

al., 2025). For swimming crab culture under thermal stress, the practical value of precision management lies in linking real-time sensing with threshold-based control and predictive intervention. Recent aquaculture studies report that automated systems can trigger oxygenation and pH adjustment during warm periods, maintaining survival above 90%, and sensor architectures can be adapted to control temperature, pH, and ammonia through pumps or heaters once preset thresholds are exceeded. Therefore, intelligent farming for swimming crab should integrate continuous sensing, early-warning models, and automated response functions to reduce the lag between environmental deterioration and management action (Zein et al., 2023; Baena-Navarro et al., 2025).

6 Case Study: Health Management Practices for Swimming Crab During High-Temperature Seasons

6.1 Overview of the case study farming area and high-temperature characteristics

The case study area can be characterized as a semi-closed coastal pond farming system for *Portunus trituberculatus* operating under intensive or polyculture conditions, where water exchange is relatively limited and environmental regulation depends strongly on in-pond management. In a representative integrated pond in Zhoushan, Zhejiang, the culture area was 1.33 ha with an average water depth of 1.2 m, salinity ranged from 14.5 to 19.0, and water exchange occurred only 1-2 times per month, which is consistent with management conditions that can magnify summer water-quality stress (Dong et al., 2022). Microbial evidence from semi-closed polyculture ponds likewise shows lower α -diversity under limited water exchange, indicating that enclosed high-temperature culture areas are ecologically sensitive and require close environmental control (Huang et al., 2024).

High-temperature exposure in such farming areas is both seasonal and biologically consequential. In early autumn culture, pond water is commonly around 30°C and can occasionally reach 33°C, while experimental evidence indicates that embryonic development remains relatively normal below 31°C but deteriorates above that threshold, with increased mortality and reduced hatching at 31°C-33°C (He et al., 2022). Elevated temperature also alters behavior and production risk in juvenile or adult crabs, because 30°C significantly increased aggressiveness and reduced behavioral predictability, while chronic summer heat in crab aquaculture more broadly is associated with oxidative stress, immune disturbance, and greater disease pressure (Liu et al., 2023).

6.2 Implementation process of health management measures

The implementation of health management during high-temperature seasons should begin with continuous water-quality regulation, especially for temperature, dissolved oxygen, pH, and ammonia. Real-time aquaculture monitoring studies show that IoT-based systems can continuously track these parameters and support rapid intervention when conditions deviate from preset thresholds, while broader sensor reviews indicate that such systems reduce mortality risk and improve the detection of atypical total ammonia nitrogen events (Shete et al., 2024; Flores-Iwasaki et al., 2025). For swimming crab ponds, this monitoring should be paired with restrained feeding, timely removal of residual feed, and controlled water exchange, because nutrient-dynamics simulations show major nutrient release from uneaten feed and summer seawater deterioration can prolong exchange intervals and intensify ammonia exposure (Dong et al., 2022; Lu et al., 2022).

A second part of the implementation process is ecological and biological stress reduction. Appropriate integrated culture can be used to improve the pond environment, because adding razor clams at suitable density improved water quality indices in swimming crab-shrimp systems, while microbial studies in swimming crab ponds suggest that potential pathogens such as *Vibrio*, *Photobacterium*, and *Flavobacterium* deserve focused surveillance during culture (Huang et al., 2024; Yao et al., 2025). At the animal level, stress buffering can be strengthened through environmental and nutritional measures: sand or PVC enrichment improved survival and reduced stress responses in *P. trituberculatus*, and heat-stress studies in crabs show that dietary supplementation such as yeast culture can improve survival, antioxidant status, immune performance, and gut health under prolonged thermal load (Xiong et al., 2024; Wang et al., 2024).