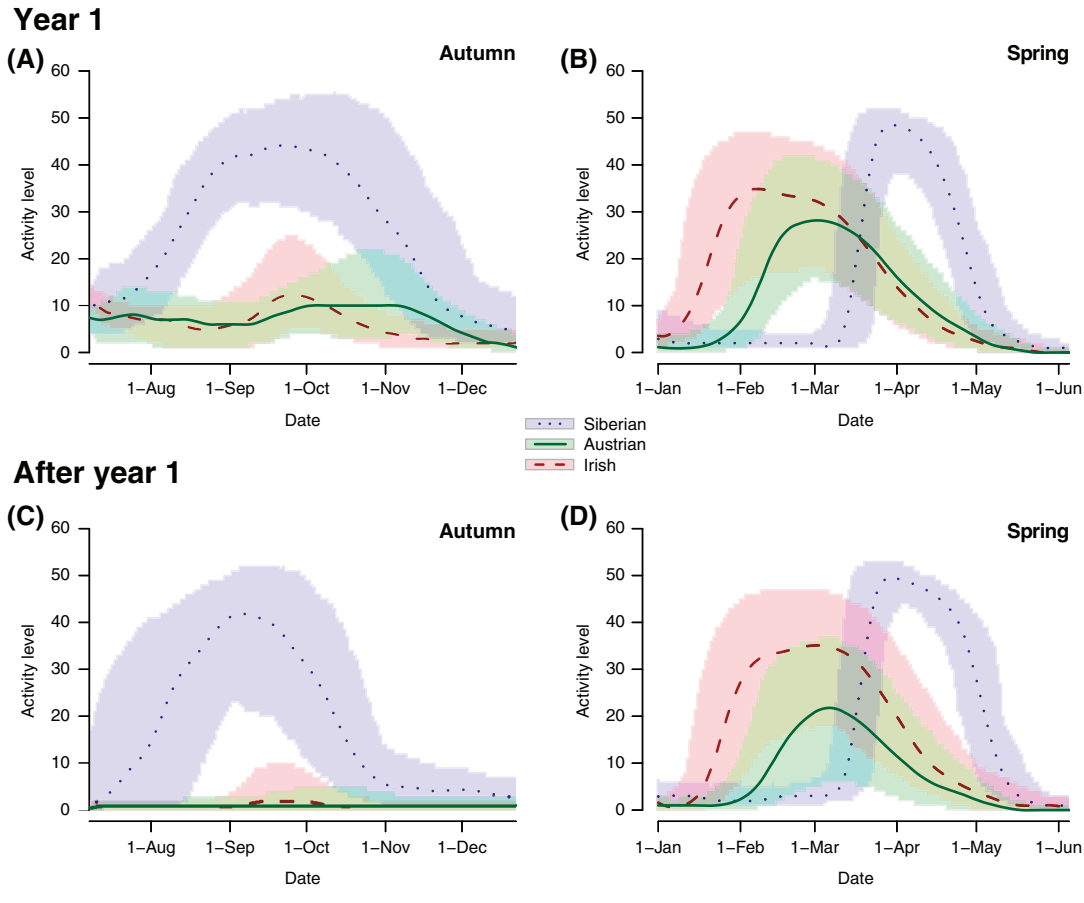

Figure 7. Population-level nocturnal activity in Siberian, Austrian and Irish stonechats, contrasting different age groups during the autumn and spring migration periods (first year (A) and (B) versus later years (C) and (D) for autumn and spring, respectively). Activity level is quantified as the number of active ten-minute periods during the night for an individual bird. Lines show medians and coloured bars show the interquartile range (middle 50%) of smoothed activity values corresponding to that day. Data shown are smoothed by fully overlapping 30-d windows, incremented by one day. For details, see Fig. 5C–F.

242.43 DF, $t = -10.36$, $p < 0.0001$). During summer and winter, diurnal and nocturnal activity did not covary significantly on a daily basis (effect for both periods = –0.02, 259.89 DF, $t = -0.11$, $p = 0.91$). During migration periods, neither sex nor population had a significant effect on diurnal activity, whereas during summer and winter, females were on average more active (effect = 5.81, 552.24 DF, $t = 3.99$, $p < 0.0001$).

Zugunruhe and activity outside a migration context

On a population level, when all individuals were included, nocturnal activity during migration periods was greatly elevated over summer and winter baseline levels for all populations studied (Fig. 8, top row). Within individuals, nocturnal activity levels during spring migratory periods were positively associated with those during summer and winter after accounting for age, sex, and population (winter: effect = 0.05, 358 DF, $t = 3.41$, $p = 0.0007$; summer: effect = 0.07, 181.66 DF, $t = 3.78$, $p = 0.0002$). This was also true for activity during autumn migratory periods (winter: effect = 0.06, 318.81 DF, $t = 4.19$, $p < 0.0001$; summer: effect = 0.02, 2.03 DF, $t = 1.32$, $p = 0.3167$); the non-significant effect of summer may have been due to a lack of data (none for first year birds) and thus very low power.

Nocturnal activity during migration periods also explained variation in diurnal activity during summer and winter, both for spring (winter: effect = 0.32, 290.41 DF, $t = 4.33$, $p < 0.0001$; summer: effect = 0.50, 146.51 DF, $t = 3.56$, $p = 0.0005$) and autumn (winter: effect = 0.29, 241.94 DF, $t = 3.66$, $p = 0.0003$; summer: effect = 0.13, 65.66 DF, $t = 0.63$, $p = 0.5341$). This indicates, for example, that a bird more active than another by an average of 100 min per night during the migration season also averaged 13–50 min more activity during the day at other times of the year.

Overall, therefore, more active individuals during the migration periods tended to also be more active during other times of the annual cycle, both during the day and at night.

Discussion

Population-specific patterns of *Zugunruhe*

Our analyses reveal clear population-specific differences in the migratory programmes of stonechats, akin to documented