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RESEARCH ARTICLE

Collect, Save, Adapt: Making and Unmaking Ex Situ Worlds

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Abstract

‘Putting the right species back in the right place’: expressed in the words of Bruce Pavlik, the Head of Restoration Ecology at the Millennium Seed Bank at Kew Gardens in a fundraising clip for the Breathing Planet Campaign, the work of biodiversity repositories seems straightforward. A simple matter of renewing the colonial and capitalistic capture of nature by exhausting its diversity in collecting, and then of reinserting species, suspended in the form of genetic information, into the neat spaces their disappearance or almost-disappearance has left in their original ecosystems, the redemptive value of biodiversity repositories seems unquestionable. ‘There is no technological reason why any species should go extinct’, the clip goes on. The cryopreservation of genetic material in seed banks and ‘frozen zoos’ is often and justifiably understood as genetic-fetishistic suspension, several times removed from animal lives in actual habitats; I propose however to read them as world-making devices in their own right too, more entangled and entangling than they might present themselves to be. Collecting and saving are two mandates that have effects both on the species whose genetic information is banked and on the natures that are made possible or impossible through the projects delineated by biodiversity repositories; but they have also been implicated in a third such mandate, the assisted adaptation of species to anthropogenic climate change (be it the plan for ‘chaperoned assisted relocation’ proposed by the Missouri Botanical Garden or the ‘cultivation of marginally hardy taxa’ proposed at the Arnold Arboretum). How are biodiversity repositories an active intervention into the shaping of natures both inside and outside, and what are the consequences of what happens within the apparatus of these repositories for

wider understandings of landscapes and species under threat? How linked is the suspension of metabolic processes and evolutionary potential and the understanding of Earth as manageable, perhaps even terraformable? What do they contribute to conservation biology's biopolitical and cultural shaping of individuals, species, ecosystems suspended and remade through the different uses for which biodiversity repositories can be put to work?

Keywords:

extinction studies; ex situ conservation; conservation biology; plant studies; environmental philosophy; environmental humanities; assisted migration

Introduction

What Kew is about is putting the right species back in the right place. Bruce Pavlik, Kew Gardens—The Breathing Planet Campaign

Science fiction is not about the future; it uses the future as a narrative convention to present significant distortions of the present. And both the significance of the distortion and the appropriateness of the convention lie precisely in that what we know of present science does not deny the possibility of these distortions eventually coming to pass. Samuel Delany, Starboard Wine

'There is no technological reason why any plant species should become extinct': this sentence, innocuously dropped into a fundraising clip for the Breathing Planet Campaign of the Millennium Seed Bank Partnership at Kew Gardens by Paul Smith, head of Seed Conservation at the MSBP, is echoed almost word for word in an article on plant ex situ conservation in botanic gardens he co-authored, and which goes on to call for 'a botanic garden-centered global system that can prevent species extinctions *in perpetuity*' (emphasis mine).¹ The ex situ conservation of endangered wild plant species, in living collections such as botanic gardens and suspended in the subzero temperature storage of the seed banks that are often housed in their facilities, is seen as a cost-effective and technologically sound method for arresting plant extinction indefinitely. As Deborah Bird Rose says of cryotechnologies in general, 'they are end-time oriented; they move some matter into a zone of suspended life—enlarging the zone of the incomplete—in order to be able to kick-start time and life again when the moment arrives.'²

The institutions now carrying a good part of the ex situ burden—zoos and botanic gardens—were born in the context of colonial expansion, and have long served as trading houses and display cases of European imperial powers. The shift to fulfilling ex situ conservation duties—while underpinned by an infrastructural preparedness of institutions long used to acclimatising and perpetuating non-native populations—has happened relatively recently, starting in the 1970s and taking a decisive turn with the Convention on Biological Diversity in 1992. It was first dominated by an emphasis on a salvific 'ark paradigm'³, which has partly given way to an integrated approach⁴, but the image of the ark still animates ex situ conservation, reappearing in the names of prominent initiatives (the Millennium Seed Bank Partnership, taking its cue from Soulé's proposed 'millennium ark', and—on the animal side of the freezer—the Frozen Ark project). The ex situ conservation of wild plant species in seed banks, a practice initially developed for food crops, has seen rapid and extensive development over the past few decades, and has come to form an important part of many botanic gardens'

conservation activities.⁵ Ex situ conservation in general is informed by and frames the question of extinction in particular ways: emerging from the structural affordances of institutions (zoological and botanical gardens) that have contributed both to extinction and the subsequent frenzy of preservation, it treads the line between responding to extinction through salvific suspensive practices and integrating it into complex, dynamic and ongoing projects.

Rose's assessment of the cryoconservation of endangered species is characteristic of the way ex situ conservation has been framed in both intra- and interdisciplinary discussions. It is a fraught and debated practice within conservation biology itself, as Irus Braverman has shown in her critical mapping of the ex/in situ conservation debate, drawing on ethnography and animal geography.⁶ In discussions around the bio-, cryo- and necropolitics of suspensive ex situ conservation, the trouble has often been couched in terms of the impossible speculations they embody: for what future are these frozen species preserved? In what post-apocalyptic landscapes will they be called upon to rise again, and walk? What of the competences, the knowledge needed to reanimate the contents of foil packets and nitrogen tanks, to inseminate animals and multiply propagules—and all this without even speaking of the possibility of cultural transmission within those species themselves?⁷

But suspension is not the only mandate of ex situ conservation. Gardens, developed as miniature representations of a harmonious political and cosmological order, can prove to be unruly and unravelling; and there is trouble in the seed bank as well, when it acts as a temporal weight in the zone of the incomplete, distorting linear narratives and projects. The simplicity of 'putting the right species back in the right place'—that deferred horizon of species and ecosystem resurrection ex situ conservation seems to tend toward—is belied by the complex temporal entanglements that emerge when it is read in the dense tangle of uses and projects it supports, enables, and is shaped by. For all the sterile suspension of the deep freeze, stockpiling, saving and remembering cannot quite help being relational, and being enlisted in projects that provide a testing ground for specific forms of relation to extinction; as Joanna Radin reminds us, 'each new use [of cryopreservation] as well as each new fantasy mutates a horizon of expectation in which frozen materials will reveal new and previously concealed forms of value'.⁸ Ex situ conservation projects are vital, animated, for better or worse, and it is their vitality, be it fruitful or dangerous, that I aim to tease out here—as well its temporal status and interventions.

'Perhaps by helping them move': suspension and translocation

Many ex situ initiatives as we know them now have obvious roots in the zoological and botanic gardens and the museums that were created and consolidated during the colonial expansion of European empires in the 18th and 19th centuries. Before becoming a national botanical garden in 1840, Kew was originally an exotic garden whose collections were enriched by its successive owners, most crucially, under George III, with the aid of the naturalist Sir Joseph Banks. Banks, whose fame and fortune as a naturalist is itself tightly interwoven with colonialist journeys, saw in Kew the possibility of founding 'a great botanical exchange house for the empire'¹⁰, where plants could be collected, acclimatised and studied for scientific and economic gain, and he succeeded in transforming Kew into the world's largest botanical collection at the time (Banks became Kew's nominal director in 1773). The Millennium Seed Bank Partnership, created in 1996 at Kew Gardens and the world's largest wild-plant seed bank, is therefore a direct offshoot of the botanical fever that had gripped prominent

naturalists such as Banks in the 18th century, and led to the creation of the most important scientific institutions of the British empire.

The momentum applied to plants by colonial botany set them into flux both ways. Scientific expeditions and collaborations with local collectors, starting in the 18th century, had a mandate to collect as much of the newly discovered natural wealth of the colonies as possible.¹¹ Introduction to the heart of the empire, in the case of Britain for instance, equally served aesthetic taste, scientific obsessions and economic goals, and was sped along by a veritable naturalistic collecting fever. But the colonies were not exempt from these imperialist terraforming ambitions either: along with unintended invasions by introduced species which still plague many of the places where empires left their heavy footprints¹², the 19th and 20th centuries saw the creation of acclimatisation societies in France and Britain in order to introduce native, ‘useful’ species to colonies in North America, Africa and Australia, and in the process to make these landscapes more similar to European ones.¹³ In 1853, Joseph Dalton Hooker (who after his expeditions went on to serve as director of Kew Gardens for twenty years) wrote that ‘we have the apparent double anomaly, that Australia is better suited to some English plants than England is, and that some English plants are better suited to Australia than those Australian plants were which have given way before English intruders’,¹⁴ a remark which perfectly encapsulates the double movement of colonial botany—always dependent on institutions that could collect, store and acclimatise plant and animal species. Collecting and storing, in this particular matrix of military and cultural domination and of knowledge practices inherited from Enlightenment science, meant setting the whole natural world into flux: plants and animals in this context came to be seen as supremely separable from their native ecosystems and from each other, malleable into commodities and transferable from native contexts of knowledge, culture and religion into what the anthropologist Natasha Myers calls the grid-able system of colonial science.¹⁵

Forged in the dismembering pressure and certainty-producing grid¹⁶ of acquisitive relationships to nature, the principles governing the ordering and management of wildlife in botanic gardens could then easily tip over into a suspensive mandate—from the productivist applications of plant collection to the safe storage and propagation of endangered species. Private botanical collections, curiosity cabinets and menageries became botanic gardens, museums and zoos, allowing of an ever more finely granulated management of nonhuman life, death and display. These collections provided an obvious starting point for the banking of wild genetic resources, situated as they were at the intersection between the necessary material infrastructures and the developing biopolitical regime enabling the management of captive wildlife.

The development of storage at subzero temperatures adds to the regime of the garden and the zoo the possibility of stabilising and disjointing life materially and temporally, ‘the ability to freeze, halt, or suspend life, and then reanimate’, as Hannah Landecker puts it:

The freezer (...) acted as a central mechanism both within individual laboratories and companies and within the biological research community more generally to standardise and stabilise living research objects that were by their nature in constant flux (...) In short, to be biological, alive, and cellular means (at present) to be a potential ‘age chimaera’, to be suspendable, interruptible, storable, and freezable in parts.¹⁷

The banking of frozen material has effects on several levels: informational (the standardisation of the material), temporal (its synchronisation) and spatial/material (its stabilisation); effects that come to bear on individual bodies, of course, but on species as well. Ice, as Erica Benson

points out in her introduction to the history of plant cryoconservation, has historically functioned as an evolutionary inhibitor; the parts of the planet that have known longer and more frequent glaciation periods display a markedly more narrow plant diversity than those that have remained out of reach of glacial onslaughts.¹⁸ As with the planet, so with the bunker: freezing once more suspends potential evolutionary becomings and pins species to ontological stability, an ironic twist on the claim regularly put forth by many seed and gene banking projects: ‘The vault at the Millennium Seed Bank holds more living plant diversity per square metre than anywhere on earth—arguably the world’s hottest plant biodiversity hotspot’.¹⁹

Combining a collection of the world and the salvation of endangered species is not, however, the only or last mandate of ex situ conservation. In what might seem a return of acclimatisation and landscape-moulding ambitions of colonial botany, recent years have seen the emergence in the scientific literature of proposals for assisted migration, the ‘translocation of a species to favourable habitat beyond their native range to protect them from human induced threats, such as climate change’,²⁰ or, alternatively and in a more nuanced language, ‘the purposeful movement of species to facilitate or mimic natural range expansion, as a direct management response to climate change’.²¹ The terminology is still as shifting and proliferating as can be expected from a ‘warm’ research in the making,²² and it has also been variously called assisted colonisation (sometimes distinguished from the first as the ‘movement of species far outside their range for conservation purposes’²³), assisted migration,²⁴ managed relocation²⁵ or chaperoned relocation.²⁶ This purposeful relocation of species would mitigate both the effects of habitat fragmentation—mimicking plant dispersal along naturally occurring corridors for example—and those of climate change, helping species migrate faster to keep up with their natural range’s shifts in the coming years and decades.

As of now, most of these proposals for assisted migration are still highly speculative, with notable exceptions such as the citizen-led *Torreya* Guardians project.²⁷ Most articles offer recommendations (for seed collecting or actual translocations),²⁸ feasibility studies,²⁹ ethical frameworks,³⁰ terminological reviews and clarifications,³¹ theoretical contributions to the ongoing debate³² or desiderata for future accessions.³³ As a very new scientific proposal in the making, it is engaged in exactly the dense tangle of rhetoric and citational practices described by Latour in *Science in Action*—the past years have seen a flurry of articles responding to and contradicting each other, some of them engaged in direct dialogue, proposing everything from unified ethical frameworks to methods for efficient seed sampling and examinations of species invasiveness, and the debate is still ongoing.³⁴

Why examine the question of assisted migration as a relevant topic to ex situ conservation? The first reason is a simple observation: the fact that some of these proposals take explicit root in ex situ conservation projects, making use of the preexisting collections, breeding and testing grounds and reserves in germplasm offered by botanic gardens possessing seed banks; a good number of the authors of those scientific papers are themselves researchers working in botanic gardens. ‘Although on its own [ex situ conservation] is not a sustainable solution for conservation, it does provide an essential step in the process of introducing species back to the wild’.³⁵ The Arnold Arboretum of Harvard University proposes the collection and cultivation of ‘marginally hardy taxa’, which might prove to be more suited to the climate in Massachusetts in the coming decades than the species now living there,³⁶ while researchers at the Missouri Botanic Garden have drafted a white paper calling for ‘chaperoned managed relocation’.³⁷ The Finnish CO-ADAPT project has set up experimental plots for three potential candidates for translocation in botanic gardens in Finland, Norway and Estonia (the plant species *Primula nutans*, *Oxytropis campestris* ssp. *sordida* and *Astragalus*

alpinus ssp. *Arcticus*), and Kayri Havens and Pati Vitt, both working at the Chicago Botanic Garden, have published a set of articles on practices of assisted migration with various other collaborators.³⁸ Assisted migration projects are ideally poised at the junction of the garden and the seed bank, and take root where two forms of ex situ conservation necessarily meet: the living collection, kept in artificial congregations of unrelated species and separated from the outside world (although the unwitting role played by many botanical gardens in uncontrolled species introductions and invasions complicates this point), and the seed bank, one more (apparent) removal from relational aliveness and liveliness. Assisted migration projects rely on the expertise accumulated by botanic gardens and on the material collected and sleeping in frozen suspension, and might potentially affect how that material is managed and collected in the future;³⁹ but they also in turn extend the managed spaces of garden and bank back into a changing and damaged landscape. They allow for an unfolding of the biopolitical and conceptual reworkings of the garden and the bank, applying them to the landscape outside—perhaps the planet as a whole—becoming representatives of what the suspension of endangered life might do for and to the rest of nature, now scrutinised through the lens of what ex situ conservation makes possible.

These projects can be said to reside in what Joanna Radin and Emma Kowal have called a thermal margin:

The production of these kinds of thermal regimes has also been accompanied by the spaces between them, what we might call the 'thermal margins': zones of precarity, ambiguity, and unexpected generativity that also reorganise ideas about what it means to be and to remain alive.⁴⁰

The articulation of ex situ conservation and assisted migration projects exist in such a gap between regimes—under the looming shadow of climate change, it shifts between the reanimation of frozen, suspended life (itself wavering between -5° to -20° degrees for orthodox seeds, and the necessity of resorting to cryoconservation at -196° in the case of recalcitrant seeds) under very specific and controlled conditions, the cultivation of plants outside of their native climatic ranges, and their reintroduction to specific thermally transformed and conditioned sites.

This leads me to the second point: as a projected outcome of seed banking, proposals for assisted migration occupy a complex temporal as well as a thermal niche. Radin and Kowal speak of the horizon of future salvation as eternally deferred by the suspensive cryopolitics of subzero storage;⁴¹ but speculating on the possibility of translocating endangered species brings this horizon forward, even just theoretically. Still speculative but present, that horizon suddenly shifts into a very near future rather than remaining in the messianic time of post-apocalyptic salvation;⁴² by connecting the repository to the landscape again, assisted migration projects address some of the suspensive questions posed by biodiversity repositories and provide an anticipated testing ground for what salvation after suspension might look like. Here the future of biodiversity repositories takes shape, scientists test out theories and hopes and present one of the possible projections and extensions of these collections into living futures. As such, these projects represent one unfolding of the potentialities of the seed bank, one entry into the fraught and teeming liveliness of suspensive conservation practices. If natures become global through successful mobilisations of objects of concern in the transformative milieu of the laboratory,⁴³ and the garden and the seed bank become themselves a laboratory or testing ground for scientific experiments,⁴⁴ then what is at stake here is the development of future

natures forged in the deep freeze of the seed bank and in the highly controlled living collection of the botanic garden.

‘To rebuild nature on a landscape scale’: ex situ projects as world-making devices

Seed banks and botanic gardens do not freeze worlds as instant mixes where you can just add water and get fully-functional ecosystem back. They are, by the very suspensions they effect, as much an intervention into worlds, natures and lives as botanical collection expeditions and acclimatisation societies have been in the past. They are devices for inscribing specific assumptions about catastrophic nature, and in turn for moulding new worlds through the specific transformations life, generation and nature undergo in the seed bank and the flower bed.

Paul Virilio, in *Bunker Archaeology*, asks of the bunkers left over from World War II on the French Atlantic coast what kind of world and violence is inscribed by their architecture. His answer: the warfare of instantaneous and complete fluidification (annihilation by aerial attack) and of a surface world made uninhabitable. A botanic garden is not a bunker, even though it might be placed on a continuum including the wildlife refugium on the one hand and the sterile shelter on the other. The seed bank isn’t either; perhaps with the notable exception of the Svalbard Global Seed Vault, which functions less as a seed bank and more like cold storage—and whose architects make marked use of bunker terminology and architecture. Seeds kept at low temperatures are never entirely static, since they need to be regerminated regularly in order to test viability and germinative ability, and in order to regrow the plants and harvest new seeds to replace and replenish the collection⁴⁵. This is yet another link between different forms of ex situ conservation initiatives: the seed bank can hardly exist without the garden or the experimental field, and frozen seeds are in a constant movement that assures their surveillance and effective management. But as protective, isolated and fortified spaces dedicated to salvific conservationist mandates, the question posed by Virilio might legitimately be asked of ex situ institutions.

While ex situ conservation does not inscribe only the momentary survival of a specific onslaught (although a case could be made, perhaps, for bunkerisation conservation ecology responding to climate change as an indefinitely prolonged version of this kind of warfare), it does speak of uninhabitable surfaces, more specifically of a world so rapidly fragmented that wild species can no longer follow those changes fast enough; in drawing them together spatially it promises the ultimate safety of a decoupling from these uninhabitable landscapes. While ex situ relies on absolute technological stability (a cold chain that can reveal itself to be the frailest of threads—’how fragile, or mortal, the cold chain becomes in an overheated world’⁴⁶), its very mandate speaks of the disquieting instabilities it addresses. Social theory and philosophy both are in the process of diagnosing a formidable shift toward a consciousness of the planet as dynamic, *unrubic*, and life on its surface as immensely precarious as a result: Emily Apter speaks of ‘planetary dysphoria’,⁴⁷ Nigel Clark of inhuman nature’,⁴⁸ both following conceptual threads—starting with the impact of the 1755 Lisbon earthquake on Kant in Clark’s case, and with Kant’s 1757 lectures on physical geography in Apter’s—that allow them to arrive at counter-histories of technological and political dominion over nature, and excavate the inhuman planetary movements that fissure and haunt human thought. Is the circumscribed safety of ex situ conservation also a negative inscription of this inescapable dynamism? In that case, the string of seed banks and botanic gardens along which plants could

be exchanged and migrating⁴⁹ starts looking like a fragile belt girding an explosive nature, markers of stability implanted into precarious ground but denoting by their very existence what they seek to defer and keep at bay. The mobile and connected networks of suspensive ex situ conservation and reconnective assisted migration projects might change institutions of conservation into outposts of relative stability, marks made in an attempt to secure a hostile world like rural crosses in pagan country, or watchposts for the inexorable forward march of climate change and Birnam Woods of our making both.

But ex situ conservation projects do not only reveal understandings of a pre-existing nature; they are active and creative participants in the shaping of natural worlds, in particular those under threat and in need of management (or the performed absence of it). In Derridean terms, archiving 'produces as much as records the event',⁵⁰ and, as one tantalisingly elusive Foucauldian aside would have it, universals (the state as much as wild nature) can be tracked by a counter-historical method that assumes they do not exist, and studies the 'different events and practices which are apparently organised' around them.⁵¹ Concepts of natural, wild, or pristine are created by the very institutions of captivity they are the counterpart of, and the very structure of these institutions is a performative act. The emergence of the zoo was also the precondition for the creation of the American wilderness; the latter coming into existence at the same time and through the institution of captivity.

However, if ex situ conservation projects are the inscription of nature as essentially inhumanly dynamic, they might also be read as participating in a different construction than that of the captive/wild dynamic. Rather than just existing on a continuum that stretches from the captive to the wild, the politics and materialities of ex situ conservation institutions, once put back into an assemblage of conservation practices and coupled with proposed uses such as assisted migration, seem rather to exist on a gradient of managerial practices that does not necessarily presuppose a counterpart constructed as pure or untouched. Managed captivity or suspension becomes a testing ground for future managed landscapes, and what is learned from supervision might pave the way for a remaking of nature entire as a mobile arrangement that can be stitched back together by exerting a finely calibrated control. The website of Kew Gardens states:

*In the ground-breaking report Making Space for Nature, Sir John Lawton and colleagues (2010) set out an ambitious new strategy for UK conservation – to rebuild nature on a landscape scale, creating resilient and coherent ecological networks to expand and link existing habitats with buffer zones, wildlife corridors and areas of active restoration and habitat creation.*⁵²

Similarly, Vitt et al. observe the 'envision a future where well-conceived translocations of species may reduce the risk of extinction, as well as increase the number of potential taxa creating new assemblages in a fluid landscape responding to broad scale changes.'⁵³ Nature, recombinant, can be had for movable parts of a moving landscape, and assemblages can be rebuilt starting with a reduced number of 'bread-and-butter species' to stabilise communities⁵⁴.

The justification for plant translocation, in fact, is often located in the previous cultivation in botanic gardens;⁵⁵ plants, it is argued, have already been moved in (supposedly) controlled settings, and extending the practice to restoration ecology is not so much a break as an explicitation of horticultural practices. This plaiting back together of disciplinary strands is actually explicitly insisted on in several papers on assisted migration:

Translocating plants is nothing new. Humans have been moving plants, particularly edible, medicinal, and more recently ornamental, species throughout our history (...). Modern horticultural and agricultural industries are responsible for wide scale translocations. (...) In addition, there is a tremendous wealth of knowledge resident in the restoration and horticultural communities in this regard, which needs to be formally documented so that it can inform decisions about assisted migration.⁵⁶

Conservation biology is a science of crisis, agriculture and horticulture practices of stability (geological, climatic, political, social): here they come back together to inform a relationship to wild plants—in the seminal agricultural gesture of seed saving and the horticultural management of wildlife—complicated by interventions learned in domestication.

Is nature, then, in the process of becoming a garden—in a doubling back to the horticultural interventions enacted in the 18th and 19th century through the introduction of exotic species to European gardens and landscapes, for instance, and assuming Western botany has ever truly left these pastoral conceptions behind? If so, the dislocations operated by ex situ conservation might help in speeding along this horticulturalisation. Only by making endangered species into the ‘immutable mobiles’ identified by Bruno Latour is it possible to imagine them in new future interspecies and geographical assemblages, and only by buying the time allotted to discontinuous life might the space for scientific debate, research and testing be carved out: ‘It gives us a little bit of space to understand how we are going to manage the material in the wild’, according to Timothy Pearce,⁵⁷ the Conservation Partnership Coordinator for Africa at the Millennium Seed Bank Partnership. These dislocations, temporal and spatial, also allow for an enclosure of nature, of the planet itself, through the extension of the managed capsule that is the repository (or the living collection) to what lies outside; a blurred distinction, since it can now be treated as an extension of the horticultural and agricultural ex situ regime. The controlled migration of species, starting from biodiversity repositories, extends their reach to encompass a future management ‘in the wild’.

But the wild so remade might be more than a garden; one more turning of the screw has been added to conservation biology by the technological-military irruption of the Earth seen from outside and above into the collective consciousness and specific scientific practices;⁵⁸ Soulé’s millennium ark seems an obvious response to self-contained fantasies about Spaceship Earth. The emergence of the environment as global and planetary was made possible by the rise of distancing and globalising visual, sensing and control technologies. Along with the emergence of Earth as an exceptional and well-regulated vessel as fragile as it is formidable, a ‘pale blue dot’ where life is contained, placed in the universe, and grounded, these technologies might also have enabled the contrary movement of an extraterrestrialisation of the planet now made alien and strange by distance. Terrestrial Mars analogues already abound; and the interventions into ecosystems and landscapes allowed by the articulation of ex situ conservation and projects of assisted migration could be seen as a practice parallel to terraforming, a response to a terradeforming that has, arguably, been ongoing all through the intensification of human interventions into the climatic, biotic and abiotic composition of the planet. Only through the distancing already performed by ex situ conservation is it possible to look back at the planet and see it refracted as matter to be intervened into through the judicious application of life and its adaptive powers. If in-situ conservation can be said to aim for a ‘Holocene museum’, in which a good Anthropocene would just be a Holocene saved and suspended,⁵⁹ ex situ conservation, while also operating with miniaturisation and enclosure, might be stockpiling the components for a future alien analogue of what the Earth once was, with a mandate to tinker for maximal inhabitability rather than exact reproduction.

‘Accommodate species in a changing world’⁶⁰: temporal potentialities

What does extinction become, then, in this shifting margin where ex situ conservation and assisted migration projects meet? The event seems to be indefinitely deferred in the deep freeze of seed vaults, that zone of the incomplete where, as suggested by Matthew Chrulew, species, ‘rescued from the catastrophe menacing their places of origin, float free of the encroaching risks of existence’.⁶¹ Latent life exists at what Thom van Dooren has called the ‘dull edge of extinction’⁶²—the time between the effective extinction of a species and the death of the last individual, made immensely plastic by the practices of ex situ conservation and frozen suspension. Ex situ conservation projects frame extinction as a problem of species plasticity (that which threatens the unadapted) as well as mobility (that which threatens those who cannot move), as Hällfors et al. note.⁶³ Both are problems solvable by making endangered species into immutable mobiles with controllable life rhythms. Or rather, solving the question of mobility might make plasticity obsolete, since all it takes for species that cannot adapt is to follow shifting habitats, and given the means to do so quicker than they would without human intervention (a seemingly accelerationist response to accelerating climate change).⁶⁴ While this approach coexists with a focus on last individuals and on the preservation of species as genotypes, counter-extinction here takes on a particular, distinctive meaning: safeguarding the mobility of species across landscapes.

While ex situ conservation enables the half-presence of species in entirely non-generative spaces (the freezer) or in environments where generational transmissions and entanglements might have been irrevocably severed through displacement and management (the zoological and botanic garden), it also enacts the spectral presence of endangered species where they are not yet, to where they might one day be translocated, resurrected or transplanted from their repositories into unravelled and shifting landscapes. Absence in the world is remediated by the passage of life through this place of deferral, a spatio-temporal valve that can remake species from ecological nomads—in Gille Deleuze and Félix Guattari’s sense—into migrants, having left behind ‘a milieu that has become amorphous or hostile’ and seeking conditions similar to their previous territory. The anthropologists Tracey Heatherington and Bernard Perley have described the Svalbard Global Seed Vault as a liminal space⁶⁵, and perhaps the freezer is indeed such a space for plants, a marginal no man’s land where they are brought to the very brink of continued existence in order to be restored to, redeemed into new environments, ostensibly unchanged but in fact existing no longer as ontologically fragile endangered species in disappearing landscapes but as fully alive and flourishing migrants ready to take root in land made newly available by climate change, on a planet extraterrestrialised.

Whether we attribute such a liminal quality to the seed bank or not, we are pointed here toward the peculiar temporal regimes at work in the salvation enacted by ex situ and assisted migration projects. The freezer remakes not only individual bodies and the species they represent, but also their interconnections; intraspecific, interspecific, with the abiotic components of their historic habitats, with climatic and seasonal rhythms, and so forth. Freezing endangered species means spatio-temporal connections severed or partitioned for storage, knots of time⁶⁶ unraveled in the hope of future reconnection. But it also tells of missed connections, of those which endangered species are not able to forge or catch anymore, of missing corridors, disjointed landscapes, disrupted synchronicities (flowering times, droughts, unseasonal frosts), and of the hopes of arresting this unravelling in order to help them remake connections, to stitch together what the theorist and artist Andrew Yang calls ‘vast ecologies

of interruption'.⁶⁷ Michelle Bastian reminds us of the fact that asynchronicity can sometimes be the goal of conservation strategies, the deliberate disconnection of a 'deadly sharing of time' between humans and nonhumans the only hope for salvation for some species—estrangement rather than more synchronicity⁶⁸. The same kind of unlinking is at work in ex situ conservation in general, in its efforts to safeguard species from an encroaching environment, the only remaining solution a radical decoupling of timelines, that of the geographic adaptation of species from the accelerating unraveling of rapid climate change. This decoupling, unlike the practices for leatherback turtle conservation described by Bastian, do not take place in situ but rather through practices of stockpiling, a form of proprietary relationship to endangered and extinct species which foregrounds their suspended past as a reservoir for future temporal rewirings.

Here we might take a short detour through anthropology, and in particular the evolutionist and comparative anthropology of Alain Testart, to unpack the temporal practices at work in ex situ conservation and its projected uses. Frédéric Keck, in an article on flu vaccines and the conservation of the past for 'unpredictable futures', builds on Testart's work on hunter-gatherers and storage to understand both the behaviour of 'virus hunters' and the different temporal and thermal regimes of flu sample and vaccine stockpiling, an example of how relevant comparative anthropology can be to cryopolitics. Testart sees in food storage the first step toward sedentarism in its deferral of immediate consumption, and, according to Keck:

*Food storage [...] brought about a 'total change of mentality': the past became more privileged than the present to anticipate the future, and nature came to be seen not as an ever-providing source of sustenance but as a capricious source of disasters.*⁶⁹

This is what he calls for seed sourcing and sampling put forth by Guerrant⁷⁰ and Havens⁷¹ are preparing for. Dwelling in the past of preservation rather than in the furiously paced present of extinction, stockpiling makes extinction a matter of property at least as much as mourning, and restoration and salvation matters of preparedness; stockpiling is not the same thing as mourning or memory work, as it is always a projection into a concrete future of use or consumption, of active and practical transformation. As I have argued earlier, the persistence of the past in suspensive conservation does not necessarily lead only to fantasies of its recreation; *anticipating the future* means activating uses of the past that go beyond simple self-identity. Ex situ conservation does not solely try to loop back into Holocene stability, but is pushed into the presence, shimmering between projection and existence, of its futures, already taken up by them, enacting them theoretically, testing what it might do with its accumulated stock.

In this sense, assisted migration projects emerge as the science-fictional expression of the frozen arks we have now, themselves part of the restorative and narrative potential banked along with seeds and gametes. As the science-fiction writer and theorist Samuel Delany puts it in his seminal definition of the genre, science-fiction is not so much a representation of the future as a 'significant distortion of the present',⁷² a definition which might be, without doing it too much violence, applied to speculative conservation projects. Assisted migration, as of now, is still confined to very small-scale feasibility studies in carefully controlled environments and at early and prudent stages of implementation. Proposals for future wider applications of these projects are entirely science-fictional, in the sense Delany gives to the word: they distort the present, a present in which vast quantities of the past have been stockpiled for uncertain planetary futures. Assisted migration is one possible expression of this stock and of the world and events (extinctions or environmental catastrophes) inscribed and constituted by that stock

– and a significant distortion in that it chooses very specific elements to actualise or to amplify, out of which to worldbuild new natures that represent only one possible planetary future.

Perhaps a finer and more accurate lens through which to read the temporal relationships between ex situ conservation and the worlds made through their use in assisted migration projects would be the philosopher Elie During's concept of retrofuturity,⁷³ adding a metaphysical layer to an anthropological and literary understanding of conservation biology practices. While During applies the idea to art, design and architecture specifically, it does useful work for understanding proposed conservation projects as well. Futures do not exist, they insist; reactivating a Bergsonian understanding of the possible, which is not the future but contemporaneous to the present, During unpacks the mode of functioning of retrofuturism, the creation of a 'floating temporality' that inhabits the present. 'This retro-futurism is signaled by the capacity of the present to carry an image of itself as the future; but also, simultaneously, as the past'; the future is already here, still here, 'a phantasmagoria of the present, not a dream of the past. And this phantasmagoria is effective; it is not a simple projection, but an objective tendency working at the heart of the contemporaneous'. What During calls retrotypes (rather than prototypes, which would be elements in a simple linear development from idea to object) are the manifestation of this retrofuture, the activation of the potentialities inherent in a present that is also the future of the past. The artwork needs not simply 'to become but to be made', and it is made by reactivating those retrofutures, explicating them through an intervention in the form of a project, a model, a sketch, always kept at the level of virtuality. If ex situ conservation as we know it now is the future of colonial pasts, and if we think of assisted migration projects as one explication of all the temporal potentialities compressed into ex situ conservation that bypasses some futures by reactivating others, we might start to think about the fraught, dangerous, connected and dizzying vitality of ex situ worlds as 'works to be made' through the projected uses they are put to.

The present of ex situ conservation, be it living or suspensive, a present which relies on the accumulated presence of an evolutionary and planetary past kept in reserve to anticipate uncertain futures, is worked through with a shimmering set of potentialities that must be studied in order to understand the full scope of suspensive practices and their interventions into future worlds. Fragmentation, control, extraterrestrialisation, cataclysmic environmental catastrophe, climate change as warfare, Earth as a self-contained and recursive cybernetic entity, the reactivation of colonial terraforming ambitions, all exist as possible world-making projects banked along with the collection of seeds – their own conceptual metabolism slowed down in the deep freeze but ready to be reactivated at any given moment, through virtual projects of which assisted migration is but one example.

Assisted migration, in a few years' or decades' time, might then stand as a monument of retro-futurity, as one of the ecological futures that might have emerged from the capsular enclosure of ex situ conservation—remaking nature as an extraterrestrialised space of transformation and horticultural care. A technoscientific entity that could be placed squarely into Donna Haraway's litany of chimerical 'objects into which lives and worlds are built—chip, gene, seed, fetus, database, bomb, race, brain, ecosystem',⁷⁴ the suspensive repository thus becomes a place where past, presents and futures simmer alongside each other, for better or worse, but certainly animating the suspended bodies in their safe cryosleep with a wealth of potential temporal becomings, binding them back into complex networks of hope and mourning, material and discursive work, despair and technological fixes. Informing various forms of thermal margins, ex situ conservation is just as explosive as it is suspensive, teeming with the manifold virtualities of the future. Just as the eighteenth-century garden

was a political 'place of investigation into the relative importance of natural powers and social interactions in remodeling the living being'⁷⁵, the experimental garden-with-seed bank is a reduced model in Lévi-Strauss's sense of the term,⁷⁶ a sketch or blueprint for various kinds of natures. Whether it becomes a device for a humbly modified attention to species, relationships to extinction and the management of disrupted landscapes and climates or a proposal for queering too self-evident technoscientific linearities depends on which experiments can be grafted on the fraught and impure pasts they have accumulated, which distortions, eventually, come to pass.

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33. William E. Friedmann et al., 'Developing an exemplary collection: A vision for the next century at the Arnold Arboretum of Harvard University', *Arnoldia*, vol. 73, no. 3, 2016, pp. 2-18.
34. See for instance the interplay of response and citation between articles and letters such as Ricciardi and Simberloff, 'Assisted colonization is not a viable conservation strategy', and Vitt, Havens and Hoegh-Guldberg, 'Assisted migration: part of an integrated conservation strategy', or the set of tightly interlinked articles comprised, among many others, of Hoegh-Guldberg et al., 'Assisted colonization and rapid climate change', Thomas, 'Translocation of species, climate change, and the end of trying to recreate past ecological communities', Webber, Scott, and Didham, 'Translocation or bust! A new acclimatization agenda for the 21st century?', Vilà and Hulme, 'Jurassic Park? No thanks'.
35. Hällfors, Vaara and Lehvävirta, 'The Assisted Migration Debate'.
36. "In the spirit of exploration and experimentation, the Arboretum has continually acquired germplasm of marginally hardy taxa to be coaxed into cultivation, despite and against all odds. To ensure that the Arboretum stays at the cutting edge of plant introduction (especially in a world of rapid environmental change), it must seek out, acquire, and test untried species for growth on the grounds. Importantly, identification of new "marginal" taxa should be coupled with targeted field collections of germplasm from parts of the taxon's natural range that are likely to predispose such accessions to ultimate success on the grounds." (Friedman et al. 'Developing an exemplary collection')
37. Smith et al., 'Chaperoned managed relocation'.
38. Guerrant, Havens and Vitt, 'Sampling for Effective Ex Situ Plant Conservation' and Havens et al., 'Seed sourcing for restoration in an era of climate change'.
39. Pati Vitt, Kayri Havens, and Ove Hoegh-Guldberg, 'Assisted migration: part of an integrated conservation strategy. Letter in response to Ricciardi and Simberloff', *Trends in Ecology and Evolution*, vol. 24, 2009, pp. 473-474.
40. Joanna Radin and Emma Kowal, 'Introduction. The politics of low temperature', in Joanna Radin and Emma Kowal, *Cryopolitics: Frozen Life in a Melting World*, MIT Press, Cambridge, Massachusetts, 2017.
41. Radin and Kowal, 'Introduction. The politics of low temperature'.
42. Donna J. Haraway, *Modest Witness: Feminism and Technoscience*. Routledge, London, 1997 and Rose, 'Reflections on the zone of the incomplete'
43. Nigel Clark, *Inhuman Nature: Sociable Life on a Dynamic Planet*, SAGE Publications Ltd, Los Angeles, 2011.

44. Uncertainty – both about the strategies to adopt now and their predicted outcomes in the future – is stressed time and again in most papers on the topic and echoed by Peggy Olwell in an article of the New York Times: “Because frankly, we don’t know what it is we’re going to need when we’re talking restoration in light of climate change. It’s going to be one big experiment” (Raver, ‘A Hunt for Seeds to Save Species’).
45. Rachael Davies, Alice Di Sacco, Rosemary Newton, ‘Technical Information Sheet 13a: Germination testing: procedures and evaluation’, Royal Botanic Gardens, Kew, Richmond, 2015.
46. Warwick Anderson, ‘The Frozen Archive, or Defrosting Derrida’, *Journal of Cultural Economy*, vol. 8, no. 3, 2015, pp. 379-387.
47. Emily Apter, ‘Planetary Dysphoria’, *Third Text*, vol. 27, no. 1, 2013, pp. 131-40.
48. The concept is used by Clark to qualify the “elemental underpinning” of social thought – the cohabitation with geological processes that predate any sort of human history and with natural catastrophes exemplifying how asymmetrical the distribution of power between humans and the planet actually is.
49. Hällfors, Vaara and Lehvävirta, ‘The Assisted Migration Debate’.
50. Jacques Derrida, *Archive Fever: A Freudian Impression*, trans. Eric Prenowitz. University of Chicago Press, Chicago, 1996.
51. Michel Foucault, *Naissance de la biopolitique : Cours au Collège de France (1978-1979)*, Seuil, Paris, 2004.
52. Royal Botanic Gardens Kew, ‘Banking the UK’s Seeds’.
53. Vitt, Havens and Hoegh-Guldberg, ‘Assisted migration’.
54. Havens quoted in Raver, ‘A Hunt for Seeds to Save Species’.
55. “Similarly, horticultural planting outside native historical distributions contributes to passive range expansions (Van der Veken et al. 2008, Woodall et al. 2010), and botanic gardens are beginning to explore their capacity to actively foster range expansions under climate change (e.g., Vitt et al. 2010).” (Schwartz et al., ‘Managed Relocation’)
56. Vitt, Havens and Hoegh-Guldberg, ‘Assisted migration’.
57. Royal Botanic Gardens Kew, ‘An Interview with Tim Pearce’.
58. Sebastian Vincent Grevsmühl, *La Terre vue d’en haut: L’invention de l’environnement global*, Seuil, Paris, 2014 and Haraway, *Modest Witness*.
59. “[...] the Isle of Man is, indeed, the Earth in the Anthropocene. It is enclosed, ultra-small [...], an Anthropocene biosphere whose ultimate ambition may be defined as becoming an artificial Holocene—a Holocene sustainable over long periods of time, thereby freezing and eternalizing the evolutionarily produced, hence somewhat arbitrary content of holocenic Earth.” (Daniel Falb, ‘Isle of Man. Poetic Co-evolutions towards the Holocene Museum’, 2015.)
60. Hällfors, Vaara and Lehvävirta, ‘The Assisted Migration Debate’.
61. Chrulew, ‘Freezing the Ark’.
62. Thom Van Dooren, *Flight Ways: Life and Loss at the Edge of Extinction*, Columbia University Press, New York, 2014.
63. Hällfors, Vaara and Lehvävirta, ‘The Assisted Migration Debate’.
64. It is worth noting that assisted migration projects are marked by an insistence on the fact that they do not suspend evolutionary becomings: “We propose a framework in which the ecological aspects of assisted migration are evaluated using rubrics from restoration ecology, i.e. establishing or preserving functional ecosystems, while preserving the evolutionary trajectories of individual species, as most conservation biologists seek. The end goal is to preserve both the ecological roles and evolutionary potential of the greatest number of species.[...]In the context of future climate change, the greatest survival limitation for many species is not their ability to adapt, nor even their intrinsic ability to migrate appropriately, given a landscape with sufficient connectivity. The most significant hurdle is that the landscapes across which they will need to move lack connectivity, and scenarios in the latter half of this century predict increasing fragmentation and decreasing effectiveness of corridors, which will impact species differentially.” (Vitt et al., ‘Assisted migration of plants’). See also: “We also assert that, rather than paying ‘little attention to the evolutionary context,’ we embody a deep commitment to ensure that long-standing products of successful evolutionary lineages have a chance to persevere and continue their adaptive pathways.” (Vitt, Havens and Hoegh-Guldberg, ‘Assisted migration’)
65. “The Global Seed Vault excites the imagination because it is a liminal space where the material substance of biodiversity—our seed heritage— returns to a state of seemingly infinite potential. However we perceive the eventualities that might unlock that potential, such places offer us resilience against the burgeoning disorder of species loss and the fateful temporality of extinctions. Highlighting illusions of endless resources and endless development that underpin late capitalism, places like the Global Seed

Vault nevertheless rescue modernity from forbidding chaos, and give us hope.” (Tracey Heatherington and Bernard C. Perley, ‘Fieldnotes from Svalbard: How Global Dreamings Take Root in the Arctic Frontier’, 2017)

66. Michelle Bastian, ‘Encountering Leatherbacks in Multispecies Knots of Time’, in Rose, Deborah Bird, Thom Van Dooren, and Matthew Chrulew (eds), *Extinction Studies: Stories of Time, Death, and Generations*, Columbia University Press, New York, 2017.

67. Andrew Yang, ‘Flying Gardens of Maybe’.

68. Bastian, ‘Encountering Leatherbacks’.

69. Frédéric Keck, ‘Stockpiling as a technique of preparedness: conserving the past for an unpredictable future’ in Joanna Radin and Emma Kowal, *Cryopolitics: Frozen Life in a Melting World*, MIT Press, Cambridge, Massachusetts, 2017.

70. Guerrant, Havens and Vitt, ‘Sampling’.

71. Havens et al., ‘Seed sourcing’.

72. Samuel R Delany, *Starboard Wine. More Notes on the Language of Science-Fiction*. Pleasantville, Dragon Press, New York, 1984.

73. Elie During and Alain Bublex, *Le futur n’existe pas. Rétrotypes*, B42 Editions, Paris, 2014.

74. Haraway, *Modest Witness*.

75. John Hartigan, ‘Plant publics: Multispecies relating in Spanish botanical gardens’ *Anthropological Quarterly*, vol. 88, no. 22, 2015, pp. 481–507.

76. Claude Lévi-Strauss, *La Pensée sauvage*, Plon, Paris, 1962.