Challenges and approaches for assessing and monitoring ecological status as required by the Water Framework Directive

- *Anne Lyche Solheim and Kari Nygaard, Norwegian Institute for Water Research (NIVA)*

- *Presentation given at "EUROINBO" conference, Krakow Poland, 27th Sept. 2004*

NIVA

Outline

- Main challenges for ecol. status assessments
- Approaches used at NIVA to meet these challenges and assist Norwegian authorities
- Main challenges for monitoring ecol. status in freshwater and marine waters
- Approaches used at NIVA to design WFD-compatible monitoring of ecol. status and develop new monitoring methods

Main challenges for ecol. status assessments

- Develop a typology for rivers, lakes and coastal waters
- Assess reference conditions for each type
- Assess the response of different biological elements along different pressure gradients
  - **Develop biological indicators to measure the response**
- Set boundaries between different ecol. status classes based on pressure-impact relationships using biological indicators

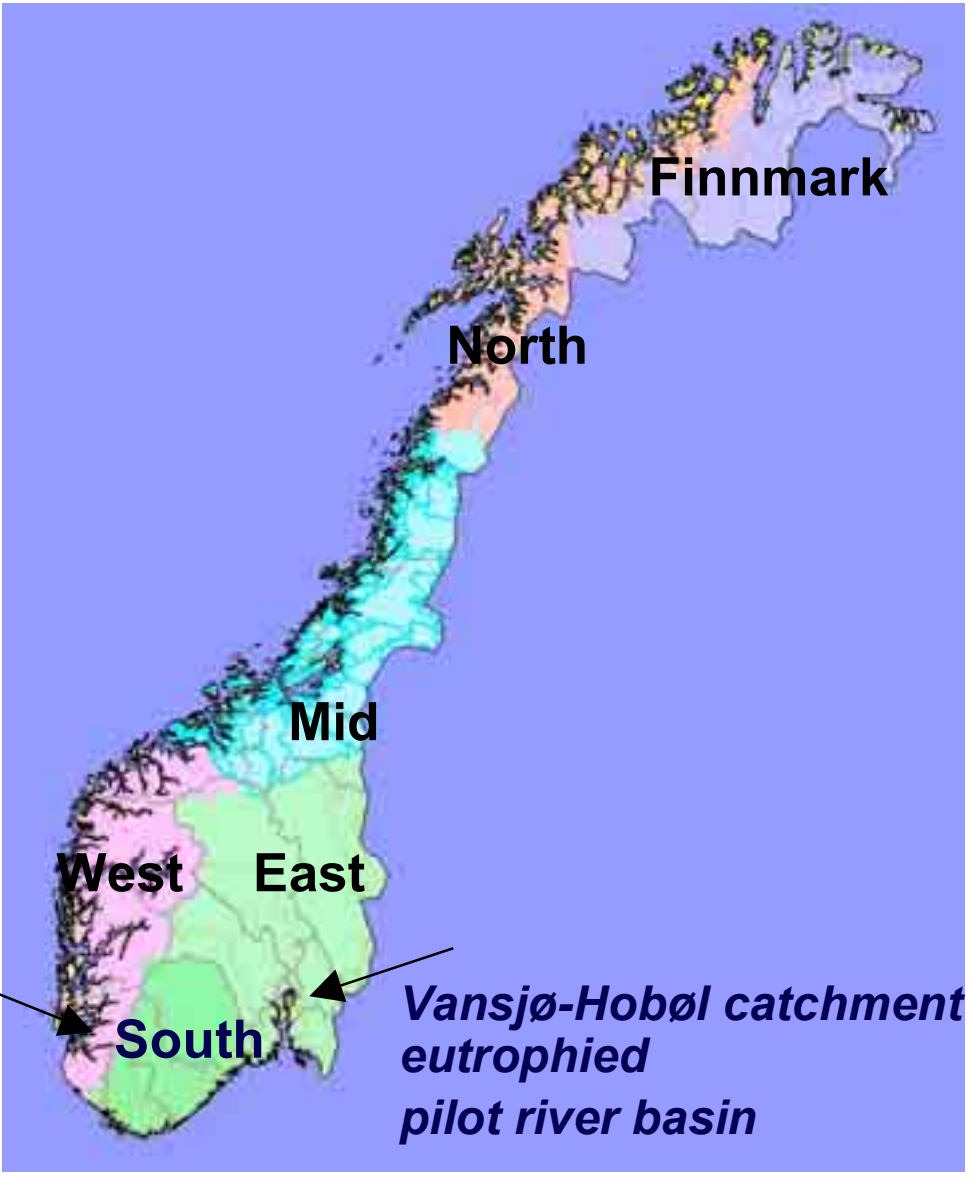
NIVA

Approaches used at NIVA to meet these challenges and assist Norwegian authorities

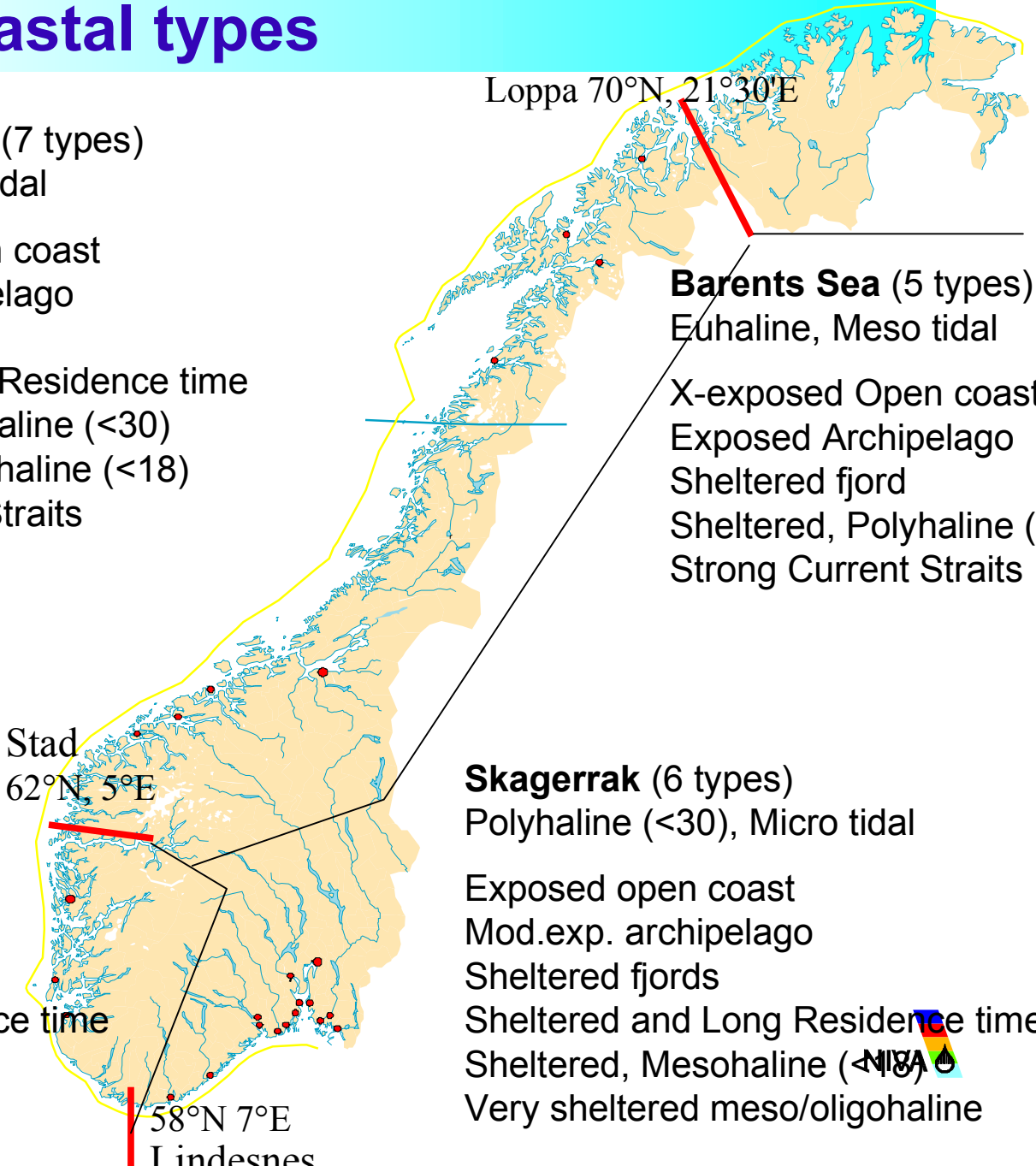
- **Typology developed for all water categories:**
  - Lakes and rivers: 6 ecoregions and 23 types in each region based on differences in altitude, size and geology defined as alkalinity and colour
  - Coastal waters: 4 ecoregions and 5-7 types in each region based on differences in salinity, tidal range and wave exposure

Lake and river typology

- **Altitude:**
  - Lowland, boreal, highland
- **Size:**
  - Lakes: <0.5 km^2, 0.5-5 km^2, > 5 km^2
  - Rivers: < 100 km^2, 100-1000 km^2, > 1000 km^2
- **Geology:**
  - Alkalinity: < 0.2 meq/L, 0.2-1 meq/L, > 1 meq/L
  - Colour: < 30 mg Pt/L, >30 mg Pt/L (humic)



Norwegian coastal types



Norwegian Sea (7 types)
Euhaline, Mesotidal

X-exposed Open coast
Exposed Archipelago
Sheltered fjord
Sheltered, Long Residence time
Sheltered, Polyhaline (<30)
Sheltered, Mesohaline (<18)
Strong Current Straits

Barents Sea (5 types)
Euhaline, Meso tidal

X-exposed Open coast
Exposed Archipelago
Sheltered fjord
Sheltered, Polyhaline (<30)
Strong Current Straits

North Sea (6 types)
Euhaline, Micro tidal

V-exposed Open coast
Exposed Archipelago
Sheltered fjords
Sheltered, Long Residence time
Sheltered, Polyhaline
Sheltered, Mesohaline

Skagerrak (6 types)
Polyhaline (<30), Micro tidal

Exposed open coast
Mod.exp. archipelago
Sheltered fjords
Sheltered and Long Residence time
Sheltered, Mesohaline (<18)
Very sheltered meso/oligohaline

Assessing reference conditions

- Fact sheets developed for each type of water body, showing natural flora and fauna, based on existing monitoring data from unpolluted rivers, lakes and coastal areas
- For types where there are no unpolluted sites, such as lowland lakes with moderate alkalinity, paleo-ecological data or land-use models will be used (work done within the new EU project REBECCA)

NIVA

Development of biological indicators to assess the response of different biological elements along different pressure gradients

- Indicators developed for:
  - **Phytoplankton in lakes**
  - **Benthic fauna in rivers**
  - **Macroalgae in coastal waters**
  - **Benthic fauna in coastal waters (soft-bottom)**
- Indicators for other elements will be developed in 2005
- Work funded by Norwegian Research Council, national authorities (EPA) and the EU project REBECCA

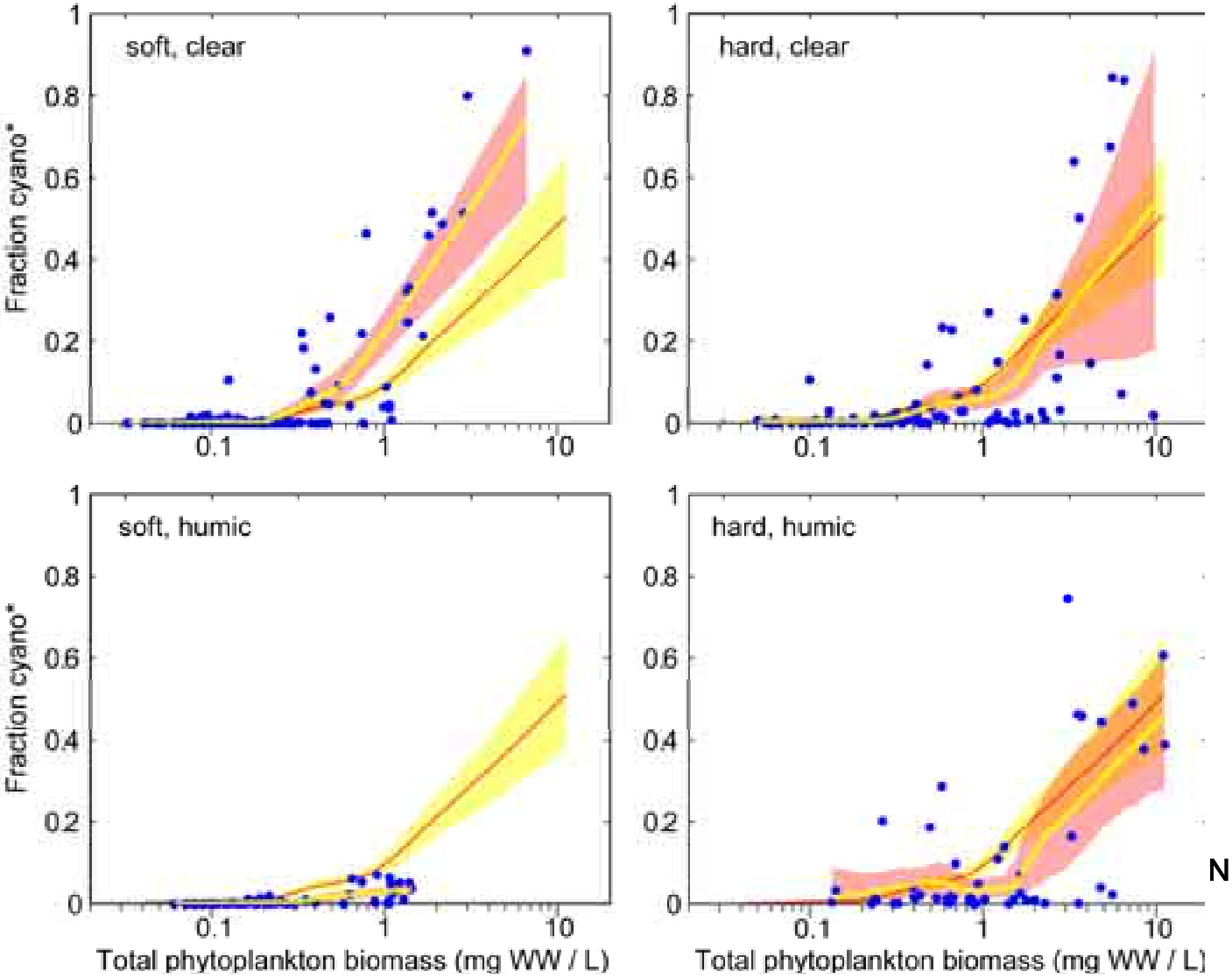
NIVA

Setting boundaries between different ecol. status classes based on pressure-impact relationships using biological indicators

- Analyzing shape of pressure-response curves for different biological indicators and different types of water bodies
- Using different statistical techniques to propose possible boundaries between classes of ecol. status
- Participating actively in Intercalibration within the CIS Working group 2a – Ecostat to compare and adjust Norwegian boundaries for H/G and G/M status classes

NIVA

Biological indicators: Phytoplankton in lakes
Non-linear regression analysis of % bluegreens vs. total biomass in four different lake types



NIVA

Biological indicators: Benthic fauna in coastal waters

Parameter	Percentile (cumulative) N obs	5 % V	15 % IV	35 % III	70 % II	100 % I	85 % Ref.
H_{63}	334	0-1.3	1.3-2.1	2.1-2.9	2.9-3.7	>3.7	4.0
$ES100_{63}$	304	0-8	8-12	12-16	16-23	>23	26
$S04_{63}$	326	0-6	6-20	20-35	35-50	>50	58
SN_{63}	328	0-1.4	1.4.1.7	1.7-1.9	1.9-2.1	>2.1	2.2
$ISI_{depth200}$	903	0-4.8	4.8-6.6	6.6-8.3	8.3-9.4	>9.4	9.9

NIVA

Main challenges for monitoring ecol. status in freshwater and marine waters

- Designing catchment based monitoring
- Designing different programmes for surveillance and for operational monitoring
- Selecting representative monitoring sites
- Selecting cost-efficient parameters enabling calculations of all relevant biological indicators and their supporting elements
- Selecting a monitoring frequency which provide sufficient statistical power to distinguish natural variation from human impact
- Develop new methods for cost-efficient monitoring of biological elements
- Data flow and reporting

NIVA

NIVA approaches to develop new WFD-compatible monitoring programmes

- Selecting sites for surveillance monitoring based on results from characterisation of water bodies (WFD-Article 5), in which areas ”not at risk of failing the objective of good status” were identified
- Designing operational monitoring for water bodies identified as being ”at risk of failing the objective of good status”
- Developing new methods for monitoring biological indicators:
  - Satellite images for algal pigments, turbidity and colour
  - In situ sensors for phytoplankton pigments
  - ROV-technology for macrophytes
  - Image analysis combined with automatic cell counters

NIVA

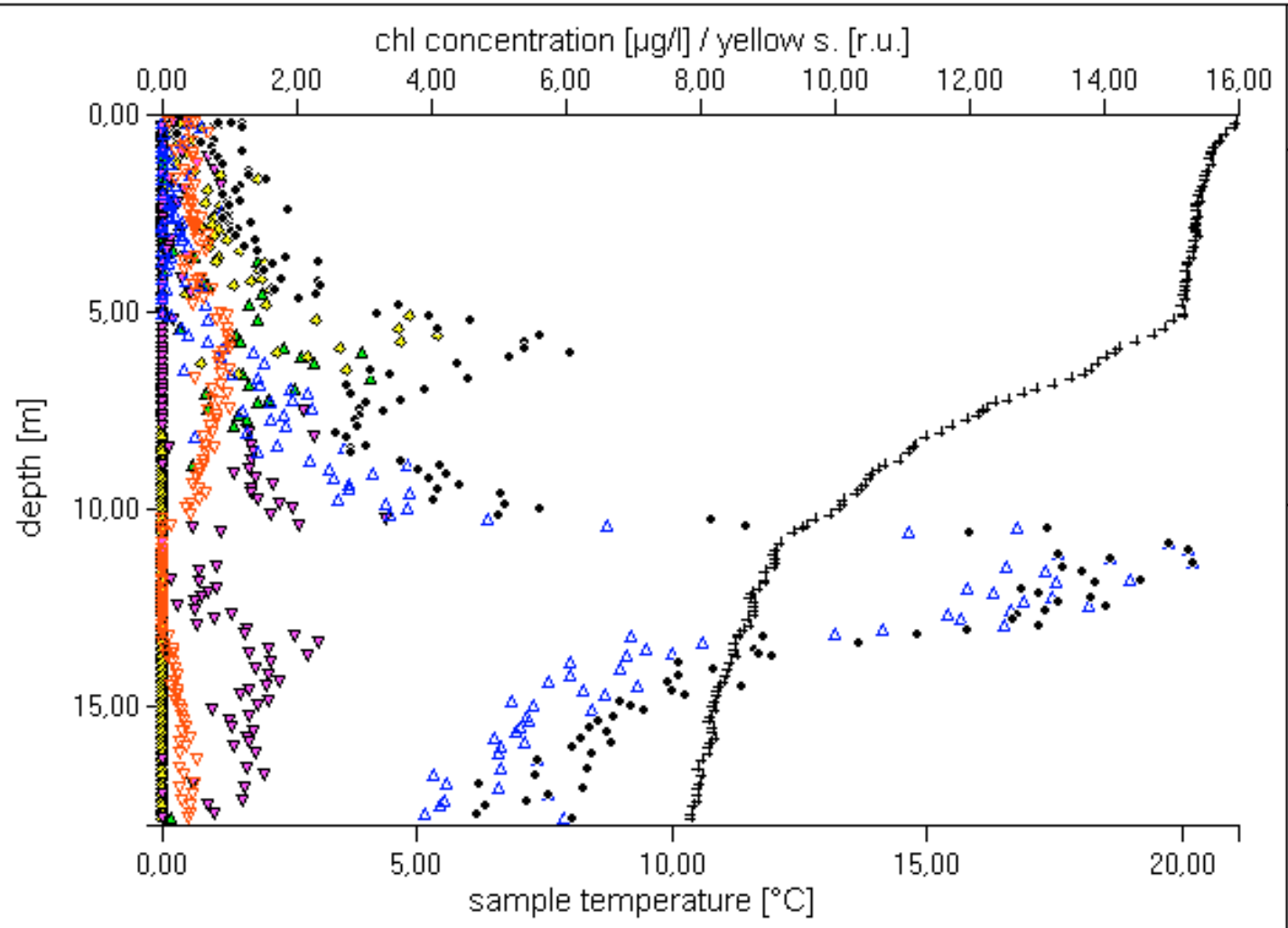
Cost-efficient monitoring of phytoplankton biomass and taxonomic composition in lakes

Fluoroprobe –

- new multi-sensor for simultaneous measurements of chlorophyll in different algal classes

NIVA

Chlorphyll profiles from FluoroProbe, for different algal classes



Ferry Ships – a new platform for marine environmental surveillance

The EU-project FerryBox – from on-line oceanographic observation to environmental information

• Eutrophication and plankton productivity, transport of particles and contaminants, stability and transport of water masses and satellite data validation (ocean color).

New FerryBox systems in Norwegian waters from 2004

Sensor systems

- *Temperature*
- *Salinity*
- *Chlorophyll-a*
- *Particles*
- *Light*

Automatic water sampling

- *Harmful Algal blooms*
- *Nutrients*
- *Micropollutants*

Development of new monitoring methods

Echosounder for habitat surveillance:

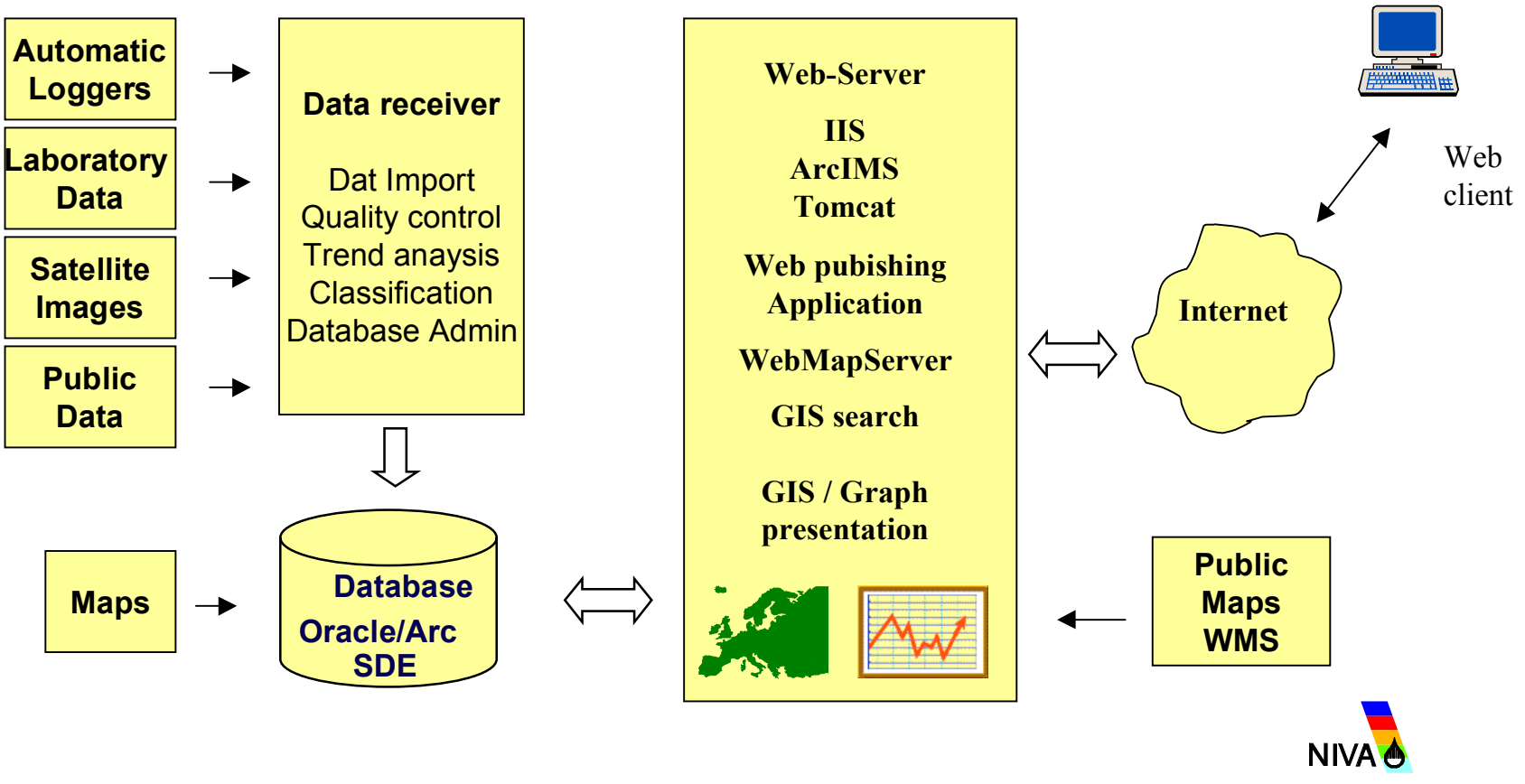
- **Substrate type**
- **Hyperbenthos and macroalgae**

ROV-camera for measuring

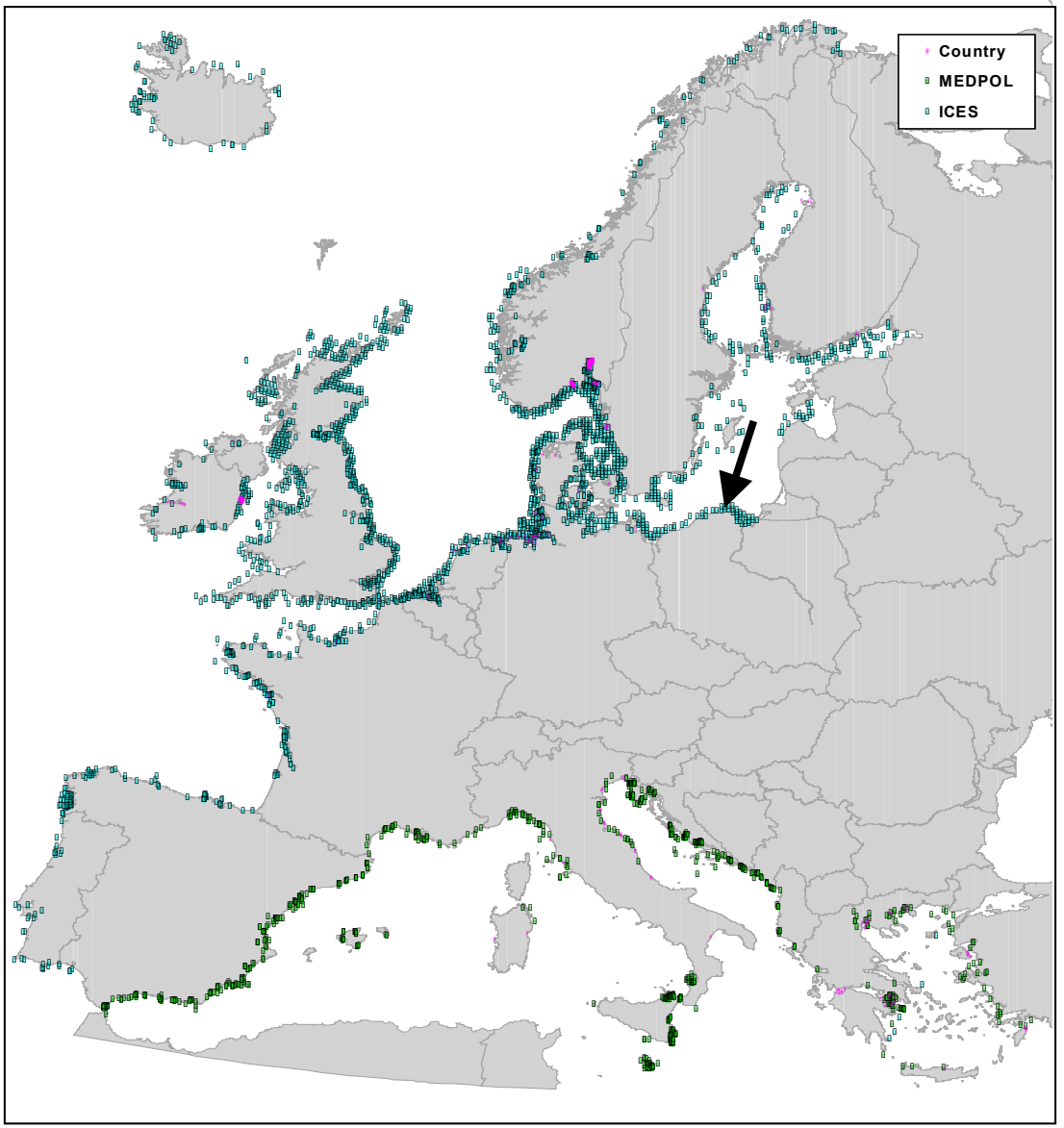
- **Macrophyte abundance**
- **Macrophyte taxonomic composition**

Data flow and reporting

NIVA Datalogging / Database / Web-publishing



NIVA hosts EEA – European Environment Agency – marine working database, delivering data to waterbase



NIVA