Sounding Natural History

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ABSTRACT: Tracing instances, object specimens, potentials and practices wherein the fields of sound art, sound studies, science and natural history are either entangled or at stake, this paper attempts to navigate ways in which underwater sound is converted into what Stefan Helmreich terms a "scientifically, technologically, and epistemologically apprehensible zone." More broadly, the paper investigates how nonhuman sound production and reception extends the notion of hearing beyond audition and where (nominally) "mute" natural matter might transmute into "things that talk" through mechanisms of sounding or notions of ecological auscultation.

KEYWORDS: Multispecies ecology, underwater audition, ocean acidification, bioacoustics, sensory realities, prostheses, auscultation, unsound.

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To what extent are etymological, material and metaphorical entanglements between water, sound and hearing meaningful alongside evolutionary chronologies and actual physiological mechanisms in querying normally landed or "terracentric"[1] paradigms of sound and human voice propagation?

That mechanical wave transduction takes place within the *spiral*-shaped cochlea and watery endolymph of the inner ear, also known as the organ of Corti – named after Latin cochlea for "snail shell" and Greek *kokhlias* for "spiral," related to *konhkos* for "mussel, conch" – might imply that the very mechanisms of hearing itself, at least in their oto-logical or ear-based dimension, are materially entangled with the figure of the spiral and water. Evolutionary biologist Lynn Margulis advanced a theory of symbiogenesis in which the human senses evolved from a once freely swimming, spiral-shaped bacterium called "spirochete," rather than from mitochondria or chloroplasts. She posited that cilia, tiny hair cells at cells' edges, which enable the mechanosensory functioning of vision, smell, touch and hearing in humans, are the result of infolded and invaginated spirochetes: instantiations of *bio-chimerical* compounds.[2]

Moreover, in that the perception of "sound" results from operations of physiological transduction of vibrations into nerve impulses or "action potentials" – except in instances of hypersonic effect or auditory hallucination, where sound is perceived without auditory stimulus – it could be proposed that "sound," so-called, is a biological imaginary, always co-produced by a sensing agent. In *Elements of Physiology*, published between 1834–1840, Johannes Muller (a mentor to Hermann von Helmholtz and Ernst Haeckel, and who favored fish and marine invertebrata in his research) provoked that "without the organ of hearing with its vital endowments, there would be no such a thing as sound in the world, but merely vibrations."[3]

Muller's statement is not strictly true, for as anthropologists Michele Friedner and Stefan Helmreich convincingly argue, "far from being peripheral, sound also penetrates deaf worlds" through alternative modes of sensing, both analogue and bionic. Yet Muller's assertion retains validity in underwater realms where, for humans, conditions of habitation and communication are paradigmatically "other" to those on land and above water. Indeed, humans, unlike highly adapted marine species with still external cilia, are effectively "deaf-mute" in underwater contexts – where sound waves propagate four times faster than in air – for the reason that human eardrums are too akin in density to that of water, and where

1. Philip Steinberg, "Of Other Seas: Metaphors and Materialities in Maritime Regions," *Atlantic Studies* 10(2013): 159.
2. Stefan Helmreich, *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. (Princeton, NJ: Princeton University Press, 2016), 175.
3. Cited in Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction*. (Durham, NC: Duke University Press, 2003), 11.

vocalizing would require the skilled manipulation of air pressure shifts, bubble noise, and bone conduction.[4]

Prosthetic technologies of transduction must, therefore, serve as substitute ears (and eyes) as underwater realms are, according to Helmreich, "not immediately a soundscape for humans because it does not have the spatiality of a landscape; one might, rather, think of it as a zone of sonic immanence and intensity: a soundstate."[5] As such, these spaces must be transduced into a "scientifically, technologically, and epistemologically apprehensible zone,"[6] and always as what Philip Steinberg dubs a *more-than-human* assemblage.[7] But how can the various sounds and "inaudible sonorities"[8] of natural, nonhuman agents and forms of life be transduced into audibility as voiced biophony in order to become "apprehensible" to publics not underwater – such that natural agents might themselves articulate conditions of climatological change? Can *re*-sounding "natural histories" of hearing through attunement to aural nature create openings for an inaudible auditory culture, or a multispecies ecology of audition?

To attend, as humans, to the mechanisms of sound production and reception in marine species themselves, "from molecular perceptions to molar perceptions,"[9] and hearing always already as a threshold condition boundaried by heterogeneous points of entry and exit, motivates the enactment or *inhabitation* of a perspective – a *habitus* – that is, I argue, (generatively) *hard-of-hearing*. Drawing upon this perspective, this paper will attempt to frame artist Jana Winderen's sonic output in terms of the complex modularity of listening and attunement elicited through her practice of underwater sound recording over time, which gathers a variety of auditory knowledges around itself, as an operative, alternative metrics for "sounding" usually unsounded dimensions of paradigmatic environmental shifts – and for theorizing the "un" in unheard, unexplored, unsound and underwater. It may even generate legal potentials.

Throughout, I am particularly interested in the conjunction that Friedner and Helmreich assert between the disciplines of sound studies and deaf studies in their co-authored essay "Sound Studies Meets Deaf Studies" (*Senses & Society*, 2012). I propose a further connection to ocean studies, especially in relation to ongoing, accelerated changes to the undersea sonic environment caused by ocean acidification; shifts which might be read productively against a discourse of disability studies and "impairment" vis-à-vis a variety of detrimental effects on marine species' own auditory apparatuses and sensory systems.

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4. Stefan Helmreich, *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. (Princeton, NJ: Princeton University Press, 2016), 143–149.
5. Stefan Helmreich, *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. (Princeton, NJ: Princeton University Press, 2016), 143.
6. Ibid., 137.
7. Philip Steinberg, Of Other Seas: Metaphors and Materialities in Maritime Regions, *Atlantic Studies* 10(2013): 159.
8. Eleni Ikoniadou, *The Rhythmic Event: Art, Media, and the Sonic*, (Cambridge, MA: The MIT Press, 2014).
9. Gilles Deleuze, *The Fold: Leibniz and the Baroque*, trans. Tom Conley, (Minneapolis, MN: University of Minnesota Press, 1992).

Jana Winderen is a Norwegian artist whose practice and sonic output intertwines artistic, aesthetic and scientific engagement, and bridges multiple genres of water that encompass the oceanic, sea ice, coastal regions, rivers and lakes. For the ways in which her work proposes to experiment with technologies to sound, in the original definitional sense of to *measure* or to *fathom*, ecological health, through mechanisms of resonance production, her work would seem emblematic of Helmreich's notion of *sounding* as a method of inquiry across and beyond the contemporary sciences – and in that, per Helmreich, resonance both "*is* and *is not* sound."[10] Her protocols, methodologies, and above all, sensitized acumen for marine species recognition and compositional assemblage, coax her subject matter into speaking, so to speak, for itself, and ultimately, I propose, into *mattering* in an active, Latourian sense, transducing *ding* to *sache*.

Trained in mathematics, chemistry, biochemistry and fish ecology at the University of Oslo, intending at the time to become a marine biologist, she then studied Fine Art at Goldsmiths College, where she deliberately diverted her attention away from making objects towards experimenting with sound and compositional processes as "physical material."[11] As a naturalist collects specimens, so Winderen conducts "sound research" under, above and around the surface of water by "fishing for sound." To collect sonic data, she makes use of processes of "vertical recording" with three or four hydrophones per session, some reaching up to ninety meters in depth, as well as Petterson Ultrasound Detectors, in order to achieve sufficiently complex "surround" sound recordings, which she later "time-expands" when recomposing her material into output mediums, translating it into an audible frequency range for human auditors – from vibrational unsound to perceptible sound.

Central to Winderen's work is her interest in understanding the physiological bases of marine species' own auditory apparatuses, and their novel mechanisms of sound production and reception, concerned as she is by "human created sound underwater and the influences it has on the life there."[12] Her projects are sited in "threatened acoustic environments," often taking years to unfold in their true complexity. Interviews emphasize the epistemological value that she attaches to voyages and field trips; she repeatedly visits her geographies for the purposes of diagramming marine inhabitants, local communities and international scientists in relation to issues or conditions at stake. Winderen's long-term project *Silencing of the Reefs*, an ongoing collaboration with Thyssen-Bornemisza Art Contemporary (TBA21) and a consortium of institutions, including MIT and Woods Hole Oceanographic Institute, accrues hydrophonic recordings from more than twelve coral reef environments off Central America and throughout the Pacific. That sound is crucial to the vitality of underwater life forms, in

10. Stefan Helmreich, *Transducing*, in *Experience Book: Culture, Cognition, and the Common Sense*, eds. C. Jones, D. Mather, and R. Uchill, (Cambridge, MA: The MIT Press, 2016), 162–167.
11. Jana Winderen in an email to the author, February 7, 2016.
12. Jana Winderen in an email to the author, February 7, 2016.

general, finds concentrated expression in coral reefs, which are hubs of multispecies noise, and makes Winderen's sited "sound research" highly pertinent in the face of "mass coral bleaching" and impaired rates of calcification. Her recordings set out to document species' "sound signatures"[13] on a per-reef basis before such sources vanish, riffing on scientists' use of sound as a technology of identification of species and population movements in the field, as well as for monitoring crucial behavioral responses in laboratory contexts.

Interpreted alongside recent scientific studies and ecological reports, Winderen's work becomes, broadly speaking, evidentiary as aural testimony of the planetary-scale phenomenon of ocean acidification, manifest as a panoply of effects deleterious to marine life forms' sensory vitality. Recent scientific studies have shown that seawater with lower pH absorbs less low-frequency sound, a phenomenon which scientist Tatiana Ilyina describes as the "less anticipated consequence of ocean acidification."[14] One study used a global ocean model to predict that the chemical absorption of sound will almost halve in regions with high levels of industrial activity, such as the North Atlantic Ocean, over the course of the twenty-first century, and could fall by sixty percent in deep latitudes and high latitudes over the next three centuries. This, paired with anthropogenic ocean noise emission, exacerbates a condition that Christopher Clark, Director of the Bioacoustics Research Program at Cornell University's Lab of Ornithology, terms "acoustical bleaching," wherein marine species can no longer navigate via sound.[15]

The full spectrum of effects remains uncharted in spite of proliferating, if largely unaggregated, scientific studies and governmental research initiatives. A study in 2011 was the first to directly link CO2-enriched environments to altered auditory behavior in juvenile clownfish in response to daytime reef noise. Conversely, a study in 2013 used 3D microcomputed tomography to model and analyze the otolith (ear stone) size and density of larval cobia, raised in acidified conditions in-situ, and found that their hearing range, auditory and vestibular sensitivity increased due to denser otolith formation.[16] This study was the first to model otolith development while inside the heads of larval fish.

Another Winderen project, titled *Nature and Renaturation: A Sensory Overview of a History of Changing Watercourses,* deploys sonic data in different ways to interrogate processes of renaturation following multiple dam dismantlements around the River Orne in France's Basse-Normandie region in an effort to improve water quality, uniting social geographers

13. TBA21, Silencing of the Reefs, accessed April 10, 2016, https://www.tba21.org/#item--silencing_of_the_reefs--564.
14. Katherine Harmon, "Could Ocean Acidification Deafen Dolphins?" *Scientific American* (2009), accessed April 13, 2016, http://blogs.scientificamerican.com/observations/could-ocean-acidification-deafen-dolphins/.
15. Richard Schiffmann, "How Ocean Noise Pollution Wreaks Havoc on Marine Life," *Yale Environment 360* (2016), accessed March 21, 2016, http://e360.yale.edu/feature/how_ocean_noise_wreaks_havoc_on_marine_life/2978/.
16. S. Bignami, I.C. Enochs, D.P. Manzello, S. Sponaugle, and R.K. Cowen, "Ocean acidification alters the otoliths of a pantropical fish species with implications for sensory function, in *Proceedings of the National Academy of Sciences* 110(18)(2013): 7366–7370, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3645591/.

with scientists and artists. For her contribution, Winderen interprets nonhuman sound production as its key analytic component – and as an indicator of health. She subverts a technique from biology, wherein fresh water biologists count underwater insects to measure levels of pollution in a river. Underwater insects produce relatively loud sounds via acts of "stridulation," which denotes vibration emitted by bodily contortion and rubbing. Aware of this, Winderen pushes said technique further by hypothesizing that, if she can identify the sounds of insects likely to survive particular pollutants in contrast to those that are not, then she might listen to and extrapolate upon the "health of a river through hydrophones."[17] Her proposition suggests that processes of (de-)pollution might be *overheard* and, consequently, that the very "health" of an ecosystem might be monitored through attunement to transduced soundings of underwater insects. According to Winderen, she would be the first to correlate underwater insect sound production with the ecological health of a river.

I would like to advance the notion of *mediate auscultation*, developed in 1816 by René Laennec, who is acknowledged as the inventor of the stethoscope and its accompanying techniques, in relation to Winderen's hypothesis that technologically assisted, hydrophonic listening to underwater insect sound production can be used as a diagnostic mechanism to ascertain or overhear the health of an ecosystem. As Jonathan Sterne theorizes in *The Audible Past: A Cultural History of Sound Reproduction*, mediate auscultation acted to redefine "the meaning of listening itself" in modern medicine, beyond a simply physiological notion of hearing, into a "mediated, skilled, and technologized" practice and episteme for medical knowledge production.[18] Laennec's monaural or "single-eared" stethoscope was a descendant of the ear trumpet, extending its principle function to assist listening: "Even as it posited the possibility that doctors could become virtuoso listeners, mediate auscultation endowed its practitioners with a functional disability. The unaided ear was not enough… now doctors – whose hearing was ostensibly healthy – could augment their auditory abilities."[19] Sterne connects its design to a lineage of other sound reproductive inventions, such as Alexander Graham Bell's ear phonautograph and telephone, and Thomas Edison's phonograph, which "fetishized the cultural status and trappings of hearing loss"[20] and were admitted by their inventors to have been born out of their proximity to (and desire to cure) deafness. Laennec's *Treatise on Mediate Auscultation*, published in 1819, served as an epistemological guide for "audile technique," emphasizing the conjunction of two types of knowledges: a comprehensive cognitive knowledge of pathological anatomy and physiology, on the one

17. Jana Winderen in an email to the author, February 7, 2016.
18. Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Durham, NC: Duke University Press, 2003), 100.
19. Ibid., 106.
20. Ibid., 106.

hand, and a "socially organized... feel for the activity, a habitus," on the other, derived from the practice of sensory perception, thereby combining both the sensory and the empirical.[21]

Stethoscopic listening signaled a shift in the semiotics of clinical diagnosis, deemphasizing patient speech in favor of the doctor's maneuvering as a silently sensing agent – now that audile diagnosis, in creating an acoustic enclosure, had turned into a veritable form of "physiological hermeneutics." Laennec's *Treatise*, which attempted to codify sounds heard through the stethoscope, instructed that the linguistic content of the patient's speaking voice was no longer as important as the resonant, purely sonic content of various bodily parts in motion; of the internal passages of liquids and gases. In this scenario, "speaking patients with mute bodies gave way to speaking patients with sounding bodies."[22]

Later, the innovation of the *binaural* stethoscope, perfected by George Philip Cammann in 1852, enabled its listener to compare multiple soundings simultaneously, extending "the stethoscopic principle to include the possibility of a rudimentary echolocation." Physician George Carrick went further in evoking the binaural stethoscope as a prosthetic device, writing that "proximal sounds had become effects of relations at a distance." Interestingly in SONAR, too, hydrophonic signals from separate underwater receivers would be converted into stereo through the use of binaural headphones to permit a dimensionally perceptible portrait of ocean space for human auditors – generating "not so much a soundscape as a soundedscape.[23]

As early as 1680, a "microphone" initially connoted an "ear trumpet for the hard of hearing."[24] I hazard that the hydrophone, first fabricated in 1901, like the stethoscope and other sound reproductive technologies that substitute for the ear, is essentially an underwater microphone that is "hard-of-hearing," and thus, proffers an extended listening. An operator like Winderen, who experiments with scenarios of recording, compositional praxis and ecological auscultation, might offer a *hydrophonic habitus* for attuning to Steve Goodman's "sonic potentials" at the interstices of sound, vibration, and the "physiologically and cultural inaudible"[25] in nonhuman sound production and reception. For Winderen's attentiveness towards the actual mechanisms of nonhuman sound production and reception in the field, we might, as a potential public, better understand that the acuity of marine species' sensory perception, and especially hearing, is at stake due to the entanglements of anthropogenic noise emission and acidification; that hearing itself is problematized by undersea sonic conflict and chemical shifts; that species are, increasingly, dispossessed of senses and,

21. Ibid., 108.
22. Ibid., 117.
23. Stefan Helmreich, *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond* (Princeton, NJ: Princeton University Press, 2016), 141.
24. Etymonline. "Microphone", accessed November 14, 2016. http://www.etymonline.com/index.php?term=microphone.
25. Steve Goodman, *Sonic Warfare: Sound, Affect, and the Ecology of Fear* (Cambridge, MA: The MIT Press, 2010), xvii.

spatially, displaced by sound – an echo of Goodman's "(sub)politics of frequency," where sonic warfare takes place in the sensations and resonance of the texture of vibration."[26]

Can the auditory consequences of acidification be read as a form of distributed impairment that either disables or "differently enables" organisms depending upon adaptation? Can sound studies, deaf studies and ocean studies be "sounded" together to further dissociate terracentrism and phonocentrism? Are Winderen's techniques of audition a form of *hydro*phonographic anticipation, a versioning of Karl Marx's "subjunctive figure of the commodity who speaks," which Fred Moten frames as prescient "phonographic anticipation"?[27]

That she insists on "understanding" the environments, ecosystems and their (both human and nonhuman) inhabitants' stories in which she works, as part of her method for *sounding*, is interesting in relation to the point that "hearing," both historically and etymologically (in French), has doubled to connote "understanding" – the source of Jacques Derrida's notorious critique of phonocentrism in *In Grammatology*. Mladen Dolar writes: "The double sense of the French *entendre*, which means 'to hear' as well as 'to understand,' points to the direct link between the voice as the origin of conceptuality, between vocality and ideality."[28] Instead, Derrida calls to "think of a new situation for speech, of its subordination within a structure in which it will no longer be the archon."[29] Winderen's sonic output, for its emphasis on *overhearing* (a form of what Brandon LaBelle postulates as "sonic agency") rather than *speaking over*, might offer such a situation.

In his essay "Some Elements of a Sociology of Translation: Domestication of the Scallops and Fishermen of St Brieuc Bay," sociologist Michel Callon uses an initiative to repopulate scallops in Normandy to reflect on the technologies of "interessement" and representation between various actors – scientists, researchers, fishermen and scallops – in view of the irony that scallops, although the constituency in question, lack articulable agency:

> A few larvae are considered to be the official representatives of an anonymous mass of scallops which silently and elusively lurk on the ocean floor. The three researchers negotiate the interessement of the scallops through a handful of larvae which represent all the uncountable others that evade captivity.
>
> To speak for others is to first silence those in whose name we speak. It is certainly very difficult to silence human beings in a definitive manner but

26. Ibid., xix.
27. Fred Moten, *In the Break: The Aesthetics of the Black Radical Tradition* (Minneapolis, MN: University of Minnesota Press, 2003), 6.
28. Mladen Dolar, *A Voice and Nothing More* (Cambridge, MA: The MIT Press, 2006), 39.
29. Jacques Derrida, *Of Grammatology*, trans., Gayatri Chakravorty Spivak (Baltimore, MD: The Johns Hopkins University Press, 1997), 8.

> it is more difficult to speak in the name of entities that do not possess an articulate language.[30]

It would seem that Winderen is less concerned with her prolific amassment of sonic data in itself, mostly of sound produced by underwater inhabitants, inaudible to humans in raw form, than with its transduction in post-production into audibility for a variety of publics – in *resounding* unsound, and thus, in *making things public*, to borrow from Latour, such that publics form around matters-of-concern rather than matters-of-fact. If "to publish" originally meant to make public through speech,[31] then Winderen's output plays at publishing the "speech" of nominally "mute" nonhuman actors. Through technological mechanisms of transduction, "mute" natural matter *transmutes* into "things that talk" for themselves – possibly extending the notion of hearing beyond audition or audibility, into the realm of underwater unsound, along the way.

Figure 1. Emma McCormick-Goodhart, *Sounding in Sign: Helmreich/Sounding the Limits*, 2016, with Louise Stern. Courtesy of the artist.

30. Michel Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen at St Brieuc's Bay." In *Power, Action and Belief: A New Sociology of Knowledge?*, J. Law (London: Routledge, 1986), 196–223.

31. Brandon LaBelle, *Lexicon of the Mouth: Poetics and Politics of Voice and the Oral Imaginary* (London: Bloomsbury Academic, 2014), 46.

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