

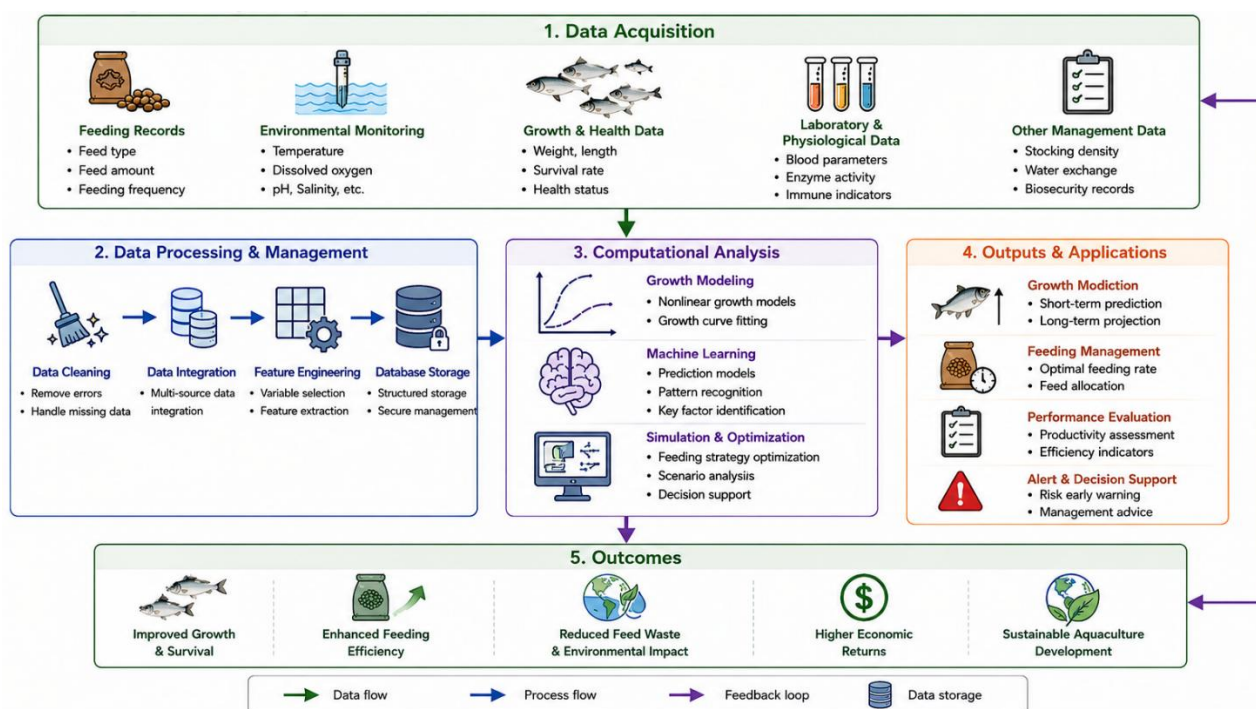


Figure 2 Computational analysis framework for growth performance and feeding efficiency in aquaculture species

Machine-learning studies show that predictive performance improves when models incorporate management and sensor variables rather than relying on water quality alone. In recirculating shrimp culture, support vector machines outperformed multiple linear regression and artificial neural networks for biomass prediction, reaching 90.91% accuracy and enabling real-time feeding decisions from sensor inputs (Chen et al., 2022). In industrial outdoor production, a weighted ensemble reached $R^2 = 0.829$, while SHAP analysis showed that days of culture, stocking density, and cumulative feed contributed more strongly to body-weight prediction than temperature, pH, or dissolved oxygen in a well-managed system (Mujahid et al., 2025).

6.3 Application of computational results in feeding management

The practical value of computational prediction lies in converting growth forecasts into feeding strategies that improve production efficiency without excessive feed waste. Mechanistic modeling has shown that shrimp growth prediction can be linked directly to feed consumption, ammonia excretion, and oxygen demand, creating a basis for stage-specific adjustment of dissolved oxygen supply and feed availability. This management logic is consistent with nutrient-budget evidence from intensive ponds showing that poor feed management raises environmental loading, and that improving feed conversion from 2.0 to 1.8 could reduce total feed use by 147 kg and save \$1027 per crop (Chaikaew et al., 2019).

Computational outputs are also valuable when they identify operational optima rather than simply maximizing feed input. In high-density biofloc culture, growth increased as feed rates approached the standard ration, but feed conversion worsened beyond an inflection point near 101% of the standard feeding rate, indicating that maximum biomass gain and maximum nutrient efficiency are not the same target (Weldon et al., 2021). Similarly, automatic-feeding studies found that moderate feeding frequencies were most effective: quadratic regression identified an optimum near 7.83 feedings per day, and the A8 treatment produced the highest profitability, supporting the use of predictive systems to balance growth, feed utilization, and economic return (Liang et al., 2025).

7 Challenges and Future Perspectives of Computational Aquaculture Analysis

7.1 Limitations of current computational models

Current computational models in aquaculture are limited first by the quality, quantity, and representativeness of available data. Reviews of AI applications consistently identify restricted access to representative datasets, environmental variability, and data-quality maintenance as central obstacles to robust model development and