SEA2SEE PROJECT

# HACKATHON 2023

## Context Scholario group


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# INTRODUCTION

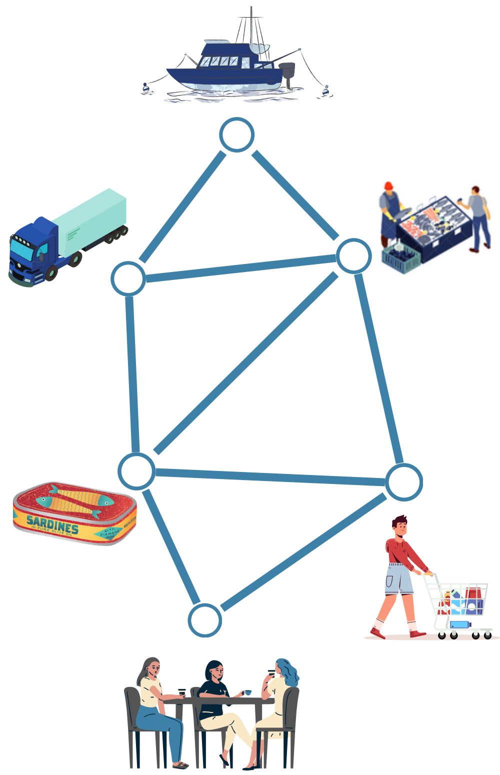
Seafood is the most traded food product in the world, but the overall lack of origin information and traceability give rise to human health and sustainability concerns (FAO, 2022). Traceability can be defined as **"the ability to trace and follow food, feed, and ingredients through all stages of production, processing and distribution"** (European Parliament, 2022), and digital technologies for this purpose have been substituting paper-based methods.

Even though some challenges can be encountered when it comes to digital traceability (such as lack of interoperability and confusing standards, lack of regulation or global lack of access to technology (Haughton et al., 2022)), it has the potential to improve trust and transparency in seafood value chains and improve security and seafood safety (Borit and Olsen, 2016; Lewis and Boyle, 2017).

The European Union (EU) is one of the largest markets in the world for seafood trade, importing 60% of the consumed seafood, which mostly comes from developing countries (CFP, 2022).

Despite all the global lack of seafood information, the EU shows one of the strongest efforts to improve traceability regulations, in order to eliminate Illegal, Unreported and Unregulated (IUU) fishing, promote sustainable fishing and food safety. All seafood that enters as is commercialized in the EU has to provide several mandatory information in its label (such as species commercial and scientific name, area where the product was farmed or caught, fishing gear used, etc) (European Union, 2015), but, in general, there is still no end-to-end traceability system to guarantee seafood's safety and sustainability.

However, in a recent communication, the EU Parliament has announced a reform to the Common Fisheries Policy rules, in order to incorporate increased monitoring and tracking of all vessels (including those smaller than 12 meters) and fully accessible digital traceability for fresh and frozen fish (European Parliament, 2023).



# INTRODUCTION

Overall, a lack of global commitment, awareness and technological interoperability pose great challenges for achieving seafood traceability and lead to information loss (Borit and Olsen, 2016; Leslie and Lugo-Mulligan, 2021). The Global Dialogue on Seafood Traceability (GDST) has developed **Core Normative Standards**, in consultation with internal members and external experts, in order to **tackle the lack of interoperability in seafood traceability systems**. These standards are endorsed by different relevant organizations as a guide to follow and implement (such as WWF Peru and Future of Fish (Leslie and Lugo-Mulligan, 2021) and key data elements include information about catch, vessel, transshipment, processing, certifications and traceable object information (Table 1).

Traceability opportunities are increasingly being reported, and include factors such as identification of origin, improve of efficiency in supply chain operations, increased value chain trust, better access to eco-certification, real-time access to information, among others (Bhatt et al., 2016; Dong et al., 2019; Gopi et al., 2019).

# INTRODUCTION

Table 1. Summary list of Key Data Elements (KDE) for wild caught seafood, according to the GDST Core Normative Standards (Global Dialogue on Seafood Traceability, 2023).

| VESSEL DATA |
|---|
| • Vessel Name<br>• Vessel Registration<br>• Unique Vessel Identification<br>• Public Vessel Registry Hyperlink<br>• Vessel Flag<br>• Availability of Catch Coordinates<br>• Satellite Vessel Tracking Authority<br>• Transshipment Vessel Name<br>• Transshipment Vessel Unique Vessel ID |
| **CATCH DATA** |
| • Catch Area<br>• Fishery Improvement Project<br>• Vessel Trip Dates<br>• Date(s) of Capture<br>• Gear Type<br>• Production Method |
| **TRANSSHIPMENT DATA** |
| • Transshipment Location<br>• Dates of Transshipment |
| **LANDING DATA** |
| • Landing Location<br>• Dates of Landing |
| **PROCESSING DATA** |
| • Expiry / Production date<br>• Product Origin |
| **CERTIFICATION AND LICENSES** |
| • Fishing Authorization<br>• Harvest Certification<br>• Chain of Custody Certification<br>• Transshipment Authorization<br>• Landing Authorization<br>• Existence of Human Welfare Policy<br>• Human Welfare Policy Standards |
| **TRACEABLE OBJECT INFORMATION** |
| • Species<br>• Product Form<br>• Item / SKU / UPC / GTIN<br>• Linking KDE (batch, lot or serial number)<br>• Weight or Quantity<br>• Unit of Measure |

# SEA2SEE BLOCKCHAIN

The Sea2See European project aims to promote sustainable seafood consumption through stakeholder engagement methods and innovative blockchain traceability.
The blockchain technology builds blocks of information and, with them, digital decentralized ledgers of transactions that can be shared in real-time and in a tamper proof way (Blaha and Katafono, 2020; Di Pierro, 2017; Lin et al., 2021).

The Sea2See platform for traceability is blockchain based, owned by all participants and auditable by design. This blockchain uses a PBFT algorithm (Practical Bizantine Fault Tolerant) "round robin" type (random validation of each block). Regarding the control tower, a Software as a service (SaaS) is used for real-time end-to-end supply chain monitoring and traceability.

It is expected to:

01

### BE USER FRIENDLY

Easy to use and to navigate.
Provide relevant and trustworthy information rapidly to consumers and retailers.

02

### EFFICIENT

Be replicable for different products and allow information access in real-time.

03

### PROMOTE SUSTAINABLE SEAFOOD

Give transparent seafood supply chains visibility.

# OUR SOLUTION

In order to build the first blocks of information into a blockchain traceability system, we need to look for the beginning of supply chains. For wild-caught seafood that data is related with fisheries activity (catch, landing and vessel data). **With this information, seafood can be traced back to its origins and stakeholders can have an understanding of where their seafood comes from**. Verifying the source of seafood is extremely important as a way of better managing fishing activities and preventing unsustainable practices such as IUU fishing. Knowing exactly where and when the fishing activities take place not only allows marine stocks to be better controlled, but also allows for vessel monitoring and assurance of onboard work conditions and seafood safety (food quality).

Our solution is focused on those first supply chain steps, and we propose a tool using blockchain technology that provides consumers with verifiable evidence of the origin of seafood products, promoting responsible and informed purchasing decisions.

In order to do so, we have looked into different online platforms with fishing vessel location information to see what information is public and can be retrieved. VesselFinder and Marine Traffic were the ones with the most complete set of vessel information on a global scale. We have compared them to understand the kind of data available with a free account (Table 2) and concluded both platforms are very similar. We have noticed gear type and targeted species is not information that is available for online viewers.

# OUR SOLUTION

Table 2. Information found on VesselFinder (www.vesselfinder.com) and Marine Traffic (www.marinetraffic.com).

| | ONLINE PLATFORMS | |
|---|---|---|
| **TYPE OF DATA** | **VESSELFINDER** | **MARINE TRAFFIC** |
| Vessel name | VesselFinder | Available |
| Port of origin | Available | Available |
| Date/Time of departure | Available | Available |
| Destination | Available | Available (not for all vessels) |
| Time of last report | Available (not for all vessels) | Available |
| Location | Available | Available |
| Gear type | Available | Not available |
| Targeted species | Not available | Not available |
| Vessel flag | Not available | Available |
| Weather | Available | Available |
| Size of boat | Available | Available |
| Track of journey | Available | Available |
| Fishing area | Available | Available |
| Vessel speed | Available | Not available (only for premium |
| Gross tonnage | Available | accounts) |
| IMO (International Maritime | Available (not for all vessels) | Available (not for all vessels) |
| Organization) vessel number | Available (not for all vessels) | Available (not for all vessels) |
| Recent port calls | Available (not for all vessels) | Available (not for all vessels) |

In the European scope, fishing vessels have to be monitored through the European Maritime Safety Agency (EMSA). The EMSA uses the SafeSeaNet system to enhance maritime and port safety and efficiency and environmental protection. It contains information regarding the historical ship positions, vessel flag, current position, destination, and other information provided by the vessel's Automatic Identification System (AIS).

However, this information is not publicly available (it is only used by European Union's, Norway's and Iceland's authorities), and the AIS system is not integrated in most small-scale vessels (since it's not mandatory for fishing vessels under 15 meters in length) (Oceana. (n.d)). Nevertheless, the European Union has a public website to consult vessel registered information, such as the vessel name, tonnage and length.

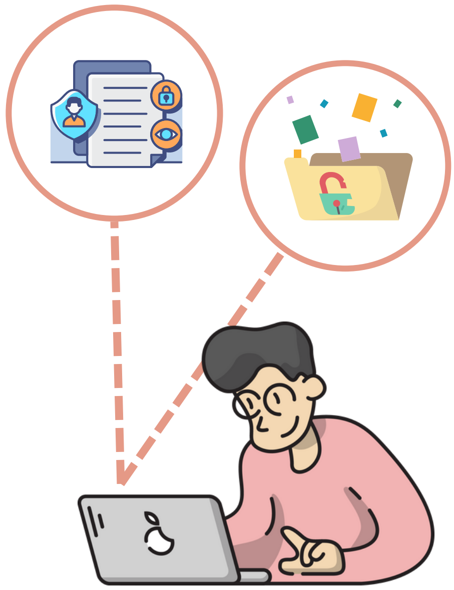
# SECURE, BLOCKCHAIN-BASED API FOR VERIFIED DATA COLLECTION

We have designed an API or a “loose open-sourced API”, with administrators that check and verify information (e.g. Sea2See), that otherwise be unpresentable and considered by regulators.

It would be crucial that for all the “variables” in “play” and that are being traced to be **private** and **secure**, attending to the users wants and needs, in efforts that the information doesn’t get breached, compromised or adulterated.

It is also equally important that the data collected is flowing within legal boundaries and parameters, so that its integrity is clear, transparent and validated. Data collection should be treated and handled with a high standard of ethics, morals, truth, and a “moderate” level of seriousness and play.

At the level analyses of user privacy and security it is important to have it always checked and updated, so that the structure remains open to contributors & benefactors, but at the same time holds some integrity in regards to the above mentioned privacy and security of the user.



That’s why we use Blockchain, to get the immutability, traceability and verifiability of the data. The smart contract would use **Zero Knowledge cryptography** under the hood to ensure privacy satisfying the required data compliance of the EU.

# SECURE, BLOCKCHAIN-BASED API FOR VERIFIED DATA COLLECTION

The Zero Knowledge Proofs (ZKP) would be used to verify the 'fisher' is legitimate **without disclosing any sensitive information**. It would also provide a secure way to verify the identity of the fisher and ensure that the data collected is accurate. Additionally, blockchain would ensure that the data is secure and protected from any malicious attacks at the same time it is public.

Our solution starts with a backend that periodically will request information from a wide range of public endpoints, such as Automatic Information System (AIS) for fishing vessels, and open data databases, such as the already mentioned VesselFinder and Marine, to cache it into 3 different distributed database/ledger technologies:

The heavy, not crucial and non-private data will be uploaded into IPFS.

01

InterPlanetary File System (IPFS)

A protocol, hypermedia and file sharing peer-to-peer network for storing and sharing data in a distributed file system.

The heavy, crucial, non-private data will be stored in Arweave.

02

Arweave

A blockchain protocol which has permanent storage, a first of its kind feature.

Aleo will serve as the settlement layer to store the links referencing the Arweave and IPFS stored data, as well as the private data that due to regulatory compliance, will only be accessible and decrypted by a minimal set of actors.

03

Aleo

An L1 blockchain which uses zero-knowledge technology to securely store private data into a public blockchain as itself is.

# SECURE, BLOCKCHAIN-BASED API FOR VERIFIED DATA COLLECTION

This approach is chosen due to:

- the high data availability and the throughput the **Arweave** and **IPFS** architecture offers us
- **Aleo** as the settlement layer for all this data to be pinned, due to it's Blockchain programmable nature.

Since, Arweave and IPFS are closed to decentralized databases than to decentralized ledgers due to its peer-to-peer content delivery network, which is different than a block-structured architecture in the main case that it doesn't has programmability in it's base layer.

Last but not least, the part of the overall architecture that would offer the curated data to be consumed, is an indexer that, through Aleo's RPC endpoint providers, would query the smart contracts storing the Arweave, IPFS pins and the encrypted private data. This private data could be **shared only by permissioned actors** the original owner has whitelisted. The Data Driven API, will extract and process information through the blockchain according to the variables and parameters accessible in the Aleo smart contract. Whilst using multiple sources, one will be able to track and simultaneously fact check the Data being extracted, ending up with a better result as opposed if it were only one source. This Data will then be stringed together through the API, in a cohesive and coherent manner, and at last made useful for further analyses and studies.

This will potentially allow one **to make better and more informed decisions on sustainable fishing**, not just in Europe, but throughout the planet. More info can be found in the Diagram(s) and Demo below.

# SECURE, BLOCKCHAIN-BASED API FOR VERIFIED DATA COLLECTION

Bellow, it is possible to see the diagram with the designed solution architecture (Figure 1), where more detail can be verified regarding the technical components described previously.

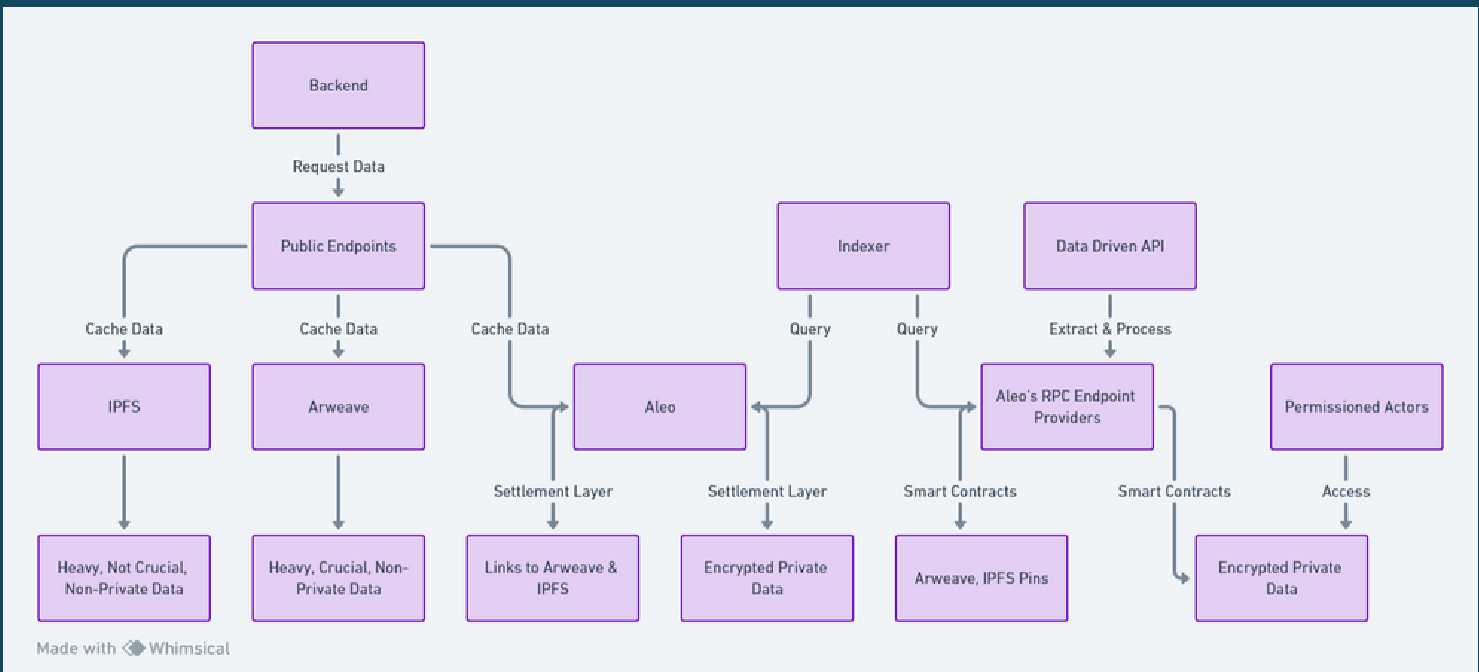



Figure 1. Technical software architecture of the proposed solution diagram

# OUR SOLUTION'S VALUE FOR OCEAN CONSERVATION

To safeguard the Ocean and its habitats, it's our duty as humans to act responsibly. We can preserve resources and use them in less destructive ways. By limiting overfishing and invasive fishing methods like industrial fishing and bottom trawling, which often devastate marine flora and fauna, we can make a difference (Gibbens, 2018). Even though there's no single solution, a combination of efforts can guide us towards better conservation and preservation of the Ocean.

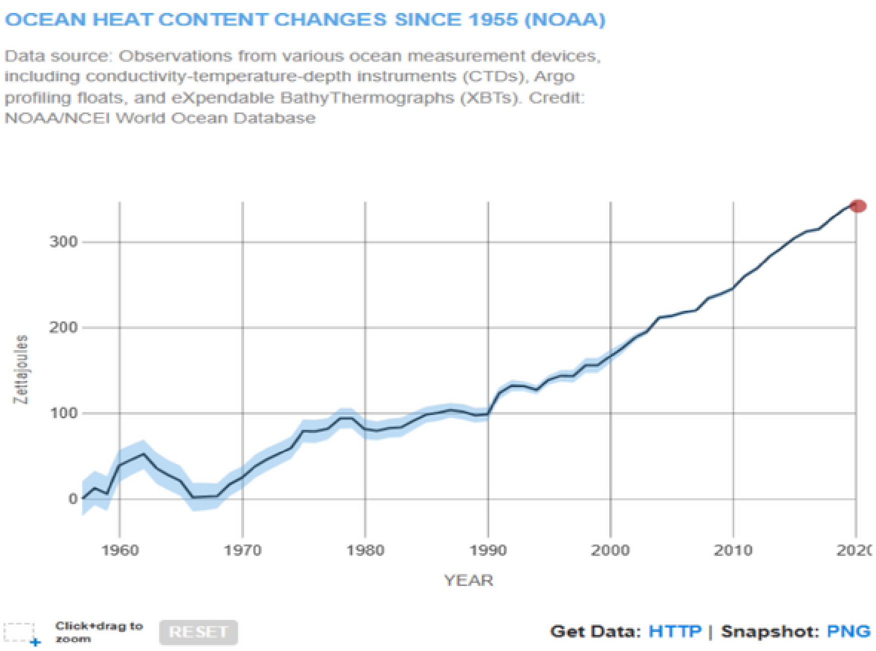



Figure 2. Historic Ocean heat changes (retrieved from: https://climate.nasa.gov/vital-signs/ocean-warming/)

The ocean and its various seas are under threat from overfishing, heating, and pollution (Figure 2). Given that a significant portion of the Earth's surface is covered by water, **it's crucial for us to care for the Ocean as we would for ourselves**.

A healthy ocean leads to healthy marine life, including all marine flora and fauna, which in turn contributes to human health. If marine life suffers, the repercussions will inevitably reach us on land. Life in water is diverse, including organisms, bacteria, viruses, and even parasites, all of which are integral to the ecosystem. It's never too late to start caring for ourselves and our environment.

# OUR SOLUTION’S VALUE FOR OCEAN CONSERVATION

Fisheries are of great importance to secure many communities’ livelihood, primary source of income and cultural identity. But we know poor fishing management and the overall **lack of data availability is a threat to our Ocean**. This lack of information is one of the reasons for traceability to be such a concern (Gibbens, 2018). That is why our team looked into what potential sources could be used as databases for vessel location, in order to bridge the gap between sustainable fishing and seafood consumption.

Our solution allows for a more informed understanding of seafood origin. Besides this having implications for onboard safety, supply chain management and transparency, it allows for Ocean protection. If vessel location and precise fishing grounds are information that is crossed with environmental scientific data, the marine ecosystems can be better managed, for instances, in terms of:

- Protection of targeted species and surrounding ecosystems;
- Determine the need for marine protected areas;
- Water quality and harmful discharges.

This availability of information allows for quicker action to take place if any change in fishing management is necessary.


**The time to act is now.** Despite challenges and limitations, we must take immediate action to protect our oceans, leveraging technology wisely as a tool to track progress, achieve milestones, and manage conservation efforts.

# CONCLUSIONS

With this solution, we have explored how vessel identification and location in real-time can automatically provide information for the Sea2See blockchain traceability system. Given the importance of verifying seafood sources, **this solution allows the identification of precise fishing grounds, time and place of landings, vessel flag and characteristics**. However, we recognize our solution has different challenges/limitations, but also benefits/opportunities.

## LIMITATIONS

### 1 - High Dependence on Specific Web Data Sources

A significant portion of our data is sourced from VesselFinder and Marine Traffic, both of which appear to utilize the same database. While these platforms are reliable, this dependency introduces a risk of data centralization. Should these services cease operations, our solution may encounter significant challenges. Additionally, besides claiming not to be responsible for the accuracy and reliability of data, these platforms do not allow the use of data for commercial purposes. The web data sources also lacks information regarding targeted species and gear type, which means that additional work would have to be put into connecting the identification of a vessel with the landed catch on port sites. This would allow for better information flow for the start of the supply chain traceability.

### 2 - Geographical and Legal Constraints

Current information, along with various regulations and laws, limit our operational scope to Europe. This limitation is substantial, though it does mean that crucial data from other continents, such as North America and Asia, remains beyond our current reach. Besides, even though legitimate information from the EU's EMSA system exists regarding fishing vessels, it will remain private for data protection and monitoring purposes and future EU traceability mandatory systems will possibly use that information for internal purposes only.

# CONCLUSIONS

## LIMITATIONS

### 3 - Infrastructure Vulnerabilities

Our reliance on certain blockchain technologies, as discussed in our report (such as the InterPlanetary File System (IPFS), Arweave, and Aleo), poses potential risks. In the event of an attack or technical malfunction affecting these systems, our solution would be directly impacted. While such occurrences are unlikely, they represent a risk factor that necessitates the development of contingency plans.

### 4 - Regulatory Compliance

The management of sensitive data is a primary concern, particularly in light of clear legal requirements. However, our use of Zero-Knowledge (ZK) technology aims to mitigate this issue by ensuring that sensitive or private data remains secure and undisclosed.

### 5 - Adoption and Trust Issues

Our preference for using relatively new technology stacks may initially create trust challenges among our customers, especially during the early stages of implementation. We believe that these concerns can be addressed effectively through clear communication and thorough explanations to all stakeholders involved.

**Each of these limitations represents a challenge to be navigated as we advance our solution, underscoring the importance of ongoing assessment and adaptation to ensure successful implementation and operation.**

# CONCLUSIONS

## OPPORTUNITIES

**1 - Tool for environmental assessment**

Vessel location and identification data can be crossed with information on ecosystem status, targeted species stocks and potential tracking for endangered species. This can be used for ocean conservation and to potentially impose environment protected areas and no-take zones. Tool through which one could better assess and have a chance for further preservation and conservation of marine flora and fauna.

**2 - Improving fishing sustainability**

Location information can also be used to assess overfishing zones, combating IUU fishing and allowing for better vessel monitoring and onboard safety. Overall, this can bring environmental and social benefits by improving fisheries' management and guaranteeing seafood supply chains start from environmentally sustainable fishing grounds. While having better traceability, there is the potential to have a better assessment regarding sustainability.

**3 - Enhancement of transparency and data security**

The use of a tool that provides the preservation of data privacy, while, at the same time, collecting fishing information in a fair and transparent way, has the potential to enhance supply chain management and trust between stakeholders. Using seemingless data transferability paired with direct access and overview of data for the responsible entities, there is a chance in both facilitating and securing private and public data on the overall health of the oceans.

# CONCLUSIONS

## OPPORTUNITIES

**4 - Food safety**

Access to precise fishing grounds location and landing might help to identify seafood safety risks and ensure wild-caught fish is of best quality. This could be done through the possibility of water data collection, and species life cycle analysis, parameters crucial for life on the oceans.

**5 - Promotion of interoperability**

Key Data Elements (KDE) for wild caught seafood, according to the GDST Core Normative Standards, mentioned in this report's introduction, are provided through this solution. Much of the information regarding vessel, catch, landing data and other information (Table 1), is provided by an Automatic Information System (AIS) for fishing vessels, and the open data databases explored in this solution,VesselFinder and Marine (Table 2). Providing information required by the GDST Core Normative Standards, promotes interoperability in seafood traceability systems.

**6 - Future vessel location information**

With the EU incorporating mandatory tracking of all vessels (including those smaller than 12 meters), location information (that connects with supply chain traceability information) can be a feature available for small-scale fisheries too (if this data is not kept private for EU services).

**With all these highlighted opportunities, we have concluded that this solution opens new possibilities for tackling the lack of seafood traceability and fishing sustainability.**

# OUR TEAM

The Context Scholario team is a multidisciplinary group of people that all have one main common interest: our Ocean's sustainability.

## ALEX ARTEAGA

Alex is a 19 years old security researcher and full stack web3 developer with two years of uninterrupted experience. He is in his second year at university at Epitech Barcelona, doing a degree in Software Engineering. He has secured victories in multiple hackathons, including the largest entrepreneurship student competition in Spain, all DeFi awards at ETHBarcelona, and the Telefonica-sponsored blockchain hackathon. Notably, he has found and reported a wide range and number of vulnerabilities as a whitehat in cybersecurity marketplaces.

Alex has developed a caring nature for the marine life and ecosystem due to his hobbies regarding marine activity such as scuba diving, windsurfing, kayaking and fishing.

## DAVID SALVATELLA

David, a budding software engineering student at Epitech, has embarked on his professional journey in the Web3 domain, focusing on both security research and development. Eager to engage in compelling projects and competitions, he finds this particular journey especially intriguing. David has skillfully blended his expertise with the engaging subject matter chosen by Sea2See, making his experience both enriching and fulfilling.

# OUR TEAM

## GISELA COSTA

Gisela is a 26 years old marine biologist from Portugal. She's a PhD student in the Marine Science, Technology and Management Doctoral Programme at the University of Aveiro, and she is developing her thesis entitled "Traceability in small-scale fisheries food systems" in the scope of the Sea2See project. She started her career by studying small-scale fisheries through an internship with the University of Exeter, where she has worked to promote participatory marine resource management in São Tomé and Príncipe. She holds a Master's degree in Marine Science – Marine Resources and her thesis was developed to better understand the blue jack mackerel's small scale fisheries in Azores and its potential for co-management implementation. Gisela worked as an Oceans and Fisheries Junior Officer at ANP|WWF (Associação Natureza Portugal, in association with the World Wide Fund for Nature) on fisheries co-management projects and other marine conservation themes. Her main interests are related with the study of small-scale fisheries' socio ecological systems, participation processes and co-management, sustainable digital transition and ocean governance..

## VINCENT SIMONIN

Vincent is a 44 years old, full stack developer with three years of uninterrupted experience and Junior Web3 developper. He is in his third year at university at DIIAGE Dijon in France, doing a degree in Software Engineering. Author of a dissertation on optimizing software development costs, he is perfecting his mastery of software architecture and design patterns. Passionate about OpenSource solutions and Web3 development, he is currently working on his Web3 skills.

Societal development projects such as Sea2See directly concern us, as we work to preserve the space in which life is possible. So it was natural for him to take part in this hackathon as a student.

Vincent is passionate about music, as a percussionist, and as soon as he finishes his studies, he'll be taking up the piano.

# OUR TEAM

## OSCAR VIEIRA

Óscar is a 26 years old Interactive Media Design student from Madeira, Portugal. He previously studied Languages & Business for his Bachelor, however, he decided to go back to technology during his current Master's in IMD. Yet to make a decision on his Thesis, he is connected to the ocean in multiple ways, not just because he lives on an island, but also because he sees the importance of the sea for all lifeforms on earth and hence how crucial it is to many species survival. Originally he tried to get into Computer Programming to pursue a career in the technological industry, but life had other plans. He then attempted once again to chase another opportunity to study the field, but eventually had to let those studies go. Ending up back in Madeira, where it all started, and enrolling at UMa for his Bachelor's Degree, and currently Master's. A big driver for the participation in this project for him has been the conversation on the matter, potential course of action, broad conservation, preservation, and overall care about and for the health of the ocean and its species. Also worth mentioning, one of Óscar's favorite activities & exercises is to swim and dive underwater, allowing himself to be absorbed by the immense vastness of space in the sea. In hopes & attempts to accelerate (even if by minimal fractions & fragments) actions towards a healthier ocean, and hence a healthier planet, he has accepted the challenge in question.

# OUR TEAM

## Team work feedback

Our journey began amidst a sea of challenges, with limitations emerging along the way. Our team, partly rooted in web3 and blockchain technologies, faced an intriguing dilemma: in our domain, we are accustomed to an abundance of data, predominantly public. Yet, surprisingly, when venturing into the realm of marine biology, we encountered a stark contrast - a significant lack of data. Determined to bridge this gap, we leveraged our collective strengths, each member contributing expertise from their respective fields. This collaborative approach enabled us to gather a substantial dataset essential for advancing our project.

Initially, our team's efficiency in balancing time spent versus work accomplished was challenging. Recognizing this, we adopted a strategy of dividing the overall task into smaller, manageable units. These could be assigned to individual team members, ensuring focused and efficient completion while remaining cognizant of the project's overarching goals and the foundational work laid by colleagues. This restructured approach markedly enhanced our productivity, ultimately allowing us to complete the report on schedule.

Throughout this process, we learned the importance of adaptability and the strength of a united team. By combining diverse skills and embracing innovative problem-solving techniques, we turned our challenges into stepping stones for potential success. We also had the opportunity of exploring topics beyond our field of expertise, either from blockchain technology or marine biology topics. This experience enriched our professional skills and enabled us to design a Sea2See complementary tool, for improving traceability and our Ocean's sustainability.

# RESOURCES

In addition to our references, we have collected different resources that can be consulted for further information.

Leo | Zero-Knowledge Programming Language (leo-lang.org) | Programming Language
https://leo-lang.org/

Aleo | Fully Private Applications | Blockchain
https://aleo.org/

Excalidraw | Diagrams & Visualization of our solution
https://excalidraw.com/#room=b65771bd9d850e51df0f,trw89dUuDDyw1UFtkQZ1_g

Demo: Aleo 🛠️ Powering Private Applications with Zero-Knowledge Cryptography - YouTube
https://www.youtube.com/watch?v=TA6Vm7jMUZg

The value of seafood traceability
https://www.worldwildlife.org/stories/why-tracing-seafood-from-sea-to-plate-is-the-next-frontier-in-sustainability

# RESOURCES

IBM and Amazon | What is an API?
https://www.ibm.com/topics/api
https://aws.amazon.com/what-is/api

What is blockchain?
Di Pierro. 2017. What Is the Blockchain? Computing in Science & Engineering, 19 (5), pp. 92-95. https://doi.org/10.1109/MCSE.2017.3421554.

Ocean challenges
https://www.nationalgeographic.com/environment/article/critical-issues-overfishing
https://education.nationalgeographic.org/resource/marine-pollution/
https://www.oecd.org/ocean/topics/ocean-pollution/

Why water is important for life (reasons to protect the Ocean)
https://sitn.hms.harvard.edu/uncategorized/2019/biological-roles-of-water-why-is-water-necessary-for-life/
https://www.britannica.com/science/life/Life-on-Earth
https://www.khanacademy.org/science/ap-biology/chemistry-of-life/structure-of-water-and-hydrogen-bonding/a/hs-water-and-life-review
https://sitn.hms.harvard.edu/uncategorized/2019/biological-roles-of-water-why-is-water-necessary-for-life/
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# TECHNOLOGY USE TOWARDS OCEAN SUSTAINABILITY.

*We thank the tutorial team for the availability and guidance.*

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