Nord Stream 2
Committed. Reliable. Safe.

Overall Environmental Monitoring Report 2020

Contents

Abbreviations

ABS	Automatic buoy station
ADCP	Acoustic Doppler current profiler
AIS	Automatic identification system
AWTI	Above-water tie in
BOD	Biochemical oxygen demand
CFU	Colony forming unit
COD	Chemical oxygen demand
C-PODs	Cetacean porpoise detector
CPU	Colony producing unit
DP	Dynamically positioned
DPD	Mean detection rate
EAL	Environmentally acceptable lubricants
EEZ	Exclusive economic zone
EIA	Environmental impact assessment
EPA	Environmental protection agency
ES	Environmental study
ESMPs	Environmental and social management plan
FNU	Formazin nephelometric units
FTU	Formazin turbidity units
HELCOM	Baltic marine environment protection commission
IFC	International finance corporation
IUCN	International union for conservation of nature
JNCC	Joint nature conservation committee
KP	Kilometre point
MPA	Marine protected area
MPC	Maximum permissible concentration
MPL	Maximum permitted level
NSP	Nord Stream project
NSP2	Nord Stream 2 project
NT	Near threatened category group in IUCN red list
NTU	Nephelometric turbidity unit
PTA	Pig trap area
RAM	Ramsar advisory mission
ROW	Right-of-way
RDBS	Red data book species
SAMBAH	Static acoustic monitoring of the Baltic Sea Harbour Porpoise
SCI	Sites of community importance (Natura 2000 site)
SEER	State environmental expert review
SEL	Sound exposure level
SPA	Special protection area (Natura 2000 site)
SPNA	Special protected nature area
TBC	Thermotolerant coliform bacteria
TBT	Tributyltin
TC	Total coliforms
TSS	Total suspended solids
TW	Territorial water
TWA	Temporary work area

Summary

The Overall Environmental Monitoring Report 2020 presents the results of environmental monitoring related to construction of the Nord Stream 2 Pipeline in 2020. Nord Stream 2 environmental monitoring is based on the five national environmental monitoring programmes for Russia, Finland, Sweden, Denmark and Germany, which have been approved by the competent authorities. The monitoring work is designed to verify, as assessed, that there is no significant impact on the environment of the Baltic Sea from project implementation and to fulfil the requirements and commitments under the respective jurisdictions of the five countries in which the Nord Stream 2 Pipeline is built.

Environmental monitoring started in 2018 and continued in 2020 in Russia, Finland, Sweden, Denmark and Germany upon receipt of the respective construction permits and start of construction activities.

Construction activities in 2020 comprised the following:

- Russia: onshore construction, rock placement;
- Finland: rock placement;
- Sweden: rock placement;
- Denmark: rock placement (including protection of pipe heads with rock bags);
- Germany: pipelay (including protection of pipe heads with rock bags).

Some construction activities may cause impacts on the marine and terrestrial environment depending on their nature, location along the pipeline route, and the period when the activity is undertaken. Therefore, the construction works have governed which parameters are monitored and when monitoring takes place in the individual countries. Furthermore, certain investigations are carried out only at selected sites, depending on specific national regulations and environmental sensitivity.

Thus, as part of the permit, each country has specified the monitoring requirements to demonstrate that environmental and social conditions remain within defined levels and standards and are in line with environmental impact assessments. In some cases, additional monitoring activities that are outside the scope of the national monitoring programmes have been implemented through specialist studies to strengthen the assessment of impacts from Nord Stream 2 implementation and/or to enhance scientific knowledge of the Baltic Sea environment.

Environmental monitoring focuses on relevant physical-chemical, biotic and socio-economic parameters likely to be impacted during various construction activities. The table below lists the parameters monitored in 2020 during certain offshore and onshore Nord Stream 2 construction activities.

Offshore monitoring in 2020

Monitored parameters	Rock placement	Pipelay	Post-construction
Physical-chemical environment			
Marine sediment quality			R, D, G
Marine water quality (turbidity)	F		R
Marine water quality (pollutants)			R
Bathymetry			G
Biotic environment			
Benthic flora and fauna			R, G
Plankton			R
Fish/Fish migration			R
Birds			R, G
Marine mammals			R, G
Socio-economic environment			
Cultural heritage	D, R*		
Munitions (chance finds)	D		
Ship traffic	R**, F**, S**, D	G	

R – Russia; F – Finland; S – Sweden; D – Denmark; G – Germany
* Involves supplementary monitoring measures, beyond those specified as part of national monitoring programmes and permit conditions, to meet additional lender or project requirements; ** Monitoring of ship traffic is not part of monitoring programme, ship traffic safety is ensured by compliance with the relevant permit requirements

Onshore Russia monitoring in 2020

Monitored parameters	Construction camp & temporary works area (outside Kurgalsky Reserve)	Kurgalsky Nature Reserve	Rosson River
Physical-chemical environment			
Soil quality		×*	
Exogenous processes		×	
Air emissions and quality	×		
Airborne noise	×		
Water quality – effluent	×*		
Hydrology		×	
Water quality – receiving water			×*
Riverbed sediment quality			×
Biotic environment			
Terrestrial flora		×*	
Birds		×*	
Mammals		×*	
Hydrobiology			×
Fish			×

* Involves supplementary monitoring measures, beyond those specified as part of national monitoring programmes and permit conditions, to meet additional lender or project requirements

Onshore Germany monitoring in 2020

No construction works were conducted at the landfall in Germany in 2020. Therefore, no onshore monitoring took place in Germany in 2020, in accordance with the German permit obligations.

CONCLUSIONS FOR OFFSHORE MONITORING

Monitoring associated with the offshore construction activities demonstrated that no impacts other than those predicted occurred in 2020.

No significant impacts on abiotic environment were reported. Monitoring of turbidity during rock placement showed that no significant impacts on water quality occurred. No increase in turbidity due to construction activities was recorded in the proximity of Sandkallan protected area, which is in line with the results of Natura 2000 assessment. Post-construction monitoring undertaken in Russian, Danish and German waters showed that there was no significant impact on the water quality or the seabed due to construction. Quality of the seawater was comparable with the results received during pre-construction surveys. Natural levelling of the seabed though action of waves and currents proceeded in line with the assessment. No contamination of the seabed sediments was observed. Analysis of chemical warfare agents (CWA) in seabed sediments along the route in Denmark demonstrated no increase in pollutant concentrations. These results confirmed conclusions of the EIA report that construction activities have not resulted in disturbance of contaminated seabed sediments associated with dumped chemical munitions.

Monitoring of the biotic environment was undertaken in Russia and Germany as part of post-construction monitoring. It was shown that general conditions of the monitored populations of plankton, benthos, marine mammals and birds were not permanently impacted by the construction activities, which is in line with the EIA reports. Analysis of benthos in 2020 revealed a progressive stage of succession for all benthic communities. It is expected that fauna and flora will recover within about two to four years and no permanent impact will remain. No invasive species were detected. Monitoring of seabirds and marine mammals showed that there were no impacts on their abundance and distribution due to construction. Moreover, it was shown that the numbers of grey seals in the Russian waters of the Gulf of Finland is steadily rising and there is an upward trend in the population size of ringed seals. Encounters of harbour porpoises continued to increase in the northern Pomeranian Bay as shown by monitoring in Germany.

Monitoring of third-party shipping traffic was successfully implemented during construction and no incidents were recorded. No disturbance of cultural heritage objects was associated with the project activities. No chance finds of cultural heritage objects and munitions occurred during construction in 2020.

CONCLUSIONS FOR ONSHORE RUSSIA MONITORING

The Kurgalsky Nature Reserve is a highly sensitive area and has therefore been extensively monitored since construction began in 2018, and throughout 2019 and 2020. Monitoring results for 2020 have demonstrated that no significant impacts on the biotic and abiotic environment of the protected area took place as assessed in the national EIA. The monitoring of soil quality, exogenous processes and hydrology mostly displayed values within natural variability of the area. The monitoring of protected plant species (RDBS) showed good survival of the relocated plants. Previously recorded changes in the pattern of migrating bird movement and feeding behaviour of ungulates is deemed to be temporary and coming back to its natural pattern. A total of 37 protected species of vertebrates were recorded during the monitoring campaigns.

Construction activities at the construction camp and work areas in 2020 were in line with the EIA assessments. Analysis of the discharged water showed some degree of contamination norms. Therefore, discharge of treated water was stopped in February and was not renewed.

Monitoring of the Rosson River was designed to capture the potential impacts caused by the water discharges to the river. Monitoring of different environmental conditions showed that water discharges did not have any impacts on the abiotic and biotic parameters. There were no significant differences in the degree of water and bottom sediment contamination during the operation of the tail drain and in the absence of wastewater discharge. The registered variation of plankton, benthos and macrophytes communities was typical for Leningrad Region; similarly, no impact on ichtyocoenosis of the Rosson River was detected.

CONCLUSIONS FOR ONSHORE GERMANY MONITORING

Onshore monitoring in Germany was concluded in 2019. No onshore construction was conducted at the German landfall in 2020, with only minor reinstatement and finalisation works taking place. Since no civil works took place, no environmental monitoring was required in 2020 according to the German permit obligations.

1 Introduction

Nord Stream 2 is a twin pipeline system running 1,234 kilometres through the Baltic Sea from the Russian to the German coast. The pipelines are built and operated by Nord Stream 2 AG.

The parallel pipelines pass through the territorial waters (TW) and/or exclusive economic zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany (see Figure 1). The starting point of Nord Stream 2 is located near Narva Bay in the Kingisepp District of Russia's Leningrad Region, where the pipeline connects to the Russian gas network. The receiving station at the German landfall near Greifswald connects Nord Stream 2 with the neighbouring natural gas receiving facility from Gascade, and thus with the European pipeline network. When fully operational the twin pipelines will have the capacity to transport a total of 55 billion cubic metres (bcm) of natural gas per year to businesses and households in the EU for at least 50 years.

Construction of the Nord Stream 2 Pipeline commenced in 2018 in Russia, Finland, Sweden, Germany, and in 2019 in Denmark upon receipt of the respective permits. Onshore and offshore construction works continued in 2020. Environmental monitoring is carried out before, during and after construction, demonstrating that impacts are in line with the environmental impact assessment (EIA) reports and certain permit conditions, as well as in compliance with the International Finance Corporation (IFC) Environmental and Social Performance Standards.

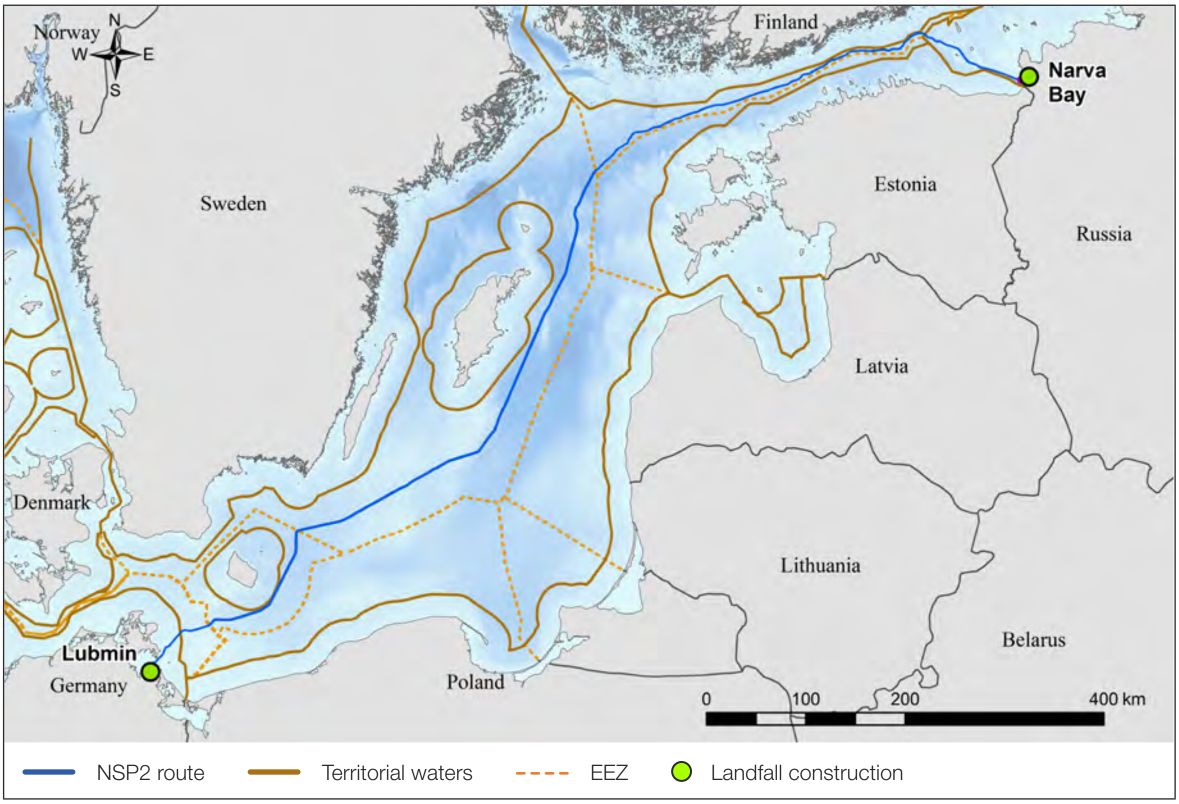

Figure 1. *Nord Stream 2 Pipeline route.*

1.1 Purpose

The purpose of this report is to present the results and conclusions of environmental monitoring carried out during construction of Nord Stream 2 in 2020 following approved national environmental monitoring programmes.

The Nord Stream 2 monitoring programmes were designed and implemented to verify that there are no significant impacts on the environment of the Baltic Sea and to ensure that certain permit requirements and commitments under the respective jurisdictions of the five countries are fulfilled. Further requirements and commitments, arising from the project financing phase, resulted in Nord Stream 2 implementing the project in conformance with the International Finance Corporation's Environmental and Social Performance Standards, the associated World Bank guidelines, Equator Principles and the environmental and social requirements of the export credit agencies.

Nord Stream 2 is committed to building a safe and sustainable subsea pipeline system that causes no significant or lasting impacts on the Baltic Sea, the onshore environment or local communities. Monitoring programmes are based on comprehensive environmental surveys and studies to determine the conditions of the marine environment with focus on sensitive areas and receptors that require monitoring as defined in the national EIAs and Espoo report.

1.2 Permits

The offshore route proposed for Nord Stream 2 passes through the TW and/or EEZs of Russia, Finland, Sweden, Denmark and Germany, with landfalls in Russia and Germany. Consent for construction and operation of the pipeline from the coastal states is based on various national laws, such as EIA Procedure Acts, Water Acts, EEZ Acts, Continental Shelf Acts and Energy Acts, which are specific for each individual country.

The national permits required for onshore and offshore construction of Nord Stream 2 were obtained in 2018 in four countries – Russia, Finland, Sweden and Germany. Following the ratification of the EEZ border agreement between Denmark and Poland, the construction permit was granted for the south-eastern route within the Danish EEZ. The EEZ border shown on the maps in this report reflects the agreed border as ratified in 2019.

Table 1 provides a brief overview of the relevant legislation in each country concerned and an overview of the permits received up to the end of 2020.

Table 1. *Status of Permits in five countries in 2020*

Country	Received Permits
Russia	Updated Construction Permit (Ministry of Construction) for Lines A and B received on 06.04.2020 in accordance with the Russian Urban Planning Code (Federal Law No 190-FZ dated 29.12.2004).
Finland	EEZ consent received 5 April 2018 in accordance with the Finnish Act on the EEZ (Act 1058/2004).
	Water Permit received 12 April 2018 in accordance with the Water Act (Act 587/2011).
Sweden	Construction permit received 7 June 2018 in accordance with the Act on the Continental Shelf (Act 1966:314).

Country	Received Permits
Denmark	Construction Permit received from the Danish Energy Agency on 30 October 2019.
	Operation Permit for Lines A and B were received from the Danish Energy Agency on 1 October 2020.
Germany	Plan Approval (PFB) for construction and operation in the TW and on German landfall by Mining Authority – received 31 January 2018.
	Permit acc. to §133 Paragraph 1 No. 1 German Federal Mining Act (BBergG) for construction and operation in the EEZ by Mining Authority – received 2 November 2017 (construction) and 16 March 2018 (operation).
	Permit acc. to §133 Paragraph 1 No. 2 German Federal Mining Act (BBergG) for construction and operation in the EEZ by Federal Maritime and Hydrographic Agency BSH – received 27 March 2018 and revised 4 May 2018.

Two permit change requests were filed with the BSH in 2020, the permitting authority for the German EEZ. In a change notification filed in early July 2020 and approved by BSH in early October, NSP2 applied for the potential continuation of pipelay in the German EEZ from October to December 2020.

Further, a material change application was filed, including an:

- Amendment regarding the construction time window for pipelay in the German EEZ. The change application documents (including an EIA) were handed over to the authorities in late July 2020. A public consultation took place in an online format (following COVID-19 regulations). No decision was taken by the responsible authority by the end of 2020 (the change permit was received on 14 January 2021).

Further, a permit amendment request was filed with the Danish Energy Agency for a change from a DP positioned vessel to an anchored lay barge for the remaining pipelay work in Danish waters. The request included an assessment of potential environmental impacts. In July 2020, the following Construction permit conditions were amended as follows:

- Condition 19 of the construction permit was amended allowing the use of an anchored vessel, a DP vessel or a combined solution (a vessel using both anchors and DP).

1.3 Overview of monitoring programme and reporting

An environmental monitoring programme is an integral part of the national permits allowing construction and operation of Nord Stream 2. The monitoring programme is based nationally and aligned to the legislation in each country. In addition, the international consultation process (Espoo consultation) as part of the permitting process has enacted environmental monitoring of transboundary impacts, allowing assessment of the impact on the global project-wide level, e.g. seal telemetry study in Russia.

The purpose of the environmental monitoring programmes is to verify that environmental impacts which may potentially occur during various stages of the project are in line with the assessment in the national EIAs and Espoo report, /01/–/06/ thus supporting certain permit requirements and permit conditions. Furthermore, the data collected from the monitoring programme may establish the need for environmental mitigation and corrective measures if, contrary to expectations, the data indicate unforeseen environmental impacts.

The national monitoring programmes are framed by the legislation of the five countries through whose waters the pipeline passes, as well as through consultation with the relevant national authorities.

Depending on the sensitivity of the marine environment and on the nature of the construction activities, the location along the pipeline route, and the period when the activity is undertaken, the construction works may cause different effects on the environment. Therefore, the construction works in conjunction with the sensitivity of the marine environment have governed which monitoring activities take place in the individual countries, and when. Furthermore, certain investigations are carried out only at selected sites, depending on specific national regulations and environmental variations.

The monitoring programmes have been planned and developed with the following objectives:

- To verify that the pipelines are installed and operated in accordance with certain permit conditions;
- To demonstrate that environmental conditions remain within required levels and standards;
- To verify that the pipeline construction and operation do not cause unforeseen environmental impacts or impacts that are greater than anticipated;
- To provide the basis for mitigation/corrective measures if necessary;
- To monitor the recovery of the environment after construction.

The Nord Stream 2 environmental monitoring programmes, which include monitoring before, during and after construction of the Nord Stream 2 Pipeline are described in /07/–/12/. Most baseline studies along the route were performed during the EIA phase and thus were not included in the monitoring programmes. However, a number of parameters were included in the programmes to be monitored before construction to collect more information or update existing baseline data. Additional monitoring activities that are outside the scope of the national monitoring programmes have been implemented through specialist studies to strengthen the assessment of impacts from Nord Stream 2 implementation, to enhance scientific knowledge of the Baltic Sea environment and/or to demonstrate adherence to lenders' standards or other standards adopted by NSP2. These studies include:

- Telemetry studies and aerial surveys of the Baltic ringed seals in the Gulf of Finland (2017–preliminary planned 2022);
- Monitoring of sediment toxicity in Finland after munitions clearance (2018);
- Additional monitoring of marine mammals as defined by Finnish authorities (2018);
- Satellite monitoring of turbidity during dredging/backfilling activities in Russia (2018–2019);
- Increased frequency of wastewater discharge monitoring at the Russian landfall (bi-weekly rather than quarterly as required under national monitoring) to enable a more rapid response to deviation from performance (2019–2020);
- Monitoring for emergence of invasive species at the Russian landfall, to prevent spread of or introduction of such species (2018–2020);
- Implementation of a watching brief for cultural heritage in the vicinity of the designated-archaeological site at the Russian landfall (2018);
- Enhanced biodiversity monitoring (additional to that required under the national approvals/permit) notably in relation to birds in the vicinity of the project footprint in the Kurgalsky nature reserve (2018–2020);
- Reinstatement of the onshore Russian landfall site (2020);
- Monitoring the implementation of conservation measures for peat, forest and sandy soils at the Russian landfall to promote retention of natural habitat (2018–2020);
- Hydrological monitoring in the vicinity of the construction footprint within the Kurgalsky nature reserve at the Russian landfall (2019–2020).

In addition, mitigation measures were implemented in the project throughout the construction phase. Such measures include environmental supervision according to certain permit conditions, environmental and social management plans (ESMPs), environmental audits and contractor reporting.

Furthermore, a number of engineering inspections and surveys applicable to the entire route are carried out immediately before, during and after construction works to ensure the highest level of safety and accuracy in construction. These activities are not described further in this report.

An overview of the environmental monitoring activities before, during and after construction in five countries is given in Table 2.

Table 2. *Overview of monitored parameters before, during and after construction/during operation in Russia, Finland, Sweden, Denmark and Germany defined in the national monitoring programmes.*

Parameter	Before construction	During construction	After construction
Offshore			
Sediment transportation			S
Seabed sediments	R, D, G	R, F*, G	R, D, G
Turbidity/Water quality	R, G	R, F, S, D, G	R, G
Underwater noise		F, E**, S, G	
Ecotoxicological effects	S		S***
Benthic flora and fauna	R, G	R, G	R, S, G
Plankton	R	R	R
Fish	R, G	R	R
Birds	R, G	R, G	R, G
Marine mammals	R, G	R, F, G	R, G
Commercial fishery	S, G		F, S, D
Cultural heritage	F, S, D, G		F, S, D
Munition object	D		D
Ship traffic****		S, D, G	
Pipeline footprint			R, F, S, D, G
Onshore			
Riverbed sediments	R	R	R
Water quality	R	R	R
Hydrobiology/Ichthyology	R	R	R
Ground water	G	G	
Terrestrial flora	R, G	R	R
Terrestrial fauna	R, G	R	R
Birds	R, G	R	R
Air quality		R	
Airborne noise		R, G	
Cultural heritage		R	
Exogenous processes	R	R	R

R–Russia; F–Finland; S–Sweden; D–Denmark; G–Germany; E–Estonia
* Supplementary monitoring outside the scope of national monitoring programme. ** Monitoring of transboundary impacts to Estonia from munitions clearance in Finland; no construction activities in Estonia. *** Monitoring during operation phase was cancelled in agreement with the Swedish authorities based on the baseline results. **** Monitoring of ship traffic is performed in all countries where relevant construction activities take place; additionally in Sweden, Denmark and Germany monitoring of ship traffic is part of the national monitoring programmes.

Environmental monitoring is focused on environmentally sensitive areas and receptors in five countries that have been assessed as likely to be impacted by Nord Stream 2 construction and operation. Thus, not all construction activities required environmental monitoring and not all parameters are monitored in all countries. Construction activities and associated environmental monitoring is described in detail in Chapters 3–5. Post-construction monitoring activities are shown in Chapter 6.

Monitoring results are submitted to the authorities on a monthly, quarterly and/or annual basis as per national requirements:

- Russia: monthly, quarterly and annually (depending on type of monitoring);
- Finland: quarterly (during construction) and annually (during construction and operation);
- Sweden: annually;
- Denmark: annually;
- Germany: monthly/quarterly (during construction) and annually (during construction and operation).

Annual overall monitoring reports similar to the present report will be prepared for each year of construction and through the initial post-construction phase when environmental monitoring takes place. To facilitate comparison of the progress and results year-on-year, future yearly reports will be similar in structure to this report.

2 Construction works

Construction in 2020 included onshore activities in Russia with minor works in Germany and offshore activities in Russia, Finland, Sweden, Denmark and Germany. Progress in pipeline installation is shown in Figure 2.

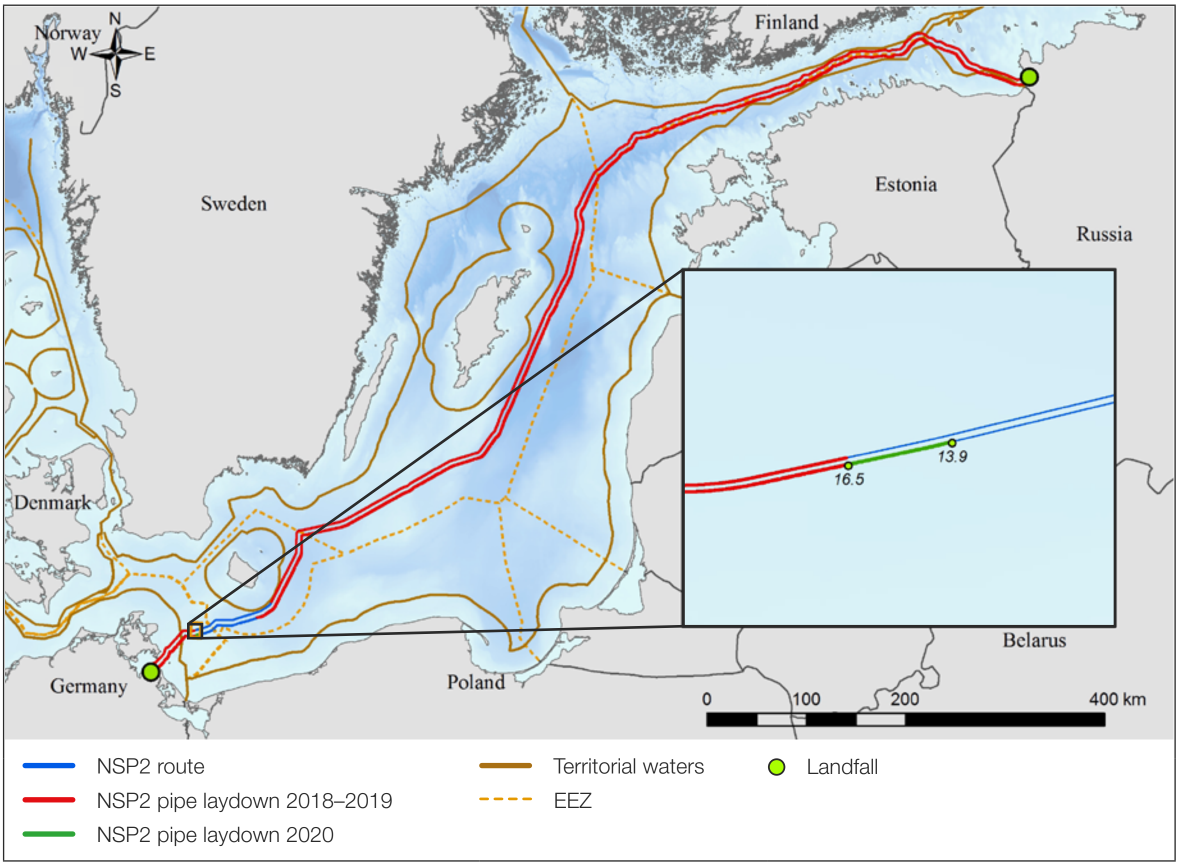

Figure 2. *Installation of Nord Stream 2 Pipeline in 2020.*

2.1 Construction overview

Construction activities in 2020 were greatly impacted by the US act ‚Protecting Europe's Energy Security Act of 2019' (PEESA) which provided the basis for US sanctions to be placed on vessel operators working in water depths of greater than 100ft. vessel operators. PEESA was passed as part of National Defense Authorization Act (NDAA) for fiscal year 2020.Due to the threat associated with the sanctions the pipelay contractor, Allseas, was compelled to suspend operations by its two DP pipelay vessels, Pioneering Spirit and Solitaire. Therefore, an alternative contractor was found and pipelay began anew in December 2020. Pipelay only took place in German waters where an additional 2.6km (Line B) were laid. Thus, by the end of 2020, 1,147km of Line A and 1,169km of Line B had been laid on the seabed.

Other offshore construction works in 2020 included rock placement for free span correction to stabilise the pipeline and protection of pipeline heads with rock bags where the pipeline was left on the seabed for resumption of pipelay at a later stage. An overview of the offshore construction milestones is given in Figure 3. Details of the offshore construction activities in the five countries are outlined below in Sections 2.2–2.6.

Onshore construction in 2020 progressed mainly at the Russian landfall. Onshore construction at the German landfall was completed in 2019, no construction took place in 2020 with only minor re-instatement works being carried out. An overview of the onshore construction milestones is given Figure 3. Details of the onshore construction activities in Russia and Germany are outlined below in Sections 2.2 and 2.6.

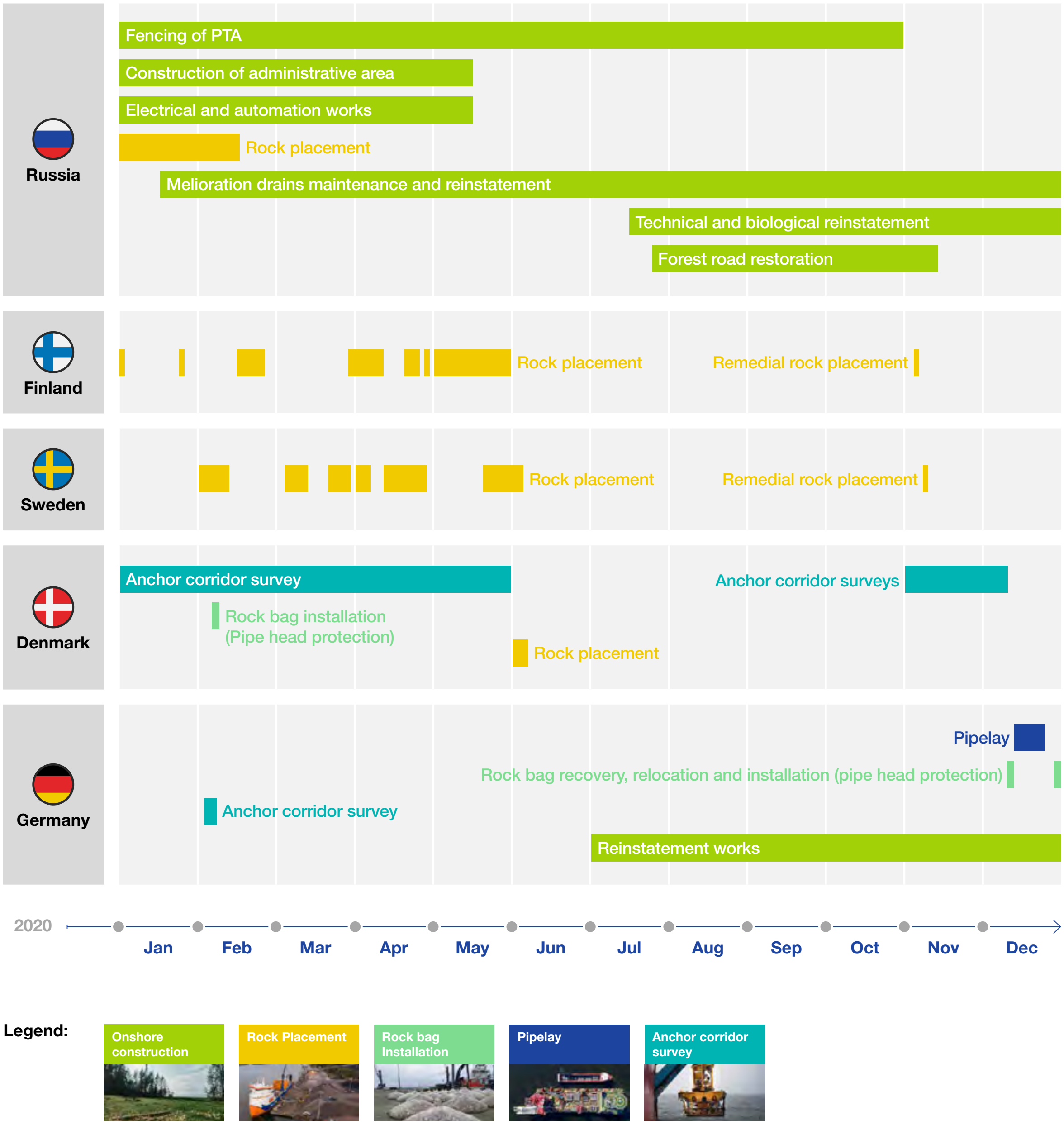

Figure 3. *Construction milestones in 2020.*

2.2 Construction in Russia

Onshore construction

Onshore works during 2020 were almost finished. The linear part from the pig trap area (PTA) to the beach, was technically and biologically reinstated, and fencing was removed. Melioration drains and forest roads were restored.

At the PTA, all main welding works were done, structural steel installed and the hydrotesting successfully completed. Permanent buildings were constructed on the administrative area and the area was fenced. The PTA was paved with asphalt. Internal, electrical and automation works are ongoing.

Offshore construction

Pipelay and most of the offshore works were finalised in 2019. Contractors installed the cofferdam, performed dredging and backfilling works, pipelay, nearshore pipe pulling, AWTI and rock placement for free-span corrections at line A. Nearshore construction in Russia was completed in 2020, with the dismantling of the cofferdam and reinstatement of the shoreline. Rock placement at line B was completed mid-February 2020. The final fish release to fully compensate for the potential fishery damage resulting from pipeline construction and rock placement was completed in October–November 2020.

2.3 Construction in Finland

Construction activities in the Finnish EEZ in 2020 comprised only rock placement. Munitions clearance and installation of mattresses had already been completed in 2018 and pipelay was finalized in 2019. Rock placement was completed on 30 May 2020, with this the construction works in Finland were completed. In June–July 2020 the relevant authorities were notified of the completion of construction in Finnish waters as required per EEZ and Water Permits. In November remedial rock placement was undertaken to repair one berm.

2.4 Construction in Sweden

Main construction activities in the Swedish EEZ were completed by the end of 2019. Pipelay started in 2018 and was finalised in 2019. In 2020 construction related works were limited to surveys and post-lay rock placement works. These works were performed at a number of discrete locations along the pipeline route. The planned constructions works were completed in June 2020. Relevant authorities were notified of the completion of construction in Swedish waters as required per Construction Permit. Following the completion of construction, remedial works were required on a berm. These maintenance works were performed in Q4 following a dedicated survey and finalisation of the engineering assessment.

2.5 Construction in Denmark

Pipelay in Denmark was suspended on 21 December 2019 due to the threat of US sanctions. At the end of 2019 approximately 175km of pipelines (for both Line A and Line B) in Denmark were laid. Line B was laid down at KP 97.4 approximately 50km from the German border and Line A was laid down at KP 77.8 approximately 70km from the German border. No pipelay took place in Danish waters in 2020. To protect the pipeline from potential mechanical disturbances (e.g. trawl board impact) rock bags were placed on the pipeline ends in February 2020. One rock berm to stabilise the pipeline in the vicinity of a munition on the seabed was installed in June 2020. Extensive survey works and evaluation of objects of potential cultural heritage value were carried out in the anchor corridor to cover an option of an anchored vessel finishing pipelay in Denmark.

2.6 Construction in Germany

Onshore construction
Construction activities at the German landfall were largely complete by the end of 2019 with only minor reinstatement and finalisation works continuing into 2020. Reinstatement works included various activities such as soil removal/replacement, levelling and seeding of dry grass plants. The temporary construction site outside of the plant area (the former tunnel pits) was reinstated during the second half of the year.

Offshore construction
Within German waters, pipelay was undertaken in 2018 with only 16.5km remaining to be laid to the German-Danish border. In December 2020, the pipelay barge Fortuna laid 2.6km (Line B) in the German EEZ. Pipelay operations were conducted between December 12 and 24. Following the laydown, the pipe head was stabilised with temporary rock bags to protect the pipeline from potential mechanical disturbances.

3 Monitoring during onshore construction in Russia

The EIA and Espoo report concluded that possible damage to biotopes crossed by Nord Stream 2 within the Kurgalsky Nature Reserve could be the main potential impact of construction activities at the Russian Landfall. Therefore, as Nord Stream 2 recognises the environmental importance of the reserve, a very thorough monitoring programme at the Russian landfall has been developed to cover both the construction activities at the temporary accommodation camp and construction site (PTA and right-of-way), as well as the environmental conditions of the Kurgalsky Nature Reserve.

The reserve comprises a network of sensitive biotopes, the most vulnerable being coastal, forest and swamp biotopes that function as habitats for protected and rare species. Monitoring there focuses on both the abiotic and the biotic environment. Monitoring in 2020 was mostly a continuation of the monitoring started in 2018. Additionally, potential impacts from construction in the protected area were assessed by the Ramsar Advisory Mission (RAM) following their visit to the Kurgalsky Nature Reserve in November 2019.

The company had faced an issue with the effectiveness of the discharge system, and thus discharge from camp and working areas was stopped in the beginning of February and was not resumed in 2020, due to repair and further investigation of the system. Monitoring of treatment facilities was performed on a monthly basis for those of facilities, which weren't put on hold. Project area wastewater was trucked out to external facilities for further treatment and disposal.

In addition, air emissions and noise emissions were also monitored at the construction camp, along with the working area and the nearest settlement.

The purpose of monitoring the Rosson River in 2020 was to confirm the stability of the river environment, taking into account non-compliance of previously discharged wastewater and absence of discharge during almost the entire year. Monitoring of the Rosson River includes both the abiotic and the biotic environment.

3.1 Monitoring of the Kurgalsky Nature Reserve

The pipelines cross the Kurgalsky Nature Reserve in a 3.9km-long and 30 to 60 metre-wide area, defined here as the "project area."

In 2018, all Red Data Book plant species (RDBS) identified in the project area were relocated to new sites prior to the clearance of trees from the right-of-way. An extensive monitoring programme was therefore established to monitor the territory of the adjacent reserve and to monitor the conditions of the RDBS in the years following the relocation. The objective of monitoring in the Kurgalsky Reserve is to identify potential deviations in landscape structure (biotopes mosaic) related to the construction activities and to assess the magnitude of the changes, if any.

The programme covers both the abiotic and biotic environment, with particular focus on the particularities of a wetland ecosystem (e.g. from the monitoring of the water regime to the monitoring of rare and protected species). The monitoring locations established in the Kurgalsky Nature Reserve are shown in Figure 4.

Monitoring activities started before construction began (i.e. before tree cutting in the right-of-way), continued in 2019–2020 and are planned to continue throughout construction and partially into the operational phase of the pipelines. The majority of monitoring activities are seasonal and thus focus on the relevant environmental aspects (e.g. bird migrations, nesting period, flowering period, etc.) rather than on the construction activities.

Activities occurring within the nature reserve are governed by national requirements for the protection of Special Protected Natural Areas (SPNAs), the Decree on the Kurgalsky Reserve, as well as by the national EIA.

Furthermore, a visit by a Ramsar Advisory Mission (RAM) was organised in November 2019. The objectives of the RAM were to assess the impact of Nord Stream 2 construction on the ecological character of the Kurgalsky Nature Reserve, i.e. on its ecosystem components, processes, as well as benefits and services /13/.

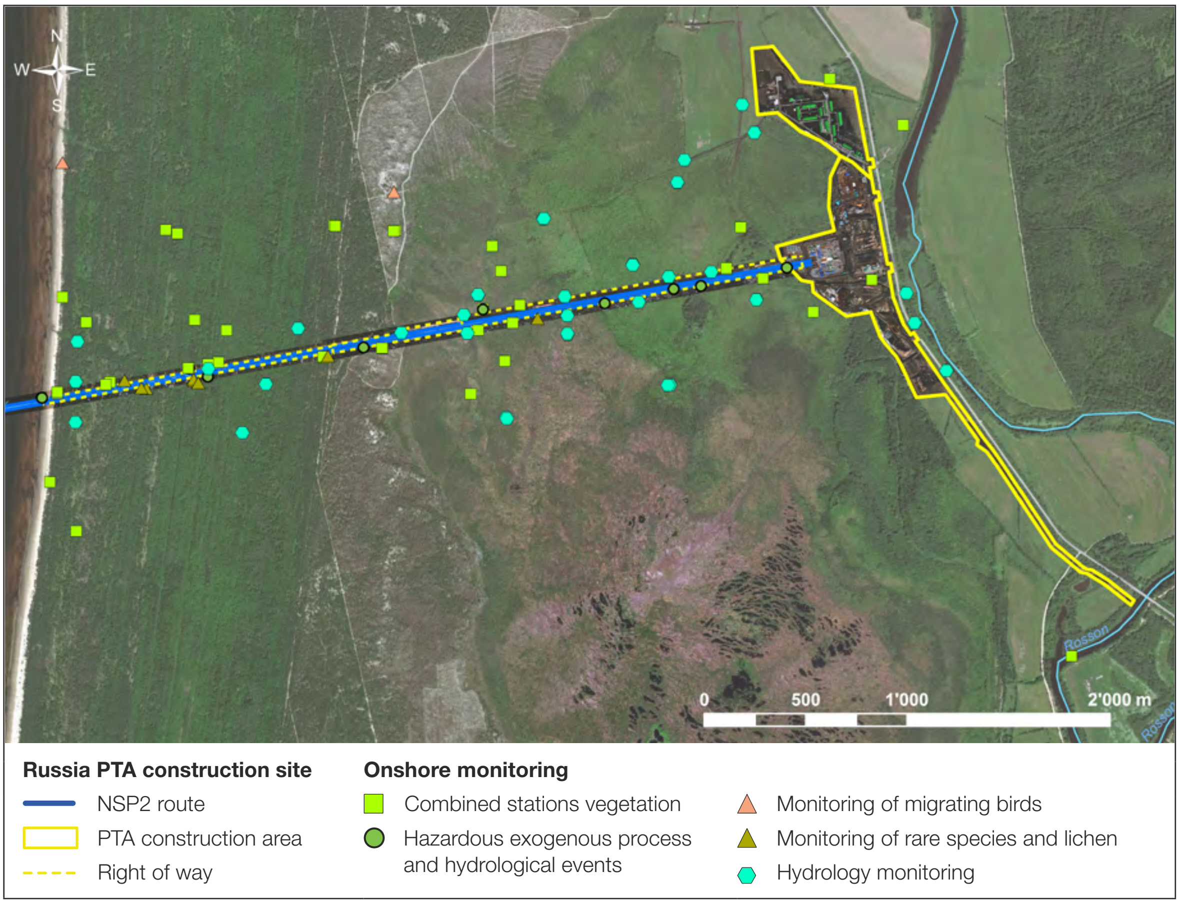

Figure 4. *Environmental monitoring at Kurgalsky Nature Reserve in 2020.*

Based on the monitoring results for 2020, no significant impacts occurred in the protected area. Soil quality and exogenous processes were found not to be affected by the construction activities (see Chapters 3.1.1. and 3.1.2). Hydrology monitoring showed that the recorded fluctuations in the water levels were generally in line with the natural dynamics (see Chapter 3.1.3). Monitoring of relocated RDBS plant species showed good survival of the relocated plants (see Chapter 3.1.4). Previously recorded changes in pattern of migrating bird movement (see Chapter 3.1.5) is assessed as coming back to natural character. A total of 37 protected species of vertebrates were recorded during the monitoring campaigns (see Chapters 3.1.5–3.1.6).

3.1.1 Soil quality

The construction corridor crosses different soil types, which are associated with specific plant communities. The purpose of monitoring soil quality is to verify that the construction activities do not have an impact on the different combinations of soil and associated plant communities. Monitoring included a description of the soil profiles as well as chemical and physical analyses of soil samples (see Figure 4).

METHODOLOGY

To monitor the potential impact of construction activities on different soil types, ten pairs of monitoring locations were established in 2018. For each soil type (and associated plant community), one plot was established in close proximity to the construction corridor ("control plot") and another one was established more than 180 metres from the construction area in an undisturbed area ("background plot"), for a total of 20 plots.

Description of the soil profiles involved recording the composition and thickness of the genetic horizons, groundwater depth, and root layer depth. Each soil horizon was then measured in terms of thickness, chromaticity, moisture and mechanical composition, structure, density, presence of neoformations (i.e. a mineral or inorganic phase newly formed in the soil in the process of pedogenesis), etc.

For each plot, five soil samples were collected from the surface layer (0.0–0.2 metre) and were analysed by accredited laboratory centres for soil texture, pH and concentrations of heavy metals, oil products (total hydrocarbons) and benzo(a)pyrene.

This sampling programme started in 2018, before the main construction activities were carried out in the Kurgalsky Nature Reserve and will last until the end of the construction period, including remediation activities within the right-of-way.

Soil samples are collected once a year. However, four sampling plots, located within the water protection zone of the Russian waters of the Gulf of Finland (500 metres from the shoreline) were monitored more frequently (on a quarterly basis), in accordance with the Neva-Ladoga water basin authority requirements.

Additional sampling was provided within water protection zone of the Russian waters of the Gulf of Finland (last 500 metres of ROW before shoreline) in 2020 – based on requirements by the Neva-Ladoga water basin authority for the post-construction monitoring cycle. Those surveys were undertaken after the end of remediation works – in the end of September 2020 (28^{th}). No soil sampling was done after this date.

RESULTS

In July 2020 there were no significant differences between the control plots and the background plots. Compared with the general background values increased concentrations of oil products were recorded both in the control plots and the background plots of peaty soils.

The content of oil products in peaty soils ranged from 1,200 to 2,700mg/kg (1.2–2.7) MPC respectively, so according to SanPiN 2.1.7.1287-03, these soils fall into the category of "moderately polluted". However, no violations (e.g. signs of oil discharges) were visible on or near the sites, therefore these excesses are not expected to be associated with NSP2 construction activities. The results were also comparable to the environmental baseline survey data and to the data collected in 2018–2019.

The same situation was recorded for arsenic content. In two locations (one control and one background) concentrations reached the level of 1–1.55MPC, which is treated as "polluted" according to SanPiN 2.1.7.1287-03. Comparing to baseline results, recorded in 2018 before construction, those levels are less or similar.

No soil contamination with organic and non-organic pollutants was observed in 2020 within the water protection zone during all seasons. Compared to baseline data, no impact to soil quality was recorded during post-construction survey.

CONCLUSIONS

According to the monitoring results, the 2020 construction activities had no impact on soil quality in the Kurgalsky Nature Reserve. Project implementation was in compliance with the national EIA and national requirements for soil, water basins and SPNA protection

3.1.2 Exogenous processes

The purpose of monitoring exogenous processes is to verify that construction activities do not cause changes in the natural landscape, such as erosion events and hydrological phenomena (see Figure 4).

METHODOLOGY

Monitoring of exogenous processes in 2020 took place during two survey campaigns: one in mid-April (after cofferdam installation and during preparation for pipe pulling) and one in early November (after the end of seeding in the ROW boundaries). Monitoring took place at the following eight locations:

- 01 – beach;
- 02 – bog-covered dune slacks;
- 03 – relict dune;
- 04 – bog-covered lower part of the Littorina plain[1];
- 05, 06, 07, 08 – drainage ditches and adjacent areas.

RESULTS

Two seasons of monitoring surveys showed that the dynamics of natural processes throughout 2020 were within seasonal changes, despite the significant impact of different construction operations and subsequent remediation including hydro seeding. However, two areas requiring actions in 2021 were recorded: a flooded area close to the PTA, which will be managed after road removal in 2021, and

1 The Littorina plain was formed by the Littorina Sea, which was a geological brackish water stage of the Baltic Sea, which existed around 7500–4000BP. The surface is formed by terraces predominantly made up of glacio-lacustrine sandy loams and banded clay.

an area of a geodetic point, where a slight erosion took place due to illegal traffic not related with pipeline construction.

CONCLUSIONS

No significant changes in dynamic were recorded during the entire monitoring period. Project implementation was in compliance with the national EIA.

3.1.3 Hydrology

The condition of a body of water constitutes the base upon which the biotic and abiotic environments coexist and thrive in a wetland ecosystem. Therefore, particular attention has been given to monitoring the hydrological regime at the Kurgalsky Natura area, which was performed in accordance with a special monitoring programme /14/ by the State Institute of Hydrology (SHI).

Part of the Kurgalsky Nature Reserve is a wetland: the Kader Swamp. The Kader Swamp is in the western part of Leningrad Oblast in the Kurgalsky Peninsula. The gas pipeline crosses the wetland in the northern outskirts of the Kader wetland area.

Different impacts on the hydrological regime of water bodies during both the construction and operation of the gas pipeline were possible. Construction activities such as clearing and planning of a gas pipeline route, deforestation, laying of a temporary access road, construction of auxiliary production facilities, creation of culverts under the road, etc., were identified as potentially affecting the hydrological regime. The impact of the pipeline construction on the aquatic environment may manifest itself in changes:

- in the natural conditions for the formation of watercourse runoff;
- in the relationship between surface and groundwater;
- in soil erosion and erosion conditions on catchments;
- in the characteristics of the channel cross-section of watercourses at construction sites.

The construction of the Nord Stream 2 gas pipeline may affect both surface and underground water bodies. The main surface water bodies in the construction route include: a section of the Kader swamp, old reclamation canals on it in the eastern part and small nameless streams in the coastal western territory. Underground water, which may be affected by construction, is represented by groundwater of the Quaternary sediments, occurring everywhere at depths from 0.5 to 4–5 metres from the ground level.

Furthermore, the presence of the pipeline, in particular when positioned perpendicular to the grid of water runoff lines (see Figure 5 and Figure 6), may cause changes in the flow characteristics of the micro-landscapes.

METHODOLOGY

Monitoring consisted in measuring the water levels of surface and underground water bodies at the existing network of standpipes, groundwater wells and on surface watercourses located in the immediate vicinity of the gas pipeline route (see Figure 5). The typological characteristics of the swamp's micro-landscapes and the grid of marsh water runoff lines in the adjacent area were considered when selecting the location of standpipes to be monitored (see Figure 6). In addition, surveys of the construction site and the adjacent areas of the swamp were carried out to identify any visible changes in the hydrographic network, water cut, directions of the water flows and other phenomena associated with anthropogenic impact on the water level in the swamp.

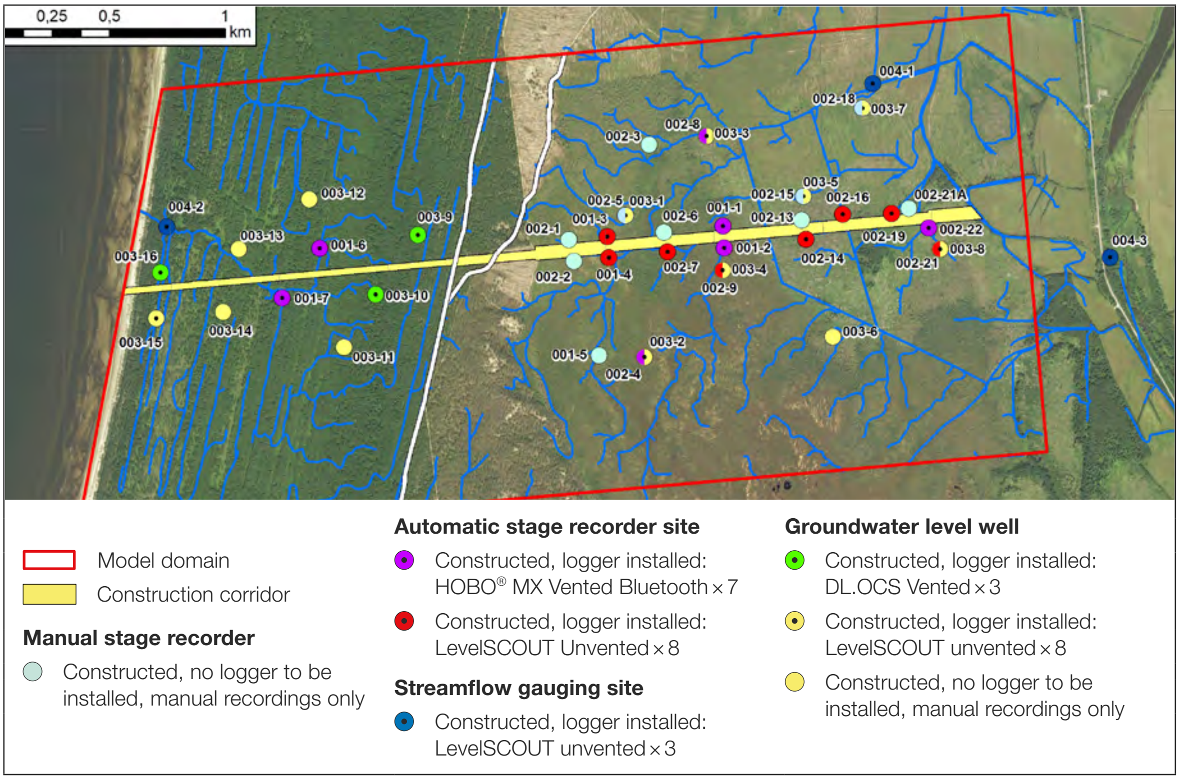

Figure 5. *Location of the monitoring sites with respect to water runoff lines.*

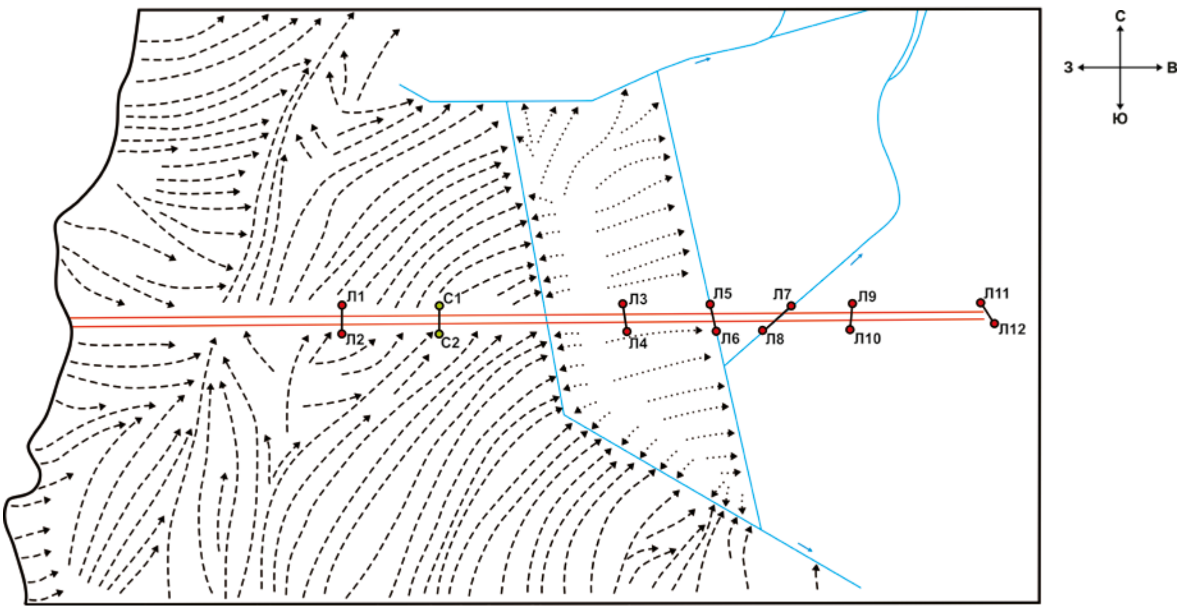

Figure 6. *Grid of swamp water runoff lines and location of control cross-sections for monitoring the swamp water level.*

According to the Federal State-funded educational institution of the State Hydrological Institute (RFSBI SHI), the boundary of this zone has been found to be 50 by 200/300 metres, the maximum width being 0.5km. Therefore, the monitoring effort should cover the strip up to a width of 0.5km on both sides of the route. Due to the value of the Kader Swamp as a specially protected natural site, the monitoring

area at the end of 2019 was increased to 1km in both directions. This allows a more objective comparison of the hydrological regime of water bodies in areas not affected by construction with the regime of water bodies located near the route.

RESULTS

As a result of monitoring, data were obtained on the hydrological conditions of water bodies in the area of the gas pipeline route. A continuous series of observations of water conditions has been going on for 2 years.

After pipelaying, dismantling of all structures, removal of the haul road and reclamation of the territory, the main impact of the gas pipeline on the level conditions of swamp waters can be traced in the western part of the swamp area. On the southern side of the route corridor, there is a backwater of swamp waters and, as a result, an increase in the water level in relation to natural conditions. On the northern side, the level decreases. The difference in water levels between the northern and southern territories adjacent to the pipeline route varies in different seasons between 40 and 80cm. The preservation of such levels, which are not typical for this section of the swamp, will inevitably lead to a change in micro-landscapes in the future.

A comparative analysis of the conditions of the swamp water level near the pipeline system with the conditions in the baseline sections of the swamp, as well as in the natural alternative swamp of Lammin-Suo (station of the FSBI SHI) showed that in the eastern part there was a higher water cut in the territory during 2019–2020. The possible reason for the increased water cut is associated with the disturbance of the peat layer caused by the fire and the high standing of groundwater here. At a peat thickness of less than 1 metre on the eastern edge of the Kader Swamp, an active water exchange is observed between the swamp and groundwater. This is confirmed by a joint analysis of the conditions of the water levels in the wells, the results of determining the salinity (electrical conductivity) and chemical analysis of the water. Reclamation canals play a significant role in vertical water exchange. At low groundwater levels, swamp waters are consumed to feed groundwater; at high water levels, groundwater can be discharged on the surface of the peat deposit and mix with swamp waters.

In the near-shore area, the monitoring did not reveal significant changes in water conditions. At this point, the gas pipeline runs parallel to the general slope of the flow into the Russian waters of the Gulf of Finland. In spring, some of the small streams crossed by the route created temporary accumulation areas up to 50 metres wide. In summer, they dry up.

The impact of the construction of a gas transmission system on the swamp occurs against the background of larger-scale changes in this nature-made object associated with other factors: drainage of the swamp by drainage canals, eutrophication by pollutants and fire-induced factor. The fire-induced factor is associated with a fire that occurred in the Kader Swamp in 2006. Currently, the drainage network continues to influence the grid of swamp water runoff line in the peat deposit. The drainage capacity of the reclamation network is influenced by beaver dams in the north-eastern part of the swamp.

CONCLUSIONS

The construction activities in 2020 caused some fluctuations in the level of the water bodies, leading to the flooding of some parts and the drying out of other parts of the swamp area. These were however within recorded natural fluctuations. Other potential changes caused by the construction activities are likely masked by the larger anthropogenic-driven changes that the wetland experiences. The use of innovative technologies (such as the waterproof jumpers in trench boxes) resulted in limited impacts of construction activities on the bodies of water.

3.1.4 Terrestrial flora

The construction corridor crosses a heterogeneous mix of plant communities made up of both pristine biotopes as well as areas that have experienced some level of anthropogenic pressure. The purpose of monitoring terrestrial vegetation is to verify that construction activities do not have an impact on the different plant communities crossed by the project area, or on RDBS located in close proximity.

METHODOLOGY

To monitor the potential impact of construction activities on different plant communities, nine pairs of monitoring plots were established in 2018. For each type of plant community, one plot was established in close proximity to the construction corridor ("control plot") and another one was established more than 190 metres from the construction area in an undisturbed area ("background plot"), for a total of 18 plots.

To monitor the status of protected species of plants and lichens near the project area and to allow for the implementation of additional protection measures if required, eight plots were established in close proximity.

Monitoring of the above 26 (18 + 8) plots included general geo-botanical surveys once or twice a year (see Figure 7). The recorded parameters included species counts and identification, measurements of density, age and height, evaluation of epiphytic (moss, lichen) cover, etc., as well as soil characteristics such as soil type, moisture content, terrain features, etc. This monitoring started in 2018 and is planned to continue until the end of construction.

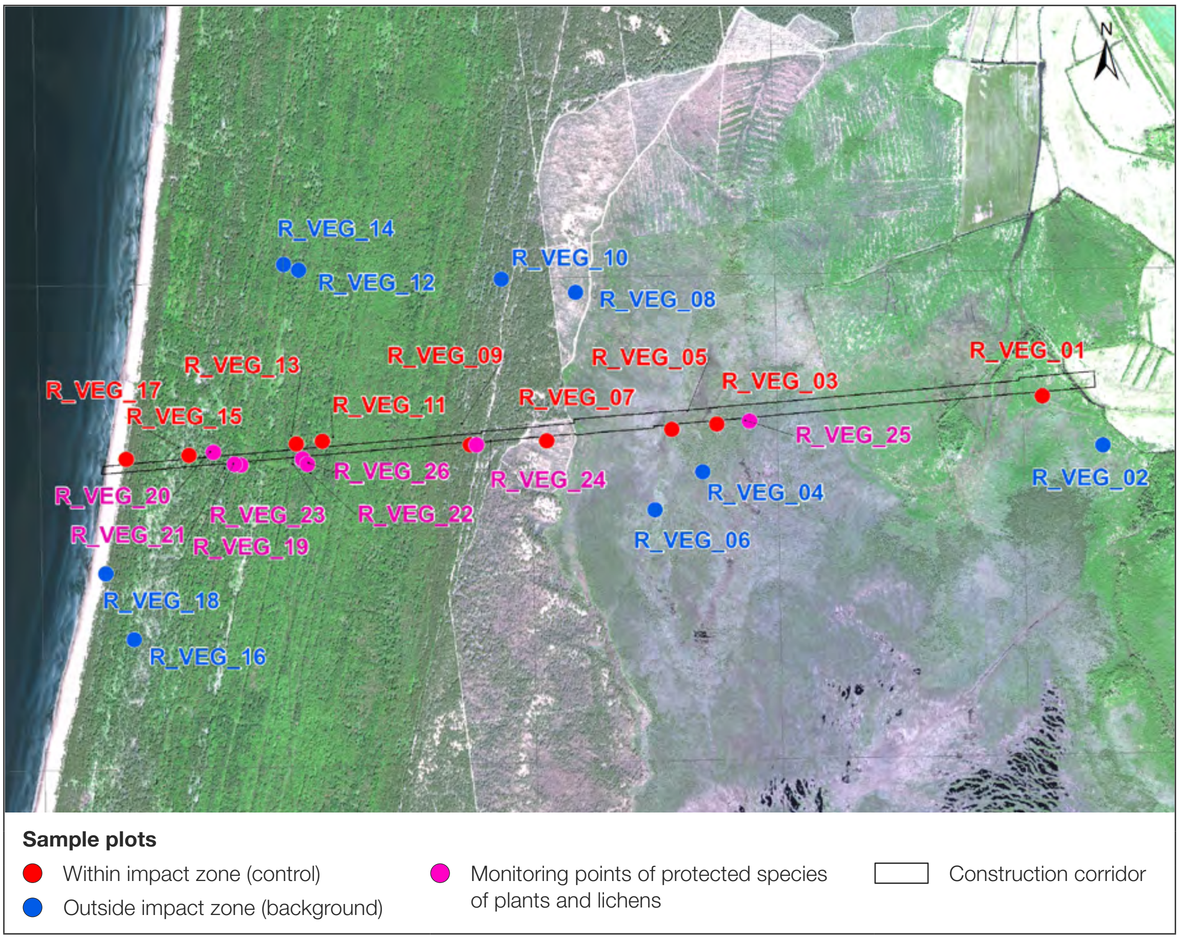

Figure 7. *Permanent monitoring plots.*

In addition, 27 plots were established for monitoring of relocated RDBS. Monitoring of relocated RDBS involved recording the plants' survival and general condition once or twice a year: in spring (May/June) and in summer (July).

Individual specimens from the following RDBS species were relocated in 2018: *Pulsatilla pratensis, Pulsatilla patens, Epipactis atrorubens, Drosera intermedia, Hottonia palustris, Neottia nidus-avis and Aulacomnium androgynum.* Monitoring started in 2018 and is planned to continue until 2020.

RESULTS

At most of the sites, changes in the state of undergrowth and individual trees occurred during the year, which are explained by the natural dynamics of plant communities.

On R_VEG_05 site (pine-dwarfshrub-sedge-sphagnous transitional bog), there was a deterioration in the condition of pines for the second year in a row, while there are no changes in the tree layer on the background R_VEG_06 site. The reasons for the deterioration of the trees are not clear. There is no visual impact from the construction corridor.

Route observations revealed an increased number of fallen trees along the boundaries of the construction corridor (319 pieces).

The impact of construction on the shrub, grass-dwarfshrub, and moss-lichen layers of plant communities is almost absent. Minor changes were noted in places in the strip adjacent to the construction corridor (about 5m). Isolated debris was occasionally observed. No other violations were found.

Protected species of plants and lichens are in good condition: the Small pasque flower *(Pulsatilla pratensis)*, the Eastern pasqueflower *(Pulsatilla patens)*, the Dark-red helleborine *(Epipactis atrorubens)*, the Bud-headed groove-moss *(Aulacomnium androgynum)*, the Green shield-moss *(Buxbaumia viridis*) Lungwort lichen *(Lobaria pulmonaria)* on R_VEG_11 and R_VEG_26.

Lobaria pulmonaria on R_VEG_15 is in a very suppressed state due to the death of the tree on which it grows. The death of a tree is not related to construction.

The disappearance of the Spoonleaf sundew *(Drosera intermedia)* on R_VEG_05 was noted. The reasons are not clear at the moment. On R_VEG_25, the species was not registered due to the high water level in the hollows.

Animals caused damage to almost all areas of the Water violet *(Hottonia palustris)* growth, including the background site. The undamaged plants are in good condition. An increase in the projective cover of the species near the construction corridor was observed.

Most replanted plant species are in good condition. There is a positive dynamic in the development of seed-grown specimens of *Pulsatilla pratensis*. An increase in the area of the *Hottonia palustris* distribution spot was noted at all replanting sites. The number of *Epipactis atrorubens* increased at all replanting sites.

The state of the replanted *Aulacomnium androgynum* fragments was generally assessed as good, with positive dynamics of plant population recovery after exposure to a complex of stress factors.

The replanted *Drosera intermedia* in the DI1c site is in good condition and maintaining a stable population. The species was not recorded on DI2c due to the high water level in the hollows.

As in 2019, aboveground shoots of the Bird's-nest orchid *(Neottia nidus-avis)*, are absent in all observation sites.

It should also be noted that *Neottia nidus-avis* has been excluded from the Red Book of the Leningrad Region by order of the Committee on Natural Resources of the Leningrad Region (No. 14 of 12 September 2017). This species has mostly an underground growth, with unpredictable appearance of aboveground flower stalks. In 2019–2020, no aerial parts of *Neottia nidus-avis* were recorded at any of the monitoring sites. Continuing observation will allow information about this type of chlorophyll-free orchids to be added and their condition to be compared with that of the replanted specimens.

CONCLUSIONS

According to the monitoring results, the impacts on vegetation in the Kurgalsky Nature Reserve that occurred due to the construction activities in 2020 were acceptable and in line with the EIA documentation. The monitoring of protected species which were affected through the change to local hydrology as a result of the open trench, such as Drosera intermedia, as well as monitoring of locations affected by wild animals will be extended into 2021. The project has been implemented in compliance with the national EIA, national requirements for protection of SPNAs, the Decree on the Kurgalsky Reserve and the RDBS relocation permit requirements.

3.1.5 Birds

Monitoring of birds in the Kurgalsky Nature Reserve was undertaken with the purpose of identifying potential changes in bird populations and dynamics due to the construction activities. The monitoring work focused on:

- Local avifauna;
- Migratory avifauna;
- Three breeding indicator species[2], one for each biotope crossed by the project area (wetlands, forest and beach);
- Monitoring of protected species of birds.

METHODOLOGY

Each of the above targets for bird monitoring was monitored according to specifically tailored methodologies. A brief description of the methodology is provided below, and an overview of the monitoring locations is provided in Figure 8. Monitoring started in 2018 and is planned to continue until beginning of operations.

- Monitoring of local avifauna was carried out on two parallel transects: one in close proximity to the construction corridor ("control plot"), and one approximately 1km south of the construction corridor in an undisturbed area ("background plot"). For each transect, the number of birds, species composition and species diversity in each of the traversed biotopes were recorded;

2 Monitoring of indicator species is a common tool in the study of complex ecosystems. Indicator species are selected as the representative species of a given biotope. The indicator species is generally identified as the most typical in the specific biotopes and its presence supports the associated community. The results of monitoring of indicator species are used as a proxy to understand impacts at the ecosystem/biotope level.

> Monitoring of migratory avifauna was carried out during the period of seasonal migration at two observation points (shore and dune). The number of birds, species identity and main direction of movement were recorded for a period of 4 hours after sunrise at each observation point. Two additional monitoring points in the northern part of the Kurgalsky peninsula (Tiskolovo and Pitkinen) were added based on previously obtained monitoring results;
> The breeding indicator species monitored were the common crane *(Grus grus)* for wetland biotopes, the black woodpecker *(Dryocopus martius)* for forest biotopes, and the ringed plover *(Charadrius hiaticula)* for beach biotopes. Monitoring of the breeding indicator species consisted of route surveys in May and June, recording of visual sightings of the species and their tracks and signs, and passive acoustic monitoring (for the common crane only). Photographs of the species were taken whenever possible (see Table 3);
> Visual observations of protected species of birds were recorded during all above-mentioned monitoring of birds.

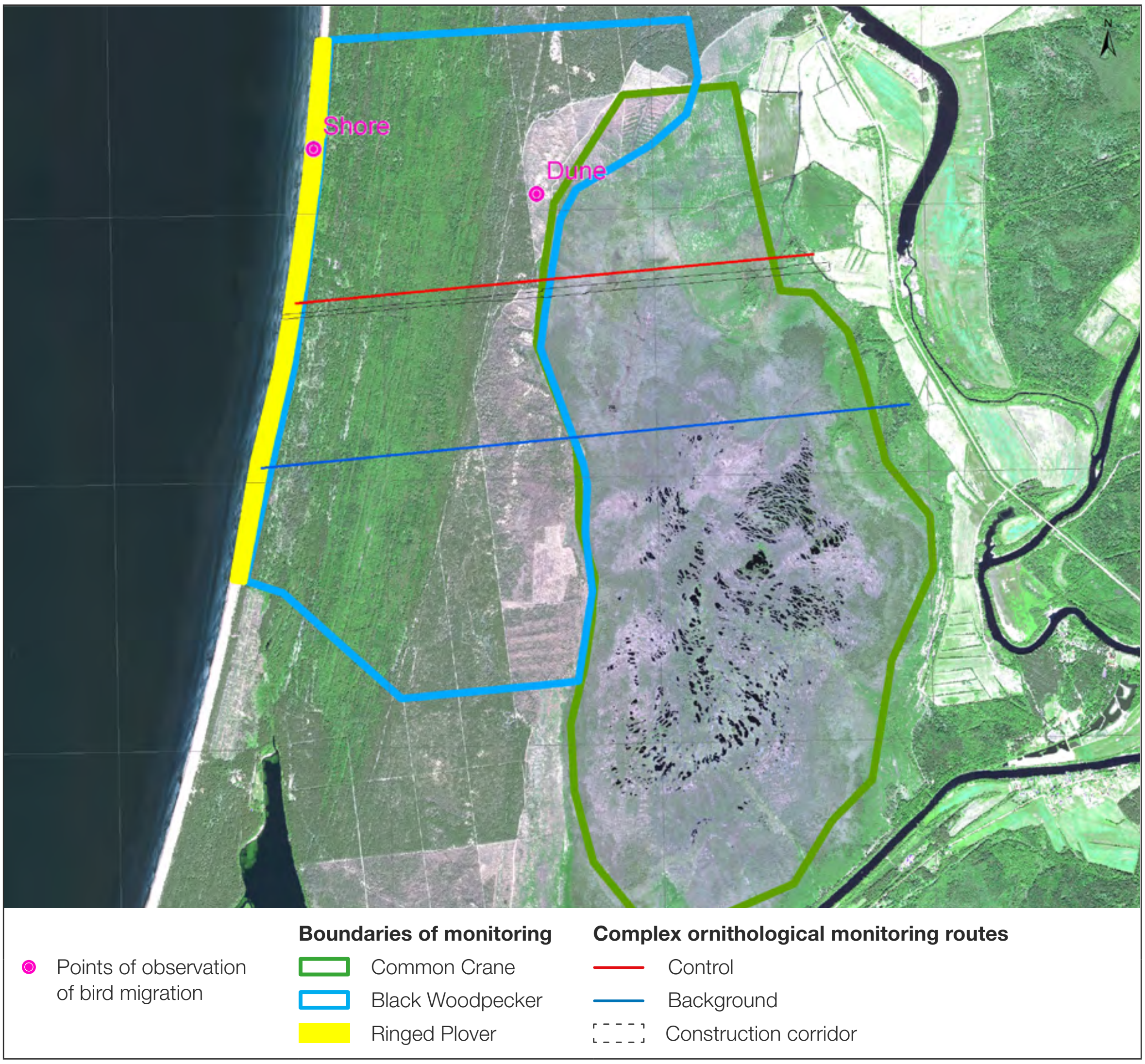

Figure 8. *Overview of bird monitoring locations at the Russian landfall.*

Table 3. *Scope of monitoring for breeding indicator species. Number of observations and findings include visual observations, tracks and signs, and vocalisation recordings.*

Species	Route surveys	Passive/active acoustic monitoring	Camera traps	Number of observations and findings
Common crane	> 11 surveys > 22 man-hours in total, 40km in total	25h in total	12 camera traps in feeding biotopes served on monthly basis during breeding and nesting period (May–August)	> Voice signals registered in 39 locations > Visual observations recorded in 7 locations (incl. 19 migrating individuals) > 23 camera traps pictures (36 birds in total). It is estimated that not less than 9 couples are nesting and breeding in the project area
Black woodpecker	> 5 surveys > 97km in total	42,5h in total	–	> 97 observations (visual and acoustic, incl. 39 answers to voice signals) > 9 new potential nesting locations (findings)
Ringed plover	> 5 surveys > 37km in total	–	–	> 23 nesting locations and 13 observations > No breeding couples were recorded in the project area

RESULTS

Based on the monitoring results for the entire observation period of 2018–2020, a tendency towards a decrease in the species diversity and abundance of birds in the affected zone (control transect up to 100 metres from the boundaries of the construction corridor) was revealed. Observations along the background transect (1,000 metres from the corridor boundaries) did not reveal any impact on the local avifauna. The results of the monitoring did not reveal any signs of the impact of the construction on the state of the local grouping in the south of the peninsula. No signs of construction impact have been identified for populations of indicative species, chosen for different biotopes crossed by the ROW (ringed plover, black woodpecker and common crane).

No signs of impact on bird migration in the spring and autumn periods of 2020 were identified. Over the entire observation period, more than 44,600 birds were recorded in areas including the:

- Project area (southern part of Kurgalsky peninsula):
  — 12,854 birds at the Shore observation point: 11,157 in spring and 1,697 in autumn;
  — 10,005 birds at the Dune observation point: 3,034 in spring and 6,971 in autumn;
- Northern part of Kurgalsky peninsula:
  — 316 birds at the Tiskolovo observation point: 1,866 in spring and 1,450 in autumn;
  — 18,489 birds at the Pitkinen observation point: 6,269 in spring and 12,221 in autumn.

In 2019, a decrease in the number of migratory geese and ducks of the *Clangula/Melanitta* group was shown, compared to the 2018 monitoring, carried out before construction in the coastal part. These processes were assessed as negative since one of the species of geese *(Anser fabalis)* and all species of sea diving ducks of this group *(Clangula hyemalis, Melanitta fusca and Melanitta nigra)* are among the rare protected species with high conservation status. The number of geese recorded during the spring migration of 2020 increased at all observation points relatively to 2019. However, the total number of migrating geese amounted to just over a third of the number of spring migrants in 2018 (see Figure 9). Anser albifrons represented the bulk of flying birds. However, *Anser fabalis* (Red Book of the Russian Federation) and *Anser anser* (Red Book of the Russian Federation and Law) were also noted.

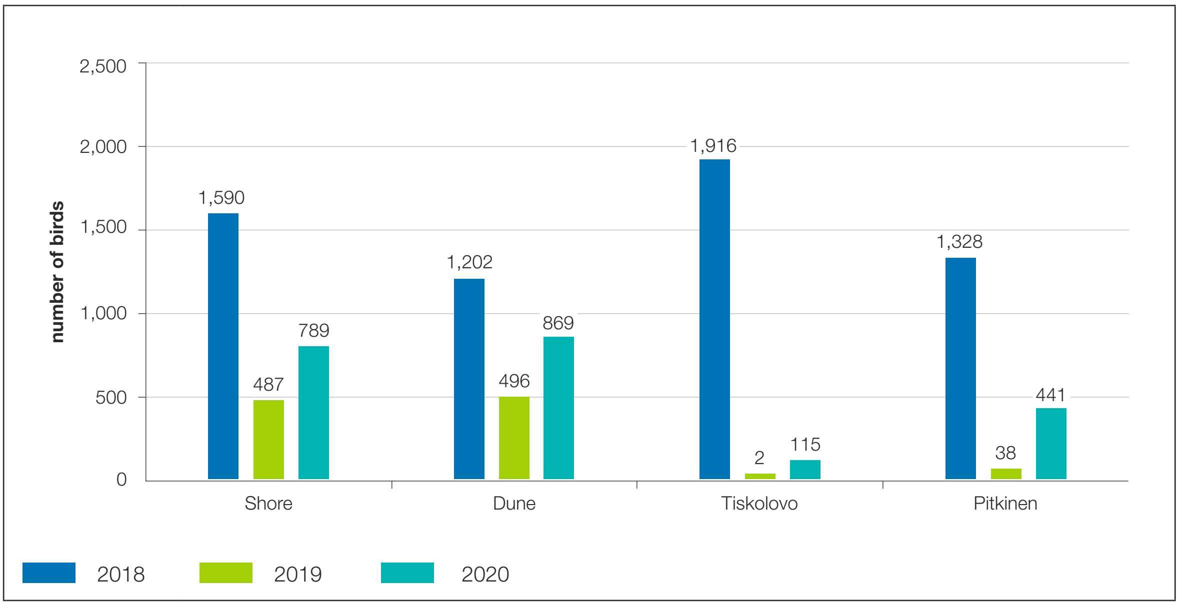

Figure 9. *Interannual comparison of the number of geese g. Anser during spring migration.*

In 2020, a small number of *Clangula hyemalis* and *Melanita fusca* appeared both migrating and at stop-overs (see Figure 10). The abundance of the *Branta leucopsis* has declined almost everywhere. At the same time, the majority of birds were recorded in the south of the peninsula within the area of the construction corridor (see Figure 11). Comparison of the results of observations in April–May 2020 with the results of observations for the same period of 2019 indicates the preservation of the main dynamic trends in spring migration for each observation point, both in terms of species diversity and the number of migratory birds.

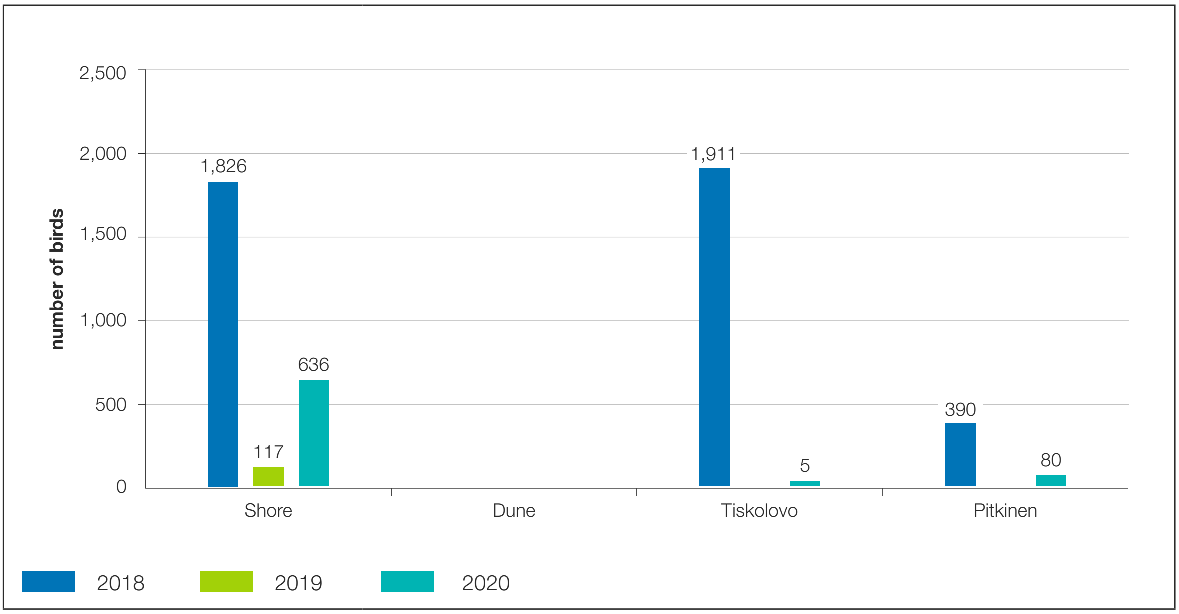

Figure 10. *Interannual comparison of the number of ducks g. Clangula/ Melanitta during spring migration.*

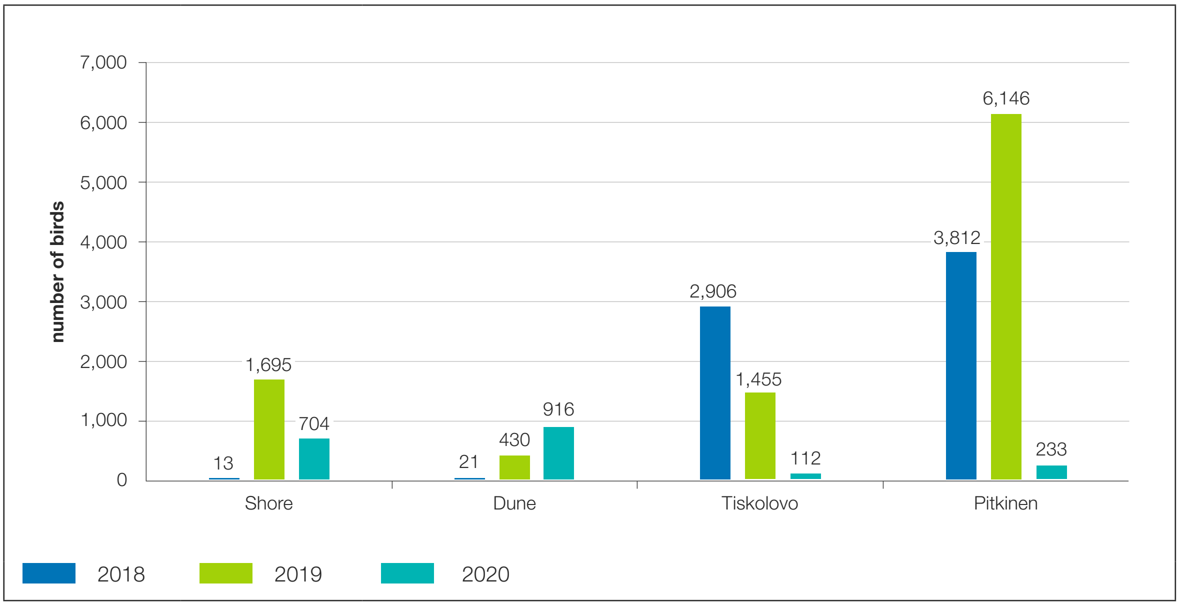

Figure 11. *Interannual comparison of the number of geese g. Branta during spring migration.*

To obtain comparable information the continued observation of the migration of waterfowl within the project area and in the north of the peninsula is recommended.

In total, 35 bird species of category 3 (NT) and higher in the Red Book of the Russian Federation, Red Book of the Leningrad Region, Red List IUSN and Red List HELCOM were recorded during the period since December 2019 to December 2020. Of the rare birds recorded, four species are representatives of the wetland avifauna, six species breed on the Kurgalsky Peninsula, and three more may breed, and only one species (the Long-tailed duck) occurs exclusively during seasonal migrations.

Table 4. *List of protected rare bird species found during the 2020 monitoring.*

Species	Status in the territory*	1 Quarter	2 Quarter	3 Quarter	4 Quarter
Class Aves					
Order Galliformes					
Black throated loon *Gavia arctica*	nest. migr.?		×		×
Order Podicipediformes					
Horned grebe *Podiceps auritus*	nest. migr.		×		
Order Galliformes					
Willow grouse *Lagopus lagopus*	nest. settl.	×	×	×	
Order Anseriformes					
Whooper swan *Cygnus cygnus*	nest? migr.		×		×
Tundra swan *Cygnus bewickii*	migr.		×		

Species	Status in the territory*	1 Quarter	2 Quarter	3 Quarter	4 Quarter
Taiga bean goose *Anser fabalis*	migr.		×	×	
Long-tailed duck *Clangula hyemalis*	migr.		×	×	×
Velvet scoter *Melanitta fusca*	migr.		×		
Common scoter *Melanitta nigra*	migr.			×	
Tufted duck *Aythya fuligula*	nest.? migr.			×	
Northern pintail *Anas acuta*	nest.? migr.		×		
Order Charadriiformes					
The Common Redshank *Tringa totanus*	nest?, migr.		×		
Eurasian curlew *Numenius arquata*	nest. migr.		×		
Numenius phaeopus *Numenius phaeopus*	nest.? migr.			×	
Northern lapwing *Vanullus vanellus*	nest. migr.		×	×	
Common ringed plover *Charadrius hiaticula*	nest. migr.		×	×	
Common sandpiper *Actitis hypoleucos*	nest. migr.			×	
Dunlin *Calidris alpina*	migr.			×	
The European golden plover *Pluvialis apricaria*	migr.			×	
The Eurasian oystercatcher *Haematopus ostralegus*	migr.			×	
The Lesser black-backed gull *Larus fuscus*	nest. migr.		×	×	×
Caspian tern *Hydroprogne caspia*	migr.			×	
Order Falconiformes					
The White-tailed eagle *Haliaeetus albicilla*	nest. settl.	×	×	×	×
Osprey *Pandion haliaetus*	nest. migr.		×	×	
Hen Harrier *Circus cyaneus*	nest. migr.			×	
Order Piciformes					
The Three-toed woodpecker *Picoides tridactylus*	nest.	×	×	×	×
European green woodpecker *Picus viridis*	nest.? migr.		×		×
The Grey-headed woodpecker *Picus canus*	nest.			×	×

Species	Status in the territory*	1 Quarter	2 Quarter	3 Quarter	4 Quarter
Order Columbiformes					
The Stock dove *Columba oenas*	nest. migr.		×		
Order Passeriformes					
The Rustic bunting *Emberiza rustica*	nest. migr.		×		
Great grey shrike *Lanius exubitor*	nest. settl.		×		×
Woodlark *Lululla arborea*	nest. migr.		×	×	
The Coal tit *Periparus ater*	nest.	×	×		
Spotted nutcracker *Nucifraga caryocatactes*	nest.			×	×
Northern wheatear *Oenanthe oenanthe*	nest. migr.			×	

* Abbreviations: nest. = nesting; nest.? = possibly nesting; migr. = migratory; settl. = settled

A pair of white-tailed eagles *(Haliaeetus albicilla)* nested at new location in about 2km to the south of the ROW border. They successfully had two chicks, one of those was ringed and called Alice. In September, Alice left the nest and made her way to the west. Later, by the beginning of winter 2020–2021, she had reached central Lithuania.

The number of Willow grouse *(Lagopus lagopus)* has decreased and amounts to 4–6 breeding couples. This is most likely due to the extremely difficult winter conditions. Completely white winter feather makes birds well visible in snowless winters. Thus, in the winter of 2020, the Willow grouse was extremely sensitive to predators.

It should be noted that in May, the presence of two couples of the Willow grouse was shown near the south of the construction corridor, and a calling bird was recorded from the north of the construction corridor. The birds were found in almost the same places where they were recorded in 2017, i.e. before the start of active construction activities. This allows us to give a favourable forecast regarding the prospects for the return of the Willow grouse to its former habitats after construction is completed.

Based on monitoring results from 2020, no suppression of breeding, change of nesting sites or other signs of the impact on these species were observed during construction activities.

CONCLUSIONS

There was no impact on birds recorded in season 2020. Project implementation was in compliance with national requirements for SPNA protection and the Decree on the Kurgalsky Reserve.

3.1.6 Terrestrial fauna

Monitoring of terrestrial fauna included monitoring of rare and protected species of terrestrial fauna and monitoring other wildlife. Rare and protected species of terrestrial fauna are defined as terrestrial vertebrates included in the Red Data Book of the Russian Federation, category 3 (NT) or higher, in the Red Data Book of Leningrad Region, in the IUCN Red List and in the HELCOM Red List, category NT or higher. Monitoring of protected bird species is presented in Chapter 3.1.5 and monitoring of protected plants included in the Red Data Book Species List is discussed in Chapter 3.1.5.

METHODOLOGY

Visual observations of protected species of terrestrial fauna and observations of their tracks and signs were recorded during all bird monitoring activities (see Chapter 3.1.5 and Figure 12). Several camera traps were also installed in sensitive areas and on potential animal migration routes (see Figure 13).

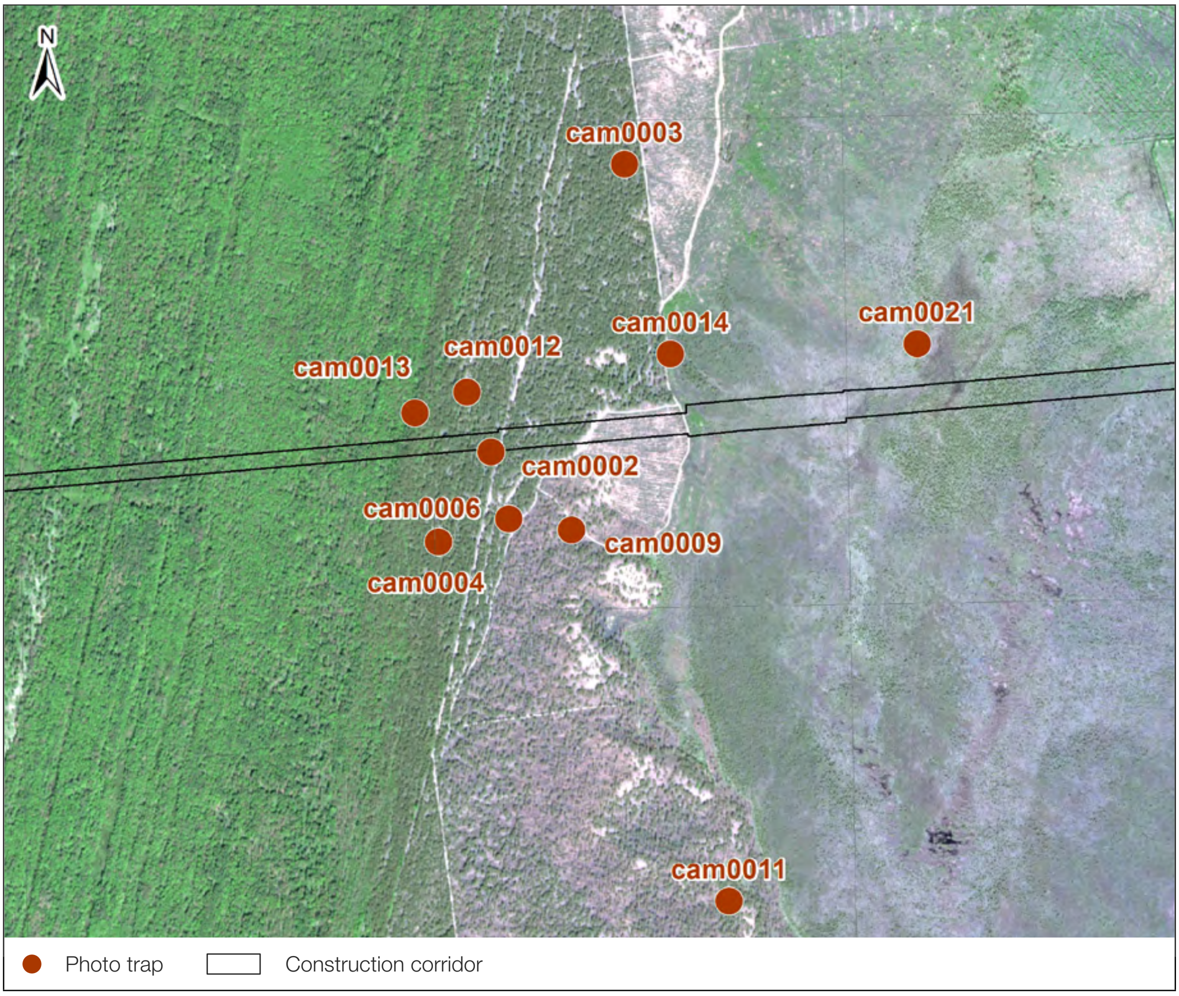

Figure 12. *Camera trap locations (monitoring of vertebrate migration).*

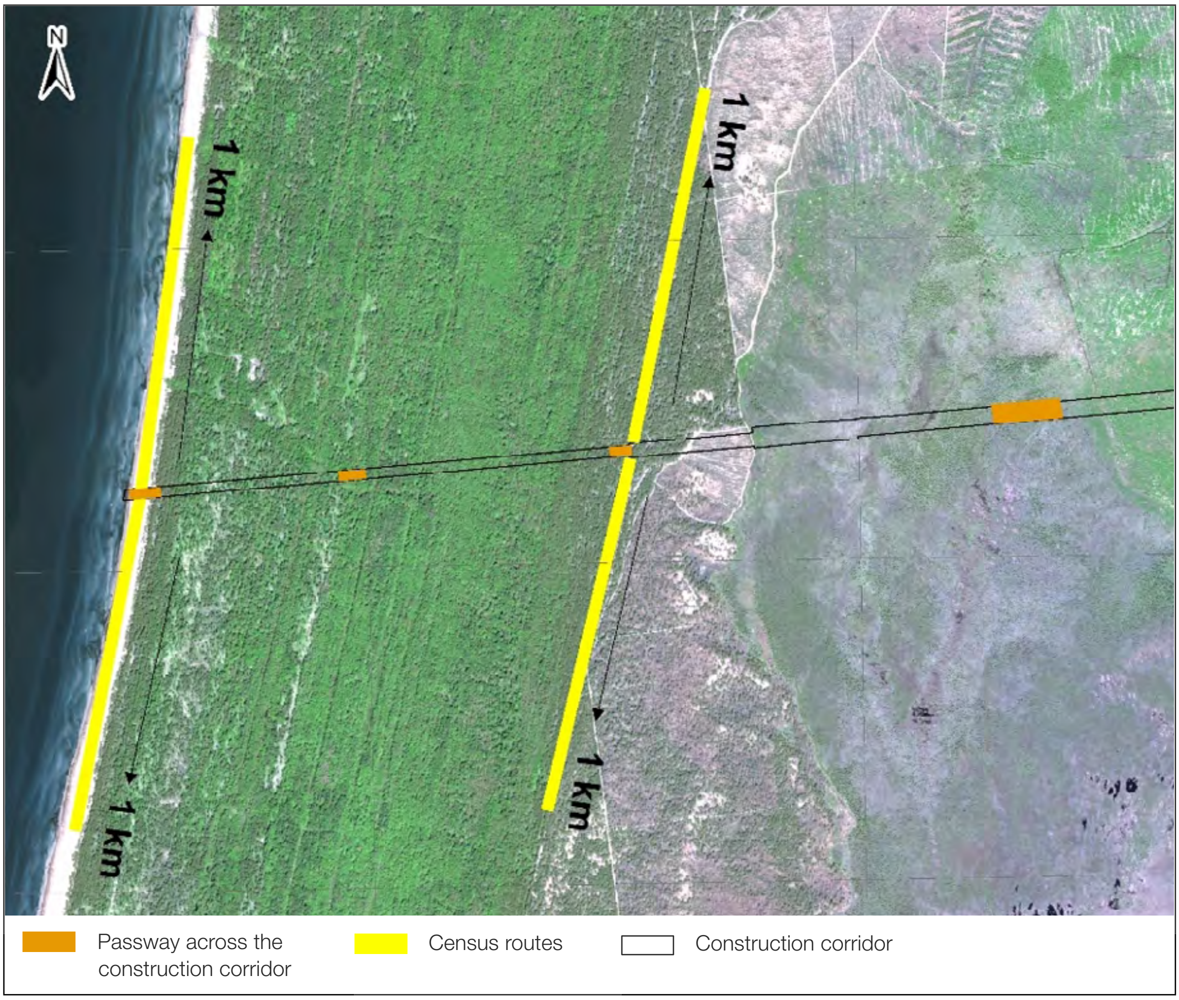

Figure 13. *Observation routes of ungulate migrations (monitoring of vertebrate migration).*

RESULTS

Both grey seal and grass snake were observed in 2018, 2019 and again in 2020.

In 2020 the following was observed:

- A grey seal (Halichoerus grypus) carcass drawn in a gill net was found on the beach in mid-summer. It should be noted that the remains of the grey seals, mainly juveniles, are observed on the coast every year, often with traces of gunshot wounds.
- In early September 2020, in the area adjacent to the northeastern part of the Kader bog and located near the construction camp, a mass appearance of recently hatched Grass snakes (Natrix natrix) was observed. Young snakes probably hatched safely near the construction site. In the same period, young snakes were also seen to the west on a forest road crossing the construction corridor in the area.

The migration routes of ungulates (such as moose and roe deer) were affected by the fencing of the ROW. Those animals (unlike wild boar and predators) avoided using the wildlife crossing corridor close to the relict dune, which was opened in beginning of 2019. This led to a high concentration of ungulates in the fenced forest section, and some local populations of rare and protected plants near the fence were affected by animals. Wider wildlife corridors were open in the end of 2019 to facilitate animal crossings in different biotopes. In late 2020 large sections of fence were dismantled.

According to monitoring results migrations of roe deer come returned to their natural character after the opening of wider crossings. Those animals used all of them, except for the coastal one. Throughout the summer, the animals preferred the migration to the mixed forest strip (see Figure 14). In June, traces of roe deer were also noted at the crossing in the wetland part of the construction corridor. In July, a significant number of the crossings were recorded on the dune. The data from camera traps (No.0002 and No.0005) indicate that males were actively moving along the dune, which may have been the same territorial individuals. The increased activity of males was associated with the rutting season in July. In August, the preference for forest crossing became almost absolute.

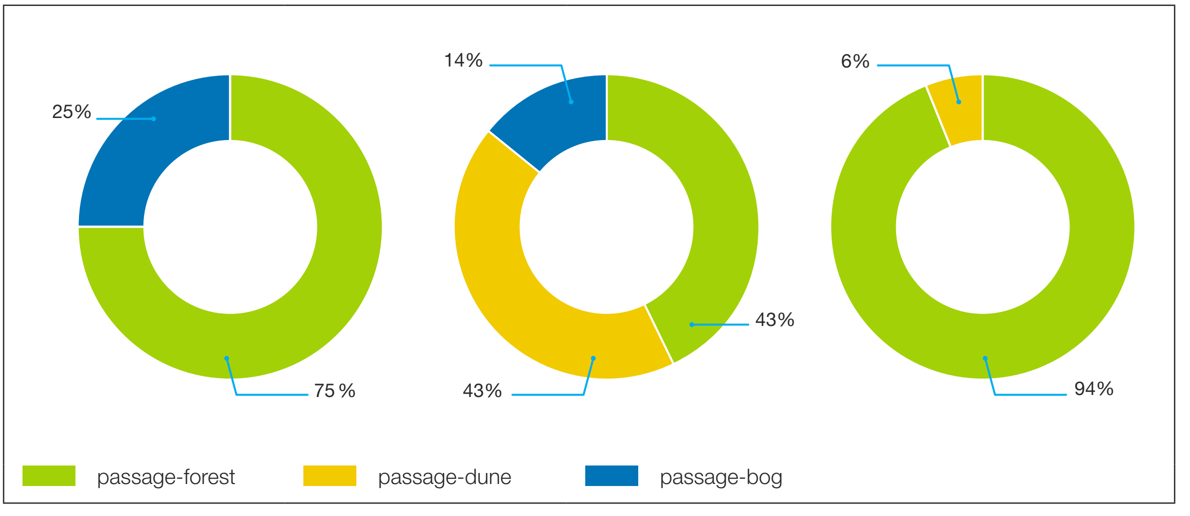

Figure 14. *Relative frequency of use of passages by roe deer in different biotopes.*

The 2019 results indicated that the construction of the gas pipeline had disrupted the seasonal movements of the elk and had an impact on the spatial and temporal distribution of animals. However in 2020, the situation has changed markedly. Observations at the passages indicate that animals of different sex and age move freely and regularly through them. The distribution of elk encounters from the north and south of the corridor became relatively uniform.

The results obtained indicate the normalisation of the distribution of elk in the south of the Kurgalsky reserve and the almost complete restoration of seasonal migration routes by December 2020.

CONCLUSIONS

Based on the monitoring results, the construction activities had no impact on Red Data Book Species. Other wildlife, such as ungulates, were affected to some extent by the construction activities, but the impacts were deemed to be temporary. Project implementation was in compliance with the national EIA, national requirements for SPNA protection and the Decree on the Kurgalsky Reserve.

3.2 Monitoring of construction camp and work areas

Monitoring at the construction camp and work sites (including the ROW) is designed to ensure that the project meets the requirements for water discharge, air emissions and noise emissions stated in the EIA, the State Environmental Expert Review report (SEER) and the relevant permits. In addition, monitoring was also conducted close to the nearest settlement to ensure that there is no adverse impact on the local community. Finally, monitoring also helps to identify possible solutions and remedial actions to be applied if permitted thresholds are exceeded. The monitoring locations established at the construction camp and work sites are shown in Figure 15.

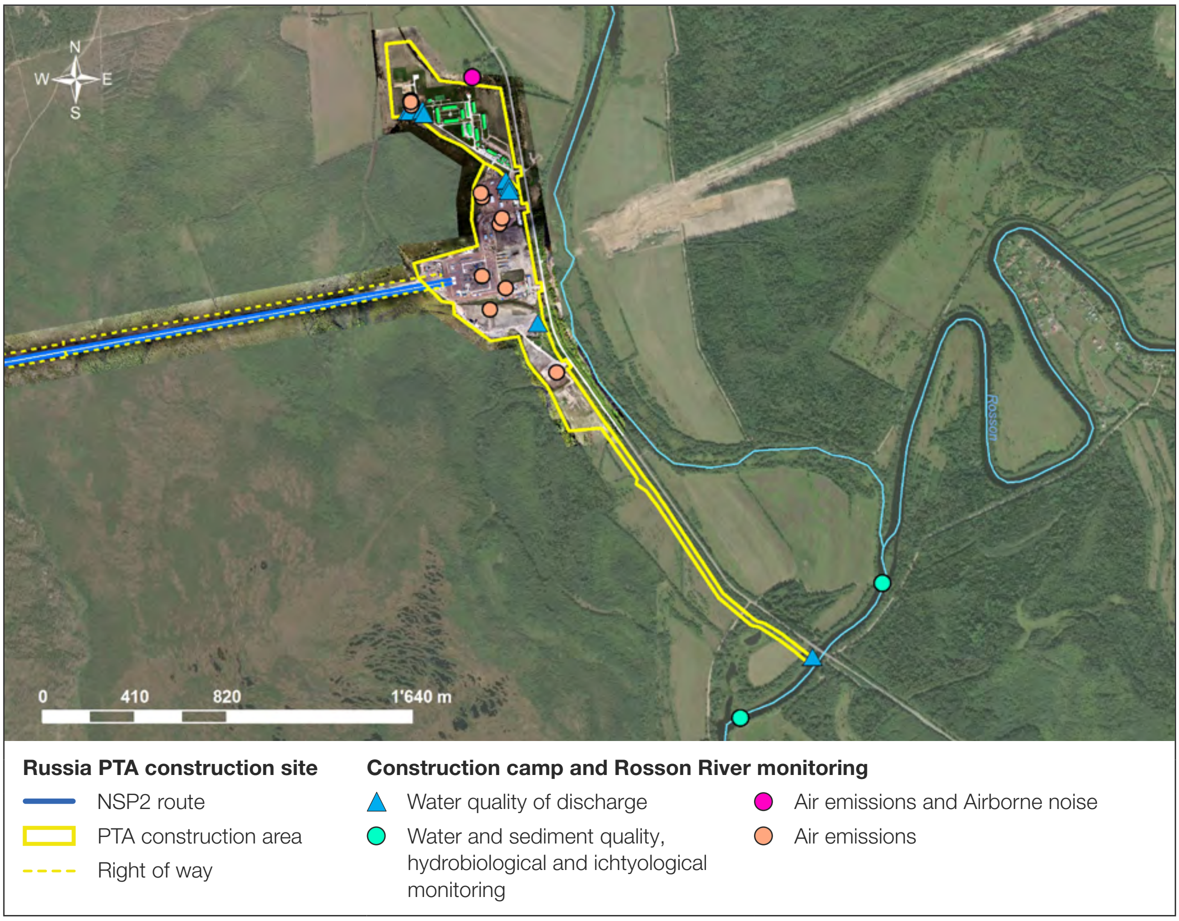

Figure 15. *Environmental monitoring at the construction camp, work areas, and in the Rosson River.*

In general, the construction activities occurring at the construction camp and work sites in 2020 were in line with the estimates given in the national EIA. The quality of discharged water was not in compliance with sanitary norms. Discharge of treated water was stopped on 3 February and wasn't renewed until the end of the year due to pipeline repair and additional investigations related to installed manholes. Monitoring of air emissions (Chapter 3.2.2) and airborne noise (Chapter 3.2.3), measured both in the construction camp and close to the nearest settlement proved to be in line with the estimated figures and with the applicable legislation. Emissions into water bodies and the atmosphere, including noise, were found to have no detrimental effects on the local population.

3.2.1 Quality of discharged water and receiving waters

Monitoring of water discharges is undertaken to verify the effectiveness of the treatment plants located at the Landfall Russia worksite. These comprise:

- A sewage treatment plant (STP) located at the workers' camp
- A storm water treatment plant (SWTP) treating runoff from parking areas, and
- A drainage water treatment plant (DWTP) treating wastewater from the dewatering of excavations at the Pig Trap Area.

Treated water from these facilities is transported by pipeline and discharged at an outfall on the Rosson River.

The discharge permit, the water licence and the discharge limit documentation regulate water discharges from the work sites and served as the basis for development of the monitoring programme for water discharges.

METHODOLOGY

The volume and quality of water discharges are monitored at the three water treatment plants. In an adaptive management sense, this information enables remedial actions to be implemented when the quality of treated effluent is out of compliance with license conditions.

Where treated water quality is above the thresholds, Nord Stream 2 suspends discharges into the Rosson River and the water is tankered away for treatment at licensed water treatment plants in the region. Discharge into the river is resumed only when water quality analysis demonstrates compliance with the licence conditions.

Sewage water and storm water from the construction camp and drainage water from the PTA are sampled and analysed at a number of locations distributed as follows (see Figure 16):

- One upstream of each treatment plant;
- one downstream of each treatment plant, except for the sewage treatment plant which had two monitoring stations (additional location was added in October, after treatment plant extension);
- one at the outfall into the Rosson River;
- two additional sampling locations shown in Figure 15 are related to baseline monitoring of the Rosson River and will be discussed in Chapter 3.3.

The original monitoring programme, issued in year 2018, specifies quarterly sampling of water discharges, which was increased to monthly since October 2019, based on obtained monitoring results and several changes in legal requirements to monitoring programmes development.

Additional sampling locations were monitored from time to time to support the operation of the various treatment plants, including the holding tank, pumping station well and pressure-reducing wells.

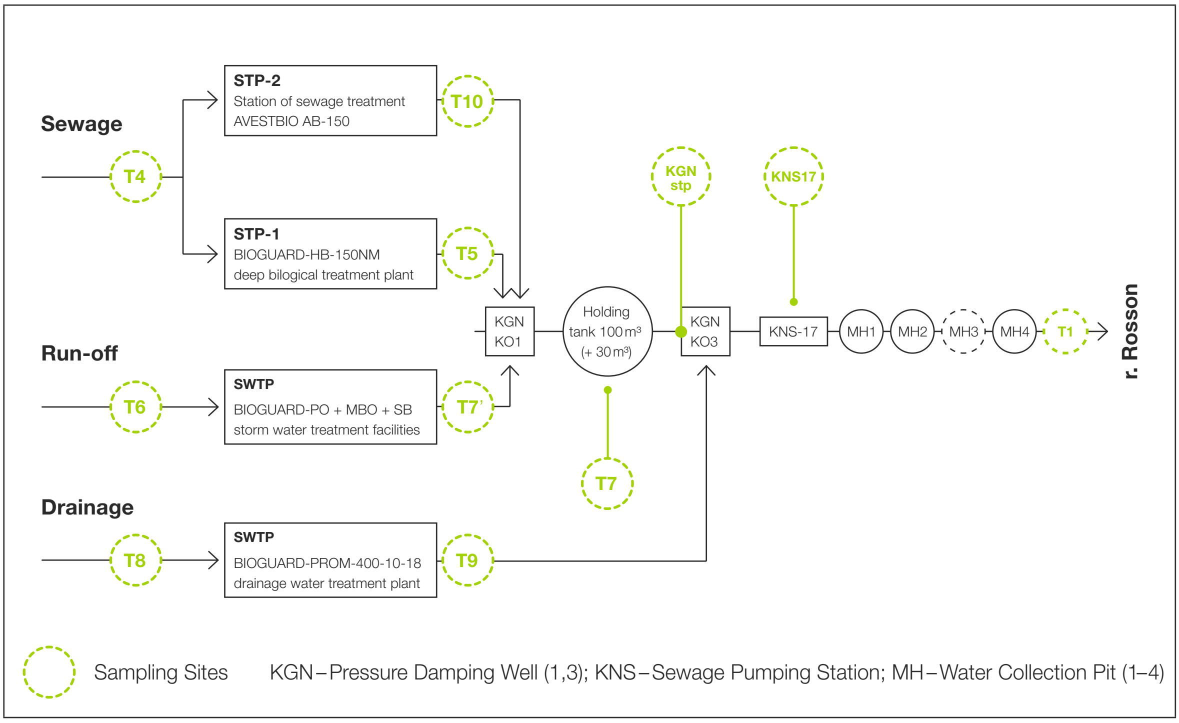

Figure 16. *Distribution of treatment plants and its monitoring. STP – Sewage Treatment Plant; SWTP – Storm Water Treatment Plant; DWTP – Drainage Water Treatment Plant.*

Water samples were analysed by accredited laboratory centres for common physico-chemical properties (including heavy metals, hydrocarbons, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrates, phosphates, pH, temperature, oxygen) and for sanitary and epidemiological parameters.

RESULTS AND CORRECTIVE ACTION

Nord Stream 2 was advised by the authorities to undertake a pressure test of the discharge pipeline before June 2020 and rectify faults no later than September 2020.

Discharge into the Rosson River was stopped for repair preparations and pipeline testing in the beginning of 2020, following the first monthly sampling results, which took place on 30 January after additional sampling at locations KGNstp and T1 on 23 January. The last discharge event took place on 3 February. Throughout 2020, treatment sewage and storm treatment facilities remained working in their regular mode. The work of drainage treatment facilities has been suspended due to the suspension of functioning of the discharge pipeline. Meanwhile on 15 and 26 February, equipment was launched in a closed loop to maintain system performance.

Although treatment facilities STP-1, STP-2 and DWTP showed high efficiency of water purification, exceeding design parameters, at the monitoring points belonging to the discharge pipeline (in the pressure damping well (KGNstp) and at outlet No.1), the wastewater was characterised by significantly worse quality compared to the water leaving the treatment plants. It also contained traces of the influence of highly saline water. The wastewater at the KGNstp demonstrated extreme instability of composition and a high content of pollutants.

The following actions were undertaken by the company to improve the situation during season 2020:

- Development and approval of working documentation for discharge pipeline testing;
- testing of the pipeline, with the first round in May (unsuccessful) and second in August (successful);
- discharge pipeline repair;
- identification of a problem related to the tightness of several installed manholes, with remaining associated issues being taken into account for finding a solution in 2021;
- verification of geotechnical studies along the discharge pipeline route and analysis of the discharge pipeline design (in particular, manholes), which are necessary to improve the functioning of the wastewater discharge system. Completion of analysis and development of further actions to improve the functioning of the discharge pipeline are planned for the 1Q 2021.

CONCLUSIONS

Monitoring results were submitted to the water basin authority and later to CNR and the Fishery Authority on a quarterly basis in accordance with discharge permit conditions /15/.

The total volume of water discharged was in compliance with the discharge permit and water licence conditions. Where water quality results were out of compliance with licence conditions, water was tracked away for offsite treatment. All wastewater will be taken away for offsite treatment until the problem has been identified and rectified.

3.2.2 Air emission and quality

Monitoring of air quality was carried out at the construction camp and at the village of Khanike, near the construction camp (see Figure 15). The purpose of the monitoring is both to verify compliance with the national EIA, the SEER report and permits, and to ensure that the construction activities do not have a negative impact on the local community.

METHODOLOGY

The air emission sources that are monitored are the diesel generators at the construction camp and the mobile generators used for certain construction activities (PTA mostly) and generators of checkpoints located in TWA. Monitoring includes comparison of the actual location of the sources with the planned location as per the EIA documentation and the sampling and analysis of the gas mixtures.

Construction camp generators were identified as the main source of air emissions potentially affecting Khanike village, as in 2018 and 2019.

Sampling campaign took 23 to 27 August to monitor 14 sources:

- 6 camp generators;
- 6 sources at PTA: 4 working and 2 reserved;
- 2 more at TWA (checkpoint and remediation contractor’s office).

Each individual sample was taken over a period of 2–2.5 hours. The samples were analysed by an accredited laboratory (see Table 5).

Air emissions were monitored between 22 May and 27 August at a sampling station located close to the village and another less than 100 metres from the construction camp. Sampling was carried out every six hours for a minimum of 30 minutes. Samples were analysed by accredited laboratory centres for meteo-parameters (e.g. temperature, pressure, wind direction and speed, etc). and nitrogen dioxide, sulphur dioxide, formaldehyde and carbon monoxide.

RESULTS

Although the number of air emission sources at the construction camp, PTA and TWA was in compliance with EIA documentation (14 in total as was planned), only 4 of them were listed in the EIA. However, thanks to optimisation of the construction processes and a conservative assessment in the EIA phase, the total emission volumes at the construction camp and Khanike village were well below the planned volumes stated in the EIA for the whole construction period (see Table 5 and Table 6).

Table 5. *Actual volume of emissions in 2018, 2019 and 2020 compared with EIA's estimates.*

No.	Pollutant	Air emission Volume (t)			
		Measured emission in 2018	Measured emission in 2019	Measured emission in 2020	EIA, whole construction period
1.	Nitrogen oxide	0.896468	4.123626	1.988689	12.684546
2.	Nitrogen dioxide	5.518161	25.376025	0.332442	78.057830
3.	Kerosene	0.098237	0.382216	0.224859	20.626482
4.	Sulphur dioxide (sulphurous anhydride)	0.507809	2.653518	0.682392	20.834053
5.	Formaldehyde	0.002511	0.028732	0.020793	0.235214
6.	Black carbon (soot)	0.029282	0.251669	0.763880	12.778055
7.	Carbon monoxide	0.685934	4.395957	3.422169	79.957796
8.	Benzo(a)pyrene (3,4-Benzpyrene)	0.0000003	0.0000012	0.000004	0.000039

Table 6. *Interannual dynamics of air pollutant concentration, mg/m*^{3}*.*

Year / type:		Suspended solids		Nitrogen dioxide		Sulfur dioxide		Formaldehyde		Carbon monoxide	
		m.s.	a.d.	m.s.	a.d.	m.s.	a.d.	m.s.	a.d.	m.s.	a.d.
Data	2016	0.2	0.2	0.029	0.0287	0.036	0.0357	0.018	0.0173	<2.0	<2.0
	2018	<0.26	<0.26	<0.021	<0.021	<0.0025	<0.0025	<0.01	<0.01	1	0.94
	2019	0.1	0.084	0.025	0.022	<0.01	<0.01	0.0088	0.006	<0.8	<0.8
	2020	0.12	0.0905	0.026	0.0224	0.028	0.0231	0.0075	0.0060	<0.8	<0.8
MPC*		**0.5**	**0.15**	**0.2**	**0.04**	**0.5**	**0.05**	**0.05**	**0.01**	**5**	**3**

* according to GN 2.1.6.3492-17, applicable in year 2020 (m.s. = maximum of single (one-time) measurements; a.d. = average of several measurements, made during the day).

CONCLUSIONS

Air emissions were in compliance with the national EIA. The total emissions volumes were well below the estimated values. The total air emissions have had no negative impact on the local community.

3.2.3 Airborne noise

Airborne noise was monitored close to Khanike village (see Figure 15). The purpose of this monitoring is both to verify compliance with the national EIA, the SEER report and the permits, and to ensure that the construction activities do not have a negative impact on the local community.

Airborne noise is regulated by the requirements of SN 2.2.4/2.1.8.562-96 “Noise at workplaces in residential, public buildings and residential areas”.

METHODOLOGY

Airborne noise emissions were monitored with the same frequency used to monitor air quality (see Chapter 3.2.2). Of the total 20 measurements taken, five covered the nighttime and 15 covered the daytime.

Equivalent sound levels and maximum total sound levels were measured for the nighttime and for the daytime period and were compared to the permissible sound levels for residential areas.

RESULTS

The results of the acoustic monitoring were evaluated by the FPHI “Centre for Hygiene and Epidemiology in St. Petersburg”, which provided a positive expert opinion regarding the noise levels originating from the construction activities.

Over the past 4 years, the noise character has not changed, despite the relative proximity of the construction site and the base camp to the residential area (see Table 7). The sound at the constant monitoring location has always been non-constant and fluctuating. The main source of noise in 2016 (before project implementation) was traffic down the A-121 (41K-109) road. Because measurements in 2016 were carried out closer to the road than in 2018–2020, the daytime noise levels in 2016 were higher than the values obtained both in 2018 (at the initial stage of construction) and in 2020 (at the final stage of construction).

Table 7. *Results of noise level measurements in 2016–2020 at the monitoring point RUS_MON_EPR_RA_2, dBA.*

Year	Day		Night	
	LAeq	LAmax	LAeq	LAmax
2016	51.3	61.6	43.7	50.0
2018	48.0	52.6	43.4	46.6
2019	53.8	56.9	45.0	49.4
2020	40.3	45.9	37.6	42.6

Compared to 2019, the noise level, both during the daytime and at night, has significantly decreased. The equivalent and maximum sound levels, both day and night, did not exceed the permissible sound levels for the residential area during the entire observation period.

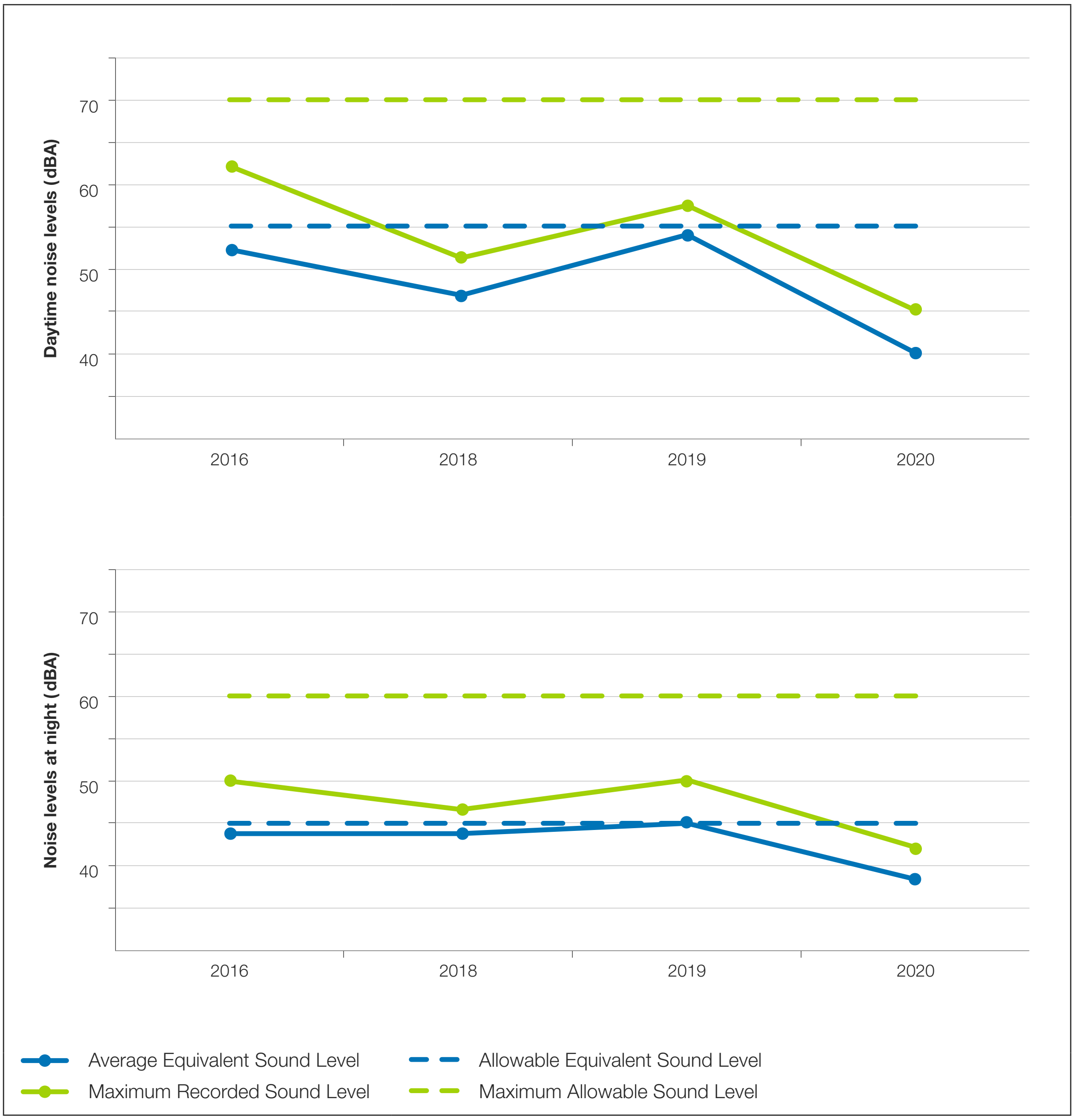

Figure 17. *Interannual variation of average and maximum recorded sound levels during day and night at the monitoring location (Khanike village boundary). Acceptable levels according to SN 2.2.4/2.1.8.562-96, applicable in 2020.*

CONCLUSIONS

Actions taken by the company based on monitoring results from 2019 (screen installation) were assessed as being very effective. Noise emissions in 2020 were in compliance with the national EIA and with the regulatory requirements for noise levels in residential areas. The noise emissions had no negative impact on the local community.

3.3 Rosson River monitoring

Water from the construction site and camp is discharged into the Rosson River. Monitoring of the river environment covers water and sediment quality as well as the biological environment, such as benthos and plankton communities and fish fauna. The two monitoring locations are situated 500 metres up- and downstream of the discharge point (see Figure 15). Monitoring of the Rosson River will continue throughout the operation of the construction camp and work site, as well as during decommissioning of the construction camp. The monitoring is designed to ensure that the water discharges from the water treatment plants at the Russian landfall do not impact the ecological status of the river.

Monitoring results for 2020 did not show any changes in the river environment related to Nord Stream 2 discharges. Monitoring of water quality started prior to the start of discharge in summer 2018. No significant changes of contamination level were registered during 2020 (see Chapter 3.2.1). No epidemiologically significant non-compliance or toxicological manifestations was detected as in 2018 (see Chapter 3.3.1). The riverbed sediments were classified as "clean" or "low contamination" in accordance with regional standards and no negative trends or pollutant accumulations were found relative to the baseline environmental survey results and pre-construction monitoring in 2018 (see Chapter 3.3.1). Monitoring of the river's biotic environment was in line with earlier baseline surveys and pre-discharge monitoring results for 2018 (see Chapters 3.3.2 and 3.3.3).

3.3.1 Water and sediment quality

Monitoring of water and sediment quality in the Rosson River was set up to assess potential impacts of water discharges from the Nord Stream 2 construction sites into the river (see Figure 15). In addition, the monitoring work also took into consideration the natural seasonal dynamics of river bodies. Monitoring took place on a quarterly basis. Starting in November 2019, the frequency of water quality sampling was increased to monthly, as defined by the updated water licence requirements.

METHODOLOGY

Monitoring of water and sediment quality was carried out at two sampling locations during eleven monthly water sampling campaigns. The April sampling campaign didn't happen due to stringent restrictions related to the COVID-19 pandemic. Four quarterly sediment sampling monitoring campaigns were also conducted in March, June, August and November.

Water samples were taken from the top 0.3–0.5 metres of the water column. These were analysed by accredited laboratories and included chemical analysis, bacteriological, parasitological, toxicological and microbiological tests.

Sediment samples were taken from the top 0.02 metre soil layer and analysed by accredited laboratories including chemical analysis tests.

Considering unstable quality of discharged water during 2019, an additional monitoring campaign was performed in the beginning of 2020 for a larger section of the river – in between the nearest settlements, located up- and downstream of the discharge pipeline outlet, for about 8km in total.

RESULTS

Regular observations on the Rosson River, except for the survey in January, fell on the period when there was no discharge of treated wastewater through onshore outlet No. 1. The observations of 2020 established the current background state of the monitored section of the river. Based on the results of assessing the quality of water and bottom sediments of the Rosson River during the period of wastewater discharge (2019–January 2020) and in the background period of 2020, the following can be noted:

According to the WPI index, the Rosson River water was assessed mainly as “moderately polluted” (III class) or “polluted” (IV class). In the additional survey (23 January 2020) in the Volkovo – Vanakyulya section, the river water along nearly the entire course corresponded to class IV (“polluted”).

According to most of the monitored *hydrochemical parameters*, the water quality during the period of wastewater discharge and after the termination of the discharge corresponded to the quality standards. The water was characterised by moderate ($K \leq 28\,\%$) pollution complexity; between 2 to 6–7 out of 25 standardised ingredients in water samples were considered contaminants. The quality of river water is to a decisive extent related to the presence of components (COD, Mn, Fe, Al) in contaminating amounts, characteristic of humid catchments with a predominance of soils enriched with humic substances. From 2019–2020 there were no significant differences in the content of these typomorphic components in water; the pollution was assessed as “stable”.

In the background period of 2020, concerning the period of wastewater discharge in 2019, the maxima, the frequency of exceeding the MPC_{fish} and average levels for ammonium ions, BOD5 decreased.Opposite trends were noted for phenols: the occurrence in water samples of the excess over MPC_{fish} increased from 19% to 45%. The average content for the periods under consideration went from 0.8 to 1.9MPC_{fish}.

For the first time over the entire observation period of 2018–2020, the inconsistency with the standards for Cu, Mo, nitrites and dissolved oxygen was revealed in single samples during the period of no discharges. The detection data indicate that cases of deterioration in water quality due to the expansion of the spectrum and/or aggravation of the amount of pollutants are not excluded and occur regardless of the mode of operation of outlet No. 1.

In terms of *microbiological parameters* at the site of Volkovo village – Vanakyulya village (23 January 2020) and at the regularly monitored section of the river, the SanPiN 2.1.5.980-00 standards for TC and TCB were exceeded in water samples (with few exceptions), which indicated an increased bacterial background for coliform microorganisms (TC, TCB) in the Rosson River. The defining results indicating the epidemic safety of the Rosson River are completely favorable results of monitoring of pathogenic microflora, helminths, coliphages, cysts (oocysts) of intestinal protozoa.

In terms of *toxicological parameters*, all water samples investigated in 2019–2020 in scheduled and additional (23 January 2020) surveys corresponded to class IV (low hazard) according to the Rospotrebnadzor classification system and almost completely to class V (almost not hazardous) according to the classification of the Ministry of Natural Resources of Russia. Four samples with water toxicity at the border between V and IV classes were a small exception according to the classification of the Ministry of Natural Resources of Russia, in which signs of water toxicity were detected only for one of the two test objects used.

Bottom sediments in the studied samples during the periods under consideration according to the Regional Standard belonged to quality class 0 ("clean" sediments) and quality class I ("slightly contaminated" sediments), with the latter due to the content of oil products between the target and limit levels. On the basis of clause 4 of the Regional Standard for the concentration of oil products to the maximum level "represent the maximum acceptable risk for both human health and nature".

The content of monitored metals corresponded to class 0 ("pure" deposits) in all samples.

According to the observations in the established section of Rosson River, there were no significant differences in the degree of water and bottom sediment contamination in terms of monitored parameters and properties during the operation of the tail drain and the absence of wastewater discharge.

3.3.2 Hydrobiological environment

Monitoring of the hydrobiological environment of the Rosson River was set up to assess potential impacts of water discharges from the Nord Stream 2 construction sites into the river (see Figure 15). The monitoring investigated the conditions of phytoplankton, zooplankton, zoobenthos and macrophyte communities.

METHODOLOGY

Sampling was performed in the beginning of August 2020 to provide comparable data for assessment of trends.

Phytoplankton was collected through the trophogenic layer (i.e. the upper portion of the water body where photosynthesis occurs); samples were identified at the species or group level and biomass was measured.

Zooplankton was collected from the surface down to 1 metre from the riverbed; samples were identified at the species level and biomass and abundance were measured.

Zoobenthos was collected from the riverbed; samples were identified at the species level (except for nematodes) and biomass was measured.

Monitoring of macrophytes took the form of a visual description of the communities within the monitored area and sampling at four sites (see Figure 15). Species projective cover and species average height were recorded by visual observation. Species identity and biomass were determined from the data collected at the sampling sites.

RESULTS

In August 2020, the development of the phytoplankton community of the area under consideration corresponded to the seasonal characteristics of the phytoplankton of the rivers of the Leningrad Region and the background studies in August 2017, both in terms of species composition and abundance. Based on the biomass of phytoplankton, the Rosson River in 2020, as before, can be included among water bodies with mesotrophic conditions with oligotrophic features.

Zooplankton community development in the area under consideration in August 2020 corresponded to the seasonal characteristics of the zooplankton of the Leningrad Region rivers. The obtained values of zooplankton biomass fit into the range of fluctuations of similar background values in 2017. An increased abundance of zooplankton was noted due to the development of rotifers of the genus *Synchaeta* and a large number of juveniles and nauplii copepods. The distribution of structural and quantitative parameters of the zooplankton community is natural.

The macrozoobenthos of the Rosson River water area surveyed in August 2020 corresponded to the seasonal characteristics of the benthic communities of the riverbeds of the Leningrad Region. The results of 2020 correlate well with the materials of the background studies carried out on the Rosson River in August 2017, both in terms of taxonomic composition and quantitative characteristics. Differences in the quantitative characteristics of zoobenthos across stations were associated with the mosaic distribution of Bivalve mollusca (*Unio pictorum* and *Dreissena polymorpha*), which play the greatest role in the creation of both the abundance and biomass of benthos. The abundance of the remaining groups of bottom invertebrates differed significantly at the stations. Given the local differences in the parameters of bottom sediments, differences in the composition and abundance of zoobenthos can be explained by natural variability.

The composition of the macrophyte communities of the studied areas corresponds to the typical plant communities of the water area and the Rosson River banks. Differences in species composition, abundance, and phytomass of macrophytes over the entire observation period are due to natural seasonal dynamics and are not associated with the construction of the gas pipeline.

CONCLUSIONS

Characteristics of plankton and benthic communities of the surveyed section of the Rosson River in 2020 corresponded to similar seasonal characteristics of hydrobiological communities of rivers in the Leningrad Region. No signs of construction impact were revealed over the entire observation period on the aquatic biota and coastal aquatic vegetation in the area of the treated wastewater outlet head.

3.3.3 Fish

The purpose of monitoring was to confirm that the project discharges of wastewater have not affected fish communities in the Rosson River. The monitoring of fish communities in 2020 took place twice:

- in spring (mid-May) as in 2019 and as agreed in the EIA documentation with the purpose to confirm that there is no impact on spawning;
- in autumn (mid-September) as during pre-construction survey with the purpose to monitor structure of fish communities and record any deviations.

METHODOLOGY

Ichthyological surveys at the two sampling locations took place twice in different seasons, as mentioned above. Fish samples were collected with combined gill nets (from 12 to 60mm) during 12-hour sampling campaigns. Species composition, abundance and biomass of the catches were calculated.

RESULTS

The species composition of fish for the entire observation period corresponded to the composition of the fish population of the Luga and Narva rivers. Of the species detected during the 2018–2019 survey, two fish species were not found in 2020 – *Sander lucioperca* and *Squalius cephalus*. However, it should be noted that these species were also small in number in the previous years of research. In 2020, two other species were caught for the first time: *Salmo salar* in the autumn, and *Osmerus eperlanus* and *Scardinius erythrophtalmus* in the spring-summer period.

The total number of fish caught in the spring-summer period of 2020 (36 fish specimens) was slightly lower than in the same season of 2019 (42 fish specimens). The total number of fish caught at two research stations in the autumn of 2020 (290 fish specimens) significantly exceeded that obtained in the spring-summer periods of 2020 (36 fish specimens) and 2019 (42 fish specimens) and was also higher than in the autumn period of 2018 (123 fish specimens). The same pattern is observed for biomass.

The distribution of fish of the detected species and their numerical characteristics were mainly determined by feeding movements (or spawning with regard to *Salmo salar*) of these species, as well as natural climatic seasonal changes and observed weather factors. At the same time, the dominant complex of species changed very slightly: in 2018–2019 in the catches at both stations, *Blicca bjoerkna* and *Gymnocephalus cernus* prevailed; and in the spring of 2020, *Blicca bjoerkna, Perca fluviatilis* and *Rutilus rutilus*; in autumn, *Alburnus alburnus, Blicca bjoerkna* and *Rutilus rutilus*. Thus, *Blicca bjoerkna* is the most constant and widespread species in the studied section of the Rosson River.

The most likely reason for the identified differences in the number of fish caught in 2018–2020, according to experts of the St. Petersburg branch of the FSBI "VNIRO" ("GosNIORH", named after L.S. Berg), is the specificity of the distribution and migration of fish in different seasons. Thus, in the spring months, the number of fish in catches in the study area was minimal, and the data for the spring catch of 2020 corresponded to the same values in 2019. As expected, the number of fish in the studied area in the autumn period was significantly higher. The results of the ichthyological survey in September 2020 can be considered consistent with the data of 2018 and the background state of the ichthyocenosis of the Rosson River in the autumn period.

Because the direct operation of the outlet (water discharge) during the construction of the Nord Stream 2 facility was not carried out either during the spring ichthyological survey of 2020 or in the fall of 2020, this facility could not hurt the state of the ichthyofauna of the Rosson River, either in the spring or in the autumn 2020 period of observations.

CONCLUSIONS

Operation of discharge pipeline from Nord Stream 2 construction sites and camp facilities during period of 2018–2020 did not impact icthyocenosis of the Rosson River.

4 Monitoring during onshore construction in Germany

Since the German landfall and the PTA are entirely located inside a designated industrial park (see Figure 18), monitoring requirements for onshore construction in Germany are characterised as low complexity compared with the requirements for the Russian landfall.

Figure 18. *Pig Trap Area (PTA) Germany (red box) in the industrial park south of Lubmin industrial harbour in July 2018. The vessel in the foreground shows the location of the offshore exit pit of the shore crossing microtunnel.*

Onshore monitoring in Germany concluded in 2019. No onshore construction was conducted at the German landfall in 2020, with only minor reinstatement and finalisation works taking place. Since no civil works tool place, no environmental monitoring was required in 2020 according to the German permit obligations. The temporary construction site outside of the plant area (the former tunnel pits) was reinstated during the second half of the year (see Figure 18 and Figure 19).

Figure 19. *Transformation of a temporary construction sites (the former tunnel pit) beside the Pig Trap Area (PTA) Germany in the industrial park south of Lubmin industrial harbour into a semi-natural grey dune habitat in autumn 2020 (September above, December below).*

5 Monitoring during offshore construction

Monitoring of offshore construction activities was carried out during 2020. This chapter presents results of environmental monitoring related to offshore construction.

5.1 Construction activities – pipelay and rock placement

Offshore construction in 2020 included pipelay and rock placement (see Figure 20). Most of the pipelay was completed in 2018 and 2019. In 2020, pipelay only took place in the Germany when the pipelay vessel Fortuna laid 2.6km (Line B) in the German EEZ.

Before or after pipelay rock is placed along the pipelines to reshape the seabed locally to provide support and ensure long-term integrity of the pipelines. Rock placement is required for free span correction and for the crossings with other pipelines. The size and shape of each rock berm are individually designed to ensure the required pipeline support and/or protection. In 2020, post-lay rock placement was performed in Russia, Finland, Sweden and Denmark. When in late 2019 the pipelines were left on the seabed for later resumption of pipe lay construction (Denmark and Germany), rock bags were placed on the pipeline ends as a temporary protection measure against mechanical impacts, e.g. from trawling vessels.

5.2 Environmental monitoring

Offshore monitoring during pipelay and rock placement in 2020 took place in Finland, Sweden, Denmark and Germany (see Figure 20). Monitoring of the construction activities described below was defined by the monitoring programmes of each country.

Environmental monitoring during pipelay in Germany included monitoring of ship traffic. During rock placement it was also performed in Finland and Denmark as part of environmental monitoring programmes. Some parameters were part of chance find procedure, which meant that monitoring would only be required should chance finds be discovered. Ship traffic was part of monitoring programme in Denmark, whereas in the other countries ship traffic safety was ensured by compliance with relevant permit requirements and no dedicated monitoring was required. Overview of monitored parameters is shown in Table 8.

Table 8. *Overview of monitored parameters during construction in 2020.*

	Marine water quality	Cultural heritage	Ship traffic	Munition objects
Pipelay			G	
Rock placement	F	R*, D*	R**, F**, S**, D	D***

R – Russia; F – Finland; S – Sweden; D – Denmark; G – Germany
Notes: * Cultural heritage chance find procedure in place – no monitoring required; ** Ship traffic monitoring during rock placement was not included in the monitoring programme. Ship traffic safety is ensured by compliance with the relevant permit requirements; *** Munition objects chance find procedure in place – no monitoring required.

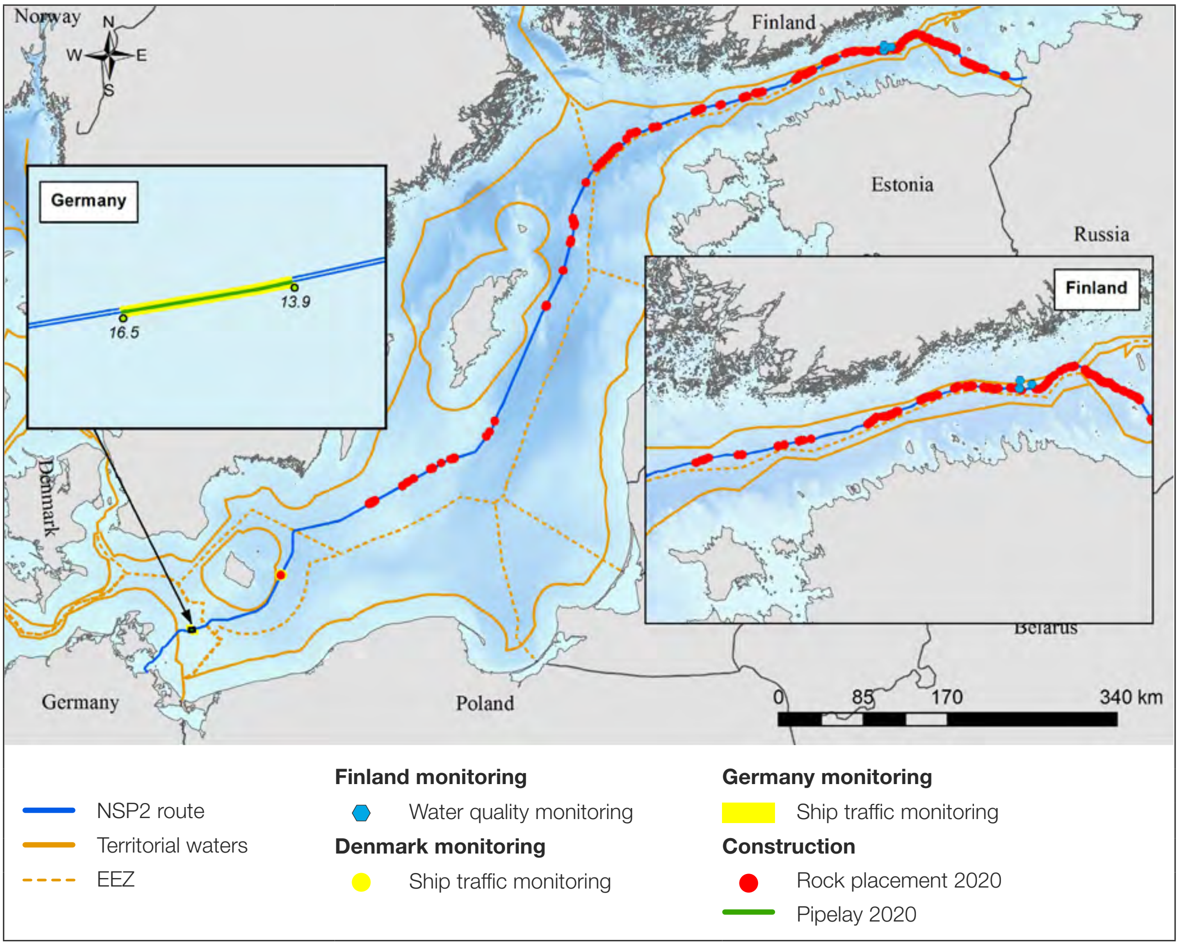

Figure 20. *Environmental monitoring associated with pipelay and rock placement.*

Marine water quality (see Chapter 5.2.1) was not affected by the construction activities as shown by monitoring during rock placement in Finland. Monitoring of shipping traffic (see Chapter 5.2.2) demonstrated that the construction vessels performed properly and safely. No incident reports have been produced from the pipelay and rock placement vessels, meaning that third-party vessels did not intrude in the safety zones that had been set up for those vessels. No chance find related to cultural heritage objects (see Chapter 5.2.3) and munition objects (see Chapter 5.2.4) were discovered during construction in 2020.

5.2.1 Marine water quality

Water quality was monitored during rock placement in Finland. The aim of monitoring was to record potential impacts of rock placement in the vicinity of the Sandkallan Natura 2000 area. Water quality was monitored at the stations in the Sandkallan protected area (protected for its reefs habitat) in 2020. Monitoring of individual berms was completed in 2018 and for long-term control stations in 2019.

METHODOLOGY

In 2020 water quality was monitored at the Sandkallan area, which is protected by Natura for its reef habitats. Rock placement took place nearby. Monitoring at Sandkallan started in April 2018 and continued until 14 May 2020, more than four weeks after the completion of the construction work in the nearby area.

At Sandkallan a triple monitoring array was used in a triangular configuration around the southern border of the protected area and each array measured salinity, temperature, oxygen and turbidity at three water depths (2, 5 and 15 metres above the seabed; depth of the monitoring stations 49–65 metres). In addition, one array was equipped with an ADCP current profiler that measures current speed and direction through the water column. Based on monitoring results in the Sandkallan area, the nearby rock placement activities did not affect water quality.

Monitoring at two long-term monitoring stations located at the coast started in April 2018. Originally, the monitoring was planned to continue until end of construction. Since the construction activities in the Finnish EEZ were almost completed and monitoring performed so far showed only small impacts to the environment, Nord Stream 2 AG proposed that monitoring would end at these two stations in December 2019. Uusimaa ELY Centre accepted the proposal in its decision on 8 November 2019.

RESULTS

No impacts from construction activities were detected in water quality at the long-term monitoring sites Control 1, Control 2 and Sandkallan during 2019. Strong halocline could be detected in the Sandkallan stations in 2018–2019 with salinities exceeding 10PSU regularly.

In 2020, practically no halocline was observed in winter or spring. Weak or missing halocline allows the transport of oxygen from the surface water to the near bottom waters. In the end of the monitoring period, the salinity in the deepest station, Sandkallan 3, reached the level of 10PSU again, indicating the re-establishment of the halocline (see Figure 21).

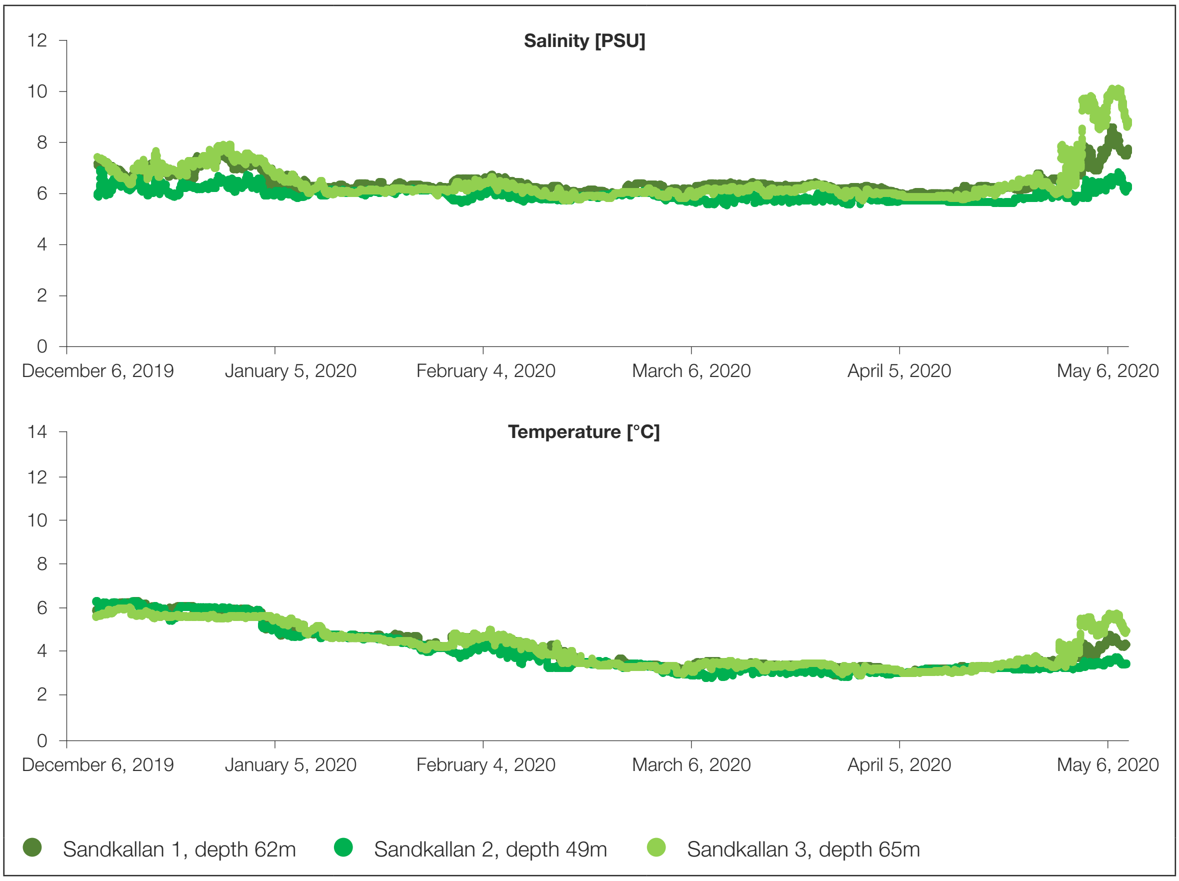

Figure 21. *Temperature and salinity in 2020 measured 2 metres above the seabed in the long-term monitoring stations Sandkallan 1, 2, and 3.*

No impacts from construction activities were detected in water quality during the monitoring period (see Figure 22). The highest measured single turbidity value was 8 FNU, which is within the natural turbidity variation in the area. The average turbidity was below 1 FNU. Oxygen conditions were good at all three stations. No anoxic periods were measured. Weak or missing salinity stratification and stormy periods during ice-free winter improved the mixing of the water layers, leading to an increase in oxygen concentration in the deeper water layers.

Figure 22. *Oxygen concentration and turbidity at the monitoring stations Sandkallan 1, 2 and 3. The images are combinations of all measurements carried out at the monitoring stations. They represent the depth range of 2–15 metres above the seabed. Rock berm construction within the radius of 10km of the stations is indicated by arrows.*

CONCLUSIONS

In line with the previous monitoring results, there were very limited, if any impacts on water quality attributable to rock placement. Monitoring in Finland in 2020 showed that no increase in turbidity due to construction activities occurred in the proximity of the Sandkallan protected area and any impacts on the water quality can be ruled out. Thus, water quality monitoring in the Sandkallan monitoring site confirmed the conclusions of the Natura 2000 assessment and showed that the NSP2 project did not have adverse impacts on the Sandkallan Natura area that would threaten the protection values of the area /16/.

5.2.2 Ship traffic

Ship traffic was monitored as part of national monitoring programmes during pipelay in Sweden, Denmark, and Germany. During rock placement ship traffic was monitored in Denmark following the same methodology as for the pipelay. In Finland and in Russia, monitoring of ship traffic is not included in the environmental monitoring programme: NSP2 however ensured that it was compliant with requirements related to ship traffic, such as safety zones, which were defined in accordance with the local authorities. Such compliance is described in the Annual Monitoring report in Finland /17/ and in the notices to mariners and reporting to the authorities.

The overall purpose of the control of maritime traffic is to minimise the risk of collisions or other accidents involving commercial shipping traffic and/or vessels carrying out construction activities for the project. Before and during construction, the locations of the construction vessels are announced by the national shipping authorities in Notices to Mariners to increase awareness of project-generated vessel traffic. To ensure notification of smaller vessels, fishing and maritime organisations are informed prior to the commencement of construction works and updated throughout.

During construction works, a daily report (and weekly reports in Finland) on all construction activities is transmitted from the vessels to the relevant authorities. These reports include the name, call sign, current position and plan of the vessel for the next 24 hours. Any unexpected vessels entering a “closest point of approach” radius during the construction work are contacted by the responsible shipping authority and monitored closely and, if necessary, the construction support vessels can be used to alert them.

The overall purpose of the monitoring of maritime traffic is to document safe navigation for commercial ships passing the construction works by analysing the ship traffic data and possible incidents. This monitoring also enables verification of the risk assessment performed in the EIA.

Monitoring of ship traffic in the Danish EEZ in 2020 was focused on construction-associated activities such as installation of rock bags at the pipeline ends for protection and installation of a rock berm for stabilisation. Monitoring of ship traffic in Germany was performed during pipelay. The methodology and results of the monitoring in Denmark and Germany are described below.

METHODOLOGY

Denmark

Monitoring activities are focused on demonstrating that information has been provided to the authorities as agreed (Activity 1), that the construction vessels such as rock placement vessels operated as intended (Activity 2) and that safe passage for third-party vessels was possible (Activity 3).

To meet monitoring objective 1, correspondence between Nord Stream 2 AG and the authorities is analysed in order to document whether information is provided to the authorities as agreed.

To meet monitoring objective 2, the proper and safe operation of construction vessel traffic is monitored using Automatic Identification System (AIS) data. The AIS data are gathered and analysed to illustrate observed ship tracks from the construction vessels. The observed ship tracks can then be compared to the intended operation of the construction vessels as described in the plans for the construction activities and the restrictions set by the safety zones, in order to demonstrate the degree to which the observed operation matches the plans. The results are presented in maps showing the operation of the construction vessels. Videos presenting vessel movements in space and over time can be produced to illustrate any incidents of special interest that may have occurred. The results of the monitoring enable Nord Stream 2 AG to either confirm or adjust the operation of the construction contractor.

To meet monitoring objective 3, AIS data are used to document that commercial ship traffic has safe and free navigation when passing the slow-moving construction vessels. The AIS data for commercial ships are analysed to generate observed ship tracks from commercial vessels, which show whether the commercial ships are able to recognise the construction vessels and their safety zone in due time to safely plan their journeys around them, also within the Traffic Separation Scheme (TSS) Adlergrund (where relevant). Videos presenting vessel movements in space and over time can be produced to illustrate any incidents of special interest that may have occurred. The results of the monitoring enable Nord Stream 2 AG to either confirm or adjust the safety measures adopted to enable safe and free passage of commercial ships passing the construction activities.

Monitoring targeted the rock placement vessels and the ship traffic around them. For operation of the rock bags installation an exclusion zone of 500 metres radius around the vessel Stril Explorer performing the work was requested. No exclusion zone was required around the vessel Rockpiper installing a rock berm.

Germany

Monitoring of ship traffic in Germany was performed during pipelay and focused on minimising disturbance to seabirds and seals. Vessel monitoring in Germany aimed at daily control of movements of vessels of the pipelay fleet. To minimise displacement effects towards staging seabirds, vessels were advised to follow three rules: (1) supply vessels shall cruise through the dedicated traffic separation scheme north of the pipeline route; (2) supply vessels shall stay beside the laybarge within a radius of 1.25nm; (3) the guard vessel shall keep drifting to a minimum. The vessel monitoring results (AIS data) were used to verify the displacement effect for marine mammals and seabirds.

RESULTS

Denmark

Activity 1:

With regard to monitoring objective 1 (notification of authorities and daily progress reports), communication between Nord Stream 2 AG and the maritime authorities took place as required. Namely, Nord Stream 2 AG issued a 48-hour notification prior to the start of the operations, along with daily notifications about the progression of the work over the previous 24 hours, the planned work for the next 24 hours, and the expected work over the following 24 to 48 hours.

Where relevant, the Danish Maritime Authority (DMA) was able to track the progress of construction and to inform approaching vessels via Notices to Mariners about the project, its activities and status.

Activity 2:

For monitoring objective 2 (behaviour of the work vessel fleet), a comparison of the work vessels' activity logs with their observed routes, as recorded by AIS data, showed coherence between the two.

Activity 3:

The results of monitoring objective 3 (third-party vessel behaviour) showed that in general, the intensity of third-party ship traffic was low, and the safety exclusion zones around the pipelay vessels were respected.

For operations to do with the rock bag installation, an exclusion zone of 500 metres radius around the vessel Stril Explorer was requested. This was granted by the DMA. No exclusion zone was required around the vessel Rockpiper while installing a rock berm. There were no observed violations of the safety exclusion zones by the 3rd party vessels (see Figure 23). Nord Stream 2 AG did not receive any

incident reports from the construction contractor on any observed incident, indicating that the situations were not experienced as threats to maritime traffic or health and safety. As such, it can be concluded the construction works in Danish waters allowed free passage to third-party vessels.

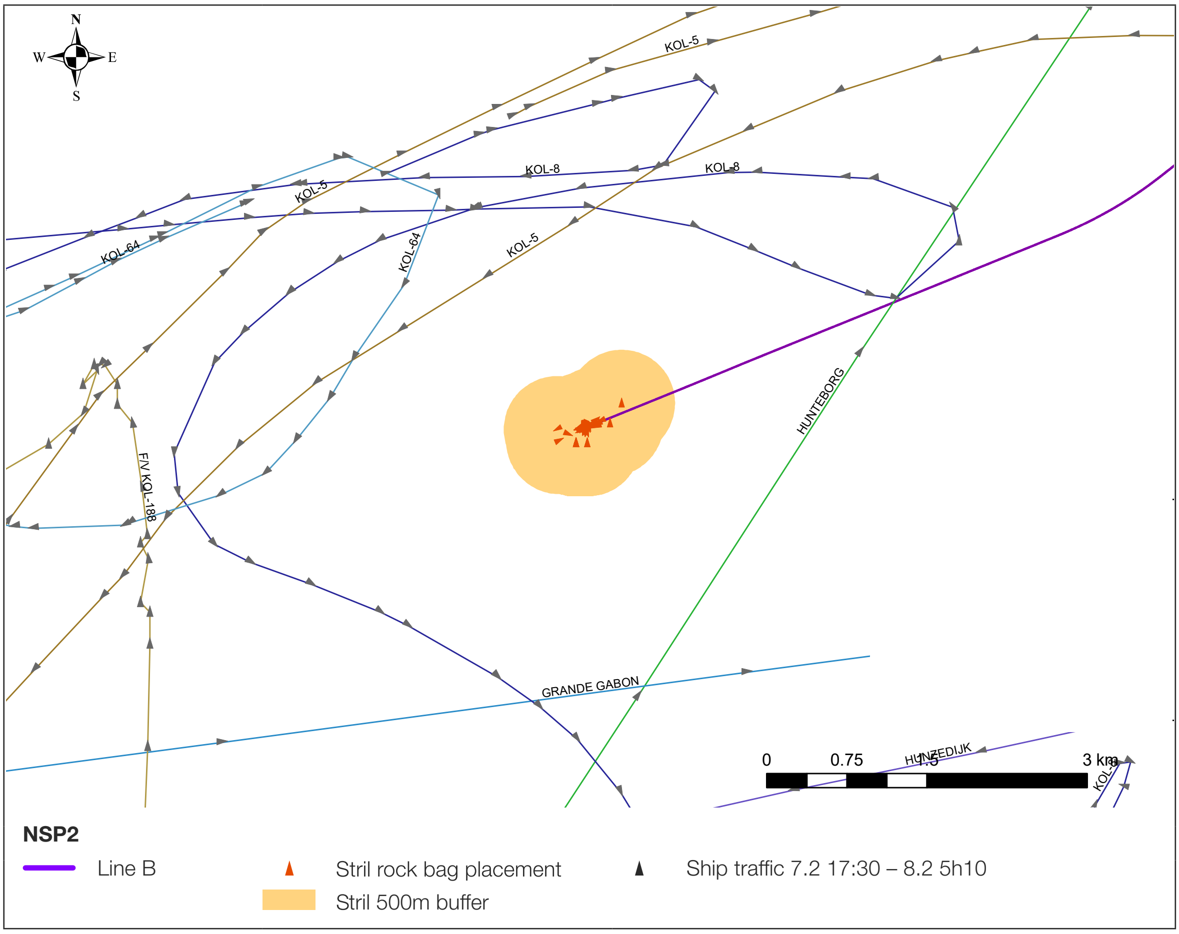

Figure 23. *Track plots of the third-party vessel movements in the vicinity of Stril Explorer on 7 to 8 February 2020.*

In summary, vessels engaged in construction-associated activities and passing third-party vessels are concluded to have operated as anticipated and in a safe manner.

Germany

Under consideration of an average displacement distance of 1.5km for sensitive seabird species (divers, common scoters), a rather small daily displacement area of 50–60km² was achieved in practice. Based on the results of a seabird survey conducted prior to the start of construction in early December 2020, it can be concluded that only very few wintering seabirds were displaced during the construction period of two weeks. Due to water depths of more than 20m, the pipeline route section KP 16.5–13.9 does not belong to the high-density seabird staging area in the Pomeranian Bay. Track logs of construction vessels and third-party vessels are shown in Figure 24.

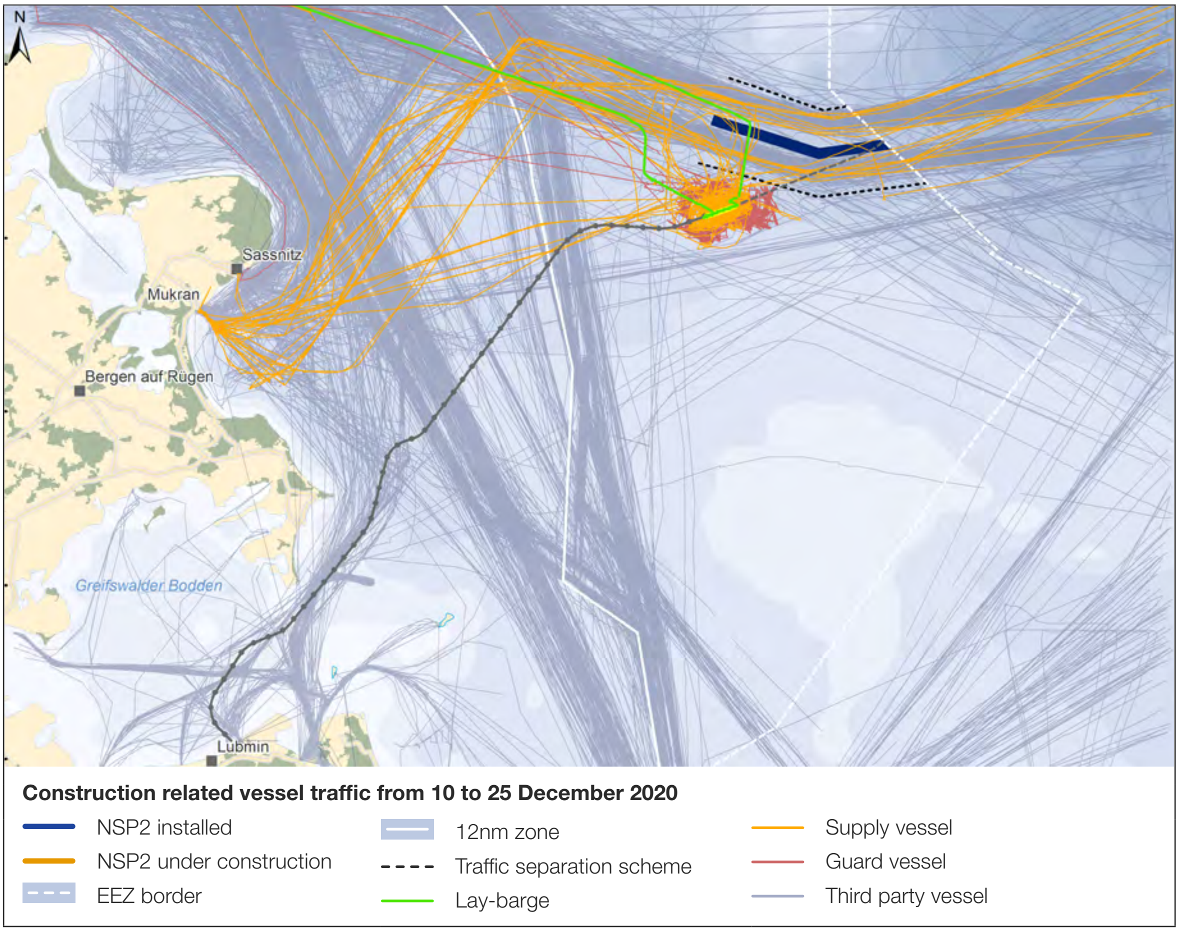

Figure 24. *Construction-related vessel traffic in Germany from 10 to 25 December 2020.*

CONCLUSIONS

Dedicated monitoring in Denmark showed good coherence between notification information and actual work performed. The construction vessels followed the communication and reporting procedures that had been agreed upon with the shipping authorities. Both the vessels engaged in construction activities and passing third-party vessels operated as anticipated and in a safe manner. There were no accidents or incidents involving maritime traffic, including fishing vessels. Impact on maritime traffic is thus confirmed as being minor, localised and of a short-term nature, in line with the Danish EIA. Additionally, other countries' compliance with navigation rules resulted in no accidents affecting ship traffic. Navigation performance of the pipelay fleet in Germany, aimed at minimising the spatial extension of disturbance effects towards staging seabirds, met the requirements. The daily displacement area was kept to a minimum of approx. 5km² only. As a result, temporary reduction of staging habitat was minor.

5.2.3 Cultural heritage

According to the countries' monitoring programmes, the survey of known cultural heritage objects was required prior to and after the construction activities in Sweden and Finland. In Denmark, the monitoring programme focuses on the identification and management of chance finds during construction and operation of the NSP2 pipelines. Additionally, a cultural heritage chance-find procedure was in place in all countries where pipelay took place, namely Russia, Finland, Sweden and, as already mentioned, Denmark. During pipelay, no unknown cultural heritage objects were found.

In Finland, monitoring of cultural heritage prior to the construction activities took place in 2018 and is therefore not covered in this report; a cultural heritage post-construction survey is planned for after the completion of construction in late 2021.

In Sweden, monitoring of cultural heritage objects was concluded in 2019. The pre- and post-construction monitoring results showed that construction activities did not impact the five identified objects. A very minor disturbance to one of the five monitored wrecks was assessed by the authority experts, but found to be due to natural factors such as currents, or fishing activities /18/.

The purpose of the cultural heritage monitoring programme in the Danish EEZ is to verify that construction of NSP2 has not damaged cultural heritage objects (CHO) near the pipeline or made them inaccessible for archaeological investigations. The results of baseline surveys undertaken in the pipelay and intervention works corridor in 2018–2019 were analysed by the relevant Danish authorities. The Danish Agency for Culture and Palaces concluded that none of the identified objects require dedicated monitoring before, during or after construction. On this basis, the monitoring programme focuses solely on the identification and management of chance finds during construction and operation of the NSP2 pipelines.

METHODOLOGY

Denmark

If new findings are identified as chance finds, they will be reported to the relevant Danish authorities to define monitoring requirements. The need for further inspections, establishment of exclusion zones and monitoring, including geophysical investigations and visual inspections, will be agreed in consultation with the Danish Agency for Culture and Palaces. Therefore, the potential extent of the monitoring area along the NSP2 route depends on the locations of any confirmed CHO that require monitoring (following identification as chance finds).

RESULTS

No CHO chance finds were identified during construction in Danish waters in 2020.

CONCLUSIONS

In Denmark, no cultural heritage object was found during the construction activities.

5.2.4 Munitions objects

Part of the route in the Danish waters goes through the area where works on the seabed are discouraged due to the risk of encountering chemical munitions. The purpose of the monitoring programme for munitions in Danish waters is to document that identified munitions objects are not disturbed during the construction or operation of NSP2.

The NSP2 routing was adapted to safely accommodate all munitions found during the baseline munitions surveys along the NSP2 pipelay corridor and intervention works footprint. All munitions finds were discussed with the Danish authorities and it was concluded that no dedicated monitoring is required for any of the finds. Therefore, the focus of the monitoring programme is on objects identified as chance finds during construction and operation.

METHODOLOGY

Visual and sonar munitions surveys are planned to be carried out by ROV for both Line A and Line B before pipelay (pre-lay survey), after pipelay (as-laid survey), and during operation. Any major anomalies such as munitions findings observed during the surveys will be reported immediately. Dedicated monitoring of any munitions found along the route must be discussed and agreed upon with the Danish authorities/Royal Danish Navy, as necessary.

Figure 25 shows an illustration of an ROV inspecting a munitions object, and an example of a monitored munition object found during baseline surveys.

Figure 25. *Left: Deployment of an ROV for inspection of a munition objects. Right: Example of munition object, showing a chemical mustard gas bomb with heavily corroded casing (re-routed around during the design phase).*

RESULTS AND CONCLUSIONS

In Denmark, most of the munitions close to the pipeline route were determined to be remains of KC-250 chemical weapons and had been classified by the relevant Danish experts as non-explosive. For some munitions safety exclusion zones were established. In some cases, local re-routing or lay avoid procedures were implemented to avoid munitions and respect the established exclusion zones. A smaller exclusion zone was established for one munitions object (R-DKSD7S-0408), in agreement with the Danish authorities, as a rock berm is planned to be constructed on the pipeline at this location.

No chance munitions finds were encountered during construction in 2020. No munitions objects were disturbed during construction activities in 2020, and all exclusion zones were respected.

6 Post-construction monitoring

As part of the permit requirements for construction of the NSP2 pipelines, an environmental monitoring programme covering the post-construction period was created in consultation with the national authorities in five countries.

Environmental monitoring after construction was developed with the following objectives:

- To verify the environmental impacts described and evaluated in the EIA reports;
- To monitor that the construction activities do not cause greater impacts than predicted in the EIA reports;
- To monitor that no significant environmental impacts occur during operation;
- To provide the basis for corrective action where necessary.

Table 9 presents an overview of parameters monitored in 2020 according to the national monitoring programmes. No post-construction monitoring in 2020 was planned in Finland and Sweden.

Table 9. *Post-construction monitoring in 2020.*

	Bathymetry	Water quality	Sediment quality	Plankton	Benthos	Marine mammals	Birds
Russia		×	×	×	×	×	×
Denmark			×*				
Germany	×		×		×	×	×

* Monitoring of CWA in seabed sediments.

Chapters 6.1–6.3 provide details on post-construction environmental monitoring that took place in 2020 in Russia, Denmark and Germany.

6.1 Post-construction monitoring in Russia

Monitoring along the route in the Russian waters in 2020 took place when offshore construction activities were completed. Environmental monitoring covered biotic and abiotic parameters as required by the national monitoring programme /19/, /20/.

Post-construction surveys in Russia in 2020 included monitoring of water quality, seabed sediments, benthos, plankton, marine mammals and birds. An overview of monitoring parameters and their locations are shown in Table 9 and in Figure 26.

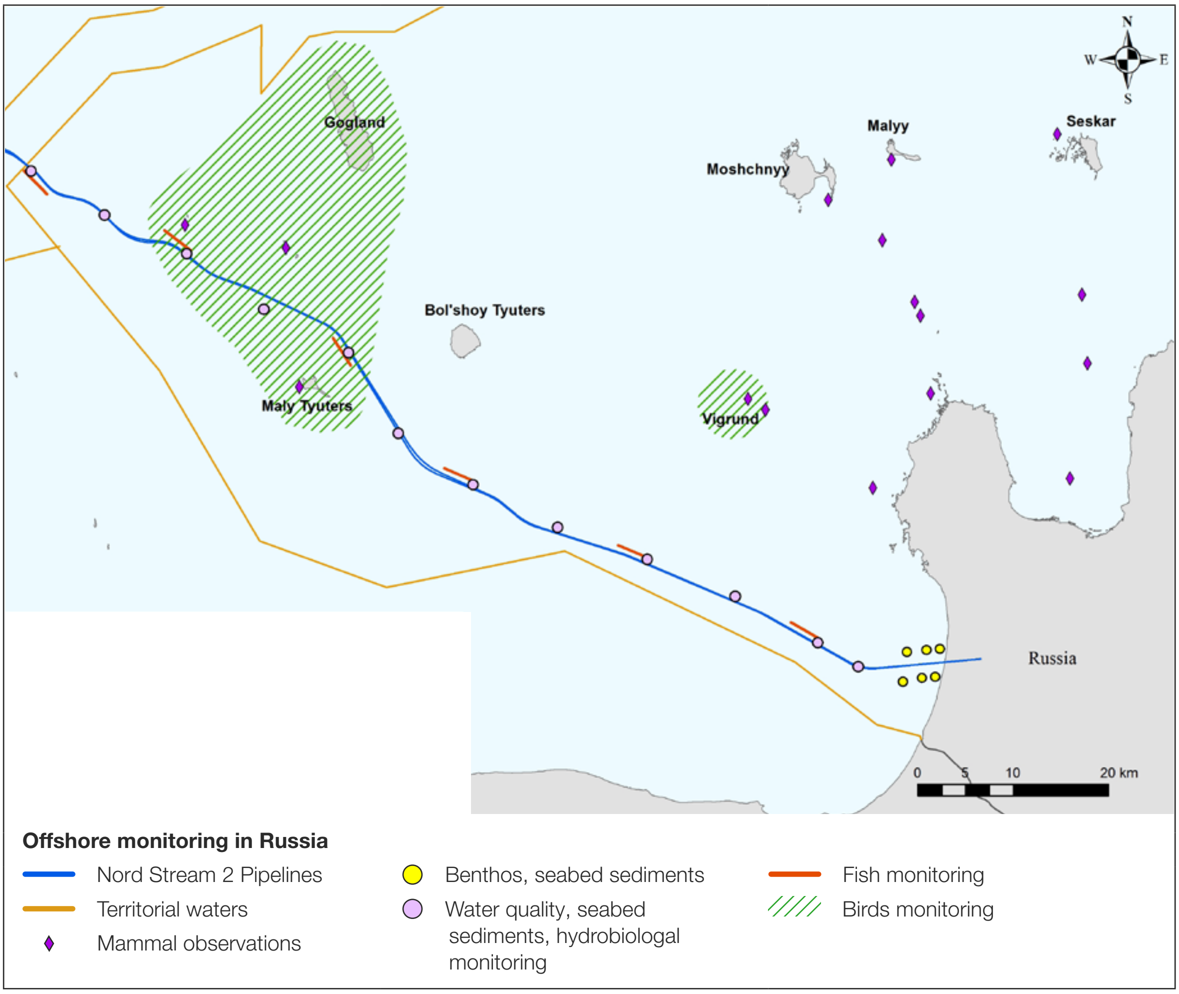

Figure 26. *Post-construction monitoring locations in 2020 in Russia.*

Post-construction monitoring undertaken in Russian waters showed that there was no significant impact on the environment. Quality of seawater and seabed sediments was comparable with the pre-construction survey results and reflected a seasonal pattern in the Russian waters of the Gulf of Finland (see Chapter 6.1.1 and Chapter 6.1.2). Analysis of plankton in 2020 showed typical species composition, no invasive species were found (see Chapter 6.1.3). Abundance and biomass of benthic communities recorded in May 2020 were within the limits of long-term variability observed in the area (see Chapter 6.1.4). Structural and functional characteristics of fish communities were stable and no impact on ichthyofauna was observed (see Chapter 6.1.5). Monitoring of marine mammals (see Chapter 6.1.6) and seabirds (see Chapter 6.1.7) showed that there were no impacts on their abundance and distribution due to construction. According to the results of spring aerial surveys, the population size of Baltic ringed seals remains at a low but a stable level with an upward trend.

6.1.1 Water quality

Seawater quality monitoring was performed in Q2 2020 in accordance with the approved environmental monitoring programme during construction /21/ .

Main construction works in the offshore section were completed in November 2019. Rock placement at the selected locations took place in January and February 2020. After that, all construction activities were finalised.

This chapter includes the results of seawater environmental monitoring performed in Q2 2020 (23 to 25 May) after the completion of construction works, with the purpose of assessing the condition of the marine environment and the potential impact of the Nord Stream 2 Pipeline construction on the marine ecosystem of the Gulf of Finland in Russian waters.

METHODOLOGY

Water sampling for hydrochemical studies was performed at 12 stations along the pipeline route (about 8km in-between) using a 10-litre bathometer from three layers (surface, medium and bottom), see Figure 26 and Figure 27. In total 36 samples were taken, while 25 parameters were analysed: electrical conductivity, temperature, pH, dissolved oxygen, BOD5, suspended sediments, total nitrogen, ammonium nitrogen, nitrate nitrogen, nitrite nitrogen, Cd, Co, Cr, Cu, Ni, Mn, Pb, Zn, Fe, Hg, As, oil products, benzapyren, phenols, surfactants.

A vessel-based laboratory was used for the first day analysis and for samples conservation for subsequent delivery to an accredited laboratory onshore.

Figure 27. *Water sampling using a bathometer.*

RESULTS

Generally, the Russian section of the Gulf of Finland is characterised by a reduced salinity due to the high freshwater inflow from the rivers. Salinity in the water column varied between 3.5psu and 9.5psu (see Figure 28). Comparing the results with the baseline values, a further decrease in both average and maximum salinity values was noted, probably caused by the large amount of precipitation in April–May in the European part of Russia, which increases the amount of fresh water flowing into the sea. Temperature in the water column varied between 2ºC and 10ºC (see Figure 29).

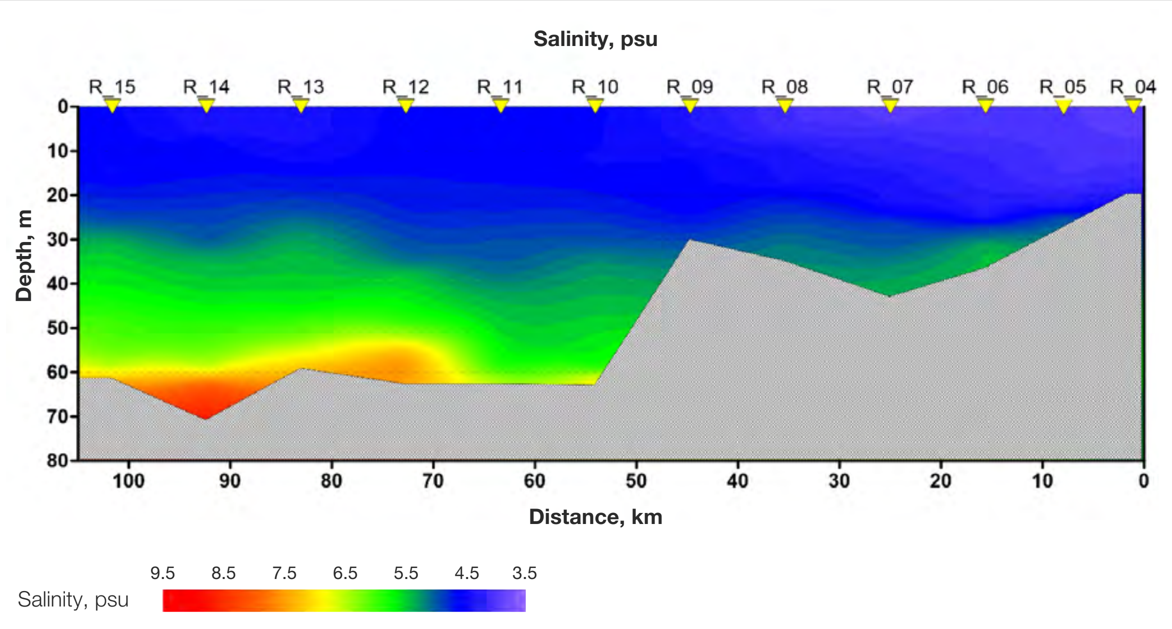

Figure 28. Distribution of water salinity (‰) — a sectional view along the monitoring stations in the offshore section (23 to 25 May 2020).

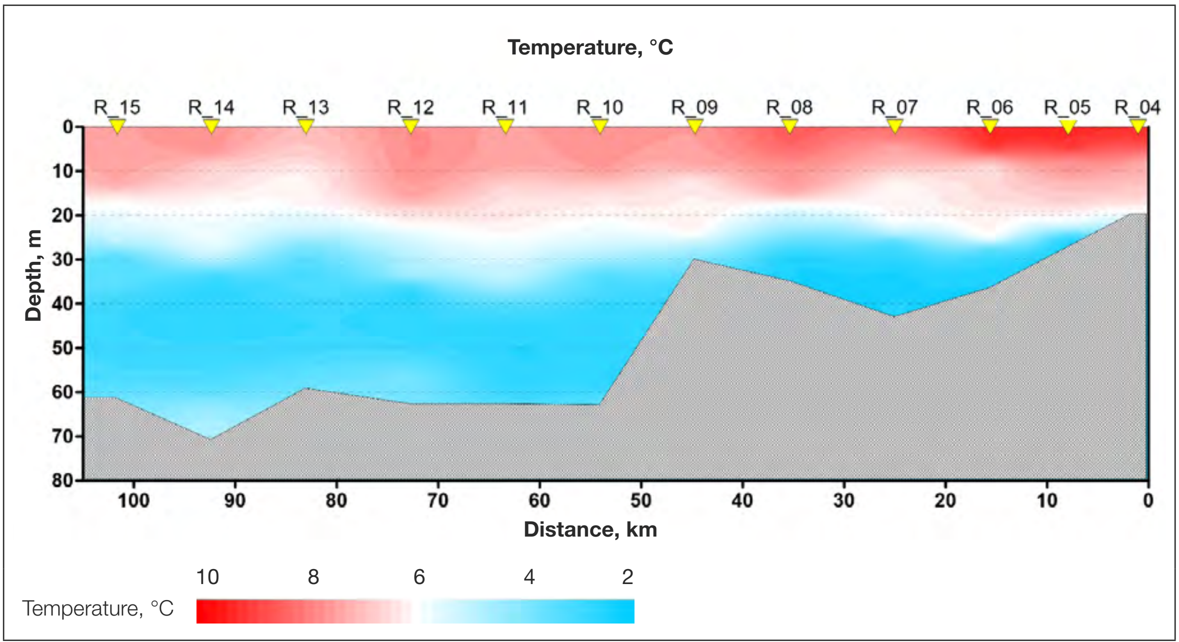

Figure 29. Distribution of water temperature (°C) — a sectional view along the monitoring stations in the offshore section (23 to 25 May 2020).

The content of **suspended solids** didn't exceed the standard of 10mg/l, and generally decreased compared to the pre-construction monitoring in April 2019.

Dissolved oxygen content in May 2020 varied within a wide range: from its maximum concentrations in surface waters – up to 10mg/l, decreasing in the intermediate horizon to 8.9mg/l, and to minimum values in the bottom horizon (min value 3.9mg/l). Vertical distribution of dissolved oxygen is characterised by a general decrease from the surface, where oxygen enters the water as a result of photosynthesis and exchange with the atmosphere, to the bottom, where oxygen is consumed for respiration and degradation. For water bodies of commercial fishery significance oxygen concentration must not be less than 6mg/l. This condition was fulfilled for all analysed samples in the surface and intermediate horizons. In the near-bottom layer at four offshore monitoring stations (NN 06, 10, 12 and 14) dissolved oxygen content was below the standard, however pre-construction monitoring results showed a deficit of dissolved oxygen in the bottom layers at the deep-water monitoring stations.

BOD5 limit (2.1mgO_2/l) was slightly exceeded in two surface water samples at the station 07 (1.05MAC) and 08 (1.2MAC).

All samples were characterised by low concentrations of **ammonium** and **nitrite nitrogen**. The ammonium content varied from <0.01 to 0.043mg/l and did not exceed the standard of 2.9mg/l.

In May 2020, the content of **oil products**, **benz(a)pyrene**, and many heavy metals such as **cadmium**, **cobalt**, **nickel** and **mercury** in all analysed seawater samples was below the detection limit of the established methods.

The content of **iron** measured during this survey varied in a narrow range below the approved maximum allowed concentrations and demonstrated a significant decrease in both the maximum and the average concentrations compared to the April 2019 pre-construction survey results.

Copper content in the samples was also very low – only 4 out of 36 water samples levels above the detection limit, while still being well below the established commercial fishery standard.

Manganese content varied in a wide range from trace values to a single exceedance of 1.06MAC in the near-bottom horizon at the station N5. This exceedance is insignificant and within the margin of error of the measurement technique.

The **arsenic** content in most of the study area was at trace values. At just 2 offshore monitoring stations (NN 14, 15) the arsenic concentration increased and was above the detection limit, while remaining below the established fishery standard.

Zinc, **lead**, and **chromium** concentrations in almost all samples were below the detection limit and in all samples below the established fishery standard.

The content of **phenols** in the analysed water samples was also trace amounts, and the **surfactants**` content in all analysed samples didn't exceed the fishery standard.

CONCLUSIONS

The seawater quality is comparable with the pre-construction survey results and reflects the seasonal pattern in the Russian section of the Gulf of Finland. The water quality along the pipeline route is within the approved standards. Compared to the baseline survey, a slight increase in manganese and chromium concentrations in the water of the study area was detected. Concentrations of oil products and other heavy metals either remained at the background level or decreased.

6.1.2 Marine sediment quality

METHODOLOGY

Bottom sediment sampling was performed at 12 stations along the pipeline route (same as water quality monitoring) using a Van Veen grab with a grab area of 0,025sq.m or 0,1sq.m (see Figure 30).

Samples were stored in a frozen condition in a shipboard freezer before transportation to a land-based accredited laboratory.

In total 25 parameters were analysed: temperature, odour, consistency, type of sediment, inclusions, water extract pH, salt extract pH, particle size composition, organic matter, mass fraction of ash, oil products, benz(a)pyrene, phenols, surfactants, Pb, Zn, Cu, Fe, Cr, Ni, Co, Mn, Cd, Hg, As.

Figure 30. *Bottom sediments sampling using Van Veen grab.*

RESULTS

Particle size distribution analysis showed the prevalence of clayey and loamy silts almost at all stations except the locations NN 4, 8, 13 where bottom sediments are represented by sands of various grain size (similar to the baseline survey results). **Water extract pH** varied from 7.5 to 7.8, i.e. was slightly alkaline.

In general, concentrations of **heavy metals** are consistent with the previous study results (2015, 2016, 2019) and comparable to the data on the regional geochemical background of these elements presented in the “Atlas of geological and ecological-geological maps of the Russian sector of the Baltic Sea”/22/.

For example, **zinc** concentrations varied from 11.79 to 116mg/kg (average 57.91mg/kg). These values are close to the average values recorded during the surveys performed in 2015 (71.5mg/kg), 2016 (66mg/kg), 2019 (59.25mg/kg).

The content of **oil products** in bottom sediments was relatively small and varied from trace (5.0mg/kg) to 61mg/kg, averaging at 27.46mg/kg. In 2016, average content of oil products in bottom sediments was below 35mg/kg, and in 2019 in most samples it was below the method’s detection limit (5.0mg/kg).

The content of **volatile phenols** varied from 0.08–1.96mg/kg (average 0.68mg/kg) which is comparable to the results of the baseline surveys (0.42mg/kg). **Surfactants** measured from 9.20 to 14.80mg/kg (average 12.34mg/kg).

The content of **benz(a)pyrene** was mainly below the method’s detection limit (0.005mg/kg) except for the station N5, where the concentration was measured 0.02mg/kg. During the baseline survey (2015/2016), benz(a)pyrene concentrations were up to 0.048mg/kg and 0.072mg/kg at 2 stations. Monitoring results from 2019 also showed slightly elevated concentrations, i.e. up to 0.049mg/kg, which is higher than 2020 results.

Currently there are no federal norms established for the bottom sediments quality assessment, therefore different regional and industry standards were used. The most applicable standard is “Norms and criteria for seabed sediments` contamination assessment in the water objects of Saint Petersburg” /23/. This document describes norms and criteria for assessment of bottom sediments quality for the dredging and possible further use (land reclamation, discharge to water bodies, storage etc). The documents correspond with the Finnish Guidelines for dredging and deposition of dredged materials, approved by the Ministry of the Environment Finland in 2015. For the assessment using this standard, the absolute concentrations are converted to standardised values depending on the organic matter content.

The assessment of 2020 monitoring results showed that the majority of samples were attributed to class 0 “clean”. In the context of the used standard, it means that no restrictions are imposed on the continued use of these sediments. Bottom sediments at stations NN10 and 15 (deep-water stations) are classified as class I “slightly polluted”. Bottom sediments of this class can be used for land reclamation and are allowed to be discharged into water bodies.

At the station N5 the bottom sediments are classified as class II “contaminated” due to a significant content of nickel. It is noted that similar nickel concentrations were also detected at the nearby stations during baseline survey 2015/2016. However, in 2015/2016 these stations were classified as “clean” with regards to nickel concentrations because standardised values were low due to high content of organic matter in the sediment samples. It can be concluded that the concentrations obtained in 2020 are of natural origin as the absolute concentrations are comparable, and the difference in particle size distribution is related to the mosaic nature of the soils in the sampled area.

CONCLUSIONS

In general, the results of bottom sediment monitoring are consistent and comparable with the results of baseline survey (2015/2016) and pre-construction survey (2019) as well with the data on the regional geochemical background of these elements presented in the Atlas of Geological and Ecological-Geological Maps of the Russian Sector of the Baltic Sea.

6.1.3 Plankton

METHODOLOGY

Monitoring took place together with monitoring of water quality at 12 stations along the pipeline route (see Figure 26).

Bacterioplankton samples were taken using a Niskin water sampler from the surface and bottom layer. Phytoplankton was sampled every metre, poured in equal quantities into the same container, and a 1.0 litre sample was extracted after stirring. Zooplankton was sampled by the total catch method (from bottom to surface) with a Juday plankton net with a fixed mesh size. Conserved samples were transported to a laboratory for processing (see Figure 31).

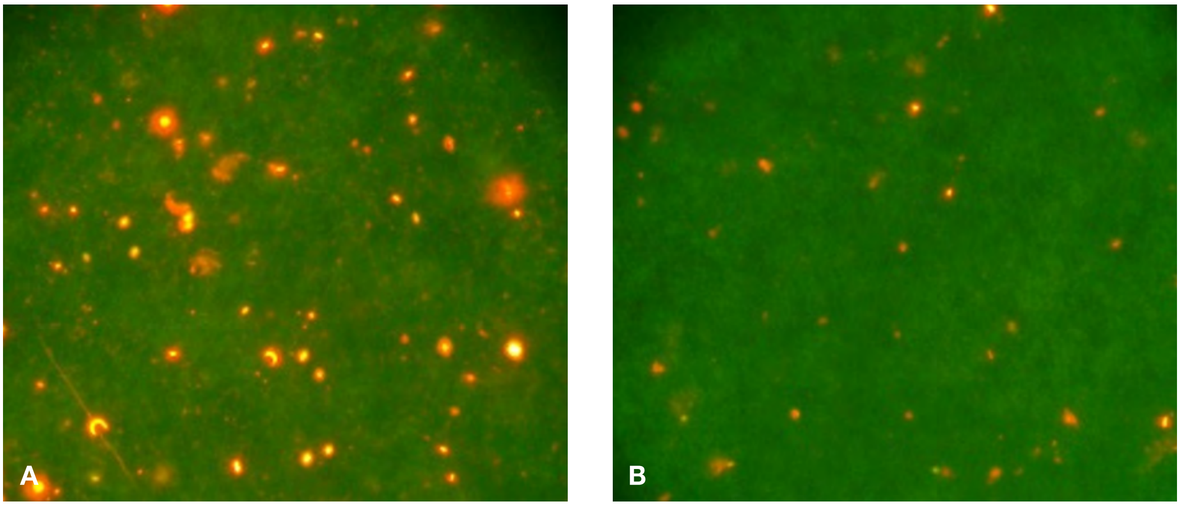

Figure 31. *Bacterioplankton from water sample taken from the surface and bottom layers at RUS_MON_IPM_15 stained with acridine orange (magnification × 1,000): A = surface layer; B = bottom layer.*

RESULTS

Bacterioplankton

Microbiological parameters are strongly dependent on the distance from the shore due to exposure to the river runoff as well as the water depth. Total bacterial number (TBN) and their biomass are usually higher at the shallow water stations. Monitoring results showed that TBN values were fairly high for the studied area, and there was no obvious regularity in the distribution of the number of bacteria and biomass.

Relatively high average numbers of bacteria (2.049mln cells/ml) and the highest biomass values (149.81mgC/m^3) were recorded at the nearshore stations NN 04–09. These values are close to those obtained from studies performed in June 2018 also at the nearshore section.

The higher values of bacterioplankton abundance and biomass measured at the offshore stations NN 10–14 (2.621mln cells/ml and 79.49mgC/m^3) could be related to the intensive ship traffic and late spring hydrobiological season (sampling in May after phytoplankton blooms).

Comparison of the results from 2020 monitoring campaign with the earlier data shows that the measured TBN values and bacterial biomass were comparable with the previously obtained data for the Baltic Sea and with the data from the pre-construction monitoring cycle of June 2018. Lower average TBN and bacterial biomass values in April 2019 were caused by earlier season of sampling and colder water.

Phytoplankton

Phytoplankton in the studied area is formed by algae of 8 divisions: bluegreen, diatom, dinophyte, euglena, haptophyte, cryptophyte, green and zoomastigophora group, see Table 10. In total 65 algal species were recorded, including 24 diatoms, 14 greens, 14 dinophytes, 6 bluegreens, 4 euglena and 1 each of cryptophytes, haptophytes and zoomastigophora. The number of species at the stations ranged from 23 (offshore station N 14) to 35 (station N 5 which is closer to the shore).

Table 10. *Primary phytoplankton dominants (≥ 10 % of the total) in the Russian waters of the Gulf of Finland in May 2020.*

Study area	Abundance	Biomass
Russian waters of the Gulf of Finland (offshore section)	*Aphanizomenon sp., Woronichinia compacta Diatoma elongatum, Chaetoceros diadema, Chaetoceros debilis, Chaetoceros socialis, Monoraphidium contortum*	*Aphanizomenon sp., Diatoma elongatum, Peridiniella catenata, Ebria tripartita, Protoperidinium brevipes, Thalassiosira baltica, Thalasiossira bramaputrae, Dinophysis acuta, Thalassiosira baltica, Coscinodiscus granii*

Zooplankton

Zooplankton in the studied area is represented by 20 taxa. The highest number of species was recorded for the small crustaceans (Copepoda). The number of taxa at different stations ranged from 10 to 17 with the highest number of species found at stations NN 4 and 14. Compared to the 2019 data, both the total number of taxa and the number of taxa at each individual station increased, which is determined by seasonal changes in zooplankton for the study area.

The composition of the dominant species genus was characteristic of the study area in late spring. The genus *Acartia spp.*, *Eurytemora affinis*, *Evadne nordmanni* and *Synchaeta baltica* reached a mass development at all stations. At stations between KP 10.0 to KP 50.0 (NN 4 to 8), the proportion of young *Cyclopoida* and *Eubosmina maritima* was high, and at stations between KP 60.0 to KP 113.5 (NN 9 to 15), *Limnocalanus grimaldii* and *polychaetes* were high. Compared with the data obtained in April 2019, the proportion of *Copepoda, Pseudocalanus elongates, Temora longicornis* and *Fritillaria borealis* decreased but at the same time there was a significant increase in the proportion of *Eurytemora affinis, Evadne nordmanni* and *Synchaeta baltica* due to their seasonal development.

Abundance and biomass of the dominant zooplankton species is shown in Figure 32 and Figure 33.

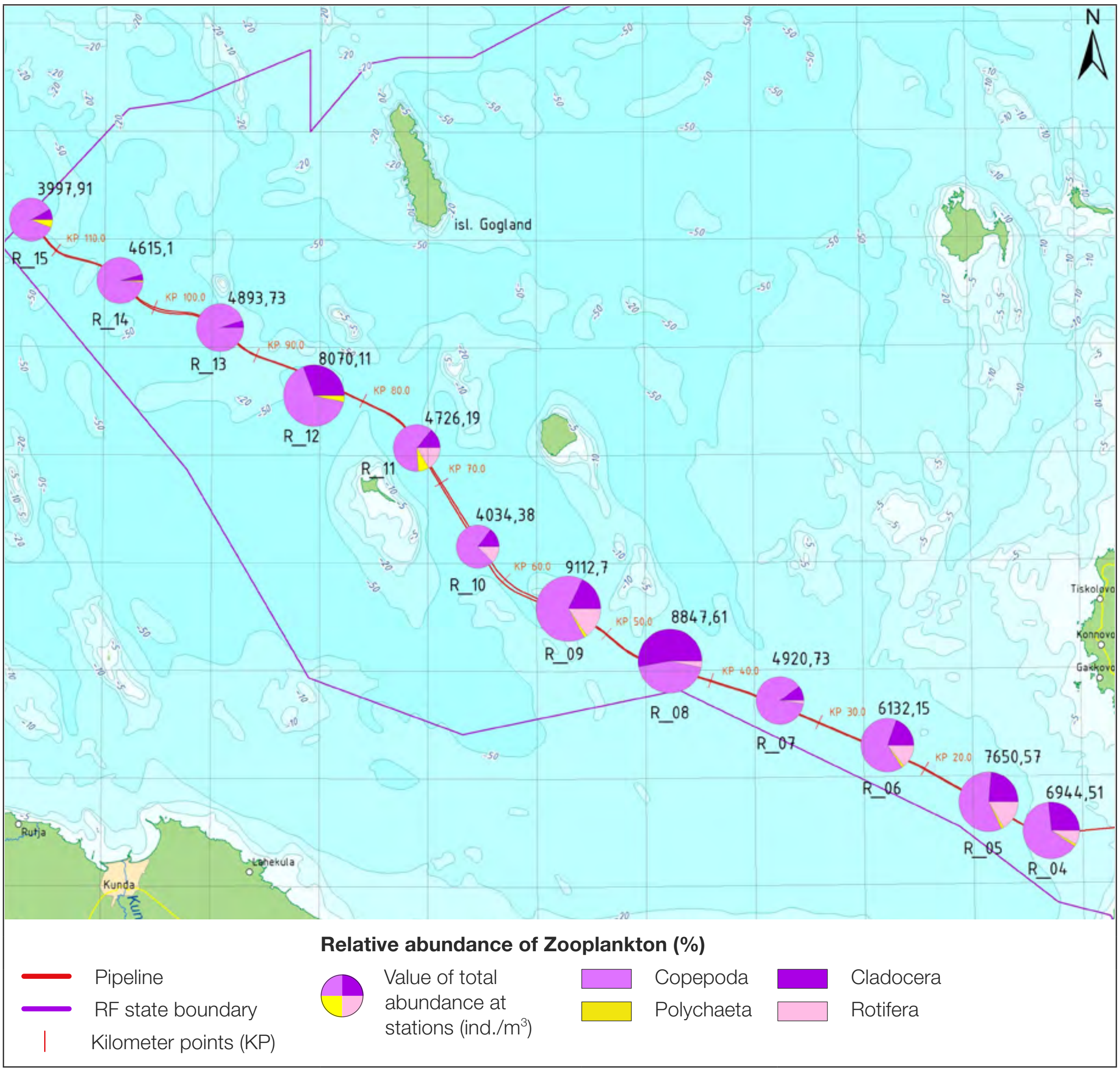

Figure 32. *Zooplankton number (ind./m^3) within the offshore section in May 2020.*

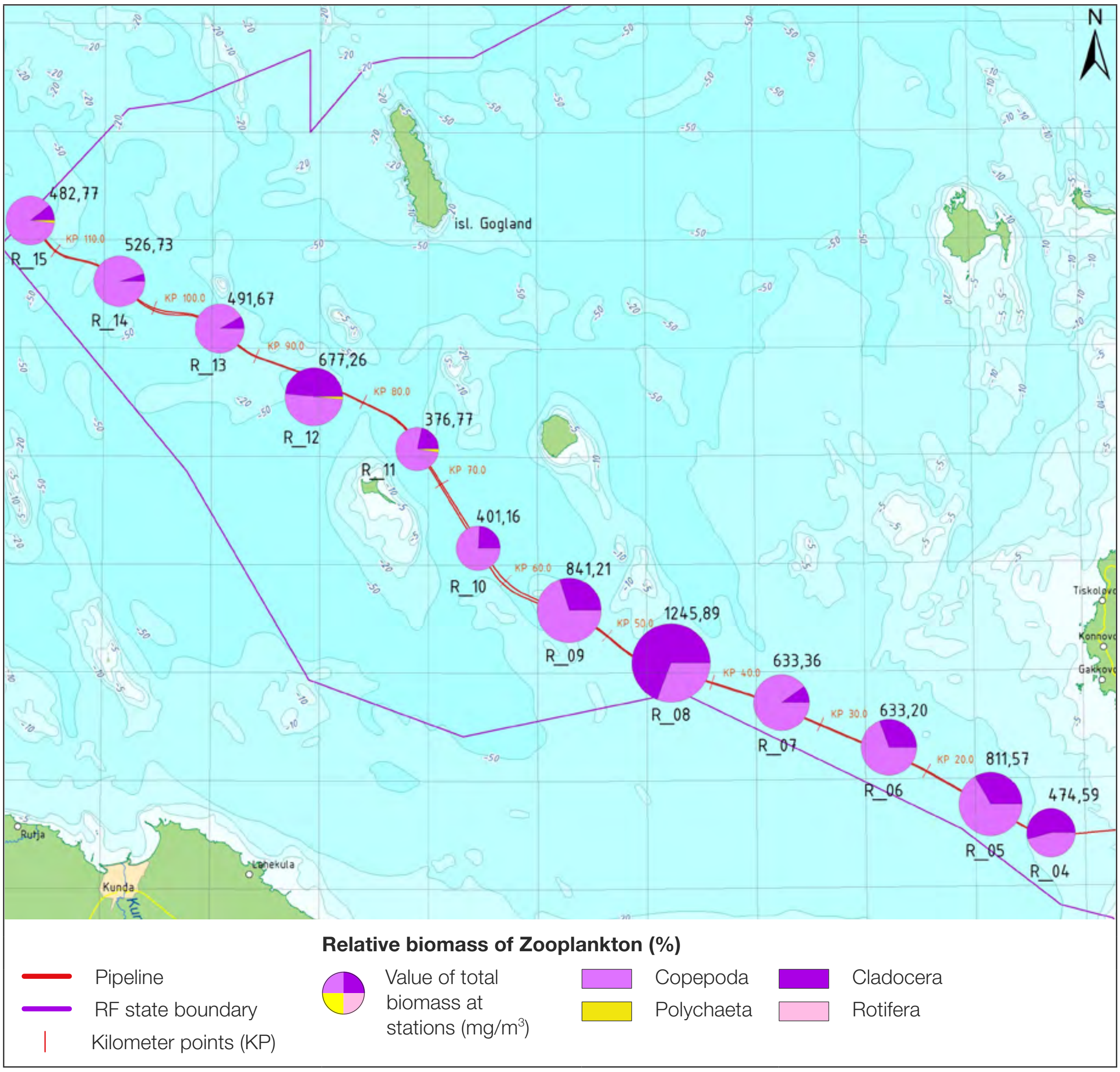

Figure 33. *Zooplankton biomass (mg/m³) within the offshore section in May 2020.*

CONCLUSIONS

Bacterioplankton is represented mostly by coccoidal and rod-shaped cells, the ratio of which varies from season to season and from year to year. According to the 2020 results, cocci were prevalent (60.3%) over rods, while during the April 2019 background monitoring both groups were present in comparable amounts — 52% of cocci and 48% of rods. Since cocci were found to be dominant, it can be presumed that microbial community activity was fairly high, which means a high potential for self-purification of water in the area during that period. At the same time, due to their smaller size, cocci accounted for only 28% of the total biomass of bacterioplankton. No significant predominance of any morphological group was observed both during the background survey 2019 and this final monitoring cycle in 2020.

The species composition of phytoplankton was typical for the spring period in the south-east section of the Gulf of Finland (in Russian TW). The number of species was dominated by freshwater species, along with brackish-water and marine forms: *Skeletonema marinoi*, *Thalassiosira baltica*, *dinophyte Peridiniella catenata*. No introduced species were found in the phytoplankton composition.

The species composition, the ratio of dominant species and groups and the quantitative indicators of zooplankton in May 2020, reflected the condition of the zooplankton community in Russian TW of the Gulf of Finland typical for the late spring period. No introduced species were found in the zooplankton composition.

6.1.4 Benthic communities

METHODOLOGY

Macrozoobenthos was sampled with a Van Veen grab with a sampling area of 0.1m² (three bottom grab samples were taken at each station). Samples were washed on sieve # 23 (mesh size 333µm) and conserved with ethanol. Conserved samples were transported to a laboratory for processing. The samples were studied under an Olympus SZ51 stereo microscope. Once their taxonomic affiliation was determined, the organisms were counted and weighed individually or in groups after drying on a filter paper (Fresh Mass – FM).

RESULTS

In May 2020, macrozoobenthos was characterised by poor diversity of species and included 13 taxons representing eight taxonomic groups: *Oligochaeta* (*Oligochaeta gen. spp.*), *Polychaeta – Marenzelleria arctia* and *Bylgides sarsi*, *Crustacea – Corphium volutator*, *Monoporeia affinis* and *Saduria entomon*, *Jaera aff. albifrons*, *Bivalvia (Limecola balthica)*, *Gastropoda (Potamopyrgus antipodarum)*, *Priapulida (Halicryptus spinulosus)*, *Ostracoda (Candona neglecta, Heterocyprideis sorbyana)* and *Acari (Thalassarachna sp.)*. The number of species identified at 12 survey stations varied from 1 (stations 10 and 11) to 10 (station 8). One invasive species (*Marenzelleria arctia*) was detected during the period of survey /24/.

Quantitative characteristics of zoobenthos were characterised by significant spatial variability (see Figure 34). The main contributors to the zoobenthos population were *Marenzelleria arctia polychaetes* (46.2% of the total population) and amphipods *Monoporeia affinis* (22.9%). *Oligochaetes* (12.3%) and bivalve *molluscs Limecola balthica* (10%) were the subdominant zoobenthos species in terms of number. Other species contributed a total 8.6%.

Zoobenthos biomass distribution was similar to that of its population (see Figure 35). Prevalent in terms of biomass were bivalves, which were represented by only one species, *Limecola balthica*, which constituted 85.6% of the average biomass. *Marenzelleria arctia polychaetes* (6.9%) and *crustaceans* (6.5%), represented mostly by *Saduria entomon*, were subdominant species. At stations between KP 60.0–KP 113.5 (where bivalves were absent) *Marenzelleria arctia polychaetes* were dominating.

A tendency of decreasing zoobenthos abundance with increasing water depth was observed during spring 2020. The highest values of zoobenthos abundance and biomass were recorded at the stations with water depth from 22 to 45 metres (stations from 04 to 09). At the stations with water depth from 66 to 76 metres zoobenthos was virtually absent. A similar spatial distribution of zoobenthos was observed in April 2019. Such spatial distribution of zoobenthos within the area of survey is probably explained by the lower oxygen content in the bottom layer.

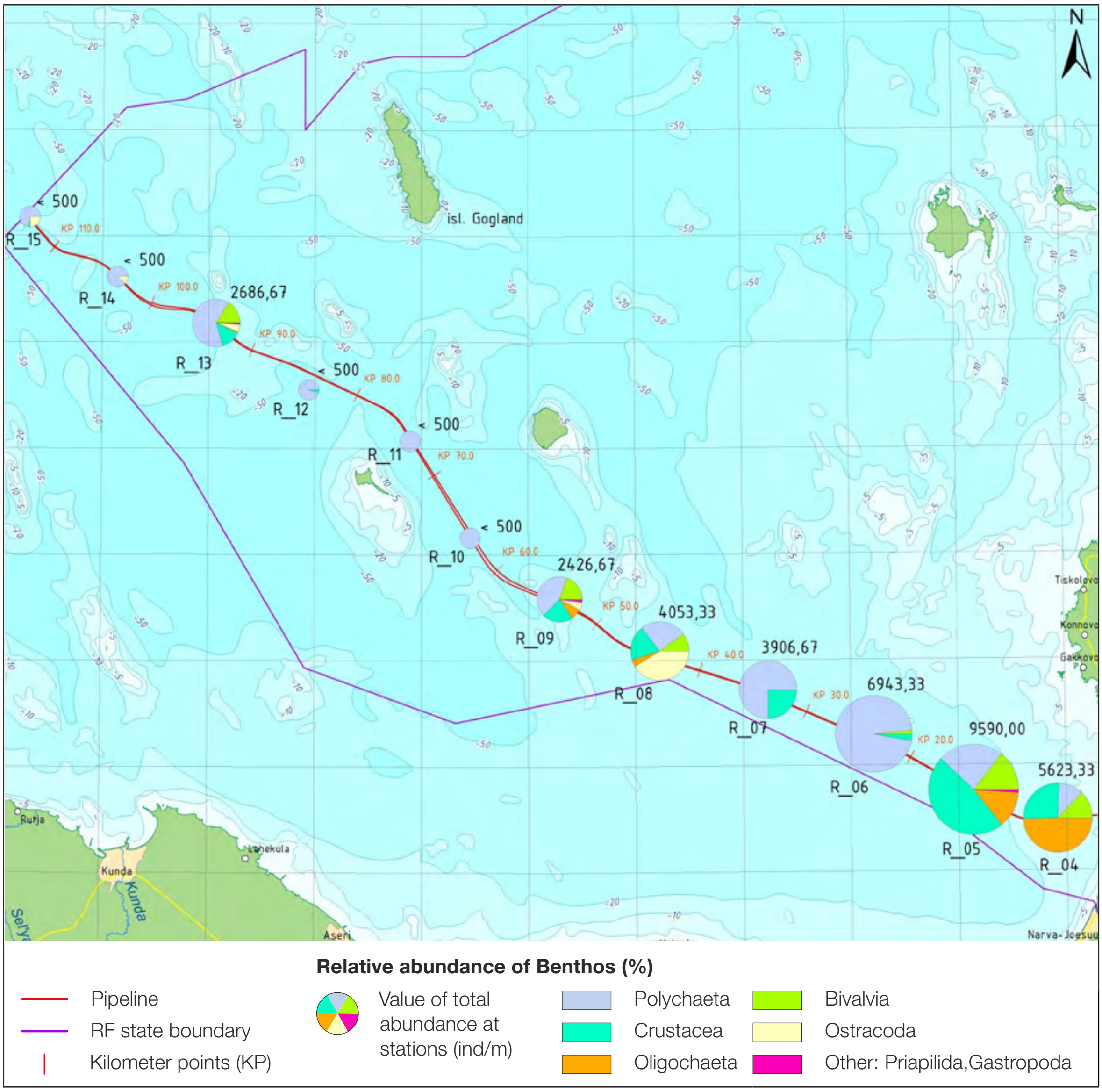

Figure 34. *Zoobenthos abundance (ind./m²) within the offshore section in May 2020.*

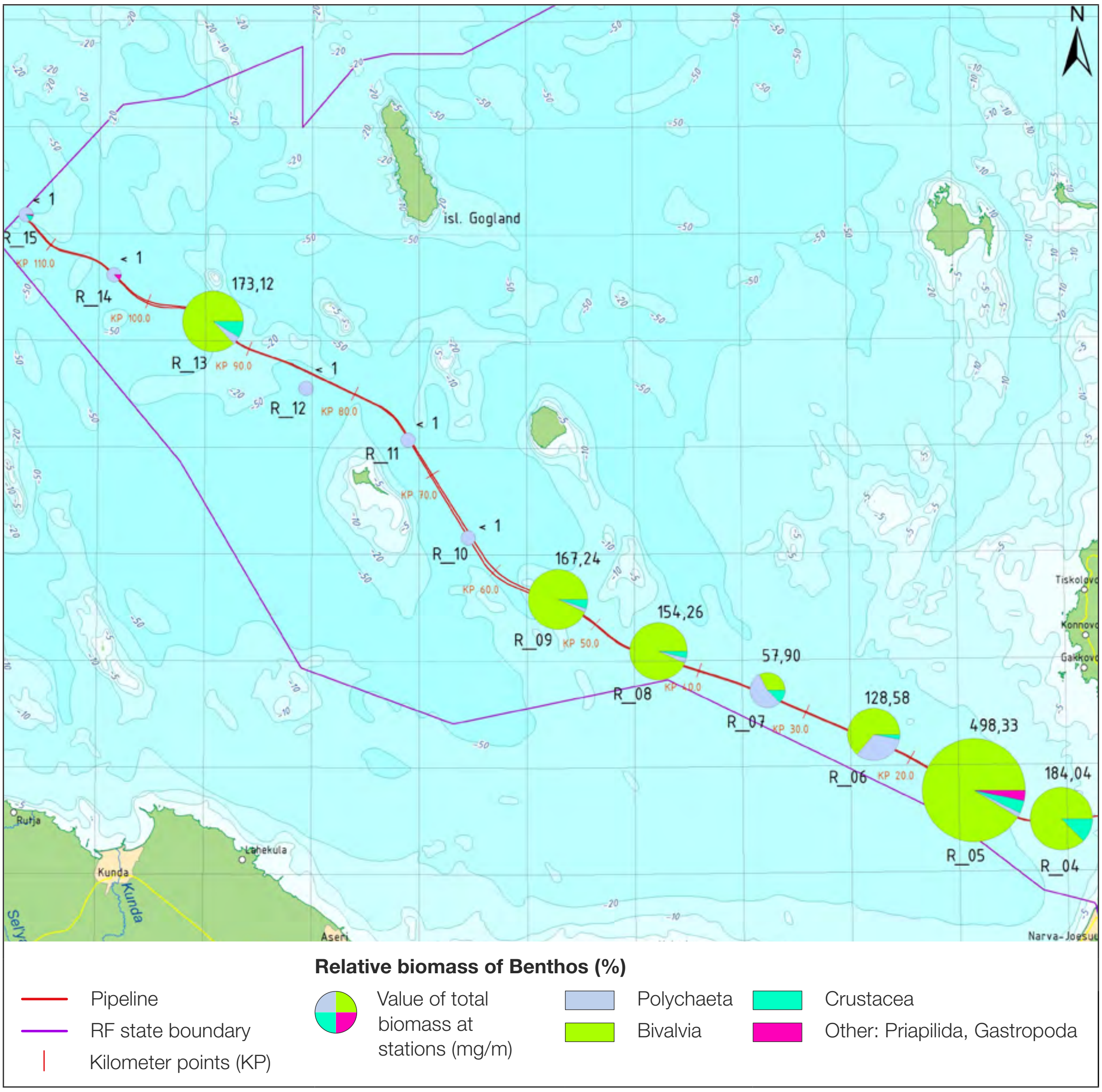

Figure 35. *Zoobenthos biomass, FM (g/m²) within the offshore section in May 2020.*

In the nearshore area impact of backfilling operations was observed at the end of 2019 during seasonal monitoring performed after cofferdam removal. In 2020, samples were taken with increased frequency, also on seasonal basis, to record all tendencies in the recovery of communities.

The 2020 studies revealed a mosaic pattern of distribution of macrozoobenthos quantitative characteristics, which can be explained as being primarily the result of seasonal dynamics of certain short-lived macrozoobenthos groups. Even within the area subject to the strongest impact, both predicted and actual (temporary soil disposal area), a gradual recovery of benthic community representing all major taxonomic groups and dominant species was observed in 2020, including a gradual increase in biomass of bivalves *Limecola (Macoma) balthica* (from 0.06 to 0.29g/m²), the dominant species in the Baltic Sea. Despite the recovery trend, the abundance and biomass of macrozoobenthos within the most affected areas (backfill material storage to the south of pipeline axis with depth about 10 metres and area to the north from line A with depths about 7–10 metres) remained low in 2020 compared to neighbouring locations and the average of the whole water area surveyed. Therefore, the model assessments do not contradict the results of the monitoring of macrozoobenthos communities performed in 2020.

CONCLUSIONS

Macrozoobenthos number and biomass values recorded in May 2020 were within the limits of long-term variability observed in the Russian waters of the Gulf of Finland. Available baseline data showed that benthic biomass decreased in summer 2016 compared to autumn 2015, while higher values of zoobenthos biomass was recorded in April 2019 and May 2020. Dynamic instability of benthic population was detected in the surveyed area, which may cause changes in its state and distribution. On the whole, the species composition, portions of dominant species and groups and quantitative indicators recorded in May 2020 were reflective of the typical state of macrozoobenthos in the eastern part (Russian section) of the Gulf of Finland. The number of species, total abundance and biomass of zoobenthos in May 2020 were higher compared to April 2019 (pre-construction monitoring).

In the nearshore area, most impacted during construction by dredging and later backfilling operations, the trend towards recovery of benthic fauna is clearly seen from 2020 monitoring data. It involves all ecological and trophic groups of benthos and all taxonomic groups found earlier in the 2016 background survey. It must be noted that species diversity, abundance and biomass of benthic community had not fully recovered during the reporting period (compared to the background structural characteristics of the climax community). This is consistent with earlier predictions about the expected timing of full recovery of bottom communities. In general, even after the completion of construction in 2019, a developed benthic fauna was found everywhere at the monitoring stations, with all major macrozoobenthos groups and its key species present. This gives reasons to expect that full recovery of benthic communities in the area may take place in 2021.

6.1.5 Ichthyofauna

METHODOLOGY

Ichthyofauna monitoring within the offshore section was performed in the autumn of 2020 after the completion of all construction operations, in accordance with the approved environmental monitoring programme. Ichthyofauna monitoring within the offshore section was performed at 6 stations (trawling areas, see Figure 26), located along the pipeline route and previously observed in 2016 (winter period) during the environmental survey, required for the design stage during EIA development. Post-construction monitoring in 2020 was done in late September.

RESULTS

Ichthyofauna in the surveyed area was found to be represented (in late September 2020) by river lamprey and 9 fish species belonging to the following 6 families: Clupeidae (herring, sprat), Salmonidae (salmon), Osmeridae (smelt), Gasterosteidae (three-spined stickleback, nine-spined stickleback), Gobiidae (round goby, sand goby) and Zoarcidae (viviparous eelpout) /25/.

Species composition in catches was slightly different from that observed during the environmental survey, performed in December 2016. The total number of species found in catches in 2020 doubled. For example, the catches of 2016 did not contain any lamprey, salmon, round goby, sand goby or viviparous eelpout.

The core of ichthyocenosis (fish species with occurrences over 50%) in the surveyed in September 2020 was represented by four pelagic species (herring, sprat, three-spined stickleback and nine-spined stickleback) and one diadromous species (smelt). Herring, sprat, smelt and three-spined stickleback were spotted at each of the six trawling stations. In December 2016, Clupeidae (herring and sprat) were also present in catches at each station, and the core of ichthyocenosis included the same species as in 2020, except nine-spined stickleback, which was then captured at only one out of six stations.

Density of fish population was high in September 2020: fish abundance ranged from 1,600–26,300ind./ha and biomass ranged from 20–249kg/ha. Ichthyofauna abundance tended to increase with distance from the shore. The lowest values of abundance (1,600ind./ha) and biomass (19.8kg/ha) were recorded at the shallowest and closest to the shore monitoring (trawling) station, while the highest values (26,300ind./ha and 248.6kg/ha) were recorded at the deeper stations.

Fish population indicators measured in September 2020 were by 1–3 orders of magnitude higher than those measured in December 2016, which is primarily due to the specifics of seasonal distribution of herring and sprat. With the decrease in seawater temperature, these species tend to form most dense and stable congestions near hydrological fronts in offshore sections on the slopes of numerous islands and banks leaving the areas where sea bottom topography is relatively flat and even, hence their abundance in the latter areas falls down to minima, which was observed along the pipeline route in December 2016.

In September 2020, just like in December 2016, the greatest species diversity was observed at the southeasternmost station in the Narva Bay; the number of fish species in catches tended to decrease in the direction toward the central part of the bay. Clupeidae (herring and sprat) were dominant in test trawl catches. Smelt and three-spined stickleback were prevalent in by-catch. On the whole, species diversity was higher in September 2020 than in December 2016.

The fact that salmon was present in trawl catch only at the nearest to the shore station confirms that salmon spawning migration routes in the area of survey run mostly along the coast of the Narva Bay.

As it follows from the size and age characteristics obtained for the most abundant fish species inhabiting the Narva Bay, the structure of population of most fish species included in the study corresponded to the state typical for the pre-winter feeding period.

CONCLUSIONS

Structural and functional characteristics of fish populations, along with their relative abundance and biomass within the area of survey, allow for a conclusion about their good condition, with no negative impact on ichthyofauna from construction activities.

6.1.6 Marine mammals

Two species of marine mammals inhabit the eastern part of the Gulf of Finland which covers the Russian section of the Nord Stream 2 Pipeline route: Baltic grey seal *(Halichoerus grypus grypus)* and Baltic ringed seal *(Pusa hispida botnica)*.

Population of grey seals is increasing in numbers – currently it is possible to observe main haul-outs at 16 locations on the islands and reefs in the Russian waters of the Gulf of Finland.

Population size of the Baltic ringed seals in the Russian waters remains relatively low, estimating around 100 individuals. Main habitats relate to the triangle “Kurgalsky – Moschnyi – Malyi” just north of the Kurgalsky peninsula, and a smaller habitat is observed near Malyi Tyuters island. Baltic ringed seals have a defined seasonal migration pattern, moving towards the northern shores of the Gulf of Finland in late autumn-winter for breeding and foraging mainly offshore during summer months.

The purpose of the post-construction monitoring activities in 2020 was to assess population size and to establish whether there are any changes in animals’ behaviour and distribution occurred due to construction activities.

The methodology included aerial survey in accordance with approved HELCOM guidelines and associated vessel-based monitoring.

Grey seals

METHODOLOGY

The aerial survey of grey seals was performed in accordance with the HELCOM guidelines /26/. Grey seals are normally observed during the moulting period when most individuals occupy the moulting haul-out sites /27/.

The work was carried out from a Cessna 182 aircraft. Average flight speed was 150km/h, flying altitude varied from 50 metres to 100 metres (average 90 metres). Two flights were conducted (26 May and 2 June) as required by HELCOM guidelines, each covering 24 islands and reefs inside the Russian waters of the Gulf of Finland, respectively.

RESULTS

On 26 May grey seals were observed on 13 islands and reefs, mainly in the area of the Kurgalsky reef and islands to the north as well as outer western islands such as Vigrund and Malyi Tyuters. The highest number of grey seals was noted, as expected, in the area of the Kurgalsky reef near Hitomatola island and on the reefs off Vigrund Island, with 221 and 282 seals respectively. On the North Virginy Island a large group of 96 grey seals was recorded for the first time. Total number of seals observed accounted to 783 individuals.

On 2 June grey seals were observed on 11 islands and reefs – the distribution is similar to the survey of 26 May. A significant increase was noted on the reefs off Vigrund Island (456 seals to compare with 282 seals observed on 26 May) and Halikarti island (see Figure 36). The situation near the islands of Itäkivi and Halikarti has changed significantly. During previous observations the seals occupied either Itäkivi or Halikarti island but never at the same time, however on 2 June marine mammals were observed on two islands simultaneously. This is most probably due to the lower water level (30cm difference between two observation dates) making more suitable rocks available for haul-outs. A record number of 595 grey seals were counted on Halikarti Island. In most of the haul-outs the number of grey seals was slightly higher during the second observation day. The size of these haul-outs resulted in a significant increase in the overall number of grey seals observed on 2 June which accounted to 1,593 individuals.

Figure 36. *Grey seals near Halikarti Island, Russia.*

Numbers of grey seals in the Baltic Sea are constantly growing. The dynamics within the grey seal population are shown in Table 11.

Table 11. *Grey seal population in the Baltic Sea, 2006–2020 /28/, /29/.*

	2006	2007	2008	2009	2010	2011	2018	2019	2020
Russian waters of the Gulf of Finland	390	326	331	400	168	446	1,204*		1,593
Gulf of Finland	756	803	965	1,040	615	1,417		1,008	2,390
Baltic Sea	20,700	22,000	22,330	20,395	23,139	23,941		38,000	40,075

* Was not included in the official statistics because the observation took place 10 days earlier than the officially recommended survey period.

CONCLUSIONS

The number of grey seals in the Russian waters of the Gulf of Finland, as well as within the whole Baltic Sea, is steadily increasing. Animals are distributed relatively even within the Gulf of Finland with the most popular locations, as expected, north of Kurgalsky reef and offshore islands Vigrund and Malyi Tyuters.

Baltic ringed seals

METHODOLOGY

Warm winters and lack of ice cover in the Gulf of Finland in the last few years made it challenging to observe Baltic ringed seals during the period specified in the HELCOM methodology (mid-April). This led to the discussions on alternative methodology suitable for population count. The most suitable method is the haul-out survey. The spring census at the haul-out sites normally gives a stable result, but with a low percentage of the population being counted. According to telemetry surveys in the Gulf of Finland, Baltic ringed seals stay on land longer in autumn, therefore the need for haul-out surveys in autumn months was stipulated at the Fourteenth meeting of HELCOM Expert Group on Marine Mammals /30/.

The 2020 winter was marked by particularly warm weather, and lack of ice cover in the Russian part of the Gulf of Finland made it impossible to do standard aerial survey of the Baltic ringed seals on the ice in April. Therefore a decision was reached to conduct an aerial count on haul-outs in May and October 2020.

The work was carried out from a Cessna 182 aircraft. Average flight speed was 150km/h, flying altitude varied from 50 metres to 100 metres (average 90 metres). In May the observations were combined with the survey of the grey seals (26 May and 2 June). In autumn there were two additional dedicated flights (7 and 16 October), each covering all islands and reefs inside the Russian waters of the Gulf of Finland.

RESULTS

On 26 May, Baltic ringed seals were observed at 5 islands and reefs: Seskar, Malyi, Moschnyi, Remisaar and Kiskolsky reef. Total 22 ringed seals were recorded. On 2 June, Baltic ringed seals were observed at 5 islands and reefs: Malyi, Moschnyi, Remisaar, Kiskolsky reef and Malyi Tyuters. In total 22 ringed seals were recorded. On 7 October, Baltic ringed seals were observed at the rocks near 3 islands: Moschnyi, Remisaar and Malyi Tyuters. In Total 16 ringed seals were recorded. On 16 October, only one ringed seal was recorded near Kotlin island (see Table 12).

Table 12. *Number of Baltic ringed seals observed on the islands during May–October monitoring campaigns.*

	Seskar	Malyi	Moschnyi	Remisaar	Kiskolsky reef	Malyi Tyuters	Kotlin	Total
26.05.20	1	10	1	4	6			22
02.06.20		11	3	2	5	1		22
07.10.20			1	13		2		16
16.10.20							1	1

Vessel based monitoring
Associated vessel-based observations were performed during offshore monitoring campaign in May 2020 along the pipeline route in accordance with the approved programme. The observations were done during the vessel transit, over the range of approximately 300 metres in each direction, in daylight hours from an open observation point on the deck, with 180° view angle and 3 to 5 metres above the water surface. No marine mammals were recorded.

CONCLUSIONS
Baltic ringed seals monitoring in 2020 was performed during haul-out periods in spring and autumn because traditional survey on ice was not possible due to warm winter and absence of ice. Population count of Baltic ringed seals in autumn depends largely on the weather. In autumn 2020, the weather was windy and temperatures were higher than normal. Due to this, the results were not satisfactory and fully representative. In spring the results were more stable and this data can be used to assess population dynamics of this species. According to the results of spring aerial surveys, the population size remains at a low but a stable level with an upward trend compared to the results of previous observations.

6.1.7 Birds

METHODOLOGY
Post-construction monitoring of avifauna in offshore sections was performed based on EIA recommendations to observe migrating and nested birds on islands, located close to the pipeline route and valid from a biodiversity perspective, in the first year after the end of construction. Considering the end of rock placement operations for line B were completed mid-February, the first migrating and breeding season to follow was the spring-autumn season of 2020 (see Table 13).

Areas of monitoring were chosen based on environmental survey and EIA recommendations. Observations of nesting and migratory bird populations were performed in the neighbourhood of Rodsher Island, North- and South Virginy Islands, Maly Tyuters Island, Gogland Island and Vigrund cliff. The last two locations in the list are most distant from the pipeline route – 16 and 19km. Other locations are located relatively close – up to 6km away (see Figure 26).

Table 13. *Timing and scope of work performed during shipboard and shore-based counts in 2020*

No.	Period of observations	Method of observations	Duration of observations, hrs
1	22–29.05.2020	from aboard a vessel	97
2	08–13.06.2020	from aboard a vessel and from ashore	56
3	12–17.07.2020	from aboard a vessel and from ashore	59

No.	Period of observations	Method of observations	Duration of observations, hrs
4	27.08.–02.09.2020	from aboard a vessel	48
6	23–28.09.2020	from aboard a vessel	77
	Total		**337**

The vessel-based and shore-based observations amounted to a complete survey of Vigrund, Rodsher, South- and North Virginy islands with adjacent water areas and all coastal zones of Maly Tyuters and Gogland islands. In areas inaccessible for walking observers, counts were performed from aboard a research vessel. The purpose was finding locations of bird congestions during seasonal and summer migrations, molting congestions and nesting places of aquatic and semiaquatic birds. In addition, counts of forest birds were performed on Maly Tyuters and Gogland islands in all the biotopes suitable for breeding.

Observations of seasonal bird migrations were carried out according to the modernised E. Kumari method. For example, monitoring of migrating birds on the Kurgalsky Peninsula was carried out using the point observations method, i.e. records were taken of all birds passing by the observation point, their numbers, primary direction of movement and flock location (on water, on land, in the air). Observations were performed in the four hours after sunrise. Shipboard counts were performed also with the help of the E. Kumari method; observations were performed not only during vessel stops, but also while sailing. Additionally, observations were not limited to morning hours (when migratory birds are most active), but continued with short interruptions all day long, especially during the 4 hours before sunset. The modernised method allowed recording migrating birds with different hours of activity as well as recording summer migrations and summer molting congestions along the vessel's traverse.

The following methods were used for studying nesting birds within the area of survey:

> **Expert-selective method**: Observation point locations are selected based on expert opinions about most indicative areas of the studied biotopes. Habitats are identified on the basis of field surveys, review of photographs, landscape or other maps
> **Point counting**: Conducted by stationary observers from fixed points. Such counts were performed mostly for birds on Maly Tyuters and Gogland islands.
> **Traverse count:** The most common method for estimating the abundance of species in monitoring surveys. Monitoring of the Kurgalsky Peninsula local avifauna was performed using a combined traverse count method, while the Gulf of Finland islands were surveyed mostly with the help of the Finnish linear transect method.
> On coastal and insular habitats the **method of absolute counting** could only be used on small islands comparable in size with standard counting points (Vigrund, Rodsher, South- and North Virginy). In this case, all-out counts were performed of nesting gulls, terns, ducks, waders, and small passerines. Bird counts were performed visually using binoculars; each species was counted separately (one after other or in "blocks"); in colonies, the numbers of gulls, terns, and cormorants were determined by direct count of breeding pairs or on photographs.

Of the techniques for determining avifauna abundance and species composition described aboce, the method of point counting was primarily chosen. This method is best applicable in situations where it is impossible to lay a representative traverse. During the 2020 monitoring, however, all birds within sight (or hearing) range were recorded without any standard distance limitations.

One of the main tasks of avifauna monitoring is determining the status of individual species representatives within the study areas. During the observations of forest birds on large islands (Maly Tyuters and

Gogland), the species status of occurrence was determined using the standard system of nesting confidence degrees developed by the European Bird Census Council /31/.

Monitoring results were compared with baseline environmental survey data and other available open data.

RESULTS

Data from 2018–2020 monitoring in the pipeline's offshore section, Gogland, Rodsher, South- and North Virginy, and Maly Tyuters islands, and Kurgalsky Peninsula and adjacent water areas, identified 180 bird species belonging to 14 orders. Of these, 114 species were recorded in and around the islands, 90 of the latter were spotted nesting, 25 species were observed only during seasonal migrations, and 3 species were identified as vagrant species. Active summer movements within the investigated part of the Gulf of Finland were observed for 37 species; molting congestions and/or molting sites were found for 13 species. Among the birds sighted within the surveyed areas of Kurgalsky Peninsula and Narva Bay 133 were spotted migrating, 4 species were identified as non-breeding summer species, and two species as vagrant species. Eighty-two species, or 66.3% of the total number registered on the outer islands of the Gulf of Finland, were sighted on the surveyed islands during the nesting period /32/.

Of all birds recorded on the surveyed islands and water areas, 102 species are both migrating and nesting birds, and 3 species (pomarine jaeger, parasitic jaeger, and black-legged kittiwake) are rare vagrant species. Among the recorded species, 2 were Gaviiformes, 2 were Podicipediformes, 1 was Pelecaniformes, 4 were Ciconiiformes, 28 were Anseriformes, 15 were Falconiformes, 4 were Pangalliformes, 4 were Gruiformes, 38 were Charadriiformes, 2 were Columbiformes, 1 was Cuculiformes, 1 was Apodiformes, 6 were Strigiformes, 8 were Piciformes, and 64 were Passeriformes. In total, representatives of more than 60% of the Leningrad Region's avifauna were sighted in the survey area, which can be explained both by the area's high biotopic diversity and relatively low degree of anthropogenic transformation.

Of all birds sighted in the area of survey, 27 species are included on the IUCN Red List (2019); 18 are on the Red Data Book of the Russian Federation (2020); 57 are in the Animals: Red Data Book of the Leningrad Region (2018, including the "biosurveillance" list); 20 are protected in the Baltic region under the HELCOM Red List of Baltic Sea species in danger of becoming extinct (2016); and 28 are protected under the Red list of Eastern Fennoscandia, 1998.

Over 2,300 breeding pairs representing 35 species of aquatic and semiaquatic birds, including 9 species of colonial birds, were spotted nesting during 2020 monitoring. A total of 22 colonies were found and surveyed, among which 11 are mixed, represented by two or more species, including: 3 great cormorant colonies; 3 razorbill colonies; 1 common guillemot colony; 2 common murre colonies, 3 little tern colonies; 8 Arctic tern colonies; 10 common tern colonies; 4 European herring gull colonies; 3 common gull colonies; and 1 black-headed gull colony. Dominant species were European herring gull, great cormorant, common tern and Arctic tern.

Breeding season of aquatic and semiaquatic birds in the surveyed islands in 2020 extended from 20 April 20 to 10 July. Average reproductive indices of aquatic birds in the area of survey, such as average clutch size, incubation success, and overall reproductive success, were generally similar to those of populations in other similar habitats in the boreal zone. Unusually high breeding success rate of up to 90–98% was recorded for a number of species in 2020, confirming good health of local ornitocenosis.

A total of 159 species were registered during seasonal migrations observed from 2018–2020. These species belonged to the following 14 orders: Gaviiformes, Podicipediformes, Pelecaniformes, Anseriformes, Ciconiiformes, Charadriiformes, Gruiformes, Falconiformes, Columbiformes, Cuculiformes, Caprimulgiformes, Apodiformes, Piciformes, and Passeriformes. Aquatic, semiaquatic and predatory birds were

represented by 97 species, i.e. by 41 species more than observed during the 2015–2016 monitoring. The richest species diversity of migrating birds was registered in Kurgalsky Peninsula – 110 species /32/.

CONCLUSIONS

The state of ornitocenoses within the area of survey after Nord Stream 2 gas pipeline construction remained generally favourable throughout the neighbouring water area and on the islands. No changes in the intensity of migration flows, timing and directions of migration of aquatic and semiaquatic birds were observed. The monitoring of 2018–2020 did not reveal any changes and/or decrease in the number of migration stopovers of birds. Species diversity, number of rare and protected species during and after pipeline construction was comparable to the baseline state. Moreover, there was an increase in the number of sightings of several rare species in the surveyed area.

6.2 Post-construction monitoring in Denmark

As part of the permit requirements for construction of the pipelines, an environmental monitoring programme within the Danish EEZ was developed by Nord Stream 2 AG in collaboration with the Danish authorities /10/. Environmental monitoring covering environmental and socioeconomic parameters is performed during construction and after construction is completed.

Post-construction surveys in Denmark in 2020 included monitoring of chemical warfare agents (CWA) in seabed sediments along the pipeline route. An overview of monitoring parameters during the post-construction surveys and their locations are shown in Table 9 and Figure 37.

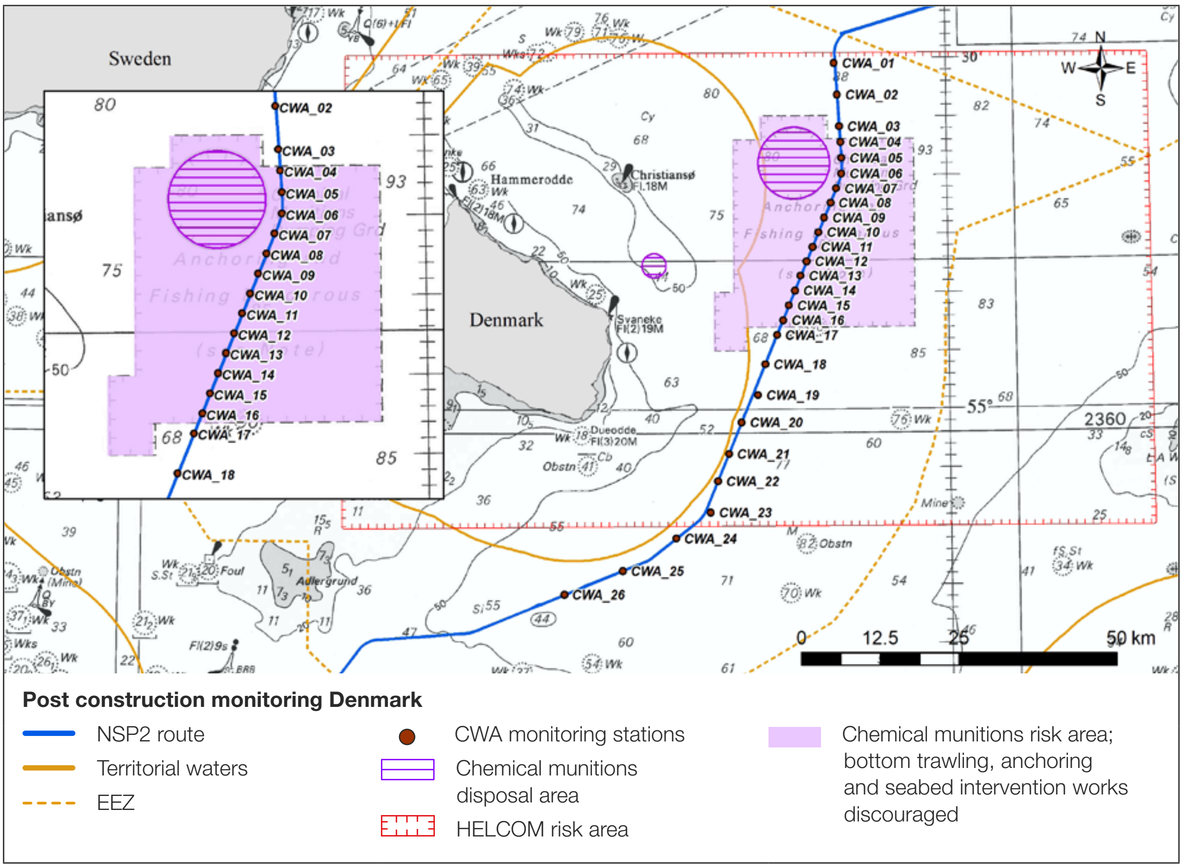

Figure 37. *Post-construction monitoring locations in 2020 in Denmark.*

Post-construction monitoring undertaken in Danish waters showed that the impact on the seabed due to construction was in line with the assessment (see Chapter 6.2.1). The CWA-positive stations and contamination levels correlate with the distance from the original dumping area where bottom trawling and anchoring are discouraged due to the risk of encountering CWA. Thus, at the stations where CWA were identified contamination levels increase with proximity to the damping area. The same trend in the CWA distribution was observed during the baseline surveys. Based on the results of post-construction monitoring of CWA in seabed sediments and comparison with the baseline data it can be concluded that construction activities have not resulted in disturbance of contaminated seabed sediments associated with dumped chemical munitions.

6.2.1 CWA in seabed sediments

The NSP2 route crosses the area where bottom trawling, anchoring and seabed intervention works are discouraged due to the risk of encountering chemical munitions. The purpose of the monitoring programme for chemical warfare agents (CWA) in Denmark is to document changes in the levels of CWA in seabed sediments following project activities that result in the disturbance of contaminated sediment and to confirm the conclusion of the EIA that there is no risk to the marine environment associated with CWA disturbance.

Concentrations of CWA in seabed sediments were documented prior to the start of construction and after construction was completed. The locations of the monitoring stations and the methodology for sampling are consistent between the baseline surveys and the post-construction surveys.

METHODOLOGY

Post-construction monitoring of CWA in seabed sediments was performed in September 2020 along the NSP2 route.

Seabed sediment samples were taken at 26 stations, CWA-01 to CWA-26. Each sampling position was inspected with an ROV before the HAPS core sediment sampler was lowered on the seabed to ensure that the area was clear of any hazardous objects, i.e. debris or munitions. A HAPS core sampler was used to collect seabed sediment samples and a ROV equipped with video and a CTDO system were used at each monitoring station, see Figure 38. On deck, the sediment samples were photographed and described. All samples have been analysed by the Finnish laboratory VERIFIN specializing on the CWA detection.

Figure 38. *Sampling of seabed sediments using HAPS core sampler.*

Post-construction CWA monitoring in 2020 was carried out according to the procedures and methodology which have been used during baseline surveys carried out for the EIA /5/. All samples have been analysed by the same laboratory, VERIFIN, which is specialised in detecting CWAs. The results of post-construction monitoring were compared against the results of baseline investigations along the permitted route which were conducted in two campaigns in 2018 and 2019 prior to the start of construction. Furthermore, post-construction monitoring data were also analysed in comparison with the baseline data collected during NSP2 route development surveys in 2015.

RESULTS

Analysis of post-construction survey data showed presence of 8 degradation products of 6 major CWA compounds at 21 out of 26 stations. No intact CWAs were found during post-construction survey.

Distribution of the identified CWA correlates with the distance from the original dumping site. Thus, the majority of the CWA are found within the munition dumping site (HELCOM high risk area, where works on the seabed are discouraged due to the risk of encountering chemical munitions) and in the nearby areas. The Sulfur Mustard degradation product 1.5, Triphenylarsine degradation product 4O, and Lewisite II degradation product 8T were primarily found within the HELCOM high risk area. The rest of the detected CWA (degradation products of Adamsite, Clark II and Phenyldichloroarsine) were found both within the HELCOM high-risk area and in the wider HELCOM risk area where vessels are required to have first aid gas equipment. The number of CWA detections was highest at the stations in the high-risk area for all 8 degradation products and derivatives. Such trend was also observed during baseline monitoring. No CWA or their degradation products were detected at two most north-eastern stations (CWA-1, 2) and at the stations outside of the HELCOM risk areas (CWA-24, 25, 26), see Figure 37.

Comparison of the results from the baseline surveys with the post-construction monitoring data shows that the CWA concentrations are within the variations found during the baseline investigations. In general, most concentrations of the CWA from the post-construction survey were lower than that of the baseline surveys with exception of derivative of Clark (3T) and Phenyldichlorarsine (5T), see Table 14. The only compound that was not found during the baseline surveys but identified during post-construction investigations is derivative of Lewisite II (8T).

Table 14. *Overview of minimum and maximum concentrations of CWA in µg/kg of DW (dry weight) found during baseline surveys in 2018–2019 and post-construction survey in 2020. Results are shown for all stations and split based on station locations in HELCOM areas /33/.*

Year	µg/kg DW	Sulphur Mustard				Adamsite		Clark I and II		Triphenyl arsine		Phenyldi-chloroarsine		Lewisite II
		1	1.2	1.4	1.5	2	20	30	3T	4	40	50	5T	8T
2018/2019	**Baseline: All samples (30 stations) along Final NSP2 Route (CWA-01-30)**													
	Conc. Min	–	0.26	0.31	0.17	4.95	2.33	5.14	0.41	0.54	6.60	5.50	0.39	–
	Conc. Max	–	**0.29**	**0.34**	**2.37**	**75**	**72**	**81**	**6**	**9**	**248**	**29**	**20**	–
	Positive samples %	–	10	10	50	13	27	33	50	23	13	37	90	–
	Stations inside HELCOM risk area (10) (CWA-1-3, CWA-17-23)													
	Conc. Min	–	–	–	0.17	4.95	2.33	5.14	0.58	0.88	6.60	5.88	0.39	–
	Conc. Max	–	–	–	**1.21**	**75**	**72**	**9**	**5**	**0.88**	**6.60**	**29**	**20**	–
	Positive samples %	–	–	–	40	40	50	30	60	10	10	60	100	–
	Stations inside HELCOM high risk area (13) (CWA-04-16)													
	Conc. Min	–	0.26	0.31	0.35	–	2.46	6.02	0.41	0.54	6.82	5.50	2.56	–
	Conc. Max	–	**0.29**	**0.34**	**2.37**	–	**8**	**81**	**6**	**9**	**248**	**27**	**14**	–
	Positive samples %	–	23	23	85	–	23	54	69	46	23	38	100	–
	Station names: South of HELCOM risk area (CWA-17-23)													
	Conc. Min	–	–	–	–	–	–	–	–	–	–	–	1.06	–
	Conc. Max	–	–	–	–	–	–	–	–	–	–	–	**3.96**	–
	Positive samples %	–	–	–	–	–	–	–	–	–	–	–	57	–

Year	µg/kg DW	Sulphur Mustard				Adamsite		Clark I and II		Triphenyl arsine		Phenyldi-chloroarsine		Lewisite II
		1	1.2	1.4	1.5	2	20	30	3T	4	40	50	5T	8T
2020	**Post-construction: All samples (26 stations) along Final NSP2 Route (CWA-01-26)**													
	Conc. Min	–	–	–	0.26	–	4.20	11	0.67	–	16	5.11	0.29	1.22
	Conc. Max	–	–	–	**1.84**	–	**18**	**11**	**16**	–	**65**	**18**	**22**	**1.22**
	Positive samples %	–	–	–	46	–	15	8	58	–	8	12	62	4
	Stations inside HELCOM risk area (10) (CWA-1-3, CWA-17-23)													
	Conc. Min	–	–	–	0.96	–	4.20	11	0.67	–	–	5.11	0.29	–
	Conc. Max	–	–	–	**0.96**	–	**12**	**11**	**7**	–	–	**18**	**22**	–
	Positive samples %	–	–	–	10	–	20	10	80	–	–	20	70	–
	Stations inside HELCOM high risk area (13) (CWA-04-16)													
	Conc. Min	–	–	–	0.26	–	5.66	11	1.11	–	16	12	2.33	1.22
	Conc. Max	–	–	–	**1.84**	–	**18**	**11**	**16**	–	**65**	**12**	**8.43**	**1.22**
	Positive samples %	–	–	–	85	–	15	8	54	–	15	8	69	8
	Station names: South of HELCOM risk area (CWA-24-26)													
	Conc. Min	–	–	–	–	–	–	–	–	–	–	–	–	–
	Conc. Max	–	–	–	–	–	–	–	–	–	–	–	–	–
	Positive samples %	–	–	–	–	–	–	–	–	–	–	–	–	–

Results of analysis of seabed sediments from the post-construction survey showed that there are fewer stations with CWA detections and lower variety of the identified CWAs compared to the baseline surveys /33/.

Furthermore, baseline surveys of CWA in seabed sediment showed presence of intact CWA substances (Adamsite and Triphenylarsine) as well as degradation products of other CWA at several stations within the high-risk area where works on the seabed are discouraged, as well as outside of this area. No intact CWAs were identified during post-construction monitoring. However, CWA-positive stations were also present outside of the risk area. Presence of the CWA outside of the HELCOM areas indicate that chemical munitions were most likely dumped not only inside but also outside of the officially demarcated dumping site. The presence of substantial trawl tracks on the seabed furthermore indicates that CWA components may have been dragged from their original dumping locations due to fishery activity in the area /33/.

CONCLUSIONS

Based on the results of post-construction monitoring of CWA in seabed sediments along the NSP2 route and comparison with the baseline data it can be concluded that construction activities have not resulted in disturbance of contaminated seabed sediments associated with dumped chemical munitions as assessed in the Danish EIA. Thus, Nord Stream 2 AG fulfilled the objective of the monitoring programme, which can be considered finalised.

6.3 Post-construction monitoring in Germany

Besides vessel tracking during pipelay in December, no monitoring activities dedicated to offshore construction were undertaken in Germany in 2020. Therefore, all monitoring activities in German waters in 2020 were regarded as post-construction monitoring.

Documentation of the environmental conditions after completion of the offshore construction work (dredging and pipelay) serves the purpose of monitoring the restoration quality of the habitat types as defined by the EU Habitat Directive. After completion of offshore construction, high-resolution multibeam surveys were conducted ±50 metres either side of the trenches in June 2019 and again in October/November 2020 to verify the seabed bathymetry as well as the reinstatement quality of reef sections. The bathymetry survey will be repeated once annually until 2022 to evaluate the stability of the trench backfill/habitat reinstatement.

Furthermore, NSP2 is monitoring the regeneration of the impaired habitat types under the EU Habitats Directive in Greifswald Lagoon and Pomeranian Bay from 2019 until 2022, in order to show that regeneration will be completed within the predicted period of about four years.

The prediction was based on results of the Nord Stream Monitoring Programme 2006/7 (baseline) and Nord Stream recovery monitoring 2011–2016 results /34/.

Beside the monitoring of benthic habitats, monitoring programmes for marine mammals and seabirds were continued in 2020. Surveys of harbour porpoises and wintering seabirds aim to follow their local population trend after offshore construction. The duration of these surveys differs among species since the potential effect in terms of quality and duration is species-specific.

All monitoring investigations followed the national offshore EIA standard STUK4 /35/. Since this German national standard for environmental offshore investigations was already applied during the Nord Stream Monitoring Programme, some trend analysis meanwhile covers a period of 14 years.

An overview of monitoring parameters during the post-construction surveys in 2020 and their locations are shown in Table 9 and Figure 39.

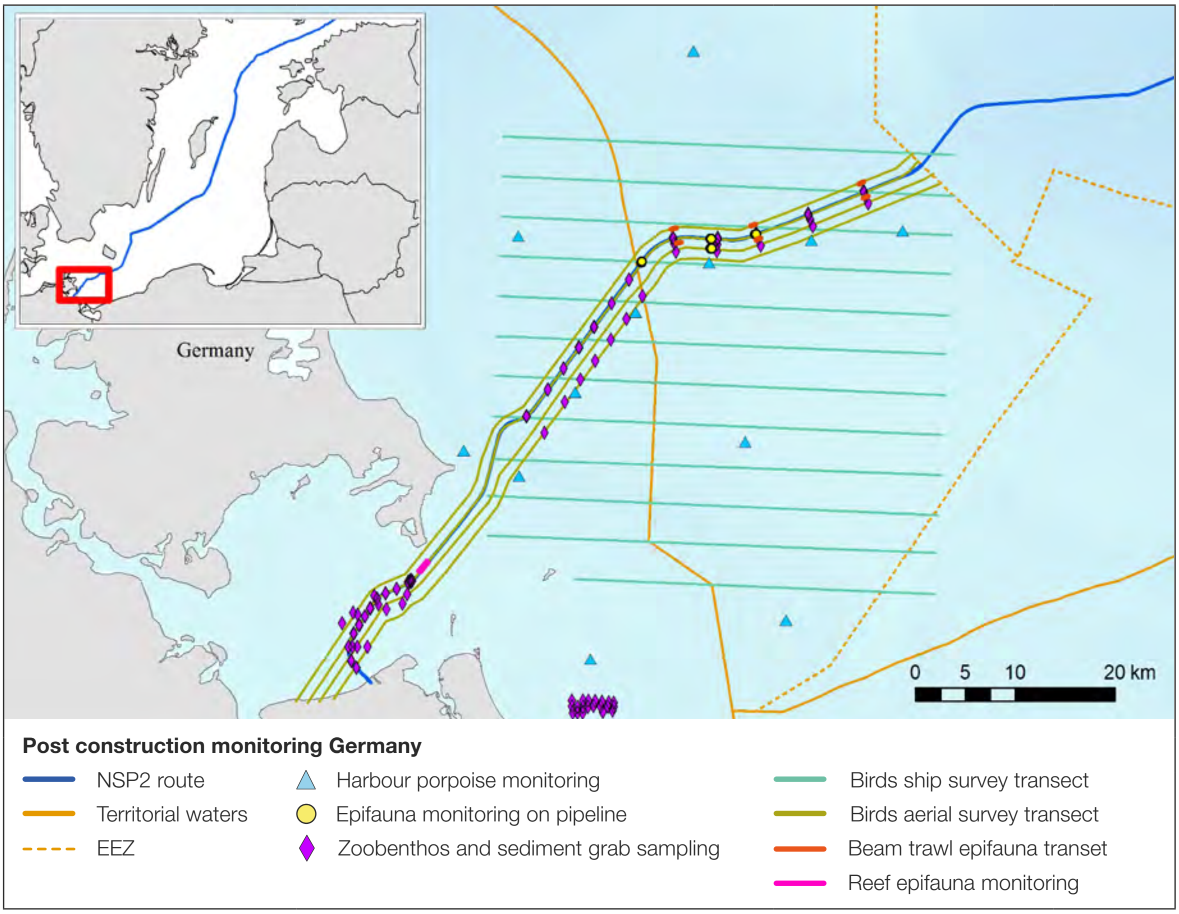

Figure 39. *Post-construction monitoring locations in 2020 in Germany.*

Post-construction monitoring undertaken in German waters showed that natural levelling of the seabed though action of waves and currents proceeds in line with the assessment (see Chapter 6.3.1). No contamination of the seabed sediments was observed (see Chapter 6.3.2). Analysis of benthos in 2020 (see Chapter 6.3.3) revealed a progressive stage of succession for all benthic communities. It is expected that fauna and flora of the entire impacted seabed area will recover within about two to four years and no permanent impact will remain. Monitoring of marine mammals (see Chapter 6.3.4) and seabirds (see Chapter 6.3.5) showed that there were no impacts on their abundance and distribution due to construction. Moreover, Harbour porpoise encounters continued to increase in the northern Pomeranian Bay along the German section of the NSP2 route after offshore construction works in 2018.

6.3.1 Bathymetry

High-resolution multi-beam surveys were conducted in 2016 as part of the technical planning phase and again prior to start of construction in spring 2018. Daily bathymetry surveys provided one of the most important quality control measures for offshore construction during dredging, pipelay and backfilling. This was to ensure the technical design parameter and to implement the planned environmental mitigation measures (minimisation of footprint and reef re-instatement). In spring 2019 and again in autumn 2020 post-construction surveys were conducted to verify the stability of trench re-instatement (vertical tolerances and reefs).

METHODOLOGY

A series of bathymetry alignment charts and difference plots (pre- versus post-construction) was computed for visualisation of status quo of seabed re-instatement.

RESULTS

Difference plots revealed progress in smoothening of the backfilled sandy trench surface by natural currents as forecasted based on experiences from the installation of the Nord Stream Pipelines in 2010/2011. All reconstructed reefs remained as installed in 2018 (see example in Figure 40).

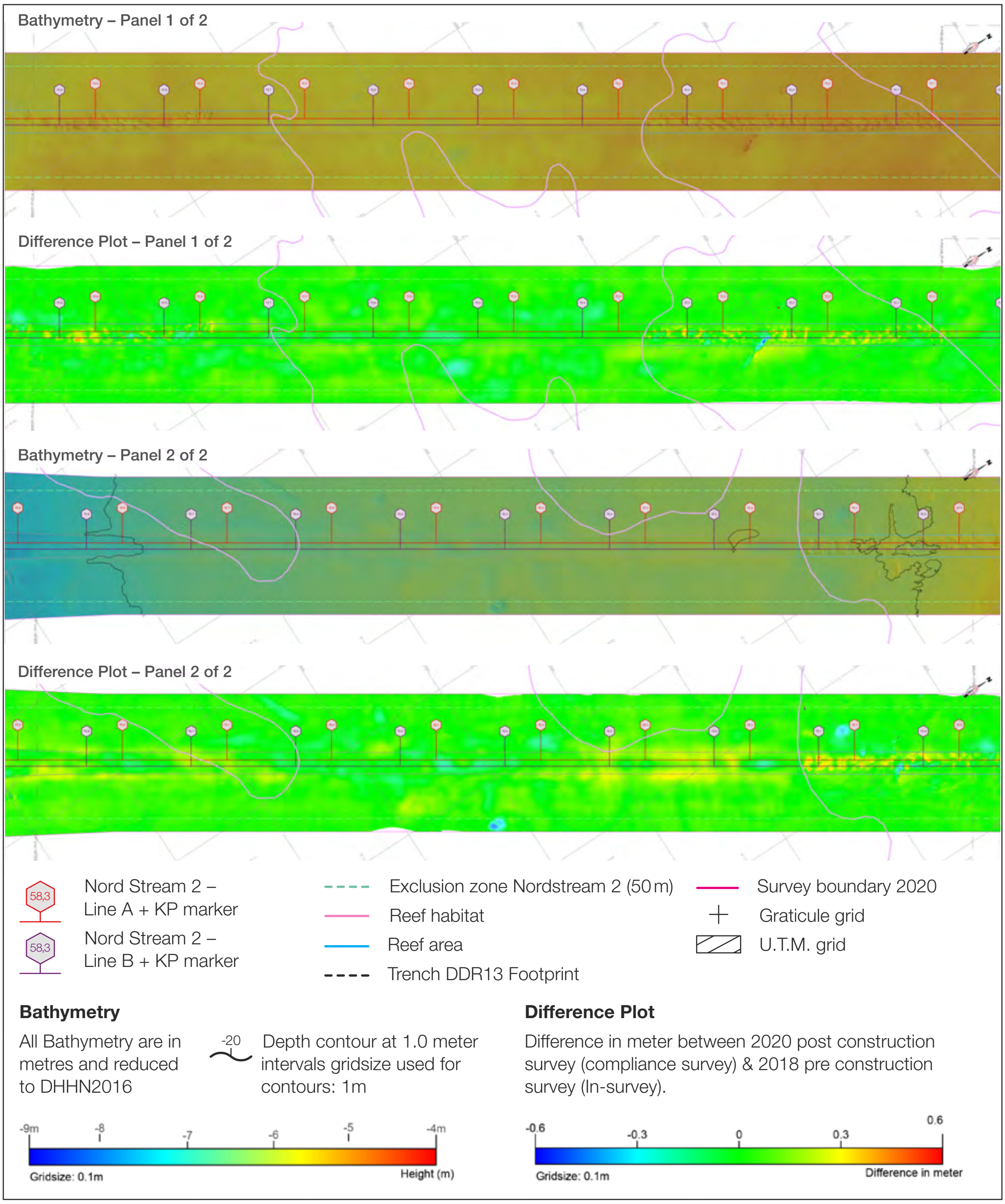

Figure 40. *Example of an alignment chart for the visualisation of soft sediment and reef re-instatement 2 years after dredging, pipelay and backfilling in the Greifswald Lagoon. Reefs are still in place on the seabed as installed. Backfilled sand sections almost completely levelled out with surrounding untouched seabed bathymetry.*

Unexpectedly, thousands of pockmarks/furrows were recorded for the first time ever between 17 metres and 25 metres water depth (see Figure 41). High resolution bathymetry surveys along the Nord Stream and Nord Stream 2 Pipeline routes have been conducted almost annually since 2010 but never recorded pockmarks/furrows before. Most pockmarks/furrows recorded in autumn 2020 were about 1.5 metres long and 0.3 metres deep. Many of them are orientated from SE towards NW. Density of pockmarks/furrows varies within the surveyed area. Their density was highest south of the pipelines installed top of seabed. The origin of pockmarks/furrows is currently uncertain. Because of their patchy distribution pattern it is assumed that large animals feeding on benthic prey (i.e. gobies or young flat fish) generated them. Harbour porpoises are a potential originator, since they use an echolocation biosonar for prey detection, which is also capable of detecting prey buried in sand. The concentration of pockmarks/furrows south of the pipelines are indicative of a localised food supply hot spot because of the artificial reef effect (aggregation of biofouling fauna and demersal fish).

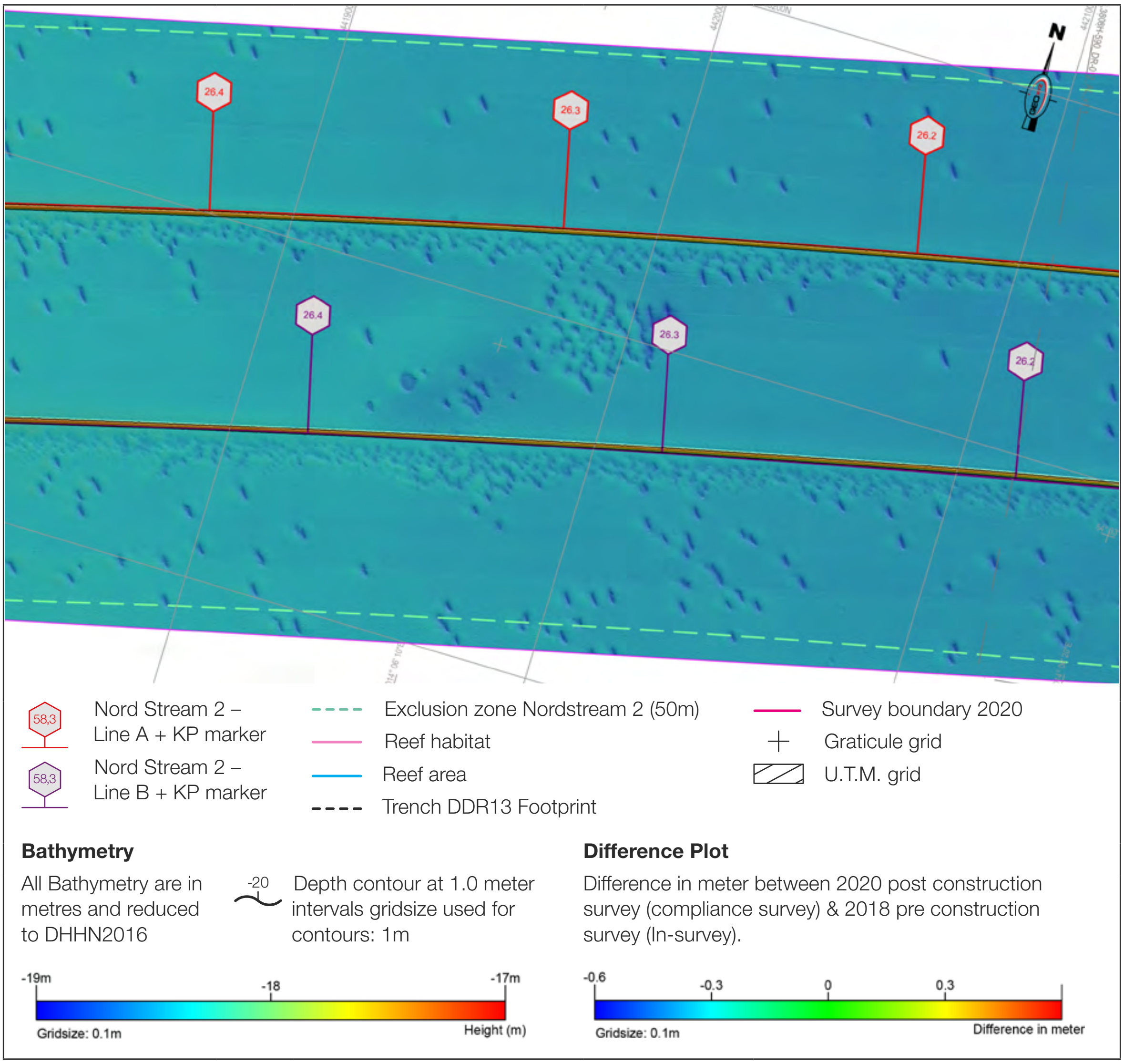

Figure 41. *Example of pockmarks on the seabed in the Pomeranian Bay in autumn 2020.*

CONCLUSIONS

The bathymetry monitoring revealed that the post-construction natural levelling of the seabed though action of waves and currents is proceeding as predicted. According to experience from the NSP Project, it is expected that fauna and flora in the entire impacted seabed area will recover within about two to four years. No permanent impact will remain.

6.3.2 Marine sediment quality

To evaluate geophysical sediment parameters (median grain size, silt content, loss on ignition), 276 sediment samples taken by means of a Van Veen grab will be collected annually in spring along with macrozoobenthos samples from 2019–2022 (see Figure 39). In addition, a number of chemical sediment parameters (nutrients, trace metals as well as organic pollutants) were analysed for 41 samples taken in 2019 to verify if any chemical pollution of surface sediments occurred as a result of dredging and pipelay works. Since no chemical effects were detected in 2019, the evaluation of chemical sediment parameters was not repeated in 2020.

Furthermore, sediment properties are visually characterised according to DIN EN ISO 14688-1 and recorded in field protocols.

METHODOLOGY

Physical sediment parameters

Grain size distribution will be determined according to DIN EN ISO 17892-4 (mesh sizes according to DIN ISO 3310-1, Part 1). The particulate organic matter content of the sediment will be determined by loss on ignition according to a method established by the German Federal Institute for Hydrology. This method differs from DIN 18128 to the extent that the sediment is ignited for 3 hours at 485°C (instead of 1 hour at 550°C). This routine will be applied due to a common high portion of carbonates in marine sediments which oxidise at temperatures above 500°C and thus would lead to an overestimation of the particulate organic matter content.

RESULTS

Physical sediment parameters

Aside from the restoration of seabed bathymetry, an appropriate reinstatement of the physical sediment parameter (both reefs and soft sediments) is the most important pre-requisite for a fast recovery of the benthic fauna and flora.

In spring 2020, median grain size of the surface sediment layer (inhabited by benthic invertebrates) of the backfilled trenches did not differ from the untouched surrounding, either inside Greifswald Lagoon or in Pomeranian Bay (see example in Figure 42). The portion of silt was similar between impact and reference sites as well. Only the particulate organic matter content was locally still a bit lower in the top layer of the trench sediment inside Greifswald Lagoon in spring 2020 (see Figure 43). This effect was predicted as a result of turbidity through sediment handling. According to the results of the NSP Recovery Monitoring Programme 2011–2016, particulate organic matter will be progressively re-imported through bedload transport and bioturbation within two years of construction.

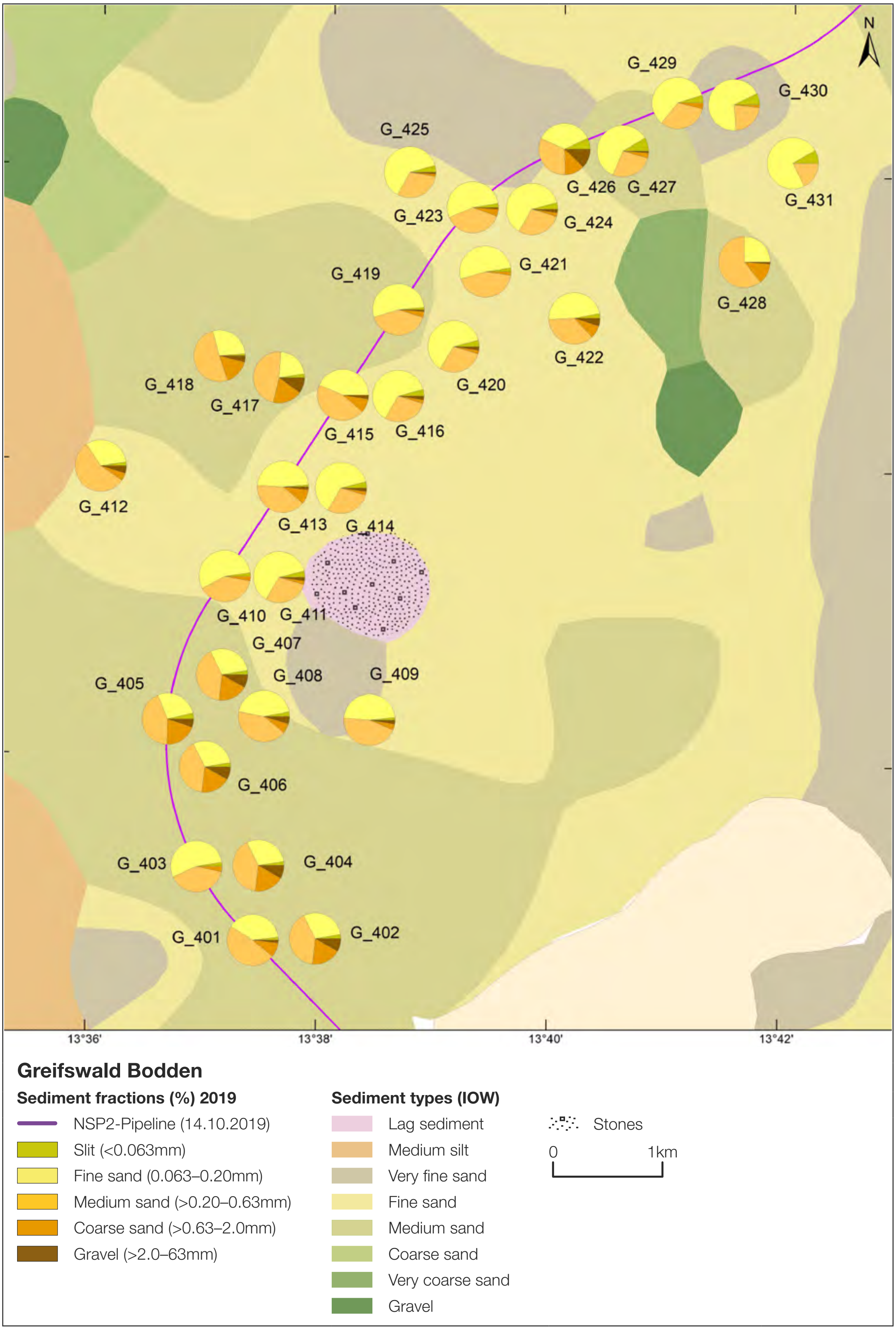

Figure 42. *Pie charts of sediment grain size composition of surface sediments inside the Greifswalder Bodden (trench, near trench surrounding, and reference sites, respectively; 93 samples).*

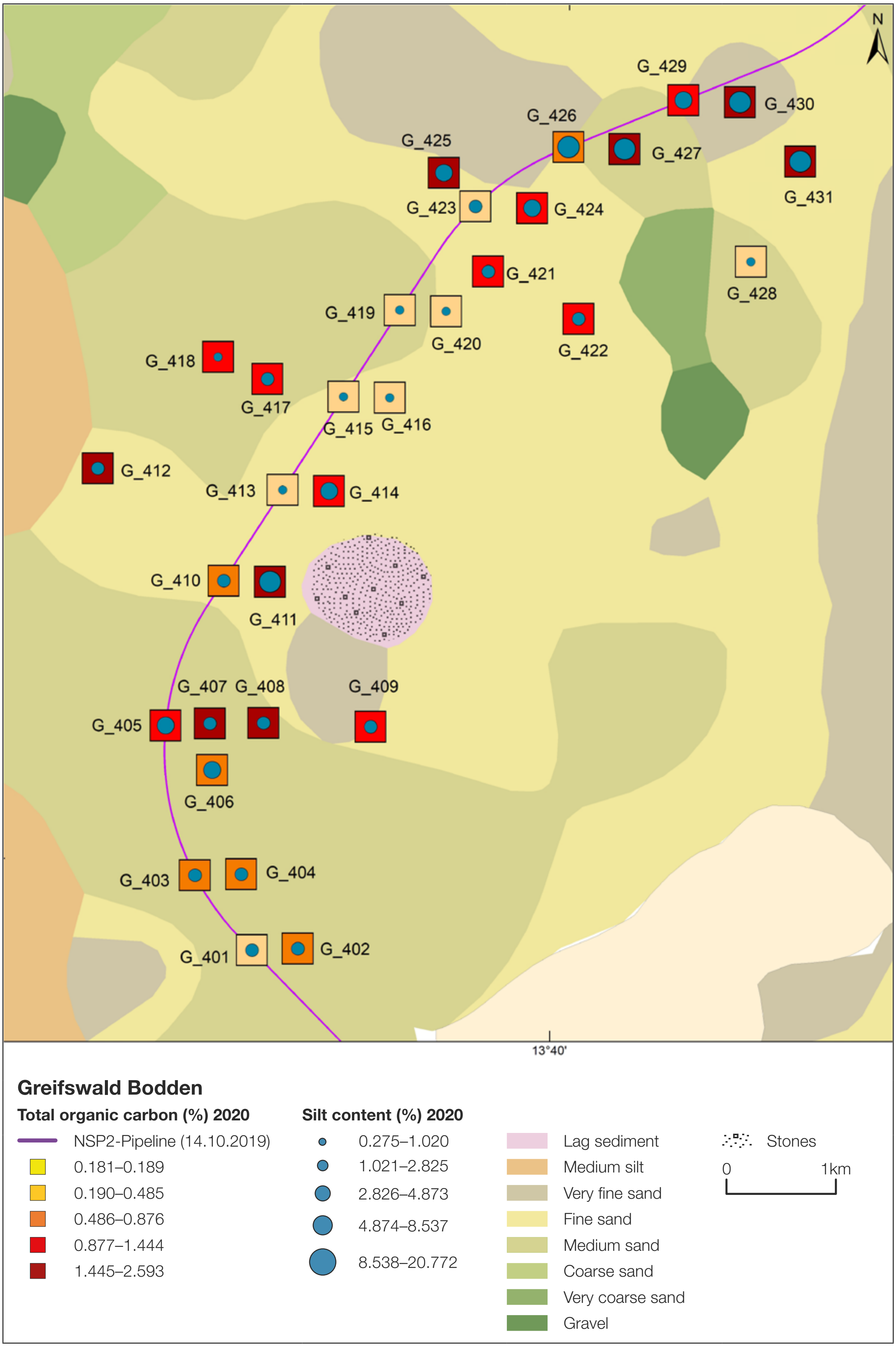

Figure 43. *Silt content and particulate organic matter content of surface sediments inside the Greifswalder Bodden (trench, near trench surrounding, and reference sites, respectively; 93 samples).*

CONCLUSIONS

Analysis of geotechnical sediment parameters after termination of offshore construction revealed that the temporary impact of offshore construction was restricted to the immediate trench vicinity. Since reinstatement of sediment quality (geotechnical parameters) was successful and no contamination of sediments with pollutants occurred, one can predict a successful recovery of the benthic flora and fauna within two to four years.

6.3.3 Benthic communities

Benthic flora and fauna were entirely removed during offshore construction in Germany in the vicinity of about 50km of trenches in the territorial waters. About 50% of the trench section runs through protected Natura 2000 SCI sites, aiming at the preservation of endangered benthic habitats: sandbanks which are slightly covered by sea water all the time (1110), large shallow inlets and bays (1160), and reefs (1170), respectively.

The post-construction GIS analysis revealed a total spatial footprint of trenches in German Territorial Waters of 174ha. Trench sections crossing protected Natura 2000 habitats affected 51ha.

All benthic habitats affected by dredging were physically reinstated through designated backfilling operations, aiming at:

> reinstatement of bathymetry with a precision of ±20cm,
> reinstatement of geophysical parameters of the surface sediment layer of soft sediments, about 30cm thick (the life horizon),
> reinstatement of reefs by placement of autochthonous stones and pebbles.

Appropriate physical reinstatement of benthic habitats is the crucial prerequisite for a successful recovery of benthic flora and fauna within two to four years. NSP recovery monitoring from 2011–2016 proved that such a mitigation concept can be successfully implemented inside Greifswald Lagoon and in the Pomeranian Bay. Natural oceanographic events (prolonged ice periods in winter, seasonal anoxia in summer) together with biological processes (spreading of invasive species) may affect the quality and duration of the recovery dynamics. According to EU and German legislation, NSP2 is obliged to monitor the recovery of the affected benthic habitats and to take remedial action if unforeseen complications may cause prolonged impacts (i.e. trench erosion). Due to the complex structure of benthic habitats along the 82km of pipeline route in Germany, an array of different investigation methods will be used.

METHODOLOGY

Benthos monitoring from 2019 until 2022 comprises of a number of different investigations (see Figure 39):

> Infauna of soft bottom sediments along trenches in Territorial Waters and in the vicinity of the pipelines laid on the seabed in the EEZ;
> Infauna of the sandbank at the marginal well between Greifswald Lagoon and the Pomeranian Bay (“Boddenrandschwelle”);
> Epifauna of reinstated reefs at the Boddenrandschwelle;
> Epifauna on soft bottom sediments in the German EEZ;
> Epifauna of the pipelines laid on the seabed in the EEZ.

The “Boddenrandschwelle”, a marginal well between Greifswald Lagoon and the Pomeranian Bay is a very diverse and dynamic geological structure within Natura 2000 SCI. It was formed by moving glaciers during glaciation and is slowly eroding since the last sea level rise 2,000 years ago. Whereas reefs form the exposed eastern slope of the well, sedimentation of mobilised sand in the sheltered Greifswald

Lagoon forms a growing sandbank on the western slope. The Boddenrandschwelle harbours a diverse benthic infauna and epifauna which is the food source for many fish. Local seagrass beds and gravel grounds are used by the western Herring population as spawning habitat annually in spring. Thousands of seabirds aggregate there during the Herring spawning season to either prey on the spawning fish (cormorants, grebes, and mergansers) or the eggs (Long-tailed ducks and Greater Scaups).

Sampling of fauna and flora is accompanied by hydrographic monitoring, which is conducted by permanent remotely operating sensors deployed right above the seabed at fixed buoys/platforms. Hydrographic monitoring covers the parameter salinity, temperature, oxygen, turbidity, and chlorophyll “a”. One station is operated by NSP2 inside Greifswald Lagoon. Data from two stations in the Pomeranian Bay can be obtained from the Federal Maritime Agency BSH Hamburg (MARNET-HELCOM stations operated by the governmental Institute for Baltic Sea Research Warnemünde). Hydrographic data are used for interpretation of biological data.

Infauna of soft bottom sediments/infauna of the sandbank at the Boddenrandschwelle
To assess spatial patterns of macrobenthic infauna, samples are collected by means of Van Veen grabs. Infauna along the pipeline route are sampled at 20 stations in the EEZ and 52 stations in Greifswald Lagoon and Pomeranian Bay after construction in 2018 annually in spring for four successive years (see Figure 39). In the vicinity of the temporary sediment storage area off the island of Usedom, an additional 20 stations are sampled (see Figure 39). Sampling stations are either located within the affected area or at untouched reference sites. At each station three samples are collected.

In the shallow waters of the sandbank at the Boddenrandschwelle, SCUBA divers collect box core samples along a transect in the vicinity of the backfilled trench and in an untouched reference area at 3–4 metres water depth (18 samples per area, respectively, see Figure 39). The area will be sampled twice per year in spring and autumn because very small short-lived invertebrate species prevail there and the top sediment itself is highly dynamic.

Sampled sediments are rinsed on board the ship into a tub in which the sediment is floated and sieved in portions over a sieve with 1mm mesh size (Van Veen grab samples) or 0.5mm mesh size (box corer samples), respectively. The sieve residues are placed in storage containers and preserved with 4% borax-buffered formaldehyde for laboratory treatment using a stereomicroscope. Lab analysis includes species identification, counting of specimen per species and fresh weight measurements. In addition, shell length of bivalves is measured. Finally, the data on benthos infauna obtained is subject to a number of statistical analyses.

Epifauna of soft bottom sediments
To assess the composition of macrobenthic epifauna in the vicinity of the pipeline route in the EEZ, epifauna are sampled by means of a 2-metre-wide beam trawl with a mesh size of 1cm.

Epifauna along the pipeline route in the EEZ will be assessed twice per year in spring and autumn along six transects, three transects are located north of NSP2 and three south of NSP2 (see Figure 39). The three northern transects are located at a distance of 1,000 metres and the three southern transects are located approximately 500 metres apart. The operational NSP pipelines are located approximately 500 metres further south of the southern transects. At each transect station, the beam trawl will be towed for a duration of 5 minutes across the sandy seafloor at a speed of 1 to 3 knots.

After trawling, the content of the cod-end (catch) is completely emptied into buckets, and specimens are identified, counted and weighed on board the vessel. Specimens that cannot be identified at species level at sea, particularly juvenile organisms, are preserved with 4% borax-buffered formaldehyde and transferred into the laboratory for treatment using a stereomicroscope. Lab analysis includes species identification, counting of specimen per species and fresh weight measurements. In addition, shell length of bivalves is measured. Finally, the data on soft bottom epifauna obtained are subject to a number of statistical analyses.

Epifauna of reinstated reefs at the Boddenrandschwelle

Two different survey methods are used for the assessment of the epifauna and flora in re-constructed reef areas and related undisturbed reef habitats nearby (reference sites, see Figure 39):

- underwater video and still image surveys by means of a towed underwater video camera system and a drop camera for still images (see Figure 44);
- sampling of epibenthic organisms attached to hard substrate (stones) by SCUBA divers.

The following parameters are quantified from underwater video and still images: stone cover, algae and hydrozoan cover, blue mussel Mytilus spec. cover and mussel length. Samples collected by divers are preserved with 4% borax-buffered formaldehyde and transferred into the laboratory for treatment using a stereomicroscope. Lab analysis includes species identification, counting of specimen per species and fresh weight measurements. In addition, shell length of bivalves will be measured. Finally, the data on reef epifauna obtained will be subject to a number of statistical analyses.

Figure 44. *Towed underwater video camera system and drop camera for still images.*

Epifauna of the pipeline

The post-construction succession and structure of macrobenthic epifauna growing on the NSP2 pipeline in the EEZ will be monitored by means of two different survey methods:

- underwater video survey by using a ROV;
- scratch sample collection by divers.

Underwater video inspection transects are being recorded at three different locations on pipeline B from 2019 until 2022 (see Figure 39). Since pipeline installation in Germany's EEZ was not completed in 2018, only two locations were inspected during 2019 monitoring. The following parameter is quantified from underwater video and still images: stone cover, algae and hydrozoan cover, Blue mussel cover, and mussel length.

Scratch sampling by divers is conducted only at one station at 18.5 metres water depth (see Figure 45). Scratch samples are preserved with 4% borax-buffered formaldehyde and transferred into the laboratory for treatment using a stereomicroscope. Lab analysis includes species identification, counting of specimen per species, and fresh weight measurements. In addition, shell length of bivalves is measured. Finally, the data on soft bottom epifauna obtained are subject to a number of statistical analyses.

In addition, the NSP pipeline installed in 2010 was also investigated one more time in 2019 (see Figure 39). The NSP pipeline is likely to function as a relevant source for various epibenthic species because the natural surrounding comprises soft bottom sediments only. However, planktonic larvae of epibenthic species in the open water (pelagial) are to be considered as the prevailing source for hydrozoan, bryozoan, barnacles, and Blue mussels settling on the concrete coating of the pipeline.

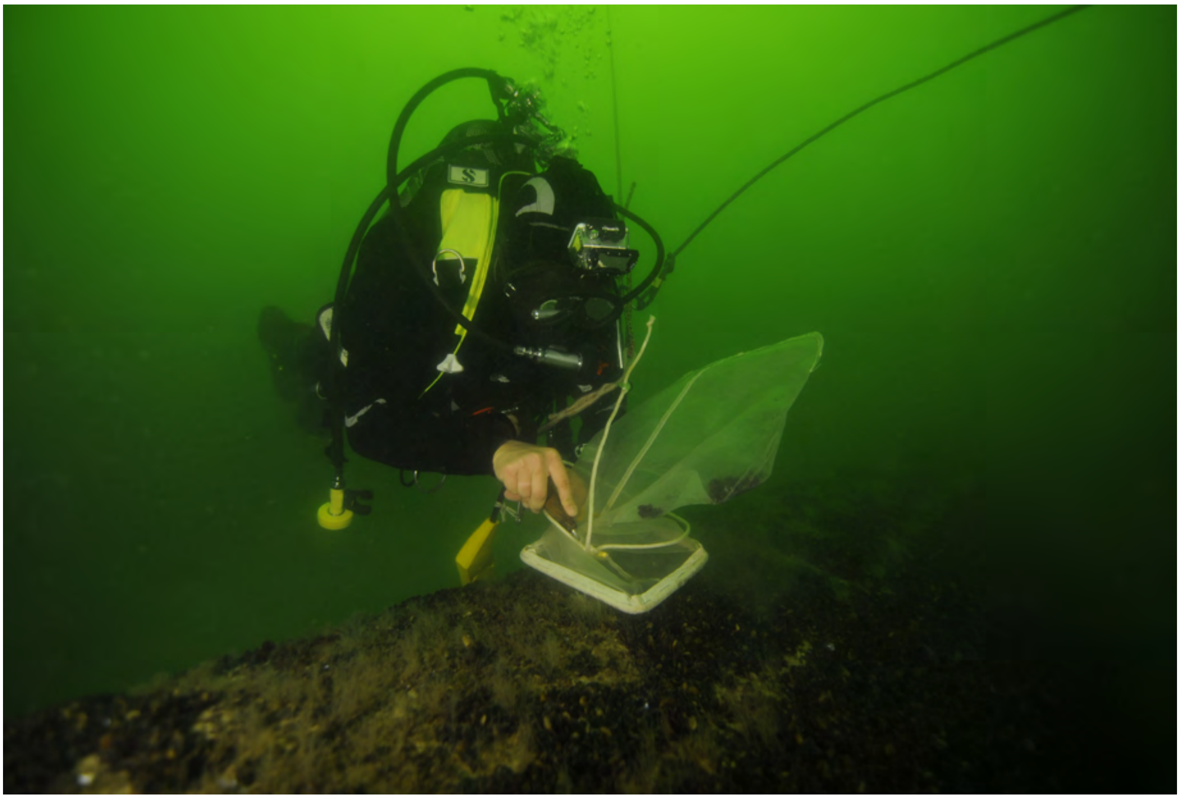

Figure 45. *Scratch sampling by a SCUBA diver on the pipeline at 18.5 metres water depth.*

Infauna of soft bottom sediments/infauna of the sandbank at the Boddenrandschwelle
Benthos recovery inside Greifswald Lagoon started immediately after termination of seabed intervention works in December 2018. About 30 species of benthic invertebrates were recorded in Greifswald Lagoon and in the Pomeranian Bay, respectively. No significant differences in species composition were observed between the backfilled trenches and untouched reference areas 18 months after physical reinstatement (see Table 15). Seven species observed belong to the diverse group of non-indigenous infauna species. All of them had been found in the area prior to installation of the NSP2 pipelines in 2018. The Oder estuary belongs to those water bodies in the Baltic Sea that are most exposed to immigration of alien species. The harbours of the Oder estuary and the Pomeranian Bay are known to be a gateway for invasive species from estuaries all around the globe /36/.

Table 15. *Macrozoobenthos infauna taxa inside Greifswald Lagoon in the vicinity of the pipeline trench and at untouched reference sites in 2020 (n = 2 × 10 stations with 3 replicate samples per station).*

Taxon	Trench	Reference
Bryozoa	**1**	**1**
Einhornia crustulenta	×	×
Cnidaria	**1**	**1**
Gonothyraea loveni	×	–
Crustacea	**6**	**6**
Amphibalanus improvisus	×	×
Bathyporeia pilosa	×	×
Crangon crangon	–	×
Cyathura carinata	×	×
Gammarus sp.	–	–
Gammarus salinus	×	–
Neomysis integer	×	×
Rhithropanopeus harrisii	×	×
Mollusca	**8**	**6**
Cerastoderma glaucum/Cerastoderma sp.	×	×
Ecrobia ventrosa	×	–
Limecola balthica/Tellinidae gen. sp.	×	×
Mya arenaria/Mya sp.	×	×
Mytilopsis leucophaeata	×	–
Mytilus edulis agg.	×	×
Peringia ulvae	×	×
Rangia cuneata	×	×
Oligochaeta	**3**	**2**
Baltidrilus costatus	×	×
Enchytraeidae gen. sp.	×	–
Tubificoides heterochaetus	×	×

Taxon	Trench	Reference
Polychaeta	**7**	**8**
Alitta succinea	×	×
Boccardiella ligerica	–	×
Fabricia stellaris	–	×
Hediste diversicolor	×	×
Marenzelleria sp.	×	×
Marenzelleria neglecta	×	×
Polydora cornuta	×	–
Pygospio elegans	×	×
Streblospio shrubsolii	×	×
Sum of taxa	**26**	**24**

Total macrozoobenthos abundance was twice as high in the vicinity of the backfilled trenches in the Greifswalder Bodden compared to reference sites (7,207ind./m² versus 3,022ind./m²). This finding results from the current low density of alder, large-sized soft-shell clams *Mya arenaria* in backfilled trenches which are filter feeding on meroplanktic larvae of other benthic invertebrates. Total macrozoobenthos biomass of the backfilled trenches doubled within 12 months (11g AFDM/m² in 2019 versus 21g AFDM/m² in 2020). However, benthic invertebrate biomass of backfilled trenches in the Greifswalder Bodden was still 50% lower compared to reference sites. The difference in biomass resulted almost entirely from the low abundance of large-sized soft-shell clams *Mya arenaria* in backfilled trenches which comprise 70–90% of the total biomass at reference sites. The burrowing soft-shell clam is a long-lived bivalve species with a low mobility/small migration volume of individuals >20mm shell-length. Hence, this bivalve was observed to have the longest recovery duration among all invertebrate infauna species during NSP's Recovery Monitoring Programme 2011–2016.

Comparable results were observed for the trenches in Pomeranian Bay and for the temporary sediment storage area off the island of Usedom.

Due to the general absence of large burrowing bivalves, the recovery of the infauna of the sandbank at the shallow exposed Boddenrandschwelle progresses faster than the recovery of the trench sections at water depths >5 metres. A total of 20 taxa (including 2 established non-indigenous species) was found during both sampling campaigns in 2020 (see Table 16). The number of taxa was lower in the backfilled trench in comparison to the reference area in spring and autumn, respectively. Both total infauna abundance and total infauna biomass were comparable in 2020 in the vicinity of the backfilled trench compared to the untouched reference area. Abundance and biomass of the amphipod *Bathyporeia pilosa*, the most characteristic invertebrate species of this exposed, dynamic habitat type, was by far greater in the trench vicinity. Tiny oligochaetes of the Genus Enchytraeidae prevailed at the reference stations.

Table 16. *Macrozoobenthos infauna taxa of a sandbank at the Boddenrandschwelle in spring and autumn 2020 (18 samples per area per sampling campaign).*

Taxon	Spring 2020		Autumn 2020	
	Pipeline	Reference	Pipeline	Reference
		Bryozoa		
Einhornia crustulenta	+	+	+	+
		Crustacea		
Bathyporeia sp.	+	+	–	–
Bathyporeia pilosa	+	+	+	+
Cyathura carinata	–	–	–	+
Heterotanais oerstedii	–	–	–	+
Idotea sp.	–	–	+	–
Neomysis integer	–	–	–	+
		Insecta		
Halocladius sp.	+	–	+	–
		Mollusca		
Cerastoderma sp.	–	–	+	–
Cerastoderma glaucum	–	–	+	+
Limecola balthica	+	+	+	–
Mya sp.	+	+	+	+
Mya arenaria	+	+	+	+
Mytilus edulis agg.	–	–	+	+
Peringia ulvae	+	+	+	+
		Nemertea		
Nemertea indet.	–	+	–	–
		Oligochaeta		
Baltidrilus costatus	–	+	–	+
Clitellio arenarius	–	+	–	+
Enchytraeidae gen. sp.	+	+	+	+
Phallodrilinae gen. sp.	–	+	–	+
		Polychaeta		
Hediste diversicolor	+	+	+	+
Marenzelleria sp.	+	+	+	+
Marenzelleria neglecta	–	+	+	+
Pygospio elegans	+	–	+	–
Sum species	**7**	**9**	**9**	**12**
Sum Taxa	**12**	**15**	**16**	**17**

Epifauna of soft bottom sediments

The epifauna of soft bottom sediments in Germany's EEZ is characterised by a low species diversity (due to the low salinity of about 8 PSU only and the lack of habitat diversity – no hard bottom substrates), a low total abundance and a low total biomass (seabed at water depth of >20 metres is below the euphotic zone – low benthic and pelagic food supply).

As in 2019, a total of 15 species of sessile and vagile epifauna species were found during monitoring in 2020. Sessile species settle on shells of Blue mussels (*Mytilus* spec.), which commonly drift in small clumps across the sandy bottom. Total abundance of sand bottom epifauna ranged between 100–20,000ind./m². Total biomass of sand bottom epifauna ranged from 0.2–23g FM/m². Blue mussels comprised >90% of total abundance and total biomass of all samples.

As in 2015/2016 (baseline investigation), no differences occurred between the samples collected either north or south of NSP2 in 2020. No differences were observed between samples collected during baseline investigations (2015/2016) in 2019, and 2020 (5, 10, 17, and 21 months after 50% of pipelay in the German EEZ, respectively). At the current stage of the project, changes in soft bottom epifauna are very unlikely. Changes in soft bottom epifauna may occur between NSP and NSP2 pipelines, when NSP2 becomes operational:

- Increase in fouling fauna on pipelines (artificial reef);
- Blocking of bedload transport between NSP and NSP2 pipelines.

Epifauna of reinstated reefs at the Boddenrandschwelle

Video inspection of the reinstated reefs at the Boddenrandschwelle 8 months after installation works proved that the mechanical reinstatement of the hard bottom structure was successful and stable (no coverage by sand). Furthermore, the pebbles and stones that had been placed were almost entirely overgrown by pioneering flora and fauna: annual red algae, hydrozoans, and barnacles. Blue mussel (*Mytilus* spec.) was also observed to be abundant 1.5 years after reinstatement (see Figure 46).

As predicted, scratch sample analysis revealed that species number and total epifauna abundance were comparable 1.5 years after reinstatement. Only total epifauna biomass was significantly lower at reinstatement sites, since alder large-sized Blue mussels were by far more abundant there. The biomass of Blue mussels was approx. 3 times higher at reference sites (see Table 17).

Table 17. *Comparison of status quo of descriptive parameter of epifauna and -flora at the Boddenrandschelle in summer 2020, 1.5 years after termination of seabed intervention works.*

Parameter	Reinstated reefs	Untouched reference reefs
Hydrozoan/red algae cover (%)	100	80
number of invertebrate epifauna species (per scratch sample)	20	19
Total epifauna abundance (ind./m²)	114,517	125,633
Total epifauna biomass (AFDM g/m²)	68	198

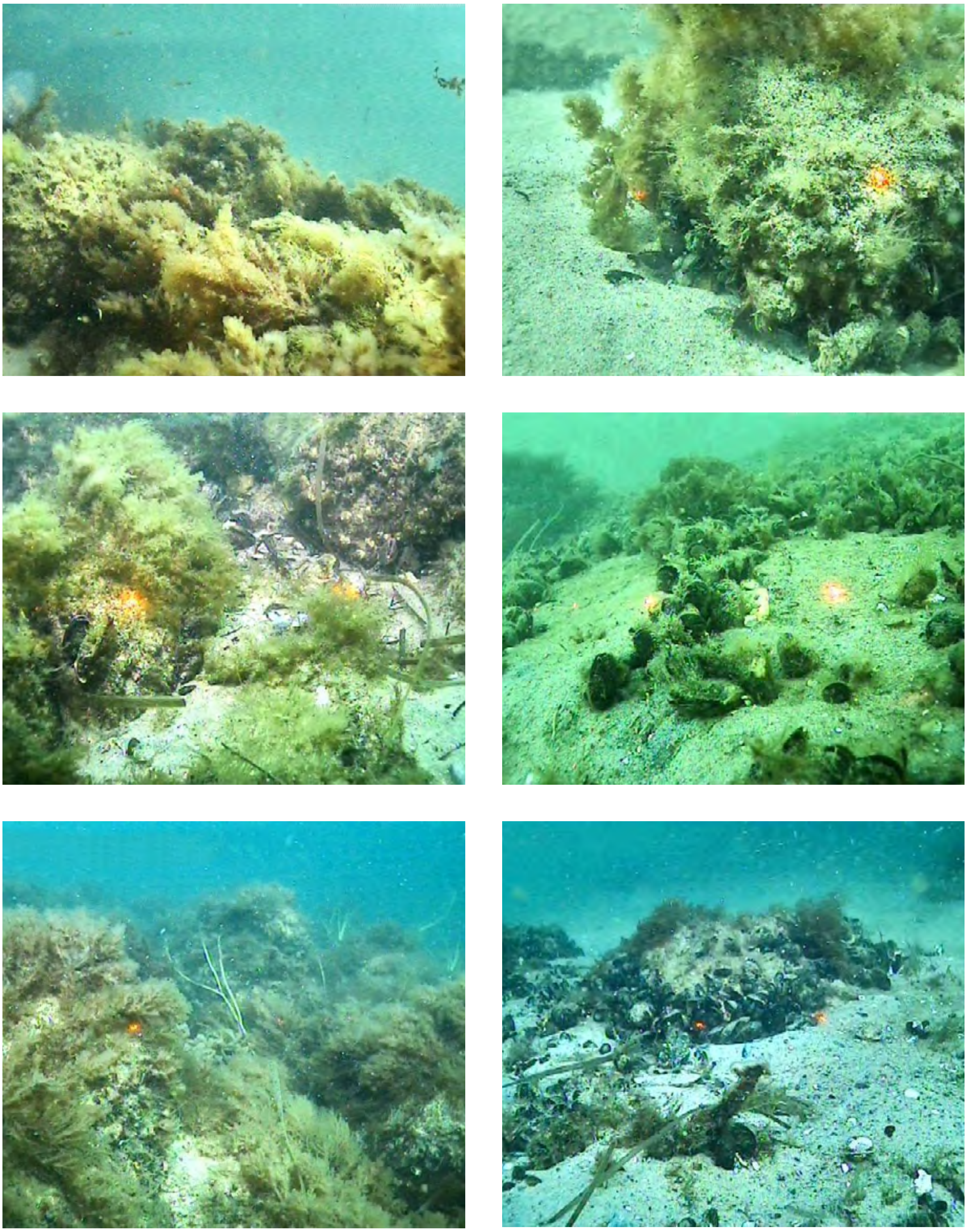

Figure 46. *Still images of reinstated reefs (left) and untouched reference reefs (right) at the Boddenrandschwelle taken 1.5 years after pipeline construction. The remaining difference between sites is a lower biomass of large-sized Blue mussels (Mytilus spec.) at reinstatement sites.*

Epifauna of the pipeline

Settlement of various sessile epifauna species was observed during ROV inspection of the NSP2 pipeline in the German EEZ in August 2020. Bryozoa, Hydrozoa, barnacles and spat of Blue mussels were recognised. Biofouling coverage ranged from 80–100%. Blue mussels were prevailing 1.5 years after pipelay (see Figure 47). A total of 19 epifauna species including two well-established invasive species was recorded in the scratch samples (see Table 18).

Side view south | **Top of pipeline** | **Side view north**

Figure 47. *Still images of biofouling on NSP2 pipelines taken in August 2020, 1.5 years after pipeline installation.*

Table 18. *Epifauna invertebrate species growing/living on the NSP2 pipelines in August 2019 and August 2020 (scratch samples). × = record; "–" = not recorded.*

Taxo	August 2019	August 2020
Bryozoa		
Alcyonidiidae gen. sp.	–	×
Alcyonidioides mytili	–	×
Einhornia crustulenta	×	×
Cnidaria		
Aurelia aurita	–	×
Campanulariidae gen. sp.	×	–
Gonothyraea loveni	×	–
Crustacea		
Amphibalanus improvisus	–	×
Aoridae gen. sp.	×	–
Balanidae gen. sp.	×	–
Crangon crangon	×	–
Crangonidae gen. sp.	×	–
Gammarus sp.	×	×
Gammarus oceanicus	–	×
Gammarus salinus	×	×
Gammarus zaddachi	×	×
Jaera (Jaera) albifrons agg.	×	×
Jaera (Jaera) praehirsuta	–	×

Taxo	August 2019	August 2020
Jassa herdmani	×	×
Jassa marmorata	–	×
Microdeutopus gryllotalpa	×	–
Mysidae gen. sp.	×	–
Palaemon elegans agg.	×	–
Praunus flexuosus	×	–
Praunus inermis	×	–
Mollusca		
Cardiidae gen. sp.	×	×
Hydrobiidae gen. sp.	×	–
Limecola balthica	–	×
Mya sp.	×	×
Mytilus edulis agg.	×	×
Peringia ulvae	×	×
Tellinidae gen. sp.	×	×
Nemertea		
Nemertea indet.	–	×
Oligochaeta		
Nais elinguis	–	×
Paranais litoralis	–	×
Platyhelminthes		
Stylochoidea indet.	–	×
Polychaeta		
Alitta succinea	–	×
Bylgides sarsi	–	×
Hediste diversicolor	–	×
Nereididae gen. sp.	×	×
Polydora cornuta	–	×
Pygospio elegans	×	×
Number of species	**11**	**19**
Number of taxa	**14**	**10**

CONCLUSIONS

Macrozoobenthos invertebrate fauna surveys, conducted in 2020, revealed a progressive stage of succession for all benthic habitats under investigation. The findings are in line with predictions made in the permit application documents, which were based on the results of the NSP Recovery Monitoring Programme 2011–2016. Future surveys will continue to document the succession of infauna and epifauna of affected seabed habitats along the pipeline route and on the artificial reef formed on the NSP2 pipeline installed on the seabed in the German EEZ.

6.3.4 Marine mammals

Two species of marine mammals inhabit the coastal waters of the German section of the pipeline route. Baltic grey seals (Halichoerus grypus grypus) use a number of haul-out sites in the eastern part of the Greifswalder Bodden. They are located in the immediate vicinity of the route and the interim storage area, respectively. Grey seals are quite mobile over the course of the year and the local population uses the entire southwestern Baltic Sea as its home range /39/. Harbour porpoises (Phocoena phocoena) occur in the northern Pomeranian Bay at low density during summer and autumn only. Due to their seasonal distribution pattern, it is concluded that these animals belong to the western management unit of the Danish Belt Sea /40/. The presence and seasonality of both species were monitored during offshore construction in 2018 and afterwards also in 2019. From 2020 onwards, only harbour porpoise monitoring was continued, as no offshore construction activities were carried out or planned in the Greifswalder Bodden.

METHODOLOGY

Harbour porpoise monitoring was conducted by passive stationary recording of their echo-location clicks. In total, 13 stations equipped with so-called C-PODs (cetacean porpoise detector) were installed across the Pomeranian Bay, with seven stations located in the vicinity of the pipeline route (see Figure 39). A similar monitoring programme, using the same spatial layout, was conducted between 2010 and 2013 during environmental monitoring for Nord Stream. The approach also mirrors the method applied during the SAMBAH project /37/.

C-PODs are capable of remotely recording, extracting and counting porpoise click trains. They do not allow for recognition of individuals. Hence, the monitoring provides information about the presence and relative intensity of use, but not for quantitative analysis. Due to the rare presence and very low abundance of harbour porpoises in the Pomeranian Bay, quantitative survey techniques (ship-based or aerial surveys) are not applicable.

RESULTS

Harbour porpoise

The presence, distribution pattern (see Figure 48) and seasonality (see Figure 49) of harbour porpoises recorded in 2020 mirrored the pattern observed during NSP monitoring in 2013 (two years after construction) and NSP2 monitoring during construction in 2018/2019. The highest detection rates were registered in the north-west of the Pomeranian Bay and in the vicinity of the pipeline routes. Detection frequency peaked again in October.

The harbour porpoise detection rate continued to increase in 2020. A continuing increase in harbour porpoise activity during summer and autumn in Pomeranian Bay has been observed since 2008 /38/. Again, animals arrived already in May (see Figure 49).

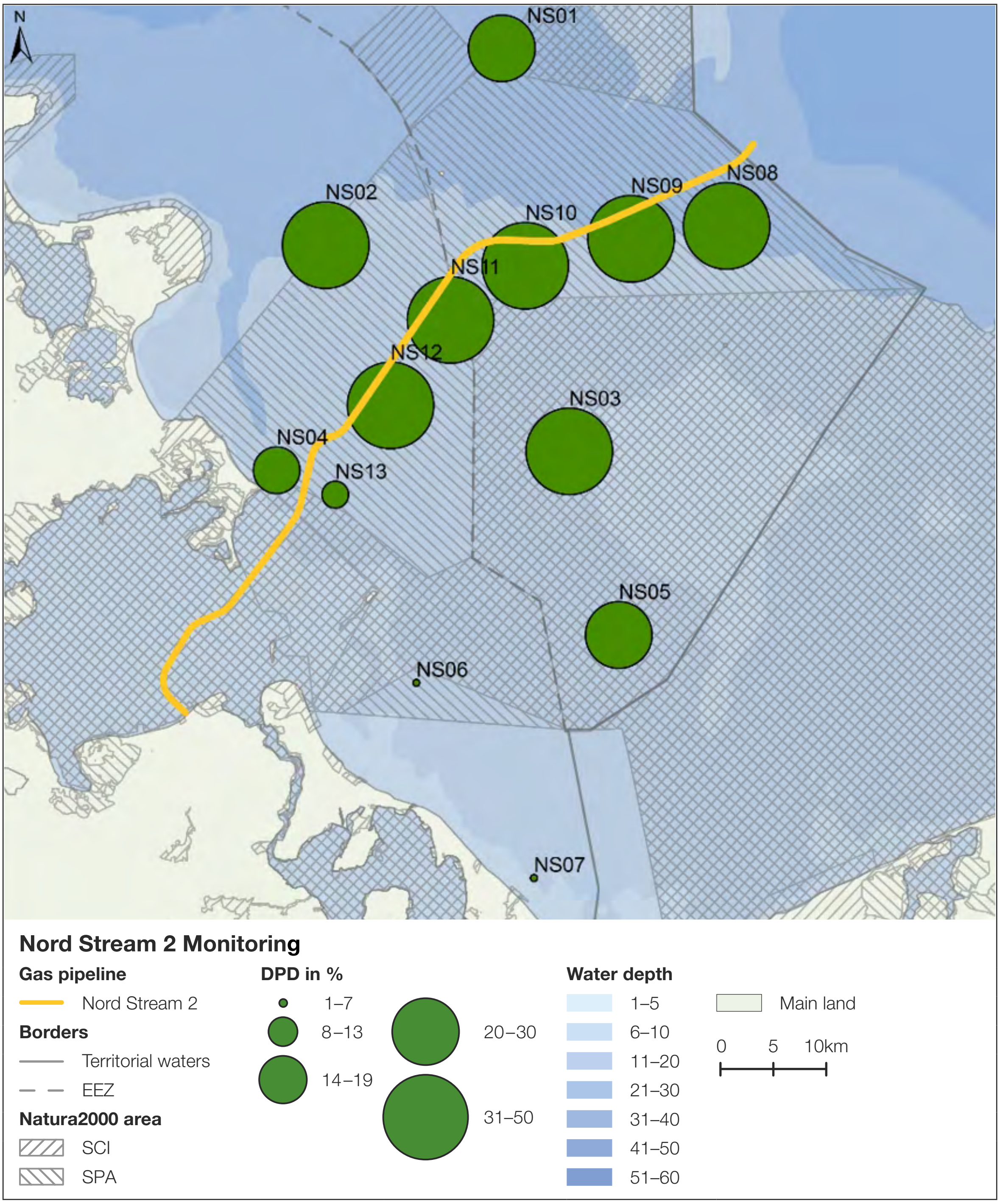

Figure 48. *Mean detection rate per month (% DPD) per station between January and December 2020 in the Pomeranian Bay.*

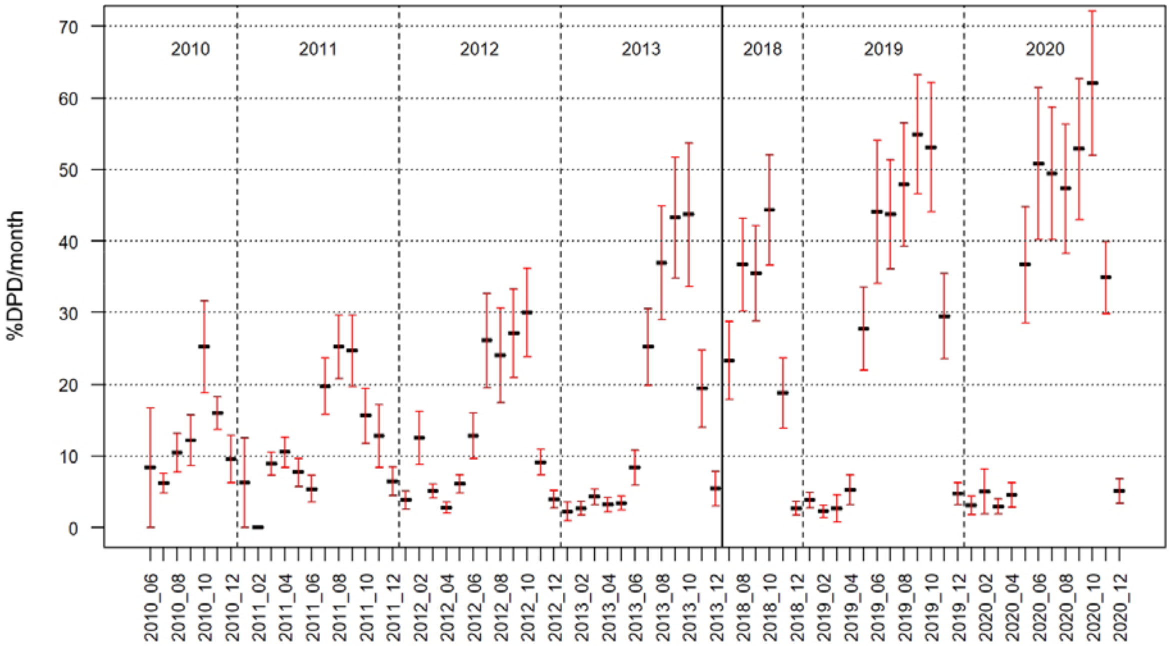

Figure 49. *Trend in mean detection rate per month (% DPD) between 2010 and 2019.*

CONCLUSIONS

Harbour porpoises continued to increase in the northern Pomeranian Bay along the German section of the NSP2 route after offshore construction works in 2018. Harbour porpoise monitoring was prolonged into 2021 since offshore construction is still outstanding for the remaining section of 16.5km in EEZ GER.

6.3.5 Birds

The Pomeranian Bay and Greifswald Lagoon are the most important wintering areas for seabirds in the Baltic Sea /39/. About 5,000km² have been designated in these waters as EU Natura 2000 sites. Three SPAs cover the German part of the Oder estuary and another one covers the Polish part of the bay.

The shallow Pomeranian Bay is the most important wintering area for benthophagous sea ducks in the West Palaearctic. Up to 1 million long-tailed ducks (*Clangula hyemalis*), common scoters (*Melanitta nigra*), and velvet scoters (*Melanitta fusca*) may spend the winter season there between November and early May. Sea ducks prey almost exclusively on bivalves living either attached to stones (Blue mussel) or burrowed in soft sediments (clams such as *Mya arenaria*, tellins *Limecola balthica*), and cockles *(Cerastoderma edule*). Since bivalves are long-lived invertebrate species, seabed intervention works will not only affect the benthic fauna, but also their predators: fish and sea ducks. The impact may last until the food supply harvestable by the sea ducks has recovered. Based on the results of the NSP Recovery Monitoring Programme 2011–2016, this effect may last for two to four years. Since the overall temporary footprint of seabed intervention works in Pomeranian Bay is comparatively low (about 4km² out of 5,000km² of potential feeding habitat), no impact on population trends was observed after NSP installation in 2010/2011 /34/.

Pipeline route sections installed on the seabed may provide a surplus of food for seabirds, because the concrete coating will be subject to biofouling. After some years, the exposed pipelines will be almost entirely overgrown by Blue mussels down to about 30 metres of water depth. The developing artificial reef may attract demersal fishes and seabirds. During the NSP Recovery Monitoring Programme 2011–2016 it was observed in 2013 and 2016 that long-tailed ducks, scoters and grebes aggregated

in the vicinity of the exposed NSP pipeline down to a water depth of 22 metres /34/. This effect disappeared again in 2018, when trawl fishery started to trawl along the pipelines and repeatedly scraped off the mussel cover.

Greifswald Lagoon is very important for wintering and migrating seabirds as well because it is the spawning ground for the western Baltic herring population. Both piscivorous and benthophagous seabirds become attracted annually during the spawning season from February until May. Cormorants, grebes, loons, and mergansers prey on spawning herring. Long-tailed ducks and greater scaups (*Aythya marila*) prey on herring eggs. Especially the marginal well towards the Pomeranian Bay ("Boddenrandschwelle") may host up to 100,000 seabirds at a time in March and April. Therefore, the herring spawning season has been precluded from NSP2 offshore construction in Germany. Impacts on seabirds could be entirely avoided inside Greifswald Lagoon through this mitigation measure.

Post-construction seabird monitoring in Germany from 2019–2022 focuses on the overall trend of wintering seabird populations in the area and on analysing small scale effects that may result from dredging works in the vicinity of trench sections (in German Territorial Waters) and from artificial reef effects for the section of the route where the pipelines were installed on the seabed (EEZ Germany).

METHODOLOGY

Three different survey techniques are being applied for seabirds during NSP2 recovery monitoring in Germany between 2019 and 2022:

- Ship-line transect surveys to estimate midwinter numbers of seabirds in the western part of the Pomeranian Bay (see Figure 39) once per year in February or March – with trend analysis,
- Search flights for flocks of long-tailed ducks and greater scaups inside Greifswald Lagoon during the herring spawning season twice per year in March and April – with trend analysis,
- Aerial digital imagery flights for the analysis of small-scale impacts in the vicinity of the pipeline (see Figure 39) twice per year in February and April – with small-scale effect analysis.

Ship-line transect survey

According to the German standard STUK4, ship-based surveys follow the routines detailed by Webb & Durinck /40/ and Garthe et al. /41/, using a 300-metre-wide line transect and two observers on either side of the vessel. Platform position is recorded at regular intervals automatically using GPS. The detectability of seabirds decreases with increasing distance from the survey platform, resulting in an effective strip width which is smaller than the total transect width /42/. The effective strip width is calculated by application of the distance sampling software package provided by Laake et al. /43/ separately for different sea state classes and flock size classes. Corrected data are used to calculate seabird densities (individuals per km^2) for grid cells of 4 × 4km. The distribution of seabirds will be mapped as seabird densities per grid cell (see Figure 52). Seabird densities are also used to calculate absolute populations in specific sea areas.

The total survey area is 2,256km^2 wide, covering the core habitats for wintering seabirds in the German part of the Pomeranian Bay (see Figure 52). Both the survey design and the survey method have been applied since 2006 for the NSP and NSP2 environmental monitoring programmes. The large extension of the survey area together with the high level of standardisation of the survey methods meanwhile allows for an analysis of trends in local seabird wintering numbers.

Aerial search flights inside the Greifswald Lagoon

Long-tailed ducks and greater scaups feeding on herring eggs inside Greifswald Lagoon cannot be counted by line transect surveys. The birds gather at certain daytime roosts to avoid predation by sea eagles and greater black-backed gulls and search for fresh herring eggs predominantly at night. Because of the patchy distribution of the sleeping ducks, targeted observer search flights are conducted to find the roosting flocks to photograph and count the number of individuals. This survey routine has been performed since spring 2007. Two search flights per herring spawning season allow for an analysis of trends in local duck populations.

Aerial digital imagery flights

Aerial digital imagery flights allow for the analysis of potential small-scale effects in the vicinity of offshore installations and vessels, since individual birds caught in the images can be geo-referenced by GIS. StUK4 /35/, implemented digital imaging as the standard method for the monitoring of staging birds and marine mammals during the pre-construction, construction and post-construction phases of major offshore projects in the German EEZ.

For the digital bird survey, a twin engine Partenavia P68 aircraft is used with a hatch allowing the installation of the camera system (see Figure 50). For image capturing with DAISI, two iXA 180 Phase One aerial cameras are in use. Each camera has a resolution of 5.2 micron and addresses 10,328 × 7,760 pixels (80MPI) with a dynamic range of >72dB. To implement this resolution, a CCD sensor with an effective size of 53.7 × 40.4mm is used as an input capture unit. The frame rate is 1.5 seconds in theory, but in practice 1.8 seconds per frame. During recording, the cameras are operated with exposure times as short as 1/1,600 second to a maximum of 1/1,000 second and with the central shutter. To achieve a resolution of 2cm, lenses with image stabilisation (FMC – Forward Motion Compensation) are used (Fast Sync lenses – FS). To obtain the most homogeneous and sharp picture as possible, both cameras are mounted on an AeroStab-Twin stabiliser. This device permanently adjusts the cameras vertically straight down when the aircraft rolls or tilts.

An image mosaic results along the captured transect line, depending on trigger interval and airspeed. To compensate for drift (e.g. caused by crosswinds) of the aircraft and to provide a homogeneous mosaic, the stabiliser pivots the camera system in the direction of the transect line (heading). Figure 51 shows an extract of a mosaic.

The images are screened visually with the image size scale set to 100%. Aerial photographs are divided into grid cells (50–80cells/image, depending on the image surface after removal of overlapping areas) with a purpose-programmed software application which guarantees an image resolution of 100%, depending on screen size. The software tool allows a complete and systematic manual walkthrough of image files by displaying one grid cell after another on the screen. All objects which indicate a bird or marine mammal are labelled manually in the programme and automatically added to a database. The subsequent evaluation steps include species identification and quantification of pre-sorted objects and the collection of additional information and parameters. At least two experts independently identify species with a specifically designed viewing and input software. The software application for manual species identification makes it possible to measure the size of objects and to enlarge or minimise pictures. There are also various additional entry fields where the respective species and any additional information about seabirds or marine mammals can be included.

The assessment of seabird populations in a study area depends on species-specific density calculations, which can be made from the number of documented individuals in relation to the analysed image area. This procedure is consistent with the basic principle of analysis of visual survey data. In the analysis of aerial photos, factors otherwise correcting for velocity and distance-related observation bias in visual aerial surveys can be omitted.

The NSP2 survey design includes the NSP2 pipelines (installed in 2018), the NSP pipelines (installed in 2010/2011), and two reference transects, partially covering 50Hz wind farm power cables. The complexity of the survey design will require sufficient sample sizes for statistical modelling. Species-specific sample sizes obtained by the surveys in 2019 were too small for any statistical approach.

Figure 50. *Survey platform for digital seabird surveys: Partenavia P68c. Detail views of the camera system.*

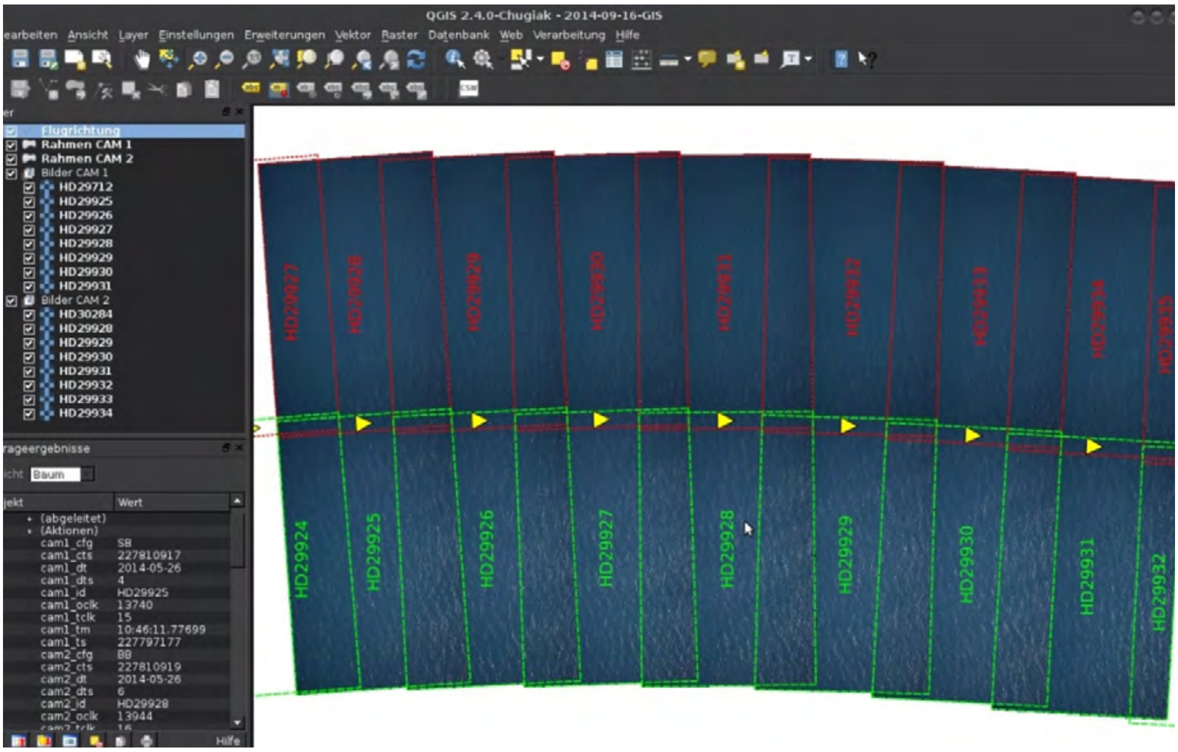

Figure 51. *Example of a photographic mosaic of overlapping georeferenced image pairs (starboard camera: red, portside camera: green, flight direction: yellow arrows).*

RESULTS

The complexity of seabird data collected by the 2019–2022 NSP2 recovery monitoring programme in Germany does not allow for an extensive presentation as part of this overall monitoring report. The NSP2 monitoring focuses especially on 10 seabird species. We selected the distribution of seabirds in the vicinity of the NSP and NSP2 pipelines.

Digital imagery flights along the pipelines have meanwhile been conducted during three wintering seasons/spring migration periods (see Table 19).

Table 19. *Density of seabirds in the Pomeranian Bay along a transect covering both the NSP and NSP2 pipelines (digital imagery flights). Data for 2016, 2019 and 2020. Species specific maxima are highlighted in bold.*

Date/species	13.02.2016	09.04.2016	27.02.2019	01.04.2019	14.03.2020	08.04.2020
Long-tailed duck	16.91	**55.25**	9.35	4.05	19.64	29.54
Common scoter	2.57	65.21	2.34	7.34	23.53	61.31
Velvet scoter	0.75	1.82	0.38	1.70	2.79	2.96
Scoter (not identified)	14.48	105.73	0.02	0.03	0.22	1.87
All Scoters	17.80	**172.76**	2.74	9.07	26.54	66.14
Grebes	0.05	0.02	**0.11**	0.06	0.01	0.00
Loons	1.87	2.20	0.54	**2.51**	1.18	1.11
Auks	0.18	0.36	0.16	0.54	**3.80**	0.48

Density of staging seabirds differed significantly between years. This variation resulted from overall Baltic Sea ice cover during winter, the breeding success of the preceding breeding season, and the annual timing of the spring migration. So far seabird numbers in the Pomeranian Bay are rarely driven by local environmental factors (only in case of ice cover). However, spatial distribution within the Bay can be affected by both local environmental factors (especially the distribution pattern of harvestable food supply) and anthropogenic effects (especially displacement along the major shipping routes).

Digital imagery flights along the NSP and NSP2 pipelines shall answer two questions:

1. Does installation of the pipelines in trenches (Territorial Waters) affects the seabird density due to the temporary lowering of the benthic food supply, especially filter-feeding bivalves?
2. Does the biofouling community growing on the pipelines installed on the seabed (EEZ) attract benthophagous and piscivorous seabirds through the “artificial reef effect”?

Aerial surveys in 2016 and again in 2020 revealed an attraction of benthophagous seaducks along the NSP pipelines (installed in 2010/2011) in the vicinity of the EEZ above 25 metres water depth (see example in Figure 52). No such effect was observed for piscivorous auks or loons (see example in Figure 53).

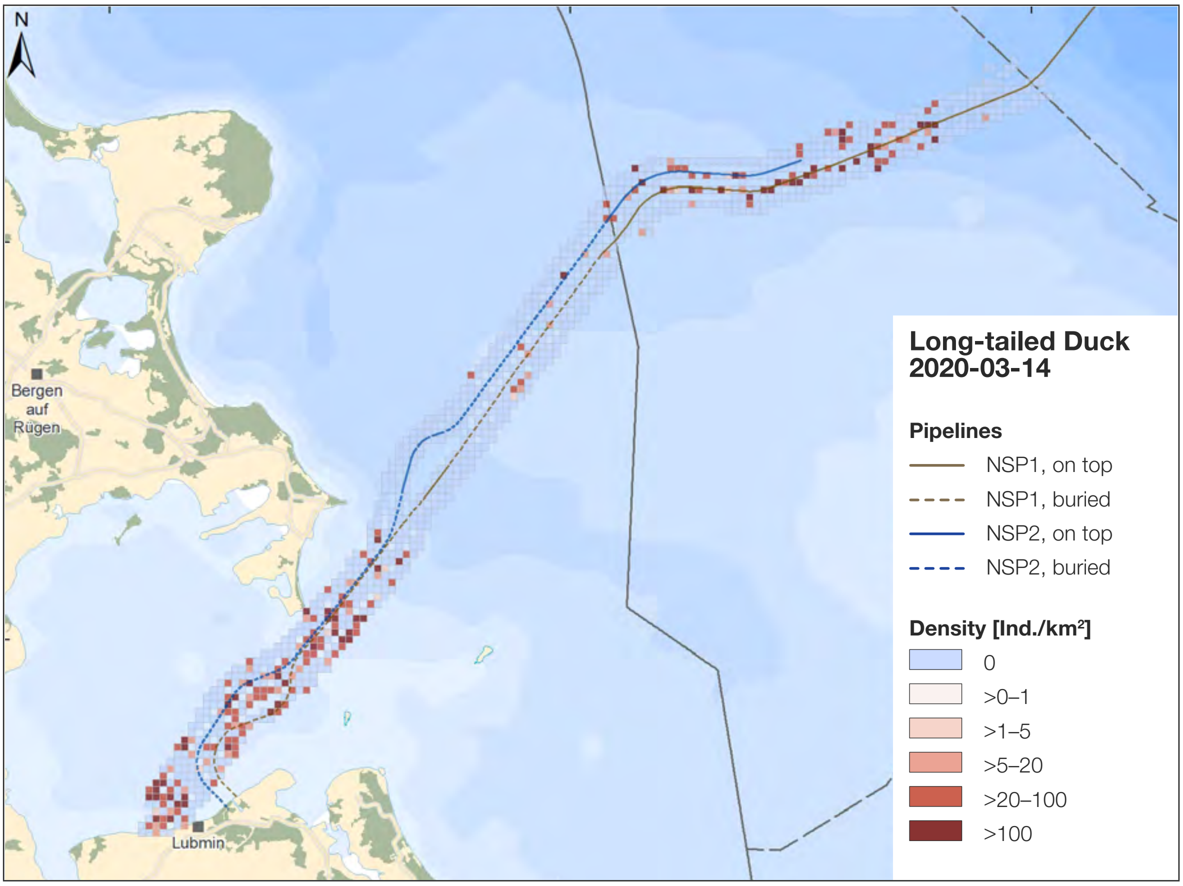

Figure 52. *Distribution of long-tailed ducks (Clangula hyemalis) in the Pomeranian Bay in March 2020 along the NSP and NSP2 pipelines. Note the attraction of the NSP pipelines installed on the seabed in the EEZ. Digital imagery flights.*

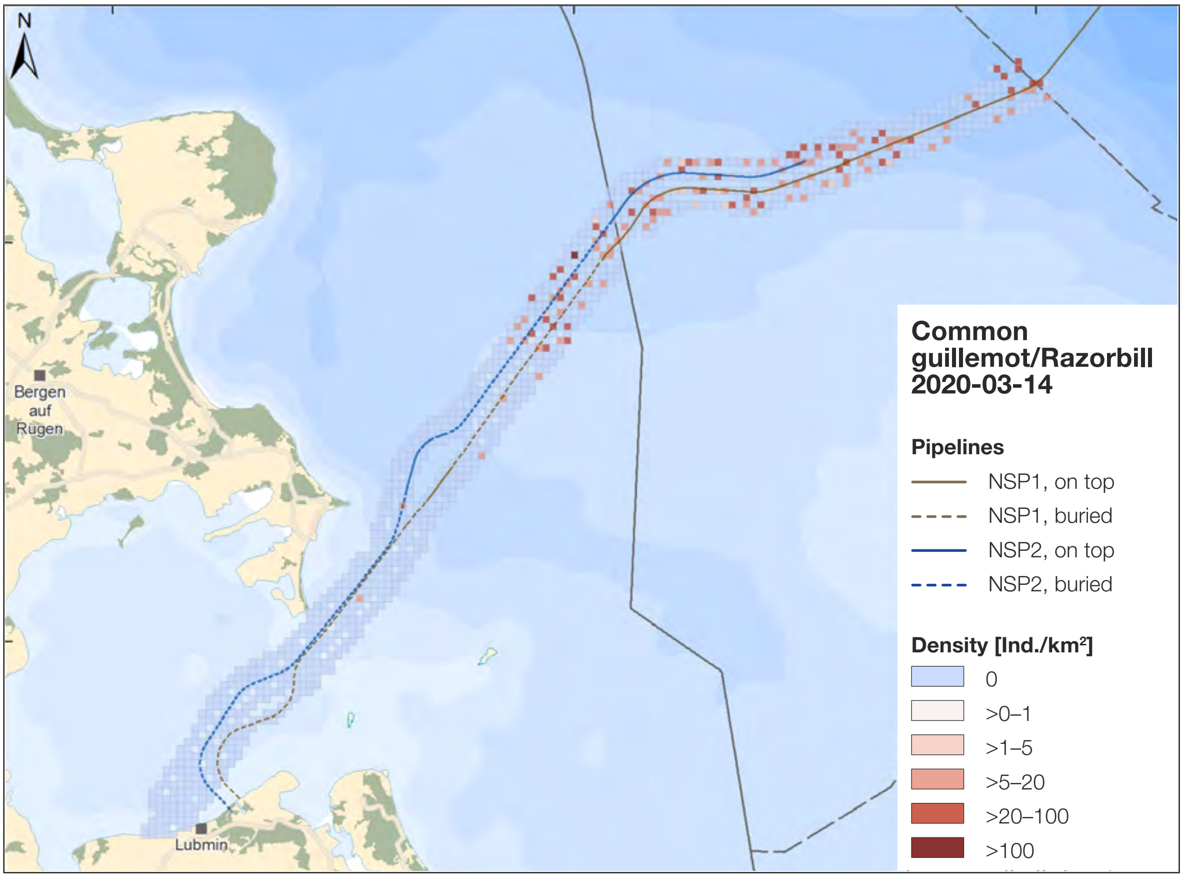

Figure 53. *Distribution of auks (Razorbill Alca torda and Common guillemot Uria aalge) in the Pomeranian Bay in March 2020 along the NSP and NSP2 pipelines. Note the attraction of the NSP pipelines installed top of seabed in the EEZ. Digital imagery flights.*

As in 2019, statistical modelling found no avoidance (pipeline installed in trenches) nor any attraction effect (pipeline on the seabed) for the NSP2 pipelines. Since Blue mussel coverage on the pipelines installed on the seabed in the EEZ is growing quickly (see Figure 47), it is assumed that the NSP2 pipelines will exert an attraction effect from winter 2021 onwards.

CONCLUSIONS

Seabird monitoring in winter 2020 did not reveal any prominent changes which might have been related to the installation of the NSP2 pipelines.

7 Unplanned events

Environmental and social incidents are classified as accidents and near misses on a three point scale of minor, moderate or major. Four environmental incidents occurred in 2020. All were classed as minor spills. All spills were below 10 litres. Three offshore spills of which two were spills to the marine environment, and one was contained on deck of a vessel. One onshore spill to the roadway hard-standing outside of the landfall area in Russia.

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