SALT RAPPORT 1098

Adapting a Riverine Litter Indicator for OSPAR Monitoring: A Framework for Norwegian Conditions M-3080|2025.

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Summary
The project proposes and tests a monitoring method for riverine litter in Norwegian rivers to develop a standardized indicator for riverine litter in Norway that aligns with the OSPAR framework. Fieldwork in eight rivers in southern Norway provide experience with data collection and a basis for adaptation of the method to Norwegian conditions. The results form a basis for further standardization of riverine litter monitoring.

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INNHOLDSFORTEGNELSE

UTFYLLENDE SAMMENDRAG PÅ NORSK

Bakgrunn og formål

Denne rapporten presenterer utvikling og uttesting av et forslag til metode for standardisert overvåking av forsøpling langs norske elvebredder. Formålet er å bidra til utviklingen av en OSPAR-protokoll for overvåking av elveforsøpling langs europeiske elver, med utgangspunkt i eksisterende retningslinjer for strandsøppel (CEMP guidelines). Den endelige OSPAR metodikken skal kunne brukes i internasjonal miljøforvaltning og inngå i OSPAR-samarbeidet for beskyttelse av det nordøstlige Atlanterhavet.

Prosjektet inngår i arbeidet med å etablere en kunnskapsbasert og sammenlignbar overvåkingsmetodikk for plastforsøpling i elver hvor det også tas hensyn til norske elvers klimatiske og hydrologiske forhold. Prosjektet skal også belyse hvordan norske elver, med sin store variasjon i vannføring, morfologi og sesongmessige forhold, krever tilpasninger for å kunne sammenliknes med data fra sentraleuropeiske elver.

Protokollutvikling

Feltundersøkelser ble gjennomført i mai 2025 i åtte elver i Sør-Norge: Haukås, Bolstad (Vosso) Numedalslågen, Lier, Alna, Otra, Bjerkreim og Orre. De valgte elvene representerer ulike påvirkningsformer (urban, industriell, landbruksmessig), samt variasjon i elvenes størrelse, substrat og hydromorfologi. For hver elv ble to segmenter på 100 meter undersøkt for mengden plast som lå langs bredden fra vannkanten til knekkpunktet på elvebredden (leveen). Tre elver (Otra, Haukås og Bolstadelva) ble besøkt igjen i oktober og november 2025 og overvåking av de samme elvestrekningene ble gjentatt for å vurdere ny forsøpling.

Metodeutvikling

I forkant av feltarbeidet ble det utviklet et utkast til feltmanual ("The Norwegian Field Guide to Riverine Litter Monitoring – Version 1") og tilhørende registreringsskjema, basert på CEMP guidelines for strandsøppelovervåking. Denne ble tilpasset med parametere relevante for elver (bl.a. elvebreddens helning, flomlinje, vegetasjonstype, vannhastighet og menneskelig bruk av elvebredden i områdene rundt). Målet var blant annet å sikre beskrivende og reproduserbare metadata på tvers av elver, gi mulighet for lik utførelse, like hensyn ved utvelgelse av segmentene og gode kvantitative data med lav usikkerhet, samtidig som metoden kunne utføres trygt av moderat trent feltpersonell uten behov for spesialutstyr.

Resultater og erfaringer

Datainnsamlingen dokumenterte store romlige variasjoner i mengde og type plastavfall både mellom og innenfor elver. Avfallsfordelingen viste seg å være ujevn, med tydelig lokal opphopning av avfall i visse segmenter. I flere tilfeller ble det observert store forskjeller i sammensetning og mengde mellom segmenter som lå tett på hverandre. Den minst forurensede strekningen kunne gjerne være nedstrøms, noe som tyder på at søppel effektivt kan holdes tilbake på elvebredden. Dermed vil det være viktigere for overvåking at området er egnet for akkumulering enn at det er nærmest mulig elvens utløp.

Observasjonene indikerer behov for å vurdere bruk av flere eller lengre overvåkingsstrekninger enn de 100 meterne som benyttes i strandsøppelprogrammet, for å oppnå representativitet og redusere antall null-verdier.

Vanlige avfallstyper var plastfragmenter, poser, landbruksplast (folie og rundballeplast) og engangsartikler. Urbant påvirkede elver som Alna og Lier hadde høyest avfallsmengder, mens rurale elver som Numedalslågen og Orre hadde lave nivåer. Mange gjenstander var ugjenkjennelige fragmenter, som tyder på gammelt avfall. Disse har lavere verdi i overvåkning da de ikke kan identifiseres til kilde.

Gjennomsnittlig tid brukt per 100 m segment for alle elvene var rundt 50 minutter for to personer ved første registrering. Etter etablering av målepunkter forventes tidsbruken å reduseres. Undersøkelsene viste at metoden er praktisk gjennomførbar, men at tilgjengelighet, vegetasjonsdekke og sesongvariasjon sterkt påvirker synligheten og tilgjengeligheten til avfallet. Det anbefales derfor at den første overvåking i Norge utføres i vårsesongen etter snøsmelting, men før vegetasjonen er fullt utviklet. Det bør utføres to til tre overvåkninger per år per segment.

Evaluering av metodikken

Prosjektet konkluderer med at en standardisert metode for elveforsøpling kan implementeres basert på OSPARs CEMP-prinsipper, men krever nøye vurderinger og mulige tilpasninger til nordiske forhold. Man bør:

- Gjøre et nøye utvalg av elvestrekninger som oppfyller egenskaper som egner seg for overvåking, deriblant ha jevn og forutsigbar akkumulering av søppel langs bredden, tilgjengelighet for personell, oversiktlighet, reproduserbarhet mellom sesonger og nok søppel å overvåke over tid (få null-verdier).
- Velge overvåkingslokaliteter med kjent og representativ påvirkning fra ulike kilder (urban, landbruk, industri).
- Standardisere lengde på overvåkingssegmenter, og vurdere om strekningene bør forlenges til å være lengre enn 100 m, eller flere segmenter overvåkes per elv.
- Ta hensyn til enten siste flomnivå ved fastsettelse av overvåkingsområdet, eller en fast elvebredde som går opp til leveen.
- To til tre målinger per år vil være å foretrekke. Tidspunktet for undersøkelsene må ta hensyn til vannføring og vegetasjon. Generelt bør hensynet være å:

    - utføre første overvåkning før vegetasjonen kommer opp og løvet spretter om våren
    - utføre en siste overvåkning når vegetasjonen har gått tilbake om høsten
    - unngå vintermålinger på grunn av is og snødekke
    - vurdere om bruken av sommermålinger skal utgå på grunn av tett vegetasjon som innfører feilkilder
- Flere unike segmenter innen samme elv kan vurderes som erstatning for mange årlige undersøkelser av samme segment.
- Utføre overvåking kun fra land for å redusere risiko for personellet

Anbefalinger og videre arbeid

Rapporten foreslår at det videre arbeides mot å:

- Etablere OSPAR-retningslinjer for elveforsøpling, med tilhørende feltmanual og grundig opplæringsmateriell for bedre kvalitetssikring
- Benytte lengre segmenter i overvåkningen i Norge (for eksempel 200–500 m) for å øke datakvaliteten, og/eller inkludere flere segmenter per elv
- Tydelig definere formålet med overvåkingen for en optimalisering av tilhørende protokoll, og utføre styrkeanalyser i tråd med Schulz et al (2019) for å vurdere evnen til å påvise endringer

EXECUTIVE SUMMARY IN ENGLISH

Background and purpose

This report presents the development and field testing of a proposed method for standardized monitoring of litter along Norwegian riverbanks. The purpose is to contribute to the development of an OSPAR protocol for monitoring riverine litter along European rivers, building on existing guidelines for beach litter (CEMP guidelines). The final OSPAR methodology is intended for use in international environmental management and as part of the OSPAR cooperation for the protection of the North-East Atlantic.

The project forms part of efforts to establish a knowledge-based and comparable monitoring methodology for plastic litter along riverbanks, while accounting for the climatic and hydrological conditions characteristic of Norwegian river systems. It also examines how Norwegian rivers — given their wide variation in discharge, morphology, and seasonal dynamics — require methodological adaptations in order to be comparable with data from Central European rivers.

Protocol development

Field surveys were carried out in May 2025 in eight rivers in Southern Norway: Haukås, Bolstad (Vosso), Numedalslågen, Lier, Alna, Otra, Bjerkreim and Orre. The selected rivers represent different types of anthropogenic influence (urban, industrial, agricultural) and variation in river size, substrate, and hydromorphology. For each river, two 100-m segments were surveyed for the amount of plastic located along the bank from the waterline up to the break in slope of the riverbank (the levee). Three rivers (Otra, Haukås and the Bolstad River) were revisited in October and November 2025, and monitoring of the same reaches was repeated to assess new inputs of litter.

Method development

Prior to fieldwork, a draft field manual ("The Norwegian Field Guide to Riverine Litter Monitoring – Version 1") and an associated recording form were developed based on the CEMP guidelines for beach-litter monitoring. These were adapted with parameters relevant to rivers (including bank slope, flood line, vegetation type, water velocity, and human use of riverbanks in surrounding areas). Key objectives were to ensure descriptive and reproducible metadata across rivers; enable consistent implementation and consistent criteria for selecting segments; and generate robust quantitative data with low uncertainty—while ensuring that the method could be carried out safely by moderately trained field personnel without specialized equipment.

Results and experiences

The data collection documented substantial spatial variability in both the quantity and type of plastic waste, within and between rivers. The distribution of litter was uneven, with clear local accumulation in certain segments. In several cases, major differences in composition and quantity were observed between segments located close to one another. The least contaminated reach was often downstream, indicating that litter can be efficiently retained on riverbanks. Thus, for monitoring purposes it may be more important that a site is suitable for accumulation than that it is as close as possible to the river mouth.

The observations indicate a need to consider using more, or longer, monitoring stretches than the 100-m segments used in the beach litter programme, in order to achieve representativeness and reduce the number of zero counts.

Common litter categories included plastic fragments, bags, agricultural plastics (film and silage/bale wrap), and single-use items. Urban-influenced rivers such as Alna and Lier had the highest litter loads, whereas rural rivers such as Numedalslågen and Orre showed low levels. Many items were unidentifiable fragments indicative of aged litter. Such fragments are of lower value for monitoring because they cannot be traced to source categories.

Average time spent per 100-m segment across all rivers was about 50 minutes for two persons during the initial survey. After establishing fixed reference points, survey time is expected to decrease. The surveys demonstrated that the method is practically feasible, but that accessibility, vegetation cover, and seasonal variability strongly influence the visibility and availability of litter. It is therefore recommended that the first annual monitoring in Norway be conducted in spring after snowmelt but before full vegetation development. Two to three surveys per year per segment are advisable.

Evaluation of the methodology

The project concludes that a standardized method for riverine litter monitoring can be implemented based on OSPAR's CEMP principles but requires careful assessment and possible adaptation to Nordic conditions. The following should be considered:

- Careful selection of river reaches that meet monitoring-relevant criteria, including relatively even and predictable accumulation of litter along banks, accessibility for personnel, good visibility, seasonal reproducibility, and sufficient litter levels to monitor trends over time (i.e., few zero values).
- Selection of monitoring sites with known and representative influence from different sources (urban, agricultural, industrial).
- Standardization of segment length, and evaluation of whether reaches should be extended beyond 100 m, or whether multiple segments should be monitored per river.
- Consideration of the most recent flood level when defining the monitoring area.
- Two to three surveys per year are preferable to establish statistically robust trends. Surveys must account for discharge conditions and vegetation. In general, the approach should be to:
    - conduct the first survey before vegetation emerges and leaf-out in spring

    - conduct the final survey after vegetation has receded in autumn
    - avoid winter surveys due to ice and snow cover
    - evaluate whether summer surveys should be omitted because dense vegetation introduces bias
- Multiple unique segments within a river may be considered as an alternative to many annual surveys of the same segment.
- Conduct monitoring from land only to reduce risk to personnel.

Recommendations and further work

The report recommends further efforts towards:

- Establishing OSPAR guidelines for riverine litter, including an accompanying field manual and comprehensive training materials to improve quality assurance.
- Using longer segments for monitoring in Norway (e.g., 200–500 m) to increase data quality and/or including multiple segments per river.
- Clearly defining the purpose of monitoring in order to optimize the associated protocol.

BACKGROUND

OSPAR (Oslo - Paris convention for the protection of the marine environment of the North-East Atlantic) has developed a standard protocol for monitoring of marine litter (CEMP Guidelines for marine monitoring and assessment of beach litter) that enables comparison across space and time. This report is the result of a project commissioned by the Norwegian Environment Agency (NEA) following call no. 2025/8819- “Testing an indicator for monitoring riverine litter on riverbanks”. The report will contribute to a knowledge base from European countries for further development of OSPAR's methodology for standardized monitoring of litter on European riverbanks. This project allows taking into consideration Norwegian rivers and their environmental and physical conditions which are different from central European rivers. Knowledge and experience from a variety of rivers across Europe is useful for a relevant adaptation of a standardized OSPAR protocol for monitoring of riverine litter that can be used across a range of different rivers. The objective of the project is to test and adapt methods for monitoring litter along Norwegian rivers, while adapting to the riverine litter monitoring program that has been developed and has been ongoing in France and The Netherlands since 2021, focusing only on the area from the water’s edge and along the riverbank, not the riverbed. Monitoring should be performed without the use of specialized equipment.

Monitoring of riverine litter should, in line with beach litter monitoring, give a representative impression of the rivers and anthropogenic impacts along the riverbanks as well as the survey area, and the amounts and changes in litter observed over time. The selection of rivers in this project represents rivers in southern Norway affected by industrial, urban and agricultural activities and impacts. Considerations are made of differences in river size, hydromorphology, substrate, seasonal water flow (discharge), accessibility, and distribution of riverbank litter for monitoring as well as health and safety considerations and challenges with respect to seasonality that differs from Central European rivers. To ensure that the selected rivers and monitoring segments were suitable for the aim of the project, the rivers were selected in agreement with the Norwegian Environment Agency through online meetings, with an aim to compare and evaluate different influencing factors and provide examples, discussions and considerations that could lead to a basis for a standardized OSPAR protocol for monitoring of riverine litter which also considered conditions in Norwegian rivers.

PROTOCOL DEVELOPMENT

The proposed methods were developed under the premise that field sampling should be feasible for personnel to perform independently following a simple, basic training, similar to procedures used in OSPAR beach litter monitoring. Accordingly, the method must enable consistent and quality-assured implementation throughout the entire monitoring period and across all locations, without the need for specialized equipment or advanced technical expertise, while also ensuring the safety of field personnel.

The area selected for the project covered southern Norway between Bergen and Stavanger in the west, Oslo in the east and Kristiansand in the south (Figure 1).

Figure 1: MAP showing selected rivers in southern Norway investigated for the development and testing of an indicator for riverine litter monitoring

A draft field guide and information form was first developed to describe the river, the monitoring area and the surroundings of each river with emphasis on Norwegian settlements and anthropogenic impact on the river. This field guide functioned as a registry form during fieldwork to collect metadata that will help describe the area and later interpret monitoring data. The draft registration form was based on the Coordinated Environmental Monitoring Program (CEMP) guidelines for beach litter monitoring and provided a structured setup to collect similar data from rivers. It included the same type of quantitative and qualitative descriptions of the area of a river, the potential sources and transportation routes for litter, as well as observations on the day of surveillance.

Although the main aim of the project was method development and testing of the proposed procedure, we also collected data on litter types and amounts per river segment. This was primarily to test the method and gain experience with the proposed protocol, but also to investigate local litter distribution within rivers, evaluate sources of error and observe how the protocol performed in a variety of rivers. After fieldwork, we evaluated the proposed monitoring procedure and data collection forms based on our experience.

The draft field guide and registration form for riverbank monitoring were tested and revised during and after fieldwork (Appendix 1). The report discusses and evaluates the experience from data collection from the Norwegian rivers. Each test site is described in more detail with photos illustrating the rivers, and a summary of properties for the rivers is given in Table 1. Focus has been on developing a method and guidelines for collection of data that aligns with the current CEMP guidelines for monitoring marine litter on beaches while being adapted to a variety of Norwegian conditions and a variety of riverbanks and litter-types. The revised field guide (Appendix 1) shows the revised version of the draft field-guide, proposed after this fieldwork.

The Norwegian field guide to riverine litter monitoring - draft version 1.

This part is a translation of the CEMP guidelines for beach litter monitoring to river conditions. In the same way as the CEMP guidelines, the riverine litter monitoring form (Appendix 1) is meant to map and describe the most important properties of the river, surveillance area and surroundings, to help classify and interpret the future monitoring data. This form is to be filled out once per site but may be amended if the conditions change substantially and revisions are considered necessary. The list presents a suggestion of conditions and elements that may influence the amount of litter and the likelihood of litter accumulation on the riverbanks.

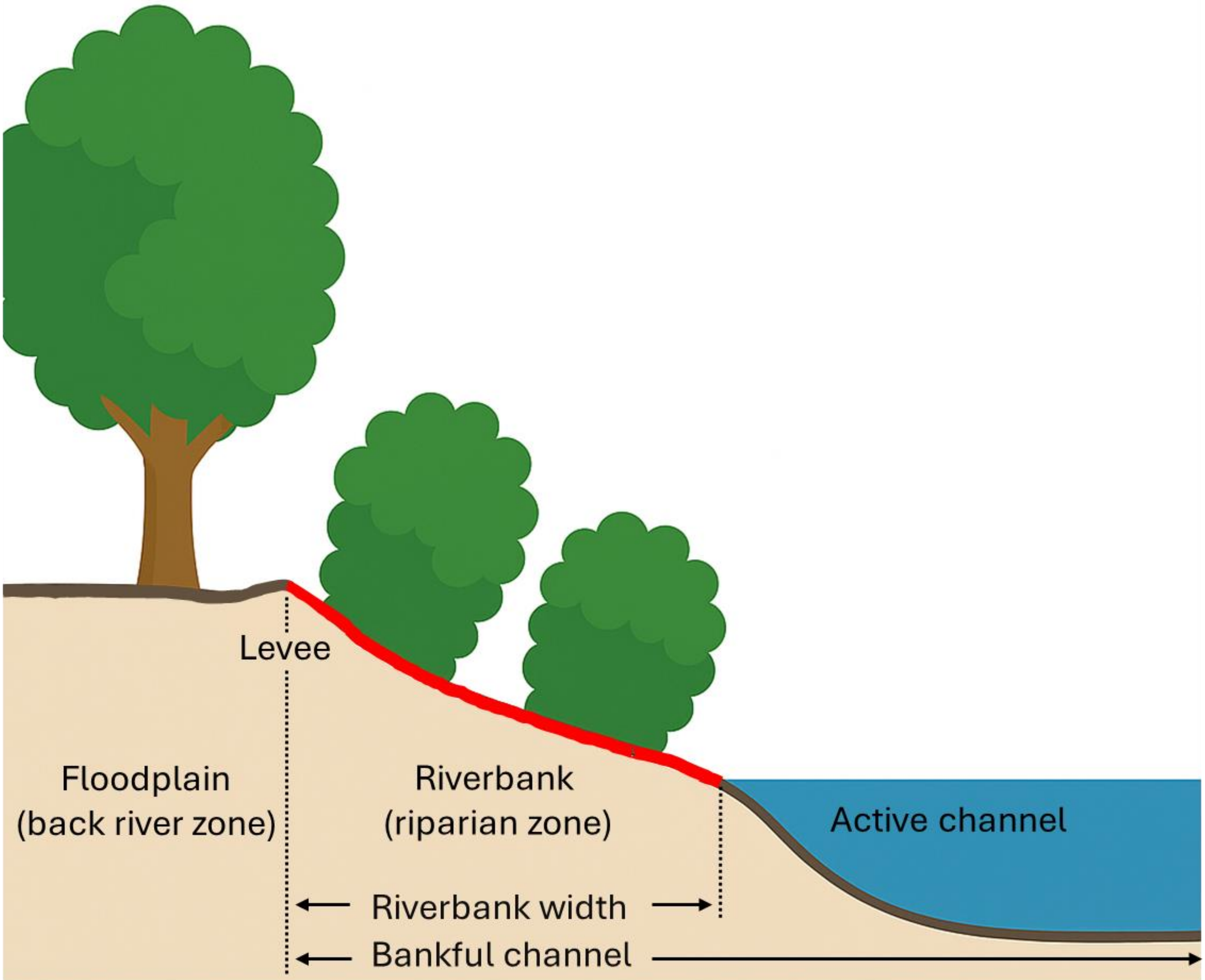

Figure 2: Schematic cross-section of a riverbank and channel, with terminology used trough the report.

Part 1 of the registration form asks for:

- A map of the river and riverbank including the survey area
- A map of the local surroundings
- GPS coordinates at the start and stop of the survey area.

Descriptions of

- The steepness of the riverbank (degrees angle of inclination)
- The morphology of the river channel (single or braided channel)
- Water speed at normal discharge (flow habitat types, e.g., rapids, riffle, glide)
- Type of vegetation in the riverbank (riparian vegetation: % cover, trees, grass, other etc.)
- Type of minerogenic surface material in the riverbank (% boulders, pebbles, sand etc)
- Types of anthropogenic impact on the riverbank (in the survey area)
- Dominating cover type in the floodplain, along the survey area (% cover):

- Major recreational riverbank usage (swimming and sunbathing, camping, fishing, surfing, sailing etc):
- Ways to access the riverbank (by car, foot, boat)
- Distance from the starting point to nearest town
- The position of town in relation to survey area
- The population size of the nearest town
- The distance from the starting point to the nearest shops
- Seasonality of shops, if relevant
- Distance to upstream bridges
- Distance to upstream human-made constructions that can prevent free flow of litter (dams, hydropower plants or culverts with grates)
- Distance from the survey area to the nearest river mouth (outlet to lake, ocean or fjord)
- Details on potential cleanup activities

Part 2 of the registration form concerns parameters that change between surveys and is to be filled in on the day of the survey. This aligns with the CEMP guidelines for marine litter monitoring. The number of repeated surveys per year must be adapted to OSPAR guidelines.

Part 2 of the registration form asks for:

- Country, name and OSPAR ID of the river
- Date of the survey (dd/mm/yy)
- Name and contact details of the responsible surveyor and assistant
- Description of the river conditions on the day of the survey (relative water flow level average riverbank width (from the active channel to the levee))
- Vegetation cover on the day of the survey, describing foliage and ground cover development and seasonality with respect to the likelihood of detecting litter in the vegetation or on the ground
- Whether litter was removed during the survey
- Whether the litter data needs adjustment to standardized length (100 meters or more)
- Other circumstances influencing the survey and the interpretation of data, such as weather conditions (snow, ice, extreme events), recent flooding events, construction work, vegetation clearing, other activities or recent cleanups.
- Unusual types and/or amounts of litter along the river (from e.g., festivals, roadwork, constructions/renovations)
- Observations of dumpsites or large objects that could not be cleaned on the day of the survey

- In addition, other interesting observations are given some space, such as interactions between litter and wild animals. This corresponds with CEMP guidelines and registration forms for marine litter.

In part 2 of the survey form (Appendix 1), the detailed litter registration form is included, in alignment with the marine litter monitoring guidelines and associated litter-registration forms. The riverine litter registration form may be amended, and for the Nordic countries may also include typical Nordic items, such as snuff boxes, road-marking-sticks and baling film from agriculture.

During fieldwork we wore waders to be able to travel quickly and safely along the rivers and find the best suited 100 metres for each survey, although this would not be strictly necessary. We evaluated the water level, flow habitat and minerogenic composition according to the field-guide. Observations asked in field guide and registration form were detailed as accurately as possible from experience with riverine dynamics and terrestrial monitoring. We used a laser distance meter (Leica Disto X4) to measure the bank width at 3-6 places per segment to calculate the average bank width in the monitoring area. The slope of the riverbank was measured using a digital inclinometer tool (Smartphone), finding a representative slope, taking multiple measurements for representative indications of slope. The NaVida GPS App was used for taking coordinates in the field.

A guideline on how to describe the properties and measurements of the river and riverbank (Figure 2) according to the form (Appendix 1), should be supplied to ensure standardized description of river properties, the monitoring segment(s) and likely litter sources. A detailed protocol description, supervision from experts, training videos or field-recordings may be included in the training of river monitoring personnel.

TEST-CASES FROM EIGHT NORWEGIAN RIVERS

The project intended to test the proposed guidelines and registration forms developed as described above. The requirements of the project were defined by NEA prior to onset.

Selection of rivers and river segments

The rivers were selected based on the call-requirements from NEA. The call asked for six rivers to be test-surveyed once, with litter data to be registered according to the OSPAR items list. Among the six rivers, the Lier, Alna and Orre Rivers were mandatory and three more could be chosen freely among a list of rivers. Among the list of rivers, we selected Bolstad River (Vosso), Numedalslågen, Otra River and Bjerkreim River. In addition, we added the Haukås River near Bergen which is a small but highly polluted river (Velle et al. 2024). The selection of rivers was made to represent rivers in southern Norway affected by industrial, urban and agricultural activities and impacts. Considerations were made to represent a variety of river sizes, hydromorphology, substrate, water flow (discharge), accessibility, and distribution of riverbank litter to investigate how the different conditions and factors would influence monitoring. The aim of the study was to perform a test-survey to help develop a method for representative monitoring across a wide selection of rivers and to provide input on what considerations must be made when monitoring Norwegian rivers.

Our initial suggestion to survey one segment of 1 km per river was replaced by NEA's request for 100 metres, which corresponds to CEMP guidelines for beach litter monitoring. To investigate and evaluate the suspected effect of river dynamics on litter distribution we investigated two segments of 100 metres in each river and compare the results among them, thus illustrating within-river variation. We suggested the river segments based on prior experience (field work in other projects and plastic mapping, see Velle et al. 2020 and Velle et al. 2024) and aerial photographs in the specified rivers and the final placement of the segments of interest was decided through online meetings and in agreement with the NEA, and were also subject to decisions *in situ* of suitability and accessibility. The segments were likely to be accumulation areas, downstream of bridges, settlements, industrial areas or close to the river-mouth. The segments would exemplify the influence of local conditions as well as river dynamics. We also aimed to compare and evaluate different influencing factors for OSPAR monitoring and provide examples, discussions and considerations that could lead to a basis for a standardized OSPAR protocol for monitoring of riverine litter that also considered conditions in Norwegian rivers.

Fieldwork

The main fieldwork for the project was carried out during one week in May 2025 (May 7. – 13). We also chose to perform the survey twice in three of the rivers (Otra, Haukås and Bolstad) that were revisited in October and November to evaluate the influence of seasonal changes and the conditions that would likely affect litter monitoring, in addition to evaluating the amount of litter that had accumulated in half a year. All rivers were free of snow and ice during the investigations. In May, the surveys were complicated by vegetation cover along some of the riverbanks, as spring came early in southern Norway. In October-November, the trees had lost the foliage, and the ground was in part covered by fallen leaves.

In the following section, each river is described, travelling from west to east in Norway. The descriptions emphasise observations that will require consideration in the further development of a standardized protocol, and a conclusion of whether this segment is considered to be suitable for further monitoring. Within the same river, more than one segment may be suitable for monitoring.

Haukås River

The Haukås River lies in Bergen municipality and is one of several small streams and lakes that drain an urbanized and residential area (Figure 3). The river flows in part through forests and meadows, but also along roads and residential areas. The source of litter is expected to be varied and may include a nearby motorway, a campsite, a business park, agriculture and a horse racing track. The river also differs from the others in that it has a low absolute water volume (485 l/sec at the time of the survey) and is only 1.5 meters wide with dense vegetation along parts of the river. The varied physical properties along the length of the river (Figures 3 and 4) have given useful experience for this project with regards to suitability and potential challenges for monitoring within a river. The access to the river is good and it is safe to travel along the riverbank. At the time of the survey in May the vegetation had developed quite a bit at Haukås, and the ground was partly covered by herbs and grass, while the foliage on the trees was less developed and did not severely obstruct the view (Figure 3, bottom). In segment A, the ground was in part slippery and rocky, with some short, shallow and braided rapids, large fallen trees and dense shrubbery along the riverbank. One place in segment A the river channel easily overflows and cut across a meander in the river when the discharge is moderately high, which complicates monitoring and is an obstacle to follow our intention to monitor only one side of the river. Although the overflow only causes a shallow stream and crossing it will not be of danger to the personnel, the area monitored will change during such overflow-events, and the area for potential distribution of litter from overflow-events needs to be included for all surveys. In May we found 133 items and 5.8 kilos of litter on the riverbank, and much litter was observed outside the monitoring area. We revisited Haukås A on October 26th, when the leaves had dropped, and the ground was covered by leaves, which can hide litter on the ground. The discharge was 265 l/sec during the second survey. The river was cleaned in a professional cleanup-event in early October, yet we did find two pieces of expanded Polystyrene (EPS) and a part of a toy car in the survey area (<0.1 kg). In the river, upstream from the 100 m monitoring segment we observed litter that may end up in the monitoring segment with time but was not included now.

Despite the densely vegetated and erratic riverbank, our observation is also that Haukås A will trap and collect litter. Finding litter items in such conditions may be challenging, especially when the foliage is fully developed, and the surveys must take the necessary time to search for all items. However, if monitoring is carried out before foliage and vegetation develops, we believe this segment could be suitable for monitoring under OSPAR.

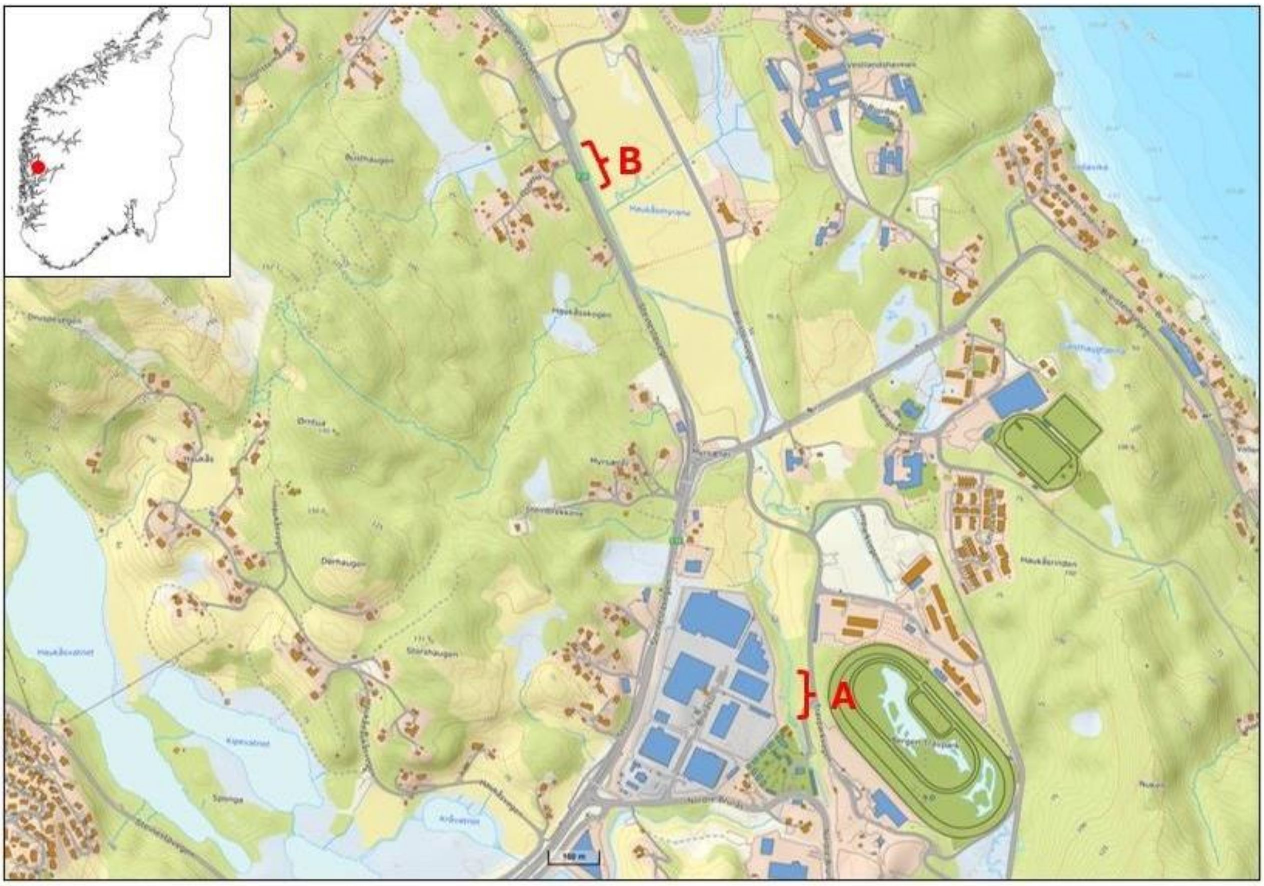

Figure 3: Map over the Haukås river with segment A and B (top).

Figure 4: Images from Haukås segment A (top), showing variation in the riverbank and vegetation properties. Segment B (bottom) where the riverbank is steep and supported by boulders (riprat). Images from the fieldwork in May 2025.

The segment Haukås B is downstream from Haukås A (Figure 3). At segment B, the river runs between the motorway and farmland. The previously plastic polluted area had been cleaned some time before the survey in May, and there was hardly any litter to be found. The riverbank is in part supported by boulders (riprat) as bank-protection walls, and the riverbank is steep, straight and smooth over large parts of the segment, making litter less likely to accumulate along the riverbank. For this reason, we consider the Haukås B segment less suitable for use in river monitoring.

Bolstad River

The Bolstad River is the lower part of the Vosso catchment in Voss municipality. The Bolstad River flows into the Osterfjord system. The river flows through areas with varying land use, such as agriculture, urban areas and along roads and railways. The relatively large discharge (usually between 50 to 300 m^3/sec according to Gabrielsen et al. 2011) means that the river can effectively transport plastic from sources far up the watercourse and out towards the fjord, which makes it suitable for studying the potential sources of plastic to the river along the entire length of the waterways. Lake Evangervatnet may hold litter back during the run towards the fjord. The Vosso catchment includes a few hydropower plants in tributaries, and one in the main river about 35 km upstream of the study sites. The river Bolstad segments A and B (Figure 5 and Figure 6) are easily accessible and safe to travel along at low to moderate water flow since the river is shallow along land. The river differs from other rivers in this project by having a coarse substrate of cobbles and sand along the riverbank in segment A and boulders in segment B (Table 1).

During the survey in May the river flow habitat type was described as riffle and rapid. Bolstad A had few litter items. It was easy to walk along, and the litter was visible despite the somewhat developed vegetation along the low brink, which could overflow during spring floods (Figure 5, bottom). Indications of the higher water level during the spring flood was evident in the shrubbery near the river as grass and litter in the trees (Figure 5, bottom), The farmland alongside the river had likely been cleaned since the last flood, perhaps during grass cutting. The vegetation along the riverbank was searched thoroughly for litter, and a few items, for example agricultural plastics, were found stuck in the branches and between the herbs on the ground (Figure 5, bottom right). Apart from this, litter did not seem to accumulate along the riverbank in Bolstad A, or there is very little litter in the river. Low accumulation rates were confirmed during the revisit to Bolstad in early November, when there were zero new items of litter. Segment A is therefore considered unsuitable for monitoring.

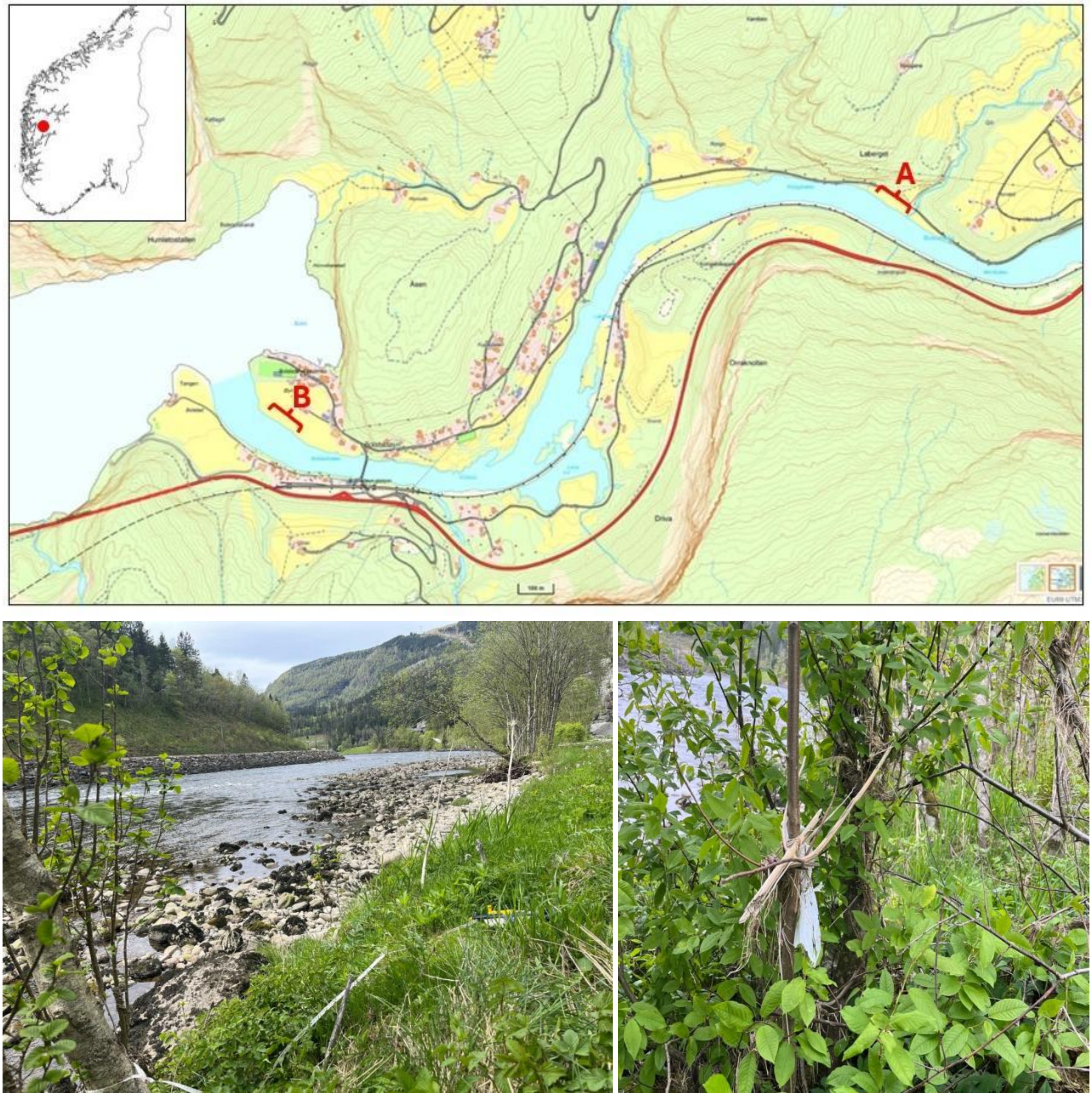

Figure 5: Map of Bolstad river in the Vosso catchment showing segment A and B (top), and photos from Bolstad segment A during the fieldwork in May 2025

Figure 6: Photos from the riverbank at Bolstad segment B close to the river mouth, during the fieldwork in May 2025

Bolstad B was placed downstream of segment A, in an area with good access to the riverbank, and about 100 m upstream of the river mouth to prevent registering marine litter that could have entered the river at high tide (Figure 6, right). Bolstad River segment B was also easy to walk and relatively easy to observe and collect the litter from the rocky riverbank. There were no overhanging vegetation or large obstacles. In Bolstad B there was a high number of litter from a variety of sources, such as building/construction, agriculture, personal use and hygiene products that indicated how litter from several origins had been deposited at this site. The items of expanded polystyrene and Litex-bathroom wall plates were small, indicating that the items were not recently deposited, or that they may have travelled far and had been exposed to high mechanical force before deposition on the riverbank. Accumulation of organic riverine debris marked the flood line along the riverbank clearly, where the majority of the small litter items were found. The riverbank was high, and overflow would require a high flood. In May we observed 679 items and 3.9 kg of litter in this segment (Table 2). With the varied sources of litter, the clear signs of accumulation, the good overview and access to the riverbank we consider Bolstad B a typically suitable area for monitoring (Table 2, Figure 19, Appendix 2).

Numedalslågen River

Numedalslågen River flows through varied landscapes from the mountainous areas of Buskerud to the outlet in Larviksfjorden, with great importance for both nature, outdoor life and society. Numedalslågen flows through densely populated areas, agricultural landscapes and forest areas (Figure 7), which provides good opportunities to identify and compare different sources of plastic litter. Numedalslågen River is among the longest and most water-rich rivers in Southern Norway. This makes it suitable for studying the transport and accumulation of macroplastic over long distances, as well as how plastic moves from the inland towards the coast. However, it is worth noting that the river includes several hydropower stations, which may provide obstacles for litter transport. The nearest hydropower station upstream from Numedalslågen River, segment A is Djupdal powerstation (about 22 km). The segments of the river are easily accessible by road and safe to walk along at low to moderate water flow (Figure 8). Segment A lies in an agricultural area downstream of the settlement Lampeland. At the time of the survey the discharge was relatively low, dominated by glide (Table 1, Figure 8). We observed only a few litter items. Close to the bridge, there were bottles, cans, cigarette stubs and litter that were likely thrown from the bridge onto the slopes towards the riverbank, and the litter did not seem to have been in the water or deposited by the river. Apart from the low level of litter, this was technically a good location for monitoring, as it showed clear signs of accumulating organic debris, and was easy to monitor.

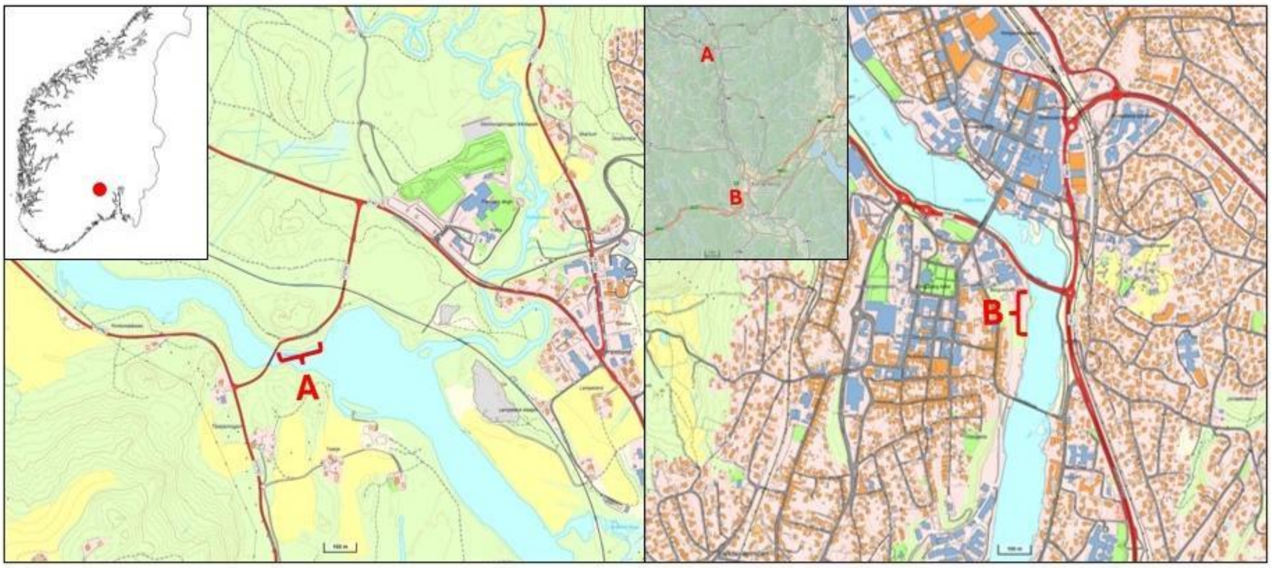

Figure 7: Map of Numedalslågen River river, showing segment A and B, where there is a variety of anthropogenic impact

Figure 8: Map of Numedalslågen with segment A near the settlement Lampeland (top) and segment B (bottom) near the city of Kongsberg.

Numedalslågen River segment B (Figure 8, bottom) was in the city of Kongsberg. The nearest power station is Pikerfoss power plant, about 8 km upstream. The segment was easily accessible and easy to walk and clean, and with a discharge of about 50 m^3/sec. The pebbles and short grass and the few trees along the riverbank were not seen as obstructions, despite the vegetation being quite developed at the time of the survey. The segment was in the vicinity of a museum, and we observed families playing by the water near the monitoring area during the survey. The museum park by the river was also well maintained and the grass had recently been trimmed. It is likely that such locations will be cleaned by by-passers or the museum wards. Both littering and removal of litter is likely to occur inside the segment. For that reason, we do not recommend setting up monitoring areas close to parks and recreational areas, corresponding to avoiding popular beaches in beach-litter monitoring.

Lier River

The Lier River is a medium-sized river that flows through the municipality of Lier (Figure 9). The river passes through agricultural areas, urban areas and industrial areas before flowing into the Drammensfjord. The Lier River is particularly well suited to testing and developing new methods for monitoring plastic litter in rivers because it is easily accessible and has parts with varying degrees of human activity, which enables testing of the methodology under different impact regimes – from relatively natural forest areas to heavily impacted zones near urban areas and industry. This was the most plastic-polluted river among 73 monitored rivers in Norway (Velle et al. 2024), surveyed by paddling about 6 km stretch of the river in 2022. At Opsal about 20 km upstream of the segments, the discharge was 0.65 m3/sec during the survey in May. It is safe to walk along the selected segments at this discharge. The river has one small hydropower station (Grøtte power station) 5.5 km upstream from segment A and 6.2 upstream from segment B. The power station is old and partly in use and we have not investigated whether it is likely to influence in-river transport of litter.

In Lier segment A (Figure 9, Figure 10) the vegetation was quite developed, which to some extent obstructed visibility and cleaning. The riverbed and steep riverbank were sandy or muddy, and the water was not easily accessible from the riverbank. Therefore, the segment was only cleaned and monitored on land. Signs of a recent flood line was visible among the trees well above the water. In October the discharge was higher than in May (about 7.5 m3/sec at Opsal). A recent flood event (85 m3/sec at Opsal) had removed a lot of vegetation at the riverbank. Some litter was visible in the trees but had not accumulated on the ground.

Due to the steep and sandy riverbank with a drop to the water, we do not believe the segment to accumulate litter except at floods, and do not recommend Lier segment A for monitoring purposes.

Figure 9: Map over Lier River with segments A and B, running through agricultural landscape and the town of Lier.

Figure10: Segment A in October when the discharge was higher than in May (top). Segment B (middle and bottom). Large items that cannot be removed must be noted in the registration form (middle right). A cleaning - event took place at the day of the survey in May (bottom left), litter still present within the river system on the day of the cleanup (bottom right).

Following the mapping of plastic in Norwegian rivers in 2024 (Velle et al. 2024), the Lier River has been cleaned by local authorities, schools, and private initiatives (e.g., the Rotary Club). More than six tonnes of litter have been removed since the mapping, including from the most accessible dump sites. On the day of our survey, the local school, Lierbyen junior high school, did a river cleanup, and we observed litter collection bags with several kg of litter collected from the riverbank in segments A and B (Figure 10, bottom left). Despite their efforts to clean the riverbank, we observed and removed litter in the vegetation and riverbank along the water, in part because we could access the river using waders, where the students could not go (Figure 10, bottom right). However, without waders, segment B would be rather inaccessible at higher water levels, and for that reason not considered suitable for monitoring. A popular walkway along Segment B also makes the area accessible for littering as well as voluntary cleanups. We also observed large pieces of metal, pipes and car parts in the river which could not be removed without specialized equipment. Such large items must be noted as "not removed" during a survey to avoid registering the same items several times (Appendix 1, part 2).

With the increased awareness of riverine litter in the municipality, the Lier River would be a very interesting river for monitoring, while segments A and B may not be the best suitable segments. Segment A is less suitable due to the steep riverbank that prevents litter from accumulating, and segment B is less suitable due to disturbances such as littering or cleanup activities. Finding a suitable and undisturbed segment for monitoring can be challenging but can be done in dialogue with the municipality and those responsible for the voluntary cleanups, and by placing signs along the access points that prevent cleanup outside the monitoring campaign. The segment should prove to accumulate litter and have access to the water at normal discharge levels.

Alna River

The Alna River is Oslo's longest river and flows through some of the most densely populated and industrialized areas in Norway. Alna is particularly interesting for developing and evaluating methods for monitoring plastic pollution in urban rivers. The river receives runoff from roads, industrial areas, parks and residential areas (Figure 11), and thus represents a realistic scenario for how plastic ends up in rivers in urban areas. In addition, the river is easily accessible for fieldwork and monitoring and has a high level of commitment from both the municipality and the local population. By using Alna as a case study, knowledge can be gained about how plastic is transported and collected in urban river, and how measures and monitoring can best be adapted to urban environments. The river can therefore function as a model waterway for similar rivers in other urban areas.

Parts of the river is easily accessible by foot and safe to travel along. Alna segment A is immediately outside a culvert downstream of the Alna terminal where large amounts of litter have previously been recorded (Velle m.fl. 2024). This section is also suitable as a test area because it is difficult to find continuous sections of the Alna that do not pass through culverts, private property, is channelized, has a riprat or paved banks.

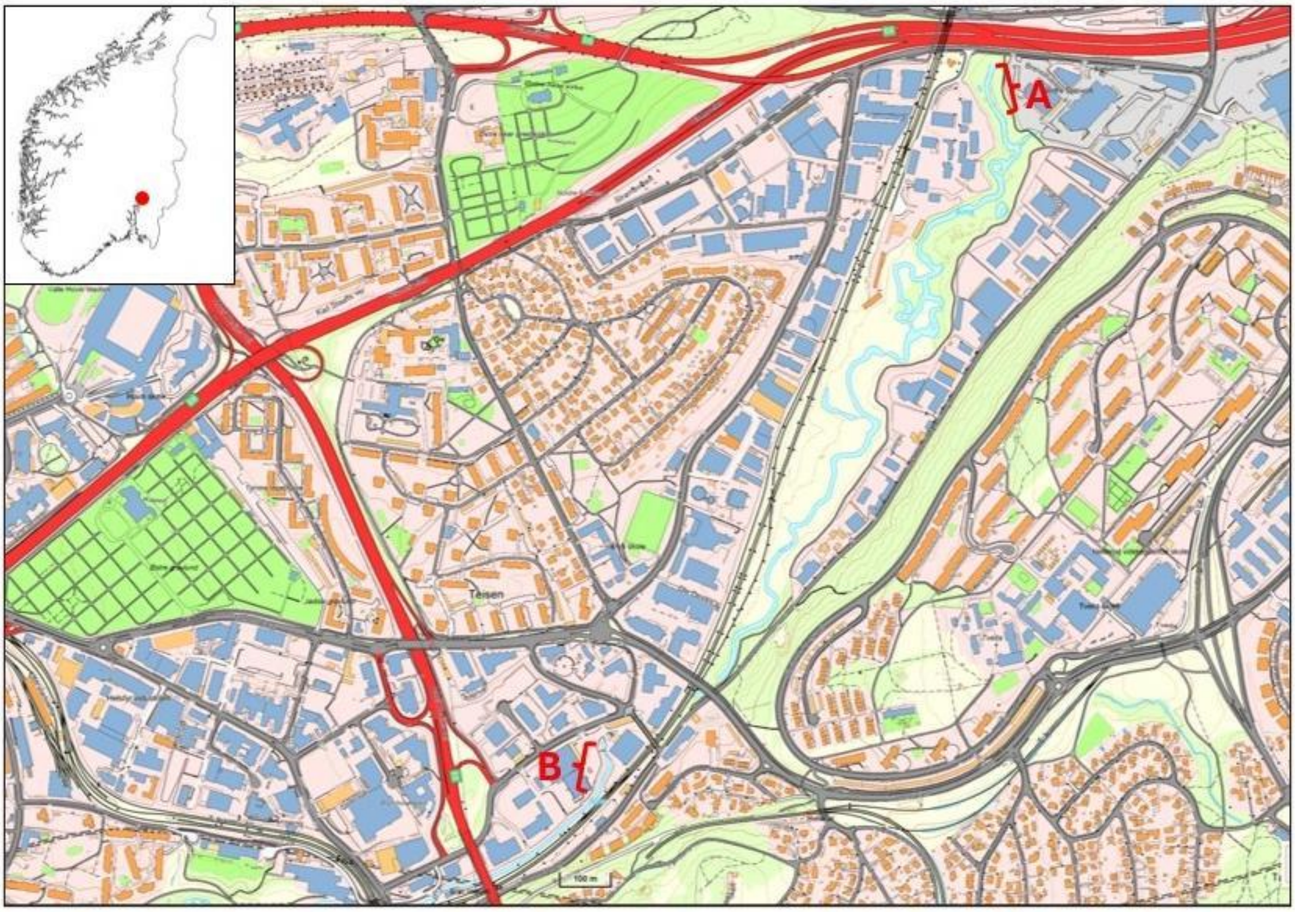

Figure 11: Map of Alna River, segments A and B.

At the date of the survey, Alna segment A had a moderate to low discharge dominated by glide. The vegetation was highly developed, which made it difficult to observe litter on the ground (Figure 12). Less than 100 metres from the culvert it was also difficult to pass the trees closest to the riverbank, and therefore to clean and monitor litter along the entire length of the segment (Figure 12, top). There have been several cleanup initiatives in the Alna River following the mapping of plastic in Norwegian rivers in 2024 (Velle et al. 2024). The position, amount and age of litter in segment A indicate, however, that this segment has not been cleaned recently.

Past events of sewage overflow were evident from several sanitary waste items on the riverbank. Sewage overflow and fertilization is also highly likely to contributed to the dense vegetation at Alna A. The soft soil on the riverbank slopes and overhanging vegetation (Figure 12, top) made this area particularly difficult to walk along for monitoring, and there was a danger of sliding into the river. At a higher discharge, it will be difficult to access the water. The presence of a dumpsite, as well as the dense vegetation and steep slopes makes Alna A not recommended as a monitoring site.

Figure 12: Photos of Alna A at the time of the survey showing the dense vegetation on the banks(top) and examples of old litter buried in the riverbank, indicative of an old dumpsite along the river (bottom). The recognizable design places this food packaging in the 1980's (bottom right).

The Alna River segment B started outside a culvert where the river exits from underneath traffic, running behind a residential area for about a kilometre (Figure 11 and 13). There might be grates in the culverts upstream of this segment, which needs to be validated. The segment is otherwise easy to travel and clean and has boulders that may trap litter between the rocks and in the vegetation on the riverbank (Figure 12). 100 metres of rather undisturbed riverbank for monitoring in an urban area can thus be found here. The riverbank is high, and the river is not very likely to overflow. We observed 103 items and 4.9 kilos of litter in segment B (Table 2). As such this segment is suitable for monitoring. The amount of annual littering , and previous cleanup activities are unknown.

Figure 13: Photos of the urban river segment Alna B, a rather undisturbed stretch of the river running between a residential area and the train-tracks.

Otra River

The Otra River is the largest river in Southern Norway and flows through several municipalities before the outlet in the Kristiansandsfjord. In the lower part of the river near Kristiansand, there are densely populated areas, industry, transport infrastructure and runoff from urban areas. All are known sources of plastic pollution (Haave et al. 2022, Velle et al. 2024). The combination of urban impact, regulated water flow and good accessibility makes the Otra suitable for testing methods for macroplastic monitoring in rivers. The water flow in the Otra is relatively stable due to hydropower regulating the flow. There is a hydroelectric power plant with a dam about 5 km upstream from the segments that we surveyed in Otra. The river was visited in May and in October.

At the monitoring site (Figure 14), the riverbank is gently sloping and covered by grassland and shrubs, and close to a fishing hut and a parking-space. Recent clearing of the riparian vegetation was done by the local landowners shortly before the survey, to give easier access for recreational fishing, and as general maintenance of the farmland. Clearing the vegetation brought old litter previously trapped under the bushes out in the open, and although the local landowner claimed to have removed litter during the clearing of vegetation, there was still old debris, packaging and bottles along the monitoring segment, indicating that this riverbank collects and traps litter, or that littering happens at the site. Segment A had a slightly more elevated riverbank than B but still accumulated more litter than segment B on both surveys in May and in October, although the absolute amounts were small (Table 2), highlighting the potential difference between segments that are close together.

On the day of the survey in May, the discharge relatively low (100 m^3/sec 5 km upstream at Heisel), but a mark from higher water levels could be seen on the riverbank in segment B, indicating the necessary width of the monitoring segment to include all potentially deposited debris and litter. Segment B had a wider riverbank than segment A, more grass cover and with less shrubs (Figure 14 bottom), which will impact deposition of litter.

Also, tyre-tracks on the riverbank in segment B indicated that boats or jet skis had been launched by use of motorized vehicles. Such use of the river may increase the chance of littering from recreational use but may also lead to a risk of cleaning of the segment outside of surveys. We advise finding similar and accessible segments for monitoring, that are not affected by sports and recreation such as fishing, camping or launching of jet skis and boats.

Figure 14: Map over Otra with the two segments A and B (top), segment A (middle) with a fishing hut and segment B (bottom) with a wider riverbank and tyre tracks along the riverbank (bottom right) indicating launching of boats or jet-skis.

Bjerkreim River

The Bjerkreim River (Figure 15) is one of the most important salmon rivers in Rogaland and flows through a partly agriculturally dominated and sparsely populated landscape before discharging into Lake Bjerkreimsvatnet and on to the ocean via Vikeså and Eigersund. The river has a relatively natural water flow regime without major regulations. The Bjerkreim River is well suited to testing methods for monitoring plastic litter in rivers because it combines natural and human-impacted areas. Although the river appears largely natural, agriculture, scattered buildings, roads and outdoor activities along the riverbanks can contribute to plastic litter. This provides opportunities to investigate where and how plastic accumulates even in apparently little-impacted waterways

At the day of the survey, relatively low (12 m^3/ sec at Gjedlakleiv 1 km downstream), and the riverbank was easily accessible. Boulders and patchy vegetation along Bjerkreim River segment A made investigating, describing and cleaning the riverbank time consuming (Figure 15, Table 1). There was one private houses along the segment, but quite a lot of old litter that could not be removed. Large and rusted metal items, such as old tools, hot water tanks, furniture and mattress-springs indicate that the river has received and transported litter over time, either dumped at will or taken down the river by floods and stranded in the riverbank in segment A (Figure 16, middle) As an accumulation area, segment A may be a good monitoring segment, although somewhat challenging to search through. We also had to leave behind large items that were embedded in the ground.

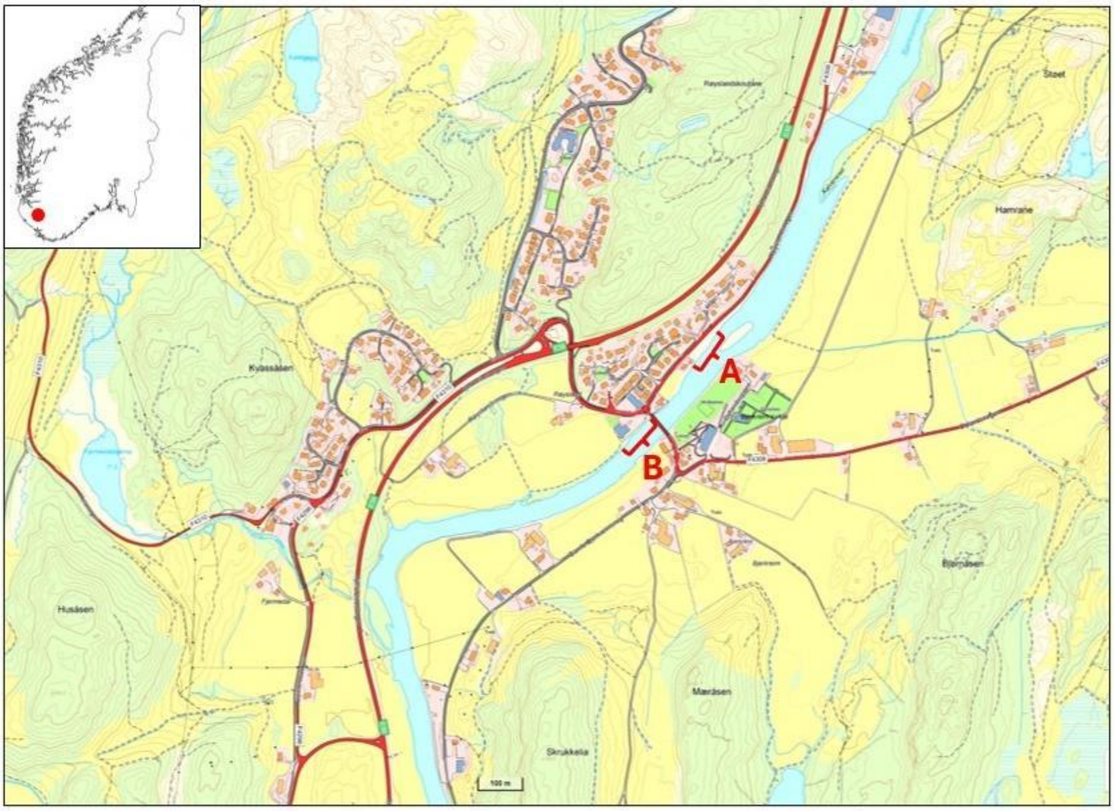

Figure 15: Map over Bjerkreim River segments A and B.

Figure 16: Photos of the riverbank at Bjerkreim segment A at the day of the survey (top), with large boulders and mounds of grass, metal scrap that could not be removed (middle), and the bridge by segment B under maintenance (bottom)

Bjerkreim segment B was downstream of a nearby bridge under maintenance (Figure 16, bottom). We observed metal and plastic litter from the maintenance-job. On the day of the survey the discharge was moderate, and the water ran fast past segment B, and we found little evidence of accumulation zones on the riverbank. The riverbank down to the river was wide and easy to walk, with some well-developed grass, herbs and shrubbery that required a thorough search for litter. The minerogenic zone was narrow, and the accumulation of litter along the riverbank seemed less likely, although a flood line was visible on the riverbank. Above the riverbank and flood line there is a shop and a parking lot, and the litter on the riverbank was dominated by food packaging from snacks and ice-cream that were likely thrown or wind-blown towards the river from the shopping area and/or bridge but had not yet reached the river. In this project we monitored the entire riverbank from the water to the levee, and therefore all the litter on the riverbank was included (Table 2). Such dominance of litter from nearby shops will be worth noticing when selecting sites for monitoring (Appendix 1). Including only the litter below the latest flood line will also exclude most of such litter thrown from nearby shops, unless it has passed the level of the flood line.

Although maintenance of the bridge contributed to littering on the day of the survey, this will be a temporary contribution. Bridges often contribute to littering from pedestrians and cars. As a potential important source of litter to rivers, we recommend including segments downstream of bridges in monitoring However, the presence of a bridge near a monitoring segment should be noted in the description of the area. The segment should also have other properties that will permit deposition and accumulation of riverine litter. In sum, Segment B receives litter from upstream sources as well as from the bridge and the shop, but it does not appear to be a strong accumulation zone. It is therefore only a moderately suitable monitoring segment.

Orre River

The Orre catchment is 103 km² and dominated by arable land (42%) and low-lying, flat terrain just above the se level, with intensive cultivation, drainage systems and nearby settlements. It includes five main lakes where the Orre River (also referred to as Orreåna) runs from the lowermost Lake Orrevatnet to the sea at Orrestranda beach in Klepp municipality (Figure 18). The river is 1.5 km long and has a discharge of 3.4 m³/s at the outlet (Eilertsen et al. 2020)

The short distance from the lake to the outlet into the sea makes the Orre River an interesting watercourse for studying the transport and deposition of plastic over short distances. Due to high agricultural activity and the proximity to popular outdoor areas, such as Orrestranda, there are several potential sources of plastic litter here. This provides an opportunity to investigate how different sources affect the amounts of plastic and how plastic is transported and deposited in a river with a relatively low slope. The river is accessible by car, has a clear river course and is safe to walk along. Segment A was placed immediately downstream of a bridge, from which pedestrians can potentially litter. On the day of the survey, the relative discharge seemed normal and ran fast past segment A (Figure 17, left). There was no minerogenic zone to walk on, and the riverbank was covered by tall reeds that made the riverbank nearest the river inaccessible. The tall and dense reeds also obstructed the view of the water, and there may have been litter items hidden in the reeds that we could not see or access safely (Figure 17, right). We observed and removed only one litter item, but the area cannot be recommended as a monitoring site, due to the uncertainty introduced by the dense reeds.

Orre River Segment B was placed by the mouth of the river, where the river enters the Orre beach, but above the normal high tide mark (Figure 18).

The riverbank was dominated by sand, and the slopes were of variable inclination and some places steep. The discharge was normal to low and the water speed slow at the day of the survey. Segment B was monitored from land.

The shifting sand dunes cover and uncover litter over the course of a year. We observed a few litter items that may have been deposited by the river, such as bottlecaps and lids and small pieces of rope and rubber belts. However, at the start of the river segment over 100 meters upstream from the ocean we found several pieces of net-cuttings that are undoubtedly of marine origin. This indicates that the bottlecaps may also have come from the sea, as bottle caps and lids are frequently found along the Norwegian coastline (Haave et al, 2025). Strong winter storms and winds may transport marine litter up the river, and this may affect the litter types and numbers in the monitoring area. For that reason, the location does not seem suitable for monitoring of riverine litter.

Figure 17: Map of Orre River Segments A and B (top). Photos of Orre River segment A (bottom) with dense reeds along the riverbank, potentially hiding litter. May 2025.

Figure 18: Orre River Segment B near the outlet at the sandy Orre beach, in May 2025. Bottom: Using the nIR tool for measuring the width of the riverbank.

SUMMARY OF QUANTITATIVE DATA FROM TEST SITES

The case studies investigated and described the properties of the river, the surroundings and the monitoring segment from the water's edge to the levee in sixteen 100-metre segments in eight Norwegian rivers (Table 1). Table 2 and Figure 19 (And supplementary Tables in Appendix 2) describe the quantitative litter data, which serve a basis for comparison within and between rivers, and adds to the evaluation and discussion of the method.

The properties of the riverbank, the substrate and hydromorphology varied within a river, as well as between rivers. The properties of each river are described in Table 1. Table 2 and Figure 19 illustrate that there are large differences in litter amounts and composition among and within a river, and that the upstream segment in the river (A) may have more litter than the downstream segment (B). We observed between 1 and 679 items per segment (Table 2, Appendix 2). Even in rivers with a high number of items per segment, such as Bolstad, Alna, Lier and Haukås, the items in the segments were markedly different. Even segments that were close together, such as segments A and B in Haukås, Bolstad and Otra, were highly different in number of litter items and composition. The segments A and B in Otra were placed adjacent to one another, and in Bolstad River they were within a short distance apart, yet there are marked differences in numbers, types and weight of the collected litter among the segments within the same river (Table 2, Figure 19 and Appendix 2). This underlines the importance of careful selection of the survey area and indicates that perhaps a higher number or longer segments should be selected for each river to provide a representative picture of the litter amounts and sources in each river.

We observed that the most polluted monitoring area could be upstream in the river, indicating that litter may be efficiently trapped on the riverbank and in the vegetation, and that the presence of accumulation areas is more important for observations of high amounts of litter than whether a segment is the furthest downstream. It may also be that once mobilized, the litter is efficiently transported away rather than deposited downstream from a pollution site. Litter in a river may, however, not always reach the river mouth or the ocean. Riverbank cleaning represents an efficient way to intercept litter before it reaches the sea, as well as maintaining the riverine ecosystem.

Table 1: Description of river and riverbank properties at the test segments surveyed in May 2025.

River name and segment	Anthropogenic impact on the riverbank	Dominating habitat type (>50%)	Dominating vegetation (>50%) and minerogenic substrate	Bank width (distance to the levee) (m)	Bank Slope (degrees)
Alna A	Urban area/ City	Glide/ backwater	Grass/herbs Silt/sand	2-2,5	45
Alna B[1]	Urban area/ City	Glide	Trees/Shrubs Soil/boulders	3	10-25
Bjerkreim A[1]	Residential	Run	Grass/herbs Boulders	9,4	6, 9, 14
Bjerkreim B	Residential	Run	Grass/herbs Boulders	9,3	18
Bolstad A	Agriculture	Riffle + rapid	Grass/trees Cobbles	9	6-9
Bolstad B[1]	Agriculture	Riffle + rapid	Grass, Boulders	5.6	15
Haukås A[1]	Forest	Run	Grass/herbs No minerogenic zone	3.1	6-15
Haukås B	Agriculture	Run	Grass/herbs no minerogenic	1.9	30-50
Lier River A	Urban	Glide	Grass/herbs Sand	4.8	30
Lier River B	Urban	Glide	Herbs, Clay to sand	4.4	30-50
Numedalslågen A[1]	Forest/Rural	Glide	Grass herbs Sand /cobbles	5	6-7
Numedalslågen B	Urban	Glide	Grass/herbs Sand/gravel/pebbles	5.3	4-5-6
Orre A	Agriculture	Run	Grass/herbs No minerogenic zone	4.9	18-35
Orre B	Agriculture + Coastal	Glide	Grass, herbs Sand	2.8	20-30
Otra A[1]	Rural	Glide/ backwater	Grass/herbs Sand/ gravel/ cobbles	3.8	6-10
Otra B	Rural	Glide/ backwater	Grass/herbs Sand/gravel/pebbles/cobbles	10,0	3-6

[1)] Has properties that makes the segment suitable for monitoring, not considering the amount of litter

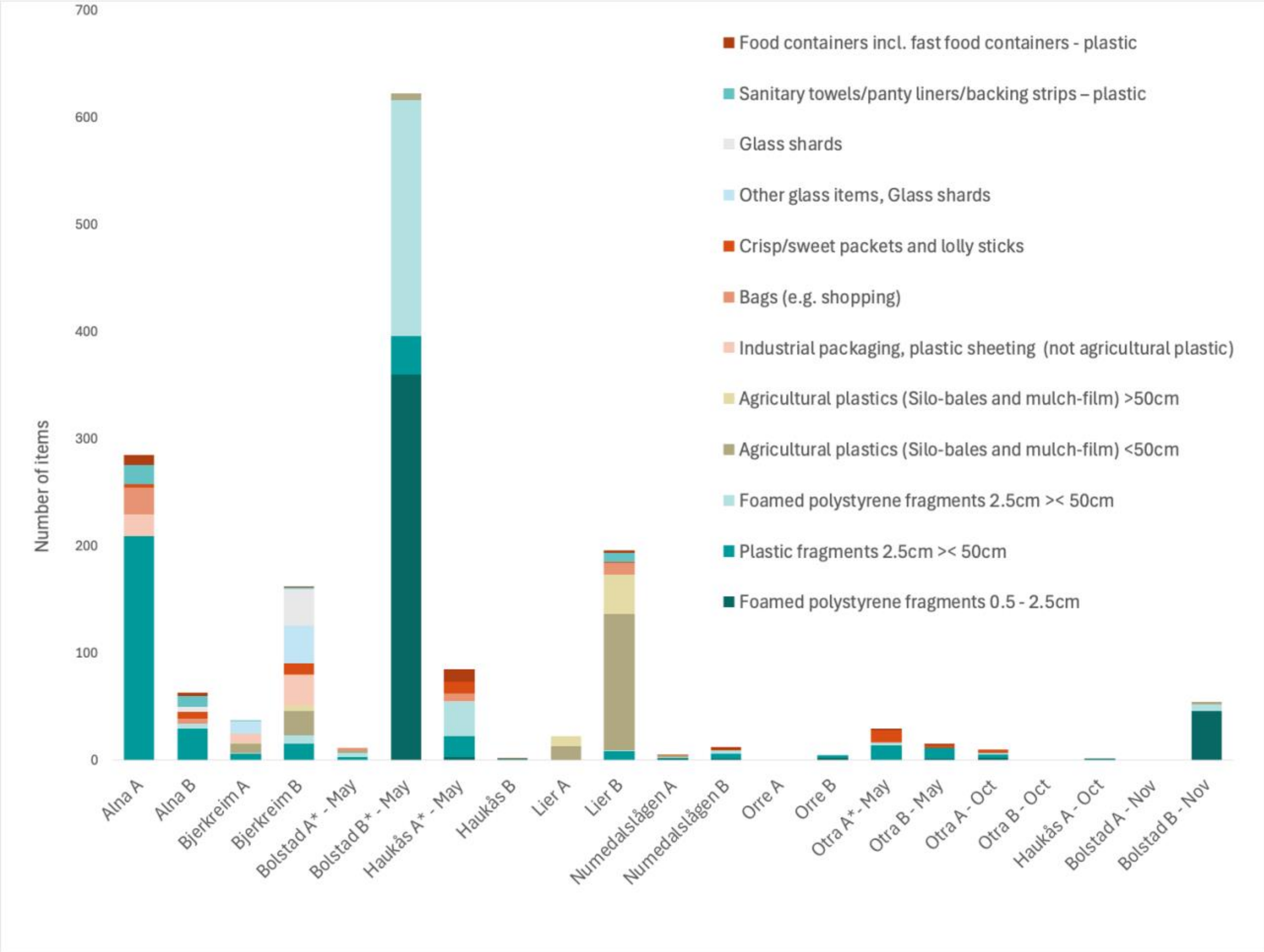

Figure 19: in October-November 2025. (Only top twelve items are shown. For the full registration of items, please see Appendix 2).

Table 2: The eight test rivers, with two 100-meter segments surveyed in each river, number of litter items and weight, time spent on the first survey in May 2025, and the number of litter items collected in the same segments in October 2025 for two selected rivers

River name	No. of items (May)	Litter weight (kg) (May)	Time used (May)	No of items (Oct.-Nov)	Litter weight (kg) (Oct.-Nov.)
Alna A	344	23.5	01:40		
Alna B	103	4.9	00:35		
Bjerkreim A	88	5	00:55		
Bjerkreim B	282	8	00:45		
Bolstad A*	26	1	00:35	0	0
Bolstad B*	679	3.9	00:55	60	<0.6
Haukås A*:	133	5.8	01:30	3	< 0.1
Haukås B	4	1.6	00:40		
Lier A	27	0.7	01:15		
Lier B	240	6.7	01:15		
Numedalslågen A	23	0.8	00:45		
Numedalslågen B	38	0.7	00:45		
Orre A	1	0.08	00:19		
Orre B	22	3.3	00:21		
Otra A*	59	1.0	00:40	14	< 0.5
Otra B*	28	0.1	00:30	2	< 0.01

*: Revisited in October and November

The time spent at the survey in May to measure the 100-meter distance, describe the river, vegetation and riverbank properties and clean the selected area ranged from 19 to 100 minutes, with an average of 50 minutes for two persons, excluding transportation to the start of the segment. Approximately one hour was then spent on litter registration for two persons following to the OSPAR items list for each river segment, noting down specific items particular to Nordic countries (Appendix 2).

The rivers were likely cleaned for the first time in a long while. After the fieldwork in May, a larger cleanup campaign for Norwegian rivers was initiated. The timing of the fieldwork before the large cleanups enabled comparison of differences and similarities of litter counts and composition within and among rivers. For the initial cleanup and monitoring round in May, unidentified plastic fragments of soft and hard plastics as well as EPS, with pieces over and under 50 cm were most frequently observed (Figure 19). These pieces could not be identified to source. Agricultural plastic, (mulch and bale-film) were also frequently observed.

FIELDWORK EXPERIENCE AND EVALUATION OF METHOD FOR RIVERINE MONITORING

Description and selection of the survey area

The case studies collected experience on the utility and applicability of the draft registration form and field guide, and how to adapt riverbank litter monitoring to a variety of rivers. In the following discussion we focus on considerations for metadata- as well as data collection that emerged before and during the fieldwork for this project. The discussion is informed by our prior experience with OSPAR beach litter monitoring, general river dynamics and behaviour and river macroplastic monitoring.

Whatever the aim of the monitoring is, the method must be reliable and replicable, and developed with the main aims in mind. The European OSPAR riverine monitoring program has so far aimed to be aligned with the beach litter monitoring, assessing trendlines as well as major sources of litter.

The selection of river segment for a survey area is of the utmost importance for future monitoring of litter on the riverbanks, as this affects the likelihood of deposition of litter. Preferably, the survey area should be placed in areas where litter accumulates on a regular basis, to map and describe relevant sources of litter and to monitor changes and long-term trends in amounts and types of litter. Zero-values in total amount or specific items will provide very little useful input to the monitoring data and prevent the calculation of trends in amount and sources of litter (Schulz et al. 2019).

We recommend that the selection of a monitoring segment is done only after careful consideration, taking into account knowledge of seasonal and interannual variations in water discharge, as well as potential and regular flood events. Experts on river hydrodynamics may be consulted before the final selection and delimitation of a survey area by OSPAR coordinators.

After the monitoring segment has been defined, the same segment must be monitored every time, in alignment with OSPAR beach-litter monitoring.

Defining the survey area

Standard length of the survey area

The optimum standard length and size of the riverine monitoring area need to be carefully considered by the OSPAR River Expert Group. While segments of 100-metres have been used for riverbank monitoring in the Netherlands and France and is proposed for the OSPAR protocol for European rivers in general, our experience suggests that 100 m may not be sufficient to yield representative estimates of riverine litter in Norway. We observed that the amount of litter differed substantially between two 100 m segments within a river, and that the litter is not homogenously distributed. These observations align with Velle et al. (2020, 2024). Consequently, litter counts over short river segments may be dominated by stochastic events and local variations, especially in low-litter segments or seasons. Zero values will greatly reduce the informative value and utility of the monitoring data. Monitoring a longer river segment or including multiple 100 m segments may be necessary to capture spatial variability and improve the possibility for statistical analyses and detection of trends. Including several segments would also reduce the vulnerability of each river to unpredictable changes of the riverbank. This is also discussed later in the report.

Width of the riverbank in the survey area

The definition of the riverbank width and thus the size of the survey area for litter, may be of importance for standardization if the amount of litter is standardized to the area and not the length of river monitored. In beach litter monitoring the length and width of the beach is measured, while in rivers, there may be other necessary considerations.

If using a set width of the survey area from the water level, as done for this pilot study, the relevant width needs to be defined individually for each river. After the width of the survey area has been defined, the same area should be cleaned and monitored every time. In case of such static and predefined width of the survey area, any litter deposited outside the predefined monitoring area by occasional extreme floods that overflow the riverbanks will be lost from the data. If deciding to use a set riverbank width, we propose to register all litter from the water's edge up to the level where the river reaches full bank condition, i.e. at the inflection point where the curvature of the riverbank changes, or the levee. The levee is a sediment mound along the bank (Figure 2). In case the bank lacks a clear inflection point (no distinct natural levee crest), a high flood line with debris deposited by floods can define the upper boundary. In many temperate, alluvial rivers, bankful river (and initial spillover to the floodplain) occurs about every 1 to 2 years. In some systems it is rarer (2-to-5-year events), and in regulated or arid rivers much less frequent. Several local impacts in the river (floods, erosion, etc) can shift the level of the levee. The predefined width should in those cases include the high-water level of any likely flood events.

Another method is to use the latest flood line as a dynamic boundary for the width of the monitoring segment at each survey, which will mean a dynamic width of the river monitoring area. This means that the only fixed measurement of the river monitoring area is the length of the riverbank. In flat areas, such as floodplains and alluvial plains without a levee or deltas, the flood-line boundary may yield an impractically wide survey strip that can be hard to define. Consider excluding segments where the width is too wide or it is not possible to define an upper limit.

The effect of vegetation and obstacles on monitoring

Visibility of the ground and vegetation cover within the survey area below the flood line is of importance for the accuracy in observations. Efficient and reliable riverbank monitoring will not be feasible in areas where the riverbank is inaccessible, and the litter is hidden in dense vegetation and/or difficult to remove. The registration form (Appendix 1) thus asks to note the permanent ground cover and seasonal development of the vegetation at the time of the survey. Personnel should be able to walk along the riverbank and reach the water's edge throughout the length of the survey area without entering the water during all surveys. One might consider avoiding placing the survey area in areas with particularly dense vegetation, for example dense reeds that cover the water (i.e., Orre River, Figure 17), or large masses of overhanging trees and bushes along the river (i.e., Alna River Figure 13).

Some obstacles along the riverbank can however be accepted, and are expected to be overcome, such as occasional bushes and trees, as long as one may pass behind or between these obstacles and also be able to remove observed litter. Larger obstacles that prevent access should not be present in the survey areas. Such obstacles could be large boulders, pipes or culverts hiding significant sections of the riverbank or survey area from view, or cliffs and rapids obstructing the movement along portions of the riverbank.

Constructions affecting the flow of water and the amount of litter in the river, such as the presence of grates or water inlets for hydropower within or directly upstream of the survey area should be investigated, known to the surveying team, and avoided to prevent blocking in-river transport of litter from potential sources.

Definition of "Inside or outside the survey area" - and the effect of small amounts of litter

In cases where the riverbank has a long slope down to the river, variables such as wind, rain, and time since the waste was deposited, will determine when the litter ends up near the water's edge, and therefore whether it is inside the monitoring area, in case this is defined by the flood-line and not a predefined width of the riverbank. Limiting the width of the survey area to the latest flood line will risk excluding litter immediately above the flood line that may end up in the river before the next survey. It can be argued that whether an item is above or below the flood line is a random variable that will exclude or include on an even keel. A range of stochastic events will determine whether the litter will be registered within this segment of the river during a later survey. Chances are that litter may move through the monitoring area before the next survey and be transported out of the river. Such stochastic events may disproportionately influence the registered amounts of litter in rivers with low pollution levels, while it may be appropriate for more polluted rivers. For Norwegian rivers with low absolute levels of litter, the effect of random events and exclusion of litter items on the riverbank, babove the flood-line may have a higher impact than in highly littered rivers.

In the repeated surveys of segments Otra B, Haukås A and Bolstad A in autumn 2025 we observed two, three and zero litter items respectively, five to six months after the initial monitoring and cleaning in May. For an area to be suitable as a monitoring site, and to be able to demonstrate any trend in litter composition and amounts over time, it is important that there is litter present and that any potential indicator items do not have too many zero-values (Schulz et al. 2019). This implies that less polluted rivers in Norway may have too low levels of litter to be relevant for litter monitoring. However, the amount of litter observed in 73 Norwegian rivers (Velle et al, 2024) implies that many Norwegian rivers have substantial amounts of litter. Rivers running through agriculture, industry or urban areas are likely to have enough litter to be monitored yearly, but the frequency can be adjusted to suit the observed level of pollution after the first cleanup. It is also recommended to include several segments along the same river for a better representation of the river littering, or to include fewer but longer segments. In short rivers, such as the Orre River inclusion of several segments will be difficult, and it may be better to include one longer segment. Some rivers may also be divided by culverts, grates or hydropower, interfering with the potential to select coherent and accessible 100-m segments that also accumulate litter. Selection of the segment or segments is of vital importance to litter monitoring.

Urban areas are also more likely to have organized cleanups that will interfere with the monitoring data. Whether this can be abated or can be allowed must be a consideration for the wider OSPAR group to decide.

For beach litter data, it has been shown that a high number of surveys are needed to give sufficient statistical power to detect long-term trendlines, and we may assume that a similar limitation is relevant for river data, although extrapolating to riverine litter is only an assumption. Schulz et al (2019) concluded that the mean number of beach surveys necessary to detect a statistically significant reduction of 30% for single items with 80% power ranged from 16 to 20, but that a 50% reduction could be observed with a lower number of surveys (<12). If the total abundance is used as an end point, the number of necessary surveys to observe a 30% reduction is reduced to a mean of 14.3 surveys compared to 17.0-19.7 surveys to observe a 30% reduction in specific indicator items (Schulz et al. 2019).

The variance and number of surveys needed to statistically conclude with a significant reduction will become evident in time. However, to increase valid datapoints, and circumvent the patchy and variable distribution of litter within Norwegian rivers we could include several monitoring segments within each river to reduce the level of zero-values.

Performing the survey

To ensure a uniform execution of surveys, we advise that monitoring should be performed from land without the need to use specialized equipment or boats (and in a way that will not compromise the health and safety of the workforce), while collecting litter from the water's edge to the defined outer limit (fixed or flexible width) along the entire length of the monitoring area, currently 100 metres.

We should keep in mind that the workforce may not be especially trained personnel with a high degree of experience from walking along rivers, and with limited background from working on or along rivers. OSPAR has previously relied on moderately trained but motivated and informed adult citizen scientists.

Time spent monitoring during each survey can in general be expected to decrease after the initial description and mapping of the surveillance area since the description of the substrate and vegetation-types and measurements of riverbank width and slope can sometimes be time consuming. If measuring the width of the riverbank is required, this may take time, as the width may vary along the segment. Digital tools such as laser distance meter and digital inclinometer (used for this study) save time during the initial description of the area, especially if the riverbank width is to be decided based on the distance to the levee. However, digital tools are not essential for accurate measurements or descriptions of the riverbank. Using the latest flood line for a dynamic definition of the monitoring area will save time during the first survey, while also introducing some uncertainty in the data over time. Photos will also be useful tools for the OSPAR Coordinators to help describe and understand the river and surroundings.

After the monitoring area has been defined and described during the first survey, the cleaning and registration may take as little as 30-minutes for a 100-meter segment. However, time spent is naturally affected by the amount of litter present. As an example, it took only 40 minutes to walk and survey Otra river segment A and B together (200 meters in total) during the second round of monitoring in October. The litter registration from both segments was completed in less than one hour. The repeated survey at Bolstad A and B took 15 and 30 minutes respectively, plus litter item registration of the 60 items at Bolstad B which took half an hour. Bolstad A had zero items in November.

Based on these observations we believe that a longer segment of the river can be travelled and monitored during each survey. We would thus recommend that in Norway a longer segment than 100 meters of the river is monitored, to compensate for the potentially high variability and relatively small amounts of litter within some rivers. Inclusion of several segments per river is also recommended for fully representing the riverine litter and would in case of low amounts of litter not take an unreasonable amount of time.

Seasonal considerations for health and safety

Special considerations for the Nordic countries include large seasonal differences in water flow and seasonal snow and ice cover that prevents monitoring. We propose avoiding the winter season for monitoring of riverine litter in Norway, as ice and snow on the ground makes walking along the river hazardous and will also cover litter on the ground. The monitoring should align to hydrologic seasons. In spring, the discharge may be high during snowmelt, and the river may cause erosion and bank slip, thus moving along the river during spring flood will pose a risk to the personnel. The same applies to periods of heavy rain with subsequent flooding. We advise to perform the first survey after the spring flood has receded, and before the vegetation sprouts in spring. This may imply a short window of opportunity that will usually appear in April, May or June, depending on interannual variations and the latitude of the survey area. In areas with no snow cover, the first spring survey can be performed at any time when the river is not flooding and before the vegetation sprouts. Later surveys can be performed as far as other considerations are met, and before ice and snowfall in autumn.

Footwear with non-slip soles and focus on work-safety can and should be sufficient to maintain safety at all selected surveillance areas. To be able to explore the areas and move unhindered along the river, we recommend using waders and wading shoes. This equipment that can be beneficial when moving along and partially in the rivers since it allows passing inlet streams and smaller obstacles along the riverbank. Waders are, however, are likely not needed at all sites. Survey areas should not include cascades or rapids where movement along cascades and rapids may also be hazardous to performing personnel.

We advise that the standard procedure includes monitoring only one side of the riverbank, and that it is warned against crossing the river. Always selecting segments with only one channel may be a solution to prevent crossing the river, and to ensure equal practice and reduce uncertainties. We also recommend that the monitoring is limited to only include litter on the riverbank and in the minerogenic zone of the river channel, to prevent personnel from reaching for floating litter or litter stranded within the channel and on branches above the channel.

We also suggest that it at least two persons should monitor a site together, for safety as well as better accuracy in the surveillance. For health and safety, consider carrying a throwline if the riverbank is steep and/or the water moves fast. River safety and access should also be described for each location, e.g., potential hazards, discharge awareness, bank-slip risks etc.

Number of surveys per year

Due to the relatively short season for monitoring in Norway it may prove difficult to perform more than at most three surveys per river per year. One of three surveys will then likely be performed within the summer season when dense vegetation and high ground cover is likely present, which may obstruct the view and reduce the ability to find litter on the ground and in the vegetation along the riverbanks. In our experience, vegetation causes high uncertainty in the monitoring data, as some items may go unnoticed due to dense foliage as well as ground cover. The presence of dense vegetation also increases the time needed per survey. Unless the river is highly polluted or frequently littered with new litter, surveys with suboptimal conditions may cause zero values for many litter types that are in fact present. This will not be representative and will hinder statistical analyses and the calculation of trendlines for these types. However, if the aim of the surveys is to give information on environmental status and point to some frequent litter types that need prevention, a high frequency of surveys may not be required. Then, one to two surveys per year may be sufficient. The first survey would then be in spring after snowmelt and before the vegetation develops, and the second in autumn after the leaves drop, which would give information on new litter arriving in the survey area during the summer-season. A summer- survey might be feasible at certain places where the summer vegetation does not influence the accuracy of monitoring, such as the rocky shores of Bolstad River (segment B), or areas with short and open vegetation.

CONCLUSION

The experience from the test-survey of sixteen segments from eight Norwegian rivers of highly variable properties and qualities has provided valuable knowledge on how to standardize monitoring of riverine litter in Norwegian rivers, with the goal of input to and alignment with European OSPAR guidelines. In conclusion, we find that the following elements are necessary to consider carefully in the standardization process:

It is necessary to select the monitoring segment for each river in collaboration with local knowledge or river experts to include accumulation areas that actively trap riverine litter, to avoid zero-values.

Including several 100-m segments and/or longer segments per river will reduce the effect of stochastic variation in litter deposition and will provide a better picture of the sources and amounts of litter within a river or river system, especially in rivers with low pollution levels.

Including a high number of monitoring segments per river will moreover reduce the impact of flood events. Flood events may also alter a monitoring segment through erosion. In a future with more extreme weather, avoiding the impact of erosion and floods may be an important consideration to obtain an unbroken timeline for each river.

Allowing dynamic definitions of riverbank width will reduce the effect of unpredictable or unusual flood events on the data, as all deposited litter can be included in the monitoring, while the results can be standardized to the length of the river segment. However, using the lates flood line will exclude litter that is in the process of entering the river. In cases where pollution levels are low, this may exclude data.

Accumulation of litter along the river is dependent on factors, such as the water speed and the ability and likelihood of litter to be deposited and retained on land. From a long experience with river dynamics as well as experience from mapping riverine litter, and experience from this study we advise to select monitoring segments that consider the following properties:

1. The segment is along the outer meander or along the side of the river with the strongest current, which is where the main waterflow is and where most plastic will be transported.
2. The water speed is slow to moderate past the monitoring segment. river. There is usually too much energy in segments with rapids or cascades for plastic to deposit.
3. Low to medium steepness /slope of the riverbank (<20 degrees) to allow deposition of litter, and surveyor access to the water. The riverbank should have areas where floating items can be washed up on land under normal discharge.
4. Vegetation on the riverbank that can trap the litter, such as trees or bushes, is beneficial. Overhanging vegetation can be beneficial for monitoring if the litter in the vegetation can be removed during the survey without entering the water.
5. Avoid river segments with plastering or sleek walls that prevent litter from attaching or accumulating even at low water speed.
6. Avoid culverts that include grates or water inlets and dams for hydropower immediately upstreams since most litter will not pass such barriers. There should be potential sources of litter between such barriers and the monitoring site.
7. The monitoring areas should aim to cover segments of the river that ensures a representative selection of litter, and to avoid zero-values.
8. Followingly, we recommend mandatory inclusion of several monitoring segments for each river, or to allow for monitoring of longer segments than 100 metres.

It should always be possible to walk along the water to observe and remove litter safely.
Health and safety of personnel must be considered for the protocol, and strict rules on crossing the river or fishing for litter within the river channel may be applied. We recommend that only one side of the river is to be monitored for each segment.

With the large variations among European rivers in terms of hydromorphology, litter sources and land use, and in consideration of the aims of the international OSPAR collaboration, we welcome the continued development of a standardized protocol for litter monitoring on riverbanks. We hope that this practical project “Testing an indicator for riverine litter monitoring” can be made useful for the long term OSPAR riverine monitoring program.

APPENDIX 1

Draft registration form Part 1: Description of conditions and properties of the river

GPS coordinates (decimal degrees) start (upstream):

________________________°N ________________________°E

GPS coordinates (decimal degrees) stop (downstream):

________________________°N ________________________°E

Riverbank slope angle: (e.g. "10-12 degrees"):

The river has a

☐ **single channel** ☐ **braided channel***

*(in a braided river, survey the riverbank on one side only, do not cross over the river or include islands in the river)

River water speed at normal discharge (flow habitat types) *

Cascade	%
Rapid	%
Riffle	%
Run	%
Glide	%
Pool	%
Backwater	%

**please refer to guide for description of water speed*

2. Type of vegetation in the riverbank (riparian vegetation)

(% cover, e.g. grass/ herbs 50%, shrubs 30%, Trees 5%, minerogenic 15%. SUM = 100%):

A = grass/ herbs	%
B = shrubs (< 3 m height)	%
C = trees (> 3m height)	%
D= minerogenic zone	%

3. Type of minerogenic surface material in the riverbank (% cover, e.g. sand 20%, gravel 10%, pebbles 10% boulders 60%. SUM = 100%):

A = clay (<0.02 mm) %

B = silt/ organic soil (<0.02-0.06 mm) %

C = sand (0.06-.2mm) %

D = gravel (2 – 16 mm) %

E = pebbles / rocks (16-64) %

Cobbles (64-256 mm) %

F = boulders (>256 mm) %

G = bedrock %

4. Types of anthropogenic impact on the riverbank (in the survey area)

Road to the riverbank ☐

Agriculture ☐

Industrial use ☐

Urban area /city ☐

Residential area ☐

Flood/ erosion control (man-made levees, boulders) ☐

Bridge foundation ☐

other (please describe below) ☐

5. Dominating cover type in the floodplain, along the survey area (% cover):

Grassland %

Pasture/ Agriculture %

Forest %

Park/garden %

Hard surface (road, pavement) %

Houses %

Other (please describe) %

6. Dominating human activities and landscape the river runs through (1-2 km upstream from the survey area) (you can tick more than one box)

Forest/rural ☐

Park ☐

Agriculture ☐

Road ☐

Residential area ☐

Industrialized area ☐

Urban area /city ☐

Other (please describe below) ☐

____

Is this part of the river regulated for hydropower upstream of the site?

☐yes ☐no

Are there any grates (culverts with grates) 1-2 km upstream of the survey area? *

☐yes ☐no

*Please see guideline for examples

Major recreational riverbank usage (swimming and sunbathing, camping, fishing, surfing, sailing etc):

Usage 1. ___________________ seasonal or whole year round: ___________________

Usage 2.___________________ seasonal or whole year round: ___________________

Usage 3. ___________________ seasonal or whole year round: ___________________

More: ____________________ seasonal or whole year round: __________________

Access to the riverbank (you may tick more than one box)

☐ Vehicle

☐ Pedestrian

☐ Boat

What is the distance from the starting point to nearest town? __________________ km

What is the position of town in relation to survey area?

☐ Upstream

☐ Downstream

☐ Alongside the survey area

What is the population size of the nearest town? ____________persons

What is the distance from the starting point to the shops? ________ km

Are the shops present all year round?

☐Yes ☐No

If no please specify which months:

What is the distance from the beach to the nearest upstream bridge? __________km

What is the distance from the survey area to the nearest river mouth (outlet to lake ocean, fjord etc? ________km

What is the name of the water body the river enters into? ___________________________

Is the riverbank cleaned regularly?

☐ Don't know ☐Yes ☐No

If yes, How often is the riverbank cleaned:___________ times/year

What method is used for cleaning:

☐ Manual ☐ Mechanical

Who is responsible for the cleaning:__________________________________

☐ Don't know

Additional comments and observations about this riverbank:

Please include:

1- A map of the river and riverbank including the survey area

2- A map of the local surroundings. When relevant please mark on this map the following:

☐ Nearest town

☐ Restaurants, kiosks, shops

☐ Nearest harbour

☐ Nearest river mouth

☐ Discharge or discharges of waste water

3- Please attach a regional map showing the area the river runs through, including constructions and conditions that you think may influence the input of litter to the river

Registration form Part 2: Survey specific details at the day of the survey

Country: NORWAY

Name of River:

OSPAR ID:

Date of survey: (dd/mm/yy)

Name of surveyor 1: name nameson

Phone number: +47 xxx xx xxx

E-mail address: name@place

Name of surveyor 2: name nameson

Phone number: +47 xxx xx xxx

E-mail address: name@place

River conditions on the day of the survey

Water discharge at the time of survey:

☐ High ☐ Medium ☐ Low

Average riverbank width on the day of the survey (m):

(Average of 5 measurements from the active channel to the levee):

1	2	3	4	5	Average width (m)

Vegetation cover on the day of the survey

Foliage: ☐ very early spring, slightly visible green leaves
☐ small leaves, not fully developed
☐ fully developed leaves
☐ no foliage (late autumn and winter)

Ground cover: ☐ very early spring, minimal, scarce, short vegetation
☐ half developed herbs and grass cover, some open ground still visible
☐ fully developed, tall herbs and grass cover the ground

☐ no green herbs and grass, winter

Was litter collected during this survey:

☐ Yes ☐ No

Did you divert from the standard lenght (m):

☐ No ☐ Yes, please specify segment length: ______m

Were there any circumstances that influenced the survey.

☐ clearing vegetation along the riverbank

☐ recent replenishment of the riverbank

☐ recent cleaning events

When was the beach last cleaned? ________ (dd/mm/yy) ☐ Don't know

Have there been any flooding events since the last survey? ☐ Yes ☐ No

If yes, please explain:

- Normal spring flood (i.e. during snowmelt in spring)
- Extreme weather with floods: _ weeks/ ____months ago ☐ Don't know

Did any of the following weather conditions affect the data of the surveys.

If so please tick appropriate box:

☐ Wind ☐ Rain ☐ Snow ☐ Ice ☐ Fog

Additional observations and comments

Did you find stranded or dead animals: ☐ No ☐ Yes

If yes, how many:____

Please describe the animal, (species name if known): ___________________

☐ Alive ☐ Dead

Sex of animal (if known):____________________

Age of animal (if known)____________________

Is the animal entangled in litter _______________

If yes, describe nature of the entanglement and type of litter:

____

____

____

Were there any events that lead to unusual types and/or amounts of litter along the river? For example festivals, events, road construction, bridge renovation or other.

If yes, please specify: ____

____

Did you observe any dumpsites along the river?

Please specify the location and type of known dumpsites, and the distance to the survey segment:

Type: ________________ ☐ Upstream ☐ Downstream Distance to the segment: ________ ______(km)

Were there any large litter items within the segment that could not be removed? Please describe:

(e.g.: Cars, pipes or other large items of metal, concrete or plastic)

____

Other observations:

____

APPENDIX 2

Supplementary Table 1: Registered items per 100-meter river segment in eight Norwegian rivers, May, October and November 2025.The list includes items on the OSPAR items list with suggested additions of some Norwegian litter types

OSPAR ID	Types	Alna A	Alna B	Bjerkreim A	Bjerkreim B	Bolstad A	Bolstad B	Haukås A	Haukås B	Lier A	Lier B	Numedalslågen A	Numedalslågen B	Orre A	Orre B	Otra A- May	Otra B- May	Otra A-Oct.	Otra- B Oct.	Haukås -A- Oct	Bolstad A- Nov.	Bolstad B Nov.
1	4/6-pack yokes												1			1						
2	Bags (e.g. shopping)	25	5		1	2		7			11					1						
3	Small plastic bags, e.g., freezer bags	5			6	1		8			1		2			4						
112	Plastic bag ends																					
4	Drinks (bottles, containers and drums)	1	2				7	4			1						1					
5	Cleaner (bottles, containers and drums)							2														
610a	Food containers incl. fast food containers - plastic	10	3		1			12			3		2			1	1					
620a	Food containers incl. fast food containers - foamed polystyrene		1				9	6			1							2				1
7	Cosmetics (bottles & containers e.g. sun lotion, shampoo, shower gel, deodorant)																					

8	Engine oil containers and drums <50 cm																**1**			
9	Engine oil containers and drums > 50 cm																			
10	Jerry cans (square plastic containers with handle)	**1**																		
11	Injection gun containers																			
12	Other bottles, containers and drums	**1**	**1**				**2**													
13	Crates	**2**																		
14	Car parts			**1**	**1**		**2**													
151b	Caps/lids drink				**1**								**1**							
152b	Caps/lids non-drink and unknown origin			**1**	**3**										**2**					
16	Cigarette lighters						**1**													
17	Pens																			
18	Combs/hairbrushes															**1**				
19	Crisp/sweet packets and lolly sticks	**3**	**6**		**10**			**11**	**1**		**1**	**1**	**1**			**11**	**3**	**3**		
20	Toys & party poppers			**2**	**3**		**1**				**2**		**1**			**2**				**1**
211a	Cups - plastic				**1**			**2**										**1**		
212a	Cups - foamed polystyrene																			
22	Cutlery/trays/straws	**1**																		
23	Fertiliser/animal feed bags	**10**									**5**									

231b	Commercial salt packaging														
24	Mesh vegetable bags														
25	Gloves (typical washing up gloves)														
113	Gloves (industrial/professional gloves)	1						1							
26	Crab/lobster pots														
114	Lobster and fish tags														
27	Octopus pots														
28	Oyster nets or mussel bags including plastic stoppers														
29	Oyster trays (round from oyster cultures)														
30	Plastic sheeting from mussel culture (Tahitians)														
31	Rope (diameter more than 1 cm)			1											
321a	String and cord (diameter < 1cm) not from dolly ropes or unidentified	2		1	1			4			4				
322a	String and filaments exclusively from dolly ropes														

115	Nets and pieces of net < 50 cm																	
116	Nets and pieces of net > 50 cm																	
1151b	Other plastic strings and filaments exclusively from fishery (incl. small net cuttings and repair cords)												**6**					
331a	Tangled nets/cord/rope and string without dolly rope or mixed with dolly rope																	
332a	Tangled dolly rope																	
341a	Fish boxes - plastic																	
342a	Fish boxes - foamed polystyrene																	
35	Fishing line (angling)														**1**			
482b	Other plastic fisheries related items not covered by other categories (e.g. from recreational fisheries)	**1**	**1**						**1**									
483b	Plastic bait containers/packaging																	
36	Light sticks (tubes with fluid)																	
371b	Floats/Buoys from fisheries																	

372b	Float/Buoys not from fisheries																					
38	Buckets																**1**					
39	Strapping bands	**4**	**3**		**1**						**1**											
40	Industrial packaging, plastic sheeting (not agricultural plastic)	**20**		**9**	**28**			**1**														
41	Fibre glass																					
42	Hard hats																					
43	Shotgun cartridges																					
44	Shoes/sandals	**1**									**1**											
45	Foam sponge																					
64	Cigarette butts											**2**	**1**				**1**					
121	Bagged dog faeces																		**1**			
481a	Biofilm support media																					
1171a	Plastic fragments 0.5 - 2.5cm							**1**	**1**			**6**			**1**							
1172a	Foamed polystyrene fragments 0.5 - 2.5cm						**360**	**3**				**1**	**1**		**2**		**1**			**1**		**46**
461a	Plastic fragments 2.5cm >< 50cm	**209**	**29**	**6**	**15**	**3**	**36**	**19**	**1**		**8**	**1**	**5**		**2**	**14**	**10**	**3**				**2**
462a	Foamed polystyrene fragments 2.5cm >< 50cm		**5**	**1**	**8**	**4**	**220**	**32**			**1**	**1**	**3**		**1**	**2**		**2**		**1**		**6**
471a	Plastic fragments > 50cm	**17**	**4**		**2**	**2**		**1**			**1**					**1**						
472a	Foamed polystyrene fragments > 50cm							**1**														
48	Other plastic items											**1**						**1**				

49	Balloons, including plastic valves, ribbons, strings etc.				**1**															
50	Boots																			
52	Tyres and belts		**1**								**1**				**1**					
53	Other rubber pieces	**1**	**1**		**1**															
	CLOTH																			
54	Clothing	**4**						**1**			**1**									
55	Furnishing																			
56	Sacking	**1**																		
57	Shoes (leather)										**1**									
59	Other textiles					**1**	**1**						**1**		**1**					
60	Bags																			
61	Cardboard			**4**																
118	Cartons e.g. tetrapak (milk)																			
62	Cartons e.g. tetrapak (other)	**2**						**1**												
63	Cigarette packets										**1**						**2**			
65	Cups							**1**												
66	Newspapers & magazines																			
67	Other paper/cardboard items		**1**	**2**	**7**			**1**			**1**						**1**			
68	Corks					**1**	**1**													
69	Pallets																			
70	Crates																			
71	Crab/lobster pots																			
119	Fish boxes																			

72	Ice lolly sticks / chip forks				1							1								
73	Paint brushes																			
74	Other wood < 50 cm			1	4	1	1	1							1					
75	Other wood > 50 cm				2															
76	Aerosol/Spray cans			1	2															
77	Bottle caps			1	2								1							
78	Drink cans		1		4					2	1	1	2							
120	Disposable BBQ's																			
79	Electric appliances		1		2															
80	Fishing weights																			
81	Foil wrappers				4		2	2			2					10				
82	Food cans				4															
83	Industrial scrap			1																
84	Oil drums																			
86	Paint tins																			
87	Lobster/crab pots and tops																			
88	Wire, wire mesh, barbed wire				23											1				
89	Other metal pieces < 50 cm		5	7	7						2	2	1			1				
90	Other metal pieces > 50 cm			7	5	1	1	1			1					1				
91	Bottles	1	2	2	10			1			1					3		1		
92	Light bulbs/tubes																			
931a	Jars incl. fragments of jars																			
93	Other glass items				35		1				4	5	13			4				

94	Construction material e.g. tiles				3																	
95	Octopus pots																					
96	Other pottery/ceramic items			9	10			3														
97	Condoms – plastic (1)																					
981a	Cotton bud sticks – plastic (1)						1															
982a	Cotton bud sticks – cardboard																					
99	Sanitary towels/panty liners/backing strips – plastic (1)	18	10	1	1						8											
100	Tampons and tampon applicators – plastic (1)		2														1					
101	Toilet fresheners – plastic (1)																1					
1021a	Wet wipes – plastic (1)		9	2						1						1			1			
102	Other sanitary items																					
103	Containers / tubes - medical																1					1
104	Syringes																					
1051a	Single use face masks – plastic (1)																					
1052a	Single use gloves – plastic (1)	2	1																			
105	Other medical items (swabs, bandaging etc.)																1					

Agricultural plastics (Silo-bales and mulch-film) <50cm			**8**	**23**	**2**	**6**			**13**	**127**	**1**										**2**
Agricultural plastics >50cm (Silo-bales and mulch-film)			**1**	**5**					**9**	**37**											
Roadmarking sticks	**2**				**2**					**1**											**1**
Tobacco/Snuff-boxes						**3**						**1**									
Single snuffbags																**1**					**2**
Pipes <50 cm	**1**		**1**			**1**															
Pipes >50 cm						**1**	**1**							**1**							
Erosion protection mat (Geotextile)	**1**								**1**	**5**											
Glasses/safety goggles		**1**			**1**																
Bikelock		**1**																			
Bicycle- and parts (metal/plastic)			**1**				**1**	**1**				**1**									
Other glass items, Glass shards			**11**																		
Food cans + tubes																					
Electric chords			**3**	**5**						**1**											
Lightbulb			**1**																		
Plastic tools						**3**															
Garden hose			**1**																		
Flower pots			**1**							**1**			**1**								
Part of 'big bag' / backpack			**1**																		
Construction foam / PU foam				**1**																	

Paintbrush				**1**																	
Barrier tape				**1**																	
Glass shards		**5**		**35**																	
Building and construction materials plastic 2,5-5 cm (PU foam, Litex plates etc)						**7**															
Building and construction materials plastic 2.5><- 50 cm (PU foam, Litex plates etc)					**3**	**9**	**2**														
Building and construction materials plastic > 50 cm (PU foam, Litex plates etc)																					
Building and consturctio materials non-plastic (cardboard, rockwool. Siporex)				**1**			**1**														
Tarp						**2**	**3**														
Stickers/labels							**3**										**1**				
bird feed-balls wrapping										**1**											
Large piece - not removed (metal)									**1**												
Umbrella and/or parts	**1**																				
SUM	**344**	**103**	**88**	**282**	**26**	**679**	**133**	**4**	**27**	**240**	**23**	**38**	**1**	**22**	**59**	**28**	**14**	**2**	**3**		**61**

Supplementary Table 2: Name and location of river segments tested in the project

River name and segment	Anthropogenic impact on the riverbank	Bank width to the levee (m)	Coordinates (decimal degrees)			
			Start N	Start E	Stop N	Stop E
Alna A	Urban area/ City	2-2,5	59.923182	10.835517	59.92234	10.83578
Alna B	Urban area/ City	3	59.911136	10.82361	59.91033	10.82348
Bjerkreim A	Residential	9,4	58.58458	6.07490	58.380	6.07413
Bjerkreim B	Residential	9,3	58.58342	6.07356	58.58276	6.07252
Bolstad A*	Agriculture	9	60.64634	5.98363	60.64678	5.98201
Bolstad B*	Agriculture	5.6	60.63940	5.95291	60.64014	5.95216
Haukås A*	Forest	3.1	60.48615	5.38157	60.48697	5.38136
Haukås B	Agriculture	1.9	60.49554	5.37139	60.49478	5.37223
Lier River A	Urban	4.8	59.79370	10.23864	59.79228	10.23837
Lier River B	Urban	4.4	59.78892	10.24320	59.78803	10.24434
Numedalslågen A	Forest/Rural	5	59.83422	9.56197	59.83446	9.56376
Numedalslågen B	Urban	5.3	59.665321	9.652147	59.66442	9.65193
Orre A	Agriculture	4.9	58.73119	5.52783	58.73083	5.52628
Orre B	Agriculture + Coastal	2.8	58.727979	5.520887	58.72811	5.51932
Otra A*	Rural	3.8	58.22093	7.93342	58.22011	7.93238
Otra B*	Rural	10,0	58.22011	7.93238	58.21884	7.93142

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Framtidstro for havet, kysten og folket.