

# DEAR ENEMY: INTERSPECIES COMMUNICATION THROUGH ARTISANAL SCENTS

## ABOUT THE AUTHORS<sup>1</sup>

GIORGIA GRAELLS is a Chilean biologist with a Master's degree in Science from Universidad de Magallanes, who has studied beavers since 2009. She codesigned the experiment, participated in the creation of scents, and wrote the main manuscript of this research.

DEREK CORCORAN is a Chilean biologist with a PhD in Ecology from Universidad Católica de Chile, who has studied beavers since 2009. He codesigned the experiment, participated in the creation of scents, made the analysis, and edited this manuscript.

CAMILA MARAMBIO is a Chilean curator, cofounder and director of Ensayos, and PhD candidate in Curatorial Practice at Monash University. She coordinated the work in Tierra del Fuego, participated in the creation of scents, conducted the experiments in the United States and Tierra del Fuego, and coedited this manuscript.

CHRISTY GAST is an artist from the United States with an MFA in Visual Art from Columbia University. She coordinated the residency at the Institute of Art and Olfaction in LA, participated in the creation of scents, conducted the experiments in the United States and Tierra del Fuego, and coedited this manuscript.

## ABSTRACT<sup>2</sup>

*Dear Enemy* is a collaborative project undertaken by scientists and artists, formulated in the Chilean and Argentinean archipelago of Tierra del Fuego to examine one of the most important ecological issues in this region: the “invasiveness” of previously introduced North American beavers. Conservationists are studying how beavers change the environment, which ecosystems are more susceptible to being damaged, how people react to these changes, and how the ecosystem, as a whole, can best be protected from the species. Research into these questions is typically undertaken from an anthropocentric point of view, that is, leaving beavers out of discussions about our shared futures—theirs as much as ours—in the archipelago. This paper reflects the result of an experiment using scents as a way to facilitate communication between humans and beavers.

The title of this project is derived from the “dear enemy effect” (Temeles, 1994), which postulates that many territorial animals respond less aggressively to neighbors than to strangers when borders are well established. The dear enemy effect posits that as territory owners become accustomed to their neighbors, they spend less time and energy on defensive behaviors. It is well established that beavers produce a scent called “castoreum” (Schulte *et al.*, 1994) which they use in order to communicate with other beavers when establishing territorial boundaries. Our experiment was developed in order to test the efficacy of using human-produced scents in order to establish interspecies communication between humans and beavers.

## INTRODUCTION<sup>3</sup>

In 1946, the Argentine government under the administration of Juan Domingo Perón conceived and implemented a macroeconomic policy to drastically reduce imported goods by creating analogous industries within the country. As part of this plan, Perón's government attempted to build its own pelting industry. Ten pairs of North American beavers (*Castor canadensis*) were introduced from Canada and released near Fagnano Lake, located on the Argentine side of Tierra del Fuego's main island (Pietrek and Fasola, 2014). Though beaver pelts had historically been highly prized, by the latter part of the century—when the beaver population was large enough to

This scientific paper is structured like those published in the peer-reviewed journals that advance all scientific disciplines. Even the list of authors, their names and degrees stacked so precariously atop each other, conforms to this structure. First authorship is given to the researcher who wields the pen, while at the bottom rests the author credited with funding the laboratory. That this bears mentioning suggests that we are operating in somewhat different territory. That territory is occupied by Ensayos, a nomadic research program in Tierra del Fuego, at the southernmost tip of South America, where the Andes fracture into an archipelago that spills from Patagonia towards Antarctica. Since 2010, Ensayos has brought an international group of artists and social scientists together with ecologists and locals to think through environmental and eco-political questions in the region. Ensayos is more focused on process than outcome, although we have made exhibitions, films, performances, experiments, and even perfumes, combining our knowledge and work methods in a way that goes beyond our disciplines. Yet we are ambivalent about the term “interdisciplinary”, in part because the prefix “inter” means “between” or “amongst,” and our research exists outside of disciplinary behaviors.



Often, the work we do together feels *undisciplined*—artists conduct field research, scientists practice aesthetic deliberation in galleries and museums, residents of the archipelago lead creative and philosophical inquiries, and disciplines begin to unravel as we seek new approaches to ecological and social questions that have a global resonance. To be clear, claiming to operate in this undisciplined mode (of existence) in no way suggests that our research is unbounded, lacking in rigor, or attempts to blur the differences between our disciplines. Instead, we are devising new rules of conduct, an ethical system that

emerges from a reflection on how, within our different disciplines, we come to know what we know, and how this knowledge is communicated and comes to bear on the world. Ultimately, undisciplined research implicates us back into the world, drawing us closer to our matter of concern.

2

To arrive at the formulation and execution of this experiment, six years of a very different type of “work” was required—although we are singling out the word “work” by setting it in quotation marks because, for the most part, we have not been paid for what we do, and more significantly, the structure of our collective inquiry resists the logic of personal, profit-driven outcomes.

Ensayos was founded in 2010, after Chilean-American curator Camila Marambio first visited Tierra del Fuego and got to know the rangers and ecologists at Karukinka Natural Park, a swath of over 700,000 acres in southern Tierra del Fuego consisting of old growth forests, peat bogs, rugged coasts, and glaciers. She was struck by the particular model for the conservation of biodiversity that Karukinka’s science research program supports, the unique history of Tierra del Fuego, and the strong sentiment that Tierra del Fuego is both a geographic and cultural “center” providing a space to reflect on the direction of art and its articulation in regards to conservation. She was convinced that bringing artists and social scientists into the fold would yield complexity and emergent solutions.

With this in mind, she and Dr. Bárbara Saavedra, director of Wildlife Conservation Society (WCS) in Chile, the NGO that manages Karukinka, brought together a group of international professionals from the fields of art, social studies, and science to work through a series of questions that would set the framework for a long-term residency program operating within and beyond the park. At that two-week meeting in Tierra del Fuego, the group determined that three pressing issues would benefit from being addressed collaboratively by these various disciplines: the impacts

be exploited—the market value of beaver pelts had diminished and the planned commercial pelting industry was rapidly abandoned. Having been introduced in an area where there were no natural predators, the beaver population boomed. They thrived in Tierra del Fuego’s sub-Antarctic forests and colonized the rest of the region, including the adjacent islands of the archipelago and the southern tip of continental South America (Anderson et al., 2009).

In 2011, the Chilean and Argentine governments officially classified beavers an invasive and harmful species (Servicio Agrícola y Ganadero, 2011) in a joint statement. By then, the beaver population had peaked to the hundreds of thousands. The two nations came to an agreement for a plan of total eradication (Funes et al., 2011). This comes as no surprise, since the beavers’ presence has had massive consequences for Tierra del Fuego’s forests, once considered to be among the world’s most pristine. Beavers cut down the forest’s southern beech trees (*Nothofagus antarctica*, *Nothofagus pumilio*, and *Nothofagus betuloides*) up to twenty meters away from their ponds (Anderson et al., 2009) to build dams that can measure up to one and a half meters tall by one hundred meters long. These beaver-made dams can slow, alter, or completely stop the flow of a river or stream (Muller-Schwarze and Sun, 2003; Baldini et al., 2008). In Tierra del Fuego, this activity has inundated the forest, destroyed the native riparian environment—by altering the plant community structure and converting it into grasslands—and impaired the native forest and aquatic ecosystems’ own ability to regenerate (Anderson et al., 2006; Martínez Pastur et al., 2006).

As beavers increase in number and colonize new areas, they mark their territory by building earthen scent mounds that they anoint with a scented glandular secretion called castoreum (Müller-Schwarze and Sun, 2003). Castoreum is an exudate stored in a sac located in the pelvic area of both female and male beavers. It is made of four pheromonal chemicals produced by beavers (4-ethylphenol, 1,2-dihydroxybenzene, acetophenone and 3-hydroxyacetophenone), which are combined with other chemical compounds beavers sequester from the plants they feed on. Therefore, the castoreum represents a chemical footprint of the environment where the beavers live. Beavers secrete castoreum by washing their glands over with urine, which is expelled onto mud mounds they construct in order to raise the scent higher than ground level, allowing it to be more easily perceived by other beavers.

When communicating via scent, beavers react differently to the scent of other conspecific individuals depending on whether or not they are known as territorial neighbors. The dear enemy theory explains this rule of communication based on studies of European beavers (*Castor fiber*) in Russia (Rosell and Bjørkøyli, 2002). Beavers recognize their neighbors by scent, while unknown and unrecognized beavers that enter their territory are treated like “others.” Although one neighbor might compete for another’s mate, they have already established their territorial boundaries. For this reason, a neighbor poses a lesser threat than an unknown newcomer. When a foreign beaver appears, local beavers react to its presence as a threat because the new beaver may take their mate and fight for their territory.

Experiments using castoreum as a means for humans to communicate with beavers have also been undertaken. These have considered the excretion as a deterrent, since beavers use it either for pre-emptive competition (Rosell and Bjørkøyli, 2002; Müller-Schwarze and Sun, 2003). Castoreum is also commercially available to beaver hunters, who use it as an attractant to lure the animals to their traps. Our joint research investigates whether it’s possible to create artificial scents to facilitate in-

terspecies communication between humans and beavers. We also seek to determine whether and how artificial scent mounds (ASM’s) attract and repel both beavers and humans.

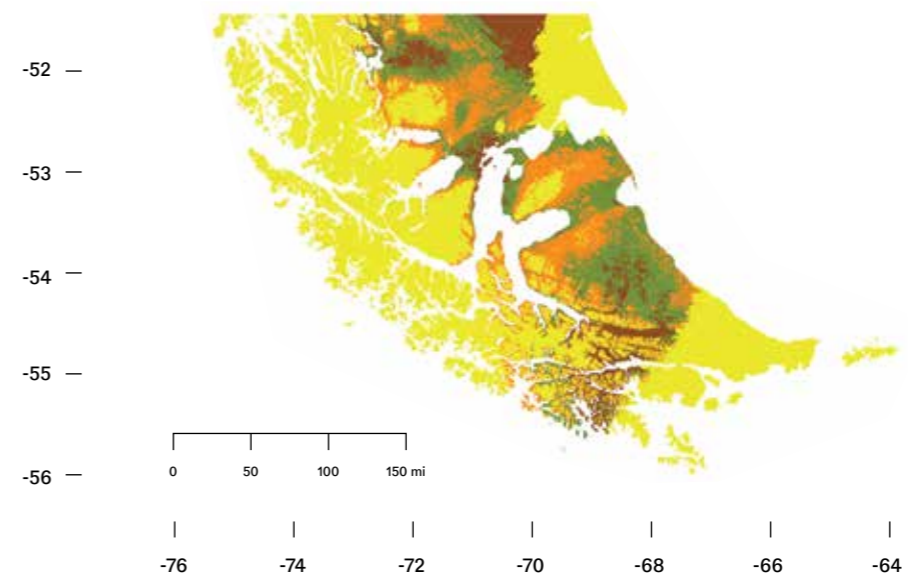
In the laboratory, we created four artificial scents that mimic four distinct biotic zones in Tierra del Fuego (see Fig. 1). One of the natural components we used is castoreum. Along with pelts, castoreum harvested from castor sacs has historically been traded by humans—used in tincture form for perfumes, and as a flavor additive for food (Burdock, 2007). Although it is naturally derived, all castoreum does not smell the same. Its scent differs depending on the environment that the beaver that produced it inhabits, since the plants a beaver eats change the chemical composition of its castoreum.

We hypothesized that synthetic scents based on the four biotic zones could elicit responses from both beavers and humans, and thus allow the two species a form of olfactory communication. In order to prove this, we have developed three objectives: First, to create four artificial scents that are representative of the four biotic zones; second, to test human reactions to these scents; third, to test beaver reactions to these scents.

#### METHODOLOGY<sup>4</sup>

In order to determine the chemical makeup of the scents, we began by dividing Tierra del Fuego into four biotic zones based on beavers’ reproduction rates. To do this we utilized data from Corcoran’s model (Corcoran, 2014) estimating the litter size for female beavers at their peak fertility rate—between eight and nine years of age. The typical number of beavers in a litter ranges from as low as a single kit to as high as octuplets. Corcoran’s model visualizes the environmental conditions that determine the beavers’ varying reproductive rates in four distinctly mapped biotic zones. The color brown represented the habitats where beavers should be unable to reproduce:

FIG. 1 Scent map of Tierra del Fuego according to beaver areas of reproduction rates.



of colonialism and capitalism on the archipelago’s ecological well being, the governance of coastal areas, and the region’s beaver dilemma. This set the stage for Ensayos as it exists today: a series of open-ended research programs focusing on specific ecological and cultural issues, with a rotating cast of collaborators from Tierra del Fuego and around the world. Ensayos is independent of Karukinka but maintains a close relationship with the park and WCS Chile.



DEVELOPING SCENTS IN THE LABORATORY AT INSTITUTE FOR ART & OLFACTION

Through this process of collective inquiry, we first had to create a common language with which to understand each other. This began with getting to know the territory (both geological and intellectual) we are exploring and dependent on, and developing relationships of trust with the institutions we have at times represented or collaborated with (and with those nonhuman forces with which we share time and space). Ever so often, the inquiries coalesce into “products,” such as this paper and the experiment that it reflects. These are not funded by the WCS, Karukinka, or any one single source, although often Karukinka hosts Ensayos, and WCS staff are at times members of the collective. Each member commits by pulling from his or her own resources and the funding available within his or her fields: academic research lines, artist travel grants, local and national arts councils, amongst others. The Dear Enemy laboratory research, for example, was funded by a grant from the Art Matters Foundation, awarded to the artist Christy Gast. It allowed her to bring the project’s four primary collaborators together for two weeks of scent development at the Institute for Art and Olfaction in Los Angeles in 2015.



The recent history of the land that today comprises Karukinka Natural Park begins in the late 1980s, when the Chilean government sold 400,000 hectares of land for about \$2 each to a Canadian/New Zealander company, which then sold it to the North American timber company Trillium Corporation in 1993. Trillium professed to practice sustainable logging. However, they lost a lawsuit brought by Chilean environmental activists, emboldened to take action after the fall of the dictatorial Pinochet regime, in that country's Supreme Court. The company soon went under, and the investment firm Goldman Sachs & Co. obtained deeds to the land when they purchased a bundle of bad loans. In 2004 Henry Paulson, the company's CEO and an avid bird watcher, orchestrated the transfer of the property to the WCS, one of the world's largest conservation NGOs. This removed the forests from the reaches of the logging industry, but it also came with another mandate: total beaver eradication.



Beavers do not conform to our notions of political geography or natural purity. Nonetheless, Tierra del Fuego is a binational island and its forests are considered some of the world's most pristine. Chile and Argentina applied an arbitrary border aligning with the 68th meridian (west) in the 19th century. This line does not follow the peaks and watersheds that naturally divide this rough territory, and the imported Canadian beavers found it irrelevant. They quickly expanded their territory to include forests on the Chilean side of the island, and began to impose their own order: that of dams and ponds.

Beavers are known as ecosystem engineers on a scale matched by no other animal except humans. When Giorgia Graells and Derek Córcoran began their study of the animals in the region, Chile and Argentina had signed a rare agreement calling for the animals'

green, where the reproduction rate would be below average; orange, where it would be above average; and yellow, where it would peak.

At the Institute of Art and Olfaction (IAO) in Los Angeles, the research team created scent profiles of each of the four biotic zones according to the characteristics of their most prevalent habitats (listed in Table 1).

TESTING HUMAN RESPONSE TO SCENTS<sup>5</sup>

To test human responses to these four scents, our team polled three groups of people: Group LA in Los Angeles, at the Institute for Art and Olfaction (IAO); Group NYC in New York, at the Bruce High Quality Foundation University Gallery; and Group TdF in Tierra del Fuego. We presented the groups with the biotic zones map, and in order to diversify the experiment, we exposed each group to different forms of our artificially created scents. Group LA was exposed to the scents sprayed on prototype experimental scent mounds (ESMs) made of mud; Group NYC smelled the scents applied to felt panels; and Group TdF smelled the bottled scents. A Principal Component Analysis (PCA)—which tests variation and pattern among collected samples—was conducted in order to measure how each sample compared to one another.

For Group LA, a public exhibition of the scent mounds and research process was set up at the IAO's gallery. Visitors to the exhibition were polled on their subjective responses, and the data collected reflected which scents they found most alluring and most repelling. All votes were registered.

In the next two surveys, Groups NYC and TdF were also polled to determine their scent preferences. Their responses, recorded as yes/no answers, were compared by filtering the responses through a Cochran-Mantel-Haenszel statistical test, which measures dichotomous responses in a large sample set. In addition, two post hoc analyses (which look for patterns in the data) along with two Z-tests of coefficients (which determine nuances within the data) were run to calculate statistical and preferential similarities and differences between each group.

TABLE 1 Representation of each of the four habitats in Tierra del Fuego. In order to represent each environmental scent, we characterized different aspects of the landscape.

SCENT GUIDE	HABITAT CHARACTERIZATION	BEAVER'S REPRODUCTION RATE
▲ Brown	Dry area, grass, rocks, dust, more wild animals, humans	0 kits per litter
▲ Green	Low areas, grassland (not dry), sheep ranches, urbanization	More than 0 but less than 3.5 kits per litter predicted
▲ Orange	Shrubs, sheep ranches, flowers, less oceanic, high hills, wild animals	More than 3.5 but less than 8 kits per litter predicted
▲ Yellow	Oceanic, mineral, fungi, freshness, forest, peat bogs, less urbanization	8 kits per litter

The beaver-response tests were conducted at two sites on the main island of Tierra del Fuego. The first site was a beaver lodge at Rio Calavera, just upstream from where that river empties into the Whiteside Channel on the island's western coast. The second, was a beaver lodge located inland at the Sector Vicuña in Karukinka Natural Park. At each site, two groups of four experimental scent mounds (ESM's) were constructed along the banks of the river at two meter intervals, beginning ten meters from the beaver lodge (Fig. 3.). Researchers used their hands and shovels to take the mud from the river banks in order to construct the ESM's, avoiding the use of mud that beavers themselves had already sprayed with their own castoreum. The scents were then sprayed in a random order on the ESM's. In total, there were four ESM's, each sprayed with a different scent, placed on each side of the river.

Since beavers are nocturnal, researchers had to wait until the next morning in order to investigate and register the beaver's responses to the ESM's.

total eradication. Beavers were officially referred to as a "plague" or "invasion". The two biologists took to the road in their caravan, a mobile home base and laboratory, for two years as they crisscrossed the main island observing, trapping, and studying beavers.



ENSAYOS INSTALLATION AT INSTITUTE FOR ART & OLFACTION

The experimental scent research divulged in the methodology section of this paper is the result of our collective insistence on engaging with the beavers in an alternative manner, which Giorgia and Derek began through their fieldwork as biologists. The four of us met through Ensayos for the first time at Karukinka in 2013, along with Laura Ogden, an environmental anthropologist, and Melissa Memory, an archeologist and wilderness manager for the US National Park Service. For two weeks we observed beavers and their impact on the forest through the lens of our disciplines. We interviewed government planners and bureaucrats, conducted an archeological survey of an abandoned dam, and contemplated and filmed the animals during the long summer dusk.

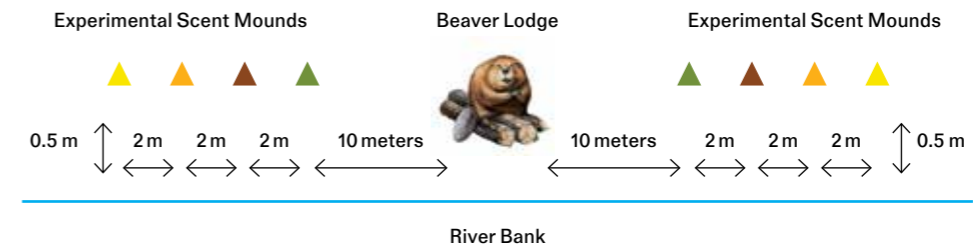
Laura asked us to consider the beavers' presence on the island not as an invasion, but in terms of an animal diaspora. What we consider to be pristine forests today, after all, were used by indigenous Ona people before colonialism, and in the last hundred years the populations of both sheep and humans in the archipelago have undergone a relative explosion. How does the speculative shift of terms change the ethics of eradication? We began to wonder how we could include the beavers in the discussion of their fate.

Our workstyle is self-funded, self-directed, and ultimately delights in enacting a set of experimental exercises or *ensayos* that test our ideas. Derived from the

FIG. 2 Experimental scent mounds (ESM) installed at Institute of Art and Olfaction.



FIG. 3 Schematic approach of beaver scent research design. At each site eight experimental scent mounds (two of each artificial scent) were installed, on either side of the beaver lodge.





FUEGIAN ARCHIPELAGO



VALLEY OF THE DAMMED AT KARUKINKA





DEREK CORCORAN & GIORGIA GRAELLS BEING BEAVERS



CAMILA ANALYZING RESULTS

French infinitive *essayer*, the noun *ensayos*—in the plural—denotes a series of “trials,” “attempts,” or “rehearsals.” *Ensayos* is named after our methodology because we believe in the power of thinking through practice; we are committed to practicing thinking. Programmatically we argue and assert the inherent potential of sequential performative experiments to comprehend and cope with the environmental complexity of Tierra del Fuego by tuning into the more-than-human, asking useless questions, getting lost in the field and translating all of the above to each other and into “data”. This requires curiosity, passion and patience.

During the years we have found like-minded practices and have often culled from them to expand our own. Some of the most inspirational and influential of these are Pauline Oliveros’s Deep Listening exercises, Goethean deep observation through drawing, Cecilia Vicuña’s ancestral vocal techniques of call and response, Donna Haraway’s notions of emergent response-ability (sitting with the trouble), Augusto Boal’s theatrics of the oppressed, and Laura Ogden’s wonder-full speculative writing assignments.

5

We, the researchers, are as much subjects as objects of study; testing ourselves and our disciplinary boundaries in order to move beyond the limitations of our own positions, biases, and objectives. Entering into the space of collective action, we trespass into each other’s “comfort zones” and hold each other in that new and often uncomfortable space where, as Haraway says, we “sit with the trouble.”

When we concluded that the beaver’s absence from conversations about its future in Tierra del Fuego was problematic, Christy Gast made a pair of beaver suits so that we might make them visible



ESM STATUS	DESCRIPTION
Intact	No clear sign of beaver response
Examined	Beaver footprints or scratch marks on ESM
Engaged	ESM material partially removed
Utilized	ESM flattened with material at least partially present
Obliterated	ESM completely removed and no material left in the original place
Communication	A new scent mound was built around it within 6" radius

TABLE 3 Using a graph from the PCA results, we were able to indicate the resemblance between the scents. The closer the scents are on the graph, the more chemically similar they are due to the makeup of their compounds. The brown, orange, and green scents are very similar in makeup, whilst the yellow scent is the most different in its composition.

COMPOUND	▲ BROWN	▲ GREEN	YELLOW	▲ ORANGE
Castoreum	40	10	19	15
Stemone	16	5	0	10
Galbanum	16	2	8	5
Verdoracine	16	0	8	0
Cedar	20	5	0	0
Guaiacol	12	3	0	0
Dirt	12	2	3	0
AAG	12	3	0	0
Oak moss	0	3	3	0
Cepes	0	1	3	2
Indolene	0	1	8	0
Cashmeran	0	3	6	0
Leaf Overt	0	5	5	0
Hexenol cis	0	10	0	5
Aldehyde c-10	0	5	0	3
Civetite	0	3	3	0
Muscione	0	5	0	0
Iso-e super	0	5	0	0
Norlimbarol	0	3	3	0
Rose acecard	0	2	0	1
Cade	0	6	0	0
Rosemary	0	3	0	1
Cosmone	0	3	5	5
Cetalox	0	0	32	0
Calone	0	0	8	0
Scntenol	0	0	10	0
Pepper	0	0	5	0
Timber propylene	0	0	3	0
Phenethyl	0	0	0	5
Cyclal	0	0	0	2

## RESULTS

### CREATING THE ARTIFICIAL SCENTS

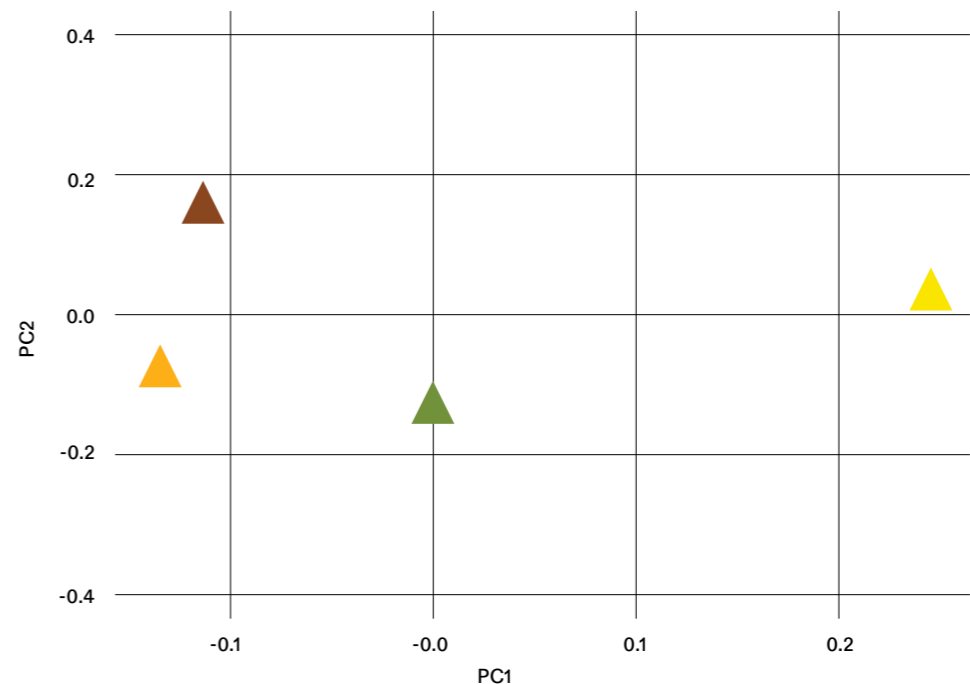
Four scents were created using a total of thirty essences (Table 3) that relate to those found within the four biotic zones in Tierra del Fuego.

Using a graph from the PCA results, we were able to indicate the resemblance between the scents. The closer the scents are on the graph, the more chemically similar they are due to the makeup of their compounds. The brown, orange, and green scents are very similar in makeup, whilst the yellow scent is the most different in its composition.

### TESTING HUMAN RESPONSE TO SCENTS

Group LA’s experiment at the IAO registered nineteen individual responses to the ESM’s. Here, the more floral scent—orange, in our scent chart—was unanimously considered the most attractive. Subsequently, the yellow scent, containing a pronounced fungal composition, was the least desirable (Fig. 5). Group TdF included twenty-two participants for whom the yellow scent had the highest proportion of likes, and the dustier brown scent presented the lowest favorability. Finally, for Group NYC a total of 124 participant observations were registered, where the orange scent ranked highest and the brown scent ranked lowest.

FIG. 4 The resemblance between the four scents based on their essence proportion, measured through PCA analysis.



by being beavers--by enacting our knowledge of the animals and practicing empathy through a series of performance experiments based on Boal’s “theater of the oppressed.”

Derek and Giorgia tested this hypothesis by donning the suits at their home in Patagonia. After some wincing, giggling, and pushing through other awkward emotions, the scientists were possessed. They channeled the knowledge gained through their fieldwork and began to occupy their property as if they were beavers. Their data suddenly came to life, leading to discussions about the Dear Enemy theory, speculation about interspecies communication through scent, and wondering how the scents might waft back to us, making us aware of our preferences and aversions.



CRISTINA SPRAYS SCENT ON ESM AT RIO CALAVERA

6

At Rio Calavera, Christy, Camila, Julián and Cristina enacted the experiment that Giorgia and Derek designed, and the next day recorded the results. To do this we had to practice beaver aesthetics. Cristina, a child who lives on a small cattle ranch up the coast from the site, and Julián, a child who is the youngest member of *Ensayos*, led this effort, scraping up wads of wet mud from the riverbed and piling it up until it matched the height of the beavers’ own mounds. They mimicked the beavers’ construction methods as we attempted to mimic their scent-making in the laboratory. As we worked, we noticed that Cristina was as much at home here as the beavers whose territory we were marking. A native of this place, she scurried over fences and down unmarked trails, over logs and through bogs without waiting for adult instruction. She and Julián worked out the puzzle of where to place the mounds and how to apply the scent. Their wild



curiosity and capacity for wonder during this process pointed back to our insistence on undisciplined research.

7

In the light of this experiment, Donna Haraway's slogan "Make Kin Not Babies" comes to mind. She writes that in the context of one of the hardest tasks facing feminists in the wake of the anthropocene (or "Chulucene" as she terms it) we must "unravel the ties of both genealogy and kin, and kin and species." Though mobilized by that shared sentiment, the design of our experiment fell into one trap. What does it mean that the data used as the foundation for Derek's map of the territory relied on a normative use of reproductive statistics as a means to measure the "success" rate of beavers in Tierra del Fuego? Asking this question now isn't a move to anthropomorphize beavers and suggest that they too have a feminist struggle against the imposition of motherhood as a



barometer of happiness. Instead, it is an attempt at triggering subsequent phases of our experiment. Beavers, too, are faced with an overpopulation problem in Tierra del Fuego. Therefore, reproducing limitlessly doesn't guarantee their survival. How might we all re-in-scent-ivize our desires and instincts to sustain a future together?

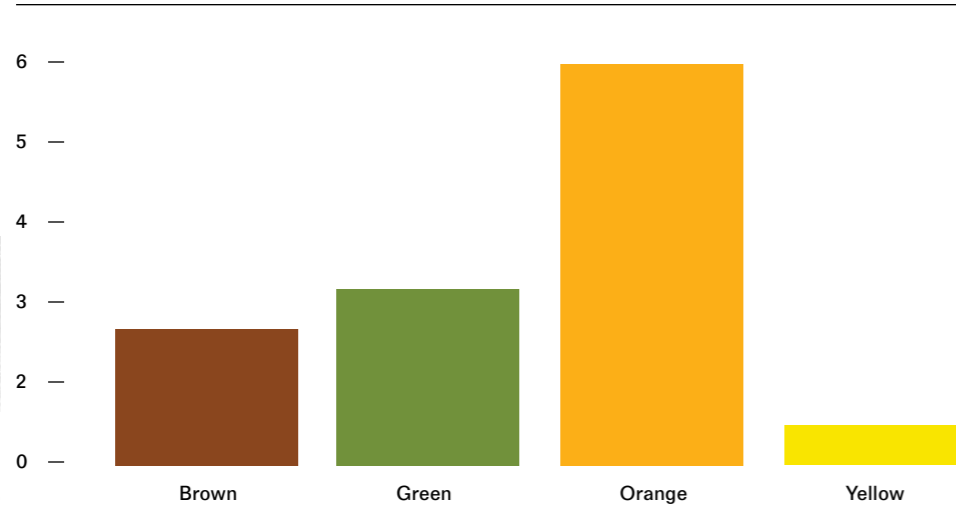
8

We appraise our collaboration as successful. Committing to a working relationship with our scientific partners, we co-developed new methodological tools that gave gravity to questions of aesthetic perception and bioethics. Furthermore, the analysis programs utilized by Derek and Giorgia to crunch the data we gathered has shed light on the use of artistic practices within the scientific method. This win-win situation is a common benchmark for assessing the success

TABLE 4 Groups NYC and TdF results results.

	▲ YELLOW	▲ ORANGE	▲ GREEN	▲ BROWN	TOTAL
Favorability Tierra del Fuego	▲ 0.83	▲ 0.5	▲ 0.17	▲ 0	—
Total observations Tierra del Fuego	▲ 6	▲ 5	▲ 6	▲ 6	22
Favorability New York	▲ 0.47	▲ 0.71	▲ 0.42	▲ 0.37	—
Total observations New York	▲ 30	▲ 31	▲ 33	▲ 30	124

FIG. 5 Human perception of experimental scent mounds at IAO exhibition



Analyzing the differences within city preferences, the Cochran-Mantel-Haenszel test shows that there are significant differences between the scent proportions. The post-hoc analysis shows that group NYC favored the orange scent and group TdF favored the yellow scent.

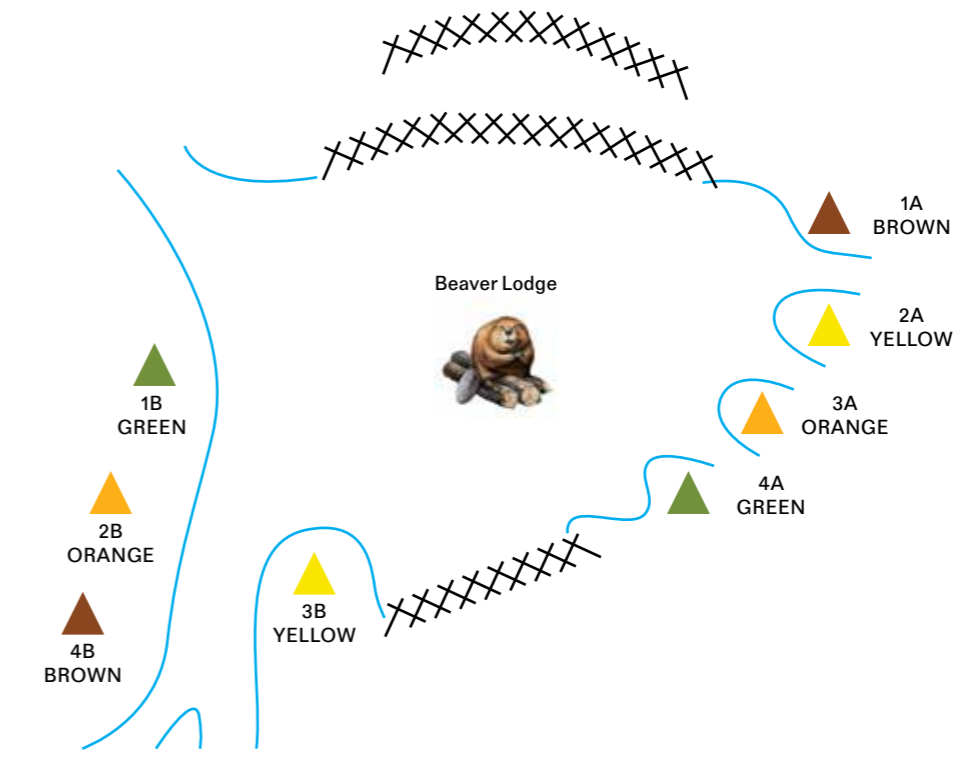
THE SCENT MOUND EXPERIMENT: TESTING SCENTS ON BEAVERS<sup>6</sup>

The scent mound experiment in Tierra del Fuego showed inconclusive differences in the responses of beavers at the two study sites. At Sector Vicuña (Fig. 6.), beavers actively reacted to two of the eight ESM's. First, beavers sprayed new castoreum next to one of the brown ESM's (1A in Figure 6). Second, beavers trampled one of the green ESM's, making it half of its original size (3B in Fig. 6.).

At Calavera River, beavers did not react to the ESM's. Although the Calavera River site appeared to be occupied (local residents provided anecdotal evidence that confirmed this) researchers did not see the animals and, as such, could not confirm that it was actively occupied by beavers.

A third site that was intended to be included in the study (Rio Caleta at Puerto Yartou, approximately 5 km from Rio Calavera) was clearly abandoned and unoccupied when our research team investigated. A local museum director reported beaver activity there a year prior, but other residents told of hunting expeditions in the region since that time. The river is extremely remote, so it is impossible to say if the site was abandoned by the beavers or whether they were hunted.

FIG. 6 Schematic drawing of Dear Enemy experiment at Sector Vicuña in Tierra del Fuego.



DISCUSSION<sup>7</sup>

The differences in composition of the four artificial scents were intended to characterize the biotic zones they represented, which in turn corresponded to beavers' reproductive rates. The scents were made from natural and man-made components that mimicked the environments prevalent in the four biotic zones. Researchers did not intend to create scents that would be explicitly attractive or repulsive to either humans or beavers. Instead, we sought to investigate environmental preference, using data determined both by beavers' reproductive success in different biotic zones, and human subjects' stated preferences for the mixtures of essences used to represent each biotic zone (Table 1)<sup>#</sup>.

This research shows that beavers react to artificial scents as predicted by the reproductive habitat map (Fig. 1), demonstrated in the experiment at Sector Vicuña, which is located in the orange zone. Beavers' reaction in this experiment resulted in a preliminary confirmation of our hypothesis: Beavers react negatively to the brown and

rate of any collective endeavor. However, in the case of Dear Enemy, what shines most brightly is the upholding of the desire to dissolve the stark hierarchical and superficial differences between the objectivity of science and the subjectivity of art. The way in which Dear Enemy reinforces our sensorial capacities to know the world furthers our reflexive tools to comprehend interdependency and biodiversity, and, finally, puts forth an intercourse of values, is an ethical imperative that we will continue to perform.



GLOSSARY	
<b>ANTHROPOCENE</b>	green scents because they represent foreign biotic zones. These biotic zones include some human habitation (towns, roads and ranches), so their representative scents include compounds derived from—or manufactured to smell like—byproducts of human habitation: industry (plastics and exhaust fumes), urban areas (concrete and cultivated flora), and human biological waste (homo sapien compounds) (Table 1).
A proposed new geological era that would follow the Holocene, marked by the effects of humanity on the earth's biophysical systems	
<b>CASTOR CANADENSIS</b>	Researchers observed evidence of two reactions by beavers to the ESM's at the Vicuña site. Beavers sprayed their own castoreum next to the brown ESM, and they trampled and left pawprints on the green ESM. This can be seen as beavers trying to defend their territory according to the “dear enemy” phenomenon (Rosell and Bjørkøyli, 2002). We thus hypothesize that the Vicuña beavers perceived these two scents to represent a threat to their territory, as they are foreign scents.
Scientific name of North American Beaver, one of the two beaver species in the world. The other species is <i>Castor fiber</i> , which is native to Europe	
<b>CASTOREUM</b>	The second site of the experiment, at the Calavera River, did not produce positive results. This missing data could be explained by several factors related to beaver territoriality or experimental manipulation in the field. Beavers did not react to our ESM's or to the artificial scents, even when they had a variety of scent possibilities to choose from. It is possible that they didn't react to the scent mounds because, due to extreme wind in the area during the day and night of the experiment, they could not smell them. It is also possible that the site was not occupied. The site was reported to be occupied by local informants, and it appeared to be occupied due to what the researchers perceived as evidence of recent beaver activity (chewed branches and pawprints on trails). However, the animals were not observed and therefore occupation cannot be confirmed.
Because this compound has the ability to capture scents, it is used in the food industry and perfumery	
<b>CHTHULUCENE</b>	Human perception of the scents correlates in some ways with the original hypothesis of this research: Humans prefer urbanized areas, or those areas already occupied by humans. We observed that most of the results show humans' marked preference for natural areas. In Tierra del Fuego, people preferred the yellow scent, which represents some urbanization, forests, and coastline, geographic characteristics that correspond with the areas of most human habitation on the island: small coastal towns and settlements. This is the only human result that confirms the Dear Enemy hypothesis: a clear positive reaction to the biotic zone most associated with human habitation (yellow scent) and negative reaction to other habitats (the brown scent represents some urbanization, but mostly open areas and grasslands). On the other hand, in Los Angeles and New York, people preferred the orange scent, which represents high hills, flowers, and shrubs. In these cases, the areas mentioned are not the habitat found within the city, but are present in the natural areas immediately surrounding those cities, and in some city parks.
A timeplace for learning to stay with the trouble of living and dying in response-ability on a damaged earth (Haraway, 2016)	
<b>NOTHOFAGUS ANTÁRCTICA</b>	
Scientific name of Antarctic Beech, one of the three southern beech trees native from South America	
<b>NOTHOFAGUS BETULOIDES</b>	
Scientific name of Magellan's Beech, one of the three southern beech trees native from South America	
<b>NOTHOFAGUS PUMILIO</b>	
Scientific name of Lenga Beech, one of the three southern beech trees native from South America	

#### CONCLUSION<sup>8</sup>

The four artificial scents, which were created at the IAO to represent four biotic zones corresponding with beaver fitness in Tierra del Fuego, were positively tested to demonstrate that beavers and humans preferred the scents that represented their own environments. The human-produced scents elicited reactions from both humans and beavers, and proved an effective approach to researching responses to olfactory stimuli in both species. Results give preliminary confirmation that interspecies communication between humans and beavers could be achieved through olfactory chemical stimulation. However, evidence confirming the Dear Enemy theory in this series of experiments was inconclusive, and further tests would be required to complement these results.

#### REFERENCES

- Anderson CB, Griffith CR, Rosemond AD, Rozzi R, and Dollenz O (2006) The effects of invasive North American beavers on riparian plant communities in Cape Horn, Chile: do exotic beavers engineer differently in sub-Antarctic ecosystems? *Biological Conservation* 128:467–474.
- Anderson CB, Martínez-Pastur G, and Lencinas MV (2009) Do introduced North American beavers *Castor canadensis* engineer differently in southern South America? An overview with implications for restoration. *Mammal Review* 39:33–52.
- Baldini A, Oltremari J, and Ramírez M (2008) Impacto del castor (*Castor canadensis*, Rodentia) en bosques de lenga (*Nothofagus pumilio*) de Tierra del Fuego, Chile. *Bosque Valdivia* 29:162–169.
- Burdock GA (2007). Safety assessment of castoreum extract as a food ingredient. *International journal of toxicology* 26(1): 51-55.
- Corcoran D (2014) “Distribución Potencial y Posibles Rutas de Migración del Castor Norteamericano (*Castor Canadensis*) En su rango Invasivo utilizando el Concepto de Nicho Hutchinsoniano.” PhD thesis, Santiago, Chile: Pontificia Universidad Católica de Chile. <https://cienciaustral.files.wordpress.com/2014/11/tesis-derek-corcoran-final1.pdf>.
- Funes M, Menvielle MF, Saavedra B, and Schiavini A. (2011) Plan estratégico del proyecto de erradicación del castor en el sur de Patagonia. Plan realizado por encargo del Acuerdo Binacional para la Restauración de los Ecosistemas Australes Afectados por el castor americano.
- Haraway D (2015) “Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin”, *Environmental Humanities* 6: 159-165
- Haraway D (2016) *Staying with the Trouble: Making Kin in the Chthulucene*, Duke University Press
- Martínez Pastur G, Lencinas M V, Escobar J, Quiroga P, Malmierca L, and Lizarralde M. (2006) Understorey succession in Nothofagus forests in Tierra del Fuego (Argentina) affected by *Castor canadensis*. *Applied Vegetation Science* 9 (1) : 143–154.
- Müller-Schwarze D and Lixing S (2003) *The Beaver: Natural History of a Wetlands Engineer*. Cornell University Press.
- Payne NF (1984) Reproductive rates of beaver in Newfoundland. *The Journal of wildlife management*, 48(3): 912-917.
- Pietrek AG and Fasola L (2014) Origin and history of the beaver introduction in South America. *Mastozoología neotropical* 21.2: 355-359.
- Rosell F and Bjørkøyli T (2002) A Test of the Dear Enemy Phenomenon in the Eurasian Beaver. *Animal Behaviour* 63 (6): 1073–78. <http://www.science-direct.com/science/article/pii/S0003347202930101>.
- Servicio Agrícola y Ganadero (2004) *El pastizal de Magallanes. Guía de uso, condición actual y propuesta de seguimiento para determinación de tendencia*. Gobierno Regional de Magallanes y Antártica Chilena, Ministerio de Agricultura, Servicio Agrícola y Ganadero (SAG) y Departamento de Protección de los Recursos Naturales Renovables, Punta Arenas, Chile.
- Servicio Agrícola y Ganadero (2011) *Legislación, La Ley de Caza y su Reglamento. Subdepartamento de vida silvestre DIPROREN 12th Edn. Unidad comunicación y prensa, SAG, SAG, Santiago, Chile*
- Schulte BA, Müller-Schwarze D, Tang R, and Webster FX (1994) “Beaver (*Castor canadensis*) responses to major phenolic and neutral compounds in castoreum.” *Journal of chemical ecology* 20, no. 12: 3063-3081.
- Temeles EJ (1994) “The role of neighbours in territorial systems: when are they ‘dear enemies’?”, *Animal Behaviour* 47:339–350

#### PHOTO CREDITS

The photos included in this article come from the research of Christy Gast, Saskia Wilson Brown, Camila Marambio. The painting in the background of the image in Footnote 8 is of Chilean poet Gabriela Mistral, by Cecilia Vicuña, an Ensayos collaborator and mentor.