equally supported across that entire range. Earlier work identified an optimal salinity around 16-17 ppt, and long-term acclimation experiments showed that growth remained stable at 0, 12, and 30 ppt but was significantly inhibited at 45 ppt (Li et al., 2023). Salinity challenge therefore demonstrates both strong environmental plasticity and a measurable cost when osmotic demand becomes excessive.

The stress response of L. *maculatus* is similarly environment-dependent. Moderate salinity elevation to 24 psu appears to improve protein utilization, whereas salinity stress also alters Na+/K+-ATPase activity, oxidative damage markers, and the expression of genes involved in energy metabolism, immunity, and osmoregulation (Hu et al., 2024). Temperature is another major regulator. Growth after 30 days was 2.76-3.22 times better at 21 °C than at 14 °C or 28 °C, showing that both low and high temperature can constrain performance even in an adaptable species (Li et al., 2023). At the molecular level, environmental stress activates coordinated defense pathways, including heat shock protein responses under thermal challenge and broad gill transcriptomic remodeling under salinity or alkalinity stress, confirming that adaptability depends on active cellular compensation rather than passive tolerance alone (Zhu et al., 2023).

2.3 Physiological constraints on survival and development

Despite its adaptability, Chinese sea bass faces clear physiological constraints that limit survival and normal development under chronic or acute stress. Early life stages occur in estuarine nursery habitats where temperature and salinity fall within relatively defined ranges, indicating that successful larval development depends on suitable brackish-water conditions rather than unrestricted environmental tolerance. In juveniles, thermal stress sharply increases vulnerability. Larger juveniles experience higher oxidative stress, more severe liver damage, and greater mortality than smaller individuals under acute heat exposure, suggesting that body size influences thermal resilience during culture (Qin et al., 2023). These findings show that survival is shaped not only by the external environment but also by ontogenetic stage and internal physiological capacity.

Long-term heat exposure imposes even broader constraints on organ function and whole-animal survival. At 35 °C, juvenile Chinese sea bass showed increased mortality together with oxidative damage, inflammation, apoptosis, and strong induction of heat shock proteins, indicating that compensatory defenses are activated but are insufficient to fully prevent injury (Yang et al., 2025). Prolonged high temperature also caused gill remodeling, liver vacuolization, reduced and broken intestinal villi, depressed digestive enzyme activities, and weakened nonspecific immune capacity, which together reduce oxygen uptake, digestion, tissue repair, and disease resistance. Survival can also decline rapidly during handling-related stress: during 9 h of simulated waterless transport, survival dropped markedly and major biochemical disturbances developed, indicating that confinement and impaired homeostasis are important non-growth constraints in production chains (He et al., 2020).

3 Overview of Different Farming Systems

3.1 Pond culture systems

Pond culture is one of the principal farming modes used for *Lateolabrax maculatus* in China, and it remains especially representative in the Bai Jiao production area of Guangdong because local hydrological conditions favor this model (Huang et al., 2025). In practice, pond systems are semi-enclosed and usually depend on tidal exchange, which makes them relatively easy to manage because of their smaller water volume, but also ties production performance closely to surrounding water conditions (Zhang et al., 2021). This basic structure supports both extensive and semi-intensive production. Extensive ponds rely more on natural productivity and lower external inputs, whereas semi-intensive ponds use greater feed input, higher stocking densities, and more active water management to raise output while still retaining the operational simplicity of earthen or coastal pond infrastructure.

The main strengths of pond systems are flexibility and comparatively straightforward husbandry, but their biological performance depends strongly on density control and water quality stability. In intensively managed earthen ponds for seabass, survival did not differ significantly among tested stocking densities, yet fish stocked at 6 fish/m^2 achieved significantly greater final weight and daily weight gain than those stocked at 10 fish/m^2 (Nhan et al., 2022). Pond environments also influence fish health through their microbial conditions, because sea bass ponds with high