Increasing seasonal temperatures are expanding the duration of the warm growing season, however the photoperiod cues that insects use to predict seasonality will remain unchanged. For European corn borer, access to longer growing seasons could provide more time to produce additional generations or to increase nutrition stores before the onset of diapause. The indirect association between increasing seasonal temperatures and the induction of diapause in W. smithii (pitcher plant mosquito) is one example of how insects could gain access to longer growing seasons. Researchers monitored the critical photoperiod of pitcher plant mosquitoes for decades. Critical photoperiod for this study corresponds to the number of daylight hours at which diapause is induced among 50% of larvae in laboratory conditions. After decades of observations, the critical photoperiod of these mosquitoes shifted down from 15.79 hours to 15.19 hours. The shift in critical photoperiod corresponds to a 9-day delay in the onset of diapause in the fall. This delay in diapause initiation gives mosquito larvae longer to grow and accumulate nutrition reserves to get them through diapause.

A similar shift in critical photoperiod has also been noted in Hyphantria cunea (Drury)

(fall webworm). Gomi et al. collected webworm larvae from the same field site in 1988 and

2002, reared them at 20◦C, and measured their response to a range of photoperiod between 14L:10D to 14.5L:9.5D. The photoperiod that induced diapause among larvae collected in 2002 was shorted by 8 minutes compared to larvae collected in 1988 (Gomi et al., 2007). Taken together, these two studies implicate longer growing seasons in increasing access to nutrition ahead of diapause (pitcher plant mosquito) and increased voltinism (fall webworm). If European corn borers respond to longer growing seasons with delayed diapause induction they would avoid the risk of premature energy depletion associated with diapause induction at higher temperatures, increase nutrition stores ahead of diapause, or possibly experience increases in voltinism (Bradshaw and Holzapfel, 2001; Gomi et al., 2007; Sinclair, 2015; Thompson and Davis, 1981; Williams et al., 2012). In our data, there is an indirect association between a longer diapause length and increasing lipid stores. Our results show that European corn borers exposed to conditions that program diapause prepare for diapause by increasing their nutrition stores and the amount of increase varies by diapause genotype (3-8B). Where larvae with the long-diapause genotype and the short-diapause genotype occur sympatrically, long-diapause genotype larvae enter diapause earlier in the growing season and exit diapause later in the spring than larvae with the short diapause genotype. The difference in the timing of diapause entry and exit and differences in lipid stores between the two diapause genotypes evidenced in our research suggests that metabolic activity during a longer diapause is met by increasing nutrition stores ahead of diapause. As climate change increases growing seasons, variation in the response of each genotype to the environmental cues that induce diapause could advance the termination of diapause in the short-diapause genotype and the delay of diapause in the long-diapause genotype.

Variation in the response of short-diapause genotype larvae to diapause programming suggests an increased sensitivity to the cues that terminate diapause be one way European corn borers take advantage of growing seasons that begin earlier (McLeod and Beck, 1963). Diapause programming for short diapause genotype individuals lead to at least two different phenotypes; a deep-diapause phenotype and a deep-diapause phenotype (3-1). Deep-diapause larvae remained in diapause for the entire duration of the 40-day trial while larvae in shallow-diapause terminated diapause at some point prior to the end of the trial. Increasing temperatures during early spring will expand growing seasons during the time when short-diapause genotype larvae are ending their term in diapause. Short-diapause larvae in a state of shallow-diapause could respond to increased spring temperatures by terminating diapause earlier. Larvae in shallow-diapause that terminate diapause early will have access to the longer growing season, increasing their active period, and possibly increasing the number of generations produced annually if there is enough time and resources to complete that additional generation.

Long-diapause genotype larvae exposed to increased temperatures at the end of the growing seasons could experience increased voltinism as higher temperatures delay the onset of diapause. Ahead of unfavorable seasonal change European corn borers integrate changes in photoperiod and temperature and once these environmental factors reach critical thresholds the diapause is programmed at the end of the last larval instar. Photoperiod will not change as temperatures continue to increase, however increased temperatures have the potential to avert diapause by shunting individuals into a non-diapause developmental trajectory (Ikten et al., 2011; McLeod and Beck, 1963). The long-diapause larvae in these regions that avoid diapause could eventually eclose as adults and produce an additional generation of herbivorous larvae.