Coastal Futures Conservatory

Listening as a Model for Integrating Arts and Humanities into Environmental Change Research

WILLIS JENKINS
College of Arts and Sciences, University of Virginia, USA

Abstract This article develops an account of listening as a model for integrating inquiries into rapid environmental change from arts, sciences, and humanities. The account is structured around interpretation of the Coastal Futures Conservatory (CFC), an initiative for integrating arts and humanities into the Long-Term Ecological Research Project at the Virginia Coast Reserve. The CFC organizes collaborative inquiry and public engagement around several kinds of listening, from field recordings and designed listening stations as practices of attentiveness to scientific data by sonifying data sets, across disciplines by commissioning convergent lines of research from humanities and sciences, and across political boundaries by creating cross-coastal exchanges. Working from reflection on CFC practices, the author evaluates the potential and the limits of a pivot from ocular to aural metaphors of creating environmental knowledge as well as the potential and limits of listening as a model for integrating that knowledge. The author then questions integration as metaphor for multidisciplinary collaboration by testing its openness to listening beyond human worlds. The article closes by arguing for the role of contemplative practices in developing "transformative listening" as a way to connect environmental sciences with processes of moral and political formation.

Keywords coastal change, listening, integration, ethics, contemplation

Amid exhibits on the abandoned towns of Virginia's barrier islands, set between antique bird hunting decoys and nineteenth-century coast guard equipment, were eight MP3 players. On one the unexpected din of an oyster reef recorded by hydrophone: it crackles with snapping shrimp, gurgles with tiny eddies, choruses with fish calls.[1] On another, carbon and nitrogen signatures of restored seagrass transform into electronic sound.[2] On yet another eight years of daily tide gauge measurements are set to

1. The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/, (click "oyster reef").

2. By Matthew Burtner, The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/, (click "seagrass sonification").

Environmental Humanities 13:1 (May 2021)
DOI 10.1215/22011919-8867274

piano.[3] Amid the artifacts of coastal pasts, we wanted to invite people to listen for coastal futures. As museum visitors slipped on the headphones their bemusement would change to brow-knitted concentration, then to smiling wonder.

The Coastal Futures Conservatory (CFC) cultivates listening as a domain in which to develop roles for arts and humanities in studying coastal change. Working with the Virginia Coast Reserve (VCR), a Long-Term Ecological Research (LTER) site funded by the US National Science Foundation (NSF), the CFC aims to connect coastal sciences with arts and humanities in ways that deepen ecological understanding, stimulate cultural imagination, and invite ethical response.

The VCR extends about 68 miles up the Atlantic shore from the southern tip of the Delmarva Peninsula. It encompasses the most extensive set of intact barrier islands in the world, and thus affords unique opportunities to investigate how coastal island/lagoon systems respond to long-term environmental changes. The VCR has been an LTER site since 1987, with some data sets reaching back to 1940. The islands have been uninhabited since the 1930s, when residents retreated to the mainland after a series of hurricanes. Because the VCR has been protectively managed by the Nature Conservancy since 1970, has been a UNESCO Biosphere Reserve since 1979, and is bordered by a mostly rural mainland, the most significant anthropogenic drivers of change within the VCR are related to global climate change: sea-level rise, increased storminess, rise in water and air temperatures, and associated species redistributions.[4] Sea-level rise is especially significant, occurring within the VCR at three times the global average.[5] Researchers thus have advance opportunity to investigate thresholds at which various barrier systems cannot adapt to the rate of change and subsequently no longer protect their mainlands.[6] VCR scientists seek to create predictive models for ecosystem state change generalizable to other coasts, perhaps leading to early warning systems for thresholds of rapid shift.[7] In short, they investigate coastal futures.

What roles might arts and humanities play in that investigation? Funded by the University of Virginia as a transdisciplinary environmental humanities lab, the CFC develops experimental answers to that question. Codirected by Matthew Burtner, a music professor and ecoacoustic composer, and myself, a professor of ethics, the CFC organizes collaborative inquiry and public engagement around several broad forms of listening: to field recordings and designed listening stations, as practices for researchers

3. Luna-Mega, "Piano Étude No. 2: Tidal Flow."

4. Stanhope, Anderson, and Reay, "Base Flow Nutrient Discharges from Lower Delmarva Peninsula Watersheds of Virginia, USA."

5. Sallenger, Doran, and Howd, "Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America.

6. Kirwan and Megonigal, "Tidal Wetland Stability in the Face of Human Impacts and Sea-Level Rise."

7. McGlathery et al., "Nonlinear Dynamics and Alternative Stable States in Shallow Coastal Systems;" Walters et al., "Interactions between Barrier Islands and Backbarrier Marshes Affect Island System Response to Sea-Level Rise"; Zinnert et al., "Crossing Scales."

and educators; to scientific data, by sonifying VCR data sets and creating public performances in which audiences can interact with the music and the underlying research; across disciplines, by commissioning humanities-based research on coastal change and convening multidisciplinary lab sessions to exchange and design new research; and across political boundaries by exchanging research with Global South partner sites and by inviting indigenous participants to shape research practices and questions.

The structure of this article follows my own questioning of our experiment as a scholar of ethics: to what extent, and in what forms, can listening give rise to moral and political responsiveness to rapid coastal change? The first section explains the CFC and its practices within a constructive account of listening as a potential model for integrated inquiry. Readers may listen along in this section; asterisks (*) indicate that a related audio file may be found in the footnote. The second section critiques integration as a goal for transdisciplinary knowledge and argues for the importance of creating dissonance to open cultural space commensurate with transformational challenges. The third section, on "transformative listening," explains why connecting contemplative with scientific practices may generate moral and political responsiveness to the more-than-human coast.

Listening Ways of Inquiry

The CFC joins the global Humanities for the Environment (HfE) Observatories network while slightly reorienting its model. With observatories on five continents, the project was initiated in 2013 with a grant of the Consortium of Humanities Centers and Institutes to encourage the advancement of humanistic tools of inquiry to investigate global anthropogenic environmental change. The observatory metaphor, writes cofounder Joni Adamson, "was chosen to quicken the imagination of humanists being called upon to think outside the limitations of traditional humanities research protocols . . . and to engage in more collaborative . . . research across all the disciplines required to understand both social and natural systems."[8] Retaining that located, collaborative, and transdisciplinary focus on anthropogenic environmental change, our variation pivots from an ocular to aural model of knowing and collaborating—from observatory to conservatory.

The composer David Dunn proposes that attending to sound is a critical practice for restoring ecological intimacy in visually oriented cultures. "When we look at the world our sense of vision emphasizes the distinct boundaries between phenomena," writes Dunn; "in contrast, the sounds that things make are often not as distinct, and the experience of listening is often one of perceiving the inseparability of phenomena."[9] Dunn claims too much for that distinction, as I will explain, but the contrast provokes scrutiny of basic premises in usual models for assembling environmental knowledge.

8. Adamson, "Integrating Knowledge, Forging New Constellations of Practice in the Environmental Humanities," 8. See Humanities for the Environment, hfe-observatories.org/.

9. Dunn, "Nature, Sound Art, and the Sacred," 97.

At least it did for me when Burtner pointed out the visualist assumption in my proposal that we work with the HfE observatory model; he directed me to Dunn's proposal for a music-based approach to refashioning relations with nonhuman life. Eventually we developed our lab on a conservatory model to foreground listening and to take advantage of the way that music can draw people into aesthetic engagement with other forms of environmental knowing.

This section interprets the work of the CFC by situating it within a broader intellectual turn to listening. While the first public for the CFC is the academy, where listening serves as model of integrative collaborations, our collaborations often aim to engage other publics. Conservatory scientists, musicians, and humanists work together to create museum exhibitions, public concerts, and interactive web portals. I describe CFC practices, participants, and publics by interpreting them around four forms of listening: as (1) embodied arts of attentiveness; (2) as epistemic metaphor of environmental knowing; (3) as interface with acoustic data, sonified data, and ecoacoustic composition; and (4) as a mode of political relation.

Arts of Attentiveness

Collaboration among the CFC's academic researchers begins with field listening exercises. While acoustic methods have become increasingly important to the study of ecological change, these initial listening exercises are preliminary to data collection, and for scientists and humanists alike.[10] They focus attention, orienting researchers' embodied attention to their immediate context. Prior to formal research, the exercises ask researchers to attend to the world aside from investigative interest and to acknowledge their own enfleshment within it. We opened the crucial first meeting of our lab by having each researcher spend thirty minutes on their own with a sound recorder and headphones, listening at a site of their choosing (for example, *to a dune sounded by wind).[11] While researchers had different levels and kinds of knowledge about their site—especially between scientists who had long worked there and humanists visiting for the first time—the reorienting experience of attentive listening seemed to open intellectual space for listening across disciplines and for reorienting attention to the living shore.

Scholars from the emerging field of multispecies studies have argued for "cultivating arts of attentiveness" as a first step of environmental knowledge. Calling for scholarship that can carry inquiry beyond observational noticing "into the cultivation of skills for both paying attention to others and meaningfully responding," their hypothesis is that better, integrated forms of knowing the living world are more likely to arise from immersion in its liveliness. Understanding follows attention, they hold; it depends on

10. Krause, *Wild Soundscapes*; Pijanowski et al., "Soundscape Ecology"; Servick "Eavesdropping on Ecosystems."

11. The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/ (click on "singing dune").

hearing voices of other creatures, knowing their cares, and rediscovering ourselves immersed in their relations. That may require, they note, "innovating novel practices of listening."[12]

At that first meeting, Karen McGlathery, lead scientist for the VCR LTER, gave expression to the pathways of understanding opened by listening. Surprised by the way the exercise had led her to perceive differently an environment she had studied for decades, McGlathery declared that every VCR researcher should undertake it at least once. When asked to explain why, she said that the attentiveness exercise expanded her observational perception and renewed curiosity in a way essential for a researcher. She then went on to say that listening to other organisms and processes gave rise to a kind of empathy that might open new possibilities of inquiry. McGlathery's interest in empathy is consistent with other LTER lead scientists, who collectively rank "building empathetic relations with the natural world" as a high priority for their public mission.[13] Defined as "a vivid, knowledge-based imagination of another's circumstance, situation, or perspective," empathy for LTER lead scientists seems to be mainly a cognitive virtue, linking open-ended attentiveness to investigative acuity.[14]

Yet already we are also involved in ethics. "Listening engenders something like a quickening," writes the theorist Lizbeth Lipari, "the startling presence of another being." While they are unguided exercises in attentiveness, the listening practices establish something of ethical significance: the liveliness of the world we would investigate. "As an enactment of ethics, listening, like quickening, brings a recognition of an unknown other to whom we are bound and about whom we feel care and concern."[15] Lipari has in mind human speech but her account fits with listening to other organisms, to webs of life, and to landscapes. Listening to the coast engenders a quickening; a living shore comes to startling presence in our attention, and in it we discover ourselves immersed in relations we do not fully understand yet to which we are bound, and for which we thereby feel some care and concern. By beginning from attentiveness, the CFC centers subsequent investigation in acknowledgement of responsibility. Listening is both a condition for ethics, in that responding to something requires first having attended to it, and an enacted ethos in itself.

Designed listening stations focus attention in particular and perception-expanding ways. Dropping a tiny microphone into the burrow of fiddler crab, for example, *one can hear how the crab's niche making sounds the wind, like a flute.[16] Here an ecoacoustic

12. van Dooren, Kirksey, and Münster, "Multispecies Studies," 6, 16. See also Rose and van Dooren "Encountering a More-Than-Human World."

13. Goralnik et al., "Arts and Humanities Inquiry in the Long-Term Ecological Research Network," 362.

14. That is the definition used in the survey instrument in Goralnik et al., "Arts and Humanities Inquiry," 364.

15. Lipari, *Listening, Thinking, Being*, 176.

16. The Conservatory, Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/ (click "crab flute").

researcher selects and curates a soundscape, usually connected with dynamics of ecological change. For example, in the *oyster reef listening station, Burtner channeled a microphone atop the reef with another inside an oyster shell on the beach.[17] The technology let him create a certain angle of meditation, connecting the sonic vibrancy of a multispecies oyster community with wind hissing through the carapace of a long-dead individual, thus drawing attention to the innumerable generations of reef life that compose the shell beach on which listeners stood. The equipment used may be more or less complex, with creative reflection assisted by a range of microphones with different capacities. However, the point of the listening station is intentional curation of attention, which can be done simply by cupping a hand to one's ear in a particular direction.

Listening stations can be designed to expand empathic attention to another scale, to patterns of coastal change. For example, another station channeled together the sound of waves lapping against a mudflat with the rustling marsh grasses that hold land in place, thus inviting listeners to attend to a square-meter microcosm of sea-level rise. Creating ways to listen to climate change or sea-level rise may be one way to attune responsibility toward pervasive patterns of change. Listening stations are especially powerful, observes Stefan Helmreich, when ordinary acoustic monitoring captures what seem to be "prophetic noises," like the sound of glaciers "sizzling" as they melt into warm waters.[18] In those cases, routine acoustic monitoring used to collect data can be turned into a listening station simply by publicizing access and inviting hearers to attend to it in a different register.

While we first introduced them as a field exercise to encourage creative collaboration among our faculty researchers, the listening practices have themselves found a broader public. As word of our listening exercises spread, people from inside and outside the academy asked to hear the recordings. In addition to posting recordings from them on our open-access portal, the CFC helps introduce the practice to others. The teacher trainings in watershed education conducted by the VCR now include a segment on incorporating listening exercises into field trips. With an inexpensive microphone and headphones, a sensory threshold may be crossed and attention focused in a way that can alter perception and stimulate curiosity.

Metaphor of Environmental Knowing

Developing attentiveness through embodied listening can reorient epistemic models. One of Ralph Waldo Emerson's most remembered lines depicts a visual model of environmental knowing: "I become a transparent eye-ball; I am nothing; I see all."[19]

17. The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/ (click "oyster reef"). Similar descriptions of this listening station and the next appear in Jenkins, "Listening for Coastal Futures."

18. Helmreich, *Sounding the Limits of Life*, xxii.

19. Emerson, "Nature," 6.

Emerson's all-seeing ocularity suggests a disenfleshed beholding, as if immaterial reception of a comprehensive vision of nature. His image seems to culminate the dominance of visual metaphors in a long North Atlantic tradition of epistemology. Moderns know by seeing; the people of "nature and culture" argue over worldviews and intellectual visions.[20]

The CFC departs from that ocular tradition by foregrounding the enfleshed ear—perhaps following the path already opened by Henry David Thoreau. "If we think of Emerson as a transparent eyeball, we might think of Thoreau as a vibrating body." So argues Jeff Titon in an essay holding that Thoreau was intensely attentive to his soundscape, in part because he understood that sound waves embed hearers in relation to other living beings in a way that the visual perception does not. "Sounds vibrate living beings into a way of knowing that proceeds by interconnection, a community of relations."[21] The ecological ethos of Thoreau, Titon suggests, was grounded in a mode of knowing that emerged from listening. Again, listening seems to set auditors into a certain kind of ethical relation—enfleshed, immersed, vibrated into responsiveness.

The CFC's *assisted-listening* exercises focus attention on the sensory affordances of human embodiment by expanding our capacity to hear. If technology often insulates people from their environments, in this case the microphone's augmented aurality forces reflection on my embodied enmeshment in the marsh ecology. Amplified into headphones through a handheld sound recorder, each careful step through the salt marsh becomes a shell-crushing, water-splashing event. Even when attempting to hold still, I hear the sound of my breathing and the wind whistling through folds of clothing. Not at all "transparent" in Emerson's sense, I know myself as enfleshed within the marsh, and setting vibrations across it.

"The intrusion of sound reveals something about our previous way of thinking," writes Don Ihde in his phenomenology of listening, "a thinking that was a viewing, a worldview." Ihde traces visual metaphors of knowing to ancient Greece but argues that reductionist epistemological visualism was not realized until René Descartes, the optical specialist who saw new realms of nature through microscopes and telescopes. "The picture of the world that began to unfold through the new instrumentation was essentially a silent world."[22] Moderns still live in an epistemic world dominated by visualism. Environmental change research knows that it must visualize its data and represent it on eye-pleasing websites. Turning to the auditory, thinks Ihde, decenters that dominant tradition. Focused listening exercises, including those aided by instruments that allow us to hear what was previously silent to our perception, can produce "increased vulnerability in an increased openness to the environment's total presence."[23] Listening thus

20. Ihde, *Listening and Voice*, 4–6; Lipari, *Listening, Thinking, Being*, 140–42.
21. Titon, "Thoreau's Ear," 145.
22. Ihde, *Listening and Voice*, 6.
23. Ihde, *Listening and Voice*, 222.

may lead toward a different, more intimate sense of environmental relations. Lipari calls that listening way of knowing one's relations *akroatic knowing*.[24]

All forms of knowing are of course shaped by organismal constraints and affordances, but one reason why the humanities have struggled to find their role in environmental knowledge may lie in their contentment to think from a relatively limited range of sensory experience. In *The Origins of Creativity*, Edward O. Wilson argues that the scope of humanistic inquiry has been narrowly anthropocentric because the limited sensory capacity of humans to perceive the living world sets conditions for the stories and ideas that orient cultural life. In a certain variation on what multispecies scholars are saying, Wilson argues that insensitivity to anthropogenic diminishment of Earth's life is a consequence of humanity's sensory limitation. Responsibility for the future of nonhuman life, Wilson therefore argues, needs the humanities to "escape the bubble in which the unaided human sensory world remains unnecessarily trapped."[25]

A hydrophone allows humans to hear the life of an oyster reef, which may otherwise seem to lie inertly as the tide slides over it. Technologically augmented aurality expands capacities of sensory experience so that one can sense its active liveliness. Hearing does not convey what it is like to be an oyster or a reef, of course, but it does let participants attend to reef life in a different way. The simple surprise of hearing forms of life that we do not ordinarily experience in sound may induce participants to attend to them anew or to imagine their participation in broader relations. Electronic assistance is not simply about expanding the ear's catchment of soundwaves; it is not even necessarily about hearing. By experiencing environments in an unusual perceptual mode one might be more inclined to wonder how other organisms perceive and navigate this environment. The point is not to "escape the bubble" of being embodied as human, as Wilson has it, but to expand possibilities of imagining with the more-than-human world—and to be vibrated into responsiveness.

Too much can be made of this pivot from eye to ear. Some criticism of visual metaphors of knowing can make it seem as if the eyes naturally alienate people from their environments "whereas the ears are holes in the skull that let the sound in so that it can mingle with the soul"—as anthropologist Tim Ingold sarcastically puts it.[26] Evaluating a broader turn to listening, Ingold notes a train of ethnographic studies correlating epistemic dominance of the visual in modern Western epistemologies with objectification, detachment, consumerism, domination, and other civilizational pathologies. In contrast, aural cultures supposedly have more relational, personifying, holistic qualities. Yet those studies are not really interested in an account of visual culture, observes Ingold; rather they offer "a critique of modernity dressed up as a critique of the hegemony of vision."[27]

24. Lipari, *Listening, Thinking, Being,* chap. 1. See also Whitehouse, "Listening to Birds in the Anthropocene."
25. Wilson, *Origins of Creativity*, second page of chap. 9 (digital version).
26. Ingold, *Being Alive*, 287.
27. Ingold, *Perception of the Environment*, 287.

The mistake in moving from criticism of the dominance of visual metaphor to supposing that the aural sense leads to restored relational harmony (as Dunn seems to do) lies in separating and then naturalizing sensory experience, such that seeing and hearing become separable faculties that drive different modes of knowing. That would lead to the obtuse, ableist conclusion that hearing environments is required for good relations with them. Moreover, it belies how senses work together in embodied perception. Seeing is informed by the whole body, including the ears, as Ingold shows; listening is informed by the whole body, including the eyes. (For example, consider the importance of *seeing movement, affect, and Maori self-representation to listen well to a CFC concert.[28]) If a certain priority among the senses caused civilizational pathologies then mass hearing exercises could repair a society's way of interacting with its environments. But modernist ways of knowing are not the inevitable product of a particular sensory faculty; rather they enlist all available senses in imagining humans as subjects set against the rest of the living world. A reparative response should seek to transform perception toward the sort of participatory engagement appropriate to organisms actively, knowingly immersed within environments to which they belong.

Listening to Science

"Listen to the science," critics often plead with those inattentive to data on rapid environmental change. The CFC makes more ways to listen to science. When the marine scientist Matthew Reidenbach heard our hydrophone recording of the oyster reef, he wondered if it carried data about the health of the reef. Upon analysis of the recording he isolated a low-pitched metabolic rumble emitted when individual oysters rapidly close their valves while feeding. Reidenbach and another researcher, Martin Volaric, realized that they could monitor life in the reef by soundscape. Snapping shrimp sound at high frequencies, for example, while fish chorus at middle frequencies, and water turbulence appears at low frequencies. They wondered if variations in the soundscape could be correlated with reef health.

In work supported by the CFC, Volaric worked with composer Eli Stine to create and deploy acoustic sensors to record oyster beds in various locations and conditions. While Volaric advanced ways to investigate and quantify acoustic signatures of reef vitality, Stine created *electroacoustic translations of their oyster reef data. Now people can hear not only the live sound of a reef but also the patterns of its growth.[29]

That work informs ongoing collaborations with another VCR scientist, Peter Berg, who was already using an acoustic velocimeter to measure vertical flows in the water column above reefs, correlated with oxygen levels as proxy for reef respiration. In other

28. The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/ (scroll down and click "Performances: WAI from New Zealand with EcoSono").

29. For a further description of their project, visit The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/research/ (click on "Coastal Soundscapes and Oyster Reef Health").

words, the metabolism of the whole reef has an acoustic signature.[30] It is possible that oyster larvae move toward the sound of a healthy reef, suggesting both ways to listen for successful reef restoration and possible sonic intervention to encourage larvae toward artificial reefs.[31] Advancing ways to listen to the reefs makes it more possible to compose worlds with and for oysters.

Sonification of data expands sensory attention to another scale. Conservatory composers and scientists collaborate to transform other VCR data sets into something humans can hear (*e.g., twenty-eight years of water-quality data).[32] Hearing data allows an auditor to experience the science of environmental change in a different somatic register, which may lead them to relate differently to reports of environmental change. Researchers are working now on sonifications of sea-level rise and wave action, allowing people to listen to coastal change at a broader scale of pattern. "Sound can provide one unexpected, sideways way in," writes Helmreich about data sonification, "a way of rattling common sense that usually operates in the domain of the visual."[33] One reason that hearing data can compel a different kind of attention may be that sound's temporality impresses into human experience the temporality of data. Easily lost to the momentary gaze taking in a plotted graph, listening to sea-level rise underscores variation over time. Because the data is plotted temporally rather than spatially, in hearing it the mind must wait on the pattern, must tarry in the record of change.

Expanding capacity of sensory attention to yet another scale of imagination, Burtner's ecoacoustic compositions incorporate sonified data sets into creative expression and live performances. "This music is built on techniques of environmental temporality and interrelated energy fluctuations, inspired by an uncommon way of listening to the natural world."[34] The science of long-term ecological change, already transformed by sonification into patterned vibrational changes felt in one's body, is thus transformed again by integration into cultural expression. Burtner's *Ice Cycle* composition, for example, integrates decades of data on sea-ice change along the Alaskan coast into a musical meditation on ice and climate change, set to dance by choreographer Jody Sperling.[35] Their performance thus enacts the twofold task of environmental humanities as described by van Dooren, Kirksey, and Münster: "the cultivation of skills for both paying attention to others and meaningfully responding." Acoustic field recording and data sonification are skills of attention; ecoacoustic composition is a mode of response.

30. Volaric, Berg, and Reidenbach, "Drivers of Oyster Reef Ecosystem Metabolism Measured across Multiple Timescales."

31. The hypothesis was informed by Lillis, Eggleston, and Bohnenstiehl, "Oyster Larvae Settle in Response to Habitat-Associated Underwater Sounds."

32. The Conservatory: Listening for Coastal Futures, "Listen," www.coastalconservatory.org/listen/ (click on "Hog Island Water Quality").

33. Helmreich, *Sounding the Limits of Life*, xxii.

34. Burtner, "Climate Change Music," 146.

35. Sperling, "Ice Cycle."

When ecoacoustic composition incorporates sonified data sets from several interacting dynamics of state change in a landscape it offers to aural experience some of the most important and difficult relations to imagine together. VCR scientists investigate how state change in one ecological system may be coupled with state changes in other systems. They are simultaneously investigating whether plant species migrations due to rising air temperature may be shifting vegetative cover on barrier dunes from a grassy foundation species to a shrubby foundation species; how those shrubs affect dune geomorphology in ways that may make islands more vulnerable to storm-surge wash-overs; and at what rate of sea-level rise the lee-side salt marshes fail to maintain viable deposition rates and therefore coast-ward island mobility.[36] Those are three separate dynamics of state change in coastal systems with complex interactions among them. An overall goal of the LTER is to understand those interactions in ways that help predict tipping points and resilience for the coast as a whole. We plan to sonify data on each dynamic in anticipation of compositions and performances that bring them together, give expression to the interactions—sounding out possible futures.

By curating field recordings and sonifications on its website, and by hosting concerts and performances, the CFC invites constituencies for environmental science and for art into the same auditory space to listen with each other. In the installation described in the opening vignette, we collaborated with the Barrier Islands Center, a museum on the Eastern Shore that curates historical memory of the island communities from which people retreated in the 1930s after a series of hurricanes. Beside each listening station were placards describing the scientific research from which the piece was developed and explaining how it relates to contemporary dynamics of coastal change.

By layering these various senses of listening to coasts, the CFC begins to integrate humanities with sciences to expand sensory limitations of human embodiment and thus expand the basis for empathy and value. Aesthetic engagement with a performance composed from sonified data and acoustic attention beyond the human world may stimulate an audience to connect coastal change with the stories by which they make sense of their lives, its pasts and futures. Again, listening is at once precondition to ethics and an ethos in itself.

Listening as Political Relation

Listening also requires being able to hear how power shapes the stories told about lives and coasts. Announcing that "the problem of the twenty-first century is the problem of the water line," Helmreich renders a jarring turn on W. E. B. Dubois's famous line ("the problem of the twentieth century is the problem of the race line") to highlight sea-level rise as a signature problem of the Anthropocene.[37] It represents both a planetary dynamic of anthropogenic change and a differentiating axis of inequality. As vulnerability

36. Deaton, Hein, and Kirwan, "Barrier Island Migration Dominates Ecogeomorphic Feedbacks."
37. Helmreich, *Sounding the Limits of Life*, xxi.

to rising seas is distributed along lines of political power, responses to a planetary dynamic make different worlds. Storm surges that engulf coastal communities along southern seas are stopped or dampened by the upscale defenses of North Atlantic cities. The relative advantage of the wealthy increases by the form of their response to a problem that, perversely, they disproportionately caused. "The disasters of the Anthropocene near future," writes Jedediah Purdy in *After Nature*, "will seem to confirm the rich countries' resilience, flexibility, entrepreneurial capacity, and that everlasting mark of being touched by the gods, good luck."[38] Inequality simultaneously intensified and naturalized is one hallmark of the Anthropocene.

Insofar as it permits universal designators to conceal actual flows of power and vulnerability, research into "coupled human and environmental systems" masks coupled racist and plutocratic systems. In structurally racist societies, "anthropogenic" factors typically name processes of white power while "human vulnerability" disproportionately refers to the vulnerability of people of color. Consider coastal flood zones in the United States. Because resources for adaptation are often assigned by property value and negotiated politically, they tend to flow to property owners with inherited wealth and political capital, who, due to histories of racist violence and exclusion, are disproportionately white.[39] The discrepancy is especially stark in buyout programs, whose race-blind criteria routinely work against very vulnerable Indigenous communities.[40] That is a classic environmental justice finding: white supremacy reproduces itself in what appears a race-neutral policy response to a general environmental problem.

Any North Atlantic investigation of coastal resilience must therefore listen across the water line—which is still a race line. Two CFC scholars, historian Andrew Kahrl and literary scholar Charlotte Rogers, investigate cultural memory as littoral zones of power. A historian of US coasts with important work on racist exclusions,[41] Kahrl undertakes comparative investigation of twentieth-century housing developments on the Eastern Shore. He describes a form of "coastal capitalism" that combines commodification of shoreline ecology with reengineered ecological functions in a way that at once encloses marshes providing public benefit and yet also relies on constant state intervention. Meanwhile Rogers investigates the connected roles of hurricanes and slavery by following patterns of aesthetic response shaped by historical experiences of disaster. While she had intended to listen to those experiences through a conventional project in comparative literature, after three catastrophic hurricanes in her research geography, Rogers redirected her efforts to lead a CFC initiative to convene artists from Puerto Rico, Florida Gulf Coast, and coastal North Carolina. The extraordinary dialogue on the role

38. Purdy, *After Nature*, 46.

39. Kleinosky, Yarnal, and Fisher, "Vulnerability of Hampton Roads, Virginia, to Storm-Surge Flooding and Sea-Level Rise."

40. Marino, "Adaptation Privilege and Voluntary Buyouts."

41. Kahrl, *Land Was Ours.*

of the arts in fostering cultural resilience and the exchange of creative works among the artists has become the basis of a digital exhibition, "Coasts in Crisis," now under development.

Listening across the water line for the CFC thus includes listening to experiences of coastal change in other vulnerable regions. Our first public research presentation was opened by the Maori music ensemble, WAI. Having explained our academic experiment, we invited WAI members to shape our research exchange as they saw fitting. WAI framed the seminar by instructing us in a *traditional Maori percussion exercise and then, having reoriented our academic postures, performed songs emerging from the waters of their homeland.[42] Our research presentations, all focused on the Virginia coast, were thus framed by listening to Aotearoa's coast. WAI ended the seminar by charging researchers to announce who they are when they enter a research landscape and listen for the response. They then closed the research space with a song honoring coastal waters.

Meanwhile, the CFC's public fellow Beth Roach (Nottoway) works with coastal tribes to reopen ways to listen to Indigenous pasts and futures of this region. An epicenter of the settler invasion of North America, coastal Virginia's Indigenous life is sometimes presented as a matter of history, silenced by genocide. In her first event with the CFC, Roach sought to counter that perception by leading University of Virginia students and faculty on a "listening paddle" on the Nottoway River, in which she and other Nottoway Indian Tribe elders introduced stories and songs of the river that resituated it as an ancestral relation of the Nottoway people in whose survivance lies the river's future. Roach's main project, "Re-Storying the Indigenous Coast," focuses on connecting tribal organizations across the mid-Atlantic coastal plain by gathering their "water stories." Her project supposes that those stories may serve as the basis for strengthening climate resilience of tribal communities, beginning with increased presence and engagement within government processes. Here again experiences of listening are at once condition for ethics and themselves an ethical relation.

Listening across the water line thus offers a way to negotiate key Anthropocene challenges to ethics. How to imagine responsibility for the emergence of "humanity's" species-level action without obscuring distributed responsibility of particular groups? How to recognize different worlds of experience and respect multiple visions for the future without losing sight of planetary relations and global challenges? For some, the idea of the Anthropocene seems an excuse to not bother to listen. If humanity is the key driver and basic subject of survival, then differential exposure to sea-level rise is a distraction, however tragic. If biomes are anthromes, it is up to "humanity" to design and assemble the ecosystem services it wants. But what emerges when we listen into particular, politically differentiated experiences of sea-level rise, at multiple scales from multiple sources?

42. The Conservatory: Listening for Coastal Futures, "Listen," coastalconservatory.org/listen/ (scroll down and click "Performances: 2018 Lab Meeting").

As Burtner's EcoSono group *performed musical expressions of the data of environmental change, the audience could feel in their vibrating bodies the emerging species-level scale of human agency. Meanwhile WAI interwove and counterpointed Maori forms of ecological music.[43] The audience was thus able to hear the way planetary dynamics of change are riven with asymmetries of freedom and power, variations of memory and voice. Where scales of time and complex interactions of forces are difficult to imagine, listening across the water line offered an audience a way to listen to the difficulty. It was a precondition to ethics and an ethical relation in itself.

Conservatory Counterpoint

The CFC is part of a growing effort to integrate arts and humanities into LTER sites. A majority of the LTER sites have some kind of arts and humanities programming, and most LTER lead scientists regard these programs as important investments. Arts and humanities, they report, are especially valued for roles in fostering creativity, moral imagination, and public engagement.[44] One of those sites, the Andrews Forest, has even developed a complementary Long-Term Ecological *Reflections* program, to archive a long-term record of creative engagement with the site, in tandem with long-term scientific observation.[45] Those efforts are in line with recent US National Academies priorities on integrating STEM research with arts and humanities, and with a number of European funding initiatives.

The turn to engage arts and humanities is critical for understanding long-term environmental change within increasingly anthropogenic ecologies. A basic claim of the environmental humanities has been that insofar as environments and their changes are entangled with humans, understanding them well requires the tools, knowledge, and skills of the humanities. However, despite the development of environmental research programs across the humanities, their involvement in multidisciplinary research on planetary change so far remains marginal. Meaningful integration of the humanities into global-change research would involve humanities from the outset, in problem formation.[46] In a major 2018 report, the US National Academies of Science, Engineering, and Medicine in fact call for integration of arts and humanities from start to finish in research and teaching. Integrative learning will not happen, they write, unless arts and humanities are included in ways that encourage researchers to make connections

43. Mayasbane, "Wai and the EcoSono Ensemble."

44. Swanson, "Confluence of Arts, Humanities, and Science at Sites of Long-Term Ecological Research"; Goralnik et al., "Arts and Humanities Inquiry in the Long-Term Ecological Research Network"; Goralnik et al., "Arts and Humanities Efforts in the US Long-Term Ecological Research (LTER) Network."

45. Swanson, Goodrich, and Moore, "Bridging Boundaries"; Brodie, Goodrich, and Swanson, *Forest Under Story.*

46. Holm et al., "Collaboration between the Natural, Social, and Human Sciences in Global Change Research."

across disciplines, synthesize different ways of knowing, and holistically apply knowledge to particular problems and contexts.[47]

The metaphor of integration, however, may mislead collaborative inquiry. In the lexicon of "hybrid," "coupled," and "integrated" research programs there persist legacies of the nature/culture bifurcation that assigns humanities and sciences to separate disciplinary objects. Including arts and humanities would often require framing environmental change differently from the outset—less as biophysical systems exogenously affected by human systems.[48] If those legacies are unchallenged in collaborative inquiry, the apparently grand ambition of integration—knowledge synthesized across disciplines in applied solutions to the challenges of coupled systems—may actually remain meager. Work from environmental humanities regularly contends that adequately understanding dynamics of planetary change requires cognitive transformation from the start. Environmental humanities researchers routinely ask "to fundamentally rethink the environment-human relationship;" to reconsider how accounts of human purpose and virtue accommodate planetary relations; or to "challenge many paradigms in environmental research, such as dualistic thinking, anthropocentrism and human exceptionalism."[49] Insofar as calls for integration exclude those transformative ambitions, they sideline precisely what arts and humanities see as their basic contribution.

What the humanities contribute to global change research, in other words, is a stronger form of integration than cultural translation of scientific findings or data about "human activities" to slot into the appropriate part of an integrated model. Arts and humanities can deepen the significance of anthropogenic ecological changes by reframing them within perennial practices of interpreting the human condition. Even—especially—when those practices raise more questions of a problem than they settle, undertaking reinterpretations of human experience within investigations of global environmental change can stimulate processes of cultural experimentation and moral imagination. Insofar as social adaptation to disruptive change involves reconsidering historical pathways or rethinking premises about the goods and purposes of life, integrated investigation of challenges of global environmental change should include deep questioning.

In too many integrative projects, Noel Castree observes, "epistemic unity is vouchsafed by a presumptive ontological monism."[50] The implicit terms of collaboration may exclude from scrutiny basic premises that frame research—for example, methodological detachment from systems and organisms being studied or restrictions of value and intelligence to human subjects. The terms may rule out listening to other creatures as

47. Skorton and Bear, eds., *Integration of Humanities and Arts with Science, Engineering, and Medicine*.

48. Palsson et al., "Reconceptualizing the 'Anthropos' in the Anthropocene."

49. Palsson et al., "Reconceptualizing the 'Anthropos' in the Anthropocene," 10; Hulme, "Climate Change and Virtue"; Kueffer, Lässer, and Hall, "Applying the Environmental Humanities," 255.

50. Castree, "Global Change Research and the 'People Disciplines,'" 63.

if they have something to say. Yet the ontology of nature and culture in which Earth cannot speak and humans cannot listen is historically a minority view.[51] In rejoinder to Wilson, not all humans experience themselves as incapable of knowing other beings and not all societies have been so anthropocentric; those are peculiar to the modern North Atlantic. Listening across disciplines should not foreclose possibilities of listening beyond the boundaries of modern humanism.

At the end of his account of *How Forests Think*, Eduardo Kohn writes, "If 'we' are to survive the Anthropocene . . . we will have to actively cultivate these ways of thinking with and like forests."[52] By that point the reader knows that his marked "we" ironizes the Anthropocene imagination and that Kohn has been taught to think with forests by listening with people who experience their knowing as part of a broader ecological knowing. Listening for coastal futures may entail thinking with and like living coasts.

Writing about the emergence of Indigenous environmental studies and sciences, Kyle Powys Whyte describes a mode of empirical science that is also spiritual, in the sense that it helps people build moral relationships and enter into accountability with a multispecies community. "Science must be part of moral relationships, increasing human accountability to nonhumans and the environment. Science must also be interdisciplinary and include diverse sources of knowledge. And investigating systems of interdependence must be rooted in and applicable to the practical activities of everyday stewardship and subsistence."[53] Indigenous environmental sciences seek a form of science committed and accountable to the futures of particular peoples in particular lands.

Meanwhile university institutions for sustainability and resilience invariably tell their publics that they will "innovate solutions" for problems of environmental change. The solutionism seems to promise that universities will invent new ways to keep silencing other ways of knowing. Perhaps institutes should instead say that they do not yet have the knowledge to repair the relations being damaged, but they are innovating ways to listen.

The CFC therefore undertakes a tense twofold task with regard to integrative transdisciplinary inquiry. On the one hand, as the NSF launches a major initiative on "coasts and people" we appeal anew for the qualitative "people disciplines" to be included from the start, to have a say in crafting problems and goals of research.[54] Yet, on the other hand, we promise that doing so will open research on environmental change to fundamental questions of meaning and involve it in culturally transformative tasks—uncomfortable entanglements for the sciences. Environmental sciences may accept collaboration on those terms where they recognize that the cultural entailments involved in managing rapidly changing coupled systems include reconsidering

51. Descola, *Beyond Nature and Culture*.
52. Kohn, *How Forests Think*, 227.
53. Whyte, "Critical Investigations of Resilience," 141.
54. Castree, "Global Change Research and the 'People Disciplines.'"

fundamental questions.[55] If global environmental change is characterized by complexity and uncertainty, and by the need for rapid and far-reaching social transitions, then research on it should be a scene of experimentation and realignment.[56] Where challenges exceed disciplinary ways of knowing and social capacities of response, the sciences may agree, paths toward understanding them require transformative knowledge.

Organizing around listening thus helps the CFC disrupt meager or misleading ambitions of integration. As Castree puts it, sometimes we need the disciplines "not merely to collaborate but *to unsettle each other* so that a new modus operandi emerges."[57] Where visual models of integration might try to resolve multiple ways of knowing into a unified vision, an aural model of integration suggests hearing multiple different and irresolvable things at once. Rather than rejecting integration as aspirational metaphor, CFC practices suppose that integrative inquiry sometimes requires creating dissonance to unsettle habits of mind and open space for transformative listening.

Transformative Listening

Listening to the living shore is not an alternative to coastal sciences; it connects sciences to processes of ethical and political formation. Robin Wall Kimmerer describes the data-collection apparatus at the Andrews Forest LTER as instruments for "listening to the land for stories that are simultaneously material and spiritual." The land speaks a language many people have either forgotten or have yet to learn. "The archive of this language, the sacred text, is the land itself. In the woods there is a constant stream of data, lessons on how we might live, stories of reciprocity, stories of connection."[58] An environmental scientist herself, Kimmerer asks researchers to listen simultaneously in multiple registers, to hear the watershed's data as also a sacred archive.

Marking something as sacred can be epistemologically dissonant in a university research context. It suggests a different order of attentive regard is required, including perhaps openness to being transformed. Suppose researchers were to regard the coastal reserve as a kind of sacred text, its data repository as words from a language we have either forgotten or have yet to learn. In learning that language, researchers may find that, like other sacred texts, the coast can ask questions of them or make claims on their cares and concern.

Not rivalrous with scientific knowing, integrating this kind of spiritual openness (let us call it) into environmental research can drive better understanding. "What might be learned by paying repeated, open-ended attention to particular places?" Reflecting on the method of his widely praised book, *The Forest Unseen*, the forest ecologist David

55. See Jenkins, *Future of Ethics*, chap. 4.

56. Holm et al., "Collaboration between the Natural, Social, and Human Sciences in Global Change Research," 31.

57. Castree, "Global Change Research and the 'People Disciplines,'" 65.

58. Kimmerer, "Interview with a Watershed," 44.

George Haskell answers his question: "Such acts of ecological meditation might reveal truths that complement and feed those of scientific experimentation, theoretical analysis, imaginative exploration, and creative expression." Contemplative engagement with a particular patch of forest floor led him deeper into understanding, as Haskell let his scientific research follow repeated, open-ended attention. "Instead of a question to guide what I discovered, I brought a commitment to return to a particular place and try to pay attention."[59] For LTER sites, that seems an apt charge. What makes their research so valuable, after all, is the commitment to keep returning to a particular place, to understand environmental change by investigating it over time. Incorporating ecological meditation or other arts of attentiveness into the process of forming research questions can open unseen pathways of investigation.

Including contemplative practices can also connect environmental science with processes of ethical transformation, without sacralizing science or inappropriately involving scientific practice in normative judgements. "Ethical claims must draw on modes of understanding that include science but also transcend science's remit and abilities," writes Haskell. "Contemplative engagement within life's community may offer a bridge between science and ethics."[60] Mature judgments seem less likely to emerge from mastering several separate investigative lines of inquiry—like adding history and music to coastal ecology classes—than from knowledgeable engagement with many strands of the living network in a place. If entered in such epistemic openness, writes Haskell, participation in the network inducts one into an integrative sense of beauty. Making space for that integrative process, offering practices within which it can happen, encourages moral imagination to develop from the relations under investigation in an LTER site.

What sort of practices can do that? Kimmerer and Haskell describe the need for affective, knowledge-transforming openness to the living relations of a land. Both describe their practices as, in a certain way, spiritual practices. The fields of religious studies and contemplative sciences may offer other practices apt for cultivating arts of openness to being instructed or transformed. With that view, forms of ecological inquiry might then look to someone such as the scholar of contemplative traditions, Douglas E. Christie, who combines premodern Christian monastic practices with meditations from contemporary North American environmental thinkers to describe "practices that will help us feel and respond to the claim of the living world upon our lives."[61] Or we might look to David Abram, who rearticulates animist sensibility within phenomenological practices to tutor human bodies to hear interlocution from more-than-human life, and thus awaken a lost ethical dimension, a forgotten etiquette.[62]

59. Haskell, "Contemplative Studies of the 'Natural' World," 123, in reference to Haskell, *The Forest Unseen.*

60. Haskell, "Contemplative Studies of the 'Natural' World," 128.

61. Christie, *Blue Sapphire of the Mind,* xi.

62. Abram, "Between the Body and the Breathing Earth."

Contemplative practices for ecological openness may of course be adapted from other cultural sources. The point is that "a common feature of such spirituality or spiritual practice is a deepening of awareness of oneself as *existing within and responsible for* the larger whole of the living world."[63]

Again, making room for contemplative practices does not displace scientific modes of analysis; it connects them to processes of moral imagination. Rachel Carson, in the preface to *The Edge of the Sea,* her book on coastal ecology, writes, "Understanding comes only when, standing on a beach, we can sense the long rhythms of earth and sea that sculptured its land forms and produced the rock and sand of which it is composed; when we can sense with the eye and ear of the mind the surge of life beating always at its shores."[64] What Carson means by understanding certainly includes scientific knowing, but it is knowing integrated into a form of wonder animated by empathy with the living world.[65]

Including such practices opens space to negotiate a conflict that lies at the heart of integrated research on rapid environmental change. That conflict is not between scientific and religious ways of knowing; "the real contest lies elsewhere," writes Ingold. "It turns on whether our ways of knowing and imagining are enshrined within an existential commitment to the world in which we find ourselves."[66] For environmental knowledge to give rise to mature interactions with the places under study, learners must be alive to claims arising from beyond human worlds, from all the living shore. In some modernist contexts, the depth of disruption required for that kind of listening might well be experienced as religious in function, but the point is simply to permit moral formation to happen within the environmental relations under investigation, as if one had an existential commitment to their future.

The CFC, to be clear, does not seek to advance contemplative practice. I am here drawing out an implication of the experiment's direction toward a form of listening that seems necessary for investigating rapid coastal change in ways that connect coastal knowledge with integrative processes in which moral and political imaginations form. Taking responsibility for coastal futures seems to require linking the predictive powers of resilience science (e.g., the threshold of sea-level rise that causes state change in marsh deposition) to prophetic powers of imagination (thresholds of cultural state change). Sensing coastal futures happens most aptly from participation in processes of becoming—by listening and responding. With a participatory sense of its emergence, says Ingold, those who participate in the becoming of a place with their full perception and imagination can, like a musician, improvise passages toward

63. Christie, *Blue Sapphire of the Mind*, 20; my emphasis.

64. Carson, *Edge of the Sea*, xiii.

65. On connecting scientific knowing and moral wonder with commentary on Carson, see Sideris, *Consecrating Science*, 172–82.

66. Ingold, "Walking with Dragons," 52.

emergent possibilities.[67] To improvise well, the CFC supposes, we must learn to listen and compose with the coast.

Human people are not the only ones imagining and improvising. "As a 'line of life' travelling through the world," writes Ingold, "every organism shapes the future both for itself and for the whole landscape, through imaginative processes that are carried on in correspondence with those of other organisms."[68] Imagine the barrier islands, which form from sand deposited by wave action, as themselves a slow-motion wave toward shore, accompanied and inhabited by lines of life that slow their movement and reshape their form, opening new possibilities of biotic relation as they do. All the relations that together make "the coast" are making futures. The extent to which human persons participate in those relations with perception and imagination is critical to which coastal futures will emerge.

Including integrative practices with disciplinary knowledge may then enliven political processes. "The arts of attentiveness remind us that knowing and living are deeply entangled and that paying attention can and should be the basis for crafting better possibilities for shared life."[69] If politics may be understood as "the making, imagining, contesting and living of shared material and affective worlds," then creative arts-sciences collaborations can play a role in opening political futures.[70] Along the warming, submerging Atlantic coast, experiments in making and contesting knowledge of coastal change may in turn stimulate public imaginations of a shared coastal life. That involves, I think, creating ways to listen across disciplines, across the water line, in concert with the more-than-human coast, to quicken in shared worlds the living shore. "Listening is the invisible and inaudible enactment of the ethical relation itself; upon it, everything depends."[71]

WILLIS JENKINS lives in the Rivanna River watershed, where he works as the Hollingsworth Professor of Ethics at the University of Virginia. He codirects three transdisciplinary labs, including the Coastal Futures Conservatory.

Acknowledgments

While this article cannot be taken to wholly reflect the views of my collaborators, Matthew Burtner and Karen McGlathery, it is deeply indebted to the gift of working with them. This article was developed from a talk presented at the Oak Spring Garden Foundation's Living Earth Symposium in 2018, which was published as "Listening to Coastal Futures" in *Living Earth Community: Multiple Ways of Being and Knowing* (2020), edited by Sam Mickey, Mary Evelyn Tucker, and John Grim. It was improved by feedback from presentations in 2019 at the Yale Institute of Sacred Music and in 2020 at the

67. Ingold, introduction, 10.
68. Ingold, introduction, 15.
69. van Dooren, Kirksey, and Münster, "Multispecies Studies," 17.
70. Gabrys and Yusoff, "Arts, Sciences, and Climate Change," 19.
71. Lipari, *Listening, Thinking, Being*, 204.

Willson Center for the Humanities at the University of Georgia. I am indebted to the patient editorial work of Julie Doyle, Dolly Jørgensen, and Franklin Ginn and to the helpful comments of two anonymous reviewers. The Coastal Futures Conservatory is supported by a grant from the Institute of Humanities and Global Cultures at the University of Virginia.

References

Abram, David. "Between the Body and the Breathing Earth." *Environmental Ethics* 27, no. 2 (2005): 171–90.

Adamson, Joni. "Integrating Knowledge, Forging New Constellations of Practice in the Environmental Humanities." In *Humanities for the Environment: Integrating Knowledge, Forging New Constellations of Practice*, edited by Joni Adamson and Michael Davis, 3–19. New York: Routledge, 2016.

Brodie, Nathaniel, Charles Goodrich, and Frederick J. Swanson. *Forest Under Story: Creative Inquiry in an Old-Growth Forest.* Seattle: University of Washington Press, 2018.

Burtner, Matthew. "Climate Change Music." *South Atlantic Quarterly* 116, no. 1 (2017): 145–61.

Carson, Rachel. *The Edge of the Sea*. New York: Oxford University Press, 1955.

Castree, Noel. "Global Change Research and the 'People Disciplines': Toward a New Dispensation." *South Atlantic Quarterly* 116, no. 1 (2017): 55–67.

Christie, Douglas E. *The Blue Sapphire of the Mind: Notes for a Contemplative Ecology*. New York: Oxford University Press, 2013.

Deaton, Charles D., Christopher Hein, and Matthew L. Kirwan. "Barrier Island Migration Dominates Ecogeomorphic Feedbacks and Drives Salt Marsh Loss along the Virginia Atlantic Coast, USA." *Geology* 45, no. 2 (2017): 123–26.

Descola, Philippe. *Beyond Nature and Culture*, translated by Janet Lloyd. Chicago: University of Chicago Press, 2013.

Dunn, David. "Nature, Sound Art, and the Sacred." In *The Book of Music and Nature*, edited by David Rothenberg and Marta Ulvaeus, 95–107. Middletown, CT: Wesleyan University Press, 2001.

Emerson, Ralph Waldo. "Nature." In *The Essential Writings of Ralph Waldo Emerson*, edited by Brooks Atkinson, 3–42. New York: Modern Library, 2000.

Gabrys, Jennifer, and Kathryn Yusoff. "Arts, Sciences, and Climate Change: Practices and Politics at the Threshold." *Science as Culture* 21, no. 1 (2012): 1–24.

Goralnik, Lissy, Michael Paul Nelson, Hannah Gosnell, and Mary Beth Leigh. "Arts and Humanities Inquiry in the Long-Term Ecological Research Network: Empathy, Relationships, and Interdisciplinary Collaborations." *Journal of Environmental Studies and Sciences* 7, no. 2 (2017): 361–73.

Goralnik, Lissy, Michael Paul Nelson, Leslie Ryan, and Hannah Gosnell. "Arts and Humanities Efforts in the US Long-Term Ecological Research (LTER) Network: Understanding Perceived Values and Challenges." In *Earth Stewardship: Linking Ecology and Ethics in Theory and Practice*, edited by Ricardo Rozzi, F. Stuart Chapin III, J. Baird Callicott, S. T. A. Pickett, Mary E. Power, Juan J. Armesto, and Roy H. May Jr., 249–68. Cham, Switzerland: Springer International, 2015.

Haskell, David George. "Contemplative Studies of the 'Natural' World." In *Living Earth Community: Multiple Ways of Being and Knowing*, edited by Sam Mickey, Mary Evelyn Tucker, and John Grim, 123–32. Cambridge: Open Book Publishers, 2020.

Haskell, David George. *The Forest Unseen: A Year's Watch in Nature*. New York: Penguin Books, 2013.

Helmreich, Stefan. *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. Princeton, NJ: Princeton University Press, 2015.

Holm, Poul, Michael Evan Goodsite, Sierd Cloetingh, Mauro Agnoletti, Bedrich Moldan, Daniel J. Lang, Rik Leemans, et al. "Collaboration between the Natural, Social, and Human Sciences in Global Change Research." *Environmental Science and Policy* 28 (2013): 25–35.

Hulme, Mike. "Climate Change and Virtue: An Apologetic." *Humanities* 3, no. 3 (2014): 299–312.

Ihde, Don. *Listening and Voice: Phenomenologies of Sound*. 2nd ed. Albany: State University of New York Press, 2007.

Ingold, Tim. *Being Alive: Essays on Movement, Knowledge, and Description*. New York: Taylor and Francis, 2011.

Ingold, Tim. "Introduction." In *Imagining Landscapes: Past, Present, and Future*, edited by Monica Janowski and Tim Ingold, 1–18. New York: Routledge, 2012.

Ingold, Tim. *The Perception of the Environment: Essays on Livelihood, Dwelling, and Skill*. London: Routledge, 2000.

Ingold, Tim. "Walking with Dragons: An Anthropological Excursion on the Wild Side." In *Animals as Religious Subjects: Transdisciplinary Perspectives*, edited by Celia Deane-Drummond, Rebecca Artinian-Kaiser, and David Clough, 35–58. London: Bloomsbury, 2013.

Jenkins, Willis. *The Future of Ethics: Sustainability, Social Justice, and Religious Creativity*. Washington, DC: Georgetown University Press, 2013.

Jenkins, Willis. "Listening for Coastal Futures: The Conservatory Project." In *Living Earth Community: Multiple Ways of Being and Knowing*, edited by Sam Mickey, Mary Evelyn Tucker, and John Grim, 141–52. Cambridge: Open Book Publishers, 2020.

Kahrl, Andrew. *The Land Was Ours: How Black Beaches Became White Wealth in the Coastal South*. Chapel Hill: University of North Carolina Press, 2012.

Kimmerer, Robin Wall. "Interview with a Watershed." In *Forest Under Story: Creative Inquiry in an Old-Growth Forest*, edited by Nathaniel Brodie, Charles Goodrich, and Frederick J. Swanson, 41–49. Seattle: University of Washington Press, 2016.

Kirwan, Matthew L., and J. Patrick Megonigal. "Tidal Wetland Stability in the Face of Human Impacts and Sea-Level Rise." *Nature* 504 (2013): 53–60.

Kleinosky, Lisa R., Brent Yarnal, and Ann Fisher. "Vulnerability of Hampton Roads, Virginia, to Storm-Surge Flooding and Sea-Level Rise." *Natural Hazards* 40, no. 1 (2007): 43–70.

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

Krause, Bernie. *Wild Soundscapes: Discovering the Voice of the Natural World*. Rev. ed. New Haven, CT: Yale University Press, 2016.

Kueffer, Christoph, Katharina Thelen Lässer, and Marcus Hall. "Applying the Environmental Humanities: Ten Steps for Action and Implementation." Swiss Academic Society for Environmental Research and Ecology, October 2017. portal-cdn.scnat.ch/asset/405b6a0d-0835-542f-a5b5-f890769ac60c/Applying_EH_summary_2017_saguf?b=df009867-06e2-5e02-9cba-3a768bb90175&v=960c47fe-40f4-599f-b322-65ce95236f6c_0&s=bRnaLeYaqbaOuaJ3aFOZenNDOVwnohoWXUTQIkSkYPCjz4u02yGhoh_RuRCfoXXaveP8zfeBu4z-N8mofFPV-9NaQtFMplW_gS1ZJnakb74wlqspebjGypYde2lgZy3AEGV5Kp6XA1d8z_7LRnP4NXXKdoJ3VapqBTcAZ6TcXZQ.

Lillis, Ashlee, David B. Eggleston, and DelWayne R. Bohnenstiehl. "Oyster Larvae Settle in Response to Habitat-Associated Underwater Sounds." *PLoS ONE*, October 30, 2013. doi.org/10.1371/journal.pone.0079337.

Lipari, Lisbeth. *Listening, Thinking, Being: Toward an Ethics of Attunement*. University Park: Pennsylvania State University Press, 2014.

Luna-Mega, Christopher. "Piano Étude No. 2: Tidal Flow." July 3, 2019. www.youtube.com/watch?v=UhGWPYkcweg.

Marino, Elizabeth. "Adaptation Privilege and Voluntary Buyouts: Perspectives on Ethnocentrism in Sea-level Rise Relocation and Retreat Policies in the US." *Global Environmental Change* 49 (2018): 10–13.

Mayasbane. "Wai and the EcoSono Ensemble." February 1, 2019. www.youtube.com/watch?v=F2zlS8UW-BM.

McGlathery, Karen J., Matthew A. Reidenbach, Paolo D'Odorico, Sergio Fagherazzi, Michael L. Pace, and John H. Porter. "Nonlinear Dynamics and Alternative Stable States in Shallow Coastal Systems." *Oceanography* 26, no. 3 (2013): 220–31.

Palsson, Gisli, Bronislaw Szerszynski, Sverker Sörlin, John Marks, Bernard Avril, Carole Crumley, Heide Hackmann, et al. "Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating

the Social Sciences and Humanities in Global Environmental Change Research." *Environmental Science and Policy* 28 (2013): 3–13.

Pijanowski, Bryan C., Luis J. Villanueva-Rivera, Sarah L. Dumyahn, Almo Farina, Bernie L. Krause, Brian M. Napoletano, Stuart H. Gage, and Nadia Pieretti. "Soundscape Ecology: The Science of Sound in the Landscape." *BioScience* 61, no. 3 (2011): 203–16.

Purdy, Jedediah. *After Nature: A Politics for the Anthropocene*. Cambridge, MA: Harvard University Press, 2015.

Rose, Deborah Bird, and Thom van Dooren. "Encountering a More-Than-Human World: Ethos and the Arts of Witness." In *The Routledge Companion to the Environmental Humanities*, edited by Ursula K. Heise, Jon Christensen, and Michelle Niemann, 120–28. New York: Routledge, 2017.

Sallenger, Asbury H., Kara S. Doran, and Peter A. Howd. "Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America." *Nature Climate Change* 2, no. 12 (2012): 884–88.

Servick, Kelly. "Eavesdropping on Ecosystems." *Science* 343, no. 6173 (2014): 834–37.

Sideris, Lisa. *Consecrating Science: Wonder, Knowledge, and the Natural World*. Oakland: University of California Press, 2017.

Sperling, Jody. "Ice Cycle—Highlights." December 2019. vimeo.com/385301362.

Skorton, David, and Ashley Bear, eds. "The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree." National Academies Press: Washington, DC, 2018. www.nap.edu/read/24988/chapter/1.

Stanhope, Jennifer W., Iris C. Anderson, and William G. Reay. "Base Flow Nutrient Discharges from Lower Delmarva Peninsula Watersheds of Virginia, USA." *Journal of Environmental Quality* 38, no. 5 (2009): 2070–83.

Swanson, Frederick J. "Confluence of Arts, Humanities, and Science at Sites of Long-Term Ecological Inquiry." *Ecosphere* 6, no. 8 (2015): 1–23.

Swanson, Frederick J., Charles Goodrich, and Kathleen Dean Moore. "Bridging Boundaries: Scientists, Creative Writers, and the Long View of the Forest." *Frontiers in Ecology and the Environment* 6, no. 9 (2008): 499–504.

Titon, Jeff Todd. "Thoreau's Ear." *Sound Studies* 1, no. 1 (2015): 144–54.

van Dooren, Thom, Eben Kirksey, and Ursula Münster. "Multispecies Studies: Cultivating Arts of Attentiveness." *Environmental Humanities* 8, no. 1 (2016): 1–23.

Volaric, Martin, Peter Berg, and Matthew Reidenbach. "Drivers of Oyster Reef Metabolism Measured across Multiple Timescales." *Estuaries and Coasts* 43 (2020): 2034–45. doi.org/10.1007/s12237-020-00745-w.

Walters, David, Laura J. Moore, Orencio Durán Vinent, Sergio Fagherazzi, and Guilio Mariotti. "Interactions between Barrier Islands and Back-Barrier Marshes Affect Island System Response to Sea-Level Rise: Insights from a Coupled Model." *Journal of Geophysical Research: Earth Surface* 119, no. 9 (2014): 2013–31.

Whitehouse, Andrew. "Listening to Birds in the Anthropocene: The Anxious Semiotics of Sound in a Human-Dominated World." *Enviromental Humanities* 6, no. 1 (2015): 53–71.

Whyte, Kyle Powys. "Critical Investigations of Resilience: A Brief Introduction to Indigenous Environmental Studies and Sciences." *Daedalus* 147, no. 2 (2018): 136–47.

Wilson, Edward O. *The Origins of Creativity*. New York: Liveright Publishing, 2017.

Zinnert, Julie C., J. Anthony Stallins, Steven T. Brantley, and Donald R. Young. "Crossing Scales: The Complexity of Barrier-Island Processes for Predicting Future Change." *Bioscience* 67, no. 1 (2017): 39–52.