VELMU
The Finnish Inventory Programme for the Underwater Marine Environment

VELMU surveys the biodiversity of the underwater marine environment

Aiming towards the sustainable use and protection of the Baltic Sea

Marine nature – a true treasure trove

Finland's marine nature is exceptionally beautiful. While it may not boast as many species as can be found in the oceans, Finland's tens of thousands of islands, skerries, straits, coves, lagoons, sandy beaches, underwater rocks and ridge formations create a particularly diverse habitat for plants and animals alike. You can find a wide array of colourful species and diverse nature, provided you know where to look.

Marine biodiversity at risk

Biodiversity is the foundation for life on earth, and the sea is no exception. However, the balance of the marine ecosystem and its biodiversity are currently under threat. Eutrophication and harmful substances are putting pressure on the Baltic Sea, while the distribution of species is changing as a result of climate change. The natural state of the sea is subject to constant change due to the construction of ports and bridges, extraction of gravel and sand, dredging, and disposal of dredge spoils. Moreover, organisms are threatened by disturbances to their habitats, excessive fishing, oil and chemical accidents, invasive species, plastic litter and underwater noise.

To avoid damaging our valuable marine environment, we need to know what kind of life exists beneath the surface of the sea. The Finnish Inventory Programme for the Underwater Marine Environment, VELMU, collects data for precisely this purpose – to promote the protection and sustainable use of the sea.

MATS WESTERBOM

Eelgrass (*Zostera marina*) is found only in the southern and southwestern marine areas of Finland. In many places there, together with other aquatic plants and some types of algae, it forms underwater meadows used by a variety of fish and invertebrate species for feeding and reproduction.

VELMU produces valuable information on Finland's marine nature

Since it started in 2004, VELMU has collected observations from more than 150,000 points, which has provided us with an overall picture of species and habitats in our marine areas.

This information is available in the open VELMU Map Service, and the programme has produced a book, *Meren aarteet* (2017), that provides general information on Finland's underwater marine nature.

The Baltic Sea is a large, geologically young and northern brackish-water basin, which makes it a unique and challenging habitat for plants and animals. The shallow bays found in the northern parts of the sea, which are sheltered from seafaring traffic, can be home to a vast array of vegetation. Species found in these waters include coral stonewort (*Chara tomentosa*), holly-leaved naiad (*Najas marina*), bladderworts (*Utricularia*), water-milfoils (*Myriophyllum*), pondweeds (*Potamogeton*) and various macroalgae (all pictured here). For invertebrates and fish, this warm jungle is a paradise: the abundant vegetation provides both food and shelter.

MAIJU LANKI, PARKS & WILDLIFE FINLAND

The objectives of VELMU are

- to map underwater marine nature and explore the characteristics of marine nature with a particular emphasis on increasing knowledge about species and habitats that are either endangered or whose status cannot be assessed properly due to deficient data,
- to process the collected data so it can be used to support the conservation and sustainable use of nature,
- to explore the characteristics of marine nature in areas under human pressure; and
- to engage in international cooperation in mapping marine biodiversity across the Baltic Sea region.

VELMU also produces data that can be used in solving topical environmental issues. For example, work on detecting the occurrence of plastic litter and the spread of invasive species has begun in many areas.

JOONAS HOIKKALA, METSÄHALLITUS

ESSI KESKINEN, METSÄHALLITUS

PEKKA LEHTONEN, METSÄHALLITUS

When material is dredged from the seabed, local species can be lost along with it. In addition to the destruction of species and their habitats, dredging clouds the water and generates strong underwater noise that carries far in the marine environment. Charophytes, a type of green algae, are sensitive to changes in the marine environment and often disappear if the water becomes clouded as a result of eutrophication or dredging. The bristly stonewort pictured here (*Chara horrida*) has been assessed as endangered. There have only been a few recent observations of the species, most of them from the Åland Islands, but also from a few sites in the Archipelago Sea and the southern Bothnian Sea. The species has not been observed in its old habitats in the coastal areas of the Gulf of Finland.

How is the data on underwater nature used?

VELMU mapping data can be used for a wide range of purposes, such as

- developing the network of protected areas
- planning the management and use of existing protected areas
- assessing the conservation status of species and habitats
- protecting threatened species and habitats
- protecting fish breeding areas and fish populations
- assessing the state of the sea
- planning the sustainable use of marine areas
- minimising the damage caused by oil and chemical accidents
- mapping regional ecosystem services
- detecting and anticipating the impacts of climate change

The data is used by the authorities, research and educational institutions, civil society organisations and private citizens alike. Finland is committed to the protection of the marine environment and the sustainable use of marine nature through national and EU legislation and a number of international conventions, such as the UN Convention on Biological Diversity (CBD) and the Helsinki Convention. VELMU produces valuable data used in fulfilling these commitments.

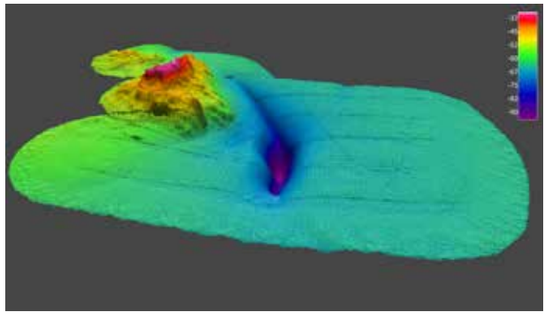
The selection of the survey method depends largely on the characteristics of the research area. Every year, underwater photography produces hundreds of pictures for VELMU that reveal the diversity of the marine environment.

KUVA: METSÄHALLITUS

LARI VENERANTA, NATURAL RESOURCES INSTITUTE FINLAND

Fish breeding grounds are surveyed in open waters using Gulf ichthyoplankton samplers.

GEOLOGICAL SURVEY OF FINLAND



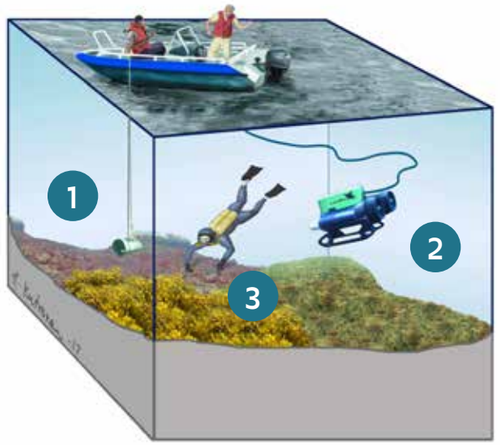
Geological surveys are conducted from research vessels using various remote sensing methods. This illustration of a geological rarity, a depression in the sea floor observed in the surveys south of Haapasaari, was created using depth data produced by a multibeam echo sounder.

How do we survey underwater marine nature?

VELMU surveys the sea floor, its flora and fauna, and fish spawning and larval habitats. The geology of the sea floor is studied using echo sounding and sediment sampling. Algae, aquatic plants and benthic animals are mapped using video recordings, diving and sample collection. Fish breeding grounds are surveyed using various scoops, seine nets and samplers.

Remote sensing methods, such as aerial and satellite images, are used to identify ground types and algae and vegetation zones in shallow sea areas (see next spread). Various semi-automatic devices, e.g. remote-controlled measuring devices, are also being tested for use in the future.

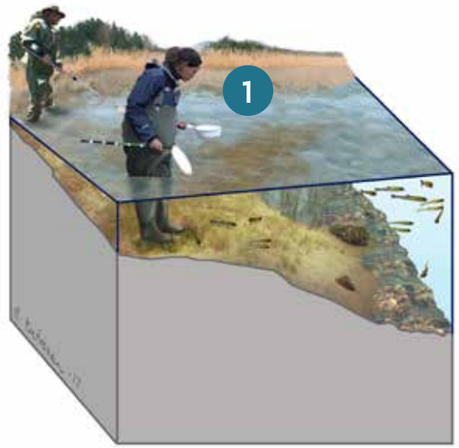
The surveys may also include measurements of different properties of the sea, such as the temperature, salinity and transparency of the water and, when necessary, samples may be taken to assess the chemical properties of the water and to identify the bottom substrate.



HARRI KUTVONEN/GEOLOGICAL SURVEY OF FINLAND

Biological survey methods

Underwater habitats are mapped using several methods. The drop video method **(1)** involves lowering a video camera on a cable close to the sea floor. Later, the video recording is used to assess the quality of the sea floor and identify the larger species in the habitat. The survey can also be conducted using an ROV, Remotely Operated Vehicle **(2)** whose movement can be controlled from a survey vessel. In the line diving method **(3)**, a 100 m transect line is led from the shore to the sea, and a skilled research diver identifies and records all species while still underwater. At the same time, samples may be taken for subsequent identification. This method provides precise, reliable information on the presence of species in a given habitat.



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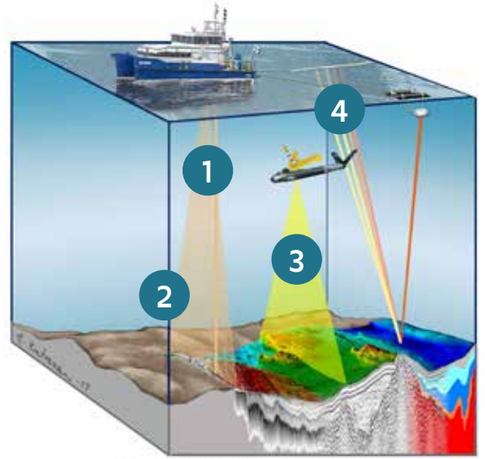
Methods for surveying fish breeding grounds

The locations of coastal fish spawning and larval habitats are surveyed using a variety of methods, depending on the fish species being studied and the habitat in which the survey is carried out. In near-shore areas with submerged vegetation, a white plate and scoop are used to sample fish larvae. In other shallow shore areas, a seine net is used, while ichthyoplankton samplers are used in open waters.

Geological mapping methods

Marine geological surveys are mainly carried out using acoustic methods. The most common of these are **(1)** single beam echo sounding, **(2)** multibeam echo sounding, **(3)** side-scan sonar imaging and **(4)** seismic reflection. Video recordings of the seabed and sediment sampling may also be used. These methods provide a precise picture of the quality and depth of the seabed. The data is used to determine the environmental requirements of the species observed.



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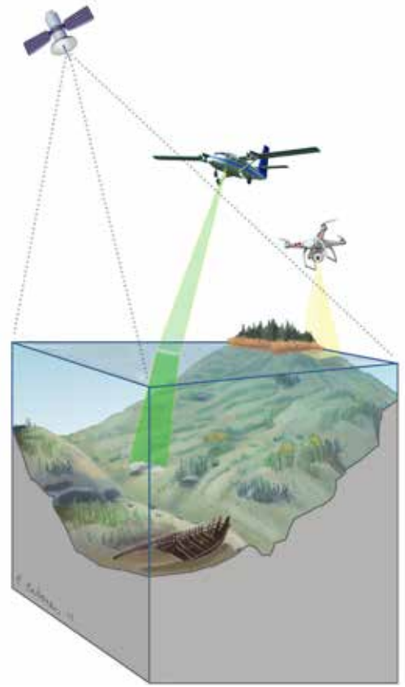

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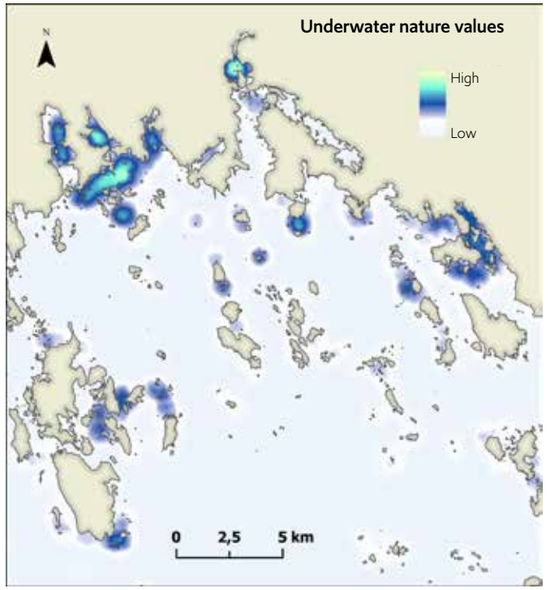
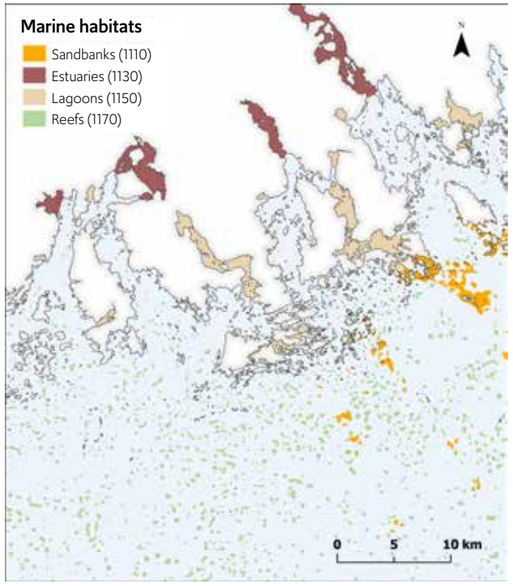
Remote sensing

Remote sensing methods, such as aerial photography, satellite imagery and green beam laser scanners (LiDARs), can be used to identify the type of seabed in shallow sea areas and to locate different types of algae and vegetation zones. Small-scale helicopters, i.e. drones, are also used to survey flads (brackish-water lagoons), for instance. In good conditions, algae zones stand out clearly in shallow water.

BACKGROUND IMAGE: JARI KOSTET / METSÄHALLITUS, NIINA SILVASTI

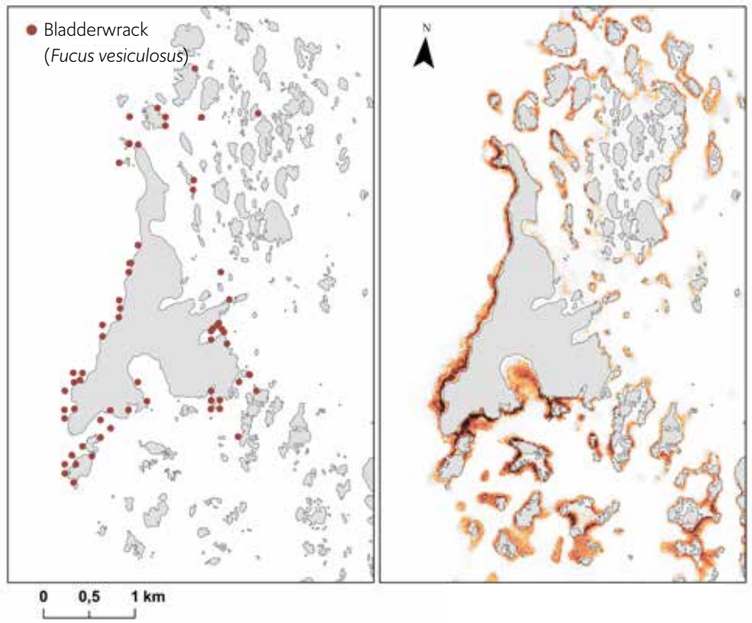




MERI KALLASVUO, NATURAL RESOURCES INSTITUTE FINLAND

In addition to maps of species and habitats, VELMU produces summary maps combining different kinds of data. This makes it possible to create maps showing hotspots of underwater biodiversity and other marine environments of high nature value. This image shows a "prioritisation map" of nature values produced using the Zonation programme. This type of map is useful in developing the network of marine protection areas and, for example, in planning the locations of fish farms and wind power so as not to compromise the most important areas of high nature value. (Source: Virtanen et al. 2018, Frontiers in Marine Science 5:1–19)

The characteristics of habitats, such as water temperature, waves, water transparency and nutrient content, as well as the quality of the sea floor, determine where different species will thrive. Therefore, the protection of the marine environment is often based on habitats. In practice, habitats are the target of protection: for example, the EU Habitats Directive lists the different habitats requiring protection. Of these, eight are home to underwater marine nature. Estuaries, coastal lagoons, narrow inlets of brackish water, large shallow bays, esker islands, underwater sandbanks, reefs and outdoor archipelago skerries, islets and islands are home to many valuable species. Some of these habitats are protected and they form a basis for Natura 2000 network sites in Finnish marine areas. In this photo, you can see some of the coastal habitats in the eastern Gulf of Finland.



VELMU has gathered a uniquely extensive body of field material, but it is not possible to scour every cove and island shore. Fortunately, we can predict the prevalence of species throughout Finland's marine areas using models that combine information on the occurrence of species with environmental data from the area. This helps in identifying habitats where a certain species is most likely to be found. Modelling can be used, for example, to find new occurrences of endangered species and to identify hotspots of diversity. The image on the left shows VELMU's observations of bladderwrack (*Fucus vesiculosus*); in the right image, a model of the probability of occurrence of species around the island of Örö, located on the eastern edge of the Archipelago Sea. In this image, you can see brown color demonstrates high probability of bladderwrack occurrence.

From data collection to the creation of maps

A picture is worth more than a thousand words. With this in mind, VELMU produces a large number of maps to illustrate the occurrence of species, habitats and other special features of marine nature in Finland's marine areas. The maps can be used as tools for conservation efforts and for planning the use of the marine environment.

However, these impressive-looking multicoloured maps can be a double-edged sword. The maps are reliable only if they are based on extensive and professionally collected field data and scientifically credible analyses. For this reason, VELMU invests in thorough surveys, extensive environmental data and the latest modelling methods.

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Wide-ranging cooperation

VELMU is led by the Ministry of the Environment and coordinated by the Finnish Environment Institute. Parks & Wildlife Finland, the Geological Survey of Finland and Natural Resources Institute Finland are primarily responsible for the fieldwork. Other partners include the Centres for Economic Development, Transport and the Environment in coastal areas, the Naval Research Institute and Åbo Akademi. Other universities, higher education institutions and consulting companies are also involved as necessary. In addition to the Ministry of the Environment, VELMU's steering group includes the Ministry of Defence, the Ministry of Finance, the Ministry of Agriculture and Forestry, Ministry of Economic Affairs and Employment, the Finnish Transport Infrastructure Agency, the Navy Headquarters, the Border Guard and the National Board of Antiquities.

Cover images: (upper left corner) Henna Nakari, Metsähallitus, ramshorn snail (*Planorbidae*). (lower left corner) Visa Hietalahti, miniature aeolis (*Tenellia adspersa*). (large photo) Mats Westerbom, Metsähallitus, bladderwrack (*Fucus vesiculosus*) and common jellyfish (*Aurelia aurita*).

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