DIS_TURBATION – AN ARTISTIC APPROACH TO FOSTER NATURE-CONNECTEDNESS

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ABSTRACT

This paper presents practice-based research on ecoacoustics, ocean soundscapes and anthropogenic noise. It explores creative strategies to the introduction, experience and perception of ocean soundscapes in artistic creation. Ocean soundscapes are a crucial tool to foster an *emotional affinity* between people and natural environments.This research questions how to convey the experience of oceanic soundscapes and their human disruption by detailing an artistic artefact - *DIS_turbation* - and its integrative approach. It explores the vibrational and particle-motion component of ocean sound and defines place attachment, creative development, *nature-connectedness* and ecology of *Æffect* as methods. The contributions include addressing biological processes to foster underwater noise dialogue, reveal qualities of vibroacoustic ecology, develop artistic artefacts to translate particle-motion in a more grasping way, and foster inclusion with nature.

Keywords: Ecoacoustics; Ocean soundscapes; Anthropogenic noise; Particle-motion; Artistic creation; Nature-connectedness

1. INTRODUCTION

Global issues such as climate change and ocean pollution are a present matter in societies. Ecoacoustics, a recent scientific field that studies sound (natural and anthropogenic) and its relationships with the environment, is a crucial tool to understand these problems (Farina & Gage, 2017; Pavan, 2017). Ecoacoustics evolved from the environmental movement ideas and acoustic ecology research practices.

In 1962 Rachel Carson wrote *Silent Spring* alerting for the absence of bird songs within the natural environment due to abusive use of pesticides (Carson, 1962). A couple of years later, Murray Schafer established the World Soundscape Project. Shafer (1977) developed the concept of soundscape, defining it as the sonic environment itself, "while any portion of the sonic environment [can be] regarded as a field of study" (Shafer, 1977, p. 224). The author also mentioned the importance of listening carefully to our environment, suggesting the world as a global soundscape. Pauline Oliveros (2005) further developed the concept of listening with attention, proposing deep listening practices and techniques to connect with the environment. At this time, significant names such as Barry Truax and Hildegard Westerkamp highlighted the potentialof soundscapes to perceive environments and developed the field of soundscape composition (Pinch & Bijsterveld, 2012, p.7). Westerkamp (2002, p. 52) defends that "its essence is the artistic, sonic transmission of meanings about place, time, environment and listening perception." While Schafer (1997, p. 9) proposed a soundscape categorisation[1] according to the presence of *keynote* sounds, *signals* and *soundmarks*, Bernie Krouse (2015, p. 12) suggested a classification of soundscapes concerning their core acoustic sources[2]: *biophonic, geophonic and anthropogenic*.

The quest to analyse the components of a soundscape paired with the evolution in recording technologies helped set the stage for Ecoacoustics to develop. The field of ecoacoustics studies the importance of sound as a component of an environment. Ecoacoustics is a combination of studies in ecology and (bio) acoustics that "investigates natural and anthropogenic sounds and their relationships with the environment over multiple scales of time and space" (Farina & Gage, 2017, p. 1). It concerns the ecological role of sounds, specifically to long-term monitoring, habitat health, biodiversity assessment, soundscape conservation and ecosystem management. Today, we see an increase in researchers, scientists and artists that rely on sound or soundscapes to study and understand environments and to a growing interest of musicians and composers to include natural sounds in their compositions (Monacchi & Krause, 2017). Therefore, ecoacoustics approaches are a promising field to improve the link between sciences and art, providing the setting for artistic exploration of sound material. Additionally, considering soundscapes as the acoustic signature of places, one can assess their overall health by studying them. Likewise, understanding soundscapes can be a powerful tool to predict the environments' evolution through time (Farina & Gage, 2017).

1 Keynote sounds for background listening, signals for perception at forefront and soundmarks as having cultural or symbolic meaning in the community.

2 Biophonic sounds are from living organisms, geophonic are from natural elements, and anthropogenic are man-made sounds.

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Furthermore, it can bridge a considerable gap in understanding noise pollution impacts in less studied oceanic communities.

The growing human interference in the ocean ecosystem is becoming a threat to marine life. These interferences may assume many different forms such as intense fishing, ship traffic, chemical pollution, coastal industrialisation, offshore platforms for oil/gas extraction, offshore wind farms, naval exercises or seismic surveys (Pavan, 2017, p. 245; Di Franco et al., 2020). Accordingly, marine noise pollution can affect aquatic species in many different ways, either directly or indirectly, and studies from all over the world support this (Williams et al., 2015; Dahl et al., 2015; Au & Lammers, 2016; Popper et al., 2020; Di Franco et al., 2020). From problems in communication caused by masking to ear damages, including acoustic trauma and hearing loss or changes in behaviour and metabolism by creating stress responses (Filiciotto & Buscaino, 2017, p. 68), these disturbances can deeply compromise the ocean health and its ecosystems.

Advances in technology made possible an in-depth exploration of the underwater world, and the field of ecoacoustics allowed access to crucial information from places otherwise difficult to reach (Risch & Parks, 2017). Moreover, it opened a whole new approach to profoundly understanding ocean soundscapes and alerted to an apparent lack of information on marine noise pollution impacts. As Risch and Parks (2017, p.147) state:

> Concerns about the increasing impact of anthropogenic noise, particularly of low-range and ubiquitous noise sources such as global shipping traffic or seismic surveys, have also led to calls for a more holistic approach to monitoring aquatic soundscapes.

Until very recently, and as explained by Angelo Farina (2018) and Di Franco et al. (2020), the large number of studies evaluating anthropogenic noise measured mainly the sound pressure level, while the kinematic nature of the sound field was lacking. Gianni Pavan (2017, p. 234) shares these ideas, pointing to a need to improve knowledge on the biology of “disturbance” since little is known about its impact on the life history of the animals and their preys. Roberts and Elliot (2017) further discuss the issue, explaining that many anthropogenic sources are “likely to cause vibration within the seabed by direct means (e.g. contact with the sediment) or indirectly (propagation via the water column)” (Elliot, 2017, p. 256). Moreover, the authors defend a clear gap in understanding vibration levels (both natural and anthropogenic) in the seabed. Farina et al. (2019, p. 51) alert to the forgotten measurement: the *particle-motion*[3]. Indeed, anthropogenic activities such as dredging, pile-driving and drilling in the seabed add significantly to the overall *vibro-scape*. Pointing to the lack of criteria for the management of seabed vibration, the authors suggest that “such criteria require information regarding the wide range of sensory abilities, source type and propagation conditions in the marine environment […].” (Roberts & Elliot, 2017, p. 256). Nedelec et al. (2016, p. 837) detail the physics of *particle-motion:*

3 Particle motion can be expressed as particle velocity, particle acceleration and particle displacement. It will be used in this text the term particle-motion to refer to the movement of water by sound or vibration.

> A sound wave propagates because particles next to a vibrating source are moved backwards and forwards in an oscillatory motion; these particles of the medium do not travel with the propagating soundwave, but transmit the oscillatory motion to their neighbours. This *particle motion* contains information about the direction of the propagating wave.

Additionally, many marine species have specialised sensorial systems that allow them to detect kinematic characteristics, such as the particle-motion, that reveal relevant spatial information of the sound field, making it possible to localise sound sources (Farina et al., 2019, p. 51). Another significant particularity is the fact that fish and aquatic invertebrates' body's composition is mainly water, which makes them be "coupled directly to the medium (water)." (Nedelec et al., 2016, p. 837). In this sense, their whole body vibrates when a sound wave passes through, and it is the presence of adapted structures that make them sense particle oscillations. Examples include the otoliths (denser calcareous structures in the ear) of fish or mechanoreceptors such as superficial surface receptors. Examples include internal statocyst receptors[4] or chordotonal organs[5] localised in joints appendages that are considered sensitive to vibration (Roberts & Elliot, 2017).

4 Used mainly for gravity detection, the statocyst is a fluid filled chamber containing a mass (statolith) and sensory hairs inside, that is also used to detect particle-motion.

5 Chordotonal organs are situated in the joints of appendages and are sensitive to vibration and in some species also to substrate motion. See Burke (1954) *An organ for proprioception and vibration sense in Carcinus maenas.*

Nedelec et al. (2016) point to the need for a deep understanding of the particle-motion component of underwater sound. Many aquatic species rely on it and not on sound pressure to perceive environments. The authors reveal the dual nature of underwater sound: "sound waves in water have both a pressure and a particle-motion component, yet few studies of underwater acoustic ecology have measured the particle-motion component of sound." (Nedelec et al., 2016, p. 836). This is especially important because while sound pressure is relevant for marine mammals and birds, particle-motion is what fish and invertebrates are sensitive to (Nedelec et al., 2016; Di Franco et al., 2020). Farina et al. (2019, p. 53) also point out that some aquatic species choose shelters based on their acoustic amplification properties. Nonetheless, when only accessing the sound pressure, the boost effect caused by particle-motion caused by the geometric characteristics of the cavities is not present. Vibration and particle-motion are the missing links for studying underwater noise impacts in ocean soundscapes on a deeper level. However, inadequate availability of appropriate equipment is still making it a challenge. Nonetheless, it is imperative to understand the consequences that small changes in vibration might cause to marine ecosystems.

In this context, Pichegru et al. (2017, p. 1) argue that one of the most intense human-made ocean noise examples in underwater context are seismic surveys[6]. Moreover, the authors defend that these activities interfere with mostly all marine life that uses underwater sound for their biological activities such as communication, orientation or individual recognition. Carroll et al. (2017, p. 10) support these findings and point to the lack of information on seismic survey impacts on fish and invertebrates. Their experiments provide scientific evidence for high-

6 Marine seismic surveys produce high intensity, low-frequency impulsive sounds at regular intervals, with most sound produced between 10 and 300 Hz.

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intensity and low-frequency sound-induced physical trauma on some fish and invertebrates. However, according to the authors, there is still a long way to understand these impacts, primarily because of the knowledge gaps on thresholds and the unrealistic sound exposure scenarios that lab conditions create. Pichegru et al. (2017, p. 1) add that seismic surveys can cause organ damage in fish, such as the sensory cells in their ears, increased fish eggs' mortality, and elevated mortality in zooplankton.

To further address this issue, McCauley et al. (2017, p. 1) replicated seismic surveys activities with zooplankton and concluded that all krill larvae were dead after the air gun operations. These preliminary findings show that these activities' potential impact on overall ocean ecosystem function is far from being truly understood and needs further research (Pichegru et al., 2017, p. 2). These results point towards the invisible catastrophic implications that marine noise pollution might be causing to ocean homeostasis. Recent research by Roberts et al. (2016), Roberts and Elliot (2017, p. 255), and Di Franco et al. (2020) support the fact that anthropogenic activities on the seabed, such as drilling or pile-driving, affect benthic species[7] and fish due to the introduction of excessive vibration. In this sense, there is an urge to improve understanding of how these activities that introduce vibrations may change particle-motion in these environments and impact other species that depend on seismic signalling[8] to communicate (Roberts et al., 2017, p. 256). These signals are essential forms of vibrational communication in many species, and they are being affected by anthropogenic influence.

A crucial biological process that many benthic species perform is *bioturbation*: "the mixing of sediment by living organisms" (Herringshaw & Solan, 2008, p. 201). In this process detailed by Herringshaw and Solan (2008), the organisms burrow, feed, and perform locomotory and ventilatory behaviours, altering biochemical reactions. They also facilitate the redistribution of sediment particles across the sediment-water interface. Moreover, the authors recognised that "benthic biodiversity plays a role in ecological and biogeochemical processes at a global scale" and that *bioturbation* directly "alters key ecosystem processes, including organic matter remineralisation and decomposition, nutrient cycling, pollutant release, sediment resuspension and microbial activity." (Herringshaw & Solan, 2008, p. 202). We question to what extent anthropogenic activities might impact the process of bioturbation. Suppose *bioturbation* is a crucial process for ocean health and nutrient recycling. What is the damage to the overall ocean health and the extension of these impacts on the aquatic environment if benthic species can't perform the *bioturbation* process due to species loss from anthropogenic actions?

Despite Roberts and Elliot (2017, p. 264) conclusions show that "further evidence is needed to determine the extent to which anthropogenic noise on the seabed affects benthic invertebrates", they claim that "for the first time it does confirm that responses due to marine activities are detectable." The authors showed how disruptions caused by bursts of movement could impact how these animals spend energy, referring to behavioural changes and physical ones. Additionally, the

7 *Benthos* in Greek means "depth of the sea" and refers to any organism that lives on or near the seabed, river, or stream bottom – the benthic zone.

8 Seismic signals are a form of communication by the use of vibrational waves. Some species use these bioseismic cues in activities such as mate finding, warning, or group cohesion. They may also serve to discourage predators from approaching.

authors detailed individual organism's responses such as antenna and mouthpart movements, stress protein produced, and oxygen and heartbeat variations. In bivalves, they identified valve closure changes due to vibration exposures that can affect their overall energy balance, to the point of disrupting or even stop heart rates. Furthermore, they point to the importance of these sessile[9] species since they cannot move away from vibration sources. Finally, they pointed to the lack of information on ambient levels of seabed vibration and on levels of impulsive or continuous sources impacting the sediment (Robert & Elliot, 2017).

9 Sessile species are usually permanent attached to a structure. They lack a means of self-locomotion.

As a response to the need to better understand the aspects of biological communication through vibration, a new field called *biotremology* emerged. It studies "vibratory communication behaviour through use of substrate-borne boundary, or surface, mechanical waves" (Hill et al., 2019, p. 15). A *vibroscape* shares the same core components of a soundscape and is a "collection of biological, geophysical and anthropogenic vibrations emanating from a given landscape to create unique vibrational patterns across a variety of spatial and temporal scales" (Šturm et al., 2019, p. 125). *Vibroscape* research as a field is still relatively unexplored but at the same time crucial in communities that rely on vibration for perceiving environments.

Understanding sound vibration is supported by studying the physical aspect of acoustics. Almo Farina described sound as a "flow of energy in the form of lateral vibrations through a medium capable of oscillation" (Farina & Gage, 2017, p. 1). If the medium is seawater, sound can travel at about 1500 meters per second (faster than in air where the speed is about 340 m/s) and propagate for thousands of kilometres given a specific depth, temperature, salinity and water characteristics (Filiciotto & Buscaino, 2017). When it comes to human perception of sounds, the underwater context has some particularities. Human eardrums are similar to water in terms of density, and according to Stefan Helmreich (2012a), underwater sounds are transmitted through our bones (not our ears), resulting in that sound is perceived as coming from every direction:

> For humans, underwater sound is largely registered by bones in the skull, which allow enough resistance – *impedance*, to use the right technical term – for vibration motion to be rendered into resonances in the body. Moreover, conduction of sound by bone directly to the inner ear confounds any difference in signal received by left and right ears, […] Unaided human ears perceive underwater sound as omniphonic: coming from all directions at once. (Helmreich, 2012a, p. 173)

The author defines it "as a zone of sonic immanence and intensity: a *sound-state*", connecting it with the self-experience of auditory immersion. By providing artistic opportunities for the human perception of underwater sound, one might foster a more in-depth knowledge about the vibroscape field.

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Many authors and artists have explored the sonic visualisation of vibratory patterns in materials. Ernst Chladni preliminary work with sand and vibrational plates can be traced back to the late eighteenth and early nineteenth centuries (Groth & Schulze, 2020, p. 5). Examples of vibration and liquids include the work of Hans Jenny (1969), which coined the term *cymatics* as the study of wave formations. Jenny was curious about the effects of vibrations in the acoustic and lower ultrasonic range. The rhythms and periodic systems in the living and non-living world interested the author that defined *cymatics* as a means to reveal a "whole phenomenology of vibrational effects" (1969, p. 8). Both authors inspired Alexander Lauterwasser to evidence the effects of sound vibration in water. Lauterwasser (2006) photography work with cymatics was a further development in documenting vibrational patterns. While these experiments allow a direct visualisation of phenomena, approaches to perceiving these vibrations in the human body as a medium are not so frequent. In this context, Helmreich (2012b) distinguishes three modes of connection between music and water[10]: evoking, invoking and soaking. The latter method refers to when music is "immersed in actual water as an encompassing medium within which it is performed, recorded, played back, or listened to" (p. 153). Human bodies are also made mainly of water, and when immersed, there is "a sensory communion with the medium" (Helmreich, 2012a, p. 174).

10 See *Underwater Music: Tunning Composition to the sounds of science* for more information.

Our artistic interest in revealing the physical aspect of sound and vibrational soundscapes aims to establish a metaphor for the human body as a propagation medium for experiencing vibrational effects (like an aquatic organism in water). According to Groth and Schulze (2020), many sound artists use approaches that focus on the physical aspect of sound. The authors point to their interest in "noise, electronic sine tones, sound waves, and natural phenomena, sound generated by musical instruments, from field recordings, or by human voices." (p. 4), focusing on a crucial issue that is inherent in the present research:

> artists reconstruct and deconstruct such sounds, or simply bring them forward and present them in a performance, installation, or recording in order to make the non-perceivable perceivable, or the unnoticed, noticed. (Groth & Schultze, 2020, p. 5)

In this sense, and as concluded by Helmreich, today's quest of sound artists is not only to soak in sound but also to "broker ear-opening accounts of human relations with the water around us" (Helmreich, 2012b, p. 165).

2. KEY CONCEPTS

The key concepts that served as a base for the theoretical framework in this research include Jean-Paul Thibaud's definition of ambience, Paul Wesley Schultz's model of inclusion with nature, and Stephen Duncombe's ecology of *Æffect*. These ideas set the development of

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design methodologies and artistic approaches based on ecoacoustics towards the realisation of creative artefacts. In this research, ecoacoustics is suggested as a valuable innovative tool for soundscape exploration in an artistic context to foster *emotional affinity*, *nature-connectedness*, an ecology of *Æffect* and a new sonic culture based on *vibroscape* ecology.

2.1 AMBIENCE

The concept of ambience explored by Jean-Paul Thibaud is relevant for this research in the way that he focuses on the world of sounds to perceive and understand places. Thibaud (2011, p. 1) defines an ambience as a:

> space-time qualified from a sensory point of view. It relates to the sensing and feeling of a place. Each ambience involves a specific mood expressed in the material presence of things and embodied in the way of being city dwellers. Thus, ambience is both subjective and objective: it involves the lived experience of people as well as the built environment of the place.

Thibaud explores what is possible to learn when one listens, pointing to the inherent multisensoriality of ambiences, referring to them as a "complex mixture of percepts and affects, a close relationship between sensations and expressions" (Thibaud, 2011, p.1). In this sense, the author proposes three different directions for connecting with an ambience from a sonic perspective: the tuning *into* an Ambience, the unfolding *of* an Ambience, and situating *within* an Ambience.

2.1.1 *Tuning into an Ambience*

It relates to how one perceives as being part of a place, how in *tune* one is with a place. As a more general approach it is the *tone* of a site (as an affective tonality). It is how one's body resonates with vibrations and frequencies of that place, like a mode of immediate communication with the world focused more on sensation than perception. It relates to when one enters a place and senses it. It can be calm or vibrant, bright or dark, cold or warm, scented or not. An ambience relies strongly on the mode of immediate communication with the world of sensory experience (Thibaud, 2011, p. 6). Moreover, he explains that sound can embody this mode of the sensory experience of an ambience:

> With sounds – as with ambiences – we do not experience the world from the outside, in front of us, but through it, in accordance with it, as part of it. The sensing object is nothing but a resonant body that gets in tune and in sync with his environment […] with the idea of *resonance*, the world of sound makes explicit the very power of attunement to an ambience. It helps to describe the very process

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> by which I feel and sense the world. This may be why sounds – like ambiences – are so close to affective and emotional experience. (Thibaud, 2011, p. 7)

2.1.2 *Unfolding of an Ambience*

It is about positioning sound with time, sound as being generative, and sound as a collective dimension. In this sense, he defines time not as an additional property of sound but as the very nature of sound. Thibaud (2011) questions that sound can "help us to record, document and describe the dynamics of an ambience". Time does not stop when one records or listens to a place. One feels the time passing by, evolving, developing, unfolding. Sound as being generative, the auditory world as being active and generative: "an ambience is not only to be felt but also to be produced" (Thibaud, 2011, p. 8). When one listens to an ambience, the process of formation, evolution and transformation is also there contributing to it, the activities that happen in that precise moment in that place. They contribute to the ambience: "Sound gives access to what is happening", is a result of action as when "the rain pours and render audible some features of the environment that were silent until then" (Thibaud, 2011, p. 9). Also, the author points out that "Sound is a very useful medium that can help us document social expression of an ambience" by being closely connected with movement, gesture and action. Sound as a collective dimension relates to the fact that one listens to the unfolding of a "social life itself" or a way of living together. In this sense, Thibaud explains that while listening to an ambience, one can hear its organisation, how people relate to each other, revealing a particular organisation mode:

> Emphasising the temporal, generative and collective dimensions of sound enables us to study and to document the unfolding of an ambience. It brings us also to a socio-aesthetics of commitment that does not rely on mere contemplation and reception but also on active involvement in urban life. (Thibaud, 2011, p. 10)

2.1.3 *Situating within an Ambience*

It refers to sound as context-sensitive and its ability to distinguish the situatedness of unique ambiences. It means that auditory cues can connect variables, conditions and circumstances that together generate an atmosphere that can be further recorded and analysed to accurately reveal the characteristics of the built environment allowing the sensory to articulate within the spatial, the social, and the physical:

> While vision tends to implement too great a distance between the perceiver and the perceived, and while the olfaction tends to produce overly diffuse and volatile phenomena, audition can mix the affective with the cognitive, the universal with the singular in a very balanced way. (Thibaud, 2011, p. 12)

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While Thibaud focuses mainly on urban ambiences, we apply the same approach to the underwater context. Field recordings allow a deep understanding of ocean ambiences. The author's design and experiment approaches may serve as a model for designing and experimenting with ocean soundscapes. In Thibaud's (2015) practice, "ambience may be considered as the basis through which the sensitive world is configured day to day, or the field from which phenomena emerge and split up" (p. 39). Establishing sensory as a field of action is crucial to start paying close attention to the sensory dimensions of places: light, sound, smell, air, heat. The *in-situ* experience of place and ambiences through field recordings and field trips is critical to developing place attachment.

2.2 INCLUSION WITH NATURE: NATURE-CONNECTEDNESS

According to Paul Wesley Shultz (2002), people who live in cities are "largely alienated" or disconnected from nature. Technology played a role in creating even more distance between people and the natural environment. In his psychological model for human inclusion with nature, Schultz (2002, p. 62) argues that the connection individuals make of themselves and nature will dictate their behaviours towards protecting it. Hughes et al. (2018) research also supported these findings. The authors (2018, p. 18) revealed that the connection to nature directly relates to the development of conservation behaviours and that connecting children to nature was crucial for future conservation practices. For Schultz (2002), "The notion of being connected to nature is a psychological one" (p. 67), and the extent of the human-nature relationship has cognitive, affective and behavioural components. Moreover, it focuses on "the understanding that an individual has of her place in nature, the value that s/he places on nature, and his/her actions that impact the natural environment" (Schultz, 2002, p. 67). The author´s definition of inclusion with nature implies three core components: *connectedness*, *caring*, and *commitment*.

2.2.1 *Connectedness*

According to Schultz (2002), connectedness with nature is cognitive and related to what extent individuals believe that they are part of the natural world or how an individual includes nature (or not) within its cognitive representation of self[11].

11 See Schultz's *Inclusion of Nature in Self (INS) Scale* (2002, p. 72).

2.2.2 *Caring*

Caring for nature is affective and is related to what extent people care about nature but starting from the point that there is already an emotional feeling towards nature. To make this clear, he gives the example of a romantic relationship and a sense of intimacy. Intimacy may be one of the crucial aspects of a close relationship, and that makes people care for each other (also, they can develop this caring feeling for an animal or a

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place). In this sense, emotion is crucial when understanding environmental attitudes and behaviours. Moreover, an *emotional affinity* defined by an individual's bond with nature is considered the base for the development of pro-environmental actions and commitments. The more time a person spends in nature, the more intimate their relationship becomes, just like two people become closer as they spend more and more time together.

2.2.3 *Commitment*

Commitment to protect nature is behavioural. Assuming that individuals have a sense of connectedness with nature and care for nature, they can be motivated to act in the best interest of nature. Here again, as with a close relationship, commitment is when the person invests time and resources into the relationship. Regarding nature, one can attribute commitment when the person develops pro-environmental behaviours. The type of actions an individual may do towards preserving or protecting nature is considered a pro-environmental commitment.

Schultz's (2002) *connectedness*, *caring* and *commitment* as the three critical concepts for inclusion with nature explain the framework of human-nature relationships (p. 70). The author suggests thatwithout caring, commitment won't happen and that probably without connectedness, caring will also be absent[12]. This means that if people's connectedness with nature is improved, it might lead to caring and commitment to preserve and protect the environment.

12 See Schultz's core components of inclusion (2002, p. 69)

2.3 ECOLOGY OF ÆFFECT: THE POWER OF ARTISTIC ACTIVISM

If *emotional affinity* is crucial for developing stronger human-nature relationships, as seen in Schultz's model for inclusion with nature, how can it be reinforced? How can one create new emotional connections between people and environments? Stephen Duncombe and Steve Lambert (2018, p. 63) define artistic activism as a field of its own. It is not art. It is not activism but a broad spectrum field that interconnects and informs one another, borrowing from their history, traditions, practices and intentions. If art is an expression that creates *affect*, and activism is an action that generates *effect*, what artistic activism aims to achieve, is an *affect* that produces an effect or vice versa, but something that none of the two fields would achieve alone. For this, they coined a new term that connects the power of *affect* and *effect* combined: the ecology of *Æffect*. Thus, artistic activism can be characterised as a practice that generates *Æffect*. Additionally, Duncombe (2016) suggests that the combination of the affect created by the arts with the effect produced by activism is at the core to creating experiences that go beyond "moving" emotionally an individual. The author further explains that for an individual to decide to change their mind towards some particular issue, first, they have to be moved on doing so by some emotional stimuli: "before we act in the world, we must be moved to act" (p. 119).

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This concept connects with the Schultz model proposition for inclusion in nature, where *emotional affinity* is vital for commitment. In this context, Duncombe (2016, p. 122) suggests many possible artistic activism goals, including fostering dialogue on a topic or revealing a reality or making the invisible visible. Therefore, if one develops artistic strategies that enhance knowledge on a specific subject of concern, *nature-connectedness* might be reinforced. This connection might as well initiate *emotional affinity*, fostering a deeper inclusion within audiences and places. When these artistic strategies can enhance *commitment*, they step into environmental artistic activism and towards an ecology of *Æffect*. Taking these ideas as a framework to develop the design methodology, we propose to explore the relations between eco-art and *nature-connectedness* as a strategy to create experiences for individuals to connect with natural environments. These artistic strategies focus on improving inclusion with nature.

Background work on the eco-art field includes questioning the destruction or degradation of land, asking for their restoration, or revealing wrong social practices towards nature. Works such as *the Survival Piece III: Portable Fish Farm Fish Feast* (1971) from The Harrisons, the *Rhine Water Purification Plant* from Hans Haacke (1972) are early pieces revealing critique to a particular societal issue. *Wheatfield - A Confrontation* (1982) from Agnes Denes or *Revival field* (1991 – ongoing) from Mel Chin were crucial for defining ecological judgment and awareness thought artistic practice strategies.

Hildegard Westerkamp and Pauline Oliveros's listening approaches opened innovative ways to connect with places through sound. As Salomé Voegelin (2010, p. 36) observed, this type of listening with focus is radical in a sense that can make us have other world perspectives, what she refers to see a different world by focused listening. Oliveros defined *deep listening* as the way to engage in all possible sound: the *sonosphere*, as a way to open body experiences of sound (Kazlauskaite, 2020, p. 351). Westerkamp pointed to the experiencing of soundscapes as a way to perceive and "to be part of the world", to open "us towards social connectedness", as "a method for forming embodied and social bonds between bodies and environment" (Westerkamp in Kazlauskaite, 2020, p. 350). In *Kits Beach Soundwalk* (1989), Westerkamp invites us to listen with focus and connect to a specific place, while underlined are an educational aspect and an induction of conservation that brings us towards those aims (Voegelin, 2010, p. 35).

Environmental artistic activism has the power to change people's behaviours, connectedness and awareness towards ecological preservation and conservation. Approaches such as in *Eco-Displacements* (2014) by Brandon Ballengée or *I don't believe in global warming by Banksy or Oil Spills* (2006) from Ai Weiwei are critical for calling attention to global issues, condemn actions, question societies and essential for developing pro-environmental behaviours.

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3. METHOD

This section details the creative strategies and the final artwork created under an artistic residence organised in collaboration by V2 - Lab for Unstable Media (Rotterdam) and Museu Zer0 (Tavira), realised in September and October 2020 respectively. Understanding the concepts presented before, Thibaud's ambience, Schultz's inclusion with nature, and Duncombe's ecology of *Æffect*, as the theoretical base for developing artworks and innovative, creative practices, this research will explore the particle-motion aspect of ocean soundscapes. Our approach is that artistic strategies based on ecoacoustics can foster emotional connections between people and oceanic soundscapes. By enhancing the understanding of environments, their sounds and their ambiences, one might reveal levels of perception of the underwater environment and their human disruption. Also, to foster ocean noise awareness and science outreach. In the end, these approaches aim to enhance *emotional affinity* towards inclusion with nature.

Significant projects that reinforce these ideas include *Spring Bloom in the Marginal Ice Zone* (2018) and *Through the bones* (2018), both from Jana Winderen, the *Biosphere soundscapes* project (ongoing), *Ocean Listening* (2016) or *Hidrology* (2017) from Leah Barclay, *Mare Balticum* (2014) or *Sub Aqua* (2009, 2010, 2011) from Asa Stjerna. However, while these artworks focus mainly on revealing and connecting ocean soundscapes to audiences, still there is a lack of approaches that address the particle-motion or the vibrational side of ocean sound. Therefore, the artistic strategies proposed in this paper aim to extend this field of experimentation, connecting with research and practice of field recording, listening, sound studies, ecoacoustics and vibroacoustic ecology, fostering *nature-connectedness*, *emotional affinity* and the ecology of *Æffect*.

As Groth and Schultze (2020, p. 26) explain, most eco-sound artworks focus on more significant societal issues or site-specific locations to influence or question the audience towards a more profound reflection on that issue or a place. In this context, growing knowledge about the negative impacts of noise pollution in marine animals requires a more conscient approach to underwater sound (both as sound pressure and particle-motion). Our artistic motivations reflect this concern, and we believe it is important to create art that conveys a message, in this case, by exploring oceanic soundscapes. The question this research aims to answer is: how can we use artistic means to convey the experience of vibrational and particle-motion components of ocean soundscapes as a way to connect people and nature?

We have engaged in a practice-based research approach to start an investigation to answer this question. By developing experimental artefacts revealing sound disturbances in underwater environments, we collected information for the research. Considering Marcel Cobussen (2021, p. 291) words, we use "methodology as a doing, a gathering, a connecting, or a way to encounter unknown unknowns". The field recordings are crucial for developing place attachment and further

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artistic creation input by revealing more about places' ambience. We explore sound (vibration, particle-motion) as an immersive medium for soundscape composition in the context of interdisciplinary sonic experiences. Concepts such as place attachment, *attunement*, synesthetic perception, or embodiment are also crucial for developing such practices. A four-step approach divides the research methodologies and creative strategies:

Place attachment
Developing a sense of place: *flaneuring, soundwalking*, boat field trips
Field recordings (contact microphones, hydrophones and passive acoustic monitors)
Attunement with the place
Understanding the ambience

Creative development
Research phase
Revealing something about the ambience
Creativity and installation

Nature-connectedness
Connection with nature – *emotional affinity*
Improve audience inclusion with nature
Participation and feedback

Ecology of Æffect
Communities as part of artworks
Connecting people and places – *affect* towards an *effect*
An emotion that creates action
Ocean soundscapes as a creative tool for changing behaviours

3.1 ARTISTIC RESIDENCE: V2 LAB FOR UNSTABLE MEDIA & MUSEU ZER0

We applied these methods during the artistic residence. The first part of the project was realised at V2 Lab for Unstable Media in Rotterdam. The proposal was to explore the feeling of touch drawing attention to the possible impacts that underwater noise might have on benthic species or on any other species that use vibration to communicate in the ocean, including microscopic organisms. It included concept development, exploring which technologies to use, final idea and prototype/ sketch proposal. The projected installation aimed that the audience could experience anthropogenic vibrations in water by visualising them but at the same time by feeling them in their bodies. We realised the second part of the residency in Tavira, Algarve. It included the implementation phase, realisation, practical experiments, and a final collective exhibition at Ermida de S. Roque presented to the general public as an audio-visual installation. The strate-

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gies used in the two places informed one another, and the creative process was always in tune with this information exchange.

3.1.1 *Place attachment*

Rotterdam and Tavira are very different places, but they both share the constant presence of water. While Rotterdam hosts one of the biggest ports in Europe, Tavira hosts Ria Formosa Natural Reserve. Both places rely on vessel transportation but in very different ways and scales and potentially distinct underwater noise impacts. We made several *flaneurings, soundwalks*, field recordings and boat trips to connect with the sites to perceive their ambiences and contextualisation.

In Rotterdam, there is an extensive taxi boat business with boat platforms all over the city, as shown in Figure 1. We used these taxi boats to access different platforms. Figures 2, 3 and 4 feature recording locations. The equipment used in the recordings includes D-series hydrophones and C-series pro contact microphones, both from Jez Riley French, an H2a hydrophone from aquarian audio, a sound devices MixPre-6, a Zoom Handy Recorder H4 and a GoPro Hero 3 camera. At the docks, we did several mono recordings exploring the contact mics and the hydrophones. The contact mics detect vibrations, and we tested them on the platforms to capture the pillars' motions. At the port, we also paired two hydrophones to realise stereo recordings.

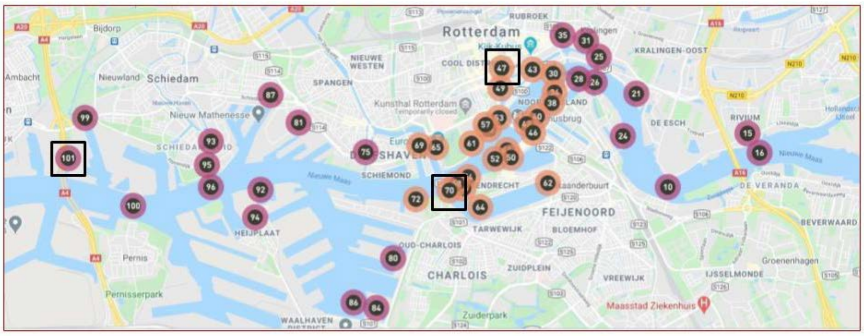
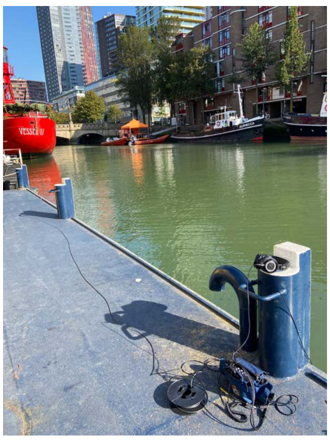
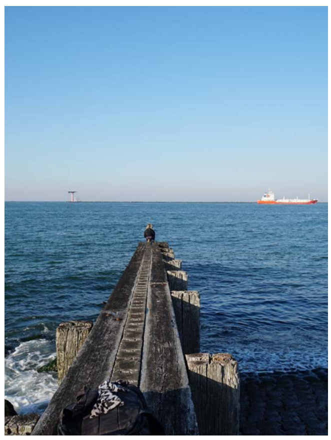


Figure 1: *Water Taxi Rotterdam*. Dock locations with recording spots highlighted in black: 47, 70, and 101. *(https://www.watertaxirotterdam.nl/steigerlocaties).*





Figures 2, 3, and 4: *Dock locations*. Water station 47 (51.9169881, 4.4838441), 101 (51.9020667, 4.3718844) and Rotterdam port (51.9832262, 4.0436095).

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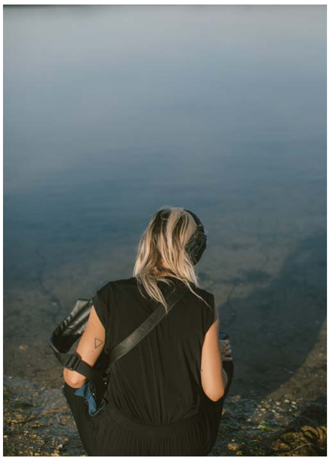
In Algarve, we stayed right next to Rio Gilão, which we crossed daily, made us observe all the existent fauna that lives on the bottom of the river that is exposed in the low tide. They became essential for artwork development. A field trip to Ilha de Faro allowed us to record Ria Formosa and its surroundings in two different locations, as shown in Figures 5 to 9. We used a sound devices MixPre-6 with the D-series hydrophones from Jez Riley French, and did both mono and stereo recordings to capture Ria Formosa underwater ambience. We used no contact mics. Also, while mentioned in the methods that passive acoustic monitors[13] could also be an option for place attachment, they were not used in this specific experiment. The main reason for using them is when we need longer recordings (they are autonomous recorders that have internal batteries that last up to 12 hours in continuous acquisitions) or for situations where it is too risky to take the recorder on board because of the possibility of water spills. The ideal conditions for using passive acoustic monitors are long-term boat field trips that we could not arrange during the residency.

13 The one we use is the digitalHyd SR-1 from MarSensing Lda.


Figures 5, 6, and 7: *Ilha de Faro. Ria Formosa. Note.* First location (37.0028911, -7.9858898). © Isla Grossi.


Figures 8 and 9: *Ilha de Faro. Ria Formosa.* Second location (37.0089876, -7.9936920). © Isla Grossi. The field trips allowed us to understand the places' ambiences, above and underwater, to further design and develop the concept and installation. Some of the recordings are available at *https://soundcloud.com/oceansoundscapeawareness.*

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3.1.2 *Creative development*

We wanted to reveal anthropogenic noise impacts caused by vibration and disturbance. In that sense, we explored how vibration could affect benthic species normal activities. Exploring the process of *bioturbation*, already detailed in the introduction, where living organisms mix the sediment, served as the starting point in the research phase for the artwork development. Only recently, the effects of biodiversity loss on bioturbation are being questioned. And it is clear now that anthropogenic activities in the seabed affect these environments and the species that live on them, as Figure 10 shows.

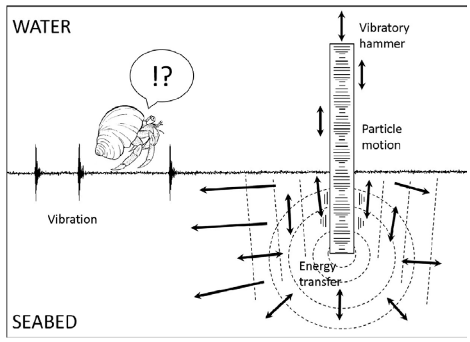

Figure 10: *Anthropogenic vibration*. Particle-motion disturbance by anthropogenic activities in the seabed. From *"Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos"*, by Roberts & Elliot, 2017, p. 255.

We relied on Roberts et al. (2016) experiments to decide the frequencies to use in the installation. The authors analysed exposure of benthic species to sediment vibration by using a hydraulic hammer every 6 seconds for periods of two hours, creating sound and sediment vibration. The frequencies used were between 5-410 Hz (Hertz). Vibration was propagating through the sediment predominantly in low frequencies (lower than 100 Hz) with core energy in the region of 25-35 Hz. Similarly, this was the frequency range used to develop the sound input for the installation.

In Rotterdam we started to explore turbulence and vibration in water. For these first experiments, we used *Lemna gibba* (duckweed), an aquatic plant covering all the lakes, canals and water streams in the city, as seen in Figure 11. We recorded at this place and collected some of the duckweed, and took it to the lab. We started studying the normal motion behaviour of these tiny organisms in the water and how they might react to turbulence and particle-motion. Also, how organisms' movement is altered due to the vibrations. For this, several fans to create water disturbances and a subwoofer to produce low frequency sounds to make water vibrate were used in aquariums and Petri dishes, as shown in Figures 12 to 15. The organism's reactions included place displacement and spread. Also, at the lowest frequencies, some organisms stay in the same place but rotate in their axis. According to Vaage (2016), working with living organisms is, most of the times, challenged by ethical questions. The discussion on how one should relate to living organisms if often a present

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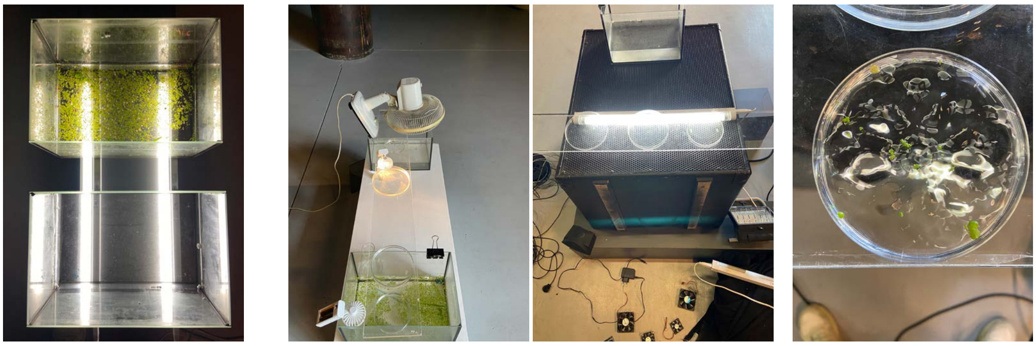
controversy. However, and referring to bio art or art that uses living organisms, the author points to the fact that “the reception of such art is dependent on the individual ideas of what art should do, and according to which parameters it should be judged.” (Vaage, 2016, p. 88).

In *DIS_turbation*, the biological materials presented in the final installation were old shells collected during our *flaneurings*. We only used plant-based life forms for the experiments. We treated them accordingly, keeping them in their mediums and disposing of them at the original places after the tests. However, any impacts that low-frequency vibrations might have caused to them was not accessed. Microscopic life forms that could be present in the water were also not evaluated in terms of being harmed by the vibrations.

Figure 11: *Lemna gibba. Collecting Lemna gibba* (duckweed) for experiments. (51.9136808, 4.4757090).



Figures 12 to 15: *Vibration experiments.* Fans, subwoofer and *Lemna gibba*. Water movement, disturbance and vibration at different frequencies.

In Algarve we continued the experiments. The idea was to explore how anthropogenic vibration affects aquatic organisms and then create a setting where the audience feels these vibrations as if they were the organisms themselves. In the implementation phase, we used different speakers, sound exciters (audio transducers) as seen in Figures 16, and bass shakers showed in Figures 17 and 18 towards the proposed goal.

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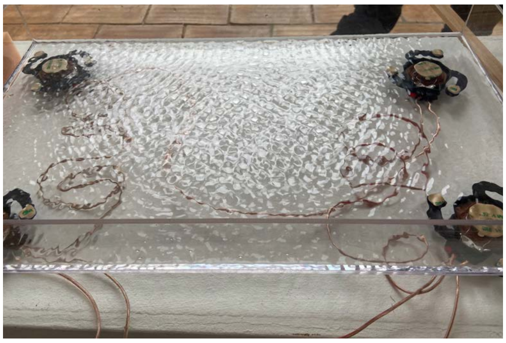

14 Defined in the introduction (Jenny, 1969).

Figures 16 to 18: *Cymatics*[14] and haptic bench. Experiments: water container with sound exciters; haptic bench, and bass shakers.

3.1.3 *Nature-connectedness*

Including elements from nature and background soundscapes was one of the forms to reapproximate people and ocean environments. Several biological items (old shells) were collected during the *flaneurings* and soundwalks in Tavira and included in the final work, as Figures 19 to 21 show. The audience should feel the vibrations while looking at the representation of the species that might be affected by these anthropogenic activities. While feeling the vibrations, the background sounds from the recorded soundscapes become masked and practically unnoticed. The goal was to provoke and critique but also to achieve curiosity, connection and *emotional affinity*.



Figures 19 to 21: *Biologic items.* Natural elements, including different algae in water containers, and oysters, mussels, and razor shells. © Isla Grossi.

3.1.4 *Ecology of Æffect*

In this installation, we created a setting for people to be emotionally connected with benthic species and ocean soundscapes by understanding what might be disrupting them. The hypothesis was that by feeling in their skin and their bodies what might happen to some of the species living in these places, people might become more aware of the impacts. In Figures 22 to 25, it is possible to see different people experiencing the vibrational

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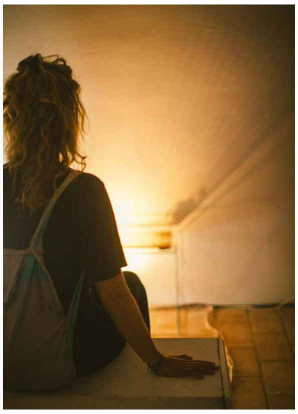
bench. Awareness is a necessary first step for people to re-think their nature values and re-equacionate their position towards these issues. This installation aimed to approximate people and places by pointing out the negative aspect of disturbance in ocean soundscapes.






Figures 22 to 25: *DIS_turbation.* Audience experiencing the vibrations. © Isla Grossi.

4. RESULTS

DIS_turbation was the output of an artistic residency held by V2 – Lab for Unstable Media in collaboration with Museu Zer0, from September to October 2020. This residency aimed to explore and reflect on the relations between humankind, territory, and environment through digital art. It was presented at Ermida de S. Roque in Tavira within the collaborative exhibition "Intimate Observations - on conducting earth observations". *DIS_turbation* is a place for tunnelling into the impact that anthropogenic noise has on marine life, eventually making the audience feel the disturbances. It is a haptic structure that creates a sense of touch through a vibrational environment and a visual interpretation of light and water disturbed by the vibrations. *DIS_turbation* investigates the challenges benthic species might encounter as a result of anthropogenic interference on the seabed. These species are responsible for a process called bioturbation, in which they stir up the sediment; this process is ecologically significant because of its influence on nutrient recycling.

The installation consists of a haptic bench where the audience can sit. Two bass shakers applied to the bench induce sound and vibration through the surface that can be felt through their bodies. In the front, there is a big acrylic container with water and four sound exciters (audio

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transducers) underneath, causing the water to vibrate in a similar mode as the audience feels on the bench. Two extra speaker cones have Petri dishes on the top, one with water and the other with water and biological materials (algae) that respond to the sound. Whenever there is a sound input, three outputs occur: the bench vibrates, the water reflects the vibrations on the wall, and the speaker cones shake the biological materials. Next to the speaker cones we presented the shells from local species collected in the *flaneurings* and *soundwalks*. The sound used in *DIS_turbation* is an exploration of the data (soundscapes) collected during the recordings, mainly used as an ambient background sound, combined with induced pure-tone low frequencies. The data used is the raw recordings from Rotterdam underwater ambiences. While the main focus is to reveal the vibrational and particle-motion aspects of the ocean soundscapes, the final composition explores pure-tone low frequencies (from 20 – 100 Hz, main focus between 25-35 Hz, such as in Roberts et al. seismic surveys experiments) that interfere with the ambient soundscapes. The ideal set up for this installation is in a dark room with a plain wall for the water projection. The use of light projectors in specific directions create the atmosphere and enhance the visualisation of the phenomena. A video can be accessed at *http://franciscagoncalves.com/portfolio-item/dis_turbation/.*

The materials used included two bass shakers from Dayton Audio (TT25 Mini Bass Shaker 8 Ohm), four sound exciters transducers from Dayton audio (DAEX25 8 Ohm), two speaker cones 100 watts 4 Ohm, a rectangular wood bench, several acrylic containers with different sizes, light projectors and focal lights, an amplifier, a raspberry pi-3, Petri dishes, local biological materials and water. Figure 26 details a technical diagram to illustrate the installation structure. The Raspberry Pi launches an audio file with the sound composition looped every 15 minutes.

Figure 26: *Technical diagram*. Installation structure. © Isla Grossi.

5. DISCUSSION

The artistic installation presented in this paper suggests creative strategies to perceive the vibrational and particle-motion components of ocean soundscapes in an artistic context, as a way to connect people and na-

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ture. Additionally, the goal was to explore how to connect people and places through sonic experiences while focusing on a particular concern (anthropogenic vibration). By examining the phenomenon of *bioturbation* and how changes in vibration due to anthropogenic activities may impact benthic species, *DIS_turbation* acts towards building *nature-connectedness* between people and places. Making the audience feel, think and question issues that might affect nature/ ecosystems negatively might foster their empathy for ecological protection and preservation (pro-environmental behaviours).

The resulting artistic artefact that included visual, auditory and touch sensations might have challenged the audience to re-think their relationship with environments. There were no surveys made, and this is an assumption considering the small sample of people experiencing the work that we could talk to directly. What was supposed to be a one-week exhibition where we would have access to more audience feedback, due to local Covid regulations, ended up only being open to the public during the opening weekend. However, we could at least access within the visitors that came to the experience that anthropogenic noise vibration was a new subject for them. We may also conclude that *DIS_turbation* contributed to fostering the dialogue on the issue, revealing a reality, making the invisible visible.

As final comments, we should highlight the importance of straightening the bond between people and ocean soundscapes. We may achieve it by creating a diversity of *nature-connectedness* artistic experiences as a form of environmental artistic activism. By fostering ecological awareness and *emotional affinity*, one might contribute to an ecology of *Æffect*. Artistic research on creative strategies that offer nature bonding experiences or open opportunities for them to happen becomes a critical contribution to perceiving nature as part of self, enhancing healthy relationships with the environment. Ocean soundscapes become essential tools for artistic exploration and experimentation that improve our interconnection with self while extending perception of natural environments, building meaningful synergetic relations. Furthermore, while experiencing, perceiving, and questioning our position within the world, we build collective thinking towards a better ecological future.

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