2019

Technical report

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Ocean Missions

EXPEDITION 2019

Ocean Missions is an inspiring project to take direct action towards ocean conservation by an excellent combination of science, education and sailing adventures during seasonal expeditions in Sub-Arctic and Arctic regions onboard the magnificent electric Schooner Opal.

Introduction

1) WHALE SIGHTINGS AND SOUND RECORDINGS
2) WHALE SKIN BIOPSIES
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Introduction

For the first expedition Ocean Missions invited experts from different fields: plastic researchers, whale scientists and bird researchers, to collect data on Icelandic ocean health and develop a citizen science field course for young people next year 2020. As Ocean Missions have INSPIRATION as a main goal we wanted to emphasize values to encourage people to protect and stand for what they admire. For this reason, nature photographers, journalists and artists also played a big role of the crew on board Schooner Opal.

Although we had to face technical problems, weather limitations and time constrictions, we consider that the project has been successful, and the enthusiasm and hard-working mood of the people on board was the best example of representing the philosophy of the project, bringing solutions and working together for the expedition to happen.

We set sail for 7 days of navigation from Reykjavík to Húsavík, covering a total of 396 nautical miles. We gathered new and relevant information about ocean health, collected trash, listened to the nature and lived together surrounded by amazing nature and wild oceans, sharing the same passion: working together for the same color, live blue.

Team OM 2019:

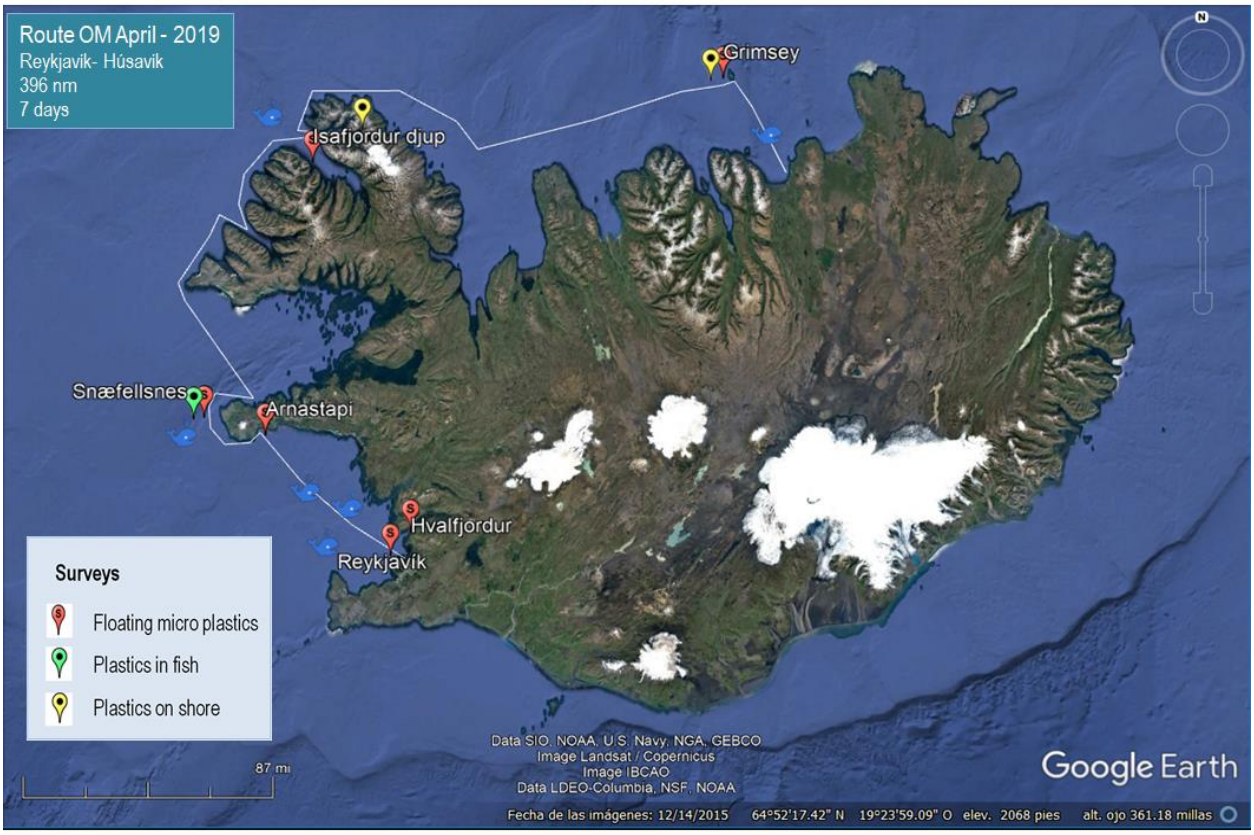
Crew

Daniel González - Nature Phographer, MSc Marine Ecosystems-based Management St Andrews University
Heimir Harðarson - Captain of Schooner Opal North Sailing
Belén García Ovide - Marine Biologist, Wildlife Guide University of Iceland. Sailor

Experts

Marianne Rasmussen, Director of the Husavik Research Center of the University of Iceland
Charla Basran- Whale researcher and Bird Research, Entanglements impacts University of Iceland
Erica (Freelance) - Journalist, plastic Researcher at Plastic Change
Torsten Geert – Project Coordinator and Captain at “Plastic Change” - Roskilde University
Frits Meyts (Freelance) – Story Teller , Journalist at Nat Geo, 4ever Travel
Axel Coumans – Campaign: The Independency of the Oceans –The Embassy of the North Sea
Louise Flensborg - Ecological Effects of Anthropogenic Activity in the Arctic. Whale Shooter for skin biopsies
Lauren Grueterich - Sailor and Environmental Management

Ocean Missions Expedition 2019: route and scientific surveys



1) Whale Sightings and Sound recordings

April is definitely one of the most interesting seasons for whales in Iceland. The ice melting in spring and early summer has already started and the days are getting longer. Cold waters and increasing sun light hours result in seasonal big phytoplankton blooms. This primary production is fed by the nutrients run-off from mountain glaciers and waterfalls. The biggest animals on the planet, like the blue whales (Balaenoptera musculus) and fin whales (Balaenoptera physalus) are often spotted at this time of the year. Food is always the main reason for the whales to come and nutrient rich Icelandic waters provide a suitable environment for the biggest migratory whale species along their long journey towards higher latitude feeding grounds. As herring schools start flourishing, pods of killer whales are sighted around Iceland and the starving humpback whales start to arrive to the North.

The following table shows the whale encounters we had during the sailing trip.

Nº	Date	Time	SP	N	Distance (m)	Description	Location	Comments	FISH. GEAR/PLASTICS
1	24.04.19	10:05	HW	1	600	Feeding	Faxafloi	Adult	yes
2	24.04.19	10:25	HW	3	600	Feeding	Faxafloi	Adults	unknown
3	24.04.19	11:05	HW	1	700	Feeding	Faxafloi	Adult	unknown
4	24.04.19	11:05	WBD	4	100	Travelling	Faxafloi		unknown
5	25.04.19	13:11	KW	1	500	Feeding	Snæfellsnes	1 Male feeding	yes
6	25.04.19	13:45	KW	2	400	Feeding	Snæfellsnes		yes
7	25.04.19	14:29	KW	30	100	Feeding	Snæfellsnes	Next to fishing vessel	yes
8	25.04.19	15:49	SW	1	100	Resting	Snæfellsnes	300m depth line	yes
9	26.04.19	13:00	HW	1	1000	Breathing	Ísafjarðarjúp	Adult	
10	27.04.19	8:00	HW	1	500	Breathing	Ísafjarðarjúp	Adult	unknown
11	28.04.19	18:30	HW	1	1000	Breathing	Skjálfandi Bay	No approach	unknown

Table 1: Whale sightings April 2019

The weather was not favorable most of the time and although the visibility was rather poor making sightings difficult, we were very lucky to find four different species in seven days. This provided evidence that Iceland is a paradise for whales.

During the first day we found humpback whales (Megaptera novaeangliae) and White-beaked dolphins (Lagenorhynchus albirostris). Humpback whales are one of the most common whales to see in summer time as these waters are within their normal feeding grounds. While feeding grounds are located in cold waters and high latitudes, the breeding grounds, on the other hand, are located in Caribbean, Cape Verde, and Azores.

We spotted one small group of White beaked dolphins. They are resident species in Icelandic waters, meaning that they can be seen here all year around. Normally, they gather in coastal waters but they can be found offshore as well. White beaked dolphins are the most northern dolphin on the planet.

Map 1: Faxaflói Bay

Although they are one of the most abundant whale species around Iceland, we did not find any minke whales (Balaenoptera acutorostrata) during our trip. It is likely that they were present but we missed them due to the weather conditions. Minke whales are the smallest of all the rorquals and they are still hunted in Iceland. However, this practice is not profitable for the Icelandic economy and the number of whales that they hunt has been reduced in the recent years. Last year in 2018, only 6 whales were hunted. This year there is only a small boat with permission to hunt minke whales during the summer months.

Picture 1,2: Humpback whale dorsal fin and fluke (Belén G.Ovide)

Picture 3: White beaked dolphin (Belén.G.Ovide)

Without a doubt, the most interesting place for us whale wise was Snæfellsnes. Due to its oceanographic characteristics and depth profile, this area provides a strategic feeding ground for two particular species: sperm whales (Physeter macrocephalus) and killer whales (Orcinus orca). Indeed there are some small local whale Watching companies operating there to take advantage of this amazing event.

This area is full of herring at this time of the year and that is the reason why the killer whales are coming. These type of killer whales are fish eaters, and they do not prey on marine mammals. However, killer whales hunting marine mammals such as minke whales and harbour porpoises (Phocoena phocoena) have been spotted in North Iceland as well. The particular characteristics of this peninsula, reaching down to 300m very close to the coast make an excellent place for deep-sea hunters: the male sperm whales that feed here mainly on squid.

Map 2: Snaefellsnes peninsula

Sailing along the coast, we found a male killer whale feeding alone. He was actively feeding, turning on his side and pushing the fish up to the surface.

Pictures 4,5 : Adult male killer whale (Belén.G.Ovide)

A few miles closer, almost at the northeast tip of the peninsula we spotted two more males and then we saw many of them in the distance. The pods were literally following the nets displayed by a big fishing boat. It was almost scary to see the boat sailing in a huge circle, displaying hundreds of meters of nets, while the whales were chasing the back of the boat. We felt that it was not the first encounter for the whales with this type of vessel. Even we had to be careful to not get in the middle of the nets. Here we found 3 different pods averaging 10 individuals in each one and many seabirds. These close interactions between whales and fishing boats can be dangerous. Nowadays, in many places, due to the climate change, overfishing and ocean pollution, the fish stocks are collapsing and fisheries get most of it, increasing the conflicts between the humans and the hungry marine mammals.

In our case in particular, this may be a problem for the killer whales that have to interact directly with fishermen and their gear, which is putting the whale's lives at risk due to possible entanglement or even being shot at by angry fishermen in some places.

Picture 6: Fishing vessel and killer whales (Frits Meyst)

Picture 7: Pod of killer whales (Belén.G.Ovide)

After collecting pictures for photo identification we kept on sailing. Not even two miles away we found one big male sperm whale in the north of the peninsula. He was diving for 30 minutes and performing deep foraging dives. Males have scars in the body skin and can be easily recognized by the round head and the blowhole on the left side.

The hydrophone was deployed in this location, where we encountered the sperm whale and the killer whales. To get recordings from whale species is not an easy task. Natural sounds like currents, waves, rain and other boat external noise caused by the boats can easily mask whale vocalization in the very lucky case that they are vocalizing or echolocating.

Picture 8: Listening to whale sound recordings (Belén.G.Ovide)

We successfully recorded the group of killer whales that was actively feeding on herring next to the fishing vessels.

Killer whales are toothed whales and they use high frequency sounds for communication (from 0.1 kHz to about 40 kHz (dosits, 2019). Killer whales have a complex social structure forming matriarchal groups with individuals from several generations (Baird, Robin W., 2002).

The calls were up 20 kHz and there were many individuals calling at the same time. In the figure below the fishing vessel noise is showed in blue color being medium- low frequency sounds, in his case up to 5 kHz. These calls are very likely to be feeding calls. In other places such as Northern Norway in Tromsø, killer whales can coordinate themselves by vocalizations to catch the fish. Indeed by echo locating in the bladder, the fish get confused and try to escape to the surface, making it easier for the whales to eat them or slam them with their tails.

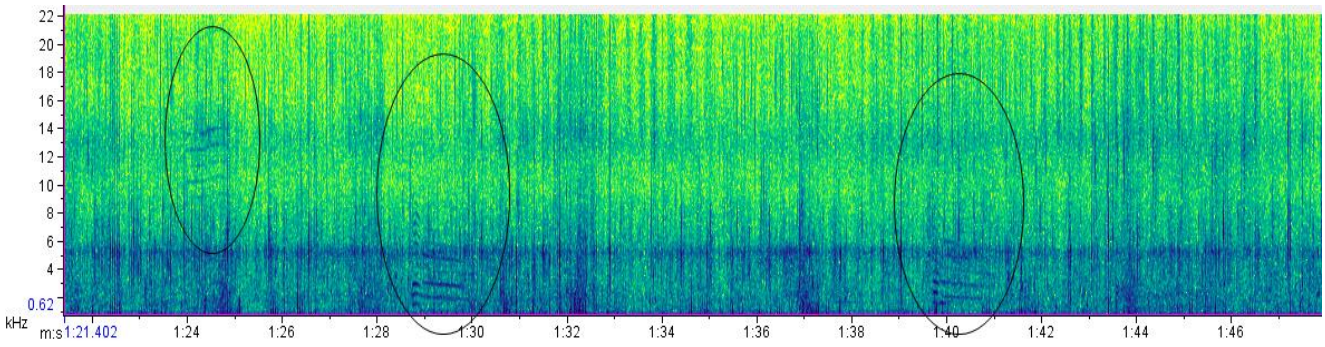


Figure 1: Killer whales calls (in black circles) and boat noise in the background (blue line)

Sperm whales can dive over 2500 m deep (Jeanne M. Shearer et al, 2019). In the deep darkness they look for their favorite pre y, squids, by echo location (like an intern sonar). Furthermore, they have one of the most sophisticated and powerful echolocation systems and they can be heard through hundreds of km away. Indeed they are one of the loudest animals on the planet, emitting sounds up to 220 db, as loud as a jet plane.

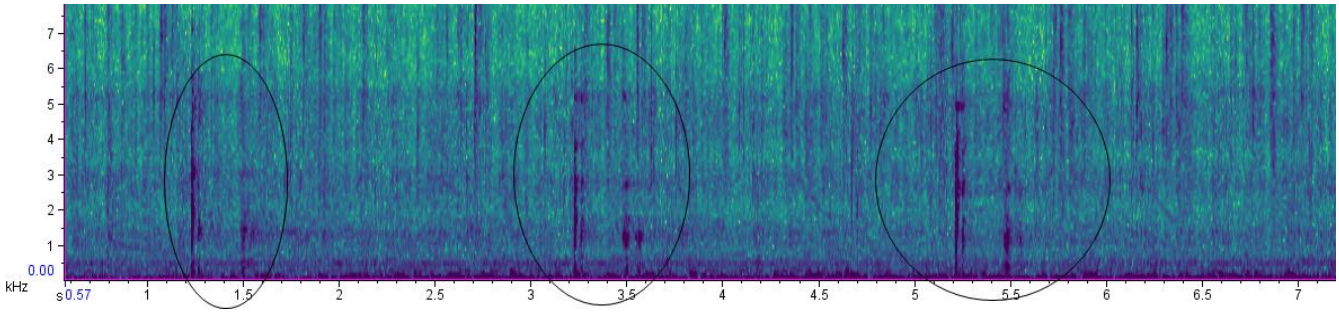


Figure 2: Sperm whale clicks

In this particular case, the sperm whale was clearly making foraging dives and we could hear the clicks very clear. The clicks go up to 6 kHz and they have two components separated by 3 milli seconds.

Picture 8: Male sperm whale (Belén.G.Ovide)

Picture 9: Male sperm whale breathing (above) and diving (below) (Belén.G.Ovide & Heimir Hardarson)

In Ísafjarðarjúp, in the Westfjords, the weather conditions started to be against us. We spotted three humpback whales in the distance, with no chance to even approach or get some biopsies samples. Even though this is well known as a hotspot for whales, the monitoring efforts are rather little in this area, and therefore, it was important for us to dedicate time and scan these waters.

First initiatives to monitor the fjord and to register whales inside the fjord were carried in 2017 from a scientist in Ísafjörður helping the local communities to start developing small local whale watching operations.

After we left the Westfjords the swell and big waves did not allow us to see anything. Even in Skjálfandi Bay, very close to our final destination, Húsavík, we did not see anything due to the weather conditions. Húsavík is the "Whale capital" of Iceland and the sighting rate is over 95% according to the whale watching operators. This makes Húsavík one of the best places (if not the best) to see whales in Iceland, at least in the summer time, attracting approximately 100.000 tourists per year (Lilja B Röngvaldsdóttir pers. comm. 2019)

It is important to mention that a few days after the survey this whale was found in Skjálfandi Bay with a large fresh scar in the tail peduncle, probably due to an entanglement in ropes or other fishing gear.

If the injury does not get seriously infected we might have the chance to see this whale again in the Bay.

Picture 10: Humpback whale with big recent scar (Marguerite Bathie)

All the pictures were sorted and the high quality images were used for photo identification in order to recognize the individuals in the existing catalogues. By doing this, we ensure that we contribute to the research that has been done in Iceland for more than 12 years. After checking the whale catalog for photo identification, we realized that this whale was seen previously without any scars in July 2017 near the Westfjords.

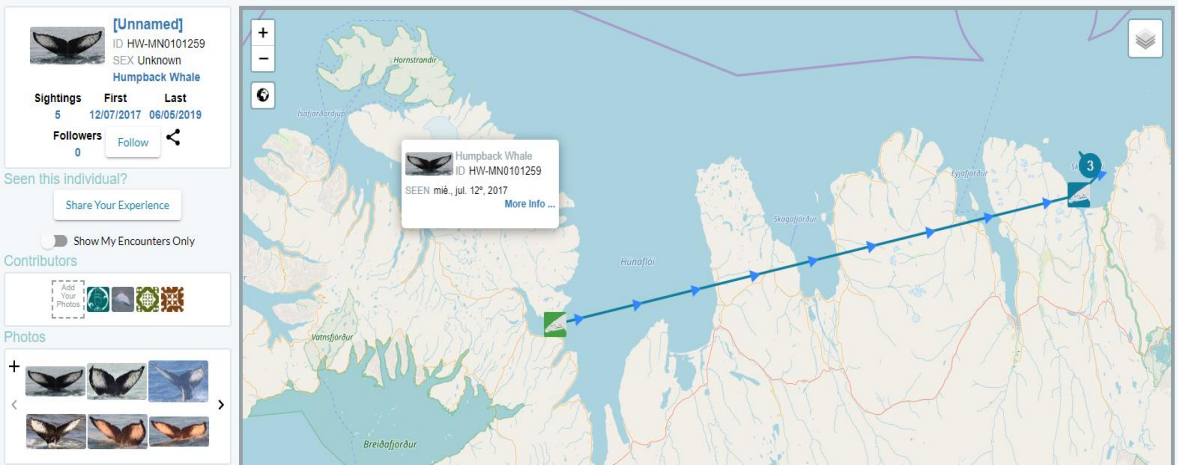


Figure 3: Happywhale platform: for Whale Photo Identification. Sighting in green in 2017. Sightings in blue are the same whale seen 3 times in May and June 2019 in Skjálbandi Bay

Killer whale pictures were contributed to “Icelandic Orca Project” and humpback whale pictures were shared with the Research Institute in Húsavík and updated to the world whale data base “Happy Whale”: https://happywhale.com/home

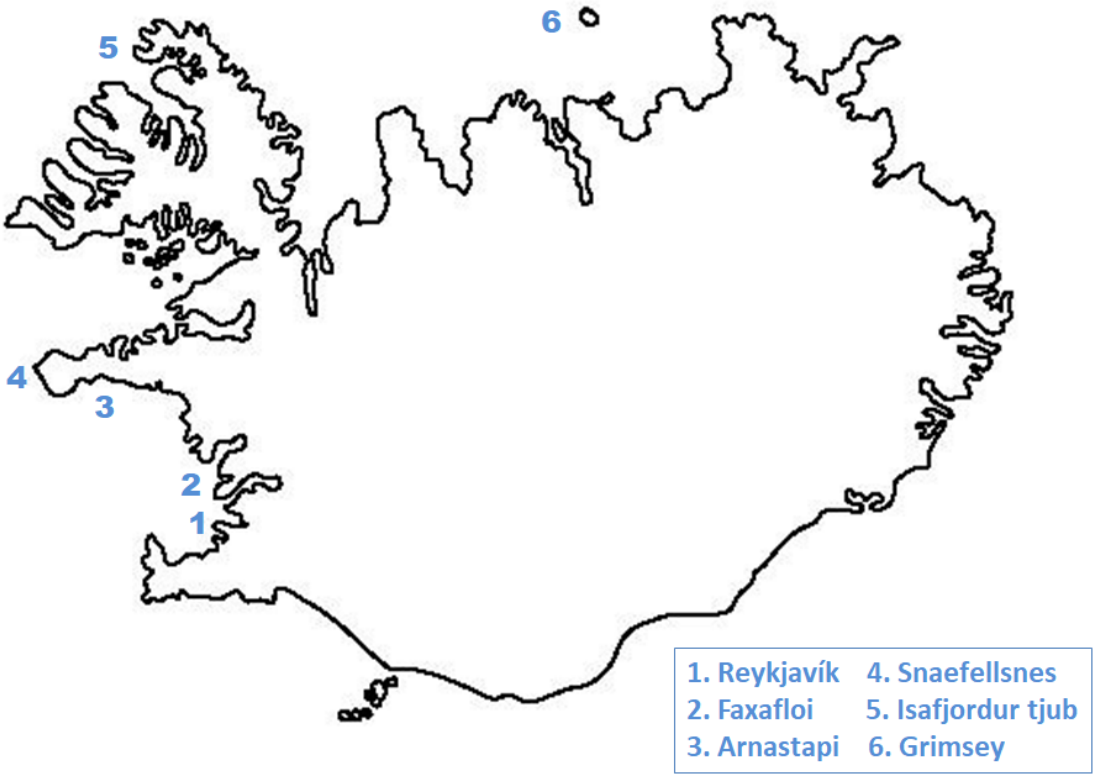
2) Whale skin biopsies

Due to weather conditions, this time we did not have the chance to take whale skin biopsies. We aimed to collect the samples by using a gun and biopsy dart. The samples can give a lot of information about whale ecology including genetic information or stress hormones and others purposes.

Picture 11: Preparing biopsy gun (Frits Myest)

3) Plastic surveys

A total of six floating micro-plastic surveys were carried on 7 days. For that we used a homemade LADI manta Trawl (protocol by CLEAR) https://civiclaboratory.nl/



Map 3: Locations for micro plastic surveys

For each survey we did three transects (30 minutes each) in a zig-zag position (in total approximately 4, 5 miles/survey). This method allows to better isolate specific study areas and therefore to get more reliable results of each location. The manta trawl is deployed on the surface always at less than 3 knots speed.

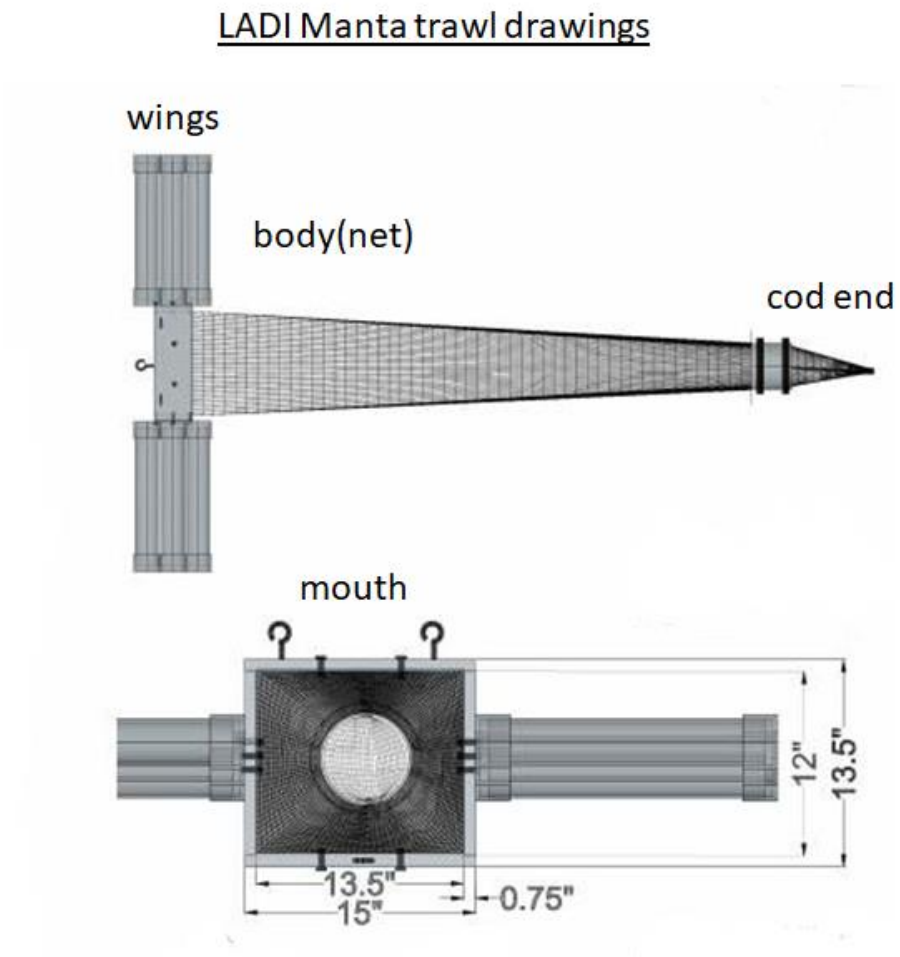
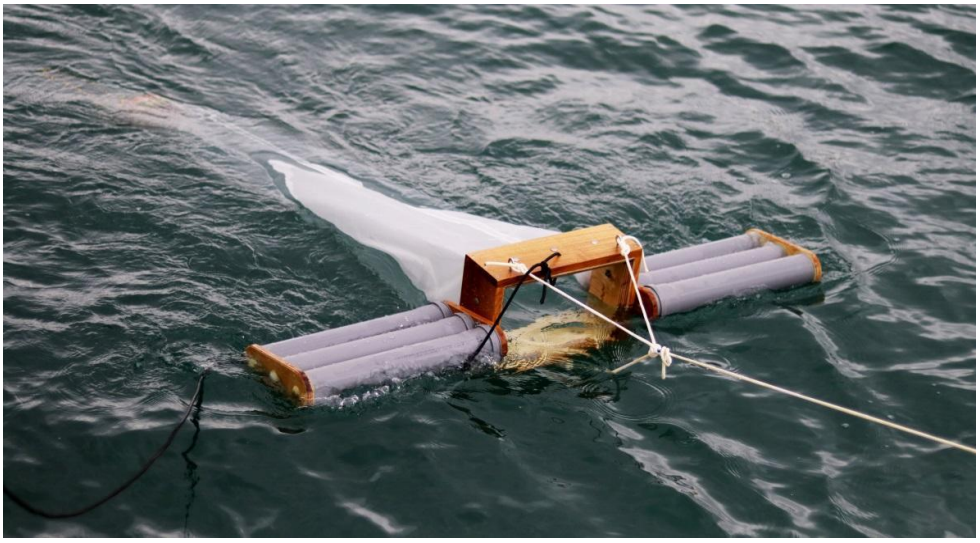


Figure 4: Manta trawl drawings (CLEAR)



Picture 12: Ocean Missions manta trawl (Erica Cirino)

Picture 13: Crew taking the manta trawl out after the survey (Belén G.Ovide)

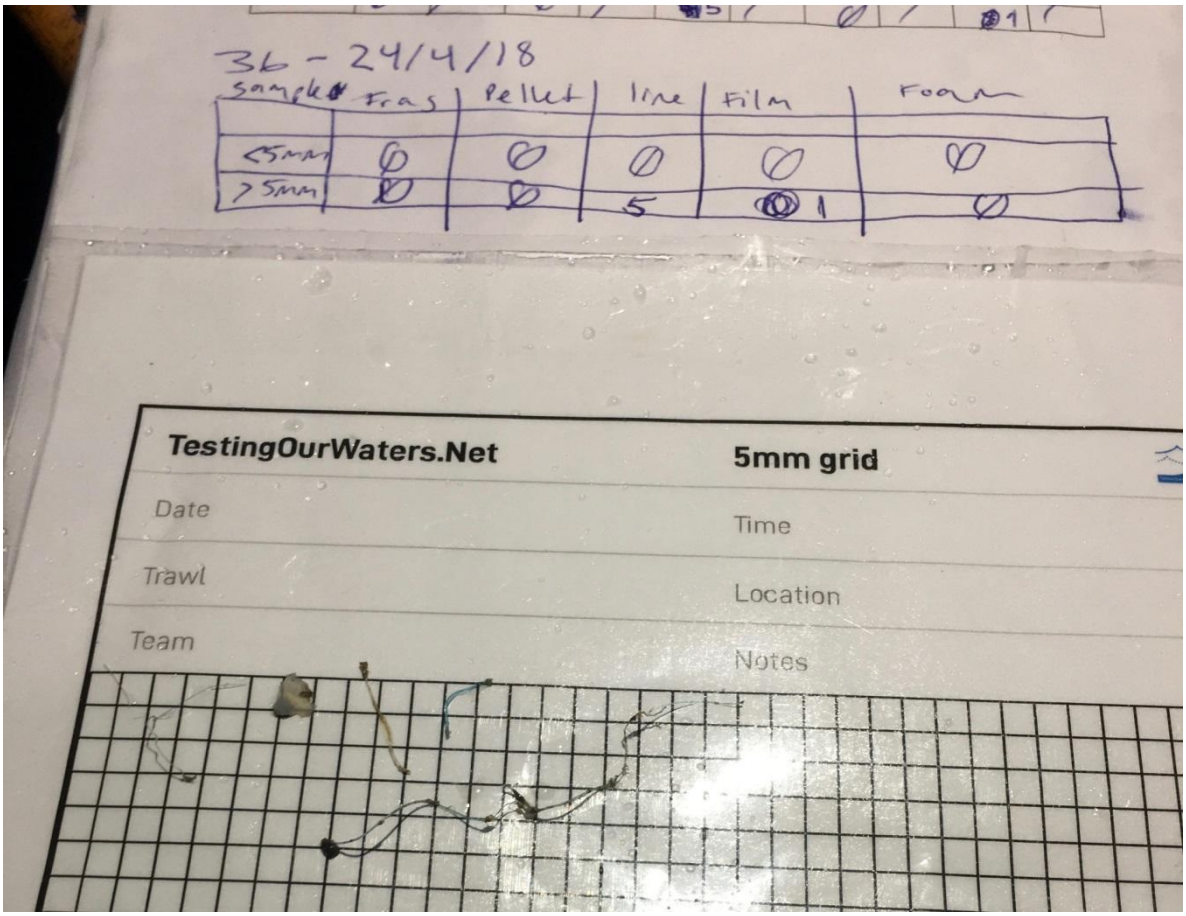
Each 30 minutes we took the manta trawl and rinsed the cod end with a house using moderate pressure. Once clean, we put the cod end back and deploy the manta again in the water for the next 30 minute transect. Now we can start analyzing the samples that came from the first transect.

Picture 14: Rinsing the cod end (Erica Cirino)

For the analysis, first we filter the samples using two sieves, one of 1mm mesh and another one of 250 micrometers mesh (standardized methods). For visualizing the samples, we use stereo microscope, tweezers and headlights.

Picture 15: Visual analysis for micro plastics (Heimir Hardarson)

We classified the plastics into five categories: fragments, pellets, lines, films and foams. We separated the plastics in two sizes in to smaller or bigger than 5 mm using a 5mm grid.



Picture 16: Example 5mm grid and samples (Erica Cirino)

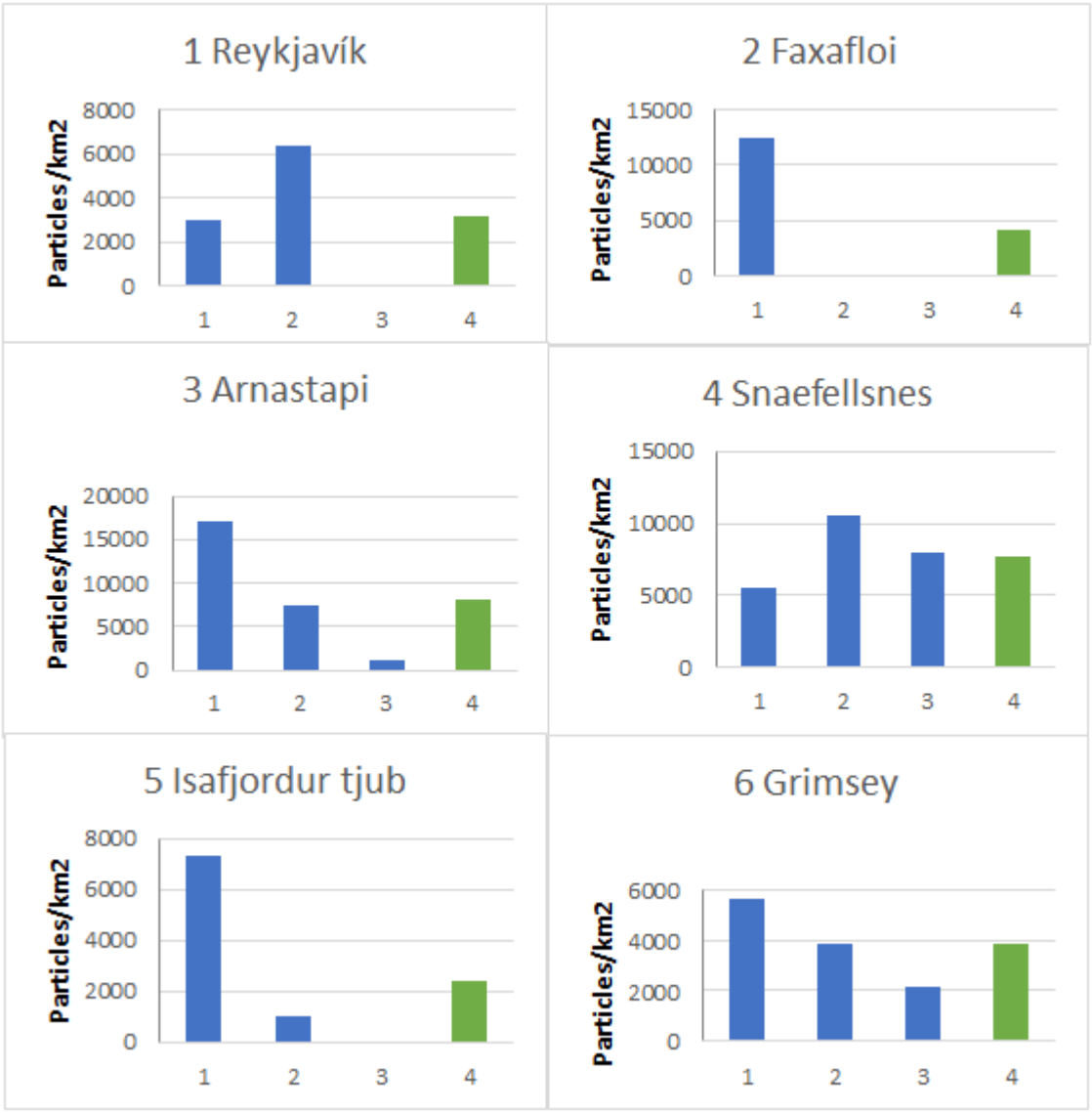


Table 2: Abundance of micro plastics in study areas: ***The numbers in the x axes refers to the transects (blue color) and the green indicates the average number of plastic particles per square kilometer found in each survey.***

Each survey represents a study area. Microplastics were present in 6/6 surveys. The maximum amount of microplastics was found in Arnastapi with a total of 8125 particles /km2 followed by Snæfellsnes with 7756 particles /km2

Reykjavík, Faxafloi and Grimsey presented similar plastic concentrations, between 3000 and 4500 particles /km2. The least polluted area was Ísafjörðarjúp with 2417 particles /km2.

Plastic concentrations on the surface can greatly vary even in the same study area as they move with the currents, disperse quickly, or aggregate in calm zones. The dramatic differences present in some cases shows high presence and absence of plastics in three consecutive transects is

suggesting that this method, performing zig zag transects, is a good method to determine plastic abundance in isolated areas.

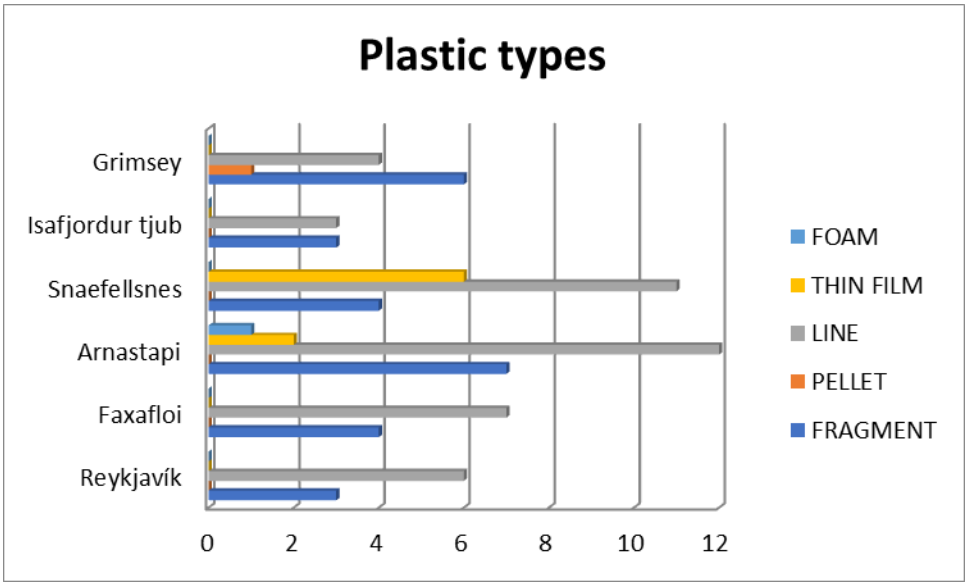
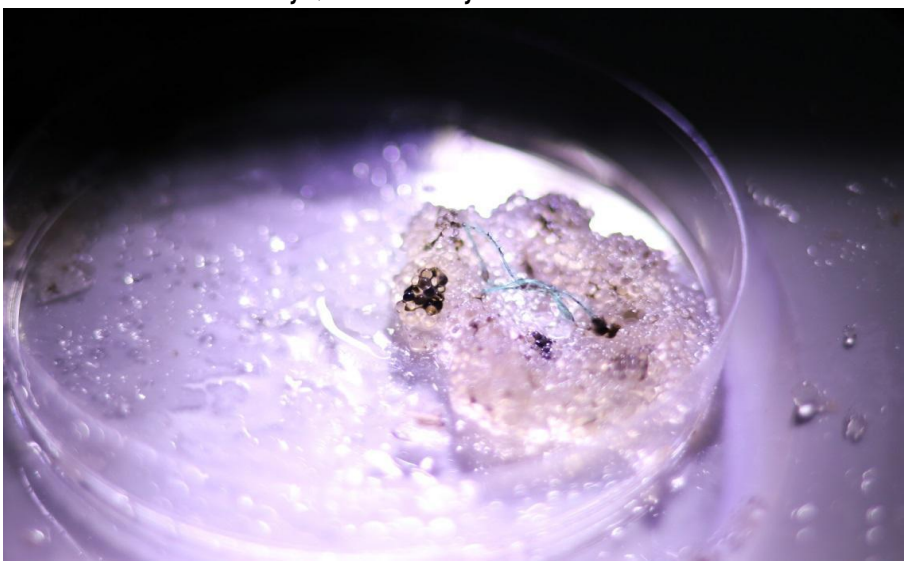


Figure 5: Plastic types in study areas

The most common plastic type present in the manta trawl was lines. Within this category we found several fishing lines and large amounts of fibers.

Fishing lines were more abundant in Snæfellsnes and in Arnastapi while fibers were present in all the surveys. The second most abundant type was the fragments, being present as well in all the surveys, followed by thin film.



Picture 17: Blue fishing line in fish eggs in Snæfellsnes (Erica Cirino)

In Snæfellsnes we found the highest number of plastics and fish eggs (read article by Erica Cirino. https://www.hakaimagazine.com/news/where-whales-and-plastic-meet/). Soon we realized that we were in a spawning area. Whales and seabirds (mainly adult gannets and gulls) were feeding at the same time. An interesting but sad fact is that our photographer only took pictures of one single gannet and soon after he realized that it had a fishing line hanging from the beak. This is just a sign of the critical situation that the seabirds are facing caused directly by human impacts at sea (such an entanglements with fishing gear, plastic pollution and habitat degradation). A recent study reveals that 70% of the northern fulmars in Iceland contain plastics in their stomachs (Aðalsteinn Örn Snæþórsson, 2019).

Picture 18: Gannet with fishing line around the neck (Frits Meyst)

Whales are coming to these specific waters for the food (krill and schooling fish). All species seem to be exposed to plastic pollution.

The results were contributed to 5 Gyres organization for further common publications. https://www.5gyres.org/

These preliminary results suggest that even arctic waters and remote places are polluted with plastics, which is an alarming outcome. However, in comparison with level of micro plastics found in busier and temperate waters the abundance in Icelandic waters was still low.

These are probably the first published results concerning micro plastics in Icelandic waters. Universities and Icelandic authorities are starting to realize that plastic pollution is an important issue and efforts have started to include these studies as part of their upcoming marine research projects (persnal comm, MATÍS,2019).

For future studies it will be interesting to investigate if the main warm circular current in Iceland would affect the plastic distribution and abundance in the coasts.

Due to the importance of these results, the samples have been sent to a special laboratory to verify that all the samples we found were truly plastics and to be examined for micro plastics (<1mm) under high resolution technology.

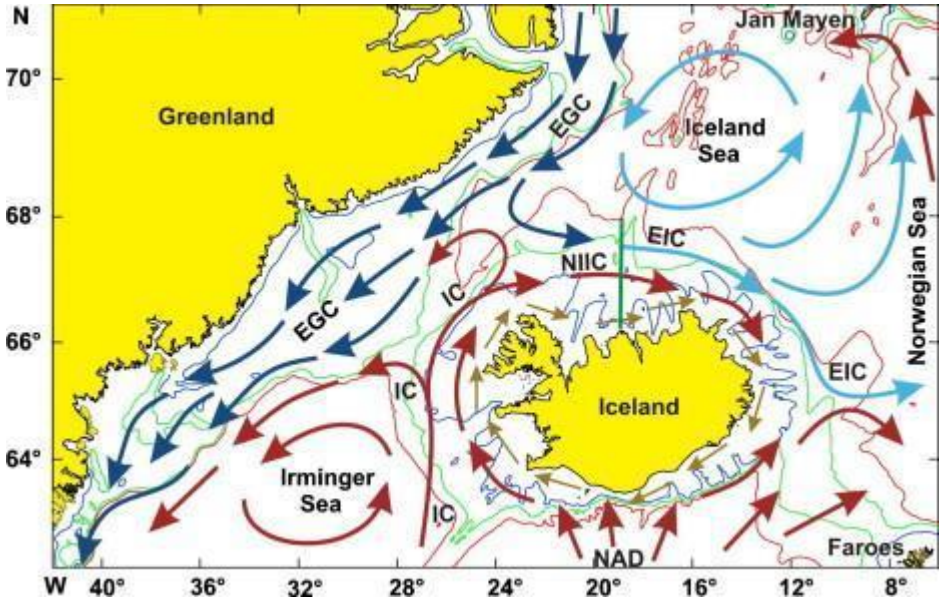


Figure 6 Schematic representation of surface ocean currents in Icelandic waters and adjoining Seas (James E. Carscadden, 2013)

No big floating fishing gear or plastics were found during the journey at sea.

4) Plastic s in fish guts

We examined a total of nine adult cod specimens (Gadus morhua). All fish were caught in the same area, north of Snæfellsnes peninsula, in the Western part of Iceland. Indeed since we were clearly in a fish spawning ground it took not more than 10 minutes to catch the 9 fish. We carefully dissected the animals, and manipulated and investigated the guts using sieves and tweezers. With a magnifier we isolated the potential plastic particles and put them under the microscope. We did not found any plastics in any of the guts. Mainly crabs and broken of sea starts were present in the analyzed fish guts. The fact of not finding plastics does not necessarily mean that they were not present. It is possible that in the stomachs plastics has been degraded already and that the particles were so small that we were not able to see them (maybe smaller than 1mm). This is out of our scope in OM however it will be very interesting to analyze those samples with high quality equipment to confirm the presence /absence of any plastic particles.

Cod feed on the sea bottom and therefore, they can be good indicators of plastic pollution in the seabed. The fact that we did find any visible plastic could be also a sign of relatively healthy oceans.

Picture 19: Fish catch (icelandic cod) (Erica Cirino)

Picture 20: Cod guts contents: mainly sea stars and small crabs (Belén.G.Ovide)

5) Beach debris survey

We conducted two beach litter surveys using a methodology developed by the Alfred-Wegener-Institute (AWI) and Birgit Lutz - who used the OSPAR Guidelines - on our trip. Beach litter surveys help to find out how much and what kind of litter we can find on our beaches with a high possibility of being washed ashore and therefore coming from the sea if conducted in remote areas. By analyzing the origin it is possible to evaluate regional political regulations or show in which fields action is necessary.

We conducted the first survey in Hornstrandir in the Hesteyrarfjörður (Westfjords), which is quite a remote area only accessible via boat or foot, in a nature reserve and sheltered area. The second one took place on a beach at the west coast of Grímsey just below the Grímseyjarflugvöllur, a quite exposed place especially in westerly winds and easy to access from ashore.

For these surveys we measured transects of 100m in length. The width of the transects arose from the extent of the beach itself. In these areas we collected everything that didn't originate in nature including manufactured wood as it is man-made. After categorizing, pieces were counted and weighed.

Hesteyrarfjörður: The 1250m² transect with rocks and pebbles had only 6 pieces for us to collect, of which 3 were styrofoam, one a ring from a plastic cap, a small fishing rope and a piece of manufactured wood. All in all, this only accounted 70g.

Grímsey: Grimsey is located at the edge of the Arctic Circle and it is an interesting place for exploring and research. Only about 70 people are leaving on .Grimsey and it is a well-known bird nesting area. Numerous species of birds gather here in summer time including the Atlantic puffin (Fratercula artica), one of the most popular species for tourists. Last year, in 2018, the Atlantic puffins were listed as an endangered species by the IUCN. The main cause for the population decline has been the lack of sand eels, their main prey, probably due to a change in the climate. However, these birds are still hunted by farmers for local consumption and the meat is sold to Icelandic restaurants. In Húsavik, thanks to public pressure and IFAW (https://ifaw.is/) campaigns, puffin and whale meat has not been served in restaurants since 2015.

Although not even double in size of the transect in Hesteyrarfjörður, the 2000m²-transect on the pebble beach in Grímsey contained a lot more litter. In total we collected around 18.4kg made up of approximately 510 pieces. Weight wise metal pieces (probably originating mostly from ships - 7.5kg), manufactured wood (2kg), wires (1.88kg) and pieces of fishing boxes (1.45kg) made up the biggest part. Different kinds of styrofoam accounted to more than 300 pieces.

Styrofoam easily falls apart into smaller and smaller pieces and is distributed by wind and waves.

Plastic is the main material that was found. From easily identifiable plastic packaging like bottles and containers, articles like hoses and tapes, to shoe soles and unidentifiable pieces of rubber and plastic.

A message inside a plastic bottle was found and provided us with an interesting insight into the origin of plastic pollution on Grimsey. The sender was found and we learned that the bottle had been thrown into the sea in Siglufjörður, North Iceland, approximately 9 days earlier.

Picture 21: Rocky beach in Grimsey (Belén.G.Ovide)

Picture 22, 23: Atlantic puffins (left) and crew collecting trash (right) (Belén G.Ovide)

Looking at the weight over 13% of the collected litter originated from fisheries. More than 15% was some kind of plastic.

Picture 24: Crew sorting out plastics (Belén.G.Ovide)

The results are updated in Empower data base https://empower.eco/ to sum up the efforts for awareness and conservation.

6) Bird Surveys

We conducted eight 30-minute pelagic bird survey transects when we were more than 3 km from shore, using the ebird app and uploading to the online international database.

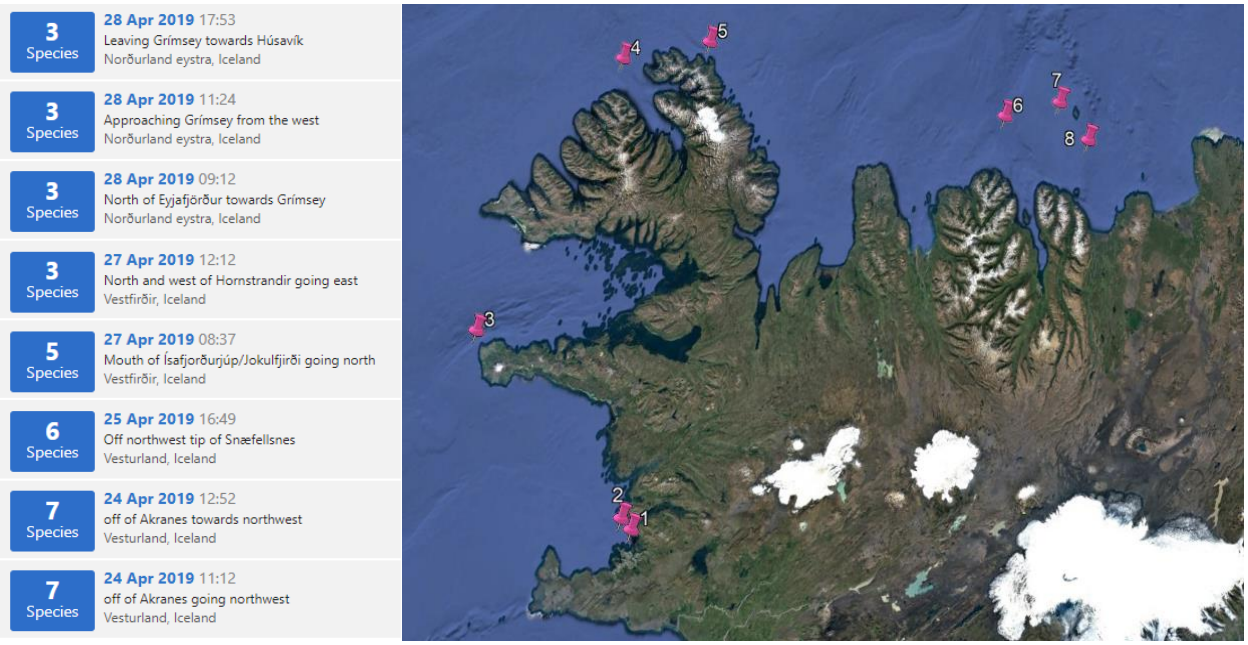


Figure 7: Bird surveys map and sightings

Overall, we recorded 13 common Icelandic seabird species: black guillemot (Cepphus grylle), common guillemot (Uria aalge), brünnich's guillemot (Uria lomvia), razorbill (Alca torda), Atlantic puffin (Fratercula arctica), Iceland gull (Larus glaucoides), glaucous gull (Larus hyperboreus), lesser black-backed gull (Larus fuscus), great black-backed gull (Larus marinus), black-legged kittiwake (Rissa tridactyla), northern fulmar (Fulmarus glacialis), northern gannet (Morus bassanus), and common eider duck (Somateria mollissima). In addition, we had one unusual sighting of a European shag (Phalacrocorax aristotelis) north of Eyjafjörður in north Iceland while on the way to Grimsey island.

Picture 25: European Shag in Iceland (Yann Kolbeinsson)

Some members of this species do breed in West Iceland but they are considered a rare sighting east of Hvammstangi (approximately 150km southwest of the sighting point) according to bird biologist Yann Kolbeinsson.

The results were uploaded and share in Ebird global online sighting platform: https://ebird.org

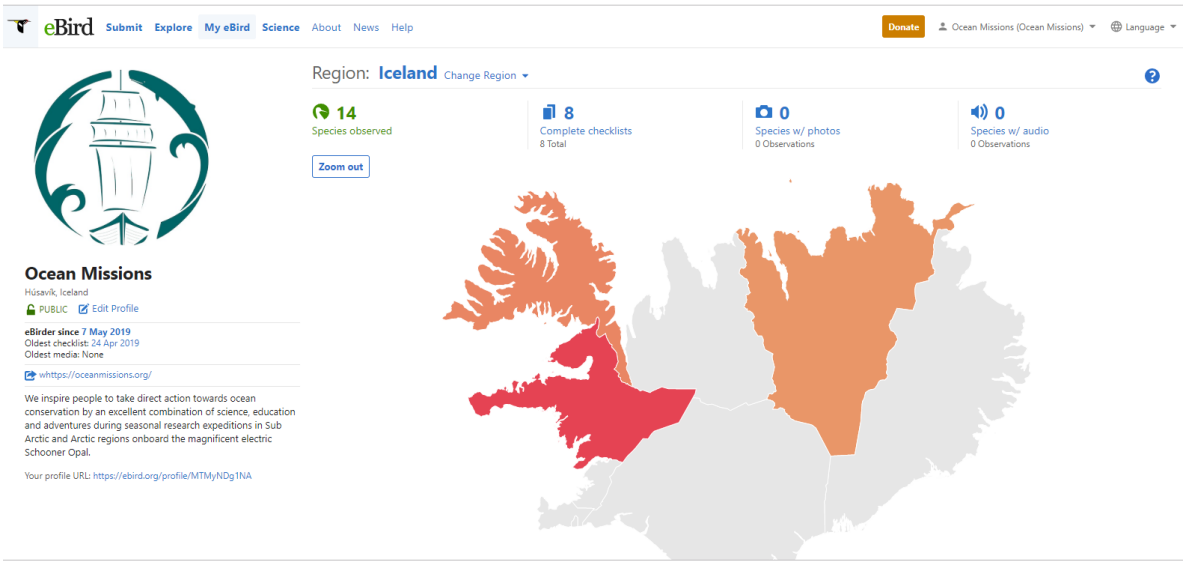


Figure 8: Ebird Online platform: The color gradient indicates the abundance of species encountered. In the West a total of 10 species in the Northwest 7 species and in the Northeast 5 species.

Today sea birds are of special concern and they need special attention as they are highly threatened and the populations are declining rapidly worldwide. The fact that several species only lay one egg per season, they show high site fidelity for nesting areas, and they may be very selective with their diets makes them more vulnerable to climate change, habitat degradation and pollution. It is imperative to understand these particular important bird areas such as those found in Iceland.

Conclusion

During the first expedition of OM we learnt to appreciate and value every glimpse of the surrounding nature. We listened to the oceans and to each other, working as a team to overcome big challenges like weather, some sickness and boat failures. We discovered that even in a remote island in the north Atlantic there are signals of unhealthy oceans and therefore, actions to take. In addition, we are aware that this was a pioneer study on plastic research in Icelandic waters and that some of the data collected could be very significant for future investigations and to raise awareness. We learnt that motivation is the key for Ocean Missions project as it keeps the people in the mood to dig into problems, be involved and find solutions.

What is coming next?

For the next short term steps, we aim to spread these results to the locals and tourists in Iceland by organizing mini OM expeditions and events in the towns, and also present the project officially to the international scientific community at the World Marine Mammal Science Conference in December 2019 in Barcelona, Spain.

As for next year, we will develop an official intense citizen science conservation program (theory and practical) to offer to enthusiastic people that want to join OM expeditions in April and June 2020.

Read more about next expedition: www.oceanmissions.org

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NORTH SAILING

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