Franklin by SimplexDNA®

The Franklin: Digital eDNA tokens to better preserve diverse life on Earth

team@simplexdna.com
simplexdna.com

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Human survival is dependent upon biodiversity. Genes, species and ecosystems sustain our food systems and protect us from disease and climate change. If they survive, there is hope for us.

However, many Earth ecosystems are stressed or ruined and many animal, plant, and microbial species are at risk of extinction. Expected human population growth, resource extraction, and CO_2 emissions through the 2020s means that this destruction of life is likely to increase unless there is immediate, global, and sustained protection and regeneration of nature.

A lack of common standards for the measurement of nature makes this difficult. The financing required for planetary scale intervention is lacking. We need to know how to invest in biodiversity and how to track the success of investments over time. Biodiversity monitoring with conventional methods is sporadic, expensive, overly technical, and unsuited for monitoring meaningful regeneration at scale. A new approach is needed.

SimplexDNA proposes a global biodiversity monitoring system financed by the novel development of digital tokens linked to monitoring biodiversity with environmental DNA samples. We call these tokens Franklins, after the pioneering geneticist Rosalind Franklin. Each Franklin is minted from an original DNA sequence readout of life forms detected in a particular place at a particular time.

Franklins will be minted using SimplexDNA's inexpensive and accurate environmental DNA (eDNA) methodology. Buyers of Franklins pay for the cost of wider eDNA sampling, often in poorer communities in the tropics which would otherwise receive no such investment. As the market buys Franklins, a network of samplers earns an income and becomes more invested in nature. Larger financing of biodiversity monitoring becomes possible, the market is incentivised to buy more Franklins, and the tokens aggregate into an open access database that tracks relevant changes in biodiversity over time.

In other words, the Franklin will generate a database that is open for science, for communities, and for non-commercial use, but which also serves to verify investments through commercial use. Its utility for markets will allow many financial instruments to be built upon it, including biodiversity credits and green bonds. In this way the Franklin will create both a public good for knowledge acquisition and an industry standard for regenerative finance.

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Problem

Earth is facing a biodiversity crisis. Overexploitation of land, overfishing, pollution, invasive species, and climate change have led to catastrophic losses: some 12% of plant and animal species are under threat of extinction[1] and we have already far exceeded the safe operating space of the planetary boundary for biodiversity change[2].

This represents an existential threat to human survival. Biodiversity delivers services equivalent to half the economy with a nominal asset value in excess of $125 trillion[3]. It yields food, energy, medicines, delivers pollination and pest control, maintains the quality of air, water and soil, regulates climate, mitigates natural hazards, and enriches human beliefs and imagination[4]. But biodiversity is unevenly distributed. The majority of species are found in the tropics, where human population is growing fastest and poverty is highest [Figure 1]. Biodiversity losses there will hurt the most vulnerable people and further destabilise insecure regions and nation states.

Figure 1

Risk to biodiversity loss and poverty level of people

Depicting the correlation between biodiversity under threat and poverty level. The Proof of Life protocol will create a win-win for a nature positive future by incentivising biodiversity monitoring jobs in regions where we need data the most and poverty is highest.[5]

Yet we live in a moment of possibility. The protection of nature is a powerful call-to-action. The United States is expected to spend $1.7 trillion in the next decade on new climate technologies[6]. Scientists, conservationists, business leaders, and policy makers are united in their public support for biodiversity. The United Nations has negotiated a new global biodiversity agreement, with associated monitoring and accounting systems[7]. Financial

institutions led by the Taskforce on Nature related Financial Disclosures[8] are working to improve reporting and tracking success of biodiversity regeneration interventions. Bankers are waking up to the importance of other species and risk of its change to their assets. The Dutch Central Bank estimates that biodiversity loss is a risk to 36% of its assets. The Swiss bank Lombard-Odier is one of several banks which has showcased a natural capital fund for its clients. Additionally, philanthropies including Jeff Bezos's Earth Fund, the Children's Investment Fund, and the Walton, Ford, Bloomberg, and Packard foundations, have pledged to push billions of dollars a year into biodiversity.

For these investments to be meaningful we need intelligence on what is happening to nature on the frontline – and this is lacking. Unlike for the carbon market, where "more sunk is better", we simply do not know what the baseline for biodiversity in a given ecosystem should be. Consider that 93% of the Earth has never been surveyed, that 80% of observations come from 10 countries, and half of the records of other life forms are concerned with only 2% of species[9].

The mandate is clear: the world needs to regenerate biodiversity and must begin with an accurate, standardised and scalable monitoring system.

Solution

Conventional approaches for measuring the presence of other life forms are inadequate to scale for global biodiversity monitoring. Manual biodiversity surveys have increased awareness, but they are labour intensive, costly, and often biased towards visible species such as butterflies, birds, and trees. New sensing technologies including acoustics, cameras, lidar, and satellites are many times more scalable. But they do not completely meet the challenge. Acoustic sensing above or below ground favours the noisiest mammals, birds, and invertebrates. Remote sensing using wavelengths of reflected light is biased towards trees and other larger life forms – and cannot penetrate under water.

SimplexDNA proposes a novel and scalable solution based on the collection, analysis, and tokenisation of environmental DNA (eDNA). Every life form sheds unique DNA as it moves through the world. This DNA can be collected and sequenced from water, soil, and air using simple, already standardised, methods. Using open source software these DNA sequences can be translated into a ledger of life in a particular place at a particular time.

To be clear, eDNA monitoring is supplementary and complementary to the many other approaches for monitoring life. It does not seek to replace. On the contrary, a full-stack of monitoring technologies is imperative for

saving life on Earth. However, there are two reasons why we can be confident that eDNA monitoring will scale quickly and widely. First, eDNA is capable of detecting many thousands of species in a given location from a single sample at exceptionally low cost: noisy or silent, visible or unseen, megafauna or microbe, any species is detectable through eDNA. Second, eDNA is simple: anyone can take a sample anywhere.

By tokenising eDNA samples taken at an exact location at an exact point in time, we propose the "Proof of Life" protocol (hereafter PoL) which makes use of – but stands apart from – existing "Proof of Work" and "Proof of Stake" Web3 protocols. In the PoL, tokens will be bought and sold. Because each new token will require an eDNA sample to be taken and sequenced, these transactions will pay for perpetual monitoring of nature across the planet. The data generated from each eDNA sample will be made available in an open access biodiversity monitoring database, yielding a vital resource for the incorporation of standardised biodiversity measurements into business, finance and beyond.

This whitepaper sets out how we intend to achieve this vision. This 1.0 version will undergo iterative improvements. It is a starting point that showcases the potential of a Web3 solution based on tokenising the direct measurement of biodiversity in a simple and scalable way.

Brief on eDNA

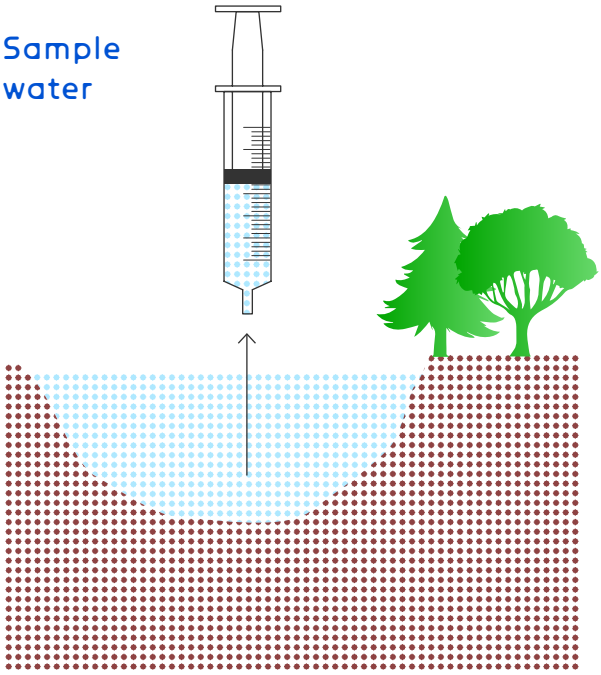
All organisms shed a trace of themselves into their environment. We can collect this genetic information, for example by filtering water and extracting DNA from the particles and cells on the filter, resulting in so-called environmental DNA (eDNA; [Figure 2], see also introductory video). Using high-throughput liquid handling robots and DNA sequencing methods, eDNA is amplified and sequenced. Taxonomic names can be assigned to the DNA sequences with the help of bio-informatic tools and DNA-reference databases such as the Barcode of Life Data System[10].

Figure 2

eDNA sampling

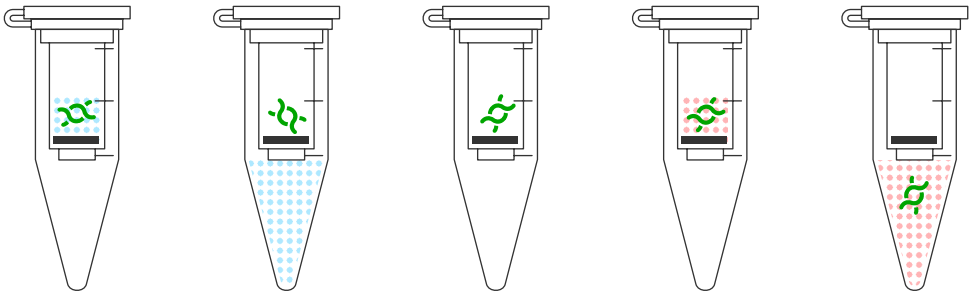
The process of sampling environmental DNA using the syringe method of filtration developed by SimplexDNA AG, coupled with standard extraction, sequencing and bioinformatic processing for the PoL to mint a Franklin. As more Franklins accumulate from the same site over time trend analysis becomes possible and data is freely available as a public good.

Sample water

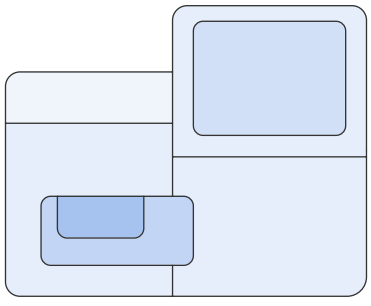


Filter water

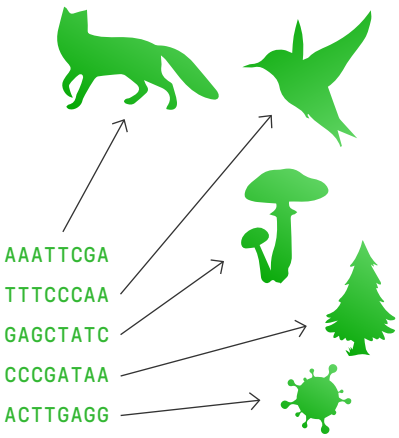
Extract DNA from filter



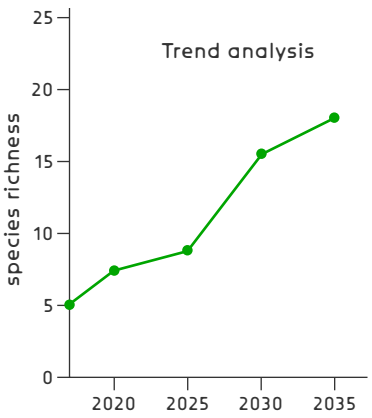
Sequence DNA



Species detected



Biodiversity metrics



Advantages of eDNA biodiversity monitoring include:

- → **Amount:** a single eDNA sample detects most, if not all, of the many thousands of species present in a location – a tree of life survey[11]
- → **Convenience:** anyone can collect eDNA samples anywhere
- → **Value:** sequencing costs have collapsed and will continue to fall
- → **Economies of scale:** high-throughput methods and instruments allow the simultaneous processing of hundreds of eDNA samples, making each one cheaper to process
- → **Durability:** both a portion of the filter and extracted eDNA can be stored indefinitely, like a museum specimen
- → **Future-proof:** samples and DNA sequences can be re-analysed again as science and computing advances
- → **Intelligence:** eDNA monitoring produces current intelligence on the presence of species. If used routinely it can measure a change of state in an ecosystem that can be trusted by markets

These advantages suggest that eDNA biodiversity monitoring will become the most universal of the biodiversity monitoring technologies over the next century – extending even into microbial biodiversity. Unlike manual field surveys, eDNA monitoring can also draw on precedents and methodologies from criminal forensics. Where required, eDNA samples can be made to observe chain of custody and third-party verification[12].

Even so, it is important to note existing shortcomings. While eDNA monitoring is accurate for commonly occurring species, it is less accurate for rarer species. Vigilance about inferences is also needed: eDNA can persist in a landscape for days to weeks after a species has moved on, or it can be transported by water or air to a location where it was never present. Continual testing in many ecosystems together with advances in the underlying science are already resolving or significantly improving on these uncertainties and will continue to improve.

Proof of Life Protocol (PoL)

SimplexDNA's PoL proposes a global biodiversity monitoring system financed by the novel development of a digital token linked to an eDNA sample. We call these tokens Franklins, after the scientist Rosalind Franklin who first photographed the structure of DNA which shaped modern molecular biology and genetics[13]. Each Franklin is a token minted from an original sequence readout of life forms detected at a particular place and time.

The protocol is self-renewing: the market buys Franklins, a network of local samplers earns an income from monitoring other species in the surrounding ecosystem, the biodiversity data used to mint Franklins aggregates into an open access platform that tracks changes in biodiversity over time, and token buyers and makers yield royalties for commercial data use.

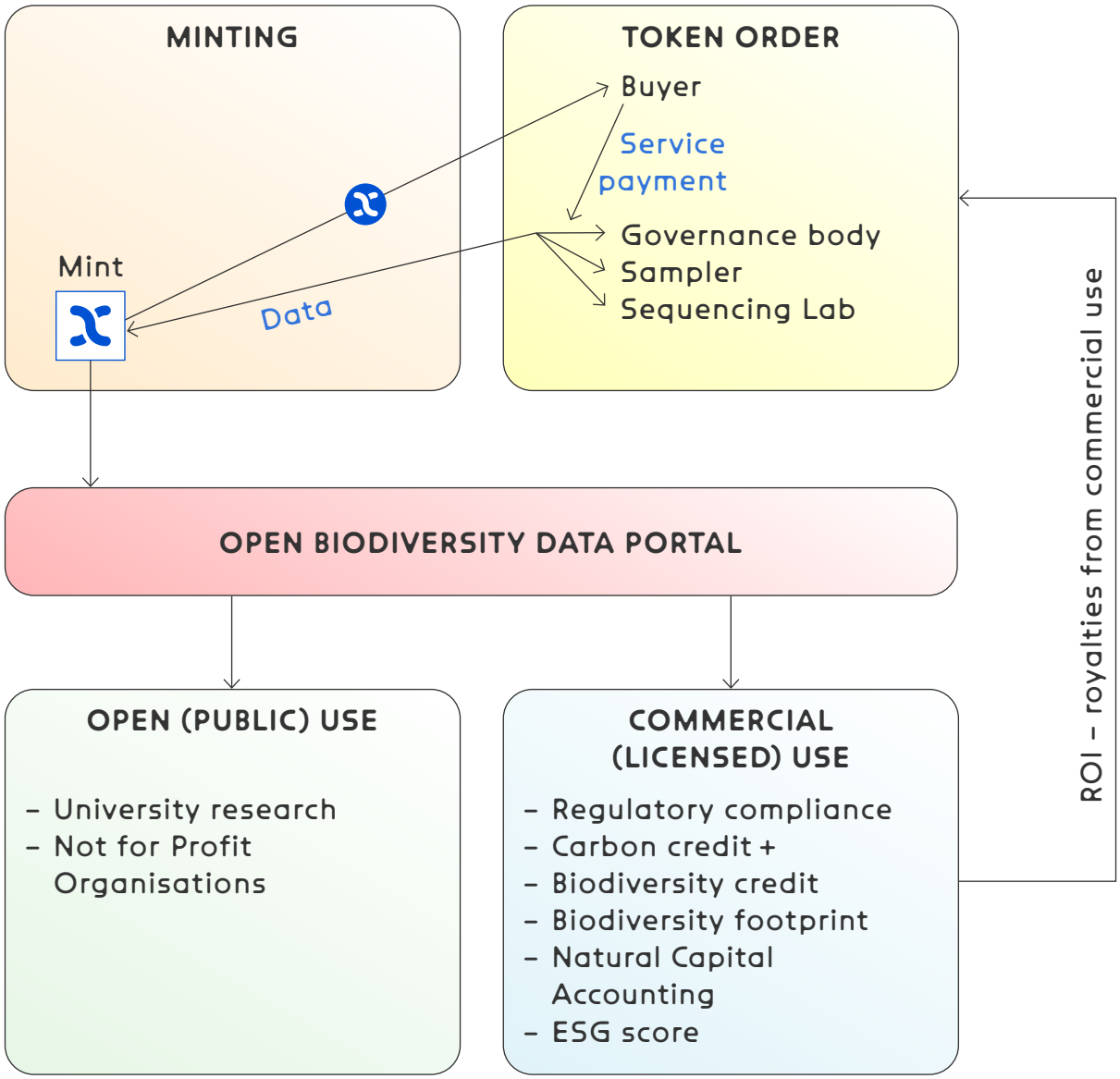
Stakeholders in the PoL include [Figure 3]:

- → **Customers:** purchase a Franklin backed by a unique measurement of life
- → **Samplers:** paid to take a verifiable eDNA sample with a standard kit
- → **Sequencing labs:** paid to receive samples and extract and sequence the DNA
- → **Governance Body:** approves samples, determines payouts, and is custodian of the global database

The investment opportunity for Franklins is substantial. The total addressable market for wildlife and conservation is minimally estimated at $80 billion per year and far larger for management of agricultural, forestry, and industrial land. This will rise as new compliance mechanisms require financial institutions and companies to monitor their biodiversity risks and offset their impact on nature. Commercial use of data will yield royalties to those who were involved in the minting of the Franklin or who purchased it.

Figure 3

The Proof-of-Life Protocol



The PoL distributes the income from the sale to different stake-holders and, as a positive externality of the trade, generates valuable biodiversity data. The data is free for public use but not for commercial use. The royalties generated go back to the token holders, creating a feedback loop where more data use leads to more token demand, due to the higher revenue, whereas increased token minting leads to an increase in data usefulness.

Anyone can become a customer and potentially receive a financial return in royalties by purchasing a Franklin, but we anticipate particular interest from the following customer types:

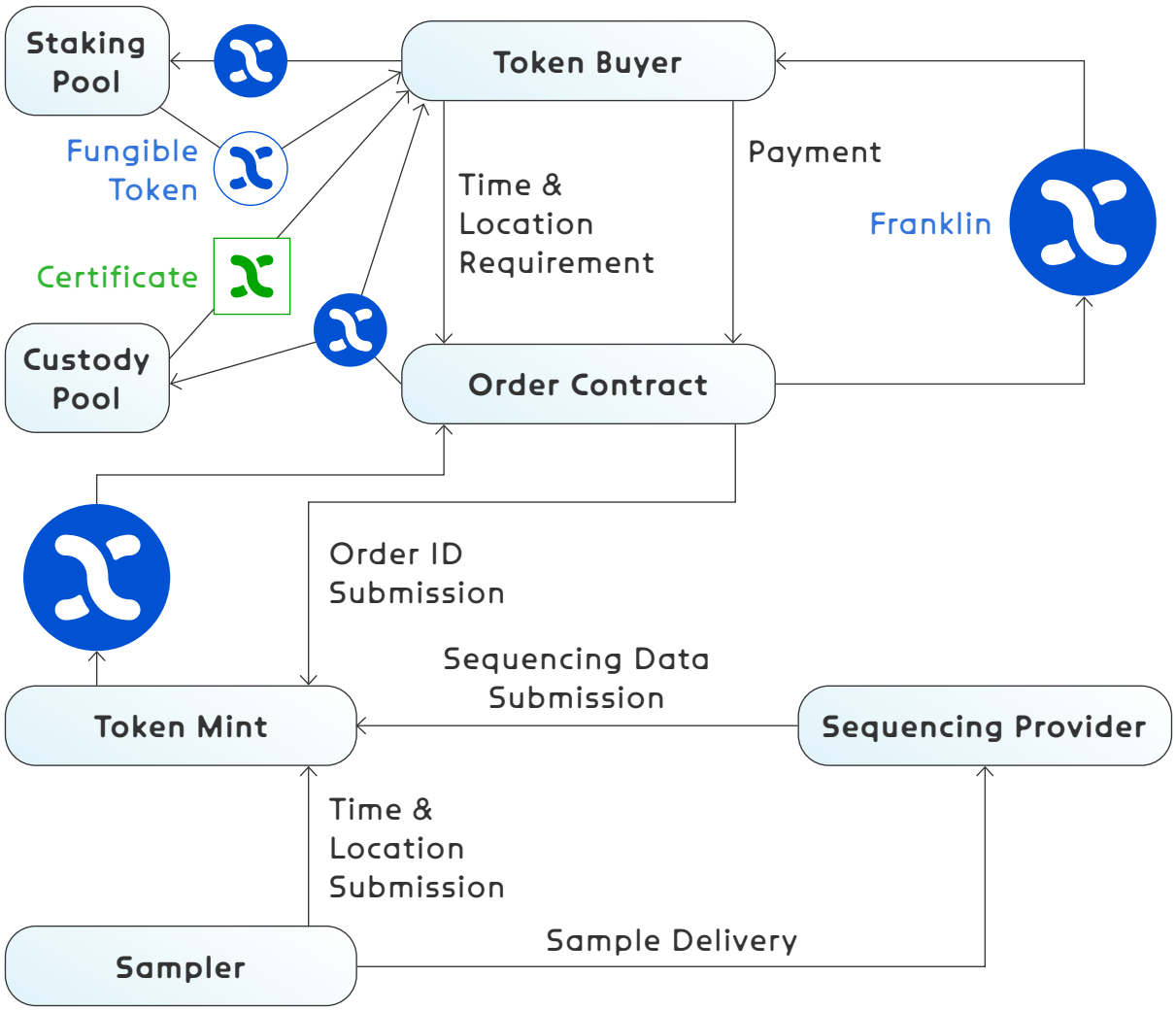
- → Multinational corporations abiding by new reporting standards and regulatory requirements with regards to their impact on nature
- → Financial institutions monitoring their own operations, assessing the impact of potential investment targets or as an asset in its own right
- → Any organisation aiming to showcase their engagement through the sale of impact certificates
- → Financial data providers that want to include biodiversity data into their ESG ratings
- → Future biodiversity offset providers needing data on the base state and the regenerated state of a particular offsetting project or carbon offset providers wanting to offer nature positive carbon offsets
- → Regenerators creating data for ecological contracts or to prove the impact they are having

The Franklin is integrated into the PoL in the following way [Figure 4]:

- → **Minting:** a Franklin is minted based on the receipt of a sequencing file including proof of life and a location and time-stamp with matching metadata. The Franklin will likely be a burnable token based on accepted standard. Multiple additional tokens will derive from it, which can be used to pay for data use, derive royalties from said use, or reward samplers and sequencing providers. At a later stage, an additional token may confer governance rights
- → **Order:** Franklins are secured by customers with a deposit of cash or digital currency. The purchase price will reflect whether the location and time on the Franklin are constrained or left open
- → **Release:** when the Franklin is released to the customer the deposit is also released and shared among the sampler wallet, sequencing provider wallet, and governance wallet at a rate determined by the governance body
- → **Guarantee:** the deposit is returned if an order is not fulfilled within the agreed time
- → **Data:** samplers and sequencing labs upload data to a decentralised storage platform. Location and time stamps and additional metadata are uploaded by the sampler. The hashes of these entries are stored in the metadata field of every Franklin token

Figure 4

Minting Process



After a token buyer submits an order to the order contract, the governance board will assign a sequencing provider and sampler to the order. They will submit their data to the token mint function. The minting function will mint a Franklin if the submitted data is valid. The Franklin is sent to the order contract. If its metadata is compliant with the order, it is delivered to the buyer and the monetary deposit is released. A token buyer, depending on their use case, can hold or burn the Franklin. The Franklin can also be deposited in a custody pool. If for regulatory reasons tokens cannot be held, the depositor will receive a certificate that allows them to redeem the tokens when necessary. Alternatively, the Franklin can be deposited into a staking pool, from which a multi-purpose fungible token can be received.

Buyers who are indifferent to a sampling location have the choice of buying an existing Franklin or submitting an order for a new Franklin to be minted. This can be with or without specifying a location or time. In the scenario where buyers of Franklins are indifferent, governance will direct this investment to pay for the cost of sampling in the neediest ecosystems. Buyers who need to monitor a particular location or who are interested in supporting a biodiversity baseline in a defined ecosystem can specify a location and time; those contracts will remain open until sampling and sequencing is completed or a time maximum is reached. Alternatively, buyers can purchase tokens on secondary markets, e.g., if they are not primary users of the generated data but wish to gain a return on the use of the data.

A multi-token model will allow the creation of fungible tokens from Franklins, such as through a staking mechanism, with which data use can be bought, from which royalties can be derived, or governance votes acquired. Furthermore, fungible tokens allow a more streamlined and open and transparent disbursement of funds to stakeholders.

The PoL will be open so that third parties can build measurement orders, biodiversity offsets, and many other tools on it. We will encourage further collaboration by making our data processing open source and collaborative, for instance by making use of Web3 revenue models for developers. Development will take place on Celo, a blockchain which, by using a Proof of Stake consensus algorithm and programmatic offsetting, is carbon negative.

Governance

The PoL will be developed and overseen by an independent governance body. It will have an independent role from SimplexDNA AG within the PoL. While the company is the first and primary sequencer of Franklins, the governance body is responsible for:

- → Onboarding and organising a scientific board and an economic board who will have voting rights in the disbursement of funds
- → Assigning the order book of Franklins according to capacity and biodiversity priorities
- → Determining payouts for Franklins to respective wallets and managing the tokenomics
- → Recruiting other stakeholders to the protocol
- → Financing, building, and making available a global biodiversity monitoring database from aggregated samples
- → Education and outreach

The scientific board determines sampling strategies, priorities for monitoring, and oversees curation and access to the database. It is responsive to conservation aims of international, national, local organisations, and indigenous communities, as well as emerging evidence from the scientific community. SimplexDNA AG and other sequencing providers work with the scientific board in order to continually improve minting, including refining the processing of samples and bioinformatics for what verifies life in an eDNA sample.

The economic board oversees the management of the Franklin and the token economics in accordance with market trends and legal regulations. It is responsive to the many indices for ESG assessment and economic policy. Recruitment to the governance body will be inclusive, in keeping with the aim of building the Franklin as a planetary good for people and other species.

Governance costs are underwritten by the minting of Franklins. One of the primary goals of the governance body is to optimise for regular sampling of biodiverse ecosystems in emerging economies, such as a complete time series sample of a rainforest ecosystem in Cameroon. Once established, engagement will be strengthened by community voting mechanisms and staking. The governance body may eventually take additional roles in education and storytelling around biodiversity.

Operations

In order to generate value for biodiversity and the markets over time, the PoL requires operational excellence. Sampling and logistics need to be efficient, order books and payments frictionless, and sequencing and bioinformatics technically advanced. Countries own their own genetic resource and use of them is subject to the Nagoya Protocol[14]. Global onboarding of laboratories is the fastest way to sequence samples and observe compliance. The PoL will work for leadership in the law that consistently favours nature, poorer communities, and open source data in order to equitably share access to data and the benefits deriving from it.

Logistics will matter. Samples need to be affordably and reliably couriered to sequencing labs. Preferred courier companies may be compensated in Franklins. Initially, sample kits and sequencing will be undertaken by SimplexDNA AG in Switzerland and will expand globally with partners willing to sequence PoL eDNA samples. The governance body will manage the approval of new labs, be responsive to quality certifications and CEN and ISO standards for onboarded and trusted sequencing providers.

In addition to blockchain solutions, last mile payments in the tropics may be completed using banks, innovative fintech, and mobile money platforms. The operations team of SimplexDNA AG will onboard samplers. Many individuals will likely be employed by governments and

non-profit organisations, others by large companies. However, we expect the biggest contributors of samples will be young entrepreneurs in the tropics. Governance will seek to maximise this market for the benefit of the entrepreneurs and their communities. Sampling for the PoL will be an attractive supplementary business for underemployed young people in biodiverse parts of Africa, India, Southeast Asia, and Latin America. These areas are often remote and impoverished, with limited income generating opportunities.

A real world example

Rio Tinto is an Anglo-Australian metals mining company with a $100 billion market value. Rio Tinto has a controversial environmental record and is engaged in an $8 billion multi-decade project in Guinea to develop the Simandou iron ore mine. Simandou is one of the largest iron ore deposits in the world with estimated reserves of 2.4 billion tonnes. Guinea is biodiverse, but poor. Per capita income is $3 a day and Simandou has the potential to double Guinean GDP. Rio Tinto wants to do a much better job in limiting its negative environmental impact. The company, the Guinean government, local communities, and conservationists might agree to order hundreds or thousands of Franklins on a weekly or monthly basis in the several thousand square kilometres surrounding Simandou. The resulting data will track the change of state in the Simandou mountains and serve as a guide for biodiversity regeneration. Because data linked to Franklins will be made available in a database and offered to the world as a public good, Rio Tinto will be able to push back on unfair criticism of its operations. Conversely, the company will be held to account by Guineans, conservationists, and by market speculators if it falls short of its obligations.

Simandou *Source: Rio Tinto*

The PoL improves on past biodiversity monitoring in that the data generated are made open from inception. In short, repeated sales of Franklins build a digital twin of the state of an ecosystem over time. This twin is highly credible with a long history of verified change. We believe this will incentivise new reparative and regenerative thinking. For instance, even if Rio Tinto were to show that its operations have an adverse effect on a section of the Simandou mountains for the duration of its operations, it may be able to prove, with the same publicly available database, that its efforts to recover biodiversity in the much larger surrounding region have been successful.

Tokenomics

Biodiversity is intangible: it is difficult to quantify and even more problematic to assign an economic value to. What is clear is that the services nature provides to people are greatly undervalued in the economy[15]. Pollination services alone are estimated to be worth over $250 billion a year[16]. Beyond the economic are the ethical concerns that other species deserve to persist simply because of their existence in the world. And then there are aesthetic and spiritual values such as the feeling we get when walking through a rich woodland known in Japanese as shinrin-yoku[17], swimming with a dolphin, or watching a moth unfold out of its cocoon. These and other experiences encode our values of biodiversity: familiarity, community and discovery[18].

Just as the services nature provides are undervalued, conservation solutions are grossly underfunded. The total global investment in nature is only a fraction of the $8.1 trillion estimated need before 2050[19]. Only about $1 billion of the estimated $24 billion a year spent on conservation worldwide ends up in the hands of the extreme poor: they receive almost no value for living proximate to biodiversity. This $1 billion needs to increase a thousandfold over the next century (about 1% of world GDP) in order to have any chance of regenerating biodiversity in the tropics where most of the world's population and nearly all of its extreme poor live. That

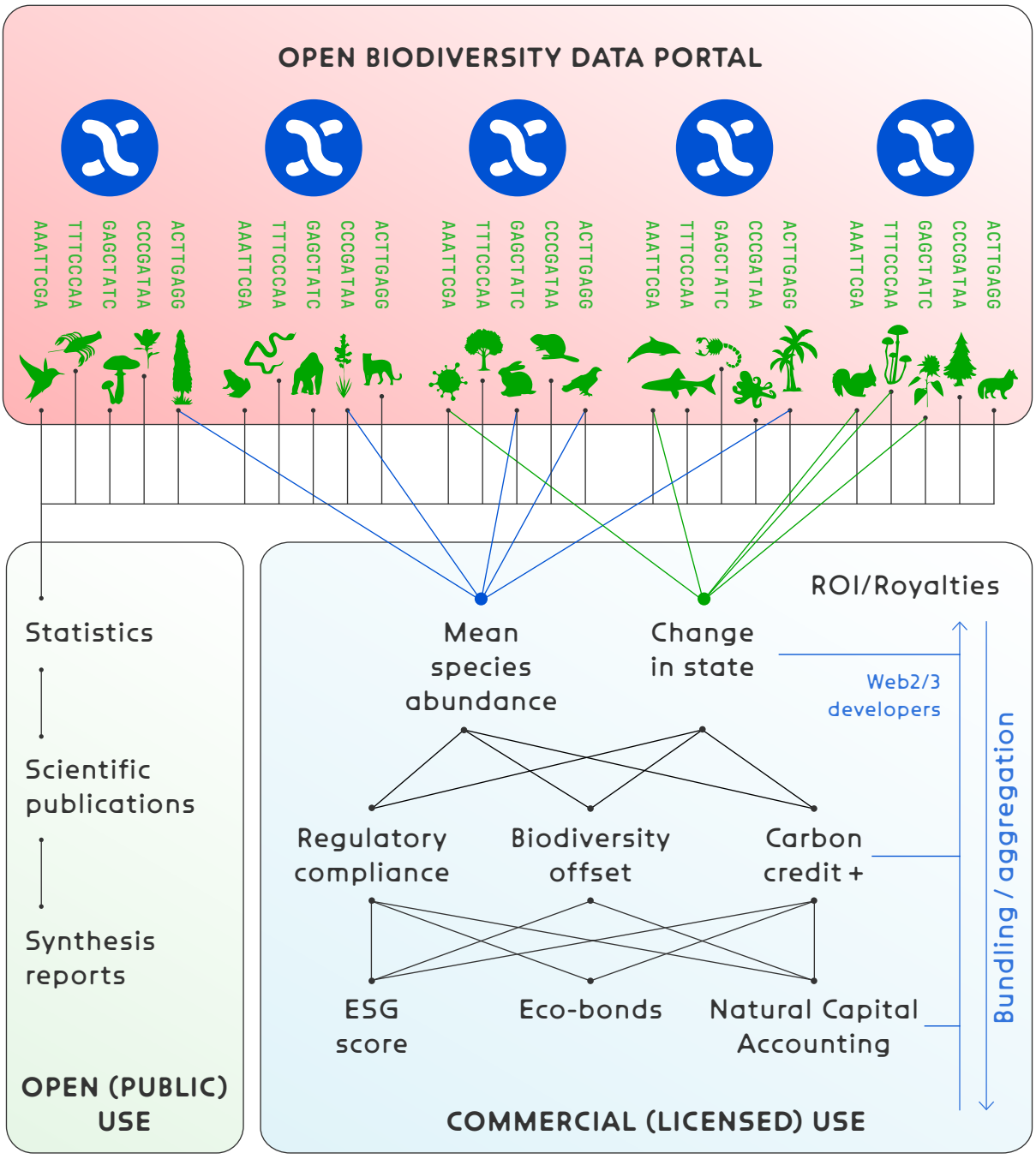
flow of money will not happen without simple solutions that can verify conditions on the ground and determine whether interventions are sensible and useful.

PoL generated biodiversity data will earn revenue through royalties for its commercial use, which will be returned to token holders [Figure 5]. The distribution of money will be designed to dampen volatility and maximise the investment potential for Franklins. Particular emphasis will be given to incentivising early buyers and achieving the ambition to obtain baseline data in the poorest and most biodiverse ecosystems. The blockchain architecture will remove friction and increase transparency, allowing data to be easily traced back to a specific token (whose minting created the data).

The PoL seeks to bring price discovery and liquidity to natural capital. Demand will reflect the extent to which Franklin-linked data is able to meet the data needs of the market. Pricing will be in line with the value the human economy places on nature – the big untested hypothesis. The Franklin is inflationary because its purpose is perpetual not momentary: new orders of Franklins need to be made in order for global biodiversity to be monitored over generations. Due to their contribution to the global baseline, the earliest buyers of Franklins will stand to create the most value for society and the monetary return on their investment.

Figure 5

Data Portal and Use Cases



The open biodiversity data portal is a database of sequence information derived from the PoL. The data can be further processed for various uses, either for open (public) use or for commercial use by the private sector. The latter generates royalties for token holders and thereby contributes to the establishment of a secondary market.

The scientific board will work to ensure that biodiversity data generated by the PoL best serves the needs of nature. It will seek to combine the best available biological research and new computational and game theoretical tools. This may lead to divergence in pricing. Every Franklin is unique in its measure of biodiversity, but some Franklins are more equal than others. Royalties are distributed to token holders in proportion to the frequency of use of the underlying data. Since data from threatened but highly biodiverse areas are more sought after by commercial users, tokens minted from such areas will yield higher earnings than others.

The economic board must help maintain the stability of the Franklin over time: DNA tokens need to be a dependable investment. The economic board will also help incentivise the ordering and holding of Franklins. A token might be bought to develop a higher-resolution understanding about a location of interest, such as the Simandou mine. But this will likely be in contrast from the well-established pay-for-services model. For example, activists may buy Franklins in order to move the share price of industrial companies by credibly showing harm they are causing to an ecosystem. Many Franklin buyers will not be direct consumers of the data or have an interest in where the token was sampled. They will buy Franklins as an impact certificate confirming their engagement in biodiversity monitoring for a public good.

The PoL will contribute to industry standards such as the LEAP approach put forward by the Taskforce on Nature-related Financial Disclosures (TNFD)[20]. Vendors of biodiversity offsets will create additional demand for tokens and data, since verification of the presence of species and their condition over time will be required to execute their contracts. As yet undefined secondary markets will further establish the Franklin as an industry standard.

The PoL will produce a versatile data product that can simultaneously provide metrics on individual species, surveil broad changes to genetic, community and ecosystem diversity, and validate other remote, image, and bioacoustic sensing measurements. Measures will be taken to protect species at risk of poaching by hiding sensitive location data. Data can be transformed by its users into indices, such as species richness, relative and rank abundance, and allelic richness. These types of indices are readily usable by financial institutions in their reporting and risk assessment. For instance, eDNA detection is already recommended by TNFD to measure change of state in nature.

At launch, the Franklin token price will exceed that of the cost of sampling and minting. However, costs are likely to go down over time as the network is established and sequencing methods and instruments become cheaper and faster. Against this depreciation is the likely appreciation in value of each Franklin.

Ambition

Our ambition is to build the world's first open global biodiversity monitoring database using tree of life sequencing of eDNA. And not just to build it, but to build it as a self-sustaining public good.

There are many advantages to such a database. The most obvious is that it is often unclear what data is needed until it is made available. Our PoL database will provide a foundational layer for calibrating other biodiversity measurements, as well as for building out a network of metrics that provide market intelligence on natural capital and allow for accounting and verification of natural assets at minimal cost to the user. Knowledge and local decision making will benefit: it will make a contribution to keeping biodiversity within safe planetary boundaries.

What we therefore propose is also the discovery of life on our planet by a new generation of explorers. The biological sciences know enough now to understand the scale of their ignorance. The lower estimate of species on Earth is 8.7 million. We have described and named only a quarter of them. If the upper estimate of 1 trillion species on Earth is correct, 99.99% of species are nameless.

This is about to change. We are embarking on the great turning towards the regeneration of biodiversity, where DNA sequencing technology will allow us to monitor all DNA-based life, without knowing who they are, how they survive, or what their function is. A purchase of a single Franklin may reveal life forms unseen to us until now. We can measure them, map their distribution, and begin to understand if we are causing them to increase, or die. In this very real sense, purchasers of Franklins will be stewards of both the known and the unknown.

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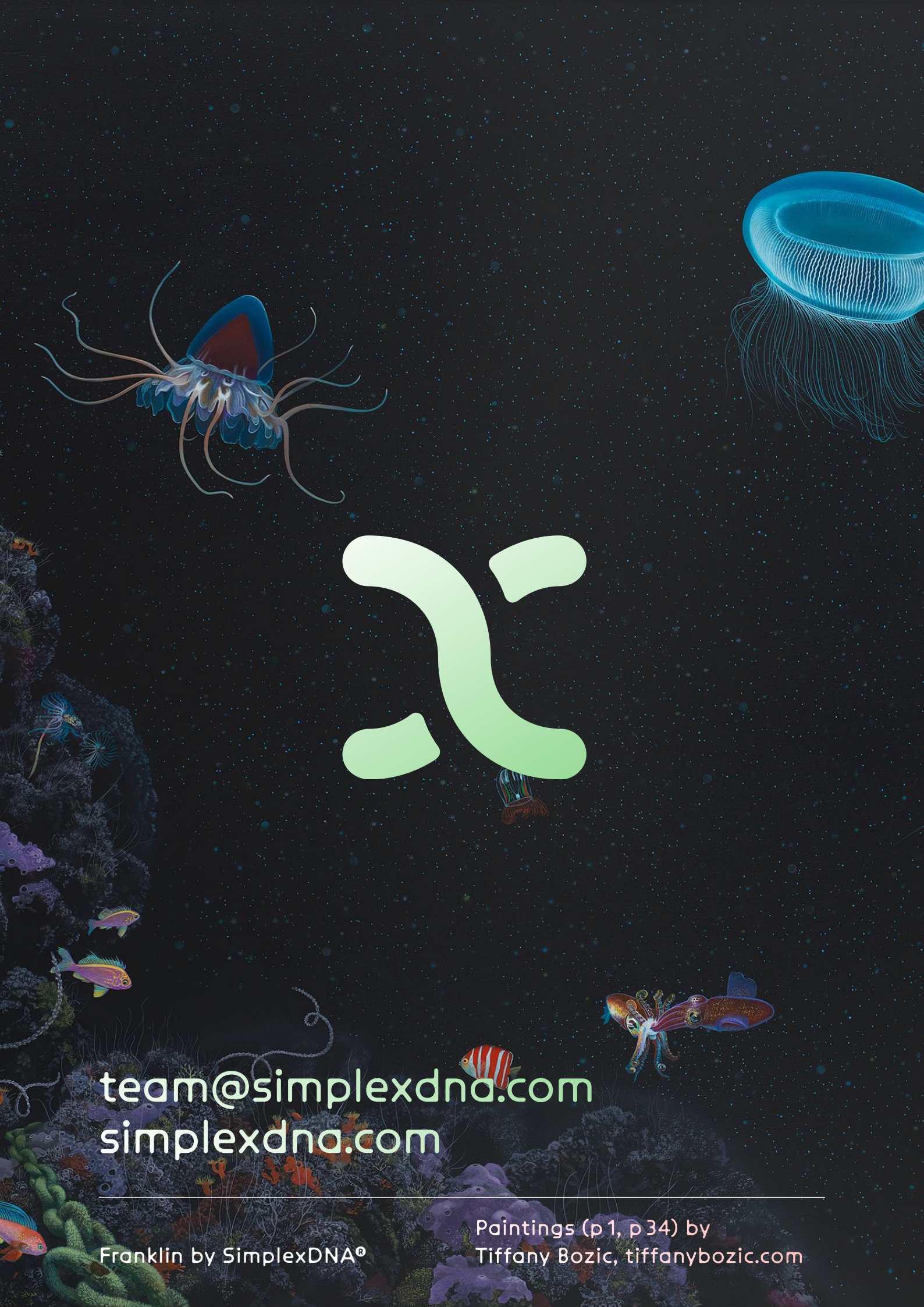

team@simplexdna.com
simplexdna.com

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Paintings (p 1, p 34) by
Tiffany Bozic, tiffanybozic.com