



A WILD BOAR CHASE: Ecology of Harm and Half-Life Politics in Coastal Fukushima

RYO MORIMOTO

Princeton University

 <https://orcid.org/0000-0001-7986-8109>

Violence does not always take visible form, and not all wounds gush blood.

—Haruki Murakami, *1Q84*

“Contrary to what outsiders fixate on about Fukushima,” Tengo, a man in his sixties, told me, “the practical obstacle of living here is the wildlife. Not radiation!”¹

On March 14, 2011, Tengo and his family had fled their home in Odaka district, Minamisōma city, Fukushima Prefecture, immediately after the second hydrogen explosion at Reactor Unit 3 of the Tokyo Electric Power Company (TEPCO)-owned nuclear power plant about sixteen kilometers (3.7 miles) south-east. Tengo finally returned to his original residence in June 2019, after eight long years of waiting, first for the reduction of ambient radiation levels and then for the rebuilding of his house, which the government-led decontamination measures had destroyed.

As a governmentally recognized evacuee, Tengo spent eight years making a series of damage claims to TEPCO regarding the land’s contamination and his loss of livelihood. Tengo’s sustained efforts had distilled for him, more than ever, the psychological attachment he had to his natal home, its physical upkeep, and the

spiritual ties to his ancestors. According to Tengo's family history and the Japanese legal system, this land is registered under his name and he owns it. However, in multispecies worlds, the land always belongs to anything that roams it or finds through it the necessities of life. In this region, macaques, masked palm civets, green pheasants, and wild boars—the focus of this article—have long coexisted with the human locals. Wild boars are particularly emblematic of the ecological upheaval (Walker 2005) that residents experience as they return to find their predisaster residences rehabilitated by animals that once abided by the anthropocentric divisions between home and wilderness (cf. Cram 2016). The city of Minamisōma reports that the number of wild boars captured in the urban limits jumped from 39 in 2011, to 1,300 in 2014, and to more than 1,700 in 2016. In July 2018, the city launched an online hazard map for visualizing locations where residents had previously spotted wildlife.²

On his return, Tengo was confronted with the mismatch between his newly reconstructed, modern-looking two-story house and the desolate wilderness surrounding it. Odaka is now, more than ever, the quintessential Japanese *inaka*, or nostalgic countryside. Since the official reopening of Odaka in July 2016, about 50 percent of its currently registered residents (3,813) had returned to the area by November 2021. While most returnees live in Odaka's central region, Tengo's residence lies in western Odaka. Here, it has become more common to encounter wildlife and bags of decontaminated waste than any of the 350 or so mostly elderly returnees. As a result, Tengo's daily routine included patrolling his property with an air rifle to chase after wildlife, like the wild boars that roamed around and stole vegetables from the family garden.

By 2019—the Japanese zodiac year of the boar—wild boars had become the prime resource competition for returnees like Tengo. The Japanese wild boar, *Inoshishi* (*Sus scrofa*), has a long, intertwined history with humans, ranging from coexistence in the Jōmon period (c. 6000 BCE) to farm pests in modern times (Niitsu 2011). In the Japanese cultural imagination, the wild boar is figured as *Chototsu Moushin* (relentless rush); individuals born in the year of the boar are believed to possess attributes such as directedness, determination, and adventurousness. Against this cultural and historical backdrop, the unruliness of boars—their movement across and beyond coastal Fukushima—has come to signify the fallout's protracted and boundary-crossing impacts, and the social and material harm caused by the state's efforts to contain the radioactive environment. In and of themselves and in relation to their human cohabitants, the boars' biotic lives and deaths have challenged the fundamental separation of humans from a radioactive

environment that the state-imposed evacuation zoning and the ensuing decontamination project attempt to hold steady.

The 2011 earthquake, tsunami, and nuclear meltdowns and subsequent governmental efforts to recover and remediate the region have radically changed coastal Fukushima's environment and human and nonhuman geography on a granular scale (O'Neill 2019). Nonhuman animals that once roamed on the outskirts of land like Tengo's have been taking advantage of the sparse and sporadic presence of humans since the evacuation orders (Lyons et al. 2020; NHK 2021). The eight-year retreat of humans has made places like Odaka safer for many nonhuman species, even despite the persistent presence of contaminants. Dwelling for years in the evacuation zone with only a few decontamination workers to contend with, wildlife in the region seems unthreatened by the human others' gradual homecoming.

Taking Tengo's struggle with the wildlife outbreak seriously, I offer an alternative story of Fukushima that unsettles the biomedically oriented, anxiety-driven "toxic discourse" of perceived threat (Buell 1998). Drawing from Indigenous studies' scholarship that calls for the suspension of damage-centered research, which tends to frame its subjects as "broken" (Tuck 2009, 409) in a way that disregards their individual experiences, I do not ask how and why locals like Tengo are fearful of radiation exposure and the risk of illness later in life. Instead, against a narrative of human exposure and nuclear victimhood (Stawkowski 2016), I illustrate the broader issue catalyzed by the government-led decontamination policy. I argue that attempting to achieve radiation safety through a strategy of decontamination has produced an ecology of harm in coastal Fukushima that renders locals, wild boars, local food chains, and the land itself complicit in the production of nuclear waste.

In a collection of ethnographic stories, I chronicle the spatiotemporal unfolding of a multiscalar ecopolitics of contamination and containment. Each story illustrates different contact zones (Haraway 2008) between locals and wild boars in Sōma and Minamisōma between 2013 and 2019. With these stories, on the one hand, I uncover how the state's decontamination policy has enabled the gradual return of evacuees like Tengo, the opportunistic incursions of nonhuman animals across the land and their subsequent culling, and an asymmetrical redistribution of contaminants across the local ecology. On the other, the stories reveal how wild boars, in their unconstrained movements, have moved contaminants across the evacuation zones and have, in the process, frustrated the government's attempt at containment.

These stories also illuminate the rupture between humans and the environment, or what I call the *half-life politics of nuclear things* in coastal Fukushima. I use

half-life here to signal the discursive and interpretative shift from “life itself” to a radiation-centered life, through which the technoscientifically measurable presence or absence of radiation becomes the central concern. *Half-life* refers not only to the temporal constants for the most prominent contaminants in Fukushima—radiocesium 134 and 137—to decrease 50 percent in radioactivity, about two years and thirty years, respectively. It also points to an anthropocentric assumption about the separability of humans from the environment that justifies harming lives, things, relations, value, historicity, and futurity. I argue that the decontamination policy, motivated by the reduction only of human exposure at all costs, proves inherently and coercively violent, as it forces human and nonhuman victims of the fallout—locals, wild boars, and everything else—to coproduce nuclear waste for their survival.

Key to this issue is the way in which this postfallout ecology has threatened to break a local model of relationality—*en*—which posits that all animate and inanimate things, animals, and the environment are ineffably connected (Goldfarb 2016; Nozawa 2015). Following Kazutaka Hashimoto (2013) and Casper Bruun Jensen et al. (2016, 160–161, 164), I use *en* (縁, or *Pratyaya* in Sanskrit) in the colloquial sense of the term used in Japanese: a lived experience of an ecological relation brought about by chance or a supernatural force, and a framework of relationality where everything is, by some extrascientific logic, interrelated. While various usages of *en* exist in Japanese to signal different relational arrangements—through blood, marriage, or fictive kinship (Goldfarb 2016)—I engage with the term’s broader meaning of “relatedness-as-such,” or an underdetermined connection that does not require qualification. Tengo, for example, felt *en* with boars simply because they happened to inhabit the same area at the same time as him.

Shunsuke Nozawa (2015, 392) describes this expansive model of relationality accordingly: *en* is “a network of hidden threads and traces, throwing people, things, animals, places, events, and the like on a possible (and perhaps fated) collision course, like rolling dice.” The hidden and underdetermined nature of the connectedness makes *en* pervasive and mundane in everyday experience. This model of relationality differs from the decontamination policy’s technoscientific one, radioecology, in which the presence or absence of radioisotopes across time, space, and body bespeaks a linkage—or the lack thereof—between humans, nonhumans, and the environment (Creager 2013). In postfallout coastal Fukushima, the state and technoscientific experts rely on a radioecological model to visualize the post-fallout “mutant ecology” (Masco 2006), focusing on decontaminating the environment to undo quantifiable entanglements of humans and contaminants.

Approaching the TEPCO accident and its remediation efforts as a struggle of competing models of relationality (radioecology and *en*) illuminates the distributed harms that transcend individual suffering in an irradiated environment. I argue that the state's efforts to remediate, remove, and contain contaminants through decontamination have both transformed the local ecology—human-boar relations in particular—and made salient the residents' sense of a presupposed connectedness to the land, ancestors, nonhuman others, and the environment: both their *en* and its rupture. Ethnographically examining how locals encounter the wild boars' life and death and the region's shifting landscapes, I explore the assumption behind the state's half-life politics, which frames contaminants as external to and isolatable from humans. This limited model of relationality has justified the destruction of the local environment *and* the ineffable *en* through which residents like Tengo attempted to make sense of contaminants as material and semiotic conditions of their postfallout livelihood.

FUKUSHIMA'S NUCLEARITY

On March 11, 2011, an enormous tsunami with waves more than fifteen meters high, triggered by a magnitude 9.0 earthquake, overcame what was believed to be the robust assemblage of the TEPCO Fukushima Daiichi Nuclear Power Plant. Through the global circulation of the explosions' live footage and a series of technoscientific visualizations of the aftermath, Fukushima became both the name of nuclear catastrophe and the land of contamination.³

Joseph Masco's (2015) critical theory of fallout argues that the global distributions of fallout's radioactive debris force us to attend to the accumulative environmental effects of the industrial era beyond national, geopolitical boundaries. Yet in 2021, more than ten years after the TEPCO accident, people living outside Japan and Fukushima Prefecture rarely discuss the disaster's boundless consequences. Using Masco's analytic as a starting point, I approach the fallout as a set of processes through which its planetary scope is *conceptually* delimited or framed as a narrow matter of regional contamination, which over time has manifested as local, quotidian struggles with ecological upheaval.

I draw on ethnographic data from Sōma and Minamisōma cities, located ten to forty kilometers north of the incapacitated plant, where I have been conducting fieldwork since 2013. Due to the physical distance from the plant's location in the Futaba region and the weather patterns in March 2011, Sōma was relatively less contaminated than Minamisōma in the south. Some parts of Minamisōma fell under the governmental evacuation order, initially determined by physical distance

(0–20 kilometers) from the nuclear plant and then later by contamination levels (Morimoto 2015). Thus, unlike in the other nine municipalities that fell under the total evacuation order in coastal Fukushima, many residents have lived in these two cities during and after the accident, despite uncertainty and heightened risks. They have lived through numerous changes in policy, physical environment, and scientific and public discourses. Over time, experts have determined that the contamination in areas like Minamisōma poses insignificant carcinogenic risks (Nomura et al. 2019; Tsubokura 2016).

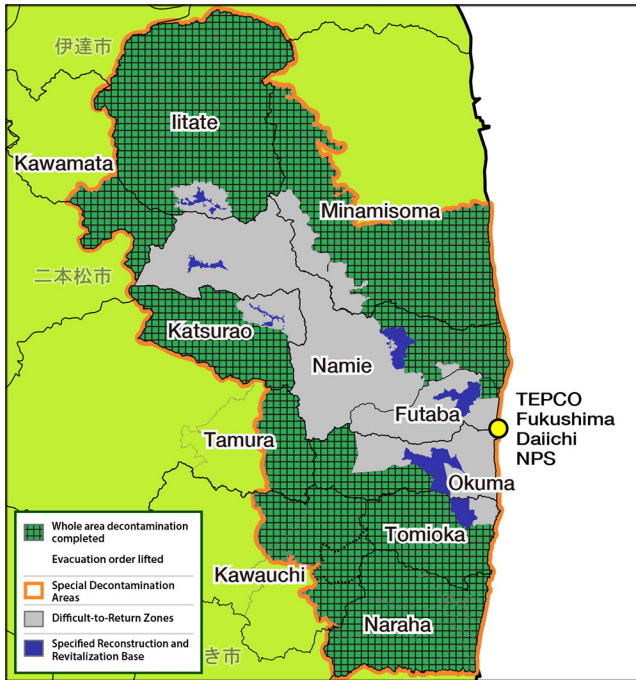


Figure 1. “Result in the Special Decontamination Area.”
Photo courtesy of the Ministry of the Environment.

Hiroshi Kainuma (2015) contends that the conundrum of Fukushima lies in its “difficulty of telling” (*katarinikusa*). Representing a continually shifting radioactive environment invites technoscientific, ideological, and political appropriations and the elaborations of existing and emerging radiological data (Kuchinskaya 2014). For example, any public and legal discussions of radiation require a familiarity with and proficiency in the technoscience of radiation and dosimetry (Kimura 2016; Morris-Suzuki 2015; Polleri 2016; Sternsdorff-Cisterna 2020). This technoscientific exclusionism frames locals as lacking in expertise, although they live

through the various, everyday impacts of radiation (Wynne 1996). Moreover, the routinized, low-dose radiation exposure that residents in large parts of coastal Fukushima have been subjected to escapes the logic of causal determinism. Its effects do not usually result in immediate or visible biophysiological consequences such as gastrointestinal issues or various cancers (Hall and Giaccia 2019). Finally, the name *Fukushima* has become a politically and morally charged metonym of polarizing discourses, such as pro- versus anti-nuclear energy (Cleveland 2014).

Central to Fukushima's *katarinikusa*, its struggle of representation, is the challenge of linking together the competing scales (Carr and Fisher 2016) of its nuclearity. Following Gabrielle Hecht (2012), I define *nuclearity* as the technopolitical and ecological distribution of nuclear things across time, space, and human/nonhuman bodies. The distributedness of nuclear things does not render their damaging effects null. Rather, it makes contaminants' impacts less perceptible and spectacular, such that their real, perceived, and accumulative violence fades from broader public attention (Nixon 2011). However, as Haruki Murakami's quote at the beginning of this essay warns, not all wounds gush blood.

To represent the less spectacular consequences of radioactive residues in coastal Fukushima, I consider wild boars as "interscalar vehicles" (Hecht 2018), or links of multiscale relations among different actors. Trailing the wild boars in and out of evacuation zones and through entanglements with foodstuffs, radioisotopes, infrastructures, and governmental policies, I examine how locals have experienced the shifting postfallout environment. Radiation itself, I suggest, is not the only concern.

ETHNOGRAPHY OF FALLOUT

Radioisotopes are both material and semiotic in nature. Their elusive material quality vis-à-vis human experience, imperceptible unless exposure crosses the threshold of human biophysiology, is de facto hypermediated (materially and technoscientifically), probabilistic (undetermined and stochastic), delayed (health effects potentially manifesting later in life as disconnected contiguity), and transgenerational (damaging the molecular structures and/or reproductive cells).⁴ The liveliness of radioisotopes—radioactivity—is characterized by an unfinished, continuously changing, decaying process that human intervention cannot control. Nevertheless, their independence relative to humans makes radioisotopes compelling signatures with which to trace often indiscernible interrelations.

The Japanese government has relied on radioecology to investigate radiological contaminants and their transboundary movements.⁵ Radioecology uses spe-

cific radioisotopes as tracers to map connections between the earth and the atmosphere, linking bodies and biotas across species divides at the elemental level (Odum 1959). For radioecologists, the dis/appearance of radioisotopes diagrams an ecological chain of shared radiological legacies among humans, nonhumans, and abiotic factors such as atmosphere and water.

Yet radioecology constitutes one of many models for describing ecological relations in the postfallout environment. Examining radiation with respect to its potential danger to differently situated actors cannot adequately explain the chance encounter between boars in former evacuation zones and individuals like Tongo who returned there, despite known risks, to sustain his spiritual and affective connection to the land and his ancestors. Thus an ethnography of fallout should aim to provincialize the radiation-centered model of ecological relationality by accounting for the interactions among co-occurring frameworks—scientific, local, or otherwise—used by various actors to conceptualize and represent the environment and its dynamics.

To decenter radioecology as one of many models of ecological relations at play in coastal Fukushima and to better describe local residents' own theorization of the postfallout ecology in terms of *en*, I employ what Winfried Nöth (1998) and others call "ecosemiotics" (Kull 1998; Maran 2018; Maran and Kull 2014). Rooted in Peircean semiotics, ecosemiotics is an orientation that expands the linguocentric study of semiosis (sign process) by exploring sign-mediated relations between humans and the environment.⁶

In anthropology, the application of semiotics has mostly been anchored in analytical identifications of signs' relationship to objects (in terms of their resemblance, contiguity, and convention) in communication and other meaning-making social and cultural practices (Parmentier 2009). While cultural semiotics enables analysts to track the "complex layering of contexts at work in any social interaction" (Mertz 2007, 343), the analytical precision of such tracking comes with the risk of delimiting what constitutes "the social" or "the cultural" in a way that renders the natural, and the environment as a whole, into an inert referent, or the static context in which the social world unfolds (Nöth 2001).

Although the scope and definition of ecosemiotics remain much debated (e.g., Kull 1998; Nöth 2001), central to its theorization is the Peircean emphasis on nondualism and the continuities between nature and culture (e.g., CP 1.216; 4.318; 5.47; 5.591; 6.202). In an ecosemiotic framework, the environment and its dynamic, more-than-human sign-making processes do not constitute an alternative mode of signification to be analyzed in isolation from the cultural but integral to

its construction. It is not precise enough to describe *en* as simply a “local model.” Rather, we must name it an ecosemiotic model, one that offers an account for the dynamism between the natural and the cultural by introducing a third category—the *supernatural*—as a key mediator of the multiscalar, ever-changing relationship between nature and culture (cf. Fernando 2017; Viveiros de Castro 1998).

My application of ecosemiotics in this article lies not in the examination of how humans or other species co-constitute ecological phenomena (Maran and Kull 2014). Instead, I approach *en* as an ecosemiotic perspective to show how scientific modeling is, though a more conventionally “logical” interpretative habit, only one among many other models of ecological relations. At the same time, I show how locals find that radioecology offers a limited account of more-than-human relations in comparison to the more expansive account that *en* offers. As such, they experience postfallout coastal Fukushima as a site of struggles over representing and determining the dynamic interrelationship between the environment—radioisotopes and boars—and themselves. Although residents do not consider radioisotopes and boars passive objects out in the world, or consider these entities to be intrinsically separate or modular, the state’s intervention on boars’ lives and deaths and local actors’ various degree of involvement in it have come to challenge the local model of relationality, *en*.

Exploring *en* as an ecosemiotic model highlights that the harm the fallout has caused flows not only from the (re)distribution of contaminants but also from the processual material, semiotic, and affective consequences of attempting to *contain* contaminants.⁷ In coastal Fukushima, the state imposition of a radiation-centered ecology has come to delimit *en*, an ecosemiotic account of the ineffable interrelatedness of all living, dying things and decaying matters.

Tracing wild boars, I tell the story of local experiences of living in the post-fallout environment through an ecosemiotic lens. Telling their stories in this way, attending to the boars’ multiscalarity, helps illuminate the tensions between the two competing models of relationality and better articulate the consequences and harms of a sole model (radioecology) being imposed at the behest of another (*en*). In utilizing this ecosemiotic approach to contour and frame my ethnography, I do not mean to enumerate what contaminants or boars mean to different actors. Instead, the approach sheds light on answers to the following interrelated questions: What model of relationality, human relations to wildlife and contaminants, does decontamination itself operate by and regiment? And how does this model impact the locals’ pervasive sense of connectedness, or *en*, in the postfallout environment? My ethnography reveals the rupture in which the anthropocentric assumption be-

hind the biochemical modeling of the postfallout human-radiation relations has been harming locals, boars, the land, and their sense of these ineffable interrelations.

RADIOACTIVE FOOD CHAIN AND SURROGATE BODIES

“Ever since we evacuated Odaka, I learned how expensive buying vegetables is,” Tengo complained in the summer of 2013 as he was running errands at a nearby store. “Look at these expensive, spoiled bamboo shoots!” he exclaimed. “Before the disaster, I would harvest them from my backyard. Now I cannot because of contamination. Since I don’t take them, boars have been eating them!”

For Tengo, who had grown up eating the vegetables, wild plants, fruits, and mushrooms growing on his family’s property, buying store products felt strange. What was even stranger for him was the fact that one could buy produce regardless of the season, since for farmers, each season is marked by what they can harvest at that time. “Things have changed, and life seems to be more convenient, but I like my old way. Maybe this is one of the few points the boar and I would agree on,” Tengo laughed.

Despite Tengo’s cheerfulness, the wildlife outbreak in and around the deserted regions has proved a dire problem, especially in coastal Fukushima, where many people once farmed their food. Frequently, evacuees would visit their abandoned houses to find that boars had harmed their farming grounds and other parts of their property. In April 2019, the city built a special incinerator on the tsunami-inundated land to address the ever-accumulating dead boars hunted or killed by car within the city, which were suspected to be radioactive because they fed off of local produce like Tengo’s bamboo shoots.⁸

What makes wild boars particularly harmful is their indiscriminating appetite, size, and high reproductive potential. Although boars are predominantly herbivores, they might also consume roots, seeds, mice, rice, fruits, earthworms, snakes, frogs, and insects, depending on the season and food-source accessibility. Nicknamed “the cleaner of the forest” (Knight 2006, 49), some boars can grow to a hefty 180 kilograms. Although boars maintain a nocturnal schedule when living close to human activity, they are typically diurnal (Ohashi et al. 2013).

In addition to the potential physical threat that their size and tenacity pose to humans, boars reproduce rapidly. A single, gestating boar can give birth to four to seven offspring on average, up to two times per year. Since boars prefer to live in human-disturbed environments rather than on uncultivated land (Ralph and Maxwell 1984), deserted farmland makes for one of their favorite dwelling sites.

Hence, not unlike the Chernobyl exclusion zone (Carver 2019), the coastal region of postfallout Fukushima is a boar's wonderland.

One evening over drinks, I asked Tengo to elaborate on the dangers of wild boars. "It is my drunken theory," he mused, "but I think that the boar is eerier than monkeys," another local pest,⁹ "because many of us used to eat boar." He continued, "The accident taught us how we could get exposed internally by eating contaminated foodstuffs, which is more dangerous than being exposed externally. But boars don't care about contamination. They are very ignorant, and because of that, they can thrive in the area where we aren't supposed to live and farm. In a way, they are the experimental bodies for us to know the reality of exposure from eating tasty things like mushrooms and wild plants, which we gave up to avoid the risk of exposure."

Tengo implies that boars can serve as a potential contaminant as much as they are harmful to the built environment. With his theory of a chain of internal exposure through ingestion, Tengo argues that precisely because boars and locals eat similar things, and locals categorize boars as consumable food, it is both easier and more intimate to imagine the ecological transfer of radioactive materials from their bodies to his. Unlike other wildlife considered pure pests, the boar constitutes a liminal creature that crosses the boundary between what is beyond humans—the environment—and what can become a part of human bodies via ingestion. "If the government did not tell us about the accident," Tengo continued, "I could have been the boar." In this statement, Tengo engages in what Brad Bolman (2018, 234) calls "species projection" by imagining the boar as a surrogate body that consumes contaminated foods on behalf of the risk-avoiding people. Here, the boar serves as a sentinel species (Masco 2006), an environmental monitor of Odaka, for Tengo, who could have remained oblivious of contamination if the government and TEPCO had kept the accident hidden from him.

Tengo's narrative offers a view into how people entertain the idea of *en* as "the pleasure and pain of finding meaningful connections, without necessarily invoking a system of rights and obligations" (Nozawa 2015, 394). The presence of contaminants in the postfallout environment made boars relatable for Tengo at multiple levels. Observing the boars eating fresh local foodstuffs reminded him of his severed connections to the land, the sense of seasonality, and the joy of farming. Tengo also realized that boars could help him understand the postfallout environment, since they would continue consuming the local harvests and thus make changes in Odaka's contamination visible. Ecossemiotically speaking, Tengo experienced the presence of boars in his community as pointing to the changes

that the TEPCO accident had caused to his livelihood, the environment, and their interconnection. Despite the changes to the texture and valence of that relationship, however, *en* sustained their connectedness. Yet these emerging recognitions of residents' *en* to boars have been threatened, as the government identified boars not only as resource competitors to be captured but also as potential contaminants to be isolated from locals like Tengu.

WILDLIFE INCINERATOR FOR THE AGING SOCIETY

The outbreak of wild boars has proved an issue not only in and around the evacuation zone but also in Fukushima Prefecture as a whole. According to the 2018 prefectural government's annual report on wildlife management, the number of captured boars in Fukushima increased from about 3,000 in 2011 to 20,000 in 2017, causing severe agroeconomic damage (\$500,000 and close to \$1,000,000, respectively). This surge relates partly to the establishment of a boar-hunting reward system within various municipalities in Fukushima. For example, in Minamisōma, hunters could receive \$200 in exchange for presenting the tail of a captured boar. Although initially people wanted to control the number of boars in coastal Fukushima to prevent the animals from damaging local habitats and the local economy (since they destroyed the farmland), once captured and killed, their bodies have posed an additional and unexpected problem.

"I am not a specialist of wildlife," said Nakata, a structural engineer who works for Sōma city. "I do not like them, but now for some strange *en*, I work with them." Nakata, the chief operator of the \$1.6 million wildlife incinerator Sōma city built and started operating in April 2016, explained why Sōma, rather than other places, became the first to host a wildlife incinerator. In Sōma, the boars' increasing presence became a serious threat to residents and their farms, and the boar problem became prominent much earlier there than in other Fukushima regions. Sōma is located outside of the government-mandated evacuation zone, and the majority of its 35,000 residents, in addition to outsiders who evacuated to the region, remained in the area following the TEPCO accident.

"But now things are better because with this machine, we can incinerate up to 120 kilograms of boar at a time, so we usually pile up a few for a single operation. This innovation is one-of-a-kind in the world, I know!" Nakata declared proudly. Located on the property of the waste management center that processes all household waste produced in the city, the incinerator looked new and clean when I visited it in the summer of 2018.

Previously, the city had destroyed captured boars at a much smaller incinerator originally designed to cremate pets, and, consequently, hunters and staff had to manually break down the bodies of the boars to fit. The government's ban on eating boars therefore meant that their capture entailed processing the boars in addition to capturing and killing them, all of which took time, skill, and patience—far more time than simply consuming them, as the hunters once had, to destroy them. “This was very problematic,” Nakata explained, “since there are not many hunters who were willing to put that much effort, not to mention that the number of licensed hunters in this region and the country has been declining.” Also, he noted, “most of them are getting old, like myself.” The city hoped that the larger, newer incinerator might mitigate the overpopulation of boars and disaster-exacerbated issues in the region, which include population decline and an aging society. The incinerator provides a means of streamlining the strenuous labor involved in eradicating wild boars, which no one, including Nakata, had imagined would prove a persistent problem.

“We thought that the number of boars would decline as time went by,” Nakata explained, showing me a chart enumerating the boars processed at the facility. “But even in June 2018, we had already burned 41 boars, and the year before, we cremated 440 of them. The number is still high, considering that we only process boars captured in Sōma and Shinci town in the north.” When I asked why, he guessed that it resulted from the progress of decontamination in previously untouched evacuation zones. Nakata observed that as time went on, more and more people returned to former evacuation zones, areas they had completely abandoned immediately following the 2011 TEPCO accident. “To be honest,” Nakata lamented, “some of the boars are highly contaminated. I mean, they must be traveling from near the nuclear plant in the south, but if we captured them in our city, then they become our responsibility to dispose of.”¹⁰

Just because boars were captured and processed within Sōma's geographical boundaries did not mean that they had only dwelled and eaten in Sōma, where contamination was less severe than in other parts of coastal Fukushima. Since there was some chance that the boars brought to the facility had passed through highly radioactive localities and eaten organisms and vegetation from them, it was crucial to locate and distill any radioactive material produced by the cremation process. According to Nakata, the incinerator was designed to contain the spread of radioisotopes embedded in boars to cut contaminants out of the ecosystem. “All burnt particulates go through a pipe connected to an air filter and then into a bag in a steel can in a separate room. Whatever remains after the operation, like some

leftover bones, our workers suck those things up with a vacuum. These vacuumed residues go through another pipe, which is also connected to another steel can in the separate room,” he said, sounding more like a nuclear power plant operator than a city official.

The boar outbreak has beleaguered the national government, which aims to signal its successful containment of the nuclear disaster to Japan and the rest of the world by gradually reopening the evacuation zones. The boars have posed an additional hurdle to the evacuees, who would like to restart their former, more familiar life. In the 2016 Japanese National Television documentary titled *Radioactive Forest (Hibaku no Mori)*, a local organic farmer in Odaka, Koichi Nemoto, expressed how parts of Minamisōma have transformed into wilderness after the fallout: “Boars don’t run away at all. They look at me like I am a visitor. . . . Wild animals that normally live in nature have taken over our world. I wonder if we are the ones now living in the cage.”

Humans did not accept life in this cage for too long. Instead, locals and the government have been chasing and eradicating boars to make coastal Fukushima “safe” again. In this process, the wildlife incinerators in coastal Fukushima encapsulate the complex interdependence between the government remediation policy, which chases radioactive boars away from the evacuation zone, and locals’ desire for regional recovery, which marks wild boars as “obstacles” to be removed and isolated. For evacuees like Tengen and Nemoto, the boars have by chance become competition for local resources necessary to their livelihood. Nakata, however, viewed boars as both empirical signs and material vehicles for transporting and spreading contaminants in an unruly manner, one that needed to be contained. The difference in the signification of boars to differently situated actors illustrates their confrontation with competing models of relationality in postfallout coastal Fukushima. Radioactive contaminants slide within and across these multiple human-boar relations and from a radioecological to local (*en*-inflected) accounts of connectivity. Although Nakata described his encounter with boar carcasses as *en*, as a government employee guided by a radioecological framework, his job was to terminate this *en* to isolate boars from contaminants through incineration. As I will show, governmental efforts to isolate humans and radiological contaminants have forced locals and boars to coproduce nuclear waste outside of the evacuation zones.

DECONTAMINATION AND THE ECOLOGY OF HARM

"I feel sorry for boars," remarked Gotanda, a Sōma resident in his sixties who farms the land where he lives and works under Nakata. "I know boars are problematic. They destroy our farms and eat everything they can find, but we always coexisted. The fact that they are contaminated, captured, and burnt like this with no mercy now is not their fault, but the fault of us humans." Gotanda recollected how he used to enjoy eating boar and treated the animals with great respect. According to him, in an impoverished region like coastal Fukushima, where meat constituted a luxury in the past, boar was a special treat.

Like many other local farmers, Gotanda sees boars as vermin (*Yūgai chōjyū*), especially since the government banned the consumption and circulation of boar meat in most of Fukushima and its surrounding prefectures in November 2011. Even in 2021, boar meat remains one of the few items that the government regulates, along with mushrooms and wild plants. These regulations continue to deflate the enthusiasm of local hunters. Typically, each municipality's local hunting association is responsible for hunting wild boars. "Some of my friends are hunters," said Gotanda, "and one time I was joking to them how the nuclear disaster made them rich because they can get over \$200 per boar. Then they got angry at me, saying that they no longer enjoy hunting boars."

A few hunters I spoke with in Minamisōma confirmed that they no longer took pleasure in chasing boars. They no longer hunted to test their skills and technique, to share the meat with their families and friends, or to confront the vicissitudes of nature. Instead, once the government imposed the boar bounty, hunters began to see boars as mere targets to be killed and disposed of, assigned an arbitrary monetary value. One hunter conceded that although some hunters may enjoy the few extra bucks for capturing as many boars as possible, he was not a killer. He did not enjoy "murdering for money." His boar hunting was solely motivated by a desire to contribute to the region's recovery. The pleasure and pain of hunting boars, he explained, was not only about exercising a set of skills; it also depended on having luck, which "is beyond one's control." Lighting a cigarette, he continued, "If you don't have *en*, you don't encounter boars. They are intelligent animals and know how to avoid humans. I happened to have *en*."

In the postfallout context, however, his *en* with boars took an ironic turn. By chasing boars to reduce their number and allow for the safe return of evacuees and for local agriculture to thrive again, he has contributed, unbeknown to him, to the further production of radioactive waste. While boars may consume radioactive

things in the environment, they are not radioactive to human beings unless humans consume them. Incineration, however, transforms boars into nuclear waste by obliterating everything but contaminants. Gotanda, who had been cremating one boar after another, was keenly aware of this. As he prepared to show me the whole process of incinerating boars, he shared his feelings of guilt. By producing nuclear waste just to get some extra money from the city in his postretirement job, Gotanda felt like he was betraying his fellow residents who wished, like himself, to have never been victimized by the threat of contamination.

On the day I visited them, Gotanda and his work partner, Watanabe, smoothly loaded a couple of boars into a green container and carried it to the side of the incinerator's bed. Then they picked up each boar with a crane and placed each body carefully on the bed. They repeated this process a few times to load four boars to get the weight to about 120 kilograms. Once the bed was pushed inside the incinerator's burning room, the door was shut, and the burner ignited. The monitor panel on the other side of the entry door showed the temperature inside jump to 800 degrees Celsius. Watanabe explained that the temperature must stay higher than 800 degrees so as not to produce dioxins, a less discussed environmental toxicant by-product of coastal Fukushima's remediation.

Once the boars were put inside, Gotanda told me that he lacked the skill of Watanabe, who had been cremating human bodies for a long time. As the fire burned, Watanabe intently watched the incinerator's inside from an eyehole, remaining close despite the sweltering heat. Stepping back a few inches, Watanabe wiped his face with his sleeve. "Cremating boars is much easier than cremating people," he remarked. "I do not have to stand here for hours, making sure I am not over-burning off the body since we are not interested in keeping boars' remains intact like we do for humans." After people's bodies have been cremated, it is the Japanese practice for families and close friends who had *en* with the deceased to pick out the bones of their loved ones to be placed in a grave later. Watanabe implied that since no one should have *en* to the radioactive boars, there was no need to preserve the physical traces of their bodies. Yet as he returned his gaze to the boars turning into bones and then dissolving altogether, Watanabe knew that even the \$1.6 million machine could not make the radioisotopes the boars embodied disappear from the world. Although the incinerator achieved the physical separation of boars and radioisotopes, the boars' remains, and radioactive potential, were stuck in the air filter and transferred into a bag in a separate room at an even-higher concentration of particles.¹¹



Figure 2. Disintegrating boar inside the Incinerator in Sōma city. Photo by Ryo Morimoto.

This physical death of boars—and the resultant production of accumulative, accidental nuclear waste—brings to light the ecology of harm lurking beneath the collective recovery projects of coastal Fukushima. What I witnessed was wildlife’s confrontation with humans “in relation of shared precarity” (O’Neill 2019, 94). It was also an enactment of half-life politics, in that the boars are destroyed to separate humans from radioisotopes in the name of radiation safety. The state’s efforts to gradually decontaminate coastal Fukushima have led to chasing boars away from the evacuation zone, only for them to be co-present and in competition with residents and returnees beyond the zone. In the process, boars have become the unruly vehicles of contamination, resisting decontamination’s intended removal of contaminants from people. In transforming the wild boars into nuclear waste by incinerating them, the decontamination policy forced residents to cut their new and old relations to boars to reclaim their territory as safe. By reassembling the

relationship between the natural, cultural, and the supernatural realm of fate, coincidence, and cosmic inevitability, decontamination and its half-life politics demanded that residents cut their *en* to their land, ancestors, and the environment.



Figure 3. Boars' (radioactive) remains after incineration in Sōma city. Photo by Ryo Morimoto.

Since 2012, the national government has budgeted more than \$55 billion for decontamination and the construction and maintenance of radioactive-waste storage sites. In Minamisōma, the government declared the decontamination of more than 23.6 square miles of land complete in March 2017. Paradoxically, the most visible outcome of decontamination has not been the disappearance of the contaminants from the built environment. Instead, it is the emergence of materialized contaminants—decontaminated waste—in the form of black container bags that need to be isolated somewhere (Kirby 2019; Morimoto 2020).

Decontamination demands that residents accommodate a newly constructed space where the government isolates the decontaminated waste through the spatial reorganization of their familiar environment. For example, in mid-2017, three years after my conversation with Tengo about the bamboo-shoot-eating boars, per decontamination protocol, his house in Odaka was demolished, and his farm and its fertile soil, passed down from his ancestors, were removed. As a result of the mass eradication of people's lived environment, decontamination produced 279 temporary waste-storage facilities at its peak in 2016, and more than 90 million bags throughout Fukushima. A few million bags are still waiting to be transferred to an interim waste-isolation site around the nuclear power plant.¹²

After Gotanda and Watanabe successfully cremated the four boars, Nakata invited me to check out the back room, where the ashes of radioactive boars are kept isolated. "I work for the government, so I should not be saying this to you, but," Nakata said, lowering his voice, "when this bag of ashes gets to a certain height, an expert from the prefecture comes to measure its radiation level. If the level is lower than the regulated 8,000 becquerels per kilogram, it is the city's responsibility to take care of it as household waste. However, if it is higher, then it is the national government's responsibility to process it as nuclear waste. It might not be appropriate for me to say this, but I cannot stop hoping that the ashes are highly contaminated. Because if they are, we do not have to keep them in our city."

Here, Nakata struggles to deal with the two competing models of relationality the TEPCO accident and its remediation have staged. His responsibility as a government employee was to incinerate boars: because this act produced nuclear waste, it threatened Nakata's *en* as a Sōma resident to the land, its people, and the environment. By wishing the boars' remains to be highly radioactive and thus the responsibility of the national government, Nakata also denied Sōma's association with contaminants, as if Sōma was separate from the broader ecology of coastal Fukushima.

Free-roaming boars that elude the decontamination-cum-reopening policy transfer radioisotopes across geographical boundaries. Their movements reveal the limits of the state's highly localized approach to the postfallout ecology. While demolishing Tengo's house and removing the soil passed down over generations, decontamination and its half-life politics chased supposedly radioactive boars out of the exclusion zones. It has also forced increasingly disinterested hunters to kill boars and for Nakata, Gotanda, and Watanabe to cremate their carcasses and disavow their remains. Through this sprawling chain of harm, decontamination has

shattered locals' presupposed *en*, while it left leveled purportedly decontaminated land, wildlife incinerators, and radioactive boar ash.

HALF-LIFE POLITICS OF NUCLEAR THINGS

In the summer of 2018, I visited Thomas Hinton at Fukushima University. Hinton had previously researched the irradiated environment around Chernobyl, using wildlife as radiotracers. Inspired by Tengo's provocations and Gotanda's anxieties, I wanted to learn about boars' potential for modeling an irradiated environment. As I started describing my research, Hinton interrupted me, shocked. "Why are people killing boars?" he gasped. For him, the liveliness of boars was fundamental to his research uncovering the state of the radioactive environment and its changes.

Hinton oversees a group of scientists who follow the movements of wild boars to track the ecology of the contaminated environment in coastal Fukushima. A collar-like device they clasp around the boars' necks monitors the boars' movements through GPS and the ambient radiation through a dosimeter. This device enables his team to use boars as a tracer, and helps them understand the transfer of external radiation levels to a mammalian body. According to Hinton, the incorporation of radiation from the environment into mammalian biology is scientifically understudied, since the global scientific community, such as the International Commission on Radiological Protection,¹³ has conventionally treated contaminated environments as something to be modified, decontaminated, and quarantined. In this paradigm, the environment constitutes an object of intervention, an abject entity that can and should be conceptually and geographically partitioned into safe zones and radioactive ones.

In an article, [Hinton et al. \(2004, 333\)](#) criticize this prevalent anthropocentric framing of radiation safety: "The fact that humans are among the most sensitive mammals, and therefore the most sensitive species, has led, in part, to the dogma that if we protect humans, then other biota are protected as well." Their critique emphasizes the central issue of anthropocentrism underlying the Japanese government's decontamination policy. Its narrow focus on minimizing the risks *only* with respect to human exposure fails to account for the fact that humans exist within a more extensive, intertwined ecological system that includes nonhuman biota with which fallout residues could travel haphazardly.¹⁴

Locally in Fukushima, this failure has manifested as the residents' confrontation with the scientific model of relationality, which draws a physical division between humans and contaminants. This delimited model justified the half-life pol-

itics that destroyed the residents' prefallout livelihoods and killed the wild boars while also cutting a pervasive sense of connectedness among people, things, and the environment.

My ethnography suggests that the human-centered efforts to remediate the irradiated environment inheres a process of delimiting and regimenting ecological relations that ultimately causes social and distributed harm. By ecosemiotically examining the competing models of relationality propelled by the TEPCO accident and its remediation, I have shown how, more than just biological monitors, wild boars represent the accident's protracted aftermaths, including the banal distribution of radiological harm and human efforts to distance themselves from those harms. Following "radioactive" boars' lives and deaths upends the anthropocentric framing of the environment and of contamination itself wrapped up in the government's decontamination policy, in which concerns for human exposure condemn anything deemed potentially radioactive as the target of removal and disavowal. Per this half-life politics, radioisotopes are the agents of contamination, external to humans and capable of being isolated. This toxic discourse fails to consider the embeddedness of radioisotopes in the *en* that entangles humans and nonhumans in a given environment, however arbitrary and magical such connection is felt to be.

While radioecology, as a technoscientifically oriented model of relationality, has enabled the visualization of cross-boundary movements of contaminants through boars, this model competes with the more inclusive model with which locals conceptualize their supernatural connections to their land, ancestors, and environment. In turn, decontamination and its half-life politics fracture this local sense of relationality while framing the presence of contaminants in a specific locale as the only issue to result from the TEPCO accident. Those who live in post-fallout Fukushima critique this radiation-centered approach for its failure to honor the historical conditions that subjected coastal Fukushima to the fallout.

As a lifelong resident of Minamisōma, a city that did not host the nuclear power plant but was nonetheless harmed by it (Sakurai and Kainuma 2012), Tengen reiterated the importance of talking about the structural inequality wrapped up in the fallout that decontamination cannot redress: "It is called the 'Fukushima nuclear disaster.' With the name, no one takes any accountability for the fallout, aside from us who have to live with the name." Since the 1970s, the Tokyo Electric Power Company has operated the nuclear power plant in coastal Fukushima to supply energy, exclusively, to the greater Tokyo region (Akasaka and Oguma 2012; Kainuma 2011). By underscoring this asymmetry, Tengen pushes outsiders to consider the TEPCO accident and its decade-long remediation as more than a series of discrete

events following an unprecedented radiological crisis. Rather, the TEPCO disaster is a latent condition of what [Ward Churchill and Winona LaDuke \(1986\)](#) call “radioactive colonialism,” through which certain groups of humans and nonhumans, in their *en*, bioaccumulate radiological harm and are rendered exposable.

Like the uranium mines and nuclear complexes located on Indigenous lands throughout North America (e.g., [Brugge et al. 2006](#); [Erickson and Chapman 1993](#); [Kuletz 1998](#)), in coastal Fukushima, wildlife incinerators and radioactive boar ash constitute the material legacy of a half-life politics’ anthropocentric delimitation of human-environment relationality. Tengo disagrees with this model, claiming that “radioactive materials are everywhere, and we are always already contaminated regardless of what we sacrifice or destroy to try distancing ourselves from them.” Echoing Tengo, I suggest that the discourse on Fukushima and the TEPCO accident ought to move beyond concerns over individual radiation dose and address its expansive distribution of harm, across species and abiotic factors and through the coercive severing of their *en*.

Willing and unwillingly, wild boars have been cutting across the artificial boundary between purity and danger that governmental decontamination policies have articulated. To protect humans from exposure in a narrowly defined way, the wild boar chase will continue, disrupting human and nonhuman *en*. The chase makes local people, boars, and any fallout residue they consume accidental collaborators in nuclear waste production, which will be provisionally dislocated and deferred to another timescape for future generations and other species of coastal Fukushima to confront. The wild boar chase suggests that even though, in theory, fallout “formally links human actions, technological capabilities, atmospheres and ecologies in a new formation of contamination” ([Masco 2015](#), 140), this hardly marks the end of the story. In practice, humans try to undo such links and disavow contamination while disregarding existing *en* among humans, nonhumans, and the environment.

Ecossemiotics affords us the possibility of grasping continuities in the sign-mediated human environment. It also provides a framework for articulating the specificities of *en*, which offers a way to make sense of the ineffable connectivity between humans and nonhumans that a scientific model like radioecology fails to capture fully. Attending to local theorization—a way people speculate some connectivity between the nature and culture—allows us to explore non-hegemonic interpretive habits like *en*, which exist alongside and in tension with technoscientific ones.

In coastal Fukushima, *en* provides an entryway into a field that provincializes toxicity as but one model of relations among people, things, and matters. *En* allows residents to problematize the scientification of the postfallout environment and the state usage of what might otherwise appear to be an “objective” and “factual” model as the dominant technique for understanding local ecology, its apparent ruptures, and efforts to redress those ruptures. Yet radioecology, I have shown, makes invisible and fails to respect residents’ spiritual connections to place, land, and the environment central to how they understand the local ecology they live in and through which they make meaning.

Accounting for the perspective of *en* and provincializing technoscientific models of the environment unsettle the damage-centered toxic discourse with which individual suffering and its representations become the sole empiric of the human-environment relatedness. It locates harm not at exposure, the moment of entanglement with the environment (cf. [Murphy 2017](#)). Instead, in an *en*-inflicted universe, harm emerges as a *déjà vu* of the always already ecological relations ([McClintock 2014](#)) and augments through the often futile efforts to separate, (re)distribute, defer, and diffuse responsibility from the environment.

An ethnography of fallout considers the material, semiotic, and affective processes of a postfallout world through which various models of relationality compete and different lives, things, and their relations may be harmed through human attempts to detach themselves from contaminants and to disavow toxic legacies. Approaching toxins ethnographically marks an act of remembrance, as we remind ourselves that toxicants can only visualize a limited version of interrelations between humans and the environment. There is always more.

ABSTRACT

This article explores how the Japanese state’s radiation-centered approach to ecological redress in postfallout coastal Fukushima impacts a local framework of relationality called en/縁. By ethnographically tracing encounters between humans and wild boars in the region through an ecosemiotic lens, the essay articulates the differences and tensions between en and the model of relationality that the government’s decontamination policy enforces. In so doing, I decenter and unsettle the dominance of biomedically oriented, anxiety-driven toxic discourses of radiological threat. Against the narratives of anthropocentric exposure and nuclear victimhood that tend to encircle Fukushima since the nuclear accident, the article illuminates the multiscale and semiotic issue that decontamination efforts catalyze. The essay argues that narrowly defining safety in terms of distancing radioisotopes from humans engages what I call a half-life politics of nuclear things, through which locals, wild boars, and the land

itself are made complicit in the production of nuclear waste. [Fukushima; nuclear disaster; contamination; decontamination; radiation; wildlife; ecosemiotics; ecology]

要旨

東日本大震災と大津波に起因する東京電力福島第一原子力発電事故は地域の環境、さらに人と自然との関わりに甚大な影響を及ぼした。事故後耕作放棄地となった土地には野生動物が進出し、汚染された作物を食べ被曝し、原発避難民のスムーズな帰還や、帰宅民の生活を脅かしている。この論文は福島県浜通り地域に出没するイノシシと、それに日々対応する南相馬、相馬市民との震災後の関係性を追ひ、日本政府による測定可能な放射線の有無に特化した環境除染政策がもたらす『縁』という世界観への影響を考察する。さまざまな物事を分断し続けている原子力災害を『縁』という万物のつながりの視点からアプローチすることにより、人間と放射性物質の関係性を生物的ダメージに特化して語るフォールアウト関連の学術的思考や、事故後の政策に見られる科学技術、汚染中心の『半減期的政治』とは異なる人と自然との関係性の考え方の重要性を示し、人間のみの被曝を減らす環境除染政策の問題点を論じる。[キーワード: 原子力災害、除染、汚染、野生動物、放射線、放射能、福島]

NOTES

Acknowledgments My deep gratitude goes to the residents of Minamisōma and Sōma for allowing an outsider like myself to be part of their postfallout lives. I thank Chris Nelson for his generous guidance, as well as three anonymous reviewers. I had many opportunities to share earlier versions of the article. I would like to acknowledge Andrew Gordon and the Edwin O. Reischauer Institute of Japanese Studies at Harvard University, Rihan Yeh and the members of the Linguistic Anthropology Lab at the University of California, San Diego, Rob Nixon, Anne McClintock, and the participants of Princeton's Environmental Humanities and Social Transformation Colloquium, as well as Erika Milam and Angela Creager at the Program in History of Science at Princeton. Finally, I thank Hollianna Bryan and Beth Semel for their editorial assistance. All errors are my own.

1. The article is linked to a digital collection hosted by the Japan Disasters Digital Archive. <https://jdarchive.org/en/collection/267>.
2. See <https://city-ms-chozyu.maps.arcgis.com/apps/webappviewer/index.html?id=a3dfb082665847e38c9e39cfe44042b6>.
3. The national government initially designated 444 square miles of coastal Fukushima (1,143 square miles) as the mandatory evacuation zone. As a result, some have argued that no humans, especially children and young women, should be living in Fukushima. See, for example, Koide and Field 2019, Yamaguchi and Muto 2012, Caldicott 2014, and Ian Thomas Ash's 2013 documentary film, *A2-B-C*.
4. See, for example, Beck 1987; Brown 2015; Erikson 1991; Jorgensen 2017; and Petryna 2013.
5. Although it is beyond the scope of this article, the history of radioecology and its development through the atomic bomb testing in the Pacific and in the unceded lands of Native North America during the Cold War period needs to be decolonized (DeLoughrey 2013; Worster 1994).
6. This theoretical stance resonates with multispecies studies (e.g., Kirksey and Helmreich 2010; Kohn 2013; Haraway 2008) in its analytic focus on more-than-human actors

and domains. However, the aim of this article is to highlight the local theorization of the postfallout ecology. I use *en* as the main local and distinct perspective, since their concerns are not multispecies ones: what relationship is more than human, how have radioisotopes and boars come to be entangled with human others, or how does such an entanglement change what it means to be human? Instead, the residents in this article ask: How does the state's decontamination policy contest their always already assumed general interconnectedness, and how does this affect them and their livelihoods?

7. I thank a reviewer for pointing out Newell's (2018) critical analysis of the affective dimension to a semiosis. Similarly, I have discussed the significance of a psychological process, which is missing in the Peircean conceptualization of sign process (Morimoto 2012).
8. Fukushima Prefecture's radiological monitoring results of wildlife can be accessed here: <https://www.pref.fukushima.lg.jp/site/portal/wildlife-radiationmonitoring1.html>.
9. NPR's 2020 Special Series on Recovering Fukushima covered a story of wild monkeys in Minamisōma: <https://www.npr.org/2020/09/10/904356338/in-rural-fukushima-the-border-between-monkeys-and-humans-has-blurred>
10. See Saito et al. 2019 for the data of wild boars' internal exposure in Sōma.
11. The data released by Minamisōma in 2021 indicate that the total radioactivity (cesium 134 and 137) of the ash produced by incinerating wildlife was over 135,000 becquerels: https://www.city.minamisoma.lg.jp/portal/shi_joho/shinsaikanrenjouhou/houshasenmonitaringukekka/kankyo_monitoring/10098.html
12. See the Ministry of the Environment's environmental remediation website for details at <http://josen.env.go.jp/en/>.
13. The ICRP largely ignored non-human organisms as the targets of protection until the publication of ICRP 108 in 2008. See the discussion on "Reference Animals and Plants" here at <https://www.icrp.org/publication.asp?id=icrp%20publication%20108>
14. Recent research by Cunningham et al. (2021) suggests that low-dose radiation exposure has not caused significant DNA damage to boars and snakes in Fukushima's evacuation zones. The researchers found lower cortisol levels among boars from high radiation dose areas, suggesting, though not conclusively, that the amount of human activity might have some impact on the stress levels of wildlife in the evacuation zones.

REFERENCES

- Akasaka, Norio, and Eiji Oguma, eds.
 2012 *Henkyō kara Hajimaru—Tokyo/Tohoku Ron*. Tokyo: Akashi Shoten.
- Beck, Ulrich
 1987 "The Anthropological Shock: Chernobyl and the Contours of the Risk Society." *Berkeley Journal of Social Sociology* 32: 153–65. <https://www.jstor.org/stable/41035363>
- Bolman, Brad
 2018 "How Experiments Age: Gerontology, Beagles, and Species Projection at Davis." *Social Studies of Science* 48, no. 2: 232–58. <https://doi.org/10.1177/0306312718759822>
- Brown, Kate
 2015 *Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters*. Oxford: Oxford University Press.
- Brugge, Dough, Timothy Benally, and Esther Yazzie-Lewis
 2006 *The Navajo People and Uranium Mining*. Albuquerque: University of New Mexico Press.
- Buell, Lawrence
 1998 "Toxic Discourse." *Critical Inquiry* 24, no. 3: 639–65. <https://doi.org/10.1086/448889>

- Caldicott, Hellen, ed.
 2014 *Crisis Without End: The Medical and Ecological Consequences of the Fukushima Nuclear Catastrophe*. New York: The New Press.
- Carr, E. Summerson, and Brooke Fisher
 2016 "Interscaling Awe, De-escalating Disaster." In *Scale: Discourse and Dimensions of Social Life*, edited by E. Summerson Carr and Michael Lempert, 133–58. Oakland: University of California Press.
- Carver, Steve
 2019 "Rewilding through Land Abandonment." In *Rewilding*, edited by Nathalie Pettorelli, Sarah M. Durant, and Johan T. du Toit, 99–122. Cambridge: Cambridge University Press.
- Churchill, Ward, and Winona LaDuke
 1986 "Native America: The Political Economy of Radioactive Colonialism." *Insurgent Sociologist* 13, no. 3: 51–78. <https://doi.org/10.1177/089692058601300306>
- Cleveland, Kyle
 2014 "Significant Breaking Worse: The Fukushima Nuclear Crisis as a Moral Panic." *Critical Asian Studies* 46, no. 3: 509–39. <https://doi.org/10.1080/14672715.2014.935137>
- Cram, Shannon
 2016 "Wild and Scenic Wasteland: Conservation Politics in the Nuclear Wilderness." *Environmental Humanities* 7, no. 1: 89–105. <https://doi.org/10.1215/22011919-3616344>
- Creager, Angela N. H.
 2013 "Timescapes of Radioactive Tracers in Biochemistry and Ecology." *History and Philosophy of the Life Sciences* 35, no. 1: 83–89. <https://www.jstor.org/stable/43862145>
- Cunningham, Kelly, Thomas G. Hinton, Jared J. Luxton, Aryn Bordman, Kei Okuda, Lynn E. Taylor, and Josh Hayes
 2021 "Evaluation of DNA Damage and Stress in Wildlife Chronically Exposed to Low-Dose, Low-Dose Rate Radiation from the Fukushima Dai-Ichi Nuclear Power Plant Accident." *Environment International* 155. <https://doi.org/10.1016/j.envint.2021.106675>
- DeLoughrey, Elizabeth M.
 2013 "The Myth of Isolates: Ecosystem Ecologies in the Nuclear Pacific." *Cultural Geographies* 20, no. 2: 167–84. <https://doi.org/10.1177/1474474012463664>
- Erickson, Jon D., and Duane Chapman
 1993 "Sovereignty for Sale: Nuclear Waste in Indian Country." *Native Americas Akwe:kon Journal of Indigenous Issues*, 3–10.
- Erikson, Kai
 1991 "Radiation's Lingering Dread." *Bulletin of the Atomic Scientists* 47, no. 2: 34–39. <https://doi.org/10.1080/00963402.1991.11459947>
- Fernando, Mayanthi L.
 2017 "Supernatureculture." *Immanent Frame*, December 11. <https://tif.ssrc.org/2017/12/11/supernatureculture/>
- Goldfarb, Kathryn E.
 2016 "'Coming to Look Alike': Materializing Affinity in Japanese Foster and Adoptive Care." *Social Analysis* 60, no. 2: 47–64. <https://doi.org/10.3167/sa.2016.600204>
- Hall, Eric J., and Amato J. Giaccia
 2019 *Radiobiology for the Radiologist*, eighth edition. Philadelphia: Lippincott, Williams and Wilkins.
- Haraway, Donna J.
 2008 *When Species Meet*. Minneapolis: University of Minnesota Press.
- Hashimoto, Kazutaka
 2013 *En no Shakaigaku: Fukushi Shakaigaku no Shitenkara*. Tokyo: Harvest-sha.

Hecht, Gabrielle

2012 *Being Nuclear: Africans and the Global Uranium Trade*. Cambridge, Mass.: MIT Press.

2018 "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence." *Cultural Anthropology* 33, no. 1: 109–41. <https://doi.org/10.14506/ca33.1.05>

Hinton, T. G., J. S. Bedford, J. C. Congdon, and F. W. Whicker

2004 "Effects of Radiation on the Environment: A Need to Question Old Paradigms and Enhance Collaboration among Radiation Biologists and Radiation Ecologists." *Radiation Research* 162, no. 3: 332–38. <https://doi.org/10.1667/RR3222>

Jensen, Casper Bruun, Miho Ishii, and Philip Swift

2016 "Attuning to the Webs of *En*: Ontography, Japanese Spirit Worlds, and the 'Tact' of Minakata Kumagusu." *HAU: Journal of Ethnographic Theory* 6, no. 2: 149–72. <https://doi.org/10.14318/hau6.2.012>

Jorgenson, Timothy, J.

2017 *Strange Glow: The Story of Radiation*. Cambridge, Mass.: MIT Press.

Kainuma, Hiroshi

2011 "*Fukushima*" ron: *Genshiryoku ha naze Umaretanoka*. Tokyo: Seidosha.

2015 *Hajimetenno Fukushima-gaku*. Tokyo: East Press.

Kimura, Aya Hirata

2016 *Radiation Brain Moms and Citizen Scientists: The Gender Politics of Food Contamination after Fukushima*. Durham, N.C.: Duke University Press.

Kirby, Peter Wynn

2019 "Slow Burn: Dirt, Radiation, and Power in Fukushima." *Asia-Pacific Journal | Japan Focus* 17, no. 19–3: 1–20. <https://apjif.org/2019/19/Kirby.html>

Kirksey, S. Eben, and Stefan Helmreich

2010 "The Emergence of Multispecies Ethnography." *Cultural Anthropology* 25, no. 4: 545–76. <https://doi.org/10.1111/j.1548-1360.2010.01069.x>

Knight, John

2006 *Waiting for Wolves in Japan: An Anthropological Study of People-Wildlife Relations*. Oxford: Oxford University Press.

Kohn, Eduardo

2013 *How Forests Think: Toward an Anthropology beyond the Human*. Berkeley: University of California Press.

Koide, Hiroaki, and Norma Field

2019 "The Fukushima Nuclear Disaster and the Tokyo Olympics." *Asia-Pacific Journal* 17, no. 5: 1–14. <https://apjif.org/2019/05/Koide-Field.html>

Kuchinskaya, Olga

2014 *The Politics of Invisibility: Public Knowledge about Radiation Health Effects after Chernobyl*. Cambridge, Mass.: MIT Press.

Kuletz, Valerie L.

1998 *The Tainted Desert: Environmental Ruin in the American West*. New York: Routledge.

Kull, Kalevi

1998 "Semiotic Ecology: Different Natures in the Semiosphere." *Sign Systems Studies* 26, no. 1: 344–71.

Lyons, Phillip C., Kei Okuda, Matthew T. Hamilton, Thomas G. Hinton, and James C. Beasley

2020 "Rewilding of Fukushima's Human Evacuation Zone." *Frontiers in Ecology and the Environment* 18, no. 3: 127–34. <https://doi.org/10.1002/fee.2149>

Maran, Timo

2018 "Two Decades of Ecossemiotics in Tartu." *Sign Systems Studies* 46, no. 4: 630–39. <https://doi.org/10.12697/SSS.2018.46.4.11>

Maran, Timo, and Kalevi Kull

2014 "Ecossemiotics: Main Principles and Current Developments." *Geografiska Annaler: Series B, Human Geography* 96, no. 1: 41–50. <https://doi.org/10.1111/geob.12035>

- Masco, Joseph
 2006 *The Nuclear Borderlands: The Manhattan Project in Post–Cold War New Mexico*. Princeton, N.J.: Princeton University Press.
 2015 “The Age of Fallout.” *History of the Present: A Journal of Critical History* 5, no. 2: 137–68. <https://doi.org/10.5406/historypresent.5.2.0137>
- McClintock, Anne
 2014 “Imperial Ghosting and National Tragedy: Revenants from Hiroshima and Indian Country in the War on Terror.” *Publications of the Modern Language Association of America* 129, no. 4: 819–29. <https://doi.org/10.1632/pmla.2014.129.4.819>
- Mertz, Elizabeth
 2007 “Semiotic Anthropology.” *Annual Review of Anthropology* 36, no. 1: 337–53. <https://doi.org/10.1146/annurev.anthro.36.081406.094417>
- Morimoto, Ryo
 2012 “The Cult(Ture) of the Second Sun: Remembering, Repeating, and Performing the Past Imperfect.” *Recherches Sémiotiques* 32, no. 1-2-3: 161–86. <https://doi.org/10.7202/1027777ar>
 2015 “Interpretative Frameworks of Disaster in Society Close Up.” In *Natural Hazards, Risks, and Disasters in Society: A Cross-Disciplinary Overview*, edited by Andrew E. Collins, Samantha Jones, Bernard S. Manyena, and Janaka Jayawickrama, 323–51. Amsterdam: Elsevier.
 2020 “From Nuclear Things to Things Nuclear: Minding the Gap at the Knowledge-Policy-Practice Nexus in Post-Fallout Fukushima.” In *Disaster upon Disaster: Exploring the Gap between Disaster Knowledge and What Enters Policy and Practice*, edited by Susanne Hoffman and Roberto Barrios, 218–40. New York: Berghahn Books.
- Morris-Suzuki, Tessa
 2015 “Re-animating a Radioactive Landscape: Informal Life Politics in the Wake of the Fukushima Nuclear Disaster.” *Japan Forum* 27, no. 2: 167–88. <https://doi.org/10.1080/09555803.2015.1040817>
- Murphy, Michelle
 2017 “Alterlife and Decolonial Chemical Relations.” *Cultural Anthropology*, 32, no. 4: 494–503. <https://doi.org/10.14506/ca32.4.02>
- Newell, Sasha
 2018 “The Affectiveness of Symbols: Materiality, Magicity, and the Limits of the Antisemiotic Turn.” *Current Anthropology* 59, no. 1: 1–22. <https://doi.org/10.1086/696071>
- NHK
 2021 “Hibakuno Mori 2021 Kawariyuku Daichi.” NHK Special. Accessed June 18, 2021.
- Niitsu, Takeshi
 2011 *Inoshishi no bunkashi kouko hen: hakkutsu shiryō nadokaramita inoshishi no Sugata*. Tokyo: Yūzankaku.
- Nixon, Rob
 2011 *Slow Violence and the Environmentalism of the Poor*. Cambridge, Mass.: Harvard University Press.
- Nöth, Winfried
 1998 “Ecosemiotics.” *Sign Systems Studies* 26, no. 1: 332–43.
 2001 “Ecosemiotics and the Semiotics of Nature.” *Sign Systems Studies* 29, no. 1: 71–81.
- Nomura, Shuhei, Michio Murakami, Wataru Naito, Tetsuo Yasutaka, Toyoaki Sawano, and Masaharu Tsubokura
 2019 “Low Dose of External Exposure among Returnees to Former Evacuation Areas: A Cross-Sectional All-Municipality Joint Study Following the 2011 Fukushima Daiichi Nuclear Power Plant Incident.” *Journal of Radiological Protection* 40, no. 1: 1–18. <https://iopscience.iop.org/article/10.1088/1361-6498/ab49ba>

- Nozawa, Shunsuke
 2015 "Phatic Traces: Sociality in Contemporary Japan." *Anthropological Quarterly* 88, no. 2: 373–400. <https://muse.jhu.edu/article/582266>
- Odum, Eugene P.
 1959 *Fundamentals of Ecology*, 2nd ed. Philadelphia: W. B. Saunders.
- Ohashi, Haruka, Masae Saito, Reiko Horie, Hiroshi Tsunoda, Hiromu Noba, Haruka Ishii, Takashi Kuwabara, et al.
 2013 "Differences in the Activity Pattern of the Wild Boar *Sus scrofa* Related to Human Disturbance." *European Journal of Wildlife Research* 59, no. 2: 167–77. <https://doi.org/10.1007/s10344-012-0661-z>
- O'Neill, Daniel
 2019 "Rewilding Futures: Japan's Nuclear Exclusion Zone and Post 3.11 Eco-Cinema." *Journal of Japanese and Korean Cinema* 11, no. 1: 85–100. <https://doi.org/10.1080/17564905.2019.1600697>
- Parmentier, Richard J.
 2009 "Troubles with Trichotomies: Reflections on the Utility of Peirce's Sign Trichotomies for Social Analysis." *Semiotica* 177, no. 1/4: 139–55. <https://doi.org/10.1515/semi.2009.070>
- Peirce, Charles S.
 1960 *Collected Papers*. 8 vols. Edited by Charles Hartshorne and Paul Weiss. Cambridge, Mass.: Harvard University Press.
- Petryna, Adriana
 2013 *Life Exposed: Biological Citizens after Chernobyl*. Rev. ed. Princeton, N.J.: Princeton University Press.
- Polleri, Maxime
 2016 "Tracking Radioactive Contamination after Fukushima." *Anthropology Now* 8, no. 2: 90–103. <https://doi.org/10.1080/19428200.2016.1202619>
- Ralph, C. John and Bruce D. Maxwell
 1984 "Relative Effects of Human and Feral Hog Disturbance on a Wet Forest in Hawaii." *Biological Conservation* 30: 291–303. [https://doi.org/10.1016/0006-3207\(84\)90048-X](https://doi.org/10.1016/0006-3207(84)90048-X)
- Saito, Rie, Hitoshi Ohmachi, Yui Nemoto, and Masahiro Osako
 2019 "Estimation of the Total Amount of the Radiocaesium in the Wild Boar in Their Body—Each Organs Survey and Incineration Residue Survey." *Journal of the Society for Remediation of Radioactive Contamination of the Environment* 7, no. 3: 165–73.
- Sakurai, Katsunobu, and Hiroshi Kainuma
 2012 *Tatakau shichō—Hisaichikara mieta konokunino shinjitsu*. Tokyo: Tokuma Shoten.
- Stawkowski, Magdalena E.
 2016 "'I Am a Radioactive Mutant': Emergent Biological Subjectivities at Kazakhstan's Semipalatinsk Nuclear Test Site." *American Ethnologist* 43, no. 1: 144–57. <https://doi.org/10.1111/amet.12269>
- Sternsdorff-Cisterna, Nicolas
 2020 *Food Safety after Fukushima: Scientific Citizenship and the Politics of Risk*. Honolulu: University of Hawaii Press.
- Tsubokura, Masaharu
 2016 "Exposure and Current Health Issues in Minamisoma." *Annals of the ICRP* 45, 2—suppl: 129–34. <https://doi.org/10.1177/0146645316666708>
- Tuck, Eve
 2009 "Suspending Damage: A Letter to Communities." *Harvard Educational Review* 79, no. 3: 409–28. <https://doi.org/10.17763/haer.79.3.n0016675661t3n15>
- Viveiros de Castro, Eduardo
 1998 "Cosmological Deixis and Amerindian Perspectivism." *Journal of the Royal Anthropological Institute* 4, no. 3: 469–88. <https://www.jstor.org/stable/3034157>
- Walker, Brett L.
 2005 *The Lost Wolves of Japan*. Seattle: University of Washington Press.

Worster, Donald

1994 *Nature's Economy: A History of Ecological Ideas*. 2nd ed. Cambridge: Cambridge University Press.

Wynne, Brian

1996 "May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide." In *Risk, Environment and Modernity: Towards a New Ecology*, edited by Scott Lash, Bronislaw Szerszynski, and Brian Wynne, 44–83. London: Sage.

Yamaguchi, Tomomi, and Ruiko Muto

2012 "Muto Ruiko and the Movement of Fukushima Residents to Pursue Criminal Charges against Tepco Executives and Government Officials." *Asia-Pacific Journal | Japan Focus* 10, no. 7–2: 1–22. <https://apjff.org/2012/10/27/Tomomi-Yamaguchi/3784/article.html>