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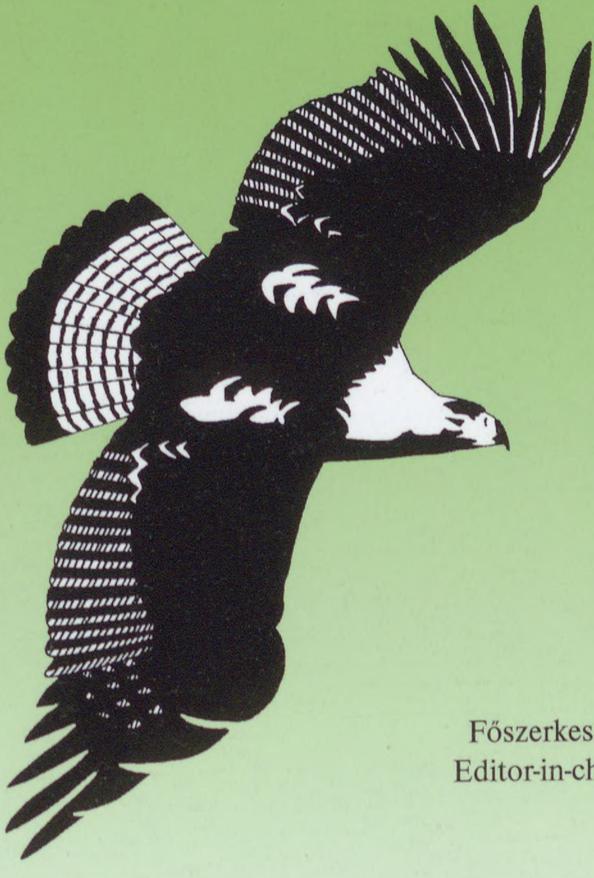
Elindította Herman Ottó
a Magyar Ornithológiai Központ folyóirataként 1894-ben



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MAGYAR GÁBOR

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Tartalomjegyzék – Contents

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Herman Ottó (1835–1914), a Magyar Ornithológiai Központ főnöke
(*Vezényi Elemér* festménye; a Herman Ottó Múzeum hozzájárulásával)

Emlékezés Herman Ottóra, az Aquila első szerkesztőjére halálának 100. évfordulója alkalmából

Száz éve, 1914. december 27-én hunyt el Herman Ottó, a Madártani Intézet első igazgatója, folyóiratunknak, az Aquilának alapítója és első szerkesztője. 2014-ben a Földművelésügyi Minisztérium emlékévet tartott a nagy tudós tiszteletére.

Herman Ottó 1835. június 26-án született Breznóbányán egy szepességi szász polgári család négy lány utáni első fiúgyermekeként. Édesapja, *Karl Herrmann* bányakirurgus volt. A fiút apja után a *Carl Otto* névre keresztelték. A család 1847-ben Alsóhámorba költözött. Az apa műkedvelő természetbúvár volt, aki a kor legnagyobb magyar ornitológusával, *Petényi Salamon János*sal is jó barátságot ápolt. A fiatal Ottó többek között Petényitől szerezte első ismereteit a természettudományok terén. 1848–1849 között a miskolci evangélikus főgimnáziumba járt, majd géplakatosnak tanult. Ezt követően Bécsbe ment, ahol 1853-ban beiratkozott az ottani politechnikumba. Tanulmányai mellett rendszeresen bejárt a bécsi Természettudományi Múzeumba, hogy természettudományos téren is képezze magát. Apja halálával nem juthatott otthonról több anyagi támogatáshoz, ezért tanulmányait felfüggesztve, lakatosként és gyári rajzolóként kereste meg a tandíjra és megélhetésre valót. 1856-ban nagyobb nyugat-európai utazást tett. Itáliai tartózkodása idején küldték meg lakcímére a katonai behívóját. Mivel a sorozáson nem jelent meg, büntetésül mint szökevényt tizenkét év katonai szolgálatra kötelezték az osztrák hadseregben, ahonnan végül hat év után sikerült leszerelnie. Egy lengyelországi, majd olaszországi kitérő után visszatért Bécsbe tanulmányai befejezése céljából. Az utókor számára ismeretlen okból rövidesen mégis Kőszegre költözött 1863-ban, ahol fényképészvállalkozásba kezdett két üzlettárssal. A vállalkozás sikertelensége miatt 1864-ben kőszegi barátja és támogatója, *Chernel Kálmán* ajánlásával Kolozsvárra ment *Brassai Sámuel* mellé preparátornak, majd az Erdélyi Múzeum-Egylet őrsegédként alkalmazásba is vette, ahol rendbe tette és jelentősen felfejlesztette az ottani állattani gyűjteményt. 1871-ben a *Magyar Polgár* című laphoz szerződött munkatársként, de az 1872. évi választások kapcsán folytatott publicisztikája miatt sajtóperek célpontja lett, így Szászvesszősre vonult vissza egy barátjához, ahol egy ideig kutatásainak élt. Ausztriai tudós ismerősei egy kameruni expedícióra invitálták. A Magyar Természettudományi Társulat azzal a szándékkal, hogy Hermant megtartsa a magyar tudomány számára, megbízta a magyarországi pókfauna megírására. A megbízást elfogadva Herman 1874-ben Budapestre költözött. Anyaggyűjtés céljából még ebben az évben a bécsi természettudományi múzeumnál tett tanulmányutat, majd hazatérve 1875. március 1-jétől 1879. október végéig őrsegédként dolgozott a Magyar Nemzeti Múzeum állattáránál. Pókmonográfiája 1876-ban jelent meg. 1877-ben indította el a *Természetrajzi Füzetek*et, melyet tíz éven át szerkesztett. „Magyarország pókfaunája" című munkájáért *Török József* debreceni professzor felterjesztette az MTA levelező tagjának, melyet azonban *Herman* tiltakozása következtében rövidesen visszavont. *Kossuth Lajos* ajánlásával 1879-ben országgyűlési képviselőnek választották. 1886-ig függetlenségi párti programmal Szeged, Miskolc, majd Törökszentmiklós követe volt. *Herman* az 1870-es években állatvédő mozgalmat is indított. 1885. július 26-án nőül vette *Borosnyay Kamilla* írónőt. A Magyar Természettudományi Társulat előbb a magyar halászat és halfauna feldolgozásával, majd a magyarországi madárvilág tanulmányozásával bízta meg. Utóbbihoz adatgyűjtés céljából 1888-ban Skandináviát is felkereste. 1891-től részt vett a 2. nemzetközi madártani kongresszus szervezésében Budapesten, majd 1893-ban minisztériumi meghatalmazással megalapította a Magyar Ornithológiai Központot, melyet 1914 végén bekövetkezett haláláig ő vezetett először mint tiszteletbeli főnök, majd 1906-tól mint tiszteletbeli igazgató. 1894-ben a magyar kormány támogatásával kezdte meg az *Aquila* című folyóirat kiadását. 1900-ban *Darányi Ignác* földművelésügyi miniszter megbízta egy könyv megírásával a madarak hasznáról és káráról, melynek első négy magyar kiadása végül 80 000 példányban fogyott el; valamint megjelent német és angol nyelven is. 1914 végén a Múzeum körúton egy teherszállító lovas kocsi elütötte, és lábtörést szenvedett. Kórházi ápolása során szövődményként tüdőgyulladást kapott. Az orvosok hazaküldték a legyengült embert, aki otthonában december 27-én reggel fél nyolckor adta vissza lelkét teremtőjének. Két nap múlva a Kerepesi temetőben helyezték örök nyugovóra. Földi maradványait 1965-ben végakaratának megfelelően a Miskolc-hámori temetőbe helyezték át. A zoológián kívül a néprajz, az antropológia és a publicisztika terén is jelentős életművet hagyott hátra.

Több mint 600 tudományos közleménye jelent meg. Jelentős közéleti tevékenységet fejtett ki: tagja volt a Királyi Magyar Természettudományi Társulat választmányának, a Magyar Nyelvtudományi Társaságnak, a Magyar Földtani Társulat barlangkutató bizottságának, az Erdélyi Múzeum-Egyletnek. A Magyar Ornithológusok Szövetsége, valamint később a Magyar Karszt- és Barlangkutató Társulat is érmet alapított a tiszteletére. Szobra többek között a budapesti Múzeumkertben, valamint a Herman Ottó Múzeum Papszer utcai épülete előtt található. Szülőházának, illetve utolsó lakhelyének falán 2014-ben emléktáblát emeltek. Számos további szobor, dombormű és emléktábla, utcanév, valamint intézménynév örökíti meg polihisztorunkat az emlékezet számára. A fehérhasú cinegelégykapó egy új-guineai alfaja *(Poecilodryas hypoleuca hermani)* annak auktora, Madarász Gyula jóvoltából ugyancsak az ő nevét viseli.

Herman Ottó madártani munkássága

Herman Ottó hátrahagyott életművéből nem a madártan teszi ki a legnagyobb részt, ugyanakkor *Petényi Salamon János* mellett a magyar madártanra ő volt a legnagyobb hatással. Saját munkássága, írásai, előadásai mellett szervező- és vezetőképessége is jelentős mértékben előmozdította a magyar madártan fejlődését, társadalmi megbecsülését. Döntő részt vállalt a budapesti 2. nemzetközi ornitológiai kongresszus megszervezésében, majd annak társelnökeként gördülékeny lebonyolításában is. Ezt követően megszervezte és megalapította a Magyar Ornithológiai Központot, mely számos hivatásos ornitológusunknak a műhelye, és még nagyobb számú műkedvelő madarásznak a tudásközpontja lett. Végül, de nem utolsósorban 1894-ben útjára indította folyóiratunkat, az Aquilát.

A madártan volt az, ami élete kritikus pontjain továbblendítette. Így Chernel Kálmán földbirtokos ajánlólevele mellett egy kitömött albínó pacsirta volt az, amellyel sikeresen pályázta meg *Brassai Sámuel*nél a kolozsvári természettudományos gyűjteményben a meghirdetett állást. Később egy madarakról szóló hírlapi vita mélyítette el kapcsolatát *Borosnyay Kamillá*val, későbbi feleségével. Egyetlen kifejezetten tudományos célú külföldi útja is madártani tárgyú volt, mivel az északi madárhegyek tanulmányozása volt a célja. Végül, de nem utolsó sorban parlamenti évei után a Magyar Ornithológiai Központ volt az, ami elfoglaltságot, társadalmi rangot nyújtott számára.

Lambrecht Kálmán, Herman legjelesebb életrajzírója ezeregyszáznegyven írásából száznyolcvannégy kifejezetten madártani tárgyút gyűjtött össze. Napilapokban megjelent publicisztikájával együtt 217 közleményét sorolja fel a *Magyar madártani bibliográfia,* közülük 19 könyv vagy egyéb önálló kiadvány; 78 cikk az *Aquilá*ban, öt közlemény külföldi madártani folyóiratokban, öt az *Erdélyi Múzeum-Egylet évkönyvé*ben, 38 az általa alapított *Természetrajzi Füzetek*ben, 65 a *Természettudományi Közlöny*ben, a további publikációk vadászati lapokban, napilapokban, egyéb folyóiratokban jelentek meg.

Herman első madártani írása a kabasólyomról jelent meg, mely az Erdélyi Múzeum-Egylet 1864. július 24-i ülésén megtartott előadása volt. Ekkor még két n-nel írta a nevét, de már ebben az előadásában is tanúbizonyságot tett öntudatos magyarságáról: odaszúrt az akkori német ornitológusdivatnak, miszerint főként múzeumokban, nem pedig terepen gyűjtötték ismereteiket. Kifejtette, hogy a kabasólyom az általa lőtt tojó begytartalma ismeretében inkább rovarevő, még ha képes is elfogni a sebes röptű fecskét is. Kevésbé haladó következtetése volt, hogy a fogságban tartott kabák öncsonkító hajlamát a természetes táplálék hiányának tudta be.

Munkaadójának, az Erdélyi Múzeum-Egyletnek az évkönyvében még további madártani vonatkozású írásai is megjelentek. 1865. április 22-i előadása néhány érdekesebb állattani közlés volt Erdély faunáját illetően. További vegyes állattani írásai mellett a Szarvas-tó állatvilágát ismertette behatóbban annak madaraival egyetemben.

Madárfajokat tárgyaló folyóirat-közleményei közül a legjelentősebb 1872-ben a *Mathematikai és Természettudományi Közlemények*ben jelent meg a Nemzeti Múzeumhoz kerülését követően. E dolgozatban a kékcsőrű réce erdélyi költését taglalta tíz oldalon keresztül. A fióka, illetve a különböző tollruhájú öreg madarak színes tábláit maga rajzolta meg. E fajt Nyugat-Európában még kevéssé ismerték keleti elterjedése okán, így sajnálatos, hogy a monográfia nem jelent meg azonnal németül vagy angolul is.

1875. március 1-jétől 1879. október végéig, múzeumi állattári évei idején a *Természettudományi Közlöny*be is rendszeresen írogatott. Első itt megjelent cikke a madárvilág 1875. évi vendégeiről, ezen belül a pásztormadárról szólt. 1877-ben kitartó fáradozásának köszönhetően elindult a múzeum tudományos folyóirata, a *Természetrajzi Füzetek,* melyben ugyancsak sorra jelentek meg madártani tárgyú dolgozatai. Miután a lap szerkesztéséről le kellett mondania, a publikálást is beszűntette itt. Már csak egy írása jelent meg 1888-ban egy korábban tévesen fecskesirályként közölt fiatal csüllő adatának helyreigazításáról.

A Magyar Természettudományi Társulat előbb a magyar halászat és halfauna feldolgozásával, majd a magyarországi madárvilág tanulmányozásával bízta meg. Elgondolása szerint ahhoz, hogy megismerjük a hazai vonuló madarak ökológiai igényeit, költő-, illetve telelőhelyüket is tanulmányozni kell. Ehhez a nálunk telelő fajok esetében Skandináviát, a tőlünk elvonuló madarak esetében Afrikát kell felkeresni. Utóbbi célból az egyiptomi Nílusdeltát szándékozott felkeresni a későbbiekben. Egyiptomi útja végül a korábbi kameruni úthoz hasonlóan nem valósult meg, de Skandináviába sikerült eljutnia: 1888-ban utazott el *Lendl Adolf* társaságában Norvégiába. Élményeiről 1893-ban megjelent könyve, „Az északi madárhegyek tájain" szolgált részletes beszámolóval. Útja során 35 faj 192 példányát sikerült begyűjtenie, melyből 64-et ki is preparált. Néhány egyéb tárgyú tudományos adatot is gyűjtött társával.

Az északi útját követő ornitológiai tevékenységét a Budapesten, 1891 májusában megrendezett 2. nemzetközi madártani kongresszusra történő felkészülés jellemezte. Magyarország előtt, részben *Habsburg Rudolf* trónörökös közbenjárására nyílt meg a lehetőség Bécs után a második nemzetközi ornitológiai kongresszus megrendezésére. A Természettudományi Társulat 1889. december 18-án tartott ülésén az *Entz Géza* elnöklete alatt megalakult rendezőbizottságban már Herman Ottó is részt vett. Elhatározták, hogy 1890-ben megfigyelőhálózatot állítanak fel a madárvonulás adatainak rögzítésére, az eredményeikről pedig beszámolnak a kongresszusnak. Ugyancsak célul tűzték ki, hogy a magyar madárfaunát a kongresszus idején egy kiállítás formájában mutatják be a résztvevőknek. A felmérésben részt vevő 21 önkéntes megfigyelő a minisztériumtól meteorológiai eszközöket is kapott. A legfontosabbnak tartott vonulási helyekre teljes munkaidős megfigyelőket küldtek a jelzett időszakra. Naponta háromszor felvették az időjárási adatokat, illetve a tíznapos időjárási átlagot is vezették. A megfigyelésekről a kongresszusra el is készült a jelentés.

Herman a kongresszuson is aktívan közreműködött: a svájci *Victor Fatio* mellett Herman Ottót is társelnöknek választották. A nyitó napon 75 perces előadást tartott „A magyarországi vándormadarak első megjelenéséről" címmel; a konferenciát követő, május 21-én induló kirándulások szervezése kapcsán pedig a Velencei-tó és a Balaton környékére tett kirándulást vezette. Ugyancsak ő rendezte sajtó alá a kongresszus eredményeit bemutató jelentéseket.

A kongresszus mind nemzetközi, mind hazai szempontból jelentős volt: a nemzetközi tudományos vérkeringésbe bekerült Magyarország, másfelől a hazai döntéshozók, politikusok számára is egyértelművé vált, hogy megfelelő, és az államháztartás számára is elviselhető mértékű támogatás mellett a hazai zoológiai tudomány képes nemzetközi színvonalon működni. A rendezvény további hazai hozadéka volt, hogy a kongresszus szervezéséhez összeszedett eszközöket, a múzeumi irodát a bútorokkal, valamint a kialakult megfigyelőhálózatot nem hagyták veszendőbe menni, és Hermant megbízták egy madártani központ megszervezésével. Ez a központ aztán – mely az amerikai után a világ második ilyen jellegű intézete volt – az alkalmazott madártan, részletesen a gazdasági madártan, a madárvonulás-kutatás, a madárökológia, valamint nem utolsó sorban az intézményes, szervezett madárvédelem hajtómotorja lett. Herman az adatgyűjtésbe a konferencia előkészületeihez hasonlóan számos önkéntest is beszervezett az általa megismert nyugat-európai ornitológiai egyesületek eredményes módszereit is alkalmazva. Innen merítette azt is, hogy a munkában aktívan részt vevő külső munkatársaknak rendes megfigyelői, levelező, illetve tiszteletbeli tag okleveleket adományozott. Mivel a működési költségek a felügyelő minisztérium révén többé-kevésbé biztosítottak voltak, az így bevont személyektől csak az adatok, cikkek, gyűjteményi példányok révén nyújtott segítséget várta támogatásként. A Magyar orvosok és természetvizsgálók nagygyűlésein úgy találta, túl sok oda nem illő ember vesz azokon részt; a tényleges szakmai eszmecsere helyett általa tapasztalt szaloncsevegés, kirándulgatás kapcsán éles kritikát fogalmazott meg, feltehető, hogy ezért sem kívánta egyesületbe szervezni a Központ külső aktivistáit. Így kiszűrhette azokat a tudományhoz nem értő műkedvelőket, akik nem járultak hozzá tényleges tudományos munkával intézetének a fejlődéséhez.

Bár életének hátralevő részében a halászat, pásztorélet, etnográfia, ősrégészet kutatása kötötte le egyre jobban, azonban a madártannal a későbbiekben sem szakadt meg a kapcsolata: továbbra is aktívan részt vett a nemzetközi ornitológuskonferenciák munkájában előadásokkal, illetve írásos közleményekkel, továbbá mind a Központ, mind az Aquila működését továbbra is gondosan felügyelte.

Herman Ottó nemzetközi megítélése zoológus körökben már bécsi évei során kedvező volt, a magyar pókfaunáról írt könyve pedig távolabbi országokban is hírnevet szerzett számára. A 2. nemzetközi ornitológiai kongresszus megszervezésében játszott szerepe madártani téren is meghozta számára a nemzetközi elismerést. Rendszeres résztvevője volt a későbbi ornitológiai kongresszusoknak, melyeken nyomtatásban is megjelent előadásokkal vett részt. Az Aquila főszerkesztői feladatai mellett „A madarak hasznáról és káráról" című, német és angol nyelven is kiadott ismeretterjesztő munkája tovább öregbítette hírnevét. Annak ellenére, hogy formális egyetemi zoológiai képzést nem kapott, a madártan fejlődését, történetét feldolgozó későbbi nemzetközi munkák leginkább Herman, illetve *Madarász Gyula* munkásságát emelik ki a magyar szakemberek közül az adott korszakból. Halálát követően több patinás madártani lap közölt részletes nekrológot tudósunkról.

Herman kihatása a magyar madártan fejlődésére

Herman Ottó madártani tevékenységének az elmúlt évszázadra kifejtett ráhatása kapcsán iskolateremtő voltáról is meg kell emlékeznünk, melyhez érdemes sorba venni egykori munkatársait, de a Madártani Intézet néhány későbbi alakját is, mivel az intézet, illetve annak folyóirata melegágya volt számos később híressé vált tudós fejlődésének is.

Herman sokban segítette hajdani mentora fiát, *Chernel Istvánt* (1865–1922), aki az ő kezdeményezésére írta meg „Magyarország madarai különös tekintettel gazdasági jelentőségökre" (Budapest, 1899–1900) című kétkötetes munkáját, valamint ő állította össze még a könyvet megelőzően Magyarország madarainak 1898-ban megjelent névjegyzékét. *Brehm* „Az állatok világa" (1902–1904) című munkájának madarakkal foglalkozó három kötetét is Chernel fordította le és igazította a hazai viszonyokhoz. *Naumann* tizenkét kötetes, „Naturgeschichte der Vögel Mitteleuropas" című nagy kézikönyvének új kiadásához a magyarországi adatok összegyűjtésével is Chernelt bízták meg, ami nemzetközi hírnevét tovább öregbítette. Ő volt az, aki Herman halálát követően tovább vezette a Madártani Intézetet egészen 1922-ben bekövetkezett haláláig.

Csörgey Titusz (1875–1961) 1895-től 1935-ig dolgozott az Intézetben. Szakterülete a madárvédelem, madárrendszertan, ökológia és gazdasági madártan volt. „Madárvédelem a kertben" című ismeretterjesztő könyvét tíz kiadásban jelentették meg. Több nemzetközi madártani, illetve madárvédelmi kongresszuson is részt vett és azokon előadást is tartott. Madárfestőként is ismert volt.

Schenk Jakab (1876–1945) 1898-tól dolgozott Herman mellett először tanárjelöltként, majd 1903-tól már asszisztensként. Főleg a madárvonulás kérdéseinek tanulmányozásával vált külföldön is elismertté. Dán példára az ő javaslatára vezették be a világon harmadikként – a dánok és a németek után – a költöző madarak fémgyűrűs jelölését 1908-ban. Jelentős volt természetvédelmi tevékenysége is, ő gyűjtött külföldről adományokat egy kis-balatoni kócsagőr alkalmazására; ezáltal neki köszönhető az ottani kócsagtelep megmentése. 1927-ben az intézet helyettes igazgatója, 1935-ben vezetője lett. Az ICBP európai alelnöke

(1938), az Országos Természetvédelmi Tanács tagja, a Deutsche Ornithologische Gesellschaft tiszteletbeli tagja volt.

Greschik Jenő (1887–1967) 1906-tól, másodéves bölcsészhallgató korától volt segélydíjas gyakornok a Madártani Intézetben. A begytartalom-gyűjtemény gondozása volt a feladata, továbbá egy maggyűjtemény létrehozásával is megbízták gyomortartalmak későbbi vizsgálatához. 1912 és 1922 között főként alapvető madárhisztológiai közleményei jelentek meg. A kor egyik legmodernebb szövettani és fotólaboratóriumát hozta létre a Madártani Intézetben. 1925-től 1944-ig a Magyar Nemzeti Múzeum állattárában a madárgyűjtemény munkatársa volt. Terepi eredményei sem elhanyagolhatóak szövettani munkássága mellett.

Lambrecht Kálmán (1889–1936) 1908-ban került gyakornokként *Herman Ottó* mellé, ott kezdett az őslénytan, közelebbről a paleornitológia szakterületével foglalkozni. A későbbiekben ugyan elkerült a Központtól, de az őslénytan maradt továbbra is a fő tevékenységi köre.

Számos további személy fordult meg a Központban gyakornokként vagy asszisztensként, akik később nem az ornitológiában lettek híresek, de fejlődésükre hatással volt Herman. Így *Jablonowski József* (1863–1943) entomológus, a magyar királyi Rovartani Állomás későbbi igazgatója volt Herman első asszisztense az intézmény alakulásával 1896-ig. *Szalay Lajos Elemér* (1875–1960) későbbi körorvos 1895–1901 között dolgozott itt orvostanhallgatóként. A továbbiakban is figyelte a madarakat, megfigyeléseit rövid közleményekben publikálva. *Pungur Gyula* (1843–1907), aki Herman Ottóval az ugyancsak függetlenségi párti képviselő *Ugron Gábor* családjánál ismerkedett meg, 1896-tól egészen haláláig szolgálattételre berendelt tanárként dolgozott az igazgató mellett. *Soós Lajos* (1879–1972) malakológus, későbbi akadémikus a budapesti tudományegyetemen folytatott tanulmányai mellett dolgozott a Központnál gyakornokként a századfordulón. *Vezényi Árpád* (1876–1960) későbbi gyűjtő és utazó mérnökhallgatóként 1901 márciusától 1903 szeptemberéig volt Hermannál asszisztens. A tihanyi levendulások kapcsán is ismert *Bittera Gyula* (1893–1970) gyógynövénykutató 1914-ben került a Központba, ahol 1917-ig gyakornokoskodott. *Kurt Floericke* (1869–1934) később híressé vált német ornitológiai szakíró 1898 elején néhány hónapot töltött a Központ alkalmazásában. Az alföldi madárvonulás megfigyelése volt a feladata *Gaál Gaszton* mellett. *Krammer Nándor* (1855–1921) tanár, múzeumigazgató, régész, néprajzi gyűjtő 1898-tól mint szolgálattételre beosztott tanár dolgozott egy időre a M. O. K.-nál.

A Központot segítő önkéntesek közül kiemelendő *gyulai Gaál Gaszton* (1868–1932) földbirtokos, későbbi országgyűlési képviselő, aki 1893-tól 1898-ig tevékenykedett a Központban. 1897-ben *Kállay Ubul* (1875–?) későbbi országgyűlési képviselő is önkénteskedett itt.

Herman halála után *Warga Kálmán, Vertse Albert, Keve András, Vasvári Miklós, Udvardy Miklós, Pátkai Imre, Sterbetz István* vitte tovább a madártan ügyét az Intézetnél, csak a legnevesebbeket megemlítve. Száz fölötti azoknak a száma, akik szakértelmükkel, önkéntes adatgyűjtésükkel, preparátumokkal, gyűrűzéssel az Intézet köré szerveződtek. Név szerint megemlítendők az illusztrátorok is: *Vastagh Géza, Vezényi Elemér, Nécsey István, Koszkol Jenő*.

A megfigyelőhálózat orgánumaként, annak továbbképzésére, szakirodalommal való ellátására Herman Ottó szinte a Központ születésével egy időben megkezdte egy tudományos folyóirat, az *Aquila* kiadásának a megszervezését. A lap 1894 júliusában meg is jelent Németország, Nagy-Britanna és az Egyesült Államok folyóiratai – a *Journal für Ornithologie* (1853), a *The Ibis* (1859), a *Gefiederte Welt* (1872), a *The Auk* (1876), az *Ornithologische Monatsschrift* (1876), a *Bulletin of the British Ornithologist Club* (1892), illetve az *Ornithologische Monatsberichte* (1893) – születését követően, a világ nyolcadik akkor létező madártani szakperiodikumaként.

A lap időnként mind szerkezetében, mind formátumában változásokon ment át. Az A4-es formátumú folyóirat első számának címoldalán még *Vastagh Géza* festménye volt látható egy szirti sasról. A 22. kötettől valamivel kisebb formátumban adták ki a folyóiratot. Ekkoriban már *Csörgey* munkája díszítette a borítót. Az 1950-ben megjelent 51–54. kötet idején vette fel a lap mai méretét. Eleinte két hasábban, magyarul és németül párhuzamosan jelentek meg a cikkek, később már nem mindegyik közlemény volt mind a két nyelven olvasható. A lap mind a mai napig jelentős szerepet tölt be cserekiadványként is: az Országos Mezőgazdasági Könyvtár 1960-as felmérése szerint az Intézet könyvtárába rendszeresen járó 310 folyóiratból 215 cserepéldányként érkezett.

Herman intézete magas színvonalon művelte az akkoriban sokakat foglalkoztató gazdasági madártan vonalát, egyebek mellett alapos gyomortartalom-vizsgálati eredmények láttak napvilágot itt. Ugyancsak kiterjedt vizsgálatokat folytattak madártelepítési kísérletekkel, mesterséges madárodútelepek kialakításával. A madárvonulás adatainak szervezett gyűjtésével is csakhamar példát mutatott más madártani központok, egyesületek számára; a vonulás madárjelölésekkel történő kutatása terén ugyancsak az élen járt. Tehetséges kutatóknak a Központhoz szerződtetésével a madárszövettan és az őslénytan is az intézmény szakterületeivé váltak. Herman halála után a Központ – ekkor már Madártani Intézet néven – egyre aktívabb lett a madárvédelem, természetvédelem terén is; a hazai fajok madárrendszertani vizsgálatait, majd ökológiáját *Vasvári Miklós, Keve András,* illetve *Udvardy Miklós* honosították meg. A második világháborút követően sajnos alábbhagyott a madártan lendülete hazánkban, melynek az is oka volt, hogy egy sor tehetséges fiatal kutatót vesztett el az ország. Vasvárit a háború kegyetlensége pusztította el, Udvardy Miklóst a formálódó kommunista diktatúra űzte külföldre, akit rövidesen további ígéretes tehetségek – *Farkas Tibor, Szijj József, Szijj László, Festetics Antal* – követtek. A Madártani Intézet egyedül a madárhangkutatás terén kezdett új tudományterület művelésébe a Növényvédelmi Kutatóintézet keretein belül, energiáit aztán 1964-től egyre inkább az állami természetvédelem szolgálata kötötte le először az Országos Természetvédelmi Hivatalhoz történő áthelyezéssel, majd az Országos Környezet- és Természetvédelmi Hivatalban történő teljes beolvadásával. A madártant a gerinces zoológia többi ágával együtt sokáig egy fajta hobbitudománynak tartotta a Magyar Tudományos Akadémia is, mivel a gerinctelen csoportokkal szemben nem tudott már új fajok leírása révén darabszámmal is könnyen mérhető új eredményeket futószalagon szállítani, a vasfüggöny előidézte tudományos elszigetelődés pedig a külföldi társintézményekkel is megnehezítette mind a kapcsolat-, mind pedig a lépéstartást.

Az Intézetben művelt alkalmazott madártant az egyre szervezettebbé váló állami természetvédelem, ezen belül leginkább a sorban megalakuló nemzeti parkok munkatársai vitték, viszik tovább a védett természeti területek madárvilágának tudományos szempontú kutatásával, mely aztán a hazai konzervációbiológiai kutatások alapjait is megvetették. A madárgyűrűzés, faunisztikai adatgyűjtés révén az Intézet köré csoportosuló aktivisták pedig az 1974-ben megalakuló Magyar Madártani Egyesület tagságának képezték a magját.

A madártant napjainkra rangjának, jelentőségének méltó helyen kezeli az MTA is, számos nagydoktori fokozatot ítéltek oda ornitológiai tárgyú disszertáció alapján az elmúlt időszakban. A szabadidős madármegfigyelés, madárfotózás közkedveltsége is jelentős fejlődésen ment keresztül az elmúlt száz évben. Ha Herman Ottó örökségéből a Madártani Intézet fennmaradását nem is volt képes biztosítani az utókor, Aquila című folyóirata, illetve az időközben a Duna–Ipoly Nemzeti Park Igazgatóság gondozásába került könyvtára ma is egyaránt szolgálja a kutatókat és a műkedvelőket, madártannal pedig számos egyetemünk tanszékein, múzeumokban, nemzetipark-igazgatóságokon, madártani célú társadalmi szervezetekben foglalkoznak napjainkban Magyarországon. Az ornitológia minden külső nehézség dacára ismert – és elismert – tudományterületté fejlődött az elmúlt évszázad során hazánkban Herman Ottó munkásságának alapjain.

Magyar Gábor főszerkesztő

Remembering to Ottó Herman, the founder and first editor of the periodical Aquila on the 100th anniversary of his death

It has been a hundred years since Ottó Herman, the first director of the Hungarian Ornithological Centre and also the first editor of our periodical passed away on 27 December 1914. The Hungarian Ministry of Agriculture announced 2014 in honour of the great scientist as a year of his remembrance.

Herman was born in Brezno on June 26, 1835 as the first sun after four daughters in a zipser family. His father, *Karl Herrmann* was a mine surgeon. The sun was baptised Carl Otto after his father. In 1847, the family moved to Alsóhámor. The father, who was an amateur naturalist was also good friends with the era's renown Hungarian ornithologist *Salamon János Petényi*. The young Otto gathered his first bits on knowledge in natural history from Petényi. He attended the Lutheran secondary school of Miskolc between 1848–1849 then he went to machinery locksmith school. Consecutively he went to Vienna, where in 1853 he enrolled the Polytechnic Institute. He educated himself in the field of science in the Natural History Museum of Vienna by visiting it at a regular basis. Upon the death of his father he received no more financial support from home, which forced him to suspend his education and earn his bread and tuition fee as a locksmith and factory drafter. In 1856, he made a larger trip to various parts of Western Europe. He was spending his time in Italy when he was drafted to the army. Since he did not show up for the conscript he was sentenced to twelve-years of service in the Austrian army as a draft dodger where he served finally six years before finally he managed to be discharged. After a detour to Poland and Italy he returned to Vienna for the purpose of completing his studies. For a reason not yet known by history he moved to Kőszeg in 1863 and started a small photography business with two partners. Since the little firm deemed to be unsuccessful, he went in 1864 to Cluj to work as a taxidermist next to *Sámuel Brassai* with the recommendation of *Kálmán Chernel,* his friend and supporter in Kőszeg. Soon he managed to get a firm job as an associate curator of the Transylvanian Museum Society. He managed to fix and considerably enlarge the zoological collection there. He became the associate of the daily news *Magyar Polgár* ("Hungarian Citizen") in 1871 but he got tangled up with the threat of lawsuits for his radical writings about the 1872 elections in his columns so he retired from journalism to a friend's house in Szászvesszős (today Veseuș in Roumania) to live for his research for a while. After some time his Austrian contacts invited him to an expedition in Cameroon but the Hungarian Natural History Society managed to keep him in Hungary by contracting him to write up a book on the spider fauna of Hungary. By accepting the job he moved to Budapest in 1874. For the purpose of collecting material for his book he revisited the natural history museum of Vienna in the same year. With his return home he became assistant curator of the zoological collection of the National Museum from 1 March 1875 until late October 1879. His book on the Hungarian spider fauna was published in 1876. In 1877, he started a periodical of the museum, *"Természetrajzi Füzetek"* (Natural History Journal), of which he was the editor for ten years. He was nominated as member of the Hungarian Academy of Science for his spider work by *József Török,* a professor at the Debrecen University but as a result of protests by Herman himself the nomination was withdrawn. He was elected as an MP in 1879 with the recommendations of *Lajos Kossuth,* former governor of Hungary but already in exile at that time for his role during the 1848 revolution. Herman represented Szeged, Miskolc, and then Törökszentmiklós until 1886 with the programme of the independence party. He started an animal welfare programme in the 1870s, too. On 26 July 1885 he married the novelist *Kamilla Borosnyay.* The Hungarian Natural History Society assigned him to write a book on fishing and the fish fauna of Hungary, and also to carry out research on the bird fauna of Hungary. For latter work he visited Scandinavia in 1888. From 1891 he took part in organising the 2nd International Ornithological Congress in Budapest, then in 1893 he established the Hungarian Ornithological Centre by the order of the Ministry of Education (he was also the leader of it as an honorary chief, and then as honorary director until his death in 1914). In 1894 he also launched a periodical in ornithology, named *Aquila. Ignác Darányi,* minister of agriculture assigned him to write up a book on the use and harm of birds in 1900. The first four Hungarian editions eventually sold over 80,000 copies. Later it was also published in German and English as well. At the end of 1914, he suffered from a traffic accident in downtown Budapest and he was hospitalised for leg fracture. While in hospital bed, he came down with pneumonia. The doctors sent home the elderly patient who passed away during the morning of 27 December. Two days later, he was buried in the Kerepesi cemetery. According to his will, his remains were later transferred to the Miskolc-Hámor cemetery in 1965. In addition to zoology, he left behind a significant amount of life achievement in ethnography, anthropology and journalism as well.

Herman published over 600 scientific communications. He had a very active public life: he was a member of the executive committee of the Royal Hungarian Natural History Society, the Hungarian Association for Linguistics, the speleological committee of the Hungarian Society for Geology and the Transylvanian Museum Society.

The Hungarian Association of Ornithologists, and later the Hungarian Speleological Society founded a medal in his honour. Statues were erected for his memory, inter alia, in the Budapest museum garden or in the garden of the Herman Ottó Museum in Miskolc-Lillafüred. Both his place of birth and his last domicile hold a plate of remembrance since 2014. A number of further public sculptures, relieves and plates, as well as institutions' names and street names commemorate the great polyhistor. A subspecies of Black-sided Robin from New Guinea *(Poecilodryas hypoleuca hermani)* bears his name as a courtesy by *Gyula Madarász,* the auctor of the race.

The ornithological biography of Ottó Herman

Ornithology may not be covering the largest part of his scientific heritage but it was Herman to have the highest impact on Hungarian ornithology right next to *Salamon János Petényi:* in addition to his own work, his writings, lectures, his ability of leadership and organising significantly enhanced the development and public recognition of Hungarian ornithology.

He took a crucial share in the organisation and management of the 2nd International Ornithological Congress. He organised and founded the Hungarian Ornithological Centre, a professional workshop of many Hungarian ornithologists, and a centre of knowledge of an even greater number of amateur birdwatchers. Last but not least, he launched the periodical *Aquila* in 1894. In return, it was the discipline of ornithology that helped him through some more difficult periods of his life. Along with a letter of recommendation by his mentor *Kálmán Chernel,* it was a stuffed albino lark that helped him to get the advertised job in Cluj-Napoca under the supervision of *Sámuel Brassai.* Later, a journal debate on the feelings of birds brought him together with her later wife, *Kamilla Borosnyay*. His only strictly scientific trip abroad was also of ornithological purpose to the bird cliffs of Norway. Last but not least, it was the Hungarian Centre of Ornithology to provide him with occupation and social esteem when he was no longer a Member of the Parliament.

Kálmán Lambrecht, his leading biographer, listed 184 papers in ornithology out of a total of his 1140 writings. Together with the articles in newspapers a total of 217 ornithological publications were listed in the bibliography of Hungarian ornithology: 19 books or other independent publications, 78 papers in Aquila, five articles published in foreign ornithological journals, five in the Museum periodical *"Erdélyi Múzeum-Egylet évkönyve"* 38 in *"Természetrajzi Füzetek"* founded by him in the Budapest museum, 65 in *"Természettudományi Közlöny"*, the rest in hunting journals, newspapers or other periodicals.

Herman's first ornithological work was published on his oral presentation held on July 24, 1864 in the Transylvanian Museum Society about the Hobby. During this time he still wrote his name with a double "n" (later he omitted the double consonants from his name to show his commitment to his Hungarian nationality), but he already demonstrated in his presentation his patriotism by a little criticism to the foreign, mostly German fashion in ornithology of studying birds mostly in the museums rather than in the field. He explained that the Hobby, in the light of the ingluvial content of the collected female seemed to be more of an insectivore than a carnivore, even if the species was known to be able to catch the swift Swallows as well. It was a less advanced conclusion he drew that self-mutilation observed on captive Hobbies was the result of the lack of natural nutrients.

In the yearbook of museum society a few more bird-related writings can also be found. His presentation held on 22 April, 1865 contained some of his more interesting zoological findings as regards the fauna of Transylvania. In addition to miscellaneous shorter communications in Zoology he presented his observations of the fauna, including birds, of Szarvas-tó in more detail.

Out of his papers in periodicals on individual species his ten-pages-long paper on the White-headed Duck in Transylvania may be regarded as the most relevant one, published in Hungarian in the *Mathematikai és Természettudományi Közlemények* ("Communications in Mathematics and Natural History") in 1872 right after he joined the Hungarian National Museum. He drew the illustrations of the article on the chick and those on the head pattern of the various adult plumages in colour himself. This species was little known at that time in Western Europe due to its eastern distribution range, so it is a pity that the monograph was not published immediately in German or English as well.

During his years in the zoological cabinet of the natural history museum from 1 March 1875 to late October 1879, he regularly published in *Természettudományi Közlöny* ("Natural History Bulletin") as well. The first such paper was written on the bird visitors of 1875, including the invasion of the Rose-coloured Starlings. As a result of his efforts the Museum launched its own scientific journal, *Természetrajzi Füzetek* ("Journal of Natural History") in 1877. Here he regularly wrote about birds as well. When he had to resign from being editor of the periodical he also ceased publishing here. His last communication appeared in 1888 on the correction of an erroneous record of a juvenile Kittiwake previously published as Sabine's Gull.

The Hungarian Natural History Society contracted him to write up a work on fishing and the fish fauna of Hungary and later to study the local bird fauna. According to his concept one needed to get to know the breeding and wintering grounds of the migratory birds before we can understand their ecological needs in Hungary. To achieve this, he wanted to visit Scandinavia for those birds wintering in Hungary, and he also planned to go to the Nile delta in Egypt to study the wintering grounds of those birds migrating south from Hungary. His trip to Egypt, similarly to his earlier plan to Cameroon, was never realised but his Nordic expedition came true: he travelled to Norway in 1888 in the company of *Adolf Lendl.* He published his book in 1893 on their travel with the title "In the region of the northern bird cliffs" with a detailed report on his experience. He also managed to collect 192 specimens belonging to 35 different species, out of which he stuffed 64 for the Museum. During the trip, they also collected some other scientific data.

After his journey to the North his ornithological activity focussed on the preparatory work to the 2nd International Ornithological Congress in Budapest to be held in May 1891. The opportunity to hold the congress in Hungary opened up in part by the intervention of *Rudolf,* Crown Prince of Austria after the one held in Vienna previously. Herman was already present on the meeting of the Natural History Society held on 18 December 1889 when the organising committee was elected under the presidency of Prof. *Géza Entz.* The committee decided to set up a network of observers to survey the bird migration in Hungary in 1890, with the aim to report on their results to the Congress. They also made a decision to show the Hungarian bird fauna to the participants of the congress in form of an exhibition. The 21 voluntary observers participating in the migrating bird survey received meteorological instruments as well from the ministry. To the most important spots of migration full-time observers were sent for the indicated period. Weather data were taken three times a day and the 10-day average of the weather was also recorded. The report of the survey was presented as planned on the congress.

Herman actively contributed to the success of the Congress itself as well. He was co-president of the conference along the Swiss *Victor Fatio;* he also gave a 75-minute-long lecture on the opening day with the title "The first appearance of migratory birds in Hungary"; he also led a post-conference tour on May 21 to Lake Velence and Balaton. It was also his resort to publish the results of the Congress in printing.

The congress earned both domestic and international recognition: Hungary was accepted as part of the international scientific network, on the other hand, it has also become clear to domestic decision makers that Hungarian zoology is able to live up to international standards even with a moderate level of financial support from the state budget. The event brought further gains by the fact that the office with its furniture, as well as the monitoring network were not let to go to waste, rather, Herman was assigned to set up an ornithological centre based on the office equipment and the network. This centre—which was the second of its kind in the World after the one in the USA—became the driving force of applied ornithology: "ornitho-economy" (the research of the role of birds in agriculture and forestry), bird migration research, avian ecology, and last but not least organised bird conservation. Herman, similarly to the preparatory work of the congress, recruited many volunteers as well, applying also effective methods he learnt from West European ornithological societies. One of such methods was the system of awarding the external volunteer staff actively involved in the work with the titles 'ordinary observer', 'corresponding member' or 'honorary member'. Since the operating expenses of the office were secured through the ministry he expected only observation data, manuscripts or collection of specimens from the persons involved as assistance but he did not want to organise an entire society around the Centre. He expressed sharp criticism that there were too many of those people present on the annual assemblies of the Hungarian medical doctors and naturalists who did not belong there, and the chitchatting, partying as well as lengthy excursions took too much time to the expense of real exchange of scientific information, it appears that his bad experience led him to screen the volunteers before accepting them as external associates of the office.

For the rest of his life, Herman became increasingly involved with the study of fishing, ethnography, archaeology but he still found time to participate on international ornithological congresses with lectures and written communications, and to supervise both the Centre and its periodical Aquila for the rest of his life.

Herman was already a renowned person in zoologist circles during his first staying in Vienna and his book on the Hungarian spider fauna definitely turned him into a well-known zoologist. His role played during the 2nd International Ornithological Congress gave him international recognition also in the field of ornithology. He was a regular participant of later congresses with oral and printed presentations. In addition to being the chief editor of Aquila, his popular science book "Birds useful and harmful", which was released in German and English, too, made him even more acclaimed. Although he never received any formal training in zoology, later works on the history of ornithology cite Herman or the taxonomist *Gyula Madarász* most frequently out of the Hungarian ornithologists of the period. Following his death a number of foreign journals published detailed obituaries about him praising his achievements in ornithology.

Herman's impact on the development of Hungarian ornithology

When evaluating the impact of Otto Herman's ornithological activity to the past century, one needs to remember his achievement as an educator and a scientific leader as well. For this, we shall enlist his former colleagues, but also some later figures of the Institute of Ornithology. By the time he was appointed as head of the Institute, he was already actively involved with some other disciplines as well. The Institute and its journal served as a hothouse of the scientific development for many researchers becoming later famous. Herman supported much *István Chernel,* the son of his former mentor, Kálmán Chernel. The young Chernel wrote the two-volume book "The Birds of Hungary with special respect to their economic importance" (Budapest, 1899–1900), and even before, he compiled the checklist of Hungarian birds in 1898. He translated and adapted to Hungarian the three volumes on birds of Brehm's "Tierleben" (1902–1904). He was the Hungarian correspondent to *Naumann's* twelve-volume handbook "Naturgeschichte der Vögel Mitteleuropas" (Natural history of the birds of Central Europe), which further expanded his recognition internationally. After Herman's death, Chernel was the one who took over the chair of director in the Institute of Ornitology until his death in 1922. *Jakab Schenk* (1876–1945) worked with Herman from 1898, first as a teacher intern than an assistant from 1903. He became internationally renown mostly for his studies on bird migration. He suggested Herman to adopt the Danish method of marking the birds with metal rings, which was officially introduced by the Institute in 1908, after Denmark and Germany. His was also involved with nature conservation by fundraising to employ an egret warden on Kis-Balaton, where the heronry with its nesting egrets could finally be saved from poachers. In 1927 he became the Institute's assistant director, and then the head in 1935. He was the European Vice President of ICBP (1938), a member of the National Council for Nature Conservation, and the honorary member of the Deutsche Ornithologische Gesellschaft. *Titusz Csörgey* (1875–1961) worked at the Institute from 1895 to 1935. He specialised in bird protection, bird taxonomy, ecology and economic ornithology. His "Birds in the garden", a non-fiction book had been released in ten editions. He participated in a number of international congresses in ornithology and bird protection by also giving presentations. He was also a recognized bird painter. *Jenő Greschik* (1887–1967) was a trainee at the Ornithological Institute since his sophomore year in 1906. He took care of the ingluvial collection, and he was also assigned to set up a seed collection as a reference material for the planned analysis of stomach contents. Between 1912 and 1922, he published papers mainly in avian histology. He built one of the most modern laboratories of the period in histology and also in photography within the Ornithological Institute. From 1925 to 1944 he worked in the zoological collection of the Hungarian National Museum. Besides his results in histology his field observations are also worth mentioning. *Kálmán Lambrecht* (1889–1936) got involved first with palaeontology as an intern next to Herman from 1908. Although he had to part the Centre of Ornithology later but palaeontology remained his main field of interest throughout his life.

A number of additional persons occurred in the Centre in the era of Herman as interns or assistants, who later became famous in disciplines other than ornithology but Herman still had a positive influence on their development. *József Jablonowski* (1863–1943), entomologist, later head of the Hungarian Royal Entomological Station was Herman's first assistant from the beginnings until 1896. *Lajos Elemér Szalay* (1875–1960), practitioner worked between 1895–1901 here as a medical student. He continued birdwatching as a hobby, and he published his observations in short communications from time to time. *Gyula Pungur* (1843–1907), secondary school teacher who had met Herman at the house of the *Ugron* family, worked from 1896 until his death as a teacher transferred for scientific service. *Lajos Soós* zoologist (1879–1972), later member of the Hungarian Academy of Science worked here part time during his university years at the turn of the 20th century. *Árpád Vezényi* (1876–1960) collector and traveller was an assistant to Herman from March 1901 to September 1903. *Gyula Bittera* (1893–1970) herb specialist was an intern from 1914 to 1917. *Kurt Floericke* (1869–1934) German ornithologist writer spent a few months with the centre in early 1898 to study bird migration on the Great Plain together with Gaszton Gaál. *Nándor Krammer* (1855–1921), teacher, museum director, archaeologist and collector in ethnography worked here also as a teacher transferred for scientific service from 1898.

Out of the volunteers *Gaszton Gaál* (1868–1932), later a member of the Upper House worked here from 1893 to 1898 and *Ubul Kállay*—also an MP later on—in 1897. The artists contracted by the Institute to illustrate birds shall also be mentioned: *Géza Vastagh, István Nécsey, Elemér Vezényi, Jenő Koszkol.*

After the death of Herman *Kalmán Warga, Miklós Vasvári, Albert Vertse, András Keve, Miklós Udvardy, Imre Pátkai* and *István Sterbetz* carried on the work in the Centre of Ornithology, just to name but a few. The number of those connected with the Institute count over a hundred people who offered their expertise, volunteered with data collection, sent in specimens, participated in bird ringing and so on.

For the organ of the observation network Herman started to prepare a new journal, Aquila, a scientific bilingual periodical in ornithology right from the start of the centre in 1893. The journal was first published half a year later, in July 1894 being still the 8th oldest periodical in the field of ornithology nowadays after those journals published in Germany, the United States and Great Britain—*Journal für Ornithologie* (1853), *The Ibis* (1859), *Gefiederte Welt* (1872), *The Auk* (1876), *Ornithologische Monatsschrift* (1876), *Bulletin of the British Ornithologist Club* (1892), as well as *Ornithologische Monatsberichte* (1893).

The journal has changed during the course of time gradually. It started in an A4 format, and the cover page, a Golden Eagle was painted by *Géza Vastagh.* From Volume 22 the journal took a slightly smaller format. By this period the front picture was already switched to that drawn by Titusz Csörgey. The journal earned its current size in 1950 with volume 51–54. The first volumes were printed in double columns with parallel texts in Hungarian and German. Later the translated parts followed the Hungarian text or the article would be published only in one (Hungarian or German) language. After World War II the international language became English.

The journal also served as a relevant exchange material. According to a survey conducted by the National Agricultural Library in 1960, out of the 310 periodicals received by the Institute about 215 arrived as exchange material.

Herman's Institute practiced 'ornitho-economy'—a popular field at the period researching the role of birds in agriculture—of a high standard. Among other things, a number of valuable papers were released on studies of stomach contents of birds. Also, extensive field trials were carried out in bird protection by establishing artificial bird nest box colonies. The systematic collection of migration data was exemplary to other ornithological organisations; it was also among the first institutes to start bird banding with metal rings. With the hiring of talented young researchers avian histology and palaeontology became also expert fields of the institute. After the death of Herman the institute became more and more involved with bird conservation issues. Studies on the taxonomy and ecology of birds were initiated by *Miklós Vasvári, András Keve* and *Miklós Udvardy.* Sadly, ornithology lost momentum after the second world war. One of the reasons for this was the loss of some talented young ornithologists to Hungarian science. *Vasvári* became the victim of the cruelty of the war; Miklós Udvardy fled the country to continue his scientific carreer in a free country rather than in a forming communist dictatorship, followed soon by other promising young researchers like *Tibor Farkas, József Szijj, László Szijj,* together with *Antal Festetics*. In the next two decades the only new discipline initiated by the Institute of Ornithology was 'ornitho-musicology'. From 1964 on the institute was preoccupied with the civil service in official nature conservation by becoming part of the Nature Conservation Bureau and later it was completely dissolved within the National Bureau for Environment and Nature. The

Hungarian Academy of Sciences regarded ornithology, together with other types of vertebrate zoology as some sort of a hobby science, since it was not able to deliver description of new species on a conveyor belt as measurable new results. The institute was isolated by the iron curtain internationally as well, which hampered both the communication and keeping pace with foreign institutions in the same field.

The activity of the Institute in applied ornithology had been taken over gradually by the staff of official nature conservation, especially by the personnel of the forming new national parks through the research of the bird fauna of protected areas, which embedded the base for research in conservation biology.

The volunteers guided by the centre in collecting observation data, participating in bird ringing, etc. built later the core membership of the Hungarian Ornithological Society, which was established in 1974. Finally, ornithology has received proper recognition by the Hungarian Academy of Science, a number of Doctor of Science degrees have recently been awarded to researchers in this field.

Even though Herman's institute was not preserved by the posterity, its library and its periodical Aquila are still at the service to both professional and spare time ornithologists, and ornithology has been practiced in a number of university departments, museums, national park directorates and ornithological associations throughout the country nowadays. The popularity of birdwatching, bird photography has also evolved considerably over the past period. In spite of all the difficulties it developed into a well known—and renown—discipline in Hungary during the last century on the basis of Ottó Herman's work.

Gábor Magyar
editor-in-chief

Mennyiben járultak hozzá a 2009–2014 között lezajlott agrár-környezetgazdálkodási program túzokvédelmi zonális célprogramjainak előírásai a túzok *(Otis tarda)* költési sikerét a fészkelési időszakban veszélyeztető tényezők mérsékléséhez?

Vadász Csaba & Lóránt Miklós

Kiskunsági Nemzeti Park Igazgatóság

Abstract—**Vadász, Cs. & Lóránt, M. (2014): How effective were the prescriptions of the Great Bustard *(Otis tarda)* zonal programmes of the agri-environmental schemes to mitigate the threatening factors to the breeding success?**

In our study we examined the effectiveness of agro-environmental schemes focusing on the protection of the Great Bustard *(Otis tarda)* in the period between 1 September, 2009 and 31 August, 2014, from the aspect of the breeding success. In tótal, 441 nest were detected in Hungary, from which 406 (92.1%) were found on the area covered by the program of Environmentally Sensitive Areas (ESA). Within that, 164 (40.4%) were found during the implementation of the Great Bustard protection schemes, while 64 (15.8%) were found during the implementation of other schemes. Representing a relatively high proportion of the detected nests, 178 (43.8%) were found within the ESA zones, but on parcels not being involved in any agri-environmental schemes between 2009 and 2014. The most relevant factors threatening the breeding success of the 164 clutches found on parcels managed according to the regulations of the Great Bustard protection schemes were mowing (33%) and pesticide treatment (23.3%). Furthermore, a high proportion of the nests were found due to human disturbance (pedestrians visiting the area for various reasons) (11.6%), or during soil-preparation and tillage (9.7%), and also during early harvesting (8.7%), as well. For the more effective protection of the species the spatial expansion of the Great Bustard protection schemes is not necessary, but the restriction of agricultural activities (mowing, pesticide treatment, disturbance, tillage and early harvesting) within the sensitive period of the Great Bustard would be essential in the forthcoming period. An appropriate tool would be the preference of crops, like set-aside fields, fallow-lands or extensively managed wheat, having cropping technology compatible with the requirements of the Great Bustard protection on arable lands.

Key words: *Otis tarda,* agriculture, agri-environmental scheme, Environmentally Sensitive Areas, bird conservation, Hungary

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Bevezetés

A túzok *(Otis tarda)* Európa és a világ veszélyeztetett állatfajainak vörös listáján sérülékeny besorolással szerepel *(Birdlife International, 2013),* tekintve, hogy világállománya globális csökkenést mutat. Teljes elterjedési területén legalább passzív (jogi) védelemben részesül.

A túzok nemzetközi fajvédelmi tervében *(Nagy, 2009)* felsorolt 9 fő veszélyeztető tényező közül összesen öt vezethető vissza részben, vagy egészen a túzok élőhelyein végzett agrártevékenységekre *(Lóránt, 2014)*, amelyek közül a mezőgazdasági munkavégzés következtében okozott tojás- és fiókapusztulás közvetlen és jelentős hatással van a Nyugat-Palearktisz túzokállományának egészére.

A megfelelő élőhelystruktúrával rendelkező nyílt pusztai élőhelyek elvesztése, mint kritikus hatású legfőbb veszélyeztető tényező után, a légvezetékekkel történő ütközés mellett jelentős hatással szerepelnek az agrártevékenységek okozta, a költési sikert közvetlenül befolyásoló veszteségek is. Magyarországon 2002 óta van lehetőség olyan kifejezetten természetvédelmi célú agrártámogatások igénybevételére, amelyek a kezdetektől fogva megcélozzák az agrártevékenységek helyes megválasztásától és megvalósításától nagymértékben függő túzok védelmének elősegítését. A 2004 és 2009 között megvalósult ötéves agrár-környezetgazdálkodási támogatások speciális túzokvédelmi előírásainak elemzése *(Németh et al., 2009)* rávilágított, hogy a túzok éves életciklusának érzékeny időszakában végzett kaszálások és növényvédelmi munkák az ismertté vált fészkek mintegy 70%-át veszélyeztetik.

Magyarországon az Európai Mezőgazdasági Vidékfejlesztési Alapból nyújtott agrár-környezetgazdálkodási (AKG) támogatások 2009. szeptember 1. és 2014. augusztus 31. között megvalósult rendszerében a Magas Természeti Értékű Területek programja (MTÉT) összesen 10 területen tette lehetővé kifejezetten túzokvédelmi előírásokat tartalmazó célprogramok elérhetőségét. Az agrár-környezetgazdálkodási támogatások igénybevételének részletes feltételeit a 61/2009. (V. 14.) számú FVM rendelet tartalmazza.

A túzokélőhely-fejlesztési előírások elméletileg szántóföldi növénytermesztés és gyepgazdálkodás esetén egyaránt lehetőséget biztosítottak a mezőgazdasági termelés okozta tojás- és fiókapusztulás mérséklésére, jóllehet az egyes célprogramok előírásai a közvetett veszélyeztető tényezők mérséklésére is irányultak, így pl. a téli táplálkozóterületek kialakítására vagy a megfelelő gerinctelen táplálékbázis biztosítására.

A túzok sikeres fészkelését leginkább veszélyeztető mezőgazdasági munkálatok a gyepek és egyéb szálas takarmánynövények kaszálása, a gabonafélék vegyszerezése és aratása, valamint a talajelőkészítési munkálatok késői megvalósítása.

E négy tevékenység közül a kaszálás veszélyeztető hatásának mérséklését szolgálják azok az előírások, amelyek a kaszálás előzetes bejelentésére, a kaszálatlan területek mértékére, a kaszálás módjára, illetve a kaszálás időpontjára vonatkoznak. Ez utóbbi előírások eltérőek a 10 MTÉT területén, így a kaszálás jellemzően április 25. előtt vagy június 15. után lehetséges, míg a Dunavölgyi-sík, Homokhátság és Hortobágy MTÉT területeken a kaszálás legkorábbi időpontja június 30.

A gabonafélék termesztése során felhasználható vegyszerek körét a rendelet általános előírásai szabályozzák, amely előírás közvetett módon ugyan elősegíti a faj védelmét, ám a növényvédő és a termékenységet fokozó szerek kijuttatása és a gabonafélék betakarítása, valamint a késői alapozó talajművelési tevékenységek által megvalósuló közvetlen veszélyeztetés mérséklésére vonatkozó kitételek egyáltalán nem szerepelnek a túzokvédelmi célprogramok előírásai között.

A legjelentősebb veszélyeztető tényezők tekintetében a 2004–2009 és 2009–2014 között megvalósuló agrár-környezetgazdálkodási támogatási időszakok túzokvédelmi előírásai közötti legfőbb érdemi különbség a kaszálások legkorábbi időpontjának egységesen június 30. után történő meghatározása, mely azonban mindössze három MTÉT területen került bevezetésre. A gabonafélék termesztésére, vagy az egyes növénykultúrák kialakításának időpontjára vonatkozó előírások lényegében nem változtak a korábbi időszakokban hatályos előírásokhoz képest.

Elemzésünkben a következő kérdéseket vizsgáltuk: 1) Megfelelő volt-e az MTÉT kijelölés (lefedte-e a költőterületet a kifejezetten a túzok védelmét biztosítani hivatott zonális célprogramok területe)? 2) A túzokvédelmi MTÉT területeken előkerült fészkek milyen arányban voltak túzokvédelmi célprogramban, illetve más célprogramokban szereplő területeken (ez az érték a célprogramok vonzóságának indikátoraként tekinthető)? 3) A túzokvédelmi célprogramok előírásai szerint hasznosított mezőgazdasági területeken előkerült fészkek esetében mi volt a költés sikerességét veszélyeztető tényező?

Anyag és módszer

Felhasznált adatbázisok

A Földmérési és Távérzékelési Intézet blokkfedvénye

A 2010 és 2014 között ismertté vált túzokfészkek térinformatikai adatbázisban szereplő adatait összevetettük a Földmérési és Távérzékelési Intézet (FÖMI) Mezőgazdasági Parcella Azonosító Rendszerében (MePAR) szereplő adatbázisával, ami az agrártámogatások eljárásainak kizárólagos országos földterület-azonosító rendszere. Így a túzok fészkelése szempontjából meghatározó jelentőségű földrészletek agrár-környezetgazdálkodási programban, kiemelten az MTÉT rendszerben való érintettsége meghatározhatóvá vált.

A nemzetipark-igazgatóságok túzokfészkeléseket összefoglaló adatbázisai

Elemzésünkben a 2010–2014 közötti időszak során, Magyarország teljes területén detektált túzokfészkek adatait használtuk fel, melyeket a működési terület szerint érintett nemzetipark-igazgatóságok munkatársai rögzítették egységes protokoll szerint, amely legalább a következőkre terjedt ki: dátum, koordináta, előkerülés oka, a fészkelés helyén jellemző vegetációtípus/növénykultúra, tojásszám, kelési siker (amennyiben megállapítható). Elemzésünkben figyelembe vettük mindazokat az eseteket, amikor a fészekcsésze, illetve a tojás előkerült, de nem használtuk fel számításainkhoz azokat, amikor a költés ténye egyéb jelek (tojó magatartása, csibevezetés, a fióka megfigyelése stb.) alapján volt csak egyértelműen bizonyítható.

Eredmények

A 2010–2014 közötti időszakban összesen 441 túzokfészket sikerült beazonosítani. A fészkek megoszlását a különböző MTÉT területek, illetve az MTÉT hálózatba nem tartozó területek között az *1. táblázat* tartalmazza. A fészkek 7,9%-a (35 db) került elő olyan területekről, amelyek nem képezték részét az MTÉT hálózatnak.

MTÉT terület megnevezése *Name of ESA site*	A detektált fészkek száma *Number of nests detected*
Bihari-sík	46
Borsodi Mezőség	1
Dévaványa és környéke	188
Dunavölgyi-sík	85
Hevesi-sík	1
Homokhátság	2
Hortobágy	85
Kis-Sárrét	3
Mosoni-sík	16
Turjánvidék	2
Nem MTÉT területek	35
Összesen – *Total:*	**441**

1. táblázat. A nemzetipark-igazgatóságok munkatársai által 2010 áprilisa és 2014 augusztusa között detektált túzokfészkek megoszlása az MTÉT területek között

Table 1. Distribution of bustard nests found by the staff of national park directorates on the different ESA sites between April 2010 and August 2014

Az MTÉT területeken megtalált fészkek megoszlását a különböző (zonális, illetve horizontális) agrár-környezetgazdálkodási célprogramokban részt vevő mezőgazdasági területeken a *2. táblázat* tartalmazza. A 406 darab, MTÉT területen detektált fészek 43,8%-a (178 db) AKG célprogramban nem szereplő területen került elő. A kifejezetten túzokvédelmi célprogramokban szereplő területeken került elő a fészkek 40,4%-a (164 darab), amiből 9,8% (40 darab) a „gyepgazdálkodás túzokélőhely-fejlesztési előírásokkal" célprogram, illetve 30,5% (124 darab) a „szántóföldi növénytermesztés túzokélőhely-fejlesztési előírásokkal" célprogram aránya. Az egyes MTÉT területeken a túzok védelmét szolgáló AKG-programokban, az egyéb AKG-célprogramokban és az AKG-célprogramban nem szereplő területeken előkerült fészkek aránya tág határok között változott. Az öt legjelentősebb költőterületen (Mosoni-sík, Bihari-sík, Hortobágy, Dunavölgyi-sík, Dévaványa) az előkerült fészkek megoszlása a következőképpen alakult: a túzok védelmét szolgáló AKG célprogramokban szereplő területeken 23,9% és 75% közötti, az egyéb AKG célprogramokban szereplő területeken 0% és 49,4% közötti, az AKG célprogramban nem szereplő területeken pedig 8,2% és 69,6% közötti arányban kerültek elő a fészkek *(3. táblázat)*.

A túzokvédelmi célprogramok előírásai szerint hasznosított mezőgazdasági területeken megtalált fészkek esetében a költés sikerességét veszélyeztető tényezők – az okok, ami miatt megkerült az adott fészek – megoszlását a *4. táblázat* tartalmazza. Az ismert okokra (mezőgazdasági területeken végzett, a túzok költését veszélyeztető tevékenység végzésére) visszavezethető előkerülések száma 103 volt. Ezek közül a leggyakoribb veszélyeztető tényezőket a kaszálás 34 (33%), a vegyszerezés 24 (23,3%), a közlekedés 12 (11,6%), a tárcsázás 10 (9,7%) és az aratás 9 (8,7%) esetben jelentették.

Az összes vizsgált területen (függetlenül attól, hogy az részét képezte-e az MTÉT rendszernek, illetve hogy az adott parcella részt vett-e valamilyen AKG-célprogramban) 125 fészek került elő kaszálás közben a 2010 és 2014 közötti időszakban. A túzok fészkelése szempontjából különböző mértékben érzékenynek tekinthető időszakokban, kaszálás, vagy

Az AKG célprogram megnevezése ***Name of agri-environmental scheme***	**A detektált fészkek száma** ***Number of nests detected***
gyepgazdálkodás élőhelyfejlesztési előírásokkal *grassland management with habitat creation prescriptions*	1
extenzív gyepgazdálkodás *extensive grassland management*	10
integrált szántóföldi növénytermesztés *integrated arable land management*	41
ökológiai szántóföldi növénytermesztés *ecological crop cultivation*	2
ökológiai gyepgazdálkodás *ecological grassland management*	1
szántóföldi növénytermesztés kék vércse élőhely-fejlesztési előírásokkal *crop cultivation with Red-footed Falcon habitat development*	1
szántóföldi növénytermesztés túzok élőhely-fejlesztési előírásokkal *crop cultivation with bustard habitat development*	124
gyepgazdálkodás túzok élőhely-fejlesztési előírásokkal *grassland management with bustard habitat development*	39
természetvédelmi célú gyeptelepítés *grassland planting for nature conservation purposes*	8
AKG célprogramban nem szereplő *not in agri-environmental programme*	179
Összesen – *total*	**406**

2. táblázat. Az MTÉT területeken 2010 és 2014 között detektált fészkek megoszlása a különböző (zonális, illetve horizontális) agrár-környezetgazdálkodási célprogramokban részt vevő mezőgazdasági területeken
Table 2. Distribution of nests found on ESA sites between 2010–2014 on agricultural land participating in different (zonal or horizontal) agri-environmental schemes

szárzúzás közben előkerült fészkek megoszlását az 5. *táblázat* tartalmazza. A túzok védelmét szolgáló célprogramok által korlátozott április 24. és június 15. közötti időszakban a kaszálás, vagy szárzúzás közben előkerült fészkek száma 49 volt, illetve 43 darab a június 16. és június 30. közötti időszakban, amely az egyetlen érdemi különbség volt az egyes MTÉT területek túzokvédelmi előírásai között.

Megbeszélés

A globálisan sérülékeny státusú fajok között szereplő túzok költési sikerét Európában elsősorban a mezőgazdasági tevékenységek veszélyeztetik *(Moreira et al. 2004; Palacín et al. 2012; Vadász & Lóránt, 2014)*. Hazánkban 2002 óta van lehetőség – többek között – a túzok védelmét szolgáló agrár-környezetgazdálkodási programokban való részvételre. A mezőgazdasági tevékenységek jelentős tojás- és fiókakori elhulláshoz vezethetnek, ezek lehetőség szerinti minimalizálása lehet az elsődleges célja a túzok védelmét szolgáló AKG célprogramoknak, hiszen a mezőgazdasági eredetű tényezőkre visszavezethető kifejlett kori elhullás nem jelentős. Ebből következik, hogy az AKG célprogramok elsősorban a tojás- és fiókakori elhullás csökkentését hivatottak biztosítani.

Ahhoz, hogy a túzok védelmét szolgáló AKG célprogramok hatékonyan járuljanak hozzá a faj hazai állományának megőrzéséhez, illetve fejlesztéséhez, három tényezőnek kell

Célprogram MTÉT *Special ESA programme*	Bihari-sík	Borsodi-Mezőség	Déva-ványa	Duna-völgyi sík	Hevesi-sík	Homok-hátság	Horto-bágy	Kis-Sárrét	Mosoni-sík	Turján-vidék	Összesen – *Total*
túzokszántó – *tillage for bustards*	5		62	24			21		12		**124**
túzokgyep – *grassland for bustards*	6		11	12	1	1	9				**40**
integrált szántó – *tillage*	3		2	33			3				**41**
extenzív gyep – *extensive grassland*			1	1			8				**10**
term. véd. gyeptelepítés – *grassland planting*				8							**8**
élőhelygyep – *grassland as habitat*						1					**1**
ökológiai gyep – *ecological grassland*							1				**1**
ökológiai szántó – *tillage*							2				**2**
kékvércse-szántó – *Red-footed Falcon tillage*							1				**1**
nem AKG – not in agri-environmental scheme	32	1	112	7			17	3	4	2	**178**
Összesen	**46**	**1**	**188**	**85**	**1**	**2**	**62**	**3**	**16**	**2**	**406**
Túzok AKG fészekarány – *ratio of bustard nests* (%)	23,9	0	38,8	42,4	100	50,0	48,4	0	75,0	0	**40,4**
Egyéb AKG fészekarány – *ratio: other AES* (%)	6,5	0	1,6	49,4	0	50,0	24,2	0	0	0	**15,8**
Nem AKG fészekarány – *ratio: not in AES* (%)	69,6	100	59,6	8,2	0	0	27,4	100	25,0	100	**43,8**

3. táblázat. Az egyes MTÉT területeken a különböző AKG célprogramokban szereplő (illetve AKG célprogramban nem szereplő) területeken az előkerült fészkek száma
Table 3. Number of nests found on ESA sites according to different agri-environment schemes (AES) the given site was participating in (together with those not participating in any of the agri-environment schemes)

megfelelniük a túzok védelmét szolgáló természetvédelmi zonális programok szempontjából: célterületük fedje le a túzok költőterületét; azokra sikeresen pályázzanak a gazdálkodók a túzok költőhelyéül szolgáló mezőgazdasági területeikkel (szántókkal, gyepekkel); valamint azok előírásai biztosítsák az elérhető legnagyobb kelési sikert, illetve tegyék lehetővé a fiókák számára a röpképes kor elérését.

A fenti tényezőket sorban megvizsgálva megállapítható, hogy a detektált fészkek magas százalékban az MTÉT területekről kerültek elő, amely alapján kijelenthető, hogy az MTÉT hálózat egységei lefedik a túzok hazai költőterületének döntő részét. Megvizsgálva azt a lehetőséget, miszerint a fészkek előkerülési/bejelentési aránya esetleg magasabb volt a vizsgált időszakban az MTÉT területek esetében, mint az MTÉT hálózatba nem tartozó területeken, megállapíthatjuk, hogy a fészkek előkerüléséről legelőször tudomást szerző mezőgazdasági gépkezelők bejelentési hajlandósága érdemben nem függött az általuk művelt terület célprogramban való részvételétől (legtöbbször nem is volt arról információjuk); így nem valószínűsíthető jelentős különbség (így torzító hatás) az MTÉT területeken belül, illetve azokon kívül megtalált túzokfészkek bejelentési arányában.

Az MTÉT területeken előkerült fészkek 40,8%-a volt olyan parcellán, amelyek részt vettek a túzokélőhely-fejlesztési célprogramokban. Egyéb (zonális és horizontális) AKG célprogramokban szereplő parcellákon a fészkek további 15,4%-a került elő. Ez azt jelenti, hogy amennyiben azokon a területeken, ahol elérhetőek a túzokélőhely-fejlesztési célprogramok, korlátozva lett volna az egyéb AKG célprogramok igénybe vételének lehetősége, maximum 56,2%-ig lehetett volna emelni a túzokélőhely-fejlesztési célprogramokban szereplő területek arányát a túzokok költőhelyein. Ennél nagyobb arányt már csak a támogatás

Detektáláshoz vezető (veszélyeztető) tényező *(Threat) factor leading to detection of nest*	**Detektált fészkek száma** *Number of nests detected*
Kaszálás – *mowing*	34
Vegyszerezés – *pesticide treatment*	24
Közlekedés – *traffic*	12
Tárcsázás – *rotatoring*	10
Aratás – *harvesting*	9
Szárzúzás – *mulching*	4
Legeltetés – *grazing*	4
Fűmagaratás – *harvest of grass seed*	2
Vetés – *sowing*	2
Kombinátorozás – *combinatoring*	1
Vadászat – *hunting*	1
Ismeretlen (illetve nem veszélyeztető kifigyelés) – *unknown (or reason of finding not threating nest)*	61
Összesen – *total*	164

4. táblázat. A túzokvédelmi célprogramok előírásai szerint hasznosított mezőgazdasági területeken előkerült fészkek esetében a költés sikerességét veszélyeztető tényezők

Table 4. Factors threatening nesting success of nests found on agricultural land according to prescriptions of bustard conservation schemes

összegének növelésével vagy a korlátozások csökkentésével (illetve e kettő kombinációjával) lehetett volna elérni. A hazai túzokpopulációk védelme érdekében indokoltnak tűnik mind a két lehetőség igénybe vétele. Figyelembe véve a túzok költési területhűségét *(Alonso et al., 2000),* a túzok védelmével össze nem egyeztethető előírásokat tartalmazó egyéb (konkurens) célprogramok nagy valószínűséggel évről évre a túzokköltések sikertelenségéhez vezetnek. A támogatás összegének növelésével pedig további költőterületekre lehetne kiterjeszteni a túzok fészkelése szempontjából kedvező rendszert.

A kaszálások időpontja kapcsán megállapítható, hogy az április 25. és június 15. közötti kaszálás tiltása önmagában nem elegendő, hiszen a fészkek közül majdnem ugyanannyi került elő a június 16. és június 30. közötti időszakban. A korábban lehetőségként általánosan biztosított (de nem minden évben gazdaságos) április 25. előtti kaszálás tilalma nem indokolt a túzokfészkek veszélyeztetése kapcsán, azonban a lekaszált területeken a túzokköltés valószínűségét, valamint az alacsony vegetációban költő tojó költési sikerét a korai kaszálás – nem számszerűsíthető mértékben – befolyásolhatja. Ha figyelembe vesszük azt a tényt, hogy a lucerna gazdaságos hasznosítása során azt májusban kaszálni kell (különben két növedéket veszít el a gazdálkodó: egyet, amely elöregszik és beltartalmi értéke rossz lesz, és a következőt is, ami pedig kimarad), akkor megállapítható, hogy a lucerna túzokbarát és egyben gazdaságos hasznosítására nemigen van lehetőség.

Elgondolkodtató, hogy milyen változtatásokkal lehetett volna hatékonyabb a 2009 és 2014 között zajló túzokvédelmi tevékenység. Tekintettel arra, hogy a kaszálások során került elő a legtöbb veszélyeztetett fészek és a kaszálások időpontjára létezett korlátozás (végig az 5 év alatt), a következőkben csak azt tekintjük át, hogy a túzokélőhely-fejlesztési célprogramok módosításával (területi hatályuk, előírásaik megváltoztatásával) milyen mértékben lehetett volna csökkenteni a veszélyeztetett fészkek számát.

MTÉT terület *ESA*	*before* 04. 24. előtt	*between* 04.24.–06.15. között	*between* 06.16.–06.30. között	*between* 07.1.–07.11. között	*after* 07.11. után	Összesen *Together*
Nem MTÉT terület/*not an ESA*	0	4	5	1	0	**10**
Bihari-sík MTÉT/*ESA*	0	3	4	2	0	**9**
Dévaványa MTÉT/*ESA*	0	13	23	14	8	**58**
Duna-völgyi sík MTÉT/*ESA*	0	23	7	3	3	**36**
Homokhátság MTÉT/*ESA*	0	0	0	0	1	**1**
Hortobágy MTÉT/*ESA*	0	3	2	0	0	**5**
Kis-Sárrét MTÉT/*ESA*	0	2	0	0	0	**2**
Mosoni-sík MTÉT/*ESA*	0	0	2	1	0	**3**
Turján-vidék MTÉT/*ESA*	0	1	0	0	0	**1**
Összesen – ***Total:***	**0**	**49**	**43**	**21**	**12**	**125**

5. táblázat. A túzok fészkelése szempontjából különböző mértékben szenzitívnek tekinthető időszakokban, kaszálás vagy szárzúzás közben előkerült fészkek megoszlása

Table 5. Distribution of nests found during the sensitive period of nesting Great Bustards, ie. during mowing or mulching on the different ESA sites

Ha az MTÉT területek lefedték volna azokat a parcellákat, ahol kaszálások során túzokfészek került elő, akkor a – Hortobágy, a Dunavölgyi-sík és a Homokhátság MTÉT esetében jellemző – szigorúbb előírások szerint 9, az enyhébb előírások szerint (amelyek a többi MTÉT esetében voltak mérvadóak) 4 fészek kerülte volna el a veszélyeztetést. Ez a mintegy 500 költő (vagy legalább is a költést megkísérlő) túzoktojó szempontjából nem jelentett volna érdemi különbséget (kb. 1-2%), tehát ez alapján is megállapíthatjuk, hogy az MTÉT-k kijelölése a túzok költőterülete szempontjából megfelelő volt.

Ha az enyhébb korlátozások helyett Dévaványán, illetve a Bihari-síkon is június 30-ától lettek volna kaszálhatók a lucernások, akkor tíz fészek kerülte volna el a veszélyeztetést. Ha figyelembe vesszük azt, hogy mekkora terméskieséssel járt volna a kaszálások további két héttel való eltolása (június 15. helyett június 30-ától engedélyezve), akkor véleményünk szerint csak a gazdasági érdekek jelentős sérelmével lehetett volna biztosítani e tíz fészeknek a zavartalanságát.

Ha – elsősorban a kifizetések magasabb összege miatt – vonzóbb lett volna a túzokélőhely-fejlesztést szolgáló szántóföldi célprogram, és azok a parcellák is részt vettek volna ebben, amelyek a vizsgált időszakban MTÉT területen voltak, de semmilyen AKG célprogramban nem szerepeltek, akkor az enyhébb előírások szerint 17, a szigorúbb előírások szerint 28 fészek kerülte volna el a korai kaszálásból származó veszélyeztetést.

Ha a túzokköltőhelyeken más horizontális AKG programra (pl. integrált szántóföldi növénytermesztés) nem lehetett volna pályázni (és azokat a parcellákat így a túzokélőhely-fejlesztési előírások szerint hasznosították volna), akkor az enyhébb előírások szerint 26, a szigorúbb előírások szerint 34 fészek kerülte volna el a korai kaszálásból származó veszélyeztetést.

A fenti – elméleti – számítások alapján az fogalmazható meg, hogy az alternatív AKG-célprogramok erős versenytársai a túzokélőhely-fejlesztési célprogramoknak, így azok korlátozásával jelentős mértékben csökkenthető lenne a veszélyeztetett fészkek aránya; ismételten élve azzal a feltételezéssel: mely szerint az integrált szántóföldi növénytermesztés horizontális programja nem lett volna elérhető kiemelt (A-zónás) MTÉT területeken, akkor az érintett parcellák földhasználói a túzokélőhely-fejlesztési előírásokat választották volna. A túzokélőhely-fejlesztési célprogramban szereplő területekre kifizethető összeg emelésével is jelentős mértékben csökkenthető lenne a veszélyeztetett fészkek aránya.

Az ismertetett adatokból nem derül ki ugyanakkor – a szántóföldek esetében – a támogatások műtermékének felfogható látszattevékenységek jelenléte és sokszor túzokvédelmi szempontból igen kedvezőtlen hatása: tapasztalatunk szerint a gyenge termőképességű területeken gyakran előfordult, hogy érdemi termelés nélkül, évente egyszer-kétszer (és ebből legalább egyszer a túzok költése szempontjából érzékeny időszakban) például tárcsás boronával sekélyen végzett talajművelésért vettek fel gazdálkodók túzokélőhely-fejlesztési támogatást. Ezen kizárólag úgy lehetne változtatni, ha a túzokélőhely-fejlesztési célprogramokban a kaszáláson és szárzúzáson kívül egyéb tevékenységek (pl. tárcsázás) végzése is korlátozott lenne a túzok éves életciklusának érzékeny időszakában.

Az adatbázisok elemzéséből jól leszűrhető, hogy bizonyos kultúrák nem összeegyeztethetőek a túzok védelmével. Az árpa az érzékeny időszakban végzett vegyszerezés és a korai aratás miatt kifejezetten veszélyes kultúra, továbbá az intenzív termesztéstechnológiát igénylő búzafajták a szenzitív időszakban végzett vegyszerezés miatt szintén veszélyes kultúrának minősülnek a túzok fészkelése szempontjából. Bármilyen kultúrában az érzékeny időszakban történő begyalogolásból, gépjárművel történő közlekedésből származó veszélyeztetés is jelentősen csökkenthető lenne, ha például az ausztriai túzokvédelmi előírásokhoz hasonlóan az érzékeny időszakban a gyalogos (és minden másféle) közlekedést tiltana a célprogram.

Az is jól látható, hogy valójában két olyan szántóföldi „kultúratípus" van, amelynek művelése teljes mértékben összeegyeztethető a túzok költésének zavartalanságával és érdemi gazdasági kiesést sem jelentenének a korlátozások termesztéstechnológiai szempontból: az érzékeny időszakban nem vegyszerezett, és az érzékeny időszakon kívül aratott gabonák (ez jellemzően a tritikálé, rozs, illetve egyes búzafajták), valamint a későn (lehetőség szerint július 11. után) hasznosítható (alászántható, tárcsázható vagy kaszálható) ugar.

Összességében megállapítható, hogy a szántóföldi növénytermesztés túzokélőhely-fejlesztési célprogramjában erősebb hangsúlyt kellene, hogy kapjon mind a késői hasznosítású ugar, illetve a fenti feltételeknek megfelelő gabona termesztése. E növénykultúrák dominanciája az ausztriai túzokvédelmi programokban is kiemelt jelentőséggel bír *(Raab et al., 2015)*, illetve a világ legjelentősebb túzokállományának otthont adó ibériai agrárélőhelyeken is kedvező feltételeket biztosít a faj számára *(Rocha et al. 2013)*. Mindezek a 2009 és 2014 között meghatározott, túzokvédelmi szempontból kedvezőnek ítélt kötelezően termesztendő növénykultúrák arányainak átgondolását teszik szükségessé.

A fenti alapelvek szerinti előírás-módosításokkal meglátásunk szerint a hazai túzokállomány a jelenlegi ráfordítás mellett a jelenleginél jóval nagyobb mértékben tudna növekedni, ami a Kárpát-medencei állomány stabilitása és tartós fennmaradása szempontjából kulcsfontosságú lenne.

Köszönetnyilvánítás

Köszönetünket fejezzük ki a Fertő–Hanság Nemzeti Park Igazgatóságnak, a Duna–Ipoly Nemzeti Park Igazgatóságnak, a Bükki Nemzeti Park Igazgatóságnak, a Körös–Maros

Nemzeti Park Igazgatóságnak és a Hortobágyi Nemzeti Park Igazgatóságnak a túzokvédelemben folyamatosan végzett tevékenységükért, különösen mindazon igazgatósági munkatársak munkájáért, akik a faj védelmének területi koordinációját, illetve az adatbázisok kezelését végzik. Külön köszönet illeti *Spakovszky Péter*t a nyugat-magyarországi túzokállomány fészkelési adatbázisának összeállításáért. Ezúton is köszönjük a Földművelésügyi Minisztérium Nemzeti Parki és Tájvédelmi Főosztályának a 2009 és 2014 között megvalósult agrár-környezetgazdálkodási program koordinációjában végzett közreműködését, a megvalósulás érdekében nyújtott segítségét, illetve a szükséges adatbázisok rendelkezésünkre bocsátását. Köszönetünket fejezzük ki továbbá a programban résztvevő gazdálkodóknak, illetve mindazon gépkezelőknek, akik nélkülözhetetlen terepi információkkal segítették e dolgozat létrejöttét.

Kivonat—Munkánkban a 2009. szeptember 1. és 2014. augusztus 31. között megvalósult agrár-környezetgazdálkodási program túzokvédelmi előírásainak hatékonyságát vizsgáltuk a túzok *(Otis tarda)* költési sikerének szempontjából a fenti időszakban Magyarországon előkerült túzokfészkek adatbázisának elemzésével. Az öt év alatt Magyarországon ismertté vált 441 túzokfészek közül 406 (92,1%) a Magas Természeti Értékű Területek (MTÉT) programjának célterületéről került elő. A 406 MTÉT területről származó fészkelési helyből 164 (40,4%) a túzok védelmét szolgáló élőhely-fejlesztési célprogramban, míg 64 (15,8%) egyéb agrár-környezetgazdálkodási célprogramban szereplő területről került elő. Az MTÉT területen ismertté vált fészkelési helyek (mezőgazdasági parcellák) közül 178 (43,8%) egyáltalán nem szerepelt az agrár-környezetgazdálkodási programban 2009 és 2014 között. A túzokvédelmi célprogramok előírásai szerint művelt területeken előkerült 164 fészek költési sikerét legnagyobb mértékben veszélyeztető tényezőnek a kaszálás (33%) és a vegyszerezés (23,3%) bizonyult, de jelentősnek mondható a területen történő közlekedés (11,6%), a talajművelés (9,7%) és az aratás (8,7%) miatt veszélyeztetetté vált fészkek aránya is. A hatékonyabb védelem érdekében a túzokvédelmi célprogramok érdemi területi kiterjesztése nem, ugyanakkor a túzok éves életciklusának érzékeny időszakában végzett kaszálások, vegyszerezések, illetve egyéb tevékenységek (talajművelés, közlekedés, aratás) korlátozása a jövőben szükséges lenne. Indokolt lenne továbbá a túzok védelmével összeegyeztethető módon termeszthető növénykultúrák; az extenzív művelésű gabonafélék és ugar előtérbe helyezése a vegyes szántóföldi növénytermesztés során.

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Third scientific symposium

of the

Memorandum of Understanding

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The protection of Great Bustard *(Otis tarda)* in Hungary between 2008 and 2012: an introduction to conservation measures taken and future suggestions

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Abstract—In this paper we give a brief summary about the Hungarian Great Bustard conservation measures taken in the last 10 years by sharing the main results and experiences. Out of the presently known ca. 220 thousand hectares of Great Bustard habitat in Hungary 83.5% are under protection on European level being part of the Natura 2000 network and 39.1% of the habitats are under national protection. The majority of Great Bustard habitats—some 80,000 hectares—are managed by national park directorates. Neither further land purchase nor expansion of protected areas is necessary for the protection of Great Bustards. However, the maintenance and improvement of suitable vegetation structure of designated areas would be essential, just like the improvement of breeding success. In the case of state-owned lands the long-term contracts containing management instructions with the requirements of Great Bustard protection could guarantee the reduction of losses of eggs and chicks during agricultural activities. On private parcels the introduction of an agri-environmental scheme with suitable and effective regulations would be the optimal conservation measure. To reduce mortality of adult birds, bird-friendly retrofitting of those overhead power lines crossing bustard flyways would be appropriate. For medium-voltage power lines the only suitable solution for this is the underground cabling. Measures against other threats listed in the international single species action plan, like the reduction of losses due to predation would be necessary to support the long-term conservation of the Great Bustard.

Keywords: *Otis tarda*, conservation, Hungary, main threats, future suggestions.

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Introduction

The Great Bustard is a globally threatened bird species with a 'vulnerable' status, attached to lowlands with undulating open countryside *(Nagy, 2009)*. Well-defined threats affect the species worldwide, with different importance in each population *(Alonso, 2014)*.

The Great Bustard is on the list of bird species protected at a national level in Hungary since 1970 *(Faragó, 2004)*. Hungary has signed up to several major international instruments to protect the species. In 2002, Hungary signed the Memorandum of Understanding on the Conservation and Management of the Middle-European Great Bustard population (MoU) within the framework of the Convention on the Conservation of Migratory Species of Wild Animals.

By joining the European Union in 2004 the Great Bustard populations of Hungary received protection under European Union legislation, too. Several Natura 2000 sites in Hungary were designated for Great Bustard. Several projects were also supported by the European Union to maintain the Hungarian Great Bustard population.

In this paper we give an overall review about the conservation efforts taken for the protection of the Great Bustard *(Otis tarda)* in Hungary between 2008 and 2012. We attempt to outline the present situation and principles of Great Bustard protection. With reference to the assessments and experiences of recent decades of Great Bustard protection we are drafting future measures that we consider essential to the long-term protection of the species.

The Great Bustard MoU gave the framework of the Hungarian national report and also of the *Scientific Symposium and Third Meeting of the Signatories (MoS3) of the Memorandum of Understanding on the Conservation and Management of the Middle-European Population of the Great Bustard (Otis tarda)*, which was held between 8–12 April, 2013 Szarvas, Hungary.

Material and methods

Monitoring data on Great Bustard observations, nests and carcasses found between 2008 and 2012 were collected systematically by the national park directorate's staff. During field visits all Great Bustard observations were recorded with *Trimbe Juno 3B* devices. Recording the monitoring data *ArcGIS ArcPad 10.2* software was used in the field and *ArcGIS ArcMap 9* for further analysis.

A single female Great Bustard was tagged with a solar powered Microwave satellite transmitter on the 12th of May 2006. The transmitter still provided data at the time of preparation of this manuscript, which data also contributed to the analysis of Great Bustard observations.

Determining the spatial distribution of the Great Bustard in Hungary the GIS database of bustard observations was used as a prior database. The individual parcels from the Land Parcel Identification System (MePAR) covering the observation points were identified. In order to get practically applicable boundaries of the Great Bustard sites further corrections were made by field experts.

To make a comprehensive analysis of the present situation of Great Bustard conservation measures, we have followed the structure of threats listed in the international single species action plan *(Nagy, 2009)* and have made a comparison to the Hungarian national report for the MoU period between 1st of November 2008 and 31st of December 2012. As the national report was based on the Hungarian Great Bustard monitoring GIS database coordinated by the Kiskunság National Park Directorate, further conclusions could have been made by the analysis of monitoring data between 2005 and 2014 in relation to field experiences in the last decade.

Results

Data about Great Bustard habitats

The Great Bustard observation points set within the frame of the Hungarian Land Parcel Identification System (MePAR) cover an area of 196 723 hectares of agricultural land *(Figure 1)*. According to the Great Bustard experts' definition in Hungary a total of 217 999 hectares of agricultural land can be identified as Great Bustard habitats, from which 85 182

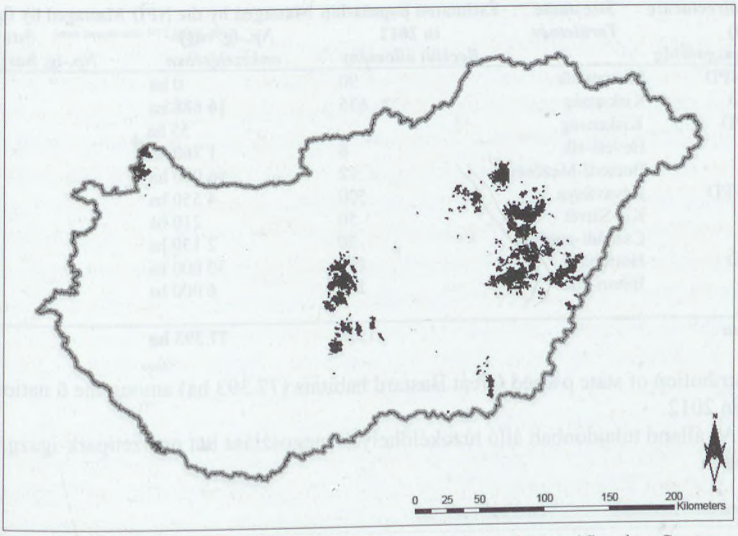

Figure 1. Hungarian Great Bustard habitats within the Land Parcel Identification System (MePAR), identified on the basis of observation points between 2005 and 2012

1. ábra. A 2005–2012 között rögzített megfigyelési pontok alapján kijelölt Mezőgazdasági Parcella-azonosító Rendszer szerinti túzokélőhelyek

(39%) hectares are under national protection. A total of 175 659 hectares from the Great Bustard habitats are designated as Special Protection Areas (SPA) and a total of 96 263 hectares are designated as Special Areas of Conservation (SAC), including a large proportion of overlapping areas. Consequently, the main part of the Great Bustard habitats in Hungary, a total of 182 007 hectares (83.5%) are under European protection being part of the Natura 2000 network.

In Hungary, 12 SPAs are designated that are also Great Bustard habitats: the Mosoni-sík (HUFH10004), the Felső-Kiskunsági szikes puszták és turjánvidék (HUKN10001), the Kiskunsági szikes tavak és az őrjegi turjánvidék (HUKN10002), the Izsáki Kolon-tó (HUKN30003), the Jászság (HUHN10005), the Hevesi-sík (HUBN10004), the Borsodi-sík (HUBN10002), the Hortobágy (HUHN10002), the Dévaványai-sík (HUKM10003), the Bihar (HUHN10003), the Kis-Sárrét (HUKM10002) and the Hódmezővásárhely környéki és csanádi-háti puszták (HUKM10004) SPAs.

In addition to the SPAs, another 7 SACs cover partly or entirely Great Bustard habitats: the Turjánvidék (HUDI20051), the Kiskőrösi turjános (HUKN20022), the Ágasegyháza-orgoványi rétek (HUKN20015), the Bócsa-bugaci homokpuszta (HUKN20024), the Mezőtúri Szandazugi-legelő (HUHN20149), the Pásztói-legelő (HUHN201489) and the Kecskeri-puszta és környéke (HUHN20145) SACs.

A total of 9 well-defined and regularly visited Great Bustard sub-populations are found in Hungary. The 9 sites are located within the administrative areas of six different national park directorates, where the six directorates manage a total of 77 393 hectares of state-owned Great Bustard habitats *(Table 1)*.

National park directorate (NPD) *Nemzetipark-igazgatóság*	Site name *Területnév*	Estimated population in 2012 *Becsült állomány*	Managed by the NPD *Np.-ig. vagyonkezelésében*	Managed by the NPD's own staff *Np.-ig. használatában*
Fertő-Hanság NPD	Mosoni-sík	90	0 ha	0 ha
Kiskunság NPD	Kiskunság	635	16 688 ha	3 035 ha
Duna-Ipoly NPD	Kiskunság		55 ha	0 ha
Bükk NPD	Hevesi-sík	8	1 760 ha	600 ha
	Borsodi-Mezőség	12	16 000 ha	0 ha
Körös-Maros NPD	Dévaványa	500	4 550 ha	2 000 ha
	Kis-Sárrét	50	210 ha	90 ha
	Csanádi-puszták	20	2 130 ha	2 130 ha
Hortobágy NPD	Hortobágy	120	30 000 ha	1 700 ha
	Bihari-sík	120	6 000 ha	0 ha
Total – *összesen*		**1555**	**77 393 ha**	**9 555 ha**

Table 1. Distribution of state owned Great Bustard habitats (77 393 ha) among the 6 national park directorates in 2012

1. táblázat. Az állami tulajdonban álló túzokélőhelyek megoszlása hat nemzetipark-igazgatóság között 2012-ben

A total of 35 784 hectares (16.4%) of Great Bustard habitats fall outside of protected areas, i.e. which are neither protected at national level nor part of the Natura 2000 network. Especially during migration further sites are visited frequently by Great Bustards *(Figure 2).* These sites are under-monitored by the national park directorate's staff. These are probably formerly occupied, currently 'abandoned' patches of the meta-population, such as the Jászság area where random observations are recorded.

Data about Great Bustard observations

During the period between 2008 and 2012 regular monitoring was carried out. Approximately 10 000 Great Bustard observations were recorded in a Geographic Information System (GIS) during field visits. Nationwide censuses were completed twice a year, from which the minimum size of the Hungarian population can be calculated. In 2012 the size of the Hungarian Great Bustard population was estimated at 1555 individuals. Between 2008 and 2012 a total of 35 dead individuals were found nationwide and a total of 364 nest locations were recorded. All data were integrated into the Hungarian Great Bustard monitoring database and also into the Central European database, coordinated by *Rainer Raab* (Austria).

Discussion

The Great Bustard is a well-monitored species in Hungary since 2005, when the LIFE-Nature project 'Conservation of *Otis tarda* in Hungary' started. Thanks to the intensive monitoring carried out in the last decade especially during the project period between 2004 and 2008, similarly to several other countries in Europe (*Nagy, 2009)*, the following threats to the species have been identified in Hungary.

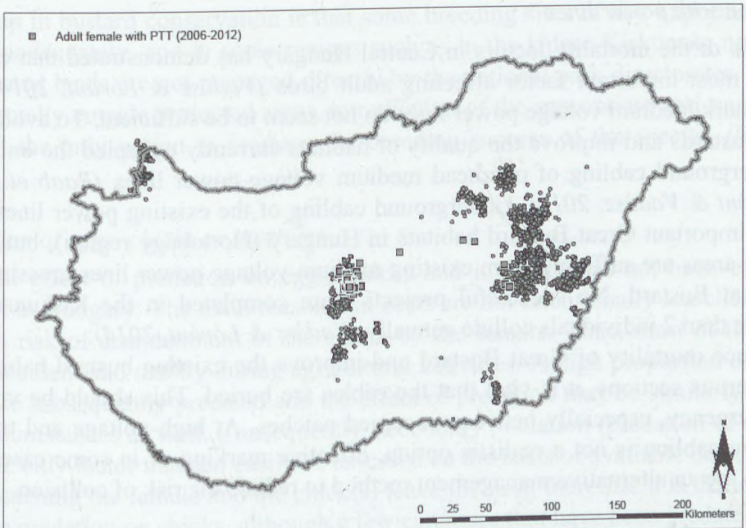

Figure 2. Great Bustard observations within the Hungarian meta-population system. Records of a female Great Bustard tagged with PTT proves the connection between the Hungarian subpopulations.
2. ábra. Túzokmegfigyelések a magyar metapopulációs rendszeren belül. Egy PTT jeladóval felszerelt túzoktojó mozgása bizonyítja a hazai szubpopulációk közötti kapcsolatot.

As the adaptation of the international conservation measures in the discussion chapter we follow the structure of the international single species action plan. In this paper we deal only with those threats identified as 'critical' or 'important'.

Loss of undisturbed open habitats with suitable vegetation structure

A total of 196 723 hectares of agricultural land have been used by Great Bustards in the last 10 years, as underpinned by observations. This is about 2.1% of the total surface of Hungary, which amounts to 9 301 108 hectares. Even if we assume that the surrounding areas might also affect Great Bustard distribution, and those patches used formerly but unoccupied presently are also important from the aspect of the meta-population system, a relatively small percentage of the country is affected by the requirements of the species.

As the main distribution area is covered by the Natura 2000 network and a high proportion is protected at a national level, we think that loss of open habitats is nowadays not the main limiting factor for the species any more. Applications for permits to major investments and changes in land-use such as afforestation, opening new gravel pits, wind farms, establishing new power lines or road constructions may be rejected by authorities according to the Hungarian and European legislation. However, the indirect effect of developments such as irrigation, fencing or the intensification of agriculture involving new crops and new cultivation methods creates an everyday challenge to the conservation of the Great Bustard.

Collision with power lines

Analysis of the mortality factors in Central Hungary has demonstrated that collision is by far the most important factor affecting adult birds *(Vadász & Lóránt, 2014)*. The attempts to mark medium voltage power lines do not seem to be sufficient. To avoid collision of Great Bustards and improve the quality of habitats currently occupied the only solution is the underground cabling of overhead medium voltage power lines *(Raab et al., 2011; 2012; Lóránt & Vadász, 2014)*. Underground cabling of the existing power lines has been applied at important Great Bustard habitats in Hungary (Hortobágy region), but still some of the core areas are suffering from existing medium voltage power lines crossing flyways of the Great Bustard. No successful projects were completed in the Kiskunság region, where more than 2 individuals collide annually *(Vadász & Lóránt, 2014)*.

To reduce mortality of Great Bustard and improve the existing bustard habitats in the most dangerous sections, it is vital that the cables are buried. This should be viewed as a matter of urgency, especially between occupied patches. At high-voltage and train power lines, where cabling is not a realistic option, effective marking or in some cases tree-line plantations are an alternative management method to reduce the risk of collision.

Destruction of eggs or chicks during agricultural works

The destruction of Great Bustard eggs and chicks due to intensive use of agricultural land is one of the main threats to the existing breeding sites in Hungary. In the Kiskunság area the main reasons of destruction of clutches are hay making (mowing) and chemical treatment of different crops, but also tillage, harvesting and grazing can be mentioned as endangering factors *(Vadász & Lóránt, 2014)*. Any disturbance within the sensitive period of the Great Bustard, which lasts from mid April to mid July results in dramatic reductions in breeding success *(Németh et al., 2009)*.

As the Great Bustard is a terrestrial bird species with an extremely slow embryonic and post-embryonic growth rate, it is seriously affected by agricultural activity on the breeding grounds throughout its entire range. Due to its strong site-fidelity to the nesting sites *(Alonso et al., 2000)* the traditional key breeding sites can be defined at each population. Careful habitat management of nesting sites is essential to ensure successful breeding. Only an extensive use of land that is adapted to its environmental potential can result in sustainable management where nature conservation, ecological and economical requirements are harmonised *(Lóránt & Vadász, 2010)*.

On state owned parcels within the Great Bustard distribution area successful management can be ensured by detailed land use specifications laid down in contracts, such as the ones offered by the 6 national park directorates. The contracts must contain specifications on grasslands and arable lands as well, and in all cases they should contain instructions on crop selection and special restrictions during the sensitive period. Extensively cultivated cereals (like *Triticum secale* or *Triticum spelta)* and uncultivated fallow lands are compulsory elements of the crop rotation on arable fields *(Moreira et al., 2004)*, while alfalfa, a favourable crop for nesting by the females can only be grown with the subsidy of suitable agri-environmental schemes due to economical reasons *(Vadász & Lóránt, 2014)*. Any type of mowing (such as mowing of alfalfa or grass), similarly to all other types of field management operations, must be completed outside the sensitive period of the Great Bustard. A remaining gap in bustard conservation is that some breeding sites of key importance are still managed inadequately, and in some regions such as in the Upper-Kiskunság notable areas of state owned lands are not managed directly by the national park directorates. On private lands, especially outside protected areas, introduction of the appropriate agri-environmental schemes is the only option to increase the breeding success of the species *(Raab et al., 2015)*.

Predation of eggs, chicks or juveniles

The real effect of predation on eggs, chicks and juveniles has not been examined in great detail in Hungary. The main reason that nests are not intentionally searched for is due to the high risk of abandonment of the clutch by the female. Thus, most of the nests are found by accident and mostly during agricultural activities. A high proportion of the detected nests are subsequently predated and the effect of predation may be similarly high under natural circumstances as well. Consequently, secondary predation (predation of endangered nests) is the only factor that can easily be assessed on the basis of available data.

After hatching the female and the chick(s) leave the nest, therefore it is difficult to keep track of the predation on chicks, although a few carcasses that have been predated are found from time to time. The main predators in Hungarian Great Bustard habitats are Wild Boar *(Sus scrofa)*, Red Fox *(Vulpes vulpes)*, European Badger *(Meles meles)*, Hooded Crow *(Corvus corone cornix)*, Common Magpie *(Pica pica)*, stray feral dog *(Canis familiaris)* and stray feral cat *(Felis catus)*. Apart from wild boars all species can be easily and effectively controlled by legal hunting methods. To reduce disturbance and increase effectiveness the use of different trapping methods is essential for successful predator management.

The lack of grazing animals in some regions in Hungary resulted in the increased growth of vegetation resulting in a consequent intensive increase of wild boar populations finding shelter in the thickets. A reduction in the number of wild boars can be successfully achieved only by the implementation of proper habitat management combined with systematic hunting during the breeding period.

In Great Bustard habitats, all of the named predator populations should be controlled during the most sensitive breeding period. Hunting of first year cubs or fledglings can result in spectacular bags but effectiveness still remains low. Hunting of breeding adults can result in a very limited level of predation temporarily and locally, which can enhance the breeding success of all terrestrial animals including the Great Bustard. The increase of game species populations is an important 'side-effect' of predator management, which can raise the income of hunting societies.

Insufficient invertebrate food supply

The invertebrate food supply was a less frequently studied subject of research in the last 10 years. The extensive use of arable lands, the lack of chemical-use or the reduction of the size of individual parcels increases the biodiversity of the agricultural environment *(Palacin et al., 2012)*. On arable land an average size of 5 hectares per parcel can provide a heterogeneous habitat suitable for nesting Great Bustards. The cultivation of different crops in each parcel can offer suitable shelter and food supply for growing chicks.

Climate change

The real effect of climate change is not assessed adequately yet within the Carpathian basin. The result of recent studies *(Osborne et al., 2008)* predict a much drier climate for the next few decades resulting in a significant loss of habitat. Female Great Bustards nesting site selection varies within the traditional breeding grounds depending on actual weather conditions and vegetation structure. Significant changes of vegetation structure or small-scale losses of habitat within the breeding area (such as afforestation or unfavourable crops grown as a consequence of irrigation) might reduce the extent of suitable nesting sites.

Poaching

Illegal hunting of Great Bustard is not a main threat to the Hungarian population. However, some cases are recorded occasionally, with approximately one bird shot in every ten years. The last case occurred at the end of December 2014 in the Bihari-sík region.

Mass mortality in harsh winters

In the last 10 years no harsh winter was experienced within the Carpathian basin. The regularly sown oilseed rape fields are the prime food supply for the Great Bustards during the winter months *(Bankovics & Széll, 2015)*. In severe winters access to food is supported by snowploughs. Both sowing oilseed rape and ensuring access for birds were part of the regulations of '*arable farming scheme with habitat improvement specifications for Great Bustard*' within the agri-environmental zonal schemes *(Lóránt, 2014)*.

Disturbance

The negative effect of human disturbance is fairly under-estimated among threats. Disturbance during the displaying and mating period can result in infertile eggs, which would nullify the results of conservation efforts. The mating system is based on a well-structured visual display of adult males on traditionally used leks *(Alonso et al., 2000)*, which needs to be undisturbed during the spring months. Most of the display sites in Hungary are under national protection.

Disturbance during the breeding period can be defined as a major threat as more than 80% of disturbed females abandoned the nest, which resulted in unsuccessful breeding *(Vadász & Lóránt, 2014)*.

Disturbance during the winter months might have an adverse effect on wintering flocks and is mostly related to hunting activities. The regulations on hunting at most Great Bustard habitats took the requirements of the species into consideration, so at the moment the wintering conditions are favourable in Hungary in this respect.

Summary

Finally, a comparison must be made between the period of the Great Bustard LIFE project (2004–2008) and the period between 2008 and 2012 from the aspect of Great Bustard conservation priorities.

During the LIFE project the main activities were the following: land purchase, habitat improvement, habitat management, winter food source, individual nest protection, burying power lines, national census, systematic monitoring of Great Bustard populations and awareness raising of farmers, hunters and the general public.

Almost all the currently known Great Bustard habitats are under national or EU protection. The spatial distribution of the species is relatively small, but is large enough to host the strongest Central European Great Bustard population.

As the proportion of state-owned land is sufficiently high on key Great Bustard habitats, land purchase is not a high priority of Great Bustard conservation in Hungary any more. The improvement of habitats and introduction of suitable habitat management both on the state-owned and in the private sector are still priority conservation measures. On state-owned parcels the long-term contracts with suitable regulations, while in the private sector the introduction of much more effective agri-environmental schemes can improve breeding success. In addition, the implementation of effective predator control could benefit the populations in all Hungarian regions.

The underground cabling of aerial medium-voltage power lines, marking the high-voltage cables and train power lines are obviously major management goals in all Hungarian regions. Cabling reduces the risk of collision to zero and improves the quality and the effective size of currently occupied Great Bustard habitats.

Ensuring winter food supplies should be part of suitable habitat management to prevent starvation and long distance migration. Safeguarding individual nests is not essential, either, as preventive measures via proper habitat management should ensure successful breeding.

Sustaining the monitoring activity, together with the regular census, more intensive awareness raising of key stakeholders (farmers and hunters) and the general public are ongoing and important measures in all regions.

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Kivonat—Munkánkban a magyarországi túzokvédelem elmúlt 10 évének tevékenységeit, legfőbb eredményeit és tapasztalatait kívánjuk röviden összefoglalni. A jelenleg ismert mintegy 220 ezer hektárnyi túzokélőhely 83,5%-a része a Natura 2000 hálózatnak, illetve 39,1%-a országos jelentőségű védett természeti területnek minősül. A túzokélőhelyek jelentős része, közel 80 ezer hektár a nemzetipark-igazgatóságok vagyonkezelésében van. A túzok védelme érdekében további területvásárlások, illetve a védett területek arányának növelése nem szükséges, ugyanakkor a jelenlegi élőhelyeken a faj számára kedvező élőhelystruktúra fenntartása és fejlesztése, valamint költési sikerének elősegítése szükségszerű lenne. Állami tulajdonú földterületek esetében a megfelelő kezelési előírásokat tartalmazó hosszú távú szerződések, míg magántulajdonú parcellák esetében egy megfelelő és hatékony

előírásokat tartalmazó agrár-környezetgazdálkodási program jelenthet megoldást a mezőgazdasági tevékenységek okozta tojás- és fiókakori mortalitás csökkentésére. A túzokok repülési útvonalát keresztező légvezetékek madárbaráttá történő átalakítása, amely középfeszültségű vezetékek esetében a földkábelezést jelenti, nagymértékben csökkentené a felnőtt korú egyedek mortalitását. A nemzetközi fajvédelmi tervben szereplő egyéb veszélyeztető tényezők, mint például a predáció okozta mortalitás csökkentése is szükségszerű lenne a magyarországi túzokállomány hosszú távú védelme érdekében.

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Endangering factors and their effect on adult Great Bustards *(Otis tarda)*—conservation efforts in the Austrian LIFE and LIFE+ projects

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Abstract—Great Bustards face many threats, both natural (such as predation and harsh weather conditions) and anthropogenic (collisions with overhead power lines, intensive agriculture, disturbance, habitat fragmentation and -deterioration). Depending on how these issues are addressed in the countries involved, Great Bustard populations may suffer or prosper in the future. Within the Austrian LIFE and LIFE+ projects a number of conservation measures were introduced to reduce especially anthropogenic threats to Great Bustards. As a result, the Great Bustard populations in Austria and the West Pannonion region have been increasing in recent years.

Keywords: *Otis tarda*, threats, conservation, population, LIFE projects, Austria.

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Introduction

The Great Bustard *(Otis tarda)* is categorized as "vulnerable" according to the latest IUCN criteria *(Collar et al., 1994; BirdLife International, 2012)*. Apart from natural threats, like predation and harsh weather conditions, there are several anthropogenic threats to Great Bustards and their habitat. The animals avoid vertical structures such as hedges and trees and are even more alert to man-made structures because of the disturbance that accompanies them and lead therefore to habitat fragmentation and deterioration. These structures include, but are not limited to, power lines, wind farms, roads and other infrastructure. These structures pose an additional threat by increasing mortality through collisions (for wind turbines cf. *Osborn et al., 1998*; *PNAWPPM-III, 2000*; for power lines cf. *Bevanger, 1995*; *Bevanger & Brøseth, 2004*; *Drewitt & Langston, 2008*; *Jenkins et al., 2010; Rollan et al., 2010)*. Migrating birds and those birds flying to—and between—resting and feeding areas face an especially high risk *(Hanowski & Hawrot, 2000)*.

Great Bustards are especially affected because of their site fidelity, their flight characteristics and their general shyness. This was made evident in the population decline in the 1900s, which coincided with agricultural intensification, hunting and massive infrastructural reinforcement *(del Hoyo et al., 1996)*. Due to careful management, the Austrian population recovered from an all-time minimum of 60 individuals in the 1990s *(Kollar, 2001)* and reached approximately 240 individuals by 2012 (*Raab et al.*, unpublished data).

Natural threats

Predation

Predation is a threat primarily applying to eggs, juveniles and immature Great Bustards. Predation of eggs and hatchlings has been reported to be a serious threat to Great Bustards throughout their range *(Eschholz, 1996; Alonso et al., 1998; Faragó, 2005; Langgemach, 2005; Yaremchenko & Bakhtiyarov, 2006; Martín et al., 2007; Burnside et al., 2012; Rocha et al., 2012)*. Thereby nocturnal mammalian predators such as racoon-dogs *(Nyctereutes procyonoides)*, badgers *(Meles meles)* and foxes *(Vulpes vulpes)* are suspected to be the major reason for losses of clutches and chicks along with some corvid species preying upon the eggs during daytime *(Bankovics, 2005; Burnside et al., 2013; Langgemach, 2005; Rocha et al., 2013)*. Under normal circumstances predation is a natural process being beneficial for both the predator and the prey population *(Langgemach, 2005)*. However in the case of Red Foxes humans interfered in this predator-prey relationship by eliminating one of the main population limiting factors of foxes by field immunization against rabies. Combined with bustard-friendly, extensive management measures a significant increase of fox populations and an enhanced predation pressure was the consequence *(Faragó, 2005; Langgemach, 2005)*.

Within the LIFE-Nature project (LIFE05 NAT/A/000077) addressing bustard conservation of the West-Pannonian population an intensive control of predator mammals was carried out in the three main Great Bustard areas Western Weinviertel, Marchfeld and Parndorfer Platte–Heideboden. Due to arrangements with local hunters a control of fox populations was possible in order to effectively protect especially clutches and chicks of Great Bustards. To reduce predation pressure large-scale hunting took place in winter time. During the rest of the year foxes were hunted as intensively as possible within the legal framework.

Harsh weather conditions

During the breeding season heavy rain can have negative impacts on the reproductive success of Great Bustards in several ways. Heavy rain in combination with disturbances, such as grazing domestic animals or predators, making the hen leave the nest and can lead to a complete abandonment of the wet nests with the uncovered, cooled eggs *(Bankovics, 2005)*. Even without previous disturbance long-lasting periods of rain can cause a flooding of the whole clutch *(Bankovics, 2005)*. Furthermore, heavy rain and downpours during the hatching period can increase mortality among the small, downy chicks due to their lowered thermoregulation capacity *(Morales et al., 2002; Bankovics, 2005)*.

Harsh winters may represent a critical period for Great Bustards *(Bankovics, 2005; Faragó, 2005)*. Food shortage due to a deep, persistent snow cover can cause losses because of starvation *(Eschholz, 1996)*. Furthermore it can force Great Bustards to leave their wintering areas *(Bankovics, 2005; Faragó, 2005; Streich et al., 2006)*. These facultative migration movements can also result in heavy losses because of moving through unfamiliar sites *(Eschholz, 1996; Faragó, 2005)*. In winter females and their offspring join flocks with other families and non-breeding females *(Alonso et al., 1998; Morales et al., 2002)*. In these winter flocks juveniles still depend on their mother and mother-offspring feedings are reported *(Alonso et al., 1998; Morales et al., 2002)*. Such long-lasting maternal effort in combination with the harsh environmental conditions makes the winter months a critical period especially for the females. Therefore, an improvement of the females' condition over the winter through sufficient food supply will result in an enhanced productivity in the following breeding season *(Morales et al., 2002)*.

While it is very little that can be done to reduce the negative consequences of un-favourable weather conditions during the breeding season, effects of harsh winters can be mitigated by ensuring access to some food throughout the winter *(Raab et al., 2014)*. Hence the risk of starvation as well as the likelihood of escape flights during winter months can be reduced.

Habitat requirements and related threats

Agricultural intensification

As an inhabitant of an open landscape largely free of trees and shelter belts *(del Hoyo et al., 1996)*, the Great Bustard is usually confronted with habitats dominated by agricultural land use systems. Therefore agricultural intensification, accompanied by agricultural specialisation and price policy *(Nagy, 2009)*, have negative impacts on Great Bustard populations due to the loss of suitable habitat *(Osborne et al., 2001; Suárez-Seoane et al., 2002; Moreira et al., 2004; Alonso et al., 2005; Pinto et al., 2005)*.

In Great Bustards the selection of foraging habitat underlies seasonal changes in response to food availability and specific habitat requirements *(Moreira et al., 2004; Palacín et al., 2012)*. During the breeding season males choose fallows over other habitat types whereas female Great Bustards primarily use cereal fields or fallows as nesting sites *(Morgado & Moreira, 2000; Moreira et al., 2004; Magaña et al., 2010; Rocha et al., 2013)*. During the winter months herbaceous plants such as cultivated lucerne *(Medicago sativa)* and oilseed rape *(Brassica napus)* become also important *(Faragó, 1996; Kurpé, 1996; Lane et al., 1999; Kalmár & Faragó, 2008; Raab et al., 2014)*.

Thus maintaining a mosaic of different habitat types seems to be essential for providing a suitable environment to Great Bustards *(Moreira et al., 2004)*. Agricultural intensification, however, leads to a simplification of the landscape and loss of necessary habitats *(Moreira et al., 2004)*. Therefore the implementation of a rotational crop system can promote a bustard-friendly habitat mosaic *(Moreiera et al., 2004; Martín et al., 2012)*. Since crop systems of such type offer little profit, financial subsidies should be provided to involved farmers *(Moreiera et al., 2004)*.

Within the LIFE-nature project LIFE05 NAT/A/000077 around 5,500 ha of arable land were cultivated in a bustard-friendly manner by means of the Austrian Rural Development Programme. This involved for example the cultivation of special Great Bustard fallows, on which the use of fertilizer or any plant protection agent were prohibited and which is subject to special mowing restrictions. Furthermore, cultivation of winter wheat was also supported. Being a preferred breeding habitat, the access was prohibited to these Great Bustard winter wheat fields between April 20th and harvest time similarly to the irrigation of these fields to avoid disturbance. In addition, suitable winter grazing areas for Great Bustards were supported by means of the Austrian Rural Development Programme.

Human disturbance

Different recreational activities, traffic (including also agricultural and air traffic) or domestic animals represent common sources of human disturbances for Great Bustards *(Bankovics, 2005; Sastre et al., 2009; Torres et al., 2011)*.

Beside the source of disturbance also the main characteristics of disturbances such as frequency of occurence, disturbances per unit time and type of response shown by Great Bustards may be useful for conservation management to identify the most harmful sources of disturbances for Great Bustards *(Sastre et al., 2009)*.

According to the response human disturbance cause in Great Bustards two categories can be distinguished. "Low-risk threatening factors", such as tractors or sheep herds, cause variable reactions in Great Bustards, but running is a typical response shown in these cases *(Sastre et al., 2009)*. "High-risk threatening factors" (cars, pedestrians, helicopters, etc.) usually cause a flight response in Great Bustards *(Sastre et al., 2009)*. Such escape flights are classified as "highly risky" as they can have severe impacts on the energy budget of Great Bustards *(Sastre et al., 2009)*. Moreover, the risk of collisions with power lines is increased by such escape flights *(Sastre et al., 2009)*.

In the main distribution areas of the West-Pannonian Great Bustard population human disturbances causing a flight response in bustards are associated with agricultural activities, traffic or recreational activities. Monitoring also has a certain effect.

In four of the five main distribution areas, traffic (including agricultural traffic, like harvesters or tractors and air traffic, such as helicopters) is the main disturbance source leading bustards to take-off. In "Marchfeld" agricultural activity—i.e. farmers working on the fields —is the main source of disturbance.

Also in other studies traffic has been reported to be a main cause of disturbance for Great Bustards *(Bankovics, 2005; Sastre et al., 2009)*, what is also reflected by the birds' avoidance of human infrastructures such as roads or tracks in habitat selection *(Lane et al., 2001; Osborne et al., 2001; Alonso et al., 2012; Palacín et al., 2012; Burnside et al., 2013)*. Therefore restricted access should be established at least at the main Great Bustard areas to keep the disturbance level low *(Sastre et al., 2009)*. Great Bustards may benefit from this lowered disturbance level especially during the most sensitive periods of the year. During the breeding season disturbances can interrupt mating activities *(Nagy, 2009)* or can even cause nest abandonment *(Gewalt, 1959; Ludwig, 1996)*, leading to a reduction in the reproductive success of a population. In winter an increase of vigilance behaviour due to higher disturbance levels can lead to a decrease of feeding behaviour and—combined with escape flights in response to disturbances—it would be hard to maintain a positive energy budget during short winter days *(Riddington et al., 1996)*.

Lack of public information and a limited appreciation of Great Bustards and their habitats can lead to unnecessary disturbance. Bustards, particularly in the breeding season, can be disturbed through leisure time activities such as horse riding, cycling, photography, nature observation, private aircraft or Nordic walking. Disturbance can also seriously affect reproductive success. If the females are forced to abandon the eggs or juvenile bustards due to anthropogenic disturbance for any time they are exposed to a higher risk of predation.

In the main distribution areas of the West-Pannonian Great Bustard population large parts of the road network are banned from driving, as a measure against traffic being a major source of disturbance. Although traffic still represents the major source of human disturbances, this type of threat in general cause a flight response in bustards less often than non-human sources of disturbances.

Non-human sources of disturbances mainly derive from birds of prey, especially from Imperial Eagle *(Aquila heliaca)* and White-Tailed Eagle *(Haliaeetus albicilla)*. Also other species such as Marsh Harrier *(Circus aeruginosus)* and even Saker Falcon *(Falco cherrug)* were recorded to cause a flight response in Great Bustards of the West-Pannonian population. Beside birds of prey European Roe Deer *(Capreolus capreolus)* and other Great Bustards are also among the sources of non-human disturbances.

Human-associated habitat loss

By 1,000 BC extensive deforestation took place in the course of human civilization to expand cropland and grazing land areas *(Kaplan et al., 2009)*, creating habitats potentially suitable for Great Bustards. In Iberia and Central Europe for example the key areas of Great Bustard distribution are currently situated in a landscape where they could not have been present a few thousand years ago *(del Hoyo et al., 1996)*.

However, over the years satisfying human needs while maintaining intact ecosystem functions at the same time became more and more difficult due to the ongoing expansion of human civilization and development *(DeFries et al., 2004)*. The maximisation of food production for example led to modern agro-ecosystems, characterised by the use of fertilizers and a depleted biodiversity and habitat heterogeneity due to monocultural farming *(Kareiva et al., 2007)*. This maximisation of production also created surplus, being the basis for global trading and huge areas of land were covered by roads to facilitate the increasing trade activity *(Kareiva et al., 2007)*. Over the time only a few pristine lands remained unaffected by human presence, roads or other infrastructure *(DeFries et al., 2004)*. Therefore Great Bustards and human civilisation became largely incompatible, as Great Bustards avoid human-made features such as villages, roads, tracks or power lines *(Lane et al., 2001; Osborne et al., 2001)*. Overhead power lines, wind farms and other structures potentially endanger flying bustards, fragment habitats and hamper exchange between subpopulations. Time and again infrastructure development leads to habitat fragmentation or deterioration. As a consequence the loss and fragmentation of suitable habitat due to the human civilisation represent a major threat to Great Bustards *(Alonso et al., 2001)*.

The fact that the world's average population density of 45 people/km^2 in 2000 will rise to 66 people/km^2 in 2050 *(Cohen et al. 2003)* underlines the importance of maintaining undisturbed, open, unfragmented and extensively managed agricultural land mixed with fallow land to ensure the viability of Great Bustard populations in the future.

Impact of transport infrastructure on birds

Our experience indicates that the habitat use of the West-Pannonian Great Bustard population is influenced by transport infrastructures, but the influence has not been quantified yet. Hence, results of studies on other bird species are more informative at the moment.

Roads, railroads and traffic

Most empirical data on the effects of infrastructure on wildlife refers to primary effects of a single road or railroad, which are easy to measure and affect the organisms directly at a local scale. Five major categories of primary ecological effects can be distinguished *(Seiler, 2001)*. Habitat loss (fragmentation effect), disturbance and pollution (roads, railroads and traffic) are to be named first. Roads pollute the physical, chemical and biological environment and consequently alter habitat suitability for many species in a much wider area than they actually occupy. Although the impact of transport infrastructure on Great Bustard has been studied only tangentially, some publications prove the avoiding behaviour of Great Bustards of these landscape features *(Lane et al., 2001; Osborne et al., 2001)*. Sometimes bustards breed close to roads. Although no reliable study on breeding success of such clutches has been carried out as yet, but it may be lower, similar to evidence from studies on other bird species (e.g. *Reijnen, 1997*).

Traffic causes the death of many birds utilising verge habitats or trying to cross the road or railroad. Collisions between vehicles and wildlife are also an important traffic safety issue. Fortunately, Great Bustards are only very rarely involved in such accidents, due to their strict avoidance attitude (*Raab,* unpublished data).

Another issue of traffic may be their barrier effect. In contrast to some other bird species, Great Bustards are especially exposed to this type of threat due to their limited ability to fly. Field observations suggest that a busy highway with its effect-zone can be too big an obstacle, and the flying birds turn back just before crossing the highway (pers. obs.).

All of the above issues may combine to cumulative effects. Especially problematic is the fact that highways are usually built as far as possible from settlements, which means that they are often planned straight through the open landscape, sometimes in Great Bustard areas.

Other infrastructural development

In addition to power lines, wind farms and transportation, many other infrastructural developments endanger Great Bustards and their habitat. These are among others the expansion of suburbs, hypermarkets and shopping centres, industry zones, the building of airports, entertainment grounds, leisure parks, photovoltaic power stations, open surface mines, etc. The negative effect of these infrastructures is ultimately very similar to those mentioned before.

The development of airports is a problem for Great Bustard areas not only in the surrounding of big cities (e.g. Berlin, Vienna, Bratislava, Budapest), but occasionally in rural areas, too, where airports are built for low cost airlines. In the past years many industrial estates and shopping centres were built in rural areas. One can find this "new" kind of infrastructure in almost every bigger village by now. In addition, leisure parks and golf courses are also encroaching as a new threat to Great Bustard areas and will be of an even greater importance in the future. Only a few Great Bustard areas have been destroyed by gravel mines in the last century, but some Great Bustard areas are still threatened by the establishment of new ones.

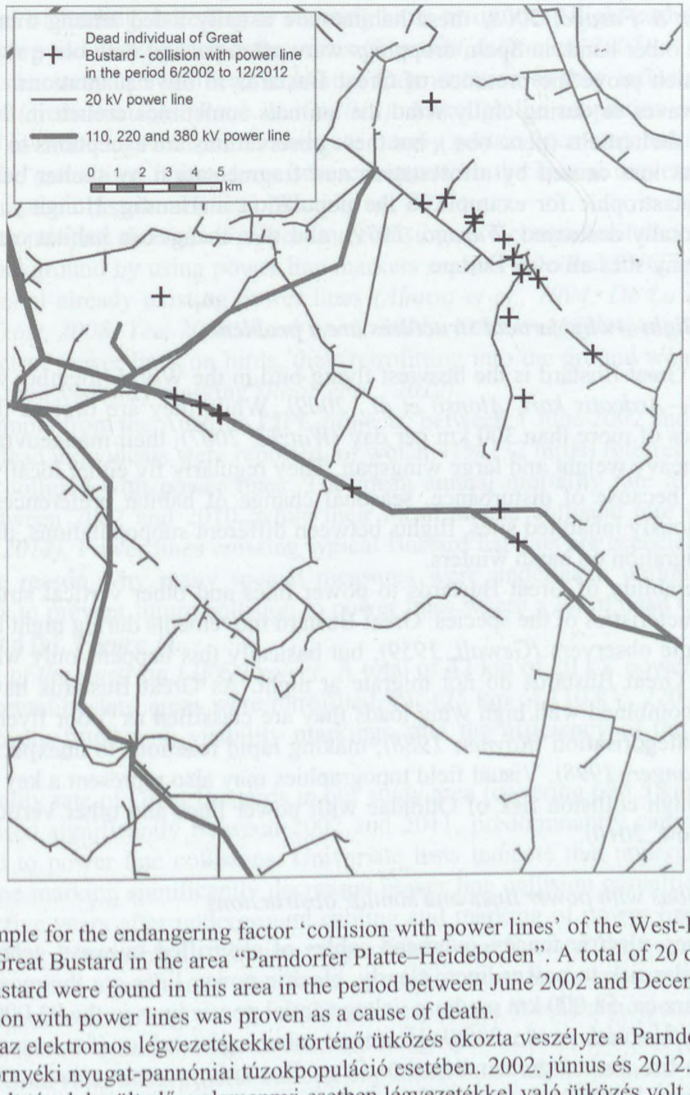

Figure 1. Example for the endangering factor 'collision with power lines' of the West-Pannonian population of Great Bustard in the area "Parndorfer Platte–Heideboden". A total of 20 dead individuals of Great Bustard were found in this area in the period between June 2002 and December 2012. In all cases collision with power lines was proven as a cause of death.
1. ábra. Példa az elektromos légvezetékekkel történő ütközés okozta veszélyre a Parndorfer Platte–-Heideboden környéki nyugat-pannóniai túzokpopuláció esetében. 2002. június és 2012. december között 20 elpusztult túzok került elő; valamennyi esetben légvezetékkel való ütközés volt a halálok. A kereszt jelzi az elpusztult példányok helyét, a 20 kilovoltos vezetékeket vékony, a 110, 220 és 380 kilovoltos vezetékeket vastag vonal jelzi.

Afforestation, shelter belts, orchards, vineyards

Evidence for an effect of afforestation, shelter belts, orchards, vineyards on Great Bustard is anecdotal; it is generally assumed that the presence of woody areas affects the distribution negatively. In scientific studies (e.g. *Lane et al., 2001; Faragó & Kalmár, 2006;*

2007; Kalmár & Faragó, 2008) these habitats are usually listed among minor or 'other' crops. On the other hand, in Spain droppings were often packed with olive stones *(Lane et al., 2001)* which prove the presence of Great Bustards in olive plantations. Additionally, during heat waves or during chilly wind the animals sometimes crouch in the shadow of tree lines and shelterbelts (pers. obs.), but these observations are exceptions to the rule.

The habitat loss caused by afforestation and fragmentation by shelter belt plantations was surely catastrophic for example to the population in Hanság, Hungary, whereby the habitat was totally destroyed *(Faragó, 1979)*, and this changes in habitat can be a recent problem at many sites all over Europe.

Bustards in flight—why vertical structures are a problem

The male Great Bustard is the heaviest flying bird in the World (together with the male Kori Bustard—*Ardeotis kori, Alonso et al., 2009)*. While they are tireless fliers and can cover distances of more than 300 km per day *(Watzke, 2007)*, their manoeuvrability is limited by their heavy weight and large wingspan. They regularly fly either locally or over larger distances because of disturbance, seasonal change of habitat preferences, occasional visits to previously inhabited sites, flights between different subpopulations, dispersion and facultative migration on harsh winters.

The vulnerability of Great Bustards to power lines and other vertical structures arises from the characteristics of the species. Great Bustard movements during night have been recorded by some observers *(Gewalt, 1959)*, but basically this happens only when birds are disturbed, as Great Bustards do not migrate at night. As Great Bustards have small and broad wings combined with high wing loads they are classified as "poor flyers" according to Rayner's categorisation *(Rayner, 1988)*, making rapid reactions to unexpected obstacles difficult *(Bevanger, 1998)*. Visual field topographies may also represent a key aspect in explaining the high collision risk of Otididae with power lines and other vertical structures *(Martin & Shaw, 2010)*.

Collisions with power lines and similar obstructions

Wire fences, electric fences, overhead cables of electrified railways, telephone cables impose a similar risk to power lines; clearly, electric power lines are the most widespread of all. There are ca. 58 000 km medium voltage aerial power lines in the 93 000 km² area of Hungary e.g. *(Horváth et al., 2008)*. However, other aerial cables (for example overhead contact lines) can pose a greater threat to Great Bustards in some areas according to the *MoU Hungarian National Report (2008)*. Collisions with power lines occur where there is an array of overhead power lines inside bustard ranges, in surrounding areas, or across flyways between different ranges. Collision with power lines is actually the main mortality factor for fully grown (i.e. immature and adult) Great Bustards in many areas (e.g. *Martín et al., 2004; Palacín et al., 2004)*. Power lines have frequently been reported to be lethal obstacles for Great Bustards *(Janss & Ferrer, 1998; Janss, 2000; Reiter, 2000a; Alonso et al., 2005; Martín et al., 2007; Raab et al., 2011; 2012)*. Typical injuries from collision with power lines are broken wings, cuts on the neck and the breast. Additionally, the risk of collision increased if such man-made structures were placed on or near areas regularly used by larger numbers of feeding, breeding or roosting birds or on local flight paths, for example between foraging and nesting or roosting areas *(Everaert & Stienen, 2007)*.

Artificial structures can also lead to habitat fragmentation as they influence the spatial movements of Great Bustards *(Raab et al., 2011)*. Although the adaptation of flight routes after take-off in order to avoid the crossing of nearby power lines may reduce the risk of collision, at the same time it may have severe impacts on the spatial movements of Great Bustards within their distribution area *(Raab et al., 2011)*.

One way to mitigate the risk of power line collisions is a contrast enhancement of wires against the background by using power line markers such as coloured PVC spirals or avian flight diverters at already existing power lines *(Alonso et al., 1994; De La Zerda & Rosselli, 2003; Frost, 2008; Yee, 2008; Raab et al., 2011)*. For the complete elimination of any negative effect of power lines on birds, their retrofitting into the ground would be recommended over their visibility marking *(Raab et al., 2012)*.

As an example from the Austrian LIFE-projects: between 1 June 2002 and 31 May 2011 a total of 78 dead individuals were reported, of which 41% (32 birds) referred to Great Bustards having collided with power lines. The mean annual mortality rate of bustards was 3.5±1.6% between 2002 and 2010, while their mean annual collision rate was 1.6±1.3% *(Raab et al., 2012)*. Power lines crossing typical Bustard habitats are especially dangerous. That was the reason why many special measures were undertaken within the Austrian LIFE-Projects to prevent future collision to power lines where a lot of dead Great Bustards had been found (cf. *Figure 1*).

Measures of the Austrian LIFE-Project: A total of 42 km of 20 kV power lines that run through important bustard areas were retrofitted, ca. 125 km of 110 kV, 220 kV & 380 kV power lines were fitted with visibility markings, and the efficiency of the marking was monitored.

The mortality rate of Great Bustards in our study area (covering 686.5 km^2, *Raab et al., 2012)* decreased significantly between 2002 and 2011, predominantly caused by reduced mortality due to power line collisions. Univariate tests indicate that underground cabling and power line marking significantly decreased power line collision casualties. Our results indicate that five years after underground cabling and marking of power lines within core areas of the West-Pannonian distribution range of the Great Bustard, the population already benefited through a significantly decreased mortality rate. Both conservation measures most likely contributed strongly to the rapid recovery of the West-Pannonian Great Bustard population observed within the last decade. Although power line marking appeared to reduce the collision risk, underground cabling explained most of the reduced mortality after implementation of these two conservation measures *(Raab et al., 2012)*.

Wind farms

Apart from direct habitat loss, which is mostly minor, there may also be an indirect loss through habitat deterioration. This might be caused by an increase in disturbance from the wind farm itself or from human activity, or by land-use changes. All may cause Great Bustards to abandon the area but quantification of the effects of wind farms can be confounded by these other changes. Disturbance can lead to displacement and exclusion from areas of suitable habitat; effectively loss of habitat to the birds. Numerous reliable studies indicate negative effects; some reviews collected the main outcomes (e.g. *Erickson et al., 2001*; *Gill et al., 1996; Horch & Keller, 2005*). The cumulative effects of large wind farms may lead to disruption of ecological links between feeding, breeding and roosting areas (*Cooper & Sheate, 2002)*. Furthermore, wind power plants always require installation of electric power lines, which introduce a serious risk itself (see above). As a consequence, cumulative impacts of various factors must be considered.

Habitat loss and fragmentation caused by wind farm development impose a higher threat to Great Bustard than direct mortality because its high fidelity to traditional leks, breeding and wintering sites. Hence, a single badly planned wind power plant can destroy very important habitats. *Wurm & Kollar (2001)* reported that a wind power plant in Parndorfer-Platte, Austria had been built occupying a large part of the Great Bustard habitats in the area. In addition, Great Bustards keep a distance of 600 meters from wind towers.

The pressure to establish wind farms in Great Bustard areas is increasing because financial conditions are highly favourable at the moment for generating wind energy and production of renewable energy is also supported. For several years, wind farm development projects have caused most of the conflicts between nature conservation and infrastructure development on both sides of the Hungarian–Austrian border of the West-Pannonian Great Bustard areas, similarly to Brandenburg, Germany according to the Hungarian, German and Austrian national reports to the MoUGB in 2008. It is likely that this pressure will affect other sites in the near future, too.

Conclusions

Adult Great Bustards face many threats, both natural (such as predation and harsh weather conditions) and anthropogenic (collisions with overhead power lines, intensive agriculture, disturbance, habitat fragmentation and deterioration). It is up to conservation efforts in the countries involved to deal with these issues and determine the severity of the impacts of these threats.

In Austria for example, only through the collaboration of farmers, hunters and local politicians with the conservation project "Great Bustard" was it possible to create suitable breeding sites and protect them against disturbance. Farmers made use of the Austrian agri-environment scheme "ÖPUL" by cultivating special bustard fields. Farmers and hunters were helping to keep disturbance in Great Bustard areas as low as possible and were also involved in the successful control of the Great Bustard conservation actions (monitoring). Additional 42 km of 20 kV power lines that run through important bustard areas were replaced by underground cables and ca. 125 km of 110 kV, 220 kV & 380 kV power lines were marked to enhance visibility to bustards within the Austrian LIFE-Project. As a result, the Great Bustard populations in the West Pannonion region have been increasing in recent years.

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Kivonat—A túzokokat veszélyeztető tényezők közt egyaránt vannak természetesek (mint a predáció vagy a mostoha időjárás) és antropogén eredetűek (pl. elektromos légvezetékek, intenzív mezőgazdálkodás, zavarás, élőhelyük csökkenése és romlása). A túzokpopulációk pozitív vagy negatív irányú változása nagyban függ attól, hogy az érintett országok miként kezelik ezeket a tényezőket. Ausztriában számos túzokvédelmi beavatkozás történt különösen az antropogén eredetű veszélyforrások hatásainak csökkentésére a LIFE és LIFE+ projektek keretében. Ezeknek köszönhetően nemcsak az osztrák, hanem a teljes nyugat-pannon populáció is folyamatosan növekszik az elmúlt években.

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Management measures for wintering Great Bustard *(Otis tarda)* populations in the Carpathian Basin

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Abstract—Within the framework of the Convention on Migratory Species, a Memorandum of Understanding was signed by the various range states in 2001 for the protection of Great Bustard *(Otis tarda)* in Central Europe (MoUGB). This paper addressed the problems encountered during the winter management of the species, which is part of the work program of the MoUGB. Methods of winter feeding with different types of food depending on the actual weather conditions are discussed. Further methods in management include opening up the deep snow cover in agricultural areas in order to enable the bustards to have access to their natural food—like rape leaves or other plants—covered by snow. Snowploughs were used for this purpose introduced by the Great Bustard LIFE program in Hungary. As a consequence of their easier access to food even during harsh winters, Great Bustards gave up their migratory behaviour during cold, snowy winters, so the migration loss on their flyways and wintering sites could be eliminated. Similar management measures are recommended to be introduced to protect other Great Bustard populations outside the Carpathian Basin.

Key words: *Otis tarda,* Convention on Migratory Species, Hungary, wintering area, habitat management, nature conservation, migration.

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Introduction

Antecedents

'The Memorandum of Understanding on the Conservation and Management of Middle-European Populations of the Great Bustard' (MoUGB) was created under the Convention on Migratory Species (CMS) based on the proposal—and later prepared by—the national scientific expert delegated by Hungary to the CMS *(Bankovics, 2005a)*. This fact on the one hand, and the successful recovery of the Great Bustard population in the Carpathian Basin on the other, warrants that Hungary must play a key role in the operation of the MoUGB, from the first day it had entered into force on June 1, 2001.

The first conference of the MoU was held in Illmitz, Austria in 2004, the second one took place in Feodosia, in south Ukraine. The location of the third meeting in Szarvas is close to one of the most important populations of Great Bustards in Hungary. Historically, Szarvas is the very place where the idea of the need for a memorandum of understanding took shape during a previous Great Bustard symposium, held in 1986.

Hungary has always made special efforts to promote field research and conservation of Great Bustards with an array of scientific publications and books published in the topic. An EU LIFE programme was also completed in Hungary between 2004 and 2008 to increase the population of the species in the Carpathian Basin, as well *(Bankovics, 2009)*. Based on experience during the Szarvas meeting, BirdLife Hungary decided to dedicate 2014 the

”Year of the Great Bustard”, focussing on the promotion of the conservation of this species.

The first meeting of the signatory states of the MoUGB (Illmitz, Austria, 17–18 September, 2004) adopted the Medium Term International Work Programme (MTIWP) for the period of 2005–2010 on the conservation and management of the Central European population of the Great Bustard, which was agreed to be extended until 2012, the planned time of the Third Meeting of the Signatories.

The MTIWP identified *inter alia* the preparation of guidelines on the species itself and on habitat conservation measures to be implemented on the wintering sites in Central Europe to secure the successful wintering of Great Bustard populations. This paper is based on experience of the winter management methods regarding populations of the Carpathian Basin, mostly in Hungary, and a draft summary is given on the weather conditions, the problems encountered and the conservation measures for the management of Great Bustard populations concerning the above-mentioned objective.

Results

A guideline is in preparation on the measures to secure the successful wintering of Great Bustard populations in Central Europe. The first part of this paper, containing the measures for the populations inside the Carpathian Basin, has already been finished. The second part of the guideline was scheduled to be compiled after the meeting in Szarvas as a result of the discussion with the participants and of the presentations held during the symposium.

The MoUGB MTIWP identified the need of guidelines on winter management of Great Bustard. This paper summarises the presentation given on the already finished part of the document, which discusses the following subjects: 1) weather conditions; 2) problems encountered during different winter types; 3) proposed conservation measures for the management.

Different winter types in the Carpathian Basin

Concerning winter management activities needed in Great Bustard protection, we distinguish three types of winter time weather conditions in Central Europe. The weather conditions in winter significantly vary between different years also within the Carpathian Basin. These differences have become more marked in the last decades, probably due to climate change.

Regarding the weather conditions we can identify three main types of winter situations, as follows: 1) unusually mild weather conditions throughout the whole winter, without or with only little snow; 2) average winter conditions with only one or few (but always short) cold periods with daily temperatures not below -10°C, and only occasional, thin (5-10 cm) snow covers; 3) harsh or severe winters with 2 or 3 weeks of cold periods (minimum daily temperatures below -15°C or -20°C). If this is combined with deep (over 20 cm) and long-lasting snow cover, it will make the conditions even less bearable for the species.

Migratory behaviour in different weather conditions

The Great Bustard, within its Central European range, is a partial migrant. Its migratory behaviour had manifested in three different ways in the past in Hungary. Firstly, bustards breeding east of the Tisza River migrated locally or regionally almost every year, whereas birds from the Kiskunság between the Danube and the Tisza rivers usually spent the winter on their breeding grounds. Secondly, almost all birds migrated in severe winters when temperature was as low as -20°C, and deep snow lasted for more than a week. Thirdly, in mild and average winters usually only the smaller females migrated further south, while the heavier males remained on or around the breeding sites somewhere on the Hungarian Great Plane *(Bankovics et al., 2006).*

Nowadays, the background of their varied migration behaviour is further influenced by the winter weather conditions but in part it is also influenced by the food supply in winter. During average or mild winters the Great Bustard populations in Hungary either do not migrate at all, behaving as a resident species or they migrate only to a (very) short distance. Their migration route may not even follow the classical direction to South nor does it reach beyond national borders, rather, it follows the major direction of East to West with an average distance of not more than 50–150 kilometres. This phenomenon is presumably due to a climatic gradient (in the East-West direction) as follows: the winter climate in the area lying east of Tisza River is more continental, and is usually colder than in the Kiskunság and compared to areas further west, by 1 or 2°C at average. This climatic variance causes sometimes the difference in the migration behaviour of the populations in the two areas.

In severe winters parts of the Great Bustard populations may migrate to Southern Europe, to the Balkan Peninsula or further to Italy, but this has been usually prevented in recent years by conservation measures. This migration type has not occurred in the last ten years in the Hungarian population, at least not in significant numbers of birds.

If the longer cold period accompanied with deep snow cover occurs in December or January the probability of migration (or partial migration) of Great Bustard groups is higher. However, closer to the breeding season in February, when the moustache of the adult males start to grow, as a sign of the beginning of the breeding season, they are more reluctant to migrate longer distances. Instead, they attempt to survive in the proximity of their normal breeding sites.

Management activities

Preliminary establishment and management of wintering grounds

As shown, there are a number of uncertainties in their migration habit, therefore it is very important that the management of Great Bustard wintering sites is planned and prepared carefully for a successful wintering in any case. The migration loss is one of the most important threats for the Great Bustard, therefore it is vital to eliminate this threat factor as much as possible *(Bankovics, 2005b).*

As the annual winter weather is also unpredictable, it is important to take measures of precaution to ensure the availability of adequate and sufficient winter food. It is necessary to encourage the farming sector, to plan the location of the different plant cultures and eventually to sow the plant seeds and establish these plots already at the end of the previous summer in order to provide larger fields in appropriate wintering areas.

The main winter food for the Great Bustard is oilseed rape *(Brassica napus),* combined with alfalfa (*Medicago sativa)* and Savoy cabbage (*Brassica oleracea* var. *sabauda)* as alternative winter food supply. All three plants supply fresh green leaves and shoots preferred by the Great Bustard.

The management of feeding sites is primarily based on the establishment of one or more oilseed rape plots within or near to traditional wintering grounds. As the seeds of the oilseed rape are small, the optimal preparation of the soil before sowing is the first and most important step. Also the timing of the seeding has an effect on the quality of the leaves. In Central Europe, the oilseed rape is sown late August or early September. If it is seeded in time, the plants can spring forth and have time to grow big enough to last all winter and offer suitable nutrition for the Great Bustards.

Besides the large plots of oilseed rape, alternative feeding plots should also be established in the vicinity as secondary and tertiary wintering ground, in case of disturbance as a consequence of possible hunting, travelling or agricultural activities. Alternative plant cultures might be alfalfa or Savoy cabbage, as mentioned above. The koolrabi (*Brassica oleracea* convar. *acephala)* has been planted and used as winter food source since the 1970s, when the Kiskunság National Park was established. Cabbage used to be planted around the edges of certain ploughed fields in one or two rows. The cabbage, using other varieties, has remained as alternative food ever since. Its stem grows high enough above the snow cover so that Great Bustards are able to pick the cabbage leaves as winter food *(Bankovics, 1996; 1997)*. In the experimental years of the 1970s, another plant, the common sainfoin *(Onobrychis viciifolia)* was also planted in the Kiskunság National Park in a small sample area. Great Bustards accepted this culture not only in winter, but preferred to be there also in summer. The "onobrychis" field has existed for some 6 years.

Furthermore, both planted oilseed rape, cabbage cultures and also natural grasslands are ideal habitats for small rodents. The protein rich food provided by these animals can be especially important for the Great Bustard in cold winter days. In wintertime the most important rodent is the Common Vole *(Microtus arvalis)* as it is active in winter during daylight hours, too. In autumn and early spring the Mound-building Mouse *(Mus spicilegus)* and the Wood Mouse *(Apodemus sylvaticus)* are also important as food sources. The latter two are nocturnal animals, but come out sometimes during daytime as well.

Beside the feeding sites, roosting sites should also be managed on the wintering property (which are, at the same time, often lekking grounds or nesting sites, too). During their daily routine, Great Bustards often fly back to their roosting sites late afternoon after having visited their feeding sites in the morning or having spent the entire day there. These roosting areas are usually perennial crops, like grassland and alfalfa fields, so providing these suitable and undisturbed habitats in the vicinity of the feeding grounds is essential. Preferably, it should be a big, open area with low vegetation, with an easy access to the feeding area.

While the plots should be open and possibly slightly undulating, the presence of various relief-elements as a shelter to the birds against strong wind or heavy snowfalls is just as important factors. Especially, if the snowfall is combined with wind, relieves will always provide snowless, bare patches, where the Great Bustards can pick the leaves of the oilseed rape (*M. Lóránt,* pers. comm.).

Site	2004/5	2005/6	2006/7	2007/8
Kiskunsági szikes puszták	5 ha	33 ha	-	48 ha
Solti-sík	-	12 ha	-	12 ha
Dévaványai-sík	-	87 ha	-	30 ha
Bihari-sík	-	27 ha	-	25 ha
Hortobágy	15 ha	34 ha	-	35 ha
Hevesi-sík	-	18 ha	-	25 ha
Borsodi-Mezőség	-	21 ha	-	23 ha
Mosoni-sík	-	7 ha	-	9 ha

Table 1. Area (in hectare) of rape fields where thick snow was removed during the project period according to project sites in Hungary on Great Bustard wintering grounds *(Bankovics, 2009)*
1. táblázat. Azon repcemezők kiterjedése a különböző teleken, ahol a vastag hótakarót eltakarították a túzok telelőhelyén a projektidőszak alatt *(Bankovics, 2009)*

Once the plots are created and occupied by the birds, regular monitoring of both the wintering flocks and the weather conditions is needed. Due to the predictable daily movements of the birds and normally well-known stamping grounds, winter counts can be carried out at feeding or at roosting sites, however it is much easier to count while birds are feeding, especially if the vegetation is covered with snow.

Because the local daily movement between the feeding sites and the roosting sites may entail the risk of collision of the flying birds, aerial power lines should be replaced to underground cables if possible. In Hungary such measures were carried out in the Hortobágy National Park and also in the Great Bustard habitat of the Borsodi Mezőség on an 11-km-long section during the LIFE programme between 2004 and 2008 *(Bankovics, 2009)*.

Management during winter

In case of mild or average winter conditions, with the minimum temperature only seldom below -5°C, the Great Bustard populations usually stay on their regular wintering sites, which are the same, or at least close to their breeding sites. During mild winters the birds do not need supplemented food, only the wintering habitats need to stay undisturbed. The birds feed on the natural vegetation and, if available, they also have animals in their diet (small rodents and the available invertebrate fauna). The most frequently used feeding habitats are rape fields while grasslands and alfalfa are the most frequented resting sites during winter.

In case of severe winters, when the leaves of the oilseed rape are covered by thick snow, or when the snow is frozen on the surface, the birds do not have an easy access to their food any more. In these cases, especially if such conditions last for several days or even for weeks, artificial food supply and enabling the access to the winter vegetation for the wintering Great Bustards must be secured.

In case of thick snow, cattle silage is put out in the fields in small piles. The silage has been usually made from the green parts of maize *(Zea mays)* provided as winter food for the Great Bustards in the cold periods. In the Kiskunság National Park this type of food supplement has been used since the 1970s, later adopted by every other national park in

Hungary with a Great Bustard population. Beside maize, green Savoy cabbage, good quality hay of dry alfalfa and also a special seed-mixture (consisting of broken wheat, maize, sunflower and different weed seeds) are also adequate as winter food supplements. Besides direct provision of food, the cleaning of feeding sites from the snow is also necessary to prevent movements of the birds and to keep them in a well-watched and safe location. Since the Great Bustard LIFE programme conducted between 2004 and 2008, it has become a practice that agricultural equipment is used to remove parts of the snow cover from rape fields. In practice, with the help of tractors equipped with snowploughs or simply by pulling 2 or 3 larger tires by a tractor or even by a four wheel drive vehicle, narrow rows of plantation (1 or 2 hectares) can be made accessible to the bustards. When the snow cover is thinner and only its surface is frozen it may be sufficient to crack the ice layer open *(Table 1).* It is recommended to put into the contract of the farmers that, if necessary, they need to open up the rape fields covered by snow to clear access to food for the wintering Great Bustard flocks, as it is the case in the Hungarian agri-environmental scheme. In the ice opening process it is preferable to use machines with front equipment and to use it a few cm above the soil surface in order to protect the shoots of the young plants. In such weather conditions daily monitoring is vital. According to the monitoring results cleaning might need to be repeated, as long as weather conditions warrant it. The snow cover may be opened up in a natural way if it is not too thick yet for the Roe Deer *(Capreolus capreolus)*, since they manage to scratch the surface of the snow cover with their hooves, which opens the way for the Great Bustards, too, to eat the leaves. All winter management practices in the breeding range ultimately aim to prevent migratory movements of the birds and to keep them in a well-watched and safe location. If the access for leaves is not ensured the populations might migrate to unknown areas where their protection cannot be guaranteed. Unpredictable movements might cause detectable losses to the Central European Great Bustard population. Because these occasional movements are not well researched yet, regular monitoring and further research are recommended in this field.

Discussion

A guideline is under preparation on the measures to secure the successful wintering of Great Bustard populations in Central Europe. The first part of this paper has already been finished containing the measures introduced above for the populations inside the Carpathian Basin. Compilation of the second part of the guidelines has been scheduled after the meeting in Szarvas based on discussion with the colleagues at the conference first and consecutively with further experts from other countries outside the Carpathian Basin. Based on their experience and results the guidelines are to be completed intersessionally.

Several questions were raised that we have to answer during the next few years with the help of the working group in order to finish the guidelines on winter managements of Great Bustard identified by the Medium Term International Work Programme:

– What can be done, when the Great Bustard population has already left and they are on their way to wintering sites?

– What happens when the Great Bustards arrive to their wintering place in one of the countries in Southern Europe?

– How should Range States ensure the adequate protection of the individuals/populations e.g. from any disturbance, hunting, etc?
– Do the authorized bodies keep the habitats where Great Bustard individuals stage on their migration route free of disturbance at the highest possible level?

Kivonat—A vándorló fajok védelméről szóló egyezmény (Convention on Migratory Species, CMS) keretén belül egyetértési szándéknyilatkozatot írtak alá az érintett országok *(Otis tarda)* Közép-Európában. E dolgozat a faj állományának megőrzésével kapcsolatban a tél során felmerülő problémákat tárgyalja, ami egyben az együttműködési megállapodás munkatervének is a része. Az aktuális időjárási viszonyoktól függő, különböző táplálékkal történő téli etetés módszereit ismertetjük. A faj védelmével kapcsolatos további intézkedések közé tartozik a vastag hótakaró megnyitása a mezőgazdasági területeken annak érdekében, hogy a túzokok hozzáférjenek a természetes táplálékukhoz, a repcelevelekhez és egyéb növényekhez. A magyarországi LIFE túzokvédelmi program e célból hókotrókat is igénybe vett. A táplálékhoz való könnyebb hozzáférés céljából hozott intézkedés következtében a túzok még zord, havas teleken is feladta vonulási hajlamát, így a vonulási útvonalon, illetve a telelőterületen fellépő állományveszteség kiküszöbölhető volt. Hasonló intézkedések bevezetése javasolható a Kárpát-medence többi túzokállományainak védelme érdekében is.

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Status and mortality factors of the Great Bustard *(Otis tarda)* in Croatia during the 20th century

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ABSTRACT—In the 20th century the Great Bustard *(Otis tarda)* was a passage migrant and winter visitor in Croatia. Birds observed in Croatia belong to the Central European population for which the harsh winters were identified as the most important cause for adult bird mortality. We investigate the mortality factors of adult birds in Croatia. Data on the occurrence of the Great Bustard in Croatia were collected from the literature and from feedback of a questionnaire distributed among hunters in 2004. During the 20th century, 35 records of at least 60 birds were reported. Occurrences were more frequent at the beginning of the century, but they turned scarcer and more irregular in later years. Birds were observed between October and April. During winter, Great Bustards were more frequently recorded in Southern Croatia, while records from Northern Croatia dominated during autumn and spring. From the total number of records, 57% referred to birds being shot. Shooting occurred between December and March mostly in Southern Croatia. The Great Bustard is strictly protected by law in Croatia since 1967, with one recorded case of birds being illegally shot since the hunting ban has been imposed.

Key words: *Otis tarda,* adult mortality, illegal hunting, Croatia.

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Introduction

The Great Bustard *(Otis tarda)* used to be a breeding species in Croatia until the end of 19th century. The only proof for its breeding is one chick from Slavonia (unfortunately without a date) kept in the ornithological collection of the Croatian Natural History Museum *(Rössler, 1902; Grbac & Kralj, 2008).* The breeding population soon disappeared, and by the 20th century the species became an irregular visitor in Croatia. There are no recoveries of ringed birds to confirm the origin of birds being found in Croatia. Also, when looking at recovery data of the nearest population in Hungary, in spite a total of 545 birds had been ringed in Hungary between 1951 and 2006, only one foreign recovery (in Albania) has been known until now *(Faragó, 2009).* However, according to the movements of the central European birds *(Streich et al., 2006)* it is reasonable to conclude that Great Bustards being observed in Croatia belong to the Central European population and originate from Hungarian, Austrian and probably Serbian (at least the observations in eastern Croatia) breeding populations. From these three populations, the Hungarian is the most numerous, but it faced a strong decline during the 20th century.

The Central European population is only a facultative migrant in response to extreme weather conditions. The mortality during migration is very high and after those winters when migration occurred, Hungarian Great Bustard populations suffered extreme declines *(Faragó, 1993).* Harsh winters were identified as the most important reason for adult bird

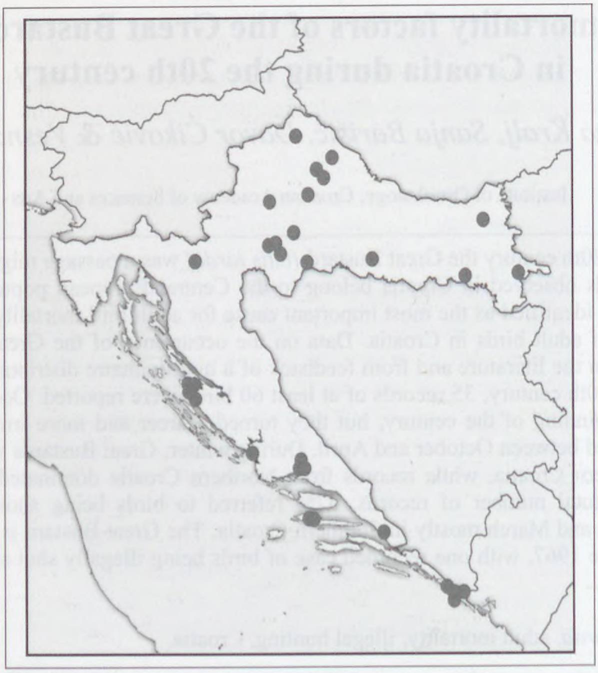

Figure 1. Localities of records of the Great Bustard in Croatia during the 20th century
1. ábra. A túzok 20. századi előfordulási helyei Horvátországban

mortality, either due to the starvation or mortality factors related to migration, such as illegal shooting, collision with power lines and predation *(Faragó, 2005)*.

In this study we investigate the mortality factors of adult birds in Croatia during the 20th century, based on literature data. The aim of our study is to identify the main mortality factors and their effect at spatial and temporal scales.

Materials and methods

Data about the occurrence of the Great Bustard in Croatia were taken from the annual reports of the Croatian Ornithological Centre *(Rössler, 1902–1918)*, various ornithological and hunting literature (*Maštrović, 1931; Krpan, 1960; Tutman, 1980; Delić & Grlica 2003*), museum collections (*Piasevoli & Pallaoro, 1991; Sušić et al., 1988: Grbac & Kralj, 2008)*, as well as from the feedback of the questionnaire distributed together with the national hunter's magazine "Lovački vjesnik" in 2004. The hunting bag statistics listed bustards until 1930, but annual totals were given for bustards and herons together *(Signjar, 1925)* therefore those data were inadequate for analysis.

For every recorded data, apart from the number of reported birds, locality, date (where available) and the type of recovery was noted (bird being observed, shot or found dead or

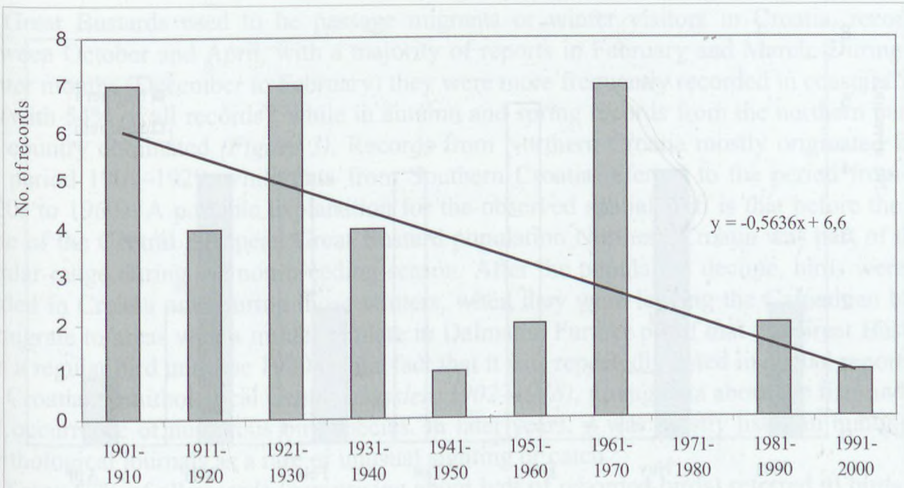

Figure 2. Number of records of the Great Bustard in Croatia in different decades of the 20th century (n = 35)

2. ábra. A túzok előfordulási adatainak eloszlása Horvátországban a 20. század egyes évtizedeiben (n = 35)

dying). Observation sites were divided to Northern (Lowland) Croatia and Southern (Mountain and Coastal) Croatia. A single record from the Croatian Mountain was merged with those of Coastal Croatia for topographical reasons. Northern Croatia consists predominantly of lowlands, so there are no greater natural barriers between Great Bustard breeding areas and Northern Croatia. To reach Southern Croatia, birds must overfly mountains (up to 2000 m height) and eventually the sea.

Results and discussion

During the 20th century, 35 records of at least 60 birds were reported *(Figure 1)*. Birds were noted at many localities in continental Croatia (from Valpovo on the east to Brežice and Kostajnica on the west) and along the Croatian coastline (from Zadar to Cavtat), including the island of Hvar. Records were more frequent at the beginning of the century, when Great Bustards were observed almost annually *(Figure 2)*. During much of the century the species was present irregularly; its occurrence was mostly related to harsh winters. Years with the harsh winter weather initiating Great Bustard migration were: 1929, 1940, 1947, 1985 and 1987 (*Faragó, 2005*). Out of these years, birds were recorded in Croatia in 1929, 1940 and 1985. Records were also more frequent in the early 1960s. The last year with several observations was 1964 when Great Bustards were reported from Ogulin, Dubrovnik and the island of Hvar.

The relatively small number of observations does not enable us to run a very detailed statistical analysis. However, we consider that even that small number can give us an indication on the main mortality factors and their effect at spatial and temporal scales.

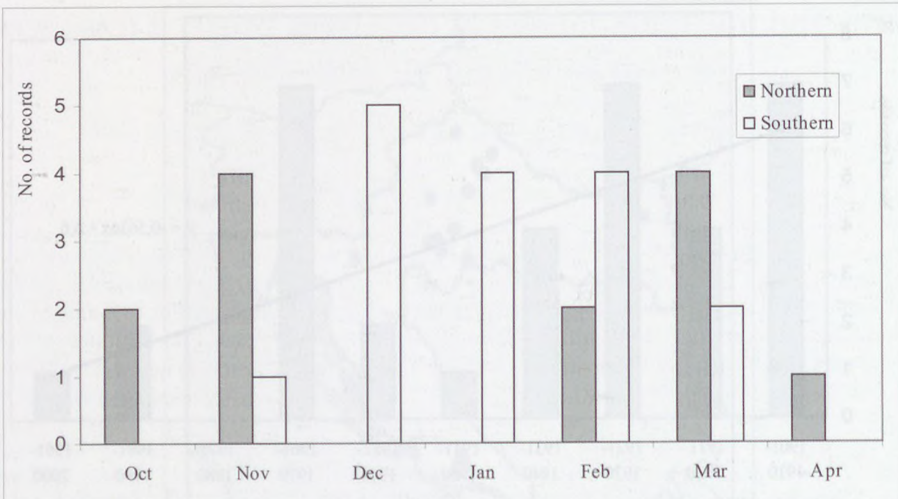

Figure 3. Monthly distribution of records of the Great Bustard in Northern and Southern Croatia (n=29)
3. ábra. A túzok előfordulási adatainak havi eloszlása Horvátországban (n=29) (szürke oszlopok: észak; üres oszlopok: dél)

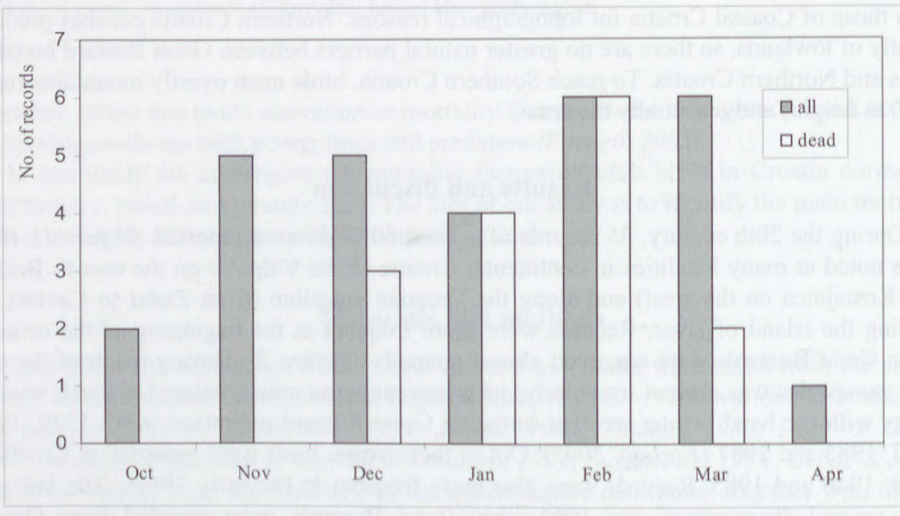

Figure 4. Monthly distribution of records of the Great Bustard being shot or found dead (n=15) compared to the total number of records (n=29)
4. ábra. A Horvátországban lelőtt vagy elpusztultan talált túzokok (üres oszlopok; n=15) előfordulási adatainak havi eloszlása az összes adathoz viszonyítva (szürke oszlopok; n=29)

Great Bustards used to be passage migrants or winter visitors in Croatia, recorded between October and April, with a majority of reports in February and March. During the winter months (December to February) they were more frequently recorded in coastal Croatia (with 54% of all records), while in autumn and spring records from the northern part of the country dominated *(Figure 3)*. Records from Northern Croatia mostly originated from the period 1901–1929, while data from Southern Croatia referred to the period from the 1920s to 1960s. A possible explanation for the observed spatial shift is that before the decline of the Central European Great Bustard population Northern Croatia was part of their regular range during the non-breeding season. After the population decline, birds were recorded in Croatia only during those winters, when they were leaving the Carpathian basin to migrate to areas with a milder climate in Dalmatia. Further proof that the Great Bustard was a regular bird until the 1920s is the fact that it was repeatedly listed in annual reports of the Croatian Ornithological Centre *(Rössler, 1902–1918)*, giving data about the first and the last occurrence of numerous bird species. In later years, it was mostly listed in hunting or ornithological journals as a rare or unusual sighting or catch.

Some 57% of all records (comprising about half of recorded birds) referred to birds being shot, all of them between December and March, with a peak in February *(Figure 4)*. Almost all birds were shot in winter, in Southern Croatia, between the 1920s and 1960s. The ratio of records of birds being shot in winter months (from December to February) is 87%. It is very likely that shooting also occurred before that period in Northern Croatia, but data were not adequately addressed in hunting statistics *(Signjar, 1925)*. Starvation was identified as a mortality factor in only one occasion near Bjelovar (Northern Croatia, on 1st March 1940). The high ratio of shot birds in winter is in line with the high mortality recorded in years with winter migration *(Faragó, 1993; 2005)*.

In the early 20th century the Great Bustard was hunted in Croatia. The species has been protected strictly by law in Croatia since 1967, when the Great Bustard already became a rare visitor. No exemption for shooting was granted after that time. After the legal protection of the Great Bustards, only three records referring to 18 birds were reported. In one occasion a flock of 5 birds was shot in 1980s, indicating that illegal killing still occurred. However, monitoring of illegal killing was not possible.

Only a few records are known from the beginning of the 21st century, all of them from Northern Croatia: Belje, Baranja (*T. Mikuska, pers. com.*) and three records near Lipovljani, Posavina during the winter and spring of 2005 (*T. Kolarić, in litt.*). All records relate to observations of live birds, which give us hope that illegal killing in Croatia will not cause the threat for this scarce visitor any more.

Kivonat—A huszadik században a túzok *(Otis tarda)* átvonuló és téli vendég volt Horvátországban. A Horvátországban megfigyelt madarak a közép-európai állományhoz tartoznak, melynél a kemény teleket jelölik meg a felnőtt madarak legfőbb pusztulási okának. A dolgozatban megvizsgáltuk a mortalitási okokat a horvátországi felnőtt madarak esetében. A horvátországi túzok-előfordulási adatokat a szakirodalomból, illetve egy 2004-ben vadászok között köröztetett kérdőív felmérési eredményeiből gyűjtöttük. A huszadik századból 60 egyedre vonatkozó 35 adatot sikerült összegyűjteni. A faj előfordulása gyakoribb volt a század elején, de később ritkábbá és szabálytalanabbá vált az egyes adatok eloszlása. A megfigyelések október és április közé estek. Télen a túzokot gyakrabban észlelték Dél-

Horvátországban, míg Észak-Horvátországra az őszi és tavaszi adatok voltak jellemzőek. Az összes adat 57%-a lelőtt madárra vonatkozott. A lelövések december és március között, többnyire Dél-Horvátországban történtek. A túzok 1967 óta a törvény által fokozottan védett Horvátországban, egy esetben fordult elő a faj illegális vadászata a lelövési tilalom bevezetése óta.

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Temporal and spatial patterns in movements of the Great Bustard *(Otis tarda)* in Hungary

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Abstract—Hungary holds one of the largest populations of the threatened Great Bustard, a bird species of grassland and arable habitats. The population rapidly declined from c. 12,000 at the turn of the 20th century to 875 individuals in 1991 before it has stabilised at around 1,600 individuals due to active conservation measures in the last decade of the 20th century. To guide recovery efforts, we carried out analyses of spatial and temporal patterns of bustard occurrences using the four years of surveys from nine major populations across Hungary. We showed that population sizes increased in the majority of bustard regions, which is in line with the long-term population trend in Hungary. Furthermore, temporal trends in the degree of aggregatedness indicate a tendency towards dispersal.

Keywords: *Otis tarda,* grassland conservation, lekking, population recovery.

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Introduction

Species extinction rates are accelerating despite the increasing extent of conservation efforts *(Butchart et al., 2010).* Globally, temperate grasslands have been identified as one of the bioms under greatest risk from extensive habitat loss, with the extent of habitat conversion exceeding that of habitat protection by a factor of eight *(Hoekstra et al., 2005).* The destruction and fragmentation of remaining grassland habitats is changing the structure and function of ecosystems, and causing rapid declines and extinctions of grassland species *(BirdLife International, 2004; Ceballos et al., 2010),* with over 10% of grassland bird species globally being at risk from extinction *(IUCN, 2013).*

In this paper, we focus on a flagship species, the Great Bustard, which was a common breeding bird across large parts of Europe and Asia during the 18th century *(Gewalt, 1959).* However, a combination of hunting, egg collection and changes in agricultural practice resulted in dramatic declines and local extinctions across its range during the 20th Century *(Palacín & Alonso, 2008);* it is currently categorised as 'vulnerable' on the IUCN Red List *(IUCN, 2013).* Great Bustards were formerly widespread in Hungary; however, in the 18th and 19th centuries, Hungary underwent a massive agricultural expansion which involved ploughing of the steppe and drainage of wetlands and marshes to create new agricultural land *(Kovács, 2012).* At the turn of the 20th century, the population was estimated to be ca. 12,000 individuals *(Faragó, 1987),* declining to a minimum of 875 individuals in 1991. The population has stabilised in the last decade at around 1,600 individuals split between ten breeding populations *(Kovács, 2012).* We focus on the Hungarian population for three reasons: first, the population is expanding from a bottleneck and therefore can benefit greatly from evidence-based conservation management at this time. Second, the Hungarian population is the third largest in Europe, and it is one of those five countries where the population is recovering *(Palacín & Alonso, 2008)*. Finally, there is high-quality data available from standardised surveys across nine of ten populations in Hungary.

The objectives of this study were to (1) analyse temporal trends in various metrics of population size and to (2) investigate spatial and temporal patterns in aggregation indices in all major bustard regions of Hungary.

Methods

Study area

Surveys were conducted as part of an EU LIFE+ project between 1st January 2005 – 30th June 2008 in nine areas of Hungary, where Great Bustards are resident: Moson (northwestern region), Kiskunság and Solti-sík (central), as well as Bihar, Dévaványa, Heves, Hortobágy, Körös–Maros National Park and Borsodi-Mezőség (eastern). Fourteen observers spent a total of 855 days in the field. Nearly all areas were surveyed by the same observer for the full duration of the project to ensure consistency in field methodology. During each survey the numbers and coordinates of sighted Great Bustards were recorded, together with information on the age and sex, totalling 8391 records.

Population estimates

During the surveys we recorded the following variables for each location: (1) number of old males, (2) number of young males, (3) number of all males, (4) number of females, (5) total number of birds, (6) ratio of males and females, (7) ratio of young and old males.

Statistical analyses

To estimate the rate of temporal development in various measures of population estimates, we fitted linear regressions of monthly medians of these response variables as a function of years reporting regression slopes and related probabilities.

To investigate temporal trends in the spatial distribution of bustard aggregations, we calculated Clark-Evans aggregation indices for each month and then fitted a linear regression model using date and year as independent variables *(Clark & Evans, 1954)*. This computation performs a hypothesis test of clustering or ordering of point patterns: the null hypothesis of the test is complete spatial randomness *(Clark-Evans* $R > 1$*)*, while the alternative hypothesis is that the point pattern is spatially aggregated *(Clark-Evans* $R < 1$*)*. Similarly, to test the saturation of bustard occurrences over the years, the annual maxima of aggregation indices were regressed against the corresponding sum of bustard counts.

Results

Temporal patterns

We obtained the following linear regression of monthly medians of population metrics as a function of years *(Tables 1–3)*. Considering monthly medians of bustard counts, the

Region	Bihar	Dévaványa	Hevesi-sík	Hortobágy	Kiskunság	KSA	Borsodi-Mezőség	Mosoni-sík	Solti-sík
Bihari-sík		0.613	0.705	0.736	0.654	0.432	0.471	0.8	0.46
Dévaványa			0.552	0.607	0.63	-0.215	0.326	0.578	0.325
Hevesi-sík				0.61	0.565	0.111	0.256	0.677	0.285
Hortobágy					0.821	0.752	0.571	0.85	0.55
Kiskunság						0.801	0.385	0.724	0.818
Kis-Sárrét							0.371	0.489	0.706
Borsodi-Mezőség								0.552	0.091
Mosoni-sík									0.552

Table 1. Spearman's correlation coefficients measured between the total number of males of distinct bustard regions. Significant relationships are indicated in bold.
1. táblázat. A számított Spearman-féle korrelációs koefficiensek a különböző túzokpopulációkban észlelt kakasok összmennyisége szempontjából

number of females increased in Kiskunság *(b = 0.001, p = 0.01),* the number of old males increased with marginally significant trends *(b = 0.006, p = 0.054)* in the Kis-Sárrét area; the number of old males increased in Borsodi-Mezőség *(b = 0.003, p = 0.003).*

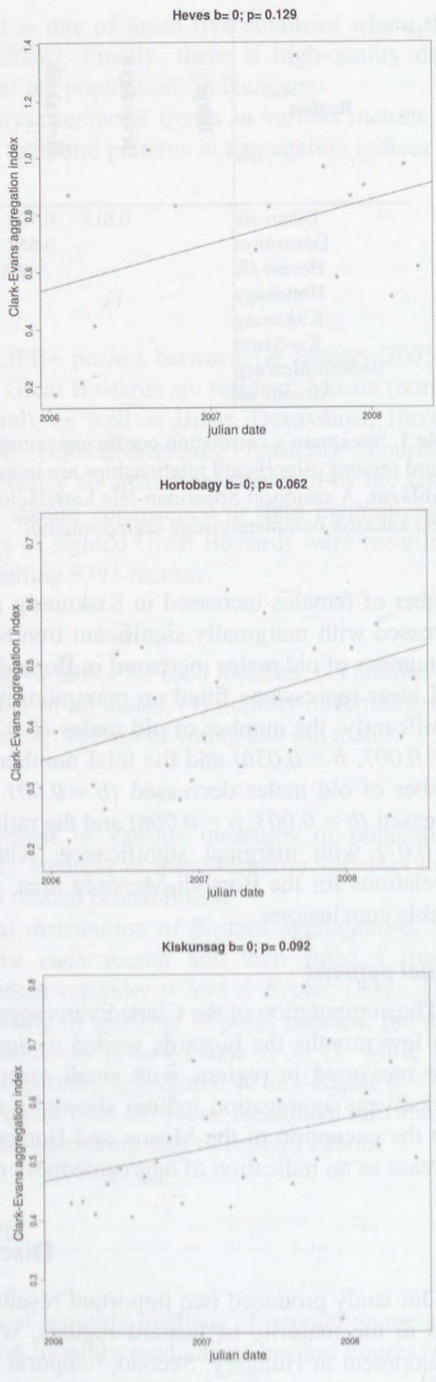
Linear regressions fitted on maximum numbers, in Dévaványa three metrics increased significantly: the number of old males *(b = 0.028, p = 0.033),* the number of young males *(b = 0.007, b = 0.056)* and the total number of males *(b = 0.04, b = 0.006).* In Heves, the number of old males decreased *(b = 0.001, p = 0.04),* while the number of young males increased *(b = 0.003, p = 0.006)* and the ratio of young and old males increased *(b = 0.001, p = 0.07)* with marginal significance. Although we detected a number of significant correlations for the Borsodi-Mezőség area, the number of observations is too low to infer reliable conclusions.

Spatial patterns

The computation of the Clark-Evans aggregation indices showed that with the exception of a few months the bustards tended to aggregate all year round. However, these values were measured in regions with small sample sizes. In contrast, temporal trends of the Clark-Evans aggregation indices showed a fairly homogeneous pattern across the country with the exception of the Moson and Borsodi-Mezőség regions where the index tended to decrease as an indication of aggregatedness *(Table 3).*

Discussion

Our study produced two important results. First, our data showed increasing population sizes in the majority of bustard regions, which is in line with the long-term population development in Hungary. Second, temporal trends in the degree of aggregatedness show a tendency towards dispersal.



Figures 1–3. Clark–Evans aggregation indices as a function of the Julian dates in Hevesi-sík, Hortobágy and Kiskunság, respectively

1–3. ábra. A Clark–Evans aggregációs indexek a julián dátum függvényében a Hevesi-sík, Hortobágy és a Kiskunság esetében

Region	Population type	b(median)	P(median)	b(max)	P(max)
Bihari-sík	old male	0	0.921	-0.012	0.120
Bihari-sík	young male	0		0.001	0.591
Bihari-sík	male sum	0	0.924	-0.013	0.100
Bihari-sík	female	0	0.841	0.006	0.502
Bihari-sík	total	0	0.999	-0.009	0.428
Bihari-sík	male-female ratio	0		0.003	0.537
Bihari-sík	young-old male ratio	0		0	0.701
Dévaványa	old male	0.001	0.553	**0.028**	**0.033**
Dévaványa	young male	0	0.344	**0.007**	**0.056**
Dévaványa	male sum	0.002	0.577	**0.040**	**0.006**
Dévaványa	female	-0.001	0.603	0.018	0.412
Dévaványa	total	-0.009	0.266	0.016	0.594
Dévaványa	male-female ratio	0	0.343	0.006	0.166
Dévaványa	young-old male ratio	0		0	0.356
Hevesi-sík	old male	0	0.666	**-0.001**	**0.040**
Hevesi-sík	young male	0	0.175	**0.003**	**0.006**
Hevesi-sík	male sum	0	0.695	0	0.658
Hevesi-sík	female	-0.002	0.104	0	0.874
Hevesi-sík	total	-0.002	0.335	0.001	0.863
Hevesi-sík	male-female ratio	0		0	0.986
Hevesi-sík	young-old male ratio	0		**0.001**	**0.070**
Hortobagy	old male	0		-0.001	0.777
Hortobagy	young male	0	0.333	-0.004	0.109
Hortobagy	male sum	0.001	0.289	-0.005	0.556
Hortobagy	female	-0.006	0.105	-0.009	0.496
Hortobagy	total	-0.004	0.475	-0.006	0.700
Hortobagy	male-female ratio	0		-0.004	0.396
Hortobagy	young-old male ratio	0		-0.002	0.119
Kiskunság	old male	0	0.187	0.009	0.602
Kiskunság	young male	0		0.002	0.865
Kiskunság	male sum	-0.001	0.150	-0.001	0.954
Kiskunság	female	**0.001**	**0.010**	-0.002	0.868
Kiskunság	total	-0.001	0.865	-0.042	0.142
Kiskunság	male-female ratio	0		0	0.891
Kiskunság	young-old male ratio	0		0.001	0.849
Kis-Sárrét	old male	**0.006**	**0.054**	0.005	0.171
Kis-Sárrét	young male	-0.001	0.506	-0.001	0.807
Kis-Sárrét	male sum	-0.001	0.905	-0.002	0.588
Kis-Sárrét	female	0.005	0.374	0.003	0.783
Kis-Sárrét	total	0.003	0.583	0.001	0.934
Kis-Sárrét	male-female ratio	0	0.895	0	0.979
Kis-Sárrét	young-old male ratio	-0.001	0.147	0	0.351
Borsodi-Mezőség	old male	**0.003**	**0.003**	**0.006**	**0**
Borsodi-Mezőség	young male	0	0.671	**0.004**	**0.054**
Borsodi-Mezőség	male sum	0.001	0.141	0.001	0.577
Borsodi-Mezőség	female	-0.002	0.477	-0.003	0.442
Borsodi-Mezőség	total	0	0.951	-0.002	0.603
Borsodi-Mezőség	male-female ratio	0	0.216	0	0.268
Borsodi-Mezőség	young-old male ratio	0	0.671	**0**	**0.007**
Moson	old male	0	0.383	0.005	0.634
Moson	young male	0		-0.002	0.694
Moson	male sum	0	0.540	0.007	0.562
Moson	female	0	0.965	0.012	0.525
Moson	total	-0.006	0.167	0.008	0.714
Moson	male-female ratio	0		-0.008	0.186
Moson	young-old male ratio	0		0	0.755
Solti-sík	old male	0.001	0.273	**-0.009**	**0.016**
Solti-sík	young male	0		**-0.003**	**0.017**
Solti-sík	male sum	0.001	0.480	**-0.009**	**0.003**
Solti-sík	female	0	0.991	-0.004	0.467
Solti-sík	total	0.002	0.783	-0.006	0.618
Solti-sík	male-female ratio	0	0.983	-0.001	0.259
Solti-sík	young-old male ratio	0		0	0.723

Table 2. Slopes and related probabilities of linear regressions fitted on various measures of population size as a function of years. Significant relationships are indicated in bold.

2. táblázat. Lineáris regressziós valószínűségek a populációméret különböző értékei kapcsán az évek függvényében. A statisztikailag szignifikáns értékek félkövéren vannak szedve

Region	b	P
Bihari-sík	0.00008	0.435
Dévaványa	0.00004	0.885
Hevesi-sík	0.00042	0.129
Hortobágy	0.00019	0.062
Kiskunság	0.00014	0.092
Kis-Sárrét	0.00036	0.684
Borsodi-Mezőseg	-0.00021	0.479
Mosoni-sík	-0.00015	0.140
Solti-sík	0.00013	0.555

Table 3. Temporal trends of Clark–Evans aggregation indices for all bustard regions
3. táblázat. A Clark–Evans-féle aggregációs indexek temporális trendje az egyes túzokélőhelyeken

Population increase in the region seems to be related to various spatial and temporal predictors. Population increase in regions with the strongest populations seems to be related to the relative increase of the ratio of young birds which is expected to further promote population increase. This pattern might be the primary driver governing spatial patterns, as the tendency towards less dense aggregations might be related to the dispersal movements of young prospecting birds. However, there might be a second mechanism explaining the process of decreasing aggregatedness. As the Great Bustard is a long-living bird, older individuals, which survived periods with intensive hunting would show a similar degree of awareness throughout their lifetime. However, younger bustards which hatched after the complete ban of hunting and the introduction of strict conservation control, experience only a minimum level of hunting disturbance thus are expected to be less cautious which allows them to be observed at larger temporal scales including less remote areas. In addition, the majority of monthly aggregation indices showing dispersion were measured in populations with small population size, therefore these results might be influenced by observational bias.

These processes do not exclude our previous predictions that population declines of smaller populations might be related to metapopulation restructuring and not only caused by local extinctions. However, this hypothesis needs to be tested in the future.

An increasing number of studies have shown that in contrast to long-distant migrant birds, residents and short-distance migrants benefit from current climatic processes by increased survival of young birds during winter *(Burnside et al., 2013)*. Although this might apply to the Great Bustard the population increase of which might partly be explained by milder winters, the limited length of our study period did not allow us to test this hypothesis.

In conclusion, here we show that even short-term, highly standardised studies can efficiently contribute to understanding temporal and spatial properties of endangered taxa that might be crucial in species-specific conservation planning.

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Kivonat—Magyarországon van a gyepi és szántóföldi élőhelyeken előforduló, veszélyeztetett túzok egyik legnagyobb állománya. Állománya a 20. század eleji 12 000 példányról meredeken lecsökkent 875 madárra a huszadik század fordulójára, és a védelmi intézkedéseknek köszönhetően 1600 példánynál stabilizálódott a 20. század végére. Az állomány-helyreállítási intézkedések mérésére a túzok-előfordulások térbeli és időbeli elemzését végeztük el a kilenc fő magyarországi részállományra kiterjedő négyéves felmérés adatai alapján. Kimutattuk, hogy az állomány mérete nőtt a legtöbb túzok-előfordulási helyen, ami megfelel a hosszú távú magyarországi állománytrend adatainak. Továbbá a aggregálódás időbeli mértéke diszperzió jeleit mutatja.

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Management of Great Bustard *(Otis tarda)* habitats in Hungary: the aspects of agri-environmental schemes

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Abstract—The population of Great Bustards has been increasing slowly but steadily in Hungary, thanks to the conservation measures taken in the past decades. The species, however, suffers from several threats throughout its entire range. Intensive agriculture is one of the most important factors, as it affects directly or indirectly 5 of the 9 main threats listed in the international action plan for the Western Palaearctic population of Great Bustard. In this paper the importance of adequate management of Great Bustard habitats is highlighted from the aspect of agri-environmental regulations. Both the legal environment and the financial instruments supporting Great Bustard conservation seem to be adequate in Hungary. Habitat management supported by the agri-environmental schemes could be improved, however, by more sophisticated regulation. The monitoring database developed in the last 10 years, including the monitoring of anthropogenic mortality factors allows us to evaluate the effectiveness of the conservation measures taken between 2005 and 2014 on habitat management. This reveals the weak points of different schemes, especially those within the programme of Environmentally Sensitive Areas (ESA), where further improvements should be made to restore the favourable conservation status of the species.

Keywords: *Otis tarda,* habitat management, agri-environmental scheme

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Introduction

Great Bustard is a ground breeding steppe bird, attracted by lowlands with undisturbed open landscape. Its conservation status is considered vulnerable, as several threatening factors has led to significant long term decline in most populations *(Alonso & Palacín, 2010),* including the one in Hungary.

As the main habitats of the species are grasslands and arable fields, agriculture is one of the main human activities contributing both directly and indirectly to the maintenance of Great Bustard habitats determining significantly also its quality.

In this paper the importance of harmonisation of agriculture production, social aspects and nature conservation priorities are discussed. The key principle is conservation of the rural environment and sustainable land use adapted to environmental conditions. To achieve this objective, proper regulation of the agri-environmental schemes is needed. This needs to be introduced throughout the entire European range of Great Bustard, as one of the main measures for the successful conservation of this species. Steps required to adjust each individual type of farming activity to the ecological needs of this emblematic bird species of Hungarian steppe lands are also highlighted in this paper.

Materials and methods

As an indicator of the efficacy of the introduced measures on Great Bustard protection in Hungary in the last 10 years, census data of national counts conducted between 2003 and 2012 are presented in *Table 1*.

When analysing the anthropogenic factors related to the management and conservation of Great Bustard habitats, the following four social groups can be identified who regularly impact on Great Bustard habitats and might affect directly or indirectly the entire Hungarian Great Bustard population: 1) farmers; 2) hunters; 3) other professionals (staff of water management, ranger service, etc.); 4) the general public (birdwatchers, anglers, tourists, etc.).

Farmers are the most important out of those social groups using agricultural land, since they are the key stakeholders of maintenance and management of agrarian habitats where Great Bustards are mating, breeding, moulting and wintering and they have a direct effect on the breeding success through their regular activity. Hence, this paper focusses on the significance of the main target group, the farmers and their activities.

A total of five different factors threatening Great Bustard populations that are related to agricultural policy and activities can be listed according to the international single species action plan for the Western Palaearctic *(Nagy, 2009)*. This list gives the framework of the present study (the global scale impact of each factor is indicated in brackets, showing their relative importance):

- loss of undisturbed open habitats with suitable vegetation structure (critical)
- destruction of eggs and chicks during agricultural works (high)
- insufficient invertebrate food supply (medium)
- mass mortality in harsh winters (low)
- disturbance (low).

From the aspect of agricultural activities each factor was examined and suggestions were made to reduce the negative effects on Great Bustard populations in general.

Different levels of legal conservation of Great Bustard have been applied to Great Bustard habitats. This took into account their location and the relative dominance of prior conservation principles followed by the application of everyday measures.

This paper summarises the present situation, the indicators and the opportunities of general Great Bustard habitat management in Hungary, together with its consequences. The potentials of the agri-environmental scheme to be realised between 2009 and 2014 were highlighted by a simple comparison of the requirements of the species and the legal regulations in operation.

Results

After a long term decline, the size of the entire Hungarian Great Bustard population has been increasing by 3-4% annually over the last 10 years (*Figure 1*). However, different subpopulations show various trends. The core subpopulations like the one in the Upper-Kiskunság and around Dévaványa show an intensive increase, the size of marginal subpopulations like Heves-Plain or Borsodi-Mezőség are now close to extinction due to a ma-

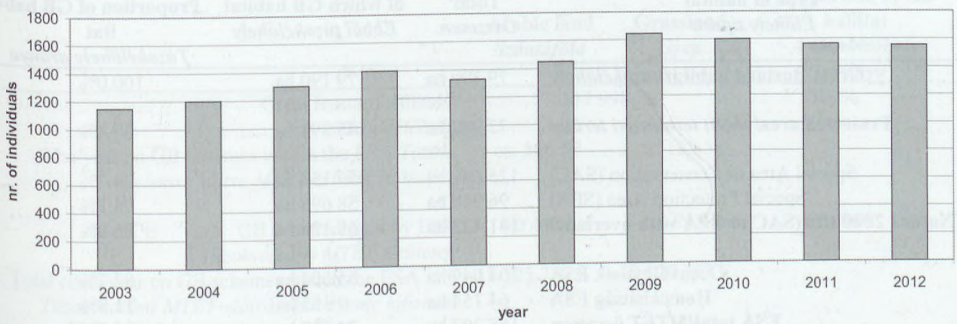

Figure 1. The changes of the population size of Great Bustard in Hungary between 2003 and 2012
1. ábra. A túzok állományának változása Magyarországon 2003–2012 között

jor decline, while some medium size subpopulations seem to be stable, or are slowly increasing, like the one in the Hortobágy. In spite of a positive trend in the last 10 years, a slight decline can be seen from 2009.

In Hungary three levels of Great Bustard habitat conservation with three major measures can be identified.

The first level is the Nature Conservation Act No. LIII of 1996, which provides legal protection to specific species and specific areas at a national level in Hungary. It forbids the disturbance of Great Bustards throughout their entire range and lifecycle. However, preventive protection via suitable habitat management can be guaranteed only within protected areas, such as national parks, landscape protection areas, nature conservation areas, or 'ex-lege' protected habitats, where main agricultural activities (like mowing) are regulated.

The second level is the European ecological network called Natura 2000, especially Special Protection Areas (SPA) designated to preserve European bird species of Community importance. For protection measures only those species considered for designation of the given site need to be taken into account, therefore prescriptions may be less strict but they cover a larger area when compared to areas protected by the Nature Conservation Act. Certain guidelines for the management of grasslands have been laid down by the governmental decree No. 269/2007. (X. 18.) on the regulation of land use on maintenance of Natura 2000 grasslands but management of arable lands is not dealt with in sufficient detail.

Environmentally Sensitive Areas (ESA) are the third level of protection, which give the most adequate regulation, as the ministerial decree No. 61/2009. (V. 14.) FVM provides detailed regulation on the management of both grasslands and arable land according to the requirements of Great Bustard protection and is reasonably flexible in terms of spatial adaptation to the actual range of Great Bustards at any given time. Once a period—like the recent one between 2009 and 2014—has been completed it can be renewed.

The Great Bustard habitats, including both grasslands and arable fields, cover approximately 220 000 hectares in Hungary, out of which 79,190 hectares are located in the Kiskunság area, Central Hungary *(Table 1)*. This region hosts the most numerous Great Bustard sub-population in Hungary.

Type of habitat *Élőhely típusa*	Total *Összesen*	of which GB habitat *Ebből túzokélőhely*	Proportion of GB habitat *Túzokélőhely aránya*
Great Bustard habitat/*túzokélőhely*	79 190 ha	79 190 ha	100.0%
Protected area/*védett természeti terület*	72 982 ha	45 394 ha	57.3%
Special Area of Conservation (SAC)	125 649 ha	59 159 ha	74.7%
Special Protection Area (SPA)	96 948 ha	58 696 ha	74.1%
Natura 2000 site (SAC or SPA with overlaps)	141 422 ha	68 126 ha	86.0%
Dunavölgyi-sík ESA	104 049 ha	65 504 ha	82.7%
Homokhátság ESA	64 154 ha	9 353 ha	11.8%
ESA total/*MTÉT összesen*	168 203 ha	74 857 ha	94.5%

Table 1. Spatial extension of areas with different protection levels together with their ratio of Great Bustard (GB) habitats in the Kiskunság area
1. táblázat. A különböző védettségi szinthez tartozó túzokélőhelyek kiterjedése és a túzok teljes élőhelyéhez képest való lefedettsége százalékban kifejezve

From Great Bustard habitats in the Kiskunság 45,394 hectares (57.3% of the total area in focus) are protected at national level, mostly as national parks. A total of 68,126 hectares (86% of the habitats), are designated as Natura 2000 sites, either as Special Protected Area, or as Special Area of Conservation since 2004, the year of accession of Hungary to the European Union. Between 2009 and 2014 a total of 74,857 hectares (94.5% of the Great Bustard habitats of the Kiskunság) belonged under the regulation of the agri-environmental scheme as Environmentally Sensitive Area (ESA), with special regulation of the Great Bustard conservation measures.

In Hungary the costs spent by the ESA program on Great Bustard conservation is theoretically sufficient to cover 62% of the Hungarian range of the species. However, only about half of this amount was spent on real Great Bustard habitats, covering only 36.2% of the total range. This ratio is slightly higher on grasslands than on arable fields. A total of 19.7% of Hungarian Great Bustard habitats are supported by the agri-environmental scheme, but not from the ESA program, without any specification of 'bustard-friendly' management *(Table 2)*.

Between 2010 and 2012, during the first 3 years of the ESA program a total of 58 Great Bustard nests were detected in the Kiskunság region. Most of these nests were found during agricultural activities, and 16 (approx. 28% of these nests; 9 on arable lands and 7 on grasslands) were found on the area of the ESA program with the regulation of the Great Bustard conservation measures. This shows the deficiency of the regulations. The most common reasons for nesting failure were mowing, pesticide treatment of crops and other types of human disturbance, such as any types of activity of farmers involving their presence by visiting the land, grazing or hunting on grasslands.

Discussion and summary

The terrestrial Great Bustard is a typical K selection strategist bird species with a very slow postembryonic growth rate. The females have been shown to lay 1.8 eggs on average

	Arable land *Szántóföld*	Grassland *Gyep*	Proportion of GB habitat *A túzokélőhely aránya*
Great Bustard habitats *Túzokélőhely*	217 998 ha		100%
€/ha/year on GB schemes within the ESA *Túzokvédelemre költve MTÉT-n belül (€/ha/év)*	ca. 306.5€	ca. 135.5€	
GB schemes paid by ESA *Túzokvédelmi MTÉT területek*	60 443 ha	74 755 ha	62.0%
Total costs/year on GB schemes within the ESA in € *Túzokvédelmi MTÉT-előírásokra évente kifizetve*	18 525 780 €	10 129 303 €	
GB schemes paid by ESA on GB habitats MTÉT túzokvédelmi kifizetések túzokélőhelyen	33 495 ha	45 408 ha	36.2%
Total costs/year on GB schemes within the ESA on GB habitats — *Túzokvédelmi MTÉT-előírásokra évente kifizetve tényleges túzokélőhelyen*	10 266 218 €	6 152 748€	
Other schemes paid by ESA on GB habitats *Egyéb MTÉT-programok túzokélőhelyen*	20 232 ha	22 737 ha	19.7%

Table 2. Data of costs paid for Great Bustard protection within the ESA (Environmentally Sensitive Area) program on and out of Great Bustard habitats in Hungary between 2009 and 2014
2. táblázat. A magas természeti értékű területeken (MTÉT) Magyarországon túzokvédelemre kifizetett összegek adatai 2009–2014 között

in Hungary *(Vadász & Lóránt, 2014)*, and after 28 days of incubation *(Fodor et al., 1971)* the chicks are led by the female for more than 3 months. In the first 6-8 weeks of their life the hatched chicks are almost unable to fly, which means that the most sensitive period of the reproduction (ie. eggs or flightless juveniles) lasts for almost three months. In Hungary, this most sensitive period is between mid April and mid July *(Németh et al., 2009)*.

From 2005, after the accession of Hungary to the European Union, a specific legal framework has been developed in Great Bustard conservation. Within the protected areas the habitat management is regulated by the responsible nature conservation authorities and is adapted well to the ecological needs of the species. Therefore birds breeding inside protected areas have an advantage. Natura 2000 sites buffering protected areas cover the major part of the distribution area of the Great Bustard in Hungary; however the lack of regulation of habitat management on arable lands is still the largest inadequacy in core areas, especially on traditional breeding sites. The ESA program, which consists only a small part of the whole agri-environmental scheme, is expected to fill in the gaps with its regular revision both in terms of its spatial coverage, and by the introduction of more effective regulatios.

In the last 10 years two periods of ESA programs of agri-environmental schemes have been completed in Hungary. Good progress can be detected in the effectiveness of the regulations *(Nagy et al., 2008)*, but there have been still concerns that some specifications in the Great Bustard protection schemes have lead to a high proportion of the nests being endangered during the implementation of the programme between 2009 and 2012.

As the major part of Great Bustard habitats are protected in some way through one of the legal instruments and adequate financial support is also available, a successful conservation of the species should be possible. It would be desirable, however to review details of the specifications of the Great Bustard habitat management for the upcoming ESA period. In the Kiskunság region the main cause for destruction of Great Bustard eggs and nests are mowing, pesticide treatment, tillage and unintended disturbance *(Vadász & Lóránt, 2014)*. Human factors should be excluded or drastically reduced by proper regulations during the incubation period of the species and during the period when the Great Bustard chicks are still flightless.

The regulation of the Great Bustard protection schemes within the ESA program should take into consideration the ecological facts on the reproduction strategy of the species and the monitoring data collected since 2005. A more sophisticated regulation of agricultural activities on the Great Bustard breeding sites during the sensitive period of the species would result in achieving the optimal level of the Hungarian Great Bustard population.

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I would like to thank the Kiskunság National Park Directorate for ensuring support in the last 10 years during my Great Bustard conservation activity in the Upper-Kiskunság region. Thanks also to the Ministry of Agriculture for the opportunity of regular and helpful consultations during the period between 2009 and 2014, when the last ESA program was implemented within the framework of the agri-environmental schemes. Finally I would like to thank all the farmers for reporting essential field information during the last 10 years.

Kivonat—A túzok magyarországi állománya lassú, de folytonos növekedést mutat az elmúlt évtizedekben megvalósított természetvédelmi erőfeszítéseknek köszönhetően. A túzokot egész elterjedési területén számos veszélyeztető tényező fenyegeti, amelyek közül az intenzív mezőgazdasági termelés az egyik legjelentősebb, hiszen a túzok nemzetközi fajvédelmi tervében megnevezett kilenc fő veszélyeztető tényező közül ötre közvetlen vagy közvetett módon hatással van. Jelen munkában a túzokvédelmi szempontok szerint történő élőhelykezelés jelentőségére szeretnék rávilágítani az agrár-környezetgazdálkodási rendszerek szabályozásának szemszögéből. A jogi környezet és a túzokvédelemre fordított anyagi eszközök megfelelőnek mondhatók ma Magyarországon, jóllehet az agrár-környezetgazdálkodási rendszerek által támogatott élőhely-kezelések fejleszthetők lennének egy átgondoltabb szabályozás által. Az elmúlt 10 évben gyűjtött megfigyelési adatok, köztük az antropogén hatásokra visszavezethető mortalitási tényezők vizsgálata lehetővé teszi, hogy a 2005 és 2014 között megvalósított élőhelykezelések hatékonyságát objektív módon kiértékeljük, rávilágítva a különböző célprogramok hiányosságaira, különösen a Magas Természeti Értékű Területek (MTÉT) programjában lévőkére, amelyek további fejlesztésével a túzok kedvező védelmi helyzete visszaállítható és hosszú távon fenntartható lenne.

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The Austrian Agri-Environmental Scheme for Great Bustard *(Otis tarda)*

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ABSTRACT—In Europe agricultural intensification is one of the major threats for Great Bustards. In order to address this issue within the Austrian agri-environmental scheme "ÖPUL" (Austrian programme for an environmentally appropriate, extensive and natural habitat friendly agriculture) special measures were implemented in order to (financially) support and provide an incentive for Great Bustard friendly habitat management (e.g. fallow land, winter wheat, a certain sowing/mowing regime, etc.). Through the support of both the EU and Austria itself the area managed especially for the Great Bustard through ÖPUL increased in three Great Bustard areas from 1,503 ha in 2001 to 5,110 ha in 2012 and by December 2012 it involved more than 450 farmers participating on a voluntary basis. As a result of the implementation of the Austrian agri-environmental scheme, the Austrian Great Bustard population grew from 60 individuals in the 1990s to ca. 240 individuals by 2012. Both this success, and the high level of satisfaction for all those involved call for a continuation since it is the key for any further improvement of Great Bustard habitat conservation in Austria.

Key words: *Otis tarda*, agriculture, conservation, population, Austria.

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Introduction

The Great Bustard is a globally threatened bird species, categorized as "vulnerable" according to latest IUCN criteria *(Collar et al., 1994; BirdLife International, 2012)*. In Europe Great Bustard populations suffered large declines mainly due to agricultural intensification, hunting and infrastructural reinforcement during the 20th century *(del Hoyo et al., 1996)*. The Austrian population decreased from 150–170 individuals at the beginning of the 1970s to around 60 individuals in the 1990s *(Kollar, 2001)*. Consecutively, it recovered to ca. 210 individuals by 2008 *(Raab et al., 2010)* and to ca. 240 individuals by 2012 (*Raab et al.*, unpublished data). The critical conservation status of the Great Bustard *(Otis tarda)* throughout its entire European range prompted the European Union to designate it as a priority species for conservation. Member states—including Austria—are therefore obliged to introduce comprehensive conservation measures for the lasting preservation of the remaining populations. The "Memorandum of Understanding on the Conservation and Management of the Middle-European Population of the Great Bustard *(Otis tarda)*" has been in force since the 1st of June 2001 after having been ratified by Hungary and five other states. Austria and Slovakia signed the memorandum on the 28th of November 2001. The aims of the memorandum include strengthening bustard conservation at an international level, supporting existing habitat conservation programmes—some of which have been operating for many years already—and ensuring the long-term survival of these programmes by putting them into an international legal context.

In Austria, the primary goal in Great Bustard conservation is to provide suitable habitat for the species. For this purpose, there are four large-scale SPAs in Lower Austria and Burgenland, covering more than 28,700 ha in size, with Great Bustard being the priority species. Bustard conservation measures are being implemented inside these SPAs on more than 5,140 ha of land under the Austrian agri-environment scheme "ÖPUL" (Österreichisches Programm für umweltgerechte Landwirtschaft: Austrian programme for environmentally appropriate agriculture).

Habitat requirements and approaches for conservation

In Great Bustards the selection of foraging habitat underlies seasonal changes in response to food availability and specific habitat requirements *(Moreira et al., 2004; Palacín et al., 2012)*. During the breeding season males choose fallows over other habitat types whereas female Great Bustards primarily use cereal fields or fallows as nesting sites *(Moreira et al., 2004; Magaña et al., 2010; Rocha et al., 2013)*. During the winter months herbaceous plants such as cultivated lucerne *(Medicago sativa)* and oilseed rape *(Brassica napus)* become also important *(Faragó, 1996; Kurpé, 1996; Lane et al., 1999; Kalmár & Faragó, 2008; Raab et al., 2014)*. Hence, maintaining a mosaic of different habitat types seems to be essential for providing a suitable biotop to Great Bustards *(Moreira et al. 2004)*.

During the mating season in late winter and early spring Great Bustards of both sexes congregate at traditional leks. These sites are selected by Great Bustards in a way that a maximum probability of encountering females (hotspot hypothesis), a minimized predation risk and low levels of human disturbance are ensured *(Alonso et al., 2012; Burnside et al., 2013)*. Adult Great Bustards of both sexes show high fidelity to these lekking grounds *(Alonso et al., 2000; Morales et al., 2000)*, to the point where spatial distribution of the leks remained stable during a decade *(Alonso et al. 2004)*, even though additional patches of suitable habitat were available *(Lane et al., 2001; Osborne et al., 2001)*. As a consequence, strict conservation measures for securing future occupancy of traditional leks will be more efficient than an establishment of new alternative patches of suitable habitat *(Lane et al., 2001; Osborne et al., 2001; Alonso et al., 2004)*. These conservation measures should be directed particularly towards smaller leks, which are at a higher risk of being abandoned *(Alonso et al., 2004)*. Regarding nest site selection, a preference for cereal fields and fallows has often been reported *(Morgado & Moreira, 2000; Moreira et al., 2004; Magaña et al., 2010; Rocha et al., 2013)*. Characteristic nesting sites are usually located in land-cover types that show the densest vegetation cover in spring compared to other vegetation types, provide good horizontal visibility and are located far from man-made structures *(Magaña et al., 2010)*, as Great Bustards are very sensitive to the higher disturbance levels associated with such infrastructures *(Sastre et al., 2009)*.

Lack of public information and a limited appreciation of Great Bustards and their habitats can lead to unnecessary disturbances, e.g. through leisure activities such as horse riding, cycling, photography, nature observation, private aircraft or Nordic walking. This can also affect reproductive success seriously if eggs or juvenile bustards are left alone by the female due to anthropogenic disturbance, as they are exposed to a higher risk of predation.

Based on these habitat requirements of Great Bustards, proper conservation measures can be implemented. To ensure the successful breeding of Great Bustards farming activities on cereal fields—a preferred habitat type for breeding—should be adapted to the breeding phenology of the females to prevent the destruction of clutches *(Magaña et al., 2010; Rocha et al., 2013)*.

Furthermore, a sufficient supply of fallow land should also be maintained, offering not only an important breeding habitat *(Morgado & Moreira, 2000; Magaña et al., 2010; Rocha et al., 2013)*, but also high densities of arthropods and important refuges during the post-breeding period for female Great Bustards with their hatchlings when the main cereal areas are already harvested *(Magaña et al., 2010)*. To increase the survival rate of hatchlings and young Great Bustards, the first step will be the bustard-friendly management of suitable habitats, as the intensification of grassland cultivation for example leads to a fast growing, very dense vegetation, which hampers the mobility of the hatchlings *(Litzbarski & Litzbarski, 1996; Ludwig, 1996)*. The very dense vegetation additionally leads to unfavourable microclimate on the ground due to limited sunlight, heat and an increase of humidity *(Litzbarski & Litzbarski, 1996; Ludwig, 1996)*. In addition, use of biocides within agricultural intensification reduces the density of arthropods *(Ludwig, 1996)*, the main food resource of young Great Bustards during their first days *(Litzbarski & Litzbarski, 1996a; Lane et al., 1999)*.

Because the winter diet of Great Bustards consists mainly of green plant material *(Lane et al., 1999; Rocha et al., 2005)*, providing a sufficient supply of herbaceous food and ensuring access to at least parts of these cultivations during winter months should be a priority in habitat management for Great Bustards.

Bustard-friendly habitat management also includes the delaying of the harvest on preferred breeding habitats, at least until the hatchlings are able to escape from the harvester *(Magaña et al., 2010)*. Certain practices such as inward concentric harvesting should also be avoided *(Magaña et al., 2010)*.

In Austria these approaches for Great Bustard conservation are partly implemented through the measures of the Austrian agri-environmental scheme.

The Austrian agri-environmental scheme and conservation measures implemented

The Austrian agri-environmental scheme was originally implemented in 1995. In the Austrian Great Bustard areas special Great Bustard measures are offered to the farmers in the Great Bustard ÖPUL project areas for the entire (5-)7 year period.

Through the support of both the EU and Austria itself the area managed especially for the Great Bustard through ÖPUL increased in three Great Bustard ÖPUL project areas from 1 503 ha in 2001 to 5 110 ha in 2012 and by December 2012 it integrated more than 450 farmers participating on a voluntary basis. If a farmer participates with one or more fields he must stay in the contract for the entire (5-)7 year period. The implementation of the measures is controlled regularly. Between 2007 and 2013, payments of about € 400 to € 700 per ha for special bustard conservation sites have provided attractive incentives to these farmers and this will be the case also in the future. Different measures are implemented in the Great Bustard ÖPUL project areas.

Great Bustard fallow land

One of the measures is promoting fallow land. The following measures must be met for fallow land to qualify for ÖPUL. The field must be located in a Great Bustard ÖPUL project area. The use of fertilizers or plant protection agents is prohibited, as is the use of the growth enhancers. The field must be mowed once a year in the period between September 1st and October 15th, but 10-20% of the area has to remain unmown.

There are two more varieties of Great Bustard fallow land. The first—"Bustard fallow with fresh seeding"—requires the one-time ploughing and seeding (with a clover seed mixture) of the field until April 15th once during the (5-)7 year period. In the second—"Bustard fallow with open soil"—the field may be grubbed, ploughed or harrowed 2-4 times per year. Mowing the field beforehand is permitted. At the end of August a mustard-rape-mixture is seeded.

Great Bustard basic protection field

A Great Bustard basic protection field must meet the following criteria during the project period. Like the fallow land, it must be located in a Great Bustard ÖPUL project area. No shelterbelts or tall-growing plants (e.g. elephant grass, poplars, willows, black locust, etc.) are to be planted in the project area. Field size may not be increased and the use of scarecrows is prohibited. If a Great Bustard clutch is found, an area of 50 m around the nest is to be left undisturbed. The use of plastic film or plastic film greenhouses is prohibited. No burning of straw is allowed, except before the planting of rape. Mowing of fields is only permitted with the agreement of the site supervisor of the nature protection department. There is a greening-obligation in place in accordance with the specifications of the nature protection department (a minimum of 2 times in 5-6 years or 3 times in 7 years)—usually with a mixture of mustard *(Sinapis alba)*, rape *(Brassica napus)*, buckwheat *(Fagopyrum esculentum)*, or similar species.

Great Bustard winter wheat cultivation

If a field in the Great Bustard ÖPUL project area complies with the prescriptions of a basic protection field, it may qualify for the winter wheat measure. Winter wheat has to be cultivated minimum 2 times in 5-6 years or 3 times in 7 years. The wheat must not be irrigated and the fields must be left undisturbed from April 20th until it is harvested. For the entire contract period, the use of rodenticides is prohibited and control measures for European Hamster *(Cricetus cricetus)*, European Souslik *(Spermophilus citellus)* and Common Vole *(Microtus arvalis)* are not permitted.

Great Bustard winter foraging areas

If a field in the Great Bustard ÖPUL project area complies with the prescriptions of a basic protection field, it may also qualify as a winter foraging area. The crops must be in

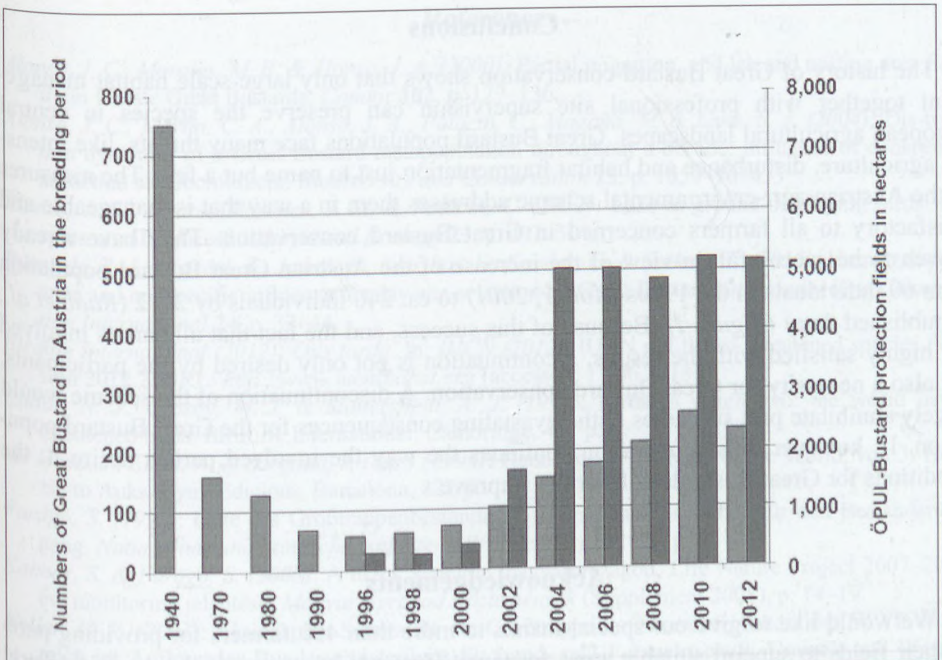

Figure 1. Size of the Austrian Great Bustard population (light grey columns) and the area of ÖPUL-bustard protection fields (dark grey columns) in different years between 1940 and 2012 (after *Raab et al., 2010* and *Raab & Spakovszky,* unpubl.)

1. ábra. Az ausztriai túzokállomány (bal oldali skála példányban megadva; világosszürke oszlopok) és az ÖPUL-túzokvédelmi területek (jobb oldali skála hektárban megadva; sötétszürke oszlopok) változása 1940–2012 között (*Raab et al., 2010;* illetve *Raab & Spakovszky* le nem közölt adatai alapján)

accordance with the specifications of the nature protection department and a winter culture (rape) must be plated at least once in 7 years. Use of rodenticides and control measures for European Hamster, European Souslik and Common Vole are not permitted during the entire (5-)7 year contract period.

Further combinations

Combining the measure sets above with the following activities is also an option to participating farmers. The nature conservation plan bonus requires the participation with at least three ÖPUL Great Bustard fields/year and the obligatory participation of the enterprise in two further training courses within the contract period. The aim of the training is to explain the farmers the biology of the Great Bustard as well as the habitat requirements and approaches for the conservation for this species. For the monitoring bonus, the enterprise must participate in a monitoring programme and in obligatory training courses, keeping records is also obligatory on the declared protection objects.

Conclusions

The history of Great Bustard conservation shows that only large-scale habitat management together with professional site supervision can preserve the species in central European agricultural landscapes. Great Bustard populations face many threats, like intensive agriculture, disturbance and habitat fragmentation just to name but a few. The measures of the Austrian agri-environmental scheme addresses them in a way that is manageable and satisfactory to all farmers concerned in Great Bustard conservation. They have already proven to be successful, in view of the increase of the Austrian Great Bustard population from 60 individuals in the 1990s *(Kollar, 2001)* to ca. 240 individuals by 2012 (*Raab et al.*, unpublished data) *(Figure 1)*. Because of this success, and the fact that all parties involved are highly satisfied with the results, a continuation is not only desired by the participants, but also a necessity for Great Bustard conservation. A discontinuation of the scheme would largely annihilate past successes with devastating consequences for the Great Bustard population. If, however, this cooperation continues the way the involved parties desire it, the conditions for Great Bustards will further improve.

Acknowledgements

We would like to give our special thanks to more than 450 farmers for providing parts of their fields to support suitable areas for Great Bustards by means of the Austrian Rural Development Program. Without the support of the LIFE Project "Crossborder Protection of the Great Bustard in Austria" (LIFE05NAT/A/000077, *www.grosstrappe.at*), the LIFE+ Project "Crossborder Protection of the Great Bustard in Austria—continuation" (LIFE09 NAT/AT/000225, *www.grosstrappe.at*), the LEADER Project 4A-F-R8511/4-2013, the LPF Project 5-N-A1025/148-2009, the RD Project RU5-S-428/001-2005 and the RD Project RU5-S-941/001-2011, the time-consuming work for the conservation of the entire West Pannonian Great Bustard population during recent years would not have been possible. The LIFE projects have been supported by the EU, many project partners and co-funders.

Kivonat—Az intenzív mezőgazdálkodás a túzokokat érintő egyik legjelentősebb veszélyforrás Európa-szerte. Ennek kezelésére az ausztriai agrár-környezetgazdálkodási programon (ÖPUL, ausztriai program a környezetbarát, extenzív és természetes élőhelyeknek kedvező mezőgazdálkodásért) belül különleges intézkedéseket hoztak, hogy (pénzügyi) támogatással és ösztönzéssel túzokbarát élőhely-kezelés (pl. parlag, őszi búza, megfelelő vetési és betakarítási rendszer stb.) alakuljon ki. Az Európai Unió és Ausztria támogatásával a túzokbarát módon kezelt ÖPUL földterület 2001 és 2012 közt 1503 hektárról 5110 hektárra emelkedett, és 2012 decemberében több mint 450 gazdálkodó vett részt a programban önkéntes alapon. Az ausztriai agrár-környezetgazdálkodási program bevezetésének köszönhetően az osztrák túzokállomány az 1990-es években számlált 60 egyedről 2012-re kb. 240 egyedre nőtt. E siker és a résztvevők teljes elégedettsége miatt a program folytatása kívánatos, sőt a túzokok védelme miatt fontos is, hogy a túzokélőhelyek fejlesztése a jövőben is biztosított legyen.

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Review of the status of Great Bustard *(Otis tarda)* in Serbia between 2006–2012

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Abstract—In Serbia, the breeding population of Great Bustards *(Otis tarda)* has been restricted to the northeastern part of the country, on the southeastern border of its range in the Pannonian plain since the 1980s. Great Bustards inhabit the largest lowland grassland locality in Serbia, consisted of saline, steppe and wet meadows on approximately 4,000 ha, surrounded with agricultural fields. Research of distribution of this population started in 2005, mainly for the purpose of better conservation and management. The total number of ca. 27 individuals in 2006 decreased to 15 individuals in 2012. Before and during 2006 approximately 10 males displayed. This number gradually declined to 6 in 2009 and then rapidly decreased to only one confirmed displaying male. The most acceptable explanation for the decline is their shift to the larger population in Hungary due to conspecific attraction. The number of females fluctuated between 7 to 9 in the period 2006–2009, and then rapidly declined to 3-4. Main threats in Serbia are agriculture, grazing and predators. Protection measures consist of legal protection of Great Bustard habitats, direct control of activities in the field by rangers, habitat management through grazing, mowing and sawing appropriate cultures, winter feeding and awareness raising.

Key words: *Otis tarda,* population decline, Serbia.

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Introduction

The Great Bustard is strongly attracted to lowlands, undulating open countryside with dry soil and low level of annual rainfall. Great Bustard populations are migratory in the east and partially migratory elsewhere. With the advent of agricultural machinery the species' range severely contracted in the 19th and 20th century and the species has become extinct from many countries. Consequently, the Western Palearctic range of the species is now highly fragmented. The latest estimate of the global population of Great Bustard is 43,500–51,200 individuals. Although the total European population of Great Bustard has not decreased over the last two decades, and even increased as a result of concerted conservation efforts in Austria, Spain, Portugal, Germany and Hungary, current numbers are still far lower than three generations earlier (i.e. in the mid 1960s) and the contraction of the species' range continues. The main threats to Great Bustard are the loss and degradation of its habitat through agricultural intensification, land-use changes and infrastructure development, increased mortality caused mainly by powerlines and reduced reproductive success due to high levels of nest destruction by machinery farming and high chick mortality through predation and starvation *(Nagy, 2009).*

The breeding population of Great Bustards *(Otis tarda)* in Serbia is since the 1980s restricted to the north Banat region in the northeastern part of the country, which is at the southeastern edge of its distribution range in the Pannonian plain. Parts of the habitat of the species were protected in 1997 as a Special Nature Reserve "The Great Bustard Pastures" (referred to as "Reserve" in further text), on the area of 980 ha. The Hunting Association "Perjanica" from Mokrin is appointed as the Manager of the Reserve. Great Bustard was protected in Serbia as a Natural rarity in 1993, with the prohibition of disturbing, persecuting, hunting and keeping it in captivity *(Стојнић et al., 2009)*.

Materials and Methods

Research on distribution of this population started in 2005, mainly for the purpose of better conservation and management. Field data on Great Bustards, as well as data on threats and conservation measures, were collected mainly by two guards of the Reserve, as well as by authors of this paper. Additional data were provided by other local people present in the field in the northern Banat region, mainly hunters, shepherds and farmers.

Results

Population size

According to the winter censuses the total number of 27 individuals in 2006 decreased to 15 individuals in 2012. Before and during 2006 approximately 10 males displayed. This number slowly decreased to 6 in 2009 and then rapidly decreased to only one confirmed displaying male. The number of females that laid eggs is uncertain, since there is no safe method for its census, but its estimated number varied from 7 to 9 in the period of 2006–2009, and then rapidly declined to 3-4.

Habitat use

In Serbia, Great Bustards inhabit the largest lowland grassland locality of the country, and one of the largest ones in the Pannonian Plain, consisting of saline, steppe and wet meadows on approximately 4.000 ha. It is surrounded with agricultural fields, of which some small patches of up to 20 ha are inside the grassland locality. Dominant crops are wheat, sunflower, maize, alfalfa and sugar-rape. The wintering locality is 5 km away on the northeast, almost completely covered by agricultural fields, with a few grassland patches smaller than 5 ha.

Displaying occurs on mowed grasslands, alfalfa and wheat. The main lekking ground, especially when the number of males dropped to one, was a cultivated field inside the grasslands called "Debeli at", which is elevated 2 metres higher than its surroundings.

Precise data on habitat use for nesting exist showing that Great Bustards lay eggs in grasslands, sometimes in wheat and alfalfa and once in sugar-beet and sunflower.

Although it was not recorded annually, the lekking and nesting area shifted towards northeast between 2003 and 2012. The population moved from an area recently overgrown by too high vegetation to a place, which is more heavily grazed, but also from pure grassland to grassland combined with crops.

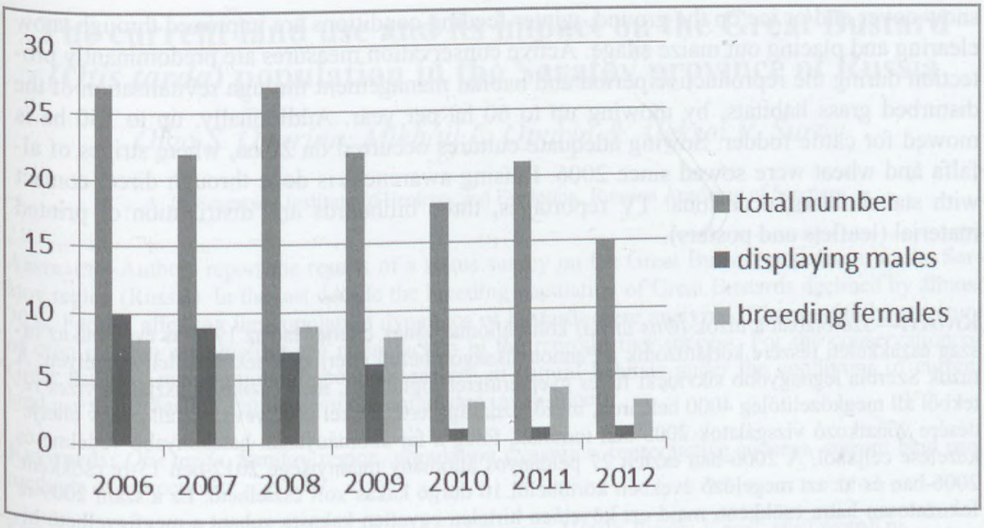

Figure 1. The population of Great Bustard (*Otis tarda*) in Serbia between the period of 2006–2012
1. ábra. A túzok állományváltozása 2006–2012 között Szerbiában (az oszlopok jelentése balról jobbra: teljes létszám; dürgő kakasok; költő tyúkok)

Discussion

There was no field evidence of male mortality that can explain the negative trend of displaying males. Therefore, the most acceptable explanation is their shift to the larger neighbouring population present in Hungary *(Nagy, 2009)*, as a consequence of conspecific attraction. Great Bustards in Spain changed their distribution in the period 1988–1998 by a similar pattern. Leks that were large in 1988 increased, while the small ones decreased, which suggest that dispersing individuals used the numbers of conspecifics as cues for breeding-site selection. Conspecific attraction and local differences in reproductive success contributed to a more aggregated distribution *(Alonso et al., 2004)*. A similar study shows that the population of Great Bustards in Spain is probably concentrating in high quality areas, and disappearing from poor quality ones *(Alonso et al., 2003)*.

The increasing size of agricultural fields in the 21st century, related to land privatisation, is recognised as the main threat is Serbia. A side effect of this is more intensive use of pesticides and disturbance by machines. Grazing and mowing of grasslands are insufficient for sustaining its ecological conditions. Since grazing is traditional, uncontrolled shepherd dogs and pigs around farmhouses are also a threat. Predators (Fox—*Vulpes vulpes*, Hooded Crow—*Corvus corone cornix*) are present in the reserve, but their influence is not measured.

Conservation measures consist of protection of the existing population and the original natural habitats, through enlarging of the part of protected area from 980 ha to 4250 ha. In the field, rangers keep under surveillance the regular agricultural works, grazing and hunting, as well as occasional visitors, water regulation works and other activities. During high snow cover and/or ice on the ground, winter feeding conditions are improved through snow clearing and placing out maize silage. Active conservation measures are predominantly protection during the reproductive period and habitat management through revitalisation of the disturbed grass habitats, by mowing up to 60 ha per year. Additionally, up to 150 ha is mowed for cattle fodder. Sowing adequate cultures occurred on 22 ha, where stripes of alfalfa and wheat were sowed since 2006. Raising awareness is done through direct contact with stakeholders, occasional TV reportages, three billboards and distribution of printed material (leaflets and posters).

Kivonat—Szerbiában a túzok *(Otis tarda)* költő állományának elterjedése az 1980-as évek óta az ország északkeleti részére korlátozódik a Pannon-síkságon belüli elterjedésének délkeleti szegélyén. A túzok Szerbia legnagyobb síkvidéki füves gyepterületét foglalja el, mely, szikes, pusztai és vizes rétekből áll megközelítőleg 4000 hektáron, mezőgazdasági területekkel körülvéve. Az állomány elterjedésére vonatkozó vizsgálatok 2005-ben indultak, főleg a faj állományának hatékonyabb védelme és kezelése céljából. A 2006-ban észlelt 27 példányos állomány mennyisége 2012-ben 15-re csökkent. 2006-ban és az azt megelőző években körülbelül 10 dürgő kakas volt észlelhető. Ez a szám 2009-re fokozatosan hatra csökkent, majd ezt követően hirtelen egyetlen kakasra zuhant a megfigyelhető hímek száma. A csökkenés leginkább elfogadható magyarázata a nagyobb magyarországi szomszédos állomány általi elvonzás. A tyúkok száma 2006–2009 időszakában 7 és 9 között ingadozott, majd gyorsan csökkent 3-4 madárra. A legfőbb fenyegetést Szerbiában a mezőgazdaság, a legeltetés és a fészekpredátorok jelentik. Védelmi intézkedések a túzokélőhelyek jogi védelmére, a területen folyó tevékenységek természetvédelmi őrök általi közvetlen ellenőrzésére, az élőhely legeltetés, kaszálás, illetve a megfelelő növényi kultúrák termesztése által történő kezelésére, téli etetése és a társadalmi tudatformáló tevékenységre terjed ki.

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The current land use and its impact on the Great Bustard *(Otis tarda)* population in the Saratov province of Russia

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Abstract—Authors report the results of a status survey on the Great Bustard population in the Saratov region (Russia). In the last decade the breeding population of Great Bustards declined by almost 70%. Factors affecting the population dynamics of bustards were analyzed. Changes in the structure of crop rotation are amongst the main factors in the reproductive success. For the conservation of Great Bustard, introduction of special measures in natural habitats under the conditions of current land use in the Saratov region were recommended in the paper.

Keywords: *Otis tarda,* Saratov region, population dynamics, reproductive success, current land use, methods of protection.

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Introduction

Within the limits of the current distribution range of the East-European Great Bustard population on the territory of Russia the main breeding-ground is situated in Saratov and in parts of Volgograd regions. We presume that the Great Bustard is still preserved in the steppes on the left Volga bank owing to the following facts: 1) availability of appropriately large fields; 2) a crop rotation structure where grain-crops, winter crops and early spring crops prevail, and their cultivation technology does not hinder the reproductive process of the species in question; 3) a sufficient number of pristine lands where birds gather in spring for display; 4) the hilly relief of the land, which plays a crucial role in nest site selection.

For quite a long time there was no apprehension as to the state of the left Volga bank population of Great Bustard. The objective of our study was to examine 1) the dynamics of the numbers of bustards and 2) the reproductive success under a changing agricultural pressure and the structure of crop rotation.

Materials and methods

The surveyed territory is situated in the southern part of the Saratov Trans-Volga region, where the highest density of Great Bustard is observed. This part of the Trans-Volga province is regarded to belong to the dry steppe zone, which is characterized by sub-boreal moderately continental Eastern European southern steppe landscapes. They consist of lowland alluvial, gently undulating, flat and gently sloping plains with a cover of loess, loess-like loams, and syrt (highland) clays *(Gerosimov, 1971).*

The study was carried out from 1998 to 2013. The censuses in the described area were carried out in 1998–2000 and 2011–2012 over an area of 12 000 km^2. In other years, censuses of the bustards were carried out only in those areas where high bird density was found previously. The counts of the bustards were performed in the second half of September before autumn bird migration commenced. A geographic map at a 1:100 000 scale was used as a cartographic basis. The system of stratification of the counting area continued throughout the period of censuses, which were carried out by 6 groups of researchers by cars. Each group was assigned a fixed plot of 2000 km² in area. Strips of 10 × 20 km were the daily counting areas for each team of observers. The count was carried out on the routes laid out in such a way that the entire territory was surveyed. The bustard locations were put on the map. Data on the number of birds, if possible, their sex and age, and time of detection were recorded.

Statistical analysis was performed using nonparametric criteria *(Gubler, 1978)*. Graphic analysis of the distribution of the Great Bustard in the study area was performed by drawing a flat graph by smoothing the data obtained using moving average *(Demyanov et al., 1999; Kanevskii et al., 1999)*. The unit of space (geometric field) was considered a square plot of 5 by 5 km, the size of which was determined empirically by the results of observations of the movement of bustards and in part by the results of satellite telemetry (data on the movements of one of the marked females during summer) *(Watzke at al., 2001)*. A more detailed description of the method was described by *Oparin et al. (2003)*.

We investigated the land use structure on the model site where a bird census was carried out in the same year. Data were recorded on a map. In addition, we used official data on cultivation areas, provided by farmers. Information about loss of clutches and chick mortality was obtained from tractor drivers engaged in land cultivation works. Occasionally, we also searched for the nests in the fields using a 30 power magnification telescope.

Results and discussion

At the turn of the millennium the number of Great Bustards was estimated at 3000 birds on the area of 12 000 km² in the left Volga bank according to our data *(Oparin et al., 2003)*. In 2004, however, a repeated census on areas with the highest earlier density of bustards revealed a detectable population decline *(Oparina & Oparin, 2008)*.

In 2011–2012 we registered about 900 birds from the same area of the survey in 1998–2000. Consequently, within a decade in the representative part of the nesting area, which occupies more than 20% of its total range, there has been a 70% decline in the number of the Great Bustard population *(Oparin et al., 2012)*. Junction diagrams were made in accordance with the acquired data on the distribution of the density of the bustard population on the studied area during different periods of the research, these were mapped consecutively *(Figures 1* and *2)*. The trends in the changes of the number of the Great Bustard and the structure of its habitat in the Saratov Volga region could be analysed on this basis. It should be noted that the majority of the Trans-Volga population of this species lives here. The Great Bustard distribution in the area in various periods of research is presented in *Table 1*. Figures demonstrate the decline of the area with a high density and a significant increase with low density of Great Bustards.

It is assumed that the population decline of Great Bustards is due to the combined effect of anthropogenic and natural abiotic factors as well as certain internal processes in the pop-

Figures 1 and 2. The density of the Great Bustard population in the area of 12 000 km² counted in 1998–2000 (top) and 2011–2012 (bottom), respectively. Density: (*1*) less than 0.04 ind./km², (*2*) 0.04 to 0.2 ind./km², (*3*) 0.2 to 0.4 ind./1 km², (*4*) 0.4 to 0.8 ind./km², and (*5*) higher than 0.8 ind./km².
1–2. ábra. A túzok állománysűrűségének az eloszlása a 12 000 km² kiterjedésű vizsgálati területen 1998–2000 (felső térkép), illetve 2011–2012 (alsó térkép) között. Sűrűség (*1*) <0,04 egyed/km², (*2*) 0,04–0,2 egyed/km², (*3*) 0,2–0,4 egyed/1 km², (*4*) 0,4–0,8 egyed/km², (*5*) 0,8 egyed/km²<.

Years *Időszak*	**Area populated by Great Bustards** *Túzok által benépesített terület*	**Density (birds per km²) – *Átlagsűrűség*** > 0.8	0.4–0.8	0.2–0.4	0.04–0.2	<0.04
1998–2000	Area – *Terület* (km²)	106	1155	3676	7063	0
	Proportion of the total area – *Területarány*	*1%*	*10%*	*31%*	*59%*	*0%*
2011–2012	Area – *Terület* (km²)	15	188	610	5861	5326
	Proportion of the total area – *Területarány*	*0.1%*	*2%*	*5%*	*48%*	*44%*

Table 1. The distribution of densities of the left Volga bank population of Great Bustards during two different time periods
1. táblázat. A túzok állománysűrűségének az eloszlása a Volga bal partja mentén a két vizsgálati periódus idején

ulation. Nevertheless, the major cause is thought to be the changes in land tenure structure in the nesting area of this species.

It is well-known that most of the areas occupied by Great Bustards belong to cultivated land. Small plots of pristine land are used by the birds during the display season only. The males return from the wintering areas during the first or second decade of March and prefer to occupy pristine land plots. There is usually still some snow remaining on the ground during that time. The females come back in late March to early April. Winter crops are about 10-15 cm high by that time. Young birds start hatching in the third decade of April.

The nests made in winter crops (wheat, rye) and in early spring crops (barley), as well as in old and middle-aged fallows that are not ploughed up in the given year are in a more favorable situation. The eggs laid in the fields intended for late spring crops (millet, oats, Sudanese herb), tilled crops (sunflower, maize) and black fallows would inevitably perish. Fallows in early stages of the restoration succession are not used by the Great Bustards due to the high grass and large quantities of dried up vegetation from the previous year in the spring.

At the end of the previous century cropland occupied 62%, while 22% were fallows. The proportion of the winter crops was no more than 15%. Black fallow made an equal part, 20% of the fields were early spring crops and 12% late spring crops.

Since the beginning of the 21st century the ratio of non-cultivated land has been increasing constantly and in 2004 it covered 40% at average, sometimes more than 60%. A natural restoration process took place in the fallows during 10-15 years, though they were ploughed up in 2007 because of economic reasons since grain prices were rising considerably in that year.

Figure 3 shows the changes in land use that occurred over a decade. The area occupied by winter and early spring crops is favorable for breeding. For ten years, this area has decreased by 11%. Fallows are conditionally suitable. Late spring cereals, tilled crops and black fallows are not suitable for nesting. As a result of research carried out in 2011–2012 we found that only 24% of the studied area (these are the winter and early spring crops) were suitable for breeding to Great Bustards, 18% was conditionally suitable (these were fallows), 58% of the studied area was unsuitable (these included tilled crops, late spring crops (millet), virgin pasture lands, community land, water bodies, planted forests, roads,

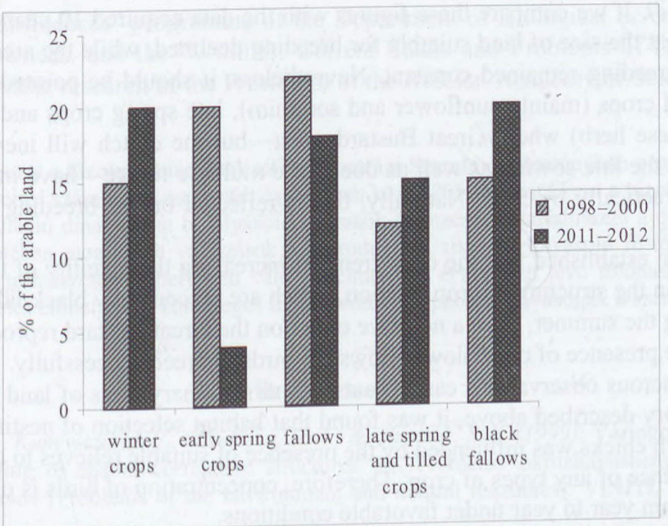

Figure 3. Comparison of the land-use structure on the study sites in 1998–2000 and 2011–2012
3. ábra. A földhasználat százalékos eloszlásának a változása 1998–2000 (sávozott oszlopok), illetve 2011–2012 között (sötét színű oszlopok) a vizsgálati területen őszi gabona, tavaszi gabona, ugar, késő tavaszi gabona és kapásnövények, illetve fekete ugar esetében

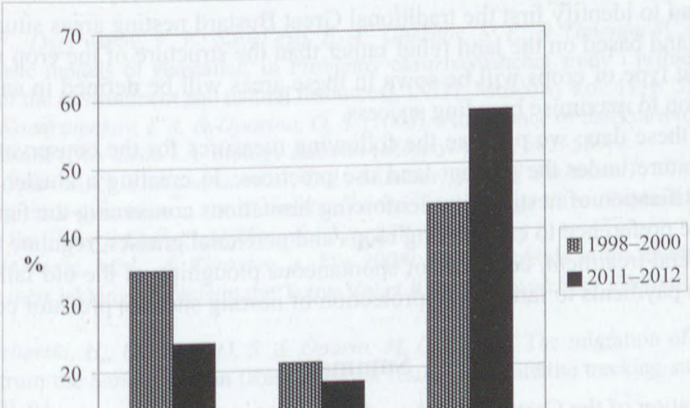

Figure 4. Ratio between suitable and unsuitable areas for nesting of Great Bustards in 1998–2000 and 2011–2012
4. ábra. A kedvező, viszonylag kedvező, illetve kedvezőtlen területek aránya a költő túzokok számára 1998–2000 (világosszürke oszlopok) és 2011–2012 között (sötét oszlopok)

etc.) *(Figure 4)*. If we compare these figures with the data acquired 10 years earlier, it will be obvious that the size of land suitable for breeding declined, while the area conditionally suitable for breeding remained constant. Nevertheless, it should be pointed out that those areas of tilled crops (mainly sunflower and sorghum), late spring crops and annual fodder crops (Sudanese herb) where Great Bustards nest—but the clutch will inevitably be destroyed due to the late sowing as well as due to the multiple tillage—have increased during the decade practically by 50%. Naturally, this is reflected on the breeding success of the species.

It has been established that the clear trend of increasing the quantity of tilled crops and winter crops in the structure of crop rotation, which are preceded by black fallow fields cultivated during the summer, have a negative effect on the Great Bustard reproduction. At the same time the presence of old fallows allows the birds to breed successfully.

After numerous observations carried out both at stationary plots of land and on the extensive territory described above, it was found that habitat selection of nesting females and also those with chicks was influenced by the presence of suitable relieves to a greater extent than the presence of any types of crop. Therefore, concentration of birds is observed in certain places from year to year under favorable conditions.

Great Bustard protection measures must consist of identifying such areas and enforcing limited farming activities there. According to the information we gathered, the area with a bustard density over 0.4 bird per 1 km² where it is necessary to limit farming activities occupies 203 km² (1.7% of the studied area). Ten years ago the area with such density of the bird population occupied 1261 km², which was 10.5% of the territory.

So, we need to identify first the traditional Great Bustard nesting areas situated in localized plots of land based on the land relief rather than the structure of the crop rotation. The choice of what type of crops will be sown in these areas will be defined in each particular breeding season to maximise breeding success.

Based on these data, we propose the following measures for the conservation of Great Bustards in nature under the present land use practices: 1) creating a cluster of protected areas; 2) identification of nesting sites; enforcing limitations concerning the farming activities, i.e. to give preference to early spring crops and perennial grasses, regulate terms of performance of land treatment, cessation of spontaneous ploughing of the old fallow lands; 3) compensation payments to farmers; 4) protection of nesting sites; 5) predator control.

Summary

The population of the Great Bustard on the left Volga bank has been declining under the current land use practices and the suitable area for nesting is also shrinking. The increase of sunflower as cultivated crop in the region has an especially negative impact on the Great Bustard population. Therefore it is necessary to take urgent measures to preserve the bustard population by introducing those measures we have proposed in this paper.

Acknowledgements

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Kivonat—A dolgozat a túzokpopulációnak az oroszországi Szaratov tartományban végzett állapotfelmérése eredményeiről számol be. Az elmúlt évtizedben közel 70%-kal csökkent a túzok költőállománya. A túzokpopuláció dinamikáját befolyásoló tényezők elemzését is tartalmazza a dolgozat. A vetésforgó szerkezetében megfigyelt változások a reprodukciós sikert befolyásoló fő tényezők között vannak. A túzok természetes élőhelyeken való védelmére az érvényben lévő földhasználati módok mellett a természetes élőhelyeken különleges intézkedések bevezetését javasolják a szerzők.

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The Status of the Great Bustard *(Otis tarda tarda)* in Central Asia: from the Caspian Sea to the Altai

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Abstract—Great Bustards were once familiar inhabitants of the steppe zones of Central Asia. Today, remnant populations are small and isolated, and the species is red-listed across this portion of its range. We review what is known about the historical status of the Great Bustard in Central Asia and the species' migratory patterns in this region. We also discuss factors, which led to sharp declines in these populations in the twentieth century. We observe a trend towards slight improvement in the status of Great Bustards in Central Asia at the turn of the 21st century. This leaves hope for their conservation if effective measures are taken across their breeding and wintering habitats.

Keywords: Central Asia; *Otis tarda tarda;* Kazakhstan; migration; conservation.

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Introduction

The Great Bustard *(Otis tarda)* originated in the steppe zones of Eurasia and North Africa. As European forests were felled for agriculture in the 16th through 18th centuries, the species expanded its range northward and westward and adopted cereal fields as habitat *(Isakov, 1974).* Since that time of maximum range expansion, the Great Bustard has suffered many regional extirpations *(Cramp & Simmons, 1980; Collar, 1985).* Today, the range of the species still stretches 10,000 km, from Manchuria to Portugal. However, across much of that range the remaining breeding populations (leks) are small and increasingly isolated. While the status of and threats facing European Great Bustards are relatively well studied *(Nagy, 2009),* populations and threats in Asia are less well documented. The goal of this paper is to review the status of populations of the Great Bustard in broader Central Asia, from the Caspian Sea to the Altai Mountains. We use primary and secondary literature from the region, which spans imperial expeditions, the socialist era, communications from contemporary researchers, and our own observations. This is a vast territory and a rich body of literature. This article is not meant to be exhaustive, but rather to describe the past and current status of eastern populations of the European subspecies of Great Bustard *(O. t. tarda)* in broad brushstrokes, to bring a wider understanding of these populations to English-speaking audiences. For simplicity and the comprehension of an international audience, we use present-day place names to describe locations.

Great Bustard during the pre-revolutionary era

Breeding Range

Populations of Great Bustards stretched across the steppe zone of Central Eurasia, southward from the edge of the boreal forest at approximately 54°N *(Menzbir, 1895).* Early

Figure 1. Countries and provinces of Central Asia referred to in the text. Dashed-line divisions within China represent prefectures of Xinjiang Province.
1. ábra. A szövegben idézett országok és tartományok elhelyezkedése Közép-Ázsiában. A szaggatott vonallal jelölt területek a kínai Hszincsiang–Ujgur Autonóm Területen belüli igazgatási egységek.

writers describe the Great Bustard as numerous in some mesic steppe areas of southern Russia and northern Kazakhstan, with populations tapering off as aridity increased to the south and southwest *(Sushkin, 1908; Shnitnikov, 1949)*. To begin at the north of this territory, with the southern tier of Russian states, Great Bustards were noted as once numerous in western Orenburg Province, but already in decline in areas of greater human population by the mid-19th century *(Aksakov, 1852)*. In the Republic of Bashkortostan, Great Bustards were declining in numbers in the upper reaches of the Ural River in the late 19th century *(Menzbir, 1895)*. Bustards nested regularly in the southern steppes of Omsk Province, but began to decline in the vicinity of the city of Omsk in the late 19th century *(Nefedov, 2001; Nefedov & Kassal, 2005)*. The Great Bustard was less frequently sighted in Altai Krai and Altai Republic to the east *(Kashchenko, 1899; Sushkin, 1938; Irisova, 2000; Kuchin, 2004)*. The Altai Mountains form a natural border between the eastern populations of *O. t. tarda* and the eastern subspecies, *O. t. dybowskii*, in Mongolia.

Abundant populations of Great Bustard inhabited modern-day West Kazakhstan, Aktobe, Kostanay, and East Kazakhstan provinces along the northern rim of Kazakhstan *(Plotnikov, 1905; Sushkin, 1908; Karamzin, 1917),* eastward into the Alakol Depression *(Plotnikov, 1905)* and the foothills and floodplains of Dzhungaria, in the western Xinjiang Province of China *(Gao et al., 2008)*. In Karagandy Province of central Kazakhstan, Great Bustards bred in the northern, more mesic habitats and declined towards the south *(Afanas'ev & Sludskii, 1947)*. Populations breeding in semi-desert regions of Almaty Province in southeastern Kazakhstan, as well as in the foothills of the Karatau and Zailiskii Alatau in Almaty Province and Dzhungarskii Alatau in South Kazakhstan and Zhambyl provinces along the southern edge of Kazakhstan were also described as healthy *(Shevchenko, 1948; Shnitnikov, 1949)*.

Accounts of Great Bustards nesting in desert steppe further south and southwest are occasionally encountered. For example, observations of lone females with clutches are described in Mangystau and Kyzylorda Provinces of Kazakhstan, Navoiy and Jizzakh Provinces of Uzbekistan and even Turkmenistan's Ahal Province *(Zarudnyi, 1896; Zarudnyi, 1915; Zarudnyi & Bil'kevich, 1918)*. These are disputed as being non-local or vagrant individuals *(Dement'ev, 1952; Bogdanov, 1956; Gavrin, 1962),* and no later such observations are available. These older accounts are also typically from foothill regions, as opposed to lowland desert.

To the east of Uzbekistan, in the Kyrgyz Tian Shan, Great Bustards regularly bred in Chuy and Osh provinces, and in north and eastern Ysyk Köl Valley. These sites include mountain steppes up to 3000 m elevation *(Severtsov, 1873; Yanushevich & Tyurin, 1959; Davletkeldiev, 2006)*. Great Bustards also bred abundantly in Khatlon Province of southwestern Tajikistan at around 1500 m *(Abdusalyamov, 1971)*. Given the breeding sites recorded for Great Bustards along the Panj River, these populations undoubtedly stretched into appropriate habitat in adjacent Kunduz and Takhar Provinces of Afghanistan.

To the west of the Caspian Sea, the Great Bustard bred in the Mugan steppes of the Tabriz region of northwest Iran, and in the Shirvan steppe of Azerbaijan *(Patrikeev, 2004; Barati et al., 2015)*. However, these leks were likely more interconnected with the broader Middle Eastern population extending through Turkey, Syria and Iraq *(Collar, 1985),* than with the Central Asian population, and will not be treated here.

North of the Caucasus, the range of the Great Bustard stretched into the Precaspian steppes and Volga River Valley. Elders and early writers report the Great Bustard to have been numerous on the steppes of Kalmykia and to have nested in Astrakhan' Province *(Yakovlev, 1873; Bostanzhoglo, 1911; Bliznyuk, 2004; Ubushaev, 2013)*. To the north, the reader is referred to the well-developed literature on Volga River Great Bustard populations *(Oparina & Oparin, 2005; Antonchikov, 2006; Watzke, 2007a; Khrustov, 2009; Oparin et al., 2013),* which today represent the healthiest Great Bustard populations outside of Spain *(Alonso & Palacín, 2010)*.

Migratory movements and wintering range

The migratory routes of Great Bustards in Central Asia have not been investigated through banding or telemetry. However, movements of Great Bustards breeding to the west, on the Lower Volga River, have been monitored, and some details are known about the passage of Central Asian Great Bustards from the notes of naturalists. Using satellite telemetry, female Great Bustards nesting in Saratov Province of Russia were found to make a weeklong, 1100 km journey to overwinter in southeastern Ukraine *(Oparina et al., 2001; Watzke, 2007b)*. It is possible that Great Bustards breeding in West Kazakhstan Province also move southwest along this migratory path.

It is also possible that West Kazakhstan populations move south along the western Caspian shore *(Belik, 1998)*. In Astrakhan' Province, Great Bustards were noted to have overwintered in "decent numbers" *(Yakovlev, 1873; Bostanzhoglo, 1911; Khlebnikov, 1930)* and in Stavropol' Krai, overwintering populations of up to 4000 were noted even as late as the 1970s *(Khokhlov et al., 2010)*. Great Bustard movements further south through Dagestan were once noted, probably ending at wintering grounds in Azerbaijan *(Karyakin, 2000; Patrikeev, 2004)*. Early writers also describe a migratory pathway along the eastern Caspian Sea as located close enough to the shore that hunters seeking ducks and coots also shot bustards *(Bostanzhoglo, 1911; Isakov & Vorob'ev, 1940)*. Throughout the rest of Kazakhstan, naturalists describe Great Bustards as moving in a roughly north-south direction *(Sushkin, 1908; Shnitnikov, 1949; Gavrin, 1962)*. An exception to this trend is for populations breeding in eastern Kazakhstan, which move in a southwest direction towards Uzbekistan along the foothills of the Tian Shan *(Shnitnikov, 1949; Gavrin, 1962; Berezovikov & Levinskii, 2005)*.

Migrants were reported as travelling throughout all of Uzbekistan *(Meklenburtsev, 1953)* and as overwintering in both Uzbekistan and Turkmenistan *(Isakov & Vorob'ev, 1940)*. Particularly large numbers were reported in two regions of Turkmenistan: in the lower reaches of the Atrek River in the southwest Balkan Province *(Rustamov, 1954)*, and in the foothills of the Kopet Dag in Ahal Province *(Isakov & Vorob'ev, 1940; Dement'ev, 1952)*. Some Great Bustards crossed the Kopet Dag to regularly overwinter in the Khorasan region of northeastern Iran *(Zarudnyi, 1903; Cornwallis, 1983)*.

The population of Great Bustards breeding in northwestern China is migratory, but its wintering grounds are unknown *(Gao et al., 2008)*. Given the migratory obstacle present in the form of the Himalayan massif, it is likely that these birds join the migratory pathway taken by Great Bustards breeding in adjacent eastern Kazakhstan. In Kyrgyzstan, Great Bustards overwintered in foothills in Osh and Jalalabad Provinces, and in Chuy River valley in Chuy Province *(Yanushevich & Tyurin, 1959)*. Great Bustards in Tajikistan overwintered in the Hisar Valley of the District of Republican Subordination to the north of breeding grounds in Khatlon Province *(Abdusalyamov, 1971)*. A single winter record is available from the Northwest Frontier Province of northern Pakistan, though if it is of the Asian subspecies *(O. t. dybowskii)* as reported, the journey it undertook must have been rather unusual *(Murray, 1889; Ripley, 1961)*.

In many regions of Central Asia, a handful of Great Bustards remained to overwinter nearer their breeding grounds *(Sushkin, 1908)*. In northern Kazakhstan and the steppe plateaus of Kyrgyzstan, these numbers increased in winters without snow cover *(Shnitnikov, 1949; Ryabov, 1949)*. Elders describe Great Bustards breeding in Omsk Province of Russia as nomadic rather than migratory, moving towards the Kazakhstan border in years when food reserves were insufficient *(Nefedov, 2013)*. Great Bustards breeding in the Karatau foothills (South Kazakhstan and Zhambyl provinces) are joined by additional overwintering bustards, and move south only in more severe winters *(Shevchenko, 1948; Gubin & Vagner, 2009)*.

Great Bustards were described as one of the earliest arriving and latest departing migrants to Kazakhstan. Arrival to breeding grounds typically occurred in April, while the bulk of fall migration occurred from October through November. However, both migrations are described in several texts as temporally variable and dependent on snow cover. *Gavrin (1962)* estimates that the spring journey lasted approximately one month. Incubation in southern Kazakhstan began at the end of April, while in northern Kazakhstan it started in mid-May *(Gavrin, 1962)*.

Habitat

Great Bustards are described as using a wide variety of habitats in Central Asia. In addition to the region's iconic open, flat grasslands, Great Bustards were often observed in forest-steppe, mountain foothills and damp meadows *(Ivanov et al., 1951)*. Overwintering spots in the south and southwest tended to be areas of greater vegetative growth in the desert steppe landscape (e.g. river valleys, foothills; *Ismagilov & Vasenko, 1950*). While Great Bustards occupied high-elevation steppe clearings in the south of their Central Asian range (e.g. Kyrgyzstan), they are not reported to have done so in the western Altai Mountains in the northeast of the European subspecies' range.

In the late 19th century, Menzbir observed Great Bustards nesting in fall-planted wheat in northwestern Central Asia, and Zarudnyi noted these birds nesting in unirrigated agricultural fields of Khatlon Province, Tajikistan *(Menzbir, 1895; Abdusalyamov, 1971)*. *Shestoperov (1929)* described Great Bustards nesting in agricultural fields in Almaty Province of Kazakhstan in the 1920s. Thus, by the early 20th century, populations in very different areas of Central Asia were already described as using agricultural lands for breeding.

Socialist period

In the 20th century, the USSR embarked on massive development and landscape transformation projects which would have effects on Great Bustard habitat, reproduction, and mortality. Traditional pastoralism in Central Asia was collectivized and eventually herds were kept at fixed points rather than moving nomadically, resulting in pasture degradation in some areas. As part of Joseph Stalin's Great Plan for the Transformation of Nature, windbreaks were planted to an effort to prevent erosion and desiccation of farmland and temper Central Asia's harsh climate *(Brain, 2010)*. Beginning in 1953, Nikita Khrushchev's Virgin Lands Campaign converted 42 million hectares of steppe lands in northern Kazakhstan and Western Siberia to wheat production *(Kamp, 2004)*. This entailed the construction of irrigation infrastructure and the expansion of the paved road network, making travel through the region more efficient and Great Bustard populations easier for hunters to access. Zinc phosphide was applied to wheat grains as a rodenticide to combat outbreaks of the bubonic plague, which was suspected of decreasing populations of steppe birds including bustards through direct poisoning *(Ivanitskii & Shevchenko, 1992; Belik, 1998; Khokhlov et al., 2010)*. When grain harvests were lower than expected in the 1960s, pesticide use was increased across the region. This included Granosan (ethylmercury chloride), which acts as an embryotoxin *(Kamp, 2004; Oparin et al., 2013)*.

Country	Listing category	Year of listing	Source
Azerbaijan	Endangered – "Rare wintering species"	1989	*Patrikeev, 2004*
China	VU [1]	2009	*Ding & He, 2009*
Kazakhstan	1 – "Species under threat of extinction"	2006	*Mityaev & Yashchenko, 2006*
Kyrgyzstan	III – "Critically endangered"	2006	*Davletkeldiev, 2006*
Russia			
National level	3 – "Rare subspecies" [2]	2001	*Gabuzov, 2001*
Republic of Dagestan	I – "Rare species, whose number is quickly decreasing"	2009	*Abdurakhmanov, 2009*
Stavropol' Krai	II – "Decreasing in population"	2002	*Khokhlov & Il'yukh, 2002*
Kalmyk Republic	1 – "Rare species"	2013	*Ubushaev, 2013*
Astrakhan' Province	3 – "Rare species, whose number is decreasing"	2004	*Rusanov, 2004*
Volgograd	1 – "Rare species, under threat of extinction"	2008	*Chernobai et al., 2011*
Saratov Province	5 – "Subspecies which is reestablishing itself, the condition of which does not call for concern, but which is not appropriate for commercial use and whose population requires continued monitoring"	2006	*Khrustov & Khrustov, 2006*
Samara Province	4/D – "Rare species with tendency to increase in number" [3]	2008	*Shaposhnikov et al., 2009*
Orenburg Province	"Very rare, sporadically nesting"	1998	*Gavlyuk & Yudichev, 1998*
Republic of Bashkortostan	1 – "Rare, disappearing from the territory"	2007	*Il'ichev, 2007*
Chelyabinsk Province	I – "Species under danger of extinction"	2005	*Zakharov & Ryabitsev, 2005*
Tyumen Province	"Likely extinct"	2004	*Bogdanov et al., 2004*
Omsk Province	0 – "Likely extinct"	2005	*Nefedov & Kassal, 2005*
Novosibirsk Province	0 – "Disappeared from territory in the 20th century"	2008	*Yurlov, 2008*
Altai Krai	1 – "Extremely rare species, almost extinct"	2006	*Irisova, 2006*
Altai Republic	1 – "Extremely rare species, almost extinct"	2006	*Irisova, 2008*
Tajikistan	1 – "Under threat of extinction"	1988	*Abdusalyamov, 1988*
Turkmenistan	I* – "Disappearing species under threat of extinction"	1999	*Rustamov & Sopyev, 1994; Atamuradov, 1999*
Uzbekistan	1(CR) – "On the verge of complete extinction"	2009	*Kreitsberg-Mukhina, 2009*

Table 1. Red List status of the Great Bustard in range states of Central Eurasia. Listings at the provincial level are included for Russia, and provinces are listed from west to east.
[1] Protected National Class I (highest); listing considers *O. t. tarda* and *O. t. dybowskii* jointly; [2] listing considers only *O. t. tarda;* [3] equivalent to Russian national category V – "populations re-establishing".
1. tábla. A túzok vörös listás besorolása a közép-eurázsiai elterjedési területén belüli országokban. Oroszország esetében a tartományok is szerepelnek nyugattól keletre történő felsorolási sorrendben.
[1] Országosan védett I (highest); beleértve az *O. t. tarda* és *O. t. dybowskii* alfajokat; [2] csak az *O. t. tarda* alfaj; [3] megfelel az orosz nemzeti V. kategóriának („újra megtelepülő populációk").

As concerns hunting of Great Bustards, in the first half of the century, *Ryabov (1940)* noted that hunters preferred to take larger individuals and described a sharp decline in the size of male Great Bustards. *Ryabov* also mentioned an increasing wariness of the species to cars, from which they were frequently hunted. *Meklenburtsev (1953)* described hunting and some limited market sales during the winter in Uzbekistan, and *Gavrin (1962)* wrote of large-scale hunting in Kazakhstan after World War II. At this time, the schedule of agricultural activity on cereal fields was also recognized as incompatible with Great Bustard reproduction *(Gavrin, 1962)*. Populations in Kostanay Province of northern Kazakhstan were estimated to have declined by 60-100% due to these two factors in the period from the 1930s to the 1960s *(Ryabov, 1982)*.

Great Bustards were also lost to severe winters during the late 1940s; *Sludskii (1956)* describes seeing only 1-3 individuals after such winters, over 2-3 months of surveys in regions of Central Kazakhstan where previously it was possible to observe Great Bustards in the hundreds. *Dement'ev (1952)* reported that the number of Great Bustards overwintering around the capital of Turkmenistan had strongly declined over the previous decade, and even more so when compared with the previous century.

In the mid-century, *Gavrin (1962)* summarized the status of the Great Bustard as shifting from that of a frequently observed species to a rarity over the previous thirty years. The Great Bustard could still be found across most steppe and semi-desert zones of Kazakhstan, according to Gavrin, but now only sporadically. Strongholds included Kostanay and Aktobe Provinces, Tengiz-Korgalzhin of Karagandy Province, and the Alakol' Depression in southern East Kazakhstan Province. A survey involving almost 2000 investigators and a territory of over 20 million ha found the Great Bustard to have disappeared from more than half of the 26 provinces surveyed *(Kandaurov, 1986)*. This survey found Great Bustards to have disappeared completely from Tyumen, Kurgan, and Chelyabinsk Provinces and the Republic of Bashkortostan, though some reproduction was recorded in Orenburg Province. From this time onward, all literature on the species in Central Asia is marked by comments about its decline, rarity, and disappearances from regions in which it was once common *(Ryabov & Ivanova, 1971; Samusev, 1973; Gavrilov & Kapitonov, 1977)*.

By the 1980s, the Great Bustard was listed in Category II of the Red List of the USSR due to catastrophic declines *(Ponomareva, 1985)*. *Isakov (1982)* estimated that the population of Great Bustards in the USSR as a whole had decreased by 65% over 10 years. *Isakov* also estimated that less than 400 Great Bustards remained in Kazakhstan, specifically, 260 in the north Caspian region (this number includes Russian Astrakhan' and Kalmykia), 100 in west and central Kazakhstan, and 20 in eastern Kazakhstan.

The Great Bustard is red-listed across the Central Asian states and in adjacent provinces and republics of the Russian Federation *(Table 1)*. As for the wintering grounds, after the late 1970s Great Bustards were no longer observed in northeast Iran *(Tareh, 2000; Rabiee & Moghaddas, 2008; Barati et al., 2015)*. They were only rarely spotted as migrants or overwintering birds in Uzbekistan and Turkmenistan *(Kashkarov & Ostapenko, 1978; Meklenburtsev, 1990; Saparmuradov, 2003)*.

Post-Independence

By the time of the dissolution of the Soviet Union, the Great Bustard was almost extinct in Central Asia *(Gubin, 2007)*. Changes stemming from the dissolution reduced the rate of their decline and resulted in slight levels of recovery in some areas. Loss of soil fertility and the transition from a planned to market economy brought about the abandonment of large areas of farmland in the former Soviet states in the 1990s (e.g. 23% of agricultural lands in

Russia; *Kamp et al., 2009; Kurganova et al., 2013*). During this time, the use of agricultural chemicals also dropped dramatically (by 90% in Kazakhstan; *Gintzburger et al., 2005*). Both of these changes likely favourably affected the reproductive success of Great Bustards in Central Asia. However, these decades also witnessed high levels of poaching.

The status of the Great Bustard in Central Asia is such that from the 1990s through today, sightings of individual or small groups of Great Bustards, on the breeding or wintering grounds, continue to be noteworthy enough for publication. Areas where the Great Bustard continues to lek in Kazakhstan, albeit in small numbers, include the Alakol' Depression on the border between East Kazakhstan and Almaty provinces *(Berezovikov & Levinskii, 2003)*, the Turgai region of Kostanay Province (*Bragin, 2004; Kessler,* surveys in 2006), the Karatau foothills of South Kazakhstan Province (*Gubin & Vagner, 2005; Kessler,* surveys in 2006), and Tengiz-Korgalzhin region of Karagandy and Akmola provinces (2-3 females; *Mityaev & Yashchenko, 2006*). The work of an artificial incubation facility in Saratov Province of Russia, which releases chicks hatched from wild-collected Great Bustard eggs *(Khrustov, 2009)*, has been attributed as having breathed new life into populations of Great Bustard in adjacent West Kazakhstan and Aktobe Provinces (*Gubin, 1996; Kessler,* surveys in 2006).

In Russia, approximately 100-120 individuals breed in both Samara and Orenburg Provinces *(Gavlyuk & Yudichev, 1998; Shaposhnikov et al., 2009)*. To the east, in Omsk Province, along the border with North Kazakhstan Province, a handful of Great Bustard sightings have occurred since the turn of the century. These are the first observations in Omsk in 40 years, and the breeding of 5-7 females was recorded in 2004 *(Nefedov & Kassal, 2005; Nefedov, 2013)*. However, this population was later decimated, apparently by the hunting of humans and free-ranging dogs *(Nefedov, 2013)*. There have also been a few sightings of Great Bustards in Chelyabinsk Province, to the north of Kostanay Province of Kazakhstan *(Zakharov & Ryabitsev, 2005)*.

Gao *et al.* (2008) describe four non-connected populations remaining in Xinjiang Province of northwest China, specifically, in Tarbagatai and Ili Prefectures adjacent to Kazakhstan, and areas east of Ulungur Lake and south of the Altai Mountains in Altai Prefecture, which is adjacent to Mongolia. The estimates for Great Bustards in this region are 1600-2400 individuals, however, this number was obtained by multiplying the available habitat by density observed on surveys *(Gao et al., 1994; Gao et al., 2008)*. As the Great Bustard has a lek breeding system, and is known to aggregate in higher-quality areas *(Pinto et al., 2005)*, this number may be an overestimate.

At the same time that slight improvements were observed on the breeding grounds, an increase in the number of Great Bustards at migratory staging points and wintering grounds was also noted.

The number of Great Bustards staging and even overwintering in the Alakol' Depression has increased *(Berezovikov & Levinskii, 2004)*. In one snowless winter, approximately 200 Great Bustards overwintered in this region *(Berezovikov & Levinskii, 2012)*. There has also been a small uptick in the number of migrating and overwintering birds in Almaty Province. While groups of less than 10 were recorded in the 1970s and 1980s, a group of 120 individuals was sighted in 2002 *(Zhuiko & Belyalov, 2002)*. The Karatau foothills of South Kazakhstan Province continue to attract overwintering birds (maximum count of 171 birds; *Gubin & Vagner, 2005; Sklyarenko & Vagner, 2005; Kessler,* surveys in 2006), which sometimes move into nearby regions of Uzbekistan, including Toshkent and Jizzakh provinces *(Kreitsberg-Mukhina, 2003).*

There has also been an increase in the number of Great Bustards observed on passage through Uzbekistan and Turkmenistan *(Kreitsberg-Mukhina, 2003; Saparmuradov, 2003).* In Turkmenistan, the number of overwintering individuals is estimated at several dozen *(Rustamov & Sopyev, 1994),* after an absence of approximately a decade *(Saparmuradov, 2003).* One Great Bustard was even noted in northeastern Iran in 2008; overwintering birds arriving from Central Asia had not been recorded in that region since 1971 *(Rabiee & Moghaddas, 2008).* To the west, however, breeding populations in Azerbaijan are extinct, and migrants and wintering birds occur there only rarely *(Patrikeev, 2004).*

An estimate of the current population of the Great Bustard in Central Asia is difficult to produce. Surveying efforts are incomplete and most red book listings do not provide population estimates. In 1998, regional experts estimated the number of Great Bustards remaining in Kazakhstan to be 100-500, and the number in Central Asia as a whole (including northwest China) to be 2000-3500 *(Smelanskii, 1998; Chan & Goroshko, 1998).* Since that time, the number may have increased slightly, but probably does not exceed 4000 individuals.

Threats and conservation measures

Recent observations leave room for hope for the persistence of Central Asian Great Bustards. However, noted increases have been slight, the region is changing rapidly, and the species is still very vulnerable. To conserve these populations, poaching and low reproductive rates must be addressed immediately. Climate change and genetic isolation are also long-term challenges.

Hunting from automobiles played an important role in the sharp declines in Great Bustard populations in Central Asia in the mid- and late 20th century, after the expansion of the paved road network *(Ryabov, 1949).* Continuing into the 21st century, illegal hunting is still cited in virtually all publications as a major threat to the survival of Great Bustards in Central Asia *(Sklyarenko, 2004).* The liquidation of some anti-poaching units, the climate of lawlessness and chaos following the collapse of the Soviet Union, and the improved availability of long-range, automatic rifles are cited as factors in the increase in illegal hunting *(Berezovikov & Levinskii, 2005; Khokhlov et al., 2010).* Additionally, sport hunting of Great Bustards came into fashion amongst the upper class, who travel from urban areas to more easily accessible flocks. Groups of such hunters use high-clearance jeeps and optical equipment to better target overwintering bustards in Almaty Province *(Berezovikov & Levinskii, 2005).* Hunting of Great Bustards at overwintering grounds in southern Kazakhstan and northern Uzbekistan is described as a particular problem, perhaps because of the proximity of capital cities. Such poaching removed, for example, up to 30% of overwintering Great Bustards in East Kazakhstan in 2012 *(Berezovikov & Levinskii, 2012),* and eliminated a flock of 200 Great Bustards in Uzbekistan *(Kreitsberg-Mukhina, 2003).* Hunting at breeding grounds also occurs, decreasing lek populations and disrupting reproductive activity (*Kessler,* surveys in 2006).

Effective anti-poaching measures should be undertaken at sites where Great Bustards consistently breed and overwinter. As migratory stopovers are unpredictable and some overwintering spots are used only during severe winters, flexibility will be required in protecting individuals at these locations. One possibility is the development of mobile, quick-response teams, which assist local inspectors in monitoring areas where Great Bustards are newly reported. Public information campaigns should be undertaken to inspire pride in the conservation of this iconic steppe species. Such campaigns will be necessary at both the local and national level, given the role of urban sport hunters.

In addition to reducing adult mortality, it will be necessary to increase reproductive success to conserve Great Bustards in Central Asia. Losses of eggs and chicks to predators have always been high for this ground-nesting species *(Ryabov, 1949)*. As many Great Bustards nest on agricultural lands, clutch loss now also occurs due to crushing by agricultural machinery. Agricultural work may also indirectly cause clutch loss by flushing incubating females, whose eggs or chicks are then more easily spotted by predators. Agriculture presents additional issues for Great Bustard reproduction in the form of chemical use and irrigation. While agricultural chemical use decreased in the last decades of the 20th century *(Gintzburger et al., 2005)*, it is likely to rise again as local economies and trade infrastructure improve. Pesticides destroy the protein-rich summer food base of Great Bustards and their fast-growing chicks *(Hellmich, 1992; Bravo et al., 2012)*, and also increase parasite loads *(Lemus et al., 2011)*. Irrigation systems in Xinjiang Province of China are reported to flood bustard nests *(Chan & Goroshko, 1998)*. To establish plans for agricultural activity that will allow both Great Bustards and farmers to flourish, it will be necessary to develop a dialogue with farmers at bustard breeding sites. The harsh climate and short growing season of Central Asia must be taken into account, and as in Europe, financial subsidies and incentives may be required. Where bustards are breeding on virgin steppe, establishment of protected areas should be considered.

When making long-term conservation plans for breeding populations, genetic isolation and climate change must be considered. The remaining breeding populations of Great Bustard in Central Asia are small (some consisting of only two or three breeding females), and often separated by hundreds of kilometres from other breeding populations. A landscape genetic approach should be undertaken when prioritizing breeding populations for conservation action, as some leks may be small, but are critically located to facilitate gene flow in the metapopulation.

Niche modelling to forecast the suitability of future Central Asian climates to breeding Great Bustards should also be undertaken and considered when prioritizing conservation work. Considering that the Great Bustard is particularly sensitive to high temperatures *(Alonso et al., 2009)*, Great Bustard populations may shift northwards. Communication between conservation stakeholders in Kazakhstan and Russia should be maintained. The frequency of steppe fires, which already cause loss of clutches and chicks *(Chan & Goroshko, 1998)*, may be further increased if soils dry.

Finally, much remains to be understood about Great Bustard populations in Central Asia, including the location of remnant breeding locations and routes of migration. An ideal first step would be to undertake synchronized breeding surveys throughout the former breeding range of the species to identify active leks, particularly in Kazakhstan. However, such an undertaking will be challenging, given the large extent of potentially suitable habitat and the wary nature of this species. Many hunters in Central Asia possess a deep understanding of the natural environment of their home region. The distribution of a survey through regional hunting groups concerning Great Bustard observations would be a good first step to both collect information about this species at the national level and develop dialogue with a group of stakeholders key to the species' survival.

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Kivonat—A túzok egykor a közép-ázsiai sztyepp területek ismert lakója volt. Ma a maradványpopulációk aprók és elszigeteltek, a faj szerepel valamennyi vörös listán elterjedési területén belül. A dolgozatban áttekintjük, mi az, ami ismert a faj történelmi helyzetéről Közép-Ázsiában, valamint a régión belüli vonulásáról. Azokat a tényezőket is felsoroljuk, melyek az állomány meredek hanyatlásához vezettek ebben a populációban a huszadik században. Egy enyhe javulás figyelhető meg a faj helyzetében Közép-Ázsiában a 21. század fordulóján. Ez reményt ad a faj megőrzésére, amennyiben hatékony védelmi intézkedések valósulnak meg a költő- és telelőhelyeken egyaránt.

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Practice of incubation, rearing and repatriation at the Great Bustard Rescue Station of the Körös-Maros National Park Directorate

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Abstract—The Great Bustard Rescue Station operated by the Körös–Maros National Park Directorate was established in 1978 to start an *ex situ* protection programme for the species. The station receives Great Bustard eggs for artificial incubation from those nests deserted by the female mainly because of different agricultural works. Due to effective habitat management measures, the number of clutches in need of a rescue has been decreased recently. The Rescue Station has received annually 37 eggs at average in the past ten years, as opposed to one or two hundred eggs three decades ago. Eggs from endangered or deserted nests are transported to the Station from the entire Great Plane and adjacent areas east of the Danube. At the Great Bustard Rescue Station all the technical facilities needed are at hand from incubation to repatriation. The applied know-how is based on experience of more than 30-year-long activity.

Key words: *Otis tarda,* artificial rearing, ex situ protection, repatriation.

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Introduction

The Dévaványa Landscape Protection Area, located in the south-eastern part of Hungary, was designated in 1975 on 3500 hectares dedicated for the protection of the Great Bustards in the area. In addition to the habitat conservation and the protection of the wild population, a Great Bustard Rescue Station was established within the Landscape Protection Area on 30th October, 1978 with the aim to support the *in situ* protection of the species by artificial breeding and repatriation *(Sterbetz, 1982).* The Rescue Station has been operated by the Körös–Maros National Park Directorate since 1994. In the following we present the practice of incubation, rearing and repatriation used currently at the station.

Description of the applied methods used on the rescue station

Origin of the eggs

While during the first decade of the existence of the station all the eggs and chicks of detected nests were collected, it is not the practice any more. The main objective of the Great Bustard conservation activity is these days to minimise the number of nests found by agricultural works, and protection of found nests is aimed at primarily by marking a buffer zone around those rather than by removing the eggs from the wild. Only those clutches deserted by the female are transported to the Rescue Station according to current practices.

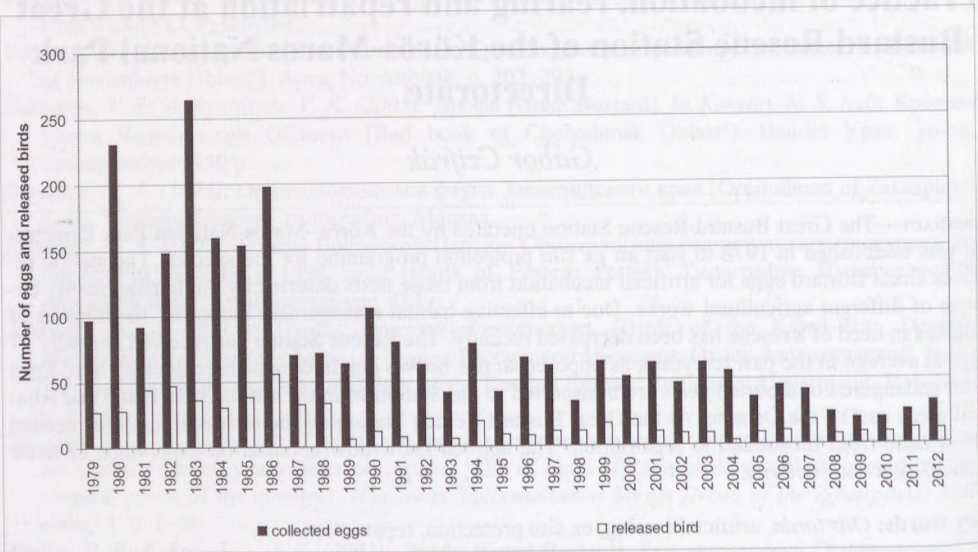

Figure 1. Number of collected eggs and released birds by the Dévaványa Great Bustard Rescue Station between 1979–2012

1. ábra. A begyűjtött tojások száma és a Dévaványai Túzokkeltető Állomás által szabadon engedett madarak mennyisége 1979–2012 között (fekete oszlopok: begyűjtött tojások; fehér oszlopok: szabadon engedett madarak)

Transport of the eggs

Eggs are transported by the staff of the National Park Directorate in all cases in a special incubator at 37.6°C.

Incubation

After arrival eggs are disinfected, numbered, and the heart rate of the embryos is measured by a Buddy Egg monitor (Avian Biotech International) and biometric data are registered on an egg registry sheet. Incubation is carried out by a commercial automatic incubator (PL Maschine Midi F90S) with the following parameters set:

Parameters of incubation

Temperature	37.8°C
Relative humidity	65%
Frequency of rotation	3 hours (automatically)
Angle of rotation	180 degrees (automatically)
Frequency of ventilation	20 min.
Frequency of cooling	twice a day
Period of cooling	15 min.
Temperature of cooling	20°C

The heart rate of the embryos is measured and registered every day during the incubation period. From the measured data the development of the embryo and the expected time of hatching are monitored. Chicks hatch on the 28th day of incubation. By this time eggs are already in the hatchers where the temperature is 37.5°C and the relative humidity is 85%.

Rearing

After hatching the chicks are removed into a rearing room where they are in boxes of 2-3 m^2 of surface. On the first two days within the box an approx. 30×50 cm plastic box restricts the chicks to move away from the infrared light. The room's temperature is 25°C, and the floor's temperature is 35°C underneath the infrared light, but the chicks are free to move to cooler parts of the box. The relative humidity in the rearing room is between 70% and 80%. From the 7-8th days when the weather is good (23-25°C), during daytime chicks are released outside to a smaller restricted area (4-5 m^2) of the yard, which is covered with a net. In case of lower temperature or rainy weather, the chicks must stay inside in the glass-house. The chicks are free to use the whole area of the covered yard (40 m^2) from the age of 2-3 weeks.

During the first 24 hours after hatching the chicks only get liquid in form of a vitamin solution. Feeding starts on the second day with house cricket *(Achtea domesticus)* and a special poultry mix. Feeding takes place at 2-hours-intervals, 7 times a day. The special mix contains the following components: green alfalfa (40%), boiled potato (35%), cottage cheese (6%), boiled beef heart (6%), boiled egg (3%) and basic mix (10%). The basic mix contains cornmeal (25%), cracked linseed (25%) and two different types of nutriment supplements (25–25%). Data collected on the rearing of the chicks are registered on a special chick registry sheet. Rearing runs under regular veterinarian surveillance.

Repatriation

At the end of August the 8-week-old chicks are removed to a 400-hectares-large fenced area, which is kept free from mammalian predators. Each bird is marked at the age of 10-13 weeks using a combination of colour rings to allow individual identification. In the repatriation area continuous human presence is ensured in the first two months. Birds gradually use larger areas and learn to feed independently. As the repatriation area provides various habitats for the wild Great Bustards in the region, they also use the fenced area, so after 2-3 months the released birds gradually join to wild flocks.

Kivonat—A Körös–Maros Nemzeti Park Igazgatóság által működtetett túzok-mentőállomást abból a célból hozták létre 1978-ban, hogy a faj *ex situ* védelmi programját elindítsák. Az állomás a különböző mezőgazdasági munkák következtében a túzoktojó által elhagyott fészekaljakból származó tojásokat kapja meg mesterséges keltetésre. A hatékony élőhely-kezelési intézkedések következtében a mentőállomásra érkező tojások száma az utóbbi tíz évben átlagosan 37 tojásra csökkent a három évtizeddel ezelőtti évi száz-kétszáz tojással szemben. A veszélyeztetett vagy elhagyott fészekből a tojásokat a teljes Alföld területéről és a Dunától keletre eső, azt környező területekről szállítják az állomásra. A túzokmentő állomáson a keltetéstől a visszavadításig valamennyi szükséges műszaki berendezés rendelkezésre áll. Az alkalmazott módszerek több mint 30 éves tevékenység tapasztalatán alapulnak.

References

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