SCUM FUTURE

a zine about:
algae •••• humans
science •• climate
design ••• aotearoa

pia sutherland
id 438783801

CONTENTS

BORING! SLIMY! TOXIC! GROSS!

She's in your waterways. She's in your soil, and she's on your trees, rocks, walls. She's in your sushi, and in your smoothie too. She's algae, and she's everywhere.

Algae are a diverse group of aquatic, photosynthetic organisms (commonly-known species include wakame, cyanobacteria, and spirulina). Many people have a one-dimensional view of algae - it's ugly, stinky, polluting. This is so far from the truth. Algae are beautiful, and they are everywhere. They're part of nature, just as we are; SCUM FUTURE calls readers to celebrate and respect algae.

SHE'S A STAR!

In a design context, algae are incredibly valuable. The organisms are organic, carbon-negative, and able to be used in many different ways. Designers have recently started to acknowledge this - we're seeing more and more projects that demonstrate algae's potential. In the next few decades, we could see the creation of a large-scale algae industry in Aotearoa. This is an incredible opportunity: we can build this new industry in a way that'll better the health of our environment and communities.

SCUM FUTURE explores how we might improve sustainability, inside and outside of the world of algae. We envision a future where algae, and all nature, are celebrated.

SCUM FUTURE ASKS READERS TO:

Understand Kaitiakitanga, and implement it where they can. Kaitiakitanga is a Maori term that represents guardianship and protection. It encapsulates the spiritual, social, and natural. This kawa means respecting those before us and those after, working to preserve our world for future generations. As well as this, it asks that we understand nature as an equal: our health is dependent on it, and its health on us.

Understand the 3 P's of te Tiriti: Participation, Partnership, and Protection. Learn how reflecting on these can help us:

DESIGN FOR ACTION

Prioritize environmental health. Demand effective, realistic, sustainable solutions to issues - be critical! Respect resources, energy and labour. Design to appreciate nature, and design to empower communities; for purpose and not novelty. As consumers, call out unethical practices, exploitation, and faux-sustainability.

DESIGN FOR INCLUSIVITY

Uplift indigenous voices. Respect traditional practices, and seek to learn from te Ao Maori. In doing this, we can preserve Maori knowledge, replace exploitative ideas of design, and understand the unique needs of our land and communities. Codesign, encourage discussion, and stay open to different perspectives. Design for social sustainability, to create jobs, provide accessible solutions, minimize harm, and to improve the lives of those who need it most.

DESIGN FOR INNOVATION!

Be passionate and persistent! Work to understand nature and technology. Experiment to develop new, unconventional solutions, optimize existing ones, and to drive change. Collaborate with others, strengthen relationships, understand different perspectives and the necessity of codesign. We're in a state of crisis - creative, holistic approaches to design are needed now more than ever.

Fig. 1

ALGAE SEQUINS

Designers Charlotte McCurdy & Phillip Lim

The fashion industry is infamous for its use of unsustainable practices and materials. Many common textiles come without sustainable alternatives – one of the worst examples of this is sequins. Conventional sequins are cut from sheets of PVC – their production uses non-renewable resources and releases carbon into the atmosphere. Sequins don't biodegrade: instead, they pollute our environment and break down into microplastics.

Designers Charlotte McCurdy and Phillip Lim developed a solution to this issue. The pair created a dress adorned with green tusks: algae-based, bioplastic sequins. As algae are exposed to heat, they bind into a bioplastic film, which can be dyed using natural pigments and cut into sequins. These are carbon-sequestering and biodegradable (Hahn, 2021). Other bioplastic sources exist, but algae-based technology has a unique benefit: unlike other sources (corn, potatoes, land crops), the cultivation of algae for bioplastics doesn't risk impacting the food industry. Additionally, algae grow quickly and require minimal resources. They can even be grown on waste. (Sreenikethanam & Bajhaiya, 2021) n developing carbon-negative, algae-based sequins, McCurdy and Lim provide a circular, sustainable alternative to existing technologies like PVC sequins and resource-intensive bioplastics. This supports Kaitiakitanga and the 3 P's of te Tiriti - the design seeks to preserve our communities and ecosystems. These sequins protect our natural environment, but also the future of the fashion industry and of creative expression. Materials and practices used to create beautiful garments are often harmful. Embellishment has become synonymous with ignorance, selfishness, and minimalism synonymous with virtue. Our understanding of 'sustainable fashion' is one-dimensional: when thinking about

Fig. 2

'good' fashion, boxy cuts, flat colours, and basic designs come to mind. These sequins challenge this stereotype: they prove sustainable fashion can be interesting. This technology is beautiful and carbon-negative: they allow for guilt-free creative expression.

Partnership is reflected in McCurdy and Lim's collaboration – by combining different skillsets and perspectives, the pair created an effective design outcome. The use of renewable technologies also supports this principle. Algae bioplastics have immense benefits for our natural environment. The sequins are eco-friendly AND beautiful: even environmentally-apathetic consumers would be drawn to them. This products' strong visual design increases excitement and demand around sustainable technologies.
Widely-used algae bioplastic would be incredible for the fashion industry; making these products accessible would have a significant impact on our environment and how we view sustainable design. However, this project is not without flaws. The amount of energy used to produce the bioplastic is not publicly known – McCurdy and Lim's design might not be as sustainable as it claims. The experimental nature of this design is another weakness. We don't know what large-scale production would look like. On a surface level, the sequins are sustainable: however, we can't take factors like transportation, workers' rights, production and cultivation into consideration. On a similar note, there are limits to how sustainable fashion can be. Overconsumption, capitalism, and a lack of social awareness are massive issues facing fashion and our environment: without addressing these, we can't make any real change. If these sequins were commercially available, they probably wouldn't be very affordable: they wouldn't have much of an impact.
To address these issues, we can continue to develop algae textiles, with an aim to lower production costs, increase sustainability, and empower workers. We need to codesign: with scientists, indigenous groups, fashion experts, workers and future consumers.

This design drives change: it raises awareness, gets designers and consumers to think about renewable technologies, and increases demand for sustainable products. By introducing sustainable technologies and working to replace harmful practices, we can create a more hopeful future for the fashion industry.

Fig. 3

THE CORAL

Designer Hyunseok An

This project is a 'household algae farm' that produces edible microalgae. It aims to strengthen our relationship with nature by welcoming algae into the home. The design challenges harmful ideas around algae; it also promotes sustainability, working to improve the health of our people and environment.

These cells darken in colour as the algae mature: the cultivation and harvest of microalgae is incredibly user-friendly. The cells can each grow around 2 grams of microalgae, which is the amount recommended for daily consumption. As the cells follow a biweekly, unsynchronized growth cycle, users can harvest this amount every day (Nature Lab, n.d.). Despite their size, microalgae are incredibly nutrient-dense. They're a valuable source of vitamins, and of plant protein: microalgal proteins have high digestibility and a balanced nutritional profile. (Wang et al., 2021).
'The coral' has an embedded message – in name and appearance, it draws attention to the devastation of coral bleaching. As the cells fill with algae, they transition from a pale, lifeless colour to a deep green: this symbolises hope for the future and the rehabilitation of our reefs. Microalgae can sequester large amounts of carbon, nitrogen, and phosphorous. Cultivation of the organisms helps to protect our marine ecosystems and atmosphere.

'The coral' reflects Kaitiakitanga and the 3 P's well. Kaitiakitanga and partnership relate to reciprocity and understanding. By designing the farm for household use, Hyunseok imagines a new way of living where partnership with nature is central to the home. Users are encouraged to participate: to create routines around algae and get involved with cultivating their own food.

This project also demonstrates Kaitiakitanga by pitching algae as a nutritious alternative to animal products. Put simply, the meat industry sucks. It accounts for over 60% of food-related greenhouse gas emissions (Milman, 2021). Immense amounts of water, land, and crops are used to keep livestock. This industry is outdated: our population is growing, and our resources are dwindling. Our climate is becoming less forgiving, and as a society, we're becoming more concerned with ethical and sustainable consumption. We need to decrease our reliance on the volatile

meat industry and other unsustainable food sources. Microalgae gives us this opportunity. These organisms can grow almost anywhere, using minimal land and resources. They have immense ecological benefits: algae has a higher carbon fixation rate than other plants (Wang et al., 2021). As well as this, the health benefits of algae consumption are immense. Common strains can have a protein content of up to 70%, are vitamin-rich, and contain many other valuable nutrients. (Wang et al., 2021).

'The coral' produces only a small amount of microalgae. While this amount provides ample micronutrients, it falls short in terms of protein and energy. Instead of becoming a significant food source, the farms work to normalize algae consumption. Algae-based food sources are on the market: companies like Aotearoa's NewFish have developed plant-based 'seafood' by extracting protein and flavour from algae (Ellis, 2022). However, these foods are still under the radar. This is where 'the coral' comes in – it's part of the movement to make these foods mainstream.

This farm is experimental, and not available to consumers: we can't experience any of the benefits offered by 'the coral'. The technology used in this design needs to be developed further, decreasing cost and difficulty of construction. Because of this, ownership of a farm like 'the coral' won't be realistic for average home owners for years to come. To increase the social impact and accessibility of this design, 'the coral' could be pitched as a community art installation, or displayed in museums: this would increase the reach of Hyunseok's message.

'The coral' serves to strengthen the partnership between humans and the environment, encourage sustainable practices, and increase excitement around promising new algae-based technologies.

Fig. 5

F.R.N.S

NIWA & Maori, Government, and Industry Partners.

Water pollution is on the rise. 95-99% of rivers running through urban and farmland areas show pollution levels exceeding national guidelines (Ministry for the Environment, 2020). This issue is incredibly complex, with many causes: urbanization, growing agricultural and pastoral industries (more animal waste and erosion), a worsening climate, and degrading wastewater systems. The health of our waterways ensures the health of our native species, ecosystems, communities, and culture. Water is taonga: it is deeply tied to our identity as a country and as individuals. We must protect it.

Existing wastewater treatment methods are poor: they're high-energy, high-cost, and use large amounts of chemicals. They can also be inefficient or nonexistent: we're struggling to combat pollution. In response to this, Aotearoa's National Institute of Water and Atmospheric Research (NIWA) has been developing algae-based wastewater treatment systems for rural environments. An ongoing research project (2020-2025) uses Filamentous Algae Nutrient Scrubbers to cleanse polluted waterways. Sloped channels direct polluted water through dense native algae, which produces oxygen, allowing bacteria to break down contaminants and absorb excess nitrogen and phosphorous (NIWA, 2022) (Ali et al., 2020). As water is treated, algae convert these nutrients into biomass: this can be converted to fertilizer, fuel, and electricity. Algae are proving to drastically reduce pollution indicators. These effects are exacerbated depending on the genus and growth conditions used (WaterWorld, 2021).

NIWA demonstrates Kaitiakitanga through this project. Algae farms are sustainable, low-cost, and effective. They could realistically replace degrading, toxic, and transport-intensive existing technologies.

Additionally, algae-based treatment can be established and operational faster than other methods of pollution mitigation. FANS provide a convenient and sustainable way to rehabilitate our waterways: this would be immensely beneficial for communities with limited resources, like rural farms and marae. This technology will help us protect our environment, people, and future.

This project also supports the principles of te Tiriti: protection, partnership, and participation. FANS were co-developed with Māori, industry, and government partners. The project was guided by a Māori advisory panel and supported by NIWA's Te Kūwaha Environmental Research team. (NIWA, 2022). Codesign allows NIWA to apply matāuranga Māori and ensure systems are developed in informed, non-exploitative, and culturally appropriate ways. Indigenous practices, ecological understandings, and values are precious: they're based on long-standing relationships between people and nature. Placing matāuranga Māori at the front of sustainable innovation will help us preserve knowledge, support kaitiakitanga, and empower whanau, hapu, iwi, Māori communities, and Māori businesses. NIWA's efforts to uphold te Tiriti signal positive changes within design and science.

This project opens up endless possibilities. FANS produce large amounts of biomass as they process waste. NIWA could investigate ways to use this to their advantage: for example, using algal biomass for electricity or bioplastic production. Another area to look into could be expanding the technology into non-rural contexts, increasing its impact. Ennesys is one group exploring these possibilities: the company has proposed a concept for urban, rooftop bioreactors which convert light and wastewater to biomass for electricity (Larsen, 2018).

FANS technology, and the change-making efforts of the farms, scientists, and iwi participating in this research project, are driving change. Water is integral to our identity and integral to our health. Finding new, convenient, and sustainable ways to protect our waterways is essential. Algae-based treatment systems are promising. As this project concludes, we will likely have a great understanding of how to implement this technology effectively in order to reduce pollution.

Fig. 6

FEATURE ARTICLE

ALGAE THROUGHOUT HISTORY

Algae are an incredibly diverse and powerful group of organisms: the term 'algae' covers everything from tiny cyanobacteria to giant kelp. Algae produce 70% of all oxygen, control the balance of aquatic ecosystems, and are widely cultivated for many different purposes. (Kartik, 2022) Despite this, the organisms have been dismissed as boring, gross, and harmful; we've only recently started to recognize their impact. Interest in research and design involving algae is increasing due to numerous factors. The algae industry is rapidly expanding. We can use this opportunity to challenge harmful ideas of algae and change how we approach science, technology, and collaboration. Once again, algae can transform our lives for the better.

1. SUPER, SUPER EARLY

2.7 billion years ago, cyanobacteria evolved on Earth. These microalgae converted water into energy, releasing oxygen as a byproduct. This was an extremely significant development: as oxygen gradually built up, it started to replace methane and other gases in the atmosphere. The Earth’s climate cooled, ice sheets formed, and the ozone layer developed. Organisms began to adapt to these conditions and evolve. In other words, microalgae gave way to life (Kartik, 2022).

2. ONE BIG TIME JUMP: EARLY, AND LESS EARLY

Algae aren't gross, they aren't useless, and we know this: we've been farming and consuming them for thousands of years. One of the most commonly cultivated and consumed algae is Wakame (*Undaria Pinnatifida*). Records of wakame aquaculture trace back to the 700s – Japan's Nara period. This seaweed was farmed for food and medicinal uses like blood purification, strengthening of skin and hair, and regulating menstrual cycles. Wakame has high levels of iron, omega-3s, and other vitamins and minerals (Hunter, L. and Leeflang, J., n.d.). Because of its taste, health benefits, and cultural significance, this species of algae is still consumed today.

Fig. 7

Spirulina is another form of algae that has become widely consumed. Endorsed by NASA and clean-eating big cheese Gwyneth Paltrow, this cyanobacteria is renowned for its health-promoting properties. While spirulina has only recently gained popularity, it's been cultivated for hundreds of years. In the 1500s, Aztec communities harvested spirulina from Lake Texcoco, processing the substance into compact, dried blue-green discs. These were portable, protein-rich, and a great source of nutrition in times of food scarcity: oral traditions note that the discs were used for endurance and taken with messengers on journeys (DeRenzo, 2021).

Fig. 8

As technology developed, people started to explore more uses for algae. One of these new developments was Agar: a gelatinous substance derived from the cell walls of red algae. This substance was originally used as a food additive and thickener in desserts. In the late 1800s, Fanny Hesse, girlboss wife/lab technician of German microbiologist Walther Hesse, suggested that the substance be used as a growth medium. Agar proved superior to other technologies: it's still used in microbiology today (Laboratory News, 2005).

Fig. 9

Algae have been significant throughout the history of Aotearoa. The organisms are recognized as an important part of our ecosystem, providing habitats for taonga species. Indigenous peoples have cultivated them for food, medicine, and construction. One of many traditional uses for seaweed is Pōha: large, airtight bags made from split, inflated kelp fronds. Pōha were developed and mastered by the Ngāi Tahu iwi and were used to preserve muttonbird (Wassilieff, 2006). Algae have been recognized as precious and powerful by our indigenous people for centuries. Indigenous people have developed tikanga around algae, as well as understandings of how the organisms interact with different ecosystems.

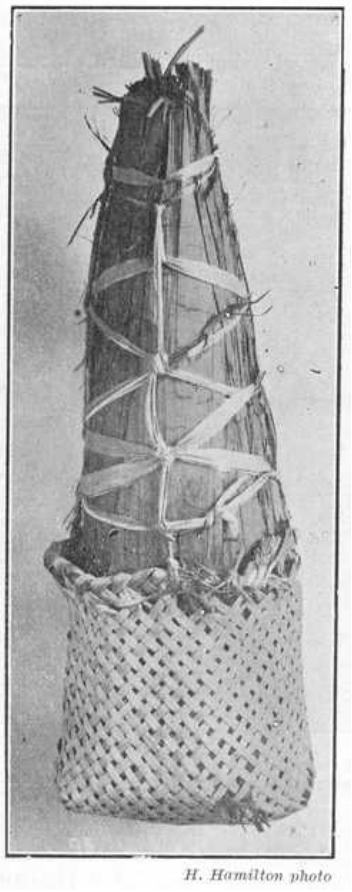

Fig. 10

These organisms have endless uses, all of them good – so why do we associate them with invasion, pollution, and grime? These negative associations are likely the result of events like Harmful Algae Blooms (HABs), and the proliferation of invasive species. In 1987, wakame was found in wellington harbour. Accidentally introduced, this species' high growth rate threatened native kelp, the habitat of pāua, and the operation of fisheries. Another instance of harm caused by algae occurred in 2000, when a bloom of toxic cyanobacteria *Gymnodinium Catenatum* was detected, posing a major health risk. This bloom closed shellfish gathering and mussel farming across the North Island's west coast for nine months (Troup, 2006). While algae can have an immensely positive impact on our lives, they can also cause great harm. These blooms disrupt ecosystems and threaten taonga species, economic industries, and the well-being of our people. However, it's important to note that in both of these instances, the algae was an invasive species introduced by humans. We were responsible for the harm caused.

Fig. 11

3. AND NOW

Our understanding of algae has developed. We're uncovering more advanced and diverse applications for algae, and the issues we face have transformed: we're changing how we approach design.

As our climate crisis has worsened, sustainability has become immensely important within design. We're turning to unconventional technologies, seeking better alternatives and solutions to issues in order to be greater Kaitiaki. Algae is one of these technologies - the organisms are carbon-sequestering, consume minimal resources, and have many applications. Because of their incredible sustainability and versatility, interest in algae-based design has skyrocketed.

Plastic is one of our biggest issues. Traditional plastic isn't renewable, doesn’t break down, and pollutes our environments. We know it's terrible, but we're reliant on it. This is where algae come in: they can be used to manufacture bioplastics. NOTPLA has developed algae-based packaging that is almost too good to be true: it's biodegradable, home-compostable, and can even be edible. Their 'oohoo' drink capsules were distributed at the London marathon in 2019, garnering mass attention (NotPla, 2023). NOTPLA provides a powerful solution to single-use plastic pollution. Bioplastics have influenced the fashion industry too. In 2019, Charlotte McCurdy designed a raincoat made of marine-algae bioplastic (Hahn, 2019). These materials have endless potential: we can create convenient, effective products that won't harm our environment.

Fig. 12

Algae have been rising in popularity as a food source. The food industry has been facing many challenges: increasing populations, depleting resources, climate change, and shifts in public perceptions of health. Our food industry needs to be sustainable, ethical, and efficient – it's far from that. However, algae are helping us change. Algae's nutrient density, high protein levels, and low resource consumption make the organisms immensely valuable for our future. (Wang et al. 2021) New products are constantly being developed: Austria's REVO released a 3D-printed salmon in 2022 (Axworthy, 2022), and Aotearoa's Cawthron Institute received funding to investigate native Karengo in 2020. (Cawthron, 2020). As well as providing food for humans, we can use algae to make existing food systems more sustainable. Algae can be used as fertilizer, livestock feed, or to cleanse agricultural runoff (NIWA, 2022). The possibilities are endless: algae are helping us shift to more ethical, sustainable, and efficient modes of food production.

There are many more areas where these organisms are driving change: recently, the Cawthron Institute has developed a non-addictive, natural pain medication (Cawthron, 2021). Algae can cleanse waterways, purify air, illuminate spaces, and even produce electricity, powering computation (Bombelli et al., 2022). Algae technologies have become immensely popular and sophisticated: we're beginning to understand how these organisms could have an immensely positive impact on our future.

Another modern development: climate change has worsened, disrupting the balance of ecosystems. Harmful Algae Blooms have become incredibly frequent. Rising temperatures, pollution, and rainfall are increasing nutrient levels in waterways, giving algae a surplus of food and encouraging their growth. This can cause immense damage. HABs can replace native seaweed, disrupting food chains. This results in a scarce food supply for taonga species; threatened plants and animals can die out. Invasive algae are often toxic. They can kill plant and animal life, poison food consumed by humans, and prevent activities like swimming and fishing. HABs threaten the health of people, plants, animals, and economies (Smedley, 2023). Climate change is only going to worsen: these events are only going to become more frequent. We need to raise awareness about HABs, find ways to prevent and recover from them, and work to address their root cause.

Fig. 13

4. TO THE FUTURE

Our issues are going to get so much worse. The climate crisis will escalate, our populations will grow, and our resources will continue to deplete. The good news is that we can use algae to navigate and develop solutions for these issues. Algae will be even more topical and have a greater influence over our lives than ever before. The organisms will play a large role in how we work to better demonstrate Kaitiakitanga and uphold te Tiriti o Waitangi. With these goals in mind, we will continue to push algae technologies even further. There will be yet another rise in algae research and design projects.

This rise in interest will mean that we see bias around algae challenged. This will be done via the mainstreaming of algae technologies, and more significantly, improved education around HABs. We'll learn how and why these events impact us; the public will start to understand that these blooms result from human intervention. We'll understand the risks of introducing invasive species, the effects of pollution on our waterways, and realize that climate change is already directly impacting our ecosystems' health. As well as this, we'll start to prioritize diagnosing, preventing, and recovering from HABs. In the long term, we'll work to address and overcome the root causes of these events. In the distant future, algae blooms will become rare. As a result, the organisms will be known not as toxic and gross, but as they really are: beautiful, versatile, and immensely influential.

As we shift towards sustainable living, we're likely to see a rapid expansion of the algae industry. This industry will be instrumental in our future – this is a unique opportunity to establish new standards within science and design. Up until now, design in Aotearoa has been overwhelmingly Eurocentric. People don't consider how products and systems affect minority groups. Social inequalities are reflected in and facilitated by our design. Housing, education, food

systems, and even product and graphic design have heavy Eurocentric biases, privileging Western aesthetics, ideas, and people over indigenous communities. We've seen attempts to empower Māori communities, but these are usually poorly informed, resulting in ineffective outcomes or the tokenization of Māori culture (Freschi et al., 2021). Indigenous perspectives are incredibly important. These groups have been in Aotearoa for longer than colonial settlers: they have deep connections to the land. Integrating Mātauranga Māori into the products, systems, and industries will have an immensely positive impact on our country. We will be able to better address issues like climate change, resource depletion, and the declining well-being of our people. Codesign will help us continue to innovate – we can use an improved understanding of our environment and Māori values to heal our world. It will allow us to act in the interest of our indigenous people, uplifting their communities, preserving Māori tikanga, and honoring Te Tiriti. The benefits of codesign are clear. It needs to become a standard practice within Aotearoa – the algae industry could help us achieve this. In this context, codesign will help us better understand our ecosystems. We can learn about native algae's uses and tikanga around their cultivation. Māori input will help us understand the big issues we're facing: climate change, pollution, and resource depletion. As well as this, we can use the algae industry to genuinely empower Māori communities by providing career opportunities, prioritizing indigenous concerns, and sharing traditions, practices, and values.

Algae will become incredibly significant, influencing our world in many different ways. Immense benefits will come from improving our understanding of algae and utilizing it in technology, science, and design. We will unlearn biases around algae, use it to heal our environment, and empower our communities. This industry will help us honor Te Tiriti and change how we design. Algae is the future!

GLOSSARY

KAITIAKITANGA
A term meaning guardianship and protection. In the Māori world view, humans and nature are closely connected: we're part of the natural world, and have an obligation to care for it. Demonstrating Kaitiakitanga means protecting our environment, people, culture, and future.

MĀTAURANGA MĀORI
Māori knowledge and tradition: te reo Māori, tikanga Māori, whakapapa/history, identity, values, and art.

TIKANGA
Traditional customs, rules, and values.

MICROALGAE
Microscopic algae! These are unicellular, and can be present in oceans or freshwater. Examples include Diatoms, Dinoflagellates, Chlorella, and Gymnodinium Catenatum.

MACROALGAE
Seaweed: multicellular marine algae. Examples include: Wakame, Bull kelp, Irish moss, and Karengo.

CYANOBACTERIA
A very old, diverse group of microalgae optimized for low oxygen environments.

Ali, J., Wang, L., Waseem, H., Song, B., Djellabi, R., & Pan, G. (2020). Turning harmful algal biomass to electricity by microbial fuel cell: A sustainable approach for waste management. *Environmental Pollution*, 266(2). https://doi.org/10.1016/j.envpol.2020.115373

Axworthy, N. (2022, June 29). *Revo Foods' First 3D-Printed Vegan Salmon Fillets Will Launch in Stores in 2023.* VegNews. https://vegnews.com/2022/6/first-3d-printed-vegan-salmon

Bombelli, P., Savanth, A., Scarampi, A., Rowden, S. J. L., Green, D. H., Erbe, A., Årstøl, E., Jevremovic, I., Hohmann-Marriott, M. F., Trasatti, S. P., Ozer, E., & Howe, C. J. (2022, May 12). Powering a microprocessor by photosynthesis. *Energy Environ. Sci.,* 2022,15, 2529-2536. https://doi.org/10.1039/D2EE00233G

Cawthron Institute. (2020, October 1). *Cawthron Institute to lead $3M global study into alternative protein sources.* https://www.cawthron.org.nz/our-news/cawthron-institute-to-lead-3m-global-study-into-alternative-protein-sources/

Cawthron Institute. (2021, October 18). *Cawthron Institute part of international collaboration to develop world's first algae-based local anaesthetic.* https://www.cawthron.org.nz/our-news/neosaxitoxin/

DeRenzo, N. (2021, January 13). *How Mexico is reclaiming spirulina*. BBC. https://www.bbc.com/travel/article/20210111-how-mexico-is-reclaiming-spirulina

Ellis, J. (2022, May 15). *Newfish nets funds to 'reimagine' New Zealand seafood.* AgFunder News. https://agfundernews.com/newfish-nets-1-3m-pre-seed-round-to-reimagine-seafood

Freschi, F., Venis, J., Nazier, K. J., Hopewell, H., Carter, L., Miller, S. C., Krishnan, T., McCaw, C., Galloway, M., Wilson, J. K. T., & Campbell, D. (2021). *The politics of design: privilege and prejudice in Aotearoa New Zealand, Australia and South Africa.* Otago Polytechnic Press. https://issuu.com/opresearch/docs/the_politics_of_design

Hahn, J. (2019, November 5). *Charlotte McCurdy creates "carbon-negative" raincoat from algae bioplastic.* Dezeen. https://www.dezeen.com/2019/11/05/charlotte-mccurdy-bioplastic-raincoat-2/

Hahn, J. (2021, February 22). *Phillip Lim and Charlotte McCurdy adorn couture dress with algae sequins to avoid "reaching for polyester".* Dezeen. https://www.dezeen.com/2021/02/22/charlotte-mccurdy-phillip-lim-algae-sequin-dress-onexone/

Hunter, L. and Leeflang, J. (n.d.) *Wakame Nurtients*. Nutrivore. https://nutrivore.com/foods/wakame-nutrients/

Kartik, A. (2022, February 18). *The Great Oxidation Event: How Cyanobacteria Changed Life.* American Society for Microbiology. https://asm.org/Articles/2022/February/The-Great-Oxidation-Event-How-Cyanobacteria-Change

Laboratory News (2005, November 1) *History of the agar plate*. https://web.archive.org/web/20121014060019/http://www.labnews.co.uk/features/history-of-the-agar-plate/

Larsen, R. S. (2018, June 22). *Algae-Powered Water Purification and Energy Production.* Global Opportunity Explorer. https://goexplorer.org/algae-powered-water-purification-and-energy-production/

Milman, O. (2021, September 13). *Meat accounts for nearly 60% of all greenhouse gases from food production, study finds.* The Guardian. https://www.theguardian.com/environment/2021/sep/13/meat-greenhouses-gases-food-production-study

Ministry for the Environment. (2020). *Our freshwater 2020*. https://environment.govt.nz/publications/our-freshwater-2020/

Nature Lab. (n.d.). *Student Work: Hyunseok An's Algae Farming Design.* https://naturelab.risd.edu/discover/student-work-hyunseok-ans-algae-farming-design/

NIWA. (2022, December 15). *Putting algae to work.* https://niwa.co.nz/news/putting-algae-to-work

NotPla. (2023). *Notpla Ooho.* https://www.notpla.com/notpla-ooho/

Smedley, T. (2023, January 12). *The pollution causing harmful aglae blooms.* BBC. https://www.bbc.com/future/article/20230110-the-pollution-causing-harmful-algal-blooms

Sreenikethanam, A., & Bajhaiya, A. (2021, December 10). Algae Based Bio-Plastics: Future of Green Economy. In K. Biernat (Ed.), *Biorefineries - Selected Processes*. IntechOpen. https://www.intechopen.com/chapters/79623

Troup, C. (2006, June 12). *Marine invaders - Invasive marine algae and plants in New Zealand.* Te Ara - the Encyclopedia of New Zealand. https://teara.govt.nz/en/marine-invaders/page-4

Wang, Y., Tibbets, S., & McGinn, P. (2021, December 4). Microalgae as Sources of High-Quality Protein for Human Food and Protein Supplements. *Foods (Basel, Switzerland)*, 10(12), 3002. https://doi.org/10.3390/foods10123002

Wassilieff, M. (2006, June 12). *Seaweed - Traditional use of seaweeds.* Te Ara - the Encyclopedia of New Zealand, https://teara.govt.nz/en/seaweed/page-4

WaterWorld. (2021, September 18). *Researchers use algae to treat wastewater.* https://www.waterworld.com/drinking-water/potable-water-quality/press-release/14210539/researchers-use-algae-to-treat-wastewater

IMAGES

Fig. 0: Seaweed ie. (n.d.). [Image of Ulva linza Linnaeus]. https://www.seaweed.ie/descriptions/Ulva_linza.php

Fig. 0

Fig. 1: Deezen. (2021). [Photo of algae-bioplastic sequins]. Dezeen. https://www.dezeen.com/2021/02/22/charlotte-mccurdy-phillip-lim-algae-sequin-dress-onexone/

Fig. 2: Dezeen. (2021). [Photo of woman wearing algae-sequined dress]. Dezeen. https://www.dezeen.com/2021/02/22/charlotte-mccurdy-phillip-lim-algae-sequin-dress-onexone/

Fig. 3: Han, G. (2019). [Photo of 'the coral' algae farm]. Design Milk. https://design-milk.com/the-coral-indoor-micro-algae-farm/

Fig. 4: Han, G. (2019). [Photo of woman looking at algae cells]. Design Milk. https://design-milk.com/the-coral-indoor-micro-algae-farm/

Fig. 5: Mckay, S. (2023). [Photo of FANS system next to a stream]. NIWA. https://niwa.co.nz/freshwater/freshwater-and-estuaries-update/freshwater-update-89-january-2023/using-algae-for-nutrient-pollution-mitigation#:~:text=Filamentous%20Algae%20Nutrient%20Scrubbers%2C%20or,animal%20effluent%20and%20human%20wastewater.

Fig. 6: Mckay, S. (2023). [Close-up photo: FANS systems]. NIWA. https://niwa.co.nz/freshwater/freshwater-and-estuaries-update/freshwater-update-89-january-2023/using-algae-for-nutrient-pollution-mitigation#:~:text=Filamentous%20Algae%20Nutrient%20Scrubbers%2C%20or,animal%20effluent%20and%20human%20wastewater.

Fig. 7: えむかと一. (2008). *boiled Wakame* [Photograph]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Boiled_wakame.jpg

Fig. 8: Humphrey, E. (2014). [Photo of an agar plate]. Thermofisher. https://www.thermofisher.com/blog/food/chromogenic-agars-past-present-and-future/

Fig. 9: Madeleine_Steinbach. (2022). [Photo of pirulina powder]. Getty Images. https://www.bicycling.com/health-nutrition/a37595656/spirulina-benefits-for-cyclists/

Fig. 10: Hamilton, H. (1924). *Pōha* [Photograph]. Victoria University. https://nzetc.victoria.ac.nz/tm/scholarly/Bes01Maor-fig-Bes01Maor422a.html

Fig. 11: McLain, D. (2009). *A bass fisherman casts a line into the algae-clogged waters of the Iron Gate Reservoir, March 2009, in the Klamath River Basin* [Photograph] HighCountryNews. https://www.hcn.org/issues/43.8/doctors-orders-undam-the-klamath

Fig. 12: Baulch, S. (2012). [Photo of marine debris]. Eia International. https://eia-international.org/blog/marine-debris-dont-let-out-of-sight-be-out-of-mind/

Fig. 13: Lexy, M. G. (2023). [Photo of seaweed and scientific equipment]. American Chemical Society. https://www.acs.org/education/resources/highschool/chemmatters/articles/from-pond-scum-to-product-the-chemistry-of-algae.html