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The *International Zoo Yearbook Volume 48 2014* has some interesting and important primate topics and we will return to these later, but it's the avian articles that make this volume really stand out. A foreword by Macek (2014) sets the tone, with each paper worthy of comment in its own right, but together they form a masterclass of twenty-first century wildlife conservation and welfare, with processes and principles applicable to any class of wildlife conservancy from invertebrates to megafauna. These articles cover the vast range of the necessary skills from the minutiae of incubation (Cornejo *et al* 2014) to the broad strokes of international co-operation (Owen *et al* 2014). The issues of avian conservation, including various aspects of *ex situ* and *in situ* are elegantly summarised by Collar and Butchart (2014).

Provision of a good captive environment is essential for good welfare and to optimise reproduction. Bračko and King (2014) advocate that flying birds should be maintained in covered aviaries, and refer to education and visitor experience, breeding, behaviour, predation, veterinary issues, avoidance of invasive species and hybridisation, welfare and enrichment and cost in their discussion. Cutting through all their arguments the main benefit appears to be to allow the birds to be kept fully flighted. Being able to fly has multiple positive welfare benefits for captive birds, for example it removes the necessity for the pinioning procedure (and see Klausen [2014] for the discussion and the statement from The Association of Avian Veterinarians pertinent to pinioning), allows full expression of ritualised behaviours that involve wing display or flight, aids avoidance of intra- and inter-specific aggression between birds, as well as giving enhanced reproductive success. This latter is exemplified by flamingos, where pinioned males appear to have much more difficulty mating than non-pinioned (King & Bračko 2014; Rose *et al* 2014). On a more general note, Klausen (2014) comments that in their new aviary, birds appear to fly for no other reason than to fly. This is arguably subjective, and to some may appear almost anthropomorphic, but whether those birds fly because of some as yet unclear motivation, or just because they can (horses have been shown to be motivated to obtain exercise [Lee *et al* 2011]), Klausen regards as functionally irrelevant — the point is that they do it and by doing so participate in a range of behaviours (as well as cardiovascular and muscular exercise) that was previously denied them. However, from a practical point of view no mention is made of the downsides of larger aviaries, such as the difficulty in capturing birds which are thought to be unwell, a procedure which if protracted puts unnecessary stress on that individual and possibly other aviary inhabitants too; to some extent this can be ameliorated by positive reinforcement training to feed stations or even to specific procedures (Heidenreich 2007).

Not all birds fly, but that does not mean that they have feet of clay. Brown kiwis were shown to climb on to and over nest-boxes provided, suggesting that they are able to climb and clamber more than was thought and that a more three-dimensional environment with ramps and soil mounds should be considered for them (Wesley & Brader 2014). A larger pool also proved unexpectedly popular with the female brown kiwis. Aviary design can take some other unexpected turns, such as that described by Plantan *et al* (2014) which allowed for the rotation of donkeys into and out of the aviary to meet the behavioural and environmental needs of the red-billed oxpecker, an obligate mammal gleaner and commensal of large ungulates. This design, if successful, should certainly be listed under the Aviary Database Project described by Bračko and King (2014).

Providing an appropriate diet is crucial in so many ways to *ex situ* captive breeding success. As might be expected, it's not just about reproducing the bird's natural diet — in fact in the vast majority of cases this is not known anyway, especially if one factors in other variables such as seasonal food availability and life-stage preferences. These and many other factors are explored by Fidgett and Gardner (2014) in their article on nutrition; a review that is broad in its generality yet thought-provoking and as equally applicable to any species kept in captivity as it is to any member of Aves.

Captive birds require a less energy-dense diet due to their markedly reduced levels of activity in comparison with their wild counterparts — something that is further complicated by the bird's innate preference for high energy foods. As a clinician seeing pet and zoo birds on a daily basis with health issues such as atherosclerosis and hepatic lipidosis, much of their article resonated with me. Offering fruits can be counter-productive as modern fruit varieties are selected for the human palate and contain higher levels of simple carbohydrates (sugars), reduced complex carbohydrates (such as fibre) and lower protein levels. These principles are also being applied to primate collections where concerns over dental disease, diabetes mellitus and intra-specific aggression (sweet foods can be prizes worth fighting over) showing the cross-taxa value of this information. Of interest, and counter-intuitively, the authors also advocate the use of manufactured foods such as pelleted feeds in an effort to replicate the nutritional balance of the diet rather than the substance, and as a means to iron out known deficiencies such as mineral imbalances. They argue not unreasonably that in many cases replication of the wild diet is impossible so the obvious alternative is to provide a nutritionally equivalent one.

Nutrition can have unexpected consequences too. F1 captive-bred Regent honeyeaters appeared to have less vibrant colouration compared to their wild counterparts, something that required an adjustment of the commercial diet they were being fed (Liu *et al* 2014). It is cited that there is now no noticeable visual difference, but the apparent lack of reproductive success of released males as compared to females does make one suspicious that the birds may see things slightly differently.

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The encouragement of populations to breed and their management, plus the successful rearing of offspring to complete the species' lifecycle is at the core of all conservation efforts. Inevitably this entails more than just housing a male and female together. The problems with pinioning in flamingos have already been touched upon, but even if fertile eggs are laid artificial incubation can be a minefield, and this is where meticulous attention to detail can make a substantial difference. Cornejo *et al* (2014) describe the evolution of their incubation procedure for the maleo and how environmental factors can affect egg viability and hatching.

Health and disease management are important aspects of any conservation effort and the inclusion of the veterinary profession at several levels is good to see and as a veterinarian myself, it was pleasing to see how integral my profession is to the welfare and conservation efforts of so many species, ranging from the actual veterinary care of individual birds (Tomita *et al* 2014) and the importance of pre-release protocols (Liu *et al* 2014; Raigoza Figueras 2014) to the monitoring and collation of data regarding disease challenges such as West Nile Virus (Nemeth & Oesterle 2014).

Many of these papers describe *in situ* conservation (Liu *et al* 2014; Owen *et al* 2014; Raigoza Figueras 2014). Here, we have the local breeding and in some cases the subsequent reintroduction of captive bred birds back into the wild. It is true that the re-establishment of free-living populations is the Holy Grail of conservation, but this requires a phenomenal amount of work and financial input, and like any major enterprise there should be some validation performed and in the realms of conservation, post-release monitoring is one way of achieving this. Radio-telemetry is the method of choice as this allows monitoring of individuals without necessarily being able to see them in dense vegetation or having to get close enough to potentially influence their behaviour (Liu *et al* 2014; Raigoza Figueras 2014). Radio-telemetry is not without its problems, especially on smaller, less-robust birds such as the Regent honeyeater where backpack harnesses required modifications following some mortalities associated with their use. However, both of these studies have been able to confirm survival of birds post-release, and in the case of honeyeaters, breeding of captive-bred females with wild males. In contrast, the release of black-winged starlings was not monitored (Owen *et al* 2014).

Modern conservation is a collaborative effort, not just between individuals and collections but outside the zoo and conservation community too. Success also depends upon education, protection and pro-action at local and government level too, because *in situ* wildlife conservation cannot happen without these. Therefore consensus and information sharing between collections and outside zoos is essential to engage, educate and ultimately earn the support of local communities and national governments. Within zoos, management of captive populations, especially if there are low numbers, is critical for long-term success. Genetic management and decisions based upon kinship are important but Lynch and Snyder (2014) detail a means of managing relatively short-lived species by subdividing the zoo populations into two groups — a core breeding population resident in a small number of collections with dedicated, off-show facilities, and a larger non-core breeding population of individuals kept in a larger number of institutions in smaller numbers. There is a mechanism for the transfer of birds between these two populations depending upon necessity, as well as the option to supply other collections with surplus birds for display only. King and Bračko (2014) suggest intelligent management of collections with flamingos by encouraging collections to hold only single species but with more individuals to encourage breeding and, for those zoos with few flamingos, to offer them to appropriate larger collections for the greater good. Taronga Zoo has worked with local schools as part of their Regent honeyeater programme (Liu *et al* 2014), while, in their efforts to reintroduce scarlet macaws, Riagoza Figueras (2014) details connections with universities, private breeding centres and government institutions.

One potentially controversial arm of conservation is that of private individuals. Such breeders can be highly beneficial, often specialising in a single species or genus and able to devote time and resources that public institutions may find difficult to match (see Boegerts *et al* 2012) yet these same breeders may be unregulated and profit-motivated. However, the commercial production of significant numbers of captive-bred, highly sought-after species can take the pressure off wild collecting, a point noted by Owen *et al* (2014)with the local commercial production of black-winged starlings by the private breeders of Klaten.

Shave *et al* (2014) detail the necessary protocols for the systematic assessment of Great Ape hearts by ultrasound. The echocardiographic assessment and presentation of some normal cardiac values given here provide the basic building blocks to quantify detected abnormalities, the first steps in the diagnosis and treatment of heart disease in western lowland gorillas, chimpanzees and bonobos. Western lowland gorillas also feature in Vermeer *et al* (2014) who present an upbeat assessment of the European Endangered Species Programme (EEP). Close monitoring and management of much of the global captive western lowland gorillas has to date resulted in an increased, genetically diverse population. The warm fuzzy glow this gives one at the thought of this charismatic species is tempered somewhat by the problems that this situation can bring — notably the excess of males, an inevitable consequence of successful breeding of a harem-maintained species. Various ways of managing this including the restriction of females to a maximum of three per male (thereby increasing the number of males in breeding situations), castration and even euthanasia are discussed candidly. Very few males have been castrated but their welfare is closely followed and it seems that they can be accepted into breeding groups and play a social role within that group which reciprocally fulfils the social and psychological needs of those individuals too.

So, there you have it — an overview of the jigsaw, or perhaps more accurately the Rubik's cube of principles, practices and protocols that are needed in place to achieve modern conservation, exemplified by the avian situation but

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complemented by the primate papers. But it does not stop with conservation because central to it all are the individual animals that need to be in good health — both physically and psychologically— and so it follows that to achieve these aims one needs good welfare, and addressing and raising animal welfare standards runs as a golden thread throughout the whole of Volume 48.

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