# Habitat mapping and biotope modelling in MAREANO

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# MAREANO habitat (nature type) mapping

MAREANO habitat mapping at all spatial scales follows and contributes to development of **N**ature Types **i**n **N**orway (**NiN**) classification system *(see talk by Arild Lindgaard)*

Landscape level – broad-scale geomorphic features

Landscape element – landforms

**Ecosystem level**

- **’habitats’** *(top down)*
- **biotopes** *(bottom up)*

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# Top-down habitat (nature type) mapping in MAREANO

NiN defined ecologically relevant variables (ecoclines) and modifiers (sources of variation)

*ecoclines*

Photic/Aphotic

MAREANO interpreted sediments recoded to NiN substrate stabilty classes

*sources of variation*

Water mass properties

Seabed energy

+ ’Special’ habitats – corals, kelp etc.

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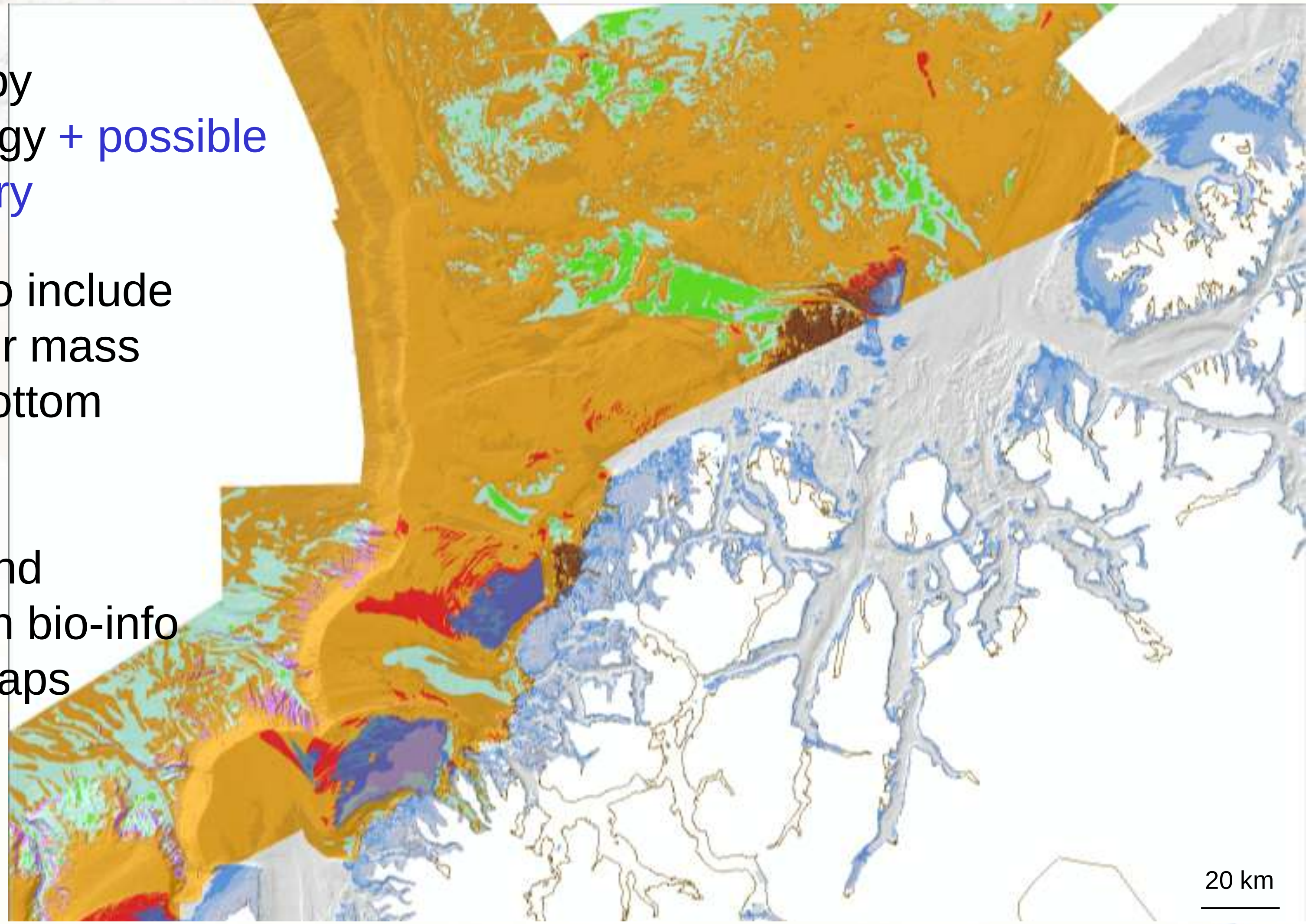
# Top-down habitat (nature type) mapping in MAREANO – initial results

Main classes by sediment/energy + possible photic boundary

Further work to include modelled water mass properties + bottom currents

Comparison and integration with bio-info and biotope maps



20 km

# MAREANO biotopes

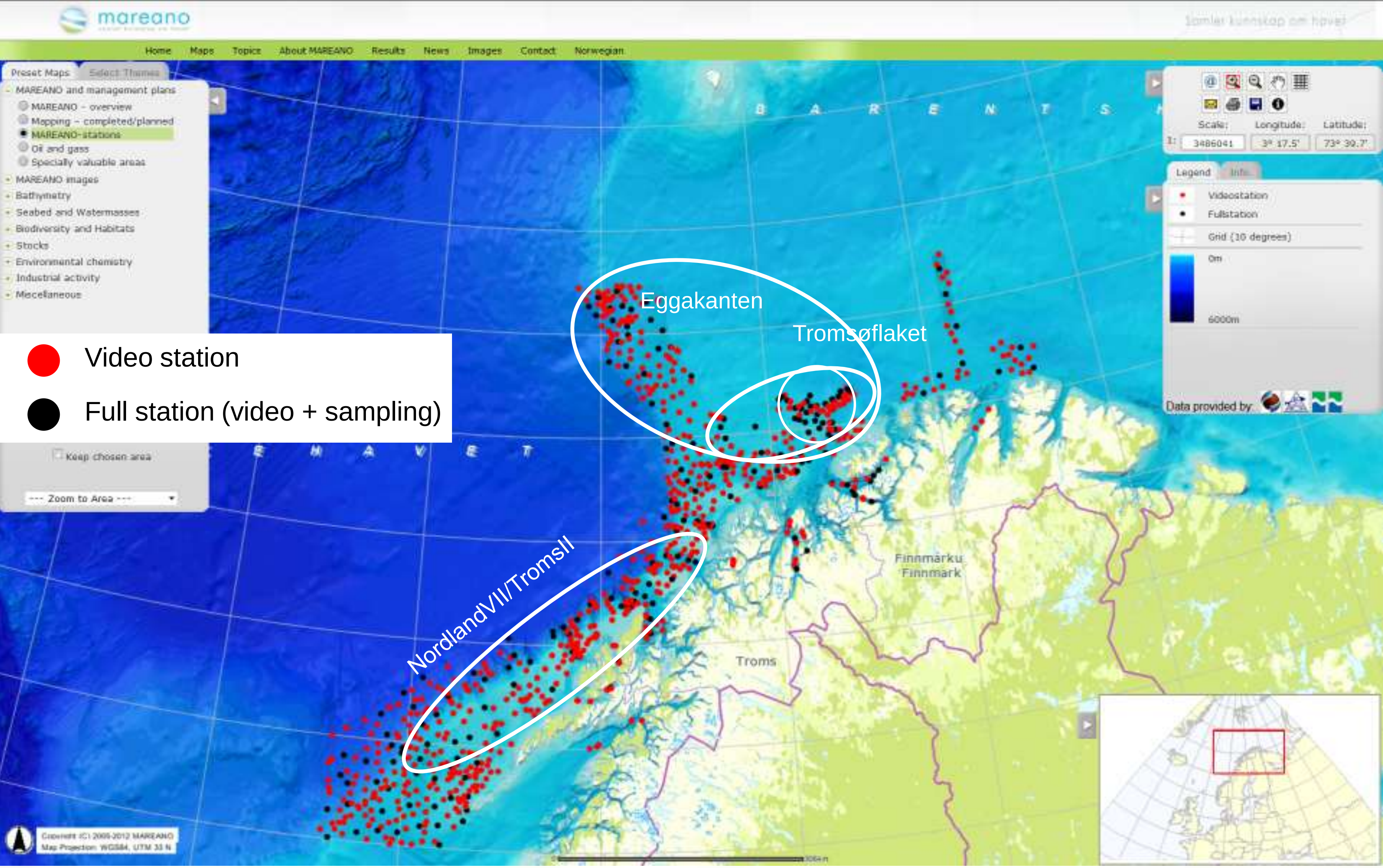
**N**ature Types **i**n **N**orway (**NiN**) classification system does not yet provide a mechanism to incorporate biological information at the ecosystem level – *work in progress NiN version 2 (2012 +)*

MAREANO to date has identified and modelled the distribution of **biotopes**

**This is a bottom up approach to 'habitat' mapping**

***N.B.*** *offshore biology poorly understood in many areas before MAREANO, not looking for 'known habitats' - need to examine species composition and identify typical communities and their environment - BIOTOPES*

- *video data are primary source of information for biotope ID*
- *multibeam data give predictor variables for distribution modelling*




Video and multibeam – major inputs to biotope mapping

Biotope modelling in 3 main areas so far – method development

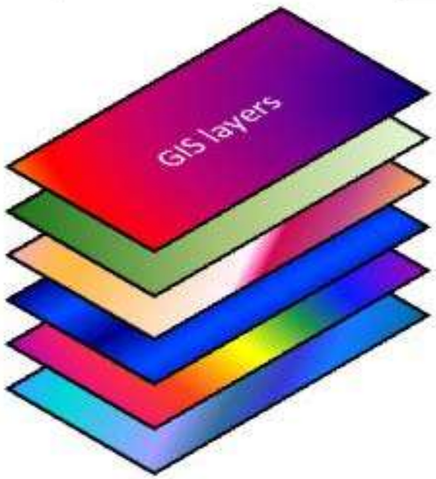
# Habitat/biotope modelling

## MAREANO – biotopes!

seabed observations

(point data) species or habitat/biotope class

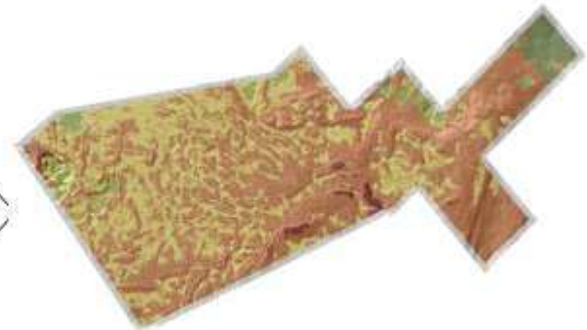
+




(full coverage data) environmental layers/predictor variables

multivariate statisitics and modelling

*classification/modelling*



habitat map

From Brown et al. (2011) Estuarine, Coastal and Shelf Science 92 (3), 502-520

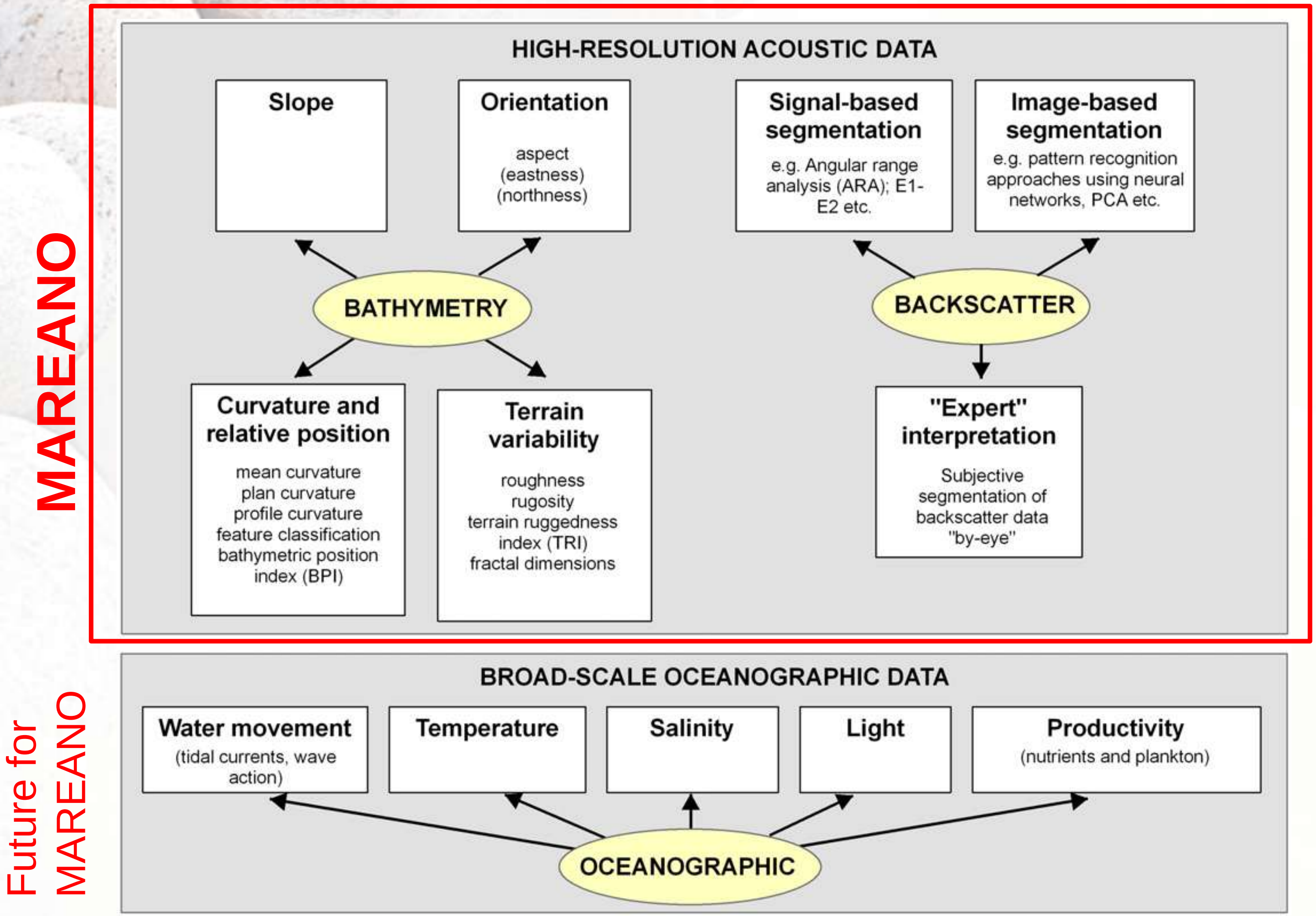
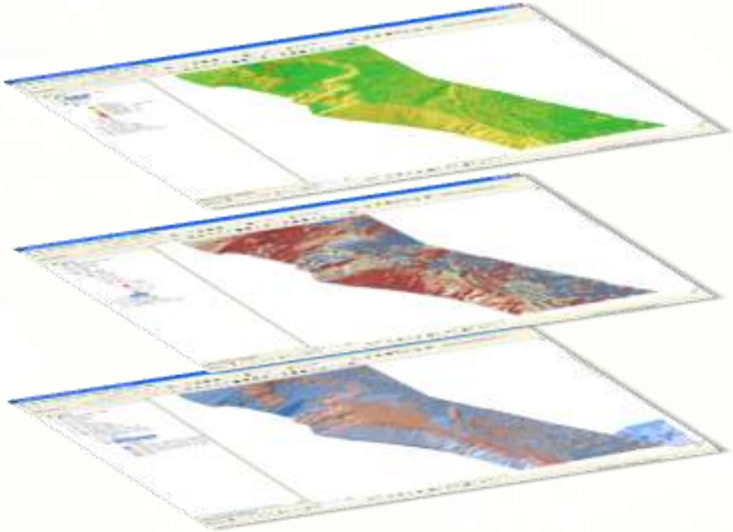



Fig. 2. Spatial data sets used for habitat segmentation. Primary data (bathymetry and backscatter), and secondary layers (white boxes). Oceanographic data can also be used, but is more difficult to measure at a spatial scale required for effective habitat delineation. Modified from Wilson et al. (2007).

***Each terrain variable can be derived at multiple scales!***

# MAREANO biotope maps - data

- Environmental info for habitat maps from multi-scale variables derived from multibeam data (bathymetry + backscatter)
  - **proxies** to ecologically relevant environmental factors
  - **also available - interpreted geology maps (sediment grain size, sedimentary environment, landscape*)**



- Biological info for habitat maps from pooled observations of taxa along each c. 200 m of video transect
  - detailed, time consuming video analysis requiring expert knowledge

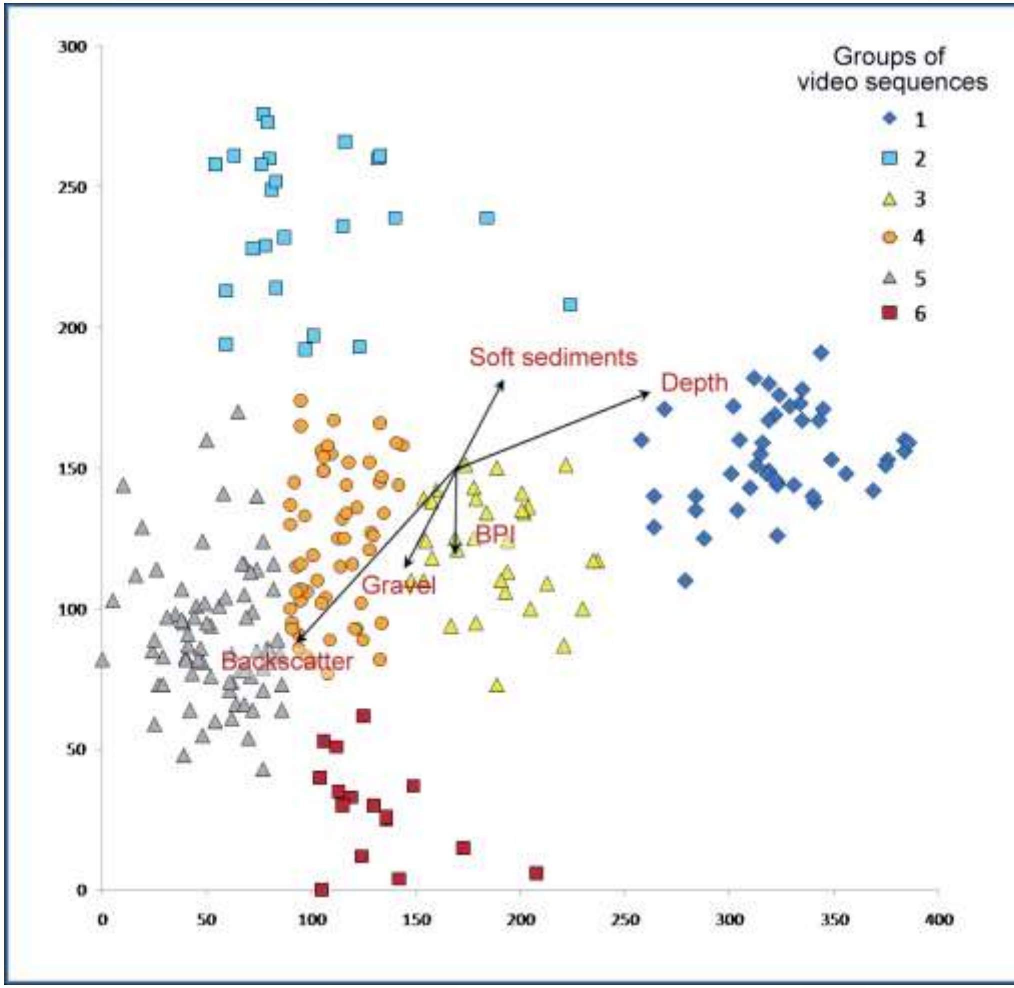
# MAREANO biotope maps - classification of biological data

- To use biological observations in biotope mapping need a method to find natural groupings of observed taxa which will be representative for each habitat
  - ➢ *Detrended correspondence analysis (DCA)*
  - ➢ *Cluster analysis*

- DCA preferred over other correspondence analysis (e.g. CCA) because it is an **indirect** gradient analysis
  - ➢ *finds biological groupings in multidimensional space and fits environmental variables onto this*
  - ➢ *preferable when little is know of the biology and therefore how well the environmental variables account for the distribution*

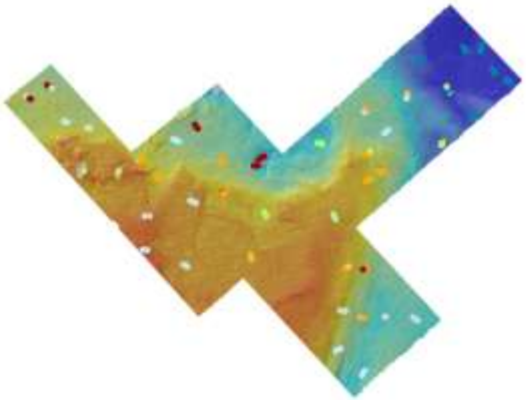
# Multivariate classification– DCA example

- Results so far indicate that DCA gives more natural groupings spatially and ecologically than cluster analysis
- Challenge to find best biotope groupings.
  - Use 3D visualisation (+ check spatially), *use statistical methods*
- Standardisation of bio data important

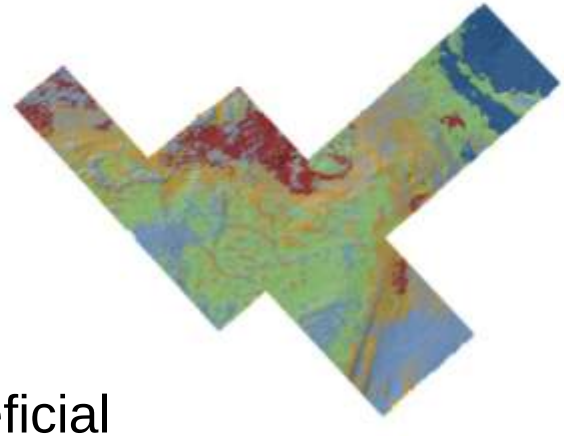


# Biotope maps – converting point observations to a full coverage map

- Initial trials on Tromsøflaket indicated classification of our data is *possible* using supervised classification/MLC in ArcGIS. Dolan et al (2009) NJG 89, Buhl-Mortensen (2009) ICES JMS 66



- Tromsøflaket fairly restricted in terms of environmental variation
  - ➢ Applications of of SC/MLC on Eggakanten etc. highlight that this approach is limited both in terms of how it uses the variables, the inputs you can use and the output statistics



- More complex classification/modelling methods beneficial e.g. MAXENT
  - ➢ general spatial modelling tool. Philips et al (2006) Maximum entropy modeling of species' geographic distributions. Ecological Modelling, 190:231-259. Many ecological applications.
  - ➢ can include categorical data
  - ➢ creates suitability model for each habitat class

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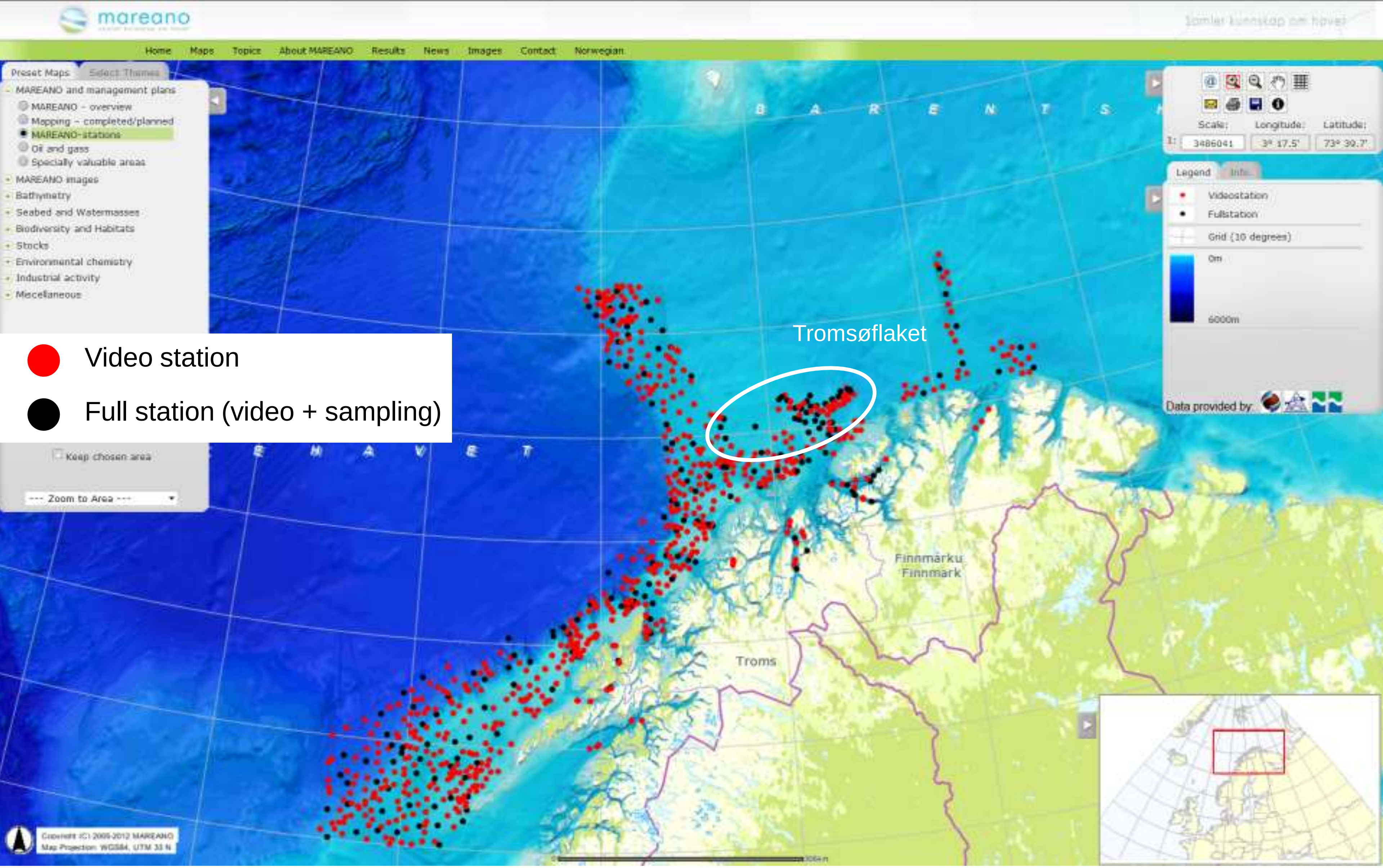
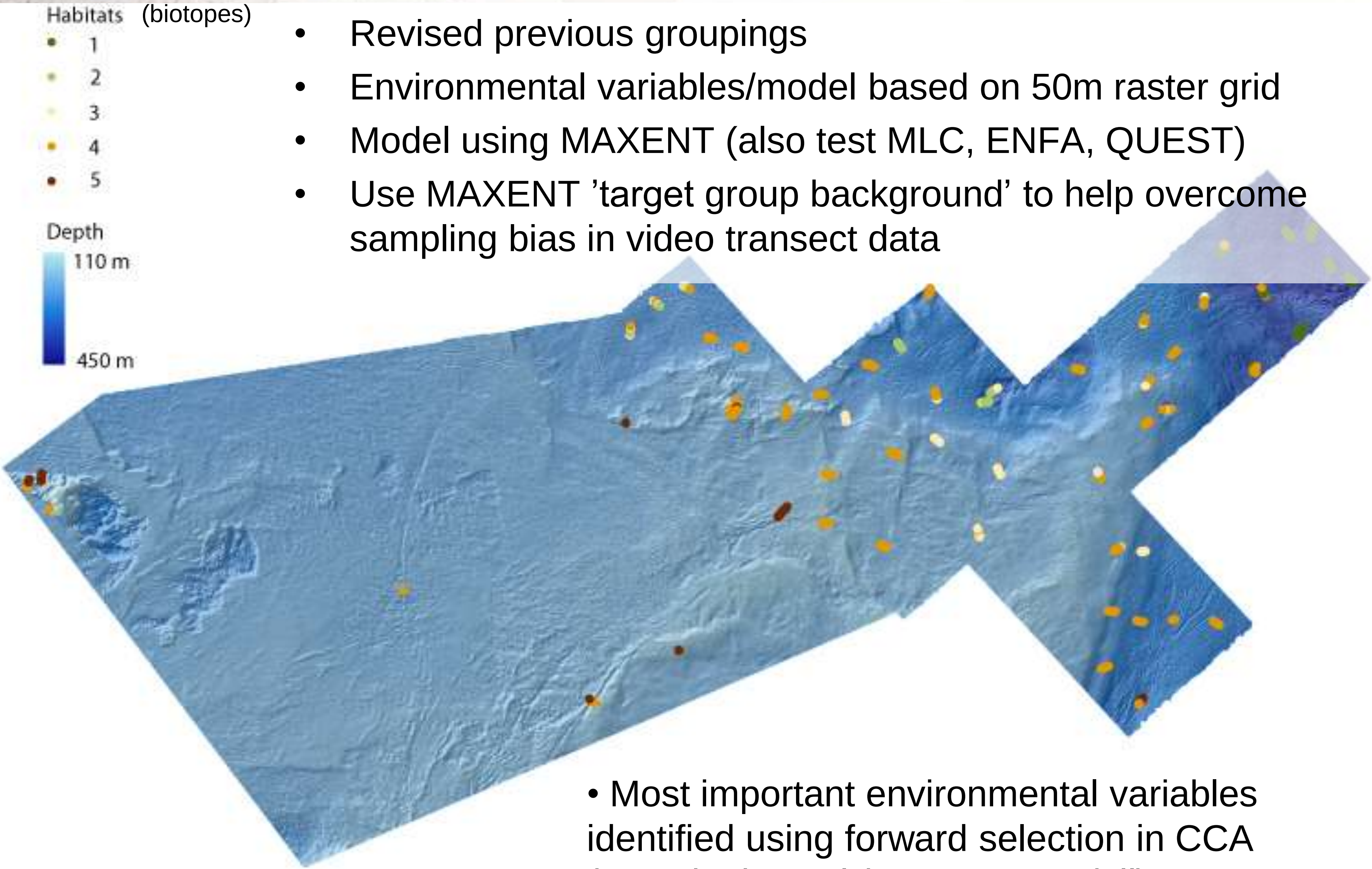



# Tromsøflaket 2010 - extend and revise biotope map

# Tromsøflaket - observed biotopes and model development




- Revised previous groupings
- Environmental variables/model based on 50m raster grid
- Model using MAXENT (also test MLC, ENFA, QUEST)
- Use MAXENT 'target group background' to help overcome sampling bias in video transect data

- Most important environmental variables identified using forward selection in CCA (quantitative only) + MAXENT (all)

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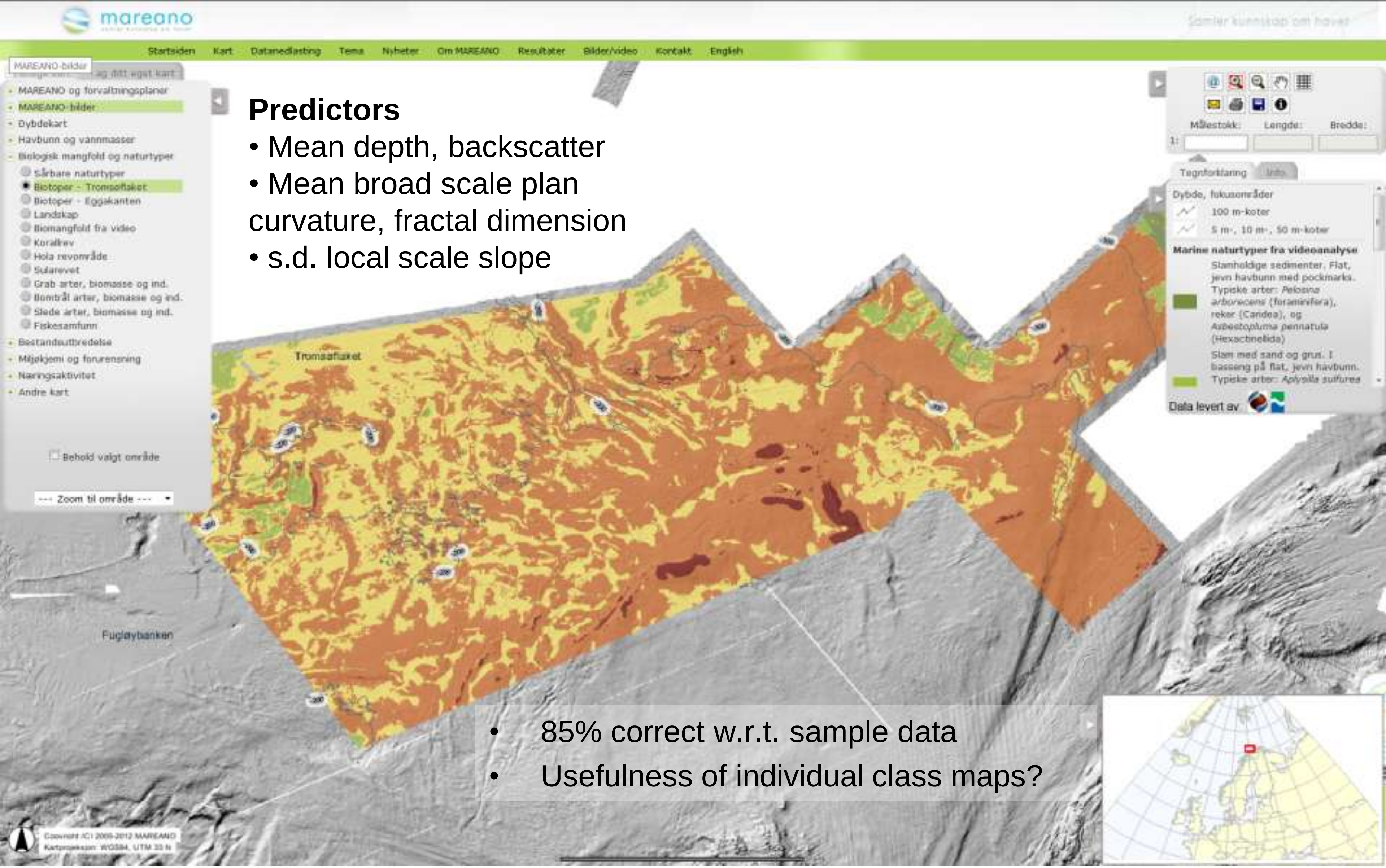
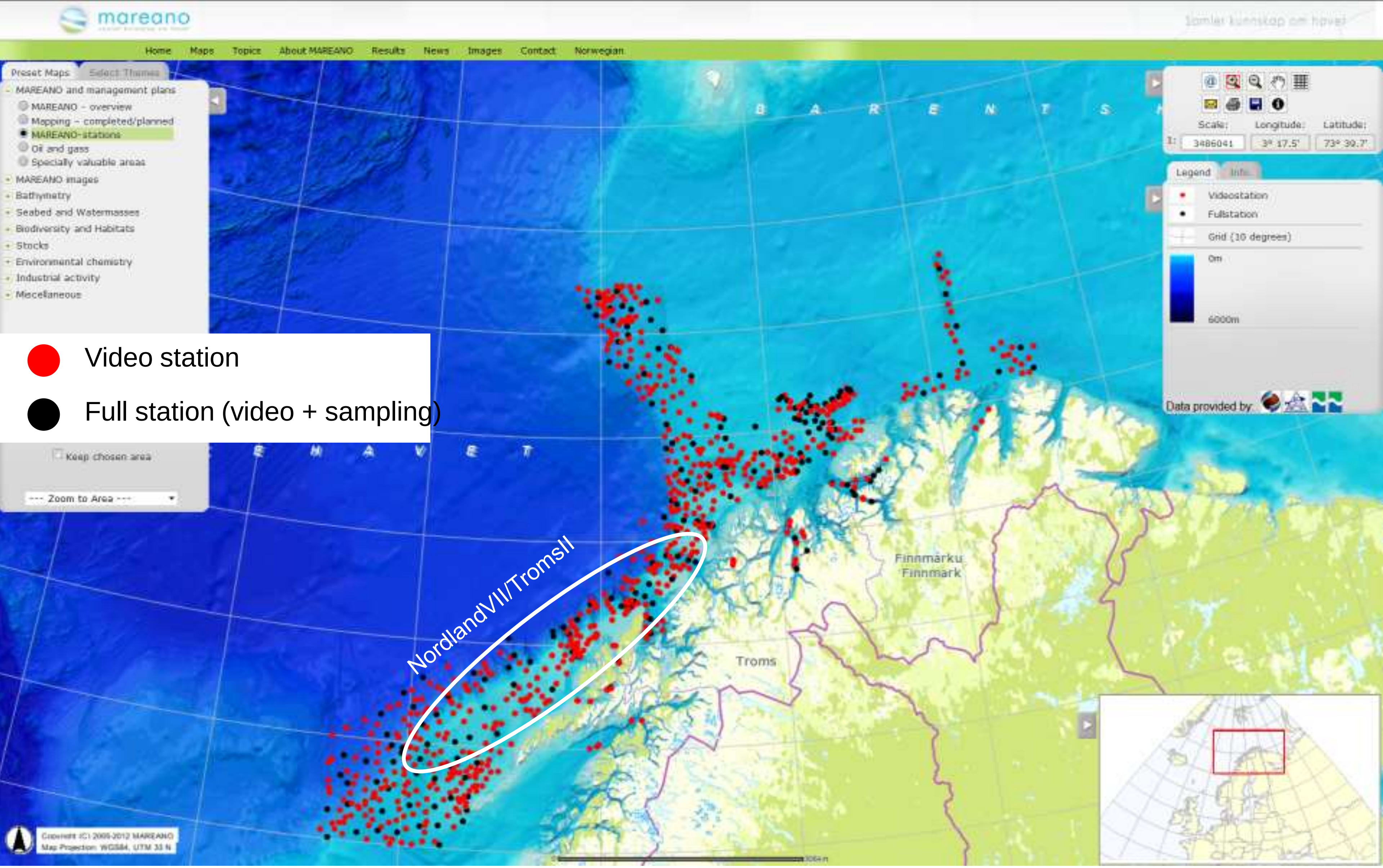



**Predictors**

- Mean depth, backscatter
- Mean broad scale plan curvature, fractal dimension
- s.d. local scale slope

- 85% correct w.r.t. sample data
- Usefulness of individual class maps?

**Biotope map for Tromsøflaket** – version 2 – revised and extended - MAXENT based model




**Nordland VII/Troms II ±2011** – biotope mapping over larger biogeographic region with lots of environmental variation

**Table 6. Summary of the physical and biological characteristics of each biotope class represented in the final composite biotope map (Figure 20).**

| Biotope class | Depth range | Landscape type (Halvorsen et al., 2009) | Sediments and terrain | Typical taxa (from video observation) | Other characteristics |
|---|---|---|---|---|---|
| 1 | 1200-1500 m | Continental slope/canyon | Variable sediment composition (mud to gravelly sand), regional/local topography uneven | Nemertini pink, Actiniaria small pink, Hexactinellida bush, *Lycodes* sp. *Bythocaris* | |
| 2 | >1500 m | Deep sea plain/ continental slope (lower) | Gravelly, sandy mud | *Rhizocrinus/Bathycrinus, Elpidia, Hymenaster, Kolga, Caulophacus* | |
| 3 | 1000-1700 m | Continental slope (middle) | Variable sediment composition (mud to gravelly sand), regional topography uneven | *Chondrocladia, Lucernaria,* Pycnogonida, *Umbellula, Ophiopleura* | |
| 4 | 150-300 m | Continental shelf plains/marine valleys | Sand/gravelly sand, flat areas | *Asteronyx, Funiculina, Ditrupa, Flabellum, Pteraster* | |
| 5 | 70-180 m | Continental shelf plains/marine valleys | Variable sediment composition (sand to coarser), flat areas | *Pteraster, Ceramaster, Hippasteria, Sebastes, Spatangus* | Mainly north of 69°N |
| 6 | <300 m | Continental shelf plains/marine valleys | Variable sediment composition (gravelly sand to coarser), flat areas | *Phakellia, Craniella, Geodia, Stryphnus, Mycale* | |
| 7 | 50-80 m | Continental shelf plains | Gravel, cobbles and boulders, flat areas | Gorgonacea, *Filograna*, Tunicata white, *Lithothamnion*, Serpulidae | North of 69°N, erosional environment |
| 8 | 500-850 m | Continental slope (upper) | Gravelly and/or muddy sand, steep areas of uneven topography | *Gorgonocephalus, Crossaster, Paragorgia, Gersemia, Drifa* | |
| 9 | 200-350 m | Marine/shallow marine valleys | Sandy/muddy sediments, flat areas | *Kophobelemnon, Parastichopus,* Pandalidae, *Virgularia, Steletta* | |
| 10 | 100-500 m | Continental shelf plains/marine valleys/ continental slope (upper) | Variable sediment composition, variable topography | *Lophelia, Acesta, Axinella, Primnoa, Protanthea* | |

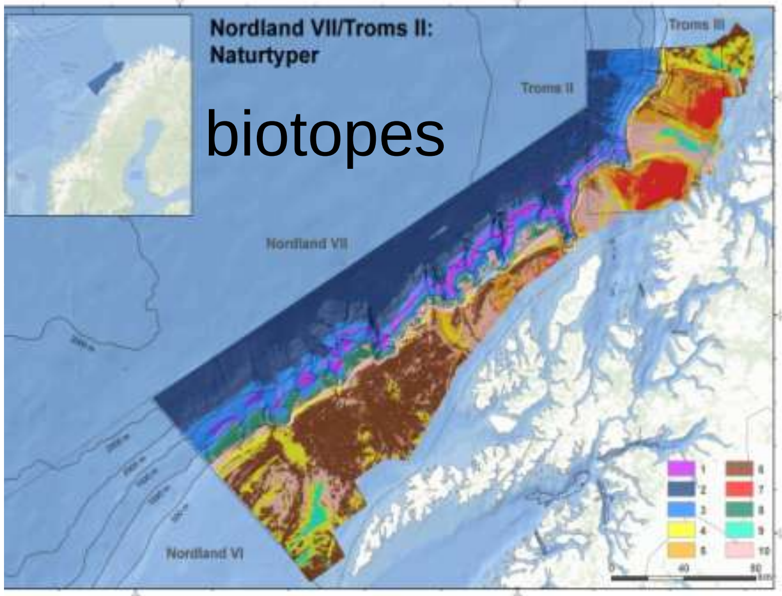




Table from Elvenes, Buhl-Mortensen & Dolan (2012) NGU Report 2012.030

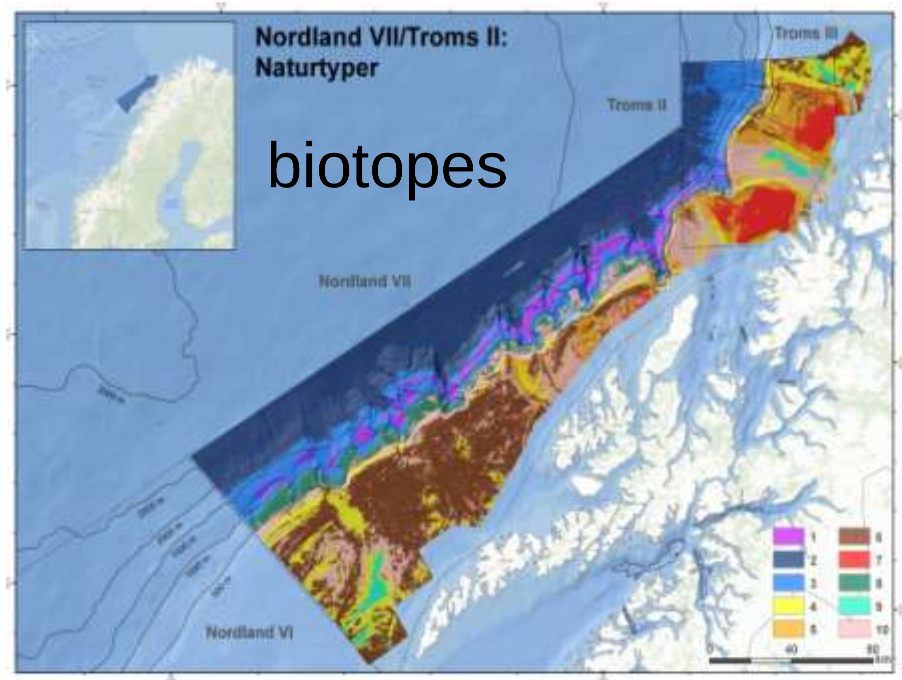
New predictors tested - Landscape (NiN), Latitude (UTM north) (biogeo)

**Table 3. Environmental predictor variables used in biotope modelling based on multibeam data. Means and standard deviations were calculated over a 200 x 200 m analysis window.**

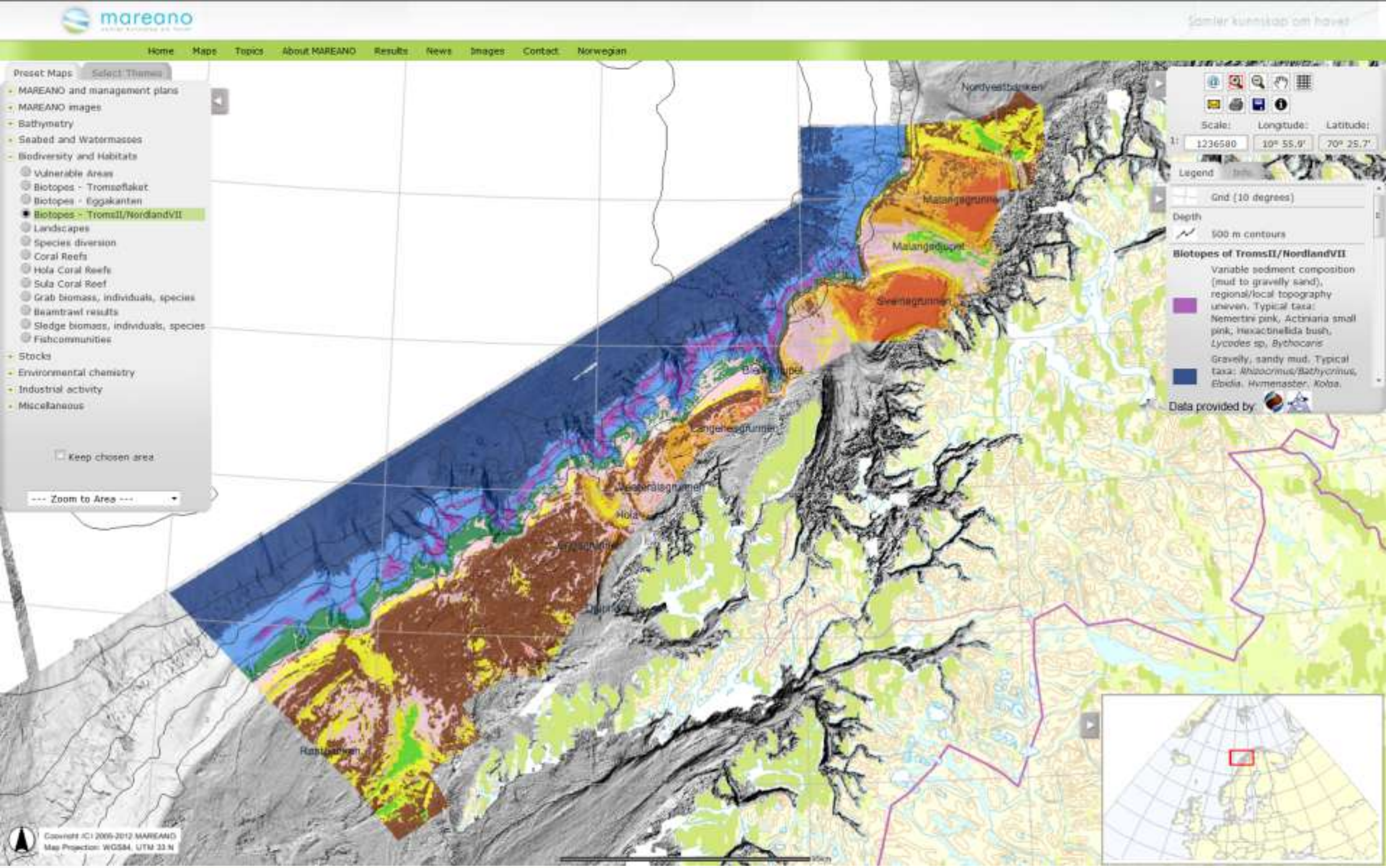
Table from Elvenes, Buhl-Mortensen & Dolan (2012) NGU report 2012-030

**Predictor variables** (not in order)

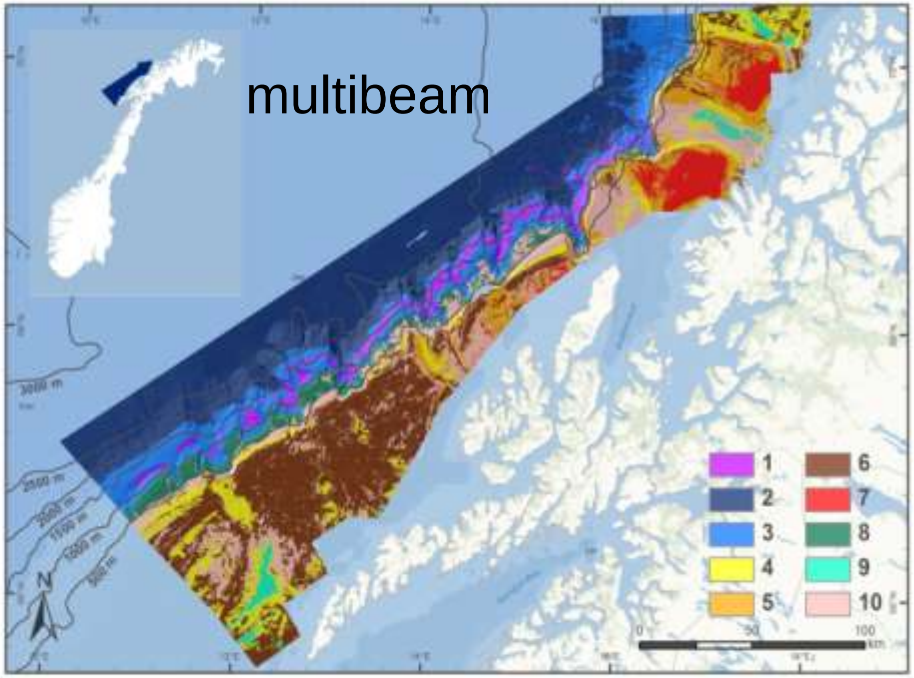
| Environmental predictor variable | Analysis window (cell size 50 m) |
|---|---|
| Mean depth | |
| Mean backscatter | |
| Landscape type (categorical) | |
| Sediment grain size (categorical) | |
| Sedimentary environment (categorical) | |
| Mean UTM latitude | |
| Mean slope | 21 x 21 cells |
| Mean slope | 49 x 49 cells |
| Mean of northness | 49 x 49 cells |
| Mean bathymetric position index (BPI) value | 49 x 49 cells |
| Standard deviation of BPI values | 3 x 3 cells |
| Mean of mean curvature | 49 x 49 cells |
| Standard deviation of mean curvature | 3 x 3 cells |
| Mean of rugosity | 3 x 3 cells |
| Mean of fractal dimensions | 49 x 49 cells |

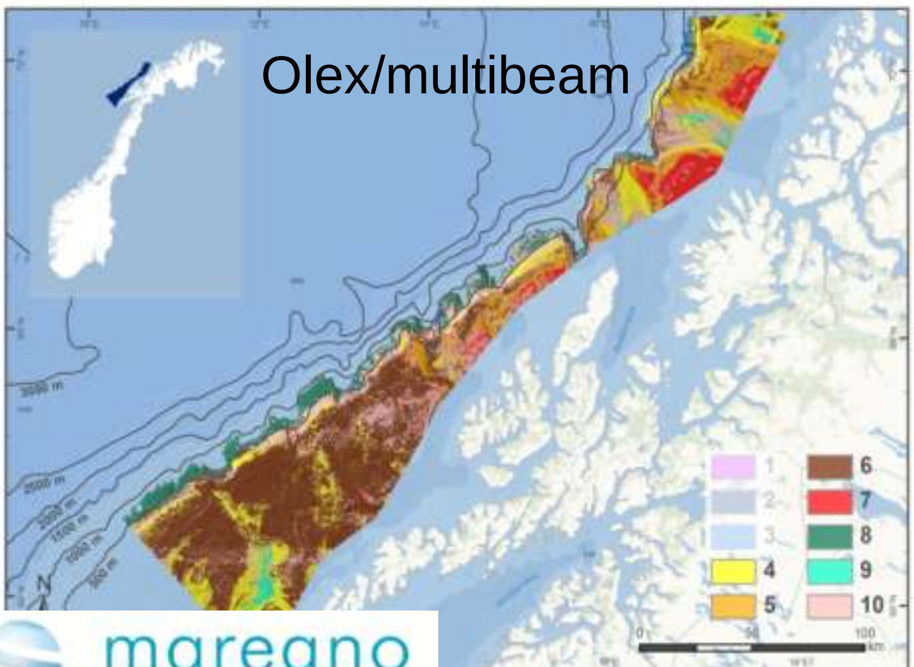



- Continue use of MAXENT based approach as Tromsøflaket
- Biotope classes - big environmental gradients – 'stepwise' DCA
- Extended range of environmental predictor variables
- Individual biotope maps, generally good performance (AUC etc.)
- Composite map ~75% correct w.r.t. sample data (50m grid)




**Biotope map for Nordland VII/Troms II** – published June 2012




From Elvenes, Buhl-Mortensen & Dolan (2012) Evaluation of alternative bathymetry data sources for MAREANO: ***A comparison of Olex and multibeam data for substrate and biotope mapping.*** NGU report 2012-030. www.ngu.no

Figure 20. Modelled distribution of biotopes in the study area. A: Combined model results from the MAREANO dataset. B: Combined model results from the Olex-MB composite dataset (area below 800 m is disregarded due to lack of Olex coverage).


Figure 2. Olex data coverage in Norwegian waters.

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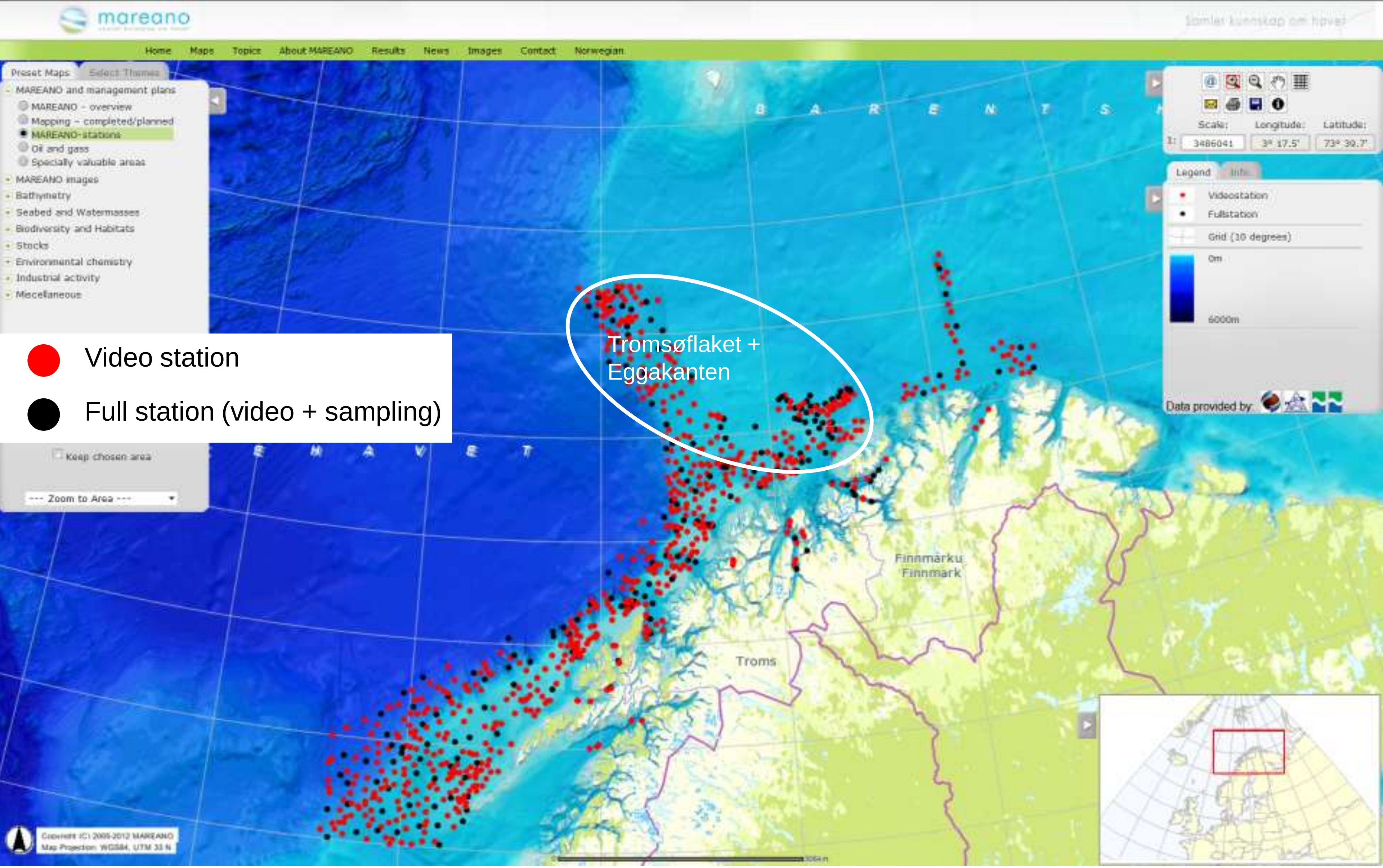



**Biotope modelling at Tromsøflaket and the Eggakanten area 2012 – revisting, extending and harmonising**

# Revisting, extending and harmonising Tromsøflaket & Eggakanten

- Standardisation of video analysis several years on – identification and taxonomic nomlencature

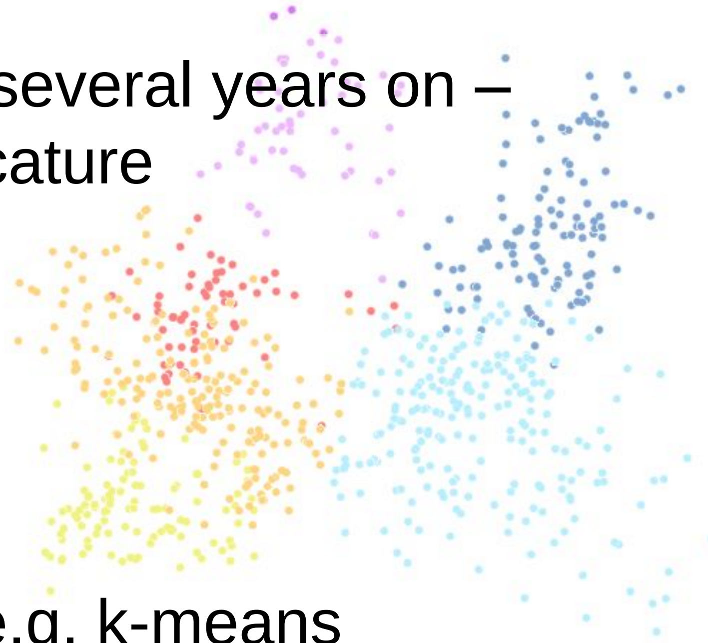
- Role of rare species

- Role of generic species

- Statistical methods for clustering e.g. k-means

- How to classify and harmonise new data?

- Improved/alternative modelling methods?



# MAREANO habitat mapping and biotope modelling – future directions

- Habitat mapping (NiN) – use best available data and classify to NiN v.1, recommend improvements for NiN v.2

- Biotope modelling
  - ➢ Harmonisation of biotope maps across all MAREANO
  - ➢ Ensure biotopes are delivering relevant information for management
  - ➢ Continue method development
  - ➢ Integration of biotope-level info in NiN v.2