# Overview of impacts of wastewater discharges (>10 000pe) on Norwegian recipients

Eutrophic status of 152 water bodies directly or indirectly affected by wastewater discharges

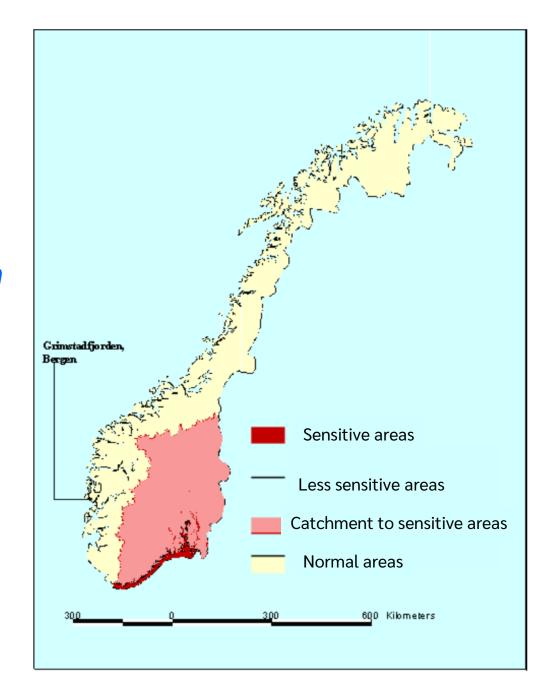
by Christian Vogelsang, senior researcher, NIVA



# Eutrophication

"Eutrophication refers to the enrichment of water with respect to nutrients, especially nitrogen and/or phosphorus compounds, which accelerates the growth of algae and higher plant species, leading to undesirable disruption of the equilibrium between organisms in the water and deterioration of water quality."

Appendix 1.1A in current "Regulations on the limitation of pollution" (FOR-2004-06-01-931)



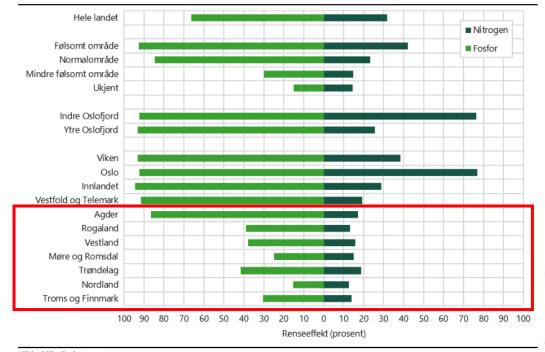


# Current treatment in the "normal" and less sensitive areas

Reported/estimated removal of total P and total N at WWTP  $\geq$  50 PE:

Figur 4.12. Renseeffekt for fosfor (TOT-P) og nitrogen (TOT-N). Avløpsanlegg ≥50 pe. Fylke, område og landet. 2023.

Prosent



Kilde: Miljødirektoratet



[Source: Berge and Hjertaas 2024]



- Advanced\*
- Nature-based
- Mechanical
- Untreated
- Other/unknown
- Inner Oslo fjord catchment
- Outer Oslo fjord catchment

\*) chemical or biological or combination of these

"Member States shall ensure that the identification of sensitive areas is reviewed at intervals of no more than four years."

91/271/EEC

"By 31 December 2027, Member States shall establish and publish a list of areas on their territory that are sensitive to eutrophication. They shall include with that list information on whether the areas are phosphorus- or nitrogen-sensitive or both. They shall update that list every six years starting on 31 December 2033."

Revised UWWTD: Directive (EU) 2024/3019

#### Desktop study:

# Identification of water bodies sensitive to eutrophication

The Client: the Norwegian Environment Agency

 Selected by the Agency: 152 water bodies affected by agglomerations >10 000 PE in normal and less sensitive areas (5 lakes, 11 rivers, 136 coastal)

#### Purpose:

- 1. Sensitive to N and/or P
- 2. Eutrophic or not
- 3. Risk of becoming eutrophic
- 4. Environmental benefit if N and/or P load is reduced
- 5. Sufficient data to conclude? If not, recommend monitoring



8095-2025

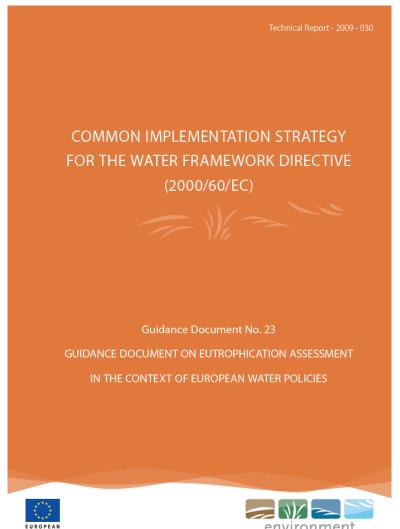
Identifisering av vannforekomster sensitive for eutrofi

#### List of authors:

Jan-Erik Thrane (project leader), Sonja Kistenich, Anette Engesmo, André Staalstrøm, Ragnhild Grimm Torstensen, Janne Kim Gitmark, Ann Elin Synnes, Mats Gunnar Walday, Maeve McGovern, James Sample and Christian Vogelsang



# Criteria for being eutrophic



Guidelines for classification of environmental status in coastal waters and freshwater (digital since February 2025)

#### Veileder for klassifisering av miljøtilstand i kyst- og ferskvann

I klassifiseringsveilederen (basert på 02:2018) finner du grenseverdier og indeksverdier til bruk i klassifisering av innsjø, elv, grunnvann og kystvann. Veilederen gir også informasjon om overvåking og datainnsamling som utgjør grunnlaget for klassifiseringen.



#### Klassifisering av økologisk tilstand



The Norwegian guidelines are in line with the EU guidelines





# Criteria for a water body being sensitive to N or P

#### Freshwaters (lakes and rivers)

According to the Classification Guidelines:

►P limited: 
$$\left(\frac{Tot N}{Tot P}\right)_{median}$$
 > 20 and  $(NH_4+NO_3)$  > 10 μ $g/L^*$  \*) in all measurements through the growth season

ightharpoonupN limited: $\left(\frac{Tot\ N}{Tot\ P}\right)_{median} < 20\ and\ (NH_4+NO_3) < 10\ \mu g/L^*$ 

➤P + N limited: 
$$\left(\frac{Tot N}{Tot P}\right)_{median} \approx 20$$

• 55% of eutrophic lakes in Norway potentially N-limited (Lyche Solheim et al. 2022)

#### Coastal waters

 Complex and dynamic transitions between P-limited freshwater systems and N-limited marine water systems = assumed sensitive to both N and P



# Key criteria to determine if a water body is eutrophic

- Assessment of Ecological Status using Biological Quality Elements
- ➤ Normalised ecological quality ratios (nEQR; 0-1):
  - 1 = reference condition
  - 0.6 = threshold between good and moderate condition
  - <0.6 = eutrophic water body</li>
  - Lowest nEQR determined ecological status

Can bring otherwise good ecological status down to moderate condition

Location	Biological quality element (index)	Supporting parameters
Rivers	Periphyton (PIT), benthic invertebrates (ASPT)	Tot N, Tot P
Lakes	Phytoplankton (CHL-a, biovolume, PTI, Cyano <sub>max</sub> ), Macrophytes (Tic)	Tot N, Tot P
Coastal	Phytoplankton (CHL-a 0-10 m), macroalgae (SMSDI, RSLA/RSL), angiosperms (eelgrass; ANTIZM), soft-bottom fauna* (NQI1)	NH <sub>4</sub> , NO <sub>3</sub> , NO <sub>2</sub> , Tot N, PO <sub>4</sub> , Tot P, DO bottom water



\*) NB: Includes stations within the influence area of emission points

#### **Data sources**

- Surveillance data last 10 years (2015-2024)
- Extracted from <a href="https://vannmiljo.miljodirektoratet.no/">https://vannmiljo.miljodirektoratet.no/</a>
- Not yet uploaded data from reports (2023-2024)
- Project data from KYSTREV (includes data from AquaMonitor@NIVA and Institute for Marine Research)
- If no data available: data from surrounding water bodies

# Minimum requirement for sufficient data

NB: Less strict than recommended by the Norwegian guidelines

#### Freshwater (rivers and lakes)

- MUST: A minimum of **one** biological quality element in addition to supporting parameters from last 10 years
- PREFERABLY: Data from at least three years within last 10 years

#### Coastal waters

- MUST: A minimum of **one** biological quality element in addition to supporting parameters from **last 10 years**
- PREFERABLY: Data on **both** phytoplankton and **at least one** benthic quality element in addition to support parameters the **last 10 years**
- PREFERABLY: The pelagic investigations represents at least three consecutive years

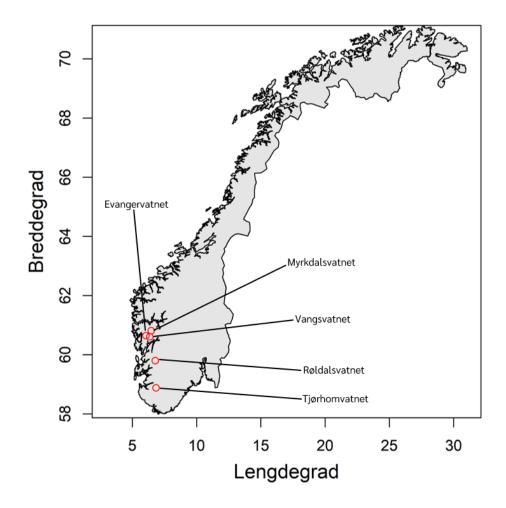


# Lakes (5)

Negative outcome
Unsure
Positive outcome
No data

~ P or N limitation

Ratio WW Tot N (%)	2.8	2.3	7.1	5.9	3.9
Ratio WW Tot P (%)	2.8	3.6	3.8	3.3	2.7
Eutrophic	-	P	Р	Р	P+N
Become eutrophic	-				
Benefit of measure	-	Ν	Υ	Υ	Υ
Sufficient info					
	Tjørhomvatnet	Røldalsvatnet*	Vangsvatnet	Evangervatnet*	Myrkdalsvatnet*

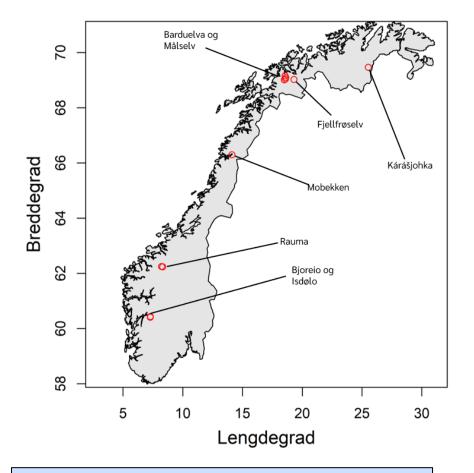


- Sufficient data: 1 of 5
- Apparently, no lakes eutrophic
- One lake P + N limited



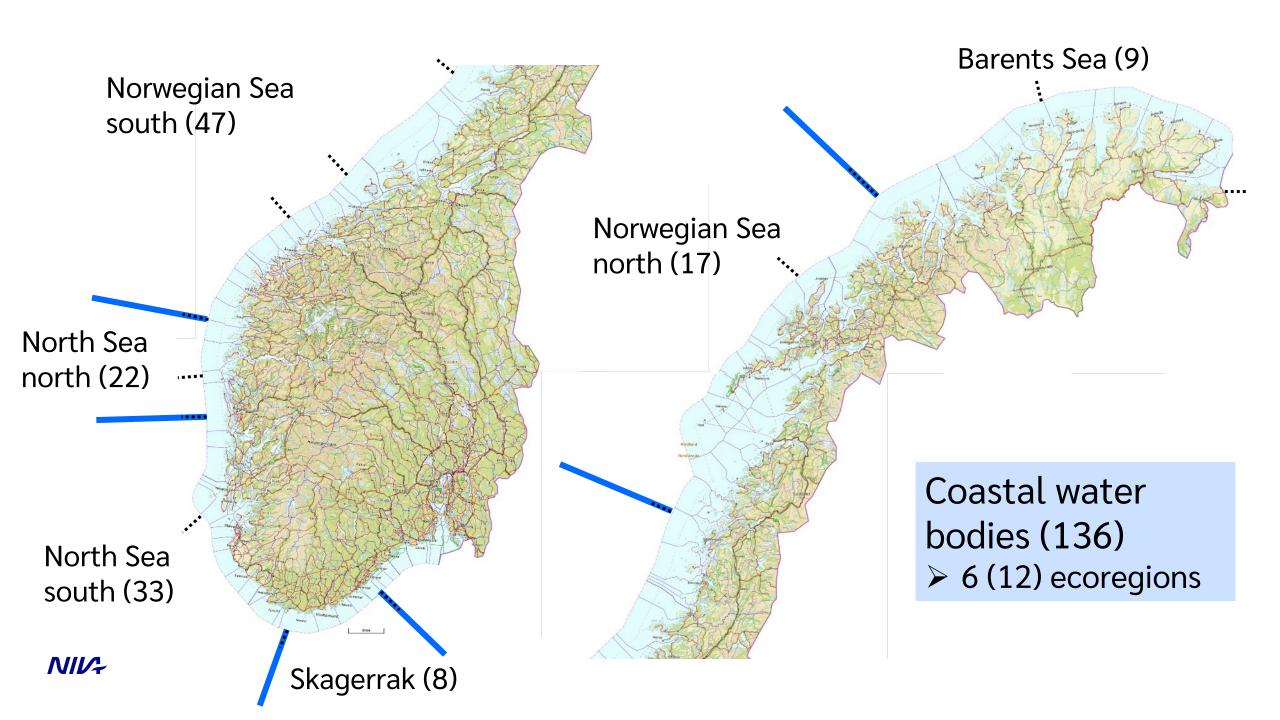
### Rivers (11)

Ratio WW Tot N (%)	0.6	2.4	0.0	5.3	70.9	21.8	4.6	4.6	6.4	6.5	1.5
Ratio WW Tot P (%)	5.3	7.8	0.0	4.1	89.2	11.2	2.9	2.9	7.6	8.2	7.2
Eutrophic	-	-	Р	-	-	-	ı	-	Р	-	Р
Become eutrophic	-	-		1	-	1	ı	-		-	
Benefit of measure	-	-	N	-	-	1	ı	-	Υ	-	N
Sufficient info											
	Bjoreio overføring fra Sysenvatnet - dam Tveito	Isdølo Isdalsvatnet - Bjoreio	Rauma mellom Bjorli og Lesjaskogsvatnet*	Rauma ved Bjorli	Mobekken	Fjellfrøselv ved Skjold	Barduelva Setermoen-Bardufoss	Nedre Barduelv	Nedre Målselv 1	Nedre Målselv 2	Kárášjohka – nedre deler



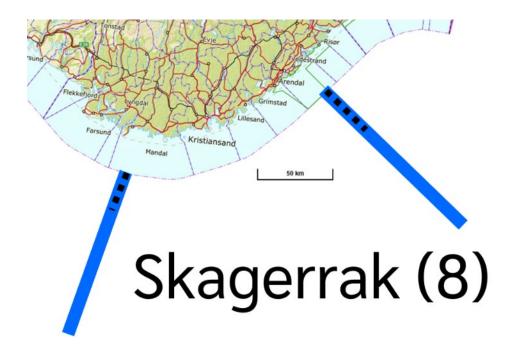
- Sufficient data: 3 of 11
- Apparently, no rivers eutrophic





# Skagerrak

Ratio WW Tot N (%)	19	19	7.3	28	28	28	8.2	8.2
Ratio WW Tot P (%)	26	26	8.1	24	24	24	16	16
Eutrophic							-	
Become eutrophic							-	
Benefit of measure	N	Υ	Υ	Ν	Υ	Υ	-	N
Sufficient info								
	Merdø - Hasseltangen	Grosfjorden – indre*	Lillesandfjorden*	Østergapet – indre*	Kristiansandsfjorden – indre*	Kristiansandsfjorden – indre havn*	Høllefjorden	Mannefjorden*



- Sufficient data: 1 of 8
- Eutrophication status generally ok, but several water bodies at risk
- Wastewater emissions significant in 3 water bodies at risk



#### North Sea south

- Sufficient data: 3 of 33
- Eutrophication status uncertain and variable, but at risk several places, partially due to increasing emissions from aquaculture (\*) and wastewater (\*)
- Wastewater emissions significant in 5 (+2) water bodies at risk

North Sea south (33)

							*			*		*																					
Ratio WW Tot N (%)	6.0	6.0	3.3	3.6	3.6	3.6	31	31	31	2.0	8.4	1.7	1.7	3.4	9.9	22	22	22	10	22	22	9.9	9.9	2.5	2.1	13	2.1	2.1	4.2	1.3	5.3	1.3	7.1
Ratio WW Tot P (%)	23	23	3.2	26	26	26	65	65	65	3.2	18	1.7	1.7	14	11	33	33	33	11	33	33	11	11	4.2	3.1	17	3.1	3.1	4.0	1.2	9.1	1.2	10
Eutrophic						-											-					-					-	-					
Become eutrophic						-											-					-					-	-					
Benefit of measure	Υ	U	Υ	Υ	Υ	-	Υ	U	U	Υ	Υ	U	U	Υ	N	N	-	N	U	Υ	U	-	U	U	U	Υ	-	-	Υ	Υ	Υ	U	U
Sufficient info																																	
	Rosfjorden*	Lindesnes – Lista*	Lafjord*	Vandringshamna – Rosshagen*	Egersund*	Sirevåg	Jærensrev – syd*	Jærensrev – nord*	Håsteinsfjorden – indre*	Stavangerfjorden – ytre*	ldsefjorden*	Håsteinsfjorden mot Kvitsøy*	Kvitsøyfjorden*	Saudafjorden*	Karmsundet-Snorteland*	Sirafjorden*	Åkrehamn	Veavågen-ytre*	Røværsfjorden*	Karmsundet-Kopervik*	Føynfjorden*	Karmsundet - Storasund	Bømlafjorden*	Ølsfjorden*	Klosterfjorden*	Aslaksvika*	Høylandsundet-sør	Høylandsundet-nord	Stokksund*	Husnesfjorden*	Samlafjorden	Bjørnafjorden	Fusa-/Bjørnafjorden



#### North Sea north

- Sufficient data: 0 of 22
- Eutrophication status uncertain and variable, but at risk several places due to increasing emissions from aquaculture (\*)
- Wastewater emissions significant in 5 (+1) water bodies at risk

North Sea north (22)



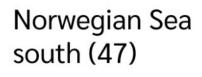
												*	*			*						
Ratio WW Tot N (%)	55	55	12	55	12	55	12	55	23	18	23	2.7	3.4	8.6	3.3	3.3	5.4	5.4	5.4	5.4	1.2	7.9
Ratio WW Tot P (%)	53	53	12	53	12	53	12	53	28	47	28	7.4	3.2	33	3.4	3.4	8.3	8.3	8.3	8.3	1.7	30
Eutrophic											ı			1	1							-
Become eutrophic											ı			ı	ı							ı
Benefit of measure	Υ	Υ	Υ	Υ	С	Υ	Υ	Υ	Υ	Υ	-	Υ	Υ	-	-	U	Ζ	Υ	Υ	Υ	Υ	-
Sufficient info																						
	Skeisosen*	Fanafjorden*	Raunefjorden*	Grimstadfjorden*	Kobbaleia*	Byfjorden indre del*	Hjeltefjorden-søndre*	Byfjorden*	Hauglandsosen*	Sørfjorden*	Herdlefjorden-søndre	Knarvik*	Hjeltefjorden-nordre*	Sogndalsfjorden	Førdefjorden-indre	Rekstafjorden*	Solheimsfjorden*	Gunhildvågen – Klubbevika*	Florevika Gaddevågen*	Botnafjorden*	Nordgulen*	Lobukta



# Norwegian Sea south

			*	*					*		<del>*</del>	<b>*</b> :	<del>*</del>	_	<del>X</del>		* *	*	<del>*</del> *		<del>*</del> *									_	<del>*</del>	<b>*</b>														*	
Ratio WW Tot N (%)	6.1	7.3			5.2	23	2.0	4.0		_				_	_	23 2	23			_		5.1	5.9	3.0	8.0	8.0	3.2	3.2 3	3.5 5	_		_	40	4.6	7.5	5.2	2.3	5.2	0.4	3.0	1.6	2.8	6.0	1.0	4.6	1.0	3.9
Ratio WW Tot P (%)	9.4	15	23	23	11	27	2.5	6.4	27	27	27	27	27 2	27 2	27 2	27 2	27	27 2	27 :	12	54	15 8	3.1	9.0	9.0	9.0	7.0	12 1	12 2	26	78	12	78	15 :	16	31 2	2.8	31	0	16	2.5	15	24	1.0	5.3	1.0	31
Eutrophic		-			-											-				- [							- [									- [		- [	- [		- (				-		
Become eutrophic		-			-											-				-							-				П					-		-	-		-				-		
Benefit of measure	Υ	-	Υ	Y(U)	-	U	U	U	Υ	N	Υ	Υ	U	N ,	Υ	- '	Υ	Υ	Υ	-	Υ	Υ	Υ	U	U	U	-	U	U	Υ	Υ	Υ	N	U	Υ	-	Υ	-	-	Υ	-	U	Υ	U	-	Υ	Υ
Sufficient info																																															
	Voldsfjorden ved Volda*	Ørstafjorden indre	Lyngnesvika*	Rundafjorden*	Sykkylvsfjorden-ytre	Storfjorden-ytre*	Storfjorden-indre*	Storfjorden ved Stranda*	Eidssundet*	Heissafjorden*	Langevågen*	Asefjorden indre*	Åsefjorden ytre*	Borgundfjorden-øst*	Borgundtjorden-vest*	Aspevågen	Ellingsøytjorden-Svinøya til Dyrøya*	Valderhaugfjorden ved Ålesund*	Ellingsøyfjorden-ytre*	Vestnesbukta	Moldefjorden ved Molde*		Sunndalsfjorden ved Sunndalsøra	Bolgsvaet*	Bolgsvaet ved Remlan*	Kristiansund-ytre	Surnadalsfjorden - Surnadalsøra	Kvith	Trondheimsfjorden - Agdenes	Indre Orkdalsfjorden*	Ladehammeren*	Stjørdalsfjorden	Trondheimsfjorden - Trondheim	Trondheimsfjorden – Levanger*	ıkjer	Sørfjorden- Sør for Nordfjorden	Bjugnfjorden*	Nordfjorden	Berfjorden	Namsenosen*	Namsenfjorden	Namsfjorden	Vefsnfjorden-indre*	Alstenfjorden*	Botnfjorden	$\subseteq$	Ranfjorden – Mo*

- Sufficient data: 6 of 47
- Eutrophication status uncertain and variable, but at risk several places due to increasing emissions from aquaculture (\*), wastewater (\*) and agriculture (\*)
- Wastewater emissions significant in 7 (+7) water bodies at risk

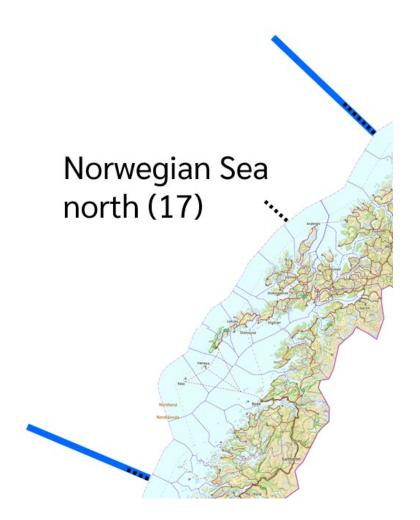




# Norwegian Sea north

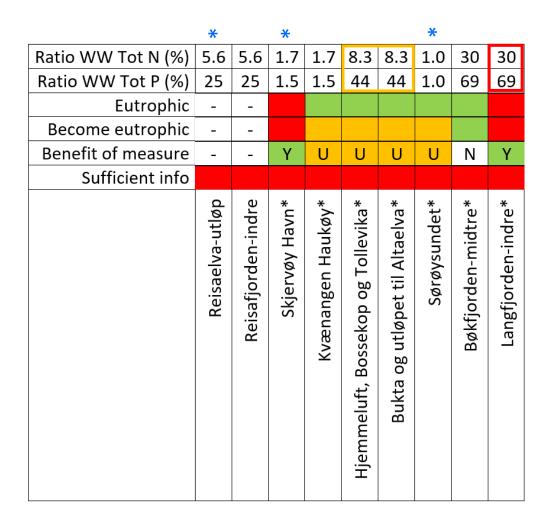
- Sufficient data: 1 of 17
- Eutrophication status uncertain and variable, but at risk several places primarily due to increasing emissions from aquaculture (\*)
- Wastewater emissions significant in 3 water bodies at risk

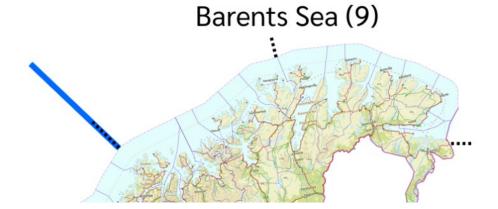
	*	*				*	*			*	*		*	*		*	*
Ratio WW Tot N (%)	12	35	35	6.1	8.2	3.4	1.7	1.7	4.7	8.2	8.2	8.2	8.2	8.2	2.0	18	29
Ratio WW Tot P (%)	21	41	41	9.5	9.6	3.8	2.1	2.1	5.3	9.6	9.6	9.6	9.6	9.6	1.9	17	29
Eutrophic			-	-	-			-	-			-			-		
Become eutrophic			-	-	-			ı	-			ı			ı		
Benefit of measure	Υ	Υ	ı	-	-	Υ	Υ	-	-	U	٦	-	Υ	Υ	ı	>	Υ
Sufficient info																	
	Fauskevika*	Saltfjorden-indre*	Hjartøysundet - Nyholmsundet	Svolvær	Lødingen Havn	Ofotfjorden	Sortlandsundet-sør-ytre*	Sortlandsundet-sør-indre	Sortlandsundet-nord-indre	Breivik – Kilbotn*	Harstadbas. Russevika – Brurvika*	Stangnes	Harstad havneområde*	Bergsvågen*	Finnfjorden-ytre	Sandnessundet*	Tromsøysundet – Tromsø*





#### **Barents Sea**





- Sufficient data: 0 of 9
- Eutrophication status uncertain and variable
- Wastewater emissions significant in 1
   eutrophic water body and +2 potentially at risk



### Summary and conclusions

- Available data not sufficient to conclude for any water bodies according to recommendations in the Norwegian guidelines
- Particularly missing biological quality elements and longer time series (at least three consecutive years) in coastal waters
- Data suggests that 23 of 136 coastal water bodies are already eutrophic and that 29 additional coastal water bodies may be expected to become eutrophic
- The extent of surveillance of "normal" and "less sensitive" areas need to be increased considerably



