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An anthropologist underwater:

Immersive soundscapes, submarine cyborgs, and transductive ethnography

A B S T R A C T
In this article, I deliver a first-person anthropological report on a dive to the seafloor in the Woods Hole Oceanographic Institution's three-person submersible, *Alvin*. I examine multiple meanings of *immersion*: as a descent into liquid, an absorption in activity, and the all-encompassing entry of an anthropologist into a cultural medium. Tuning in to the rhythms of what I call the "submarine cyborg"—"doing anthropology in sound," as advocated by Steven Feld and Donald Brenneis (2004)—I show how interior and exterior soundscapes create a sense of immersion, and I argue that a transductive ethnography can make explicit the technical structures and social practices of sounding, hearing, and listening that support this sense of sonic presence. [*anthropology of science, anthropology of sound, soundscapes, immersion, cyborgs*]

I am preparing to sink into the sea, probably the first anthropologist to join the research submersible *Alvin* on a dive to the ocean floor. The three-person sub sits like a massive, oblong washing machine on the stern of the research vessel *Atlantis,* where a thick rope temporarily tethers it to an enormous metal A-frame rising from the ship's fantail. Clambering down a steep ladder into the submarine, I find pilot Bruce Strickrott already adjusting *Alvin*'s array of knobs, buttons, and computer screens. Geologist John Delaney is next to descend; delivering a foul-mouthed oath, he wedges his tall frame into a nook on the port side of the sub. As we are lowered into the waters of the northeastern Pacific on this cloudy June day in 2004, wet-suited escort swimmers survey the exterior of our capsule to make sure we do not go down gurgling. They snorkel past our individual four-inch-thick acrylic view ports, each window just wide enough to fit the features of a face.

In what I initially imagine to be an idle pun, graduate students on *Atlantis* have joked that I will now truly "immerse" myself in the culture of deep-sea oceanographers, seeing their preferred medium with my own anthropological eyes. As we begin our hour-long descent, my attention is, indeed, captured by such traditional icons of the deep as the evanescent jellies that flash past my window. But I am also fascinated by the sounds that accompany and enable our descent. The snug seven-foot-diameter interior of our titanium sphere is awash in the metallic and muffled pings of distant sonar devices, the echoes of telephone voices from the *Atlantis,* and the quiet pop music that percolates from *Alvin*'s stereo sound system. These bleep-blooping, burbling, and babbling sounds do, in fact, contribute, I find, to a feeling of immersion. Submerging into the ocean almost seamlessly merges with a sense of submerging into sound—and into a distinctively watery soundscape.

The easy image comes to me of *Alvin* as a ball of culture submerged in the domain of nature. After all, submarine settings often take "to an extreme the displacement of the natural environment by a technological one" (Williams 1990:4). As the noted vent biologist Cindy Van Dover suggests, in a more

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sensational turn of phrase, "descending the water column in a submarine is an unnatural act" (1996:16). But natural and cultural dynamics develop dense interrelations as well, feeding back into one another in *Alvin*'s immersion. The assemblage of the sub and its encapsulated scientists is clearly a cyborg, a combination of the organic and technical kept in tune and on track through the self-correcting dynamics of visual, audio, and tactile feedback. Positioned in the sub, our bodies are threaded into a media ecology of communication and control, networked into a semiotic order that extends, modulates, and conditions our senses. As an anthropologist on *Alvin,* I am anxious about my role in this circuit. Recalling an iconoclastic one-liner delivered by Chris Kelty (2003), another ethnographer of the hypertechnological, I ask myself, "What would Margaret Mead do?" Delaney unsuspectingly offers a possible answer, scripting me into the informatic loop, wisecracking that my research will constitute a "recursive study of ourselves studying." Mead, as readers may recall, was not only fascinated by sex in Samoa and trance and dance in Bali but was also a fan of feedback systems. In an article entitled "Cybernetics of Cybernetics" (Mead 1968), she called for anthropologists to become familiar with the vocabulary of information theory, to take seriously the possibilities and effects of systems thinking and doing.[1]

In this article, I take up that charge, paying special attention to the role of sound in constituting the experience of cybernetic and cultural immersion. I follow Steven Feld's recent call for "doing anthropology in sound" (Feld and Brenneis 2004)—which, for the setting that concerns me here, entails attending to the "sounds of science" (Mody 2005), placing "sound studies" at the center of investigations of technoscientific practice (Pinch and Bijsterveld 2004).[2] In asking after the sounds that float in and out of submariners' consciousness, however, I am less interested in the self-referential looping of a "cybernetics of cybernetics" than I am concerned with the technical transformations of sound and signal that support cybernetic sensibility and consciousness in the first place. I am curious about the cognitive, affective, and social effects of transducing—that is, converting, transmuting—sound from the medium of water into that of air, and about what an anthropology of such transduced sensing can make explicit about the conditions that permit immersion (and, I maintain, that create senses of presence as such), whether people speak of immersing themselves in water, sound, or the medium of culture. The *Oxford English Dictionary (OED)* defines *transduce* as follows: "To alter the physical nature or medium of (a signal); to convert variations in (a medium) into corresponding variations in another medium."

Such alterations and conversions are about the simultaneous structuring of matter and meaning. I counterpose, then, to the recursive recipes of reflexive ethnography the possibilities of a transductive ethnography—an inquiry motivated not by the visual rhetoric of individual self-reflection and self-correcting perspectivalism, but one animated by an auditorily inspired attention to the modulating relations that produce insides and outsides, subjects and objects, sensation and sense data. Rather than seeing from a point of view, then, I suggest tuning in to surroundings and to circumstances that allow resonance, reverberation, echo—senses, in brief, of presence and distance, at scales ranging from individual to collective. Using my dive in *Alvin* as a narrative vehicle, I meditate less on what I saw in the teensy patch of ocean floor I visited (mostly passing apparitions of flesh and rock) and more on what we in the sub (and sometimes, by extension, we in the ship–sub system) heard and listened to.

In operating the concept of "transduction," I develop and refine for anthropological purposes an exposition offered by historian of sound Jonathan Sterne, who argues in *The Audible Past* (2003) that mechanisms of transduction, built into such technologies as the telephone and radio, have been read back into the very nature of hearing; transduction is now imagined as a universal infrastructure for a range of cultures of hearing (see, e.g., Arehart 2005). I suggest that hearing cultures (cf. Erlmann 2004)—or, better, listening to social and cultural practices—can be sharpened by sounding out concretions of this infrastructure, pressing us as ethnographers toward discernments of material and semiotic relationships often washed out of attention by the all-encompassing idiom of immersion.

In adapting transduction for the anthropology of sound, I hope to illustrate how novel ethnographic results might follow from attending to the ways soundscapes are fashioned and to how hearing and listening are conceived and experienced. At various points during my dive narrative, I flag other ethnographies of sound I think zero in on transductive dynamics—or that might benefit from doing so. I also identify a loose constellation of anthropological scholarship that explicitly works with the notion of transduction (to anticipate: Fischer 2007; Myers 2006; Silverstein 2003) and that in some instances takes transduction beyond the realm of the auditory to consider a range of other sensory relays and transformations of matter and meaning. Drawing on phenomenological and philosophical treatments of transduction as a process of constituting, structuring, and modifying spatial and logical relations (Deleuze and Guattari 1987; Mackenzie 2002; Simondon 1992), I conclude that such ethnographies of transduction press toward considering ethnography *as* transduction.

Soundscapes

The *Alvin* dive I have joined will employ a high-resolution imaging sonar system called "Imagenex" to map portions of the Mothra Hydrothermal Vent Field, a seabed region of black smokers on the Endeavour Segment, a narrow submarine volcano situated on the Juan de Fuca Ridge, the edge of a major tectonic plate that sits some 200 nautical

miles off the Pacific Northwest coast and about 2,000 meters down. I have talked my way into *Alvin* as part of ethnographic research into how oceanographers imagine and encounter such abyssal ecologies as hydrothermal vents (see Helmreich 2003). Chief scientist Deborah Kelley, of the School of Oceanography at the University of Washington in Seattle, learned through colleagues about my project on the anthropology of contemporary marine biology, and when a berth opened up on *Atlantis* for this National Science Foundation (NSF)–funded trip, she invited me along. My dive will be a standard eight-or-so hours long. I have been able to sign on largely because no groundbreaking research is slated for this routine excursion, Dive #4020—an indication of the safe and steady rhythm into which *Alvin* dives have settled since the Woods Hole Oceanographic Institution in Massachusetts began operating the sub in 1964.[3]

As we drop down to the ocean floor, amidst a wash of submarine sounds, some questions surface: How did the domain that Jacques Cousteau (with Dumas 1953) once named "the silent world" become so sonorous? How did the underwater realm, this zone to which humans cannot have extended, unmediated access (without drowning, that is), become imaginable and accessible as a space of sound? What kinds of technical work have been necessary to bring this field into audibility for human ears? And what have been the cultural effects—for people in submarines, for example—of such work? Learning the answers requires dipping into some submarine history, tuning into the technical specifics of underwater listening, considering cybernetic networks of communication and control, and querying the multiple modes through which people imagine immersion: as a descent into liquid, as an absorption of mind and body in some activity or interest (such as music), and—in a meaning of relevance to anthropologists—as the all-encompassing entry of a person into an unfamiliar cultural milieu.

Key to thinking through how the sensation of auditory immersion is produced is the concept of a "soundscape." Ecologically minded musician R. Murray Schafer advanced the term in 1977 to call attention to his worry that natural sonic environments were being polluted by industrial noise. Historian Emily Thompson, in a more formal register, defines the soundscape as "an auditory or aural landscape . . . simultaneously a physical environment and a way of perceiving that environment; it is both a world and a culture constructed to make sense of that world" (2002:1). A soundscape includes what Feld calls an "acoustemology," a "sonic way of knowing and being" (Feld and Brenneis 2004:462; see also Feld 1996).[4]

There are, of course, many genres of such knowing and being, "diverse meanings of the auditory" (Mody 2005:193), and, although it may seem to go without saying, three-dimensional space has been central to the conception—the acoustemology—of the soundscape (Schafer's composition of soundwalks, in which sonic landscapes are experienced via movement through space, makes spatiality explicit). In *Village Bells* (1998), a lush history of sound in 19th-century rural France, Alain Corbin argues that the ringing and reverberation of church bells served to define the auditory circumference of village communities, rooting people in local territories by placing them in a soundscape that symbolically reinforced their social proximity to town centers. In "Sounding the Makassar Strait," Charles Zerner describes how Mandar fishermen off the southwestern coast of Indonesia's island of Sulawesi employ spells and calls—"prayers, exhortations, and instrumental performances" (2003:62)—to summon flying fish into floating traps they fasten to their small outrigger sailboats. The soundscape that fishers create across this stretch of water—made of their whispered speech, shouted songs to spirit guardians, and Koranic recitations—responds to and demarcates local maritime territories. Thompson's *The Soundscape of Modernity* (2002) tells yet another tale of space and sound; in the early 20th century, she reports, the rise of electroacoustic devices redescribed sounds as signals, which allowed for the measurement and standardization of soundscapes. In that machine age, the spatialization of sound came ideally to be dictated not by the acoustics of places (like concert halls) but by techniques of sound reproduction, aimed at making diverse places—from public auditoriums to private homes—all sound the same.

Corbin, Zerner, and Thompson describe sounds organized and perceived through air. But what about sound underwater? Technologically constructed transductive apparatuses are essential for the submarine medium to be rendered into a soundscape for humans. I attempt below to map out the phenomenologies that result from attending to—as well as from forgetting—such transductions. In aid of that inquiry, I develop the figure of the submarine cyborg—the cyborg in a deep-sea soundscape—to make explicit the material transformations across media that have to unfold for the seemingly seamless transfer of information in cybernetic systems to be accomplished. I argue that a transductive ethnography provides tools for making audible the conditions that produce what many people have come to think of as the self-evident experience of watery and auditory immersion.

Let me return to my ethnographic setting, inside the sub, from which seat I will spin stories of sounding, soundscaping, listening, hearing, not listening, immersion, and transduction.

Sounding

We are well into our descent, some 400 meters down. Pilot Bruce switches off *Alvin*'s exterior lights to save power, leaving the outside ink black. The phone rings. Kelley on *Atlantis* has a question for John about a grant proposal. Her voice, soaked with echo like a track on a Jamaican dub recording, bounces around the sub as she and Delaney agree about an e-mail she will send.

We continue to sound—in the sense of diving into and also investigating, fathoming—the deep. Such sounding employs devices, like sonar (**so**und **na**vigation and **r**anging), that, in a confusing pun, capture and transmit sound (*sound* as fathoming has its etymological moorings in the Old English *sund,* "sea," whereas *sound* as vibration reaches back to Old English *swinn,* "melody"). With the interior lights dimmed, a cycle of blips and bleeps captures my attention. Bruce identifies these for me as a 9-kilohertz tracking pulse sent out from *Alvin* to *Atlantis* every three seconds, a 9.5-kilohertz response from the ship, and a steady metronome of "pings" from transponders dispatched to the seafloor by *Atlantis* in advance of *Alvin* dives. Transponders are spheres about the size of beach balls that, anchored and floating about 180 meters off the seafloor, transmit sonic signals that help the sub to continually locate itself in three dimensions using triangulation. Bruce tells me he thinks of transponder pings as background noise. But they are not exactly the meaningless patter that journalist Victoria Kaharl, who descended in *Alvin* in 1989, rendered in her dive narrative as occasional interruptions of "Wa WA wawa WAWA wowo wowo WOWO wawa WAWA" (1990:335–336) and "POP weewee wo WOP ka POP weewee wo" (1990:337). For Bruce, the noises secure a sense that the sub is somewhere rather than nowhere, supported in a web of sound rather than lost in a featureless void. Even though he jokes that the prattle of pings can be an "acoustic 'will-o'-the-wisp' "—"a thing that deludes or misleads by means of fugitive appearances" *(OED)*—for Bruce, these echoes are the warp and weft of a reassuring soundscape ("without them, it'd be too quiet," he offers). Far from being "noise" as "irrelevant or superfluous information" *(OED),* transponder pings constitute noise as the hum of a world, as what musician Aden Evens calls an "implicated reserve of sense" (2005:142).

In "The Sounds of Science: Listening to Laboratory Practice," Cyrus Mody writes that "labs are full of sounds and noises, wanted and unwanted, many of which are coordinated with the bodily work of moving through space, looking at specimens, and manipulating instruments" (2005:176). And so it is here in the oceanographic field, too; work in *Alvin* is coordinated by and through sound, even if we are not always fully tuned in to quite how. Indeed, our task this afternoon to map a tiny swath of the seafloor makes use of a system that translates sonic soundings (which we do not hear) into computer-generated topographic images. *Alvin* moves through and creates a multiplicity of soundscapes, at various frequencies and levels of accessibility to submariners' ears.

Transducing a submarine soundscape for humans

How have underwater soundscapes come into audibility for humans? Devices that permit listening across different media—from water over into air environments (like the inside of the sub)—are key. *Alvin,* maintained at one atmosphere of pressure in its interior (i.e., at everyday, sea-level pressure), can only deliver to passengers a sense of an exterior soundscape because of such transducers.[5] What might be less obvious is why the underwater realm is not a soundscape for people unless such prosthetic technologies are made available to our naked ears.

Consider a skin diver. The sensation of floating in a three-dimensional net of sound is not immediately available to people swimming submerged in water. This is in part because it is nearly impossible for humans to use underwater acoustic vibration to locate themselves in space. For one thing, sound waves travel four times faster in water than in air. For another, human eardrums are too similar in density to water to provide the resistance that can interrupt many underwater vibrations so that they might be translated into tympanic movement—sound—in the ears; lots of vibrations pass right through our bodies. For humans, underwater sound is largely registered by bones in the skull, which allow enough resistance—*impedance,* to use the technical term—for vibrational motion to be rendered into resonances in the body. Moreover, conduction of sound by bone directly to the inner ear confounds any difference in signals received by left and right ears, making it impossible to compose what audiophiles call a "stereo image." Unaided human ears perceive underwater sound as omniphonic: coming from all directions at once (and, indeed, because of sound's seemingly instantaneous arrival, often as emanating from within one's own body). In this (transductively phrased) framing, the underwater world is not immediately a soundscape for humans because it does not have the textured spatiality of a landscape; one might, rather, think of it as a zone of sonic immanence and intensity: a soundstate.

A couple of acoustemologies can be imagined that correspond to this phenomenology. One acoustemology might have the auditor feeling the immediate compressing power of an alien medium, perhaps experiencing a shock akin to that felt by 18th-century European cure seekers who traveled to the seashore to be suddenly immersed in cold water. Another acoustemology might posit a oneness, a sensory communion, with the medium, what Don Ihde in his "Auditory Imagination" calls a " 'dissolution' of self-presence" (2003:62). Such a sensibility might regard the immediacy of sound as a sign that one is "merging with the elemental forces"—a phrase Corbin (1988:164) uses to describe the sensation desired by those Romantic poets who sought through swimming to achieve sublime union with the sea.

Neither of these two acoustemologies opens out into the dimensional topography of a soundscape. It takes technical and cultural translation to carve a soundscape for humans out of the subaqueous milieu, to endow submarine space with sonic distance and depth, to create immersive space. Equipment must first be constructed that can capture submarine vibrations in the audio register—hydrophones, for example, like the ones manufactured by the International Transducer Corporation in Santa Barbara, California,

devices that can get hold of underwater vibrations, usually using a microphone fashioned of ceramic or another material sufficiently denser than water to allow propagating waves to be impeded (see International Transducer Corporation n.d.). Once sound has been received by a hydrophone, signals must then be transported into an airy medium for apprehension by human ears. Such sound can be rendered into stereo using devices that transform signals arriving at separate underwater receivers into "binaurally centered" impressions in headphones or from speakers, translating captured submarine sound into spatial relations dimensionally meaningful to hearing humans (Höhler 2003).[6]

With hydrophones and speakers, even such items as submerged bells might be assessed for their underwater reverberation: In 1901, the Submarine Signal Company of Boston sought robust methods for submarine communication, imagining "a network of underwater bells whose sonorous gongs would carry through the water at great distances" (Schlee 1973:246). The company, seeking an alternative to foghorns and responding to growing densities of ship traffic, built receivers to capture the resulting resonances for listeners onboard ships, although it must be said that the system envisioned never came into focus; plans to use bells to send Morse code were swamped by the turbulent, scattering character of the submarine medium.

Bringing underwater sound into human-occupied air pockets like *Alvin* requires and entails transduction. Indeed, the possibility of imagining oneself immersed in a submarine soundscape depends on transduction—as, indeed, in its own way, does the sense of feeling omniphonically at one with a soundstate summoned forth by a skull-enveloping fluid.[7] The ear itself, it is crucial to note, has for the last century or so been understood as a transducing device, translating vibrations in air into corresponding motions in the eardrum (Sterne 2003), a description that, as I have already suggested, folds an engineering formulation into scientific understandings of the sense of hearing as such.[8] If, as Thompson suggests, the soundscape of modernity is patterned by sounds "increasingly the result of technological mediation" (2002:2), underwater soundscapes do not exist at all for humans without such mediation all the way down—or, more exactly, all the way across (and, in the case of *Alvin*'s pinging sonarscape, without first becoming *sounded*scapes—which, because sonar sounding depends on knowing the speed of sound in water, demonstrates that subs use "sound to map time into space" [Evens 2005:54]).

From listening to hearing

And so, transponder signals must be transduced to create the echoing sounds carried to listeners cocooned inside the sub. Bruce's joke about the "will-o'-the-wisp" character of these sounds speaks to the sometimes misleading nature of the aqueous vibrational field. Turbulence and refracting motions of water can produce fluctuating amplitudes, "frequency-smearing" effects, and "blobs of reverberation" that make directionality difficult to discern, even once sounds are converted across media (Urick 1983). Water waves—which form and even crash underwater, where liquid layers of different temperatures meet—can also change the contours of vibration, introducing such complexities as Doppler effects, even for submarine auditors staying "still."

Closer listening cannot really help when these factors pile up on one another, as they sometimes do. But none of us in *Alvin,* not even the pilot, really needs to listen to the sounds of sonar closely. These days, onboard computers process transponder and other sonar signals. "No one now wears headphones and a rapt, faraway look, attentive in ambient hush. For all that modern oceanography relies so much on acoustic techniques, it is the machines which do the listening" (Hamilton-Paterson 1992:21). On *Alvin,* sound has been so transposed (often into visual data) for more than a quarter of a century.[9] In the early 1980s, when computers were first installed in *Alvin,* they were divided into three kinds, collectors, listeners, and nodes, which—in sequence—gathered, sorted, and displayed data and allowed a human interface (Stetten 1984). Listeners were not strictly or only dedicated to sound processing but were so named because of their general interpretative, sorting functions; they were programmed to make data presentable, worthy of attention. The word *listening* is crucial. Listening has been associated with active, often highly technical, efforts to interpret or discern auditory sensation, whereas hearing has been imagined as passive, a letting of sounds wash over the ear (Carter 2004; Sterne 2003).[10] *Listening,* by this definition, is work. If listening to sonar on *Alvin* has been delegated to machines, the result is that we passengers now hear in a much more diffuse, less disciplined way than people may have in earlier days. The "sonic habitus" (Feld and Brenneis 2004:468) animating submariners' sensibilities has been transformed.

To be sure, *Alvin* pilots must remain attentive to rhythms of the sub. Bruce, after all, is able to describe sonar sounds once his attention is directed to them. But I gather he focuses most of his technical listening on the sounds of the vehicle's engines and thrusters, over which he has more control. It was incumbent on earlier generations of submarine pilots to be attentive auditors of sonar, and it was through such close listening that the crackling of crustaceans, snapping of shrimp, and singing of whales were first disclosed, providing a portrait of soundscapes already in existence for underwater creatures with the means to hear them—soundscapes likely altered by such sounds as *Alvin*'s transponder pitter-patter, to say nothing of the racket created by large-scale sonar surveys (on the *Alvin* dive I joined, animal sounds were nearly absent; in another ecology—warmer, closer to shore—the soundscape may have been quite different, with more organic components).[11] Scientists no longer think the deep is a quiet, meditative space, a silent world; as Delaney

tells me, "The ocean is wired for sound" (*Alvin*'s depth rating, not incidentally, was originally guided by U.S. Navy specifications for a vehicle that could inspect seafloor arrays of sound-capturing, submarine-detecting hydrophones [Oreskes 2003]).[12] When it comes to the routine work of subs like *Alvin,* however, humans no longer need to listen closely to such sound.[13]

This is not to say that sound inside subs is no longer as present as it was back in the era of, say, WWII, when sonar headphones were standard equipment. But sound is now heard differently. At the risk of repeating myself, if it is made audible at all, sound is heard rather than listened to or for. One result of this shift is that sound from outside *Alvin* becomes a just-out-of-consciousness buoy for passengers' perception of floating presence. Because we do not need to work at the boundary between self and sound—that is, because we do not have to be actively aware of transducing—the boundary becomes imperceptible, inaudible; we become immersed, absorbed. Mody suggests that "the boundary between desirable sound and unwanted noise is very much a constructed, contingent, and historically variable one" (2005:177). So, too, with the boundary between sound listened to and heard, between meaningful sound and background hums. The building of this boundary into machinic and bodily techniques contours how people perceive their relation to spaces, places, and their own embodiment.

To amplify this point, let me offer an example from another anthropology of sound concerned with listening in the making of sense and sensibility, reception and presence. In "The Ethics of Listening: Cassette-Sermon Audition in Contemporary Egypt" (2001), Charles Hirschkind argues that listening to recorded Islamic sermons often helped the men in Cairo with whom he worked acquire modes of pious comportment. Audition is a practice through which "the perceptual capacities of the subject are honed and, thus, through which the world those capacities inhabit is brought into being, rendered perceptible" (Hirschkind 2001:624). This making of capacities can be construed as a transductive operation, a making, perhaps, of capacitances that permit a seamless flow between believers and religious messages—an interpretation made explicit in an Islamic digest Hirschkind quotes, which explains why some auditors of cassette sermons have difficulties being fully receptive: "The Quran is effective in itself," an article in the digest suggests, "just as the electrical current. If the Quran is present [to your ears], and you have lost its effect, then it is you yourself that you must blame. Maybe the conductive element is defective" (Hirschkind 2001:627). This writer is worried about transduction—a worry Hirschkind's interlocutors phrase in terms of the hearing–listening dyad: "The men I worked with often made a distinction between the verb commonly used for 'hearing,' *sam'*, and two other terms that suggest a more deliberate act: *anṣat,* meaning to incline one's ear toward or pay close attention, and *aṣghā,* to be silent in order to listen" (2001:633). A "moral physiology," argues Hirschkind, is "acquired through . . . listening exercises" (2001:628)—that is, through working at the boundaries that permit new worlds of experience to materialize, that smooth transductions to capacitate presence in an "ethical soundscape" (Hirschkind 2006).

. . . And back to listening (to music, e.g.)

It is not all hushed, ambient techno in the world of *Alvin.* There is a more familiar, interior, air-pocketed soundscape, too. As we continue our descent, a quiet classic rock soundtrack accompanies us from Bruce's MP3 player, plugged into the sub. Sociologist Chandra Mukerji, in her analysis of videotapes from *Alvin* dives, suggests that music functions as a social and psychological means for "normalizing the process of working in a small sphere on the dark seafloor" (1989:71). This contention in mind, it might come as no surprise that the North Americans who are the overwhelming majority of users of *Alvin* often compare it to a car. Playing music in automobiles, as Michael Bull writes in "Soundscapes of the Car" (2003), often serves to sever drivers from the outside world, creating a private, interior space.[14] Such a severing operates to some extent in *Alvin,* keeping our sense of identity bathed in familiar melodies that shield us against the alien world outside. This musical soundscape creates a sense of absorption in the interior space of the sub, but because it mingles with the transduced soundscape of the outside, the effect is to feel at once inside a bubble and porously immersed in a wider world.

According to Sterne, the dominant phenomenology of Western science and religion holds that "hearing is concerned with interiors, vision is concerned with surfaces . . . hearing tends toward subjectivity, vision tends toward objectivity . . . hearing is a sense that immerses us in the world, vision is a sense that removes us from it" (2003:15). The sounds of *Alvin*—echoing from outside, trickling from inside—reinforce the notion that we are in an interior space that is itself both sonically and wetly immersed. The various pings and pongs create an echoing sense of being in a landscape that extends beyond the confines of the sphere, perhaps one reason few people become claustrophobic in the tight space of *Alvin.* The music gently bouncing off the walls of the sphere reinforces this sense of immersion. Music, of course, has often itself been imagined as immersive. David Toop writes in *Ocean of Sound* that "the image of bathing in sound is a recurrent theme of the past hundred years: Debussy's *Images* and Ravel's *Jeux d'eau* ripple around the listener; Arnold Schoenberg's *The Changing Chord-Summer Morning By a Lake-Colours* wraps us in flickering submarine light; Gyorgy Ligeti's *Atmospheres* envelops us in steam" (1995:271).[15] *Alvin* divers may not favor such modernist compositions, but they do go for soundscapy music: Pink

Floyd's 1973 *Dark Side of the Moon* album is a perennial favorite on dives.[16]

When we arrive at the seafloor, Bruce turns on the sub's exterior lights, illuminating the rocky landscape around us. Spider crabs crawl lugubriously over brown boulders. The 300 atmospheres weighing on the sub outside are impossible to imagine from inside our tight titanium bubble. We scrabble around for words, metaphors, associations. The desert. National parks. Outer space.[17] My notepad scribbles are disappointing encounters with clichés about other planets, although the sheer fact of living through a sci-fi fantasy reminds me that "the boundary between science fiction and social reality is an optical illusion" (Haraway 1991a:149). None of this is coming together as a narrative, even if it looks like one on this page. After all, the erasure of the boundary between ethnographic science fiction and social reality is also an illusion, and perhaps a partly auditory one. My use of the ethnographic present tense in this article has its own potentially immersive effects for you, reader, reading aloud or to yourself, and my calling attention to this device here means to direct your awareness to how ethnographic experience is always transduced into ethnographic text. I use *transduced* instead of *translated* here in resonance with the work of Michael Silverstein, who, in his intervention into linguistic anthropology, "Translation, Transduction, Transformation," urges readers to imagine the work of rendering meaning from one milieu into another as akin to transduction:

> We should think seriously of the underlying metaphor of the energy transducer that I invoke, such as a hydroelectric generator. Here, one form of organized energy [e.g., the gravitationally aided downstream and downward linear rush of water against turbine blades] is asymmetrically converted into another kind of energy [electricity] at an energetic transduction site. . . . much of what goes into connecting an actual source-language expression to a target-language one is like such a transduction of energy. [2003:83–84, first set of brackets in original, second set of brackets mine]

For Silverstein, translations unfold within and across "configurations of cultural semiosis" (2003:91), and meaning is nearly always transduced—and sometimes radically transformed—in such transfers.[18] Just so with this text and its reception by various possible readers or auditors. And just so with the transduced sounds and signals in *Alvin*.

We approach a complex of hydrothermal vent chimneys called "Faulty Towers," after the British television sitcom, and John tells me, "What you're going to see is what you see on the poster in the *Atlantis* dining room." This reference to the composite photograph displayed in the mess hall of the ship gives me a template against which to judge my vision. I fiddle with one of the digital cameras provided in the sub. Delaney instructs me to look out the window, "Right now, if I were you, I'd be focusing exclusively on looking. Never mind the photography. I've got thousands of pictures. Just fill your eyes." Right. In this cyborg setting, we can play with the prosthetics that modulate and channel our sensing. We can also fiddle with the ratios between different senses. I take a picture at Faulty Towers despite Delaney's scold—of a fish whistling by a hydrothermal black smoker. It turns out blurry.

Yet another soundscape weaves through the sub, that of the fugitive speech of passengers. Not all speech is evanescent here, however, for each passenger is provided with a cassette player to make verbal notes about the trip. Delaney narrates some impressions into his tape recorder. I ask, "If you're doing all this tape recording, does that mean you spend a lot of time back on land listening to your own voice?" "Most scientists are very chatty with their machines, not each other," he replies. "Yeah, their auxiliary brains," adds Bruce. Or their externalized memories. After all, recording automatic speech allows for later listening, permitting *Alvin* divers to be "focusing exclusively on looking"; even so, the exteriorization of our inner voices contributes to the notion that sound is immediate, unmediated, ephemeral, a fleeting sign of reality itself. So, although James Clifford famously argued that, "once cultures are no longer prefigured visually—as objects, theaters, texts—it becomes possible to think of a cultural poetics that is an interplay of voices, of positioned utterances" (1986:12), this rhetorical gambit leaves open the work of comprehending how voices are imagined as signs of presence—and position—in the first place.[19] With *Alvin*'s tape players, the voice as a sign of presence is secured as a kind of back formation from the recording itself (cf. Kittler 1999).

And so, *Alvin* is a recording studio. Maybe this is not surprising. After all, a previous chief engineer for *Alvin* had substantial audio experience: "Jim Akens . . . joined the Alvin group in 1977 after a decade in the rock-and-roll business; he built state-of-the-art sound systems for Joan Baez, Jeff Beck, Sonny Rollins, Steely Dan, Joni Mitchell" (Kaharl 1990:273). By the 1970s, recording studios had become places that were standardized; they had become sites of signal routing, monitoring, and controlled feedback (Poynor 1986; Théberge 2004:770)—control and communications systems, like *Alvin*.

Submarine cyborgs

The sub, then, can be profitably thought of as a cyborg. *Cyborg* names an entity that exists through the ongoing maintenance of its equilibrium and boundaries (the android played by Arnold Schwarzenegger in the *Terminator* series and the robot-handed Luke Skywalker of the *Star Wars* saga represent some of the more famous Hollywood cyborgs. People with pacemakers or internal defibrillators are more everyday examples. But cyborgs need not be material compounds of

flesh and machine; anything that can be described in terms of information dynamics can be considered a cyborg). The boundaries of cyborgs are subject to shifting and expanding as they are networked to other feedback dynamics across scales and contexts (e.g., the coordination of submarines with surface ships, which describes a bigger cybernetic system than the sub alone). The frame of the cyborg can tune analytical attention to how flows of communication are articulated to maintain and modulate the integrity of self-regulating entities, at various scales.

Although the cyborg is an imaginative and material product of scientific and technological work, it began a career as a productive figure in social theory, when Donna Haraway, in "A Cyborg Manifesto" (1991a), directed her readers' eyes across the landscapes of simulation and information sciences—exploring, for example, how telepresence has substituted computer visualization for human vision and how genetic engineering has depended on seeing DNA as a code to be rewritten. Haraway found an unexpected, ironic, utopian promise in the figures of cyborgs initially created to automate warfare or de-skill workers; cybernetics opened up possibilities for recoding our human bodies and selves, for short-circuiting the idea that a durable "nature" dictated our destinies. Somewhere in cyborg bodies might whir a liberatory consciousness.[20]

Cyborgs have primarily been imagined in a visual, even textual, register—as made of inscribed surfaces, of information and codes; "writing," writes Haraway, "is pre-eminently the technology of cyborgs" (1991a:176). Cyborgs, she argues, have been organized by surfaces and boundaries, whereas the sheerly organic has been imagined as constituted by "depth, integrity" (1991a:161). Cybernetics has been a behaviorist science, insisting that the interior state of entities does not matter to accounts of their equilibration (Edwards 1996). So, for all the attention to signal and noise that has animated cybernetic thinking about fusions of flesh and information, such qualities have been rendered as readable quantities—as measurements legible as lists of numbers or patterns on graphs. *Alvin* as cyborg, however, draws attention to sonic dimensions of cyborg embodiment. As a submarine cyborg, *Alvin* can be used as a model for sounding the interiors of cybernetic entities, for calling into audibility the transductions that unfold at and create the boundaries of such entities.[21]

Directional sound is the key currency—the carrier of feedback signals—for submarine cyborgs. Submarines slid into cybernetic waters beginning in 1941, when oceanographers at Woods Hole published a report for the Navy entitled *Sound Transmission in Sea Water* (Iselin and Ewing 1941), which suggested ways military submarine pilots might fine-tune their deadly games of underwater hide and seek.[22] By this time, echo-ranging systems had been constructed that could transmit high frequencies, producing a "sharp beam of sound analogous to the cone of light from a searchlight, rather than a hazy glow of sound" (Schlee 1973:285). Directional sound made questions of feedback and equilibration central to submarine warfare (even though, for institutional reasons, these questions were organized more under the rubric of operations research than cybernetics [Fortun and Schweber 1993]). It also demanded new consideration of the properties of water.

The speed of sound in water varies with temperature, and temperature with depth, so that, most of the time, sound traveling obliquely through seawater does not move in a straight line but is bent like light through a prism. Submarine pilots confronting enemy vessels unequipped with local temperature profiles could fire on them with crippling accuracy and then, predicting how the beams of their adversaries' targeting echo-rangers would refract through the water column, take evasive action by hiding in sonic "shadow zones."[23] In the idiom of Norbert Wiener (1961), founder of cybernetics, they enacted a "Manichean" practice, using feedback oppositionally, to outsmart an enemy. The result was that pilots saw their adversary, as themselves, as constitutively oppositional, a vision that embedded in the cyborg bodies of submarines and submariners what historian Peter Galison (1994) calls an "ontology of the enemy." And it was a vision; Galison writes that "the cybernetic philosophy was premised on the opacity of the other" (1994:256). This opacity, this inscrutability, was preserved and reinforced in the practice of sound ranging, which was, after all, premised on bouncing signals off exteriors, not penetrating interiors.[24]

The interior of the sub is a space many imagine as the province of helpless humans, dependent on machines even as they control them. Van Dover, who became the first scientist to pilot *Alvin* (and the first woman, after a line of 48 men), expresses some of the cybernetic intimacy that pilots often develop with the submersible: "When the sub was on deck, I would work inside her and, with my eyes shut, reach out to touch a specific one of the hundreds of toggle switches to learn their locations by heart" (1996:24–25).[25] Passengers can only feel a fragment of this almost erotic connection. At one step of remove, passengers like Delaney and me, listed on the sub roster as "observers," make up what might be thought of as a cyborg manifest.

What might the figure of the submarine cyborg help one to understand about the exterior and interior sounds of *Alvin*—the incidental noises heard, the sounds no longer listened to, the resonances merely sensed as immersive surround? Science fiction author Samuel Delany, who entitled his analysis of Haraway's manifesto "Reading at Work" (1996), drew attention to the labor of interpretation. Transposing Delany into another key, I have meant so far to explore the meanings of *sounding, listening,* and *hearing* at work (and, with the sub's stereo, listening at play). In the sub's interior, our sense of immersion, of intimacy, of a feeling for the cyborg, is accentuated by our subliminal and subjective sense of the sounds that surround us, sounds we

are no longer encouraged to comprehend, let alone experience, as transduced. What Hillel Schwartz (2003) names "the indefensible ear"—that organ imagined as always vulnerable, always "on" (an account that, he points out, conflates hearing and listening)—has become a channel people think they cannot turn off and that opens into their innermost selves. But, as Sterne argues, modern audio technologies themselves have been bound up in reconstructing "acoustic space as a private, interior phenomenon belonging to a single individual" (2003:138). The sense of *Alvin* as a private, interior space—belonging, to be sure, to three closely squashed individuals—is accentuated and enabled by this acoustemology.

By directing an ethnographic ear to the sounds of submarine cyborgs, I mean to make explicit how the idea of immersion depends on the fashioning of sensing as itself imperceptible (the goal, in fact, of early cyborg theoreticians Manfred Clynes and Nathan Kline, who coined the term *cyborg,* defining it as an "organizational complex functioning as an integrated homeostatic system unconsciously" [1995:30–31]). Here, I second an argument advanced by Joseph Dumit, who suggests that "the very invisibility of our sensorium to us, its apparently silent, straightforward, and reliable functioning, is precisely what we need to be trained to doubt" (2006:188; and historicize; consult Crary 1990 on 19th-century fashionings of vision as a transparent tool of empiricism). We need, too, to examine how such functioning can be secreted within the very technologies with which cyborg circuits are formed.[26] As Sterne suggests, "If media do, indeed, extend our senses, they do so as crystallized versions and elaborations of people's prior practices—or techniques—of using their senses" (2003:92). It is the crystallization and forgetting of such practices that permits the identification, for example, of absorption in music with immersion; such crystallization allows Toop to conclude *Ocean of Sound* with this cybernetically inflected contention: "Music—fluid, quick, ethereal, outreaching, time-based, erotic and mathematical, immersive and intangible, rational and unconscious, ambient and solid—has anticipated the aether talk of the information ocean" (1995:280). The muting of the transductions behind such phenomenology permits submariners like John, Bruce, and me to feel immersed.

In asking that anthropologists and other analysts of social worlds attend to sounding, listening, and hearing at work, I mean to suggest that we begin to listen to or for that which we usually only hear. "If, as Bishop Berkeley notes, 'sounds are as close to us as our thoughts' then by listening we may be able to perceive the relationship between subject and object, inside and outside, and the public and private altogether differently" (Bull and Back 2003:5). Moreover, I am asking for a particular kind of listening, what Jim Drobnik calls "listening awry" (2004:11, drawing on Žižek 1991), bending our ears to sounds just out of usual consciousness. We might engage in what James Hamilton-Paterson, in his book *The Great Deep* (1992), calls "sensing the oblique"—a strategy he illustrates most vividly when he reports on snorkeling amidst coral reefs at night, not looking, as most people would do, but listening.

All of the above, I should note, assumes a clean functioning of audition; it might be productive to think about moments when hearing and listening break down, when the putatively transductive operation of hearing encounters crisis. For ears, this might come with tinnitus, vertigo, or earaches. In *Alvin,* it may come with a change in cabin pressure. Bruce tells me that the oxygen in the sub is lower in concentration than we might be used to. He says, "I like to keep the O_2 at 18%. If it's higher, it becomes a fire hazard and people get giddy. If it's lower, people come up tired." The conditions that permit transduction are material conditions that must be maintained.[27] Transductive ethnography might find useful conditions of attention in discomfort, from unwelcome ringings and buzzings in the ear.

"We are merging with our data"

Two thousand feet down in *Alvin,* at 10:00 a.m. Pacific Standard Time—15:00 GMT, I note, trying to imagine the chimes of London's Big Ben—Delaney and Strickrott begin mapping segments of the Mothra Hydrothermal Vent Field, building on charts made by University of Washington geologists. Bruce, having recovered from a disoriented instant while reading sonar, now murmurs, "I see, said the blind man." As if on cue, Ray Charles issues from Bruce's MP3 player. Our task is to run lines up and down and back and forth along a defined area of the vent field, an activity Bruce refers to as "mowing the grass." If our vertical arrival at the sea floor was saturated with the imagery of immersing ourselves in an alien medium, this horizontal motion takes us across a wilderness to be tamed.

In most narrations of *Alvin* dives, such movement is described as a kind of frontiering. As Van Dover puts it, "Deep-sea research . . . remains . . . a frontier science. The seafloor is the largest and least known wilderness on our planet" (1996:4). *New York Times* journalist William Broad—who also dived with Delaney—extends the U.S. character of such imagery, offering that the midocean ridges are "like seams on a baseball," the mid-Atlantic ridge is like the "Rocky Mountains," and the Juan de Fuca ridge is "akin to the gentle hills of the Appalachians" (1997:104). Before I embarked on my dive, one scientist on *Atlantis* prepared me: "It makes you feel insignificant, being down there. If they were all visible, above water, these places would be national parks." The national park—particularly in its west-of-the-Rockies guise—is a common image; Kaharl reports in *Water Baby* that the other observer on her dive said, "This looks like Bryce Canyon, incredible" (1990:340). Bruce's summary of our day's work as "mowing the grass" domesticates such similes, casting us as

doing the mundane work of keeping the space known and cultured, maintaining it as a sort of U.S. subdivision.

Then again, careful scrutiny of our coordinates reveals that we are, in fact, in Canada. Or, to be exact, Canadian waters.

In other words, we are not in a simply immersive space; rather, this is a zone in which our work is rigidly structured, even surveilled. Our submarine cyborg must move within circuits already configured by governance. As part of cruise planning, Kelley had to get clearance from the Canadian Navy and State Department to deploy *Alvin* in these seas, part of a marine protected area. The science party had to work within a circumscribed zone, a circle with a five-nautical-mile radius centered at 48˚00′ N and 129˚ 06′ W. A variety of legal and state transductions are necessary to submerge in this space.

As Delaney and I look at *Alvin*'s position displayed on one of the sub's computer screen maps, we pinpoint the position of the vehicle relative to mapped and unmapped portions of the seafloor. Several minutes into our mowing of the underwater lawn, Delaney delivers what, to me, is an astounding announcement as he watches the icon of *Alvin* move toward the already charted area of Mothra. Eyes fixed on the computer screen he intones, "We are merging with our data." This idea of becoming one with the data, of the map becoming the territory—of culture folding into nature in a cybernetic one-to-one mapping—speaks to the intimacy Delaney feels with this terrain. *Merge* derives from the Latin *mergere,* to dip or plunge, the same root for *immersion*.

A couple of days later, at a science meeting on *Atlantis,* Delaney enacts his sense of merging corporeally. As he reviews the topography of Mothra, he directs a postdoc—the person who painstakingly created the final graphic—to pan and tilt a three-dimensional computerized map, projected on a video screen. He moves his body like a conductor and even says, "Music please," embodying the orchestrating, directing relation of professor to postdoc so characteristic of the natural sciences. In this synaesthetic dance, his body fuses with the map; he merges with the data.

One can interpret this relay of motion and energy as a more general, less auditory, genre of transduction (but note Delaney's call for music!), one akin to that described by anthropologist of science Natasha Myers (2006) in her ethnographic exploration of how biologists who model proteins develop bodily intuitions about how molecules move, crafting a habitus that has their fingers, hands, and bodies responding to, miming, computer models of the protein structures they study. Myers writes that, "through their intra-actions with each other and with their models, protein modellers can be seen to transduce and so propagate the molecular affects and gestures they have cultivated in order to communicate their feeling for protein forms and mechanisms" (2006:23). Here, transduction reaches out of the auditory into the tactile, and sometimes toward the gestural, continuing all the while to refer to materiality.[28] "Transduction," Myers argues, "forces me to account for the specificity of the modelling media, and the kinds of bodies involved in these mimetic exchanges" (2006:24). These specifics matter, too, in Delaney's performance of merging with the data: The transductive media of water, of the Imagenex sonar system, and of the scientist's body itself are all called into play. Transduction also tunes me in to the many sorts of bodies—students, technicians, submarine pilots, computer scientists—that are all part of the transductive chain through which, for Delaney, the deep sea becomes the intimate, immersive, ocean. The presences produced through these transductions and immersions operate at scales beyond the individual, beyond the three passengers in the sub, to produce one version of the oceanographic field as such, a sense of oceanspace as a kind of virtual reality through which the appropriately cyborg subject might swim.

Immersion versus transduction

Mody asks of laboratory practice, "Do sounds merely surround knowledge making in labs, or are they also bound up in the knowledge that gets made?" (2005:185–186). A consideration of sound in ocean science can extend such curiosity to an examination of how knowledge is crafted not only in the lab but also in "the field." Indeed, sounding with sound has fundamentally enabled the very making of the undersea realm as a field. Historian Sabine Höhler documents the transition from sounding with piano wire to using sonar and writes in her "Floating Pieces, Deep Sea, Full Measure: Spatial Relations in Oceanography as a 'Field Science' " that

> oceanographic research could not rely on the direct observation of its object. It had to create its images of ocean depth by sinking instruments into the deep. . . . Depth became a matter of scientific definitions, of the right tools to see beyond the visible surface, of huge amounts of sounded data, and of their graphic representations. . . . The *opaque* ocean was transformed into a scientifically *sound* oceanic *volume*. [2001:2, and see Goodwin 1995 on "seeing in depth"]

A full history of the making of this oceanic volume—and of the soundscape of the sea—remains to be written (Höhler 2002 takes the story from 1850 to 1930). What I hope to have illustrated here is how submarine sound has these days sunken into the scientific background; heard, not listened to. How is this process "bound up in the knowledge that gets made"? When cybernetic practices—like echolocation—become fully automated, they can slide into an epistemic ground that spirits them into an unacknowledged common sense, into a cultural medium in which people are then "immersed."

This has epistemological and methodological resonance for anthropology as a field science. How are

transductions "bound up in the knowledge that gets made" in ethnography? In this extended conclusion, my answer takes me through a continued critique of immersion and to discussion of a few recent ethnographies that I think listen for transductive fashionings of subjects, objects, presence, and fields—in contexts ranging from human–animal relations to projects of imagining national and diasporic community. From these ethnographies of transduction I offer the experimental claim that one might consider ethnography itself as transduction.

It is cliché to say that anthropologists specialize in placing themselves in "the field" to immerse themselves in culture—whether in social worlds distinct from their everyday lives or in more finely inhabited versions of something they already thought was familiar (Kirsten Hastrup, e.g., invokes Mead to argue that "immersing oneself in local life is good . . . fieldwork implies that the well-established opposition between subject and object dissolves" [1990:46]). But what might anthropologists mean by this? What are the possibilities and limits of the image of immersion? How can we use the story I have told here to meditate on what this metaphor includes and excludes?

Immersion has been a signature demand of anthropological fieldwork. An articulation in the old-school language of the discipline comes from Alexander Goldenweiser, pronouncing in a review in *American Anthropologist* that

> a field student who is also an ethnologist must combine two rarely existing qualities: the ability to forget his own culture and immerse himself sympathetically *(Einfühlung)* into the primitive viewpoint, and the ability to forget not only his own but also his favorite tribe's standpoint, as local and subjective, in order to be prepared to view the subject at hand in a broader perspective and with critical objectivity. [1933:349]

Goldenweiser here describes immersion—something like participant-observation—as a matter of seeing and sympathizing (and, do not forget, of forgetting). Later anthropological formulations move into the register of sound, with language immersion the paradigmatic (and pedagogical) mode of such forms (this meaning entered English, according to the *OED,* in 1965 with Berlitz's "total immersion" language courses). Here, immersion in what bilingual educators Merrill Swain and Sharon Lapkin (1982) refer to as a "language bath" has a person surrounded by a sonic medium in which words ideally move from the diffusely listened to or for toward the automatically overheard (sloshing up any hard and fast distinction between hearing and listening). Language as culture becomes a medium analogized to water.[29] No wonder diving in *Alvin* felt like perfect anthropological fieldwork.[30]

What does immersion leave out? I submit that immersion is a poor tool for thinking about the structure of space, about the materiality of the media in which ethnographers as participant-observers–auditors move.[31] To borrow another term from Haraway (1991b), immersion is not necessarily situated knowledge. Oceanographers do not just merge with their data. Submarines do not just dive in unstructured space. And anthropologists do not just soak up culture. One way immersion functions as a rhetorical tool promising experiential "truth" is by eliding the question of the organization of space, of medium, of milieu—whether of an ecosystem or a social order—positing a fluid osmosis of environment by an emplaced participant-observer–auditor.[32] Immersion has come to suggest being submerged in a space as well as becoming one with it, dissolving into it. Immersion does not immediately open up questions of how boundaries are produced and crossed.

Transduction can be used as a device for recognizing the hidden conditions of immersion. The metaphor of transduction can tune one in to textures of disjuncture, to the corporeal character of transferring signals, particularly in cyborgian settings. If the information sciences have it that information is an abstract property that can be transferred across boundaries and substrates—the transcoding dream of the cyborg—the concept of "transduction" recalls the physical, material dimension of such transfers and summons up questions of resistance and distortion, complicating a rhetoric of flow with one of turbulence (see Sarai Editorial Collective 2006). Silverstein's (2003:83) example of the hydroelectric generator as the kind of transducer one might think of when translating between languages is perfect for my purposes, because it adds turbulence to conceptions of water as always a figure of immersion.

One ethnography that queries the construction of immersion and that I think is consonant with the transductive approach I advocate here is Joseph Masco's (2004) analysis of the "immersive theater" in which nuclear weapons scientists experience simulated explosions. Masco's study describes the structures that must be comprehended, inhabited, and swept out of attention to produce immediacy. Another is Natasha Schull's study of gamblers addicted to video gaming, which examines how genres of attention come into being, describing how "the zone, a state of absorption characterized by flow and continuity" (2005:78), emerges for gamers as a phenomenological world in which "human and machine seem to *merge*" (2005:76). Schull offers a mapping of the machinic translations that unfold for "immersion" rather than "perspective" (2005:79) to take hold. Those translations are transductions.

I hear transduction as one tool with which to answer Bill Maurer's call for a lateral, postreflexive anthropology, an anthropology that attends to the transformations that permit the very production of texts and contexts, that might "refigure the practices delineating the interior and exterior of inquiry—the observer and the observed, the sensorium and the sensed" (2005:5). A simply personal reflexivity too often "merely reinforces the perspective and voice of the

lone, introspective fieldworker" (Marcus 1998:193), whereas the sociological demand for "objectifying the objectivity that runs through the supposed site of subjectivity" (Bourdieu 1990:20) still holds steady inside and outside boundaries and "presumes a subsequent extraction of the researcher from the researched and a retreat to the study" (Maurer 2005:6). Reflexivity as the politics of location—a "reflexive awareness of the historical connections that already link [ethnography] to its subject matter" (Marcus 1998:197)—is more promising, although it risks assuming that such connections exist "already" and remain only to be discovered (Robertson 2002).

A transductive ethnography would hear things out or across. According to phenomenologist Gilbert Simondon, transduction "maps out the actual course that invention follows, which is neither inductive nor deductive but rather transductive, meaning that it corresponds to a discovery of the dimensions according to which a problematic can be defined" (1992:313).[33] Transductive ethnography would be a mode of attention that asks how definitions of subjects, objects, and field emerge in material relations that cannot be modeled in advance. Most modestly, I offer it as one idiom for thinking through anthropologies of sound. (There are other idioms. After all, although "transducers operate on a very simple set of physical principles, they are also cultural artifacts" [Sterne 2003:22].) More expansively, I suggest that a transductive ear can help to audit the boundaries, to listen for how subjects, objects, and presences—at various scales—are made. Let me offer further examples.

Laura Kunreuther's "Technologies of the Voice: FM Radio, Telephone, and the Nepali Diaspora in Kathmandu" explores how a diasporic community is "made 'present' " to urban Nepalis through "the hearing and voicing of telephone calls made between Nepalis in Kathmandu and those abroad that are broadcast on a popular Kantipur FM program" (2006:324). The "presence of a Nepali diaspora in Kathmandu" (Kunreuther 2006:325), then, is not so much mediated by phone and radio as it is produced through a series of transductions that are then shuttled out of attention. "FM radio," writes Kunreuther, "is perceived in contemporary Kathmandu as a medium of transparent, direct connection" (2006:327). But, as she points out, "FM radio is not simply a medium for broadcasting conversations with Nepalis abroad, but it produces, as one of its persuasive effects, the idea that 'urban Nepalis' and a 'Nepali diaspora' are entities that exist prior to their mediation through the telephone or the radio" (Kunreuther 2006:325). This is an imagined community created through transduction. Part of what Kunreuther's ethnography of sound—and, I would argue, of transduction—offers is a way of thinking about how publics and their presences are made (it also sidesteps worries about whether presences are finally real, phantom, or prosthetic, because all are produced in transduction).[34] As Michael M. J. Fischer puts it in a recent article in *Cultural Anthropology,* the juxtaposition of "different cultures" can make "accountable the network of transductions and changes that cultural assumptions and recognitions undergo as they scale or travel up and down, across, around, over, and through networks" (2007:42). Transduction offers ways of thinking about scales of presence.[35]

Joshua Barker's "Engineers and Political Dreams: Indonesia in the Satellite Age" (2005) offers promising material for an ethnography of transduction. In this piece, Barker examines the Indonesian satellite system, Palapa, inaugurated in 1976, and argues that engineers working on this system during the early years of the Suharto regime sought to imbue the project with nationalist meanings. They hoped the system, employed in television broadcasting, could make the nation present to itself. But "the view that territorial obstacles to nationalist unity could be overcome by electronic media" (Barker 2005:711) depended in part on making media transparent—on a dream in which, as Philip Kitley summarizes it, "the fragmented, far-flung archipelago is unified in a seamless electronic net that annihilates space and imposes its own time, drawing the vastness and diversity of Indonesia into a whole, structuring for the periphery a clear and constant fix on the centre" (Barker 2005:708). The nationalist discourse "portrayed the ether through which communication signals passed as the truest and purest medium for the new nation" (Barker 2005:711), but, as I understand it, a series of transductions had to be negotiated. These included the use of particular brands of transmitters and the density of ground stations, both of which had implications for the geographical reach of the system. The National Planning Board worried that in Kalimantan, on the island of Borneo, people would be "watching Malaysian television because the signals were coming in much more clearly" (Barker 2005:717).Barker asks how meaning is assigned to the system as engineers mediate between nationalist discourses and the system itself. But transduction might be a finer tool than mediation to make manifest the "consequences of the encounter between meaning and matter," as Webb Keane (2005:720) puts it in his critique of Barker. As Barker himself points out, "Signals from the satellite were not restricted to the space inside national borders" (2005:708). Transduction can tune ethnographers in to how the object of "Indonesia" is technically created—and not only or simply semiotically stabilized by engineers trying to control a discourse. Transduction can also permit us to ask how entities—and ethnographic "fields" (such as "Indonesia") are made present in our own ethnographies. Ethnography entails its own transductions.

Transductive approaches to comprehending the coalescence of presence—partial, full, or otherwise—need not always have auditory or technical articulations. In "How Dogs Dream: Amazonian Nature and the Politics of Transspecies Engagement" (2007), Eduardo Kohn outlines an ethnographic practice describing relations between humans and nonhumans, relations he says are fundamentally semiotic. He writes that "semiosis is always embodied in some way

or another, and it is always entangled, to a greater or lesser degree, with material processes" (Kohn 2007:5). It is just this material process to which transduction can attune ethnographers and ethnologists (and, perhaps, ethologists). Kohn gives an example of biosemiosis that is quintessentially transductive:

> The cilia of a single-celled paramecium function as an adaptation that facilitates the organism's movement through a liquid medium. Their specific organization, size, shape, flexibility, and capacity for movement capture certain features of the environment—namely the resistance afforded by the characteristics of the particular fluid medium in question. [2007:6]

Kohn argues that "selves" materialize as loci and products of such interpretative capture. Considering the paramecium a submarine cyborg, I would amplify the second part of Kohn's claim: Selves emerge at different boundaries depending on where meaning is made to materialize. A transductive frame allows one to understand a moment in Kohn's piece when dog dream interpretation creates the conditions by which "dogs and people come together as part of a single affective field that transcends their boundaries as species—an emergent and highly ephemeral self distributed over two bodies" (2007:17). Transductions create and enable immersions, singular and plural.

Rather than thinking immersively or reflexively, then, what about thinking transductively? In *Transductions: Bodies and Machines at Speed,* Adrian Mackenzie, building on Simondon, writes, "To think transductively is to mediate between different orders, to place heterogeneous realities in contact, and to become something different" (2002:18).[36] To think transductively is to attend to the earache, to imbalance, to all the embodied capacitances of the ethnographer—and to the work necessary to place oneself in particular networks, machinic and social. To think transductively is to pay attention to impedance and resistance in cyborg circuits, to the work that needs to be done so that signals can link machines and people together, at a range of scales, from the private to the public. To think transductively is to think from inside the infrastructure that supports the transmission of information across media. To think transductively is not only to listen to the changing qualities of signals as they propagate across media but also to inquire into the idea of the signal itself (which then leads back to the fluid metaphors that suffuse discussions of electricity, with its flows and currents).[37] Indeed, to think transductively demands inquiry into the very histories and languages that organize conceptions of sensing—and is, therefore, an endeavor in dialogue with the anthropology of sensing more generally (see Classen 1993; Desjarlais 2003; Stoller 1997; Sutton 2001). To think transductively is thereby also to consider ethnography itself as transduction—and the ethnographer as a kind of transducer.

It does not follow, though, that transduction should be taken as a universal frame through which to (re)think ethnography; rather, it is one tool among many possible. I do not mean to inflate transductive ethnography into a programmatic demand, a slogan. I argue for its necessary modesty; unlike the more sight-centered idiom of reflexivity, which scaled up its perspectivalism into a grand epistemological claim with methodological and theoretical implications (piggybacking, perhaps, on the notion of "theory," a term that, fittingly, derives from the ancient Greek for both "to look on" and "to contemplate"), transduction might be heard as a heuristic, most immediately appropriate, perhaps, for "doing anthropology in sound" (Feld and Brenneis 2004), for getting at acoustemologies formatted by the soundscape of modernity (Thompson 2002), and for mapping otologies not ontologies. How far transduction can be pushed beyond particular practices of hearing, listening, sounding, soundscaping, transmitting, touching, and gesturing remains to be known. One can well imagine other sensory addresses for ethnographic epistemology—in taste (e.g., Seremetakis 1994; Terrio 2000), smell (Latour 2004), or balance (Geurts 2003)—starting points that can generate a variety of organizing metaphors for anthropological accounts. What can emerge from such studies are not the simple "recursive studies of ourselves studying" that my copassenger in *Alvin* joked about but, rather, transductive, gustative, palpative ethnographies, tuned to the conditions that allow and produce anthropological senses of presence, distance, association, and dissociation at all.

Notes

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1. Also advocated by Gregory Bateson in the second edition of *Naven* (1958) and in *Steps to an Ecology of Mind* (1972).

2. Trevor Pinch and Karin Bijsterveld write that the field of sound studies is characterized by "a focus on the materiality of sound, its embeddedness not only in history, society, and culture, but also in

science and technology and its machines and ways of knowing and interacting" (2004:636).

3. The U.S. Navy owns *Alvin,* although most research conducted by the sub is civilian, with access granted through the Office of Naval Research and NSF.

4. Feld's phrasing avoids Thompson's cleaving of the world into physical and cultural components.

5. A different circumstance obtains in saturation diving, which acclimatizes divers to pressures greater than one atmosphere for prolonged periods and requires extended decompression. Saturation diving allows people to live in air-filled undersea facilities maintained at ambient (high) pressure. To prevent oxygen poisoning, helium is often added to the mix, causing divers' voices to rise, making them sound like the 1950s novelty act Alvin and the Chipmunks (whose castrati songs were the result of speeding up tape recordings). Access Historic Naval Ships Association (n.d.) to listen to a 1965 recording of Commander Scott Carpenter of Sealab II leading his crew of saturation divers in a helium-voiced version of "Goodnight Irene."

6. Sabine Höhler writes that "acoustic methods of depth measurement based on the binaural technique relied on making humans and their sense of hearing a crucial part of the sounding technology" (2003:134).

7. This brings up the question of whether the inside of the head can be considered a soundscape. The long history of inner voices would suggest this possibility. Friedrich Kittler, however, in *Gramophone, Film, Typewriter* (1999), argues that the specifically stereo spatialization of cranial interiors arrives only with headphones. Roy Wagner, urging a biosemiotic take on the question, plays with the idea that the human is "an introversion of the bat, with its 'cave' on the inside" (2001:xiv). For me, this "echo-subject" is constituted through transduction.

Another way to think about interior bodily soundscapes—and their commingling with exterior soundscapes—is through an oft-told story about composer John Cage's 1950s visit to an anechoic chamber, an acoustically insulated room that prevents sounds resonating within it. Left alone in this space, Cage reported hearing the sound of his own blood flowing and concluded that there was no such thing as silence. Douglas Kahn points out that, "although he had internalized acoustical space, he did not transform it to an 'inner space' of the mind" (2005:6)—at the same time that this melting of body boundaries required a transcendent, disembodied mind to take note of its own dissolution. Kahn argues that this Cagean epistemological armature "keeps the immersive edifice upright" (2005:7).

8. On the reading of transcriptional techniques into bodily ontologies, see Lenoir 1994. An early conference on sensation as transduction was held by the National Academy of Sciences in 1962. In the foreword to the pamphlet published in connection with that meeting, the reader learns that

> engineers are becoming increasingly intrigued by the fact that biological transducers exhibit fantastic sensitivities. One species of fish can recognize a change of electrical field of 3/1000ths of a microvolt per millimeter in water; the rattlesnake has an infrared sensing device that recognizes temperature changes of 1/1000th of a degree Centigrade at the surface of the sensing organ. The B-17 airplane, developed in 1940, had some 2,000 electronic parts, but the present B-58 has 97,000 electronic elements. Functionally this is beginning to simulate in complexity a living system. [Cannan et al. 1962:v]

In 1992, a meeting on "sensory transduction" was held at Woods Hole; consult Block 1992 and Shepherd and Corey 1992. See also Borsellino et al. 1990. On hearing as transduction, consult Geleoc and Holt 2003.

9. The transposition of sonic into visual data describes the historical trajectory of much oceanographic representation. Other sciences have lately seen moves to "sonify" rather than visualize data. NASA's sound representation of the Huygens probe's January 2005 entry into the atmosphere of Saturn's moon Titan results from bringing vibrations up in pitch (into the frequency range of human audition) and compressing them in time (see Johnson and Lecusay 2005). The "sonocytology" of University of California, Los Angeles, chemist Jim Gimzewski, meanwhile, brings vibrations of cells up in volume (amplitude) so that humans can hear them (see Roosth n.d.). One of Gimzewski's collaborators reports that the "frequency of the yeast cells the researchers tested has always been in the same high range, 'about a C-sharp to D above middle C in terms of music,' . . . Sprinkling alcohol on a yeast cell to kill it raises the pitch" (Wheeler 2004). Less mimetic versions of sonification are being considered for apprehending high-dimensional data (e.g., Hermann and Ritter 2004).

10. Hillel Schwartz notes that listening and hearing on occasion change places: "Listening itself might well be indiscriminate and automatic, as for example with telegraph and telephone operators, and hearing might well be specific and voluntary, as with hypnotic commands, only some of which would be 'heard' and acted upon" (2003:488).

11. For a thorough review of underwater acoustic ecology as it pertains to marine animals, see Stocker 2002–03. Research into vent sounds has begun, with the claim made that acoustic energy from these settings "may provide some local organisms with behavioral or navigational cues" (Crone et al. 2006:1).

12. Delaney reminds me of the SOFAR (SONAR Fixing and Ranging) channel, a layer of seawater in which the speed of sound reaches its underwater minimum. Low-frequency vibrations can travel long distances through this conduit (which sits about 800 to 1,000 meters deep at midlatitudes and higher toward the surface in temperate zones) before they dissipate. Marine scientists have been able to listen in on whale calls and other submarine sounds by placing hydrophones in this channel (consult Munk et al. 1995).

13. Sound remains important in marine bioacoustics research—although submarines like *Alvin* are too disruptive to be used as primary instruments in this enterprise. Sound is also key to ocean acoustic tomography, the study of ocean temperature using sound data, although human listeners are hardly necessary for this work.

14. And these days, for cars at least,

> designers of factory-installed stereos can know exactly what listening spaces and what speaker and listener positions they are dealing with, things they can't know when designing home systems. With this knowledge and a lot of detailed measurements, they can design systems that at least partially overcome that car's acoustical deficiencies. Systems can even be tailored to the sound-reflecting character of the car interior's materials—leather or cloth upholstery, for example. [Berger 2003]

This tailoring, pioneered by Massachusetts Institute of Technology professor Amar Bose for 1983 General Motors cars (Bose 1984), engineers soundscapes into cars from the get-go.

15. Some composers have attempted quite literally to fuse the immersively oceanic and the musical. Michel Redolfi (1989) has created pieces to be played underwater. His "Sonic Waters" was performed in the early 1980s just beneath and beyond the pier of the Scripps Institution for Oceanography in La Jolla, California. Listen also to David Dunn's 1992 "Chaos and the Emergent Mind of the Pond,"

a collage of underwater recordings of aquatic insects in ponds in North America and Africa.

16. Musical atmospheres recall the more literal one atmosphere of pressure that obtains inside the sub, a necessary condition of our immersion in senses both poetic and technical; *atmos,* from the Greek $\alpha\tau\mu o\sigma$ (vapor) and the earlier Sanskrit *atman* (breath or spirit), signals the life-sustaining function of the air we breathe, and *sphere,* of course, finds a material housing in the titanium orb within which *Alvin* divers breathe.

17. I leave aside in this piece metaphors that configure the deep as a primitive and hostile environment in which scientists quest for secret knowledge of a lost world—a formulation animating pronouncements such as the following, by Van Dover: "Raw and powerful, black smokers look like cautionary totems of an inhospitable planet" (1996:101).

18. Compare Karen Barad's discussion of the "ongoing transduction between feminist and queer studies and science studies" (2001:102) in her "Performing Culture/Performing Nature: Using the Piezoelectric Crystal of Ultrasound Technologies as a Transducer between Science Studies and Queer Theories." Barad employs the piezoelectric transducer, similarly to the way I use the metaphor of transduction, "as a tool to examine the question of the relationship between the material and the discursive more generally" (2001:99).

19. Insofar, too, as " 'culture' is always relational, an inscription of communicative processes that exist, historically, *between* subjects in relations of power" (Clifford 1986:15), more attention is needed to how this betweenness is made; transduction offers one tool.

20. Compare Haraway's ironic (re)vision of cybernetics with Bateson's irenic usage.

21. Note that scuba divers are not sonic submarine cyborgs, monitoring their equilibrium, rather, through visual checks of dive computer screens and surrounding space. Insofar as Scuba divers register sound, it is primarily the noise of their own Darth Vader–like breathing.

22. Maritime military history entwines with musical history, as James Hamilton-Paterson reports:

> In the early days of submarine warfare the help of people with musical knowledge and perfect pitch was sought in order to classify the sounds made by submerged craft. In World War I the composer and conductor Sir Hamilton Harty was called in by the British Admiralty's Board for Invention and Research to identify the most likely frequency bands of hull and propeller noises, "anticipating by a whole war a similar attempt in America, where the conductor André Kostelanetz was approached for much the same purpose. . . . " Ernest Rutherford also took a colleague with perfect pitch out in a small boat as part of the war effort. At a prearranged spot one of the great names in atomic physics took a firm grip of his companion's ankles while this man stuck his head into the Firth of Forth and listened to the engine note of a British submarine. Hauled back into the dinghy and toweling his head he announced it was a submersible in A-flat and he would recognize it anywhere. [1992:114–115, citation omitted]

Scientific research on sound transmission through water dates back at least to the early 18th century. In an issue of the Royal Society's *Philosophical Transactions,* Francis Hauksbee published an "Account of an Experiment Touching upon the Propagation of Sound through Water," in which he pronounced that a bell rung underwater sounded "much more mellow, sweet, and grave at least three notes deeper than it was before" (1708:372). See also Colladon 1973 on 1826 experiments at Lake Geneva.

23. The temperature profiles of many of the world's waters were public knowledge. Information about the area around Japan, obviously of keen interest to the United States during WWII, had been published by the Japanese Hydrographic Department years earlier (Schlee 1973).

24. Galison notes that "antisubmarine warfare was the formative problem for operations research . . . [whereas] antiaircraft fire control was the key to cybernetics" (1994:232), but this division had more to do with knowledge communities than epistemological differences. Fortun and Schweber argue that

> traditional operations research, for the most part, addressed problems where the objectives were precisely spelled out, and the existing systems and weapons (the "hardware") were considered fixed and unchangeable. OR was usually concerned with tactical problems and could be stated quantitatively and mathematically, and the aim of the analysis was "to find more efficient ways to operate, in situations where the meaning of 'more efficient is fairly clear.' " [1993:606–607, citation omitted]

Such an approach is not antithetical to questions of control and feedback, which, as Mindell 2002 shows, exceed (and, often, preexist) cybernetics as an articulated research area.

25. Although *Alvin* is cramped and cold, the feeling reported by most passengers is of safety, of floating in a bubble of security. Many joke that being in *Alvin* is like being in a womb, listening to the heartbeat of the motherly sea outside (an inverse womb, with water on the outside and air on the inside). In such framings, *Alvin* is described as a "she," partaking of a historical tradition in European languages of gendering ships female. Van Dover's mention of working "inside her" follows this lead but suggests something else too. Submerged, the submarine's femininity modulates into the maternal, into the ship that will take care of you.

If one wanted to listen with a Freudian ear to the scientists' and crew's jokes, the sounds of *Alvin* submerged could be interpreted in line with such maternal imagery. Toop writes that "submersion into deep and mysterious pools represents an intensely romantic desire for dispersion into nature, the unconscious, the womb, the chaotic stuff of which life is made" (1995:270). The sounds around *Alvin* become amniotic—the sea offering "a hydrologically filtered mother's voice promising the bliss of undifferentiation" (Kahn 1999:257). *Alvin,* like the maternal feminine for psychoanalysis, which sees "woman as omniscient mother, harboring amniotic oceans" becomes "the cause and means of representation of an immersion within a psychological state, a dreamy state accompanied by . . . droning, modulating, oscillating sounds" (Kahn 1999:256). Kahn points out that wombs are noisy places:

> There is clear evidence that external voices, music, and sounds are heard in the womb after a certain point of development and that the newborn can demonstrate a memory of these sounds. Moreover, all these voices and sounds would be heard on the constant backdrop of a full array of internal fluid sounds, although the constancy of the sound could not be equated with the sustained tones and drones, or mellifluousness associated with women and water. [1999:257]

On research into hearing in utero, consult the 2003 article by Smith et al. entitled "Intelligibility of Sentences Recorded from the Uterus of a Pregnant Ewe and from the Fetal Inner Ear."

Overflowing psychological interpretations aside, practices around gender have been wrapped up in the use of *Alvin*. In *Water Baby* (1990), Kaharl reports the sobering stories of women who found their presence in *Alvin* a source of worry for male sub mates, who wondered how to urinate discreetly into their Human

Element Range Extenders (less technically known as "pee bottles"; the acronym, HERE, speaks to the ideal of presence sought in these out-of-the-ordinary locales). Women worried, too; geologist Kathleen Crane wrote in her 1977 journal—just six years after the first woman dived in *Alvin*—"I feel that to fit into this submersible operation, I have to become completely sexless, so that nobody will notice that I am any different from the others" (2003:125). Women like Crane often found themselves trying to be female men—a drag performance that did not always get them into the sub. Kaharl quotes *Alvin* electrician Bill Page: "The male graduate students would suddenly have their turn in the sub on the third or fourth day out, but if they were female graduate students, they might not get a turn at all" (1990:194). The gender-neutral body was understood, as in early space travel, to be male. In its initial incarnation so was the cyborg, imagined as the ideal form for the astronaut integrated with the controls of his spaceship. David Mindell, commenting on the cybernetic image of the steersman, argues that, "From sea captains and riverboat pilots to aviators and computer operators, these figures stood for a masculine ideal of control over two worlds, the natural and the technological" (2002:2). In this imagery, particularly if the sea is imagined as feminine, *Alvin* can morph from being a maternal ship to being a sort of masculine partner to the virile steersman—not surprising, given that Alvin is a male name. This gendering was playfully offered by one of the *Atlantis* crew, Kevin Threadgold, Ordinary Seaman, who recited a verse he wrote about *Alvin* on our expedition's poetry night:

> *Alvin* is my favorite sub
> I'd like to take him to a pub
> We'd sit and drink our favorite beer
> and I'd say WHAT'S IT LIKE DOWN THERE?
> He'd smile and smoke a fat cigar
> and say I'M JUST A BIG WHITE CAR
> that drives around the ocean floor
> finds a rock and drives some more.

Threadgold's poem led to a jocular debate among scientists and crew about the gender of *Alvin,* with the chief mate defending the case for *Alvin* as a motherly female. When I exited the sub the previous day, she recalled to me, I had been drenched in cold water by graduate students. This was not only the traditional ritual greeting for first-time divers but also a baptism, an immersion, affirming her sense that *Alvin* was a mother whose womb birthed new scientists. Some of the shipboard joking about gender reflects shifting demographics among the crew, who now see more women in the ranks of oilers, able-bodied seamen, engineers, and third, second, and first mates. *Alvin* is an object on which people project changing ideas about the nature of scientists and machines at sea.

26. Without so doing one slides uncritically toward metaphors of immersion to describe such forms as virtual reality, as do psychologists Craig D. Murray and Judith Sixsmith (1999), when they align virtual reality experiences with psychiatrist John Lilly's experiments in flotation tanks.

27. In the sub, these conditions are calibrated to the demands of human breathing. For deep diving, remotely operated robots (like those deployed to search the wreck of *Titanic*), which also function through chains of transduced signals, such metabolic conditions are not necessary—which, some argue, makes them a superior choice for deep-sea exploration. Much turns on how sub and remotely-operated-vehicle advocates respectively value—and define—human presence in the deep sea.

28. It also makes clear that transduction need not always serve ableist audio analysis. In "Edison's Teeth: Touching Hearing," Steven Connor reports that Thomas Edison

> would champ on the wood of a gramophone in order to hear faint overtones that, as he claimed in a 1913 interview, were normally lost before they reached the inner ear: "The sound-waves thus came almost directly to my brain. They pass through only my inner ear. I have a wonderfully sensitive inner ear . . . [that] has been protected from the millions of noises that dim the hearing of ears that hear everything. . . . No one who has a normal ear can hear as well as I can." [2004:169]

(Consider, also, the fish's lateral line, a sense organ that apprehends vibration in general [on nonhuman sensing, consult Hughes 1999].) Other meanings of *transduction* move further away from hearing. In cell biology, signal transduction describes the conversion of extracellular signals into biochemical events and reactions inside a cell. In genetics, transduction is "the transfer of genetic material from one cell to another by a virus or virus-like particle" *(OED).* What all cases have in common is an attention to the materiality of meaningful action.

29. A conception of immersion as a kind of communion achieved through dissolution only became thinkable, I propose, after swimming in seawater became understood as sublimely healthy and appealing. Early (18th-century) therapeutic immersions in the sea—in, for example, seashore Britain—delivered not a reassuring sense of fluid connection ("as if, being seven tenths water, one's body were transparent" [Hamilton-Paterson 1992:110]), but a bracing and shocking thrill. Corbin's *The Lure of the Sea* documents the rise in the 18th century of European beliefs in the therapeutic and "beneficial effects of the shock caused to the nervous system by immersion" (1988:67). Such shock had earlier been harnessed, he suggests, within another genre of immersion: "By purifying man's animal spirit and compressing its excessively irregular fluctuations, baptism by immersion once prepared the soul to receive the divine mark" (Corbin 1988:64). In the wake of the Romantics, immersion moved into a meditative mode: "Diving provides an occasion to enjoy the feeling of being attuned to elemental forces and experiencing the conaesthetic harmony that exists between the movements of the sea and those of the original waters carried within the human body" (Corbin 1988:178). Hillel Schwartz (personal communication, March 28, 2006) points out that some physicians viewed the Water Cure with suspicion, believing that colds might be brought on by "water in the ear."

The use of *immersion* to speak of human participation in the world has a lineage that can be disentangled from its watery relation. This version of immersion began its career as something to be avoided. The *OED* records two 17th-century usages that have immersion as the opposite of spiritual attention:

> 1693 SOUTH *Twelve Serm.* (1698) III. 86 Holding the Soul of Man to be a Spiritual Immaterial substance [they accounted for its] failures and defects..from its Immersion into, and intimate conjunction with matter.
>
> 1647 H. MORE *Song of Soul* To Rdr. 7/1 Others, whom sensuall immersion or the deadnesse of Melancholy have more deeply seiz'd upon.

I take *immersion* these days to have lost that edge, to be a scaled down version of what Freud in 1930 called the "oceanic feeling," a sensation of egoless unity with a fluid surround. Even on those occasions when immersion is imagined to produce shock (e.g., sudden cold or culture shock), structural conditions are not thereby called into audibility.

30. Immersion is not only one ideal of ethnographic practice but often a desideratum of ethnographic writing as well. The "ethnographic present" often aims at producing a sense of immersive presence. Critics argue that this tense too often lifts the dynamics

under discussion out of history into a timeless flow, a critique that, as Hastrup 1990 shows, overstates the demands that come with tense. The ethnographic present can also preserve the experiential basis of ethnographic knowledge and the fashioning of ethnographic presence, the labor of which means to correspond to the ethnographic present.

31. Compare Nigel Thrift (2004) on "movement-space," in which he argues that senses of motion and space themselves (particularly in cybernetic contexts, sustained by a constant hum of background machinic calculation) are effects, not preexisting qualities or quantities.

32. On visual immersion in water, consult Hayward 2003.

33. This is a call to think about transduction as a logical operation, much like induction and deduction or, even, abduction—defined by Charles Sanders Peirce as "a method of forming a general prediction without any positive assurance that it will succeed either in the special case or usually, its justification being that it is the only possible hope of regulating our future conduct rationally" (Quoted in Helmreich 2007:230).

34. Transduction, thus, performs in an audio idiom work similar to that of Haraway's optics of diffraction, "the production of different patterns," which "might be a more useful metaphor for the needed work [of world making] than reflection" (1997:34). "Reflexivity," Haraway writes, "has been much recommended as a critical practice, but my suspicion is that reflexivity, like reflection, only displaces the same elsewhere, setting up the worries about copy and original and the search for the authentic and the really real" (1997:16).

35. Transduction is linked to scale in the anthropology of an earlier period. In "Ritual, Sanctity, and Cybernetics," cultural ecologist Roy Rappaport, describing how the periodic ritual slaughter of pigs by the Tsembaga Maring of New Guinea calibrates to larger-scale dynamics of ecological conflict between Maring-speaking groups, argues that the ritual cycle "operates as a transducer—a device which transmits energy or information from one subsystem into another—for it articulates the local system to the regional subsystem" (1971:61). Like my notion of transduction, Rappaport's speaks to questions of scale—although his version takes transduction to operate between already existing scales, rather than as a process bound up in the delineation and deliquescence of such scales in the first place. Thanks to Sophia Roosth for locating Rappaport's usage.

36. To think transductively is also to ask after the meanings of such words as *medium* and *milieu* (that French coinage that places organisms variously in preexisting circumstances or in worlds summoned forth by their very emplacements, although always "in the middle" [Canguilhem 2001]). "Transduction," write Gilles Deleuze and Félix Guattari, "is the manner in which one milieu serves as the basis for another, or conversely is established atop another milieu, dissipates in it or is constituted in it" (1987:313). Simondon, again:

> *Transduction* . . . denotes a process—be it physical, biological, mental or social—in which an activity gradually sets itself in motion, propagating within a given area, through a structuration of the different zones of the area over which it operates. Each region of the structure that is constituted in this way then serves to constitute the next one to such an extent that at the very time this structuration is effected there is a progressive modification taking place in tandem with it. [1992:313]

37. Human eardrums, for example, were not understood as transducing signals until the mid- to late 19th century, when "scientific understandings of sound . . . and medical approaches to the human ear" (Sterne 2003:35) rescripted scientific explanations of how hearing worked as a mechanical process.

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