
ARCTIC WHALE
Design: bionstev@gmail.com
LOW RES SAMPLE
ARCTIC
WHALE
An expedition to highlight the threat
of ocean plastic on marine life

ARCTIC WHALE

A PROJECT BY

TURNSS

Barba

CHRISANIC

"Through our sponsorship programme, we have worked with the outstanding team at Arctic Whale and are proud supporters of this project," says Silje Hauland, CEO Chrisanic. "We strongly believe in supporting initiatives that help reduce plastic consumption and discover ways of cleaning and aiding the health of our oceans."

Chrisanic is a privately-owned investment company focusing on long-term partnerships within the financial sector, real estate and business development. A key objective for Chrisanic is to hand over business and investments to the next generation in an improved state – financially, operationally and reputationally. Chrisanic therefore strives to operate in line with the UN Sustainable Development Goals and maintain a value-oriented, global and long-term investment strategy.

OFFICIAL PARTNERS

SUMMAEQUITY

SELVAAG

BONUM

INTRODUCTION

Arctic Whale was a project launched in 2019 by Norwegians Andreas B. Heide & Sandra C. Ness. Together with a team of passionate conservationists, scientists and storytellers, the mission of the two-month expedition from Norway to Iceland was to document and highlight the threat of plastic pollution on our oceans and marine life. With an emphasis on microplastic data collection, whales found in the waters of the Arctic would form the main focus of study, alongside acting as the messengers for change too. In doing so, they aimed to inspire action to reduce plastic consumption and show that we can make a difference when fighting this issue, especially when we work collectively.

This coffee table book not only provides a visual showcase of the expedition itself, including encounters with the gentle giants of the North Atlantic, but also gives insight into the science conducted during the journey and its subsequent communication.

LONG-FINNED PILOT WHALE

Globicephala melas

Pilot whales are one of the largest members of the dolphin family, reaching up to 6.5 m in length and weighing as much as 2300 kg. Sadly, research indicates that some have been contaminated with alarming levels of pollutants such as DDT and PCB; a result of human overconsumption. Fortunately, the species is still thriving, and the population is estimated to be around 1 million individuals.

During our crossing from the Faroe Islands to Iceland, we were followed by a pod in excess of 200 individuals for over 30 minutes. The clicks and whistles from the whales could be heard through the hull of the boat; both crew and whales appeared equally excited about the encounter.


LOW RES SAMPLE

THE MISSION

Today, it is estimated that 8 million tons of plastic accumulate in our oceans each year, of which almost 240,000 tons are microplastics. On a macro-level, which includes plastic bags, disused fishing nets and single-use bottles, approximately 100,000 marine mammals and turtles, alongside 1-million seabirds, die each year as a direct result of ocean plastic consumption.

When larger plastic objects (macroplastic) make their way into the ocean, they are broken down by solar UV radiation and oxidation. With further deterioration caused by wind and wave power, the plastic objects break into increasingly smaller pieces. When they are <5 mm, they are classified as microplastics.

It is the microplastic epidemic that we focused on. By using ground-breaking techniques, we aimed to document microplastic levels in the waters and whales of the North Atlantic. As such, the goal of the project was not only to collect data, but also to highlight the harmful impact of microplastic pollution on our oceans. With the whales as the messengers and visually spectacular storytelling as the tool, we set out on a mission to help protect the oceans from this invisible threat.

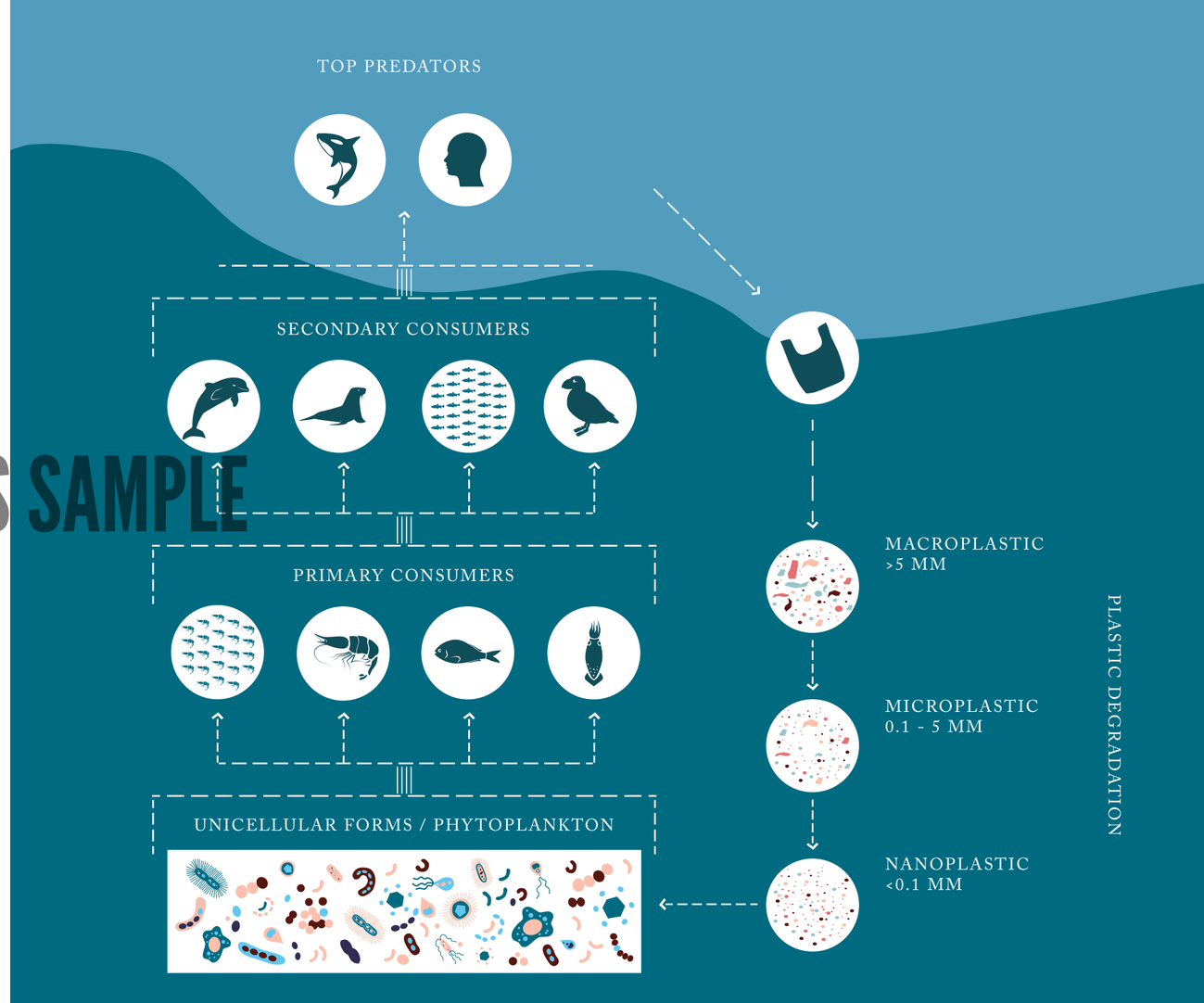
NANOPLASTIC - THE BIG UNKNOWN

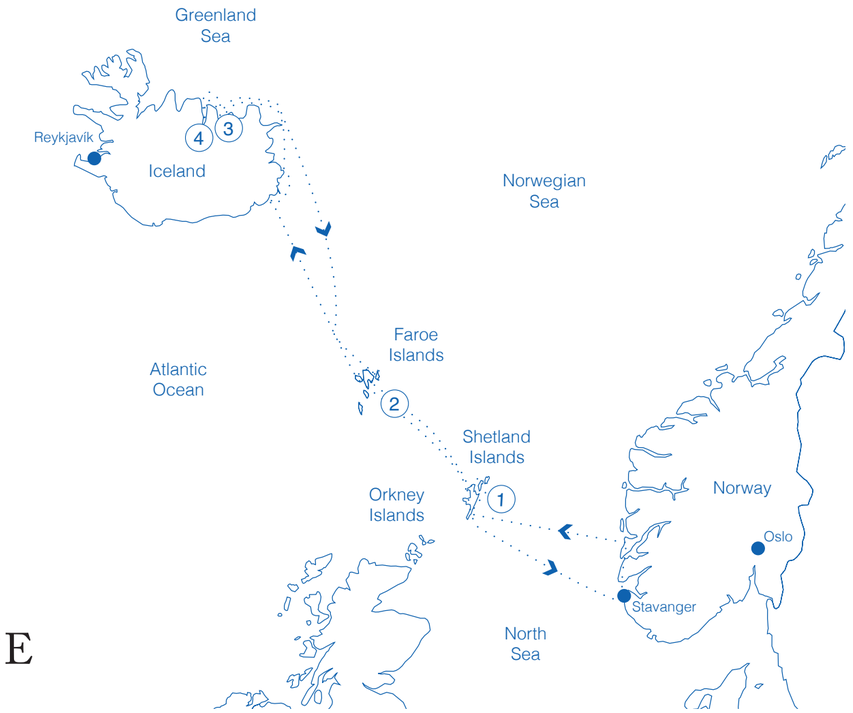
Nanoplastics are pieces of plastic smaller than 100 nm and come from various sources, such as clothing, furniture and fishing nets, which shed fibres with each use. For example, every time an item of synthetic clothing is washed, thousands of individual fibres break off and make their way into the environment. Nanoplastics may also come from the degradation of larger plastic particles that have already entered the environment.

At present, it is difficult to determine the exact amount of nanoplastic humans and other species are exposed to because of its small size, alongside the lack of detection and characterisation methods. However, it is known that particles of this size may pass through cell membranes, enter the circulatory system and accumulate in different tissues. As a result, nanoplastics can cause damage on a cellular level, which can lead to adverse effects in marine organisms (i.e. cytotoxicity, inflammation and immunological effects).

Plastics also contain certain endocrine (hormone) disrupting chemicals such as Bisphenol A (BPA), phthalates and brominated flame retardants, which are added when plastic is produced. These chemicals are of particular concern as they can affect foetuses, infants and adolescents by interfering with their development and fertility. Contaminants such as DDT, PCB and heavy metals may also attach to the plastic particles from its surroundings. When these plastic particles are ingested, the contaminants can be released and accumulate in the body.

This can cause great harm, especially in top predators such as orcas and pilot whales. The next page shows a simplified illustration of how plastic accumulates in the food chain.





THE ROUTE

1 Lerwick 2 Thórshavn 3 Húsavík 4 Akureyri

The 2200 nautical mile (4000 km) journey would take us from southern Norway into the North Sea and subsequent deep-water trenches between the Shetland Islands, the Faroe Islands and Iceland. Unknown to most, these waters are home to numerous whale species. The ultimate destination of the journey was Húsavík in North Iceland. Known as the whale capital of Europe, it is home to The University of Iceland's Research Centre, which we proudly partnered with for the project.

FOUNDING PARTNERS

Andreas B. Heide
From Stavanger, Andreas holds an MSc in Marine Biology and has a diverse background working with and for the ocean. He is a former Navy diver and parachutist with experience in fisheries export, scientific work at the Institute of Marine Research and business development in the oil and gas industry.

Andreas currently works as an expedition sailor using his boat Barba as a platform and tool for ocean conservation. He has received global attention for his work using whales as ocean ambassadors, with a live interview for BBC World News and a feature in a Sir David Attenborough narrated documentary as preliminary highlights. He has led sailing expeditions to Greenland, Jan Mayen and Svalbard.

Sandra C. Ness
From Oslo, Sandra has an MA in Digital Media Management from Hyper Island and is the Founder of Turnss.no, which has a mission to deliver the necessary tools for companies to build sustainable value creation. Recognised as a “Woman to watch in shipping” 2019 by Youngship International, Sandra has been working as a spokeswoman for sustainable impact within different ocean industry organisations.

Through a purpose-based work style, she not only believes that sustainability is good for future industry value creation, but that it is possible to align the economical and the ecological to navigate towards a healthy future for both us and the planet.

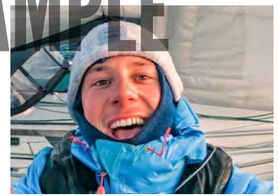
THE CREW

DIANE SEDA
Biotechnologist and sailor.
Chief onboard scientist.

Onboard: Norway-Iceland-Norway

PETER SVANBERG
Sailor and adventurer.

Onboard: Iceland-Norway



TORD KARLSEN
Sailor and photographer.
tordkarlsen.com

Onboard: Norway-Iceland

HUGH FRANCIS ANDERSON
Journalist and press
liaison Arctic Whale.
hughfrancisanderson.com

Onboard: Faroe Islands - Iceland

CONOR MCDONNELL
Photographer and
WWF ambassador.
conormcdonnell.co.uk

Onboard: Iceland

FABRICE SCHNOLLER
Whale conservationist
and founder of DAREWIN.
clickresearchs.com

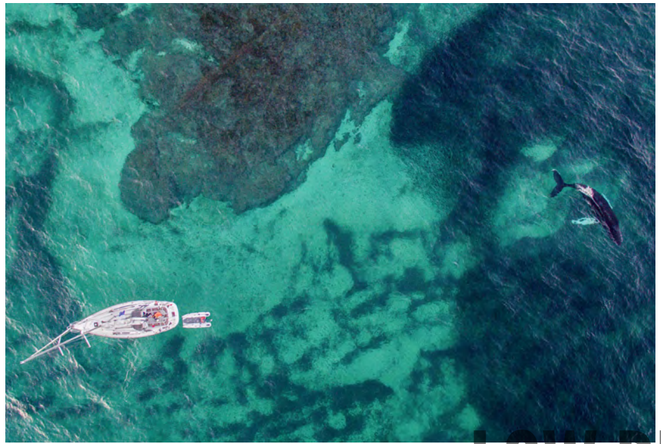
Onboard: Faroe Islands-Iceland

THE PLATFORM

Sy Barba is owned and skippered by Andreas. With the help of a devoted team of sailors and scientists, the yacht has sailed to Jan Mayen and as far north as the pack ice surrounding the North Pole. It has spent four winters in Arctic Norway documenting orcas and humpback whales and serves as a platform for scientists and storytellers in the greater context of ocean conservation. The boat has received global recognition for its work, including features in USA Today, BBC World News, ABC news, international sail press and work with scientific institutions such as Yale University.

It has additionally supported numerous international film crews and has been featured in a documentary narrated by Sir David Attenborough. Its latest assignment was for a French-German production in collaboration with the Smithsonian Channel, which will feature globally in Autumn 2020. The vessel is run and operated under the inspiration of Andreas' ocean hero, Jacques Cousteau. It is named after Andreas' faithful childhood dog, *Barba*, and will embark on new expeditions in the Arctic in 2021.

For additional information, visit www.barba.no



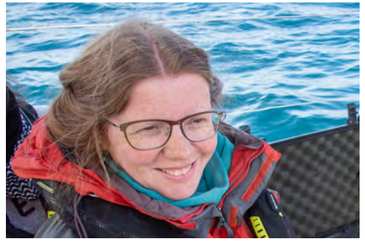
BLUE WHALE

Balaenoptera musculus

The blue whale is the largest animal known to have ever existed, reaching a maximum length of 30 m and a weight of 170 tons. They were nearly hunted to extinction in the 19th and 20th centuries by commercial whalers but following the ban of hunting blue whales in 1966, the population has shown signs of recovery and has since returned to the waters around Iceland and Svalbard.

It was a dream come true for us as we made our first of many sightings in Skjálfandi Bay near Húsavík, Iceland. The whales have an extraordinary capacity for evoking emotions in humans and represent an important symbol of why we need to care for our oceans.

SCIENTIFIC CREW



DR. MARIANNE RASMUSSEN
Research Professor & Director of The University of Iceland's Research Centre in Húsavík. Marianne provided vital support for the project as an advisor, onboard scientist and through facitilating the whale biopsy samples conducted during the expedition.

JESSICA EMILY ROOS
Master of Science, University of Oslo. Jessica coordinated the handling of manta-trawl samples and the processing of whale biopsies through the use of scanning and transmission electron microscopy.

TOM GROVE
PhD student, University of Edinburgh. As an onboard scientist, Tom coordinated the collection of blow samples in order to measure the cortisol (stress) and nanoplastic pollution levels of humpback whales.

The Whale Wise team. From the left: Abigail Robinson, Flordespina Dodds, Alyssa Stoller and Tom Grove.

Andreas with a successful shot at a humpback whale for blubber sampling. The fluorescent dart can be seen bouncing off the whale.

BIOPSY SAMPLES

One of the big unknowns is to what extent microplastic absorbs and accumulates in the food chain. In collaboration with the University of Iceland, we collected blubber samples from humpback whales using a biopsy gun; a modified rifle that shoots out a dart. Upon impact, it bounces off the whale, bringing with it a small blubber sample. It causes minimal discomfort to the whale and is similar to a human having their skin pricked by a needle. The dart is subsequently collected from the water and the sample is preserved in an alcoholic solution. The sample provided material both for genetic studies conducted by the University of Iceland and for analysis using an electron microscope at the University of Oslo. To our knowledge, we are the first to use an electron microscope to look for nanoplastic at a cellular level in whale blubber samples.

PUFFIN

Fratercula arctica

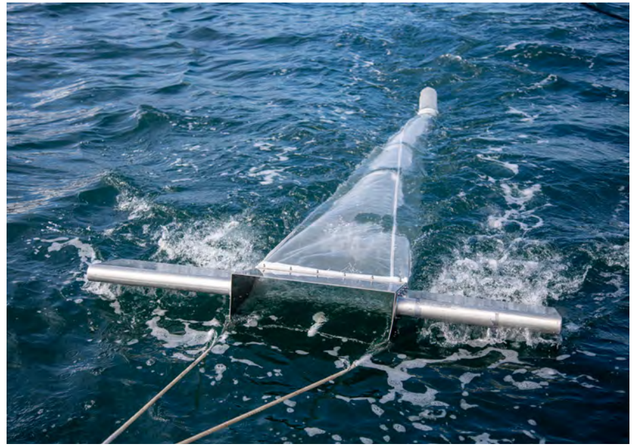
A joyous sight in both the Faroe Islands and Iceland was the charming and colourful puffin. It's an ocean dwelling bird that primarily feeds by diving for fish. For centuries, it has been an important food resource for the coastal population in selected regions of the North Atlantic. Since 2000, a sharp population decline has been seen in Iceland, Norway, the Faroe Islands and Greenland. A decrease in available prey is one of the hypotheses behind its decline. However, the puffin still exists in large numbers.

An estimated 200,000 puffins nest on the small island of Lundey in Skjálfandi Bay near Húsavík, where these photos were taken.


LOW RES SAMPLE

MANTA TRAWLING

At selected locations in Norway, the Shetland Islands, the Faroe Islands and Iceland, we used a manta trawl to sample for microplastic. The manta trawl is a device that filters out microparticles when towed alongside a vessel. As shown in the microscopy imagery below, it collects a large amount of organic material in the form of plankton, fish eggs and other organisms barely visible to the human eye. In the samples, we predominantly found microplastic in the form of fibres. Over time, these fibres will break down into nanoplastic which can be ingested by microorganisms that mistake them for food. The samples were preserved in alcohol for later analysis at the University of Oslo. Sadly, microplastic has been found in every ocean, including the seemingly pristine waters of the Arctic.

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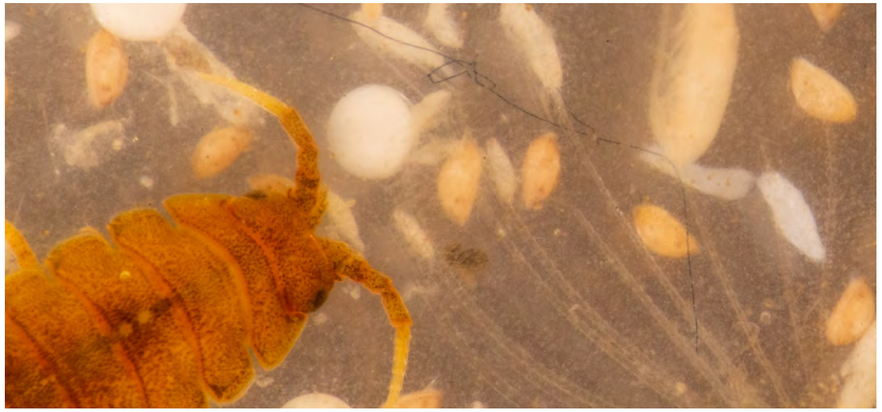
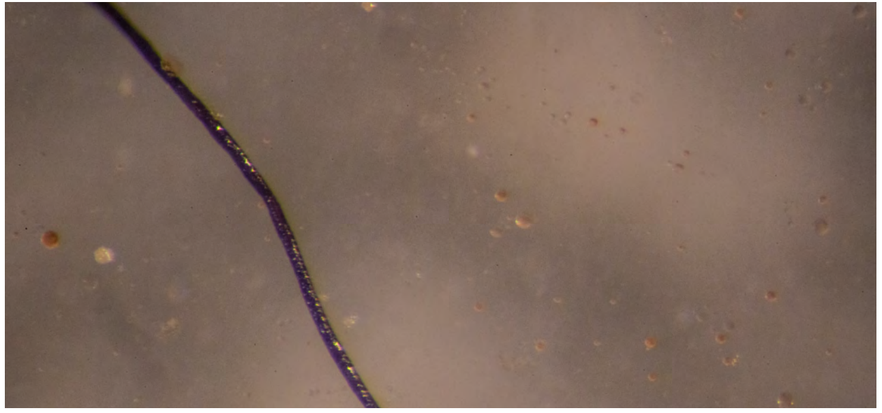
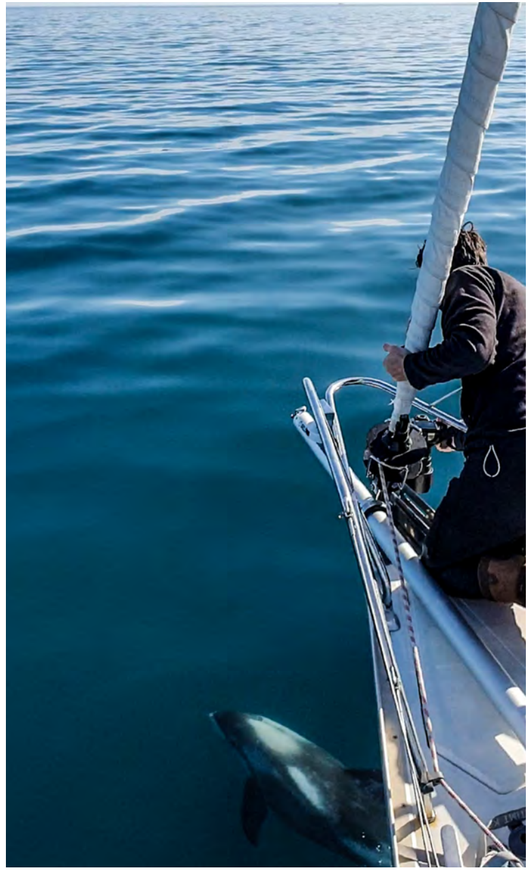
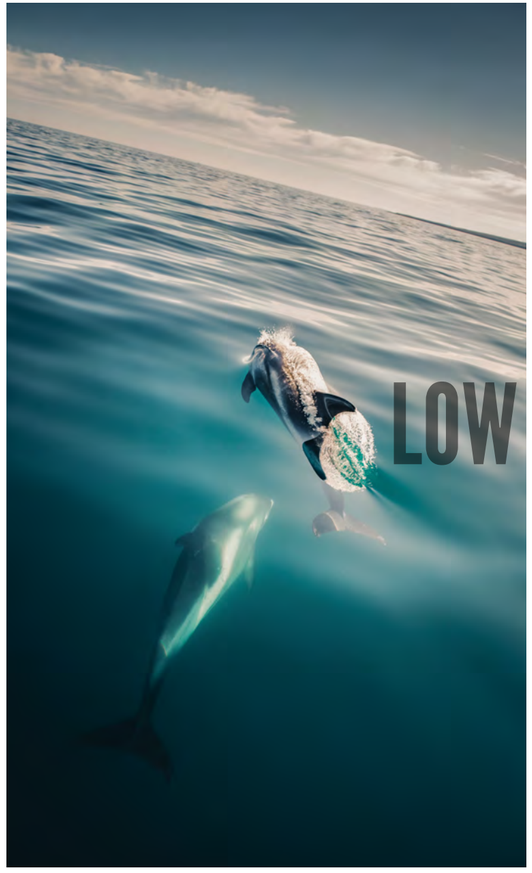




A fibre strand observed in one of the trawling samples. In order to determine if it was a plastic strand, we needed the sample to be further processed in a laboratory through our scientific partners.



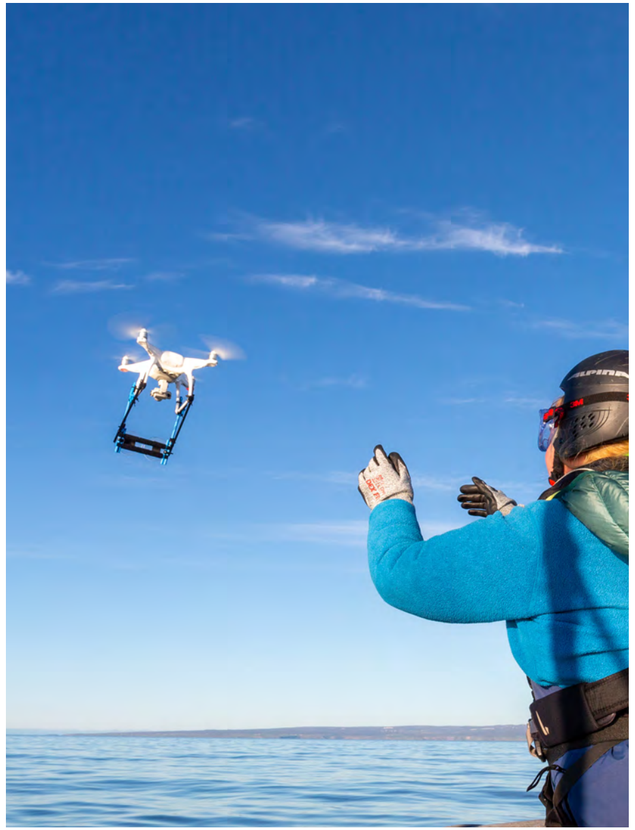


WHITE-BEAKED DOLPHIN

Lagenorhynchus albirostris

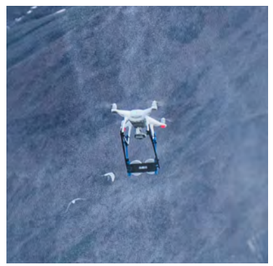
Adults can reach up to 3.1 m, weigh up to 350 kg and roam in the cold temperate and subarctic waters of the North Atlantic Ocean. Most sources estimate that there are several hundred thousand individuals. We made numerous sightings during our time in Húsavík.


LOW RES SAMPLE



BLOW SAMPLES

As human activity in the oceans grows worldwide, it is crucial to measure the response of marine life to this disturbance. The challenge is how to study these animals without disturbing them. Working with the Universities of Iceland and Edinburgh, we collected samples of humpback whale breath (known as 'blow') with a drone: a non-invasive sampling device whereby Petri dishes are attached to the drone and flown through whale breath as the animal surfaces. Each sample is measured for the concentration of cortisol, a stress-related hormone. These samples will provide the first baseline in Iceland for cortisol in wild humpback whales and allow us to monitor changes in stress as human activity grows. Samples will also be analysed for nanoplastic particles in whale cells, which will represent a cutting-edge approach to monitoring plastic accumulation in marine life.



HUMPBACK WHALE

Megaptera novaeangliae

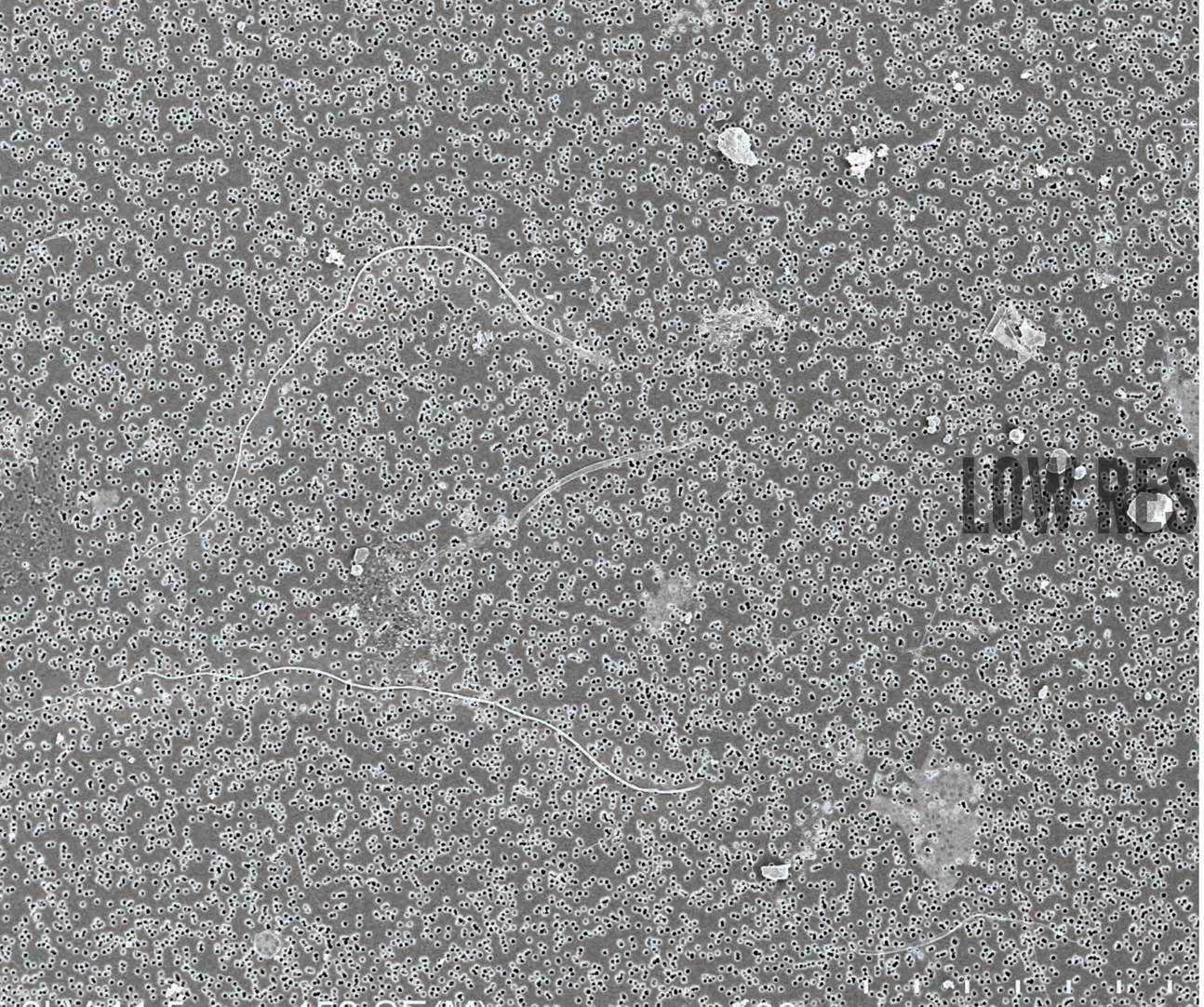
Although substantially smaller than the blue whale, adult humpback whales can reach up to 16 m in length and weigh up to 30 tons. The species was once hunted to the brink of extinction but has since made a partial recovery. In some regions it is believed to have recovered to pre-whaling population size. Found in oceans and seas around the world, they feed in polar waters and migrate to tropical or subtropical waters to breed and give birth, fasting and living off their fat reserves. They predominantly live off fish and krill. As with many whales, they are prone to entanglement in fishing equipment, which can lead to death. We encountered numerous healthy and thriving individuals in Skjálfandi Bay near Húsavík, Iceland and it was the chosen species for both breath and blubber samples.


LOW RES SAMPLE

ARCTIC CLEANUP

In collaboration with our partner Empower.eco, we gathered a group of amazing helpers from Húsavík Whale Museum, Whale Wise, University of Iceland Research Centre, Gentle Giants Whale Watching, North Sailing Whale Watching and the local community to help both plan and execute the world's first blockchain driven Arctic beach clean-up.

Joining forces to work as one goes a long way in making a difference. It is therefore important to remember that your actions matter, no matter how big or small. With this mindset, we hope to inspire many more beach clean-ups across the world. The collected plastic was registered with Empower. By using Blockchain technology to ensure both transparency and traceability throughout the value chain, Empower is creating a solution to the plastic waste problem by giving plastic a value.

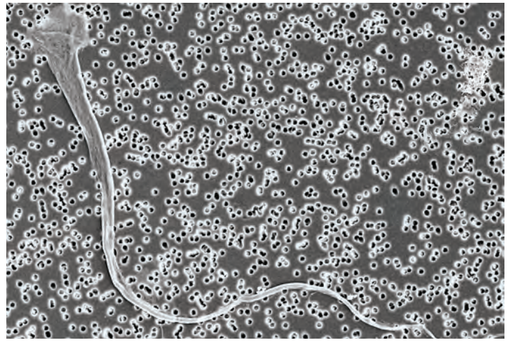


RESULTS

The samples from the manta trawling (page 36-39) were processed at the University of Oslo. All organic matter was dissolved using hydrogen peroxide, which left only non-organic matter, predominantly plastic on filters.

These same filters were prepared and studied in a scanning electron microscope, which can detect particles as small as 3 nm (a nanometer (nm) is one billionth of a meter, 0.000000001 or 10^{-9} meters). This is due to the extremely short wavelengths of electrons compared to visible light. Where standard light microscopes have a resolution of 200 nm, a typical electron microscope has a resolution of 0.2 nm.

In the picture on the left, there are putative microplastic fibres (threads) and round micro-particles (both > 0.001 mm in width), as all organic material is washed away. The holes in the background are the pores on the filters, so everything smaller than these holes is filtered out together with the organic material. Some of the plastic particles also seem to melt during preparation, such as the plastic fibre in the picture on the right side.



Previous page: an electron microscope photo of plastic strands. Picture top right: Jessica Emily Roos using an electron microscope to analyse the samples. Picture lower right: a plastic strand up close.

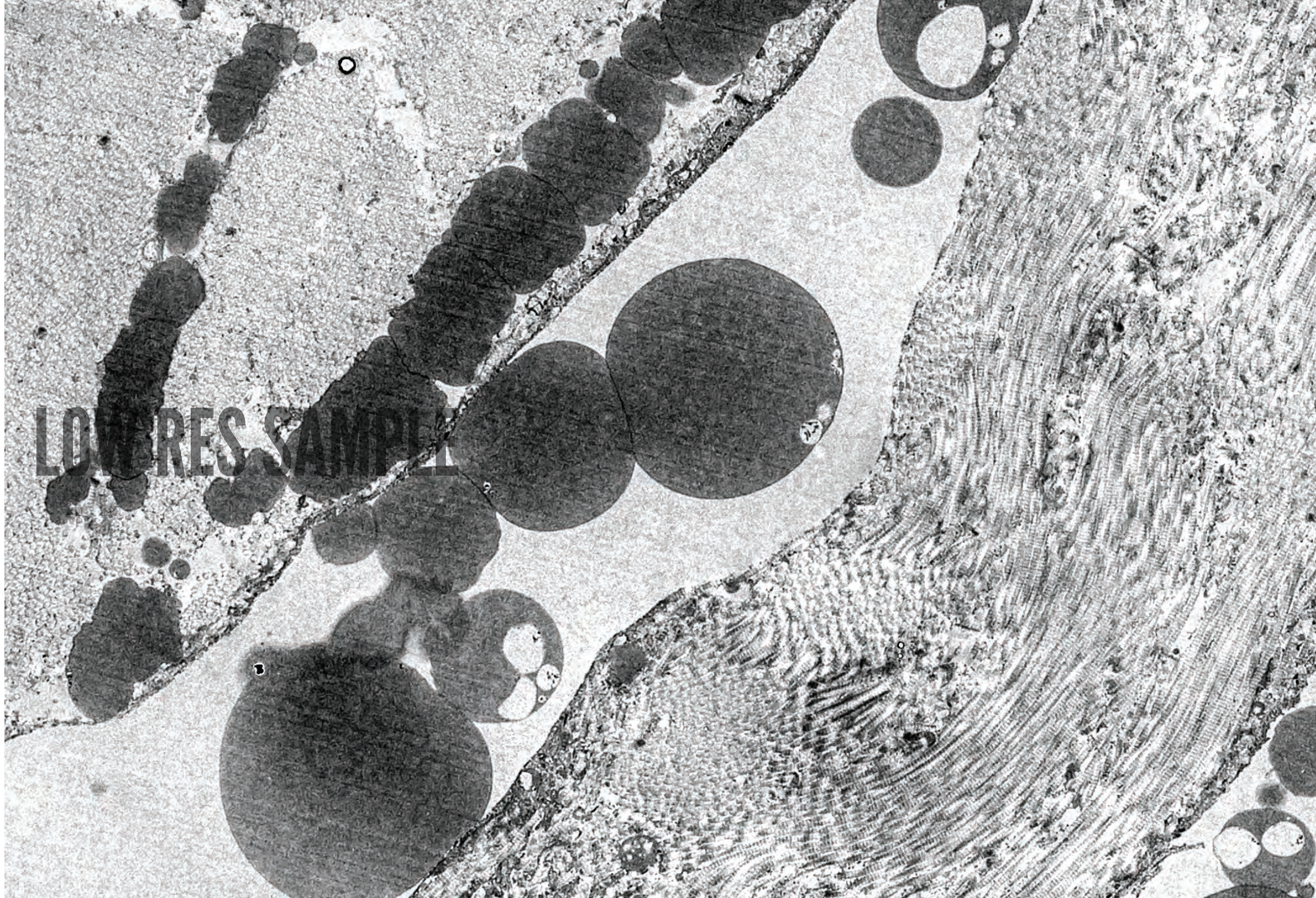
RESULTS

The biopsy samples that were collected from humpback whales in Iceland (page 30-31) were analysed at the University of Oslo to look for indications of plastic contamination in the blubber itself. In other words, would the microplastic found in the manta trawl samples end up in the humpback tissue as nanoplastic?

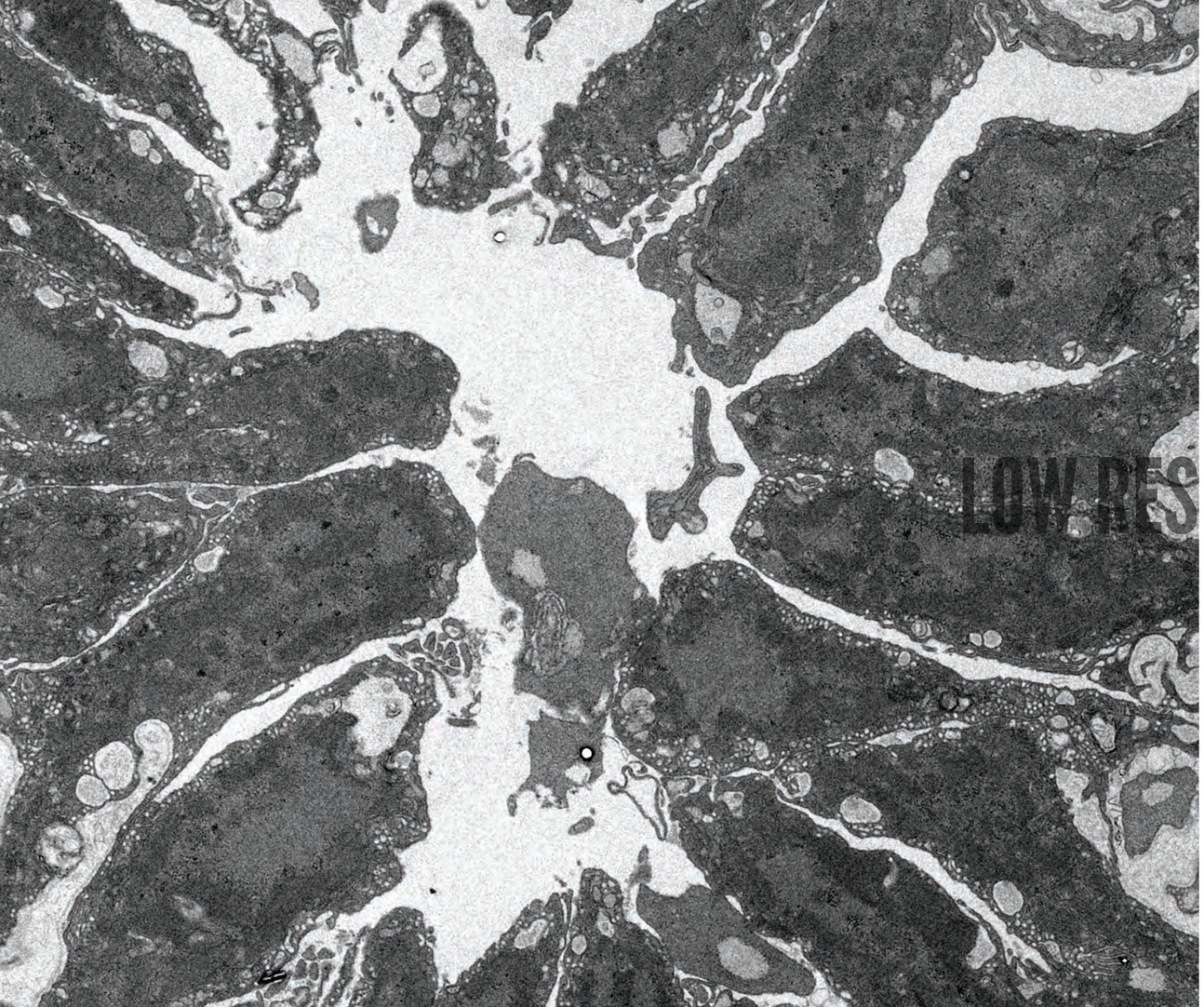
The whale biopsies were prepared in a way that preserved the cell structures in the samples. The preservation and dehydration method gave us a unique opportunity to observe cellular structures in humpback skin tissue.

In the picture of the whale cells to the left, there are some black drops inside the cells, which are likely lipids (fat). These usually disappear during the fixation and dehydration of samples but are very clear using this method. On the right side of the picture there are rows of collagen, which are prevalent in all samples. There were also some very unusual cellular structures (page 60), which we have not been able to identify or find in current literature. These unusual cellular structures will be further researched at the electron microscopy laboratory at the University of Oslo. Despite analysing numerous samples, we were not able to find indications of plastic contamination in the tissue.

Next page: Electron microscope photo of a humpback whale from Iceland sampled in Skjálfandi Bay. The largest circular object is approximately 0.005 millimeters wide, and likely contains lipids (fat).




LOW RES SAMPLE



DISCUSSION

Although it was not possible to detect the presence of plastic contamination in the biopsy samples, it does not exclude the presence of nanoplastic at a cellular level.

One problem with micro and nanoplastic fibres is that they can be small in one dimension and long in the other, which means that they may be able to pass the cell membrane in one direction and cause a lot of damage once it enters the cell due to its large volume. In addition, the plastic itself has contaminants both as additives and attached to the surface as described on page 16.

As both micro and nanoplastics are emerging pollutants with harmful effects on marine organisms and a risk for human health, there should be a focus on developing effective methods to detect, characterise and quantify small plastic particles in various samples, such as water, sediment, soil, air and food. To date, there is also a lack of knowledge concerning the exposure, quantity and effects of micro and nanoplastic on the environment and organisms, and as the production of plastic continues, the amount of micro and nanoplastic available for exposure increases.

There also needs to be a focus on conveying these findings to the general public in order for people to understand the threat plastic has not only in nature, but also on humans. Using the electron microscope, we can observe extremely small plastic particles yet can only characterise by assumptions based on knowledge and current literature. However, there is something special about actually seeing plastic particles in such a small size range, as they are invisible to the naked eye and their existence is easily overlooked.

The plastic particles above are so incredibly small and surround us daily in our air, food and water. Had the particles been visible to the naked eye, it would most likely have created public outcry for reducing the intake of these presumed harmful particles. Although the Arctic Whale project did not produce any major scientific discoveries, we feel that we have been able to help highlight the problem in question. Hopefully our work, combined with a massive global effort, will help turn the tide on marine plastic pollution.

Previous page: There were also some very unusual cellular structures in the humpback whale samples, which could not be identified or found in current literature. The width of the photo represents a length of approximately 0.024 millimetres.

IMPACT

The impact of plastic pollution: What does it mean for us and the planet? There are around 90 species of whale, dolphin and porpoise. Some species filter the water for food (e.g. plankton) and others hunt larger animals. Either way, ingestion of both small and large plastic particles is a daily threat. When ingesting large particles, it often punctures and tears the stomach lining, leading to starvation and even death. Smaller particles (such as microplastic) may accumulate in the tissue and cause inflammation, oxidative stress or other internal damage. Individuals, businesses and governments are all part of the problem, and we all have a role to play in fighting back.

The impact of our work: We used a mix of digital and physical presence both onshore and offshore to amplify the impact of our message. The impact of data collected and shared: data acquisition and sharing are not happening fast enough to understand if policies and regulations are having an impact on the ocean environment. The aim with sharing our data in collaboration with our partners was, and still is, to provide new possibilities for innovation, technical advancements and large-scale impact.

At Nor-Shipping 2019 we had several events underlining the importance of data sharing and cleaning our oceans.

MEDIA COVERAGE

With a goal of inspiring hope for the future of our oceans, one of the main tools for raising awareness was the work to achieve global media coverage. In this way, we aimed to increase the understanding of the Arctic eco-system using science, modern technology and education.

ADVISORY BOARD

MARI S. ESPEDAL
Founder of Puriosity
Strategic business
& leadership advisor

Mari combines 25 years of international leadership experience with hands-on cross-cultural insight. She challenges leaders and companies on how to deliver valuable impact and meaningfulness in wise ways for the future.

ENDRE AABERG JOHANSEN
Partner Corporate
Communications

Endre is an advisor within strategic and operational corporate communications, PR, financial communication/ investor relations, issue and crisis management.

KARINA NILSEN
Senior advisor Corporate
Communications

Passionate about people and our planet, Karina helps leaders and companies drive meaningful conversations with key stakeholders and is a firm believer in the precautionary principle.

turnss.no

TURNSS

Turnss is a communication agency with the purpose of aligning ocean economies with ecology, alongside working with companies in the ocean industry that want to lead the path toward a more sustainable alignment between people and the planet. Turnss was founded to inspire the ocean industry to identify, understand and implement sustainable value creation and help companies demonstrate their positive impact to the market, proving that sustainability is good for business. Turnss is very proud to be a co-founding partner of Arctic Whale's important mission. Turnss mission: deliver the necessary tools for companies to build sustainable value creation. Through global collaborations, Turnss vision is to empower companies to take on an ocean ambassador role with substance and pride and restore the oceans by aligning the two eco's (economic and ecological).

SCIENTIFIC PARTNERS

Whale Wise

UNIVERSITY OF ICELAND

UiO : Department of Biosciences
University of Oslo

PARTNERS

Nor-Shipping 2021 Oslo 01-04 June

Empower.eco

CLICK'R from ocean to virtual reality

WWF

RS(+)

Ocean Missions

Katapult Ocean

DEN NORSKE KRIGSFORSIKRING FOR SKIB GJENSIDIG FORENING
The Norwegian Shipowners' Mutual War Risks Insurance Association

Corporate Communications

VERACITY by DNV GL

Stargate Media

KSAT KONGSBERG SATELLITE SERVICES

SUPPLIERS

SEIL MAKER PETER HOEG

Southern Cross Spars

Clearwater DYNAMICS

MARITIMT KOMPANI

SHIP-SHAPE

TECHNICAL PARTNERS

MUSTO

dubarry of Ireland

spinlock

B&G

YANMAR

PHOTO CREDITS:

Conor McDonnell: cover, 4, 6, 14, 18, 20, 21, 27 (bottom photo), 31 (top left photo), 32, 33, 34/35, 40, 42, 43, 44/45, 48, 49, 50, 51, 53, 58/59, 73.

Tord Karlsen: 2, 9, 10, 11, 12/13, 36, 37 (top photo), 38 (bottom right photo), 66, 70, 74/75.

Andreas B. Heide: 29, 31 (bottom left + right photo), 37 (bottom photo), 38 (top + bottom left photo), 39, 41, 46, 47 (left and middle photo), 63.

Peter Svanberg: 30, 47 (top + bottom right photo) **Daniel Hug**: 24 (bottom photo), 25. **Jason Cartwright**: 52, 64, 69. **Tom Grove**: 26, 27 **David Gonzáles**: 24 (top photo), **Manon Verijdt**: 28 (bottom photo) **Sandra C. Ness**: 62.

SPECIAL THANKS TO:

(in alphabetical order)

Adam Smith, Alex Bocage, Alexander Thorsen, Anders Hovelsrud, Anne M. Havn, Betsy and Ulf Heide, Bjørn Einar Grøsvik, Carsten Karlsrud, Christian Ness, Christina Egeland, Christoffer Mollestad, Darren Harcus / RNLI Shetland, Emilie Christiansen, Fredrik Jensen, Fredrik Myhre, Hillswick Wildlife Sanctuary, Iselin Ness, Jason Cartwright, Jo Øvstaas, Kari Tybring-Petersen, Kári Mikkelsen, Karin Bøhmer, Kjartan Sverdrup, Knut Frostad, Kristian Olsen, Krister Nyløkken, Kristian Nygård, Liv Toril Sandal, Maren Hjorth Bauer, Mark Romanov, Martin Svangtun, Megan Brunswig, Mike Grundon / BBC Shetland, Odd Ståle Ness, Per Kjellin, Pia Meling, Randi Aardal Wetteland / Bloom, Reynir Indahl, Rikke Eckhoff Høvding, Rikke Hegge Jørgensen, Ruben Wilhelmsen, Saško Despotovski, Silje Bareksten, Silje Hauland, Sissel Vatnehol, Stefan Yan, Thomas Låver, Wista Norway.

AFTERWORD

We believe that the key for inspiring action is both raising awareness and evoking emotions for the environment by bringing people closer to it and creating a lasting connection. We all have an obligation to protect it not only for ourselves, but for future generations too. The task at hand can seem overwhelming at times, yet it is important that we all do our part. If we care as consumers, when we cast our vote, when we teach our children and make our choices as investors and decision makers, the sum of many small steps can and will translate into big change. Although the two-month, 4000 km Arctic Whale expedition concluded in 2019, the result of our findings and our subsequent storytelling will continue to have an impact for many years to come. With this project, we hope to have inspired change for the better in terms of protecting our oceans. We extend a big thanks to all those who made this project come to life.

Sandra and Andreas