GES Center Issue Brief #2015.1

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De-extinction is the process of inserting recovered or synthetic DNA of extinct organisms into a host egg in order to recreate the extinct species. This process requires well preserved DNA. In fact, that is why the mammoth and the passenger pigeon were chosen to be recreated because both have well preserved DNA and their genome can be reconstructed from the well preserved remains. De-extinction would not be possible using DNA that is degraded. Therefore, the fictional story *Jurassic Park* would not be possible due to the quality of the remnant tissues and the lack of DNA sequences in currently available fossilized remains. However, with data on the sequence of the whole genome of an extinct animal, DNA sequences of that animal could potentially be synthesized or new genetic engineering techniques could be used to alter genes from existing and related species to make genes and perhaps whole genomes of the extinct animal.

Some scientists and conservationists are taking de-extinction projects more seriously than in the past, because of the new potential of quick DNA synthesis and editing. Together they have created a plan for choosing and developing de-extinction projects. The International Union for the Conservation of Nature (IUCN) has developed guidelines that include the following points:

- Background studies, allowing for identification of the species' habitat requirements
- Identification of lessons learned from prior projects of similar species
- Selection of appropriately diverse genetic stock
- Assessment of the socioeconomic context of project[1]

Being proactive, scientists and conservationists are guiding decision-making as to which species are the best candidates for de-extinction, along with the appropriate location of release for these extinct species (see Table 1). Candidate species for de-extinction are being identified through a set of guidelines that have been translated into 10 questions:[2]

1. Can the past cause(s) of decline and extinction be identified and addressed?
2. Can potential current and future cause(s) of decline and extinction be identified and addressed?

[1] Taken from *"Reintroduction and De-extinction"*, Dolly Jorgensen; American Institute of Biological Sciences, Sept. 2013
[2] Taken from *"Reintroducing Resurrected Species: Selecting De-extinction Candidates"*, Phillip J. Seddon, Axel Moehrenschlager, and John Ewen; March 2014

3. Are the biotic and abiotic needs of the candidate species sufficiently well understood to determine critical dependencies and to provide a basis for release area selection?
4. Is there a sufficient area of suitable and appropriately managed habitat available, both now and in the future?
5. Is the proposed de-extinction compatible with existing policy and legislation?
6. Are the socioeconomic circumstances, community attitudes, values, motivations, expectations, and anticipated benefits and costs of de-extinction likely to be acceptable for human communities in and around the release area?
7. Is there an acceptable risk of the de-extinct species having a negative impact on species, communities, or the ecosystem of the recipient area?
8. Is there an acceptable risk of pathogen-related negative impacts to the resurrected species and the recipient system?
9. Is there an acceptable risk of harmful impacts on humans and livelihoods, and indirect impacts on ecosystem services?
10. Will it be possible to remove or destroy de-extinct individuals and/or their offspring from the release site or any wider area in the event of unacceptable ecological or socioeconomic impacts?

Table 1: De-extinction candidate species [3]

	Region	Year of Extinction
Baiji, Chinese river dolphin	Yangtze River, China	2006
Pyrenean ibex, Bucardo	Iberian Peninsula	2000
Ivory-billed woodpecker	Southeastern USA	1944
Xerces blue butterfly	San Francisco, CA, USA	1941
Thylacine, Tasmanian tiger	Tasmania, Australia	1936
Carolina parakeet	Eastern USA	1918
Passenger pigeon	North America	1914
Cuban red macaw	Cuba	1864
Dodo	Mauritius	1662
Woolly mammoth	Northern steppes	(6,400 yrs. before present)

"The Great Passenger Pigeon Comeback" is the flagship project for *Revive and Restore*, a non-profit organization associated with the Long Now Foundation, dedicated to genetic rescue of endangered and extinct

[3] Table adapted from *Reintroducing Resurrected Species: Selecting De-extinction Candidates* by Phillip J. Seddon, Axel Moehrenschlager, and John Ewen; March 2014

species. Passenger pigeon museum-specimen DNA are from the collections of the Royal Ontario Museum, the Field Museum of Natural History (Chicago), the Denver Museum of Science and Nature, and the Rochester Museum and Science Center. The following illustrates the process that *Revive and Restore* plans to use for de-extinction.

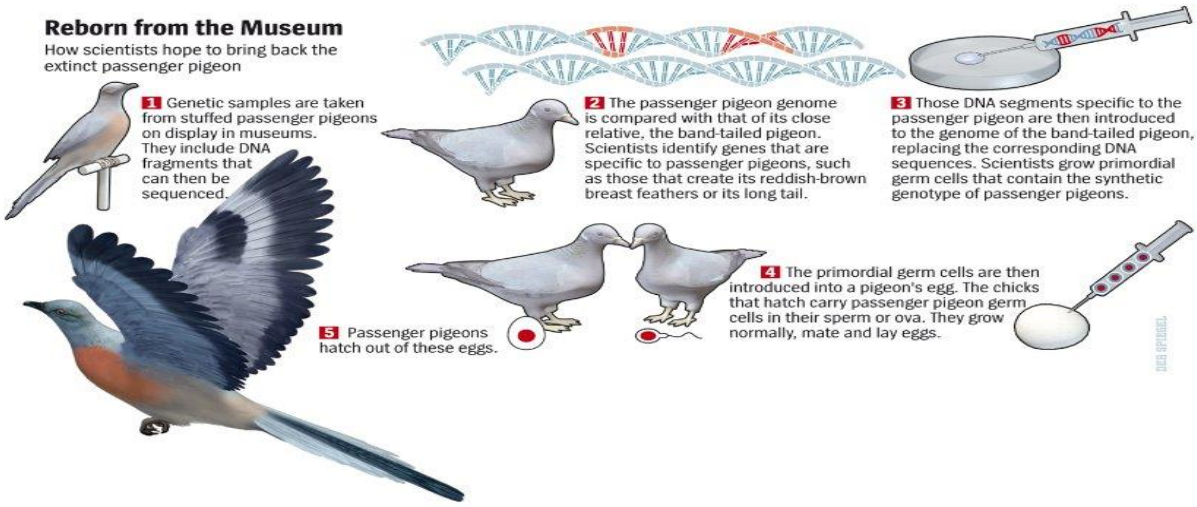

Image: http://www.spiegel.de/international/zeitgeist/bild-893744-483223.html

What is the controversy surrounding the de-extinction projects?

Experts from both sides have raised very passionate arguments. One group is excited to move forward, while the other is notably concerned about the implications. Other scientists and citizens are still weighing the evidence. Ethical issues rate high in this controversy. Are the geneticists and biologists playing God? If the de-extinction is partially flawed, will the resurrected animal be unhealthy and in pain? Will some de-extinct species become only curiosities in zoos? What are the implications if the new species become invasive in non-targeted environments? Should we be moving forward with these applications when there are so many endangered species that could be supported now? Will society be less concerned about endangered species based on the expectation that resurrection will be possible? These questions and many more will require thoughtful and candid public debate, informed by natural and social scientists, humanists, and other thought leaders. We may soon have the ability to accomplish de-extinction; however, the real question is, *should we*?

Risks Associated with De-extinction Projects	Benefits Associated with De-extinction Projects
• Destabilizing effect on the environment. • Unintended consequences to environment and public • Funnels funds away from current conservation projects • High conservation dependency • Inability to adapt to change	• Ecological partners like pollinators or seed dispersers to maintain current diversity • Flagship species that inspire habitat protection and benefit other species • Help maintain organisms that are endangered or threatened • Benefit to other science fields including agricultural and medical sectors • Penance for prior extinctions

References and Resources:

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This issue brief has been produced by the NCSU Genetic Engineering and Society Center, whose mission is to serve as a hub of interdisciplinary research & analysis and inclusive dialogue surrounding opportunities and challenges associated with genetic engineering and society.

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