Cambridge University Press
0521812151 - Reproductive Science and Integrated Conservation
Edited by William V. Holt, Amanda R. Pickard, John C. Rodger and David E. Wildt
Excerpt
More information

PART I

Introduction

1

Toward more effective reproductive science for conservation

DAVID E. WILDT, SUSIE ELLIS, DONALD JANSSEN AND JENNIFER BUFF

INTRODUCTION

Reproduction is the foundation on which a species survives, thrives or, failing this, becomes extinct. Therefore, the study of reproduction is fundamental to conserving species, populations and, indirectly, the vitality of entire ecosystems. Historically, reproductive biology research has been directed at easy-to-study domesticated livestock, laboratory animals and humans. The general approach has been one of scholarly, systematic studies that emphasised understanding mechanisms, sometimes seemingly arcane information that had (or did not have) practical application (e.g. making livestock more reproductively efficient or combating human infertility).

Reproductive biologists involved with wildlife also conduct scholarly research, often in a challenging environment. These explorers are hampered by limited resources and the practical difficulties of accessing rare, intractable and sometimes dangerous study specimens. Nonetheless, there has been progress in the study of the reproductive biology of wildlife, including endangered species. Perhaps the most important lesson learned during the past quarter-century has been that species vary remarkably – and wondrously – in precisely how they reproduce. The mechanisms that regulate reproductive success in the cow are quite different from those that control reproduction in the elephant, dolphin, snake, shark, parrot or frog. This reproductive machinery varies significantly even within families, species positioned in the same branches of the evolutionary tree (Wildt *et al.*, 1992, 1995). Therefore, for example, mechanisms controlling reproduction in the cheetah are likely to be different from those of a lion or snow leopard.

Understanding these species-specific strategies has become a top priority. The resulting discoveries provide intellectual capital that has practical value for monitoring, enhancing or controlling reproduction.

There is a perception problem about reproductive biology – the discipline is poorly understood by colleagues in the wildlife community. Reproduction is not even listed under 'topics of interest' in major journals devoted to biodiversity conservation (see, for example, publication guidelines for the journals *Conservation Biology* and *Animal Conservation*). One reason for such benign disregard is that reproductive scientists are often seen as enamoured with using 'high-tech' assisted breeding methods (artificial insemination, *in vitro* fertilisation, embryo transfer and even cloning). Conservation biologists traditionally have eschewed techno-fixes, fearing that reproductive technologies could divert funds from protecting habitat while giving a false sense of security that species on the brink of extinction could be easily resurrected (Wildt & Wemmer, 1999). We have presented alternative arguments in other venues showing how assisted breeding has contributed to species conservation, including *in situ* (Howard *et al.*, Chapter 16; Wildt *et al.*, 1997; Wildt & Wemmer, 1999).

The point remains – there is a need to change the way that reproductive biology is perceived so that the discipline provides more mainstream contributions to conserving threatened species. A commonsense first step is redefining 'reproductive biology' under the umbrella 'reproductive sciences'. This more inclusive and accurate descriptor embraces any and all skills required to address priorities for understanding, monitoring, enhancing or controlling reproduction. Historically, reproductive biologists have been sub-disciplinarians within animal behaviour, physiology and endocrinology. But ecologists, population biologists, geneticists, nutritionists, veterinarians and animal scientists have long studied reproductive patterns, performance and fitness. It is logical to develop a way of thinking that merges related disciplines to understand more clearly the factors that regulate reproductive success, a cornerstone of species management.

However, semantic change is a small step compared to the need to leap into larger and more coordinated research efforts for all threatened wildlife species. The general aim of this chapter is to discuss how the reproductive sciences can play a more valued role in conservation. We begin by introducing and advocating integrative research, cooperative multidisciplinary studies that can more efficiently address wildlife management problems. Our second objective is to provide evidence on the woeful amount of reproductive research accorded virtually all wildlife species on earth. The chapter concludes by exploring how the essence of the discipline, sex, is a provocative subject that gives rise to public curiosity. This inherent interest is not being exploited, and we cite our experience in using reproductive science stories to inspire and educate children, the next generation of conservationists.

REPRODUCTIVE SCIENCES IN AN INTEGRATIVE APPROACH

Uni-disciplinary to multidisciplinary

Scientists are highly trained specialists, many being experts in a defined sub-field (e.g. dominance behaviour, sperm function, ovarian–endocrine relationships) who focus on a single species (Figure 1.1*a*). This approach is the hallmark of academic research, inevitably resulting in fundamental knowledge. However, this 'uni-disciplinary' strategy applied to wildlife can have minimal practical impact on conservation. This is because conservation can be likened to a complex jigsaw puzzle where the puzzle pieces are issues, stakeholders or scientific disciplines themselves (Figure 1.2). It is unlikely that any single discipline (e.g. reproductive physiology, genetics, nutrition) could be the sole key to solving a particular conservation puzzle. However, assembling additional pieces (more disciplines to generate more knowledge) substantially increases the chances of solving the puzzle. Thus, a more 'conservation-effective' model can be represented by the scientist with specific tools and skills focused on a given species, but now in parallel and partnership with others (Figure 1.1*b*). These partners represent diverse stakeholders in the life sciences, as well as sociologists, economists, demographers and wildlife/habitat managers themselves. Multidisciplinary partnerships will be key to more efficient problem solving in conservation.

An integrative case study, the giant panda

The giant panda, a carnivore that eats bamboo, has been the object of fascination for centuries. An early descendant from the line leading to more modern ursids, the giant panda once thrived in nature. However, due to habitat erosion, there are now fewer than 1200 wild giant pandas restricted to the mountainous bamboo forests of the Sichuan, Gansu and Shaanxi provinces of China. The wild population also is compromised by its scattered demography among 32 fragmented reserves with no corridors to allow genetic exchange. The national protection programme is under-funded, and there are enormous needs for community development, education, reserve

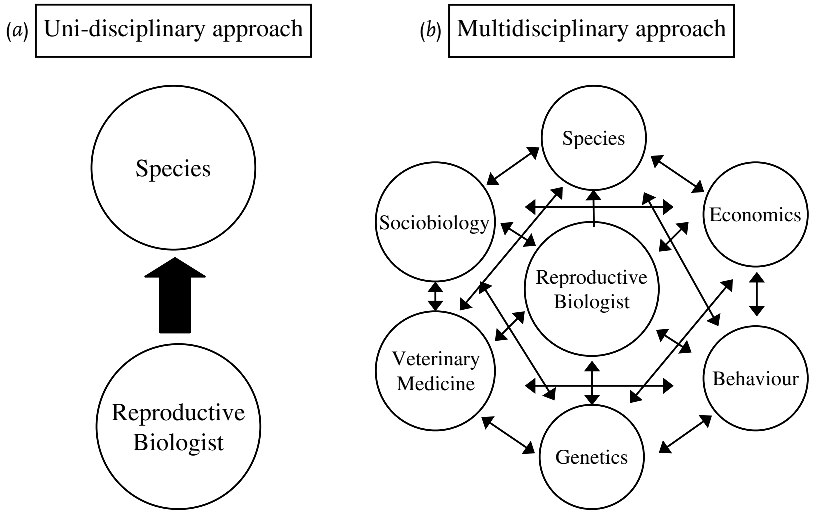


Figure 1.1 The 'uni-disciplinary' (*a*) versus the 'multidisciplinary' (*b*) model of conducting wildlife research for conservation.

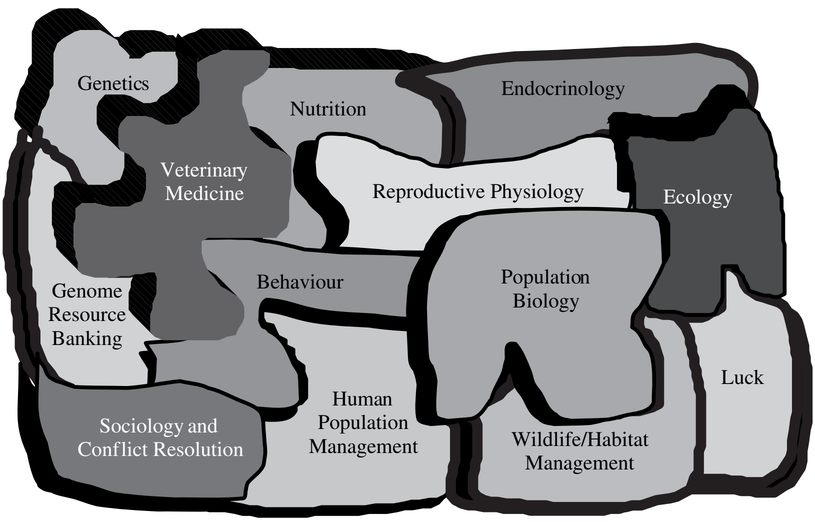


Figure 1.2 Conservation as a jigsaw puzzle where there are many 'pieces' including scientific disciplines, management, social processes and luck.

infrastructure (roads and buildings) and skilled staff to monitor habitat and prevent poaching.

The unstable status of wild giant pandas has provoked special interest in the *ex situ* management programme within China. Giant pandas in captivity provide some assurance that there is a hedge against potential extinction. This population also is a valuable source of new biological information from research and for educating the public about the precarious status of wild counterparts.

There are two independent *ex situ* panda populations within China, one under the authority of the State Forestry Administration (SFA, also responsible for pandas living in nature) and the other managed by the Chinese Association of Zoological Gardens (CAZG, under the Chinese Ministry of Construction or MoC). Because SFA and MoC have been placed in the position of competing for funding from the central government, communication and cooperation have been minimal. Nonetheless, both agencies have had serious concerns about the viability of the *ex situ* giant panda population. Substantial governmental funding has been allocated to zoos and breeding centres to develop a self-sustaining population that would eliminate the need ever to remove more pandas from nature. However, until recently, successful reproduction in giant pandas *ex situ* has been inconsistent.

In 1996, the CAZG requested advice from the Conservation Breeding Specialist Group (CBSG), a non-governmental organisation operating under the IUCN–World Conservation Union's Species Survival Commission. CBSG is renowned for its ability to assist in developing recovery plans for endangered species: as a neutral facilitator, it catalyses change, builds communication and encourages partnerships. Its effectiveness is amplified by a network of more than 800 members world-wide who volunteer expertise to assist in projects. As the result of the CAZG invitation, CBSG facilitated an *Ex Situ* Management Planning Workshop for Giant Pandas in Chengdu in 1996 attended by more than 50 Chinese specialists. CBSG's advisory team comprised five Western scientists. Working together, participants created a plan for managing the *ex situ* population (Zheng *et al.*, 1997). Action-based recommendations emerged during the week that would begin to address the observations of poor reproduction and health problems in all age classes. The most significant recommendation was for a Biomedical Survey of the extant population. The reasoning was simple: developing a self-sustaining population would require maximising the use of the healthy, reproductively fit individuals, which then could be intensively managed to retain existing genetic diversity. This could only be achieved if the health and reproductive status of the existing population was first known.

Biomedical Survey of giant pandas

CBSG was invited to organise and implement the Survey. This facilitated stakeholder buy-in and cooperation because, under the authority of the IUCN–World Conservation Union, CBSG was seen as neutral with no agenda other than to ensure excellent science. The Survey was conducted during the pre-breeding/breeding season (February/March) in 1998, 1999 and 2000 (Zhang *et al.*, 2000). Over this interval, the CBSG–USA team consisted of 20 specialists from seven institutions who represented the disciplines of veterinary medicine, reproductive physiology, endocrinology, animal behaviour, genetics, nutrition and pathology. This group was complemented by more than 50 Chinese counterpart specialists from MoC and SFA organisations. There was strong political support from the Chinese government, and the USA zoo community provided funding with equipment donations from corporations.

The overall objective was to thoroughly examine as many pandas as possible in order to identify the factors that limited reproductive success. Remediation then would allow the population to become self-sustaining. Teams worked together to collect and interpret data. Sixty-one animals were anaesthetised and subjected to an intensive medical examination that included multiple procedures for massive data collection (Table 1.1). Each animal was categorised according to the teams' consensus on its value to the future of the *ex situ* population. Seventy-eight per cent of the population appeared healthy and reproductively sound whereas 22% were compromised, some severely (Figure 1.3).

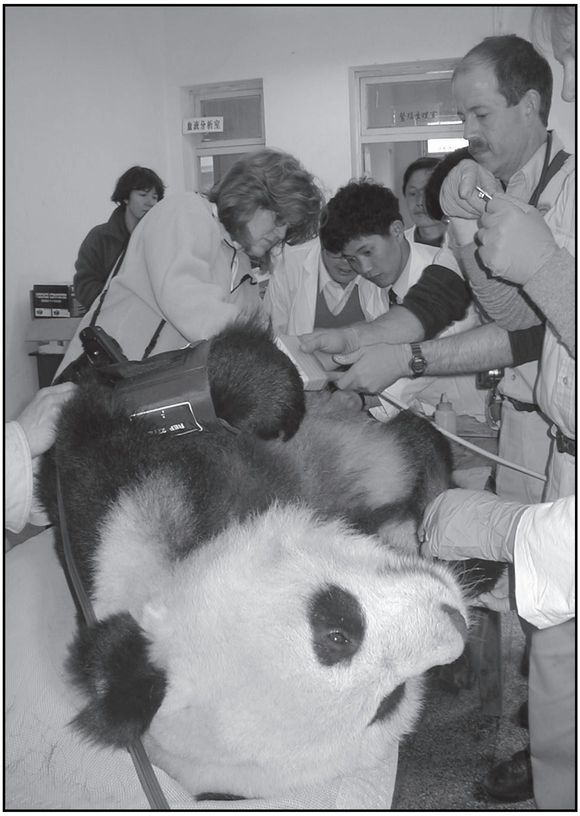
Limits to giant panda reproduction

Six factors were identified as limiting reproductive success: (1) behavioural incompatibility between males and females introduced for mating (primarily expressed by excessive male aggression); (2) many individuals with unknown paternity (following the common practice of natural mating with a single breeder male combined with simultaneous artificial insemination with sperm from a non-breeding, under-represented male); (3) genetic over-representation by certain individuals (reflected by a few individuals always producing offspring, causing disproportionately high distribution of 'common' genes); (4) suboptimal nutrition (a consequence of the feeding of a high protein, palatable concentrate that reduced bamboo and, thus, fibre intake; (5) stunted growth syndrome (whereby 9.8% of individuals were abnormally small in stature and experienced multiple medical complications), and (6) testicular hypoplasia or atrophy (as indicated by a unilateral small

Cambridge University Press
0521812151 - Reproductive Science and Integrated Conservation
Edited by William V. Holt, Amanda R. Pickard, John C. Rodger and David E. Wildt
Excerpt
More information

Table 1.1 *Technical procedures applied to giant pandas ($n = 61$) in the Biomedical Survey.*

Histories (breeding/behaviour/pedigree)
Anaesthesia/monitoring
Physical examination (including ultrasound)
Body morphometrics
Blood sampling/analysis
Tissue sampling
Transponder/tattoo
Urine analysis
Parasite check
Diet evaluation
Semen evaluation
Laparoscopy



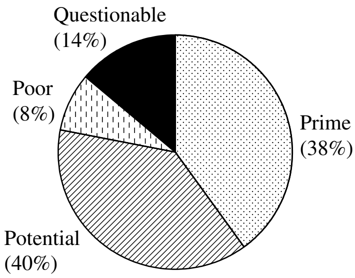


Figure 1.3 Giant pandas ($n = 61$) were objectively categorised as prime breeders, potential breeders (healthy, but prepubertal), questionable breeding prospects and poor breeding prospects.

testis). Isolated medical conditions were also identified, ranging from simple vaginal/cervical infections to untreatable squamous cell carcinoma.

Our multidisciplinary approach was key to revealing that no one variable was impeding reproductive fitness in giant pandas. Rather, failures appeared to be the culmination of multiple, linked factors (e.g. poor nutrition leading to compromised health that directly, or indirectly, decreased reproduction or offspring survivorship). Without the disciplinary collaboration, some causes and interactions would have gone undiscovered. In some cases, remediation was simple. Reproductive tract infections were treated with antibiotics that allowed some previously non-reproductive females to produce offspring. Others, such as modifying diet and sorting out paternities, were more complex and detailed systematic studies are in progress. Regardless, the point is that the Survey has provided the blueprint for continued action.

Another dividend of the project was the opportunity to conduct more basic research. For example, a by-product of male fertility evaluations was 'surplus' semen available for investigating the sensitivity of panda sperm to cooling and cryopreservation. New semen handling protocols emerged that have been useful for improving artificial insemination. One practical benefit was the production of a surviving cub from a wild-born, under-represented male with a lethal squamous cell carcinoma. Up to this time, such an individual would have died, its genes unrepresented in future generations. Artificial insemination will continue to be important for genetic management, including circumventing sexual incompatibility problems as well as moving genetic material among breeding centres and from *in situ* to *ex situ*.

Other project benefits

Close partnerships that developed in the intensive working milieu (over anaesthetised animals) inspired trust between Chinese and American scientists. Chinese colleagues became comfortable with proposing the need for training courses. A veterinary workshop was held in Chengdu in 1999 that involved the training of 49 veterinarians from 27 Chinese institutions in veterinary diagnostics, anaesthesia, pathology and nutrition. Trainers included Western and Chinese specialists who had participated in the Biomedical Survey. Similar requests for capacity building have emanated from a CBSG facilitated workshop in 1999 on Conservation Assessment and Research Techniques conducted at the invitation of SFA (Yan *et al.*, 2000). The focus here was on the status of giant pandas in nature and research methods that could enhance the accurate monitoring of wild pandas while eventually linking *ex situ* and *in situ* populations. Again training emerged as a priority, especially in (1) remote sensing and geographical information systems (to assess habitat quality), (2) radiotelemetry (to track panda movements in nature) and (3) non-invasive DNA assessment (to identify individuals via molecular assessments of DNA extracted from faecal samples).

This project that began with a simple request from Chinese colleagues for information exchange has resulted in a remarkable cascade of (1) new biological data, (2) enhanced management practices and (3) capacity building. The project also illustrates the value of integrative, multidisciplinary research. Whether this is an 'ideal' model, to be touted for the future, is debatable. The charismatic giant panda is of inordinate interest so its high profile eased the way for the required approvals and funding. It may be more difficult to stimulate enthusiasm and to secure grants for less exciting species that may be as rare or even more ecologically important than the giant panda. Finally, there was widespread interest in participation by many USA specialists, thereby allowing the best scientists as well as those most likely to be team players to be selected. Not all multidisciplinary projects would have the luxury of unlimited numbers of eager scientists.

However, there were other project traits that should be considered in formulating similar studies in the future. Clearly, organising multiple institutions under a neutral entity like CBSG avoided the perception that any