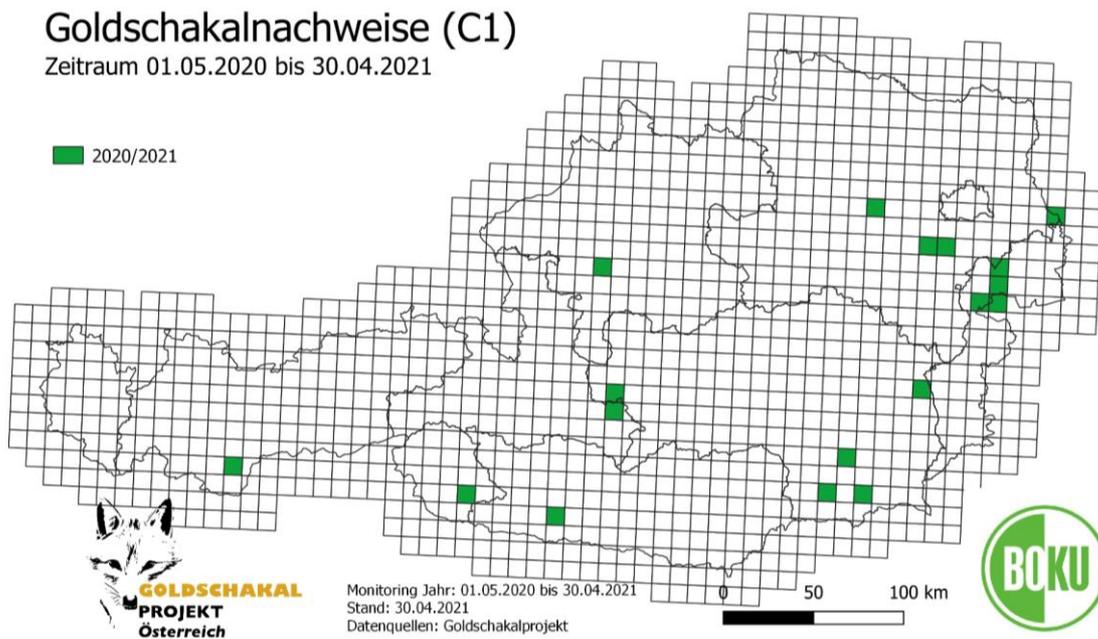
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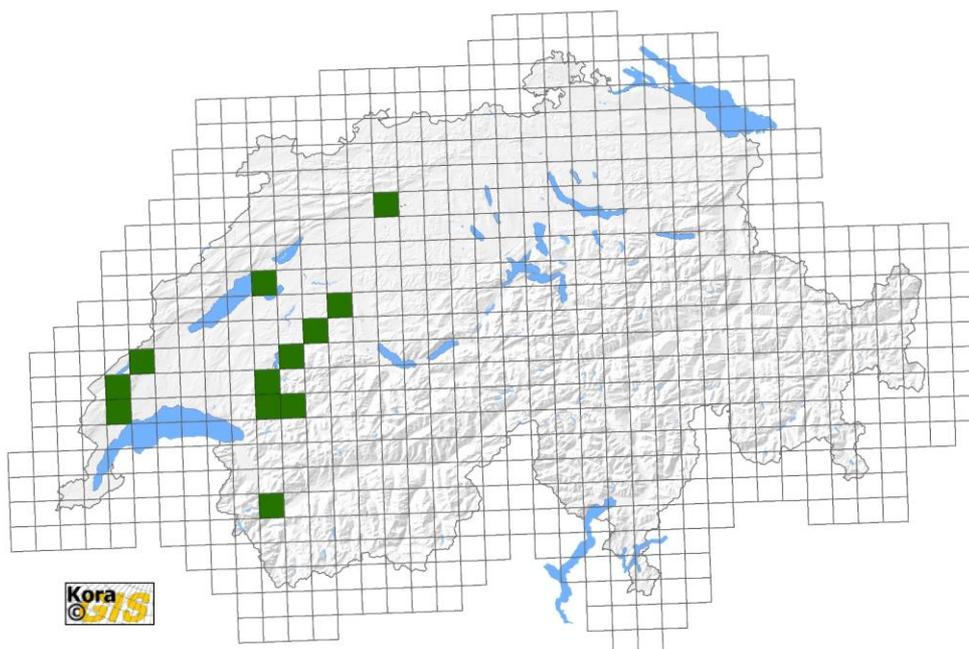
SUPPLEMENTS

Golden jackal occurrence in Austria, Germany and Switzerland in the monitoring year 2020/2021 (01.05.2020-30.04.2021) (10x10km EU-EEA-Grid) green = min. one C1 records.

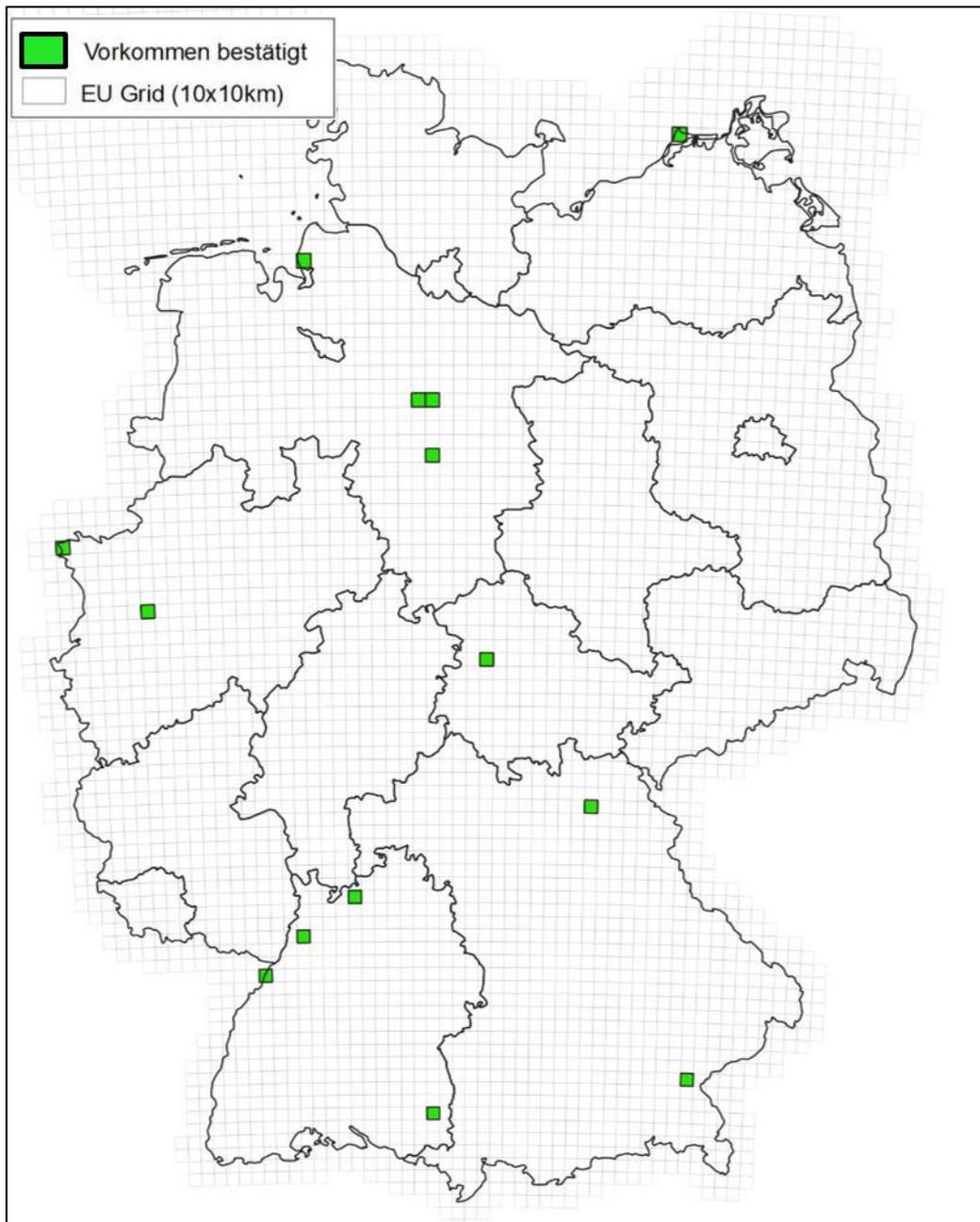
Supplement I.I: Golden jackal records in Austria



Supplement I.II: Golden jackal records in Switzerland.



Supplement I.III Golden jackal records in Germany.





Actual Version: www.goldschakal.at/kriterien/
Golden jackal project, 2021

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Department of Integrative Biology and Biodiversity Research (DIBB)
University of Natural Resources and Life Sciences Vienna
Gregor-Mendel-Strasse 33
A 1180 Vienna