

bloom at peak population. Evidence from spring feeding studies supports this strategy: colonies supplemented in spring began brood rearing earlier and produced more workers by late April or early May, while feeding with stimulatory syrup from late March to the start of white acacia flowering increased colony strength, brood rearing, and honey productivity under weak supporting forage conditions. Management during the acacia period should also avoid overexploiting colonies before subsequent flows, because intensive use for spring-summer honey collection can slow brood growth and weaken later performance. This trade-off appears in commercial feeding and migration systems as well: colonies stimulated in late March and moved first to rapeseed and then to acacia produced 14.67% to 45.49% higher profit, but broader farmland evidence shows that maximizing spring honey production at the expense of brood can reduce later honey yield and halve overwinter survival.

## 7.2 Summer stress management in honeybee colonies

Summer case studies show that heat stress management is fundamentally a labor-allocation problem inside the colony, because workers shift toward cooling behaviors such as fanning and water collection when ambient temperature rises. Colony-level tracking further shows that heat stress increases overall activity and causes bees to reorganize away from the brood area, indicating that summer management should reduce heat load before thermoregulation begins to compete with normal colony tasks (Figure 2).

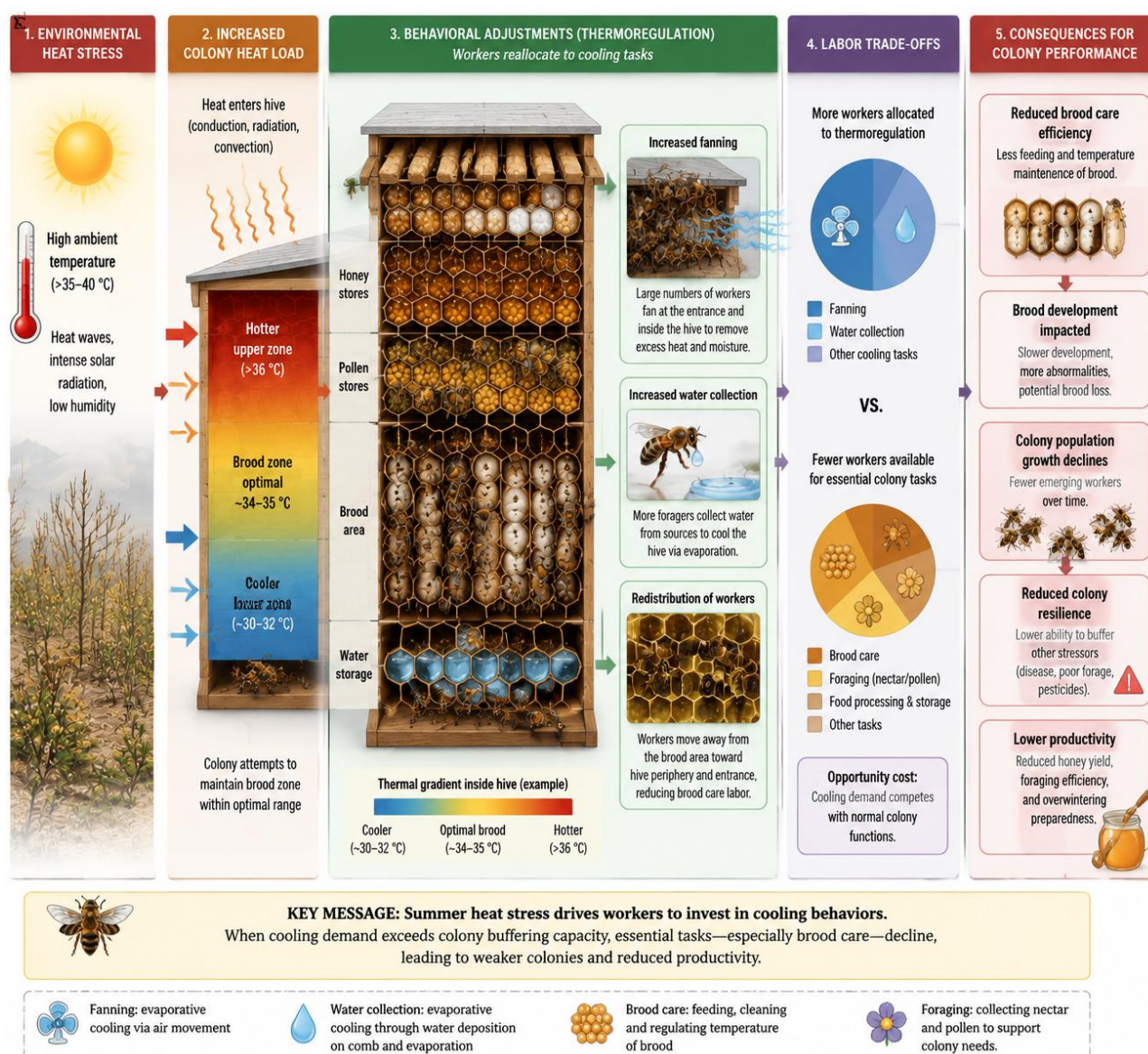


Figure 2 Mechanistic framework illustrating labor reallocation and colony-level consequences of summer heat stress in honey bees