Anthropogenic Marine Litter in the Barents Sea workshop

22 March 2021, Murmansk, Russia

Marine litter in the Arctic seas – Norwegian-Russian research collaboration and innovative litter mapping solutions

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MALINOR DIMARC ArcToMal

On-going Norwegian-Russian marine litter projects lead by Akvaplan-niva

- MALINOR: Mapping marine litter in the Norwegian and Russian Arctic Seas
  The Research Council of Norway NORRUSS programme funded project 2019-2021
- DIMARC: Detecting, identifying and mapping plastic in the Arctic using robotics and digital solutions
  Norwegian Retailers Environmental Fund funded project 2020-2022
- ArcToMal: Arctic tourism in the Barents Sea – awareness and participation for marine litter prevention
  The Norwegian Ministry of Climate and Environment funded project 2019-2021

Forskningsrådet Handelens Miljøfond Klima- og miljødepartementet Akvaplan niva

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Partners

Norway
- Akvaplan-niva
- SALT Lofoten
- Maritime Robotics
- University Centre in Svalbard (UNIS)
- Norwegian Institute of Air Research (NILU)
- GRID-Arendal
- Meteorologic Institute
- UiT – The Arctic University of Norway
- TerraNor
- Association of Arctic Expedition Cruise Operators (AECO)

Russia
- Murmansk Marine Biological Institute (MMBI)
- Zubov State Oceanographic Institute (SOI)
- Association Maritime Heritage: Explore&Sustain
- WWF Barents Sea Office
- Russian Arctic National Park

Advisory group
- Ifremer, France
- Alfred Wegner Institute, Germany
- Toyo University, Japan

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Main objectives

MALINOR
To map areas of marine litter and describe its characteristics in the Norwegian Sea, Barents Sea, Kara Sea and the High Arctic with a multi-disciplinary approach in collaboration with Norwegian and Russian institutes.

DIMARC
To detect, identify and map plastic litter in the Norwegian and Russian Arctic seas, offshore and onshore by developing robotics, digital solutions, machine learning and ocean modelling.

ArcToMal
To increase awareness and responsibility of Arctic tourists and to gather new knowledge about marine litter pollution in the Barents Sea and the High Arctic through citizen science, participation, cooperation and outreach.

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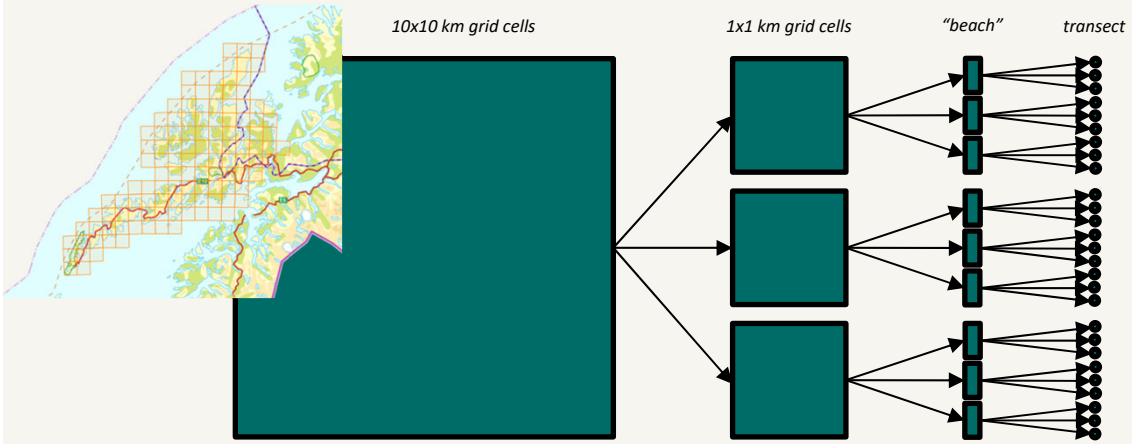
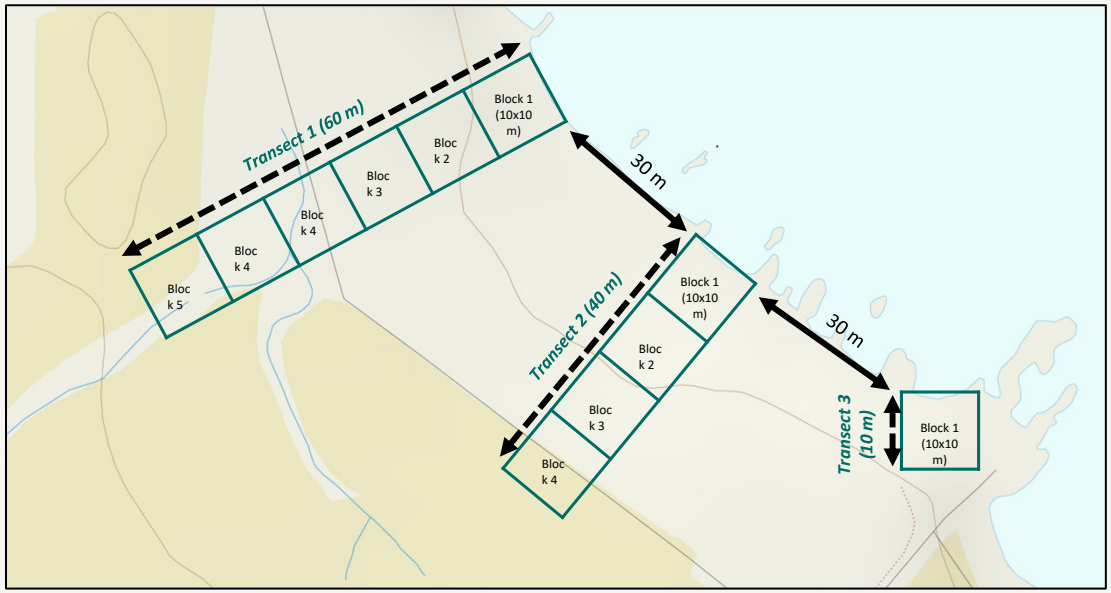


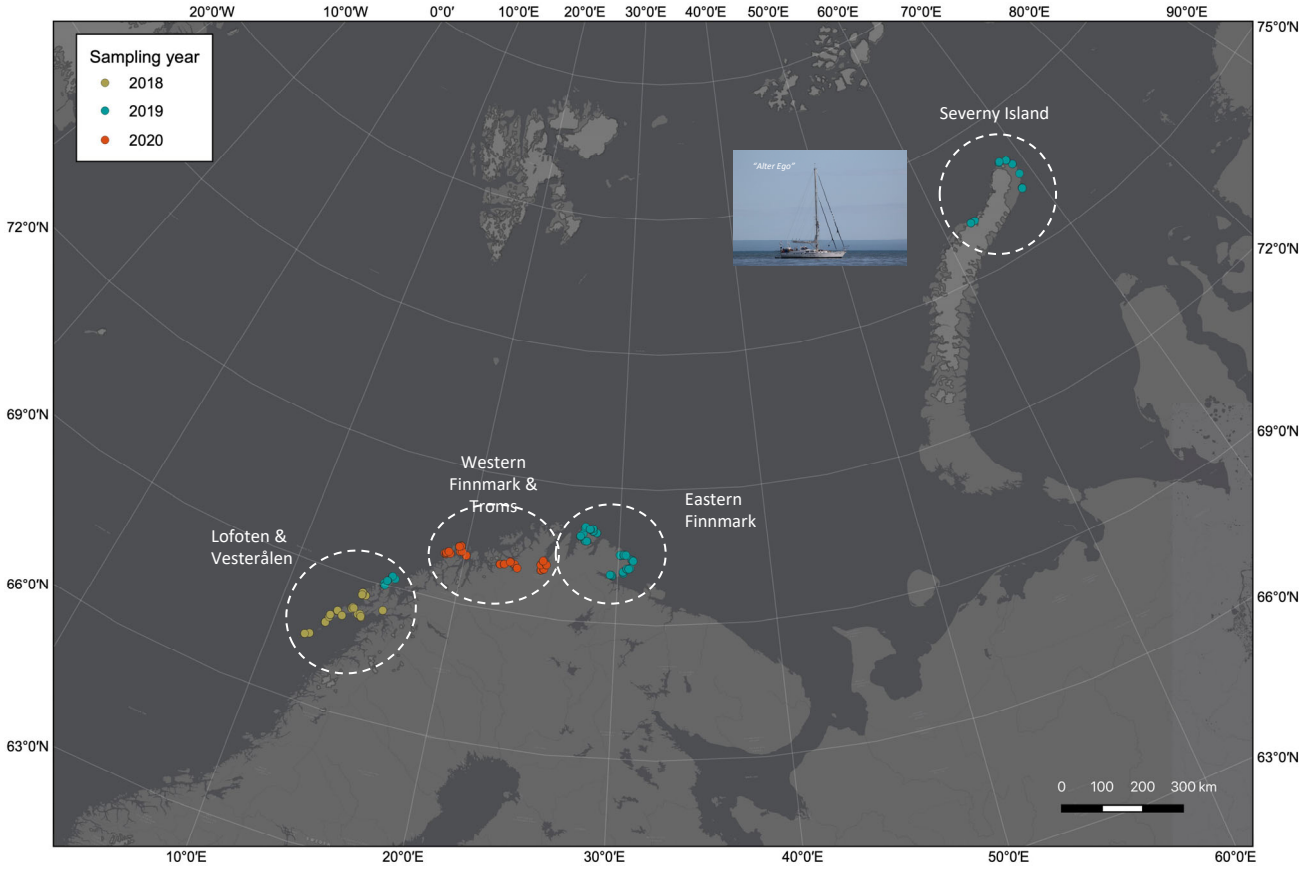


Beach litter sampling: Methodology

Beach litter was sampled in three 10 m wide transects on "beaches" (100 m stretch of coastline).

Each transect is built of 10x10m blocks with litter counted and weighted in each. Blocks extend until litter is no longer present (last block empty).

"Beach" locations were randomly selected within a tiered grid cell system, except in Novaya Zemlya where landing sites dictated sampling locations.



Beach litter sampling: Scope

Data from 19 beaches on Severny Island, Novaya Zemlya were collected during a research cruise with the Alter Ego organised by the Association Maritime Heritage.

Data were collected in northern Norway over 3 years: 65 beaches in Lofoten/Vesterålen, 61 beaches in western Finnmark/Troms, and 77 beaches in eastern Finnmark.

Transects were considered significantly polluted if at least one block contained ≥10 small and/or ≥3 medium and/or ≥1 large items. This threshold was based on the 25th percentile block litter density in Eastern Finnmark and applied to increase sampling efficiency on Severny Island.

Beach litter sampling: Results

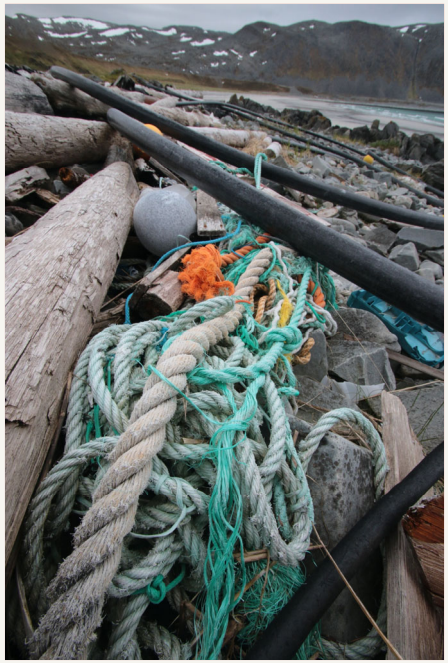
Lofoten and Vesterålen

72% of transects significantly polluted
Mean litter density in significantly polluted transects: **212 items, 11 kg**

Western Finnmark and Troms

47% of transects significantly polluted
Mean litter density in significantly polluted transects: **33 items, 15 kg**

Eastern Finnmark



70% of transects significantly polluted
Mean litter density in significantly polluted transects: **127 items, 42 kg**

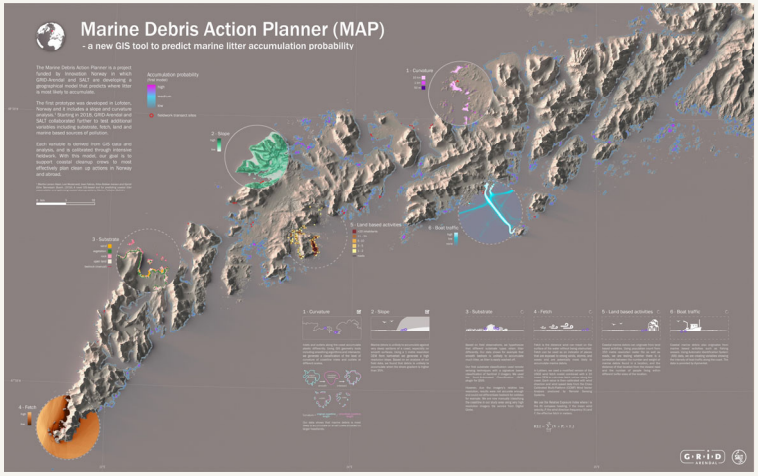
Northern Severny Island, NZ

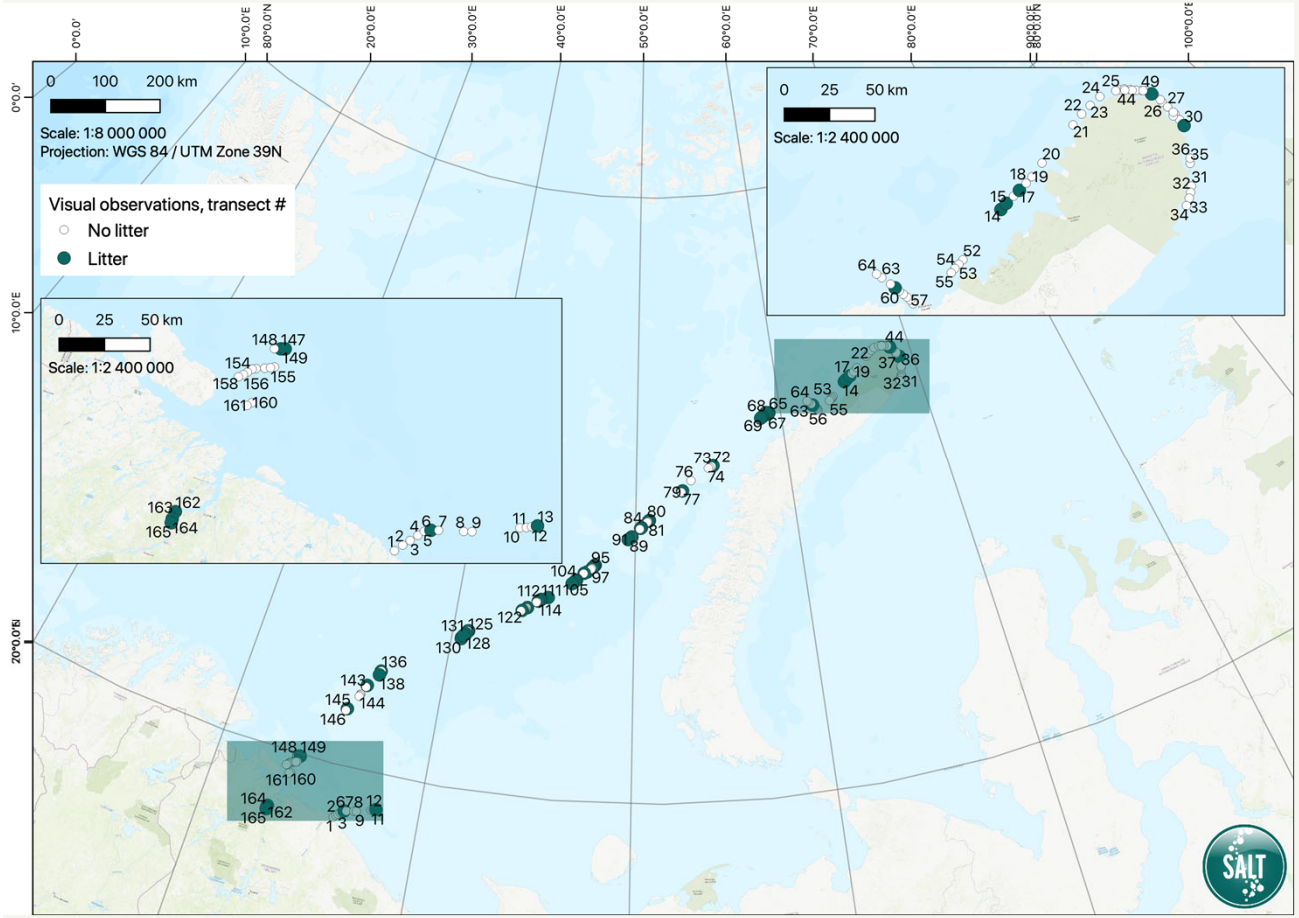
34% of transects significantly polluted
Mean litter density in significantly polluted transects: **31 items, 13 kg**

Beach litter sampling: Data analyses and next steps

Beach litter density data will be analysed in relation to various GIS derived variables such as beach slope, curvature of the coastline over different scales, fetch and wind exposure, and population density and vessel traffic within different surrounding radii.

These GIS derived variables are being generated by GRID-Arendal.





At-sea sampling

At-sea visual surveys of floating litter were conducted during the cruise to Novaya Zemlya.

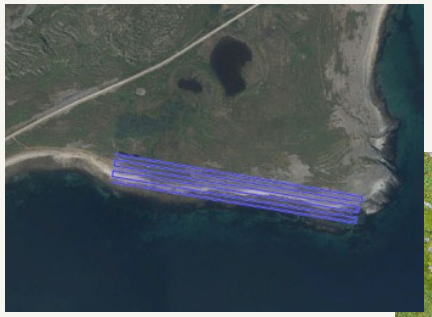
A total of 165 transects, each lasting for a duration of 15m, were surveyed.

A total of 108 items of anthropogenic litter and 162 items of natural debris were observed.

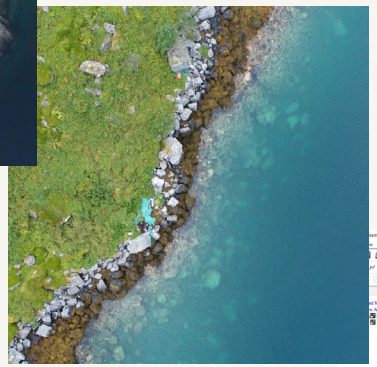
Most (86%) of anthropogenic litter was <20cm in length.

Anthropogenic litter was observed in 1/3 of transects.

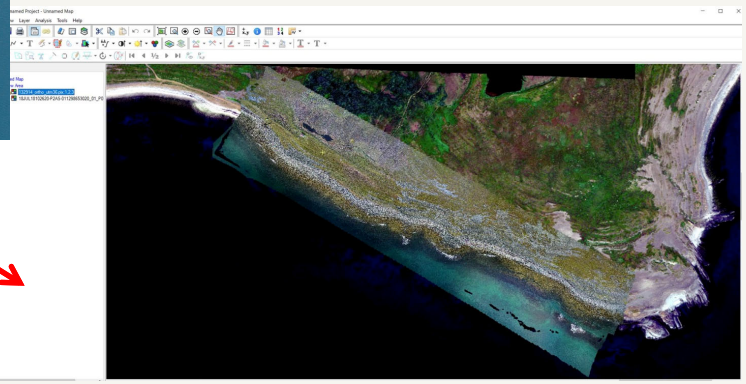
AUV testing in Troms and Finnmark 2019-2020



Drone transect



Single raw pictures



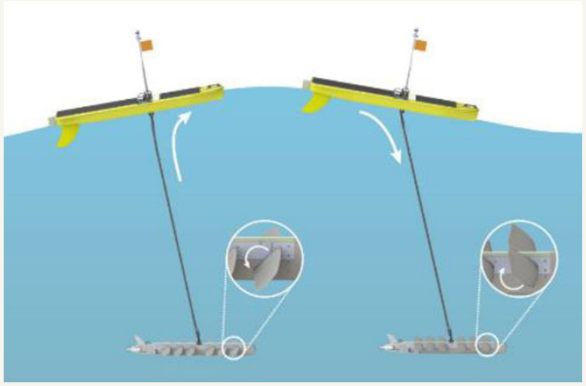
Map model in GIS

Different heights and speed of the AUV were tested

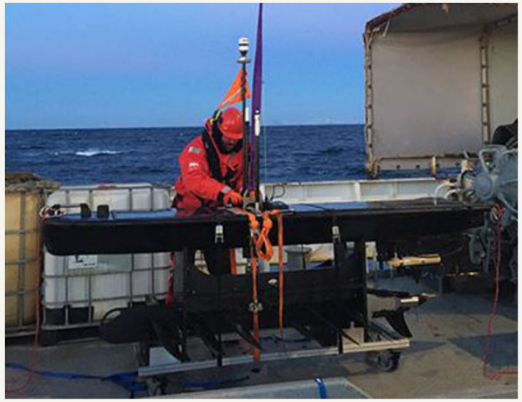
Test of subsea camera on sea AUV – WaveGlider

- To collect data on floating litter at the surface
- Go-pro camera attached to Glider
- Takes automatic picture every 7 seconds

Plastic floating at the sea surface.



Principle of the WaveGlider propulsion using wave energy

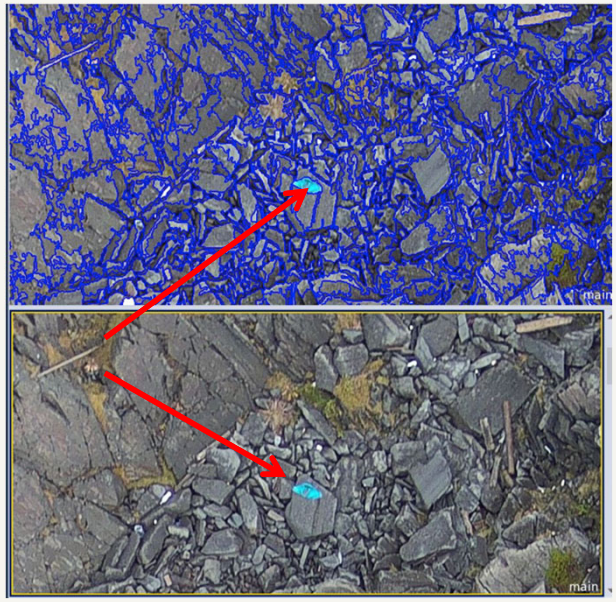


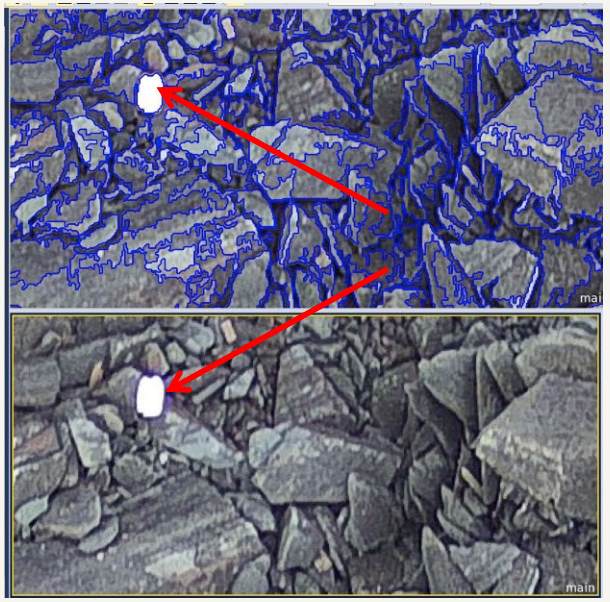
WaveGlider of Akvaplan-niva

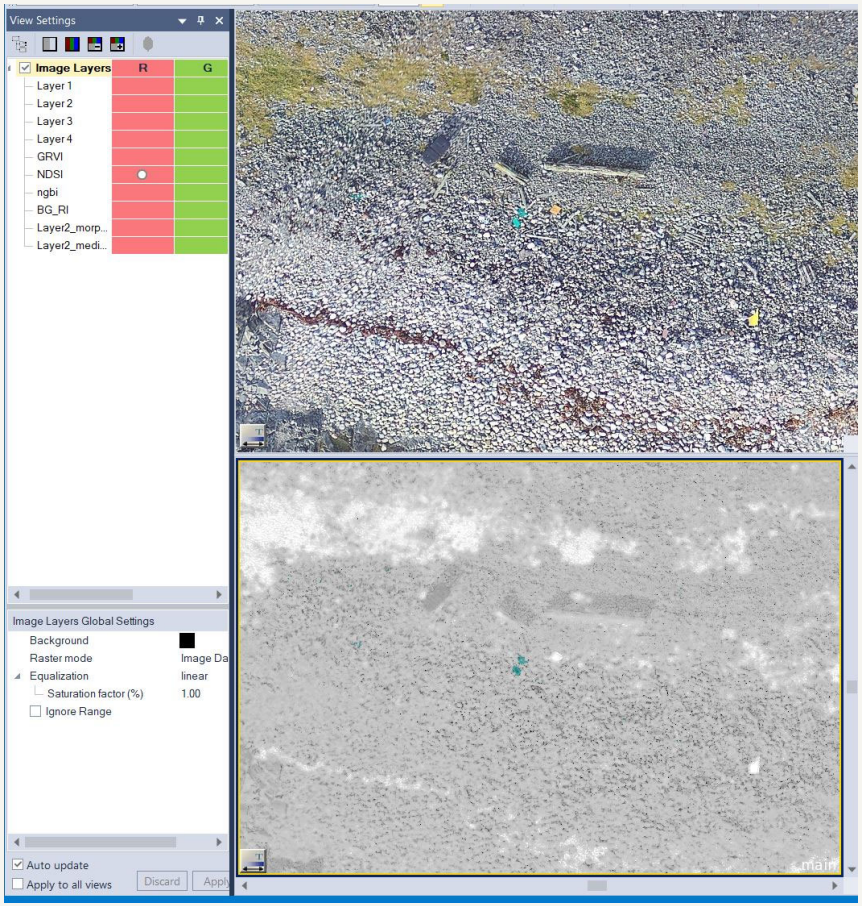
Machine learning

Picture analysis from drone pictures: multiresolution segmentation techniques in eCognition

Green and white plastic







eCognition detects also smaller pieces of plastic creating new layers with countless possibilities of algorithm

Detecting beach litter from satellite images

Satellite pictures are always readily available

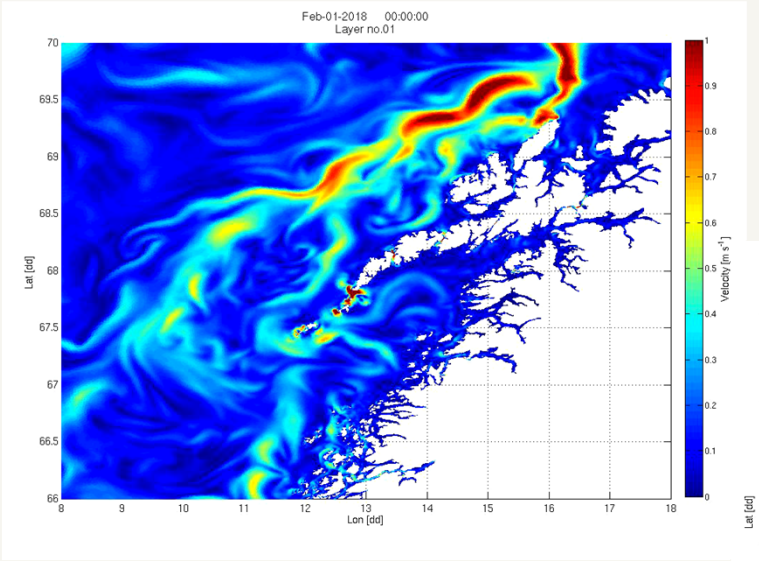
Use of free satellite images from Sentinel 2 and Landsat 8 with commercial WorldView and Kompsat satellites

Sample method: plastic debris quantification combining satellite images and ground truth data by SALT

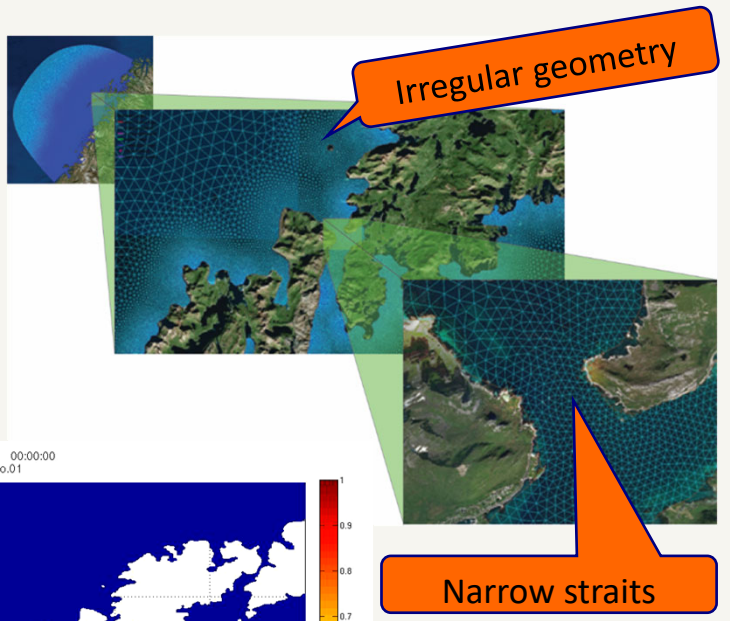
Detecting "ghost nets"

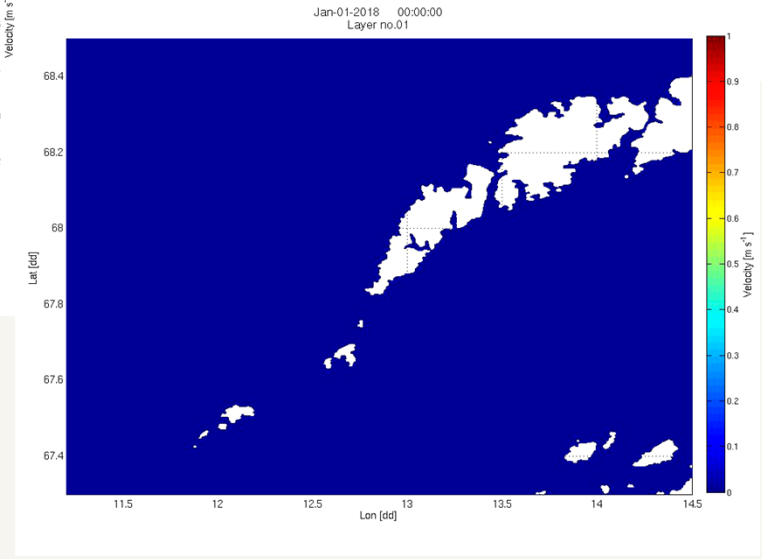
Modelling

HD Model: unstructured grid model FVCOM



A multi-scale (from 30m to 2.4km) is implemented to resolve multi-scale dynamics

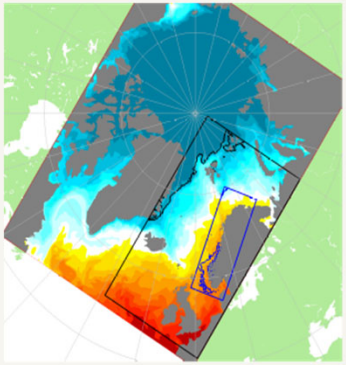




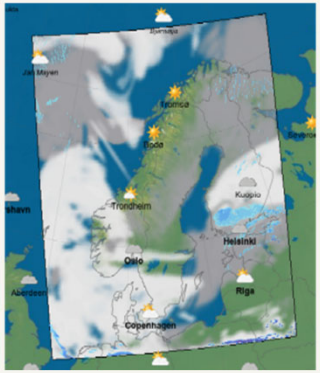
Modelling

HD and Drift models coupled

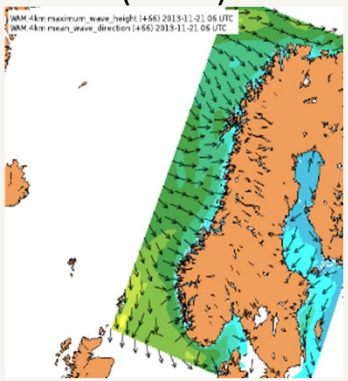
Ocean model (ROMS)

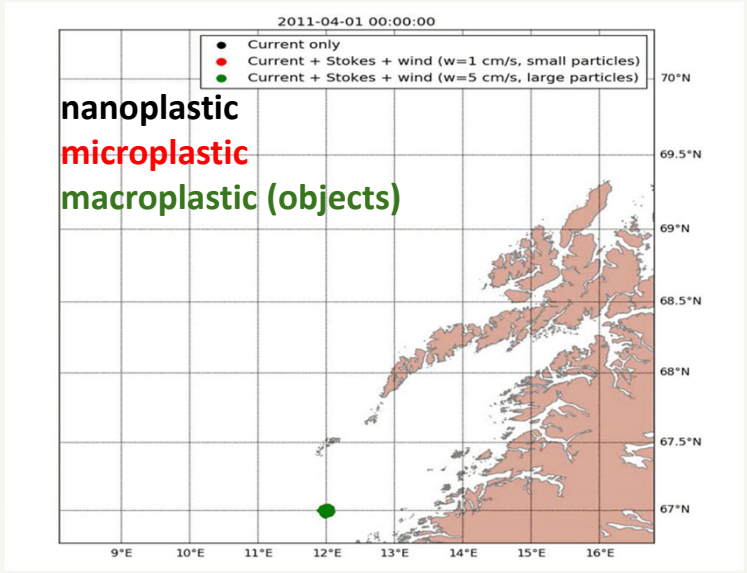


Atmospheric model (Arome)



Wave model (WAM)

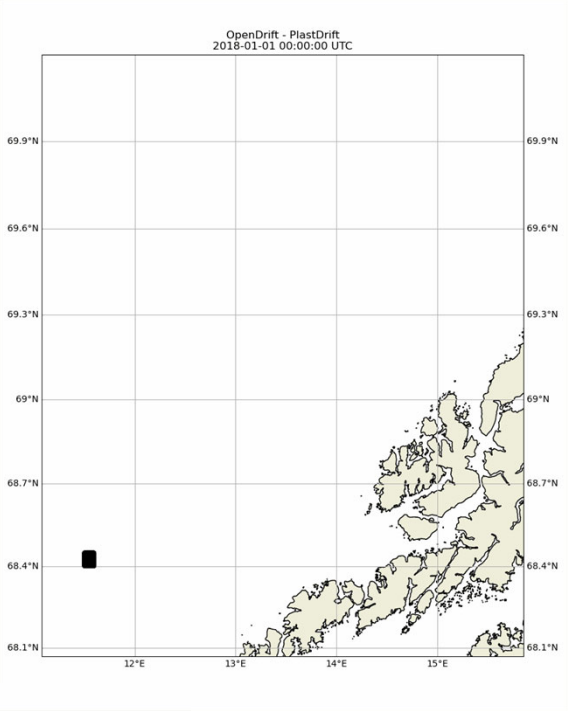




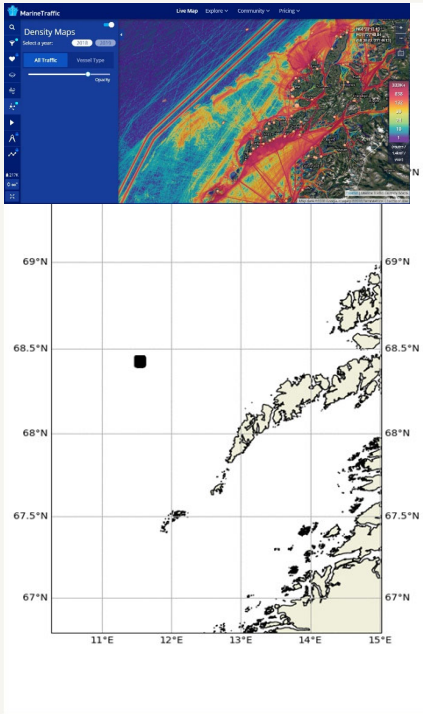
FVCOM ↔ OpenDrift ↔ Modules

Experiments: example scenario

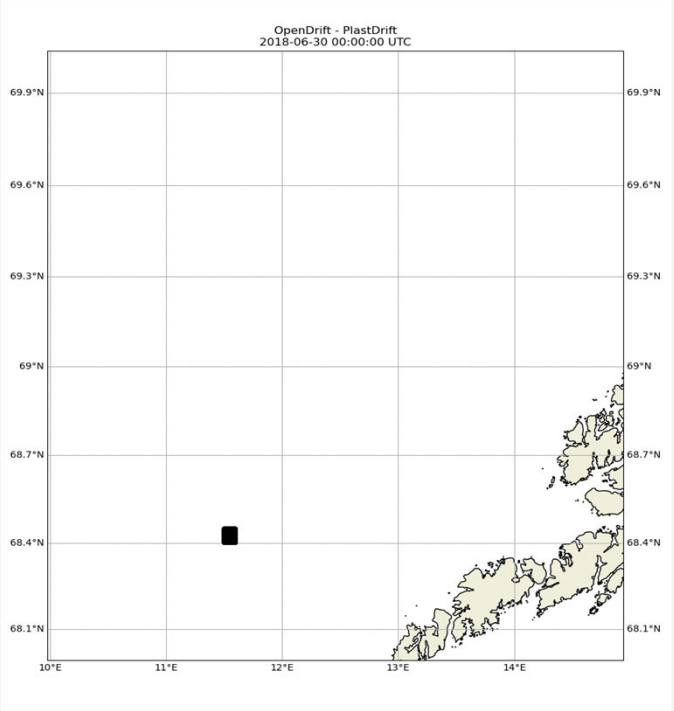
Initial release: 5000
January 2018



Initial release: 5000
April 2018



Initial release: 5000
July 2018



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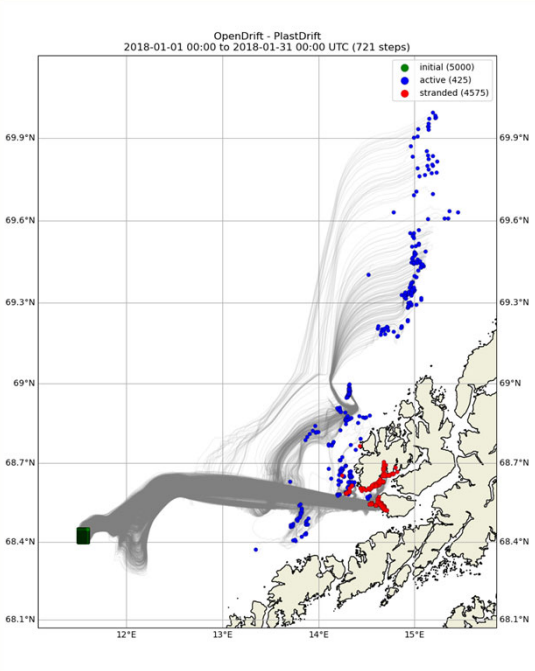
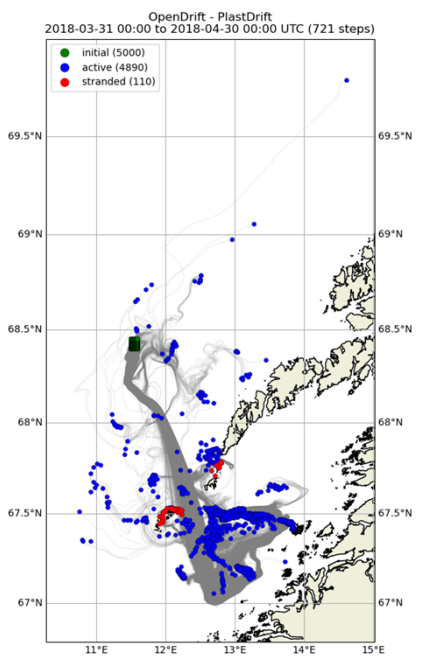
Experiments: trajectory



January 2018
Initial release: 5000
Active: 425
Stranded: 4575



April 2018
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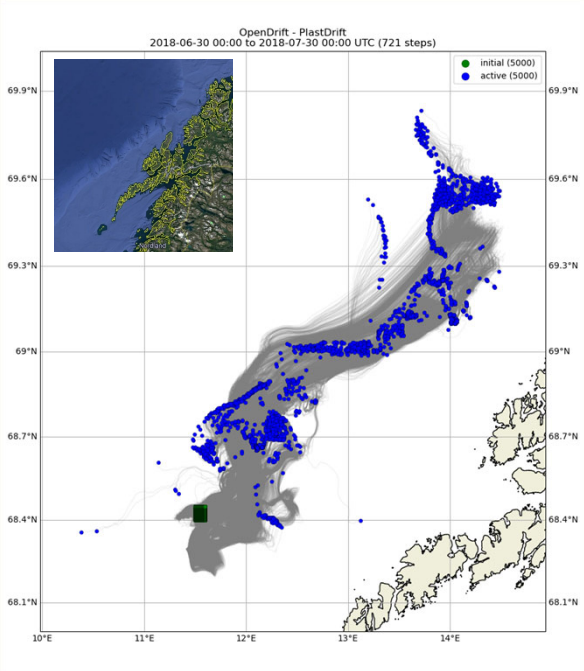
Stranded: 110



July 2018
Initial release: 5000
Active: 5000
Stranded: 0

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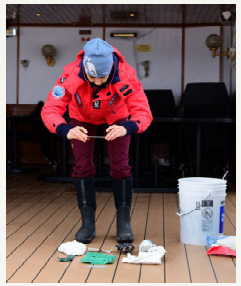
Citizen science

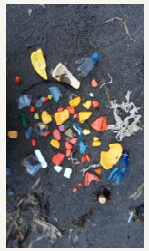
Engaging tourists and tourist operators in citizen science activities

In 2019, Akvaplan-niva scientists participated in Arctic voyages, gave lectures for tourists and crue onboard cruise vessels and involved them in mapping marine litter on beaches:

- August 2019: Poseidon Expeditions voyage to Franz Josef Land; 5 beaches on 4 islands; litter mapping with Litterati mobile app
- September 2019: Hurtigruta voyage to Svalbard/Spitsbergen; 14 beaches; litter mapping with OpenLittermap mobile app

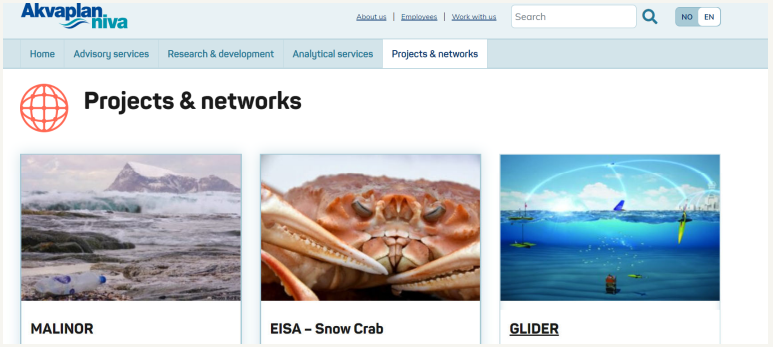
In 2020, RANP and MMBI carried out litter mapping in the Russian Arctic islands during research cruises applying MSFD, OSPAR and Marine LitterWatch methodologies

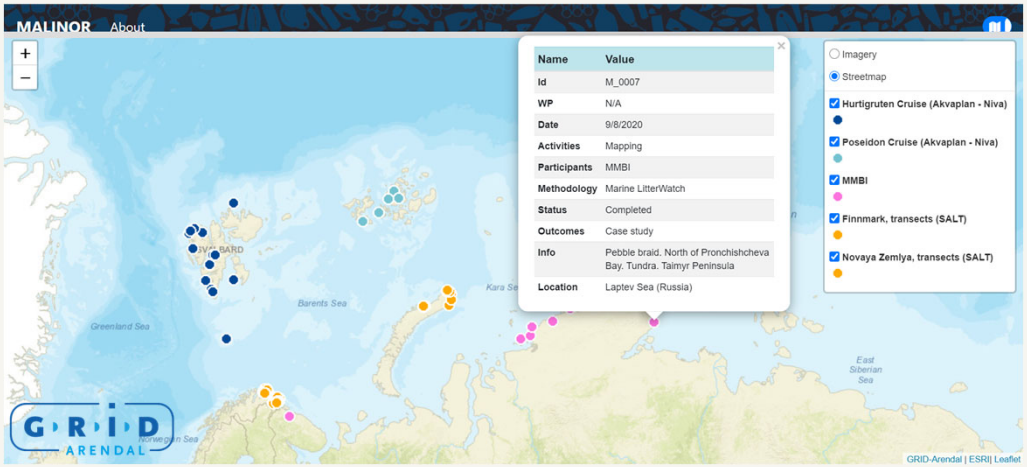


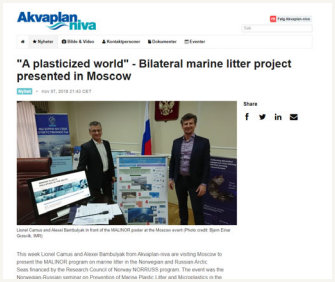


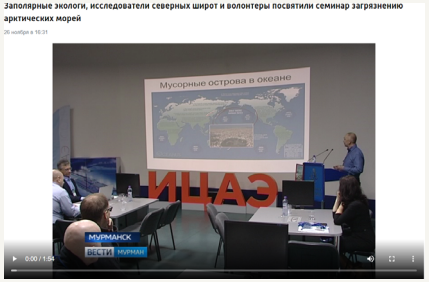
Outreach

- ✓ Project page at Akvaplan-niva web-site
- ✓ Presentations at conferences, seminars, workshops, meetings
- ✓ News and reports in media: TV and newspapers
- ✓ News items in social media: MyNewsDesk, Facebook, Twitter
- ✓ Lectures for students and public
- ✓ Scientific papers and reports
- ✓ Web-GIS with project activities and results by GRID-Arendal









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