Monitoring program in the Tana catchment and fjord

Joint Environmental Management of the River Tana

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Tanamunningen, Frank Martin Ingilæ

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Luke
LUONNONVARAKESKUS

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The Tana River catchment is 16 386 km² and it discharges into the Barents Sea via Tana Fjord. Land area is dominated by mineral soils and thin humus layer. Aquatic environment is characterized by small oligotrophic headwater lakes and a network of steep river valleys. Human pressures in the region are generally low. Currently the biggest direct anthropogenic pressures are communal sewage treatment plants discharging into the Kaarasjok, Utsjoki and the Tana River, salmon fishing and introduction of alien species.

Responsible authorities

Aquatic monitoring is coordinated by competent national or regional authorities. Centre for Economic Development, Transport and the Environment in Lapland (ELY-centre) coordinates monitoring on Finnish side. Water quality in the border rivers belongs to the Finnish national monitoring program of water quality in transboundary waters. In case of a sewage treatment plant, a separate monitoring is run for detecting the impact of their operation. Fish community and salmon stocks are the responsibility of the Natural Resources Institute Finland (Luke).

On Norwegian side, the Norwegian Environment Agency is responsible for surveillance and reference monitoring, and monitoring of salmon stocks. The County Governor of Finnmark coordinates the regional program for operational monitoring, including water chemistry and biology in waterbodies with significant anthropogenic pressures.

Monitoring of water quality and biology

The main stem Tana and Anarjohka have history of the basic water quality monitoring since 1964. Early biological studies were separate surveys (eg. Lax et al. 1993, Huttula et al. 1996, Sivonen 2006). The current consisting biological monitoring begun with the EU Water Framework Directive after 2006. The Finnish sewage plants have had monitoring of recipient in their environmental permit. In Norway the plants are smaller and more numerous. Their monitoring has been developed as part of the Tana Interreg project.

When monitoring is aimed at detecting possible effects from a sewage treatment plant, it is considered operational. *Operational* monitoring takes place yearly, eg. in upstream and downstream from the sewage plant. *Surveillance* monitoring aims to detect long-term trends and overall regional environment quality. Surveillance monitoring is either annual, as in few selected main stem stations, or less frequent, as in the most stations, taking place in every 3rd or 6th year.

Water quality is analysed by standardized techniques in accredited laboratories. Analyses vary between the stations and sampling occasions. The basic physio-chemistry includes at least nutrients, pH, alkalinity, turbidity/colour, suspended solids and conductivity (table 1). Additional analysis, including heavy metals, are included in the Inarijoki/Tana main stem. Lake surface water is also analysed for chlorophyll a. Operational monitoring may also include thermotolerant coliform bacteria, when relevant. In the Tana River annual water quality stations also metals, including mercury, are analysed (table 7-8).

Biological sampling and data analysis follow national protocols. National methods focus on biodiversity and community structure, but might be conducted in different manners. Outlines of biological monitoring are given in the EU Water Framework Directive (table 2).

Table 1. The basic water quality analyses.

Analysis	**unit**
Alkalinity	mmol/l
Colour	mg/l Pt
CODMn	mg/l
Conductivity	mS/m
Iron	µg/l
Ammonium-N	µg/l
NO2-3-N	µg/l
Total N	µg/l
Oxygen	mg/l
Oxygen saturation	%
pH	
PO4-P	µg/l
Total P	µg/l
Suspended solids. 0,4 µm	mg/l
Turbidity	FNU
Temperature	°C

Table 2. Biological quality elements for lakes and rivers

Rivers	**Lakes**
1. Benthic algae 2. Benthic macroinvertebrates 3. Fish	1. Phytoplankton 2. Benthic algae 3. Benthic macroinvertebrates 4. Macrophytes 5. Fish

There are altogether 26 river monitoring stations. Monitoring focuses on the biggest tributaries and the main stem. The Tana-Aanarjohka is the most frequently monitored river reach as it has several annual and intensive water quality stations and annual sampling of river biology and electrofishing. At the moment there is only one station in a small river.

The monitoring program covers three lakes, including the catchments largest lakes Ieasjavri and Pulmankijärvi. All the three lakes are under biological monitoring. The lakes in the region are centered in the headwaters, where they are difficult to access but also aside from direct human impact. There is very little history of small lake monitoring in the Tana region.

Table 3. Number of water bodies (WB) and monitoring stations in each country in the Tana River Basin. The greater number of freshwater water bodies in Norway reflects both the larger share of the basin and that smaller water bodies are included in river basin planning.

	Coastal	**Lake**	**River**	**All**
Fi WB's		46	39	
FI stations		1	17	18
NO WB's	19	156	507	
NO stations	11	2	9	22

Table 4. Monitoring according to the type operational/surveillance.

0	**Coastal**	**Lake**	**River**	**All**
Operational			11	11
Surveillance	11	3	15	29

Table 5. River monitoring stations according to size classes (very large > 10 000 km², large > 1 000 km², Medium 100-1000 km², small < 100 km²), excluding fish stock monitoring.

River size	Number of water quality stations	Number of biology stations
Very large	8	4
Large	13	5
Medium	4	2
Small	1	1

Fish stocks

The salmon stock monitoring program of Natural Resources Institute Finland and Norwegian Institute for Nature Research comprises five main objects:

1) Counting ascending and spawning salmon in tributaries. Ascending fish are counted by video monitoring (annual sites Utsjoki and Laksjohka, some alternating sites) and sonar monitoring (alternating sites). Spawning fish are counted by drift diving (annual sites Pulmankijoki, Nilijoki and Akujoki)
2) Counting ascending salmon in the Tana mainstem (Polmak)
3) Monitoring salmon parr densities by electrofishing at 54 annual stations locating in the Tana main stem, Inarijoki and Utsjoki.
4) Analysing salmon age and growth patterns from scale samples
5) Compiling salmon fishing and catch statistics. Catch statistics have been collected since 1970's in Finland.

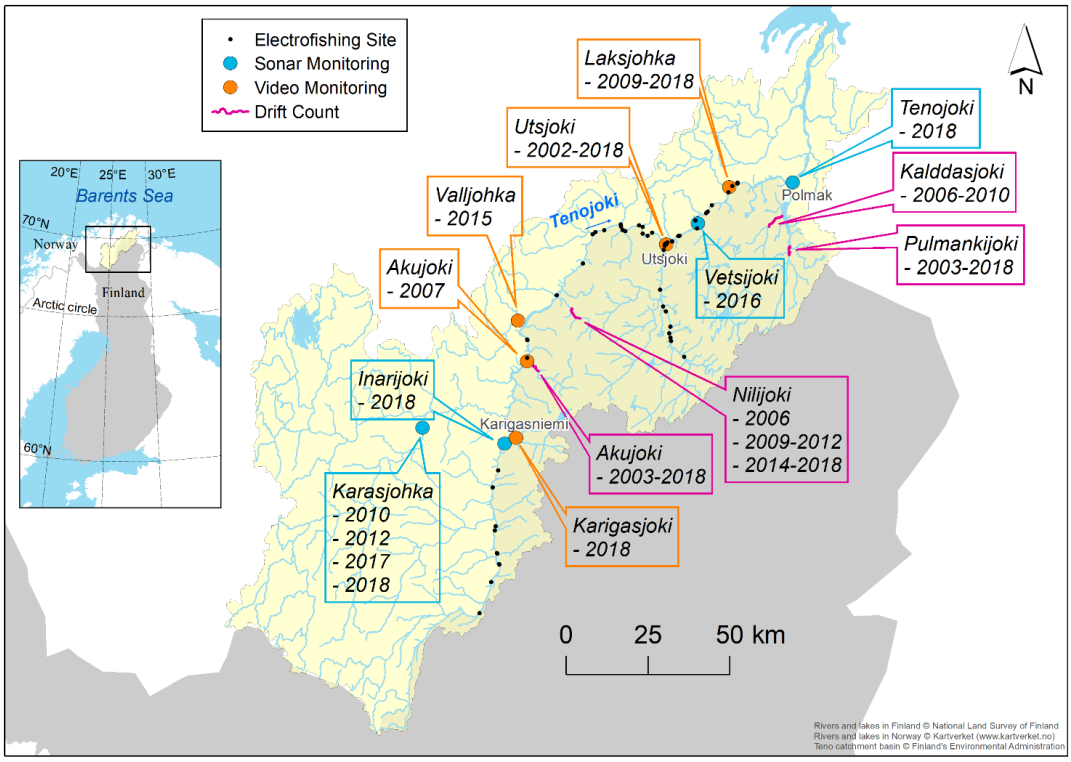

Figure 1. The salmon stock monitoring sites according to the method and length of time series. Electrofishing sites have annual data from 1979.

Electrofishing in the Tana, Eero Niemelä

Recommendations

The long and consistent time series from the Tana main stream are scientifically valuable data. Maintaining the data integrity is the first priority in the future.

Data from many parts of the river basin is scarce. The small subarctic headwater lakes and rivers are underrepresented in monitoring. Even though they face little direct human impact, they are the first to react to climatic changes and therefore recommendable for monitoring. The small rivers and streams also form a feeding habitat for salmon parr.

In the Tana Interreg 2017-2019 information gaps were filled by organizing supplementary monitoring in 7 rivers, which include 3 small rivers and locations were classification data is most needed (figure 3). When applicable, these stations are included in the monitoring program.

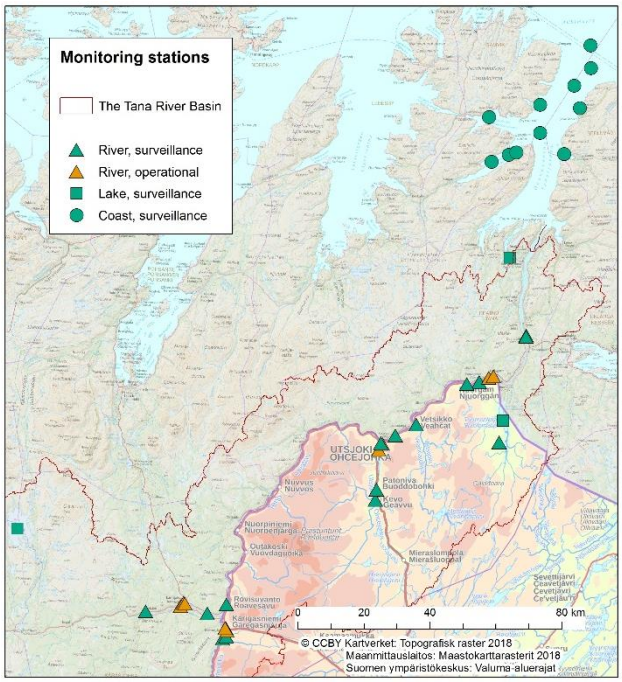

Figure 2. Water quality monitoring stations according to the type of monitoring and water body.

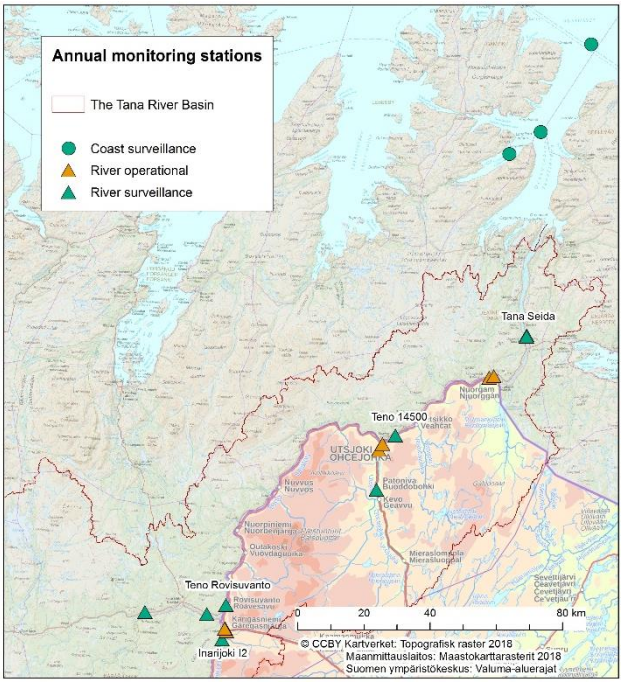

Figure 3. Annual water quality monitoring stations.

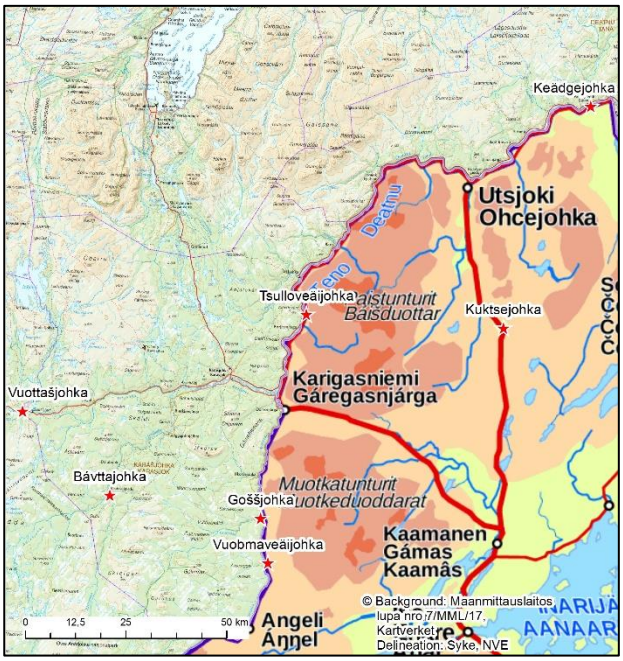

Figure 4. Additional monitoring sites funded by Tana Interreg project.

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Table 6. Sewage water treatment plant operational monitoring

Station name	WQ_frequency	WQ_samples/a	BIOL_benthicalgae_frequency	Water Body	River/lake/coast	Wastewater treatment plant	N_WGS84	E_WGS84
INARIJOKI 8	Annual	2		Inarijoki	River	Karigasniemi	69,39635	25,84513
INARIJOKI I 5C	Annual	2		Inarijoki	River	Karigasniemi	69,40363	25,83455
INARIJOKI I 5B	Annual	2		Inarijoki	River	Karigasniemi	69,40328	25,83265
INARIJOKI I5A	Annual	2		Inarijoki	River	Karigasniemi	69,40318	25,83189
TENOJOKI JVP YLÄP.	Annual	3		Teno alaosa	River	Nuorgam	70,086	27,89509
TENOJOKI NUORGAM 150	Annual	3		Teno alaosa	River	Nuorgam	70,08985	27,93236
UTSJOKI 11	Annual	3		Utsjoki	River	Utsjoki	69,89266	27,019
UTSJOKI 2	Annual	3		Utsjoki	River	Utsjoki	69,90826	27,04716
Karasjohka -st.1	Every 3rd	3	Every 3rd	EU-ID:NO234-982-R	River	Karasjohka	69,46048	25,48259
Karasjohka - oppstrøms st.2	Every 3rd	3	Every 3rd	EU-ID:NO234-982-R	River	Karasjohka	69,46936	25,50445
Karasjohka - nedstrøms st.3	Every 3rd	3	Every 3rd	EU-ID:NO234-982-R	River	Karasjohka	69,46758	25,5151

Table 7. River and coastal stations. Fish monitoring does not include Luke annual electrofishing sites.

Station name	WQ_frequency	WQ_ samples/a	BIOL_ Invertebrates_frequency	BIOL_ benthicalgae_frequency	BIOL_ fish_frequency	Water Body	River /lake /coast	N WGS84	E WGS84
Inarijoki I 2	Annual	4	Every 6th	Every 6th	Every 6th	Inarijoki	River	69,37407	25,81223
Kalddasjohka 1	Every 6th	4				Kalddasjohka	River	69,90991	27,97129
Karigasjoki 1	Every 6th	4	Every 6th	Every 6th	Every 6th	Karigasjoki	River	69,3808	25,84037
Kevojoki 1	Every 6th	4	Every 6th	Every 6th	Every 6th	Kevojoki	River	69,75624	26,99169
Keädgejohka 1	Every 6th	4	Every 6th	Every 6th	Every 6th	Keädgejohka	River	70,07526	27,81922
Tenojoki 14500	Annual	12	Annual	Annual	Annual	Teno alaosa	River	69,93161	27,14881
Utsjoki Patoniva 14510	Annual	4	Every 6th	Every 6th	Every 6th	Utsjoki	River	69,78447	26,99971
Vetsijoki 1	Every 6th	4				Vetsijoki	River	69,96105	27,31442
Teno T1 Rovisuvanto	Annual	5				Teno yläosa	River	69,46794	25,83796
FINETAN / Tana ved Seida / Tenojoki T13	Annual	12	Every 3rd	Every 3rd		EU-ID:NO234-124-R	River	70,19944	28,2018
FINETAN3	Annual		Every 3rd	Every 3rd		EU-ID:NO234-122-R	River	70,06986	27,7203
FINETAN4	Annual		Every 3rd	Every 3rd		EU-ID:NO234-115-R	River	69,9109	27,03436
Tana 500m oppstrøms Tana bru (Tenojoki T12)	Annual	10				EU-ID:NO234-124-R	River	70,19593	28,19832
Karasjohka 2, Hålganjarga (Karasjoki K2)	Annual	10				EU-ID:NO234-982-R	River	69,44245	25,69192

Karasjohka 1, Assebakti (Karasjoki K1)	Annual	10				EU-ID:NO234-982-R	River	69,4438	25,21361
Langfjorden VR7	Annual					EU-ID:NO0423011200-C	Coastal	70,69149	28,08601
Tanafjorden midtre VR24	Annual					EU-ID:NO0423010300-1-C	Coastal	70,75002	28,34678
Gulgofjorden BR40			Every 3rd			EU-ID:NO0423011700-C	Coastal	70,69088	28,54
Langfjorden BR41			Every 3rd			EU-ID:NO0423011200-C	Coastal	70,69803	28,14864
Tana ytre 2 BR45			Every 3rd			EU-ID:NO0423010300-1-C	Coastal	70,92225	28,78158
Tana ytre 1 BR43			Every 3rd			EU-ID:NO0423010300-1-C	Coastal	70,87586	28,63803
Tanafjorden ytre VR25	Annual					EU-ID:NO0423000030-11-C	Coastal	70,98425	28,78324
Værneset HR 90				Every 3rd		EU-ID:NO0423010700-C	Coastal	70,79529	27,92834
Øyenden HR91				Every 3rd		EU-ID:NO0423011200-C	Coastal	70,67337	27,94264
Dego HR 92				Every 3rd		EU-ID:NO0423010300-1-C	Coastal	70,82617	28,35228
Krøkebærnes et HR 93				Every 3rd		EU-ID:NO0423010300-1-C	Coastal	70,81429	28,68037

Table 8. Lake stations.

Station name	WQ_frequency	WQ_samples/a	Lake macrophytes	Lake phytoplankton	Lake zooplankton	N_WGS84	E_WGS84	Water Body	Lake area km^2
Pulmankijärvi	Every 6th	4	Every 12th	Every 6th		69,96861	28,00287	Pulmankijärvi	24,8
Smalfjordvann	Every 2nd	6	Every 2nd	Every 2nd	Every 2nd	70,41163	28,08009	Smalfjordvann	2
Iesjavri (Several stations, loc. not yet defined)	Every 4th	5	Every 2nd	Every 2nd	Every 2nd	69,65537	24,19208	Iesjavri	68

Table 9. Water quality analyse selection per station.

Station name	**WQ_frequency**	**WQ_samples/a**	**WQ_analysis**
Inarijoki I 2	Annual	4	TenoABC
Kalddasjohka 1	Every 6th	4	RiverA
Karigasjoki 1	Every 6th	4	RiverA
Kevojoki 1	Every 6th	4	RiverA
Keädgejohka 1	Every 6th	4	RiverA
Tenojoki 14500	Annual	12	TenoABC
Utsjoki Patoniva 14510	Annual	4	RiverAB
Vetsijoki 1	Every 6th	4	RiverA
Teno T1 Rovisuvanto	Annual	5	TenoABC
Pulmankijärvi	Every 6th	4	LakeABD
INARIJOKI 8	Annual	2	FI_Operational
INARIJOKI I 5C	Annual	2	FI_Operational
INARIJOKI I 5B	Annual	2	FI_Operational
INARIJOKI I5A	Annual	2	FI_Operational
TENOJOKI JVP YLÄP.	Annual	3	FI_Operational
TENOJOKI NUORGAM 150	Annual	3	FI_Operational
UTSJOKI 11	Annual	3	FI_Operational
UTSJOKI 2	Annual	3	FI_Operational
Smalfjordvann	Every 2nd	6	Reference
FINETAN / Tana ved Seida / Tenojoki T13	Annual	12	Reference
Tana 500m oppstrøms Tana bru (Tenojoki T12)	Annual	10	TenoABC
Karasjohka 2, Hålganjarga (Karasjoki K2)	Annual	10	TenoABC
Karasjohka 1, Assebakti (Karasjoki K1)	Annual	10	TenoABC
Karasjohka -st.1	Every 3rd	3	TenoABC
Karasjohka - oppstrøms st.2	Every 3rd	3	TenoABC
Karasjohka - nedstrøms st.3	Every 3rd	3	TenoABC

Table 10. Water quality analyses

Unit	Analysis	RiverA	RiverB	RiverC	TenoABC	FI_Operational	Lake ABD
µg/l	Total aluminen		X		X		
mmol/l	Alkalinity	X			X		X
mg/l	Calcium		X		X		
mg/l	Cloride		X			(X)	
mg/l Pt	Colour	X			X		X
mg/l	CODMn	X			X		X
mS/m	Conductivity	X			X	X	X
µg/l	a-klorophyll						
µg/l	Iron	X			X		X
mg/l	K		X		X		
mg/l	Mg		X		X		
µg/l	Mn		X		X		
mg/l	Na		X		X		
µg/l	Ammonium-N	X			X	X	X
µg/l	NO2-3-N	X				(X)	X
µg/l	Total N	X			X	X	X
mg/l	Oxygen	X				X	X
%	Oxygen saturation	X				X	X
	pH	X			X	X	X
µg/l	PO4-P	X			X	(X)	X
µg/l	PO4-P 0.4 um Nuclepore		X				
µg/l	Total P	X			X	X	X
µg/l	Total P, 0,4 µm Nuclepore		X				
mg/l	SiO2		X		X		
mg/l	SO4		X		X		
mg/l	Suspended solids 1,2 µm				X		
mg/l	Suspended solids. 0,4 µm	X					
no/100ml	Coliform bacteria				X	X	
mg/l	TIC		X				
mg/l	TOC		X		X		
FNU	Turbidity	X			X	X	X
°	Temperature	X			X	X	X
µg/l	AS			X	X		
µg/l	CD			X	X		
µg/l	CR			X	X		
µg/l	CU			X	X		
µg/l	NI			X	X		
µg/l	PB			X	X		
µg/l	ZN			X	X		
µg/l	Hg			X	X		
mg/l	Chlorophyll a						X
(X) Phosphate and nitrate-nitrite included in Utsjoki and Nuorgam stations Chloride included in Nuorgam stations							