David Wildt's Evolving Ethics Concerning the Roles of Wildlife Reproductive Sciences in Species Conservation [1]

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David Wildt [4] is an animal reproductive biologist who directs the Conservation Biology Institute in Fort Royal, Virginia. In 1986, Wildt argued that artificial reproductive technologies should only be used for species conservation efforts if standard techniques to aid natural reproduction are not effective. Between 1986 and 2001, Wildt revised his views and values primarily in relation to two things: which methods captive breeding programs ought to use, and how reproductive scientists ought to contribute to the larger work of conservation. His arguments became institutionalized in varying species conservation organizations such as the Smithsonian National Zoological Park [5] in Washington, DC, the International Union for Conservation of Nature's Captive Breeding Specialist Group, and the United States Fish and Wildlife Service, headquartered in Washington, DC.

Wildt developed an experimental approach to species conservation. He worked to navigate the value-laden decisions that reproductive conservationists grapple with, in contrast to those who take a more traditional preservationist and nonexperimental approach to species conservation. Wildt based his ethical arguments in part on the conservation biology positions put forth by biologist Michael Soulé, who worked at the University of Michigan [6] in Ann Arbor, Michigan. In his 1985 publication "What is Conservation Biology?" Soulé linked functional and ethical principles of biodiversity to help produce a research and value framework for conservation biology. Soulé said that different people require different kinds of motivations, so he appealed to various values to encourage environmental conservation. He recounted civilization's dependence on, and unprecedented destruction of, nature as an example of society's reliance on the instrumental values of nature. Soulé argued that biodiversity has an inherent value or right to exist on its own, regardless of its instrumental value for people. For Soulé and Wildt, effective species conservation is ethically obligatory. Wildt developed scientific methods to aid the recovery of threatened species. He also articulated views about how assisted reproductive technologies (ART) ought to be used, and how reproductive scientists ought to work on behalf of the larger context of conserving species in their habitat.

Wildt developed and applied ARTs to endangered species since the late 1970s. He researched domestic and livestock species at the Houston Zoo [7] in Houston, Texas, from 1978 to 1980, and at the US National Institutes of Health [8] (NIH) in Bethesda, Maryland, from 1980 to 1983. Wildt later recalled that his research interests shifted towards wildlife during his time at NIH, reflected in his domestic cat and cheetah experiments from 1978 to 1983. In 1983 the Smithsonian Institution in Washington, DC, hired Wildt to develop and direct various departments of the zoo, such as the Department of Reproductive Sciences and the Conservation Biology Institute.

In Wildt's 2001 paper "Linkage of Reproductive Sciences: From 'Quick Fix' to 'Integrated' Conservation," he described how his research at the Smithsonian developed through four phases. The first he called the quick fix approach, which aimed to increase population numbers of threatened species by any means available. In Wildt's experience, this approach resulted in failed attempts to adapt ARTs for livestock to wildlife. He said that when he realized that each species' reproductive systems are evolutionarily specialized, he transitioned to a second phase, which he called species-specific research.

Next, Wildt's research extended beyond captive breeding programs. According to Wildt, the counterparts of captive populations living in nature must benefit from research for conservation to be effective. Wildt termed this stage the applicability stage of his reproductive research. The last step of his research evolution [9] was integration, where reproductive science is just one vital disciplinary player in the concerted effort to conserve biodiversity. Wildt noted that collaboration across disciplines, in addition to application to both captive and wild populations, was key to conservation success. He argued that conservationists must take into account animal welfare, political science, and other dimensions that influence the stability of a healthy species.

A comparison of Wildt's four research phases with the two major themes of his ethical argument reveals the changes in Wildt's views and values on which methods captive breeding programs ought to use, and about how reproductive sciences ought to contribute to the larger work of species conservation. Every time Wildt changed his research focus, his ethics similarly evolved.

In late 1980s, Wildt was the main author of "Developing Animal Model Systems for Embryo Technologies in Rare and..."
Endangered Wildlife," and "Reproductive Research in Conservation Biology: Priorities and Avenues for Support." Within these two articles, Wildt proposed that if improved standard approaches available to reproductive scientists, such as animal husbandry informed by field observations of how animals breed, were not enough to improve propagation rates for threatened species bred in captivity, then—and only then—should researchers consider alternative and artificial reproduction methods. Wildt claimed that most threatened species would be bred in captivity before the end of the twenty-first century due to rapid rates of extinction driven by human-caused habitat change. He said that the more traditional species conservation approach of habitat preservation looked unrealistic, and he urged scientists to research alternative reproduction strategies.

This stage of Wildt's career focused on captive breeding through the use of ARTs. He said that the inevitable captive breeding of most threatened species would be done through the use of \textit{artificial insemination} (AI), \textit{embryo transfer} (ET), and \textit{in vitro fertilization} (IVF). Researchers would use these reproductive procedures with the global transportation of cryopreserved gametes and other genetic material, and individual animals' viabilities for reproduction would be evaluated by non-invasively monitoring endocrine activity. Wildt said that researchers could use AI, ET and IVF to increase propagation rates for captive breeding programs, and they could refine also genetic material for cryopreservation and endocrine monitoring methods to increase the likelihood of success for AI, ET and IVF. In other words, reproductive conservationists could more rapidly improve threatened species population numbers and genetic health through these alternative reproduction strategies.

Wildt's views changed in the early 1990s, as marked by his 1992 "Embryogenesis in Conservation Biology—Or, How to Make an Endangered Species Embryo." Wildt had predicted in 1986 that assisted reproduction methods would be routine before the end of the twenty-first century, but in 1992, he stated that they would be routine within a decade. Additionally, his research shifted towards a focus on accumulating species-specific reproductive data in relation to the repertoire of ARTs then available. The scientific value of discovering species' reproductive patterns led Wildt to favor IVF over AI because IVF allows for sperm and ova to be studied independently and then together, whereas AI more simply deposits the sperm inside the female's reproductive tract. Additionally, systematic embryo transfers provide data for when a female of a particular species can and cannot successfully receive the transferred embryo to yield insight into reproductive cycles.

Wildt acknowledged that such experimental approaches to animal reproduction had made little practical progress in species conservation by the early 1990s. They had low \textit{pregnancy} success rates and even lower healthy offspring production success rates. Wildt defended his assisted reproductive strategies from these criticisms by arguing that the reality of conservation is a continual and incremental process of collecting, assimilating, and disseminating knowledge. He argued that in the early 1990s, wildlife reproductive sciences were on the verge of practical contributions for a few species. But, according to Wildt, it was more important that the systematic science revealed previously unknown mechanisms of reproduction.

Wildt's research focus transitioned from species-specificity to applicability in the mid-1990s, reflected in his 1997 publication, "Genome Resource Banks: Living Collections for Biodiversity Conservation." For Wildt, the value of scientific novelty lost priority to the value of success and ease of use as the determining factor for ranking the different ARTs. In other words, application became more important than discovery. Wildt compared and contrasted AI with ET and IVF, and he concluded that the simplicity of AI was a significant benefit for application in captivity and in the wild. The more complicated and expensive aspects of ET and IVF detracted from, but do not remove, their value for the conservation of endangered species.

Additionally, Wildt argued that ARTs could have increased value by developing a system for indefinite storage of genetic material for current and future applications. He noted that cryopreserving biological samples of gametes, embryos, and even stem cells in resource banks could increase the number of artificial reproduction options for species that might otherwise be faced with the deleterious effects of having too small of a gene pool.

Wildt provided three reasons why cryopreservation of genetic material could help researchers manage fragmented populations. First, the cost of transporting cryopreserved genes was significantly less than the cost of transporting whole animals. Second, transporting an animal often harms the animal, and the process of collecting genetic from an animal was a significantly less harmful alternative. Third, Wildt said that organisms from threatened species should remain in their natural habitats because of the ecological roles the species may play in maintaining the integrity of those habitats. Furthermore, researchers gained an additional value from storage of cryopreserved genetic material in resource banks, because the availability of that genetic material enabled breeding strategies that could otherwise be lost when dealing with, for example, a critically endangered species.

Wildt claimed that resource banks would never replace conventional conservation approaches, such as habitat protection. The complexity of conservation required multidisciplinary work to increase the likelihood that biodiversity could be conserved. The beginning of Wildt's integrated research phase began to appear.

In 1999, Wildt published "Sex and Wildlife: The Role of Reproductive Science in Conservation." Wildt criticized wildlife reproductive biology for developing into a specialized field focused on highly technological solutions for breeding problems in
captive threatened species. By his account, the assisted reproductive technologies of AI, ET, and IVF had dominated the discussion at the price of forgetting the value of field observation and assisting natural reproduction. Wildt had earlier argued that if improved standard approaches, such as animal husbandry informed by field observation, were not enough to improve propagation rates for threatened species, then and only then should alternative and artificial reproduction approaches be explored. According to Wildt, researchers had inadequately observed animal behavior in the wild and then mimicked it in captivity, or monitored endocrine activity to determine mating times. Wildlife reproductive biologists in zoos had mostly dismissed standard techniques for natural reproduction before artificial breeding techniques.

In Wildt's 2001 paper, "Linkage of Reproductive Sciences: From 'Quick Fix' to 'Integrated' Conservation," he continued to describe two harms that artificial breeding had on species conservation. First, he said that merely breeding a species in captivity is not itself conservation, and that threatened species ought to be bred in captivity to stabilize and contribute to the species' population as a whole, especially those in habitat preserves. Second, standard ARTs required more improvement to become more widespread in wildlife breeding. Integrated conservation, according to Wildt, required that disciplinary experts from veterinary medicine, nutrition, animal behavior, physiology, endocrinology, wildlife management, and political science participate in conserving species. Species conservation required more than breeding, and successful species conservation should be a collaborative and multidisciplinary effort. Earlier in his career, Wildt had indicated otherwise.

The technologies available for species conservation changed, too. In the wake of the first successful cloning of a gaur in 2001, cloning became a part of the repertoire of wildlife reproductive technologies. Given Wildt's evolving positions, he said that cloning was of little immediate relevance due to its high cost, low success rate, and the fact that it produces genetic clones. A tenet of species conservation is genetic diversity and health, and cloning produces genetically less diverse animals.

According to Wildt, wildlife reproductive science was a single piece of an integrated strategy to conserve endangered and threatened species. Captive conservation should use all sciences that help researchers understand the whole animal, the whole species, and the social pressures driving declines in populations. If artificial breeding is necessary, researchers should first pursue artificial insemination due to its success rate, ease, and genetic value over IVF, ET, and cloning. Wildt maintained his claims that people should conserve threatened species for moral reasons, and that wildlife reproductive science ought to inform the use of species conservation techniques.

Sources

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