Economic analysis of marine biodiversity monitoring programme: factors determining the cost effectiveness of indicators

MARMONI Final Conference

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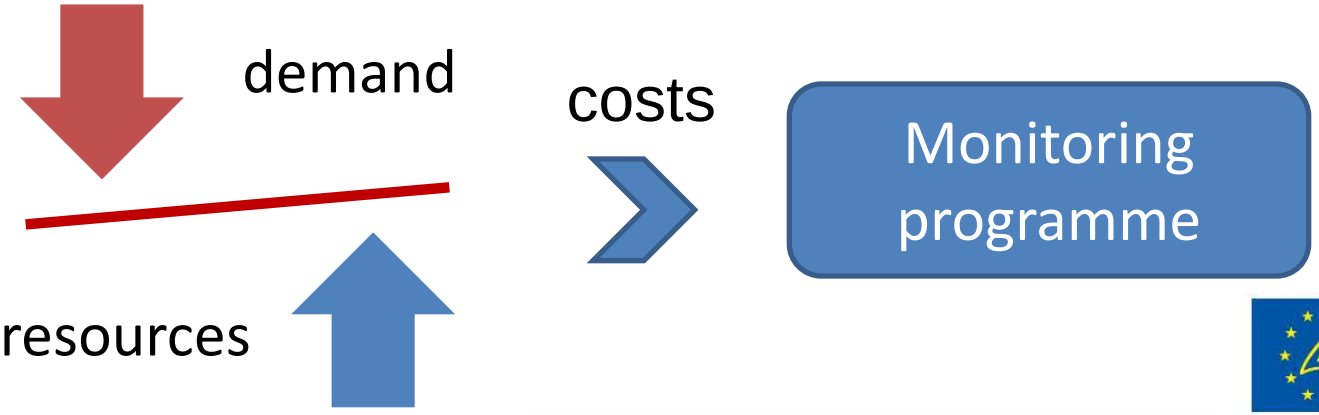
Why economic analysis?

- Demand to deliver data and information for evaluation of policy implementation (HB; BD; WFD; MSFD; HELCOM, national laws)
  - Coordinated; coherent; compatible
  - Diverse sets of criteria and indicators
- Financial resources are limited for environmental policy implementation including monitoring

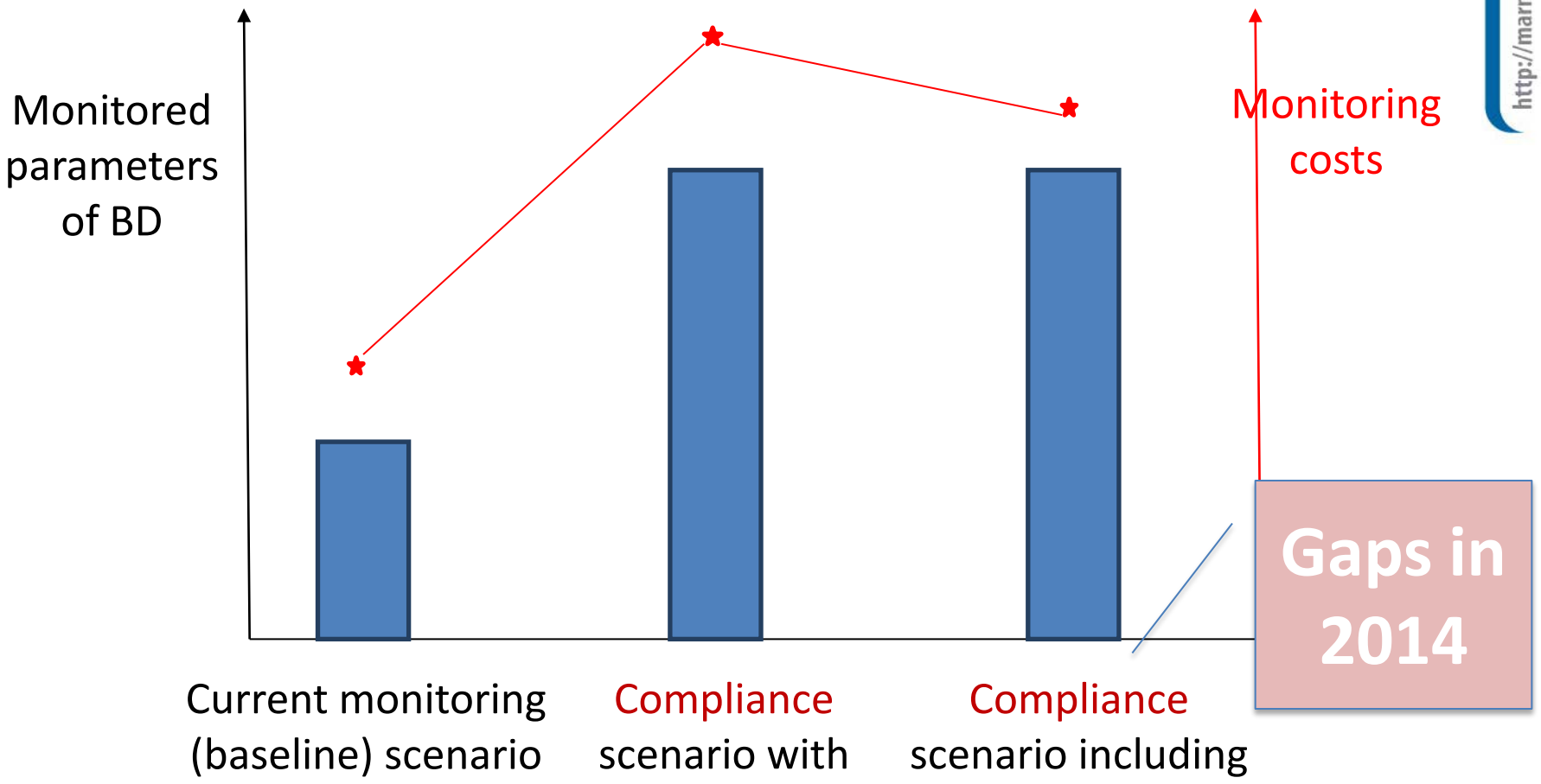


Economic rationale

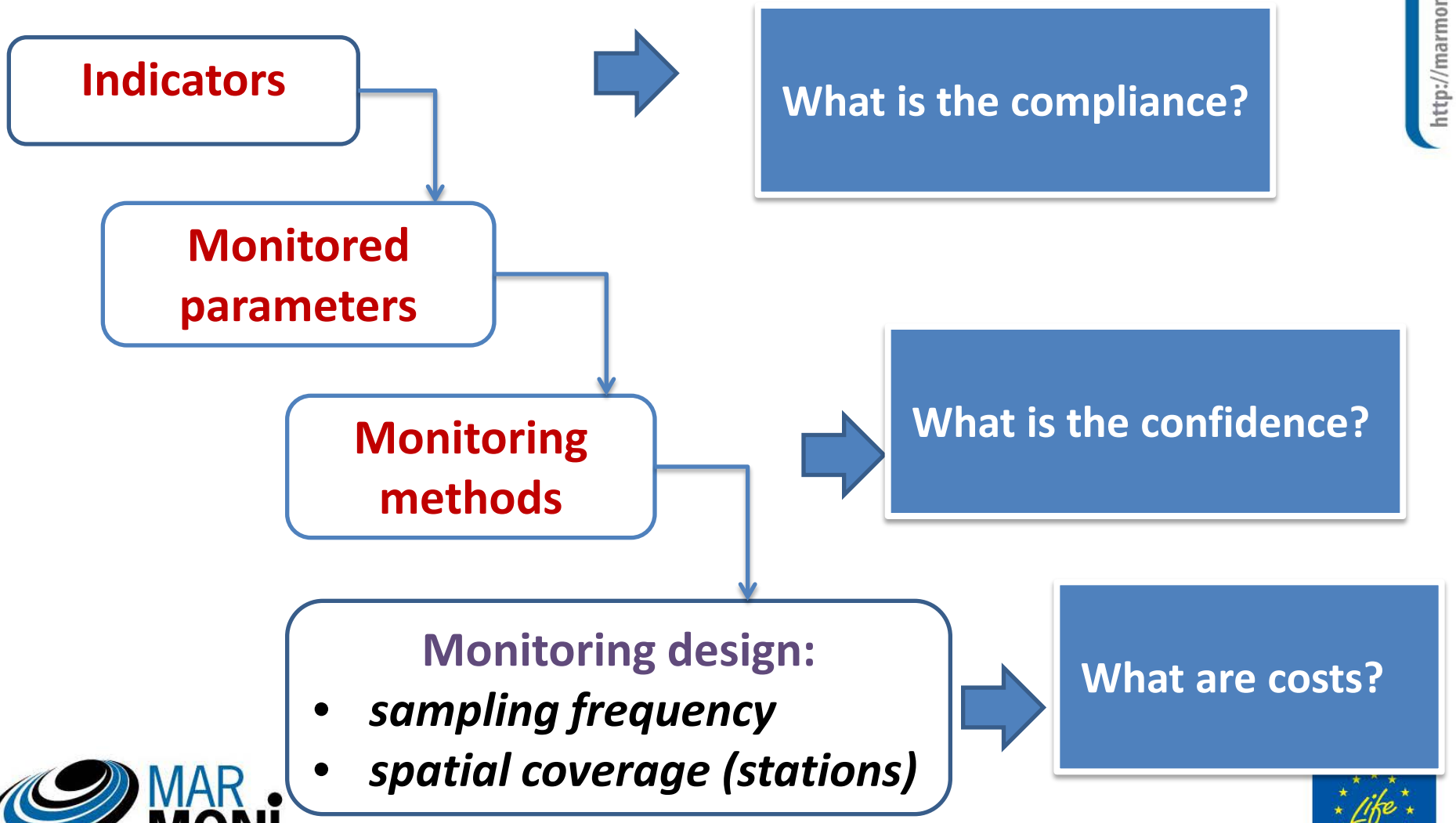
Cost-effectiveness

- least cost way for reaching predefined aims of the monitoring programme, i.e., to ensure the compliance with MSFD or other legal requirements;
- to choose among alternative options for the same compliance needs:
  - Indicators – which indicator provides better compliance for assessment needs in relation to the costs involved
  - Monitoring methods – which method provides better/more appropriate information to ensure confidence in the assessment in relation to the costs involved

Monitoring programme: scenarios



Approach of economic analyses



Assessment of compliance of indicators and confidence of methods

Scale from “0”to “4”

0 “no compliance (confidence) at all”

1 “low compliance (confidence)”

2 “moderate compliance (confidence)”

3 “good compliance (confidence)”

4 “excellent/full compliance (excellent confidence)

3 - The lower bound for satisfactory/optimal compliance/confidence.

Costs for monitoring

- Field works
  - Sampling frequency (often set by the method on monitoring parameter or indicator)
  - Spatial coverage (number of stations, area, km)
- Laboratory works
  - Sample or data treatment
- Modelling works
- Data management reporting

- Ship/plane
- Equipment
- Supplies
- Labour
- Other costs
- Overheads

TOTAL COSTS /INDICATOR/YEAR

Assessment criteria of indicators

1. Costs/Compliance ratio (costs/indicators)
2. Cost/Confidence ratio (costs/methods)

Total cost-efficiency of indicator or monitoring programme

$$Total\ CE_{ind} = \frac{Costs\ per\ indicator}{(1+2)/2}$$

$$Total\ CE_{mp} = \frac{Costs\ per\ monitoring\ programme}{(1+2)/2}$$

Marine biodiversity indicators

- MARMONI project has developed new indicators which are covering existing gaps (or building fundament) in assessment of the marine biodiversity
  - Fish indicators
  - Benthic indicators (vascular plants, bottom fauna, habitat)
  - Pelagic indicators (phytoplankton; zooplankton)
  - Bird indicators (wintering, breeding, migratory birds, impacts on birds)

What are alternative choices with indicators for the cost-effectiveness assessment?

Indicators – compliance (zooplankton)

GES criteria and indicators relevant for assessing status of zooplankton		3.7 Copepod biomass	3.9 Microphagous mesozooplankton biomass	3.10 Zooplankton mean size versus total stock
1.1 Species distribution	1.1.1.	0	0	0
	1.1.2.	0	0	0
1.2 Population size	1.2.1.	**4**	**4**	**4**
1.3 Population condition (1.3.1. - demographics)	1.3.1.	0	0	**3 (2)**
	1.3.2.	0	0	0
1.6 Habitat condition (as food base for fish)	1.6.1. or 1.6.2	**4**	**4**	**4**
1.7 Ecosystem structure	1.7.1.	0	0	0
	Average:	**1.1**	**1.1**	**1.6**
		Summary score for Compliance scenarios: SYKE/LIAE		**1.6(1.4)**

Indicators – compliance (wintering water birds)

GES criteria and indicators relevant for assessing status		4.1	4.2	4.3	4.6	4.7	4.8
1.1 Species distribution	1.1.1.	0	0	0	**4**	0	0
	1.1.2.	0	0	0	**4**	0	0
1.2 Population size	1.2.1.	**4**	0	0	0	0	0
1.3 Habitat condition	1.3.1.	**0**	**0**	**0**	0	**0**	**0**
1.6 Habitat condition	1.6.1.	**3**	**4**	**4**	0	**4**	**3**
	1.6.2.	4	0	0	0	0	0
1.7 Ecosystem structure	1.7.1.	0	**3**	**3**	0	**3**	**4**
	Average Compl. score:	**1.57**	**1.00**	**1.00**	**1.14**	**1.00**	**1.00**

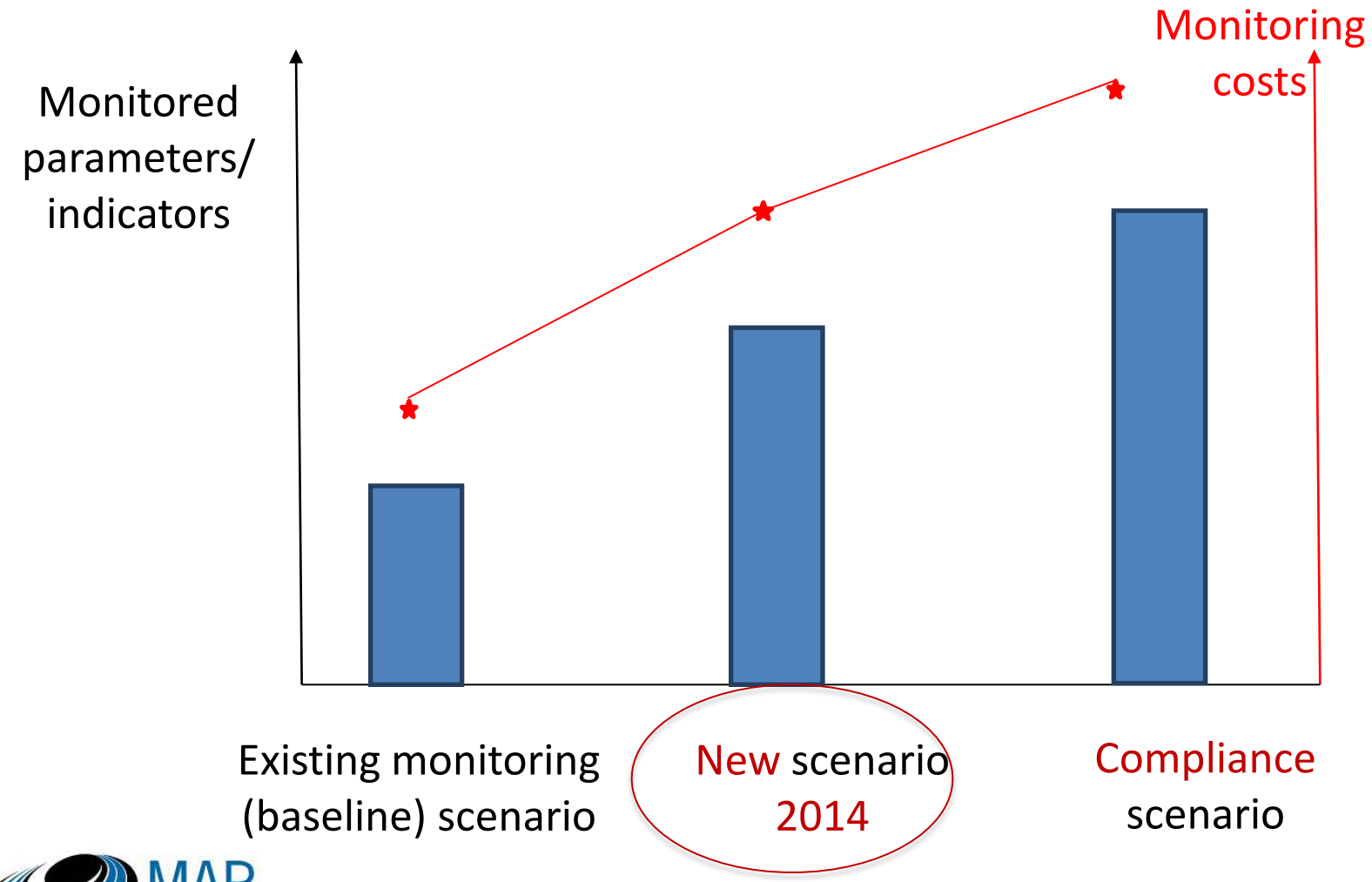
4.1. Abundance index of WWB species (single)
4.2. WWBI; 4.3. WWBIFG (Multi sp.)
4.6. Distribution of WWB species (single)
4.7. Distribution of WWB species (multi species)
4.8. Distribution of WWBFG

Summary score for compliance scenarios: **3.4**

Indicators – compliance (benthic, soft bottom fauna)

GES criteria and indicators relevant for assessing status of zooplankton		FI-BBI	2.9 Population structure of Macoma balthica
1.1 Species distribution	1.1.1.	0	0
	1.1.2.	0	0
	1..1.3	0	0
1.2 Population size	1.2.1.	0	0
1.3 Population condition	1.3.1.	0	3
	1.3.2.	0	0
1.6 Habitat	1.6.1.	4	4
	1.6.2.	3	2
1.7 Ecosystem structure	1.7.1.	2	0
	Average:	**1.0**	**1.0**
		:	**1.3**

Monitoring programme



Monitoring methods- confidence

- Monitoring methods – which method provides better/more appropriate information to ensure confidence in the assessment in relation to the costs involved
  - Current or existing methods
  - New methods tested in MARMONI:
    - Increase spatial or temporal coverage
    - Increase cost efficiency in field work
    - Increase cost efficiency in lab work

What are alternative choices with methods for the cost-effectiveness assessment?

Monitoring methods and cost efficiency

- Automated image analyses - decrease time for treatment of samples in laboratory (labour costs)
  - Zooplankton analyses: 1 sample per day by the current method versus 3 samples by the new method
  - Zoobenthos size measurement- 10 sample per day by the current method versus 20 samples by the new method
- Automated image analyses –
  - decrease subjectivity and eliminate biases caused by differences in the knowledge level of experts - to be used for birds indicators, but needs further development

Assessment of confidence of methods (scale 0-4)

Finland

Methods	Group	FI-IA	3.7	3.9	3.10
Zooplankton sampling	Current	4	4	4	4
Automatic image analyses	New		3	2	4

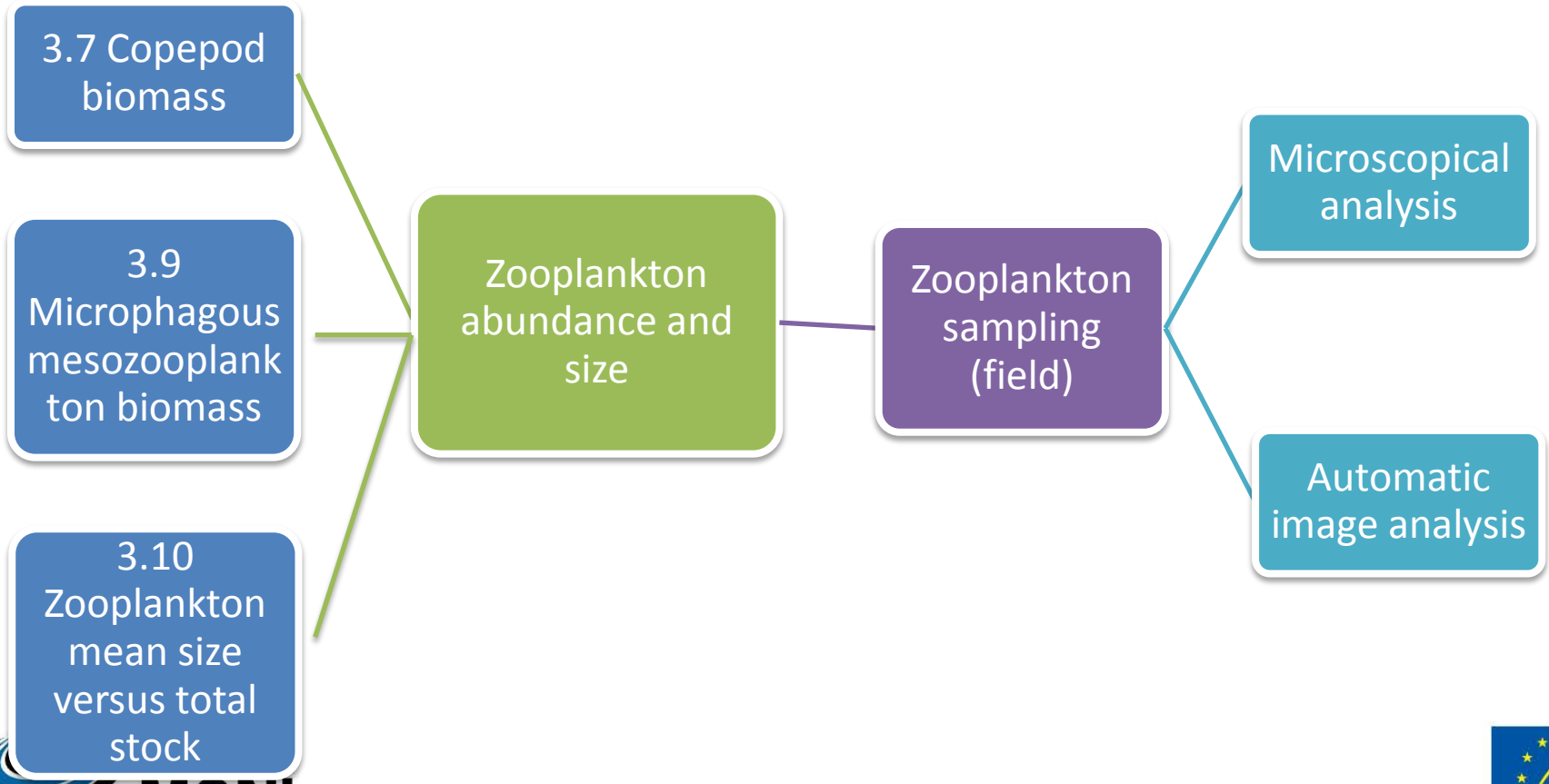
Latvia

Methods	Group	LV 3.3	3.7	3.9	3.10
Zooplankton sampling	Current	4	4	3	4
Automatic image analyses	New		2	1	2

Purpose: decrease time (labour costs) in laboratory, but it decreases confidence on the information for some of the indicators

Cost implications of introducing new methods

Example: Zooplankton automated image analysis



Cost implications of introducing new methods: zooplankton

- Field works
  - Sampling frequency (often set by the method on monitoring parameter or indicator)
  - Spatial coverage (number of stations, area, km)
- Laboratory works
  - Sample or data treatment

Joint field work in offshore waters for sampling of phytoplankton, chemicals, etc.

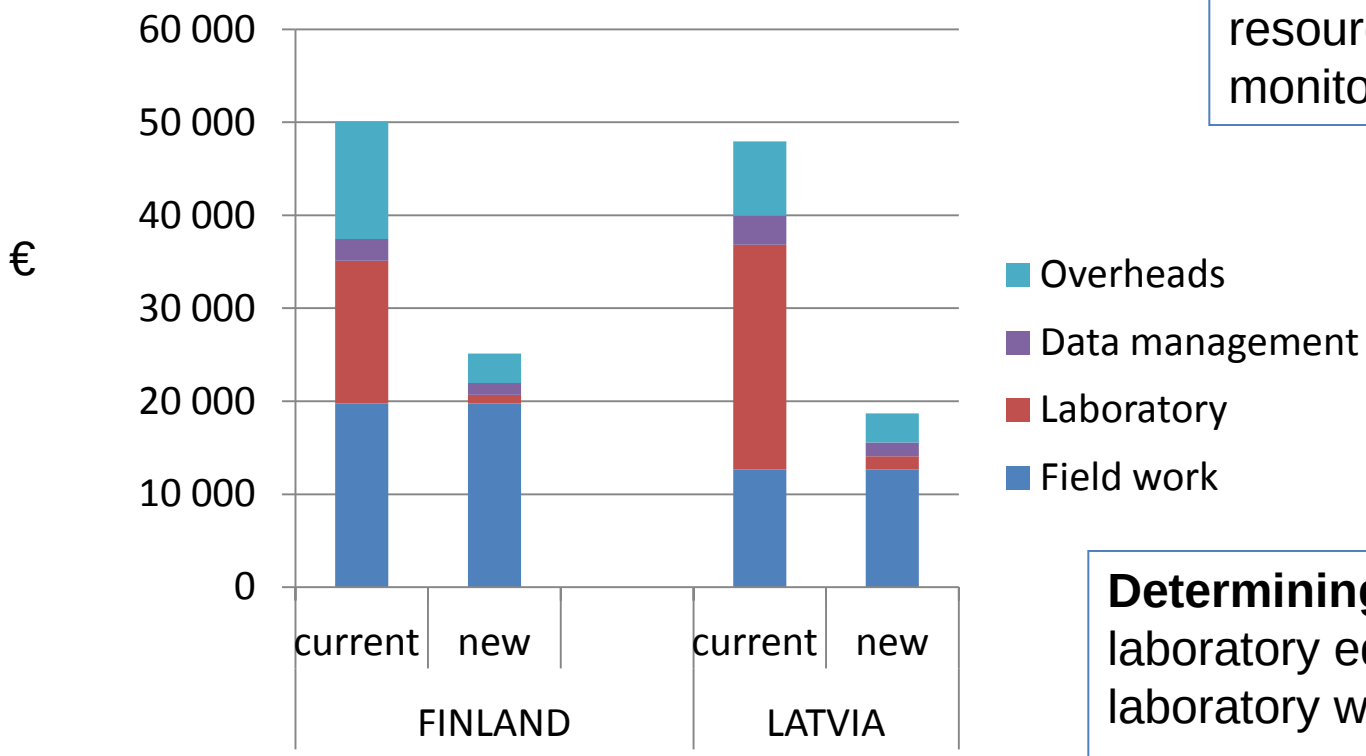
Max number of ship stations:

- FI: c.a. 55 stations (14 zoopl.*3 replicates) visited 2 times/year
- LV: 49 stations (25 zoopl) 9 times/year

Numbers of zooplankton samples:

- FI: 84 samples
- LV: 225 samples

Cost implications of introducing new methods: zooplankton



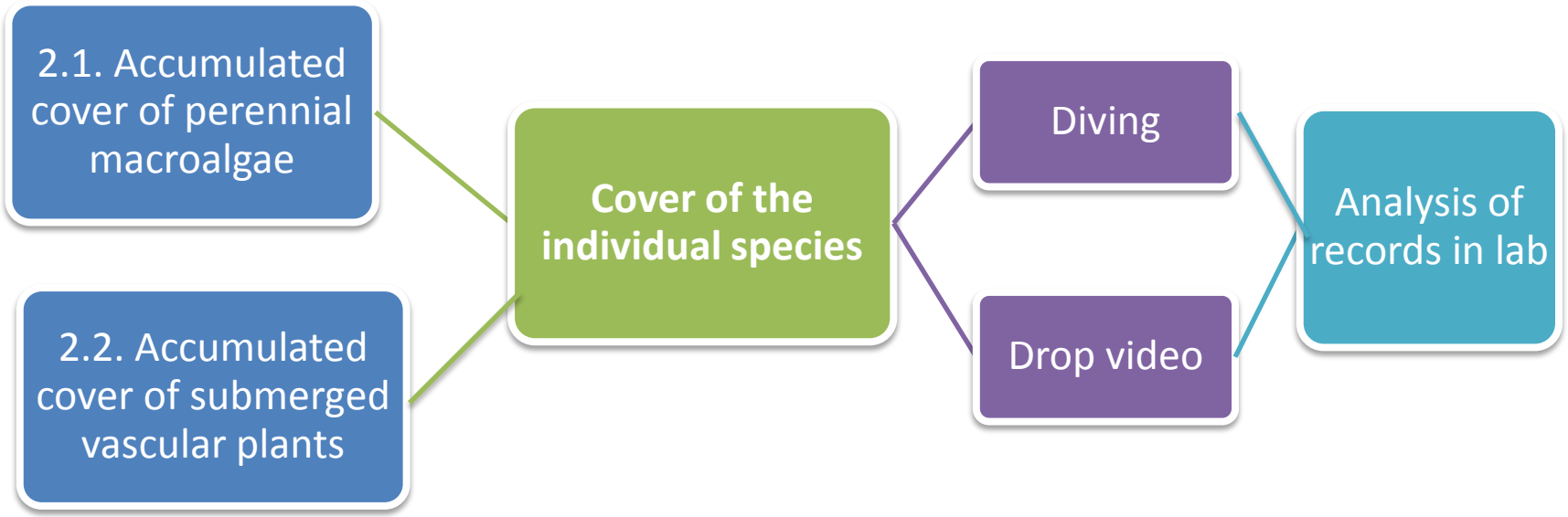
Costs exclude resources to build the monitoring programme

Determining factors:
laboratory equipment and laboratory work load

1 person for full time

Monitoring methods and cost efficiency

- **Example of phytobenthos (method developed in Sweden) - aim to increase the spatial cover** (decrease of field work costs and time)



Cost implications of introducing new methods: phytobenthos

- Field works
  - Annually (in summer or early autumn),
  - Spatial coverage (number of stations per day)
  - Different teams

- Laboratory works
  - Data treatment

Phytobenthos monitoring season
- max season 60 days
- common field work for both indicators

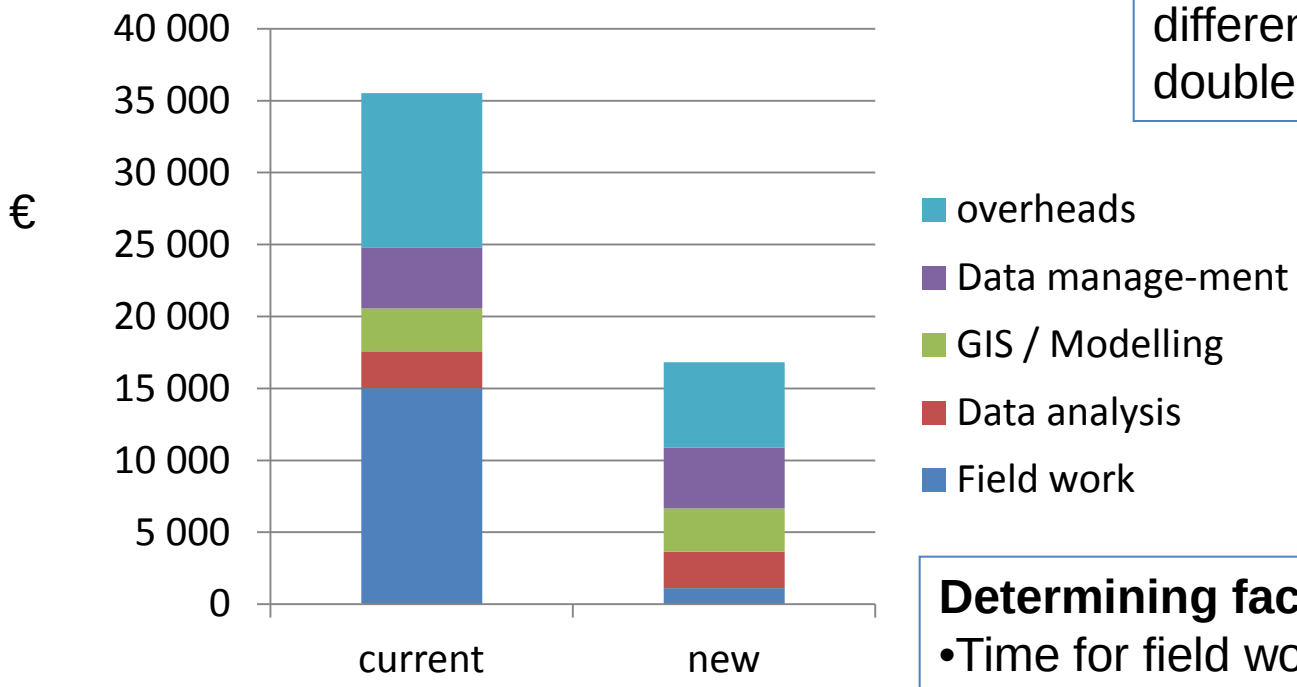
Max number of stations per day:
- diving – 3 stations
- drop videos – 30 stations

Team involvement:
- diving – 3 person
- drop video – 2 persons

- Data from 12 stations can be treated per day

Cost implications of introducing new methods: phytobenthos

Costs for 30 monitoring stations: difference is more than double

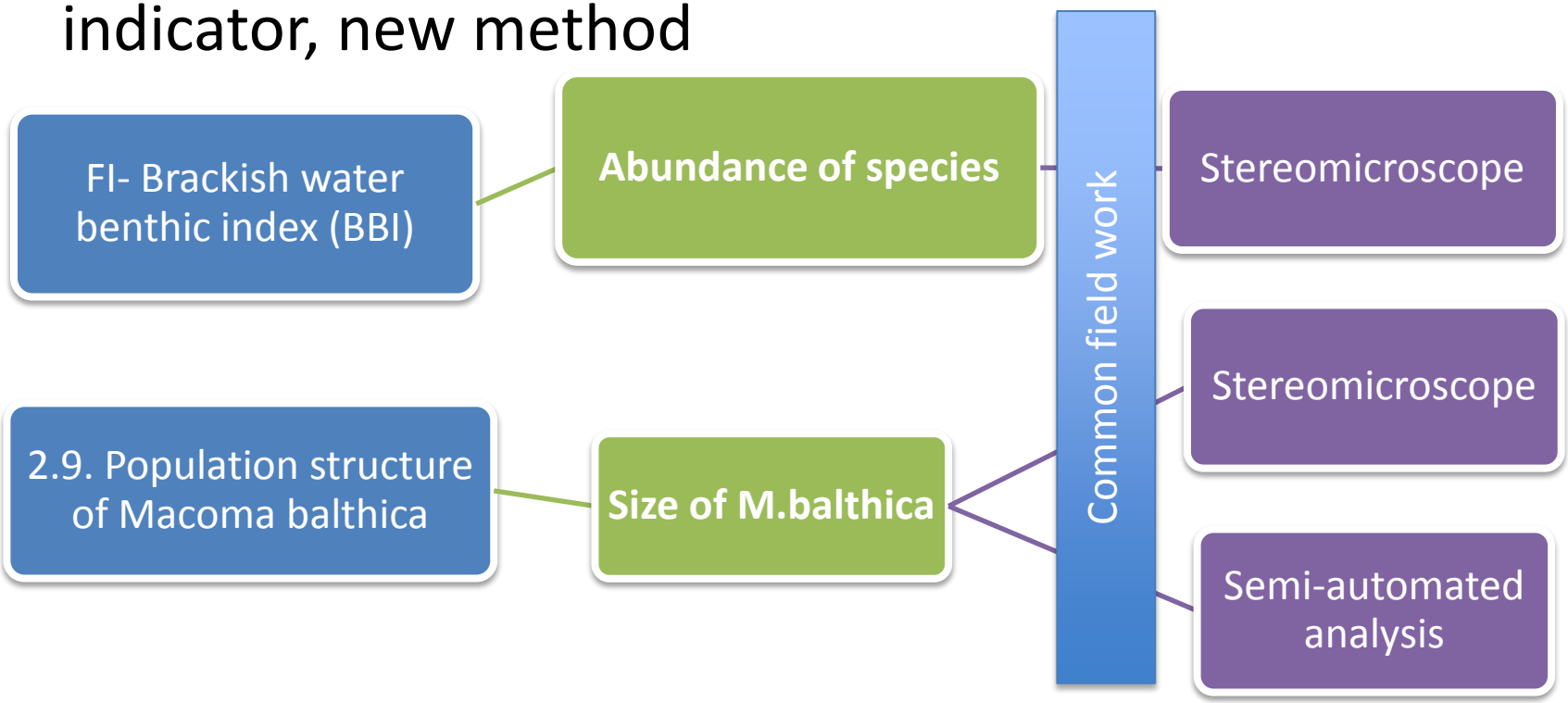


Determining factors:

- Time for field work – related travel and personnel costs
- max season of 60 days – 180 stations (diving) or 1800 stations (drop video) for 1 team

Cost implications of introducing new indicator and method: soft bottom fauna

2.9. Population structure of Macoma balthica – new indicator, new method



Cost implications of introducing new indicator and method: soft bottom fauna

- Field works
  - Annually for BBI
- Laboratory works
  - Laboratory work for BBI

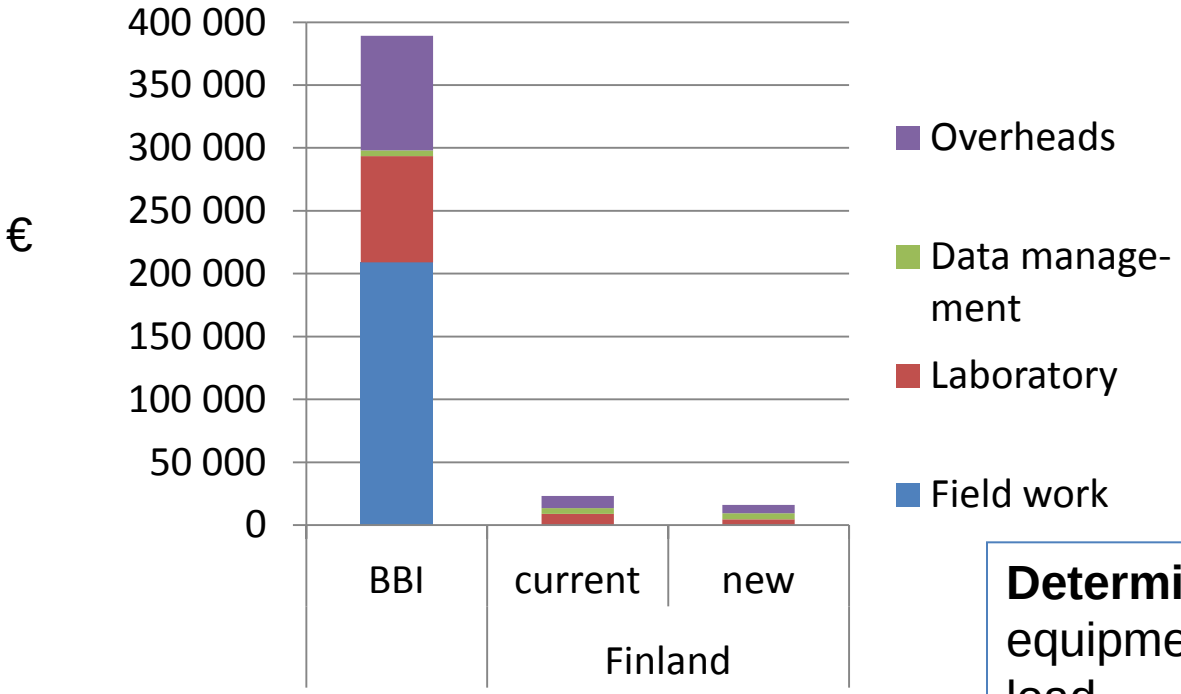
Finland: 4 soft bottom fauna samples can be collected per day; during summer (June-September) in Finland, 360 stations
Latvia - in May, 45 stations

- Laboratory works
  - Laboratory work for M. balthica

Current – 10 samples per day
New - 20 samples per day

Cost implications of introducing new indicator and method: soft bottom fauna

Costs for 360 monitoring stations: field works 90 days



Determining factors: laboratory equipment and laboratory work load

1 person for full time:
36 for BBI + 18 for M.b. = 54 days

Assessment criteria of indicators

1. Costs/Compliance ratio (costs/indicators)
2. Cost/Confidence ratio (costs/methods)

Total cost-efficiency of indicator or monitoring programme

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$$Total\ CE_{mp} = \frac{Costs\ per\ monitoring\ programme}{(1+2)/2}$$

Total cost-effectiveness

- Example of zooplankton monitoring: 3 new indicators; current and new method

LV	Monit. Indic.	Costs / Compliance Ratio	Costs / Confidence Ratio	Total cost-efficiency
current methods	3.7	47948	11987	19179
	3.9	47948	15983	23974
	3.10	33564	11987	17665
	TOT	**33564**	**13077**	**18821**
new methods	3.7	18691	9345	12460
	3.9	18691	18691	18691
	3.10	13083	9345	10903
	TOT	**13083**	**11214**	**12077**

No extra costs to calculate indicator when values of the parameters obtained

Despite of lower confidence of new method, the cost efficiency is higher for new method

Difference in c.a.60%

Total cost-effectiveness

- Example of phytobenthos: 2 indicators; current and new method

SWE	Monit. Indic.	Costs / Compliance Ratio	Costs / Confidence Ratio	Total cost-efficiency
Current	2.1.	39966	8881	14533
	2.2.	39966	8881	14533
	TOT	**39966**	**8881**	**14533**
New	2.1.	18941	5612	8659
	2.2.	18941	5612	8659
	TOT	**18941**	**5612**	**8659**

No extra costs to calculate indicator when values of the parameters obtained

Both indicators are not alternatives

Despite of lower confidence of new method, the cost efficiency is higher for new method

Difference of sampling 30 station is c.a.60%

Total cost-effectiveness

- Example of soft bottom fauna: new indicator with new method

FI	Monit. Indic.	Costs / Compliance Ratio	Costs / Confidence Ratio	Total cost-efficiency
new ind&current methods	FI-BBI	389320	97330	155728
	2.9.	23289	5822	9315
	TOT	**309457**	**103152**	**154728**
new ind&new methods	FI-BBI	389320	97330	155728
	2.9.	16036	5345	8018
	TOT	**304017**	**115816**	**167734**

Both indicators are not alternatives, ensures the same level of compliance which is direct cost estimation

The costs of a new indicator in soft bottom fauna monitoring are not significant, therefore the savings generated due to new method are not strong in total CE.

Key findings and recommendations

- With regard to compliance and cost assessment:
  - There still too little number of alternative options to use costs as the key determining factor for an indicator selection for monitoring programme;
  - Although addressing similar criteria/indicators for D1, the developed indicators address different functional groups or subgroups
  - Science and research needs to be strengthen for achieving better compliance with MSFD
- Taking into account extensiveness of MSFD monitoring and requirements, it is recommended that more resources are given to monitoring programme.

Key findings and recommendations

- With regard to confidence and cost assessment:
  - New methods still have lower confidence therefore it is recommendable:
    - that the current methods need to be included also in monitoring for calibration and verification.
    - to continue further development of the methods
  - Confidence in new methods differ between countries; the country which has developed new method assigns the higher confidence to the method. Therefore joint capacity building and training between countries of interests would be recommendable.

Key findings and recommendations

- With regard to cost implications of current and new methods:
  - New methods are having less costs, therefore providing higher cost effectiveness (CE) in majority of cases
  - The CE of indicators or monitored parameters is largely determined by the monitoring intensity – frequency and density of monitoring network; coordinated actions for sharing costs in particular for field works.
  - The CE assessment can help to build an optimal monitoring programme (to use equipment and staff resources to full extent)