25 Cloning in Restorative Perspective

Eileen Crist

Where does all this work [on cloning] fit into the agenda of ecological restorationists? Obviously, if cloning of rare and endangered animals ever becomes commonplace restorationists will be called upon to provide suitable habitats for their long-term well-being.

—Dave Egan, Society for Ecological Restoration International

Even as conservationists remain wary of the approach that cloning represents, the potential of cloning for conservation is receiving increasing attention in scientific circles and the public.[1] Can cloning be used to rescue species or bring back extinct animals? If the answer is potentially affirmative, doesn't the technology merit the involvement of conservation scientists and restoration ecologists? I argue that despite its limitations cloning represents a tenable conservation tool, especially one that can be prepared for by preserving cell-lines of endangered species for future efforts. If undertaken in conservation contexts, and with the interests of the animals and their habitats in mind, cloning species that people have extinguished or decimated can be a justifiable strategy.

Does cloning extinct and endangered animals have the potential to substantively redress biodiversity losses? The answer is a resounding no: when all facets of present-day biodepletion are tallied—mass extinction, unrecoverable losses of species, subspecies, and genetic variation, destruction of ecosystems, and habitat fragmentation—it becomes clear that the implementation of cloning technology is largely inconsequential. A more reasonable question to pose is whether cloning can make a limited contribution to restoration efforts. I offer cautious support for using cloning in conservation practice—for there are compelling reasons to be suspicious of cutting-edge technologies as proffered solutions to the destruction of biodiversity. Before discussing why I support cloning as a limited but potentially effective tool, I briefly summarize the most powerful criticisms of why it is irrelevant or even detrimental to restoration efforts.

Conservationists tend to be suspicious of this still-experimental technology for at least five reasons. First, the biodiversity crisis is too multi-dimensional for any purported technological solution; even focusing on extinction alone, it is happening at a magnitude and rate that only a profound change

in the relationship between humanity and the natural world can turn things around.[2] Second, protecting landscapes and their interconnectivity constitutes the soundest approach to sustaining species, populations, ecosystems, biological processes, behavioral patterns, and genetic variability; cloning can amount to a distraction from the scientific principles of, and appropriate investment in, conservation efforts.[3] Third, high-tech approaches to ecological problems reinforce the conceit that technological solutions or replacements can atone for the damage inflicted on the natural world; to turn to a technological fix—especially one as chock-full of hubris as creating life by manipulating cells across organisms and species—is redolent with folly.[4] Fourth, cloning harbors the peril of fostering false security in the public by encouraging the illusion that science can fix extinction after the fact;[5] indeed, cloning endangered or extinct animals is often reported under grossly misleading but catchy "end of extinction" headlines. Last but not least, cloning for conservation encourages more interference with, and management of, wild nature, promotes the further erasure between the natural (wild) and the artificial (man-made), and may risk unintended consequences.[6] To top off these grievances, cloning endeavors are unreliable—resembling experiments that "evolve haphazardly" in Quammen's apt words;[7] such experiments often involve animal suffering, which argues for postponing applications of the technology.

These are compelling concerns that any argument favoring the use of cloning must grapple with. But well-founded and thoughtful critiques of technological approaches to biodiversity conservation and restoration efforts leave unaddressed the urgency of the problem of losses—and the need to employ every possible countermeasure, including high-tech options. If the technology can be considered as a limited tool (all the more so today when it is by no means a routine procedure), conservation- and restoration-minded communities might begin to scrutinize its potential utility, rather than dismissing it *tout court* for its shortcomings.

Many animals have already been cloned for a variety of purposes—mostly domestic and laboratory animals, like goats, cattle, pigs, mice, and cats among others. Because of the fascination exerted by this relatively novel development in biotechnology, we are likely to see more cloning, of both domestic and wild animals, down the pike. If high-profile publicity is a gauge, the proposal to clone extinct and endangered animals enjoys great popularity. Developments in this arena have been a mixed bag of success, failure, wishful thinking, future potential, and dubious motivation—but all bring home one point: that efforts to clone endangered and extinct species, for better or worse, are already with us and unlikely to go away.

The first endangered animal to be cloned, an Asian wild cow known as the Gaur, died within two days of birth. His death was not a setback for long. The European mufflon, an endangered Mediterranean wild sheep, was cloned a year later in Italy. Two clones of the Banteng, another endangered Asian wild cow, were created from cell-lines stored in the 1980s in the

San Diego Zoo; one of these animals survived and is a denizen of the zoo. There have been steps in the direction of cloning the Panda and the Asian Cheetah, but technical difficulties, political obstacles, and controversy have thwarted both endeavors to date. The Bucardo or Spanish Ibex, gone since 2000, may turn out to be the first extinct subspecies cloned from frozen tissue. The project to clone the extinct Thylacine (also known as Tasmanian Tiger and Tasmanian Wolf), from an alcohol-preserved specimen dating to 1866, was initiated in 1999 but quietly abandoned in 2005 as unfeasible (at least for the time being). South Korean scientist Hwang Woo-suk, internationally disgraced for fraudulent research on human embryonic stem cells, recently confessed buying "Mammoth" tissue samples from the Russian mafia and attempting to clone the Mammoth. One of the latest cases to appear in press involves Vietnam's antelope-resembling Saola—among the few mammals discovered in the twentieth century. The species found just ten years ago is already threatened with extinction, and, unable to breed the animals in captivity, some scientists want to clone them—indeed, have already unsuccessfully tried.

Both challenge and necessity in the domain of cloning endangered and extinct animals is applying the technology of "cross-species nuclear transfer" (or simply "cross-species cloning"). Opting for cross-species cloning—in which non-endangered species bear the brunt of the procedure—stems from self-evident objections to subjecting endangered animals to invasive procedures. Easily accessible cells of an endangered animal are used (for example, skin cells), the genome-bearing nucleus from such cells is extracted, and then the nucleus (or sometimes the whole cell) is injected into the enucleated egg-cell of a closely related, non-endangered species. From this chimera an embryo is coaxed into formation, which is then implanted into the womb of the surrogate, non-endangered animal.[8]

Cloning requires living cells, which is why the resurrection of extinct animals has proved elusive. But the application of the technology to endangered species is feasible and, as noted, already underway. The conservation rationale is to help prevent their extinction by boosting the numbers of animals (also an aim of captive propagation) and by maintaining their extant genetic diversity. Cloning of course cannot add genetic diversity, but by preserving cell-lines from as many animals of an endangered species as possible, its existing genetic variability can be placed in reserve for a future time. Should the numbers of an endangered species continue to decline, at least their present genetic profile (compromised though it already is) might be recovered. If such a species became extinct despite efforts to save it, freeze-preserved tissues might provide a fighting chance to bring it back.

Scientists like Robert Lanza, Oliver Ryder, and William Holt, who support cloning for conservation, do not necessarily call for immediate cloning ventures but have instead staked a precautionary position. They argue for the systematic stocking of "frozen zoos" as living databases for small and declining populations.[9] As Robert Lanza stated in an interview following the ill-fated cloning of the Gaur, "we wanted to send the message to the conservation groups that you should be protecting genetic diversity now. And although we still may not have the technology to do it efficiently, it is real. When an animal dies, all you have to do is freeze a few cells to preserve the genetics of the animal forever . . . Cloning is a tool to reintroduce genes that would otherwise be lost."[10]

Institutional action has paralleled such arguments, and recently gathered speed. In the United States, the Audubon Center for Research of Endangered Species (ACRES), the San Diego Zoo, and biotech company Advanced Cell Technology (ACT) have been at the forefront of preserving tissues of endangered species, and, to a limited extent, undertaking cloning experiments. The UK-based "Frozen Ark Project," inaugurated in 2004, involves the collaboration of numerous institutions world-wide—including the American Museum of Natural History, the San Diego Zoo, and the Laboratory for the Conservation of Endangered Species in Hyderabad, India—in building a global library for endangered animal cell-lines. The stated mission of The Frozen Ark is "to save DNA or frozen viable cells from endangered species before they go extinct. The DNA gives a vast amount of information about an animal's relationships, evolution, genetics, development, diseases, and ecology. If we act now we can rescue this information, or even the animals themselves. If not, there are no such hopes." While nowhere on its website does the organization explicitly advocate cloning—that possibility is clearly and intrinsically part of its enterprise.

Publications and interviews of scientists involved in cloning often reveal motives that are closely aligned with those of conservationists. And yet when it comes to cloning endangered and extinct animals, there is a dogged disconnect between reproductive biologists who undertake the experiments and conservation scientists who bear witness to the results. "Some conservation biologists have been slow to recognize the benefits of basic assisted reproduction strategies, such as in vitro fertilization, and have been hesitant to consider cloning," maintain Lanza and his colleagues.[11] Deep-seated distrust of high-tech solutions to ecological degradation understandably endures among the conservation-minded, who emphasize habitat "protection, management, and restoration" as the key for conserving species, as well as genetic diversity, ecological processes, and evolutionary potential.[12] Conservationists have consistently underscored that cloning is expensive, and that funds would better support conservation if they were funneled into habitat procurement and protection.[13] But cloning advocates have countered that a different type of patron tends to finance biotech, without resources being diverted from habitat conservation. On this view, "the sources of funding would not necessarily compete."[14]

While habitat protection is the crucial ingredient for conserving biodiversity, the jury is still out on whether cloning might serve as a restoration tool—a new technological spin on captive breeding. With the participation of conservation scientists, questions regarding potential habitat, the fate of

cloned wild animals, and the reasoning for undertaking cloning projects (as well as the timing of such projects) would become prominent aspects of applying the technology to endangered or extinct species. Such cloning projects are not likely to be conceptualized and implemented for the benefit of the animals and their native habitats, as long as conservationists, ever-suspicious of hyperbolic biotech claims, hold cloning at arm's length. But by becoming actively involved, conservation scientists could steer cloning projects toward the goal of reintroducing animals to their available or restored habitats; indeed, as Dave Egan argues, cloning endeavors "may bring restoration [ecology] closer to its allied field of conservation biology."[15]

Without an explicit conservation intention and agenda, cloning extinct and endangered species will remain susceptible to experimentation for its own sake, or to the quest for the fame attending headline science. To serve the cause of conservation, the technology must be implemented in the context of a multidisciplinary effort in which cloning, itself, is an auxiliary part rather than the main event. Within a multidisciplinary team context all the pieces of the conservation puzzle, within which the assisted procreation of wild animals makes sense, can be addressed: habitat, behavior, reproduction, genetics, ecological interactions, and so on. A conservation paradigm must frame the cloning of endangered and extinct animals, if such projects are not to be driven by the ambitions of "boys with their toys" and "science for the sake of science," as the Director of the Tasmanian Conservation Trust wryly commented when questioned about the Thylacine cloning project.[16] Without a strong contingent of conservation scientists actively involved, cloned wild animals are far more likely to end up as displays in cages, human-created oddities of theme parks, or objects for advancing the careers of their makers.

Instead of highlighting the predictable contrast between the holistic approach of habitat conservation and the "laboratory gimmickry" of cloning,[17] conservationists might re-imagine cloning as a reproductive technology that can be leveraged to push for wild animal habitat. For example, tiger biologist Ullas Karanth dismisses the proposal of cloning tigers as "irrelevant," maintaining that "we are concerned about protecting habitats for them to live and not increasing their numbers."[18] What's more, he had nothing positive to say about the plan to clone the Asian Cheetah, given the absence of places for this critically endangered subspecies to live. While Karanth's denunciation of cloning endangered megafauna is well-founded—currently such projects seem more concerned with achieving a technical feat than genuinely serving the conservation of the species—an alternative tactic would be to press forward for Asian and Middle Eastern regions that might be ecologically restored for the reintroduction of the Asian Cheetah. Rather than denigrating cloning as glitzy, this same admittedly questionable feature can be exploited as opportunity for securing wilderness. In other words, cloning species that people have extinguished or decimated, and for which habitat can be restored and protected, can

be a justifiable restoration strategy if it is tactically exploited: to negotiate habitat availability and to fulfill the moral and ecological need for restoration—of rescuing animals thoughtlessly destroyed and returning them to their ecological niches.

As misleading as hype about cloning can be, it can be turned into an advantage if habitat stipulations are successfully hitched to such endeavors. Just as charismatic animals are useful for conservation purposes as "umbrella species," providing popular grounds for protecting entire biotic communities, so the glamour of cloning makes it potentially serviceable as an "umbrella technology" for negotiating the restoration of places in which animals (boosted in numbers or brought back through cloning) can live. If cloning could be implemented as part of a conservation plan, subject to efforts to secure wild living spaces, then there is arguably no reason that the technology should not merit the support of the conservation community.

Unlike ambitions to resurrect animals of previous eras (like the Mammoth), the cloning of endangered and extinct species of the Holocene is far more ecologically sound and viscerally appealing, "if only because we might be able to care for those beings by returning them to their former or restored habitats."[19] Cloning animals destroyed by people has found both popular and scientific support because it taps into the need for restoration—restoration in the double sense of restoring justice and restoring the land.[20] While clones of endangered species have yet to be reintroduced to the wild, as David Quammen makes a point of noting, this is not necessarily an indicator of how things should, or will, stand in the future—and all the more reason for conservationists to become involved.

In discussions of cloning, mammals get most of the attention. It is regularly forgotten that frogs were cloned decades before the first mammal.[21] The potential of cloning charismatic megafauna like the Thylacine, Asian Cheetah, or Panda inevitably gets plenty of media coverage, while the possibility of cloning endangered or extinct amphibians has yet to make a headline. Ironically, however, frogs might presently receive the greatest benefit from cloning.[22] Costa Rica's Golden Toad has become a poster story of anthropogenic extinction. It has taught us that species are not safe from human impact even in protected natural areas, and it has served to call attention to the dire repercussions of climate change for biodiversity.[23] Would it not have been a sound provision if cell-lines from the Golden Toad had been preserved? By extension—how could the banking of cell-lines from the world's frogs be regarded as anything other than a rational safeguard, best undertaken immediately?

A final point in favor of cloning technology is to suspend *our* judgments, and allow future people to assess its applications. In this regard, Sarah Burnette of the Audubon Nature Institute's Center for Research of Endangered Species (AICRES) raises a valid question: "What if 100 years from now people finally figure out how to save the habitats, but there are no animals? Cloning is part of the answer."[24] Environmental ethicist Jeffrey Yule makes

a cognate point: "If and when the human species gets to a point where the planet's many ecosystems have been restored sufficiently to support extinct species, it would be consistent with the tenets of conservation biology to consider restoring these species on a case-by-case basis."[25] However we reasonably censure cloning today—as technological fix or human artifact—we arguably owe future people to decide whether or not they want to use it.

As David Lowenthal reflects in this volume, "we cannot know what future generations may want, but we can anticipate what they may need to recover from some global calamity." Given humanity's incapacity to respond with needed alacrity to the biodiversity crisis—which in retrospect is bound to be seen as the main calamity of our time—the least we might do is step up the project of preserving cell-lines of endangered species from the whole animal kingdom: mammals, birds, reptiles, amphibians, insects, and so on. Future people might then decide for themselves between the better of the two "hyper-real" options—an Earth thinned of life or an Earth restored partially through cloning.

"With the cloning genie out of the bottle," in Egan's words, the cloning of endangered and extinct species will undoubtedly proceed apace. Is not restoration the appropriate rationale for such projects? Without an overarching conservation framework, the motives for cloning endangered and extinct animals are likely to remain nebulous, subject to political caprice, and driven by experimental curiosity or individual ambition. The fact that cloning is still in its infancy means that it should be approached with caution, if only for reasons of animal welfare.[26] At the same time, this early stage of cloning offers opportunity for conservation scientists to step into a forming picture, and help shape the ecological contexts within which cloning the extinct and endangered might be undertaken.

Any argument in favor of cloning must come to grips with the compelling concerns outlined in the beginning of this chapter. Endorsing the technology for conservation purposes must not be indiscriminate, nor vulnerable to grandiose, end-of-extinction illusions that a "technology-infatuated public" is often susceptible to.[27] And yet the specter of extinction provides abundant warrant for closely considering the potential usefulness of cloning, limited as it may be, rather than dismissing the technology as an untrustworthy technological fix. Human-driven extinction is spiritually and materially devastating; most measures to stop or reverse it are justified. Therefore if we lose species, have ourselves to blame, and cloning is the only way to bring them back—then let us use cloning by all means.

NOTES

1. See Cynthia Mills, "Second Chance," *Conservation in Practice* 7:4 (Oct.–Dec. 2006): 22–27.
2. E. O. Wilson, *The Creation: An Appeal to Save Life on Earth* (New York: Norton, 2006).

3. David Quammen, "Clone your Troubles Away: Dreaming at the Frontiers of Animal Husbandry," *Harper's* February 2005; David Ehrenfeld, *The Arrogance of Humanism* (New York: Oxford University Press, 1978).
4. Bill McKibben, *Enough: Staying Human in an Engineered Age* (New York: Henry Holt & Company, 2003); Gary Meffe, "Techno-Arrogance and Halfway Technologies: Salmon Hatcheries on the Pacific Coast of North America," *Conservation Biology* 6:3 (1992): 350–54.
5. David Ehrenfeld, "Transgenics and Vertebrate Cloning as Tools for Species Conservation," *Conservation Biology* 20:3 (2006): 723–32; Jeffrey Yule, "Cloning the Extinct: Restoration as Ecological Prostheses," *Common Ground* 1:2 (2002): 6–9.
6. Eric Katz, "Understanding Moral Limits in the Duality of Artifacts and Nature," *Ethics & the Environment* 7:1 (2002):138–45; Jack Turner, "The Wild and its New Enemies," in Ted Kerasote, ed., *Return of the Wild: The Future of our Natural Lands* (Wash., D.C.: Island Press, 2001).
7. Quammen, "Clone your Troubles Away."
8. Robert Lanza et al., "Cloning of an Endangered Species (*Bos gaurus*) Using Interspecies Nuclear Transfer," *Cloning* 2:2 (2000): 79–84; Sylvia Pagan Westphal, "Copy and Save," *New Scientist* (19 June 2004).
9. Oliver A. Ryder, "Cloning Advances and Challenges for Conservation," *Trends in Biotechnology* 20:6 (2002): 231–32; Oliver A. Ryder et al., "DNA Banks for Endangered Animal Species," *Science* 288:5464 (2000): 275–77, 2000.
10. Robert Lanza, "Second Chances: An Interview with Robert Lanza," *California Wild, The Magazine of the California Academy of Sciences* (Summer 2002).
11. Robert Lanza, Betsy Dresser, and Philip Damiani, "Cloning Noah's Ark," *Scientific American*, November 2000.
12. Ehrenfeld, "Transgenics and Vertebrate Cloning as Tools for Species Conservation;" Quammen "Clone your Troubles Away."
13. Sharon Begley, "Cloning the Endangered," *Newsweek*, 136:6 (16 October 2000): 56–57; Scott Weidensaul, "Raising the Dead," *Audubon* (May–June 2002): 58–66.
14. William V. Holt, Amanda R. Pickard, and Randall S. Prather, "Wildlife Conservation and Reproductive Cloning," *Reproduction, The Journal of the Society for Reproduction and Fertility* 127:3 (2004): 319.
15. Dave Egan, "Resurrection Ecology," *Ecological Restoration* 20:4 (2002): 237.
16. Quoted in Weidensaul, "Raising the Dead."
17. Quammen, "Clone your Troubles Away."
18. Interviewed in the *Deccan Herald*, www.deccanherald.com, October 3, 2005.
19. Egan, "Resurrection Ecology."
20. Eric Higgs, "What Is Good Ecological Restoration?," *Conservation Biology* 11:2 (1997): 338–48,; William R. Jordan III, *The Sunflower Forest: Ecological Restoration and the New Communion with Nature* (Berkeley: University of California Press, 2003).
21. Harry Griffin, "Cloning of Animals and Humans," in John Bryant, Linda Baggott la Velle, and John Searle, eds., *Bioethics for Scientists* (New York: John Wiley & Sons Ltd, 2002), 279–96.
22. Holt et al., "Wildlife Conservation and Reproductive Cloning."
23. Thomas E. Lovejoy and Lee Hannah, eds., *Climate Change and Biodiversity* (New Haven: Yale University Press, 2005); J. Alan Pounds, Michael P. L. Fogden, and Karen L. Masters, "Responses of Natural Communities to

Climate Change in a Highland Tropical Forest," in Lovejoy and Hannah, eds., *Climate Change and Biodiversity*, 70–74.
14. Amy Hembree, "Cloning is no Extinction Panacea," *Wired News*, www.wired.com, 13 February 2001.
15. Yule, "Cloning the Extinct."
16. Steven Best and Douglas Kellner, "Biotechnology, Ethics and the Politics of Cloning," *Democracy & Nature* 8:3 (2002): 439–65.
17. Ehrenfeld, "Transgenics and Vertebrate Cloning as Tools for Species Conservation."

26 NLIMBY
No Lions in My Backyard

C. Josh Donlan and Harry W. Greene

Lion: the fiercest and most magnanimous of the four footed beasts
—Samuel Johnson's Dictionary of the American Language (1775)

No lion shall be there,
Nor any ravenous beast shall go onto it,
They shall not be found there;
But the redeemed shall walk there
—Book of Isaiah (~2700 Before Present)

If they get near me, my family, friends or my property,
I'll be careful when I place the crosshairs on them,
And slowly squeeze the trigger of my Remington 300Ultra-Mag
—R. Weir (August 28, 2005, in response to the idea of lions in North America)

What types of information should guide societies in their efforts to conserve and restore biodiversity? Should certain time periods in the past serve as reference points? And if so, what should those benchmarks be? As importantly, what types of information and experiences influence or bias our perspectives with respect to biodiversity conservation? These are important questions with wholesale implications for biodiversity and humanity, yet they are rarely discussed and thus this volume is particularly timely. These questions and their answers will inherently involve ecology, evolutionary biology, and the social sciences—but human behavior and psychology will also heavily influence them.

Given our deep and complex relationship with large animals[1], the explosive reactions from the scientific community, the media, and the public-at-large came as no surprise as they pounced on the 1700 words published in August 2005 in the journal *Nature* under the title, "Re-wilding North America."[2] In that short paper, along with ten co-authors, we fundamentally