AQUAVETIC LABS

OCEAN RESTORATION ENGINEERING

DEVELOPING WAYS TO STEM THE TIDE OF OCEANIC DECLINE

The accelerating state of oceanic decline

Oceans around the world are becoming warmer, more acidic, and more polluted. The rate of deterioration is already fast—and it's accelerating. Based on all available evidence, oceanic systems are poised to suffer a cascading biologic decline.

The broad array of problems converging on our oceans includes:

- Temperature increase
- Ocean acidification (OA)
- Hypoxic dead zones
- Harmful algae blooms
- Biologic and food web decline
- Habitat destruction
- Noise pollution
- Sea surface thermal anomalies (SSTAs)
- Pollution (chemicals, toxins, plastic debris, micro-plastics)
- Overfishing
- Nutrient suppression
- Sea-level rise

Driven by anthropogenic climate change and human activity, most of these conditions are getting worse year over year, and many of them work in concert to create feedback loops. Higher ocean temperatures, for example, increase the occurrence and size of harmful algae blooms (HABs), which create the conditions that lead to hypoxia. At the same time, high carbon content in the ocean can cause some HABs, like pseudo nitzschia, to increase in toxicity, offering a perfect illustration of how multi-stressor scenarios can have cascading effects: algal blooms are growing not only larger and more damaging but also more toxic, shutting down valuable fisheries and poisoning shellfish, marine mammals, and birds, while also indirectly increasing hypoxia (lack of oxygen).

The world's oceans are a nonlinear system, and part of what's tricky about nonlinear systems is that individual problems can appear manageable—or at least containable—nearly up to the point at which systemic collapse becomes irreversible. The climate is another such nonlinear system. And just as the effects of climate change are exacerbating the decline of ocean health, so the changes happening in the oceans are intensifying the negative effects of climate change.

Climate change: The oceans as the great modifier

More than 90 percent of the warming that has happened on Earth over the past 50 years has occurred in the ocean. Recent studies estimate that warming of the upper oceans accounts for about 63 percent of the total increase in the amount of stored heat in the climate system from 1971 to 2010, and warming from 700 meters down to the ocean floor adds about another 30 percent.

Atmospheric CO_2 emissions are resulting in higher global temperatures, which are directly increasing both temperatures and CO_2 levels in the ocean surface layer—and that added carbon in turn is contributing factor to increased ocean acidification. These twin problems of warmer and more acidic oceans are two primary drivers of the current multi-decade decline in ocean health, including the declines in habitat (coral) and marine biome (plankton).

But what's happening is not so simple as more CO_2 in the atmosphere making the ocean warmer and more acidic. Increased CO_2 in the atmosphere is heating the planet—and therefore the sea surface—which is expanding the thermocline layer, which in turn is reducing upwelling of nutrients. In regions where the supply of nutrients to the euphotic zone is declining, reducing primary biologic production, so too is the function of the biological pump, as the ocean's natural process of carbon sequestration and redistribution is called. After surface-layer carbon is converted into plant matter, a portion of it is eaten and makes its way up the food chain before being distributed to deeper layers. The portion of the carbon that makes it to the ocean floor becomes part of the geologic record. But as nutrients decline, so too does the food chain on which the biological pump depends.

In other words, increased atmospheric CO_2 is not only a primary contributor to declining oceanic health, but is also impairing the biological pump's ability to sequester carbon in the oceans, creating a destructive feedback loop. And an instructive one at that, for it serves as a useful reference when examining related questions: What happens when the heat-absorption capacity of the oceans starts to decline? Or as oceanic oxygen production continues to fall? Or when ocean acidification and upwelling suppression even further deplete the primary productivity of phytoplankton and zooplankton? Or when the upper stratified layer becomes super-saturated and stops taking in carbon?

When it comes to anthropogenic climate change, the oceans are the great modifier. Either they will continue to protect the habitability of Earth or they will accelerate catastrophe. For those of us dedicated to finding a new way forward, it's essential to recognize that relationship. Innovating new ways to help restore biological health to the oceans isn't only about protecting our largest natural resource; it's also about harnessing our biggest natural tool in the fight against climate change.

Innovating technologies to create targeted solutions

When it comes to enacting and sustaining a fight against oceanic decline and anthropogenic climate change more broadly, three categories of action tend to dominate the conversation: conservation, policy change, and behavior change.

But behavior change and conservation are most effectively advanced by policy change—the current speed of which lies somewhere between glacial and nonexistent. And at this point, even effective conservation can't be used to prevent continued ocean syndromes like acidification and nutrient suppression.

We propose a new category that allows us to harness the human talent for innovating and spreading new technologies: ocean restoration engineering. Can we "save" the oceans with technology? We cannot. They're too big—roughly 362 million square miles. But what we can do is identify localized areas and develop, test, and iterate technologically enhanced solutions that remediate targeted problems.

This approach will enable us to experiment safely and test effectively, as well as reduce the risk profile of unintended consequences and decrease the R&D financial risk profile. When a given solution is demonstrated to be effective, we can spread it to other locations around the globe that are similarly suited to benefit from it.

In many cases, we don't have to start this effort from scratch. We can combine technologies that already exist with observational capacities already in place, and in so doing, we can help create a new model for developing and scientifically vetting tools that help preserve and restore pockets of biodiversity across our oceans.

There are multiple benefits to this approach, not least of which is the relative speed with which it can be adopted. Even still, the timeline for developing, testing and iterating a given technology-assisted solution is measured in years. If we're to have a real shot at helping prevent cascading oceanic decline, we have to get started now.

Ocean restoration engineering: A new kind of partnership

Ocean scientists study and describe problems to the highest possible levels of verifiable detail. Engineers build technologies that perform specific functions. We believe scientists and engineers have room to forge a new kind of partnership and lead a new category of development: ocean restoration engineering.

By designing, prototyping and testing technologies that leverage the field of ocean science's expertise and observational capacities, we can help establish a sustainable and scalable model for developing an evolving set of ocean restoration solutions. And in so doing, we can meaningfully and measurably pursue the following goals:

- Increased biologic productivity
- Decreased hypoxic dead zones
- Increased fish stocks
- Decreased harmful algae blooms
- Bolstered natural processes of carbon sequestration and oxygen production

Our best way forward is a cooperative one, with a heightened emphasis on collaboration relative to what you'd find in a typical capitalistic sector. Ocean restoration technology development will require a parallel research component via grant-funded research programs such as the Pacific Northwest National Laboratory.

Potential stakeholders include first nations and Native American tribes, coastal communities and municipalities, and all manner of industries that rely on a healthy marine ecosystem.

Aquavetic Labs

Formed in 2016 as an engineering think tank, AVL is comprised of engineers, scientists, business consultants and advisors. Multiple engineers on our team have experience in the medical device field, and early on they offered a metaphor that's proved apt in defining our mission: building medical devices for the ocean. We are devoted to ideating and developing technologies that can have meaningful impacts on ocean health.

AVL transitioned to an incubator in 2019 and is now raising capital to develop ocean restoration technologies, with the ultimate goal of incubating and spinning out multiple highly focused companies based on actionable technology, concrete initiatives, and traction with partners, stakeholders, and customers.

Our focus

AVL's primary areas of interest are centered on exploring technological approaches to mitigating ocean conditions caused or exacerbated by human activity, with a particular focus on supporting existing natural processes and ecosystems in the following arenas:

- Carbon sequestration through supporting and/or augmenting natural ocean processes
- Thermal attenuation of habitat or species such as thermal refugia for salmon in heat stressed rivers or for coral to reduce bleaching
- Pollution filtration through static, active, and biologic methods
- Re-oxygenation of hypoxic conditions
- Biologic life support and habitat development
- Reducing harmful algae blooms
- Mitigating the effects of ocean acidification or rebalancing pH
- Mitigating pollution, plastics, and excessive waste introduced into rivers and estuaries through industrial or agricultural runoff
- Exploring ways tidal or ocean current dynamics can be harnessed to enhance the effectiveness of technological solutions
- Examining how geologically controlled bodies of water respond differently to biologic enhancements compared to open-ocean areas
- Improving conservation in marine biodiversity hotspots
- Exploring energy capture and usage in situ, with materials and manufacturing methodologies suited for harsh weather and corrosion

Technology pipeline

At present, AVL is incubating two companies: one focused on engineered ocean upwelling (pelagic aquaculture), the other on mitigating thermal stress in salmon rivers (thermal refugia).

Additionally, our work groups are exploring projects in the following areas:

- Desalination tech: Pipeline and mobile
- Re-oxygenation: Mixing, compressed O_2 input, hydrogen production byproduct
- Reaper series: HABs, purple urchin, sea lice, invasive species
- Filtration and extraction: Pollution, toxins, plastic debris, micro-plastics
- Augmented nature: Free range aquaculture
- Asset repurposing: Oil rigs and tankers, seabed pipelines, cargo ships

Due to the confidential nature of technology development, proprietary details of engineering designs are not made public.

Funding Sources

Governmental agencies and research efforts are ready for engineered solutions that can have measurable positive effects, but the funding systems currently in place are small and sporadic, while the problems at hand are large and continuously growing. In other words, the private sector has a key role to play alongside the public.

In order to create ocean health technologies that can play a role in adaptation and mitigation of the effects of climate change, substantial financing mechanisms need to become available. Potential sources include new grants from government agencies and private foundations, as well as new investments from angel consortiums, private equity, and venture capital. Financing into ocean restoration engineering companies via impact investing will also play a role.

Our organizational model

Part of the mission of AVL is to spin out actionable businesses that positively effect change in the context of a demand. Whether the buyer is an individual, corporation, or government, we must create technologies that solve real-world problems for customers at economically viable costs. This business-driven approach will help maximize the proliferation of remediation technologies by allowing economic incentives to be part of the motivation.

AVL is actively pursuing partnerships across governmental, academic, nonprofit, and business sectors, including state and national agencies, national laboratories, universities and private foundations, the offshore wind energy industry, the fossil fuel industry, maritime and cruise line industries, and fisheries and aquaculture industries.

Conclusion

Vulnerable populations worldwide are becoming aware of both the state of oceanic decline and the lack of solutions at hand. But governments, financial institutions, the business sector, and citizens currently lack a concrete way to confront the unfolding crisis.

The moment is right for a new model of action: ocean restoration engineering. By developing, testing and iterating targeted remediation technologies, we can protect and preserve pockets of biodiversity and aquatic productivity. AVL is focused on improving the health of the oceans, reducing the impact of human activity, and ultimately participating in the global reaction to climate change and its many effects.

We're interested in connecting with potential investors and corporate partners, engineers, ocean and climate scientists, journalists, tribes and first nations, as well as anyone with a powerful voice in entertainment or politics.

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References:
1. https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content
2. https://sos.noaa.gov/datasets/ocean-atmosphere-co2-exchange/