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New Records, first Estimates of Densities and Questions of Applied Ecology for Jackals in Danube Delta Biosphere Reserve and Hunting Terrains from Romania

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Abstract: Territorial reproductive groups of jackals have been recorded recently inside Carpathian arch and in Danube Delta Biosphere Reserve. Acoustic surveys in Romania have started in 2010. In total, jackal monitoring with acoustic method has been performed from 66 calling stations. The presence of golden jackals was confirmed in different habitat types throughout Romania. Using acoustic methods we were able to obtain first estimates of jackal densities for Romania: 1.41-1.74 territorial groups/10 km^2 in areas from Giurgiu, 0.59-0.73 territorial group/10 km^2 on the hunting terrain from Calarasi County, 0.46-0.52 territorial groups/10 km^2 in Dobrogea (Dobrudzha) and 1.56-1.74 territorial groups/10 km^2 in Danube Delta maritime levees (0.55-0.61 territorial groups/10 km^2 for Grindul Chituc and 2.36-2.64 territorial groups/10 km^2 for Grindul Lupilor). The stomach content and internal organs of a young female collected this summer in Alba County were also analysed. The stomach contained 98% corn (*Zea mays*), showing the omnivorous character of the studied specimen.

Hunting bag data available for Timis, Dolj, Giurgiu and Calarasi counties show oscillations in the number of the specimens harvested from 2004 to 2010: from 6 specimens in 2004 to 122 in 2007, 106 in 2008, 163 in 2009 and 129 in 2010.

In Romania, geographical distribution of golden jackal has been interpreted as having an intermittent dispersal pattern, with more than one origin of movement as occurred in 1954-1970, 1980-1996 and 2000-to present periods.

Applied ecology for jackal specific ecosystems needs to include an integrated and specialized monitoring before any management measures.

Key words: acoustic surveys, population expansion, *Canis aureus*, biogeography, Romania

Introduction

In Europe the jackal has been located on the Balkan Peninsula, reaching South Hungary and the southern parts of Romania, in periods of high number of population (Spassov 1989). During the last decades new vagrants and reproductive groups of golden jackals (*Canis aureus* Linnaeus*,* 1758) have been recorded in Central Europe with increasing frequency (Lapini *et al.* 2009, Krofel 2009, Krofel and Potočnik 2008, Zachos *et al.* 2009, Koubek and Cerveny 2007). It seems that golden jackal is expanding in areas where in the last 70 years it was declared extinct or has never been recorded. Population expansion and increase in jackal numbers have been recently recorded in northern parts of the Balkan Peninsula and southern part of Pannonian Basin: in the west, jackals have been reported on the east coast of Adriatic Sea in Peljesac Peninsula in Croatia, (Krofel 2008), in north-eastern Italy (Lapini *et al.* 2009), in Hungary in areas from

Transdanubia and Bàcs-Kiskun county (Szabo *et al.* 2009) and in Serbia at Donji Srem, Smederovo, Veliko Gradiste, Velika Plana and Negotin (Zachos *et al.* 2009) at the confluence of Sava, Great Morava and Timok rivers with Danube. In the east, jackals have been reported in the last decades on the left bank of Danube River in southern part of Romania (Krystufek *et al.* 1997) and on north-eastern limit of Balkan Peninsula in Dobrogea (Dobrudzha) (Angelescu 2004). On the other hand, in the last decades, population declines, due to changes of human agro-pastoral activities as observed in lowland Greece (Giannatos *et al.* 2009).

The largest population from Europe seems to occur in Bulgaria. The total number of jackals recently reached 39 343 animals (Markov 2011). During the 1950s small number was found only to the south of Burgas, as well as the Strandzha foothills along Black Sea coast. It was declared protected species in 1962 (Spassov 1989). A real expansion northwards and westwards began in the 1970s. In 1984, owing to reported damage to game and agriculture, the status of a protected species was lifted and regular measures were taken to reduce its number (Spassov 1989). According to the data obtained from the game count carried out in 2011, the increase in total number of jackals becomes more and more sensible in the recent years (Markov 2011).

A new monitoring tool represented by acoustic survey with broadcast jackal howls has been successfully used in the last decade to detect presence of territorial jackals and determine population densities in several other countries, such as Greece (Giannatos *et al.* 2005), Hungary (Szabo *et al*. 2007), Slovenia (Krofel 2009), Croatia (Krofel 2008), Italy (Lapini *et al.* 2009) and Serbia (Cirovic, *unpublished data*). While estimates of jackal densities are available from surveys performed in Greece, Hungary and Croatia, for most other regions, including Romania, such data are not available.

The presence of golden jackal in Romania is mentioned for first time in 1929 (Calinescu 1931), but probably species was present in this country for much longer. Most likely jackal number has increased considerably since 1980 (Angelescu 2004). According to Almasan (1995) and Murariu and Munteanu (2005), stable populations of golden jackals have been found since 1984 in the area of Niculitel (southeast of Dobrogea), as well as in Danube Plain located in the southern part of the country (Arnold *et al*. 2011). Since the beginning of the 1990s the jackal has also been recorded in Walachian Plain south of a line running through Turnu Severin, Craiova, Bucuresti and Sutesti (Krystufek *et al*. 1997). It seems to be most common in Oltenia region (Almasan 1995, Teodorescu 1995, Krystufek *et al*. 1997).

Murariu and Munteanu (2005) reported that jackals in Romania mainly live in chaparral herbs, berry bushes, thickets of ivy, blackberry and reed prayers in Black Sea coastal area and Danube Delta floodplain. Inland jackals are believed to occur mainly in marshy areas, along rivers and irrigation channels, around ponds with reeds, willows, and chaparral, mainly below 500-600 m a. s. l. Dens were found usually in abandoned burrows of foxes and badgers, and the length of such burrows was around 2 m with the couch at a depth of 1.0 to 1.5 m. In areas with compacted soil or rock, jackals are believed no not to dig dens, but gather branches and grasses for couch located in the thicket of vegetation (Murariu and Munteanu 2005)

In this work we present first estimates of jackal densities for Romania together with new records of jackal presence. We also present a review of all available literature on jackal distribution in Romania and neighboring regions, which is in large part unavailable to broader scientific community. By combining jackal records in Romania during the last decades with our new records we also discuss biogeography of jackals in Romania. Finally, we discuss questions of management's aspects of jackal specific ecosystems as a possible start for further studies in the field of applied ecology.

Literature Review of Golden Jackal Distribution ın Romania

At the beginning of XVIII century (1714), Dimitrie Cantemir, prince of Moldavia in his geographical, ethnographical and economic description of Moldavia *Descriptio Moldaviae* mentions also an animal of the ground named 'cical' as coming from southern Danube (Angelescu 2004).

Vasiliu (1961) and Vasiliu & Sova (1968) considered golden jackal to be an occasional visitor from Balkan Peninsula, crossing Danube when frozen during severe winters, whilst Pop & Homei (1973) exclude it from their two volume *Mammals of Romania* (Krystufek *et al.* 1997).

Southern Romania: in 1929 jackal presence was

mentioned in southern Romania near Danube during a hunting session in Dolj County (Calinescu 1931). In 1954 it was recorded near Craiova, Calarasi, Nisipari, Jijia and Bucharest region in Prundu and Comana (Roesler 1989, Angelescu 2004). In 1963, one jackal was killed at Gaesti GMU (Georgescu 2011). In Southern Dobrogea in forest of Hagieni Reserve jackals were seen at 1996 during surveys realised for Dobrogean fauna by researchers from Natural History Museum Grigore Antipa (Murariu, *pers. comm*., Radulet 2005). At present, it is believed that jackals live up to Oltenia and Muntenia, following the Danube effluents and in Dobrogea in southern forests from Romanian-Bulgarian border until Niculitel Hills (Angelescu 2004). In 2010 groups of 4 jackals were reported in Mozacu forest and 7 jackals in Cantacuzeanca forest, on hunting terrains from Arges (Georgescu 2011).

North-eastern Romania: in 1954 jackals were reported near Piatra Neamt and Focsani in Moldavia (Angelescu 2004). Also jackals have been recorded in Buzau County in Dedulesti in 1971 until 1975, and at Stefanesti near Bucharest. In 1991 jackals were hunted on Dobrina hunting terrain at Husi GMU. Footprints were observed on hunting terrain of Humor Monastery and 2 jackals were hunted in 1970 on Voronet hunting terrain (Angelescu 2004).

Western Romania: jackals were reported in West Land at Berveni in 1970 on Barcau river basin, and in Toboliu reeds from Barcau river in 2008 (Pintea 2010). In 2007 a jackal was hunted at Cricau inside the Carpathian Arch and one jackal was killed on road at km 338th from DN7 in Alba County (Dragomir 2010). In 2011, specialists from GMU Lunca Timisului from the National Forest Department Romsilva reported jackals since 2008 in Cheveresu Mare and Pischia hunting terrains.

Neighbouring countries: in Bulgaria, until the early 1960s the jackal occurred only in the region of Strandzha Mountain, in the Southeast part of the country (Markov 2011). In the Ex-soviet Union it was recorded in Caucasus and Middle Asia; sometimes it was reported in Moldavia (Anonimus 2011) near eastern part of Romania, on the left bank of Pruth River. In Hungary, species became extinct by the middle of the last century. New population was established in Transdanubia (Somogy and Baranya counties) in the 80s, then between the River Danube and River Tisza (Bács-Kiskun county) in the first part of the 1990s (Szabo *et al.* 2007).

In the 1950s jackals have been reported in southern part of Romania but also in the east near Focsani in Moldavia. In the 1980s they have been reported in Southern Dobrogea and in the north-eastern part near Husi, on the right bank of Pruth River in Moldavia. Since 2000, increasing number of reports has been related in southern part of the country in Dobrogea, Calarasi and Giurgiu counties. In the last 3 years they have been reported in counties of western part in Timis and Bihor and inside the Carpathian arch in hunting terrains of Alba County.

Jackals were present in Moldavia in 1950s (Angelescu 2004) while at the same time in Bulgaria they were reported on Black sea coast, south of Burgas, mainly in Strandzha Mountains (Atanasov 1953, Spassov 1989, Markov 2011), far from Romanian-Bulgarian border and in contrast during the presence in Southern Dobrogea, in 1980s, by the expansion of the populations from Southern Bulgaria after 1960s, they were not reported on northern part of Moldavia. This can indicate that in Romania, the jackal movements have an intermittent colonization pattern in different parts, which occurred probably in pulses in 1955-1970 and 1980-1995 with Moldavian-Ukrainian origin and in 1930s, 1980-1995 and 2000-present from Bulgaria. In western part of Romania the expansion seems to have taken place in 1970s and in period 2005 to present and originated from Pannonian Plain and Tisza tributaries (Fig. 1).

Study Area and Methods

Mountainous, grassland, and deltaic ecosystems dominate Romania's landscape. In the central and western parts of the country, mountainous areas comprise some 28% of total land area, dominated by vast tracts of relatively undisturbed forest in the U-shaped Carpathian Mountains. Around the mountains, forests gradually give way to grasslands, which have been predominantly converted, to agricultural use. Native steppe and steppe-associated wet meadows have been systematically converted to cropland and pastures (Hansen *et al.* 2002).

Our studies were conducted in woodland, grassland, arable land, pasture land, wetland in six areas from Transylvanian Plateau, lowlands from left bank of Danube River, Dobrogea and maritime levees from Danube Delta (Fig. 2). These areas are: 1) Hunting terrains near Blandiana, Mereteu and Teleac villages in Alba County inside the Carpathian

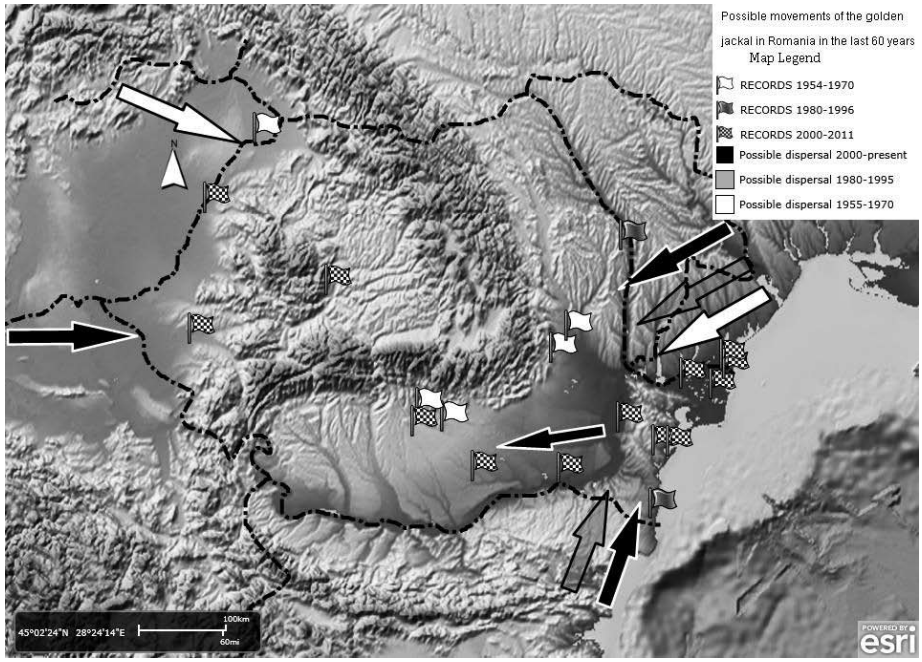


Fig. 1. Records and possible movements of jackals in Romania during the last 60 years.

arch where Mures River joins with Tarnava tributary; 2) Hunting terrain Cheveresu Mare in Lunca Timisului Game Management Unit in Timis County near Timis River in western part of the country; 3) Hunting terrains near Vlasin and Petru Rares villages in Giurgiu County; 4) Boianu and Fundulea hunting terrains in Calarasi County; 5) Danube Delta Biosphere Reserve from Tulcea County on maritime levees, and 6) Open land layer (silvo-steppe) joint with river course Casimcea and villages from mid Dobrogea in Constanta County. In total, five monitoring stages of 5-7 days each, took place in October 2010, February 2011, April 2011, August 2011 and October 2011.

Several methods were used to detect jackal presence in Romania:

Documentation of local data: we analysed data provided to us by game management units GMU or by local people and found historical data published in national hunting association magazines and in scientific literature. For our surveys we have chosen areas where Game Management authority observed an increasing number of jackals. We also selected terrains wherefrom we received testimonies provided by Romanian NGO Crispus Sibiu, data collected during the expeditions in the Danube Delta since 2001.

Direct observations: all coincidental observations during the field-work and observations made using spot lighting sessions were recorded. This data were partly used to decide where to do our systematic monitoring. We also documented hunting trophies (coats and skulls).

Searching for dens, tracks and signs: during the field work of survey stages we have searched for footprints and dens in different areas of study.

Hunting Bag Data: data were provided by the National Forest Department ROMSILVA for the last 7 years. We used these data to monitor population trends and to compare this trend with red fox where data were available. The harvested specimens were counted systematically since then and every year the optimum and proposed to hunt effectives (Table 2) are calculated by specialists in base of annual evaluations and previous year's harvests.

Photo and video trapping: two infrared photo-traps with PIR, movement sensors and 110 º wide spectrums were installed for one night during all stages of monitoring at potential jackal paths. In summer stage we also installed one infrared camera on a tree in Letea Forest in Danube Delta for 3 months.

Acoustic monitoring and spotlighting: an acoustic (play-back) method (Giannatos *et al*. 2005) was used to determine the presence of territorial groups of jackals. Calling stations were pre-selected in suitable habitats at distances that enabled us to cover entire study area. Linear distance between successive trial calling stations was usually between 2 and 4

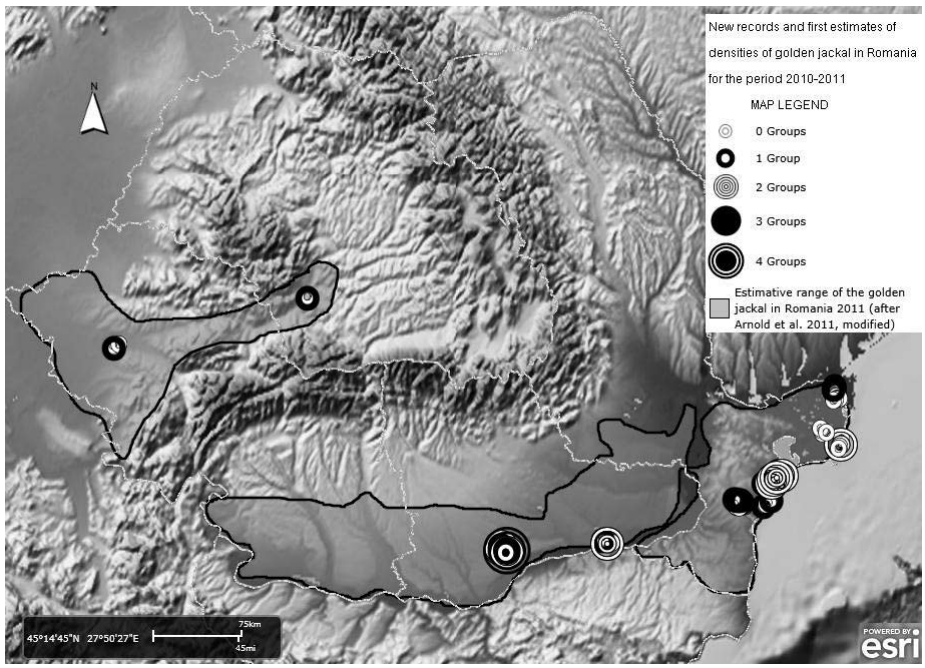


Fig. 2. Study sites of golden jackal monitoring using acoustic surveys in Romania in 2010-2011.

km, depending on terrain and available road network. Calling stations were selected according to topographical characteristics in order to optimize sound transmission. We avoided sources of background noise (main roads, settlements). From each calling station a recorded group yip-howl by two to four jackals was broadcasted (records were made in Hungary and Slovenia). We used a Megaphone 50Watt Etrion MR 800gr in connection with mobile phone or portable computer. Field work was not done on windy and rainy nights. Each broadcasted howl lasted for 30 sec and was followed by a 3 min pause. If there was no response, this set of broadcast and pause was repeated for five times on each calling station, which totaled to overall session time of approximately 15-20 min. When jackals responded to the broadcast we determined the direction of howling jackals using a compass and roughly estimated the distance. In order to avoid doubling we marked each response direction on topographical maps. Geographical coordinates and altitude of locations were recorded by GPS. We also noted the time needed for jackals to respond and the number of howling jackals (single or a group). After response we also scanned the area with a spotlight at calling stations located in open habitats. We always began with the survey at least one hour after sunset and finish at least one hour before sunrise.

For the calculation of jackal territorial group's densities we followed Giannatos *et al.* (2005), who determined the maximum human hearing distance on windless nights from a vantage point in an open terrain with no background noise at 1.8 to 2 km. Therefore the effective area for an audible response from jackals was estimated to be between 10.18 to 12.57 km^2 (πR^2 = surface area). If sound transmission was hindered in one or more directions due to topographical features, we subtracted the corresponding share of the effective area to one quarter of the area, using 7.64 to 9.43 km^2 for the calculation of effective covered area (as occurred for Alba, Timis or Giurgiu). It was assumed that only territorial groups of jackals were responding to the broadcasted howls and that each response direction coincided with a different territorial group (Giannatos *et al*. 2005). Spatial analyses were done in ArcGIS program.

Results

In October 2010, February 2011, and October 2011 jackal monitoring was performed using acoustic method from 66 calling stations in 6 regions (Fig. 2). In total we recorded response of 39 different groups and we recorded 25 direct observations and 36 other signs of presence of jackals. One jackal was recorded with photo-trap.

As is shown in IUCN red list (Giannatos 2007) the preferred habitat for jackal is represented by Wetlands (inland) – Bogs, Marshes, Swamps, Fens,

Peatlands (5.4), Artificial/Terrestrial – Arable Land (14.1) and Artificial/Terrestrial – Pastureland (14.2). For Romania, we would like to add Temperate Shrubland (3.4) (Dobrogea silvosteppe) and Forest (1.) If we choose Elton and Miller (1954) and Elton (1966) habitat categories classification (Gilbertson *et al*. 1985) for animal survey purposes, in Romania, we can say that jackals were reported in all of four types of terrestrial vegetation: open ground (Dobrogea), field layer (Calarasi), scrub (Alba) and woodland (Timis, Giurgiu and Alba) and in aquatic-terrestrial transition (Danube Delta). Every time we recorded jackals near perennial medium and large rivers like Mures, Timis, Danube or lakes and wetlands near Ogarca and Albele hunting terrains from Giurgiu County or maritime levees Chituc and Lupilor from Razim-Sinoe lagoon Complex in Danube Delta.

Alba. After the data on shot jackals mentioned by Dragomir (2010), we made a survey with acoustic monitoring in spring, summer and autumn 2011 in this area. During spring and summer survey no response was recorded at any of the 8 calling stations covering 61.12-74.4 km^2. In autumn 2011 we recorded one response, which is the first confirmed record of territorial jackals for this region. Density responds to approximately 0.43 territorial group/10 km^2, but because the sample size, where we recorded the group, was less than 8-15 km^2, considered as home range for sub adult male jackals radio collared during 12 months (Giannatos 2004), it is not a reliable estimate. We also analysed 3 year old female specimen shot next to the horse carcass in Teleac hunting terrain on 2th August 2011. The ranger from the local hunting club saved the specimen and forensic physician performed a necropsy. We collected and measured all internal organs and analyzed stomach content which had more than 98% of corn *Zea mays* (Fig. 3). For two nights we installed infrared video-trap, but no jackals were recorded, however, we detected presence of the Eurasian lynx, *Lynx lynx*. On Teleac Hill we also recorded several dens of jackals (Fig. 6). Seven entrances to dens were found. Distances between individual entrances were 3-5 meters sited on north-west part of a small hill with 45º slope. Individual entrances were 40-50 cm wide, with deep cave in argyles type ground. The visibility around entrances was good, with wide view to Mures River and villages. The place was on top of a hill with shrub vegetation and pastureland being inside hunting terrain administrated by a private hunting association.

Timis. Survey using acoustic method was performed from 6 calling stations in Cheveresu Mare hunting ground. The area covered was estimated to 45.84-56.58 km^2. We recorded one group of territorial jackals, which would correspond to density of 0.21-0.17 territorial groups/10 km^2. From this area we also collected tissues samples from 3 jackals killed in the winter 2010/2011 for future genetic analyses.

Giurgiu. In Ghimpati ROMSILVA Local Unit in Giurgiu County we monitored jackals from 6 calling station covering 45.84-56.58 km^2. We recorded presence of 8 jackal groups and estimated density to 1.74-1.41 territorial groups/10 km^2. Presence of jackals was also confirmed by photo - material in autumn 2010.

Calarasi. In Calarasi hunting ground, surveys were done in October 2010 and February 2011. We set 4 calling stations covering 40.72-50.8 km^2. We recorded response of 3 groups, which corresponds to densities of 0.73-0.59 territorial groups/10 km^2. During the field work we observed one group of jackals, 1 adult and 3 sub-adult. We also collected biological tissue from a specimen killed on the road. Local officials from NFD ROMSILVA reported that on average once jackal per month is recorded killed on road.

Dobrogea. In Dobrogea (Fig. 4) study area we performed survey from 10 calling stations covering 95.3-109.3 km^2. We recorded response of 5 territorial

Fig. 3. Biometry and macroscopic analysis of the stomach content of female golden jackal shot in Alba County, August 2011; Photos: O. Banea, D. Dragota & B. Dragomir.

groups. The density was estimated to 0.46-0.52 territorial groups/10 km^2. During the field work in Dobrogea, we also observed 5 separate jackals and 5 red foxes. We were also able to photograph several individuals. On the way to Bucharest we also found one jackal killed on the highway 10 km from the entrance to the capital.

Danube Delta. We have collected data about jackal's presence through 7 testimonies of local people since 2002 in Caraorman village inside central delta. The jackal expansion seems to have a south-north direction from southern levees to Saraturi levee near Sfantu Gheorghe locality and Caraorman forest (Fig. 5). Since 2005 people from Periprava declared the presence in this area near Ukraine border and, in 2009 we observed jackal footprints on the sent dunes from Letea forest. On Caraorman levee we photo-trapped a jackal during the October 2010 stage (Fig. 7).

In October 2011 we observed an individual 4 km south from Periprava village, at daylight, inside the Letea Forest Reserve during day surveillance on the maritime levee, Letea. Here we also deployed an IR camera on a tree, set for continuous video monitoring during three months, from August to the end of October 2011. From 105 video recordings, 1 of them had roe deer, 2 showed wild boar, 25 feral horses and more than 50 domestic cattle. Jackal presence was not confirmed with this method. In this area, domestic pasture activities and forest management is forbidden, because Letea Forest is national protected area.

In Letea Forest Nature Reserve, 3 km south from the Periprava village, on 15th February 2011 we recorded a response of territorial jackal group to a play-back. In Danube Delta a total number of 6 territorial groups were recorded in October 2010 and February 2011. In October 2011 more systematic survey was performed from 11 calling stations covering 74.5-83.2 km^2 at Grindul Lupilor and Grindul Chituc in the lagoon complex of Razim-Sinoe (Fig. 4).

We recorded responses from 13 jackal groups and estimated density to 1.56-1.74 territorial groups/10 km^2 (0.55-0.61 territorial groups/10 km^2 for Grindul Chituc and 2.36-2.64 territorial groups/10 km^2 for Grindul Lupilor). In Chituc and Grindul Lupilor we also directly observed 5 jackals and one red fox and on several locations we found jackal footprints (Fig. 6) and scats. We were also able to photograph 2 jackals (Fig. 9) and recorded the vocal responses.

In total from 66 calling stations in different areas of Romania, we recorded 30 vocal responses to acoustic stimulation. In most cases (70%) jackals responded for the first time after the first broadcasted howl and to a lesser degree after later playbacks

Fig. 4. Dobrogea study area (left) and Lagoon complex Razim Sinoe with Lupilor and Chituc levees (right).

Fig. 5. Jackal presence on areas from maritime levees in Danube Delta Biosphere Reserve.

Fig. 6. Golden jackal footprint in Chituc levee (left) and den in Alba (right); Photos: O. Banea.

(Fig. 8). Densities in Romania show different levels in different landscapes similar to the densities found in Croatia, Hungary and Greece.

Hunting Bag Data. Data provided by the National Forest Department ROMSILVA show that in four regions with available data the hunting quotas as well as number of removed jackals increased in the last years (Fig. 10). Comparison between number of removed jackals and foxes in Calarasi (Fig. 11) shows that number of removed specimens of both species fluctuated similarly and both increased in time.

Discussion

We were able to find new records and to determine first estimates of densities in Romania, also in areas where before jackals were rare or completely absent. This shows that jackals are still expanding in the last years.

In recent past, distribution boundaries of the golden jackal species in SE Europe fluctuated and two main centers of distribution were identified: 1) Eastern Thrace (Turkey) and Strandzha Mountains (Bulgaria); 2) Dalmatia and

Fig. 7. Golden jackal recorded with photo trapping on a trail in Caraorman forest (left) Habitat in Dobrogea study area (right); Photos: O. Banea.

Table 1. Summary of recorded jackal densities (number of recorded jackal groups/10 km^2) in Romania and comparison with literature data available for Europe.

Area	Jackal groups recorded	Density
Chituc levee Danube delta	2	0.55-0.61
Lupilor levee Danube delta	11	2.36-2.64
Dobrogea	5	0.46-0.52
Giurgiu	8	1.41-1.74
Timis	1	0.17-0.21
Alba	1	0.35-0.43
Calarasi	3	0.59-0.73
Ravni kotari, Croatia[1]	19	0.61-0.75
Vir Island, Croatia[1]	2	1.15
Kétújfalu, Hungary[2]	19	3
Bacs-Kiskun, Hungary[2]	24	1.42
Vestonida – Nestos, Greece[3]	11	5
Mornos delta Fokida, Greece[3]	53	5
Peloponnese, Greece[3]	45	0.8

[1] Krofel (2008), [2] Szabo *et al.* (2007), [3] Giannatos *et al*. (2005).

Northern Greece (Demeter and Spassov 1993).

Jackal presence in Romania was mentioned in the literature available in different periods of time and in different regions around Carpathians (Fig. 1). During our monitoring stages we observed three possible dispersal routes since 2000 to present. From South Dobrogea to the West over Danube, using maybe human infrastructure with presence in Calarasi in 2003 and in Giurgiu 2005, to North until Lupilor and Chituc levees and inside the mid Delta in 2001, at Caraorman levee. As jackals were recorded near Braila (Blaga *et al* 2008) and since 2009 at Periprava with the lack of their presence on Letea levee between Chilia and Sulina Danube delta branches until 2005, we think that another dispersal movement could happened these years from

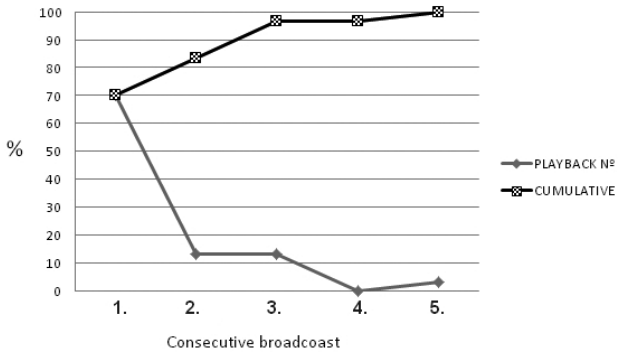
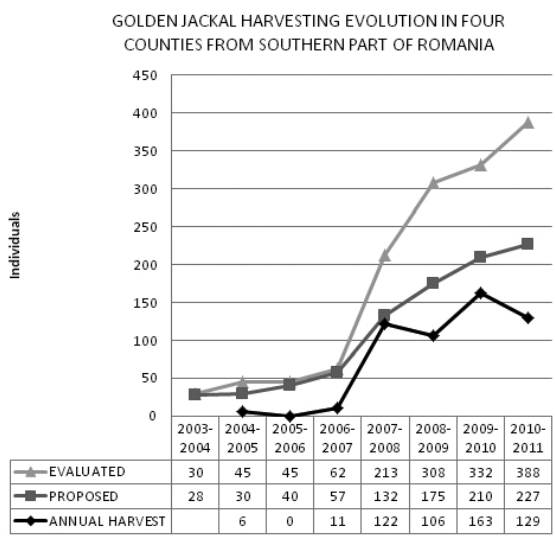


Fig. 8. Time needed (proportion and cumulative responsiveness) for jackal responses (N=30). We separated broadcastings with 3-5 min.

Fig. 9. Golden jackal photographed during the field-work in Danube Delta Biosphere Reserve; Photo: M. Krofel



	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
EVALUATED	30	45	45	62	213	308	332	388
PROPOSED	28	30	40	57	132	175	210	227
ANNUAL HARVEST		6	0	11	122	106	163	129

Fig. 10. Golden jackal harvest in four counties from southern part of Romania from 2003 to 2011; Data source: Nfd ROMSILVA.

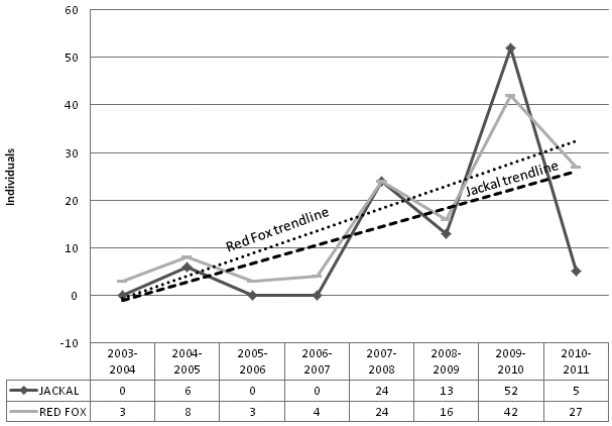
Moldova and East border with Ukraine. In West, the third movements' origin, seems that dispersal occurred after the population growth in Hungary, in 80s, 90s and 2000 (Szabo *et al.* 2007). Jackals were seen on hunting terrains from Timis County in 2008, and recently inside the Carpathian arch in Transylvanian plateau at Cricau, (Dragomir 2010). We recorded the first reproductive group in this area during the autumn stage in October 2011.

Applied Ecology. The ecology and biogeography of jackals in Romania have applications in conservation management, environmental assessment, sustainable hunting, potentially public health if zoonoses are identified, and for the human-wildlife conflicts in general.

To analyze the biota of any particular region, one must determine the distributions of its organisms beyond that region as well as the distributions of their closest relatives (Wallace 1876, after Lomolino *et al.* 2010). British biologist A.R. Wallace also said that competition, predation and other biotic factors play determining roles in the distribution, dispersal and extinction of animal and plants (Lomolino *et al.* 2010).

Few studies were done in different countries from Europe on jackal distribution and densities in specific areas. Diet composition studies were performed recently in Greece, Serbia, Turkey and Israel (Giannatos *et al.* 2005, Cirovic 2011, *pers. comm.*). Overlapping of the jackal trophic niche and foxes was also studied in Hungary (Lanski and Heltai 2002, Lanski *et al.* 2006). In Pench Tiger Reserve, Madhya Pradesh, India, has been studied the temporal activity patterns of the Golden Jackal *Canis aureus* and the Jungle Cat *Felis chaus* (Majmuder *et al.* 2011).

In a stomach content of a *Canis aureus* young female, shot in August 2011 in Alba County, we found more than 98% of corn *Zea mays*. In Bulgaria, stomach content analysis identified *Ulmus* and *Querqus* sp leaves, *Gramineae*, fruits of *Smilax excelsa*, (Atanasov 1953). Another analysis of stomach contents of 10 jackals showed: 2 stomachs full of grapes, one with pig ears probably from a beat waste, 2 were full of plums, 2 had remains of sheep, but not being able to be recognized and 3 had feathers and bones of poultry (Genov, Wassilev 1989). These facts motivate to study jackal diet for different seasons and in different habitat types. Interspecific relations and food habits studies have to be continued with the aim to define the jackal importance in their specific ecological systems, as spreading and reproduction of plants, control of increased rodents' populations, role of scavenger, etc. and do not overestimate their pre-



	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
JACKAL	0	6	0	0	24	13	52	5
RED FOX	3	8	3	4	24	16	42	27

Fig. 11. Golden jackal and red fox harvest in Calarasi County from 2003 to 2011; Data source: Nfd ROMSILVA.

dation habit on livestock and small game species.

It is assumed that where all vegetation layers are present, as for example at the edge of a woodland, or in open-woodland habitat, species diversity will be high, (Gilbertson *et al.* 1985), with increased mesopredators occurrence along habitat edges and small forest fragments (Cervinka *et al*. 2011). Thus the cumulative predation pressure on prey species (e.g. reptiles, birds, small mammals) should be monitored and/or controlled to maintain high biodiversity in these types of habitat where also many of carnivore species are present.

Landscape ecology has to be part of future studies of golden jackal expansion to focus on the relations between anthropic effects of the land use, presence of settlements and lakes or lowland streams. Intensive and extensive agriculture could also modify the number of individuals differently (e.g. by using of pesticides and reducing rodents' populations - one of the most important diet components for jackals). The other effect on biology diversity and jackal movements can be monitored through the modern techniques as continuous video and photo trapping, stomach content analysis or telemetry. It is necessary for maintaining this species, for its stabilization, but mainly for landscape management that would be friendly to this species and other wildlife.

For the European jackals population is characteristic a dynamic change of its number in pulsations with rapid decreases and increases. This was observed despite the low economy of hunting land and livestock activities, that kept up to date food sources, and despite the small number of jackals in the neighboring countries (Spassov 2007). We think that abandoned of agriculture use terrains could explain these observations by increased number of species in pastures or free of pesticide terrains, as i.e. rodents.

For jackal dispersal into Central Europe, according to Giannatos (2011 *in verbis*), positive factors could be: plains and low altitude as no barriers, daytime refuge (lowland plantations, few small forest remnants, riverside or channel-side dense vegetation), Danube River catchment, probably less snowy winters, large food base from anthropogenic sources (agriculture, livestock, hunting terrains).

Last decade's distribution maps, environment factors and land use change studied by generalized linear model (GLM) shows by 2030-2050 in Ukraine Region that the dominated pressure against jackal dispersal is represented by land use change without any effect by the global climate change, (Prydatko, Kolomitsev 2011), in concordance with natural resettlement.

We think that neighboring clusters and population density are also important for the recovering capacity of an area where jackals decreased their level and for areas where jackal wasn´t reported before.

Conclusions

New records of reproductive territorial groups inside Carpathian arch and near Periprava village in northern part of Danube Delta Biosphere Reserve demonstrate that jackal expansion is an active and actual process.

The response of jackal howling to acoustic stimulation was similar to previous studies; nevertheless we sometimes recorded response also after the 5th recording, so we advise that at least 5 playbacks should be made at each howling stations.

First estimates of densities in natural areas from Romania show similarity with other study areas in Croatia, Hungary and Greece. We observed variation in jackal densities between different areas. In general we found higher densities in eastern and southern parts of Romania.

The golden jackal populations' expansion in Romania seems to have an intermittent pattern.

Hunting bag data confirmed the increasing of jackal population in the last 7 years. More data of entire country are needed to draw the harvest evolution which is supposed to be related to the population dynamic. Possible competition of jackals with mesocarnivores or other medium size predators like

foxes or lynxes could be an interesting relation to measure by the effect over the ground-nesting birds on the habitat edges in field layer habitat inland and inside Danube Delta or over small herbivorous game species in woodland and scrub habitat types.

Urgent measures for the sustainable management of jackal specific ecological systems must be taken in Romania, but also to the largest population of jackals in Europe, which is in Bulgaria, a main distribution center.

Further studies are needed to achieve a model of how a population might grow under favorable conditions, but also when the populations reach its density limits, to avoid chaos or crash patterns of population dynamic which can produce local extinction of the species. Common studies between countries have to be done to evaluate: the biotic factors and land use in European environments, responsible of density levels, possible impact over biodiversity and especially on the wild bird's communities and small game species like ungulates.

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