SHORING

Issue 04 The Society for the Diffusion of Useful Knowledge May 2019

Lois Weinberger, *Holding the Earth* (detail), 2010. Photograph. PHOTO: PARIS TSITSOS © STUDIO WEINBERGER.

shore (n.)
"**land bordering a large body of water**," c. 1300, from an Old English word or from Middle Low German *schor* "**shore, coast, headland**," or Middle Dutch *scorre* "**land washed by the sea**," all probably from Proto-Germanic **skur-o-* "**cut**."

shore (v.)
mid-14c., "**to prop, support with a prop**;" of obscure etymology though widespread in Germanic (Middle Dutch *schooren* "**to prop up, support**," Old Norse *skorða* (n.) "a piece of timber set up as a support"). Related: *Shored*; *shoring*. Also as a noun, "**post or beam for temporary support of something**" (mid-15c.), especially an oblique timber to brace the side of a building or excavation.

The Society for the Diffusion of Useful Knowledge is a serial broadsheet publication produced by the Blackwood Gallery, University of Toronto Mississauga, as part of *The Work of Wind: Air, Land, Sea*, a site-specific exhibition, public program, and publication series designed to expand perspectives on climate change through artistic practices, cultural inquiry, and political mobilization.

The Work of Wind: Air, Land, Sea

Exhibition: 14–23 September 2018
Books: Fall 2018, Fall 2019, Spring 2020
Public Programs: June 2018–September 2019
Broadsheet Series: June 2018–September 2019

The Work of Wind: Air, Land, Sea aims to foster a deeper public awareness of the complex entanglements of ecologies of excess, environmental legacies of colonialism, the financialization of weather, contemporary catastrophism, politics of sustainability, climate justice, and hopeful resilience. It sets out to develop durable visual-cultural literacies and invites publics to create new encounters in the common struggle for a future. The project flows across the city of Mississauga and is distributed locally, nationally, and internationally through a three-volume book series co-published with K. Verlag and *The Society for the Diffusion of Useful Knowledge*, an innovative public program and publishing platform.

The Society for the Diffusion of Useful Knowledge **(SDUK)**

In order to productively collide with the present crisis, we recognize that ideas cannot be constrained by disciplines. *The Society for the Diffusion of Useful Knowledge* (SDUK) composes and circulates an ecology of knowledge based on the relationship and antagonism of "useful" ideas. The name of this innovative platform is borrowed from a non-profit society founded in London in 1826, focused on publishing inexpensive texts such as the widely read *Penny Magazine* and *The Library of Useful Knowledge*, and aimed at spreading important world knowledge to anyone seeking to self-educate. Both continuing and troubling the origins of the society, the Blackwood Gallery's SDUK platform brings artists, scientists, activists, and publics into an interdisciplinary, intercultural, intergenerational reassessment of the history of capitalism and colonialism and their environmental legacies in the present.

The **SDUK** broadsheet series brings together contributors from diverse fields in the sciences and humanities, students and faculty from across the University of Toronto Mississauga, community organizations and activists, policy makers and policy agitators, artist researchers and speculative thinkers, all to advance new forms of literacy around climate change discourse.

The Work of Wind: Air, Land, Sea
Curated by Christine Shaw
Presented by the Blackwood Gallery in partnership with the University of Toronto Mississauga, the City of Mississauga, and K. Verlag.
2018–2019

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Holding the Earth

Lois Weinberger

Over six years, Lois Weinberger excavated hundreds of everyday objects from his parents' centuries-old farmhouse in Austria. These objects span 700 years of local history: animal skeletons, coins, cutlery, fabric, foodstuffs, nails, newspapers, tools, pottery, an intact egg with slight cracks. Entitled *Debris Field*, Weinberger's archaeological dig into the history of his family, culture, and region marks how industrialization did—and didn't—affect peasant lives in rural Austria.

Weinberger's arm limply and ambivalently holds a mass of earth, staining his white shirt. Soil holds histories: it's the medium in which archaeology finds objects worth keeping. But as a medium, it's the excessive matter discarded in the process of looking and finding. Holding soil from his parents' house, Weinberger shifts focus from objects found in the soil, to the soil itself.

Weinberger's hold acknowledges the complex histories tied to one's family and birthplace. His hold is inflected by race and gender: we don't often see white men photographed as caring or tender. But his hold doesn't invert this relationship—it complicates it. A hold is an em/brace: sometimes tender, sometimes forceful. Weinberger's hold is both, and the earth held in the crook of his arm mediates legacies of capitalism and colonialism. The gesture of care shown here is a messy one, enmeshed in how soil bespeaks environmental violence: compacted soils need enrichment; toxified soils need remediation; stolen soils need rematriation.

How to Read this Broadsheet

This fourth broadsheet in the SDUK series is themed **SHORING**—a concept that touches on both literal shores (representing the meeting—or separation—of land and water), and broader representations of terraforming, resource extraction, data visualization, interdisciplinary research, and the many other supports that have held up existing infrastructures, exploitations, and innovations. A few questions might guide your encounter with this issue:

Repeat readers of the broadsheet series may note that this issue in particular is saturated with images, and thus ask, **how can we read images of our world through the lens of environmental justice?** Projects in this issue demonstrate the ability of photography to narrate and create access to remote climate and atmospheric research (Weaver, p. 20), and to dispute and re-examine the stories images give us of ecosystems we may never encounter face-to-face (Morét, p. 13). Meanwhile, an image by Lois Weinberger (cover and above) asks us to see histories, land-use, settlement, order, and disorder in the archaeological fragments shored up in private property (in this case, his parents' Austrian farmhouse).

Those compelled by conversations about the shift from fossil-fuel reliance to sustainable energy may wonder, **how can we see the effects of resource extraction and energy production when much of it is designed to remain obscure?** Genevieve Robertson's *Still Running Water* (p. 4) catalogues hydropower projects along the Columbia River, while poems from Laurel Albina's *Energy Series* (p. 6) evoke the violence and invasiveness of mining and drilling, and Jessica Caporusso's study of Mauritius's "green" energy economies (p. 18) attends to their legacies of colonialism, slavery, and exploitation.

Following the impacts of resource extraction, a network of environmental consequences becomes perceptible. **How do our coastal spaces become sites of intertwined human-environmental distress?** Ruth Beer (p. 16) answers this question by scrutinizing the gas station at the junction of British Columbia's Highways 16 and 37 in an ongoing project on trade and extraction routes in Western Canada, while Alison Cooley (p. 22) addresses Mississauga's Lakeview Village Redevelopment as a site of urban reimagination and potential connectivity to the non-human. The Synthetic Collective (p. 8) offer opportunities to respond to the "wicked problem" of plastics pollution through interdisciplinary research. Their contribution includes a directory of organizations working to confront plastics in oceans, beaches, and urban spaces—a tactic for sharing the existing work of important initiatives mirrored in our own "Local Useful Knowledge" section profiling organizations in the GTHA (p. 26).

Those motivated by the prospect of entrepreneurialism and invention may wonder **what role innovation plays in meeting the challenges of environmental collapse**. Fraser McCallum's profile of Just Vertical (a startup with origins at UTM) highlights the potential of indoor hydroponic gardening as a response to food insecurity (p. 25), while, in a regular column by D.T. Cochrane, readers are encouraged to question the promise that innovation alone offers a way forward through climate crisis (p. 24).

As in each broadsheet issue, we close with a glossary of terms—key concepts that are defined, animated, problematized, challenged, and illuminated over the course of the broadsheet series.

Still Running Water

Genevieve Robertson

Still Running Water is an in-process video that follows the Columbia River over nearly 2,000 kilometres from a spring just west of the Kootenay Glacier in southeastern BC, to Astoria, Oregon, where it dumps into the Pacific Ocean. At the river's source spring, water gently gurgles up from blue-grey mud, past Bunch Grass and Wild Camus, eventually sending rivulets of silt towards the sea. At the mouth, the Columbia River is over six kilometres wide and known as one of the most hazardous waterways to navigate in the world. This massive river runs through the heart of many interrelated Indigenous cosmologies, and was historically one of the most ecologically (and spiritually) important salmon-bearing rivers in the Pacific Northwest. It is also home to fourteen hydroelectric dams on the main stem and over 400 in the entire Columbia River watershed.

The dams—in British Columbia, Washington, and Oregon—are heralded for energy production, flood control, irrigation, and navigation for inland freight. However, their efficiency has also incurred irreversible ecological and cultural costs; these massive structures have irrevocably reshaped the course of the river. The Columbia is monitored and monetized down to the millilitre, drastically altering ecological rhythms both micro and macro. The hydropower projects have destroyed a culturally invaluable steelhead and salmon fishery;[1] reduced wildlife and wetland aquatic habitat and greatly impacted the lives of many in the watershed, including numerous Indigenous nations. Many communities were forcibly removed from their ancestral territories and their cultural practices centred on the river without meaningful consultation. The dam constructions also flooded and desecrated many sacred burial sites and several culturally and spiritually important fishing and trading sites, including Celilo Falls in Oregon and Kettle Falls in Washington.

Still Running Water records the river from source to mouth: the monolithic dams, as well as the demolished townsites and flooded forests in the reservoirs behind them. While the filming process was essentially an attempt to grasp the immense scale of the river and the complex geopolitical relationships playing out on its shores, these images are not meant to be exhaustive. Instead, they offer some reflections on the human hubris of large-scale industrial energy production and its impact on the Columbia River watershed.

Still Running Water is a contribution to *River Relations: A Beholder's Share of the Columbia River*, which was a two-year interdisciplinary artistic research project undertaken by a collective of artists, geographers, and poets between 2016 and 2018.[2] *River Relations* responds to the extensive damming of the river and the renegotiation of the Columbia River Treaty. *Still Running Water* is being produced at a timely moment. The treaty—between Canada and the US, signed in 1961 and ratified in 1964—attempted to align divergent bi-national interests. It set the stage for further hydro development[3] in both countries and granted the US some management rights over the Canadian portion of the Columbia River for American energy and flood control needs. While the treaty has provided notable economic, power-generation, and flood-control benefits, at the time of ratification there was little value placed on either Indigenous territorial rights or ecological impact, and this is clear in the cultural and ecological losses that the upper Columbia basin region has faced. With flood-control provisions expiring in 2024, the treaty is now under active re-negotiation. The changes will affect the environmental and social well-being of the Columbia basin on both sides of the border, and hopefully address environmental issues such as upstream salmon migration, the health of wetland ecosystems, and nutrient flow. Other emerging issues include agricultural water shortages experienced in central Washington, Indigenous sovereignty, and shifting climate patterns due to global warming. It is presently unclear what kind of meaningful change will result from the re-negotiation.

Still Running Water bears witness to the impact of this political deal, and the development of hydro-power along the Columbia at large, through a series of static video shots taken along the river over two years. The project does not assert a narrative structure, but rather allows the river and the changes impressed upon it to form a connective tissue. How does this riverine geography emblematize broader issues of ethical watershed governance, Indigenous-settler relationships, and trans-border dynamics—as well as regional, national, and global futures for energy production?

1 The Grand Coulee Dam, built between 1933 and 1942 in eastern Washington, cut off upstream salmon migration completely from the upper Columbia watershed. Chief Joseph Dam, constructed between 1950 and 1955, is located just downstream of Coulee also blocks salmon passage.

2 This project involved Nick Conbere, Rita Wong, Fred Wah, John Holmgren, Emmy Willis, Matthew Evenden, Zoe Kostuchuk, and Genevieve Robertson, and can be found at www.riverrelations.ca.

3 Four dams were built under the Treaty: Keenleyside Dam (B.C.), Mica Dam (B.C.), Duncan Dam (B.C.), and Libby Dam (Montana).

All images: Genevieve Robertson, *Still Running Water* (video still), 2017–ongoing. COURTESY THE ARTIST.

Energy Series

Laurel Albina

Surface Mining

You lift skin.
Peel back watered hollows.
Tear up birds' brush wet land.
Suck and scrape.

My boreal, my bog, my peat, my muskeg.

You call it overburden.

Spit and chew my fine skin.

But I am compressor of sediment, viser of sea bed, mistress of fossil.

I ooze slow
sink under
slip sticky black between sand.

You alchemy
bitumen into oil barrel.
Shoot hot water
cut siphon slush
slurry my broken matter.
Trap me
in tanks and tailing ponds.
Split me apart. Spit me
into silver Athabasca.

Bring your big diggers.
Your mappers, your prodders.
Your seven-storey shovelers
your hundred-ton trucks
your conveyer belts and drums
your pipes and your lines.

Bring your coffee break to my eon,
your night shift to my star gaze.
I boom beyond shifting gears and lit engines.
I am the night ring in eardrum,
my voice still beating.

Offshore Drilling

My bone marrow biopsy.

The length of the needle's shaft
as it sunk through the thin skin

of light

into the water
and down to sea floor.

Through
muck and mud
sand and clay
stone and shale.
The crack
against cap rock.

Face down. Covered.
A sterile blue barrier
a square hole cut
centered above the small of my back.
My stomach sweaty
and stuck to the soft tissue
torn paper. Each hand
gripping the edge of the table.
I breathed out
a trade wind, a gulf stream, a North Sea storm.

Below
a hollow needle punctured bone
a barbed drill spun
a syringe sucked
all manner of molecules and marrow up.

I moaned so low my hands shook with vibration
and something slipped into the dark sea.

What became of the green blush of algae, the jellyfish's perfect pulse?

all manner of hydrocarbons and thrombocytes up.

Embracing an interdisciplinary approach to plastics pollution awareness and action

Sara L. Belontz, Patricia L. Corcoran, Heather Davis,
Kathleen A. Hill, Kelly Jazvac, Kirsty Robertson, Kelly Wood

Clockwise from top left: Learning how to sample during the Plastics Pollution Think Tank, Lake Huron, June 2016 PHOTO: KIRSTY ROBERTSON; Microplastic pellets (nurdles) collected on the shores of Lake Huron by members of the Synthetic Collective, Fall 2018 PHOTO: TEGAN MOORE; Max Liboiron and Patricia Corcoran using BabyLegs to collect plastics from the Thames River, London, Ontario, June 2016 PHOTO: KELLY WOOD; Sampling microplastics from a strandline, Lake Huron shore, Fall 2018 PHOTO: TEGAN MOORE.

This article presents a new approach to investigating and mitigating plastics pollution by employing an interdisciplinary research framework built on the disciplines of science and the arts. Our group, the Synthetic Collective, is composed of artists (sculpture, installation, photography, activists), humanities scholars (visual culture, media studies), and scientists (geology, environmental science, biology, chemistry) working together to:

1. describe how plastic waste invades, impacts, and is preserved in the environment;
2. provide examples that show the utility of citizen science, outreach, and media outlets;
3. explain how plastic debris is presented in various art forms; and
4. present an interdisciplinary model we have used to tackle the wicked problem of plastics pollution.

Wicked problems do not have a definable mission, and their comprehension and resolution controls the questions that require asking.[1] Plastics pollution is considered a wicked problem because pollution of the natural environment with plastic debris is a complex, global concern that cannot be solved within the context of a single discipline. Issues associated with plastics pollution include the following: (1) plastics are mass produced because of their resistance to degradation, low cost of transport, and reduction of cross-contaminants; (2) plastic debris arises from multiple sources, such as stormwater outflow, agricultural runoff, spillage, and littering; (3) the amount and timing of plastics being released into the environment are unknown; (4) there are direct and indirect drivers, such as anthropogenic activities and land-use practices; (5) inconsistencies in sampling methodology and data analytics complicate research; (6) management and mitigation practices depend on location and resources; (7) changes in human attitudes and behaviours towards reduction, reuse, and recycling are required; and (8) leadership and unity are necessary for problem-solving.

Sources, dispersal, and preservation

Plastics dominate nearly all aspects of contemporary daily life, but notwithstanding their benefits, there is a lack of appropriate disposal methods as the demand for plastic grows. As of 2015, only nine percent of global plastic waste had been recycled, whereas seventy-nine percent had accumulated in landfills or in the environment.[2] Plastics pollute the terrestrial environment as litter and landfill accumulation, as well as spillage in factories, during transport, and off-loading. They can reach aquatic environments both directly and through water systems. One study estimates that between 0.41 and 4 x 10^6 tons per year of macro- and microplastic debris reach the oceans via rivers.[3] Once in oceans, wind-driven surface currents, tides, and waves contribute to the dispersal and resuspension of plastics.[4] The debris often becomes trapped in floating organics and is beached along the strandline.[5] Not all plastics remain at the water surface. Common plastics that sink include polyvinyl chloride (PVC), used primarily for construction materials, and polyester and polyethylene terephthalate (PET), often used in clothing.[6] Low-density microplastics found in benthic sediments[7] may result from the presence of mineral fillers, development of biofilms, adsorption of clay minerals, and flocculation with organic matter.[8]

The majority of buried terrestrial plastic debris is found in unmanaged landfills, cities and developing towns, and in shoreline sediment.[9] In unmanaged landfills, the top layer of debris may be covered with soil to mimic the surrounding landscape, but burying plastic only increases its chance of preservation. In developing towns or cities, soil and other aggregate material may be dumped and buildings erected directly over plastic debris. This produces a plastic "marker horizon" in the sedimentary record.[10] Plastics deposited along shorelines may become buried during storm events or where sedimentation rates are high.[11]

Existing approaches

The Synthetic Collective's approach is informed by ongoing scientific, artistic, and interdisciplinary initiatives which research and disseminate information on plastics pollution.[12] For example, scientists have worked meaningfully with fisheries and citizen scientists (including tourists and children) to analyze plastic ingestion and beach pollution, demonstrating that these collaborations generate reliable results.[13] Beyond data collection, conveying the wicked problem of plastics pollution to the public is a key concern. Outreach campaigns can be hampered by existing conventions, such as the use of charismatic megafauna (among them sea turtles or polar bears) to draw attention to environmental plight.[14] More successful outreach campaigns have eluded a singular focus on visibility and animal life, acknowledging that in fact most pollutants are miasmic, and nearly invisible.[15] These campaigns use the wide reach of social media to connect different stakeholders and communicate across the globe.[16] See the accompanying table (p. 11) for well-known organizations addressing plastics pollution, many of which use thoughtful outreach strategies employing social media and visual art.

Individual artists and artist groups have likewise responded to the challenge of visualizing plastics pollution with the goal of raising consciousness, creating speculative representations of possible plastic-polluted futures, and charting efforts to remediate environments. Artists employ wide-ranging and adaptable strategies to address the wicked problem of plastics pollution, ranging from drawing attention to plastic waste through collecting and displaying salvaged materials to working collaboratively with communities to address environment and local economies. Such efforts are paralleled by scholarly contributions in the humanities and social sciences about plastics pollution, environmental studies, and ethics.[17]

Art and science approaches are often far removed from one another, but this need not be the case. One key example of plastics pollution visualization through interdisciplinary collaboration, undertaken by two members of the Synthetic Collective prior to the group's formation, is the description of plastiglomerate, an agglomeration of plastics and natural materials,[18] which resulted in a scientific manuscript, international art exhibitions, lecture invitations, and media coverage. The plastiglomerate was treated as a geologic sample and a new kind of stone, and was additionally exhibited as a readymade sculpture in a number of international venues. Following this lead, the Synthetic Collective attempts to build on and draw from all of the above-mentioned initiatives, in the quest to create and maintain a successful and long-lasting interdisciplinary collaboration.

Embracing an interdisciplinary approach

According to the National Academies of Sciences, Engineering, and the Institute of Medicine, interdisciplinary research is: "A mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice."[19] Tackling the wicked problem of plastics pollution requires researchers to be willing to take risks, to be open-minded, and to extend beyond their singular disciplines. Collaboration should take place from the outset of the research in order to witness substantive, rather than superficial, results. This produces unique perspectives on how the issue may connect to broader cultural and scientific concerns. The results from collaborative meetings of the Synthetic Collective indicate that each discipline possesses specific problems and assets when trying to address this issue, including the necessity of artists and activists to fully understand the science informing their artistic work in order to communicate effectively. From the science perspective, appreciation is gained of the power of artistic impact not only through communication, but also through contemplating problems and solutions. Working with individuals from different research fields helps showcase strengths, ideas, and networking connections that can ultimately benefit all investigators. As members of the Synthetic Collective, we feel that what is known through science, and what is seen through citizen science, outreach, and education, become significantly more impactful when combined with what is translated through artworks.

Information gained from meetings, workshops, and retreats of the Synthetic Collective indicates how each discipline addresses the issue of plastics pollution. The scientists in our group are focused on providing accurate data on the distribution, effects, and composition of plastic debris. Once quantitative and qualitative information is gathered, scientists share it with their peers, the research community, students, and occasionally the public, media, and citizens using tables, figures, and numbers in publications, lectures, or presentations. The artists focus on targeting consumers, citizens, and occasionally policy-makers when trying to address plastics pollution. An artist's main audience is the public, and must thus convey their work in an interpretive and creative way that targets individuals directly to stimulate an emotional response. Although changing consumer behaviour may be difficult, activist artworks often motivate individuals to change their everyday habits or, crucially, to pressure politicians to change legislation.

When initiating a new interdisciplinary environment, researchers should avoid restricting themselves to traditional methods of project delivery. Rather than coming together at the end, or separating individual tasks to each discipline, researchers need to work together at every step of the way to reach all short- and long-term goals. Bringing scientific and artistic research to the problem of plastics pollution has enabled our group to: (1) engage in field work, workshops, and retreats; (2) publish papers in scientific and art-related journals and books; and (3) give joint presentations at conferences and museums, and engage in outreach. In addition, our collaborations include training of undergraduate and graduate students in the laboratory, in the field, and in research techniques. Through course lectures, labs and tutorials, students have learned about the deleterious effects of plastics pollution. Specific activities of the Synthetic Collective have led to tangible results through our collaboration. We found success in using our eight-step Interdisciplinary Model, which helped avoid the issues that inherently arise with multifaceted projects.

Step 1. Passion is what drives individual participation. Despite the risks associated with joining an interdisciplinary group, researchers with different backgrounds and expertise join because they identify gaps in solving the problem. According to one white paper, the magic of interdisciplinary research takes place "when unlikely collaborators find a shared focus for their passions and are supported by stable institutions and programs willing to take risks."[20] The Synthetic Collective developed from one artist attending a

public talk concerning plastics pollution that was hosted by one scientist. Both researchers were passionate about the topic and brought collaborators in from their respective disciplines to participate in meetings to discuss future joint projects.

Step 2. Communication is "at the heart of interdisciplinarity."[21] One approach that our research group utilized was participating in a think-tank workshop, for which the planning and execution was jointly led by a scientist and several artists. The workshop enabled individuals from different academic disciplines (earth sciences, visual arts, art history, cultural studies, sociology, biology, chemistry, law) as well as local government (Ontario Ministry of Natural Resources and Climate Change) to positively interact with one another in different sites, with a focus on visualizing possible outcomes and projects. In doing so, it built trust within the group and enforced healthier future collaboration. For one project, the group visited a river, and with the help of an environmental scientist used a "BabyLegs" trawl to collect plastic debris.[22] A field trip to a beach with abundant plastic pellets was led by an earth scientist. The group also toured the lab of a chemist who develops polymeric drug-delivery systems, and participants attended a tour of a recycling centre in London, Ontario. The think-tank part of the workshop was organized and facilitated by three artists.

Step 3. The workshop provided a safe space to pose critical questions regarding plastics pollution, including: (1) what is the group's vision? (2) what are the planned outcomes? (3) what resources are needed to achieve specific goals? (4) what are the next steps? and (5) who else should be invited? Some of these questions were considered by small (3–4) groups of people in break-out sessions. The results were then presented to the group at large, and notes were written on a flip chart for future reference. If a group is finding it challenging to establish a common goal or framework, it is helpful to look at recent publications that encourage the involvement of different partners, communities, scientists, decision makers, and the public when addressing a wicked problem.

Step 4. Sustaining involvement and cooperation within the group depends on the roles and responsibilities that each researcher adopts. The success of an organizational structure rests on how well it fosters communication, enables work activities, and involves joint decision-making.[23] All interdisciplinary research teams require leaders or coaches—people who encourage continued engagement, plan joint activities, and manage the budget. Some groups may have co-leaders, while in other groups, the leadership role may change depending on the nature of planned events or personal connections. In our research group, joint sampling is led by the scientists who have prior experience and knowledge of proper techniques, whereas the artists have organized logistics for museum exhibitions and other forms of cultural interaction. Notwithstanding the expertise in our respective fields, input is not only welcome, but solicited on all decisions related to joint activities.

Step 5. Balancing funding stability and program growth is essential in sustaining an interdisciplinary research group. The amount of funding a project is allotted will determine a group's short- and long-term goals and help establish the group as a significant force. Funding agencies for interdisciplinary research should make it relatively easy for researchers to apply, be communicative throughout the funding window, and be flexible to delays and changing needs.[24] Unfortunately, the number of funding opportunities depends on the country, government priorities, and institutional policies.

Step 6. The assignment of specific roles and responsibilities according to each researcher's academic background should be avoided. When working as an interdisciplinary group, it is essential that communication takes place throughout the entire decision-making process. Artists should not focus solely on deciding how to translate the issue in an aesthetically appealing way to the public, and similarly, scientists should not only be involved in making decisions regarding the methods required to gather scientific data. Collaboration should extend to writing grant proposals, identifying other funding sources, creating websites and databases, and most importantly, developing a plan that urges global translation.

Step 7. It is essential to make use of the connections of all collaborators to extend the network into other communities, which could include academics at other institutions, policy makers, industry leaders, government officials, Indigenous peoples, and members of the public. Through art and science presentations, art exhibitions, and publications in art and science journals and books, our group has been able to cast a wide net to expand our network into local communities, as well as municipal, provincial, and federal government organizations. We were also successful at mentoring students at undergraduate and graduate levels who were involved with the think-tank workshop, as well as website and database development.

Step 8. Determining the impact of interdisciplinary research is complex because of its multidisciplinary nature, inherent uncertainties in defining the term "interdisciplinary," and ambiguity in the sources and types of tools with which to evaluate it.[25] According to educational researchers Huutoniemi and Rafols, the three main epistemic values of interdisciplinarity are breadth, integration, and transformation. In our approach to raising awareness of plastics pollution, the value of breadth is met in our varied skills and visions from different disciplines. Integration, in turn, takes place by taking our disparate knowledge and skills and combining them into a whole through shared meetings, workshops, retreats, and outputs. Our group certainly faces many challenges, such as securing funds, determining who coordinates different projects and meetings, and finding the time for all members to meet. The success of our integration, however, is a direct result of the shared values we hold concerning the subject matter. In the four years that the Synthetic Collective has been engaged in interdisciplinary research, we have produced numerous outputs that can also be considered as evidence of impact.

Conclusion

Bridging the divides between different disciplines, such as the arts, sciences, social sciences, and humanities, is the best way to tackle the wicked problem of plastics pollution. The methodologies used by the Synthetic Collective are based in deep interdisciplinary engagement, using results gathered by scientists to produce artworks, artefacts, curatorial interventions, articles, and other knowledge outcomes understandable to academic audiences, policy makers, art supporters, and the public. Scientific-artistic hybrid analytical and interpretive methods result in projects that use multiple forms of evidence and platforms to address citizens' dissociation from the plastic they produce and use. While mobilizing evidence, artworks and exhibitions are usually specifically designed to elicit strong affective responses in viewers. Often a goal is to change the way viewers think about a problem, and to ideally change their own behaviour or lobby for change. As art writer Jennifer Higgie asks, "how can change be manifested if it can't first be imagined?"[26] Indeed, art can act as a catalyst for consumer and industry change by making the scope of plastics pollution visual, and the vast complexities of the wicked problem of plastics pollution conceptually accessible.

The collaborations of the Synthetic Collective were initially developed, and derive their strength, through the interdisciplinarity of arts and science. Most interdisciplinary work involves fields that include multiple sciences or multiple arts, but the joining of arts and sciences achieves a greater breadth of perspective and synergy. This breadth also allows for a greater potential for focused, quantitative scientific research to be better connected to larger cultural concerns and criticality. In turn, humanities scholars consider the cultural nuances of scientific research and contemplate the impacts of plastics pollution on human behaviour and attitudes.

Despite their differences, the link between scientists and artists is strong because they are both passionate about creating and understanding the "new," and aim to share what they have with individuals, whether it be the public or other scientists and researchers.

Table: Well-known organizations employing arts and sciences disciplines and public engagement to address the "wicked problem" of plastics pollution.

Organization	Goal/Mission	Example Actions
Algalita algalita.org	"educate and equip local and global influencers with the knowledge and resources needed to prevent plastic pollution"	Monitoring plastic litter through ocean expeditions; beach and schoolyard clean-ups; *Youth Summit*; Teacher Workshops; STEM workshops
Alliance for the Great Lakes greatlakes.org	"involve tens of thousands of people each year in advocacy, volunteering, education, and research to ensure the lakes are healthy and safe for all"	Involves student and public volunteers in *Adopt-a-Beach* program; championed federal ban on microbeads; active blog and press releases on website
Bahamas Plastic Movement bahamasplasticmovement.org	"build a community of education and activism around plastic pollution," "aim to evolve mindsets and spark cultural practices that will be pivotal in executing changes at the policy level"	Beach surveys; *Plastic Pollution Camp* for students; *Junior Plastic Warrior Program* for children aged two to twelve; *Ocean Ambassador Program* for high school students who wish to develop awareness campaigns; *Art in Action Program*
By the Ocean We Unite bytheoceanweunite.org	"to take people out to our oceans and seas, be it real-life or digitally, and make them aware of the plastic soup our waters have turned into"	Documentaries, lectures, symposia; outreach at fairs and shows; tips on how individuals and organizations can help by reducing and reusing plastic
Litterbase litterbase.awi.de/litter	"summarizes results from 1,689 scientific studies in understandable global maps and figures and opens scientific knowledge on marine litter to the public"	Developed database that allows creation of maps to illustrate the distribution of litter across the globe; easily accessible to the general public
Monterey Bay Aquarium montereybayaquarium.org	Ocean Plastic Pollution program, "reduce the sources of ocean plastic pollution," "make positive changes for the ocean and the animals that call it home—not just today, but for generations to come"	Works with twenty-one aquariums in the US to reduce plastics pollution; reduced use of plastic in aquarium operations; annual *Ocean Plastic Pollution Summit*; *#MyBag #MyBolsa* campaign; provides volunteer guides, programs, and exhibits focusing on plastic debris
Ocean Blue Project oceanblueproject.org	"Saving the ocean, beaches, and rivers through education, awareness, and learning projects"	Beach clean-ups; active blog and news on website; online store—funds from sale of items go directly to clean-up and conservation efforts; #goingstrawless petition; photo contest; *Blue School Program and Arts Initiative*
One World One Ocean Foundation oneworldoneocean.com	"to spark a global movement to protect our seas, by showing the world just how much we stand to save, if we stand for the ocean"	*The Plastics Breakdown* media campaign to raise awareness, encourage the public to reduce plastics use, and provide communities with tools to spread awareness of plastics pollution
Plastic Ocean Project plasticoceanproject.org	"to educate through field research, implement progressive outreach initiatives, and incubate solutions to address the global plastic pollution problem, working with and for the next generation to create a more sustainable future"	Hope Spot clean-ups; Fishing4Plastic tournament; travelling art exhibit *What Goes Around Comes Around*; joined with the company Renewlogy to turn plastic waste into fuel; *Green Beans* initiative to encourage coffee houses to offer alternatives to single-use plastic items; partnered with Boomerang Bags to offer recycled reusable bags at grocery stores
Plastic Pollution Coalition plasticpollutioncoalition.org	"a growing global alliance of individuals, organizations, businesses, and policy-makers working toward a world free of plastic pollution and its toxic impacts on humans, animals, waterways and oceans, and the environment"	Provides key resources and guides on how to take action against plastics pollution; opportunities to take pledges such as *Skip the Straw* and ban polystyrene; curricula for K-12 teachers and university instructors; art competition for students to inspire and engage the public
Surfrider Foundation surfrider.org	"dedicated to the protection and enjoyment of the world's ocean, waves and beaches through a powerful activist network"	Encourages the public, government, and companies to stop using single-use plastics through campaigns such as bag and foam bans, *Rise Above Plastics*, and *Ocean Friendly Restaurants*; community outreach and beach clean-ups
Take 3 take3.org	"to reduce global plastic pollution through education and participation"	Encourages people to take away three plastic items each time they visit the beach; beach clean-ups; education programs to schools, communities, and surf clubs
5Gyres Institute 5gyres.org	"to empower action against the global health crisis of plastic pollution through science, education, and adventure"	Science projects such as *Trawlshare* and *Plastic Beach Project*; maps of global plastics pollution estimates available online; eighteen sailing expeditions that brought scientists, artists and filmmakers together; curricula for students; one-day expedition opportunities to underserved schools; *Bahamas Youth Summit*; *GyreSailors*; *Plastic Waters Exhibit* 2013–2018

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Following spread: Skye Morét, *Antarctica: a Chromatic Paradox*, 2015. Data visualization.

Antarctica: a Chromatic Paradox

Skye Morét

Yellow sponge with amphipod from the Antarctic Peninsula. PHOTO: PAUL NORTH (NATIONAL GEOGRAPHIC EXPEDITIONS AND MEET THE OCEAN).

LOW ISLAND, ANTARCTICA — JUNE 2015
When I first gave thought to what might live under the sea in Antarctica, I imagined that the fish and other animals would be the same grey-blue hue of the landscape above. Never did I expect the vibrant colours and fantastical shapes that have appeared before my eyes on the back deck of this US Antarctic research vessel—or appreciate the disruption that climate change has already begun to impose on the vitality of such a delicate ecosystem.

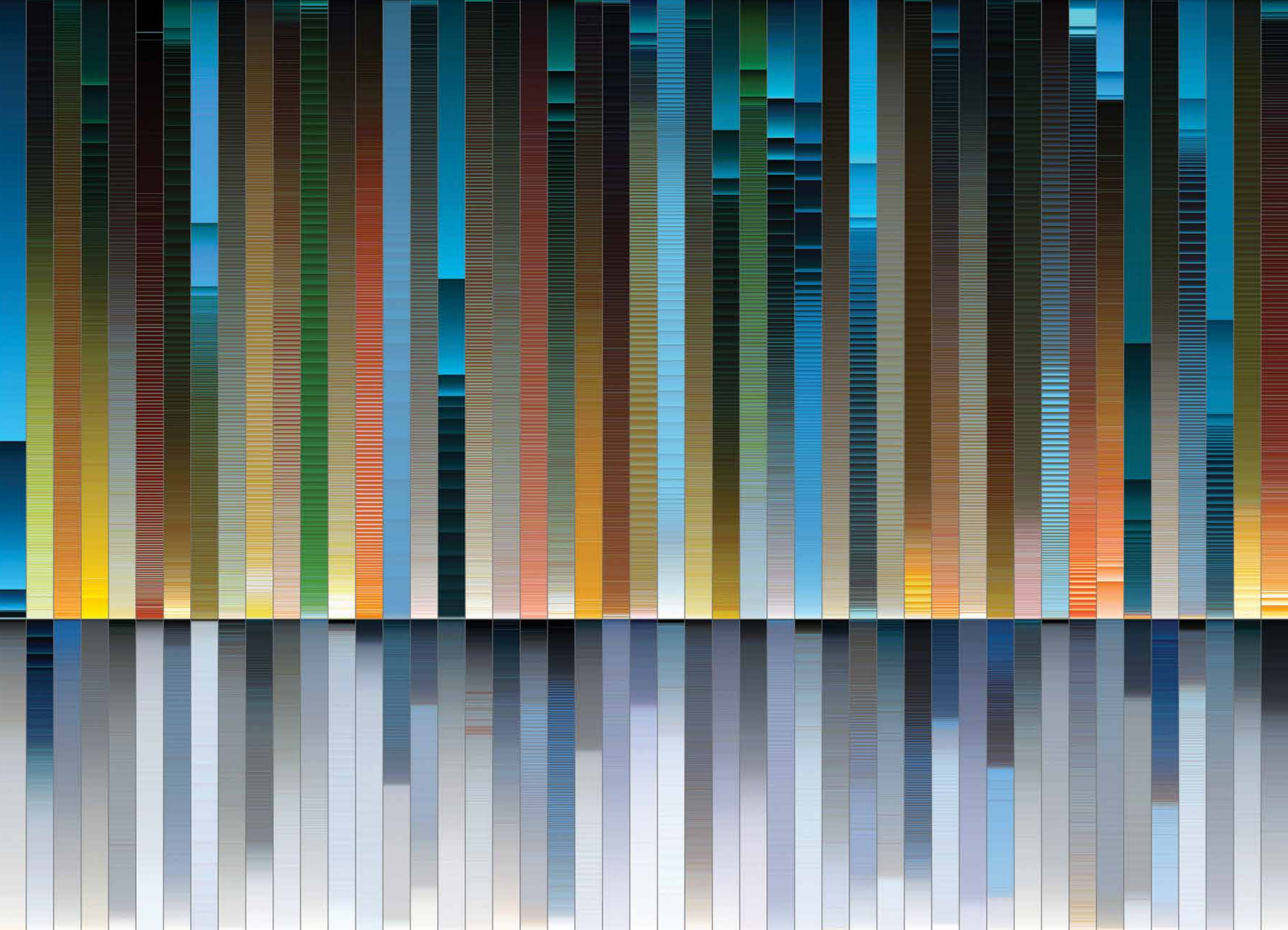
For three to four months each year I sail around Antarctica as a marine science technician for the US Antarctic Program, where my job is to facilitate science: to help researchers on seagoing and island expeditions sample and study an ecosystem that few have explored. When I’m not at sea I create visualizations to tell data-driven narratives. I use programming, illustrative techniques, photography, and participatory research to explore new and visual forms of storytelling in the context of complex environmental issues such as climate change.

In my visualization from this trip, to capture the diversity of life above and below the sea surface, I compared colour pixels from 100 photographs taken here on the Antarctic Peninsula. For each image, I systematically subsampled pixels and sorted them by RGB colour values to create a vertical pixel bar. Fifty upper vertical bars represent images captured of the land and seascape above the sea surface, while fifty lower bars exemplify the vibrant and varied world beneath the waves. The end result is a juxtaposition of colour and intensity that exposes our assumptions of a “colourless” Antarctica and reveals a surprising realm below, one that tends to be neglected in popular dialogue about a quickly warming Antarctic Peninsula. But first, a bit more context from these weeks at sea…

I’ve been sailing along the continent since mid-May. Our singular goal on this voyage: to skim the sea bottom and collect fish, which we will keep alive to bring back to a research station within a day’s steam. In order to get there, we had to cross the notoriously formidable Drake Passage, where the entire Southern Ocean squeezes between South America and Antarctica. It’s now gusting up to sixty knots and the ten-foot swells are consistently flooding the back deck with water—not ideal weather for putting expensive trawl nets over the side.

Our big steel ship, the *Laurence M. Gould*, seeks refuge between two islands on the Western Antarctic Peninsula to ride out the strong gale. Our work will start early the next day, and before heading to bed I take anti-nausea meds—a rare step for an experienced sailor, but quite necessary given the large rolls we are experiencing. Periodically throughout the night we poke our bow out into the weather to see if the seas have sufficiently calmed so we can head north for science.

Sure enough, by 0400, in the military parlance of seafaring expeditions, the winds have laid down. We head for the shallow waters of Low Island, with its self-descriptive silhouette, and deploy our net into the sub-zero waters. It takes about forty-five minutes for the net to reach the bottom, fifteen minutes to trawl for creatures, and another forty-five minutes to haul them up to the surface. By the time the bulging end of the net, called the “cod end” for where cod collect when fishing for them, is finally hauled up and over the stern, we are eager to open it



and transfer the fish to tanks. Once the net is hauled into a safe area, we quickly untie the fancy slipknots on the cod end and expose the net's bright, wriggling contents.

At first glance, the diversity of both shape and texture defies expectation: hairy sponges, rigid fish, spiny urchins, feathery hydroids. But as all of the fish are whisked away, the animals accidentally caught in the net remain the true spectacle.

I see bright yellow sea stars the size of throw pillows, spindly sea spiders as large as my hand, toddler-sized sponges, and pink sea cucumbers with white bumps like a garden cucumber. As everyone grabs shovels to quickly return these creatures to the sea, my gloved hands touch skates with three-foot wingspans and thick worms with inch-long gold spines that look like fine jewelry. Everything is vibrant and colourful in contrast to the frosty grey world above the surface. I gently pick up peach-coloured soft corals the shape of cattails and bulbous tunicates that look like wrinkled, white potatoes and return them back to the briny deep.

This little glimpse of what lives at the murky bottom is truly awe-inspiring. A completely different universe below that may host undescribed species and new habitats—a seascape that most humans will never regard.

I return to Antarctica as both a scientist and information designer because it is extraordinary; rife with stunning scenery and scientific discovery. It is the last unexploited continent on the planet.

Though I have mixed feelings about fishing in such a vulnerable area, even for science, I never grow tired of seeing what we pull up from the Antarctic depths. It's like looking through a keyhole at a secret garden of colourful undersea creatures at the bottom of the Earth. Their stark juxtaposition to the white, blue, and brown hues that dominate the scape above motivates my need to show this dichotomy of Antarctic colours through my work: a portrait of above the sea surface versus below. As a data-driven artist I want to evoke curiosity, awe, and awareness of the vibrant, diverse, and abundant life beneath the surface at these latitudes.

Unfortunately, the Antarctic Peninsula persistently experiences the greatest temperature anomalies in the Southern Hemisphere. The average annual temperature here has been warming 1.1°F (0.6°C) per decade. That's more than 7.4°F (4.1°C) since 1947, when air temperature was first consistently recorded in the region.

South, beyond the latitudinal thresholds of our cultural consciousness, these colourful creatures are incredibly vulnerable and are now the true test subjects in our outcome-uncertain, human-induced experiment called climate change.

Gas Station

Ruth Beer

In many rural and remote northern communities, the frictions and possibilities of pipeline proposals have galvanized Indigenous and non-Indigenous groups who hold divergent views of oil and gas industry expansion, and whether to support it. At a moment when complex cultural, geopolitical, economic, and ecological tensions inflect the conditions of dialogue about pipeline projects, how can artistic practices engage publics in meaningful ways? How can artists support contemporary struggles for decolonization and the transformative possibilities of affirmative environmental actions? Driven by a need to disentangle from the legacy of big oil and our habituated use of fossil fuel, can artistic practices propose new ways of thinking and support resistance to infrastructures of extraction during this time of energy transition?

A strategy we have adopted in "Trading Routes: Grease Trails, Oil Pipelines," a research-creation project that focuses on the intersecting geographies of Indigenous fish grease trails and proposed Alberta-British Columbia oil pipelines, is to look closely at our landscapes, through scholarship and material production. By examining the converging trade and extraction routes in Western Canada, including pipelines that overlay the geographic routes along which fish oil/grease was traditionally traded, we seek to better account for the ways in which an environmental/social justice perspective can be supported by research-creation practice.

Gas Station is a portrait of one of the many places we encountered on our field visits to northwest British Columbia. It draws our attention to the complex questions of how to see and understand the current state of colonial violence, resource extraction, and environmental destruction in this region. The Petro-Canada station is situated at the junction of Highway 37 and Highway 16, two of the very few travel corridors within this vast territory. Here, the expansion of oil and gas pipelines continues to be debated, including concern for the subsequent increase in tanker traffic that would threaten the pristine shores in this culturally rich area. The station is stately, acting as a beacon and a geographic marker in this contested terrain of mostly unceded lands in the territory of the Tsimshian, Haisla, Wet'suwet'en, Gitxsan, and Nisga'a peoples. From this crossroad, these highways link to urban centres many hours away, and connect sparsely populated local communities (including reserves).

Highway 37 originates at the Pacific coastal town of Kitimat and extends northward to link BC to the Yukon and Alaska. Kitimat, planned and built the Aluminum Company of Canada (Alcan) in the 1950s, is the terminus of highly contentious proposals for oil and gas pipelines and an expanded tanker port. It is at the head of the treacherous 80-kilometre-long Douglas Channel waterway that would be used for shipping crude oil to oversea markets. It is also one of the finest fjords and principal inlets of the BC coast. Extreme tides, remoteness, and its inaccessible shoreline make it particularly vulnerable to maritime accidents. Economic and environmental tensions along this route are part of cultural life—with the area bearing the cyclical history of boom-and-bust mining and logging economies. Resource extraction and infrastructure projects are negatively impacting ocean waters, fisheries, and the salmon-bearing rivers that once also supported huge harvests of oolichan, a small fish rendered to produce oil/grease valued for its sustenance, cultural significance, and trading commodity status.

Highway 16 from Prince Rupert on the Pacific coast, extending east into central Canada, is a land artery in a region where road travel is problematic, with—until just this past year—no reliable public bus service or cell phone connectivity. Highway 16 is also known as the "Highway of Tears," a name that demarcates a travel route where many Indigenous woman and girls have met with violence.

The junction of these highways is not only a site where contradictions and tensions related to the movement of resources become apparent—it also carries deep interspecies relationships, centuries of Indigenous histories, and ongoing trauma driven by settlement, cultural erasure, and land dispossession. While they extend far beyond its bounds, these difficult relations are condensed in the photographic image. The monumental Petro-Canada sign evokes the red and white Canadian flag with its semblance of a maple leaf. The sign's underline of bank and credit card logos fuses nationalism and consumption (of both petrochemicals and credit card deals). Somewhat less obvious, on the edge of the frame, an RCMP cruiser with its royal crest insignia makes Canada's colonial heritage and institutional presence felt.

Distinct from the authority conveyed in these highly-designed markers, hand-painted signs on weathered wood point to places of bears and glaciers, while small official maps enclosed behind glass beckon travelers to come closer. Other signs express deeper forms of community (Friends of Wild Salmon) and reference the cultural and environmental significance of the Sacred Headwaters of the Nass, Stikine, and Skeena Rivers—affirmative calls for protective impulses, expressions of ecological concerns, and the need to defend land, water and fish.

Positioned at the highway intersection, demanding our attention, the gas station appears out of sync with the landscape. Polarized national debates about energy infrastructure expansion are prominent and flood popular media, but it is primarily small communities in remote northern landscapes, far from the eyes of Canadians living in urban centres, that are most directly affected and where the effects are seen and experienced. I contend that by thinking through images like this one—attuning ourselves to what they show us and what they hide—we can provoke questions about the intersection of colonial violence, resource extraction, and environmental destruction in Canada's North.

Image: Ruth Beer, *Gas Station*, 2014.
COURTESY THE ARTIST.

The State of Energy:
Material dimensions of "dirty" renewables in Mauritius

Jessica Caporusso

When you flick on a light switch, what do you see? What is happening? Depending on where you are in the world, the electricity illuminating that lightbulb in front of you comes from a particular aggregate of energy sources. If you hail from southwestern Ontario, the energy mix is likely to be a combination of nuclear energy, hydroelectric, wind, natural gas, and miscellaneous renewables including solar and biomass.[1] If you find yourself in the small island developing state (SIDS) of Mauritius in the western Indian Ocean, that mix is more likely to be composed of non-renewable energy sources (79%), mostly derived from imported coal and natural gas, and renewable sources (21%), mainly in the form of locally grown sugarcane biomass and its discards.[2]

Electricity is often perceived to be an ephemeral, fleeting substance, and thus difficult to study; it is transient, instantaneous, and notoriously elusive to pin down.[3] However, as several energy scholars have recently elucidated, electricity—along with its production and its discards—is materially grounded in particular histories and political geographies.[4] Where and how energy is produced matters.

In Mauritius, the local energy supply depends on a socially combustive[5] mix of fossil fuels and renewable energy sources drawn from seemingly fixed, material landscapes. One such energy feedstock, bagasse—a fibrous byproduct of the island's sugarcane industry and derivative fuel used in colonial-era sugar processing—is in the process of being converted into a modern, sustainable biofuel feedstock. This move is driven by the government's desire to decrease dependency on foreign fossil fuels while capitalizing on increasing demands for a local, sustainable biofuel economy.[6] Mauritian state-owned agencies and private enterprise, in particular, have also pushed for local green-energy solutions in line with governmental dreams for national energy security fueled by renewable energy sources. At present, approximately sixty-six percent of the island's total energy mix comes from combination of bagasse and coal combustion produced by the country's four sugar-millers turned power-producers, each managing its own thermal power station.[7]

Although the ready availability of sugarcane discards makes bagasse an appealing energy feedstock, the success story of byproduct-to-fuel source is not as green as it is purported to be. While energy generated from bagasse seemingly "recuperates" value from waste, this process obscures bitter histories of sugarcane plantation labour and the energy extracted from enslaved peoples forced to farm it.[8] So, how does sugarcane, a commodity crop rooted in colonialism, become converted into a driver of economic growth bound up in dreams of sustainable development?

In order to understand how a nascent green energy sector is shored up by plantation economies, it is imperative that we turn our attention to the material dimensions of power and waste. Discard studies scholar Max Liboiron, in particular, has called attention to the importance of studying systems of waste and wasting as social, economic, and political problems, as opposed to technocratic ones.[9] Using the analytic of "discarding" instead of waste or wasting, Liboiron further draws attention to the ways that wasted materials, as well as "people, landscapes, futures, [and] ways of life," are also made expendable as matter-out-of-place,[10] or matter not readily available for capitalist extraction.

One small story may unearth the rippling effects of such complex relations. In the summer of 2016, in the midst of my doctoral research on "green" energy transitions, I was invited to participate in a Plant Propagation training workshop at the Mauritius Sugar Industry Research Institute (MSIRI). Aimed at budding horticulturalists and retirees, the workshop taught plant grafting techniques, as well as how to care for local varietals and the proper handling of gardening hormones and equipment. During our leisurely tea breaks, I had cultivated a relationship with Michel, one of the long-term administrative staff members, who during tea one day, shared the story of the program's origins. "You know," he explained, "at the outset, this program used to be for sugar labourers. It was to retrain them after [the sugar industry] 'restructuring'…[it wasn't] for hobbyists."[11] In other words, labourers had been made "redundant" through industry downsizing and needed to be re-skilled for other sectors. Such stories are not singular occurrences in Mauritius.[12]

Bagasse shredder. PHOTO: JESSICA CAPORUSSO.

Mill effluent/wastewater. PHOTO: JESSICA CAPORUSSO.

Submerged in the story of sugarcane are enduring legacies of exploitation, extraction, and discarding. Imagine the intertwined histories of global capital, slavery, and indentureship that terraformed an island thick with endemic ebony wood into mono-crop sugarcane plantation economies. As a thrice-colonized sugar plantation enterprise and enduring sugar producer, Mauritius shares with the Caribbean a long history of raw material production at the service of industrial capitalism.[13] The original inhabitants of the island, the ill-fated Dodo bird, were displaced by circulating flows of similarly displaced peoples through processes of enslavement and indenture that were woven into the very fabric of Mauritian society.[14] What violence, injuries, uprootings, and upheavals were met out in order for such "Plantationocene" logics to take form?[15] What livelihoods and ways of living where discarded to make way for this system? What uprootings continue to take place?

Current systems of power extraction do not break from past colonial enterprises, but rather shore up them up. As Christina Sharpe contends, "in the wake, the past that is not past reappears, always, to rupture the present."[16] For Sharpe, being "in the wake" means a mourning of, but also reckoning with, the rippling effects of an enduring, far-reaching colonialism; that is, a colonization that does not end with a formalized decolonization but submerges and resurfaces over time. Drawing on anthropologist Michel-Rolph Trouillot,[17] Sharpe highlights the ways that the "past" has not passed. Being in the wake is a matter of holding to account how colonialism's effects reverberate through time, amplifying the enduring injuries against enslaved peoples, their descendants, and colonized environments on a planetary scale.

Bagasse milling. PHOTO: JESSICA CAPORUSSO.

In moments of such resurfacing, what does it mean when "green" energy systems are built upon the enduring legacies of indentured and enslaved peoples' labour?[18] For Mauritian labour activists and environmentalists, sugarcane's dirty past greatly problematizes its potential as an ecological and socially viable source of power. Green energy cannot be socially "sustainable" if it is founded upon systems of exploitation and extraction—systems, that in turn, maintain sugar barons' hold on power. In other words, shoring up a contemporary "green" energy industry in Mauritius cannot be disassociated from plantation forms of power. As Mauritius comes to grips with its energy future, what counts as "sustainable" practice matters. To redress these concerns, several labour and energy activists in Mauritius have aimed to disconnect renewable energy feedstocks from any association with colonial exploitation, specifically wresting it from the control of former sugar baron families—some of whom presently run the sugar mills-turned-thermal power plants in Mauritius.

At present, several environmental groups and labour networks are attempting create more livable futures. Some argue that sugarcane and its discards cannot exist as a socially just, "sustainable" energy feedstock.[19] The way forward, instead, lies in environmental justice initiatives such as solar energy cooperatives. Other interlocutors have noted that solar energy panels are cost-prohibitive and therefore unattainable for the vast majority of Mauritians.[20] Other activists and industry-stakeholders have argued that bagasse can be an important transitional fuel source that supports smallholder farmers' livelihoods—and their knowledge—while responsibly utilizing plant discards for energy consumption. In these disagreements, we find underlying refusals[21] to accept common, fixed understandings of sustainable energy forms—differences that have much to teach us about the contingencies and contexts of power.

Spent bagasse or "bottom" ash. PHOTO: JESSICA CAPORUSSO.

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4 See Antina Von Schnitzler, "Traveling Technologies: Infrastructure, Ethical Regimes, and the Materiality of Politics in South Africa," *Cultural Anthropology* 28, no 4 (2013): 670–93; Gabrielle Hecht, "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence," *Cultural Anthropology* 33, no 1 (2018): 109–41; Gökçe Günel,"What Is Carbon Dioxide? When Is Carbon Dioxide?" *PoLAR: Political and Legal Anthropology Review* 39, no. 1 (2016): 33–45; and Gretchen Bakke, *The Grid: The Fraying Wires Between Americans and Our Energy Future* (New York: Bloomsbury USA, 2016).

5 I use the phrase "socially combustive" to highlight the charged emotions that surround discussions of energy production on the island.

6 "Mauritius Renewable Energy Act 2015," Legal Supplement to the Government Gazette of Mauritius No. 100, 3 October 2015, http://mauritiusassembly.govmu.org/English/acts/Documents/2015/act1115.pdf.

7 During the six-month sugarcane harvest, thermal power stations generate electricity from bagasse feedstock. Outside of the harvest season, these same thermal stations rely on imported coal to substitute bagasse.

8 Sidney W. Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Penguin Books, 1986); Vijaya Teelock, *Bitter Sugar: Sugar and Slavery in 19th-Century Mauritius* (*Moka*, Mauritius: Mahatma Gandhi Institute, 1998).

9 Max Liboiron, "The What and the Why of Discard Studies," *Discard Studies*, 1 September 2018, https://discardstudies.com/2018/09/01/the-what-and-the-why-of-discard-studies/.

10 Ibid.

11 In 2006, the Mauritian Ministry of Agriculture released a report to address what it termed a national crisis in sugar production, called the worst economic threat in the island's history. The report declared that Mauritius would adopt a concentrated model of sugar production in order to protect the economy from collapse. This action plan aimed at transforming the sugar industry into "sugar clusters" meant to streamline production while diversifying sugar's potential use-values through derivative products (e.g. molasses, sucrose ethanol, bagasse). Alongside this sugar cluster streamlining came "right-sizing," the consolidation of the industry's workforce (MAAS SEA 2006:13).

12 In Mauritius, agricultural "bust and boom" cycles have been long entangled in the political and economic occupations on the island. Historian Richard Allen (1999) has highlighted sugar barons' practices of selling off unprofitable landholdings to would-be smallholder farmers during periods of economic hardship—periods later to become known as the *grand et petit morcellements*.

13 See Richard B. Allen, *Slaves, Freedmen and Indentured Laborers in Colonial Mauritius* (Cambridge University Press, 1999); Richard H. Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600-1860* (Cambridge: Cambridge University Press, 1996); Sidney W. Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Penguin Books, 1986); Eric R. Wolf, *Europe and the People Without History* (Berkeley: University of California Press, 1982).

14 Jean Houbert, "Mauritius: Independence and Dependence," *The Journal of Modern African Studies* 19, no. 1 (1981): 75–105.

15 Donna Haraway has written that the "Plantationocene" stands in for "the devastating transformation of diverse kinds of human-tended farms, pastures, and forests into extractive and enclosed plantations, relying on slave labour and other forms of exploited, alienated, and usually spatially transported labour." Donna Haraway, "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin," *Environmental Humanities* 6 (2015): 162. See also Anna L. Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press: 2015).

16 Christina Sharpe, *In the Wake: On Blackness and Being* (Durham: Duke University Press, 2016), 9.

17 In *Silencing the Past* (1997), Trouillot carefully interrogates the ways that power weaves together certain histories and while simultaneously and strategically unravelling others.

18 Often excluded from the story of contemporary sugarcane production is the unaccounted-for agricultural knowledges taken from enslaved and indentured peoples.

19 I draw attention to the sociocultural dynamics of "sustainability," which tend to be overshadowed by the seemingly singular environmental dimensions of sustainable development discourses.

20 Of related concern is the reliance on petrochemicals in solar panel manufacturing processes.

21 Carole McGranahan, "Theorizing Refusal: An Introduction," *Cultural Anthropology* 31, no. 3 (2016): 319–25.

Observing our Changing Atmosphere from the Northern Edge of the Canadian Arctic

Dan Weaver

↓ *The PEARL Ridge Lab*

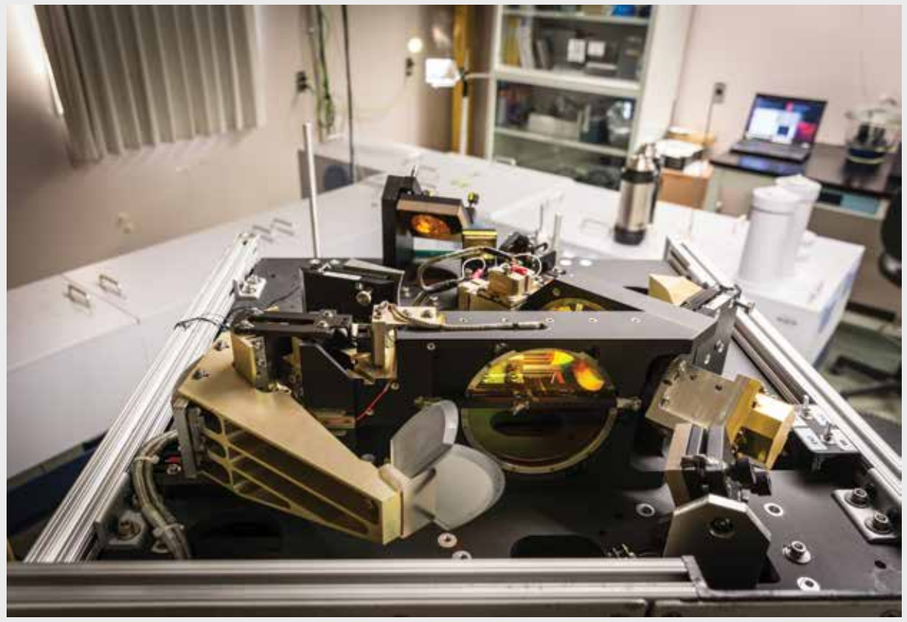
The Polar Environment Atmospheric Research Laboratory (PEARL) is the most northern atmospheric observatory of its kind (80°N). PEARL hosts dozens of instruments across three main facilities. The Ridge Lab sits atop a ridge at an altitude of 610 metres, approximately twelve kilometres from Eureka, with a spectacular view of the surrounding landscape. It was originally built by Environment Canada in the early 1990s as the Arctic Stratospheric Observatory (AStrO), but its operation was ended in the early 2000s. A group of academics (CANDAC) revived the lab in 2005 and re-opened it as PEARL. The datasets produced by PEARL measurements contribute to a variety of global measurement networks that study, for example, the carbon cycle, ozone depletion, the water cycle, air pollution, and aerosols.

→ *Eureka, Nunavut at sunrise*

Eureka is a remote, high Arctic research outpost located on Ellesmere Island, first established in 1947. At 80°N, it is one of the most northern, continuously occupied places in the world. The environment is extreme. Temperatures can be as low as -50°C during the winter and as high as 10°C during the summer. Between mid-October and mid-February, there is no sunlight at all (polar night); from mid-April to the end of August, the sun never sets (midnight sun). Several full-time staff work at the site all year round, typically staying for a few months at a time. In addition to conducting meteorological measurements year-round, the site supports government and academic researchers on a campaign basis.

← *Installing rooftop atmospheric instruments at the PEARL Ridge Lab*

A team of Canadian scientists install instruments on the roof of the PEARL Ridge Lab in late February.



↑ *Isolation and connection*

A scientist walking near the PEARL Ridge Lab. The satellite dishes in the foreground provide a communications link between the remote PEARL facility and the rest of the world. The connection speed is limited, so its use for data transmission and personal communication is carefully rationed.

← *PEARL infrared spectroscopy lab*

The internal components of the Portable Atmospheric Research Interferometric Spectrometer for the Infrared (PARIS-IR) are visible while its cover is off during the setup procedure for a measurement campaign at the PEARL Ridge Lab. An instrument identical to PARIS-IR is on board the Atmospheric Chemistry Experiment (ACE) satellite, which was launched into Earth's orbit in 2003. The ACE instruments were designed and built in Canada. They acquire measurements of dozens of atmospheric gases to study the chemistry and composition of the atmosphere.

The instrument in the background is a permanently installed, high-resolution Fourier-transform spectrometer that gathers measurements of atmospheric composition by observing sunlight directed into the lab using a tracker on the roof.

← *Science through sunlight*

The dome of a Brewer spectrophotometer, a Canadian-designed instrument used to measure atmospheric ozone using observations of UV light. They are deployed world-wide to monitor the ozone layer, as well as SO_2 and NO_2.

→ *Moments of reflection*

A PEARL researcher takes a moment to look out on the stunning Canadian Arctic landscape near Eureka. The high Arctic's environment is expected to change significantly due to climate change.

Shorelines and other imagined spaces

Alison Cooley

It is easy to get deep in water's metaphors: porosity, clarity, flow, murkiness, its body, your body, the floodgates, thirst, immersion. It is easy because water tells us so much about the spaces we inhabit. We wade and get absorbed. We make and re-make shores. Coastal scientists call it hardening: the creation of shoreline barriers (bulkheads, seawalls, jetties) ostensibly to armour the shore and protect against erosion. The opposite (shorelines whose "soft" ecosystems remain) are called living shores.

Urban planners often speak of "connectivity"—a desirable network of urban resources, facilities, services, and communities that promotes economic growth, supports existing systems, and ideally, fosters climate resilience. But among planners and geographers, there is also a turn to understand connectivity in a more expanded sense—one that engages multispecies entanglements and relationships to worlds beyond and within city space,[1] and the shore is a perfect place to apprehend this.

So what can the history of our human-made shores tell us about the divides between our imaginative capacities and the anthropocentrism of urban development conversations?

As artist Dylan Miner describes, the lake is a place where "different peoples/ecologies/worlds" meet, and the shore can be a site of sustenance, movement, contact, encounter, tension, trade, occupation, communion, violence, writing, and re-writing.[2] Shores are also spaces of invention, hubris, imagination, and problem-solving. In particular, human-made shores can teach us about the inseparability of human and non-human worlds—their resistance to segmentation and control demonstrates connectivity at its deepest.

For example, the shores of Lake Ontario have seen innumerable coasts reconfigured for the benefit of trade, transportation, recreation, and waste disposal over the last 200 years (a corollary to the colonization and dispossession of Indigenous lands beginning in the 1600s in the region): the creation of the landfill park which eventually became Toronto's Leslie Street Spit; the infilling of Toronto Harbour to create Lakeshore Boulevard in the 1920s; and a fantastical (and only partially realized) vision for Ontario Place and a huddle of sustainable, utopian, human-made islands proposed by architect Eb Zeidler in the 1970s.[3]

For nearly a century, the harvesting of shale slabs from the Lake's rocky shores supported much of the GTHA's stone infrastructure, with Port Credit dominating the stonehooking industry.[4] But the removal of these natural wave breakers resulted in floods in Port Credit, drastic erosion at the base of the Scarborough Bluffs, and sudden threats to shoreline nooks and weeds serving as nurseries for fish.

Compare this to the contemporary, global extraction of riverbed sand for the production of concrete, window glass, and other silica-based structures from which our housing developments, bridges, universities, and malls are built. As journalist Vince Beiser has documented, a massive industry has blossomed around riverbed sand, which is used to reshape shoreline borders, shore up new human-made islands, and birth massive concrete infrastructure projects. Despite the crisis-level overconsumption of sand, humans continue to harvest these shallow beds in search of structural aggregate for strong concrete—all in the service of reimagining their urban environments.[5]

The shore's traces mark the connective tissue running through all built environments (beyond the fundamental waters that sustain human life, whether the resources be wave-breaking shales or riverbed-mined sands, or the many fuels, labours, and energies that enable urban development). Acknowledging the necessity of new infrastructure and new configurations of public space is integral to the work of restructuring our urban spaces more equitably, sustainably, and collaboratively.

A more current, localized example of the complexities of imagination, urban planning, and the creation of human-made shores is now emerging just east of the former stonehooking hub of Port Credit: the Lakeview Generating Station, a coal-fired power plant in operation from 1962 to 2005. Led by the Lakeview Ratepayer's Association, the collective reimagining of this shoreline brownfield space has taken shape in the years since.[6] By 2017, Lakeview Community Partners Limited (a partnership of infrastructure contractors, homebuilders, and developers) had taken over the project and purchased the land, building on the existing plans and policy frameworks developed by community members and the City of Mississauga.[7]

This groundwork attests to a profound exercise in collective social and environmental imagination undertaken by citizens: envisioning better, connected public transit; increased walkability and bicycle infrastructure, with shopping, school, work, and cultural experiences not organized around automobility; support for public space and recreation; and a recognition of environmental remediation and conservation needs in the area.

The plan capitalizes on the desirability of lakefront access, offers links to the existing Waterfront Trail, proposes artificial canals and a recreational pond (closed systems not connected to the lake, but intending to create the illusion of being so), and aims to restore and naturalize Serson Creek on the eastern side of the development. Promises including the development of a "Blue and Green Network" and an "Innovation Corridor" alongside the Credit Valley Conservation-supported Jim Tovey Lakeview Conservation Area are geared to solicit a particular brand of optimism—a seductive discourse of order and design promoting a kind of green urban utopia built on concepts of precision and functionality,[8] where nature, culture, business, school, and home each fit in their proper place.

But if connectivity is the goal, and the Lakeview Village Development Master Plan is a map for how humans will relate to the world around them, let's also reorient ourselves to consider how the non-human world will bear on us. In a plan based on the hyper-separation of designated "natural" spaces (e.g. conservation areas) and "public" space (e.g. ponds, canals, town squares), how do we recognize other forms of natural entanglement? Weeds, birds, pests, and bacteria, each with their own agency and entanglement within shoreline ecosystems, (those still "living," and those surviving amidst "hardening") will be inevitable co-habitators at Lakeview Village. In keeping with the imaginative capacities that have shaped existing visions for public transit, walkability, access, and climate resilience in Lakeview Village, there is also a need to acknowledge that this space attracts, impacts, and encroaches on non-human others—and will thus be affected by non-human logics.

Beyond a vision of the shoreline as a space of human control, if we are to imagine new urban futures, we have to open ourselves up to connectivities beyond the human.

Lakeview Coal Plant demolition, June 12, 2006. PHOTO: LAWRENCE R. NICOLL. COURTESY MISSISSAUGA LIBRARY SYSTEM.

Part four of a serial column by a member of *The Society for the Diffusion of Useful Knowledge* team on the physical and material traces of climate change and environmental violence in the region.

1 Housten et al., "Make kin, not cities! Multispecies entanglements and 'becoming world' in planning theory," *Planning Theory* 17, no. 2 (2018): 190–212.

2 These complex histories of the water's edges are explored throughout the *Work of Wind: Air, Land, Sea* project, including in Dylan Miner's installation *Agamiing – Niwaabaandaan miinawaa Nimiwkendaan // At the Lake—I see and remember*, in Natasha Naveau's *Shkakamikwe Kido: It Comes Through the Land* (*SDUK 02*, p. 14), and Macarena Gomez-Barris's "Colonialism at the Sea Edge of Extinction" in *The Work of Wind: Land*, eds. Christine Shaw and Etienne Turpin (Berlin: K. Verlag, 2018). Outside of this project, also see Leanne Betasamosake Simpson, "Big Water" in *This Accident of Being Lost* (Toronto: House of Anansi, 2017).

3 For more on Eb Zeidler's vision and the influence the Zeidler family on Toronto's architectural identity, see Nicole Cohen, "The Zeidler Effect: How One Family Transformed Toronto," in *uTOpia: Towards and New Toronto*, ed. Alana Wilcox and Jason McBride (Toronto: Coachhouse, 2005).

4 "The Stonehookers of Lake Ontario," City of Oakville, https://www.oakville.ca/culturerec/bronteharbour-essay5.html.

5 Vince Beiser, *The World in a Grain* (New York: Penguin Random House, 2018).

6 Citizen and government action has been key to this process, including significant advocacy by the late Jim Tovey, City Councillor and once head of the Lakeview Ratepayer's Association.

7 The 2018 Development Master Plan put forward by Lakeview Community Partners is available at https://lakeviewcommunitypartners.com/dl/Development_Masterplan.pdf.

8 This approach to visualizing a segmented, hyper-functional urban utopia is not unique to the Lakeview project—for more on the aesthetic and rhetoric of developer plans, see Molly Sauter, "City Planning Heaven Sent," *e-flux*, February 2019, https://www.e-flux.com/architecture/becoming-digital/248075/city-planning-heaven-sent.

What is Innovation?

D.T. Cochrane

"Innovation Nation" is the title of a recent *Financial Post* series,[1] the sub-heading of which tells us that Canada is competing in a "cutthroat global ideas economy." An editor's note adds: "Canada has a rich history of innovation, but in the next few decades, powerful technological forces will transform the global economy… At stake is nothing less than the country's prosperity and economic well-being."

It is difficult to dissemble a concept like innovation; in its conventional use, the term is propagandistic, not analytical. It is yoked to the concept of growth, discussed in the previous column (see *SDUK03*, p. 20), and within popular economic discourse if growth is the goal, then innovation is the means.

At no point in the *Financial Post* series is innovation defined. There are mentions of new technologies, as well as research and development. It is implicitly assumed that these are part of innovation, but there is no examination of how innovation could be something more. And there is certainly no question that we always want more of it. But what if innovation is not inherently desirable?

For starters, innovation is not invention, which we can think of as the subset of art deriving newness from the practices and materials of production. The climate crisis demands radical transformation of our productive systems, so invention is needed now more than ever. But what about innovation?

When economists speak of innovation, the most prominent theoretical touchstone is Joseph Schumpeter, for whom entrepreneurs were a key component. He wrote, "[T]he function of entrepreneurs is to reform or revolutionize the pattern of production by *exploiting an invention* […]. This function does not essentially consist in either inventing anything or otherwise creating the conditions which the enterprise exploits. It consists in getting things done."[2] Schumpeter is best known for the phrase "creative destruction," which he considered the "essential fact about capitalism."[3] To get things done is to bring inventions—new products, new processes, new organizational forms—to the market. It is the market that will then pass judgement, deciding whether the new destroys the old. Market success is taken as proof that the new is preferable.

Innovation is the process of channelling invention to satisfy the need for financial returns. The term "exploit" is perfect in this sense. There are many possible trajectories of an invention as it transforms society; different inventions could alter technologies in various ways with wildly different consequences. Among these evolutionary paths, expected profits provide a selection mechanism: entrepreneurs must show investors that their offering will generate market-beating returns. This means acquiescing to the "one dollar, one vote" economy dominated by the wealthy. For example, middle-aged men humiliated by their erectile dysfunction have more disposable income than children dying of malaria, so pharmaceutical companies prioritize the development of boner pills over anti-malarial medication.

The demand for returns also encourages externalization. If costs can be shifted to others, then profit margins can be increased or prices can be reduced, further enticing buyers. Capitalists put their money into new projects, which are always assessed on their ability to generate returns. However, there is no necessary correlation between financial returns and the betterment of society. For decades, investment in oil and gas, used to develop new technologies for faster and cheaper production, enjoyed sizeable returns. But those returns were predicated on the externalizations that produced the climate crisis. Are we really better off for innovations in the oil and gas industry that facilitated the increased use of fossil fuels?

The reflexive insistence on innovation accepts that virtue is aligned with money; where money circulates the good is found. To question the correspondence of the good with the valuable, or to suggest a negative correspondence—that money sows destruction—invites derision. When outlets like the *Financial Post* sound the alarm that Canada is failing to be as innovative as other countries, they express concern that we will fail to attract investment and spending dollars. It is simply a given that we want to attract those dollars, that we must attract those dollars, and we must vigorously pursue whatever might do so. In other words, we just assume that we must allow the wealthy to pass judgement on our creativity and productive output.

In *Forces of Production*, the historian David Noble describes the process by which one automation technology rather than another was chosen in the machine tool industry.[4] The rejected technology was proven to increase output per work-hour more than the chosen technology. However, the other technology deskilled machine tool workers. Since skilled workers have more bargaining power, they can demand higher wages and better working conditions; this increases costs, cutting into profit margins. As such, the deskilling technology was adopted.

The philosopher Cornelius Castoriadis observed that our creativity is just as capable of harm as it is of betterment: "Auschwitz and the Gulag are creations just as much as the Parthenon and the *Principia Mathematica*."[5] How do we ensure more of the latter and less of the former? Certainly, the mere promise of market rewards is not sufficient to conclude that an innovation will make life better.

It was the demand for returns that made it logical for Exxon to obfuscate the knowledge that fossil fuels were drastically changing the global climate. By the Schumpeterian definition of "getting things done," oil executives and their functionaries were highly innovative, introducing new forms of public ignorance. For example, they leveraged the scientific language of hypothesis to cast doubt on the near-consensus among scientists that human activity was transforming the climate in ways that may doom humans as a civilization, or even as a species. As well, profitability in the oil and gas business means that the market has greatly rewarded this innovation.

As mentioned above, invention must be part of grappling with the climate crisis. But, as Schumpeter understood, invention is not sufficient; we must get things done by introducing sustainable practices and changing destructive habits of production. However, there are also existing social practices we wish to sustain, which we need to shore up. We cannot expect the mechanisms that rewarded innovations like Exxon's deliberate obfuscation of climate science to offer what is needed—both the old and the new—to save us.

Part four of a serial column on the fundamental concepts of commerce and exchange as driving forces that propel climate change.

Issue 01: What is the Economy?
Issue 02: What is the Market?
Issue 03: What is Growth?
Issue 04: What is Innovation?
Issue 05: What is a Price?
Issue 06: What is Value?

1 "Innovation Nation," *The Financial Post*, http://innovation.financialpost.com.

2 Joseph A. Schumpeter, *Capitalism, Socialism and Democracy* (New York: Harper Perennial, 2006 [1942]), 132; emphasis added.

3 Ibid., 83.

4 David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Alfred A. Knopf, 1984).

5 Cornelius Castoriadis, *Philosophy, Politics, Autonomy: Essays in Political Philosophy*, ed. David Ames Curtis (New York: Oxford University Press, 1991), 3.

Just Vertical:
The multifaceted benefits of vertical gardening

Fraser McCallum

When Kevin Jakiela and Conner Tidd met as students in the University of Toronto Mississauga's Master of Science in Sustainability Management program, both were working on research-driven projects about environmental issues and food production. Tidd completed an internship at a large agricultural corporation, analyzing their public relations strategies in light of increasing concern from environmentalists. Jakiela had conducted research for a vertical farming company, determining best practices for growing seedlings indoors. Their combined expertise from these placements lay the foundation for their belief in vertical hydroponic gardening—both as a viable business opportunity, and as a means to grow produce year-round, with fewer adverse environmental impacts.

In the summer of 2016, Jakiela and Tidd began pooling their knowledge to found Just Vertical, a start-up creating products for consumer-friendly indoor vertical gardening. Before moving to a mass-market scale, however, they built their knowledge base by working with Growing North (now known as Green Iglu), a non-profit organization devoted to building greenhouses in Northern communities. After Growing North erected its first hydroponic garden inside a geodesic dome in Naujaat, Nunavut in 2015, Jakiela and Tidd lent their expertise to support high school students in maintaining their new local greenhouse, and drew on their technical experience with irrigation and lighting to streamline Growing North's building process for future projects throughout the region.

Jakiela and Tidd's work in Northern communities highlighted the widespread and growing nature of food insecurity. As a result, Just Vertical encourages consumers to decrease their reliance on the fluctuations of global food supply by maintaining stable hydroponics at home.

Since shifting focus to a mass-market scale, Just Vertical has been creating products with a simple premise: small edible plants growing from vertical supports arranged in columns, lit by LED lights, and watered through an internal irrigation system. Since founding the company, Jakiela and Tidd have created a series of these planters—some of which can be found supplying UTM's cafeterias—with increasing refinement and success. Their first hydroponic systems were built using pragmatic, hardware-store supplies. After completing further market studies, they found prospective buyers were looking for a growing system that doubled as décor in their living space, rather than the do-it-yourself approach associated with most hydroponics.

Just Vertical's flagship product, the Aeva, addresses these desires: it's a growing tower which includes a walnut base with a storage cabinet, lights across the centre, and two columns of planters running up each side. The Aeva pumps water to the roots of each plant directly, forgoing the need for a regular watering schedule. Owners can buy plant nutrients and seeds tailored to their diet on a subscription basis, ensuring ease of use for even the least green-thumbed. As Just Vertical's marketing materials are keen to point out, the Aeva's sleek design fits neatly into modern homes and condos.

Tidd characterizes their customers as "people living in cities and urban centres who want to grow their own food but cannot due to living in an urban jungle. At the same time, they want a simple, mess-free, elegant solution that they can show off."

Beyond Aeva's polished design, Just Vertical has serious ecological aspirations for its products. The company hopes to reduce food miles (the distance traveled, and resulting pollution involved in shipping food) by encouraging consumers to grow their own greens, herbs, and vegetables. Their goal is to eliminate eight billion food miles before the eight-billionth person is born onto the planet. If this goal seems ambitious, it's equalled by market enthusiasm for Just Vertical's product offerings to date: the company has won awards at several sustainability tradeshows, and their first major production run of Aeva units has recently shipped to consumers. In addition, Just Vertical continues to create custom solutions for larger growers, including a recent 28,000-plant facility in London, Ontario.

Amid booming interest for domestic hydroponic products—owing in no small part to the recent legalization of cannabis, but also to increasingly turbulent food prices—Just Vertical enters the market at a challenging time. Home hydroponic kits of all shapes and sizes are available online, many of which use "smart home" technologies offering app-based monitoring of grow lamps and watering schedules. For Jakiela and Tidd, the Aeva's design-forward approach is one way their product stands out from its competitors. Equally important, however, is their rigorously scientific approach; Tidd asserts that the Aeva can grow larger plants, in greater quantities, faster than other systems.

A persistent and legitimate concern about home hydroponic systems is their reliance on power, and the resulting strain on the electricity grid—the energy needed to grow hydroponics is only as ecologically friendly as the grid powering it. In response to these concerns, the Aeva uses high-efficiency LED lights and a single pump, resulting in a low power draw. Beyond energy efficiency alone, Tidd is quick to point out the other offsets created by home hydroponic gardening: "When we look at the emissions saved, some of the big things we look at are the packaging we eliminate—by being right in your kitchen, no packaging is needed—and savings on last-mile transit. If we can save you one trip to the grocery store per week, that takes miles off the road." Even if gardening with the simplicity of solar energy alone will never lose its appeal, the broader ecological impacts of vertical hydroponics have undeniable rewards.

By reintroducing gardening into improbable places, Just Vertical empowers consumers to reclaim some agency in their food consumption. Jakiela and Tidd learned of the adverse environmental impacts of food production first-hand, through their diverse research experience at agricultural corporations, hydroponic start-ups, and in Northern communities. Informed by issues such as crop failure and scarcity, emissions from food miles, and the waste of food packaging, they saw potential in vertical hydroponic gardening as a sustainable alternative to large-scale agricultural industry. After developing several successful growing systems, they turned their attention to marketing and design—discovering that consumers are not afraid to highlight their elegantly designed hydroponics. This last arc in their trajectory is a crucial one: the increasing popularity of indoor gardening systems in living rooms and kitchens emphasizes that food is not simply grown *out there*, but is an integral part of our everyday lives requiring attention and care.

Local Useful Knowledge: Resources, Research, Initiatives

Ancient Forest Exploration and Research (AFER) is devoted to tracing, researching, and preserving the few remaining old-growth forests in Southern Ontario and the Northeast US. Since nearly every part of the region has been logged at some point since the beginning of European colonization and settlement, forests free of recent human disturbance are extraordinarily rare. AFER's online database maps and describes mature and old-growth forests, thereby empowering readers to learn about environmental history and ecology. The organization has also published *Ontario's Old-Growth Forests*, which provides in-depth detail on precolonial forest history, including thorough maps and access points for each listing. In recognition of the region's complex histories, AFER does not presuppose that only old-growth forests are worthy of appreciation and study; rather, their database highlights forests strands of unique age and character in heavily urbanized areas as well. As such, local sites such as Bronte Creek, Rattlesnake Point, and Mississauga's Rattray Marsh are all listed, the latter for its mixed hardwood, hemlock, and white pine trees of up to 150 years old. With the Ancient Forest Database and *Ontario's Old-Growth Forests*, nature enthusiasts, hikers, and city-dwellers alike can find a new entry point to appreciate the forests in our midst, and the histories that accompany them.

eXXpedition leads sailing voyages made up of all-women crews to collect data and raise awareness about issues facing the world's bodies of water. Each summer since 2014, the organization has sailed different oceans, seas, and lakes worldwide, focusing on the harms caused by plastics, chemicals, endocrine disruptors, and carcinogens. In 2016, the eXXpedition team co-ordinated a water sampling and microplastics study across the Great Lakes region. The team oversaw the efforts of citizen scientists from throughout the Great Lakes—from sailors near Duluth to beachcombers in Kingston—to collect data for a global microplastics database created by Adventure Scientists for Conservation. eXXpedition's work serves not only to collect and analyze data from its sailing voyages, but also to empower women in science, through this unique and challenging mode of fieldwork. Noting the lack of gender and racial diversity in STEM fields, eXXpedition's voyages enact change through experiential learning. Their voyages have captivated environmentalists worldwide, becoming the subject of numerous documentaries and articles, catalyzing citizen science on a global scale, and inspiring women and girls to pursue scientific education and vocations.

Greening Sacred Spaces Halton-Peel (GSS) works with faith groups to build connected, environmentally friendly, and resilient communities throughout the region. Engaging diverse faith communities, GSS holds workshops (including nature appreciation, natural care product-making, and waste reduction), creates and maintains community gardens, and conducts energy benchmarking audits for buildings owned by faith organizations. These audits by GSS are aimed at curbing emissions and consumption, with the dual outcome of decreasing energy costs and reducing greenhouse gas emissions. Beyond their guidance for individual faith organizations, GSS works to build interfaith connections—as seen in their Extreme Weather Toolkit, a guidebook for fostering community resilience to extreme weather. The Toolkit acknowledges that faith buildings are crucial to extreme weather planning, since these spaces often have the necessary infrastructure and community connections to centralize communications and resource-sharing in disaster scenarios. With the Toolkit, faith groups can build their capacity for emergency response. As such, GSS Halton-Peel is fostering community resilience by building a network—both by strengthening individual nodes and creating new connections.

The **Placing Parks Toolkit** is a new initiative of Etobicoke-based community arts organization **MABELLE Arts**. Named for the street where their home park is sited, MABELLE Arts has run programs in Etobicoke parks since 2007, encompassing music, theatre, visual and media arts, food, storytelling, and more. The Placing Parks Toolkit arises from MABELLE Arts' collaborations with organizations in five cities across Canada in 2018. These programs—ranging from neighbourhood art-making in Winnipeg to programs aimed at linking newcomer and refugee communities with local artists in Halifax—form the experiential basis for the Toolkit. The latter offers guidance on issues such as fundraising, active inclusion, park infrastructure, and the "art of hosting." With these tools, artists, educators, and organizers can learn from the experiences of MABELLE Arts and its partners to re-examine their approach to community engagement—or, to put it simply: they can learn how to be a good host. With the help of the Toolkit, park programmers can prioritize accessibility, equity, and cultural safety, while facilitating dynamic and responsive programs.

Dr. Yuhong He's **Remote Sensing and Spatial Ecosystem Modelling Lab** (RSSEM) at the University of Toronto Mississauga collects, monitors, and analyzes environmental data using innovative technologies such as remote sensing, GIS, and drone imaging. These technologies enable the lab to monitor large natural areas with less reliance on localized data sampling. In previous work, Dr. He has partnered with Credit Valley Conservation to map infestations of Emerald Ash Borer in Mississauga-area trees, and she has analyzed the biochemical properties of Canadian grasslands (demarcating important metrics for understanding environmental resilience). Her current project uses drone imaging to study how extreme weather and climate change affect the heat output of Canadian grasslands and forests—essentially tracking how deforestation and fire has a warming effect on the environment at a larger scale. Dr. He has also published widely on her lab's use of technology for environmental monitoring, thereby sharing the use of these tools with broader research communities in geography and the sciences.

UTM's Environmental Affairs Office leads the University's sustainability initiatives across its broad operations, including waste, green building, energy, and UTM's unique natural areas along the Missinihe/Credit River. To ensure the health of plant and animal life on campus, the Environmental Affairs Office works in multifaceted ways, such as naturalizing former lawn areas, prioritizing native species and pollinator plants for new landscaping, and maintaining a pond habitat from treated stormwater runoff. For UTM's well-loved deer population, Environmental Affairs ensures forested areas remain relatively undisturbed, and thus habitable for herds. On an everyday basis for students, staff, and faculty, the Office is currently piloting new waste bins that incorporate compostables, and will look to expand the availability of organic waste disposal if the trial proves successful. Alongside waste, energy is a major environmental concern for UTM. Energy efficiency has also been prioritized through geothermal and solar power projects, upgrades and retrofits to building infrastructure, and the installation of dashboards to monitor local energy usage. These initiatives carry forward into UTM's future, with its commitment to green building through a minimum LEED Silver certification for all new building projects.

Biographies

Laurel Albina is a Canadian-born Palestinian-American writer and trade-union negotiator. She is a 2011 alumna of the Writers in Residence program at Hedgebrook, a 2014 fellow with the Jack Straw Writers Program, and a graduate of The Writer's Studio at Simon Fraser University. Her poetry has been published in *Grey Sparrow Journal* and *Prairie Fire*, and she is the 2016 winner of *Briarpatch*'s Writing in the Margins poetry contest. She lives in East Vancouver, BC, with her partner and two children.

Ruth Beer is an interdisciplinary Vancouver-based artist whose artworks (which include sculpture, photography, video, and sound) have been presented in national and international exhibitions and publications. Her research-creation practice is informed by social sciences and humanities within the expanded field of contemporary art and media. Recent supported projects as lead artist/researcher include "Trading Routes: Grease Trails, Oil Pipelines" (tradingroutes.ca) and "Shifting Ground: Mapping Energy, Community and Geography in the North" (mappingchange.ca), both of which address energy, culture, and ecologies in transition. She is a Professor in the Faculty of Art and Graduate Studies at Emily Carr University of Art and Design.

Jessica Caporusso is a PhD Candidate in the Department of Anthropology at York University. Her research interests meet at the intersection of political ecology, bioenergy, and discard studies. Her dissertation examines how "waste"—as an externality and as resource—is defined through neocolonial logics, by investigating the transformation of crop residues into biofuel feedstock in the small island developing state of Mauritius. Jessica's work explores the multiple and contested meanings of waste and value while also tracking the development of bioenergy as a source of energetic, political, and economic power. She is an active contributor to the Plant Studies Collaboratory and the Energy Working Group at York.

Skye Morét is a data-driven designer and marine scientist. Her diverse background on the ocean—having sailed 80,000+ miles around the globe—fuels her belief in the power of art and design in communicating nature and science. Her work investigates the complex relationship between nature and technology-mediated human expectations, experiences, and engagement. Skye is a Senior Researcher on the Ocean Archive Project with User Group Co-op and is an Assistant Professor in the Collaborative Design + Design Systems graduate program at the Pacific Northwest College of Art. Her work has been published in *Science*, *Slate*, *Migrant Journal*, *Popular Science*, *Roads & Kingdoms*, and Public Radio International, among others.

Genevieve Robertson is an interdisciplinary artist with a background in environmental studies. She holds an MFA from Emily Carr University (2016) and a BFA from NSCAD University (2009), and presently serves as the Executive Director at Oxygen Art Centre in Nelson, British Columbia. Through recent research on the Salish Sea and the Fraser and Columbia rivers, she has engaged with the complexities that emerge when relating to land and water in a time of large-scale industrial exploitation. She has exhibited her work nationally and participated in residencies internationally. Her work is informed by a personal and intergenerational history of resource labour in remote forestry camps on British Columbia's west coast.

Synthetic Collective is an interdisciplinary collaboration between visual artists, cultural workers and scientists working together to sample, map, understand, and visualize the complexities of plastics and micro-plastics pollution in the Great Lakes Region. Their enquiry is at the intersections of geologic processes, plastics pollution, and artistic production. The collective is working to expand its network of resources and researchers with the goal of developing a more tangible understanding of plastics pollution as a wicked problem: one that is both a local and global systemic issue, yet also a potential site for innovation and remediation. Synthetic Collective includes Sara L. Belontz, Patricia L. Corcoran, Heather Davis, Kathleen A. Hill, Kelly Jazvac, Kirsty Robertson, and Kelly Wood.

Dan Weaver is an Assistant Professor at the University of Toronto Scarborough, focusing on physics education. He researches the Arctic atmosphere and climate change, and during his PhD he collected data using a high-resolution spectrometer at the Polar Environment Atmospheric Research Laboratory (PEARL), near Eureka, Nunavut (80°N). Dan is an advocate for science and evidence-based public policy decision-making. He is also a photographer.

Lois Weinberger (born 1947 in Tyrol, lives in Vienna, Austria) works on a poetic-political network that draws our attention to marginal zones and questions hierarchies of various types. Weinberger, who sees himself as a field worker, embarked in the 1970s on ethno-poetic works that form the basis for his ongoing artistic investigations of natural and man-made spaces. He has contributed significantly to discussions on art and nature since the early 1990s.

GLOSSARY
An entangled lexicon for a rapidly changing world

Aerosol: Suspended solids or liquids in air, naturally occurring as clouds, fog, dust, or steam; or anthropogenically created, as haze or smog. Scientists study aerosols because of the impact of cloud formation on global climate (see Moore, p. 7, and Sobecka, p. 8, both in *SDUK02*). Atmospheric research identifies how aerosols contribute to warming or cooling (by reflecting or absorbing sunlight), and to the "greenhouse effect," particularly in relation to ozone-layer depletion through pollution (see Weaver, p. 20).

Attention denotes thoughtfulness and care to places and beings, both human or nonhuman. Attention can be thought, felt, or sensed (see Beer, p. 16; Synthetic Collective's interdisciplinary methodology, p. 8). Amid increasing concern over the commodification of attention through media, contributors to these *SDUK* broadsheets reclaim attention as a way of knowing environments to promote multi-species flourishing.

Capitalism is an economic system where a limited number of people control the resources and property required to participate in society, either as producers or consumers. Capitalism divides spheres of production and consumption, within a logic of production that emphasizes novel, often superficial innovation (see D.T. Cochrane, p. 24) and conspicuous consumption, often obscuring the ecological destruction, social stratification, and colonial violence upon which it relies (see Beer, p. 16).

Charismatic megafauna are large animals often used to represent environmental distress (including elephants, polar bears, and giant pandas), also known as **flagship species**. Some have criticized the reliance on charismatic megafauna in environmental discourse for oversimplifying complex inter-species relationships, and undervaluing less-popular victims of climate breakdown (see Synthetic Collective, p. 8; Xiang, *SDUK03*, p. 23).

Citizen science is research, sampling, monitoring, or analysis conducted by non-professional scientists. Citizen scientists work in diverse ways—including air or water quality sampling, species counts, or shoreline clean-ups (see a profile of ACER, *SDUK01*, p. 26). Professional scientists often work collaboratively with citizen scientists, since the latter can monitor local environments in ways inaccessible to scientist teams (see Synthetic Collective, p. 8).

Collaboration involves working together toward a common goal, with the origin of the word being *co-labour*. Collaborative practices often involve different levels of engagement, including retaining the individuality of each contributor, or acting under a collective name. Collaborative practices can share knowledge from different fields, with examples of **interdisciplinary collaboration** in this issue including Genevieve Robertson's work in *River Relations: A Beholder's Share of the Columbia River* (p. 4), Ruth Beer's *Trading Routes, Grease Trails, Oil Pipelines* (p. 16), and Synthetic Collective (p. 8), all of which include contributors from the humanities and sciences for a broader consideration of the impacts of climate change.

Creativity describes the imaginative capacity of generating new concepts, relationships, and ways of doing. In contrast with innovation (where new ideas are mobilized in the service of measurable returns), creativity's outputs are not always easily consumable. This makes creative research an effective tool for understanding complex problems (see Beer, p. 16; Robertson, p. 4; Synthetic Collective, p. 8). However, as Cochrane (p. 24) notes, neither creativity nor innovation are virtuous by definition—they are equally capable of harm.

Debris: Waste, remains, or scattered pieces of something larger which has been broken. Consider the residual debris of mining and resource extraction (see Robertson, p. 4), agricultural waste (Caporusso p. 18; Canada's Waste Flow, *SDUK02*, p. 23), or the archaeological debris of settlement (Weinberger, p. 3). Consider also the relationship between debris and disaster: What remains after a crisis?

Entanglement: The interwoven relations between social, political, economic, and ecological issues, which may appear to be isolated concerns, yet are irrevocably linked (see Beer, p. 16). Complex relationships between and among species can be characterized as entanglements (see Cooley, p. 22). This term can also refer to animals literally entangled in debris and plastics pollution, as discussed by the Synthetic Collective (p. 8).

Glacier: A mass of dense ice, formed gradually when snowfall and ice build-up exceed melt in seasonal thaws. Glaciers form on land—but while **glacial** pace may indicate the slow passage of time, they are in constant movement. Sediment deposited in glaciers archives deep environmental histories (see Robertson, p. 4; Morét, p. 13).

Grease trails are trading routes used by Indigenous nations of the Pacific coast and Pacific Northwest interior. Traders carried the processed oil of oolichan (a small, abundant ocean fish) overland to exchange for goods. Whereas grease trails derive their name from the fish oil trade, petrochemical oils threaten the ecologies of the region due to increased freight shipping and pipeline development (see Beer, p. 16).

A **hold** is an embrace, often expressing care and affection, but also suggestive of ambivalence, necessity, or non-reciprocated support (see Weinberger, p. 3). Christina Sharpe (referenced in Caporusso, p. 18; and Shotwell, *SDUK03*, p. 8) deploys "hold" as a noun, as **the hold** of a trans-Atlantic slave ship. For Sharpe, the shackling of enslaved Africans in the ship's hold marks an irreversible trauma for Black people living in the wake of slavery, and the hold emblematizes European slave traders' dehumanization of Black people as insurable property.

Insecurity may refer to a sense of unease, discomfort, or anxiety (as in the face of climate collapse). Structurally, insecurity denotes vulnerability to a threat, be it social, political, military, of political. Consider food in/security (McCallum, p. 25), energy security (Caporusso, p. 18), access to housing and transit (Cooley, p. 22), or job security (LEAP, *SDUK01*, p. 10).

Measurement: The act or method of quantifying something, often done by comparing one set of data to another (Weaver, p. 20; Synthetic Collective, p. 8; Morét, p. 13; Cochrane, *SDUK02*, p. 21). How might we apply measurement to artistic research, to acts of witnessing, to knowledge systems more anchored in subjectivity? (Beer, p. 16; Robertson, p. 4; Albina, p. 6) How can we see the immeasurable?

Overburden is a mining term referring to plant life, soil, sand, and rock that separates valued minerals from the Earth's surface (see Albina, p. 6). In surface mining processes, it is excavated as waste. Conversely, when sand, gravel, or rock is used as construction fill or foundation, it is referred to as **aggregate** (see Synthetic Collective, p. 8).

Production: The creation of material objects, as well as systems that facilitate this creation (e.g. manufacturing). Production has increasingly been framed within the logics of **capitalism**, and often involves a focus not on invention for the betterment of society, but on modes of production that increase profitability for investors (see Cochrane, p. 24). New ideas of productivity should not be seen in isolation, as they often continue past colonial enterprises within extractive economies (see Caporusso, p. 18).

Spectroscopy originated as the use of the visible light spectrum to measure the chemical composition of materials based on their light absorption, but now includes the use of other radiative energies (based on wavelengths and frequencies of electromagnetic radiation, acoustic waves, and even gravitational waves). The PEARL Lab (see Weaver, p. 20) uses spectroscopy to study the chemical composition of the atmosphere, while the RSSEM Lab (p. 26) analyzes spectral data to understand the role of plants and forests in altered climate conditions.

Terraforming: A term originating in 1940s science fiction referring to the transformation of the planet by humans. Despite its fictional origins, extractive industries have long reshaped the environment, for instance building land where there was once water or flooding large areas in the construction of major dams (see Cooley, p. 22; Robertson, p. 4; Caporusso, p. 18). In *SDUK01*, Heather Davis and Zoe considered this mass alteration of ecosystems in the context of settler colonialism (p. 12), while Shannon Mattern described cities as grafted terrains (p. 5).