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Forum

Animal Behavioral Responses to the COVID-19 Quietus

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Lockdown measures fundamentally reshaped human society during the COVID-19 pandemic. We present a framework featuring seven animal behavioral changes as a result of the calming effect of the lockdowns on human actions (COVID-19 quietus). We demonstrate how this framework can be used to quantify animal behavioral responses with implications for ecology and conservation.

The Coronavirus Disease 2019 (COVID-19) Quietus

The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19, began to spread person-to-person in a wet market in Wuhan, China in December 2019. Given

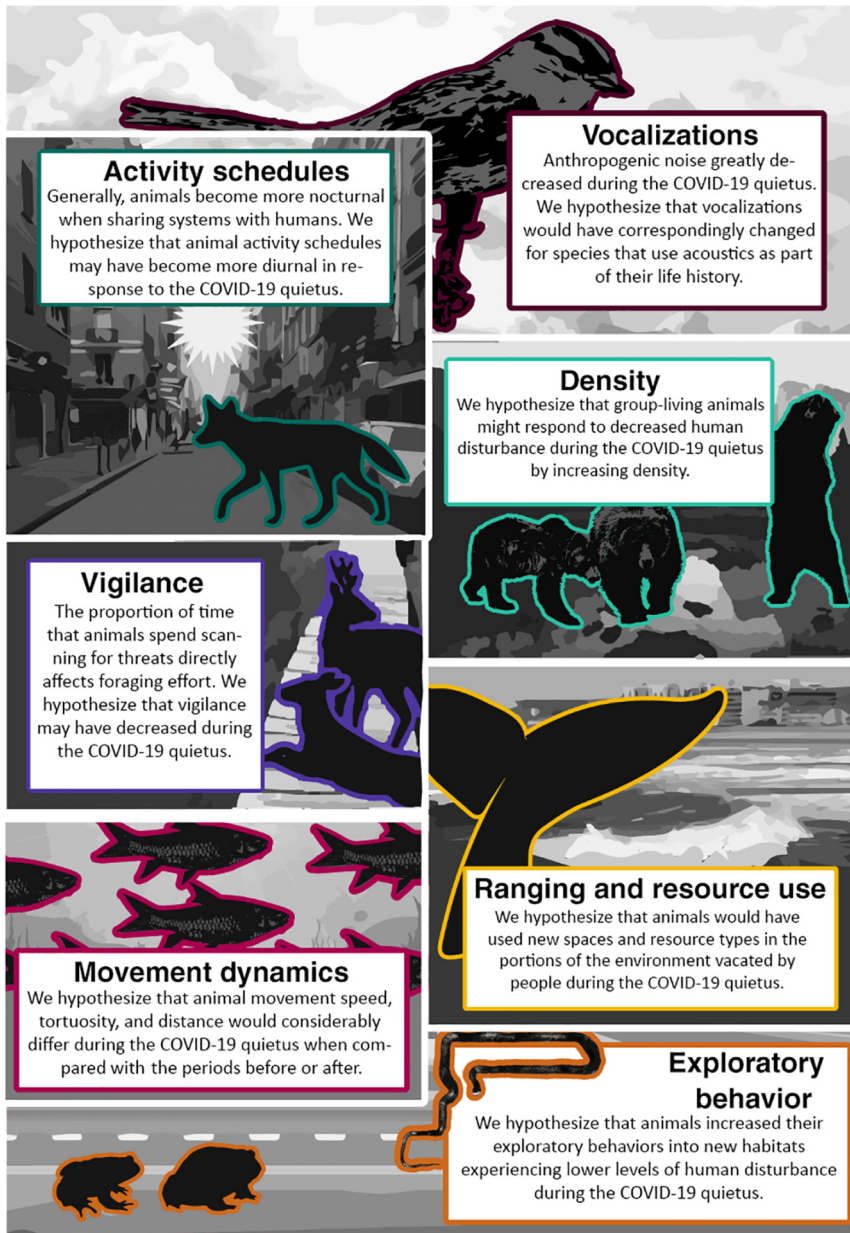
the high degree of global human interconnectedness, the disease followed transportation networks and was classified as a pandemic by the World Health Organization on 11 March 2020. Between March and July 2020, >100 countries around the world implemented some version of a lockdown, with subsequent national and regional lockdowns occurring periodically thereafter. Restrictive measures included banning large public gatherings, closing educational institutions, strictly regulating travel, and isolating people in their homes. Consequently, the organization of human society around the world fundamentally changed and the spatio-temporal intensity of human activities calmed. Correspondingly, we refer to these phenomenological changes as the ‘COVID-19 quietus’. Though quietus is a word with many meanings, including a release from debt or indeed from life, we use it here to describe, as the Oxford English Dictionary defines it, ‘a quiet period’ or ‘a time of inactivity’.

Unintentionally, the COVID-19 quietus provided a quasi-experiment by which to measure the recovery of the natural world to fundamental changes in human behavior. Ecological analyses immediately began describing the impact of the quietus on Earth’s abiotic characteristics. The consumption of fossil fuels, for instance, reached 25-year lows in the COVID-19 quietus, with US oil prices plunging into the negative for the first time in history [1]. Accordingly, the daily global CO₂ emissions reduced by 17% during the quietus when compared with rates from the previous year [2]. Shortly thereafter, studies began to emerge describing changes in animal behavior in response to the COVID-19 quietus. White-crowned sparrows (*Zonotrichia leucophrys*) in the San Francisco Bay area of California, United States, for instance, responded to swift reductions in anthropogenic noise by shifting their song volume and structure to maximize

communication distance [3]. Eastern cottontail rabbits (*Sylvilagus floridanus*) in Italy were significantly more active diurnally when compared with previous years [4]. Furthermore, several species of carnivore explored urban areas in Chile, though it was unclear whether these observations could be attributed to the quietus [5]. We highlight here that detecting changes in animal behavior in response to the COVID-19 quietus should be expected. Such changes, however, may not be particularly influential unless they have corresponding impacts on animal survival and reproduction [6]. Therefore, quantifying the costs and benefits of these animal behavioral responses is integral to determining the impact of the COVID-19 quietus on animal ecology and conservation. To facilitate such studies, we developed a typological framework of animal behaviors that could reasonably be expected to vary in response to the COVID-19 quietus.

Typology of Animal Behavioral Responses

Our typological framework includes animal: (i) activity schedules, (ii) density, (iii) exploratory behaviors, (iv) movement dynamics, (v) ranging and resource use, (vi) vocalizations, and (vii) vigilance (Figure 1). We highlight that the boundaries between these typologies should not be envisioned to be mutually exclusive. On the contrary, we should expect changes in animal behavior across numerous typologies. For instance, an animal might expand their exploratory behaviors in the COVID-19 quietus with coupled changes in activity schedules and movement dynamics. Quantifying the precise impacts of the COVID-19 quietus on animal behavior will depend on comparison of these typologies across spatial and temporal extents.



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Figure 1. A Framework Representing Seven Typologies of Animal Behavioral Responses to the Broad Scale and Coordinated Changes in Human Activity Resulting from the Lockdowns Initiated to Reduce the Novel Coronavirus Disease 2019 Pandemic (i.e., the COVID-19 Quietus). Corresponding to each typology is a testable research hypothesis about the ways in which animals may have responded to the COVID-19 quietus. **Prospective cover art:** African lions (*Panthera leo*) and spotted hyenas (*Crocuta crocuta*) exploring Skukuza Golf Club, South Africa during the coronavirus disease 2019 (COVID-19) quietus. Though the golf club is located adjacent to the broader Kruger National Park system, the use of the course by large mammals, such as these, were highly rare occurrences prior to the COVID-19 quietus. Photo taken by Jean Rossouw on 29 March 2020.

It is also important to note that via the presentation of this typological framework (Figure 1), we are not presuming directionality of animal responses. While many animal species are negatively affected by human activity, others

experience positive feedbacks [7]. Additionally, the COVID-19 pandemic triggered a series of complex direct and indirect effects on animal populations and the environment [8]. Thus, there are scenarios in which animal responses across these typologies might increase, decrease, or maintain stasis in the periods before, during, and after the COVID-19 quietus. What our framework provides is a platform to develop research hypotheses that can be tested and compared across species and research sites (Figure 1). The subsequent research testing these hypotheses must be longitudinal and seek to quantify the impacts of the behavioral responses on animal survival and reproduction. These fitness effects, as we emphasized earlier, will be vital to the determination of the population-level consequences of the COVID-19 quietus with subsequent implications for conservation.

Implications for Conservation

Quantifying animal responses to the COVID-19 quietus is important for a number of reasons. Faunal biodiversity plays an integral role in regulating the structure, function, and health of all ecosystems on Earth. Thus, measuring the nature of animal-habitat relationships not only provides invaluable information for the creation of ecological knowledge but also for the implementation of effective environmental conservation and sustainability initiatives [9]. Documenting the strength of animal behavioral responses is also needed because of the intentionally doctored or exaggerated stories that surfaced during the COVID-19 quietus. Whether to bring false hope of ecosystem recovery to people during the pandemic or to intentionally deceive, such misinformation complicated the interpretation of animal responses to the profound changes in human behavior. Even when not falsified, another challenge is to distinguish whether the animal observations that people made

during this quietus were actually novel. Observations of animals in the COVID-19 quietus may simply have been byproducts of people spending more time in nature watching animals during the lockdown. In combination, these points emphasize the importance of a typological framework that can facilitate inter- and intraspecies comparisons across scales.

The implicit assumption of our typological framework is not that the COVID-19 quietus was a panacea for animals. On the contrary, rates of illegal harvest of animals increased around the world during the COVID-19 quietus, given that tourism and protected area surveillance were at record lows [4,10]. Additionally, the lack of tourism revenue likely presented persistent and long-term negative impacts on biodiversity conservation. Models of conservation around the world depend upon revenue and subsidies from various user communities [4,10]. Not only were those user communities largely absent during the COVID-19 quietus, but while the time necessary for user rates to return to pre-pandemic levels is presently undetermined, it is reasonable to believe that it will be quite lengthy.

Ecological theory suggests that even degraded ecosystems can, in time, return to their native state [11]. Given the persistent expansion of the human footprint

(i.e., in activity, magnitude, and physical extent) in the Anthropocene, however, rarely can such principles be tested at broad scales. Perceptions of these anthropogenic impacts on the environment as being both negative and unrelenting can engender apathy, subsequently imperiling conservation and sustainability practices [12]. Occasionally, however, natural experiments emerge that illustrate how ecosystems, even degraded ones, can recover via broad scale and coordinated changes in human behavior. The global response to the COVID-19 pandemic provided, among other things, a moment of experimentation within this context. The pandemic initiated tremendous personal and financial hardship for millions of people around the world, but it might also have illustrated how collective human action, albeit rather austere, can lead to correspondingly profound changes in the recovery of various biotic and abiotic characteristics of the world. Thus, learning from the quasi-experiment initiated by COVID-19 may provide agency to individuals, governments, and intergovernmental partnerships seeking to create a more sustainable future.

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