Sensing Scale in Experimental Gardens: Un-Lawning with Silphium Civic Science

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DOI: https://doi.org/10.37536/ecozona.2023.14.1.4831

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Abstract

Gardening experiments are timely in the context of what many now call the Anthropocene, an era that highlights questions of how humans collectively relate to the larger Earth systems in which we are embedded. In *Ecocriticism on the Edge: The Anthropocene as a Threshold Concept*, Timothy Clark reflects on the "unreadability" of the Anthropocene. He invites ecocritics to address this challenge by practicing "scale framing," reading texts in variable and increasingly broad scales, and engaging the contradictions that emerge. We applied a scale framing approach to a story of relationships with *Silphium integrifolium* in an experimental gardening project. Silphium is a native North American perennial prairie plant being domesticated as a future oilseed crop. We are researchers and participants in a civic science project, in which individual garden sites are designed to collect data on and conserve silphium ecotypes while being linked into a wider network. In particular, we analyzed a civic science video story created by Ellie Irons called "Un-Lawning with Silphium." Through our ecocritical analysis, we generated a framework to visualize nested and cross-scalar relationships in gardening projects. This framework could help inform the design and assessment of experimental gardening projects that feature the arts and humanities (e.g., digital narratives, ecocriticism, and pedagogy) and connect them with the natural and social sciences (e.g., plant breeding, botany, geography, and ecology) through transdisciplinary and participatory research methodologies for public engagement (e.g., civic science). We found that civic science gardening with silphium, and other gardening experiments in the Anthropocene, can guide public sensory engagements with scale, help spark recognition and investigation of contradictory scale effects, and motivate us to imagine and build relationships of caring responsibility.

Keywords: Civic science, garden, plants, scale framing, story.

Resumen

Los experimentos de jardinería son oportunos en la época que muchos denominan el Antropoceno. En esta época resaltan preguntas sobre cómo los seres humanos se relacionan con los sistemas terrestres que los rodean. En *Ecocriticism on the Edge: The Anthropocene as a Threshold Concept [Ecocrítica al borde: El Antropoceno como concepto umbral]*, Timothy Clark reflexiona sobre la "ilegibilidad" del Antropoceno. Invita a los ecocríticos a afrontar este desafío utilizando "scale framing" [marco de escalas], leyendo textos

utilizando marcos distintos y cada vez más grandes y analizando las contradicciones que surgen entre escalas. Aplicamos este enfoque a historias de relaciones con *Silphium integrifolium* que surgen en un proyecto experimental de jardinería. El silphium, una planta perenne originaria de las praderas norteamericanas, se está domesticando como futuro cultivo oleaginoso. Somos investigadores y participantes en un proyecto de ciencia cívica en el que se diseñan huertos individuales mientras se participa dentro de una red más amplia, para recopilar datos sobre los ecotipos de silphium a fin de conservarlos. Analizamos "Un-Lawning with Silphium", un vídeo de ciencia cívica creado por Ellie Irons. A través de nuestro análisis ecocrítico, generamos un marco conceptual para visualizar las relaciones anidadas y trans-escalares en proyectos de jardinería. Este marco conceptual podría orientar al diseño y la evaluación de proyectos experimentales de jardinería que incorporen las artes y humanidades (como narrativas digitales, ecocrítica y pedagogía) y los integran con las ciencias (como fitomejoramiento, botánica, geografía y ecología), empleando metodologías transdisciplinarias y participativas para generar un compromiso público (ciencia cívica). Descubrimos que la ciencia cívica mediante la jardinería de silphium, y otros experimentos de jardinería en el Antropoceno, invitan a la reflexión pública sobre la escala mediante actividades sensoriales, fomentan el reconocimiento y la investigación de los efectos contradictorios de la escala, e impulsan la imaginación y la construcción de relaciones solidarias.

Palabras clave: Ciencia cívica, jardín, plantas, escala, historias.

Introduction: Gardening Collaboration

Silphium integrifolium (silphium, silflower, rosinweed) is a perennial prairie forb (herbaceous flowering plant other than a grass) with many-petaled yellow blossoms that attract a multitude of pollinating insects. Silphium is native to North America, may have genetic origins in the Southeast (Raduski et al.), and has grown and co-evolved in ecosystems Indigenous peoples know as homelands. Ethnobotanical records document Meskwaki medicinal uses of *Silphium integrifolium* in the early 20th century (Smith 216). Further research is needed to better understand historical and contemporary human communities' relationships to this particular plant species both culturally and ecologically.

Silphium's range in the contemporary United States spans east from Indiana, west to Colorado, and as far north as Minnesota and as far south as Texas ("Silphium integrifolium Michx."). Because this species has such a wide range, silphium has also developed many differing growth habits to survive and thrive in these unique habitats, such as different morphologies and variable climate adaptations, and expresses resistance to susceptibility differently to biotic pressures in contrasting environments.

As a perennial with a deep root system, silphium has the potential to access water deeper in the soil profile than annual crops, and also could sequester carbon and hold soil with those living roots. The potential to use silphium's seeds as an oilseed grain similar to sunflower (*Helianthus annuus*) is being pursued through crop domestication (Van Tassel et al.). As a perennial grain, silphium could help conserve and restore ecological processes while providing human food.

Maintaining ecotypes, or locally adapted varieties within the species collected from across silphium's wide range, is of interest to researchers in order to preserve genetic diversity for future domesticated varieties and to make seed available for research and restoration. This interest catalyzed a silphium ecotype conservation civic science project beginning in 2020 in which participants were invited to plant, care for, and study garden-scale plots of different silphium ecotypes (Figure 1). Researchers in plant

breeding and botany, ecology, the environmental humanities, and participatory methods created the project.

The three of us co-authoring this article began collaborating in the context of this civic science project. Aubrey Streit Krug co-initiated and leads the civic science research program that includes this and other experimental projects. While she grew up in close proximity to silphium, she didn't know *Silphium integrifolium* by name until beginning to work with colleagues at The Land Institute. She now regularly interacts with silphium in a range of locations, including her backyard, and she is motivated to facilitate caring human cultural relationships with perennial grain crops across geographies for the long term (Streit Krug). Anna Andersson's international and interdisciplinary inquiry into the arts, psychology, geography, ecology, pedagogy, and community organizing has informed her approach to joining the civic science research group at The Land Institute, where she stewards communities and projects. She has identified silphium in prairies, created educational materials about the plant for non-scientists, and most recently, planted silphium in her home space for the first time.

Ellie Irons was one of the civic scientists selected to join this project. She was motivated to volunteer because of her long engagement with plants and land as artistic partners, and her curiosity about perennial agriculture and the domestication process. Irons received Ecotype #1 to plant in Troy, New York—2,400 kilometers away from the original source site. The wild ecotype Irons tends and conserves was collected on Ponca land, currently the US state of Nebraska. This *Silphium integrifolium* ecotype seed was collected in 2017 by John Holmquist, a research technician at The Land Institute. Ecotype collection efforts have continued to the present day by other researchers, spanning across the central United States.

The experimental gardens for silphium ecotype conservation that we will describe feature labor, observation and negotiation, inquiry and reflection, cooperative sharing of data, and creaturely competition for food and energy. The writing of this article about our research collaboration has also itself been a collaborative process. Each of us made distinct contributions during the writing and revision process, and we have noted in the text when our individual vantage points and situated knowledges are particularly relevant to the interpretations offered. Generally, though, we have worked to provide a shared ecocritical analysis and collective voice.

This article was sparked by the silphium story shared in video form by Irons at the end of the project's 2021 growing season (Irons, "Un-Lawning with Silphium"). Amid the diversity of stories invited and submitted in the civic science community, this video caught our attention as researchers because of the way it engaged with scale. Civic science experimental gardens had begun with an open-ended sense of what civic scientists—and researchers—might learn. Through experience, we started to notice how scale was emerging as a conceptual and practical theme. For example, the civic science research group engages with scale in terms of translating research questions into accessible educational materials and meaningful scientific activities, and in terms of the size of the project and whether or how to grow it.

Challenging questions arose as we tried to navigate the everyday experiences of facilitating and participating in the silphium ecotype conservation civic science project in the context of rapidly changing planetary systems. How do we support the learning of civic scientists who have many constraints within their daily lives, and who are

 ISSN 2171-9594

simultaneously part of societies that are shaping systemic changes that exceed Earth's planetary boundaries? How do we help make connections between silphium research, the histories and contemporary communities of particular local places and landscapes, and the forces and systems driving global challenges like climate change and biodiversity loss?

Gardening experiments are timely in the context of what many now call the Anthropocene, an era that highlights questions of how humans collectively relate to the larger living Earth systems or ecosphere in which we are embedded. In *Ecocriticism on the Edge: The Anthropocene as a Threshold Concept*, Timothy Clark reflects on the "unreadability" of the Anthropocene in terms of the "counter-intuitive relations of scale, effect, perception, knowledge, representation and calculability" (13). Clark invites ecocritics to engage this challenge, address the limits of our understanding, and practice "scale framing," reading texts in variable and increasingly broad scales.

We applied this method of scale framing through an ecocritical analysis of Irons' video narrative about her relationship with silphium through the work of caring for this plant in an experimental garden plot. We found that, rather than try to uncritically scale up the method of civic science, we preferred to experiment with conserving silphium ecotypes in gardens. Scale framing inspires a framework for our project and potentially other projects to grapple with the contradictions of scale and to guide public sensory engagements with scale through gardening. This framework could help inform the design and assessment of experimental gardening projects that feature the arts and humanities (e.g., digital narratives, ecocriticism, and pedagogy) and connect them with the natural and social sciences (e.g., plant breeding, botany, geography, and ecology) through transdisciplinary and participatory research methodologies for public engagement (e.g., civic science).

Figure 1: Journey map of researchers, civic scientists, and plants in the silphium ecotype conservation civic science project. Illustration by Lydia Nicholson. [1]

1. Researchers at The Land Institute develop scientific research questions that would lend themselves to be explored using the civic science method, and could help advance crop

[1] All figures and captions made by the authors.

 ISSN 2171-9594

domestication of perennial grains. The journey between researchers, civic scientists and plants is initiated here.

2. Researchers collect wild germplasm seeds in remnant prairies in the central Great Plains and in other regions in the United States. They bring the seed back to a research facility where they are stratified, or cold treated to simulate winter dormancy for two to six weeks, are planted in a greenhouse, and are cared for until they are seedlings.
3. People across the country express interest in participating in research and joining a civic science project. Based on their location and suitability for the research questions, civic scientists are selected to join the multi-year project.
4. Seedlings are sent from the research facility to civic scientists via mail in the spring of the first year.
5. Civic scientists plant 36 Silphium integrifolium seedlings in private and public facing settings, such as backyards, schools, or community gardens. They join the project with varying experiences in gardening, with many people having little or no prior relationship with silphium.
6. Educational materials in various modalities, such as a printed field guide and captioned instructional videos, introduce civic scientists of all ages to the plant, project, and data collection protocols (The Land Institute).
7. Through civic scientists' sight, touch, verbal, and written communication, participants in this project contribute data toward the three core research question themes: ecotype conservation, disease monitoring, and community learning. They collect and upload project data through an open-source digital infrastructure, CitSci.org, or share by email or phone.
8. Civic scientists share their experiences and stories with fellow community members, such as by hosting garden tours, making project-inspired art pieces, and sharing on social media.
9. Through webinars and site visits, the transdisciplinary community of civic scientists, plant breeders and ecologists, and civic science researchers gather throughout the season to share findings and build community.
10. Harvested seeds and project feedback are sent back to The Land Institute. Feedback informs the next year's project design and educational materials to address barriers to participation and continue to support civic scientists. Researchers identify as learners alongside civic scientists.

Framing Scale

In invoking the themes of scale and the Anthropocene, we join a broad and varied conversation that has evolved over recent decades around how to understand, articulate, and act on human responsibility in and for this era. The Anthropocene itself is a fraught and contested concept (Davis and Todd, Moore). We are drawn to the importance of "contextualizing the Anthropocene." In their article that uses this phrase, Frank Biermann and colleagues argue that "the Anthropocene can be a useful conceptual frame *only when* it is viewed from a cross-scalar perspective that takes into account developments at local, regional and global levels, variant connections among those levels and issue domains, as well as societal inequality and injustice" (342, , cursive in original).

We connect this cross-scalar perspective with Clark's approach of scale framing and boundary-sensing. Clark explores how different phenomena emerge in prominence as texts are read at different scales and contexts, and how such "scale effects" can produce "*contradictory understandings and evaluations at the same time*" (23, cursive in original). Following Clark's consideration of the power and limits of literature and ecocritical analysis in the Anthropocene, we wondered how scale framing might help us self-

reflexively investigate questions and decisions of scale in our civic science gardening experiments, making potentially contradictory understandings more apparent and thus possible to intentionally engage as we evolve current projects and design new ones.

To conduct scale framing readings required us to consider how to define scale. Is scale a predetermined system of classification that makes it possible to measure and study different sizes of phenomena? It can be, but given the collaborative nature of our approach, we have been intrigued by Marleen Buizer and colleagues' point that scale is constructed by humans as well as based in biophysical and material reality. They observe that scales "are increasingly being considered as co-produced in processes in which scientists and laypeople work together" (Buizer et al.). By choosing below to closely analyze a text produced by a civic scientist, and seeing what scales emerge as relevant during the reading process rather than choosing and applying them in advance, we hope to have generated a more collaborative and co-authored understanding of scale grounded in the context of our project.

Another framing of scale that we are indebted to is offered by Max Liboiron. Writing on anticolonial research methods in the sciences, Liboiron describes the significance of scale as one of relationality, emphasizing that "Scale is not about relative size. Scale is about what relationships matter within a particular context" (85). During our analysis, we found it helpful to name scales in terms of relationships. Identifying who is relating to who and what prompted us to consider how those relationships were realized, and our roles and responsibilities in them.

Picking up this theme of relationality, María Puig de la Bellacasa reminds us that while they may be asymmetrical, obligations exist across species (156). Thinking and acting on these obligations at the level of a single experimental garden patch, a network of distributed garden patches, or an intertwined human-plant partnership that exists across time and space (like the evolution and domestication of silphium in the past, present, and future) required tracing salient relationships and ties across scales.

The text we analyzed below does this work of tracing in the form of a narrated series of digital images, published as a video. Technological mediation therefore becomes relevant as we considered if and how scales are constituted, not simply recorded, which is an observation made by Gabriele Dürbeck and Philip Hübkes in the introduction to their edited collection, *Narratives of Scale in the Anthropocene: Imagining Human Responsibility in an Age of Scalar Complexity*. They notice how it "*matters* on which scale a system is observed or analyzed" (cursive in original) because "the behavior at one particular scale can be literally incompatible to the behavior at another," similar to Clark's noticing of how scale effects can produce contradictory understandings (6-7). Grappling with our responsibility is not a simple matter: "responsibility cannot simply be upscaled from the level of the individual human being to the level of species" (7).

Alex Hanna and Tina M. Park question another form of upscaling in their writing "against scale thinking," the idea that in technological innovation there can be efficient growth without having to change or rethink "basic elements," so that ideas, businesses, and products are simply scalable or not. Hanna and Park further connect scale thinking with datafication, in which individuals are "rationalize[d] into legible data points." We realized that if we use a scale thinking approach or seek to simply scale up our civic science experimental gardening, civic scientists would become interchangeable data

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collection cogs, erasing their local place connections and responsibilities to land in ways that maintain rather than challenge colonialism (Liboiron).

Participatory research methods can be susceptible to oversimplified ideas of scaling up, implying that more participants or bigger data collection initiatives are always better. Sometimes yes and sometimes no. Ultimately it depends on the project's ability to meet its scientific goals and ethical standards. Decisions about project scope require intentionality and awareness about capacity, values, and relationships. Potential impacts of growth on a project's integrity can range from destructive (e.g., researchers do not have the capacity to sustain or support relationships, and participants who expect more personal interaction don't receive it) to constructive (e.g., practitioners are pushed to innovate new approaches or efficiencies in program design to retain values alignment, or participant relationships are enhanced because of increased proximity to or access to more fellow participants with shared context).

Naming our work at The Land Institute as civic science has helped us try to accurately and specifically represent our method with regard to research relationships. Within the broader fields of participatory research and citizen science, we aim to convey our projects' contributory and collaborative nature in contrast to co-created or community-driven projects (Bonney et al.). Civic science questions so far have arisen from researchers rather than independently from communities. There are active conversations underway about the name "citizen science" and the vocabulary used to identify participatory and scientific research practices beyond traditional institutions (Shirk, Legrand & Chlous). We were introduced to the term civic science in 2019 by artist Carmen Moreno and appreciate how "civic" points to what members of a society do, their rights and responsibilities, and how their behavior affects others.

It remains critical for researchers and practitioners to focus on actions and approaches that advance inclusive research relationships with participants (Cooper et al.). In our work, civic scientists must be informed of and able to consent to expectations for their participation in the project and know what they can expect from us as researchers, so that everyone can fulfill their responsibilities in a community of trust. As we design and grow multi-year projects with perennial plants, we strive to right-size expectations, clearly communicate the opportunities and limits of our method, invest in pedagogical activities, and be accountable for our learning by seeking and acting on feedback and reporting back results, insights, and changes.

Civic science has continued to attune us to the directionality of scale, which can go down and out, not just up. Sensing scale means sensing different and new contexts of relationship: with civic scientists in their places, within our lab, with our colleagues, and with plants, crops, and agricultural and cultural systems. Relationships are central to the research questions we are pursuing in developing novel perennial grain crops. Domestication relationships may be advanced in part through participatory research that shapes civil society and co-creates food futures (Van Tassel et al.). Can we grow and deepen inclusive relationships, rethinking and evolving basic elements of our method as we go, rather than simply upscaling projects?

Hanna and Park write that mutual aid, or collective care, resists scalability because it encourages tangible connections between people in order to help meet their various needs. Civic science gardening experiments have provided an opportunity to begin to critically name, practice, distribute, and value the care work that people provide for

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plants, places, and each other (Streit Krug). We consider that a starting place for building such critical, collective care that resists scalability might be a willingness to sense the reality of scale as relational. Gardening offers a tangible way to experience scale through temporal and embodied relationships with humans, plants and other creatures, land, and a range of systems and processes.

Un-Lawning with Silphium

Because of our interest as researchers in understanding relationships and learning, our civic science projects have been organized to invite participants to share their stories, reflections, and feedback along with other forms of data, such as scientific observations, measurements, samples, and photographs. In the second year of the silphium ecotype project, researchers specifically invited each civic scientist to reflect on their experience by creating and sharing "My Silphium Story" in whatever form they might like. Several optional prompts were provided, including instructions for a photo voice method in which one or more images could be selected by the civic scientist, who could then use their voice to describe how the image represented the story of their relationship with silphium. To engage civic scientists, particularly for those new to the experience, researchers facilitated two webinars focused on reflective storytelling activities, such as visually mapping relationships to silphium temporally and spatially and engaging in free-writing prompts.

Numerous stories in varied formats have been shared over the ongoing project, including narratives embedded in emails, handwritten notes sent back with harvested materials, phone calls, and handmade interpretational art pieces such as beaded clay sculptures representing *Silphium integrifolium* flowers at different stages (Whittier et al.). In December 2021, Ellie Irons submitted a silphium story in the form of a nearly 12-minute video recording featuring a series of 48 still photographic slides in roughly chronological order (Irons, "Un-Lawning with Silphium"). Some slides were a single photo and others were compilations of multiple photos, almost all of which were taken by Irons during her fieldwork over the first two years of the project. Irons created and narrated the slide show, speaking from a written script.

While all the stories shared by civic scientists have helped our research team get a richer picture of the impacts of civic science and improve and investigate our approach, Irons' story was selected for analysis because of the way it engaged with scale. The novelty and detail of the extended photo voice format lent itself to closer analysis. In the future, we look forward to analyzing themes across multiple stories and growing seasons, including stories we have been gathering from ourselves as researchers and our research colleagues. We as researchers have participated in story creation along with civic scientists in order to support reflexivity and understand civic scientists' experiences as they engage with project requests.

Before turning to a close analysis of Irons' media artifact and the scales of analysis it provoked, it may be helpful to understand a bit more about Irons' positionality and relationship to civic science. The silphium story Irons tells is centered around what she refers to as a "gap-filling lawn," a detrimental form of land stewardship that is a default response to maintaining so-called vacant land in the Northeastern United States where Irons is based. Born in California, Irons is a guest on this land. Her ancestors came from

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various parts of Europe, settlers on the American continent. Some of them lived in Troy two centuries ago, in the midst of colonial and industrial upheaval that continues to echo through this land today. As an artist, educator, and scholar she practices a form of interdisciplinary art that revolves around multisensorial fieldwork, combining socially engaged art and ecological art through the lens of multispecies studies.

Irons' interest in lawns and un-lawning grows out of a long engagement with weedy plants, urban ecosystems, and living sculptures. Intrigued by the potential of weedy plants to make depauperate lawn ecosystems more bioculturally diverse, Irons worked with sculptor Anne Percoco to create the *Lawn (Re)Disturbance Laboratory (Lawn Lab)*, a series of sculptural un-lawning interventions that are guided by seeds lying dormant in the soil (Irons, "The Next Epoch Seed Library's Lawn Lab"; Irons, "Practicing Plant-Human Solidarity"). One particularly fruitful Lawn Lab intervention has continued as a long-term experimental un-lawning site and provides the focal point for the silphium story we analyze here.

With a goal of cultivating plant-human solidarity through artistic practice, Lawn Lab activates land-based sculptures with hands-on activities ranging from seed-saving workshops, to participatory fieldwork, to audio tours, creating opportunities for *phytocentric pedagogy*: forms of teaching and learning with and from weedy plants. In framing her artistic practice as pedagogical, Irons draws on forms of land-based and place-based pedagogy infused with aspects of critical plant studies and anticolonial STS that insist on the agency of plants and the land as world-building partners. In her contribution to The Land Institute's request for "My Silphium Story" she turned to the concept of "storied land" (Paperson) and "seeding planthroposcene(s)" (Myers) to build a narrative out of a collection of many research photos taken over eighteen months with silphium. Combining these detailed plant-focused images with a voiceover that alludes to pasts and futures already present in the land, she wondered what each might learn from the intertwining of a human, an urban lawn, and a wild(ish) prairie plant.

With this context about the text's creator and the silphium civic science project in mind, we together analyzed the text produced by Irons. We did not select scales or build a framework of relationships in advance. Instead, Streit Krug first closely watched and re-watched the text, taking notes based on subject matter, imagery, point of view, composition, word choice, theme, and other rhetorical choices. These notes were informed by Streit Krug's training in ecocriticism and critical plant studies and experience in agricultural research. The notes were sorted into groups by Streit Krug based on her perception of relevant scales of relationship illustrated in the text. Streit Krug named these scale frames. Andersson and Irons then reviewed, edited, and provided feedback and questions to inform revision of the analysis. For example, Irons provided clarification and correction on the subject matter of several images. Through this iterative process, we co-authored the scale framing reading.

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Figure 2. Screenshot of the opening image from Ellie Irons' "Un-Lawning with Silphium" video (0:00). The full-length video is available at https://ellieirons.com/silphium/.

The opening image of "Un-Lawning with Silphium" (Figure 2) (Irons, 0:00) was photographed from above the ground, looking down from a close perspective of perhaps 30 centimeters. A silphium plant is centered in the photograph, with two green leaves emerging symmetrically in opposite directions, their midribs tilting slightly off center from the vertical line of the photograph. The large silphium leaves stand out from the surrounding tangle of many other smaller leaves. Grasses, plantain, and clover are visible across the left half of the image, which appears to be in the shade.

In the right half of the image is an outstretched human hand, pressing down the grass, nearly but not quite touching the silphium. The fingers are straight and extended horizontally, in juxtaposition with the vertical orientation of the silphium leaves. The hand is bright with sunlight, with the shadows of a few blades of grass crisscrossing the light skin—one shadow is a straight line, contrasting with the curves of veins under skin—and sun glinting on a gold ring band.

In the upper left corner are the words of the video's title, "Un-Lawning with Silphium." Irons begins by stating, "My Silphium Story starts and continues with an urban lawn."

Beginning with and returning to the first slide's visual and verbal introduction, we analyze the video through four scale frames (Figure 7):

The Personal Scale, of Individual Human and Non-human (mostly plant) Bodies and Their Relationships to Each Other.

The video's opening makes apparent the proximity of individual plants and a human body, in textured detail. The main characters of silphium and Irons are introduced to each other and to viewers as co-actors and companions (00:00-02:30). The title indicates Irons works "with silphium" and the first image shows a particular moment of her hand positioned toward the plant.

Similar moments appear in the rest of the video, in which the majority of the images include silphium and only one, a selfie (11:22), shows Irons' face in detail. Instead, we see the plants through her eyes. A theme emerges of Irons visually understanding the scale of silphium plants based on their relationship to her body. As the silphium leaves get

bigger in their first growing season, she remarks on how they match "the width of my hand" (04:22). Later they are pictured with a boot next to them, which Irons explains: "At this point the wear of the season is visible on the silphium plants…but I also notice some of them are big enough I can measure them against my foot, rather than my outstretched hand" (05:52-06:03). The following spring, when "the first tips of new silphium leaves" emerge, they are shown next to Irons' finger tips, so close that we can see the number on the accompanying orange plant tag (06:57). Irons illustrates differences within plants in the small plot by using comparative images that include her hand as a reference point.

Another image, zoomed in on a single silphium leaf, includes some of Irons' fingers holding the leaf steady. From this close-up Irons describes the results of her and others' scientific and aesthetic gaze: "I also observe the first extensive brown patches on silphium leaves—in consultation with [project researchers], we decide they are insect damage—likely to the individual leaf layer, not rust…we observe how the discoloration is shaped in ways that match the leaf venation, and that it is flat, not raised…looking closely at the leaves is so satisfying…the sandy/hairy texture and intricate venation…wow!" (05:01-05:29).

The personal scale of relationship is also realized through the touch of Irons' hands. As the plants grow up in the second year, Irons mentions her enjoyment of "the rough texture of their leaves." As she conducts her first seed harvest, we see her hand holding a scissors and brown paper bag, getting ready to snip and collect the brown seedheads (Figure 3) (09:44-10:19). Not emphasized in the video, but implicit in this and other images, is the hands-on care work of experimental gardening that involves preparing space, planting seedlings, inoculating them, watering, weeding, harvesting, trimming back after harvest, and recording data—including taking all of these photographs. We will return to this point about mediation below.

Figure 3. Screenshot of hands-on preparation for plant harvest from Ellie Irons' "Un-Lawning with Silphium" video (09:44-10:19).

 ISSN 2171-9594

The Garden Scale, of Human Community Relationships to a Plant Community, Neighboring Buildings, and the Seasons of the Year.

The opening image shows not just a silphium plant and Irons' hand, but also what Irons describes as "low-growing weedy plants" who are later named (03:42-03:49). The shade and sunlight in the video's opening image hints at what will become visible in subsequent images: the physical location of the garden with buildings around it, including one that casts a shadow. The garden scale of relationship connects groups of humans and plants within the bounds of a particular place. It includes Irons' child, a toddler shown sitting amidst the grass while Irons does fieldwork, and other human collaborators who come to help and visit (02:02). As the summer passes, we see a side view of the small square garden plots, now surrounded by brown grass, and Irons uses the plural first-person voice to narrate shared actions: "We haul water, and wait for rain" (03:36-03:38). In other images, signs showing the name of the partnering research institution and civic science project indicate more far-flung connections and suggest other similar garden sites exist in other community contexts.

Insects like spittle-bugs and bees are part of the garden, too, as pests and pollinators. Later, other taller plants are connected and compared to silphium: a wild sunflower relative, grown here for the purposes of supporting conservation and advancing agricultural domestication. A side view of the garden places the silphium flowers in the context of other wildflowers and domesticates, including tall blooming "cultivated sunflowers."

Returning to the opening image, the spring green of the young plant leaves establishes the seasonal chronology that organizes the story. Though Irons does verbally reference "pandemic time," not surprisingly, most of the visual and narrative developments of the video are tied to stages of plant growth or phenology, cycling through two years of seasons. The impacts of spring and summer warmth, drought, and rain are chronicled, as are fall and winter coolness, frost, and snow.

Finally, Irons' depiction of the garden scale includes a belowground component of the garden that is not photographed, but is noted several times in relationship to surviving seasonal turns. While it is out of the limits of perception, it is within bounds of community understanding. In the first fall, she remarks on the small silphium plants and her "hope they are growing robust root systems out of view that might help them overwinter and return strong in the spring." Later, a closing depiction of garden plots and signage in winter brings satisfaction and anticipation: "I enjoy knowing the Silphium is sleeping under the snow, their root structures intertwined with the rubble, roots of other plants, dormant grubs, seeds…waiting for spring" (Figure 4) (06:27-06:41).

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Figure 4. Screenshot of garden plots and signage in winter from Ellie Irons' "Un-Lawning with Silphium" video (06:27-06:41).

The Lawn Scale, of Human Relationships to Landscapes Through Processes of Settler Colonialism, Urbanization, and Industrialization.

The video's opening image contains at least one clue to landscape-scale change: next to the silphium plant is *Plantago lanceolata*, narrow-leaved plantain, a species native to Eurasia introduced to and now common across disturbed landscapes of North America. The national and continental scale of settler colonialism, across decades and centuries rather than the yearly turn of seasons, is later alluded to by Irons as she names her particular location in the "post-industrial and residential neighborhood on Mohican land in current-day Troy, New York." Through narration accompanying a series of images that look up and out over the lawn, we learn not only its present location between buildings, as in the garden scale, but also its history and legal standing as property, owned by a landlord who does not live here. Irons explains that this is a "gap-filling lawn" that used to have a building on it (0:38-01:15).

The urban context of this lawn is made visible through Google Earth images; a street view shows power lines, and an aerial view includes the nearby Hudson River and stores like a convenience store and plumbing supply store. Irons references environmental harm done to the river and the people who live in this neighborhood over time by naming "industrial decline, redlining, and systemic disinvestment." The Hudson River bears the less visible, but impactful, legacy of industrial waste and polychlorinated biphenyls (PCBs)—associated with the chemical Anthropocene (01:15-01:30). These persistent organic pollutants were released into the river north of current-day Troy between 1947 and 1977 by two General Electric capacitor manufacturing plants (US EPA). Other images throughout the video show the yellow metal pyramidal frames Irons uses to mark the silphium plots, and nearby asphalt and concrete associated with urbanization. An autumn photograph stands out, in which the point of view is from close to the ground, featuring the concrete texture of the bordering sidewalk with the lawn as a midline. A brown fallen leaf, edges curled up, is the punctum in focus along with cracks in the sidewalk; a human in the far background next to the plots is small and blurry.

In contrast to the personal and garden scales in the opening image and prompt of "My Silphium Story," Irons as the video creator and storyteller quickly asserts that her

story "starts and continues with an urban lawn." The lawn scale recognizes how the planting and maintaining of lawns broadly changes landscapes, replacing native vegetation, and contributing to planetary impacts. Lawn is both place and process, connected with the processes of settlement and urbanization. Irons' language recognizes this. In the quotation above, the urban lawn is the place for her story and a driver of it, starting and continuing it. And in the video's very title, lawn is understood as a verb to assert the idea that processes of "un-lawning" are possible.

An image in the video shows un-lawning in the form of grass being removed. Tools—boots, a shovel, and a hammer—are included in the image, repurposed for the work of undoing industrial development. The result is finding "a layer of asphalt below the turf" (Figure 5) (01:51-02:00). Some asphalt gets broken and some remains intact. Through her Lawn Lab project, mentioned above, Irons works with a collaborator who takes soil samples. She summarizes: "We learn we have low to normal zinc, copper, and arsenic levels in most of the lawn, and a slightly elevated lead level in the back half of the lot—484 parts/million. Our precautions with touching and breathing the soil will continue" (08:11-08:41).

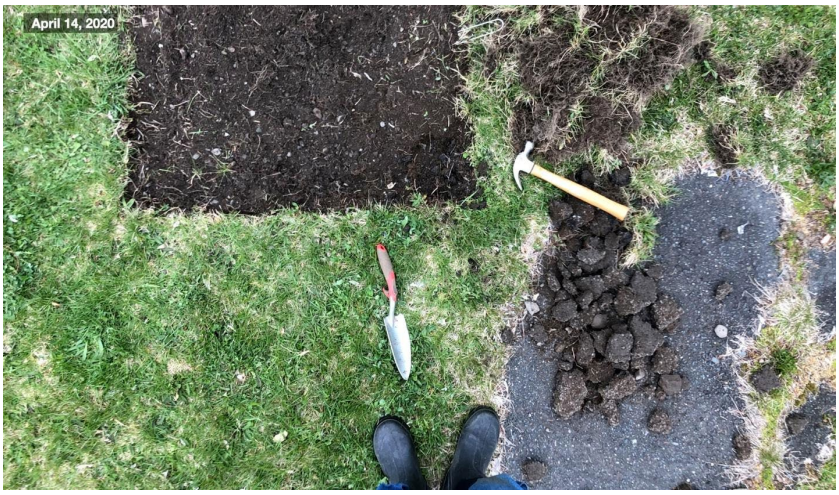

Figure 5. Screenshot of asphalt below the turf from Ellie Irons' "Un-Lawning with Silphium" video (01:51-02:00).

The Food-Energy-Water Scale, of Human Relationships to Biogeochemical Cycles Through Agriculture and Fossil Fuels.

While the video's "un-lawning" title directly evokes the lawn scale and names the need to undo it, the mediated digital form of the video itself can also be understood as indirectly pointing to an even broader scale and the need to engage it. From the start and throughout, the video sequences still photographs with voiceover. Despite the seasonal organization of garden images over time, there is no "smooth zoom" (Woods 134) spatially within or across images and scales. Like the experimental garden plots demarcated in space, each photograph is one snapshot in time from one vantage point, and the photographs switch as the narrator speaks and stitches them together with story.

The video juxtaposes images that foreground different and sometimes multiple scales, from the personal to the planetary, without resolving differences or completing the narrative. The project connects the narrator with silphium, and the experimental purpose

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is also isolating silphium in these plots from potential interactions with other silphium. The lawn is being undone, and also most of it still remains in the lot along with an understory of asphalt. The garden is a place to convene community, and also due to lead in the soil and the pandemic time of the project, a place to take care when touching and breathing.

The broader scale of the food-energy-water nexus can be interpreted in the material infrastructure that is not foregrounded in the video but that makes possible the creation and dissemination of any video, including this one: the software and hardware, the internet and server farms, the energy grid and energy sources that power digital systems, and the food systems—from grain fields through supply chains, with the sun, nitrogen fertilizers, water, soil, other chemicals, machinery, transportation, processors, and retailers—that provide calories and nutrition to the humans who make, watch, and share digital texts.

Humans live in relationship to biogeochemical cycles, and in the Anthropocene these relationships are shaped by agricultural practices and the use of fossil fuels. The food-energy-water scale is also apparent in the video through the plastic in the garden. Early in the video is a frame of two images together: on the left is a seedling with several leaves, in a plot that is in the shade of the building in the morning; on the right is a toddler in the expanse of the lawn with a green plastic watering can (Figure 6) (03:37). The watering can crosses scales—relating a person to the act of caring for plants, a child to the human community of learning to garden, and an industrially produced object to the watershed—and infuses them with the planetary breadth and stakes of the food-energy-water scale.

How long will it take the plastic watering can, made with fossil fuels or petrochemicals, to decay? With the time scale of plastics in mind, we can recall their prevalence in the video: the plastic lawn chair set up for an audio tour of the garden offered during the ongoing pandemic; the white plastic tarp spread over the lawn, on which a group of people, wearing masks, gather in a cluster over a new garden plot; the soil samples, labeled with their location and elemental levels written in black sharpie on white stickers, pictured in clear plastic bags.

Figure 6. Screenshot of toddler with green plastic watering can from Ellie Irons' "Un-Lawning with Silphium" video (03:37).

 ISSN 2171-9594

Conclusion: Engaging Contradictions

Using scale framing to analyze the story of un-lawning with silphium civic science highlights contradictions between personal care work and planetary change. Does the story mean that we, as researchers and participants in a civic science project, are working to practice caring relationships for silphium plants and land? Yes. Does it mean that we are complicit in non-caring relationships between human cultures and societies and continental and global cycles? Yes. But if we cannot simply "upscale" our responsibility at individual and community levels, what do we do besides recognize the contradiction?

We found ourselves looped into the struggle of trying to face limits in the Anthropocene. Though our fossil-fueled petroculture encourages us to live as if there are not ecological or biophysical limits to the planet and to our own lives, this project has helped us become more attuned to practical limits. Our silphium ecotype conservation civic science gardening experiment and the research results it generates have been limited in scope and by our capacity and resources as project designers, facilitators, and volunteers. The silphium plants are limited in small isolation plots and by the biophysical resources they have access to in the locations of these plots. The stories we analyze, in writing and through the video, are limited in what they can convey and portray with the English language and digital photographs.

For instance, Irons' siting of her silphium plots in a malnourished, gap-filling lawn has not been the ideal habitat for the formation of robust, productive silphium seed heads. The plants she is in relationship with have grown more slowly and produced less seed than silphium plants growing in rich garden soil. Simultaneously, their presence on this particular land created a logic and pretense for un-lawning, pushing the limits of comfort for a landowner who would otherwise maintain a trim, if ecologically bereft, lawn. The plants themselves continue to adapt and grow to meet this challenging habitat, while Irons and the surrounding human community have learned about their limits and capacities as plant caregivers, civic scientists, and neighbors. These are experiential, embodied learnings that can be described and analyzed, but not reproduced or repeated, as they are formed in relation to a particular sociocultural and ecological context.

The scales that we have framed, and the contradictory scale effects we have highlighted, prompt us to consider again the reality of scale as relational. A single lawn moves toward becoming a garden, a place that can produce and sustain food, biodiversity, and plant-human solidarity. This is one small contribution toward moving through, or against, the Anthropocene, and must happen again and again in myriad ways across societies that have an extractive orientation toward land and the life it sustains. Across the silphium ecotype conservation plots, similar relationships have been negotiated daily. Irons' story and our analysis prompted us to grow in awareness and intentionality of the scales we have engaged with, and the relationships we are responsible to, as civic science researchers, project designers, and silphium stewards. Reflecting on our experiences and analysis, we now ask ourselves: what might communities that feature caring and responsible human-silphium relationships look and feel like in a future with less plastics, or without the fossil-fueled systems which currently help power our lives, work, and the digital infrastructure of a decentralized network?

 ISSN 2171-9594

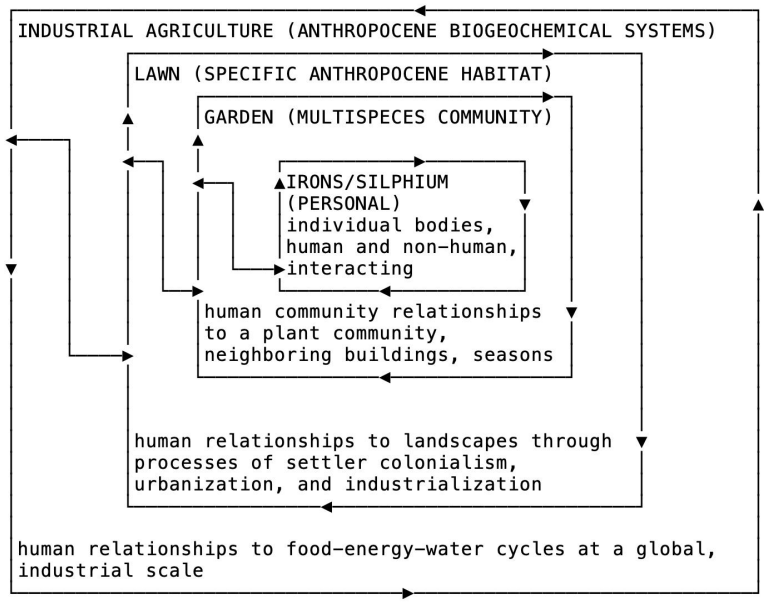

Figure 7. A framework depicting the nested and cross-scalar relationships in experimental gardening projects. Visualization by Ellie Irons.

Each scale level includes a title specific to our analysis of "Un-Lawning with Silphium" (IRONS/SILPHIUM; GARDEN; LAWN; INDUSTRIAL AGRICULTURE), a more general category (PERSONAL; MULTISPECIES COMMUNITY; SPECIFIC ANTHROPOCENE HABITAT; ANTHROPOCENE BIOGEOCHEMICAL SYSTEMS), and a series of descriptive phrases that elaborate on the human relationships featured in our analysis.

Civic science gardening with silphium, and other gardening experiments in the Anthropocene, can guide public sensory engagements with scale, help spark recognition and investigation of contradictory scale effects, and motivate us to imagine relationships of caring responsibility. We offer a framework (Figure 7) to visualize and support experimental engagement with nested and cross-scalar relationships in gardening projects. Each scale level is described using terms specific to our analysis along with a general categorization to invite other projects to self-reflect on their own work. Storytelling prompts can emerge from these categories:

- What kind of multispecies community is your experiment enmeshed in? What multispecies players inhabit a lab, a greenhouse, or a biological field station?
- What specific Anthropocene habitats–those ecological arrangements that didn't exist hundreds or thousands of years ago, and might disappear soon–is your project embedded in? The international research university, an eroding shoreline, a botanical garden gathering atypical varieties of plant biodiversity?
- What Anthropocene-impacted global biogeochemical systems is your project embedded in and reliant upon? What different or similar kinds of future relationships can you imagine with these systems?

While scales in the framework are rendered as discrete frames with neat, two-way flows of impact, the process of scale framing is inevitably about simplification and reduction, which is messy. Much like an experimental garden plot, some variables have to be removed to sense others more clearly. What doesn't fit within any given scale, or the contradictions and tensions that arise when moving between scales, are key to sensing

the limits of the framework. Further questions for self-reflection emerge. How do different frames of reference highlight and exclude varied aspects of reality? And how should we respond when those varied aspects are in tension or contradict one and other?

Finally, the missing but omnipresent axis in our framework is time. As Irons notes in her silphium story, the land the silphium roots in has had and will have many names, as does silphium itself, in this plant species' myriad relationships with different human cultures across time and space. This epoch of land theft and enclosure, of soil being owned and plants rooted in private property, is deeply entangled with the other realities represented in the figure, across scales. As white women educated in interdisciplinary research working with plants and land, this contradiction is not lost on us. Our access to land in North America for cultivation and experimentation is predicated on Indigenous dispossession, even as we work to practice and experiment with forms of perennial plant-human relationships to build the potential for responsibility.

Because "responsibility cannot simply be upscaled" (Dürbeck and Hübkes 7), looking forward, we seek to design and steward gardening projects that guide sensory engagements with the contradictions of scale in order to generate practical possibilities for learning and change. We call for fellow experimental gardening researchers and practitioners to join us in investigating how to evolve our methods and relationships in order to participate in a more deeply contextualized, "down-scaling" of the Anthropocene concept (Biermann et al. 348).

Acknowledgements

The authors thank all civic scientists, past and present, for their generous and valuable contributions to realizing experimental civic science projects with silphium and for their willingness to learn together in community. The authors thank colleagues at The Land Institute for ongoing research collaborations with silphium, with particular thanks to David Van Tassel for his leadership of the silphium domestication program and Lydia Nicholson for the illustration she developed for this article. Finally, the authors would like to recognize the Sanctuary for Independent Media, whose environmental campus surrounds the parcel of lawn where the silphium plants Irons tends are rooted, and whose ongoing land stewardship creates conditions for experimenting with gardening against the Anthropocene.

Submission received 15 July 2023 Revised version accepted 21 February 2023

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