mass mortality showed bacterial community structure and function that differed significantly from low-mortality ponds (Deng et al., 2021). These findings indicate that pond farming can support strong production, but as semi-intensive management increases, growth and survival become more sensitive to ecological imbalance, crowding, and deterioration of the pond environment.

3.2 Cage and net pen aquaculture systems

Cage and net pen aquaculture is the other major farming system for Chinese sea bass, and it is widely used in sheltered marine waters where open-water exchange can support intensive fish production (Zhang et al., 2021). In these systems, fish are confined within mesh enclosures while surrounding water flows freely through the cage, which facilitates feeding, observation, and harvesting while also helping to maintain water quality and disperse wastes. This makes cage farming attractive for carnivorous, high-value fish such as sea bass. However, the same openness that improves exchange also exposes stocks and infrastructure to waves, currents, temperature shifts, and other external stressors, so site selection and engineering design are central to production success.

Performance in cage culture depends heavily on stocking density, hydrodynamics, and structural stability. In open-sea floating net cages, *Asian seabass* stocked at 10 fish/m^3 showed the best overall growth and production metrics, indicating that moderate density can outperform both lower and higher loading under offshore conditions (Figure 1) (Mostofa et al., 2024). At the same time, cage systems are mechanically sensitive because nets bear most hydrodynamic load, can deform under waves and currents, and thereby reduce culture space and water exchange, both of which affect fish welfare. Environmental modeling for deep-sea sea bass cages in the Yellow Sea further suggests that water-column quality can remain acceptable, although organic wastes may still accumulate in underlying sediments, highlighting the need for careful layout and environmental monitoring in offshore expansion.

3.3 Recirculating aquaculture systems and industrialized systems

Recirculating aquaculture systems (RAS) and other industrialized land-based systems represent a more controlled farming strategy in which water is repeatedly reused after mechanical and biological treatment (Lindholm-Lehto, 2023). These systems are increasingly promoted because they reduce water consumption and environmental discharge while allowing farmers to regulate key production variables more precisely than in ponds or sea cages (Li et al., 2023). As a result, RAS and industrialized systems are particularly relevant where biosecurity, standardized production, and year-round environmental control are priorities. Their technological basis also aligns with the broader trend toward more intensive and mechanized aquaculture development in China and elsewhere.

The main advantage of RAS is continuous environmental control, but this benefit depends on effective treatment and monitoring because wastes can accumulate rapidly in closed-loop systems. Hazardous substances such as particulate matter, ammonia, nitrite, and nitrate can build up from feeding and excretion and directly threaten fish safety and system operation if treatment performance declines (Li et al., 2023). Evidence from integrated land-based recirculating production shows that water-quality variation within the system is reflected in final weight, survival, specific growth rate, and yield, confirming that fish production responds directly to the success of recirculation management. Modern RAS therefore offers strong potential for improving growth consistency and survival of Chinese sea bass, but its practical value depends on reliable biofiltration, oxygenation, and real-time monitoring rather than on water reuse alone.

4 Effects of Farming Systems on Growth Performance

4.1 Growth rate differences across culture systems

Growth performance differs across culture systems because ponds, cages, and recirculating systems expose fish to distinct combinations of flow, salinity, density, and environmental stability. In Chinese sea bass, pond aquaculture and marine net-cage aquaculture remain the two dominant production modes, and recent industry review evidence notes that desalinated fish in pond-based production can grow about one-third faster than those reared in seawater, although high-density freshwater pond farming can reduce product quality (Huang et al., 2025). At the same time, offshore cage culture appears more favorable than conventional cage culture in ecological-economic performance, suggesting that differences among open-water systems are also biologically and operationally meaningful rather