Museum Ecologies and Digital Collection Systems

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Abstract

New research highlights the importance of making more productive connections between museum activities and the environment to take action to work more sustainably. This paper provides an understanding of museum 'things' as evolving bundles of ecological relations, and offers a novel method for tracing museums' impacts on the environment. In our pilot project, *Museum Ecologies and Collection Management*, we have worked with digital collection databases as an example to show how museum collections are interlinked with environmental and climate change. The research elaborates on how museum ecologies can be used to move beyond anthropocentric notions of human-thing relationships, using environmental humanities perspectives with tools from critical feminist post-humanism and new materialism; and by acknowledging Indigenous knowledge. This paper investigates how museums and cultural heritage, observed, and understood as ecological agents, can guide us as we struggle to find new ways to live in the Anthropocene.

Introduction

Museums are central to explaining, understanding, relating to, and acting on issues of sustainability (Cameron and Neilson 2015; Mitman et al 2018; McGhie 2019). Active online communities gather around these questions of how museums, galleries and culture (understood as an 'all-inclusive term') can work with sustainability in an open dialogue with stakeholders.[1]

The important role of museums and heritage today, particularly in matters of futuremaking, has been underlined by many researchers (Holtorf and Högberg 2015; Newell et al 2017; Fredengren and Owman 2023), and there is a drive to ecologize and to work differently with the more-than-human world in museum and heritage contexts (Cameron 2015; Fredengren and Karlsson 2019; Fredengren 2021, 2022; Fredengren and Owman 2023; Owman 2021; Fredengren, Nilsson, Holmstedt and Owman 2024; Bangstad and Pétursdóttir 2021). Connected to this, heritages bring with them several materializing relations from the past that also stretch through the present and territorialize the future by pushing materializing legacies onto emerging human and more-than-human communities (Fredengren 2015; Harrison 2015; Harrison and Sterling 2020; Fredengren and Åsberg 2020). Hence, museum collections (and other types of heritage), set up and activate relations between past, present, and future generations by storing, exhibiting, and storying features from the past. Such 'intragenerational' relations, which entangle more-than-human agents together over time (Fredengren 2022), also have environmental impacts. Thus it is important to investigate how museums can be linked to the ecologies of the situated worlds they draw upon and bring forth, with the complexity of human and more-than-human agents that they are enmeshed with.

This paper explores how entangled museum 'things', come about, exist, and work ecologically by drawing upon case studies from the Museum Ecologies and Collection Management pilot project. What is proposed in this paper is a more-than-human approach that could make a difference in understanding and tracing how museum things act in collections, curation, conservation, and storytelling. Our research provides both a theoretical exploration

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as well as a prototype for an analytic tool that could be of interest for the museum sector.

The research presents a method for how to analyze museum things in ecological and relational ways, by moving from working with museum artefacts as bounded objects, to working with them as agential relational phenomena. The method provides a novel entry into museal processes and systems, by asking questions about the manifold agentialities and ecological ties of museums and their collections, and how they fit into the digital collection systems used by museums and are changed by such registration. Such systems both add connections between collections, museums, and the external environment, and also cut them apart from relations. Our overall objective is to investigate how ecological tools can provide a better understanding of museum things - as bundles of evolving relations - and the role of museums as environmental actors.

In our project, we trace museum ecologies and bring them into the discussion of museum processes. More specifically, we test how digital collection management systems handle and transform museum things. Our aim is not to critique existing digital museum collection systems but to explore how, and if, things in such systems can be acknowledged as having agency, and what relations they form both within such systems and outside them. We also discuss how the use of digital systems, together with the use of linked data, alters the agentiality of things both in an environmental way and with regards to the animacity of them.

The empirical material that forms the basis for this article is a pilot study of a set of museum things and their digital registrations as museum objects. In the study we explored various collection management systems used in Sweden (such as Carlotta, Axiell Collections, and Primus) and co-worked with researchers at the National Historical Museums, The National Museums of World Cultures, Skansen, and Museum of Östergötland. The project worked with so called 'test-beds', where each museum selected a few objects (as museum things) from their collection to engage with. The museums reviewed the things' digital documentation before applying a museum ecological method, and then carried out workshops to trace their ecological relations. This tracing was also complemented by limited archival research into the shadow places and future territorializations of the selected museum things. The digital collection management system was then tested to see if it could represent such relations or if other measures were needed to carry out the task. The goal is to use this pilot study as a stepping stone for building a future large-scale research project, that widens the understanding of the processes and relationalities of museums as actors in times of environmental and climate change.

Museum things as guides through the Anthropocene

There are new and creative ways to activate museum things and explore them as guides when dealing with ecological challenges of the Anthropocene in the areas of both public engagement and collection management and conservation. For example, Bruno Latour and Peter Weibel (2005) have traced what happens when exhibition things are made public and become matters of concern. Latour has, on several occasions, argued for taking things more seriously and challenging the artificial boundary set up between what is an animate or non-animate phenomena. Not only rivers but also tectonic plates and volcanoes have a significant agential capacity and it is of uttermost importance to acknowledge such agencies in the Anthropocene (Latour 2014; however, see the critique of Latour for the lack of recognition of Indigenous scholarship in Todd 2016). Such an expanded conceptualization of agency that can be found in Indigenous scholarship, as with Latour, is of relevance when thinking about an ecological understanding of museum things.

Latour and Weibel's work has provided the basis for Tingenes Metode, an important educational tool for interaction and participation, used to combine museums' needs for openness and inclusion in their tasks of interpretation, management, and research on collections, that has been used by both national and local museums in the Nordic countries (Huseby and Treimo 2018). It focuses on the museum's role in society and draws on Latour's explorations of the double meaning of the word 'thing' (2005: 22-23; Huseby and Treimo 2018: 10). A 'thing' is a word for an object and a parliament, as in the Icelandic *Þingvellir* (or *Thingvellir*), and this ambiguity was made use of when formulating Tingenes Metode. The purpose of the method

is to find new perspectives and knowledge on the collections that make them more relevant today by involving more people in an assembly (a *Thing*) to talk about museum processes, and share their interpretations about museum things. Thus, the method investigates what happens when museum experts open up to acknowledge that other humans, beyond museum personnel, have relations to and knowledge of museum things (Huseby and Treimo 2018: 11).

However, we argue that despite the merits of the method and its theoretical background (in terms of engaging with the relationality of museum things) in focusing solely on human-thing relations this approach overlooks other important agencies. Just like heritage in general, museum things can be understood as multi-relational and evolving phenomena that come into being and change over time as their relations shift (Fredengren 2015; 2018). Museum things come about through 'agential cuts' that are made into an interconnected world. Such cuts are provisional stabilizations of the world (Barad 2007) made to document and study it. Museum things are 'cut to shape', and 'stabilized' so to speak, through accession processes, classifications, bureaucratic processes, registrations in museum collections systems, and regimes of conservation and heritage care. Yet, whilst things can be projection spaces for many different human interpretations, they are also more than that as they work materially in a number of different ways. For example, things form relations in museum stores as they exchange chemical compounds, as they interact and change in their processes of decay, or become habitats for fungi and different insects. Museum things can also be deeply toxic, which has been noted particularly in processes of repatriation where things handed back to Indigenous communities are poisonous and therefore difficult to handle (Jordan Simms and Macintyre 2014). Furthermore, they also form relations with various technical and digital systems. Hence, things can be understood as a coming together of several material and immaterial relations that from time to time attract human attention, but sometimes go on 'under the radar'. This means that not only are there different human stories attached to these things, but the things themselves emerge and change in response to various historical and material relations. Such an approach can offer new perspectives, and our work with museum ecologies thus seeks to move beyond an anthropocentric focus on human meaning making, to open up a more-than-human relational analysis of things that takes into account their expansive and transtemporal ecological relations. Here our project works with related, but different, tools derived from the fields of new materialism, critical posthumanities, multispecies studies, environmental humanities, and Indigenous scholarship (Barad 2007; Bennett 2010; Braidotti 2013; Haraway 2016; Todd 2016).

With this our approach goes further to examine the several more-than-human agencies at work in museums. As Jane Bennett's (2010) work on 'thing power' proposes, things have an active role in public and political life: they constitute lively, vibrant matter, capable of forming relations with or without human interlocutors. According to Bennett (2010: 6) there exists a 'curious ability of inanimate things to animate, to act, to produce effects dramatic and subtle'. Applying this to the museum context, museum things are not silent, waiting to be ascribed memories or meanings by experts and visitors, but actively generate relational realities, contribute to storytelling, and create circumstances that facilitate and hinder actions for humans, animals, and the environment. What we argue, therefore, is that paying closer attention to the relations museum things establish can help guide us through the ongoing Anthropocene environmental crisis.

Ecology and museum ecologies

Traditionally, ecology studies the interplay between animals, plants, other organisms, and their environment. From a humanistic perspective, Tim Morton (2010) has expanded the concept and points out that ecologies are not limited to what we traditionally see as 'nature'. They are more than that: humans and more-than-human agents coexist with technologies, and all are enmeshed in each other's worlds and ecologies. This understanding of ecologies can be brought into a museum context, as shown by Christina Fredengren and Johnny Karlsson's (2019: 116) research into the museum ecologies around a wetland find in the stores of the National History Museum of Sweden. Museum things connect up and extend particular ecological relationships and there is a need to capture and trace what the materialization

processes of collections and museums do, and follow their joined ecologies to a greater extent from their existence out in the world. Our version of museum ecologies involves working with museum things in a process-ontological way, where they can be traced as evolving bundles of ecological relations.

The work on museum ecologies involves questioning the binary divisions into natural and cultural, as in the splitting up of collections into artefacts and ecofacts. These understandings have been used by Christina Fredengren and Caroline Owman (2023) to look into the more-than-human temporal relations at work in museum settings: investigating museum things that stretch out in queerly temporalizing ways which tie past, present, and emerging more-than-human generations together. Hence, a museum ecological method expands the ecological and explores things as transtemporal ecological relations (Fredengren 2015; 2021) as they gather up relations with landscapes, local lived worlds, relations to fungi, plants, animals, fields, forests, mountains, lakes, river, technologies, and stories. In the study of so-called 'media ecologies', Fuller (2005) and Hörl (2017) also work with an expanded ecological concept. It is about exploring the complexity of contemporary media systems and how they affect which agents are in motion, as well as which conditions for life forms (human, or superhuman) will be created in different planetary futures. Our work builds upon Fuller and Hörl's media ecologies, to acknowledge that museum ecologies also consist of the different media systems that museum things are immersed in, for example, an object's packaging, storage place, computers, server halls, and scanning apparatuses. When bought, inherited, or excavated, and musealized, the object could be said to be transferred from one media system (e.g. a prehistoric burial site) to another (museum storage facilities and digital records), whilst connecting both through this very displacement (Holmstedt and Fredengren, forthcoming). Nodes of importance shift and multiply, together with material connections. In this version, museum things are, themselves, also *storage media* that have connections with particular environments, and may inform practices for how to relate to and to get on in situated locations under other ecological circumstances. Museum things thus hold potentialities for establishing knowledge and material contacts between generations, which are also entangled in ecologies both within and outside museums.

Museum ecologies need to take into account the concerns of not only past and present generations, but also of emerging generations. As such there is a need to include questions about more-than-human, intragenerational justice and care (Fredengren 2022) in museum deliberations. Of interest here are methods of researchers such as Eben Kirksey (2014), who has developed the Multispecies Salon, which offers a multispecies ethnography that brings animals, fungi, trees, and plants into concern. Such expansions in museum contexts would move beyond the creation of a parliament of things that focuses on meanings and storytelling ascribed by human stakeholders. Instead, a more democratic parliament of things would emerge that includes a range of 'othered' participants: such as excluded communities, future generations, and those who are classed as nature (e.g. bugs, animals, fungal growths), as well as digital systems and technology. It would bring in concerns about other stakeholders and also allow the tracing of the ongoing material and immaterial ecological entanglements of museum things within situated worlds.

Shadow places and future interventions

Based on these expanded concepts of ecology and a relational understanding of things, our pilot study tested how a selection of museum objects could be relationally mapped and hence provide a better understanding of how they act and influence both environments and environmental thinking. In practice this could mean tracing the origin of a thing back to the extractive economies behind its chain of production, which might have left unhealed wounds in the landscape. Or it could be to trace a relational cartography of the colonized power arrangements and the oppression of Indigenous communities, which feed into an object's eventual musealization. This endeavor can be understood in relation to the work of Val Plumwood (2008), that urges us to trace the 'shadow places' of different phenomena. Shadow places, as Plumwood (2008: 139) frames it, 'are capitalism's externality': its 'disregarded places of economic and ecological support'. Applying this to a museum object, the process of tracing

shadow places can be expanded to show links to place, and material and immaterial structures important to the object's making, use, and disposal that affect environmental conditions and ways in which it relates to how the Earth is inhabited. To trace the shadow places of a museum thing might also involve a mapping of, for example, the colonialist, imperialist, and invasion stories and relations that lurk in the background of how a particular museum thing has come about. Such structures, practices, and relations actively construct a geography of justice/injustice that constitute the multiple shadow places of a museum thing. Shadows are also cast into the future through museum collections and activities which impose, facilitate, or hinder coming action possibilities.

A concrete example of such future interventions can be noted when museum things are borrowed and transported to museums around the globe. Not only do they create relationships with other places, but such courier journeys also link the museum object to CO2 footprints. Thereby, museum objects extend outside themselves and, together with cars and airplanes, co-produce CO2 increases in the atmosphere that add to present and future climate change. Challenging commonplace ideas about what a thing is, Timothy Morton (2013: 1) describes phenomena such as climate change as 'hyperobjects' that are 'massively distributed in time and space relative to humans'. Furthermore, as Zoe Todd (2016: 8) emphasizes, the climate is a general organizing force. As such, climate and climate change intermingle with and exert agential powers on museums and their stores, but also feed into the production of larger entities such as global warming. Moreover, the use of digital collection management systems has a vast environmental impact itself, with the energy consuming practices of the digitized (and climatized) data storage adding to those of the climatized storage rooms within which objects are physically kept (Monserrate 2022; Nguyen et al 2020).

Another example is how conservation measures may create both situated human-animal relationships (Owman 2021) and tie future generations into networks where continued care of the collections is implied. Instead of understanding museum things as delimited objects that can be ordered by classification and systematized into artifact types, museum ecological thinking tools focus on the many more relations that gather around museum things to create webs over time. Museum things keep connections with a whole landscape and environment within them as multifaceted more-than-human materializations. Museum things are not only memory banks for humans, but are also storage devices for practices and relations.

A museum ecological method widens both heritage and museum stories by examining what ties exist between these and the environment. However, we want to both respect and move beyond a focus on human storytelling. To follow museum ecologies means to add to the question of what a museum thing is with the important extension: what does the museum thing do, and what agential relations render it capable of doing what it does ecologically? In effect, this is a move to acknowledge the agentiality of museum things, and this way of understanding is explored in our case studies below.

Case studies and test of digital collection management systems

The project used these museum ecological tools to test a selection of collection management systems used by museums in Sweden (some of which are also used abroad). The project worked with the Axiell Collections, Carlotta, and Primus relational databases. These databases consist of modules where data regarding the object itself, and the processes related to the object such as accession, history, location, and condition can be noted. The information on the museum items can be linked up to controlled vocabularies[2] that hold definitions of, and cross-references for, key concepts in the databases. Already much effort is being made in the museum sector with open linked data, which facilitates users outside the museum to tap into museum resources. There are several projects, such as Wikidata, that explore the use of these types of data for research. What we add is an expanded knowledge of how relations between humans, materialities, and the environment can be captured by placing the museum collections in an ecological context. We have been working with digital cataloging of a selection of museum things with a particular focus on how ecological relationships are articulated, and how more-than-human agency was captured and expressed in the museum's digital collection management system. We were curious as to what extent relationalities

between objects, shadow places, and future territorializations could be captured in an in-depth registration via events and linked data in the digital collection systems, and also to what extent the digital contributes to a more digital vitality of things. Furthermore, we want to highlight the challenges that arise when trying to register and handle museum things with their ecologies in a selection of these digital systems.

The selected study materials ranged from artifacts to soil samples to buildings, all of which are handled in digital collection management systems as objects.[3] The museums were asked to choose a test object from their collections. They then constructed an analogue mind map of all possible information that captures the particular thing's ecological footprint in the past, present, and future (e.g. in their shadow places and future interventions). The museum documented through a screenshot how the object information looked in the digital system before the test documentation started. Then the actual registration was carried out and it was explored what linking was possible to do within the system. What information could not be captured was then noted. Screenshots were taken of how the object information came across after the test documentation was carried out.

Tracing shadow places and future territorializations in collections

Museum of Östergötland: sugarloaf mould

Museum of Östergötland focused on an archaeological find within their collection of a sugarloaf mould from the town of Norrköping in central Sweden.

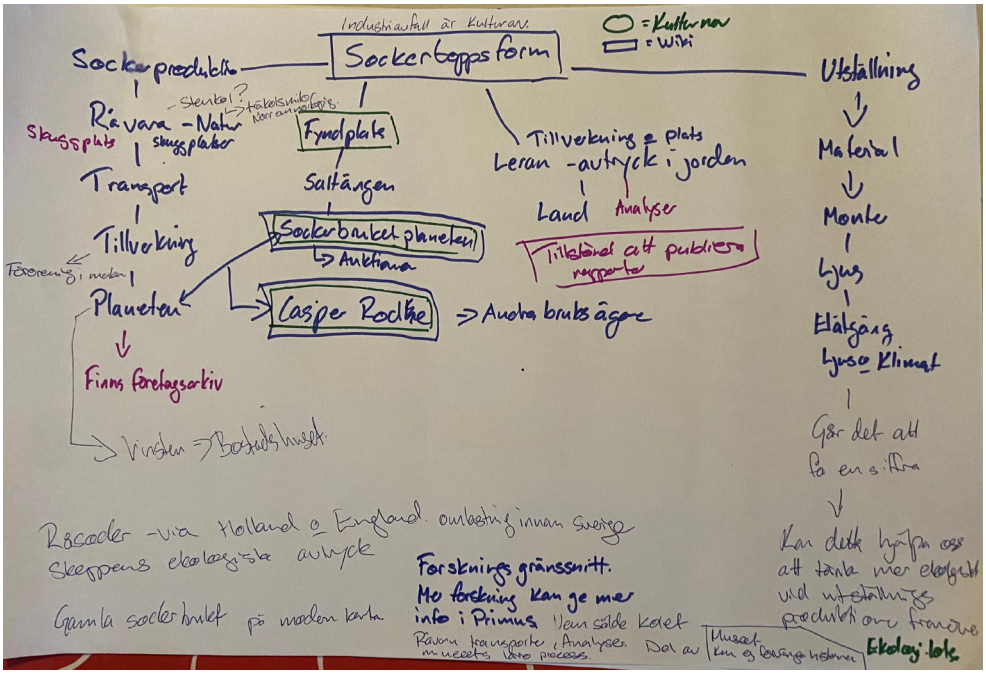

Fig. 1: Mindmap, in Swedish, of sugarloaf mould in the collections of Museum of Östergötland

The mindmap tracing (Fig. 1) shows how the mould is a relational coming together of the agentialities of humans and clay. It is composed of different materializing relations that traditionally have been captured as either natural or cultural, but such sources and forces coincide to become the thing of the sugarloaf mould. The tracing shows connections to extraction activities of clay that have left lasting imprints in the landscape, as well as links to the creation of waste from industrial activities associated with sugar loaf production, and the development of the factory system. Furthermore, in the shadow places of this museum thing, there are relations to the colonialist practices of the international raw sugar trade of England and the Netherlands, the sugar plantations, the enslavement of people, and the slave trade.[4]

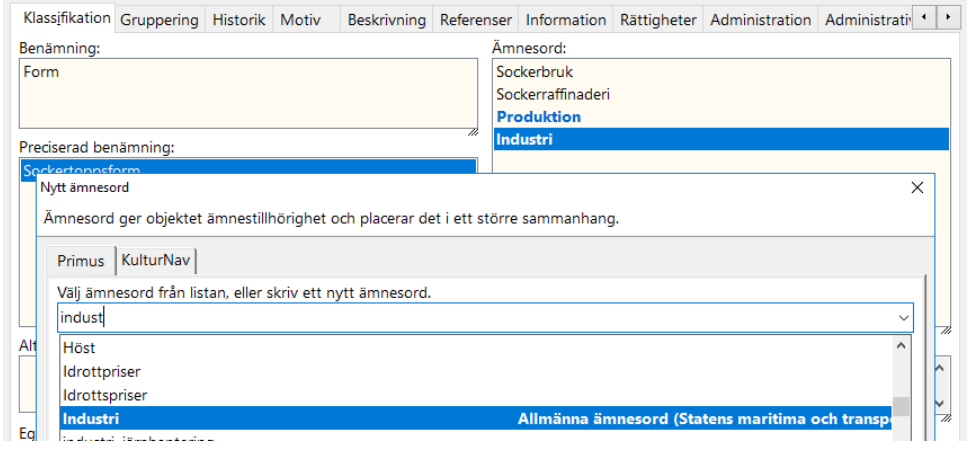

Fig. 2: The find was documented in the collection system Primus, with classification and links to Kulturnav – a Nordic platform for managing controlled vocabularies and authorities in museum settings

The team also looked at the relations that formed in the use of the item in exhibition production, where it requires a display case with light and climate controls. Here one has to take into account the energy use for the climate regulation within the museum and the environmental burdens of exhibitions. In discussions the museum staff highlighted that the energy that the exhibition of the sugarloaf mould demands, together with the other items on display, contributes to the museum's energy consumption, which would link up to a global hyperobject of CO2 buildup and climate change and hence make impacts on, and territorialize, future environments. A registration was made in the digital collection system, Primus (Fig. 2) to see to what extent the relations could be captured in the system, and it was noted that there was a need to expand the controlled vocabularies and authorities with terms that were related to ecologies, climate, and environmental change.

National Historical Museums: Wooden post and soil sample

The National Historical Museums worked with a wooden post from the Neolithic Wetland site at Alvastra, also in County Östergötland.

Fig. 3: Mindmap, in Swedish, of wooden post from Alvastra in the collection of the National Historical Museums, where links to both shadow places and future territorializations were made. The mapping also distinguishes between links that could be made directly in the Adlib/ Axiell digital collection system (green), what was desirable to add to the system (pink) and where it was possible to link to other infrastructures or to Wikidata to expand connections.

The mindmap traced events, metadata, and relations (Fig. 3) that were possible to add to the museum's collection database: Axiell Collections. There was ecological information about the wooden post such as wood species and date that was possible to input directly into the system. Tracing the post's shadow places there were also several relations (such as those to wetlands or the extraction of trees that were involved in the construction of the wooden platform) that were not directly accessible in the system, but that could be added in the future through Wikidata. Notably, however, what the system did *not* cover currently – that is of interest for future studies – were factors linked to the environmental effects of the management of the collections. Among these were, for example, the resources that will go into the climate management of the storage areas, and also running the servers for the electronic management of the collections for the future. In addition the environmental burdens pushed onto future generations in relation to transport and inspection connected to activities when collections are on loan to other museums, were not linked to the artefact of the post. Taken together, such factors and relations that go into estimating energy and climate expenditure cannot be handled in the system. Furthermore, the system does not take into account how the present collections impose relations of care onto future generations, and the environmental and climate liabilities

that accompany the processes for keeping museum things stable through conservation. As such it was identified that there was a need for improvement in the collection management system in regards to the handling of effects that stretch out over longer periods of time.

The National Historical Museums also worked with a soil sample kept in the museum. Here, the museum registration process performs other 'agential cuts' in dividing the material into things or samples, or into artifacts or ecofacts, which determine how a particular entity will be treated. This soil sample derives from an excavation of an Iron Age burial site in Gärstad, at Linköping in central Sweden, and is thus the result of both natural and cultural processes that stretch over long periods of time.[5] It bears witness to and carries the material memory of both burial practices and offerings, as well as radical landscape transformations and pollutants. The sample could be said to constitute a highly permeable archive encompassing several temporal realities. Instead of asking whose expertise this thing (or museum sample) calls for, museum personnel asked a museum ecological question: what ecological relations have produced this thing and what material relations does the thing draw attention to? Macro- and microscopic analysis of the sample links up to a landscape with plants and animals.[6] A preliminary report from a soil DNA analysis[7] indicates that the nearby motorway and the heavy traffic in the area has transversally manifested itself through DNA remains of petroleum-eating bacteria in the sample. It also reveals that a soil bacterium, *Bacillus mycoides,* which is highly adaptable to changing environmental conditions, has been present in this soil for at least 2000 years (Holmstedt and Fredengren, forthcoming). This soil sample is a living material that has continued to create relations during different periods of time. It holds glacial till, fragments of plants, burnt food, coal, clay, as well as human remains in its matrix. The soil sample connects to events in the past when the meadow on site was transformed into a burial ground and cremation site, where the burnt remains and the soil were eventually collected in a clay pot. This museum sample has also been produced as a result of land exploitation in the more recent past, as the archaeological excavation was carried out to facilitate the expansion of a waste-treatment plant in Linköping. The 'agential cuts' performed through the musealization process separated the soil from the bones and the pot, and leave the soil in a fragmented state with an ambivalent status as simultaneously heritage, sample, and a residue to be discarded after analysis has been performed. Thus, this museum thing was interconnected with several different, situated ecologies that extend both within and outside the museum building, and provide links to the more-than-human world**.**

The National Museums of World Culture: G'psgolox totem pole and gut skin jacket

The National Museums of World Culture chose the G'psgolox totem pole from the collections of the Ethnographic Museum. The pole was made from a tree called Thuja plicata or Western Red Cedar. The totem pole connects the Haisla and Xanaksiyala people with human and more-than-human ancestors, animals such as bears, spirits, and the trees in the forest. It is also tied to colonial museal practices and relations - in both Canada and Sweden. These colonial practices can be seen as shadow places of the pole as a museum object..

The totem pole was transformed into a museum object through a series of 'agential cuts' consisting of bureaucratic and colonial practices that separated it from its original location and the community relations that it was entangled in. However, the process of making the pole into a museum thing does not overwrite the meaning and role of the pole for the Haisla people, as a site of ancestral relations, and a node and keeper of stories.[8] Referring to the conceptual work of museum curator and Musqueam scholar Jordan Wilson, in writing about the return of the Ni'isjoohl totem pole from National Museum of Scotland to its community in Canada, Amy Parent and William Moore (2023) discuss the pole as a *belonging*, going beyond a Eurocentric conceptualization of an 'artefact' or 'object'. The concept of belonging points towards a mutualistic relationality between the respective communities, the totem pole, and the land: they belong to, and come into being in relation to, and with, each other. This conceptualization can also be applied to the G'psgolox totem pole, with all its relations to forest spirits, family history, disease, life, and death.

The G'psgolox totem pole was repatriated to the Haisla People in 2006 after years of negotiation, and was replaced at the museum by a replica made by Haisla craftspeople.[9]

After repatriation it was decided that the pole was to be left to decay at a graveyard near its original location (Jessiman 2011; Björklund 2016). In a film uploaded to the Haisla community website, it is stated that this was done in order to connect the pole back to Mother Earth.[10] The joining together of the G'psgolox totem pole with the earth through decay could be understood as a 'rematriation' – rather than a process of patriarchal repatriation - where both soil and pole relate to each other as living and sentient matter (see Parent and Moore 2023 regarding the Ni'isjoohl pole).

This case raises questions about the relational tensions that arise between goals to preserve museum objects and Indigenous ontologies. The intention of collection management and conservation is to halt the deterioration of museum things (Krmpotich 2024), yet in the case of the G'psgolox totem pole, such conservation hindered the material relations with agents of decay that were necessary to reconnect the pole with the soil. Furthermore, conservation concerns can also hinder Indigenous communities' contact with such ceremonially important artefacts: agentially cutting off physical relations. As Cara Krmpotich (2024) argues it should be possible to find a balanced 'healthy aging' approach to negotiate such use and preservation. This speaks to the field of research that deals with decolonizing museums and the question of how museums can support the continuation of relational links of this kind (which involve, for example, physical access and supporting appropriate decay processes). Thus it is important to understand the wider ecological relational networks of museum collections with due respect to the ontologies of a living Mother Earth.

An ethical question can also be raised in regards to whether such eco-spiritual relations ought to be captured in a digital collection system or remain unregistered. It also raises other museum ecological questions on what planetary relations are tied and set in motion through the digital connections that are made. Whilst the original, material G'psglox totem pole has been rematriated and allowed to disintegrate and become one with earth, data about the pole is retained by the museum within its systems of documentation (and through the replica pole on display). As such, the pole can be seen as living on digitally, and has, in effect, not been repatriated (or rematriated) like the original pole. There are several other digital imprints of this totem pole on the web, and these digital multiplications can also be seen as prolonging the life of the pole in a way that may be at odds with Indigenous ontologies.

The National Museums of World Culture also chose a jacket of gut skin from the Arctic area. The jacket was made of seal bodies and points towards a specific way of managing human-animal relations, about the killing of seals, and of human bodily interaction with the cold environment. The museum registration in Carlotta shows that the pieces have been treated with chemicals, and also that it has been eaten by insects. It needs to be stored in a cold space to survive into the future. What becomes clearer in this case is how the museum collections not only have a chemical and toxic ecological legacy as a future territorialization, but with the presence and interaction with insects that they are also lively and alive in more than one way. The attraction of museum things to such agents of decay is part of the expansive multi-species museum ecologies that clearly show how museum objects, far from being inanimate, are continuously changing and being reshaped as they are inhabited by multi-species entities (Owman 2021; forthcoming). This observation contributes to an expanded understanding of the relational ecologies and agencies of care and decay at work within museum storage areas that do not always make their way into collection management databases.

Skansen: Labrostugan

The open-air museum Skansen chose to work with a building that is part of their collections – Laxbrostugan – which is registered in the collection database system Primus. They found that while the system primarily is built on registering events, these events could be tweaked to be registered as relations. The shadow places could be captured in the documentation of the building's earlier history, and the move of the building to be re-assembled in the outdoor space of Skansen, and added to the information in the accession register. Future interventions such as management cost and environmental impact (as in the heating of buildings) could possibly be added as free-text.

However, temperature fluctuations, climate regulation, and energy expenditures

are registered in other digital systems and it was hard to find a place for such information in Primus. The potential risks of the house (as possible future happenings) could be linked up to KulturNav[11] as our project has created datasets within this platform to contain the ten factors of deterioration: physical forces (which includes both natural catastrophes and incorrect handling in the museum), risk for thieves, vandals and displacers, fire, water, pests, pollutants, light, incorrect temperature and relative humidity as well as custodial neglect and disassociation (as in the loosing of links and documentation of the finds). These museum ecological tracings opened up several environmental risk relations and phenomena connected to the museum things.

Summary of case studies

There were aspects of the relations from the past, present, and future that came into view by using the museum ecological method. With regards to the shadow places of the things, unequal power relations with Indigenous communities, as well as extractivist and colonial legacies, emerged. Also, present and future relational and ecological territorializations in terms of environmental burdens of energy expenditure, factors of decay, and future potentials of the collections were acknowledged. The museum ecologies also highlight how, in their use within museums - for example in exhibitions - museum things contribute to the production of CO2 burdens (adding to the hyperobject of climate change) and the energy expenditure of the museum. Hence, the museum things work outside their immediate objecthood in material ways that may not necessarily be captured in museum storytelling and meaning making. Thinking with the help of Indigenous knowledge and the example of the G'psgolox totem pole, things as belongings can be understood as having a particular aliveness that co-produces human-nature relations that link up the Earth. This resonates with Bennett's (2010) writings about thing power and Barad's (2007) agential realism, which here also could apply to museum things and beyond as they co-produce situated realities.

These studies underline the importance of recognizing the immaterial and material agencies of museum things, where materialization processes follow their own logic as they draw us and the surroundings into different and rich ecological relationships. Furthermore, museum things have a future-assembling capacity, in that they are the building blocks of futures. They also tie intragenerational bonds of care and neglect (Fredengren 2022) between past, present, and futures through museal processes.

The ecologizing possibilities with linked data

The observation made is that some relations could be captured in the digital collection systems, while the ecological relations such as the shadow places and future interventions were not as easy to fit into the systems and could only be hinted at. Neither could the systems build up the cumulative climate effects of exhibitions, storage, and this territorialize relations with future generations. Currently there is no direct way to visualize relations between museum objects and environmental actors within the collection management systems. Such thing relations would be easier to capture outside the collection systems. One alternative is to use the Wikidata function 'entity graph' to show such connections. As seen in Fig. 4 several of these relations could be visualized and linked back to the museum item.

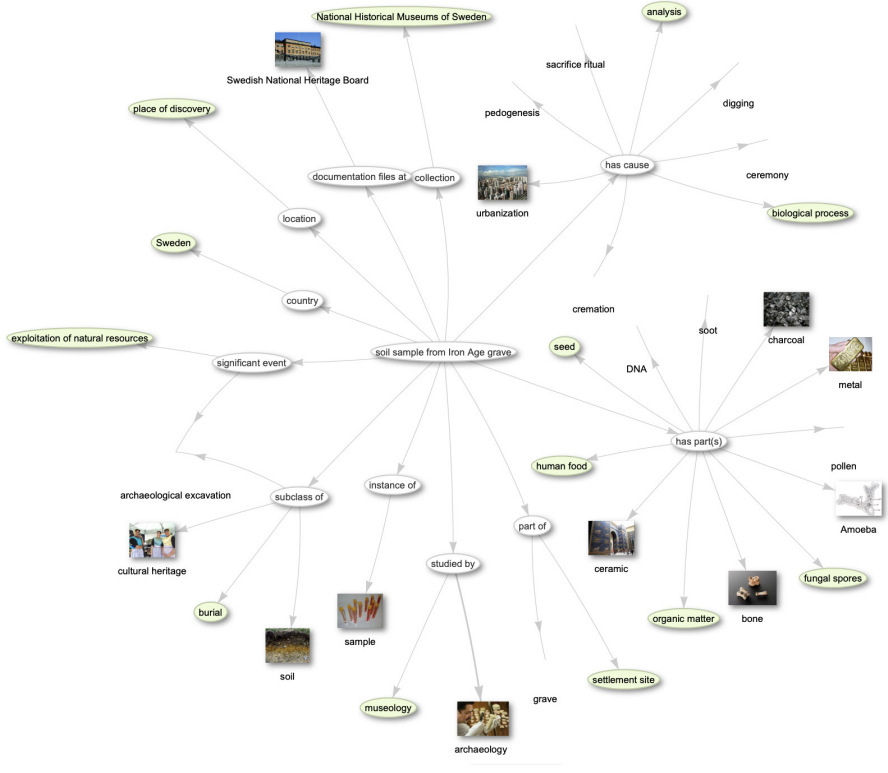

Fig. 4: Some of the relational aspects captured in Wikidata in an exploratory and a partial mapping of the soil sample from the National Historical Museums (SHM).

In the case of the soil sample, the item was a subclass of 'soil' and through that linked to 'climate change'. Under 'studied by', several disciplines can be added, such as 'archaeology', 'museum studies', and 'heritage science'. The soil sample can be linked to several causes, such as 'cremation', 'biological processes' and 'ceremony'. It also connects to soil formation processes ('pedogenesis'), 'exploitation of natural resources', and 'garbage economies' that makes deep time interventions into the textures of situated worlds (compare Fredengren and Åsberg 2020). The mapping in Wikidata was guided by the question: what does the soil sample testify and call attention to? The links created show how a museum thing can be related to several places, disciplines, and times, and how it is situated and changes as a part of a larger museum ecology and within a diverse knowledge field. The thing throws the user into a bundle of relations with several different nodes and not all of them human-centered.

Nevertheless, the linking up of museum things to shadow places and future intervention, or the creation of hyperobjects, still requires humans to pay close attention to the things-in-relation to suggest links. There are, however, through ongoing and 'self-assembling' relational linkages, possibilities that museum things get their own digital lives that extend beyond the original intent of the person who added the relations in the digital system. For example the linking up of the soil in Wikidata resulted in a flash-point where the system itself found other linkages. Such a phenomenon where the digital system, the internet, and eventually also AI, make interconnections could be discussed in terms of digital aliveness. One can talk about an Object Intelligence to be compared to an Artificial Intelligence and these relational connections take place both in digital worlds and in museum stores.

Discussion

The approaches of the museum ecology method seek to further highlight the agential, relational, and materializing aspects of museum things by adopting a more expanded version of materiality, and by adding additional aspects on relationships with the environment. As can be seen in the case studies, the method has also been useful in bringing up discussions on the 'othered' beings that risk becoming marginalized in musealization processes. It includes adding fields of knowledge to the meanings created by humans, and takes materializing processes into account to a greater extent. Whereas Tingenes Metode adds to a wider web of meaning creation with more stories from different human perspectives, the museum ecological approach also includes how the museum things, as bundles of relations, or belongings, are materially active in situated and transtemporal material environments. As highlighted by the G'psgolox totem pole and the Indigenous ontologies of the Haisla, for example, museum things are not just connected to relations between people, but can have ancestral connections that also belong to the living Mother Earth. The museum ecology method acknowledges the agential capacities of matter and challenge both the divisions into a passive material nature and active meaning-making culture ascribing stories to museum things. This also shifts the understanding of the human, with matter and environments co-creating humans' ways of thinking, acting, and existing. This in turn pushes us to heed how different media systems - such as the museum collection systems - interact, distort, or write over each other in museal processes.

Museum things work ecologically 'behind our backs' as they shape material relationships with other phenomena, such as agents of deterioration, but their handling and use also add to climate and environmental burdens and cause planetary harm. This in turn affects and composes relations with future generations. The deepened digital cataloguing that was carried out connected several ecological relations to capture how more-than-human agency is expressed in the museum systems. The manual relational tracing tried to do a rudimentary following of the dynamic processes and relationships around museum things as relational phenomena, so their ecological impact could be discussed both forward and backward in time. This was operationalized by tying objects to their shadow places, or investigating how they territorialize the future. This was done through the registration of events and linked data connected to climate, environment, and sustainability in past, present, and future.

What is registered in the digital collection management systems is always a necessary simplification of reality - an 'agential cut' - which itself also shapes reality. Database and classification terms hold their degrees of standardization and reality is never reproduced exactly. The museum realities are structured chaos, just as the general world is. Sometimes museums are critiqued for too clunky categories of registrations and one has to bear in mind that the detail and depth of the investigation and registration of museum things depends on what resources are given to the activity. To critique museum collection systems on this basis is not what we are after, as that is pushing in the wrong direction. What we are exploring is how things in digital systems, with the help of linked data, may start to form their own relations and to show how they have a life of their own, with and beyond human agents. In doing so we have studied the metabolism of the museum by paying curious attention to the ecological relationships and imprints of what we call the 'museum organism'.

Conclusions

The Museum Ecologies and Collection Management project has worked to further the concept of museum ecologies by applying it into the collection management processes and the collection databases of various museums. The method developed places its emphasis on understanding the agency of things, and the ecological relationships that museum objects are intertwined in. This has involved shifting from an understanding of museum things as being mainly projection spaces of differently situated human storytelling, to an understanding of museum things as lively material, that contain and expand relations beyond what is captured in human meaning making alone. The pilot study has clarified how museum objects, when being analyzed ecologically, can provide in-depth and branched and tentacular knowledge about how we as humans, the objects (materially and digitally), and the environment are interlinked. In this study, we have drawn attention to how museums' materialized ecological

relationships develop over time. The pilot study has focused on the agency of things and of the museum, incorporating the more-than-human to examine what skills and relationships they bring into the ecologically active organism of the museum. This in turn can give us new and updated insights into central museum processes and systems and their impact on sustainability matters as the method identifies environmental impact in past, present, and emerging futures.

This pilot study has made visible the role of the museum in climate and environmental matters with a particular focus on the collections and the digital collection management systems. The study has highlighted how museum things hold both their shadow places and future territorializations and how they can contribute to hyperobjects such as climate change and environmental damage. The case studies discussed in this paper focused on a subset within this area by looking at the digital registration of museum objects. It was noted that while some of the relational aspects of these museum things can be captured within the collection databases, some of the materialities follow alternative logics to those of the museum database structures and need to be captured by other means. These findings have the potential to fundamentally change the understanding of the connections between materiality, environmental issues, and musealization processes. As such the Museum Ecologies and Collection Management project offers the museum and cultural sector tools that can radically change the way of navigating sustainability issues. Furthermore, Tingenes Metode needs to be expanded with a parliament of things that takes onboard the concerns of more-than-human and future generations, acknowledging past, present, and future stakeholders and relations. The role and function of the museum in ecological systems can thus be examined further, to analyze the creative, protective, or destructive forces that emanate from the museum.

The museum ecology approach works in reverse to what we are used to. Usually a museum's aim is to identify, from the flows of time and place, what is worth preserving that is then handled in the cultural environment work. Our interest has instead been focused on dissolving fixed and taken for granted categories, trying new compositions and constructive connections. Another incentive for cultural heritage work (kulturmiljöarbete) is to preserve objects, places and environments for future generations of people. The museum ecology interest in the more-than-human creates, on the other hand, constructive disorder in this well-established ambition, by asking questions about how the museum objects works. Museum things work as transtemporal nodes, can keep ecological intragenerational relations with the environment, and hence function as more-than-human materializing storage devices. Hence, they have the potential to work as guides for how to deal with ecological challenges in the Anthropocene.

With this the question of the relevance of museum ecologies for sustainability can be reformulated as a new forward-looking endeavor. From a museum ecological perspective, the museum and the objects are part of a larger, more-than-human system that has relevance for the climate and the environment, for the living, the unborn, and dead. This has consequences, not only for how we study the museum from the outside, but also for how the museum is understood from the inside.

This pilot study breaks new ground for issues of sustainability within the cultural heritage sector. Radically new ways of highlighting the collections' ecological relationships and 'footprint' have been tested here, putting the spotlight on the museums' climatological and resource/material effects over time. This provides a new understanding of how museums are environmental actors. Museum ecologies provide new methods for elucidating complex contexts between people, animals, and landscapes, as well as power structures between generations. The pilot study has showcased some ways in which an expanded conceptualization of museum things as bundles of relations can be used to develop understandings of how situated practices feed into the Anthropocene, with climate change, environmental damage, and practices of 'othering'. However, museum ecologies also open up opportunities for further studies into how museum things, with their entanglements, can work as guides in - and possibly through - the Anthropocene by opening up new ways of relating with, and being sensitive to, the materializing world.

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Notes

[1] Ki Culture. https://www.kiculture.org/, accessed 25 February 2025. See also: CSC, The Centre for Sustainable Curating, Sustainable Curating. https://sustainablecurating.ca/, accessed 25 February 2025; GCC, Gallery Climate Coalition. https://galleryclimatecoalition.org/, accessed 25 February 2025.

[2] 'Getty Vocabularies', The Getty Research Institute https://www.getty.edu/research/tools/vocabularies/, accessed 25 February 2025; KulturNav. https://kulturnav.org/, accessed 25 February 2025; 'Wikidata:WikiProject Authority control/Archive', Wikidata. https://www.wikidata.org/wiki/Wikidata:WikiProject_Authority_control/Archive, accessed 25 February 2025. KulturNav is a platform for the management and distribution of digital open terminology and authorities for museums and heritage institutions primarily in Sweden and Norway.

[3] This study has not yet dealt with plants, animals (i.e. living collections) or immaterial collections (practices and traditions, e.g. dance, or digital born objects), and there is thus potential to explore these in a future project.

[4] See 'Sirap, socker och slaveri', Arkeologerna 2019. https://arkeologerna.com/bloggar/arkeologi-i-norrkoping/sirap-socker-och-slaveri/, accessed 25 February 2025.

[5] See also Fredengren 2024 for a reflection on soil as nature/cultural heritage.

[6] Macro- and microscopic analysis performed by Jens Heimdahl and Jonas Bergman, Arkeologerna, SHM 2022-09-12 for the research project Humus economicus, SHM.

[7] DNA analysis performed by the SciLifeLab Ancient DNA unit on behalf of the research project Humus economicus, SHM.

[8] See 'Haisla & Our History', Haisla Nation. https://haisla.ca/community/haisla-our-history/, and *Totem: The Return of the G'psgolox Pole* (2003) Directed by G. Cardinal. https://www.nfb.ca/film/totem_the_return_of_the_gpsgolox_pole/, accessed 1 March 2025.

[9] See 'G'psgolox totempåle', Etnografiska museet 2023. https://www.etnografiskamuseet.se/besok/om-museet/totempalen/, accessed 1 March 2025.

[10] See 'Haisla & Our History'; and the film *Totem: The Return of the G'psgolox Pole*. In the film Haisla elder Louisa Smith recalls stories of how the pole was taken against the will

of the people and Dan Paul, Chief G'psgolox, explains that the pole should have been left in place and the importance of where the pole falls as it goes back to Mother Earth.

[11] See: KulturNav, https://kulturit.org/kulturnav.

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