

though the highest density increased gross productivity (Khôi, 2015). In tidal-zone culture of hard clam *M. meretrix*, growth declined progressively as biomass density increased, and an appropriate range of 249.40-372.38 g·m⁻² was suggested for market-sized animals. Stocking plans should also be adjusted to environmental carrying capacity and season. Ecological modeling from Jiaozhou Bay showed that bivalve stocks had exceeded maximal carrying capacity, and recommended reducing average Manila clam seeding density to about 700 individuals·m⁻² (Liu et al., 2021). The same study found that carrying capacity was lower in summer and autumn because high temperature and filtration demand intensified food limitation.

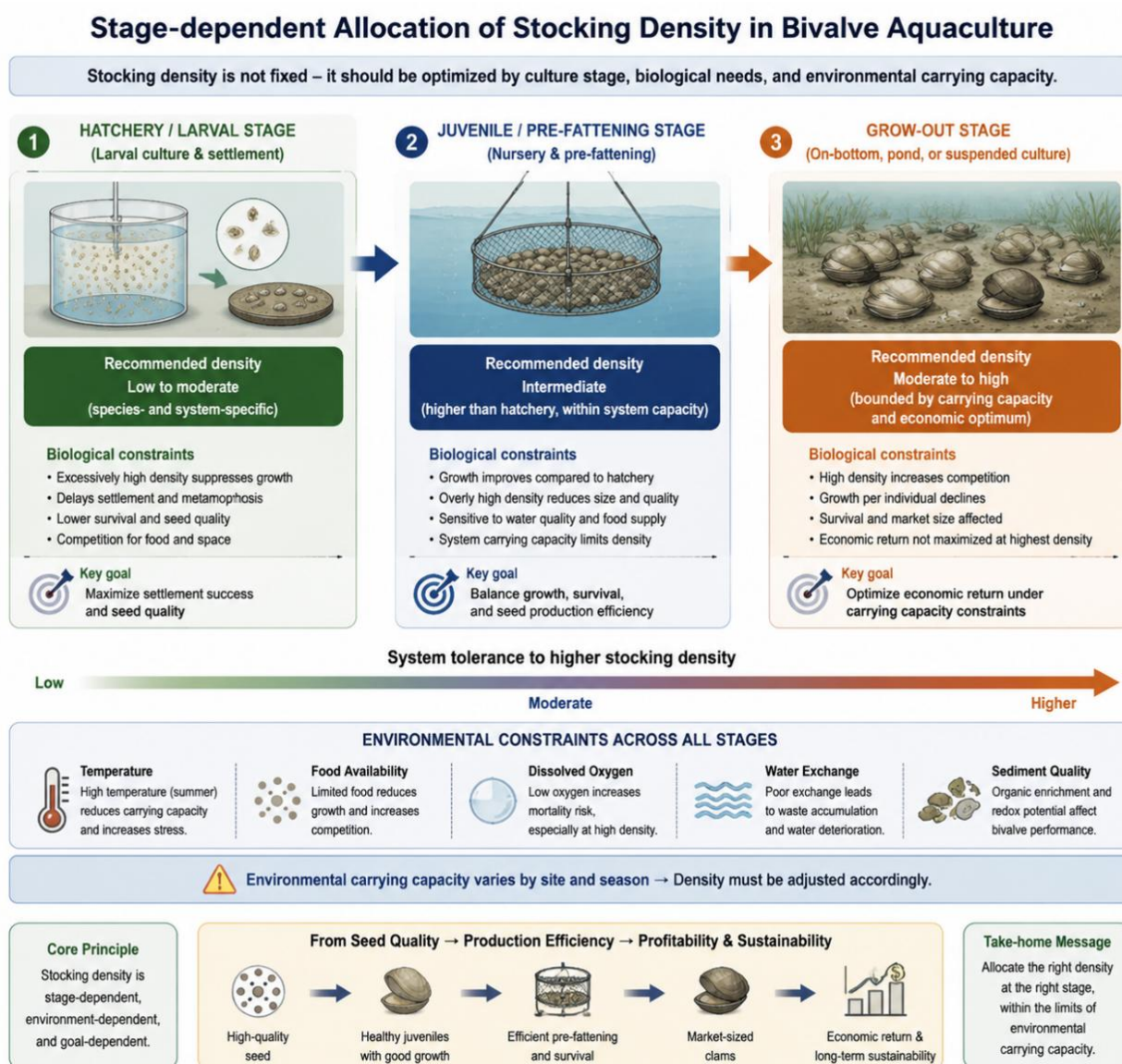


Figure 3 Stage-dependent allocation framework of stocking density across hatchery, juvenile, and grow-out phases in bivalve aquaculture systems

7.2 Graded culture and dynamic density adjustment techniques

Graded culture is justified because the negative effects of crowding strengthen as clams grow and their demand for food and space increases. In suspended mussel culture, density effects became evident only after several months, when animals had reached a larger body size, indicating that higher early density can be tolerated but later thinning is necessary. This principle is consistent with soft-shell clam field culture, where juveniles of 8-10 mm were recommended for spring planting at 333-666 m⁻² so that animals could grow rapidly toward a size refuge. For hard-clam production, graded culture should therefore combine size sorting with timely redistribution of biomass.