Biosphere Open Microphones (BIOM) – Towards a network of remote listening points in the UNESCO Biosphere Reserves

by Soundcamp: Maria Papadomanolaki, Dawn Scarfe, Grant Smith

Abstract

BIOM is a collaborative project to develop a network of open microphones in the UNESCO Biosphere Reserves, making real time sounds from these environments available on the Locustream soundmap. It brings together independent work at the intersection of arts, ecology, science and technology to create new online resources for public engagement and research. Participants include Biosphere Soundscapes (Brisbane), Locus Sonus (Aix-Marseille), Cyberforest (Tokyo), Jasper Ridge Biological Preserve (Stanford, CA), Sound + Environment (University of Hull) and Soundcamp (London).

This work can be considered as part of the wider development of 'sensing practices' associated with the 'becoming environmental of computation').[1] It shares overlaps with a variety of approaches including citizen science, civic science, street science, participatory sensing, crowdsourcing, DIY media, and citizen sensing. Its distinctive features include a concern with sounds at the scale of the soundscape, and an interest in the way humans and non humans hear and listen to such sounds, in addition to their significance as generalised data sets (e.g. for biodiversity indexing). This gives a character to the work shared across different projects, at the same time as it aligns it with other initiatives where (trans)formative exchanges are possible among people, technologies and their surroundings.[2]

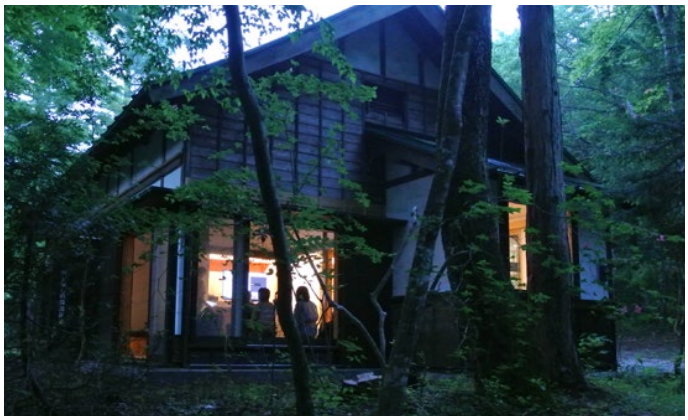
In this paper, Soundcamp outline the BIOM project, describe work that informs it, and share ways to be involved.[3]

Cyberforests and concerned citizens

The drawing on the following page (page 24) depicts a sensing situation. The microphones are deployed in a remote location: Tabushima Island is uninhabited by people. They have provided detailed sound transmissions since 2014 in a technically challenging installation with an off-grid satellite array. They reflect Cyberforest's long experience with this field, live streaming sound and images from a range of sites across Japan since 1997.[4] Innovative elements of the wider research programme include the recruitment of Sooty shearwaters as mobile weather sensors for the Japanese meteorological office.[5]

The stream has provided startling experiences for remote listeners who have happened on the sounds of the shearwaters emerging from their nesting burrows at first light or returning in the evening, anticipated by the cries of the waiting chicks. The live link introduced a strange periodicity into the day of those tuning in from different timezones. For regular listeners, a gap was felt when the Tabushima equipment was damaged by typhoons on two occasions, and the stream stopped.[6]

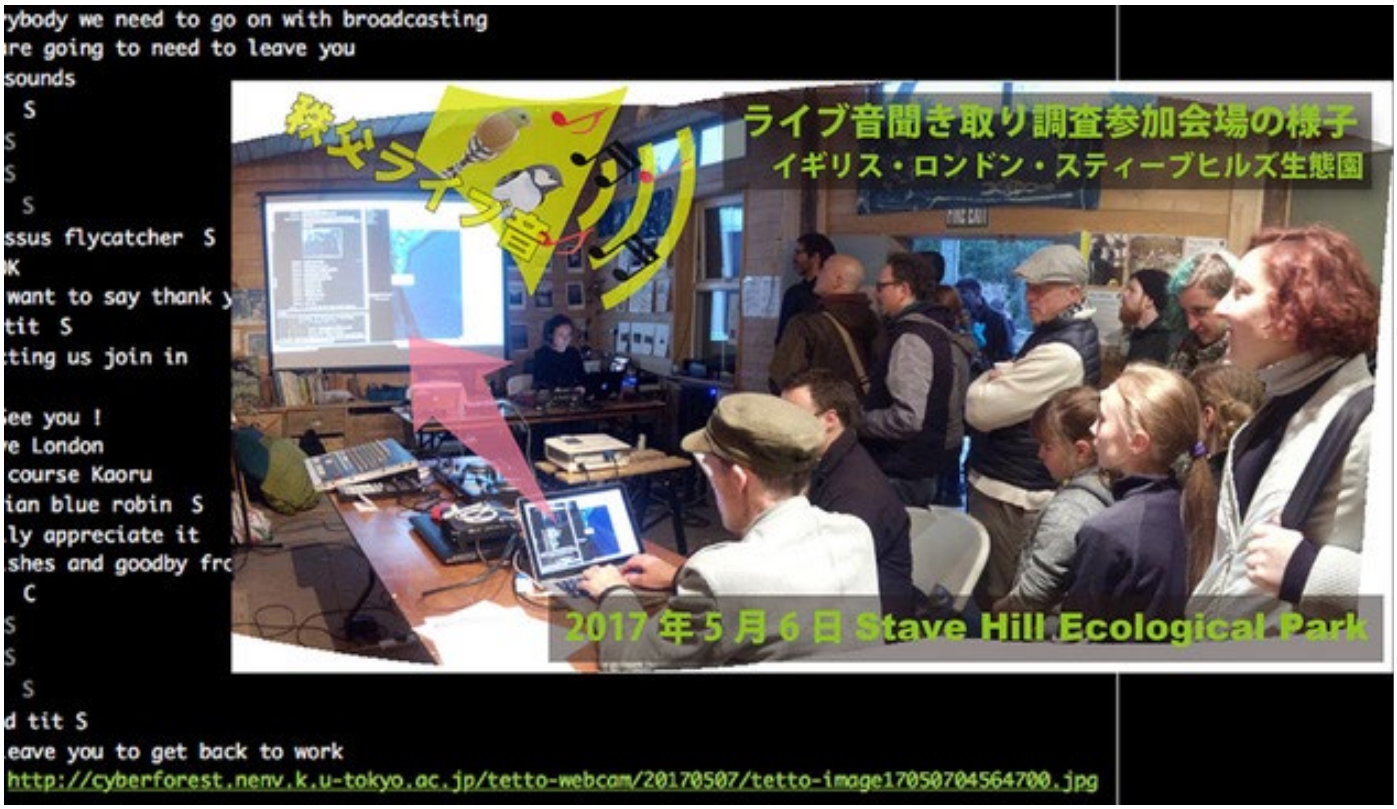
Along with other streams in the cluster of microphones operated by Cyberforest, the sounds of Tabushima are logged 24/7 to a public server, where they are available for listening and analysis. The project has created long term data sets going back up to twenty years, which are currently being analysed in collaboration with SABIOD (Toulon).[7] But the texture of the Cyberforest project comes from the live audio feeds and the conversations and activities they give rise to. This is exemplified by the remote audio census program:



Remote audio bird census with students and visitors, Fuji Iyashinomori study centre, May 2016

Each spring, ornithologists working in association with Cyberforest open the live streams in forests owned and managed by the University of Tokyo to identify and count birds by ear. They listen from separate locations in their homes or offices, and communicate using Limechat, a version of Internet Relay Chat (IRC), using a simple notation to rapidly annotate what they hear. The stereo field allows them to reference the location of birds singing, calling or drumming to left or right, to the fore, middle or back of the sound space as heard in their headphones or on speakers. The ornithologists are often joined by Cyberforest researchers and sometimes by students and other listeners.

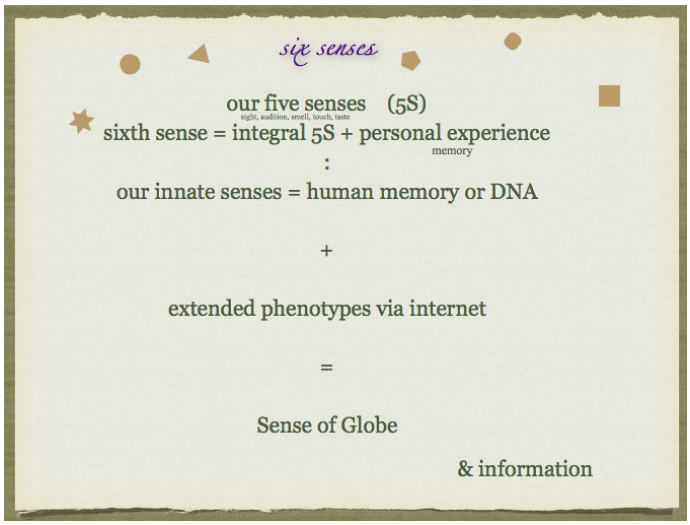
Microphones installed on Tabushima, an island uninhabited by people. Live relay by Cyberforest, University of Tokyo.
Drawing by Sam Baraitser Smith from a webcam capture on 20/8/2015



Joining the census from the London soundcamp May 2017. Image: Kaoru Saito

In May 2019, the ornithologists Reiko Kurosawa and Mutsuyuki Ueta (Japan Bird Research Association), together with Kaoru Saito (Cyberforest) were joined by audiences at two soundcamps,[8] one in London and the other in Marseille.[9] Despite the primary purpose of the census being scientific, translations and commentary helped non-specialist audiences follow the identification of unfamiliar species. Listeners remarked on the speed and skill of the ornithologists in identifying not just residents but migrating birds appearing sometimes for the first time that season, in a dense and rich dawn chorus. After 20 minutes listening in Hokkaido, the census moved south to the lower slopes of Mount Fuji, where daybreak at the start of May comes later. Here again the audience noted the precision and attentiveness which the ornithologists brought to the process of notating the unfolding dawn sounds.

Ornithologists could be observed 'reading' the soundscape, their attention moving from deeper in the forest to close at hand, from left to right of the field, quickly noting a positive identification or an agreed uncertainty (medium woodpecker). The audience could also detect and share their enthusiasm at the appearance of key 'cultural birds' (Ueta's term) for the first time that spring. If there were nobody up at 4AM to listen in to the forest in Hokkaido, these sounds would presumably not be heard by people. There was a sense, then, of a consciously ethical act of witnessing that has led these researchers to maintain their regime of listening, logging, and sharing the remote sounds, over many years and even beyond retirement. This seems like a good example of the way people and technologies can assemble or enact 'relations of concern'.[10] This is referenced perhaps obliquely by core members of the Cyberforest team, who are referred to humorously among themselves as the 'deep foresters' – people whose preoccupation with the digital and analogue forests they are engaged with presumably exceeds narrow professional interest, becoming indistinguishable from their general experiences of the world. We are reminded how for Whitehead such contacts are constitutive of the subject – and not merely something added on.[11] When he talks about the potential to acquire a 'sense of globe',[12] Saito



Ken Ishida. "Acoustic Data for Animal Monitoring, or Sense of Air Waves for Nature and Us." Presentation slide for 'Sense of Globe' University of Tokyo, 2016

has these kinds of exchanges in mind: involving real-time remote listening at the level of the soundscape, and accessing a number of streams from around the world.[13]

Soundmap – becoming planetary[14]

In 2015, the Cyberforest streams were added to the Locustream Soundmap, which presents feeds on the open microphone platform operated by Locus Sonus since 2006.[15] By transposing the distribution of microphones on the ground to the screen, this soundmap provides an intuitive public interface where live sounds hosted on an Icecast server can be activated by clicking on a microphone icon.

The soundmap is the default way of interacting with the streams online and has become the most familiar of various ways in which

Locustream Soundmap (2006-ongoing) by Locus Sonus. Screenshot, 4 June, 2019

Locus Sonus have presented the streams (which includes a basic list of server mountpoints available as an option from the map). This simple spatial transposition has consequences as, de facto, the project becomes about places and listening in to other places. The map interface has a predictable levelling effect, with all the streams appearing together on the same virtual plane, as if on the surface of the earth.

As with any map, the top down perspective gives a deceptive sense of uniformity across sites, which can be differentiated to some extent by inserting a descriptive text and image, available as a popup. This provides context and local detail, reminding the user that the distribution of data across the map is not uniform. The interface makes clear the way streams are concentrated in some parts of the globe, while drawing attention to exceptions: streams in oceanic regions or the Global South, what is silenced or inaccessible. Most significantly, as Angus Carlyle has described, the emergence of sound has the effect of disrupting some of the map's topographical consistency, (re)introducing a vertical axis and a sense of being at ground level. Sound exists incongruously with the lofty view and fixed pins. The "all-possessing eye" "starts to.. lose its certainties" when sound flows from the screen.[16]

This sense of emplacement resonates with Gabrys' use of the term 'planetarity'[17] as something comprising 'multiple earths,'[18] each of which is elicited by different practices of inquiry and attention by specific constellations of organisms, people and equipment in certain surroundings. "Rather than bringing the Earth into view as a total object, as is often discussed through the figure of Earthrise, the planetary remains that which cannot be fixed or settled".[19] The soundmap sustains a tension between an abstract, encompassing overview, and the dissonance of many different sounding milieux.[20]

Cerro Pelón and Jasper Ridge – communities of transmission

In 2017 an icon appeared on the soundmap showing the installation of a live solar powered stream in the Monarch Butterfly Biosphere Reserve (BSR) on a mountain above Morelia in State of Mexico.[21] The site is one of 686 in the World Network of Biosphere Reserves designated by UNESCO in 122 countries. It sits within

Solar streambox, Cerro Pelón, Monarch Butterfly BSR, January 2018. Photo by Rob Mackay

the frame of the Man and the Biosphere Programme (MAB), an interdisciplinary programme set up in 1971 'to establish a scientific basis for the improvement of relationships between people and their environments,'[22] and dedicated to finding innovative social and environmental approaches to sustainability. The programme is growing: the total number of BSRs has increased from 669 in 2017.[23] The Monarch Butterfly BSR (Reserva de la Biósfera Santuario Mariposa Monarca) has been a UNESCO World Heritage site since 2008. It includes the butterflies' main winter roosting place, used by about 70% of the migratory eastern population of monarchs in

North America (some 1 billion butterflies). The stream attracted wide interest among the network of Monarch researchers and advocates, as a tool for public engagement, music composition, and expanding appreciation of the habitat's importance and fragility. It is a pilot for an extended project to link key points in the butterflies' migration routes from Mexico to Canada, drawing attention to the need for collaborations across disciplines and borders to conserve a charismatic indicator species.

The stream has been significant in bringing together a group of people of varied backgrounds and research interests,[24] who have embraced the technical challenges of the installation, finding inventive ways to carry out running repairs with remote Whatsapp support, and working through the frustrations of prototyping and field testing in a mountain location where batteries have to be carried up on horseback and the mobile connection is patchy. The formation of this group resonates with Jeff Kolar's description of the 'community of transmission',[25] and seems to involve a similar sense of interest in sharing sounds of things that are at once everyday and extra-ordinary: periodically the butterflies animate this otherwise unexceptional patch of evergreens; then they are gone. The broadcast, itself fragile, distributes this sense of tenuous presence / absence in ways that are different from conventional media portrayals of an iconic species. Despite the design of custom microphones and pre-amplifiers, the stream has so far not relayed sounds of the butterflies themselves in a convincing way. Rather, it has shared, perhaps, a sense of the locale as experienced by the arborists themselves, who are engaged in managing the habitat and spend most time out in the field at different times of the year.[26] The close involvement of Pato Moreno, one of the arborists on the team, has been key to keeping the installation running. This has given rise in some cases to streams conveying an intimate spatial sense of listening in the meadow at the forest's edge: insects, hummingbirds and other unidentified 'critters' come close to the microphones; on the weekend, sounds of people and music drift up from Macheros in the valley; on weekdays, blasts from nearby mining operations and sounds of overflying aircraft recall the site's situation within wider social and economic realities.

The stream runs off-grid over 4G and is subject to ongoing testing and temporary outages. Captions on the Locus Sonus soundmap include listening notes and links to assist with identifying commonly heard species, prepared in collaboration with ornithologists at the Universidad Nacional Autónoma de México (UNAM).

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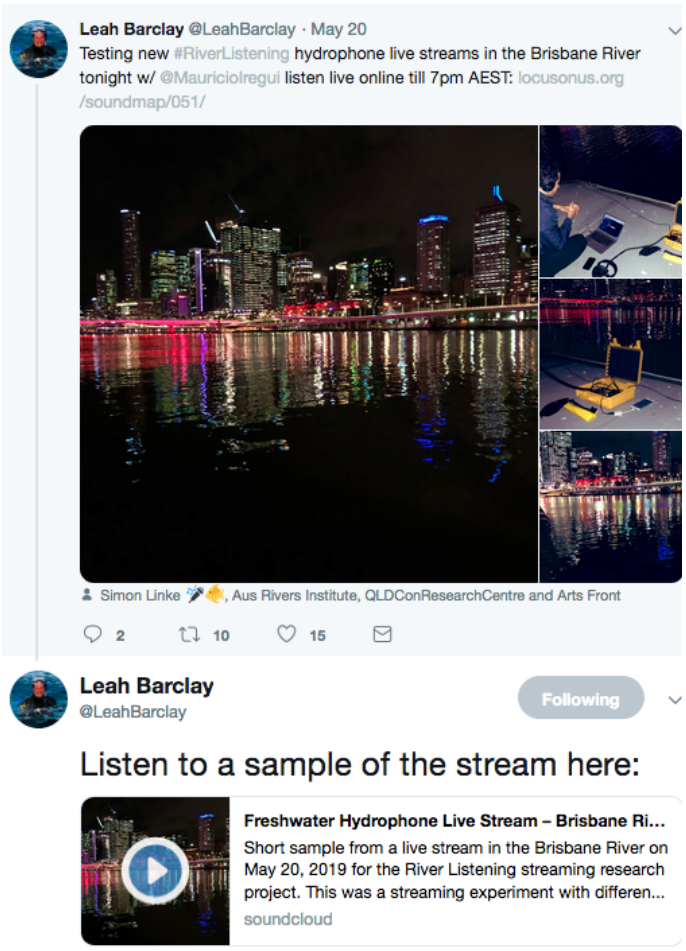
> Bones and muscles and feathers fan forcefully, crossing the threshold between water and air. Brays and gurgles, creaks and groans, roars and mewls, chirrups, howls – these cries of sorts. Thin, high and sharp pings, peeps and squeaks – these whistles of sorts. These whistles and cries slide disconcertingly across the zoological spectrum; having blocked out the announcements I have no compass to orientate me to beak or mouth or throat sac or chitin. I am sinking into a lush Le Douanier fantasy and then another border is tunnelled under: the sky is slowly torn in two by an overflying jet.
>
> *Angus Carlyle Listening to Jasper Ridge Biosphere Reserve on 1st May 2015 14:45–15:2527 in Sounds Remote, Soundcamp / Uniformbooks 2015*

A new phase of the project is in preparation with Jasper Ridge Biological Preserve (JRBP), the Golden Gate Biosphere Reserve and other partners, to develop a network of microphones spanning the monarchs' main migration routes. Jasper Ridge already has a history of operating a live audio feed: Trevor Hebert's 'Birdcast'[27] has been used as a point of contact with the reserve by less mobile visitors, and citizen sensing projects with professionals and lay experts have included bird surveys and bat counts assisted by algorithmic listening. Starting as a technical proof of concept for a cross-site WiFi network, Birdcast has created a dedicated listenership to its sounds of wetland and scrub from a carefully chosen location at the intersection of micro-habitats.[28]

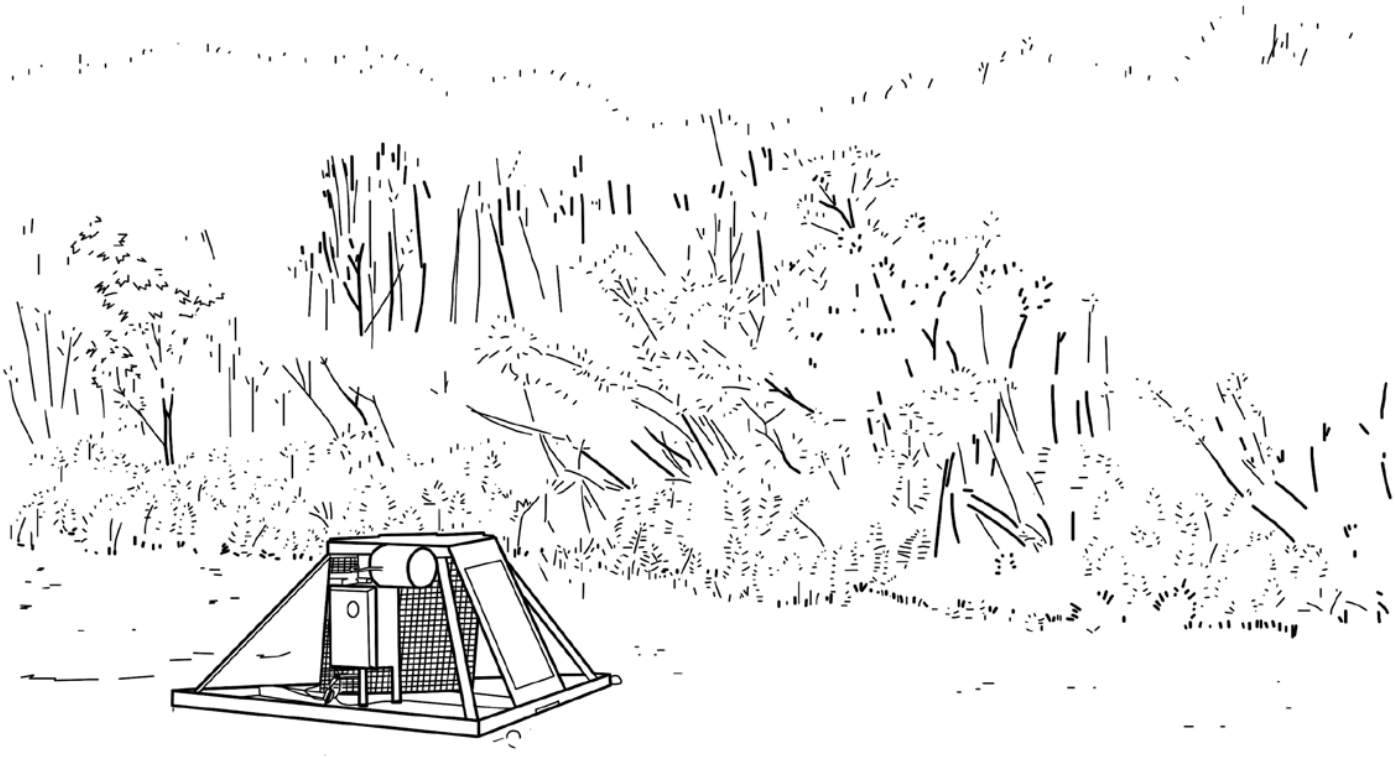


Tweet from @LeahBarclay 20 May 2019. Listen to sounds beneath the river at **https://soundcloud.com/leah_barclay/freshwater-hydrophone-live-stream-brisbane-river-excerpt**

Biosphere Soundscapes – fish and other things

With Biosphere Soundscapes, Leah Barclay has been listening to things, especially fresh water ecosystems, in settings linking research, sound art and public engagement, in the UNESCO Biosphere Reserves since 2011.[29] Biosphere Soundscapes has used live streaming to widen awareness of the value and precarity of freshwater ecosystems in the Noosa Biosphere Reserve in Queensland, where the program originated, and internationally.[30] Key elements of this work have included: sound recording projects with indigenous groups as extensions of claims to land and cultural recognition; establishing data bases of sounds of freshwater organisms (fish, crustaceans, insects) to support research and public engagement; and citizen art science projects involving young people in sound recording with hydrophones.[31]

The Biosphere Soundscapes programme has included extensive work with live streaming as part of River Listening[32] and other projects. Live transmissions of a fresh water dawn chorus for the Reveil broadcast relayed snapping shrimps, grunting catfish and large fish bumping into the microphones.[33] A new long term installation at Mary Cairncross Scenic Reserve,[34] makes broadcast quality



Pond Station, Zach Poff (2015-ongoing), Wave Farm, Acra, New York. Drawing: Sam Baraitser Smith

sounds from a subtropical rainforest canopy available on site and online. The new stream is immediately noticeable as the only icon currently on the map in Australasia. At a micro level it opens onto a new locale: an open-ended 'live archive'[35] in which the listener can begin to orientate themselves among scattered constellations of frogs and insects at night, varying over time from dense and syncopated to sparse, with occasional squacks and a recurring descending drawn-out *zzzzz* that sometimes appears to move swiftly across the sound space. This is a forest remnant on a main road, surrounded by agricultural land and close to major population centres. So the sounds of fruit doves at daybreak, heard in Reveil 2019, which evoke the writing of Steven Feld,[36] overlie a background of rush hour traffic, and at night, as now, there is the bellow of a cow, shouts, hammering and a dog, all quite muted by distance, with high pitched rustling foliage close by.[37] It is anticipated that it will acquire online listening notes and a dispersed listenership who gradually familiarize themselves with its circadian and seasonal flows, as has been the case with the Cyberforest microphones.

The Mary Cairncross installation has also served as proof of concept for placing a streambox powered over ethernet high in a large tree 100m from the Reserve's interpretation centre, where the stream and soundmap are presented along with other exhibits. It gives remote access to the canopy biome and a sense of the site early and late when it is closed to the public.

Biosphere Soundscapes aim to make an appreciation of sound and ecoacoustics part of education and public policy, while continuing to demonstrate and develop that understanding at a base level through community engagement. This provides an essential pool of experience and approaches for the BIOM project going forward.

Another point of reference in this emerging field is Zach Poff's *Pond Station*. Consisting of a custom array of hydrophones and other sensors, *Pond Station* is a permanent floating monitoring platform that relays live sounds from near the bottom of a pond at Wave Farm in the Upper Hudson Valley, New York. The pond becomes animated as the water warms through the day, and as the whole pond warms up in spring. Over a longer cycle, duck weed has grown more thickly on the surface, reducing light penetration and overall biotic activity. The Pond Station has inadvertently become a monitor of the effects of agricultural run-off on freshwater diversity. It has also effectively enlisted Poff as an activist, looking for ways to mitigate the effects of enrichment on the pond's soundscape.[38]

The Spit – Listening to uncertainty

> DS (Walney): i wonder if listening at night puts you in a different frame of mind?
>
> JK (Seoul): could be. i think listening is not like a discrete object , but more like... water. it doesn't have fixed shape. everyone discovers something different while listening. the listeners situation affects how they listen.
>
> DS: do you literally picture yourself there… somewhere in the scene?
>
> JK: i feel like i stand still. the static position of the streambox affects how I listen remotely. it kind of forces me to find something.
>
> DS: a bit like the audio equivalent of a bird hide?
>
> JK: haha, yes, similar to a bird hide.
>
> *Dawn Scarfe and Jiyeon Kim discussing a live stream from 'the Spit' 14:58 28/08/2017*

Soundcamp have collaborated with Full of Noises and the Cumbria Wildlife Trust on a live stream from South Walney Island (2016 – ongoing), also available on the Locuscast soundmap. The location is a Site of Special Scientific Interest (SSSI) whose unstable shingle ecology means that it is normally inaccessible to the public.[39] A Raspberry Pi based streambox places the listener low down on a wind-blown spit, which separates an area of tidal salt marsh and mudflats from the Irish Sea.[40] The stream has led to a residency

The Spit, South Walney Island, Cumbria, UK Cumbria Wildlife Trust, Summer 2018. Trailcam photo by Sarah Dalrymple.
http://soundtent.org/biom/places/south_walney.html

program on the island and various public presentations, including Gull Spit (Soundcamp for FON, Autumn 2017), which explored connections between the site and the city of Barrow-in-Furness across the bay. An installation in Barrow Market played live sounds from the Spit, together with other off-grid microphones and showed archival materials from the island's history as a field station for Herring gull research. Sarah Dalrymple, warden at South Walney, visited the market space to give a talk about Gull ecology. South Walney Radio invited listeners to tune into the island from the project space, an un-let retail unit with changing rooms converted into makeshift listening stations.

Listening to South Walney can be an austere experience. The wind vibrated the speaker cones in the modified changing booths in Barrow Market, modulating with a high to medium pitched turbine drone from what is currently the largest off-shore windfarm in the world. Extended passages of hiss and drone border on the fully abstract, evoking an ill-defined, shifting object, very schematically imagined, in a literally flattened ontology of weather, syrinxes, water, nuclear waste vessels, air encountering a variety of surfaces over time.[41]

This is a different mode of listening than that employed during a Cyberforest bird census. A listener with a particular interest in ornithology will pick out species. But often what can be heard is not diversity but repetition; not variability but a restricted set of sounds: there is a paring away here, the open flat stretch reduces resonance, sounds are stretched thin. Over time you can tune to the soundscape and hear it more acutely. You can become a kind of (ignorant) expert.[42]

The live streams are sometimes interesting because nothing happens[43] and because, even when it does, of the uncertainty they embody: not only is the sound source hidden (acousmatic); it is often unclear, unfamiliar or maybe still to reveal itself or be announced. We listen particularly closely to something we hear but can't identify: the *informe* which evades naming occupies a particular zone of curiosity.[44] Partly through perplexity, the listener to remote soundscapes can perhaps acquire a sense of the texture of an environment not available through other modes of engagement. The sense of soundscape that results remains fluid, fleeting and unresolved.

The Walney stream tells us there is something inseparable about the concentration of nuclear infrastructure, nature reserves and migration. Despite the routine imposition of boundaries between them (in industrial, heritage and wildlife discourses), these things can be heard to be entangled in compelling ways.[45]

Reveil – Listening to things with others for a long time

Reveil is a 24 hour broadcast of live sounds of daybreak coordinated by Soundcamp, which relies on the practices above and has been interested to draw them together, in an annual event since 2014. Starting near the Greenwich Meridian at 5AM, Reveil travels west following the grey line just ahead of sunrise, when birds and other organisms generate a continuously changing wave of sound. Live audio feeds are supplied by streamers around the world using devices from phones, laptops and Raspberry Pi's to commercial broadcasting equipment. Domestic scale projects join formal research networks to realize a collective composition of environmental sounds lasting one earth day. Reveil links a series of micro festivals (soundcamps) on International Dawn Chorus Day.

Together with other projects described here, Reveil anticipates the concerns of the BIOM project. Developing a broadly ecological approach, in the spirit of Guattari's Three Ecologies[46] or Gablik's 'connective aesthetics,'[47] it has been interested to link separate sound and ecology projects, sometimes revealing connections that were unsuspected or obscured, and setting up new solidarities and exchanges.[48] [49]

The broadcast creates opportunities to listen to things other than human speech and music. It includes only a few minutes' total announce time, opening a space that is uncommon in the radio spectrum. Although Reveil shares ground with Bruce Davis' Wilderness Radio,[50] in fact few of the feeds for Reveil come from wilderness areas. The program's occasion on International Dawn

Chorus Day invites participants to consider the contributions of birds and other organisms to the soundscape. This extends to fish, amphibians, machines, weather, diversifying attention at a time when human sounds tend to be reduced, and even congested urban soundscapes can reveal sonic 'wild life'.[51]

Reveil has helped widen participation in the Locus Sonus open microphone project, by providing technical support, a focus for collaborations on DIY broadcasting tools, and opportunities for group listening outside conventional cultural spaces.[52] The crowd-sourced nature of the broadcast means that the ways people interact with Reveil are participatory and experimental from the outset, and include the 'noise' of transmission, from microphone handling to EMI affecting analogue devices, to network hiss.

This extends to the quality of the 'real-time' connections provided by the streams. A performance at Soundcamp 6 involved an improvisation between two environmental streams, live electronics and two keyboards, separated between London and Jeju Island, South Korea. The performance conveyed a sense of distance partly through the way the players negotiated the challenges of coordinating rhythms and harmonies with lag times on the network fluctuating up to several seconds. Making a real-time connection, as Jean Cristófol argues, is about participating in a common process, not about establishing an immediate link.[53] Rather than trying to minimise or compensate for latency and other artefacts of transmission, Reveil takes them as an indicator of what is at stake when a remote stream is established.

For the 'DIY environmental broadcaster,' the experience of setting up a stream in the dark at daybreak is of having your attention divided between the sounds around you and that you are making, the equipment you are working with, the transmission device(s) you are using to access a network, and the remote frame of the broadcast you are trying to synch with in the window between civil twilight and sunrise, at the point when the station will pick up your stream and these quite fluid entities will coincide, along the grey line of first light as it reaches your location.[54] Frustrations and anxious calculations, together with tiredness as the broadcast continues, together contribute to a curious collective sense of 'environmental concern.'[55] [56]

Reveil creates opportunities to listen to live environmental sounds together – in one place and many,[57] for a long time,[58] in situations where co-production and crowd-sourcing tend to blur artist and audience roles. Those sounds reflect collaborations across arts and sciences, through co-productions and research partnerships.[59]

Taken together, these elements are looking for ways to provide a sketch or 'proposition' of an emerging set of practices and places, which draw attention in their different ways to sound as a common resource that tends to escape private or public designation.[60] Reveil is interested to imagine what can be gained by thinking these practices together and bringing them into communication. This is a basic inspiration for Biosphere Open Microphones.

BIOM

It was proposed to develop the BIOM project within the frame of the UNESCO MAB program, as an extension of Biosphere Soundscape's work in the UNESCO Biosphere Reserves (BSR's) and because it resonates with the program's support for innovative relationships between people and their environments. The partners are those organisations that have already been involved with live environmental sounds in different ways over an extended period. The program was launched at Sound + Environment 2017, with the following aims:

BIOM aims and objectives

- To establish a new network of live streams from UNESCO Biosphere Reserves, available in real-time via an online soundmap as a public resource for artists, researchers and activists.
- To use the UNESCO Man and the Biosphere programme as a frame to make real-time connections and share learning and experiences between sites.
- To preserve the diversity of the current pool of live streams, which spans from domestic interventions to formal research programs, across the arts and sciences.
- To work with local groups to set up and operate new streams, using a range of approaches from commercial broadcasting technologies to DIY streamboxes and mobile apps.
- To support installing resilient open microphones in a variety of habitats in UNESCO BSRs, with the sounds publicly available for remote listening in real-time (with streaming servers hosted by Locus Sonus).
- To record the audio from the open microphones, creating long term public data-sets for the sites (with archive servers hosted by Cyberforest, University of Tokyo).
- To be led by local groups in the setup and maintenance of the open microphones, making them a hub for learning and engagement in the BRs.

BIOM streams

The following longer term streaming projects are currently in BSRs:

Shiga Highland Biosphere Reserve Shiga Nature Education Park, Nagano, Japan – Cyberforest (University of Tokyo), Shinshu University Institute of Nature Education **soundtent.org/biom/places/shiga.html**

A long term stream is operated by Cyberforest in collaboration with the Shinshu University Institute of Nature Education. The project comprises real time stereo sound transmission, data logging and public engagement, with phenological research, citizen science activities and machine based audio analysis by the SABIOD big data program at CNRS, University of Toulon. In an annual remote bird census, ornithologists listen in pairs to the live streams around dawn, communicating by IRC chat to log the species and estimate the numbers of birds they hear. The census moves from one site to the next each day. The Shiga stream is part of a program streaming live data from the University of Tokyo forests since the early days of the public internet.[61]

The area around Kobushi is currently being proposed as a new Biosphere Reserve. This would include live streaming points at Tetto and Yatake. Sounds from these sites can be heard on the Locus Sonus soundmap. Logs over many years can be accessed at the Cyberforest project page.[62]

Jeju Biosphere Reserve Jeju Island, South Korea – Weather Report **https://www.mixcloud.com/weather_report/stream**

Weather Report, an arts collaborative based in Seoul, have operated temporary open microphones from Jeju island over 3 years, including a stream from Culture Space Yang, Georo Village and a soundcamp in Gyorae Forest Park in May 2017. Weather Report have developed work with music and live remote streaming of environmental sounds, enabling local and remote audiences to become more aware of acoustic and environmental changes over time. This links to research and advocacy around local development.

Monarch Butterfly Biosphere Reserve, Cerro Pelón, State of Mexico – University of Hull, Universidad Nacional Autónoma de México, Forestry Service, Arborists' training program, Morelia **soundtent.org/biom/places/cerro_pelon.html.**

A collaboration between Rob Mackay and a cross disciplinary team from Mexico, UK, US and Canada. See Cerro Pelón above. The stream is available on the Locus Sonus soundmap at **http://locusonus.org/soundmap**. It runs off-grid over 4G and is subject to ongoing testing and periodic outages.

Golden Gate Biosphere Reserve, Jasper Ridge Biological Preserve, CA – Stanford University, Golden Gate Natural Recreation Area, Bodega Marine Reserve **soundtent.org/biom/places/jasper_ridge.html.**

The BR is a highly diverse and culturally rich complex of urban, multi-use and wild environments with coastal forests, chaparral, scrub, prairies, rare serpentine grasslands, and islands. Birdcast, a live audio stream by Trevor Hebert, shares a changing soundscape of waterfowl, amphibians, songbirds, large mammals and overflying aircraft. Launched in 2013, Birdcast soon became popular with online communities, letting ornithologists and lay experts supplement conventional bird surveys, listen out of hours and hone ID skills, and providing contact with the site for older and less able birders. New streams, archiving and additional remote sensing equipment are planned, which would reach new ecosystems above and below water, opening collaborations with other stakeholders (see Jasper Ridge above).[63]

Noosa Biosphere Reserve, Noosa, Queensland, Australia– Biosphere Soundscapes **soundtent.org/biom/places/noosa.html**

The Noosa BSR comprises 60 distinct ecosystems, with more than 300 bird species and 1300 plant species, with many endemics. An ocean corridor supports marine fauna including some 18,000 humpback whales on annual migration. Permanent streams are under development as part of an extended research and public engagement project by Biosphere Soundscapes, exploring the Biosphere Reserve via a range of recording, field studies and live streaming activities, and through public and specialist research programs with attention to both terrestrial and aquatic ecologies (see Biosphere Soundscapes above).[64]

Next steps and how to be involved

BIOM welcomes proposals for new sites and related activities. We can provide advice and technical assistance.

Raspberry Pi based streamboxes are easy to build using streaming software from Soundcamp or Locus Sonus.[65] They can also be purchased assembled or as kits.

You can start by setting up an account at Locus Sonus:

- **http://locusonus.org/soundmap/dev/admin/login** >
- 'open a new microphone and join the Locustream SoundMap project'.

A summary of methods, equipment and resources is available here: **http://soundtent.org/streaming_recipes.html**

A detailed discussion of streaming and the Locus Sonus open microphone platform is available at: **http://locusonus.org/wiki/index.php?page=Locustream.en**

Please contact one of the partners to discuss planning and setting up a stream.

Conclusion

BIOM is a diverse open microphone network, a public resource, and a creative response to the variety of planetary soundscapes and ways of encountering them.

BIOM will involve more sites, and get more people listening to them. It will engage people directly in setting up streams and talking about them, beyond conventional cultural spaces and research laboratories. Listening is not (just) about sitting, or even walking, quietly: BIOM invites listenings that embrace noise, dissonance and the paraphenalia of sensing – organic and non.

In a simple yet insistent way, BIOM is about widening participation in ecoacoustics and environmental sound art by working with affordable equipment. But participation is not confined to supplying data or oiling the networks of the smart city. As Jennifer Gabrys reminds us, participation is 'always a diverging rather than [...] unifying set of engagements',[66] and BIOM is imagined as a framework for a variety of both collective and divergent activities, with different tones and modes.

The projects described here span a great variety in terms of their artistic and scientific concerns and the kinds of engagement they invite. Yet they also share certain commitments to ecologies, translation and exchange. This poly-vocal quality is reflected in the current paper, which documents different periods, grabs, feats and failures of attention over time and across sites, as attested by different people, listening 'out of synch, but in time.'[67]

Endnotes

1 Gabrys, Jennifer 2016, Program Earth, University of Minnesota Press, Minneapolis, 20

2 Ibid. 54, 118, 132

3 This paper is based on a presentation at the Sound and Environment Conference, University of Hull in July 2017. We are grateful for thoughtful suggestions from two anonymous reviewers.

4 Saito, Kaoru et al (2015), Ambio 44(Suppl 4): 572. Accessed June 4, 2019. **https://doi.org/10.1007/s13280-015-0708-y**

5 A study into shearwater fishing behaviours fitted the birds with GPS transmitters. By accident it was found that, as the shearwaters fly or rest on the water, their movements can be disaggregated from wind and ocean currents, revealing detailed local weather patterns. Ishida, Ken: Remarks at Sense of Globe conference, University of Tokyo 2016

6 Soundcamp, personal communication

7 SABIOD accessed online 9th June 2019. **http://sabiod.univ-tln.fr/**

8 Soundcamps are micro festivals of sound and ecology linked by Reveil: a 24 hour radio broadcast that picks up live streams from the soundcamps and a network of other streamers around the world. See **http://soundtent.org**

9 Suko, Yasushi. "Natural sound from Japanese forest was relayed to Marseille". Accessed online 4 June, 2019. **https://www.youtube.com/watch?v=tgUVqbP6uBk&feature=youtu.be**.

10 Gabrys, Jennifer. "Practicing, materialising and contesting environmental data" (2016). Big Data & Society Accessed June 3, 2019. **https://doi.org/10.1177/2053951716673391**

11 Stengers, Isabelle 2011, 2014, trans. Michael Chase, Thinking With Whitehead, Harvard University Press, Cambridge, Mass., eg 256–260 and elsewhere.

12 Saito, Kaoru. "Cyberforest: a sense of globe." Presentation for TEDxUTokyo 2015. Accessed online 4 June, 2019. **http://tedxutokyo.com/en/speaker/kaoru-saito**.

13 As a concept or proposition, 'Sense of Globe' perhaps sits somewhere between the model of a subject whose range of experience is extended by engaging with online environmental sounds or other media, and the promise of more fluid, (trans)formative relationships between people and their environments through such activities.

14 Gabrys, Jennifer. Becoming Planetary. Eflux. Accessed online 4 June, 2019.

15 Sinclair, Peter. Locus Stream Open Microphone Project. 2018 ICMC Daegu, South Korea. Accessed online 4 June, 2019. **https://hal.archives-ouvertes.fr/hal-01791828v2/document**

16 Carlyle, Angus. 'The God's Eye and the Buffalo's Breath,' presentation at WFAE Viseau, Portugal 2015. **http://invisibleplaces.org/2014/pdf/ip2014-carlyle.pdf** p. 10 Accessed online 5 June 2019.

17 "'Planetar-ity" was figured as a word set apart from notions of the planetary, the planet, the earth, the world, the globe, globalization, and the like in their common usage. Planetarity is not susceptible to the subject's grasp. The globe is on our computers. No one lives there. The "global" notion allows us to think that we can aim to control globality. The *planet* [our emphasis] is in the species of alterity, belonging to another system (Gayatri Chakravorty Spivak in Cassins, Barbara, The Dictionary of Untranslatables, trans. Emily Apter. Accessed online 6 June 2019.

https://slowrotation.memoryoftheworld.org/Barbara%20Cassin/Dictionary%20of%20Untranslatables_%20A%20P%20(14416)/Dictionary%20of%20Untranslatables_%20-%20Barbara%20Cassin.pdf

18 Gabrys, Jennifer (2016). Program Earth: 14, 104.

19 Gabrys, Jennifer. Becoming Planetary. Eflux. Accessed online 4 June, 2019. **https://www.e-flux.com/architecture/accumulation/217051/becoming-planetary/**

20 For the value of the *milieu* for thinking about sound, we are grateful for the comments of Roberto Barbanti within the framework of the symposium Pratiques de l'écoute, écoute des pratiques #8: écologies sonores, écosophie et communs auditifs, 21–11-2018, organised by antiAtlas, Locus Sonus and Iméra.

21 Mackay, Rob et al. 'Following the Flight of the Monarchs', presentation for Ecoacoustics Congress, Brisbane 2018. Accessed online 9 June 2019. **https://ecoacousticscongress.files.wordpress.com/2018/07/ecobooklet_monday16july_final.pdf** p106. The live stream is a collaborative project by Rob Mackay (University of Hull, UK) with Pablo Jaramillo (Universidad Autónoma de México), David Blink (College of the Sisquiyous, USA), the Forestry Service in Morelia and a local NGO: Butterflies and their People who provide training in arboriculture. Technical and remote support by Soundcamp, UK. The stream is available on the Locus Sonus soundmap at **http://locusonus.org/soundmap** > cerro-pelon. A remote capture of the stream giving a sense of the soundscape is at **http://soundtent.org/present/acoustic_commons_marseile/cerro_pelon.html**.

22 UNESCO. About MAB. Accessed online 6 June 2019. **http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/about-mab/**

23 World Network of Biosphere Reserves 2017–2018. Accessed online 9 June 2019. **https://unesdoc.unesco.org/ark:/48223/pf0000259695**

24 Some of these are involved directly: ecologists (Pablo Jaramillo-López and ornithologist colleagues at UNAM); arborists with the locally based NGO Butterflies and Their People (butterfliesandtheirpeople.org); forest rangers (Pato Moreno and colleagues); musicians and sound artists (Rob Mackay, David Blink, John Sanders, Vaughan Garland); poet Rolando Rodríguez; a video artist Jessica Rodríguez; documentary maker Anna Chahaneau; and local networking engineer Franco Ramírez. A wider group has included the 800 members of the Kansas based Monarch Watch citizen science network (monarchwatch.org). The livestream has been the subject of discussions with scientists for potential ecosystem monitoring, as well as being as used in live performances and exhibitions (Ambient@40 Conference – University of Huddersfield; CENSE Conference – Budapest; British Science Festival – University of Hull). It will be featured on a radio programme forthcoming on the BBC.

25 Kolar, Jeff: personal communication. Jeff Kolar (founder and director of the Radius, Chicago) was talking about the collective experience and effect of participating in Eric Leonardson's *SoundTent* at *Camp Sherwin*, a live transmission from Marion Mahony Griffin Beach Park on the shore of Chicago's Lake Michigan on Saturday May 2, 2015 at 5am CST. **https://theradius.us/episode63**. It resonates with Tetsuo Kogawa's thinking on mini radio, for example at: **https://anarchy.translocal.jp/radio/micro/radiorethink.html**

26 The idea that exchanging sounds can usefully be thought of as linked to the (paradoxical) process of pointing and drawing attention to the common-place was suggested by Ella Finer in a round table discussion organised in the frame of Soundcamp 6 with members of the Acoustic Commons Study Group, Tower Hamlets Cemetery and Stave Hill Ecological Park, London, 4–5 May 2019. See also Michel de Certeau: The Practice of Everyday Life.

27 Jasper Ridge Biological Preserve is a field station of Stanford University. More information and the Birdcast live stream by Trevor Hebert is available at **http://jrbp.stanford.edu/about/facilities/live-audio-stream**.

28 The network development is being led by Rob Mackay (University of Hull).

29 Barclay, Leah and Toby Gifford, Acoustic Ecology in UNESCO Biosphere Reserves, Biosphere Journal Volume 1-1 #2 Accessed online 9 June 2019. **https://biospherejournal.org/vol1-1/second-article/**

30 Barclay, Leah 2014, Biosphere Soundscapes, Leonardo 47(5):496–497 October 2014

31 Barclay, Leah and Toby Gifford, Acoustic Ecology in UNESCO Biosphere Reserves, Biosphere Journal Volume 1-1 #2 Accessed online 9 June 2019. **https://biospherejournal.org/vol1-1/second-article/**

32 More information: **https://leahbarclay.com/portfolio_page/river-listening/**

33 Eudlo Creek (2019); Mary River, Noosa Biosphere Reserve (2018); more recently from the Brisbane River with Mauricio Ireguí (see tweet above).

34 Mary Cairncross Scenic Reserve, Queensland. Live stream accessed 6 June 2019 at **http://locusonus.org/soundmap/**

35 Soundcamp (2018) "The Live Audio Archive". Leonardo, Volume 51 Issue 3 June 2018. **https://www.mitpressjournals.org/doi/abs/10.1162/leon_a_01536**

36 Feld, Steven (1982). Sound and Sentiment: Birds, Weeping, Poetics, and Song in Kaluli Expression. Durham and London: Duke University Press 2012. See eg: 30, 31-2ff.

37 Listening notes, Grant Smith (London), 7 June 2019 14:59 UTC+1. Recording available.

38 **https://www.zachpoff.com/artwork/pondstation** accessed online 9 June 2019. Zach Poff in conversation with Soundcamp for The Acoustic Commons, Resonance Extra, 15 December 2017: **http://soundtent.org/acoustic_commons**

39 Soundcamp. BIOM South Walney. Accessed online 4 June, 2019. **soundtent.org/biom/places/south_walney.html**

40 The Walney stream has been a useful prototype for an installation over mobile networks in a site exposed to strong winds off the sea. Soundcamp and Octopus Collective's Andrew Deakin developed a rubberised timber enclosure based on a small vernacular building, weighted with stones, to house the microphones, and custom wind-screens with wool wadding. The box creates a roughly binaural sound space, in which the listener can track seabirds, insects, nuclear waste vessels, and seals as they pass and approach and recede.

41 'That no-matter-what is something indicates nothing other than the possibility of a flatness: that by which everything is equally.' Garcia, Tristan 2010, 2014: Form and Object: A Treatise On Things, Edinburgh University Press, trans. Mark Allan Ohn and Jon Cogburn, 30. Also Gabrys 2016, 153–4.

To listen directly and for detailed listening notes including Maria Papadomanolaki's 'Transmitting turbulence', see: **http://soundtent.org/south_walney/GULLSPIT.html**]

42 'Artists can contribute fundamentally to [...] the art of detection, the augmentation and radicalisation of sense perception – listening, seeing, detecting physicality, and bringing to attention – which is perhaps more connected to the idea of art as a form of intense connoisseurship.' Weizman, Eyal (2017) "We Are All in the Mud". Interview with Lucas van der Velden, Sonic Acts Research Series #32. Accessed June 9 2019. **https://sonicacts.com/portal/we-are-all-in-the-mud**

43 Sinclair, Peter, in conversation with Soundcamp for The Acoustic Commons, Resonance Extra, 22 December 2017 **http://soundtent.org/acoustic_commons/**

44 'The *informe* is the agent of uncertainty in perception. It is that which casts doubt, a sort of anti-identification.' Bonnet, François 2016, The Order of Sounds, Urbanomic, Falmouth, 282ff.

45 On entanglements as problematic and indispensable connections, see: Tsing, Anna Lowenhaupt (2015) The Mushroom at the End of the World: On the possibility of life in capitalist ruins. Princeton: Princeton University Press 2015: 5–6, 168 and elsewhere. Also: Haraway, Donna J (2008). When Species Meet. University of Minnesota Press.

46 Guattari, Félix (1989). The Three Ecologies, trans. Ian Pindar and Paul Sutton. London: Bloomsbury 2014.

47 Suzi Gablik suggests that 'connective aesthetics' emerge from a "fieldlike conception of the self that includes more of the environment – a selfhood that releases us into the sense of a radical relatedness". Gablik, Suzi (1992). Connective Aesthetics, American Art, Vol. 6, No. 2 (Spring 1992): 2–7.

48 Solidarities or 'communities of inquiry' comprising experts, lay experts and others. See, for instance: Donna Haraway, "Symbiogenesis, sympoiesis, and art science activisms for staying with the trouble". In Tsing, Anna et al (2017) Arts of Living on a Damaged Planet. University of Minnesota Press. Chapter 2: M25ff.

49 Ways that disparate projects can find surprising solidarities in response to precarity and precarization are described notably by Isabell Lorey in Lorey, Isabell (2015). State of Insecurity. London: Verso. See for example the introduction (p15) and her account of the activist research activities of Precarias a la Deriva pp 91 ff.

50 Davis, Bruce (1975). "FM Radio as Observational Access To Wilderness Environments". Alternatives, Spring 1975: 21–2.

51 Ella Finer: Falling Outside: Sonic Miscellanies and the Wild Life of Sound. Accessed online 7 June 2019. **https://www.gold.ac.uk/calendar/?id=12262**.

52 At the London soundcamp in Stave Hill Ecological Park, the Reveil feed is played out in a canvas bell tent (soundtent), where a group of listeners can follow the broadcast, while continuing to hear the local sounds around. The blueprint for a soundcamp referenced by some twenty soundcamps in other locations each year, includes having some kind of point for group listening, which may be minimal, depending on power and network conditions.

53 Jean Cristofol 2008, 'Flows, stocks and leaks' **http://temporalites.free.fr/?browse=Flux,%20stock%20et%20fuites** accessed online 4 June, 2019.

54 The crowd-sourced, experimental broadcast sounds different from most radio, with its emphasis on achieving a consistent and unbroken surface. The 2019 Reveil broadcast included a vivid transmission by Nhung Nguyen, in which periodic dropouts enhanced the sense of movement as the artist walked through a market in Hanoi in the very early morning, negotiating a way through traders, nightowls, market paraphernalia, and variable mobile networks. See Reveil 2019, schedule of streams: **https://paper.dropbox.com/doc/Reveil-6-2019--AetD0w6c36RBIJwySPolNixSAg-0uREPQ0BhaC4o9uztt7p2**).

55 'A relation does not spring up between two terms that are already separate individuals, rather, it is an aspect of the internal resonance of a system of individuation. It forms a part of a wider system [Simondon in Gabrys, 2016, 105]. Gabrys offers a detailed and rewarding account of how subjects (or superjects) arise out of such relations of resonance within milieux, whether, for our purposes here, as streamers, listeners or both. Her account offers ways to understand work with environmental sound as part of wider kinds of 'sensing' that are at once more active and more collective than classical accounts of listening that focus on quiet and receptivity. Gabrys' account is based in close readings of Whitehead, sometimes as 'thought together with' Isabelle Stengers; and of Simondon and others.

56 In streaming, the remote and real time sense of place is transposed onto the immediate environment of a listener, cohabiting, contradicting and enriching the personal, social and political significance and understanding of the world around us, on a micro and macro scale. Such a concern echoes Westerkamp's idea of listening as a hugely enriching process to understand what is happening and to 'reconnect to our environment' in "How opening our ears can open our minds" CA:CBC.2017. Accessed online 4 June, 2019. **https://www.cbc.ca/radio/ideas/how-opening-our-ears-can-open-our-minds-hildegard-westerkamp-1.3962163**

57 At the London soundcamp in Stave Hill Ecological Park, the Reveil feed is played out in a canvas bell tent (soundtent), where a group of listeners can follow the broadcast, while continuing to hear the local sounds around. The blueprint for a soundcamp referenced by some twenty soundcamps in other locations each year, includes having some kind of point for group listening, which may be minimal, depending on power and network conditions.

58 Experiences with extended listening are relatively rare. Reveil has had chances to listen for a long time to the sounds of Kolkata, as sounds of crows, dogs and cuckoos give way to sounds of human activities, or a bog in Estonia as a dense, detailed dawn chorus builds. They can involve more abstract listening experiences, comparable to listening to music (drones etc) in which restricted sets of sounds establish a register that varies slightly but decisively, as the listener becomes attuned to subtle variations. This is a feature of passages of the Reveil broadcasts, where typically time-poor listeners have the strange luxury of listening to seemingly interminable stretches of austere hydrophone drones as the broadcast creeps across the Pacific in real time See: Soundcamp (2016). "Sounds nothing like the sea". Performance Research Volume 21 No 2 April 2016: On Sea/At Sea and a digital supplement at **http://soundtent.org/on_at_sea/on_at_sea_working.html**. Accessed November 1 2019.

59 In addition to partnerships with Cyberforest at the University of Tokyo, the University of Hull and Aix-Marseille University, recent work has included a live stream from the Milpe Bird Reserve in Ecuador by Paola Moscoso and a team from the Sussex Humanities Lab, linked to Alice Eldridge's research on 'humanising algorithmic listening.' See Eldridge, Alice et al (2016). "A new method for ecoacoustics? Toward the extraction and evaluation of ecologically-meaningful soundscape components using sparse coding methods". PeerJ, 4. E210. 2016.

60 A milieu is altered, to some extent, when its sounds are placed online, putting them (in some senses, to some degree) in the public domain. Potential shifts in value, register, sense of ownership and access are seemingly at stake. Opening a site to remote listening can be linked to a wider concern with sound as it crosses and queries boundaries between public and private space. Elsewhere we have suggested this can usefully be thought of as a kind of 'acoustic commoning'. See, for example, a series of site specific conversations and broadcasts entitled Acoustic Commons: **http://soundtent.org/acoustic_commons**. Soundcamp 6 (May 2019) included a round table discussion convened by Ella Finer with the Acoustic Commons Study Group. See also **http://www.antiatlas.net/pratiques-de-lecoute-ecoute-des-pratiques-8-ecologies-sonores-ecosophie-et-communs-auditifs**. The idea of 'latent commons' is discussed by Anna Tsing, 2015, 133, 255.

61 Kaoru Saito et al. "Utilizing the Cyberforest live sound system with social media to remotely conduct woodland bird censuses in Central Japan" Ambio vol. 44, Suppl 4 (2015): 572–83.

62 Cyberforest project page: **cf4ee.nenv.k.u-tokyo.ac.jp/en/pad/otanomo.php** For streams from the proposed Kobushi BR, follow #Tetto or #Yatake, or go to the soundmap at **http://locusonus.org/soundmap**

63 Golden Gate Biosphere Reserve. Accessed June 9 2019. **http://www.unesco.org/mabdb/br/brdir/directory/biores.asp?mode=all&code=USA+42**

Listen to the Noosa Biosphere Reserve: Barclay, Leah (2017). Accessed 9 June 2019. **https://soundcloud.com/leah_barclay/dawn-in-the-noosa-biosphere-reserve-excerpt-from-reveil2017-live-stream**

64 On the Noosa BR see **noosabiosphere.org.au / biospheresoundscapes.org** Listen at **soundcloud.com/leah_barclay/dawn-in-the-noosa-biosphere-reserve-excerpt-from-reveil2017-live-stream**

65 Available at **http://locusonus.org/locustream/#phone** and **https://itunes.apple.com/us/app/ locuscast/id866992547?ls=1&mt=8**. Or go to **http://soundtent.org** and choose 'Stream'.

66 Gabrys, Jennifer: Program Earth, University of Minnesota Press, Minneapolis 2016, p 223.

67 Moten, Fred and Wu Tsang: Who Touched Me? If I Can't Dance I Don't Want to be Part of Your Revolution, Amsterdam 2016, p7. **https://monoskop.org/images/b/ba/Moten_Fred_Tang_Wu_Who_Touched_Me_2016.pdf** accessed 9 July 2019).