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W. Douglas Robinson,
Oregon State University, United States

*CORRESPONDENCE
Melissa L. Grunst
melissa.grunst@indstate.edu
Andrea S. Grunst
agrun001@ucr.edu

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Editorial: Bioenergetic and behavioral effects of rapid anthropogenic change and eco-evolutionary implications

Melissa L. Grunst[1]*, Andrea S. Grunst[1]*, Jérôme Fort[2] and Jacquelyn K. Grace[3]

[1]Department of Biology, Indiana State University, Terre Haute, IN, United States, [2]Littoral Environnement et Sociétés (LIENSs), Unité Mixte de Recherche (UMR) 7266 Centre National de la Recherche Scientifique (CNRS)-La Rochelle University, La Rochelle, France, [3]Department of Ecology and Conservation Biology, Texas A&M University, College Station, TX, United States

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Editorial on the Research Topic
Bioenergetic and behavioral effects of rapid anthropogenic change and eco-evolutionary implications

Rapid anthropogenic environmental change encompasses a suite of disturbance factors, including climatic warming, noise and light pollution, chemical contamination, and urbanization. Both independently and in combination, these disturbance factors can have potent direct and indirect effects on organismal behavior and energy balance (Grunst et al., 2023a, b). Sources of direct effects include thermoregulatory challenges resulting from altered temperature regimes (Choy et al., 2021), disruption of hormonal and circadian systems by artificial light at night (ALAN) (Grunst and Grunst, 2023), and neurotoxic and metabolic effects of exposure to chemical contaminants (Blévin et al., 2017). Indirect effects may arise via alterations in trophic networks, with implications for both top-down and bottom-up processes (Bartley et al., 2019; Grunst et al., 2023a).

Organisms may adapt to rapid environmental change through behavioral and bioenergetic plasticity (Sih et al., 2011). For instance, behavioral plasticity may allow animals to maintain positive energy balance by shifting to novel food resources when historical sources decline (Grémillet et al., 2012). Furthermore, changes in energy allocation decisions may be essential to maximizing fitness. For example, long-lived species may benefit by forgoing breeding under deleterious foraging conditions, such as those associated with El Niño (Cubaynes et al., 2011). Such plasticity forms a first line of defense against changing environmental conditions that threaten to outpace the speed of microevolutionary change (Sih et al., 2011; Grunst and Grunst, 2024). Understanding the scope of plasticity and its limitations is critical when attempting to forecast broader-scale responses of populations and ecosystems.

The aim of this Research Topic was to highlight behavioral and bioenergetic responses that avian species are displaying in response to human-induced environmental change while also considering underlying physiological mechanisms and impacts on fitness and

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evolutionary dynamics. Avian species serve as excellent model species for considering behavioral and bioenergetic effects of anthropogenic environmental change, as they often play critical roles in ecosystems and have frequently been used as indicator species for environmental pollution and degradation (Burger and Gochfeld, 2004). The collection of four articles in this Research Topic examines diverse species, disturbance factors, and behavioral, energetic, and physiological response variables. Thus, each article offers unique insights and perspectives regarding how rapid environmental change may affect behavior and energy balance.

First, Kiere et al. reported on the effect of heavy metal pollution on the exploratory behavior of streak-backed orioles (*Icterus pustulatus*). Toxic pollutants, including heavy metals, have neurotoxic effects that can affect movement and exploratory behavior in free-ranging animals, including birds (Ecke et al., 2017; Grunst et al., 2019). Alterations in movement behavior and exploratory tendency may have important effects on energy use dynamics. Interestingly, here, the authors report a lack of effect of mining-related metal exposure on the focal species, perhaps due to a long history of exposure that has resulted in adaptation. Indeed, the time frame of exposure may be an important variable affecting behavioral and bioenergetic outcomes, both because adaptive evolutionary responses may occur and because of the potential for transitory responses or time lags (Jackson et al., 2021). Alternatively, metal measured in feathers, as in this study, may reflect a detoxification mechanism (Burger and Gochfeld, 1992). Levels measured in a different matrix, such as the blood or organs, could differentially reflect behavior.

Second, VanDiest et al. examined the effect of urbanization and brood parasitism on the growth and body condition of song sparrow (*Melospiza melodia*) nestlings. A shortage of arthropods in urban areas may compromise growth and body condition in developing organisms (Chatelain et al., 2023), with protein limitation being a potential underlying mechanism. Deleterious effects of resource limitation in the urban environment may be exacerbated by brood parasitism by brown-headed cowbirds (*Molothrus ater*), especially as the ubiquity of parasitism increases in some urban areas (Rodewald, 2009). Indeed, the authors report that urban nestlings had lower growth rates than rural nestlings, with this pattern being stronger in parasitized broods. However, there was no evidence that a decrease in amino acid concentrations was the underlying mechanism.

Third, Karnovsky et al. explored how variable levels of prey biomass affect the diving behavior and reproductive fitness of Cassin's auklet (*Ptychoramphus aleuticus*). This species feeds in the California Current System, which has recently been subject to anomalous atmospheric and oceanographic conditions. These conditions affect upwelling dynamics and the abundance of the auklet's zooplankton prey. Using time-depth recorders, the authors document plasticity in the dive characteristics of Cassin's auklets. Dives were shallower, shorter, and more numerous during foraging trips when krill abundance was low. Shallow, short dives are hypothesized to reflect a higher proportion of unprofitable dives, reflecting low krill density and/or patchy distribution, or a shift to an alternative prey species. Under such conditions, energetic stress is likely to increase, and the birds face a decrease in reproductive success. With an increase in the frequency of climate change-linked perturbations, Cassin's auklets may be unable to increase foraging effort to buffer the effects of low krill biomass on breeding success. Furthermore, effects of increased foraging effort on adult survivorship may exist that have yet to be documented.

Finally, Kimball et al. studied how conspecific alarm calling affects novelty responses in house sparrows (*Passer domesticus*). They found that attenuation of a neophobia response occurred in individuals exposed to contact calls or no playback (control), but that attenuation did not occur when conspecific alarm calling was present. This result demonstrates the importance of social cues and feedback to behavioral responses to novelty. Social learning, in which individuals link alarm calling to the need to maintain vigilance, may prevent habituation and generalization of the novelty response. Thus, learning may be crucial for navigating dangerous situations in anthropogenic environments and making adaptive decisions about novel food resources.

In conclusion, this Research Topic draws attention to the diverse challenges posed by rapid anthropogenic environmental change and the plethora of responses that can result. We hope that this Research Topic can help motivate further research in this area. We would like to draw attention to some particularly outstanding knowledge gaps in this field, including: 1) how interactions between multiple disturbance factors affect patterns of bioenergetic and behavioral plasticity and the potential for multiple behavioral optimums; 2) effects of disturbance on the repeatability of behavior and underlying among- and within-individual variance components; 3) hormetic (dose-dependent) effects of disturbance on behavioral and bioenergetic phenotypes and fitness outcomes (Costantini, 2014); and 4) the importance of timing of exposure (early versus later in life; time lags in response) on behavioral and bioenergetic outcomes.

Author contributions

MG: Conceptualization, Writing – original draft. AG: Conceptualization, Writing – review & editing. JF: Writing – review & editing. JG: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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