The Wake of the Anthropocene

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Naked humans are as rare as naked cosmonauts. To define humans is to define the envelopes, the life support systems, the Umwelt that make it possible for them to breathe (Latour 2011, 158).

Introduction

At 1656 GMT on 10 February 2009 an operational US communications satellite, Iridium 33, and a decommissioned Russian communications satellite, Cosmos 2251, collided in orbit 790 km above Siberia. The intersection of their orbital planes resulted in a collision velocity exceeding 11 km per second and “two distinct debris clouds extending through much of low Earth orbit” (NASA Orbital Debris Program Office 2009, 1). This was the first accidental hypervelocity collision of two intact spacecraft in history. The resultant debris clouds are now part of more than 100 million pieces of debris estimated to have been accumulating in orbit above the Earth since the launch of Sputnik in 1957 (see Figure 1). NASA estimates that debris in orbit above 1000 km will “normally continue circling the Earth for a century or more” (NASA Orbital Debris Program Office 2014) after which time, depending on its materials and mass, it will be pulled into the atmosphere and burn up or crash into the planet’s surface.

What is it to be a member of a species for whom the discards and remainders of their technological capacities are not only populating territory beyond the planet that species inhabits but doing so to such an extent that they are accidentally colliding into one another? This is a metaphysical question. It raises issues of meaning and existence. I pose it not with the hope of being able to answer it in any full sense here, but the Cosmos-Iridium collision is a concrete way to come to grips with the claims of archaeologists who more than a decade ago began to argue that extra-terrestrial space is sufficiently

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populated with the remains of human technological artefacts to be considered a cultural landscape (e.g., Rathje 1999; see also Gorman 2009; Gorman 2014; Gorman 2015; Gorman 2016; O’Leary and Capelotti 2015). More recently, in an analysis of the archaeological significance of orbital debris Gorman notes that “[p]erspectives and data derived from satellites in Earth orbit have been integral to the very apprehension of what is now being called the ‘anthropocene’” (Gorman 2014, 87).

This essay is about the discards and remainders of human extraterrestrial activity, or offworld rubbish. It bears pointing out that not all offworld rubbish arises offworld. Vast terrestrially based infrastructures must exist so that human beings and their technologies may operate extraterestrially. Those infrastructures have attendant discards and remainders, rubbish, as well. About offworld rubbish I make two claims. First, that offworld rubbish can be usefully interpreted as a wake of the Anthropocene. Like the passage of a ship through water or an atom through a cloud chamber, human technological capacities leave their tangible trails. Like the wakes of ships and atoms their passage provokes the capacities of other things, themselves set in motion or on different trajectories by the passage. Aquatic bioluminescence blooms in the wake of a ship. Mist forms around the atoms and molecules of supersaturated water or alcohol ionized by the passage of particles or radiation moving through them near the speed of light. If as Latour (2013a) argues the Anthropocene is about becoming more sensitive and responsive to the envelopes of conditions that sustain the groupings we pertain to, then we need more means, more instruments and mechanisms—more ‘bubble chambers’—to sense the shapes and limits of those envelopes. Working from German philosopher Peter Sloterdik’s opus, what Latour is pointing to with ‘envelopes’ is all the life support systems on which humans depend for their subsistence. These systems are not confined to technoscience (though they include it), nor are they all systems—though some humans may think of them that way (e.g., as ecological, economic, political, or cultural systems; see Descola 2014). They are the entanglements, often messy, with many other humans and nonhumans on which continued human ways of existence asymmetrically depend. These ‘ties that bind’ do not necessarily do so equally or with mutual concern. The arrival of the Anthropocene announces not the triumph of Man, but the fragility of envelopes in which human lives unevenly subsist. There is, then, a need to become ever more sensitive and responsive to the fragilities of our envelopes if subsistence is to be maintained.

This need points to my second claim: inventories of offworld rubbish are useful instruments for sketching out the shape and limits of several of the envelopes crucial to our scattered formations as groups of people at the Anthropocene. My point is not to draw together, via offworld rubbish, a larger whole that groups ‘us all’. Instead, it is to suggest how inventories of offworld rubbish help us sense the patchy, distributed, and noncoherent partial and situated groupings we might pertain to. Noncoherence is not the same as incoherence; the former retains the possibility of at least partial knowability (Law 2004). Such inventories may help teach us that some of the envelopes relevant to some of us literally, not only figuratively, exceed the planet on which we live. They may also help some of us appreciate the fragilities surrounding the maintenance of our ways of subsisting. In these ways inventories of offworld rubbish might elicit questions of sufficiency: given that the discards and remainders of human technological capacity exceed the planet, how much such capacity is enough? For whom? Under what conditions? I do not purport to offer any answers to these questions here. I only intend to suggest how offworld rubbish might be useful for thinking them through.
Banality in Extremis: the Anthropocene and Offworld Rubbish

The Anthropocene is a term used to describe the increasingly measurable changes in Earth systems attributable to human activity. The recent prominence the term Anthropocene in English emerged in 2000 when atmospheric chemist Paul Crutzen and ecologist Eugene Stoemer used it to group the vast range of changes in environmental processes traceable to the entanglement of human activity into a distinct time period. The contemporary debate in the geological sciences is about whether the term is “scientifically justified” by the geological signals in rock strata currently being formed and whether the term is useful as a formal scientific concept (Subcommission on Quaternary Stratigraphy 2014; Waters et al. 2016).

In making their case, geologists have not eschewed linking the contemporary notion of Anthropocene with historical precedents. The etymological and biographical connections in these precedents are suggestive in their minglings of science and religion such that they cannot be disentangled. In 1873, for example, Antonio Stoppani, an Italian geologist and Catholic priest, referred to the “anthropozoic era” when characterizing human influence on Earth (cited in Crutzen 2002, 23). By the late 1970s, Soviet and Czechoslovakian geologists respectively made use of the terms Anthropogene and Athropozoikum as alternatives to the Quaternary period which they had discarded as an antiquated classification system (Nilsson and Gerasimov cited by Subcommission on Quaternary Stratigraphy 2014). Crutzen (2002) even includes as an historical precedent to the contemporary notion of Anthropocene that of ‘noosphere’—the sphere of human thought analogically related to atmosphere and biosphere—that is variously attributed to Russian mineralogist and geochemist Vladimir Vernadsky and to French philosopher and Jesuit priest Pierre Teilhard de Chardin (who also trained as a palaeontologist and geologist). In these admixtures of science and religion are hints at why ‘Anthropocene’ is a helpful term to describe the disparate experiences of having never been modern (Latour 1993; Latour 2013a). In this sense, the Anthropocene has cosmological resonance—that is, as a myth in the anthropological sense of that term; not a false or mistaken account, “but a cosmological blueprint that lays down fundamental categories and meanings for the organization and interpretation of experience” (Ferguson 1999, 13–14). As such, an esoteric scientific debate amongst a small group of scientists—there are only 30 people listed as members of the Working Group on the Anthropocene—is in an accurate sense coextensive with all the other modes—religious, political, economic—of gathering together the collective of which that debate is a part (Latour 2013b). What is significant in the debate over naming the Anthropocene by a group of scientists is that in that debate all other domains of ostensibly modern life (religion, politics, economics) are so thoroughly mixed up that disentangling them into purified forms makes no sense, other than to attempt to reinstitute a way of being modern that, try as we might, has never been actualized (Latour 1993). Rituals of purification, as Douglas (1966) showed, make and stabilize shared symbolic systems. But attempts at purification inevitably encounter that which cannot be categorically purified within the system. Such matter out of place—‘dirt’ in Douglas’ formulation—threatens symbolic order and must be dealt with in a satisfactory manner so as to maintain and repair that order. Religion out of Science and Politics. Politics out of Science and Religion. Order! One should be cautious about
presuming that the dirt of Douglas' systems is equivalent to cognate concepts such as rubbish, waste, junk, trash, or garbage, but let me suggest this much here: taking notice of that which is discarded from systems, whether those systems are scientific, technological, or otherwise—is useful for thinking through the possibilities and limits those systems hold for knowing and being in the world.

5 As an offworld rubbish event, the precise nature of historical precedent set by the Cosmos-Iridium accident bears careful unpacking. Much of the evidence of environmental change said to diagnose the Anthropocene is derived from data remotely sensed and measured by satellites (Gorman 2014). Rubbish things, so some anthropologists have argued (Douglas 1966; Thompson 1979), persist in a place betwixt waste and value. Rubbish, then, is not synonymous with waste, garbage, or their cognates and remains unthreatening to symbolic systems or cognitive categories so long as identity is in abeyance. Events like the Cosmos-Iridium collision, however, shift the balance between being benign and being threatening. Following the action out from such events helps us trace the particular shapes of the collectives of which we are part and the envelopes on which we have come to depend for that shared existence.

6 Accidents have the virtue of bringing into view the convoluted and numerous associations that gather humans and nonhumans into collective groups. As forms of breakdown, accidents help illuminate the ties from which those collectives are assembled and have become, despite their miraculousness, so mundane as to be invisible, so a part of the daily functioning of gathering together that their presence is absent (Latour 2005, 81; Law and Mol 2002). As Latour (2005, 81) writes, “[t]hose who watched the Columbia shuttle instantly transformed from the most complicated human instrument ever assembled to rain as debris falling over Texas will realize how quickly objects flip-flop their mode of existence”. Even at the scene of a minor automobile collision, the event’s entanglement with multiple infrastructures of the Divine (‘Oh God! Look out!’), law (police; lawyers), medicine (ambulance services), and finance (insurance) flash into view, which only moments before were ticking along more or less invisibly with every depression of the gas pedal. With an accident ties that bind—envelopes of mutual entanglement—flash into prominence. Absent presences (Hetherington 2004) explode into view. They assert their relevance, their shape and—crucially—their extent, that is, their limits.

7 That the Cosmos-Iridium crash was the first ‘hypervelocity’ collision of ‘intact’ spacecraft tells us that it was a first in a very particular way and preceded by earlier accident events that were other than hypervelocity collisions between intact spacecraft. The wrecks of the Columbia space shuttle already referenced and that of Challenger (Vaughan 2009) come to mind. Columbia broke up on re-entry 1 February 2003. Challenger exploded during take-off 28 January 1986. Between 1961-2007 NASA documented 194 satellite breakups in orbit (Johnson et al. 2008, iii–vii). But those events exclude accidents involving satellites either before reaching orbit or, having reached orbit, fail and succumb to Earth’s gravitational pull. For example, on 24 January 1978 a nuclear powered Soviet satellite, Cosmos 954, crashed in Northern Canada spreading a radioactive debris field over parts of northern Alberta and Saskatchewan, the Northwest Territories and what is now Nunavut. Some residents of the region are still seeking compensation for the toxicological consequences of that event. Before that, on 21 April 1964, an American Transit navigational satellite was launched from Vandenberg Air Force Base in California, but failed to reach orbit. The onboard power source for the Transit included approximately 1 kg of Plutonium 238 (Pu-238) in a ‘Systems for Nuclear Auxiliary Power’ generator or SNAP. The SNAP 9-A
manufactured for the Transit, “was not built for an intact re-entry” (Hardy, Krey, and Volchok 1972, 1). The ensuing uncontrolled burn up of the satellite and its SNAP 9-A power source entailed “a three-fold increase in the global fallout of this [Pu-238] isotope” after accounting for all atmospheric nuclear weapons tests conducted to that point in history (Hardy, Krey, and Volchok 1972, 1). Yet, this brief list is of only punctuated events. Rocket bodies and debris typically substantially exceed the number of payloads delivered to orbit. Debris generation and collisions are ongoing processes. Of the 3,857 “payloads” launched into orbit as of October 1, 2014 a trail of 13,137 “rocket bodies and debris” also ensued (NASA Orbital Debris Program Office 2014, 12). In other words, for every payload launched, approximately three pieces of orbital discards arose. NASA’s European counterpart, the European Space Agency (ESA), claims that only 7 percent of all objects tracked by its Space Debris Office are functioning satellites (European Space Agency 2013b). On orbit collisions of debris happen continually. What this brief list of figures shows is that debris from the infrastructures flinging satellites into orbit is more common than the satellites themselves. Offworld rubbish, then, is not an anomaly. It is a norm in excess of that from which it arises. It is extreme in its localization beyond the planet its makers inhabit, but it is a banal consequence of human space operations.

From Whole Earth to Composite Inventory

On December 24th, 1968 as the Apollo 8 mission executed a planned maneuver in lunar orbit, Earth swung into view. In the moment, astronaut William Anders exclaims, “Oh my God! Look at that picture over there! There’s the Earth coming up. Wow, is that pretty.” Approximately 7 milliseconds later, his crew mate, Frank Borman follows with a joke: “Hey, don’t take that [photograph], it’s not scheduled” (NASA 1969, 113). Sacred and secular exclamations uttered with less than a heartbeat separating them, on a specific date and time recorded with millisecond precision in NASA’s Apollo 8 Voice Transcription. Three men, after thousands of hours of practice, riding in a capsule of a few cubic meters, comprising a complexly accumulated envelope of Cold War infrastructure stretching out around the Moon and, though no one could have known for sure in the moment, back to Earth. They fumble for film (NASA 1969, 113):

Excerpts from (European Space Agency 2013a) edited by author
“Hand me that roll of color quick, will you [...]”
“Hurry. Quick.”
“It’s down here?”
“Just grab me a color. That color exterior”
“Hurry up!”
“Got one?”
“Yes, I’m looking for one.”
“Anything, quick.”
“Here.”

2. NASA image AS8-14-2383 or “Earthrise”

And NASA image AS8-14-2383 is snapped. “Earthrise” (see Figure 2). Others have demonstrated the gender politics and religiosity loaded into the manufacturing of the Whole Earth image (Gaarb 1990; Cosgrove 1994). The global image is a God’s eye trick (Haraway 1991). But the verbal exchange between the Apollo 8 astronauts brings the trick of the image somewhat back down to Earth. It reminds us that the photograph is a composite. In a tiny space, the mere 70mm frame composing AS8-14-2383, one encounters a mixture of existents impossible to neatly sort into the realms of nonhuman Nature over there and human Culture over here—in which category, for example, do you place the chemicals comprising the film in the custom formula mixed for the Apollo 8 mission by the Kodak Corporation? “Earthrise” is not the whole Earth. It is a partial and situated composite image projected inside complexly interlinked, but extremely narrow and
fragile envelops of media infrastructure that make viewing it possible. A complete inventory of that infrastructure would be lengthy—among other things it would include electrical cables, screens, power generation, undersea cables, and, yes, satellites in orbit—but not infinitely so. It would not lead everywhere. And it would certainly not lead to a singular point where everything, including the list, could be seen. The ‘large format’ film that captured AS8-14-2383 is only 70mm wide. The whole is always smaller than its parts, not the other way around (Latour et al. 2012).

In her classic 1994 text, A Global Sense of Place, geographer Doreen Massey poses a thought experiment for understanding the then ostensibly novel era of globalization without having to let go of the specificity and particularity of ‘place’. She does this through the notion of ‘power geometry’ which describes her sense of socially differentiated experiences of globalized space produced in late capitalism. To do this she starts in orbit:

Imagine for a moment that you are a satellite, further out and beyond all actual satellites; you can see the ‘planet earth’ from a distance and, unusually for someone with only peaceful intentions, you are equipped with the kind of technology which allows you to see the colours of people’s eyes and the numbers on their numberplates. You can see all the movement and tune in to all the communication that is going on. Furthest out are the satellites, then the aeroplanes [...] some of this is people moving, some of it is physical trade, some is media broadcasting. There are faxes, e-mail, film distribution networks, financial flows and transactions. Look closer and there are ships and trains [...] Look closer still and there are lorries and cars and buses, and on down further, somewhere in sub-Saharan Africa, there’s a woman—amongst many women—on foot, who still spends hours a day collecting water (Massey 1994, 148–49).

Massey’s thought experiment seeks a vantage point that is, in actuality, literally impossible. There neither is, nor can there be, any satellite further out and beyond all actual satellites since if there were it would not be actual. Massey knows this. But her thought experiment works for many, perhaps most, of her readers because so many of us are now, after half a century or more of practice, so familiar with images of the apparently whole Earth. So well connected within the necessary infrastructure are we who can do Massey’s thought experiment successfully that we can do it without noticing the equipment necessary for our success. That equipment, that envelop, has not disappeared; it has just become so familiar, like so many of our envelopes, that it is hard to feel it anymore. Perhaps tracking the wake comprised by the discards and remainders of those envelopes might help us inhabiting them to better appreciate their importance and their effects.
Writing in the early 1990s, it would be exceedingly unlikely that the more-or-less imagined ‘African woman’ in Massey’s description would possess a cellphone. Today, many do (see Figure 3). And in doing so, she and I—and very probably, you—are enlooped in envelopes of infrastructure that groups us through the satellites that enable our use of this and other forms of modern communication technology. In a very partial sense, but an accurate one, she and I (and anyone using such devices) form a ‘we’ through satellites, their infrastructures, and the offworld rubbish left in their wake.

But it is a troubling ‘we’, isn’t it? She and I could be differentiated in so many other ways, not least along divides of socioeconomics—health, wealth, education (this list could be longer). Yet satellites and their debris envelop she and I into a ‘we’ in undeniable ways. We depend on the matter and energy folded together in satellites and their attendant infrastructure—fossil fuels, rare earths and precious metals, more or less exploited labour to mine and manufacture, energy for distribution and use (again, the list could go on, but not infinitely)—to produce the narrow envelop of one of the spaces common to our persistence. In the wake of the Anthropocenic Earth, as it vortexes through space, are the satellites and their debris. Offworld rubbish. This wake of the Anthropocene collects ‘us-es’ (plural), assembles groups together; forms traceable collectives. But not equally so. The ‘we-s’ and the ‘us-es’ gathered up in the ‘anthropos’ of the Anthropocene are variable geometries of connection and disconnection, variable power geometries (Massey 1994; see also Chakrabarty 2009).

Making the Familiar Strange Again: Building Partial Inventories of Offworld Rubbish

Both the ESA and NASA maintain offices devoted to inventorying offworld rubbish. Their focus is debris in orbit around Earth. The population of such debris numbers in the hundreds of millions. These numbers are estimates, since much of the debris is too small to be remotely detected, though they could cause damage to satellites and space vehicles, such as the International Space Station, also in orbit. Such estimates are only partial.
inventories of offworld rubbish. Left out of these inventories are the offworld rubbish remaining on the Moon (including 96 bags of human urine, feces, and vomit) (Garber 2012). Nor does it include more than 200,000 tonnes of offworld rubbish estimated to persist on other planets in the Solar System (Mars, Jupiter, Venus) and interplanetary bodies such as meteors and comets (Capelotti 2010).

4. Haystack Radar complex, Lexington, Maryland, USA

![Image of Haystack Radar complex](http://orbitaldebris.jsc.nasa.gov/measure/radar.html)

Source: http://orbitaldebris.jsc.nasa.gov/measure/radar.html

5. MCAT optical telescope on Ascension Island

![Image of MCAT optical telescope](http://orbitaldebris.jsc.nasa.gov/measure/optical.html)

Source: http://orbitaldebris.jsc.nasa.gov/measure/optical.html

Inventories of orbital debris are created through measurements and modelling. Measurement data is collected from ground-based instruments such as the Haystack...
Radar (Figure 4) in Lexington, Maryland and the Meter-Class Autonomous Telescope (MCAT) on Ascension Island (Figure 5). Space-based infrastructure and the surfaces of returning spacecraft also feed data into the inventories of offworld rubbish.

Measured orbital debris is categorized in size classes. Debris between 3mm and 10cm can be tracked from the ground. At the lower end of this scale, radars are used to sample portions of extraterrestrial space and develop statistical estimates of the total debris population. Debris below 1mm can be measured based on impact features evident on returned spacecraft and a reconstruction of their known path.

6. Reading TLE data

Orbital debris objects are given a discrete numeric designation called a two-line element (TLE). TLEs describe the position and velocity of each cataloged debris item (see Figure 6). These data are aggregated into tracking databases, some of which are publicly available (e.g., celestrack.com 2015). TLE data are fed into computer models of the orbital debris environment such as NASA’s Orbital Debris Engineering Model (ORDEM) and the ESA’s Debris Risk Assessment and Mitigation Analysis (DRAMA) tool.

The models combine TLE data with statistical functions to generate an estimated debris population orbiting Earth. These data and estimates are the digital elements used to compose visual inventories of the population of offworld rubbish in orbit around Earth like those in Figure 1. Juxtapose such inventories with that of the ‘Blue Planet’ of ‘Earthrise’ (Figure 2). Both are composites. Both circulate in complexly interlinked, but extremely narrow and fragile envelopes of infrastructure enabling them to be viewed. But, the visual inventories of offworld rubbish give a different shape to a view of Earth. They give a very different sense of the ‘human footprint’ that is visually absent in Earthrise (making it easier to play the God trick with that image). Threat is made apprehensible by the very technological apparati that enabled the iconographic image of the ‘Blue Planet’ to be made and circulate. Like any map, these inventories massively exaggerate the scale of some features so as to make them legible. The size of debris objects in visual inventories of them are exaggerated to make them visible. This exaggeration of scale is similar to how common road maps, for example, often exaggerate the scale of features such as highways or symbols for points of interest deemed relevant to their users. Visual inventories of offworld rubbish offer a very precise impression of the externalities arising from the infrastructural envelopes that also collect us in many
varieties of patchy, distributed, and noncoherent groupings we may pertain to at the Anthropocene.

**Offworld Rubbish and the Composition of Novel Ecosystems**

In the deliberations over the existence of the Anthropocene, where to put the proverbial ‘golden spike’ is, almost without exception, a matter of looking down past the terrestrial surface and into the geo-logic of depth (for an exception, see Zalasiewicz et al. 2014, 37). Yet, as Gorman (2014, 90) shows, “the anthropocene cannot be understood without reference to [extraterrestrial] space”. Launching satellites to look down at ourselves entrains, as we’ve seen, depositing debris into patchy and distributed patterns within and beyond near Earth orbit.

Lisa Parks (2012, 233), a scholar of film and media studies, argues that “[s]atellites require expanded thinking about what ‘the environment’ is and a recognition that this domain extends contiguously from below the Earth’s surface up through the atmosphere and out through orbital space”. In other words, technological matters of concern (Latour 2004) engender existential ones. For NASA scientist Donald J. Kessler (now retired), the ontological shift in the meaning of ‘environment’ was apparent in a 1976 report he wrote for the Agency’s Environmental Effects Project Office:

The Earth’s exosphere is part of the environment and is the location of much of our space activity. Communication and weather satellites operate in the exosphere, and man [sic] (via the Space Shuttle) is planning to work in this environment. Also, if some current planning is realized, man may live in the exosphere in space stations, solar power stations, or large space colonies. It, therefore, becomes important to keep this part of the environment safe for these types of activities (Kessler 1976, 1).

Kessler and fellow NASA scientist Burton Cour-Palais went on to describe a theory of orbital debris (now known as the Kessler Effect or sometimes the Kessler Syndrome) in which collisions between satellites in increasingly crowded orbits create cascading crash events leading to the generation of an Earth orbiting belt of debris (Kessler and Cour-Palais 1978). 22 years later at the American Astronautical Society, Kessler and three colleagues presented a paper in which they claimed that while changes to space operations over the last 30 years have slowed the growth in orbital debris, these procedures have not been adequate to prevent growth in the debris population from random collisions [...] we are at a point where we must obtain near 100% compliance with guidelines established over 10 years ago and, in addition, we must retrieve a number of objects that are already in orbit. Fortunately, by selectively retrieving the most likely future debris sources, the rate of retrieval may be manageable, as long as at least 90% of future launches adhere to current debris mitigation guidelines...a percentage that has not been met in the past (Kessler et al. 2010, 13 emphasis added).

What Kessler et al (2010) are saying, effectively, is that rubbish removal from Earth’s orbital environment is now necessary, not optional, if a safe operating space for orbital craft is to be possible. Such removal from orbit is an obligation. As a form offworld rubbish, orbital debris has switched registers. It is identifiable and as such shifts from rubbish to ‘dirt’—matter out of place in the anthropological sense of the term (Douglas 1966). But here is where one anthropological approach to offworld rubbish might also
reach a limit. Douglas’ investigations of purity and danger, condensed into ‘dirt’, are about the threat such matter poses to symbolic systems and cognitive categories. Offworld rubbish-as-orbital-debris is more than a symbolic threat (though it may be that too). In this sense, orbital debris is as much a part of the ‘planetary boundaries’ and ‘safe operating space’ with which the “new epoch, the Anthropocene, where humans constitute the dominant driver of change to the Earth System” are associated (Rockström et al. 2009 no page number). Rockström et al.’s (2009) characterization reasserts the image of human mastery over nature enacting precisely what others have pointed to as a key danger of Anthropocenic thinking: the invocation of a singular ‘species-being’ (Chakrabarty 2009; Dibley 2012; Roelvink 2013). Interfering with the presumption of the relevance or possibility of such a settled image is something for which inventories of offworld rubbish might be useful. Such inventories continually point to the action of nonhuman materials and, as I suggest briefly below, to that of nonhuman life that compose our envelopes. In this way, perhaps, inventories like these might help to stave off the presumption of human- and even Terran-centrism.

Perhaps, then, the strange banality of inventories of offworld rubbish offer an implement useful for what Anna Tsing (2015) calls the arts of noticing. Here is an example of what I mean. In their diagnoses of the Anthropocene biologists and ecologists have recently introduced the concept of ‘novel ecosystems’ (Robbins and Moore 2013). Novel ecosystems result directly and indirectly from human activities [...] and occupy space alongside existing semi-natural or natural ecosystems in the world’s landscapes and seascapes. Although recognized for at least three decades, novel ecosystems have heretofore been overlooked and apparently undervalued by both the scientific and conservation communities (Bridgewater et al. 2011, 423).

Notice the locales the biologists and ecologists are pointing to: the landscapes and seascapes on Earth. Yet for Kessler and his colleagues the ‘exosphere’ already matched much of what defines a novel ecosystem, but offworld. The exosphere, Kessler (1976) explains is the locale of “much of our space activity”. ‘Much’ implies some, but not all of that activity. Indeed, one of the notable features of the notion of the exosphere is that it has no clear line demarcating an inside and outside. It is a zone without bounds where molecules, such as those comprising the gases of Earth’s atmosphere, are held gravitationally in orbit but at a density too low to behave as gas. The remainders and discards of human extraterrestrial activity persist within and beyond this zone-without-bounds. Kessler (1976) was concerned about keeping this zone safe for human activity. Yet, NASA missions have explicitly had to expend substantial engineering efforts to mitigate the risk of inadvertently introducing terrestrial viruses and microbes to offworld sites during interplanetary missions. There was a concern during the Apollo missions, for example, that viable microbic and viral matter from Earth could contaminate the Moon’s surface. Indeed, there is speculation that a common bacterium, Streptococcus mitis, may have been found surviving in the unprotected vacuum of the lunar surface within a TV camera left behind by the unmanned Surveyor 3 mission of 1967 (NASA 1998; though some NASA researchers contest this idea, see Rummel, Allton, and Morrison 2011). More recently, in 2003 the main craft of the Galileo mission was deliberately sent into Jupiter’s atmosphere to disintegrate for fear that upon mission completion it might contaminate one of Jupiter’s moons, Europa, which may have a subsurface ocean capable of supporting life. Notwithstanding the uncertainty over the provenance of bacteria from the Moon missions, current and future Mars missions are having to grapple with the ethics of
potential contamination of that planet by Earth life. NASA Planetary Protection Officer Catherine A. Conley notes that, “a variety of organisms could actually survive on the martian surface, and potentially proliferate at least transiently [including] bacteria [and] lichens” (Conley and Rummel 2013, 588; see also Fairén and Schulze-Makuch 2013). Thus, inventories of offworld rubbish are even sensitive enough to help us register our connections to even more novel ecosystems. While bacteria are by-and-large indifferent to human persistence at the Anthropocene, our dependence on them is total (Hird 2010). Yet, these nonhuman lifeforms that vastly outnumber human beings may have been awash in the wake of the Anthropocene since it left the planet.

Engineers, archaeologists, and media studies scholars have alerted us to the strange familiarity of extra-terrestrial space as a human environment and cultural landscape. Yet it is clear from the partial inventories of offworld rubbish depicted above that neither the human nor the cultural are sensitive enough devices to detect where we live and with whom and what we are connected at the Anthropocene. Offworld rubbish may be a scape, but its scope exceeds the human and the cultural. This is one reason why it may be useful to interpret offworld rubbish as a wake of the Anthropocene. A wake results from the passage of existents. The passage elicits responses from the involved existents with indeterminate consequences. To build inventories of offworld rubbish is to offer one means to increase our sensitivity to the narrow envelopes of patchy, distributed, and noncoherent spaces common to our persistence.

Conclusion

Offworld rubbish is a form of discard. ‘Discard’ is a useful word. It is both verb and noun—ridding of a person or thing rejected as no longer useful or desirable; the person or thing so rejected. In it we can grasp both action and thingness without having to settle on one or the other, here or there, now or in the future. Discard is an indexical proposition. The meaning of discard, like the reality of that which it labels, is situational.

The wake exceeds the passage of the ship in water, the atom or radiation through a bubble chamber, their effects ongoing long after they pass. My essay made two claims. First, that offworld rubbish can be usefully interpreted as a wake of the Anthropocene. Second, that inventories of offworld rubbish are useful instruments for sketching out the shape and limits of the multiple envelopes that gather our scattered formations as groups of humans and nonhumans at the Anthropocene. Such inventories are useful for becoming more sensitive to where we live and with whom and what we are connected for our modes of existence.

In the instant of their collision, Cosmos 2251 and Iridium 33 became something else—or, indeed, multiple other things. In that instant a shift of ontological registers is detectable. As they shattered into pieces, they became something other than technological objects of human manufacture. What were communications satellites manufactured by human hands, became nonhuman others: bits and pieces of metals and other matter with indeterminate—at best probabilistic—characteristics in terms of number, size, mass, and velocity among other possible measures like toxicology and radioactivity. The shift is one from useful machine to debris, from human techne to nonhuman agency. Earlier catalogued accidents involving satellites, such as Cosmos 954 and Transit SNAP-9A, register for us the action of nonhuman matter and offers a rather different shape to the ‘Blue Planet’ at the Anthropocene. Yet, not only matter, but nonhuman life, with its own
interests and indifference to us, also rides in offworld rubbish, the wake of the Anthropocene.

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ABSTRACTS

Discards and remainders of human forays into extraterrestrial space have been accumulating for almost 60 years in orbit around the Earth, on the surfaces of the Moon and other celestial bodies in the Solar System. What is it to be a member of a species for whom the discards and remainders of their technological capacities are not only populating territory beyond the planet that species inhabits but doing so to such an extent that they are accidentally colliding into one another? State organizations such as the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA) construe orbital debris as hazards to be tracked, managed, and mitigated. But what else are, or might, these remains be and for whom, where, and under what conditions? Tentatively, I interpret offworld rubbish as a wake of the Anthropocene. I claim that visual inventories of offworld rubbish are one useful instrument for becoming more sensitive to the narrow envelopes of patchy, distributed, and noncoherent spaces common to shared existence at the Anthropocene.

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