Erich Pietzsch, USGS 2007

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The Virtual Field

Sensing is an integral part of collecting data in the field. As apparatuses become more refined, they increase the capacity and precision of data that can be collected in even the most forbidding of zones. Historian of science Etienne Benson describes how the increasingly complex infrastructure of sensing is altering the experience of fieldwork, the persona of the scientist, and the nature of the knowledge that is produced.

Fieldwork isn't what it used to be. Time was, when you wanted to know something about the world, you really had to go out into it—to brave the ice, to climb the mountain, to sweat under the sun, to immerse yourself in the depths, to throw yourself into the life of the village. It was a risky business, this fieldwork; it took you away from creature comforts, separated you from friends and family, put you in physical danger, and forced you to dig deep. Most people came back from fieldwork, but some didn't. Planes crashed, boats sank, epidemics erupted. Fieldwork was your rite of passage—if you survived it—on the way to becoming a full-fledged anthropologist, ecologist, oceanographer, entomologist, geologist, or whatever other kind of field scientist you were a would-be version of. Even historians, a mostly sedentary species, had field-like tales to tell of battles hard-won in the dusty archives. Doing fieldwork meant putting yourself—your actual bodily self—in unfamiliar places, with unpredictable results. 1

These days you can skip most of that. Not all of it, to be sure. Some data can still only be gathered in person and some credit still accrues only to those who go forth, boldly and bodily, to the places they study. For the production of certain kinds of facts, the necessary chains of reference must still be accompanied from beginning to end. 2 But for many

1 Robert E. Kohler and Jeremy Vetter, "The Field," in Bernard Lightman (ed.), A Companion to the History of Science. Hoboken, NJ: John Wiley & Sons, 2016, doi: 10.1002/9781118620762.ch20; George E. Marcus (ed.), Fieldwork Is Not What It Used to Be: Learning anthropology's method in a time of transition. Ithaca, NY: Cornell University Press, 2009.

researchers, much of the time, most of the “field data” they need can be gathered from afar. Rather than wheezing in the archives, the historian grows bleary-eyed and finger-sore from clicking through digitized manuscripts; the pajama-clad anthropologist stays up late observing online videos and participating in chat rooms; the oceanographer is swept up in wave after wave of satellite images; the hydrologist drowns in a flood of data from automated stream gauges. In our networked world, studded with sensors and crisscrossed with camera angles, one can learn a great deal about “the field” without ever leaving one’s office. The stories may be rather humdrum, the adventure somewhat muted, but the science goes on.

2 Bruno Latour, “Circulating Reference: Sampling the soil in the Amazon forest,” in Pandora's Hope: Essays on the reality of science studies. Cambridge, MA: Harvard University Press, 1999, pp. 24–79.

The USGS gaging station on the St. John River at Nine Mile Bridge. USGS 2015

At some point, of course, someone does have to go out into the field to lay those cables, hoist those antennas, launch those satellites, calibrate those sensors, and capture those videos. Wildernesses do not wire themselves. 3 Fieldwork of a sort continues to be practiced, then, but in a radically different mode than it once was. Instead of conducting their own observations in the field, with or without technically sophisticated instruments, scientists now install and maintain automated devices that will feed them a steady diet of new data after they have returned home. When the cost and complexity of a new instrument become too great for any one scientist to handle, they band together to install and maintain it as a collective, often with the help of corporations and nation-states that have the resources to install very expensive instruments in very hard-to-reach places, such as the Earth’s orbit or on the surface of other planets. 4 The time may be approaching when scientists will no longer go out into the field in order to collect data, but instead solely to install the devices that will collect it for them.

3 Etienne Benson, Wired Wilderness: Technologies of tracking and the making of modern wildlife. Baltimore, MD: Johns Hopkins University Press, 2010.

4 Pamela E. Mack, Viewing the Earth: The social construction of the Landsat Satellite System. Cambridge, MA: MIT Press, 1990; Janet Vertesi, “Seeing like a Rover: Visualization, embodiment, and

interaction on the Mars Exploration Rover Mission," Social Studies of Science 42, no. 3 (2012): pp. 393–414.

New as it undoubtedly is, the novelty of this situation should not be overestimated. For centuries, much fieldwork has been conducted by proxy: if not by "devices," *per se*, then at least by people who have been instrumentalized, exploited, and forgotten. Between the eighteenth-century sailing ships that carried handwritten reports of distant climes to European centers of calculation and the twenty-first century telecommunications networks that collect data from automated weather stations, then, we might see a difference of degree rather than kind, of speed rather than topology. 5 But if the continuities are real, so are the ruptures. In networks built of human observers, even if the body of the scientist is not present at the scene of observation, somebody's body—sensitive, suffering, ecstatic, exhausted—inevitably is. As sensor networks supplant social relations, the field of observation begins to float free of the limits and potentials of the historically situated human body. In the disinhabited field of automated observation, other kinds of bodies and relations—lifeless but not necessarily therefore inanimate—are now in play. 6

5 Bruno Latour, Science in Action: How to follow scientists and engineers through society. Cambridge, MA: Harvard University Press, 1987, pp. 215–57; Jan Golinski, British Weather and the Climate of Enlightenment. Chicago, IL: University of Chicago Press, 2007; Paul N. Edwards, A Vast Machine: Computer models, climate data, and the politics of global warming. Cambridge, MA: MIT Press, 2010.

6 Jennifer Gabrys, Program Earth: Environmental sensing technology and the making of a computational planet. Minneapolis,MN: University of Minnesota Press, 2016.

Bloodless as it may seem in comparison with personally embodied observational fieldwork, the sensor-based science of installation, maintenance, and remote data-collection nonetheless has its own virtues, and even its own heroism. Tracking a GPS-tagged great white shark from California to Hawaii and back may require little effort and even less courage, once the tag is on. 7 But getting the tag on the shark in the first place takes guts, and chum, and a ship, a crew, and the readiness to put your own body—or somebody's body, anyway—up against the water, wind, and the recalcitrant weight of a gigantic, toothy predator. There is rich material here for barroom fish tales and behind-the-scenes television specials, and for the continuing construction of Romantic personae in an age of secondhand experience. 8 So, too, are there adventures to be had in the construction and maintenance of infrastructure. No matter how resilient the system or sophisticated the algorithm, there will still be rusty bolts and broken wires in uncomfortable places, and people who are asked to fix them. 9

7 Andre M. Boustany et al., "Expanded niche for white sharks," Nature 415, no. 6867 (2002): pp. 35–6.

8 Donna J. Haraway, "Crittercam: Compounding eyes in naturecultures," in When Species Meet. Minneapolis, MN: University of Minnesota Press, 2008, pp. 249–64.

9 Nicole Starosielski, The Undersea Network. Durham, NC: Duke University Press, 2015.

New virtues and talents are also in demand back at the lab, the office, or the living-room couch. If the success of the field scientist of yesteryear depended on a well-developed sense of place, honed through long experience in the field and often dependent on exchanges—coerced or otherwise—with well-informed residents, the networked scientist of today needs other skills. 10 These include the ability to aggregate data from multiple sources, to determine their quality and their limits, to incorporate them into meaningful models, and to recognize when existing instruments are no longer sufficient and new ones must be deployed. There is a loss here, but also a gain. Instead of the embodied intuition that comes from observing at a particular field site over time, the researcher develops a kind of *Fingerspitzengefühl* (fingertip feel) for the virtual field and for the data, models, and

10 Robert E. Kohler, "Paul Errington, Aldo Leopold, and wildlife ecology: Residential science," Historical Studies in the Natural Sciences 41, no. 2 (2011): pp. 216–54.

visualization techniques that make it real. The experience of scientific "fieldwork" continues to be direct and embodied—there is no real alternative—but the nature of the "field" experienced by the scientist changes: it becomes digital, distant, distributed, discontinuous.

USGS hydrologist collects location data using GPS during a near-surface geophysics survey. The survey was conducted as part of an applied research effort by the USGS Office of Groundwater Branch of Geophysics in 2007. USGS 2007

As this mode of fieldwork-at-a-distance expands in reach and popularity, it is also changing the experience of scientists who resolutely continue to transport their own bodies out into the field, whether to install and maintain sensor networks or to carry out observations. Even when they leave their laptops and smartphones at home, they carry the virtual field with them: it informs the questions they hope to answer, their selection of field sites, the paths that they take through those sites, and their understanding of the relationship between the data they are collecting and the data that they and others have collected at other sites. Waist-deep in mud, in the middle of the ceremony, caught in the storm, or leaning over the precipice, they encounter a field mediated by some combination of global telecommunications systems, satellite images, digital maps, GPS locators, and computational models of their field sites' pasts and futures. Science remains situated—as with embodiment, there is not really another option—but the texture and topology of its situation has changed. 11

11 Donna J. Haraway, "Situated Knowledges: The Science question in feminism and the privilege of partial perspective," Feminist Studies 14, no. 3 (1988): pp. 575–99; David N. Livingstone, Putting Science in Its Place: Geographies of scientific knowledge. Chicago, IL: University of Chicago Press, 2003.

Ontologies, not just epistemologies, are at stake in this rewiring of the world. New topologies are emerging that change not only what can be known and how, but also what is there to be known in the first place. Contrary to the railroad- and telegraph-fueled nineteenth-century fantasies of instantaneity, space and time have not been annihilated by speed, but they have been rerouted. 12 Sites that were once distant as measured across the spherical geometry of the globe are now virtually adjacent, while sites that are physically proximate and seemingly subject to the same forces—the same sun, the same traditions, the same markets—move to very different rhythms in relation to their webs of distant connection, whose topologies are also subject to change. Through a conservation approach known as dynamic ocean management, for example, fishing regulations are reworked in real-time to protect sea turtles and other migratory species, drawing virtual borders on the waters that shift with winds, currents, temperatures, seasons, and the movements of fish and fishing fleets. 13 From one side of the line to the other, in dialog with distant and discontinuous places, the rules are in flux.

12 Wolfgang Schivelbusch, The Railway Journey: The industrialization of time and space in the 19th century. Berkeley, CA: University of California Press, 1986; Richard White, Railroaded: The Transcontinentals and the making of Modern America. New York: W.W. Norton, 2011.

13 Alistair J. Hobday et al., "Dynamic ocean management: Integrating scientific and technological capacity with law, policy and management," Stanford Environmental Law Journal 33, no. 2 (2014): pp. 125–65.

For the scientist peering out from the prow of the ship, though, there is not much to see. As infrastructures of remote surveillance and control expand around the world, direct observation by the

emplaced body of the individual scientist increasingly confronts its own virtual horizon. Time, perhaps, to get back to the office, where the real fieldwork can begin.