7. Technology and the environment

A. De-extinction: can we / should we bring back extinct species?

https://www.thecollector.com/extinct-animals-scientists-trying-bring-back/

1. *Preparation task: important vocabulary*

For each word, choose the correct definition:

a) "To plummet", as in "The number of Asian elephants has plummeted by at least 50% in the past three generations":

i. to fall very quickly and suddenly
ii. to rise extremely quickly
iii. to fluctuate

b) "To run amok", as in "There were 50 little kids running amok":

i. to accidentally hit someone while you are moving
ii. to be in a bad mood
iii. to behave without control in a wild or dangerous manner

c) “To breed”, as in “His main income comes from breeding cattle”:

i. to do what is necessary to keep someone or something in a good condition or to improve their condition
ii. to keep animals for the purpose of producing young animals in a controlled way
iii. to illegally catch animals on someone else's property

d) “To prevent”, as in “Can anything be done to prevent this?”:

i. to tell someone that something bad or dangerous may happen
ii. to stop something from happening or someone from doing something
iii. to improve something by making a slight change

Match each word with the correct synonym:

a) extinct	.	.	larger than normal
b) endangered	.	.	risk
c) offspring	.	.	threatened
d) outsized	.	.	descendant(s)
e) hazard	.	.	vanished

Match each noun with the correct definition:

a) geoengineering	1. A type of cell that has the ability to develop into different cell types in the body.
b) genome	2. The deliberate modification of Earth's systems, particularly its climate, in order to counteract or mitigate the effects of climate change or other environmental issues.

c) relative	3. A member of one's family, such as a brother, sister, aunt, uncle, etc.
d) flock	4. A zone of Earth that encompasses all living organisms and their interactions with the non-living components of the environment.
e) conservation	5. All the animals and plants in a particular area, and the way in which they are related to each other and to their environment.
f) stem cell	6. The management and protection of natural resources and environments to ensure their sustainability and survival.
g) biosphere	7. The complete set of genes or genetic material present in a cell or organism.
h) keystone	8. A group of organisms of the same species that gather together, typically birds or sheep.
i) ecosystem	9. A fundamental or essential part of something, without which the whole would collapse or fail.

2. *Listening comprehension*

Watch the two video clips on de-extinction and answer the questions in English *(https://www.youtube.com/watch?v=MurFdzEpQbQ&ab_channel=BeSmart; https://www.youtube.com/watch?v=7z8rXihJV4Y&ab_channel=PBS Terra)*

1. What is the primary motivation for pursuing de-extinction?

_____

2. What is a keystone species?

_____

3. What is the story of the passenger pigeon?

4. Why is the passenger pigeon a keystone species?

5. How does de-extinction work? Describe the different steps of the process and the challenges

   a. for the passenger pigeon.

   b. for the woolly mammoth.

3. *Reading comprehension*

Work in pairs.

i. ***Student A*** *reads the text entitled "The Case for De-Extinction" and fills in the chart with the arguments traditionally put forward against de-extinction and how Stewart Brand responds to them.*

Student B *reads "The Case Against De-Extinction" and fills in the chart with the objections against de-extinction raised by Paul and Anne H. Ehrlich.*

ii. ***Student B*** *presents Ehrlich and Ehrlich's objections against de-extinction to* ***Student A****, who gives Brand's counter-argument (when available).*

iii. ***Both students*** *discuss their opinion on de-extinction together.*

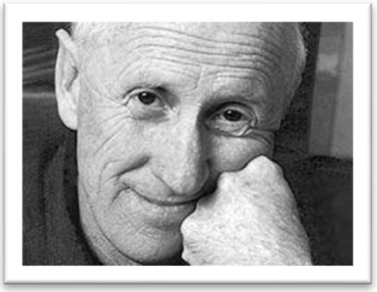
Student A's chart: "The Case for De-Extinction"

Arguments against de-extinction	*Brand's counter-arguments*
1. *2.* *3.* *4.* *5.* *…*	

Student B's chart: "The Case Against De-Extinction"

Arguments against de-extinction
1. *2.* *3.* *4.* *5.* *…*

The Case for De-Extinction: Why We Should Bring Back the Woolly Mammoth



By Stewart Brand

Sequenceable DNA can be recovered from museum specimens and some fossils of extinct species. That discovery in the 1980s set in motion the idea that it might be possible to bring some extinct animals back to life. The advent of ever-cheaper shotgun-sequencing of living genomes meant that the highly fragmented condition of “ancient DNA” was no barrier to reconstructing the whole genome of creatures long gone. Meanwhile, the rise of “synthetic biology” since 2000 is providing highly precise genome-editing tools. Maybe we can edit long-dead genomes back to life. Maybe extinct species could walk the Earth again. Maybe they could once again thrive in the wild.

But why do it? What’s the point of bringing back some pigeons that have been gone for a century, or some hairy elephants that disappeared four millennia ago? Well, what’s the point of protecting unhairy elephants in Africa or over-specialized pandas in China or dangerous polar bears in the Arctic, or any of the endangered species we spend so much money and angst on preserving?

We protect endangered species, conservationists retort (and most of the public agrees), in order to preserve the richest biodiversity we can, to retain creatures that have important ecological roles, or that people love, or as emblems to protect whole endangered ecosystems. We protect them to learn the science to protect them better. We protect them to undo harm that humans have caused.

All those reasons apply to bringing back extinct species, plus some — such as the pure thrill of the prospect of herds of mammoths bringing tusker wisdom back to the far north, or clouds of passenger pigeons once again darkening the sun. It would be a reframing of possibilities as momentous as landing humans on the moon was (at a tiny fraction of the cost).

Aldo Leopold described the ecological role of passenger pigeons as if they were a forest fire: “Yearly the feathered tempest roared up, down, and across the continent, sucking up the laden fruits of forest and prairie, burning them in a traveling blast of life.” Their old habitat, the renowned Eastern deciduous forest, is largely back, perhaps needing the return of an important bird species that only the oldest trees remember.

The woolly mammoth was one of the most important keystone species of all, according to Sergey Zimov, the Russian scientist who founded “Pleistocene Park” in northern Siberia. When the herds of northern megaherbivores were killed off by humans ten millennia ago, Zimov says, the largest biome on earth, called the “mammoth steppe,” converted from grassland to boreal forest and tundra. In these days of global warming, thawing tundra is releasing greenhouse gases, whereas grassland fixes carbon. Zimov is currently restoring grassland in the far north. He is waiting patiently for mammoths. “We knock down the trees with military tanks, but they make no dung.”

The idea of plausible de-extinction entered the public discourse in March 2013, when Ryan and I organized a “TEDxDeExtinction” at the National Geographic Society in Washington, D.C., featuring 25 scientists speaking on the subject. It was widely reported and discussed. Debate was encouraged, and the subject duly became “controversial.” Arguments against the idea fell into three patterns, depending on who was voicing the doubts — the general public, professional conservationists, or people with biotech knowledge.

Public worries centered on what would happen when formerly extinct animals are reintroduced to the wild. They might run destructively amok! Or, surely they could not survive because the world has changed so much since their time; with their habitat gone, all they could hope for is a life in zoos, and that would be pathetic. Nature, in other words, is widely seen as either hopelessly fragile or already completely broken.

Conservationists voiced few such concerns because they know how common it is, these decades, to successfully reintroduce animals to the wild after a long absence. The return of wolves to Yellowstone National Park after an absence of 70 years is regarded as one of the great recent conservation coups. Beavers are being reintroduced all over Europe, and wolves are reintroducing themselves there, thanks to the widespread reforesting of abandoned farmland. Nature is not broken, nor is it particularly fragile.

Two things worry conservation professionals. One is that de-extinction would be so expensive and high-visibility that it would divert money and attention from crucial programs to protect endangered species. In what universe, I have to wonder, would people newly excited about mammoths become suddenly indifferent to imperiled elephants? More likely is that de-extinction will attract significant new sources of funding and interest for conservation.

The other worry among conservationists is that the great warning “EXTINCTION IS FOREVER!” will lose its sting, and politicians will stop funding the protection of endangered species with the argument: “It’s okay if the whatevers go extinct; you can bring them back later.” Exactly the same fear was raised 35 years ago when Oliver Ryder at the San Diego Zoo founded the Frozen Zoo to cryopreserve cells and DNA from endangered animals. Over a thousand species have now been preserved there, to the great benefit of research on the protection of endangered species and with no apparent harm to political support for protecting them. De-extinction is likely to bring new knowledge and new public involvement in preventing extinction.

The best arguments against de-extinction, I think, are the most technical ones, focused on the extreme complexity of resurrecting extinct genomes. It hasn’t been done yet. Maybe it’s impossible.

Whole genomes have been shotgun-sequenced and reassembled from eight extinct species so far. The woolly mammoth is one of them; early next year the passenger pigeon will be the ninth. But how different are their genomes from their relatives, the Asian elephant and band-tailed pigeon? Can the important genes to transfer from the extinct genome to a living genome be identified? What if there are an overwhelming number of genes that have to be transferred? Research on those questions is now under way. Encouraging answers are not guaranteed.

Then there’s the task of converting gene data into living genes. This is done routinely in synthetic biology these days, usually in microbes but increasingly with vertebrates such as mice. But shifting a whole suite of extinct traits into a living genome has yet to occur.

And how do you then get to a living animal? With mammals you’ll have to do interspecies cloning — somatic-cell nuclear transfer of the reconstituted genome of the extinct species into the enucleated egg of a surrogate mother and then implanting of

the early-stage embryo in her uterus. This extremely tricky process has been proved only once, when a Javan banteng calf (using DNA from the Frozen Zoo) was successfully birthed from a domestic cow.

The tools of synthetic biology are advancing. What seems impossible one year is merely expensive a couple years later and routine soon after that. Technical criticism of the processes of de-extinction will often be dead right, but not necessarily for long.

The final question will be whether the resurrected animal is really the extinct animal. If it looks like a passenger pigeon and flies like one, is it the original bird? We don't have any living originals to compare it with. If it's mostly passenger pigeon, is that good enough? Kent Redford, former chief scientist for the Wildlife Conservation Society, points out that the American bisons we avidly protect are only mostly bison, with quite a lot of cattle genes. Suppose we duplicate the passenger pigeon genome in its entirety. Is the genome the bird? Is your identical twin a human?

To me, one of the greatest attractions of bringing back extinct species is how long it will take. Even if all goes well, getting passenger pigeons back (along with other species if the techniques work) will take decades. For a baby female woolly mammoth to grow up and have a daughter takes twenty years. Getting herds back to the subarctic, grazing the mammoth steppe back into existence, will be a century-scale project.

Children growing up in such a century might have a view of the relation of humans with nature that is not tragic, for a change.

Adapted from: https://e360.yale.edu/features/the_case_for_de-extinction_why_we_should_bring _back_ the_woolly_mammoth.

The Case Against De-Extinction: It's a Fascinating but Dumb Idea

Paul Ehrlich and Anne H. Ehrlich

Wouldn't it be great to have vast herds of mammoths roaming the Canadian tundra, or a thrill to see hundreds of millions of passenger pigeons settling in Michigan forests once again? Of course, being able to rent a pair of velociraptors to add spice to the "reality" TV show you're directing would be nice too. An appealing picture to say the least: *Jurassic Park* in reality, bringing vanished animals back to life, made possible by spectacular progress in molecular biology.

After all, isn't *Homo sapiens* destined to use its fine brains to engineer the entire planet (or universe)? But let's restrict our dreaming to recreating organisms that *Homo sapiens* has itself exterminated. Surely, if that's an achievable goal, and we want to do it, humanity should go full speed ahead and resurrect the creatures we have wiped from the earth.

Or should we? I'll answer this question, but not before I briefly address another: Could we? Would it be possible? It seems likely that in some cases a simulacrum — perhaps a quite reasonable simulacrum — of an extinct organism can be produced. And one would be foolish to predict that even making a fully successful reconstruction of an extinct species is impossible. Science has come a long way in genetics, genomics, and development in a very short time; much that can be done today seemed impossible a few decades ago.

So, even though I suspect the resurrectionists generally underrate the genetic and environmental dimensions of the problem they recommend tackling, for the purposes of this discussion let's assume that reconstructing extinct species eventually will be practical at some level. Yet I believe that the resurrectionists have been fooled by a cultural misrepresentation of nature and science — as in *Jurassic Park, Avatar, X-men*. As my colleague Chase Mendenhall put it, "We need more representations of the future, but we must live and act in the present, and there are far more urgent and tractable ways for creating imagined futures that don't include bringing back a "pet" for humanity before you've had time to prepare its terrarium."

So what are the objections to an effort to restore the victims to life? The soundest scientific reason, in my view, is misallocation of effort. It is much more sensible to put all the limited resources for science and conservation into *preventing* extinctions, by tackling the causes of demise: habitat destruction, climate disruption, pollution, overharvesting, and so on. Spending millions of dollars trying to de-extinct a few species will not compensate for the thousands of populations and species that have been lost due to human activities, to say nothing of restoring the natural functions of their former habitats.

Moreover, resurrecting a population and then re-inserting it into habitats where it could supply the ecosystem services of its predecessor is a monumentally bigger project than recreating a couple of pseudo-mammoths to wander around in a zoo. The passenger pigeon is often mentioned as a target for de-extinction. But to create even a single viable population might well require fabricating a million birds or so, since the species apparently survived by a strategy of predator saturation.

And if the passenger pigeon were synthesized, where could it be introduced? The vast forests the pigeons required are partly gone and badly fragmented at best, and one of the birds' food sources, the American chestnut, is functionally extinct. The passenger pigeon's previous habitat is utterly transformed, and if humanity does not very quickly and substantially curb greenhouse gas releases, the pigeon's old homeland will likely be completely unrecognizable in less than a century. In practical terms, in the near future in which action is required, extinction is certainly "forever."

Reintroductions of surviving endangered species (which are vastly more important than attempted de-extinctions) illustrate the complexity and scale of the task. Culturing and reinserting animals into nature is already known often to require intense and expensive effort. And as *National Geographic* photographer Joel Sartore has emphasized to me, zoos are already overwhelmed trying to breed endangered species for reintroduction and thus facing conundrums about which species to save and which to let go. Allocating more effort there is far more essential than research into laboratory-created resurrections.

De-extinction thus seems far-fetched, financially problematic, and extremely unlikely to succeed on a planet continually being vastly transformed by human action. There are also risks beyond failure. Resurrected, previously benign organisms could become pests in new environments, might prove ideal reservoirs or vectors of nasty

plagues, or might even harbor dangerous retroviruses in their genomes. But frankly, I think such problems will probably prove minor compared to the main problem, which is “moral hazard.”

Moral hazard is a term invented by economists for a situation where one becomes more willing to take a risk when the potential costs will be partly borne by others. The problem is that if people begin to take a “Jurassic Park” future seriously, they will do even less to stem the building sixth great mass extinction event. But recovery from a sixth mass extinction could easily take five or ten *million* years.

Right now the biggest moral hazard on the environmental front is created by the folly of “geoengineering” — the idea that, if humanity fails to limit the flux of greenhouse gases dramatically in the near future, overheating of the earth could be prevented by any one of a series of stupid schemes. I’ve already had questions in classes about the possibility of engineering biodiversity back into existence. Moral hazard is already there.

Scientists interested in trying to resurrect extinct species should surely be free to pursue their interests if they can get the needed support. Perhaps there will be some significant scientific positive fallout, and maybe, as my friend Stewart Brand suggests, we’ll be pleased to have some interesting results in a century (if civilization persists). But if de-extinction advocates are really concerned about the state of biodiversity, they should not be holding meetings or debates about de-extinction. They should be putting much of their time into such efforts as keeping plastics and persistent organic pollutants out of the environment, pushing reduction of meat eating, and educating decision-makers about the roles biodiversity plays in human lives. Above all, de-extinction scientists should be struggling to get a rapid transition to renewable energy, promote a stop-at-two goal for family planning, and generally seeking ways to reduce the scale of the human enterprise. Failing in those areas will make all discussions of de-extinction irrelevant, even in the long term.

Adapted from : https://e360.yale.edu/features/the_case_against_de-extinction_its_a_fascinating_but_dumb_idea.

4. *Speaking: debate*

Discuss the following questions in groups of 3 to 5 students.

a) De-extinction also raises a series of ethical issues:

"The first few individual woolly mammoths born would be some of the loneliest creatures imaginable" (philosopher Christopher Preston).

"Rapid aging, ongoing health problems and premature death are common among cloned animals" (philosopher Heather Browning).

"The cloning stage also carries risks for the surrogate mothers, who will have no choice about their participation in the project. The mother may need a C-section for the birth, as woolly mammoths are larger than Asian elephants — and surgery on an elephant isn't easy. She would then be confronted by a strange, hairy child whom she may or may not accept" (freelance journalist Dayton Martindale).

Source: https://www.vox.com/future-perfect/23696294/de-extinction-colossal-biosciences-woolly-mammoth-dodo-ethics.

Are these risks a necessary evil for a greater good (= repairing the damage caused by humans to biodiversity)?

b) Now that you are familiar with the main arguments in favour of and against de-extinction, do you think that trying to de-extinct species is a good idea? Why (not)?

Images: https://www.extinctanimals.org/.

5. Vocabulary list

Word	Translation	Additional information (countable / uncountable; BrE/AmE; structure; etc.)
1. Preparation task: Important vocabulary		
to plummet	chuter, dégringoler	The value of the euro plummeted = (La valeur de) l'euro a chuté.
to run amok	a) (literal) être pris d'une crise de folie meurtrière OR furieuse b) (figurative) devenir fou furieux, se déchaîner	
to behave	se comporter, se conduire	He behaved badly towards her. = Il s'est mal conduit envers elle.
to breed	élever, faire l'élevage de	a breed = une race, une espèce
income	revenu	a source of income = une source de revenus
to prevent	éviter	to prevent somebody (**from**) do**ing** something = empêcher quelqu'un de faire quelque chose **≠ prévenir qq'un (= informer)**: to inform sb, to let sb know **≠ prévenir (= mettre en garde)**: to warn
to improve	(s')améliorer	
species	espèce	Plural : species
extinct	disparu (espèce, race)	extinct species to go extinct preserved extinct animals = animaux disparus conservés (dans des musées)
to vanish	disparaître	
endangered	en voie de disparition	endangered species
offspring	descendants, progéniture	= plural noun
outsized	énorme, colossal	
hazard	risque, danger	a health/fire hazard = un risque pour la santé/d'incendie
geoengineering	géo-ingénierie	= l'ensemble des techniques qui visent à manipuler et modifier le climat et l'environnement de la Terre et par extension d'une planète en

		première intention et à grande échelle. L'objectif est généralement correctif, plus que préventif (https://fr.wikipedia.org).
genome	génome	= ensemble du matériel génétique, c'est-à-dire des molécules d'A.D.N., d'une cellule.
relative (noun)	parent(e)	She has relatives in Canada. = Elle a de la famille au Canada.
flock (noun)	troupeau ; vol(ée) (d'oiseaux)	a flock of birds
ecosystem	écosystème (= milieu naturel)	
cell	cellule	stem cell = cellule souche (= cellule à l'origine de toutes les cellules)
biosphere	biosphère	= ensemble des écosystèmes de la Terre
keystone (noun or adj.)	clé (= très important)	keystone species
conservation	préservation (de ressources naturelles)	nature conservation = défense de l'environnement
climate	climat	climate change = changement climatique
issue	question, problème, problématique	environmental issue = problématique environnementale
sustainability	durabilité	
survival	survie	
gene	gène	genetic (adj.) = génétique genetic**s** (noun; uncountable) = génétique
to collapse	s'effondrer, s'écrouler	
2. Listening comprehension		
to pursue	mettre en œuvre, poursuivre qqch	
challenge (noun)	défi	to challenge = défier
fantasy (noun)	fantasme ; idée fantasque	Some people think that *Jurassic Park* isn't a total fantasy.
to undo	annuler, réparer	To undo the damage = réparer les dégâts
to restore	restaurer, rétablir	
overhunting	chasse excessive, surchasse	
decade	décennie	
in captivity	en captivité	

a chain reaction	réaction en chaîne	To set off a chain reaction = déclencher une réaction en chaîne
to figure out	arriver à comprendre	Scientists need to figure out the science of de-extinction.
DNA	ADN	
sample	échantillon, prélèvement	A DNA sample
trait	trait, caractéristique	
behaviour	comportement	
niche	niche, créneau	I think we have found a niche in the toy market.
to bring back	ramener	
cloning	clonage	
embryo	embryon	
to be responsible for sth	être responsible de qqch	
to reverse engineer	faire de la rétro-ingénierie ; rétroconcevoir	Reverse engineering is one way computer programs are pirated. = La rétro-ingénierie est l'une des façons de pirater un logiciel informatique.
3. Reading comprehension		
To bring back to life	ramener à la vie	
millennium	millénaire	Plural: millenniums / mille**n**ia
greenhouse gases	gaz à effet de serre	
habitat	habitat	
To divert attention from	détourner l'attention de	
surrogate mother	mère porteuse	
dumb	bête	What a dumb idea!
herd	troupeau	
achievable	atteignable	
to underrate	sous-estimer	
sensible	sensé, judicieux	
far-fetched	farfelu, tiré par les cheveux	
pest	animal nuisible	
extinction	extinction	De-extinction To de-extinct
to be concerned about/for sth	être inquiet pour qqch	
pollutant (noun)	polluant	
renewable energy	énergie renouvelable	