What leading aquaculture experts expect the industry to become

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The strongest common conclusion

The future is **not** simply "more fish farms," nor is it "RAS replaces marine cages." The most credible view across FAO and OECD projections, leading academic work, WorldFish/CGIAR, the World Bank and WWF, and the strategies of major aquaculture corporations is that aquaculture will become:

larger, but slower-growing; more biologically sophisticated; much more data-driven; more climate-adapted; more tightly regulated; and more differentiated by species, geography and production system.

The decisive advantage will move away from merely owning tanks, cages or ponds. It will come from controlling **genetics, juvenile quality, survival, disease, feed conversion, water and oxygen, energy, operating data, licences, processing and market access**. Your attached historical report reaches essentially the same conclusion: future constraints are ecological carrying capacity, climate, feed and energy, disease, social licence, access rights, regulation and the credibility of technologies—not simply physical production capacity.

The representative academic backbone includes Rosamond Naylor, Max Troell, David Little, Jane Lubchenco and colleagues; the scenario work of Jessica Gephart, Frank Asche, Ben Belton, Shakuntala Thilsted and Edward Allison; and Christopher Costello, Ling Cao and the wider *Future of Food from the Sea* team. These researchers differ on the precise scale and form of future growth, but broadly agree that technology alone will not determine the outcome: governance, economics, nutrition, environmental limits and social equity will be equally important. (Nature)

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1. The numerical anchor: what the industry probably looks like around 2035–2036

In 2024, aquaculture produced **103 million tonnes of aquatic animals**, representing **53% of global aquatic-animal production**, while capture fisheries produced about 92 million tonnes and remained within the plateau observed since the late 1980s. Nearly all net growth in global aquatic production over recent decades has therefore come from aquaculture. FAO expects total aquatic-animal production to reach approximately 214 million tonnes by 2034, with roughly 85% of the additional output coming from aquaculture. (FAOHome)

The newer OECD–FAO 2026–2035 baseline projects:

- **121 million tonnes of farmed aquatic animals by 2035**;

- aquaculture supplying **56% of total fisheries and aquaculture production**;
- aquaculture supplying **62% of aquatic products destined for human consumption**;
- aquaculture growth of approximately **18% over the decade**, compared with 51% during the previous decade;
- Asia still accounting for about **88% of world aquaculture**, although Africa and the Americas grow faster from smaller bases. (OECD)

That 18% decade-long increase is equivalent to average growth of only about **1.7% annually**. The global sector is therefore moving from its earlier expansion phase into a more mature phase in which survival, productivity, cost control and value per kilogram matter more than headline volume.

The future is also much less salmon-centred than European investors often assume. OECD–FAO expects the 2035 aquaculture mix to remain dominated by carp, molluscs, catfish and other freshwater species. Its projected shares are approximately 32% carp, 19% molluscs, 17% other freshwater and diadromous species, 10% shrimp and prawns, 7% tilapia and only 4% salmonids. (OECD)

A further commercial warning is important: OECD–FAO projects the **real aquaculture price to decline by about 15% by 2035** relative to the 2023–2025 average. This does not mean every species or branded product will fall by 15%; it means the average producer will face continuing productivity pressure and competition from poultry, pork and other proteins. Commodity production without superior biology or market differentiation will become less attractive. (OECD)

The industry in ten years: around 2036

2. Precision aquaculture will become normal operating infrastructure

Cameras, hydroacoustic sensors, automated feeders, water-quality probes, machine vision, artificial intelligence and remote-operated vehicles will move from pilot projects to standard equipment at professionally managed medium and large farms.

The technology tables on pages 60–69 of your attached *Next Wave of Blue Growth* report already describe this operating stack: precision feeding, sensors, RAS, automation, artificial intelligence, robotics, disease detection, genetic improvement, water monitoring and digital farm platforms. They are expected to raise survival, improve biomass estimation, reduce feed losses and shorten the period between recognising a biological problem and acting on it.

The future farm manager will not merely walk cages or inspect tanks manually. The manager will supervise a continuous stream of information on:

- biomass and weight distribution;
- appetite and feeding behaviour;
- oxygen, temperature, salinity, pH and ammonia;

- abnormal swimming, lesions and disease indicators;
- mortality and welfare;
- predicted harvest windows;
- energy, water and feed use per kilogram.

This does **not** mean autonomous farms with no husbandry expertise. Artificial intelligence will identify patterns and recommend interventions, but biological interpretation and accountability will remain with experienced production managers, biologists, veterinarians and engineers. Machine vision is only as reliable as the underlying cameras, water clarity, training data and operating discipline.

Mowi's current capital allocation is a strong corporate signal: it is combining larger post-smolt production with its Mowi 4.0 and Smart Farming programmes, using automation, cameras, digitalisation and big data to improve biological performance, welfare, feed use and production control. (Mowi Company Website)

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3. Biology will become the principal competitive moat

The most important future technology may not be the tank or cage. It may be the **biological package placed inside it**.

Leading scientists expect conventional selective breeding and genomic selection to produce cumulative improvements in:

- growth;
- feed conversion;
- disease and parasite resistance;
- heat and low-oxygen tolerance;
- robustness during handling;
- fillet yield and product quality;
- reproductive control.

Aquatic animals often have high reproductive output and, for some species, relatively short generation intervals. This makes long-term genetic improvement particularly powerful. WorldFish's 2030 strategy therefore places genetically improved, resilient strains and genomic technologies among its core priorities. (worldfishcenter.org)

Disease will remain one of the industry's greatest systemic risks. Higher density, animal movement, warming water and concentrated farming regions can amplify pathogens. The likely response is a combination of better broodstock, healthier juveniles, vaccines, rapid diagnostics, microbiome management, improved nutrition, compartmentalised production and stronger biosecurity—not simply more medication.

Cermaq's strategy illustrates this direction. It combines vaccination, screening, breeding, water-quality monitoring and larger post-smolt production with trials of closed and submersible pens. The company explicitly links larger, more robust juveniles and shorter marine exposure to reduced climate, environmental and disease risk. (Cermaq Global)

Gene editing is more uncertain. Technically it could accelerate disease resistance, sterility and climate resilience, but regulation, escape risks, food-market acceptance and consumer perceptions differ sharply across jurisdictions. Genomic selection is therefore likely to become broadly mainstream well before gene-edited seafood does.

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4. Feed will become a precision-nutrition and circular-economy industry

Feed will remain one of the most important determinants of both profitability and environmental performance.

The future feed basket will become more diverse rather than being replaced by one miraculous ingredient. It is likely to combine:

- responsibly sourced fishmeal and fish oil;
- fish-processing trimmings and aquaculture side streams;
- improved plant proteins and oils;
- algae-derived oils;
- insect proteins;
- microbial and single-cell proteins;
- fermentation products;
- functional ingredients supporting immunity, digestion and stress resilience.

Fishmeal and fish oil will not disappear. OECD–FAO projects that by 2035 aquaculture will consume approximately **85% of global fishmeal and 54% of fish oil**. Scarce marine ingredients will increasingly be directed toward hatcheries, juvenile stages, high-value species and formulations where their nutritional value is hardest to replace. Processing by-products are projected to rise to about 30% of fishmeal production. (OECD)

The leading feed groups are already positioning themselves accordingly. Cargill is combining lower-footprint ingredients, regenerative agriculture, health nutrition and data analysis; BioMar describes feed as evolving from a commoditised input into sophisticated species- and system-specific nutritional solutions; and Skretting is integrating growth models and digital tools with its feed portfolio. (cargill.com)

BioMar estimates that feed can represent more than 50% of operating expenditure and up to 80% of the carbon footprint for farmers of high-value species. The future leader will therefore sell not merely feed tonnes but **biological performance**: survival, growth, FCR, health, welfare, water quality and harvest value. (BioMar)

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5. No single farming technology will win

Experts and major corporations do not expect ponds, marine cages or flow-through farms simply to disappear. Instead, the industry will use a **portfolio of systems**, each suited to particular species, climate, market and cost structure.

The likely winning model is a chain of systems

A future salmon, seabream, amberjack or trout production chain may include:

1. controlled broodstock and hatchery production;
2. a nursery or post-smolt stage in RAS or high-reuse flow-through systems;
3. grow-out in marine cages, semi-closed pens, land-based systems or exposed/offshore sites;
4. automated harvesting and processing;
5. side-stream recovery and full product traceability.

RAS will expand where biosecurity, water scarcity, discharge rules, proximity to the consumer, temperature control or high product value justify the capital and energy cost. But the technology exchanges water and environmental control for greater energy use, capital intensity, technical complexity and operational concentration risk. It is a strategically important technology, not a universal replacement for ponds, raceways or marine cages.

Major salmon companies reveal this hybrid direction:

- **Mowi** is investing heavily in land-based post-smolt and digital sea farming rather than replacing all marine grow-out with full land-based production.
- **Cermaq** retains ocean farming as its core model while adding post-smolt RAS, closed pens, submersible technology and environmental forecasting where conditions justify them.
- **SalMar** continues to develop exposed and offshore farming as a selective growth frontier, while recognising technological, capital and competitive risks from alternative production systems. (Mowi Company Website)

The corporate message is consequently **not "all RAS."** It is "greater biological control at each stage, using the most appropriate production environment."

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6. Sustainability will become an operating and market-access requirement

By 2036, sustainability will increasingly be measured through operational data rather than general claims.

Retailers, regulators, lenders and consumers will expect information on:

- survival and mortality;
- stocking density and welfare;
- antibiotic and chemical use;
- feed origin and deforestation exposure;

- fishmeal and fish-oil sourcing;
- escapes;
- benthic and nutrient impacts;
- carbon and energy intensity;
- labour conditions;
- traceability from broodstock or egg to final product.

Thai Union is already integrating artificial intelligence into food-safety, quality and traceability systems, while its SeaChange programme extends across sourcing, aquaculture, climate and labour. (Sustainable Seafood Company | Thai Union)

Finance will follow the same direction. The attached UNEP FI report expects future seafood finance to favour certification, reduced aquaculture impacts and demonstrable sustainable practices. Its sustainability-linked loan examples tie credit terms to measurable indicators such as ASC certification, antibiotic reduction, clean energy, waste management, carbon and water performance.

The 2026 BlueInvest survey also makes clear that investors are not treating the sector as philanthropy: **74% named achieving return targets as a principal five-year priority**, while grants, subsidies and blended finance were requested mainly to de-risk innovation and make commercial projects bankable.

The industry's future version of ESG will therefore be:

lower mortality, lower FCR, less treatment, better welfare, secure permits, stronger market access and cheaper capital.

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7. Asia remains the volume centre, but growth becomes geographically broader

Asia will still dominate in 2036, especially through freshwater fish, shrimp, molluscs and seaweed. The industry will not suddenly relocate its centre of gravity to Europe or North America.

Nevertheless, OECD–FAO expects aquaculture growth to be fastest in **Africa, at approximately 37%, and the Americas, at approximately 24%, through 2035**, compared with 17% in Asia and 14% in Europe. (OECD)

This suggests three different future industry models:

Asia: enormous domestic and regional markets, freshwater and coastal production, increasingly automated farms, vertically integrated feed and processing, but also millions of small and medium producers.

Latin America: export-oriented shrimp and salmon, increasingly sophisticated genetics, disease management, processing and digital feeding.

Europe and the Middle East: lower overall volume but higher-value opportunities in premium species, import substitution, hatcheries, advanced marine systems, land-based production, processing, traceability and technology.

For Europe in particular, the scarce asset will increasingly be **the established licence, approved site, operating history, skilled team and biological dataset**, rather than the physical farming hardware alone. OECD–FAO attributes slower expansion partly to stricter environmental regulation and the limited availability of new high-quality production sites. (OECD)

The industry in twenty years: around 2046

8. Aquaculture becomes a form of biological manufacturing

There is no credible single-number forecast specifically for 2046. The serious long-term studies use scenarios because policy, capital, climate and consumer demand can alter the outcome significantly.

My synthesis of the most likely 2046 industry—not a formal forecast—is that aquaculture will resemble a biological manufacturing network.

A professionally managed farm will begin with selected broodstock and digitally recorded genetics. Juveniles will be screened for health and quality. The nursery stage will take place in controlled systems. The grow-out system will be chosen according to species, climate, energy, water, market and permit conditions. Feeding and health management will be continuous and predictive. Harvesting, processing and logistics will be coordinated against contracts and demand. Waste streams will become oils, proteins, fertilisers, biogas, collagen or other co-products.

The physical farm will increasingly be only one component of an integrated platform comprising:

genetics + hatchery + nutrition + health + production technology + data + processing + distribution.

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9. The 2050 production range is very wide

The World Bank–WWF 2025 study provides two markedly different pathways, excluding seaweed:

- a business-as-usual investment pathway reaching approximately **159 million tonnes of aquaculture by 2050**;

- a much more ambitious investment and policy pathway reaching approximately **255 million tonnes**, associated with a cumulative $1.5 trillion investment opportunity and potentially 13–22 million new jobs. (World Bank)

The upper figure should not be treated as a consensus forecast. It assumes exceptionally strong investment, infrastructure, policy reform and productivity improvement.

Costello, Cao and colleagues reached a different but complementary conclusion: under plausible demand, policy and technological scenarios, **edible marine food** could increase by 21–44 million tonnes by 2050, with the strongest potential coming from mariculture. That figure is not directly comparable with the World Bank number because it uses edible marine food rather than total global farmed live weight and does not cover the entire freshwater aquaculture sector. (Nature)

The defensible conclusion is therefore not a precise 2046 tonnage. It is that substantial additional production is possible—but only where biology, economics, governance, infrastructure and environmental carrying capacity align.

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10. Climate will redraw the aquaculture map

By 2046, site and species selection will increasingly be exercises in **climate zoning**.

Temperature, oxygen availability, drought, flooding, salinity change, harmful algal blooms, jellyfish, storms and pathogen ranges will influence which species can be farmed profitably in particular locations. Under high-emissions scenarios, FAO expects exploitable fish biomass to decline by more than 10% by 2050 in several regions, increasing the importance of adaptive aquaculture and diversified aquatic food production. (FAOHome)

Likely responses include:

- heat- and disease-resilient strains;
- shorter grow-out cycles;
- larger and more robust juveniles;
- seasonal or deeper-water production;
- submersible cages;
- controlled oxygenation;
- semi-closed or land-based stages;
- alternative species;
- relocation toward more suitable regions;
- renewable energy and heat recovery.

Cermaq already reports that warming, oxygen decline, algal blooms and jellyfish are increasing the need for monitoring, oxygen addition, closed containment and post-smolt production—while also increasing energy use. This illustrates an important future trade-off: climate adaptation can reduce biological risk while raising energy and infrastructure requirements. (Cermaq Global)

11. Low-trophic aquaculture grows—but does not automatically replace finfish and shrimp

Mussels, oysters, clams, seaweed, sea cucumbers and integrated multi-trophic systems will receive more attention because many require no formulated feed and can provide environmental services under suitable conditions.

However, the likely future is not an automatic seaweed or shellfish revolution. European seaweed experts identify real opportunities through co-location with offshore wind, IMTA and new processing chains, but also highlight the continuing need to establish markets, processing capacity, permitting systems and commercial viability. (Nature)

The most probable 2046 composition remains mixed:

- freshwater fish supply mass-market nutrition;
- shrimp and salmon remain major internationally traded premium products;
- seabass, seabream, seriola, trout, catfish and tilapia expand regionally;
- molluscs and seaweed gain importance where markets and ecosystems support them;
- premium new species grow selectively rather than simultaneously everywhere.

12. The industry will be both more consolidated and more decentralised

This appears contradictory, but both trends are likely.

Large corporations will gain advantages from integrated genetics, feed, health, processing, certification, purchasing and distribution. Capital intensity, biosecurity and data requirements encourage consolidation.

At the same time, Asia and Africa will continue to contain very large numbers of small and medium producers. Digital services, contract farming, shared hatcheries, diagnostic platforms, feed programmes and mobile finance may connect them into professional networks without every farm being corporately owned.

Gephart and colleagues' future scenarios show that the industry's eventual form depends not just on technological development but on whether food systems become more globally integrated or locally oriented, and whether policy prioritises maximum economic growth or environmental and distributive outcomes. (Aquaculture Science Hub)

Therefore, the 2046 debate will increasingly concern not only **how much aquaculture produces**, but:

- who controls the licences and genetics;
- who receives the economic benefits;

- whether local populations can afford the products;
- whether aquaculture complements or displaces traditional fisheries and coastal uses;
- whether the environmental costs are genuinely accounted for.

What the largest companies are really signalling

Corporate strategy is not neutral scientific evidence, but it reveals where experienced operators are committing money.

Mowi: larger post-smolt, shorter marine exposure, underwater visibility, Smart Farming, automation and integrated feed. This points toward hybrid production and better biological control rather than complete migration to land. (Mowi Company Website)

Cermaq: ocean farming remains fundamental, but the company is adding closed pens, submersible systems, post-smolt RAS, vaccination, screening and climate monitoring. It is explicitly balancing biological risk reduction against additional energy use. (Cermaq Global)

SalMar: conventional coastal operations remain central, while offshore and exposed systems are being developed as additional growth options. This suggests offshore production will be important in selected jurisdictions but is unlikely to become the universal model. (SalMar)

Skretting/Nutreco, Cargill and BioMar: all are moving from feed manufacturing toward integrated nutrition, data, health, footprint measurement and farm-performance services. Skretting's AquaVision 2026 framed the industry's future around resilience, data sharing and collaboration amid climate, raw-material and geopolitical uncertainty. (Skretting)

Thai Union: places increasing emphasis on AI-supported food safety, traceability, responsible sourcing, labour standards and supply-chain transparency, indicating that the future seafood company will manage information and social risk as intensively as raw material. (Sustainable Seafood Company | Thai Union)

The combined corporate signal is clear:

The future is hybrid systems, stronger biology, precise nutrition, digital control and verified supply chains—not one grand technological replacement.

Where leading experts genuinely disagree

Full-grow-out RAS

Optimists expect falling energy costs, better engineering, automation and proximity to markets to expand land-based production rapidly. More cautious scientists and operators point to capital intensity, energy demand, ramp-up risk, biological concentration and repeated difficulty achieving stable costs at commercial scale. The most defensible outcome is substantial growth in RAS, especially in hatcheries, nursery/post-smolt and premium local markets, without universal replacement of lower-cost systems.

Offshore aquaculture

Supporters see greater water exchange, reduced coastal conflicts and access to larger sites. Critics emphasise weather exposure, logistics, maintenance, worker safety and capital cost. Offshore farming will probably become meaningful, but only for suitable species, technologies and jurisdictions.

Gene editing

Genomic selection will almost certainly grow. Gene editing could eventually deliver dramatic advances in disease resistance, sterility and climate resilience, but public acceptance and regulation may keep it fragmented for many years. (ScienceDirect)

Seaweed and restorative aquaculture

The environmental potential is large, but the commercial path depends on real markets for food, feed, biomaterials and ingredients. Environmental claims such as carbon removal will also require rigorous, location-specific verification.

The scale of 2050 growth

Conservative institutional forecasts see continued but slower expansion. High-investment scenarios envisage a sector more than twice today's size. The difference is mainly explained by assumptions about capital, infrastructure, market demand, policy reform and biological productivity—not by disagreement that aquaculture will grow.

Implications for V5's strategy

1. Established operators become more valuable, not less

The expert outlook supports investing in established companies possessing licences, operating teams, hatchery and production knowledge, biomass records, processing infrastructure and customer relationships. As good sites and regulatory permissions become scarcer, those assets acquire strategic value.

This favours V5's model of partnering with proven operators and modernising them rather than treating every investment as a greenfield technology experiment.

2. The investment case should be biology-first and technology-second

A technology should be selected because it solves an identified biological or commercial problem:

- reducing marine exposure;
- improving juvenile quality;
- controlling temperature or disease;
- enabling a premium species;
- improving water or waste management;
- locating production near a market;
- overcoming a binding site limitation.

“RAS” by itself is not an investment thesis. A specific species, site, energy source, operating team, feed programme, survival curve, market and system design together form the thesis.

3. Premium-species diversification can create value—but requires strict gates

Mediterranean amberjack, Common Sole, tuna and other premium species may provide attractive differentiation. But the future expert consensus is that species diversification succeeds only when accompanied by:

- reliable broodstock and juvenile supply;
- proven diets;
- acceptable FCR and survival;
- disease knowledge;
- scalable grow-out protocols;
- predictable processing yields;
- genuine market demand and price depth.

A rare species with poor juvenile availability or unstable biology can be less investable than an established species with better genetics, health management and market access.

4. Denmark and Oman may mitigate energy or climate constraints, but cannot remove execution risk

Low-cost or low-carbon energy materially improves RAS economics. It does not replace the need for stable water chemistry, trained operators, mature system design, robust juveniles, disease prevention, contingency capacity and realistic production ramp-up.

The attached historical analysis correctly concludes that aquaculture systems have radically different feed, land, energy, nutrient and biodiversity footprints; broad claims that a particular type is inherently sustainable are analytically weak.

5. The strongest investor proposition is measurable operational improvement

The future institutional investor will respond most positively to verified improvements in:

- survival and mortality;
- FCR;
- growth rate;
- harvest quality;
- energy and oxygen per kilogram;
- medication and treatment;
- water discharge;
- escapes;
- welfare;
- processing yield;
- contracted sales;
- cash conversion.

That supports positioning V5 as providing **secured real-asset capital plus specialist operational modernisation**, rather than selling investors a speculative technology story.

Bottom line

In ten years, aquaculture will be a larger but more mature industry in which precision feeding, cameras, sensors, genomic selection, vaccination, post-smolt systems, traceability and hybrid production are normal. Asia will remain dominant, while Africa and the Americas grow faster and Europe concentrates on value, technology and scarce licensed assets.

In twenty years, the best aquaculture businesses will resemble integrated biological-manufacturing platforms. They will combine genetics, hatcheries, nutrition, health, automated production, climate adaptation, processing, data and market access. Conventional ponds and cages will still exist, but they will be far more instrumented and accountable; RAS, semi-closed and offshore systems will be deployed where their control benefits justify their capital and energy costs.

The winners are unlikely to be those with the largest announced CAPEX. They will be those that achieve the most reliable **survival, feed conversion, welfare, product quality and cash flow per unit of biological and financial risk**.