



NUAGUA

# Nuagua's White Paper

How we plan to accelerate the world's transitions toward regenerative food production.

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Let's start by making a deal.

I will acknowledge that time and attention are precious and scarce resources. On my side of the deal, I will aim to write as concisely as possible. In return, I will appreciate 10 min of your full attention and the request to reach out if a concept or solution needs details or clarification. Deal?

PS: We aim to use first principle thinking which means boil things down to their fundamental truths and reason up from there, as opposed to reasoning by analogy. Therefore, we need to start from the fundamental truths.

## Why do we work on this

The extractive, unsustainable and unfair way in which food and especially seafood is produced is destructive. An environmental and social tragedy. The human species needs to move towards a regenerative and fair food production system or collapse as a species in the long term. Not no need to panic, focusing on the past nor clinging to the status quo. Nevertheless, action towards accelerating the transition is important.

Nuagua's Mission is to accelerate the transition towards globally fair and regenerative food production.

Why?

Because we are the net sum of a 13.8 billion years unbroken chain of evolving towards greater consciousness. Life and consciousness are precious. We need to follow the trend, we need to protect and increase the scope and scale of consciousness.

That is a fact. The ultimate universal, measurable, and objective fact. As simple as that

## Where to focus

Planet earth has to be understood as Spaceship Earth; a self-contained spherical spaceship traveling in space where all life creates the biosphere. Where limited resources are continuously recycled by organisms, where energy is transferred from the sun as heat and light, a fraction of light is converted into biomass by primary producers and transferred up a multi-trophic food chain. The process is regenerative and not extractive which means that



generates more than it takes, is a positive contributor. Therefore the net biomass, complexity, and consciousness increase over time. This is also a fact.

Please make sure you understand these concepts since we are not used to thinking in big perspectives for long time frames. Do not agree or believe them before putting them to the logical test. Are they universally true for any observer? Are they objectively measurable? Do they comply with the physical rules of the universe?

With spaceship earth in a perspective now we can appreciate that the world's oceans are the critical life support system. The global life support system creates and regulates; the atmosphere, the air we breathe, the carbon cycle, and weather (weather has to be understood as heat, air, and water distribution throughout the spaceship). Tempering and damaging the world's life support system will have global negative consequences. The oceans were relatively undisturbed until 200 years ago (negligible time within the evolutionary time's scope). Now the disturbance to the oceans is dramatic.

Therefore, reducing the disturbance to the oceans and producing biomass and protein without adding more CO<sub>2</sub> to the atmosphere is important. The most effective way to achieve it is with algae-based multi-trophic aquaculture (AB-IMTA).

Aquaculture refers to growing seafood (fish and shellfish) in water. Multi-trophic refers to using multiple trophic layers (as Primary producers like algae; primary consumers as zooplankton and shrimps, and oysters; secondary consumer and fish)

Integrated refers to connect the cycle as a circular economy. Where the waste from the organism is the food from another. An example is when the waste nutrients from fish and shrimps become the food for algae and zooplankton and the biomass and protein from algae and become the food for fish and shrimps.

The Blue Revolution refers to the significant growth and intensification of global aquaculture production -domestication and farming of fish, shellfish, and aquatic plants

## How to enter alga based Integrated aquaculture

The world's AB-IMTA industry is virtually non-existent besides some production in China. Nevertheless, aquaculture, in general, is booming which makes Aquaculture the Fastest Growing Food Production Sector, According Agriculture Organization (FAO) Report. According to Statista.com The global seafood market reached a value of 159.31 billion U.S. dollars in 2019 and is projected to reach about 194 billion dollars by 2027

The aquaculture industry is growing exponentially mainly in China and Southeast Asia. Europe, Latam, and The Middle East are catching up at a fast pace. I had to delete some graphs to honor my deal of keeping it short. Therefore, please check out the industry status in this great infographic page: <https://ourworldindata.org/seafood-production>



The Nature Conservancy (TNC) wrote the report 'Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems in 2019' where the 3 selected sectors within the seafood industry were the following

1. On-land finfish recirculating aquaculture systems (RAS);
2. Offshore finfish aquaculture systems; and
3. Bivalve and seaweed aquaculture systems.

Therefore the best sector to invest within the fastest growing food production industry in the world is recirculating aquaculture systems (RAS) combined with algae production. Adding process control, aeration, and water treatment to aquaculture to dramatically increase productivity while reducing water use and pollution. Smart aquaculture or engineered aquaculture is equivalent to moving from traditional agriculture to process-controlled horticulture.

While RAS aquaculture is a great leap from current food production (for Example beef production or wild fishing) is not enough on its own since problems can be just moved out of sight like the existing practice of using feed from wild fishing. Therefore, the integration of algae is important in the long term.

The limiting factors, key areas, and the knowledge gap within aquaculture are; i) process control, ii) aeration, and iii) water treatment. Literally, a shrimp production client in Latam where environmental conditions are ideal has a survival rate of 50% and a productivity of 13 shrimps per m<sup>3</sup>. Where 95% survival rate and productivity of over 650 shrimps per m<sup>3</sup> have been proven. The missing factor is process control, aeration and water treatment.

It is also important to understand that engineering is never the limiting factor, Trust and financing are.

## Competitive advantage to solve the challenge

Nuagua's background is in water treatment, process control, and aeration.

Its Co-founder and Chief Technical Officer have 15+ experience in water treatment and bioreactors with a Ph.D. from TU Delft in membrane bioreactors and advanced aeration. He is an expert in biotechnology which means using engineering to provide water



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treatment, process control, and aeration to create bioreactors to clean water and create biomass using biologically based processes. An unusual highly specialized engineer and academic and a multi-disciplinary approach and a lateral thinker.

The director has 10+ years in water treatment business development, especially in introducing and implementing new technologies to market especially in Latam. Including the agriculture sector such as high-tech horticulture.

With an MSc in Water treatment, BA in Civil Engineering, and start-up experience.

Trilingual, international, and infinite minded teambuilder with multi-disciplinary expertise.

The frustration from the disregard the economy has for water and water treatment its been transformed into potential. The current economy does not price or value water, therefore the water industry has been forced to treat, aerate and process controlled water at the lowest possible cost since there is no incentive nor obligation to pay.

The water industry carries big responsibilities without the financial incentive to innovate creating a male-dominated, risk-averse, conservative industry with low cross-pollination with other industries.

To convert frustration into potential and have the biggest long-term positive impact is why we joined the Blue Revolution.



## Philosophy

**Protect and expand consciousness** We are the sum total of a 13.8 billion years chain of unbroken evolution now looking at itself. Life and consciousness are simply too precious, we need to preserve and expand them, it's our duty.

**Sustainable and regenerative food production** is needed, is feasible, and advisable

**Fair and donut economy.** To break the vicious cycle of an imperialistic economy of extraction and environmental degradation. Create a sustainable and regenerative system

**Invest and not extract the Global South.** Acknowledging that the global south already has the assets, meaning the land, know-how, and workforce. Trusting the global south by providing knowledge and technology. To reinvest the profits into innovation, the community, and the environment.

**Engineering Solution as a Service.** To reduce time to benefit by becoming the client's partner and engineering and R&D+I department. Empowering aquaculture technology and tools before out of reach.

**Iterative design and incremental model** to maximize knowledge, flexibility, and Lowering initial delivery cost. To create a flywheel where the benefits from previous improvements pay for the following

**Biotechnology with a biomimicry perspective** Nature as our inspiration and guide. Nature has 13.8 billion years of evolutionary optimization design, let's put it to practice and mimic nature's zero waste regenerative design.

**Blockchain for traceability and governance** Trust, fairness, and accountability are key. Blockchain technology allows the creation of better systems while avoiding extractive, unfair, and corrupted ones.



## Technical solutions.

The limiting factors, key areas, and the knowledge gap within aquaculture are; i) process control, ii) aeration, and iii) water treatment. Adding algae will create a regenerative system and by adding solar power the system will be energy self-sufficient, decentralized, and independent.

### Process control

**Problem:** Traditional industry data integration system (SCADA) for process control is out of reach technical and financial for aquaculture growers. Process control and data acquisition is practically non-existent

**Solution:** Nuagua developed and implemented for IHE-Delft labs the first working model of data acquisition hardware and software. Capturing data optically allows us to read any sensor from any brand and any protocol and process the data in our software to control any equipment.

Saving costs and providing the flexibility to use any sensor and be able to control any equipment.

### Aeration

**Problem:** Dissolved oxygen is (DO) critical for seafood survival. The lack of DO is killing the shrimp and limiting growth.

In hot water, biomass grows faster (algae, bacteria, fish, shrimps) requiring more oxygen. At the same time, hot water retains less oxygen than cold water, salinity decrease the oxygen saturation even lower.

Traditional aeration blows air which is only 21% oxygen (5x more energy required for pumping) and the air is lost by bubbles rising to the surface. Aeration at the bottom layers is very challenging.

Oxygen transfer is killing shrimps and limiting growth.

**Solution:** Nuagua's CTO wrote the book on advanced aeration, at least its Ph.D. dissertation.



By concentrating pure oxygen and efficiently dissolving to water oxygen transferring rates improve from  $\pm 7\%$  for air diffuser to  $\pm 90\%$ .

We use 2 technologies;

**Speece oxygen Cones:** Dissolves pure oxygen into the water where gas transfer efficiency is around 90%.

**Nanobubble generator:** Advance gas-liquid transfer creates nanobubbles whose small size allows them to remain in the water in random motion instead of floating to the surface.

Dramatically reducing energy, pumping, Opex and allowing optimal oxygen rates for growth

Nuagua will assemble the Speece cones themselves and we are a distributor of [Moleaer](#) a leading nanobubbles technology.

Additionally, Hydrodynamic and pond soil conditions will be accounted for to make sure that the oxygenation process happens safely and efficiently. We work with [Landing Aquaculture](#) an Engineering company specialized in aquaculture plants design.

## Water Treatment

**Problem:** The same nutrients that are the key to life, are killing the shrimp. Ironies of ignorant man-made systems.

Also, water has to be treated to control bacteria and disease. Until now, there is no treatment. The solution is to dump dirty water down the river and use more. The other even worse option is to use tons of antibiotics to prevent disease like they do in South East Asia. That is an irresponsible practice with far-reaching negative consequences.

Bad water quality is killing the shrimps and limiting growth

**Background:** In Nuagua was born with the merger of [Water Colombia](#) a water treatment company operating in Colombia and [Synergy Cooling Towers](#) a consulting company offering chemical-free water treatment solutions for industry, based in Amsterdam.



**Solution:** Engineered Biological treatment plant to remove nitrogen, phosphorus (nutrients), suspended solids, and control virus and bacteria.

Water Colombia developed modular, transportable membrane bioreactors (MBRs) to treat sludge and reuse the water.

To honor my deal and avoid making the document too large, I will restrain myself to get into the technology's details and how it works. Please reach out for more info.

**PS: From here on the proposed solutions are important but are not limiting factors for biomass growth.**

## Algae

**Problem:** Excess nutrients are killing the shrimp and limiting production. Feed represents the biggest cost for agriculture.

What is killing the shrimp/fish is the key to life growth.

**Solution:** Growing microalgae in controlled reactors to remove excess nutrients and CO<sub>2</sub> and producing high-grade feed (highest quality since is superior in protein content and omega-3).

The algae will be coagulated, flocculated, and fed back into the pond. This is HUGE since the feed conversion rate drops below 1. Tipping the system from extractive to regenerative.

We work with [LGem](#) for everything microalgae

Food for thought: Algae, as bacteria also grows exponentially.

## Insect-based protein production

**Problem:** The fish waste (skin, bones, and gut) is a smelly/sanitary problem in which the producers lack adequate disposal solutions. It creates pollution.

The surrounding community does not have an organic solid waste system

**Solution:** By breeding black soldier fly it is possible to convert waste into high-quality protein food and generate a nutrient-rich substrate for soil remediation or organic food production.

This solution improves the feed conversion rate (FCR). Additionally, we can provide adequate and circular organic solid waste services to nearby towns.



## Solar power

**Problem:** Growers lack an adequate power supply. Are forced to use expensive monophasic electric lines at best or diesel generators. Powering equipment is costly and unreliable.

They think they cannot afford to aerate, but in reality, what they cannot afford is inefficiency.

**Solution:** solar panels to power equipment. There is plenty of sun on the equator. We work with [Kova Innovación](#) for solar panel installation.

## Starlink

**Problem:** There is no internet connection at the aquaculture sights. No time to wait for local providers.

**Solution:** Purchase a Starlink solution with 2022 expected delivery to have high bandwidth internet anywhere. Allowing to remotely operate the plant with a cloud-based process control system. In case you don't know about [starlink](#)  
Ability to support growers in every step.



## Social solutions

**Engineering is never the limiting factor. Trust and financing are.**

### Engineering as a service:

**Problem:** The traditional engineering sales process for water treatment solutions is extremely slow and inefficient. Things get worse when dealing with the global south. Making Solutions unaffordable for aquaculture growers.

Aquaculture growers lack the necessary data for design and access to finance to implement it. They lack an engineering department to understand, implement and operate the solution.

European technology providers cannot afford to make a consulting study and travel to sites to generate the data. Nor can they properly operate remotely, especially if service is not paid for.

**Solution:** Engineering solutions as a service (E-SaaS) where the service cost is paid by the benefits generated.

A simple agreement is signed which states the terms of collaboration. In short, Nuagua invests and operates the solution and the benefits are split.

This allows the use of iterative design. Aeration is implemented in the smallest tank, the increased production will pay for the expansion, and the data generated will determine exactly when dissolved oxygen is no longer limiting.

Similar for water treatment. An optimal solution is reached in the smallest tanks and reproduces iteratively, always improving, always learning, always innovating.

The huge part is that we become the engineering and R&D department. Becoming partners and multiplying production without costly and time-consuming efforts of buying land and building from scratch. The sales and implementation cycles are dramatically improved.



## Regenerative

By changing the formula from maximizing sales in the short term to maximize the level of service and productivity in the long term. The whole mentality and equation change.

Knowledge has to be transferred locally and increased locally.

The knowledge of aquaculture increases exponentially and innovation can be transferred from grower to grower.

Technology and innovation hubs serve multiple growers.

## Blockchain traceability and governance

**Problem:** The market is demanding certification and traceability. The seafood food chain creates profound exploitation of human labor, exploitation of animals, and exploitation of the planet. End users are starting to demand fairness and traceability but it is hard to enforce. At the farm level is lacking; will, resources, incentives, and punishments.

**Solution:** We plan to use the [Open Food Chain](#) developed by [The New Fork](#) which is a customizable blockchain solution that can tell a product story, manage ESG risks, and create more efficient supply chains.

Nuagua will generate the necessary data for process control and the open food chain will be an open accounting system.

Allowing selling directly at large buyers for a better price.

## How we are organized

Making the production environmentally sustainable or even regenerative does not solve the fairness nor the stakeholder supremacy. We need to go deeper.

## Dynamic Equity split; slicing pie model

The Slicing Pie model is based on observable events and self-adjusts over time to stay fair no matter what changes over time. This means that we account for value-added to the project (ingredients), continuously updated and your total share is determined by;



$$\text{your share \%} = \frac{\text{Value invested}}{\text{Total value invested}}$$

Therefore, the time contribution by mentors and collaborators is remunerated in equity shares. Also provides a clear indication in time of the vested contribution of everyone and the fair volume of their voice. In short, if you contribute to the project, you become a member and shareholder.

### Our main partner is nature.

By far nature is doing the heavy lifting. To assure that the project is regenerative with the environment and community and follows the donut economics philosophy, a foundation will own 50% of undiluted shares. The remaining 50% of shares will be allocated using the slicing pie model.

The foundation has one just cause and one requirement.

**Just cause:** To accelerate the transition towards globally fair and regenerative food production.

**Requirement:** To assure the health, mental and financial basic needs for all the members of the Nuagua cooperative.

This prevents stakeholder supremacy and extraction to secure that the funds are reinvested in the community and environment.

