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THIRD MEETING OF THE SIGNATORIES OF THE MEMORANDUM OF UNDERSTANDING ON THE CONSERVATION AND MANAGEMENT OF THE MIDDLE-EUROPEAN POPULATION OF THE GREAT BUSTARD (Otis tarda)

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CMS/GB/MoS3/REPORT
Annex 5

GUIDELINES FOR REINFORCEMENT AND REINTRODUCTION OF THE GREAT BUSTARD *OTIS TARDA*

BirdLife International
European Division

Guidelines for Reinforcement and Reintroduction of the Great Bustard *Otis tarda*

Prepared for the Memorandum of Understanding on the Conservation and Management of the Middle-European Population of the Great Bustard (*Otis tarda*) under the Convention on Migratory Species (CMS)

by

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Photo: A. Eisenberg

1. General considerations prior to starting a reinforcement or reintroduction project

General criteria and legal aspects

- Reintroduction projects shall follow the IUCN guidelines for reintroductions and conservation translocations (IUCN 2012). First of all, no reintroduction should be started as long as the factors causing the population decline and/or extinction still exist.
- Reinforcement projects for shrinking populations that are not yet extinct should be considered in the same way.
- The objective of each reintroduction, reinforcement, or any conservation translocation project must be a self-sustaining population.
- For both reintroduction and reinforcement projects, criteria for an exit strategy should be established 1) for cases where the population no longer requires reintroductions or reinforcements, and 2) for the case of lacking success of the project.
- An adaptive management approach basing on good monitoring data should be implemented in all parts of a project.
- All relevant legal aspects (hunting, nature conservation, animal welfare etc.) have to be respected, from the state (or federal state as in Germany) level up to the international / EC level.

Captive breeding

- In spite of successful breeding of captive Great Bustards and even breeding success due to artificial insemination (www.avutardas.com), captive breeding is not yet sufficiently developed for large-scale application in conservation projects.
- Therefore, these guidelines deal with artificial incubation, rearing and release into the wild whereas captive breeding, including supporting methods such as artificial insemination might be subject of a later issue of these guidelines. Scientific and practical work on captive breeding should be continued in order to make the results available for conservation practice.
- For more information see relevant literature on Great Bustard (GEWALT 1966, GRUMMT 1977, LITZBARSKI & LITZBARSKI 1993, MÖDLINGER et al. 2000), and other bustard species.

Translocating wild-catches

- So far, there is no experience in translocating juveniles or even adult birds obtained as wild bird from donor populations. Therefore no guidance in this method is possible.
- Consequently this paper deals exclusively with juveniles gained from eggs in order to be hand-reared and released later.
- In other species such as Capercaillie (*Tetrao urogallus*) translocation of birds caught in the wild proved to be more successful than the release of captive reared birds (e. g. UNGER 2009, UNGER & KLAUS 2007). Therefore this approach might be considered carefully in the future.

Feasibility study

- A feasibility study is necessary in order to assess all requirements for the project:
  - availability of suitable eggs or juveniles,
  - rough assessment of the annual number of birds to be released.
  - availability of finances, facilities and skilled personal,
  - logistic aspects,
  - probability of success etc.
- It is important in this context that a greater number of successfully released birds per time unit raises the chance of success whereas the same number shared over many years are much less efficient.
- A pilot project of two or three years with smaller releases might be sensible in order to get familiar with the equipment and methodology and to establish a nucleus of semi captive birds before a larger release.
- Financial support by the state or other donors should be guaranteed for a sufficient period of time. A coherent business plan could detail where income will come from over the length of the project thus showing that the important issue of long term funding had been addressed and actions put in place.
- From the beginning on, there must be room enough for all periods of the breeding cycle. The need for later expansion should be kept in mind.
- Political support is regarded as helpful.

Co-operation

- Other projects on the Great Bustard or related species should be contacted in order to take benefit from existing experience and to build up co-operation.
- Potential subjects of co-operation are exchange of experience and scientific results, exchange of eggs or juveniles, logistics, and mutual political support.
- As well, co-operation is necessary with landowners and land-users in the project area (mainly farmers and hunters), regional stakeholders, politicians, and potential sponsors.
- Competent and specialist veterinary assistance must be available.
- Co-operation with universities or similar institutions provides scientific background necessary for analyses and evaluation of project data in the context of relevant environmental data.

2. Egg collection

Origin of eggs

- Eggs for artificial incubating might come from
  - autochthone breeding populations,
  - other donor populations,
  - captive breeding groups (natural brooding and rearing by the females has to be taken into consideration as it may provide fitter young for release).
- If eggs are obtained from the field, they might be from
  - broods that are disturbed / abandoned,
  - clutches which are considered to be without chance of success in the field,
  - clutches that are searched for and collected systematically under certain pre-conditions.

Decision criteria for taking eggs from the field

- A system of decision criteria for taking eggs from wild populations shall be established in each reintroduction or reinforcement project in order to avoid any damage or even the risk of damage for the donor population(s).
- Prerequisites for collecting vital eggs are:
  - low or lacking chance of success of a clutch, e. g. due to
    - cultivation measures very close to the nest-site,
    - a fox den nearby or
    - generally high predation pressure,
  - evidence that normally no more than one juvenile is successfully reared – taking single eggs from clutches of two or three eggs may be considered then,
  - demonstrably vital donor populations which easily compensate for lost eggs, e. g. by replacement clutches or high reproductive success of other females; if necessary, a population viability analysis has to be done,
- There are three main ways for managing clutches in the field and a mix of these as the fourth one:
  1) Eggs remain outside
  - circumstances favourable / land use appropriate or
  - land use needs to be adapted / special management if need be

  2) Collection of first clutches in order to provoke a replacement clutch
  3) Exchange of eggs for dummy eggs from wood or other materials (mainly if predation pressure is high and eggs shall be rescued)
  - changing back prior to hatching or
  - replacement clutch if wooden eggs get lost

  4) Mix of methods, e. g. taking single eggs from a clutch with or without exchange for wooden eggs.
- It is important to have in mind that the first part of the incubation period is the most sensitive one. Taking eggs soon after laying instead of waiting at least one week gradually reduces the hatching success.
- Generally, one or more substitute clutches can be taken for granted in the Great Bustard. However, hardly anything is known about a calendar effect in Great Bustards under natural conditions in Central Europe, i. e. changing egg size, hatching and rearing success etc. In Germany, very late clutches (July) have lower insemination rate, and juveniles from these might be affected by harsh weather in late autumn or beginning winter due to their physiological immaturity.
- An example for decision criteria is given in fig. 1.

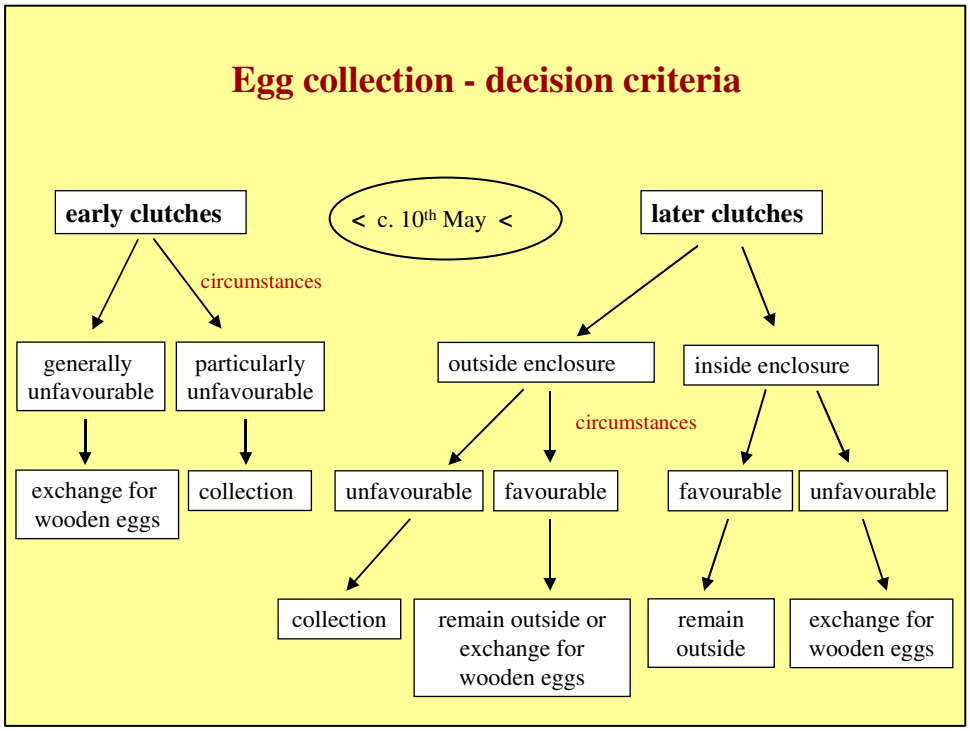

Figure 1: Decision criteria for taking eggs from the wild in the German Great Bustard project. "Enclosure" means areas of 15 – 20 ha that are fenced-off in order to provide fox free breeding refuges for free-living females.

Transportation

- Eggs should be transported by skilled personnel. A second person is helpful for holding the transport device.
- Transportation boxes should be upholstered against vibration, e. g. using styrofoam.
- For longer distances, transportable incubators are recommended.
- In case of cross-border transportation quarantine regulations of the respective countries have to be regarded. The same is true for juveniles to be transported to ensure diseases which are not endemic in the importing country are not introduced in order to protect the indigenous population or wildlife in general. Even birds looking healthy may be carriers of infections.

3. Artificial incubation

Facilities / equipment

- The whole hatchery building shall be used exclusively for the Great Bustard project. A mix with other species puts the bustard project at risk as does any livestock keeping / breeding or even rehabilitation in the vicinity.
- Ideally, the entire breeding process from receiving the eggs to hatching and later rearing is designed as a more or less linear flow through the hatchery building with as few cross-over points as possible.
- From the hygienic perspective eggs have to be regarded as "clean" whereas chicks are associated with "dirty". All parts of the hatchery building must be accessible without movements from a dirty area to a clean area.

- The hatchery building should have three separate rooms:
  - reception room (reception of eggs, control for damages, pollution or smell, sanitation, measuring),
  - incubator room (incubation, monitoring and documentation),
  - hatching room.
- The size of the rooms depends on the size and number of incubators / hatchers and should allow easy and cheap expansion if necessary.
- Size and number of incubators should correspond to the egg size and the expected number of eggs. Eggs that are likely to fail should be removed to a separate incubator. An additional incubator is advisable in case one of the others breaks down.
- General requirements of the hatchery building are good aeration efficiently extracting stale air, air condition (ca. 22-24 °C, 50 % air humidity) and materials that can be cleaned and disinfected easily.
- A broad range of commercial automatic incubators are available. Force-draught incubators seem to work better in Great Bustards than still-air machines.
- Even if there are combined incubators/hatchers available, hatching should take place in separate incubators ideally operating in a separate room (see above).

Egg handling, hygiene, and bio-security

- A stringent disinfection scheme during the breeding season is essential. Non toxic broad spectrum disinfectants should be used in combination with detergents. Initial fumigation of incubation and hatching rooms is recommended. Due to its toxicity formaldehyde which used to be effective is increasingly replaced by other substances such as ozone or hydrogen peroxide.
- To avoid any contamination, the eggs shall be touched as little as possible using rubber gloves or thoroughly cleaned and disinfected hands.
- Only badly contaminated eggs are washed (after careful mechanical removal of adherent coarse particles) in a washing solution or under running water of about 35-40°C - certainly above egg temperature in order to avoid influx of water and germs into the eggs due to the temperature gradient.
- Suspect eggs (e. g. slight smell, no movements, no calling before hatching, physical damages) have to be separated for further incubation.
- Eggs that are certainly unsuccessful are selected as early as possible and stored for later analysis.
- Failed eggs have to be considered a valuable source of information. Immediate analysis in an experienced veterinary laboratory might provide results that are important even for the same breeding season (insemination status, at what age do embryos die?, alterations compared to normal embryos/chicks, size and shape of the air space, microbial contamination etc.).

Incubation

- Before setting any eggs it has to be checked that incubators and hatchers are cleaned and disinfected thoroughly, and operating properly over several days. Beginning this early enough enables one to identify and replace failing or faulty components.
- Breeding parameters that have proved successful in force-draught incubators are
  - 37.4°C (slightly higher in still-air machines),
  - 60 % humidity,
  - 8 – 12 x turning per day.
- So far it is uncertain if periodic cooling is necessary. Additional aeration is not necessary in force-draught incubators with automatic fresh-air ventilation. In still-air incubators it might be helpful to open the incubator once per day for a while.

- Keeping these parameters, eggs usually need about 24 days till hatching.
- If the laying date is not known there are several signals for beginning hatching: louder calls of the chick and scratching noise due to internal pipping (perforation of the egg membrane). “Buddy monitors” () may be used which pick up the heart beat and any other movement within the shell (see below “Monitoring and documentation”). First movements of eggs on a smooth surface are visible around five/six days before hatching. A simple approach for rough estimating the age of vital eggs is the change of the longitudinal axis from horizontal in freshly-laid eggs to ca. 45° at the age of 17 days and vertical at 3 weeks; with increasing air space prior to hatching the egg starts swimming.

Hatching

- Appropriate for hatching are one-stage still-air incubators as well as force-draught incubators.
- Moving the eggs to the hatchers about one day before hatching guarantees that the incubator unit remains “clean” (cf. paragraph “Facilities/equipment” above).
- Suitable breeding parameters within the hatchers are
  - 37.0 °C,
  - 90 % humidity,
  - no turning but ability for the egg to roll around relatively easily in order to support chicks’ activities.
- Hatched chicks stay in the hatchers or are set into a box with infra-red light and/or ground-heating until they are fully dry and fluffed up. They should be allowed to evade the direct heating-source in order to avoid drying out. Clothes or “Astro Turf“ (“plastic grass”) prevent the chick from straddling legs.
- First care comprises health check and weighing (after drying). Navel disinfection usually is not necessary. Insufficiently retracted yolk-sacs might be dabbed with a disinfectant (e. g. Sagrotan) or antibiotic (e. g. gentamycin).

Monitoring and documentation

- Temperature and humidity have to be checked and recorded on a daily basis during incubation. This should be done several times per day regularly. An additional routine look at the machines is recommended for every case of entering the incubator room. The water supply in the humidity bottle or pan also has to be checked regularly.
- The room temperature should be checked at least twice per day.
- Every egg has to be marked for continual identification during brooding and for the control of regular turning.
- Weighing each egg in an interval of maximum five days is recommended in order to calculate the weight loss and to be able to adjust the humidity for further brooding. A weight loss of about 15 % (10-18 %) of the initial egg mass during incubation until the opening the egg-shell is recommended for domestic fowl. Weight loss in (also precocial) Great Bustards seems to be lower with 10-11 % in the projects in Hungary and Germany, and 13.6 % in Chinese birds (*O. t. dybowskii*) (JINGJUN et al. 1998). With regard to vitality this is of limited diagnostic value as weight loss (as well as an increasing size of the air space) is also found in rotten eggs.
- The hatchling weight in precocial birds is about 69 % of the initial egg mass, and about 68 % in Great Bustards (provisional data from the German project).
- Additional controls comprise daily checks of egg vitality (movements on a smooth surface from ca. five/six days before hatching on, calls about 24 h prior to hatching) or any alteration (damages, oozing, smell). Swim tests in sufficiently warm water (see chapter “Egg handling and hygiene” above) might be used in uncertain cases for better visibility of movements, moreover to check the change from initially horizontal to more sloping

position with the sharp end downwards towards the end of the incubation. Candling of Great Bustard eggs is impossible due to thickness, structure and pigmentation of the egg-shell.

- A rather new and sophisticated approach is using digital heart-beat monitors (http://www.avianbiotech.com/buddy.htm) which are able to indicate vitality as early as five days after incubation has started. Following experience in Devavanya (Hungary), the heart frequency is increasing over the incubation period up to 300/min before hatching. Calculation of the age on the basis of weight loss failed to far in Great Bustard eggs. Very rough estimation of an egg from the field is possible by checking the egg-shell which gradually changes from dull after laying to smooth and shining towards hatching.
- Post-mortem findings of failed eggs provide a valuable additional source of information (see "Egg handling and hygiene") and should be recorded in as much detail as possible.

4. Rearing in captivity

Facilities / equipment

- Warm boxes of ca. 40 x 40 cm and a litter from cellulose, paper or clothes are necessary for chicks on their first day after hatching and for the first 1 – 3 nights.
- From the second day on the chicks be outside in a nature-like environment as much as possible, as far as the weather conditions allow.
- Predatory birds or mammals have to be excluded by a suitable and reliable fence and netting above. These pens may be about some 100 m^2 in size during the first week and several 1000 m^2 later on. Somewhat larger is better as a general principal as microbial pressure per square unit is reduced. The grassland vegetation within the enclosures should include herbs/weeds that are preferred by the bustards (see below "Feeding") and form a mosaic of shorter and taller patches to meet all the requirements that wild chicks have access to (cover, shadow, food). Additional food might be offered by growing lucern. Patches of gravel provide small stones as stomach grit. Sandy patches enable sand-bathing.
- A glass-house or a stable is required for the nights during roughly the first eight weeks. Additionally it may give shelter against cold, rainy or stormy weather during the first weeks. A litter of gravel proved to be optimal in the German project. A glass house provides steady contact to the surroundings whereas a closed building isolates the birds as long as they are kept inside. An option is to allow the chicks access to the outside through a pop hole - if the weather is bad they may be taken inside, but if the weather is warm they stay outside (usually they don't move inside on their own). Access of predators has to be avoided in a suitable way.
- Heating inside the glass-house / stable is necessary during the first weeks. Infrared lamps combined with a ground-heating compensate for the lack of a mother until the chicks are able to regulate their body temperature by themselves. The birds' individual condition and the weather should be assessed in order to find the right moment to cease additional heating. In Germany this is after some 40 days whereas the warmer and dryer climate in Saratov, Russia, allows a much earlier cessation of heating.
- Pens and buildings shall be protected from extremes in weather.

Feeding

- During the first 24 hours the chicks are not fed. It is assumed that this corresponds best to the natural behaviour of bustards, helps the chicks to retract their yolk sac and to recover from hatching.
- In general, food shall be from reputable sources and replicate natural diet as far as possible.
- Within the first two weeks the chicks are fed only by insects - commercially available crickets and insects from the field. From day seven on little pieces of herbs are added, preferably stinging nettle (*Urtica dioica*), dill (*Anethum graveolens*), dandelion (*Taraxacum officinale*), yarrow (*Achillea millefolium*), chickweed (*Stellaria spec.*), alfalfa (*Medicago sativa*), plantain (*Plantago spec.*), clover (*Trifolium spec.*), lucerne (*Medicago sativa*) etc. The percentage of plants in the diet increases during the following weeks. Vitamin B complex may be supplemented in weak chicks. The diet may be adapted to the local availability and experience.
- From the third week on an additional diet for growing birds from "Lundi", a German producer, has proved worthwhile, offered as pellets. A protein content not too high is important for metabolism and development of the skeleton, i. e. about 35 % during the first 5-6 weeks and 20 % afterwards.
- Supply of good quality water *ad libitum* is essential!
- Small amounts of probiotic may be given during the first week or later in weak or sick chicks.
- Careful monitoring of the occurrence of any defects attributable to excessive protein or other metabolic problems is crucial mainly during the first month (see chapter "Health precautions and veterinary care" below).

Additional demands during the rearing period

- Within the first month of life, the birds should be kept in groups of similar age.
- Reduced or completely avoided contact to humans supports bustard specific behaviour after releasing.
- The best way is completely anonymous feeding and caring. Alternatively, uniformly clothed personnel with a dress that is unlikely to be met in the field reduces the pattern of humans to a very narrow scheme making a later approach to human beings unlikely. Staff should be restricted to very few experienced persons.
- Any stress due to stocking density, handling etc. shall be avoided because of the risks of panic and lower immune resistance. Handling is restricted to weighing and medical treatment if necessary.
- A short hand-feeding period of max. 7 days is recommended. Restrictive feeding prevents metabolic problems and encourages the chicks to feed by themselves. Afterwards feeding by food bowls and later on by automatic feeders is the best way. An additional supply of naturally grown herbs in the enclosures supports natural feeding behaviour.
- Feeding remains and faeces have to be removed at least once a day.
- Daily walks of increasing length promote optimal growth, development and behaviour. In the German project, this happens first inside the enclosure but later even in free nature. This way the birds get familiar with their natural surroundings and become independent at an early age. The guiding person stays more and more in the background but still is able to lure the young into the enclosure by offering attractive food such as pellets.

Health precautions and veterinary care

- Bio-security and vigilance is important. Regular inspection should include behaviour of the stock, food and water uptake, and changes in faecal matters.
- Infections or parasites need to be diagnosed by a veterinary laboratory. Isolation of suspect birds is necessary but often leads to steady calling due to stress.
- Angel wing occurs in many chicks around the end of the first week. Usually it is simply a temporary nuisance. It is routinely cured by fixing forearm and hand with little rubber bands or sticking plaster for 2-3 days. Usually no repeat is required.
- Symptoms of long bone deformities or perosis in single birds should be treated with low doses of minerals (calcium, phosphate, selenium). Larger extent of the problem usually reflects metabolic imbalances due to protein surplus and/or insufficient exercise. Feeding and management should be carefully analysed and adapted.
- Fractures mainly of wing bones and legs may be prevented by avoiding any kind of fright. A nocturnal marten or raccoon on the roof of the stable can cause panic and severe damage. It is not yet fully understood if the known susceptibility of Great Bustards to fractures is more a problem of captive-reared than wild bustards due to imbalances in metabolism.
- Clogging or congestion of the stomach may occur as a result of plant particles which are too large and lacking intake of small stones.
- Cases of *prolapsus cloacae* in some of the few days old chicks are a special phenomenon of unknown genesis in the German project. Treatment with *Buscopan comp.* (0.05 ml/100 g) immediately after noticing the first symptoms helps in many cases after one or two injections. If not, a small surgical operation usually leads to success after one day.
- The only routine veterinary care is treatment against *coccidiosis* at the age of about three weeks.

Sexing

- Sexing is relevant at the stage when the birds are fitted with rings and/or radio-transmitters as there are different rings or tags because of sexual dimorphism.
- Methods used are
  - general appreciation by the exterior,
  - body measurement / indices,
  - genetic methods.
- The method used in Spain (index tail length / mass) is rather accurate in wild birds whereas it did not work in captive birds probably to the influence of feeding intensity in hand-reared birds
- In the German project, a defined diameter of the tarso-metatarsal joint proved most successful.

Monitoring and documentation

- Marking with commercially available chicken rings of different colour during the rearing-period allows individual record of the life history of each bird (for final marking prior to release see 5.).
- Body weights may be taken in certain intervals in order to make the results between chicks, groups or years comparable and to be able to correlate these with factors such as nutrition, weather or health status. In contrast, excessive handling may result in stress, injuries, feather damages, or familiarisation with humans. Therefore, unrestricted regular weighing cannot be recommended.

- Vitality of the chicks is checked routinely by observation. Any deviation from the normal course of growing should be noted, e. g. growth delay, health problems, food supplementation, veterinary care, medicine etc.

5. Releasing into the wild

Facilities / equipment

- The release enclosure should be of sufficient size to allow the released birds to exhibit natural behaviour including feeding. The outer fence has to be constructed in a way that there is no access for predatory mammals larger than a stoat. Interaction with wild living bustards is highly desirable and may be promoted (see "Methods" below). In practice this may mean building an enclosure as large as funding permits, although maintenance of the fencing and monitoring of the release-group must be carefully considered.
- A smaller enclosure inside the larger one allows a step-by-step release as well as care and supervising at the beginning. The small one is opened after some days to enable the birds to extend their activities after first contact with their further environment.
- Netting the smaller enclosure to keep flying predators outside may be necessary for a while (see below). Any obstacles inside the enclosures should be removed in order to avoid collisions of the flying birds.
- A stable to spend colder nights inside is necessary only if birds younger than 8 weeks are released.
- Anonymous feeding as long as the birds are in the enclosure promotes distance behaviour towards human beings after release. This might be realised by automatic feeding-devices, the uniform-like clothing the birds are used to from the rearing period or clothing that camouflages human build, and finally suitable and attractive cultivated or naturally grown vegetation.

Methods

- The main goal of the release period is to integrate the released birds into the wild population as soon as possible. Means to support this are 1) avoiding disturbances, 2) providing preferred food (e. g. oil-seed rape, alfalfa or kale) near the release-sites to attract free-ranging birds and 3) a semi-captive group nearby in case there is no wild population; this could serve as a nucleus for a later population.
- Releasing into the wild is a process of several weeks beginning with the transportation to the release-site at the age of about eight weeks and ending with independence from artificial feeding.
- International projects may have time/age constraints due to logistical or bureaucratic obligations, or simply as quarantine is required. General methodological changes may help, e. g. import of eggs instead juveniles.
- The release period should start as soon as the young bustards regulate their body temperature by themselves (ca. 8 weeks). Circumstances may cause a delay or adaptation of the strategy, e. g. weather conditions or predation pressure.
- Even hand-reared chicks are naturally very alert and shy when detecting any strange objects even at a great distance. There is evidence that post-release mortality due to White-tailed Eagles – the top predator in the German project - is more a problem of poor body condition of the still untrained birds than a problem of lacking awareness. Wild young would still try to hide at this age whereas the mother tries to escape by flying!

- Management of the predatory species (mainly goshawks, eagles, foxes) has to respect the legal framework of the respective country. Additionally, anti-predator training might be taken into consideration. So far, there is more anecdotal than systematically gained knowledge on anti-predator training in Great Bustards. Teaching experiments on a scientific basis would be desirable.
- In case of high predation risk in their later environment the young might be kept under nets for a longer time. At least they ought to spend the nights under the net whereas the daylight should be spent outside as long as possible. Accompanying the birds by a person in the uniform cloth is a compromise between the objective to reduce human presence and give protection from predators on the other side. Even a person over some hundred meters reduces mortality risk due to White-tailed Eagles.
- Offer of preferred feeding items such as pellets may attract the birds in the evening in order to bring the group together and into the shelter of the fence.
- The time when additional feeding after release stops depends on the birds' behaviour (independence, joining of free-ranging bustard groups) and the circumstances (e. g. predation pressure). The date may change from year to year.

Marking and post-release monitoring

- Post-release monitoring is mandatory for each re-introduction or reinforcement project and the main basis for evaluating its success. Main criteria of success are bustard-specific behaviour after release and survival of a significant number of released birds.
- Marking is the basis for this monitoring and later control of the birds on an individual basis.
- Marking methods which have been successfully used are
  - ringing / colour-ringing,
  - wing-marks,
  - subcutaneous micro-chips,
  - radio-tracking,
  - satellite-tracking.
- The methods used in a certain project depend on availability of finances, personnel capacity for field work, vegetation structure (for reading colour-rings) and predation pressure (possibly increased visibility of birds due to wing-marks?).
- Radio- or satellite-tracking additionally improves the chances to find groups of wild (unmarked) birds after released birds have been integrated. For long-term investigations tags with solar-panels are recommended.
- Radio-transmitters may be used as tail-mounted tags, necklaces (females only!), and back-pack transmitters with harness. Tags glued at wing-marks had some disadvantages. For more details see ALONSO (2008).

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