

For *C. farreri*, nonlinear density effects are especially evident when food depletion and hydrodynamics are considered together. A depletion model for Sungo Bay predicted that at 50 ind m⁻³, density could reduce growth anywhere from 0% to 100% depending on current velocity below 20 cm/s, which means the same nominal density can be either tolerable or strongly growth-limiting depending on local flow. Carrying-capacity modeling in a Chinese bivalve culture bay likewise estimated that scallop capacity is seasonally low in spring and summer and proposed that mean-size scallop density should not exceed 59 ind m⁻², reinforcing the idea that the biologically acceptable density range is context dependent and bounded by seasonal ecological limits rather than by a single universal value (Liu et al., 2025). Overall, growth performance in *Chlamys farreri* responds to stocking density through reduced shell and tissue growth, lower specific growth under crowding, and nonlinear threshold effects shaped by environment. These response characteristics support using moderate or low density ranges in culture practice, especially where warming, weak flow, or food depletion increase the likelihood of growth suppression (Figure 2).

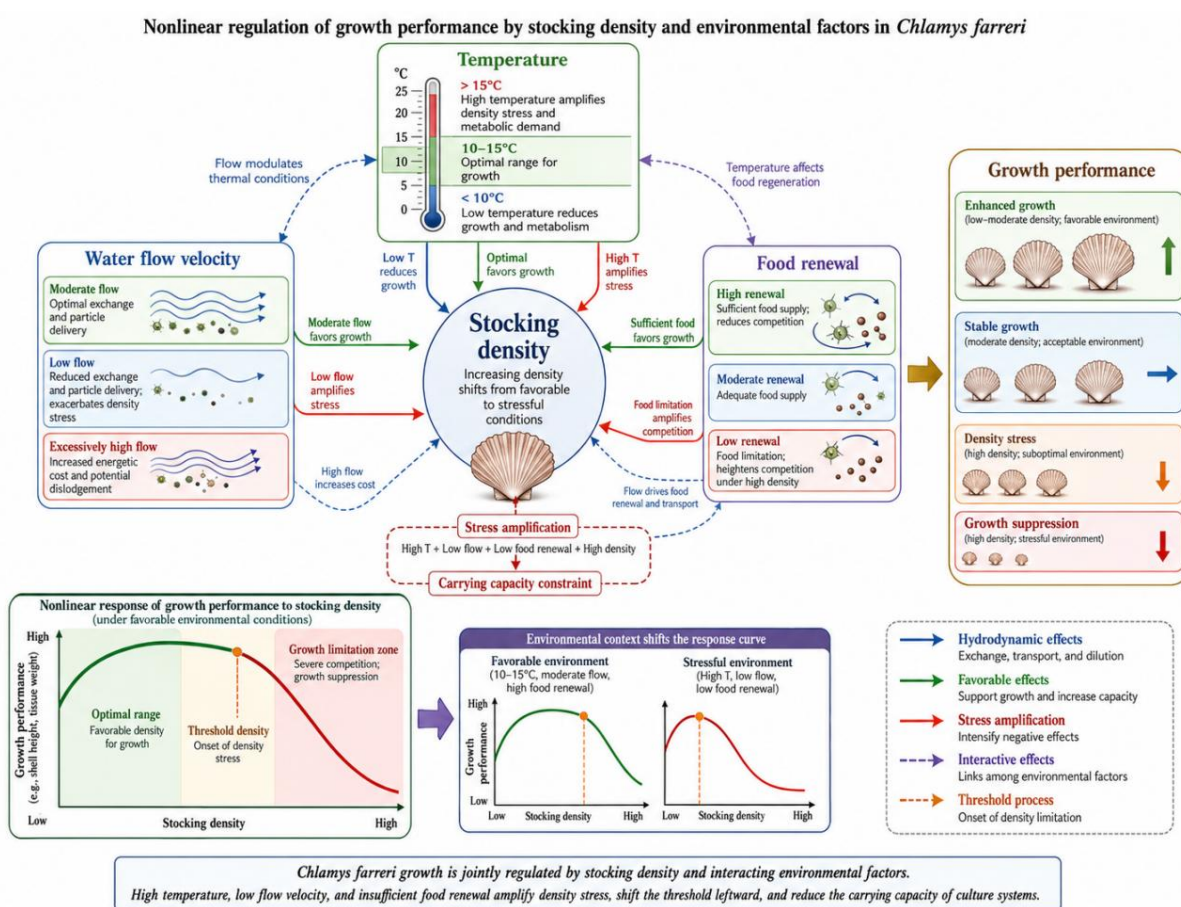


Figure 2 Conceptual framework illustrating the interactive effects of stocking density, temperature, hydrodynamics, and food availability on scallop growth. Environmental conditions modify density-dependent responses by regulating food renewal, metabolic demand, and ecological thresholds

6 Survival Rate Variation and Influencing Factors

6.1 Identification of mortality patterns under density stress

In *Chlamys farreri*, mortality under density stress is strongly seasonal rather than uniform across the culture cycle. A large field study in northern China found that most deaths occurred in July and August, during the later spawning season when water temperature reached 23°C–26°C, and cumulative mortality eventually reached 85%–90% across sites. A separate hanging-culture study in Korea also showed that mortality clustered in March–April and September–October rather than increasing steadily through time, indicating that density-related loss emerges in seasonal pulses linked to changing environmental and physiological conditions (Park et al., 2012).