While bird migration altitudes are increasingly well described, low altitude migrations (<200m above ground level) have received less focus, in large part due to the difficulty in studying these altitudes with conventional weather radar.

large part due to advances in radar ornithology and the widespread availability of weather radar data (Bridge et al. 2011). These studies describe the altitudinal distributions of nocturnal avian migrants and examine how those altitudes shift in response to wind, weather, and artificial light during migration (Bauer et al. 2019). These studies primarily focused on altitudes >200m above ground level (a.g.l.), at which most birds are assumed to spend the bulk of their migratory flights.

However, altitudes <200m are particularly relevant to avian mortality during migratory flights, given this represents the height range of most obstacles posing collision risk, including buildings (365–988 million bird collisions per year, Loss et al. 2014), wind turbines (234 thousand bird collisions per year, Loss et al. 2013), and communication towers (4–5 million bird collisions per year, Gehring et al. 2011). Identifying the frequency of avian flights within the altitudinal range of these obstacles is an important aspect of measuring avian vulnerability and directing conservation efforts.

Most weather radar systems, such as NEXRAD in the United States, do not characterize migratory flight altitudes in the <200m band effectively because ground-level obstacles and the curvature of the Earth cause the lowest observable altitude to increase with distance from the weather radar station (Rogers et al. 2020). Horton et al. (2016) estimated mean flight altitudes for nocturnal migrants throughout the United States as 418–459m a.g.l. and did not observe any flight altitudes below 120m. Several studies using bird-mounted transmitters and dataloggers, however, have characterized low altitude flights of nocturnal migrants. Bowlin et al. (2015) found that of 13 tracked Swainson’s Thrush (*Catharus ustulatus*) migratory flights, one bird spent over an hour flying at altitudes <100m before rising to altitudes of 300–500m. A second thrush spent the entirety of its ~2 hour migratory flight at an altitude of ~40 m. Norevik et al. (2021) found that European Nightjar (*Caprimulgus europaeus*) spend an appreciable portion of their migratory flights <200m above ground level, especially during fall. Flight altitudes likely have considerable inter-species variation due to morphological and physiological adaptations affecting the ability to achieve higher altitude flight (Butler 2016), and a proclivity to fly at low altitudes could cause increased susceptibility to collision with airspace obstacles.

the circumstances which lead to low altitude flights and the prevalence

Integration of these techniques with species-level data, such as from GPS transmitters, can allow us to better understand variation in airspace use among individuals or species and better understand why certain species are more vulnerable than others to obstacle collisions.

However, airspace <200m AGL remains understudied compared to higher altitudes, in large part due to limitations in weather radar below this altitude. The continued use of transmitters or dataloggers to track flight altitude can improve study of low altitude flight and contribute to knowledge of individual- and species-specific differences in use of low altitude airspace (Bowlin et al. 2015). Portable radar technologies may also provide opportunities to better quantify low altitude airspace use in local areas, and particularly in response to stimuli such as artificial light and weather (Nilsson et al. 2018). Further study may allow us to integrate data on flight and collision risk, to better understand the circumstances that result in obstacle collisions and guide mitigation strategies to reduce bird mortality.