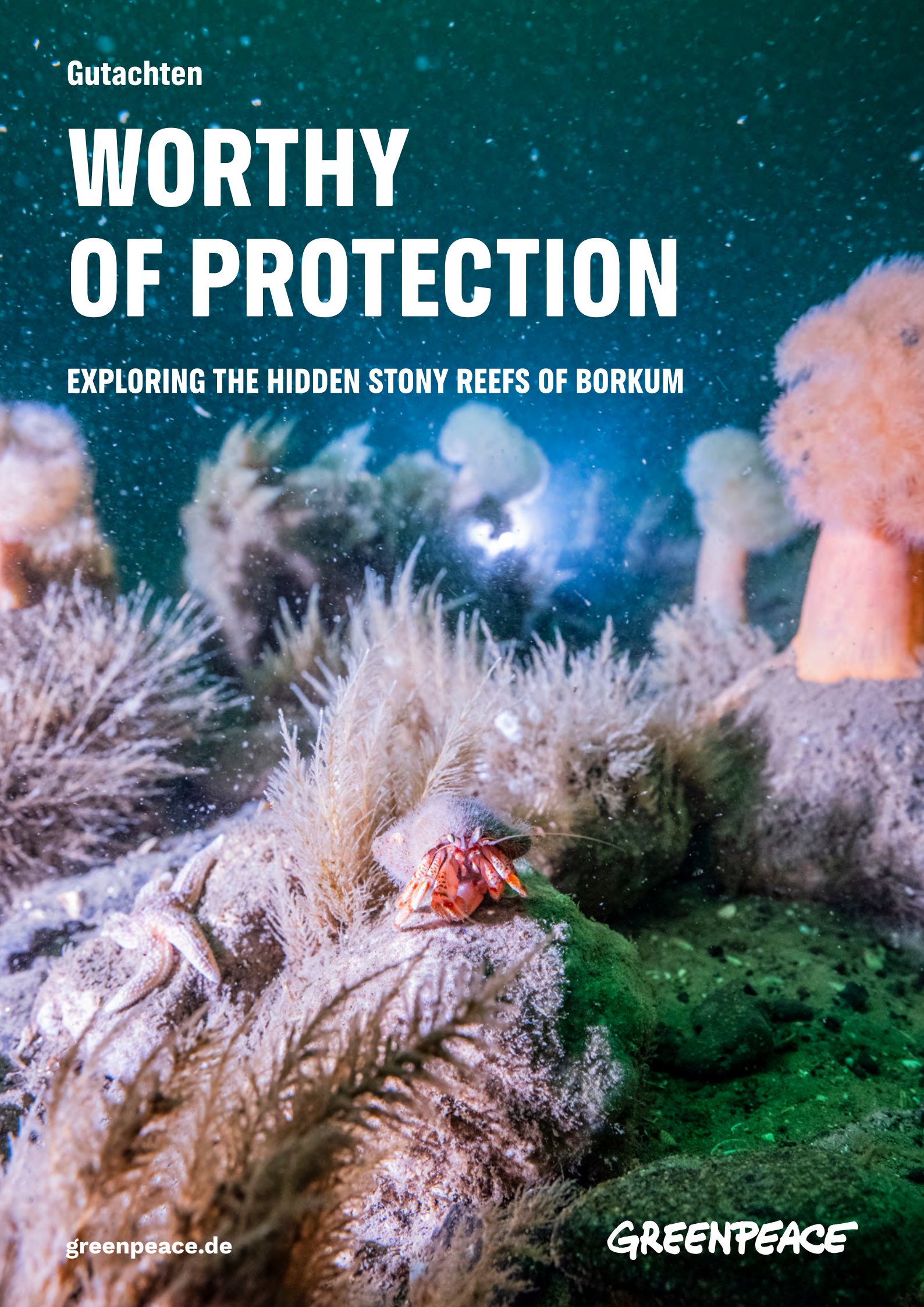
Gutachten

# WORTHY OF PROTECTION

## EXPLORING THE HIDDEN STONY REEFS OF BORKUM



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# WORTHY OF PROTECTION

## EXPLORING THE HIDDEN STONY REEFS OF BORKUM

## Demarcation of the habitat type “Reef” (H1170) in the ‘Borkum Riffgrund’ area with side scan sonar

Gutachten erstellt im Auftrag von Greenpeace e.V.


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# Content

# Figures and Tables

# Summary

In this study, side scan sonar (sss) surveying was used to demarcate the habitat type "reef" in the Borkum Riffgrund area off the coast of Borkum, where a new gas project is planned. Priorly, a habitat assessment (HAB) was carried out by MarineSpace (2022a, b) for the N05a platform area and the N05a-Riffgat OWF cable route area. According to these documents, where the Dutch mapping guideline and for the reef-demarcation only underwater video transects were used, no stony reefs (H1170) following the Annex I habitats of the EU Habitats Directive (1992) were detected.

Using the German mapping guideline for reefs of the Federal Agency for Nature Conservation (BfN) from 2018 in combination with the data from MarineSpace, geogenic reefs of the type "boulder field" are present in the vicinity of the platform location N05a and also in the area of the planned power cable (see BioConsult 2022). They are classified as stony reefs (H1170) following the Annex I habitats of the EU Habitats Directive (1992).

Diver surveys conducted in April 2023 at the so called Alpha, Bravo, and Charlie sites in areas with rocks found by Greenpeace e. V. by means of side scan revealed reef-typical fauna. Since these areas are partially also located in areas where MarineSpace's surveys indicate no stones occur, a new large-scale side scan survey of the area around the planned platform, cable, and pipeline was conducted on behalf of Greenpeace in August and September 2023. These surveys are briefly presented here and compared with the results of the side scan surveys.

According to the present study and based on the analysis of the available data following the mapping guidelines of the BfN (2018), large geogenic reefs of the type "boulder field" are present in all four surveyed areas, i.e. also in the vicinity of the platform location N05a, in the vicinity of the planned power cable and in an area formerly described as a potential reef (RVF) area in German waters. In the survey area "pipeline" a small reef was found, yet the surveyed area only covers a short section of the planned pipeline area. The reefs are classified as stony reefs (H1170) following the Annex I habitats of the EU Habitats Directive (1992). The available data from 2019, 2021 and 2023 result in respectively different reef demarcation when applying the German mapping guidelines. Since the general distribution of boulders is roughly similar in all three years despite the lower number of boulders in the year 2021 and the higher number of boulders in 2023, it is likely that missing or (re-)appearing boulders are temporarily or periodically covered by sediment.

The mapping guideline of the BfN uses the stones larger than 30 - 50 cm that can be detected by sss. Collections of more than 20 stones larger than 30 - 50 cm and a distance of less than 150 m between the individual stones are defined as geogenic reef, if the average distance to the nearest neighboring stone is less or equal 50 m. The stones larger than 30 - 50 cm can be seen as indicators for the occurence of smaller stones (6.4 cm up to 30 - 50 cm). For this reason, the relatively large distance of less than or equal to 50 m was chosen for the mapping guideline. In contrast to the Dutch mapping guideline, the more explicit mapping guideline of the BfN provides reproducible results.

Although the Dutch mapping guideline contains information on the minimum size of a reef (100 m² in one or more areas that have a functional coherence, as a rule of thumb less than 20 m distance between the areas) it does not specify whether complete coverage of the seabed with stones and

gravel [1] is required in this area. For this reason, a reef demarcation according to the Dutch mapping instructions is less reproducible. Nevertheless it is likely, that the small areas with "regular occurrence of objects <0.3 m" found in 2023 are reefs. However, a final classification of these small areas following the Dutch mapping guideline is only possible after a video examination of the areas, as no statements can be made about the stone densities within these areas based on the sss data.

The presence of larger reefs in the survey area is also assumed by BioConsult & submaris (2023), who sampled and analyzed the reef-typical fauna. The investigations by Bos et al. (2014) also suggest the presence of reefs.

[1] Following the Dutch mapping guideline gravel from 8 to 64 mm is a settling substrate for sessile organisms. Gravel is therefore also taken into account in the definition.

# Deutsche Zusammenfassung

In dieser Studie wurde ein Seitensichtsonar (SSS) eingesetzt, um den Lebensraumtyp „Riff" im Gebiet des Borkum Riffgrunds vor der Küste von Borkum abzugrenzen, wo ein neues Gasprojekt geplant ist. Zuvor wurde von MarineSpace (2022a, b) eine Habitatbewertung (HAB, vergleichbar mit einer FFH-Verträglichkeitsstudie) für das Gebiet der Plattform N05a und das Gebiet der Kabeltrasse von N05a zum OWP Riffgat durchgeführt. Nach diesen Unterlagen, bei denen der niederländische Kartierungsleitfaden und nur Unterwasser-Videotransekte verwendet wurden, wurden keine Riffe (FFH-Lebensraumtyp 1170) nach Anhang I der EU-Habitatrichtlinie (1992) festgestellt.

Unter Verwendung der deutschen Kartieranleitung für Riffe des Bundesamtes für Naturschutz (BfN) aus dem Jahr 2018 in Kombination mit den Daten von MarineSpace sind geogene Riffe vom Typ „Steinfeld" in der Nähe des Plattformstandortes N05a und auch im Bereich des geplanten Stromkabels vorhanden (siehe BioConsult 2022). Sie sind als FFH-Lebensraumtyp „Riff" (1170) nach Anhang I der EU-Habitatrichtlinie (1992) einzustufen.

Die im April 2023 durchgeführten Untersuchungen durch Taucher an den sogenannten Alpha-, Bravo- und Charlie-Standorten in den von Greenpeace e. V. mittels Side-Scan gefundenen Gebieten mit Steinen zeigten eine rifftypische Fauna. Da diese Gebiete teilweise auch in Bereichen liegen, in denen nach den Erhebungen von MarineSpace keine Steine vorkommen, wurde im August und September 2023 im Auftrag von Greenpeace eine erneute großflächige Side-Scan-Untersuchung des Gebietes um die geplante Plattform, das Kabel und die Pipeline durchgeführt. Diese Untersuchungen werden hier kurz dargestellt und mit den Ergebnissen der Side-Scan-Untersuchungen verglichen.

Entsprechend der vorliegenden Studie sind nach der Auswertung der vorliegenden Daten in Anlehnung an die Kartieranleitung des BfN (2018) in allen vier untersuchten Gebieten große geogene Riffe vom Typ „Steinfeld" vorhanden, d. h. auch in der Nähe des Plattformstandortes N05a, in der Nähe des geplanten Stromkabels und in einem Gebiet, das früher als potenzielles Riffgebiet (RVF) in deutschen Gewässern beschrieben wurde. Im Untersuchungsgebiet „Pipeline" wurde ein kleines Riff gefunden, wobei das untersuchte Gebiet nur einen kurzen Abschnitt des geplanten Pipelinegebiets umfasst. Die Riffe sind als FFH-Lebensraumtyp „Riff" (1170) nach Anhang I der FFH-Richtlinie der EU (1992) eingestuft. Die vorliegenden Daten aus den Jahren 2019, 2021 und 2023 führen bei Anwendung der deutschen Kartieranleitung zu einer jeweils anderen Riffabgrenzung. Da die generelle Verteilung der Steine in allen drei Jahren in etwa gleich ist, trotz der geringeren Anzahl von Steinen im Jahr 2021 und der höheren Anzahl von Steinen im Jahr 2023, ist es wahrscheinlich, dass fehlende oder (wieder) auftauchende Steine vorübergehend oder periodisch von Sediment bedeckt sind.

In der Kartieranleitung des BfN werden die mit dem SSS detektierbaren Steine größer als 30 - 50 cm verwendet. Ansammlungen von mehr als 20 Steinen größer als 30 - 50 cm und einem Abstand von weniger als 150 m zwischen den einzelnen Steinen werden als geogenes Riff definiert, wenn der durchschnittliche Abstand zum nächsten Nachbarstein kleiner oder gleich 50 m ist. Die Steine größer als 30 - 50 cm können als Indikatoren für das Vorkommen von kleineren Steinen (6,4 cm bis 30 - 50 cm) angesehen werden. Aus diesem Grund wurde für den Kartierungsleitfaden der relativ große Abstand von höchstens 50 m gewählt. Im Gegensatz zur niederländischen Kartieranleitung liefert die explizitere Kartieranleitung des BfN reproduzierbarere Ergebnisse.

Die niederländische Kartieranleitung enthält zwar Angaben zur Mindestgröße eines Riffs (100 m² in einem oder mehreren Bereichen, die einen funktionalen Zusammenhang aufweisen, als Faustregel gilt weniger als 20 m Abstand zwischen den Bereichen), gibt aber nicht an, ob in diesem Bereich eine vollständige Bedeckung des Meeresbodens mit Steinen und Kies erforderlich ist. Aus diesem Grund ist eine Riffabgrenzung nach der niederländischen Kartieranleitung weniger reproduzierbar. Dennoch ist es wahrscheinlich, dass es sich bei den im Jahr 2023 gefundenen kleinen Flächen mit „regelmäßigem Auftreten von Objekten <0,3 m" um Riffe handelt. Eine endgültige Klassifizierung dieser kleinen Flächen nach der niederländischen Kartieranleitung ist jedoch erst nach einer Videountersuchung der Flächen möglich, da anhand der SSS-Daten keine Aussagen über die Steindichten innerhalb dieser Flächen gemacht werden können.

Das Vorhandensein von größeren Riffen im Untersuchungsgebiet wird auch von BioConsult & submaris (2023), die die rifftypische Fauna beprobt und analysiert haben, vermutet. Auch die Untersuchungen von Bos et al. (2014) legen das Vorkommen von Riffen nahe.

# 1. Background and purpose

ONE-Dyas BV plans to develop a drilled well in block N05a of the North Sea Dutch Continental Shelf. A power cable from the platform to the Riffgat OWF and a pipeline to transport the gas to the coast are part of the project. The Project runs along the Dutch German border within Dutch blocks N04a and N05a, with a portion crossing over into German waters.

The project is located in an area where stones occur on the seabed on the Dutch and German sides. Stone deposits are classified as the protected habitat type reef if they meet the national criteria. In Germany, stony reefs are also protected biotopes in accordance with § 30 BNatSchG.

A habitat assessment (HAB) for the N05a platform area and the N05a-Riffgat OWF cable route area was carried out by MarineSpace (2022a, b). According to these documents, no stony reefs (habitat type H1170) following the Annex I habitats of the EU Habitats Directive (1992) were detected in the survey area around the planned platform location N05a and the cable route to the Offshore Wind Farm (OWF) Riffgrund.

BioConsult GmbH & Co. KG was commissioned in autumn 2022 by Deutsche Umwelthilfe e.V. to verify the above statement using the data available in the HAB. The standard used for the verification is the mapping guidelines for reefs of the Federal Agency for Nature Conservation (BfN) from 2018. The use of the guidelines is mandatory for all projects in the German Exclusive Economic Zone (EEZ) of the North Sea and the Baltic Sea. The mapping guidelines are also used for approval procedures in Germany that concern areas within the territorial sea that are further away from the coast.

The future N05a processing platform is planned in the Dutch territorial sea approximately 500 m from the border with the German territorial sea. Since the power cable to the platform runs through the German territorial sea, an application of the German mapping guidelines for the route of the power cable is appropriate and, in order to create a uniform assessment basis, also for the platform location.

The results of this study were published in BioConsult (2022). According to the analysis of the available data shown in MarineSpace (2022a, b) and following the mapping guidelines of the BfN (2018), geogenic reefs of the type "boulder field" are present in the vicinity of the platform location N05a and also in the area of the planned power cable. They are classified as stony reefs (H1170) following the Annex I habitats of the EU Habitats Directive (1992). The available data from 2019 and 2021 result in reef demarcations that differ from each other. Since the distribution of boulders is similar in both years despite the lower number of boulders in the year 2021, it is likely that they are still present in the area but covered by sediment.

In order to study the reefs and especially their fauna in more detail, Greenpeace subsequently commissioned a diver survey of three areas with stones (Alpha, Bravo and Charlie) in April 2023, in comparison with a particularly well-developed and known reef on the German side. The results are presented in submaris & BioConsult (2022). Because this survey found stones (and also reefs) in the more southern areas where MarineSpace (2022a, b) reported no stones, new side scan images of the seafloor were subsequently commissioned by Greenpeace in September 2023 to verify the results of MarineSpace (2022a, b), covering a much larger area than in April 2023. Geo Ingenieurservice

Nord-West and BioConsult were commissioned to analyze these data and subsequently delineate the reef areas presented in this study.

# 2. Survey area

## 2.1 Existing data 2019 and 2021

The basis for the demarcation of the reefs 2019 and 2021 are the data collected by GEOxyz (see MarineSpace (2022a und 2022b), each in Appendix C) for sediments and seabed features >0.3 m (see Fig. 1 and Fig. 2). In this regard, the text about the platform location (MarineSpace 2022a) and cable route (MarineSpace 2022b) states:

*"Interpretation of seabed features, sediment and seabed contacts from the current and 2019 SSS data is presented in Appendix C.*

*Seabed sediments were interpreted within the northern half of the 1 km x 1 km survey area as to comprise sand and clay. In the south of the survey area sediments were expected to comprise fine sand with shell fragments.*

*Outcrops of clay were interpreted within the survey area. These had a positive relief of up to 0.5 m above background seabed levels with measured gradients of up 6° on their flanks.*

*Numerous SSS contacts were identified within the charted area, with the majority interpreted as boulders within the charted area. Most of these contacts were identified within the areas where seabed sediments were interpreted as coarse sand and clay although occasional contacts were seen outside these areas. The closest contact to N05a platform location occurred 52 m north-north-east and was interpreted as boulder with height of less than 0.5 m."* (MarineSpace (2022a), p. 4-3)

*„Numerous SSS contacts were identified within the charted area, with the majority interpreted as boulders within the charted area. Most of these contacts were identified within the areas where seabed sediments were interpreted as coarse sand and clay although occasional contacts were seen outside these areas.*" (MarineSpace (2022b), p. 4-3)

*"Eight-Hundred-Thirty (830) side scan sonar contacts were observed within the route survey. Most of the contacts are boulders located around the N05-A platform and stretching to the east side to Riffgat, besides the bolders the following contacts are found, twenty-six (26) debris items, two (2) wrecks."* (Appendix Basic Design Report)

The 830 side scan sonar contacts are >0.5 m and were found in 2019. They are listed in the Appendix Basic Design Report together with the coordinates. These coordinates can be used to evaluate them in GIS according to the mapping guidelines. Of the total of 830 side scan sonar contacts, 800 are classified as "objects". Of these, 397 are located in the map section in Fig. 1 and thus in the vicinity of platform location N05a. In the 1 x 1 km survey area around platform location N05a there are 85 objects. In the area surrounding the cable route to OWF Riffgrund there are 398 side scan sonar contacts >0.5 m (see Fig. 2).

In addition to the side scan sonar contacts >0.5 m, Fig. 1 and Fig. 2 also include contacts >0.3-0.5 m. Since no coordinates are available for these contacts, they are digitized from the

georeferenced map at a scale of 1 : 5,000. 64 of the 372 "objects" >0.3-0.5 m from Fig. 1 are located within the survey area. Another 314 "objects" >0.3-0.5 m are located in the area of the cable route to OWF Riffgrund (Fig. 2).

Both figures also show more recent data from 2021, which are not discussed in detail by BioConsult (2022). In total, only 314 "objects" were recorded in 2021, considerably fewer than in 2019.

The two survey years were therefore evaluated separately by BioConsult (2022).

When interpreting the results, it should be noted that the side scan sonar contacts classified as "objects" in the Appendix are not all boulders (see citations above). Since further differentiation is not possible based on the available data, all side scan sonar contacts are classified as "boulders" by precaution. This represents a "worst case" or precautionary approach, which seems adequate regarding potential deterioration or loss of areas to which the habitat type reef applies. This approach is also appropriate because reefs in the North Sea, which is largely characterized by sand and silt, contribute greatly to biodiversity and are particularly sensitive to covering with sediment and pollutant inputs.

Due to inaccuracies of roughly up to 30-50 m in the digitization of the individual stones, there may also be slight differences in the reef demarcation compared to the original data.

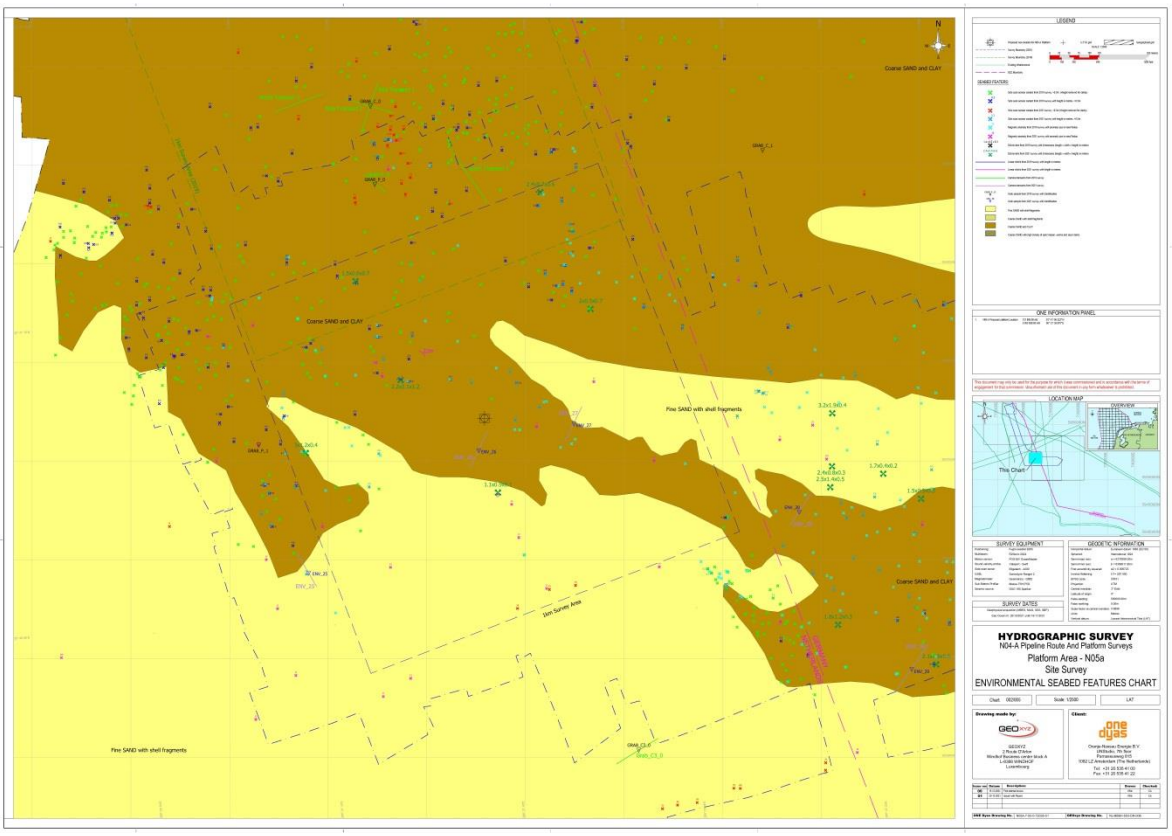


**Fig. 1:** Environmental seabed features chart platform area N05a (from: MarineSpace 2022a).

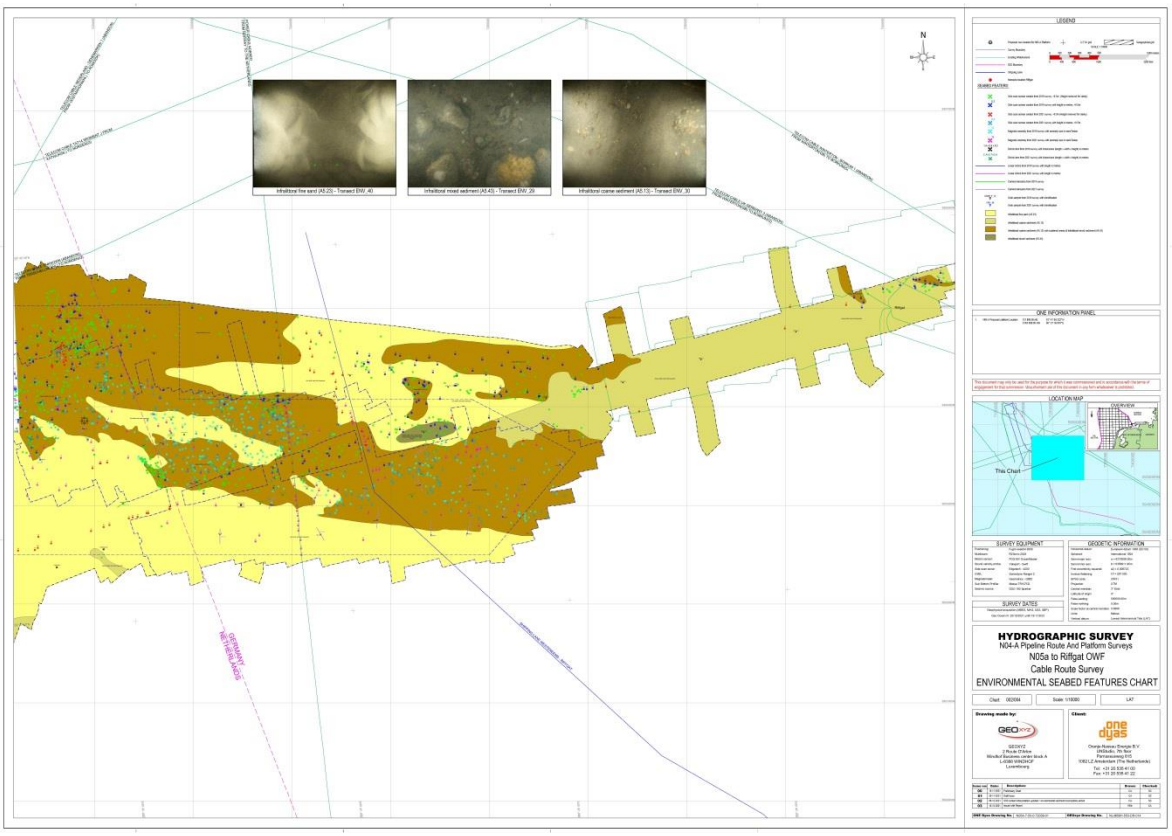


**Fig. 2:** Environmental seabed features chart cable route (from: MarineSpace 2022b).

## 2.2 Location of the five survey areas 2023

In 2023 five areas were surveyed by external specialist Gavin Newman on behalf of Greenpeace (see 3.1). Area "Alpha & Bravo" focuses on the platform location and parts of the power cable and pipeline, the areas "Charlie" and "Charlie 2" focus the eastward power cable connection to OWF Riffgat, the area "Pipeline" focuses on a part of the pipeline route to the south and the area "RVF" (see Fig. 3) focuses on a northern area where reefs have been suspected according to the German Federal Ministry for the Environment (BMU 2018). The "RVF"-area is relevant according to the drift-experiments by Greenpeace. These drift-experiments indicate that hazardous substances from the platform can reach this area within a few hours (Greenpeace 2023, see Fig. 4). For the experiments free floating drifters were used, the drift of which is intended to describe where potentially released hazardous chemicals could drift in the event of an accident. The drifters were deployed to the water at the location of the N05a position at different tides (high tide, low tide and in between). However, the experiment is just a snapshot at the time and under the conditions it was carried out. Further conclusions can only be drawn after more systematic investigations considering different weather and current conditions.

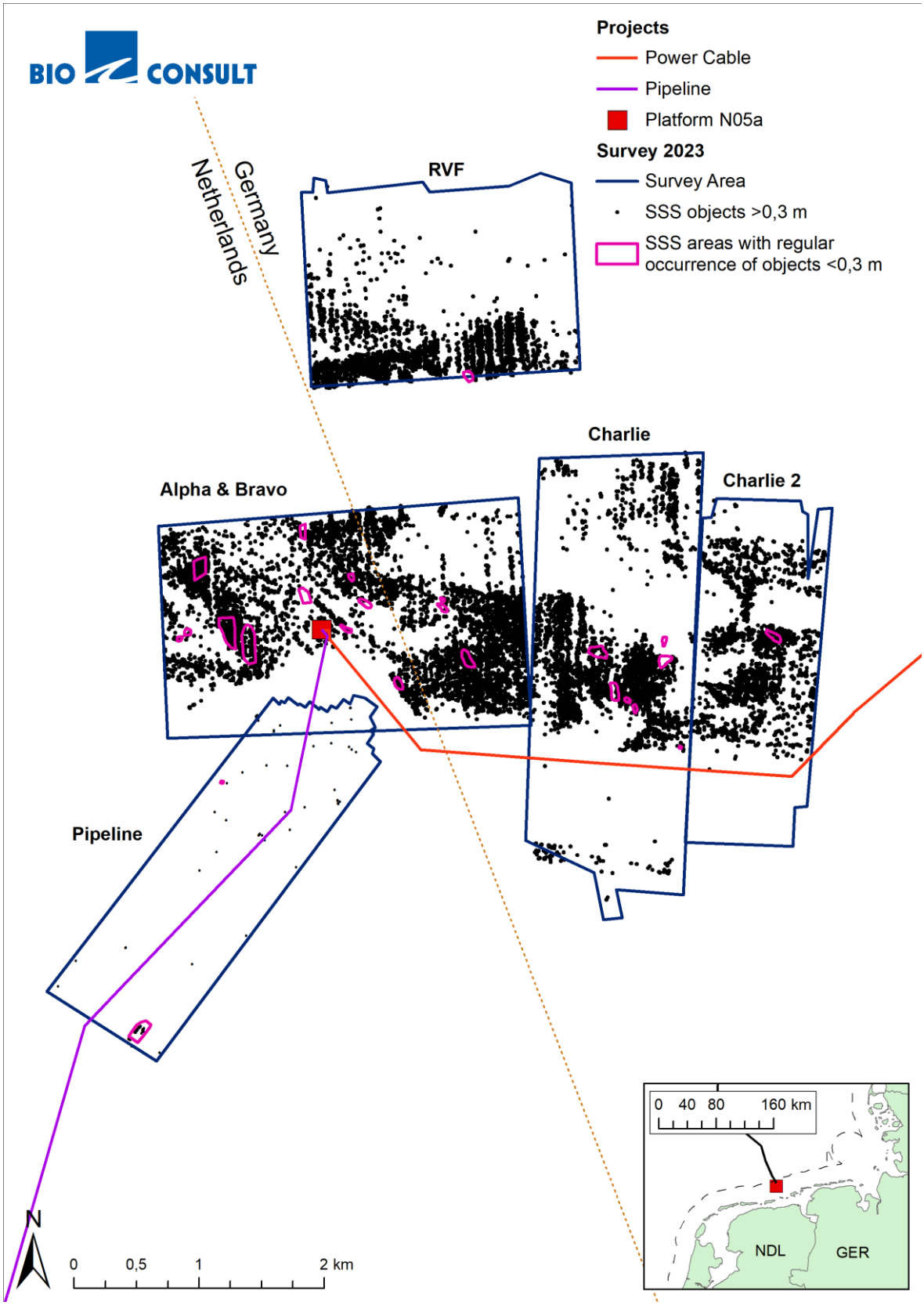


**Fig. 3:** Location of the five survey areas 2023 with SSS objects 2023.

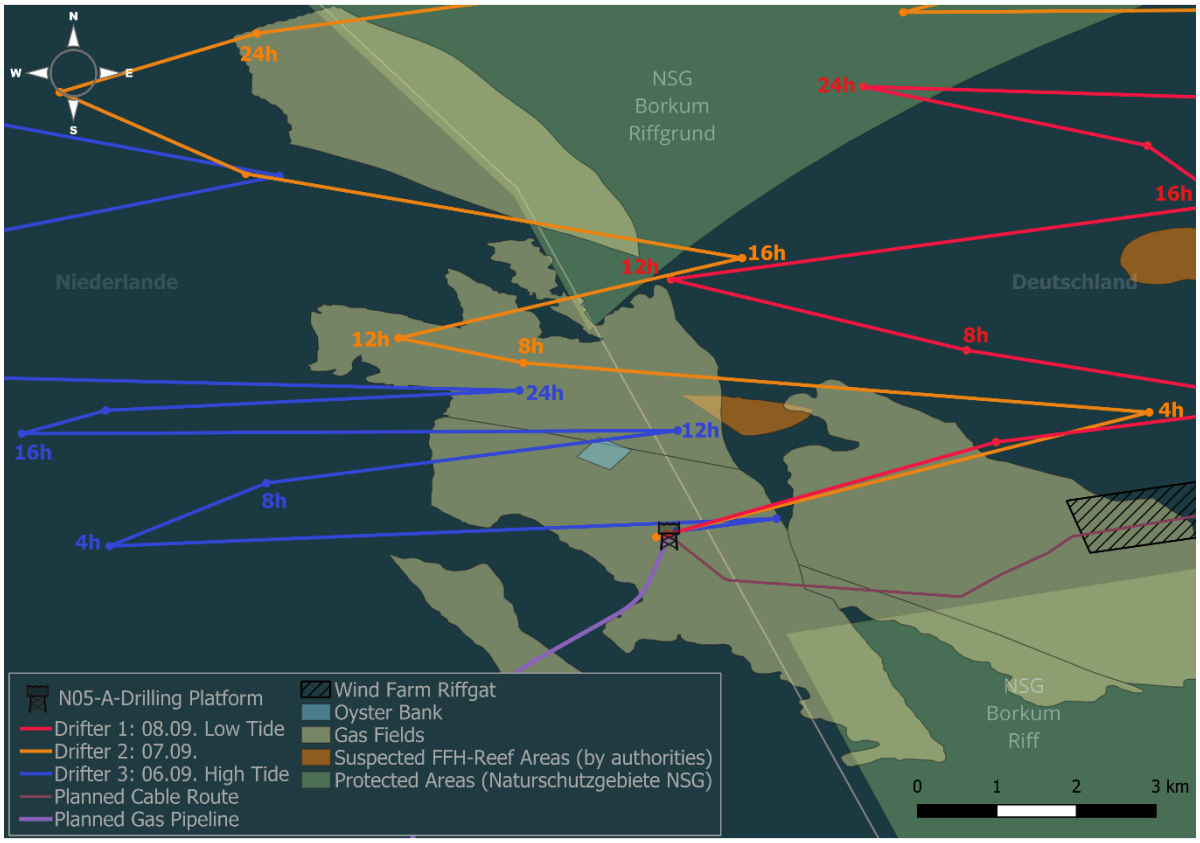


**Fig. 4:** Results of Greenpeace's drift-experiments, showing where and how fast the three free-floating drifters that were released at the location of the planned drilling platform N04-A were carried (Greenpeace 2023).

## 2.3 Protection status

The platform N05a is located 2.7 km northwest of the Special Protected Area (SPA) „Niedersächsisches Wattenmeer und angrenzendes Küstenmeer" (see Fig. 5). The minimum distance from the planned cable route to the SPA is 10 m. The next FFH-Area is the „Borkum Riffgrund" 4.5 km north of the platform location. The distance from the platform to the FFH-Area "Nationalpark Niedersächsisches Wattenmeer" is 14.6 km, the minimum distance from the planned cable route to the FFH-Area is 6.5 km.

These three protected areas are located in the German coastal waters respectively the German EEZ. The nearest Dutch protected area is the FFH-Area "Nordzeekustzone" 12.6 km south of the platform location.

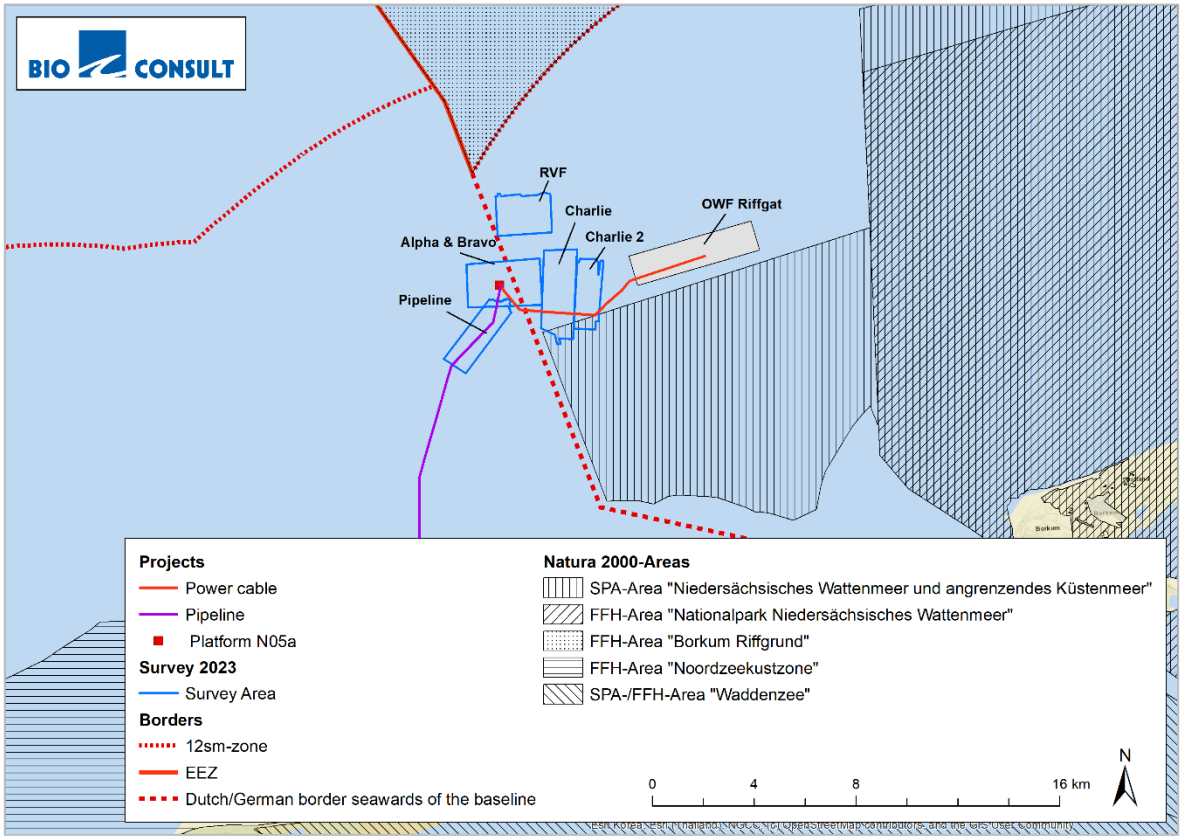


**Fig. 5:** Protected areas.

# 3. Methodology for mapping

## 3.1 Conduction of the Side Scan Survey

The side scan survey in August and September 2023 was conducted in the German and Dutch North Sea between the islands of Borkum and Schiermonnikoog in areas of the planned gas project by ONE-Dyas. The survey was conducted by Greenpeace e.V. and the equipment was operated by the external specialist Gavin Newman as follows:

**Equipment:**

- EdgeTech 4125i Side scan Sonar Unit
- 100m EdgeTech SSS Cable
- Hemisphere Vector VS131 Differential GPS Unit
- Software used for Data Capture
- EdgeTech 4125D Discover Software

The software captures data in both EdgeTech proprietary .jsf format and the generic .xtf format used by other survey programs. As well as the GPS Geo Located survey position data the software also captures other data including Water Depth, Survey Fish Depth, Altitude, Pitch and Roll. [2] [3]

The 4125i Sonar unit is a Dual Frequency unit of 400/900 kHz. For this survey, only the higher resolution High Frequency Function of 900 kHz was used. The sonar fish was towed approximately 90 m behind the survey vessel. The layback data was entered into the software compensating for the position of the GPS receivers in relation to the sonar cable. The software then calculated the position of the sonar fish (L) using depth data (d), deployed cable length (c) and height (h) using the hypotenuse calculation:

$$L = \sqrt{c^2 - (d + h)^2}$$

All transects were run in straight lines to eliminate any distortion of the data due to turning circles. Transect speed was always between 2.5 - 3.5 knots to enable the sonar fish to maintain an altitude approximately six to seven meters above the seabed.

Sonar swath width was set at 50 m either side of the center line giving a total survey width of approximately 100 m (subtracting the center line directly beneath the fish where it cannot survey). These parameters were chosen after initial test runs to give the best combination of image quality and range coverage. Data was captured using the EdgeTech supplied Getac Computer system and backed up to external SSD drives at the end of each day. No stabilized power supply was available

[2] For full information on the software please see: https://www.edgetech.com/wp-content/uploads/2019/07/0004841_Rev_C.pdf
[3] The Discover Software can be downloaded here: https://www.edgetech.com/resource-center/

onboard the vessel used for the survey which caused electrical interference visible on the generated sonar images.

## 3.2 Data cleaning/processing (by GEO)

**Postprocessing of the side scan survey data collected by Greenpeace**

**Dataset information & Task**

Geo Ingenieurservice Nord-West GmbH & Co.KG (GEO later in the document) has been contracted by Greenpeace to postprocess the collected side scan data and mark all objects bigger than 30cm. GEO received a data set which consisted of 3 main areas (Alpha, Bravo Charlie) and two other named RVF and Pipeline. Received data was a set of standalone side scan lines, where the position of the sonar was calculated by a layback. During the side scan survey only GPS (Global Positioning System) was available (see chapter 3.1) which results in a GPS accuracy of 5 to 10m in the horizontal position. As informed by the client the used layback during the survey was 90m, but due to influence of the side currents, the current direction itself and different survey speeds the alignment between the lines had to be recalculated during the processing. Overall positioning uncertainty is around 30m, due to all environmental and equipment effects as GPS accuracy and layback accuracy. As described in chapter 3.1 no stable power supply was available therefore striping in the data was caused by the unstable power supply, yet it was possible to correct and minimize this influence on the data.

**Postprocessing procedure**

In the first step the data was loaded into the software SonarWiz to be able to align the collected data to each other. As the survey was a standalone side scan survey with a layback, possible alignment in the postprocessing the data was done using objects visible in neighbouring lines or other features. For example, in the Alpha and Bravo areas trawler marks were used. During postprocessing, when applying the layback with 100m the values of the layback varied between 50% and 135% (Fig. 9).

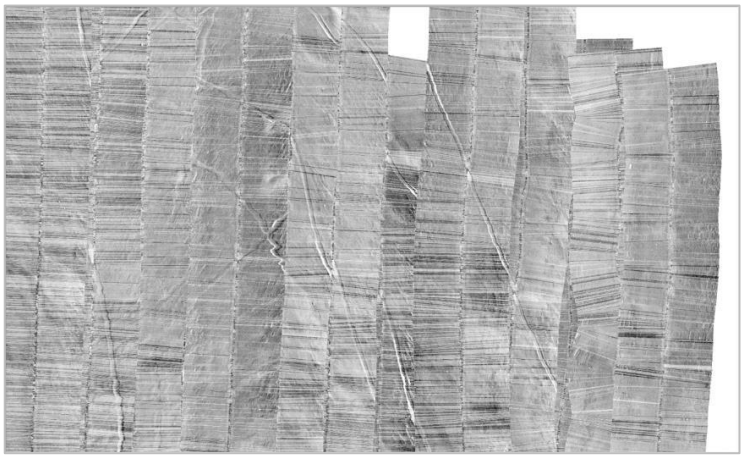

**Fig. 6:** Loaded survey data of alpha and bravo with applied layback

Processing of side scan data consists of few steps which was done as follows. After loading the data, the Nadir is cleaned up. This means reducing the water column records and provide a continuous log of the seabed below the sonar. Nadir value varies, as it is based on the height of the sonar above

the seafloor. After clearing the Nadir, an Empirical Gain Normalization has been calculated based on the dataset to have a consistent palette over the whole data set from a certain day or surveyed area. In this part also a destriping filter can be applied, which in this case was used to smoothen the unstable power input for the survey system. Lastly the layback correction can be applied to connect all data properly one to another based on the features observed while cleaning the Nadir.

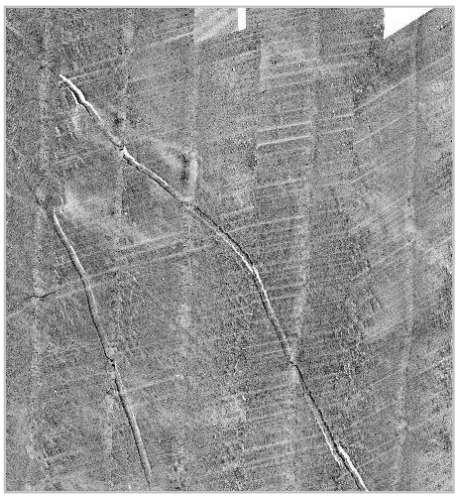

**Fig. 7:** Postprocessed data.

After applying the mentioned steps (Fig. 7), the object identification was done. This part is self-explanatory, where in the view of sonar data objects or stones were marked. In order to validate an existence of an object on the seabed it is necessary to have it recorded on two lines in opposite directions. Using this method, it is also possible to determine a layback or positioning error (Fig. 8).

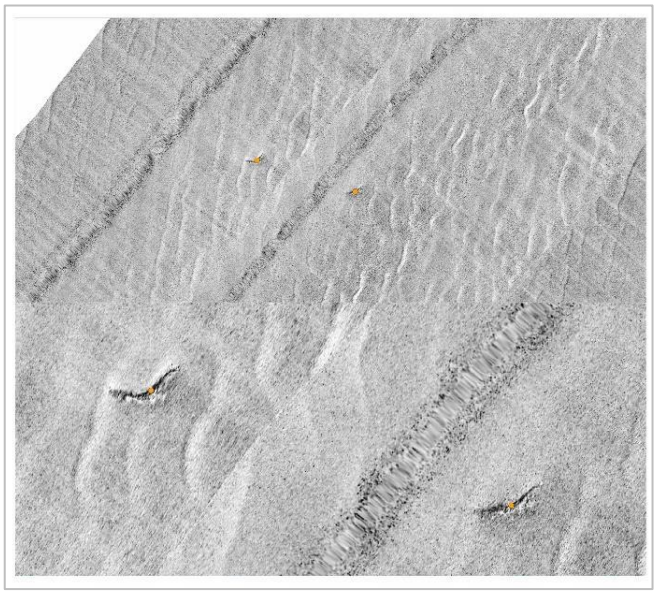

**Fig. 8:** Object identification on two lines.

When all steps above are accomplished with the dataset, the requested files or materials were exported from the project. Provided are .geotiff files and .shp, which will include processed data as well as all listed objects. Additionally, after the export, all data was cross-checked in ArcGIS software

to confirm right coordinate system and mark additional areas with possible fields of stones which were smaller than requested or regions with a suspected occurrence of stones, but yet unsure due to the higher positioning uncertainty.

Sometimes the targets seem to be running in north-south direction (Fig. 11, RVS area), which represents the survey direction. This results from a semi-automatic target picking. Most likely, in these areas stones are also present.

## 3.3 Data assessment following existing mapping guidelines (by BioConsult)

### 3.3.1 "Interpretation Manual of European Union Habitats" (EUR28)

The definition and a general description of the characteristic features of the habitat type "Reefs" (H1170) in the European seas including regionally differentiated examples of characteristic settlements are taken from the "Interpretation Manual of European Union Habitats" (EUR28) in its current version:

*"Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions.*

*Clarifications:*

*- "Hard compact substrata" are: rocks (including soft rock, e.g. chalk), boulders and cobbles (generally >64 mm in diameter).*

*- "Biogenic concretions" are defined as: concretions, encrustations, corallogenic concretions and bivalve mussel beds originating from dead or living animals, i.e. biogenic hard bottoms which supply habitats for epibiotic species.*

*- "Geogenic origin" means: reefs formed by non-biogenic substrata.*

*- "Arise from the sea floor" means: the reef is topographically distinct from the surrounding seafloor.*

*- "Sublittoral and littoral zone" means: the reefs may extend from the sublittoral uninterrupted into the intertidal (littoral) zone or may only occur in the sublittoral zone, including deep water areas such as the bathyal.*

*- Such hard substrata that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota are dependent on the hard substratum rather than the overlying sediment."*

### 3.3.2 German mapping guideline for the EEZ

However, the interpretation manual does not contain any information on minimum sizes of reef areas or information on their demarcation from the surrounding environment. This gap is filled for the German EEZ by the mapping guidelines of the BfN. For the North Sea, the mapping guidelines of the BfN differentiate between three types of reefs:

- „boulder field (North Sea)"
- „boulder > 2 m"
- „residual sediment with occasional stones and/or boulders"

Based on the data from MarineSpace (2022a, b) and the data from this study, the occurrence of the reef type „boulder field (North Sea)" in the vicinity of the platform location N05a cannot be excluded. According to the mapping guidelines this reef type is defined as follows:

*"Recording and spatial delimitation is based on hydroacoustic geoscientific methods (side scan sonar mosaics) and includes the following criteria and parameters:*

*Criterion 1:*
*The minimum size of individual stones to be digitized is based on the currently smallest detection size for individual objects when evaluating side scan sonar data in the frequency range ≥ 300 kHz (resulting stone size approx. 30 - 50 cm). Such single stones or blocks are given buffer zones with a radius of 75 m and presented that way.*

*Criterion 2:*
*If the distance between adjacent individual stones (≥ approx. 30 - 50 cm) or blocks is ≤ 150 m, i.e. if their buffer zones either touch or overlap, they are combined into a "stone or block collection" (Fig. 9).*

*Criterion 3:*
*If such a "stone or block collection" has at least 21 individual stones (≥ approx. 30 - 50 cm) respectively blocks with an average distance to their nearest neighbor of ≤ 50 m, it forms a geogenic reef of the "boulder field" type (Fig. 9).*

*Criterion 4:*
*If there are areas without stones or blocks that are within an area that meets all of the preceding criteria (1-3) for a geogenic reef than these areas are also assigned to the total area of the reef (Fig. 10)."*

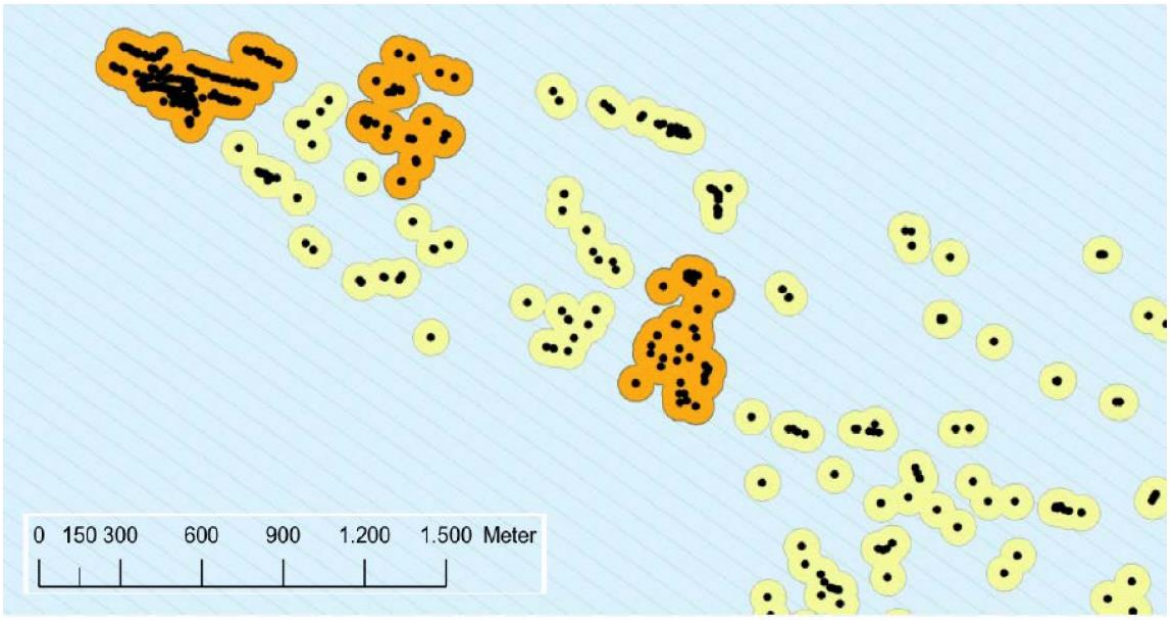


**Fig. 9:** The orange “aggregation of stones” form the geogenic reef type "boulder field (North Sea)", the yellow "aggregation of stones" and the individual stones with a surrounding buffer zone do not (criterion 3)

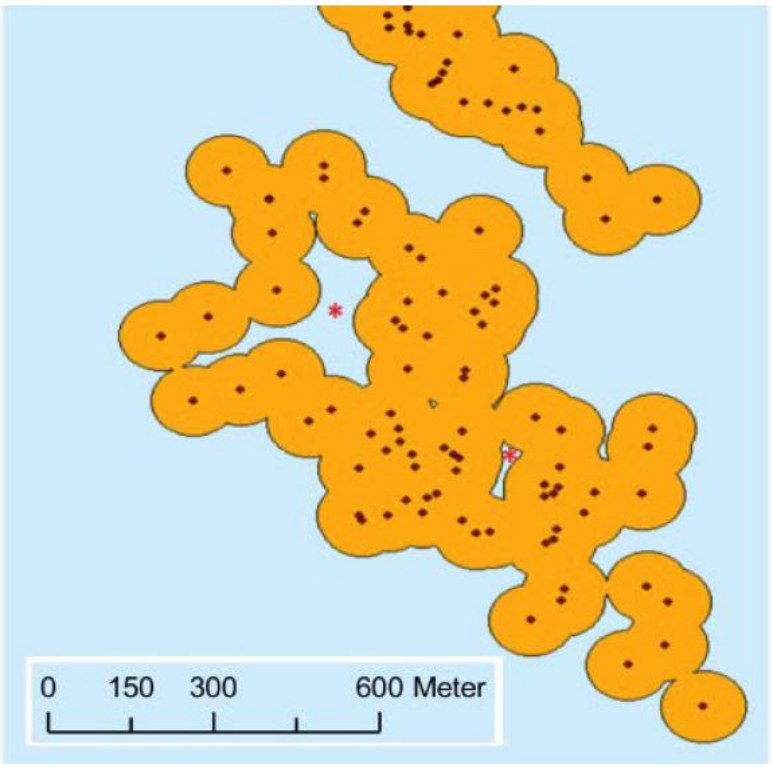


**Fig. 10:** Areas within in a "boulder field" but without the occurrence of stones / boulders (*) are also assigned to the reef (see explanations for criterion 4).

### 3.3.3 Dutch Mapping guideline

The Dutch mapping guideline (MANFQ 2014) defines reefs (H1170) as follows:

*"The reefs habitat type (H1170) is characterized by geomorphological features and occurs in the northwestern Exclusive Economic Zone (EEZ) in the Clover Bank area. Essential to habitat type H1170 is the occurrence of hard substrate (large stone/ shell banks) that rises above the sediment surface. Characteristic of non-biogenic reefs is the presence of stable hard substrate in the form of large boulders and/or a coarse gravel fraction. There may be the occurrence of mosaics of (coarse) sediment types in which different sediment types occur alternately: places with gravel and boulders alternating with coarse sand.*

*(...)*

*The definition is applicable only if the minimum area is met, that is, in locations where the habitat type covers at least 100 m². This size can refer to more than one site, provided that these sites are functionally related (rule of thumb: the distance between them is maximum 20 meters)."*

The Dutch mapping guideline only specifies a minimum area, but does not specify how many stones must lie in a site or what minimum stone coverage for a site is necessary. Both must be defined by the editor. This is not the case with the German mapping guide. The Dutch mapping guide is therefore less specific than the German mapping guide and leaves room for interpretation.

# 4. Results 2023

## 4.1 Mapping guideline for the German EEZ

According to the methodology of the mapping guideline for the German EEZ described in chapter 3.3.2, a buffer zone with a radius of 75 m was placed around each "object" (classified as boulders by precaution) using the program ArcGis 10.8.1 Desktop. All overlapping buffer zones with >20 objects were assigned with an ID. The results are summarized in Tab. 1.

**Tab. 1:** Buffer areas 2023 with more than 20 objects in the survey areas Pipeline, Alpha, Bravo, Charlie & Charlie 2, RVF. Area data in brackets specifies the area without closed gaps (Criterion 4).

| Area | buffer-ID | Minimum Distance (m) | Average Distance (m) | Maximum Distance (m) | Number of objects | geogenic reef of the "boulder field" type | Area (km²) |
|---|---|---|---|---|---|---|---|
| Pipeline | 1 | 1.80 | 7.32 | 52.74 | 34 | yes | 0.06 |
| Charlie | 2 | 2.03 | 16.37 | 45.86 | 22 | yes | 0.08 |
| Charlie | 4 | 2.78 | 19.05 | 90.19 | 56 | yes | 0.18 |
| Charlie | 11 | 1.10 | 10.24 | 40.66 | 46 | yes | 0.09 |
| Alpha, Bravo, Charlie & Charlie 2 | 10 | 0.16 | 8.32 | 139.88 | 13192 | yes | 8.53 (8.43) |
| RVF | 20 | 0.67 | 6.80 | 148.97 | 3474 | yes | 1.93 (1.92) |

Since in all aggregations of boulders the mean distance to the nearest neighbor was ≤50 m (criterion 3), the six aggregations from the year 2023 are to be classified as geogenic reefs of the type „boulder field (North Sea)" according to the mapping guidelines of the BfN (2018). These areas can be seen in Fig. 11.

A contiguous reef area extends over large parts of the Alpha & Bravo, Charlie and Charlie 2 areas, which at 8.53 km² represents the largest reef area in the observation area (Buffer ID 10). This reef band is at the platform location (Alpha & Bravo) and at its middle (Charlie 2) partially crossed by the planned power cable. The distance between the reef area and the cable route in the eastern part of Alpha & Bravo and the Charlie area differs between a minimum of 40 m and a maximum of 200 m.

Another large reef area was identified in the RVF area (Buffer ID 20); at just under 2 km², this reef area is the second largest reef area in the observation area. About half of the RVF area was thus classified as a reef area. Further small reef areas were identified in the northern and southern border areas of the Pipeline and Charlie areas. Reef areas were thus identified in all sub-areas of the study area.

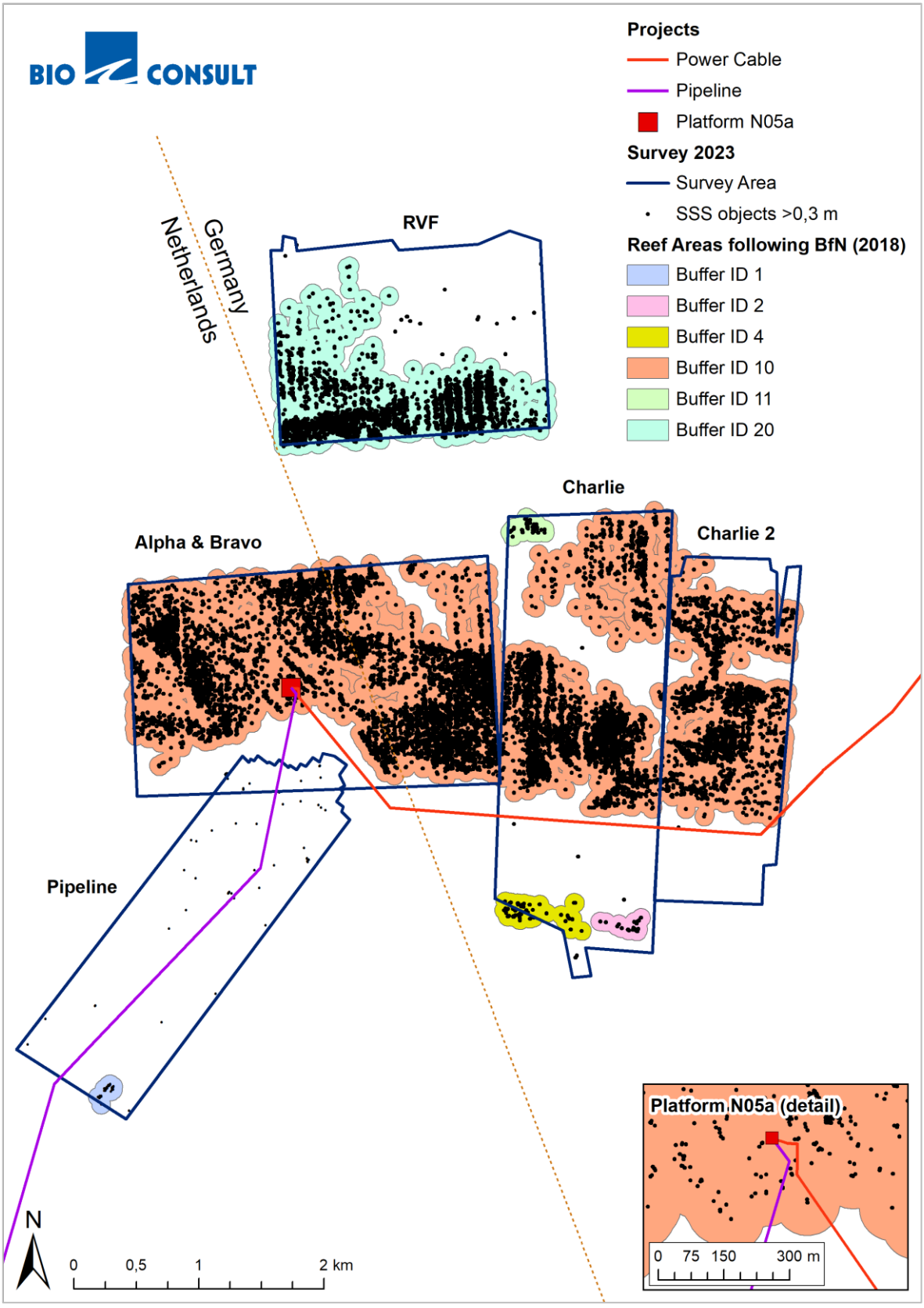


**Fig. 11:** Reef survey 2023: reef areas following BfN (2018).
The different Buffer IDs and colorations show different contiguous reef areas.

In order to highlight the core reef areas, a map with buffers of 25 and 50 m compared to buffers of 75 m was generated to supplement the mapping guidance (see Fig. 12). The map shows that even with a buffer of only 50 m or 25 m around the individual stones, large contiguous reef areas are present. Even with a stricter interpretation of the BfN mapping instructions, no fundamental differences in the distribution would therefore be seen. This means also that even if not all of the mapped objects were to be stones, it can be assumed that large reefs would be present in the study area with a buffer of 75 m in accordance with the BfN mapping guidelines.

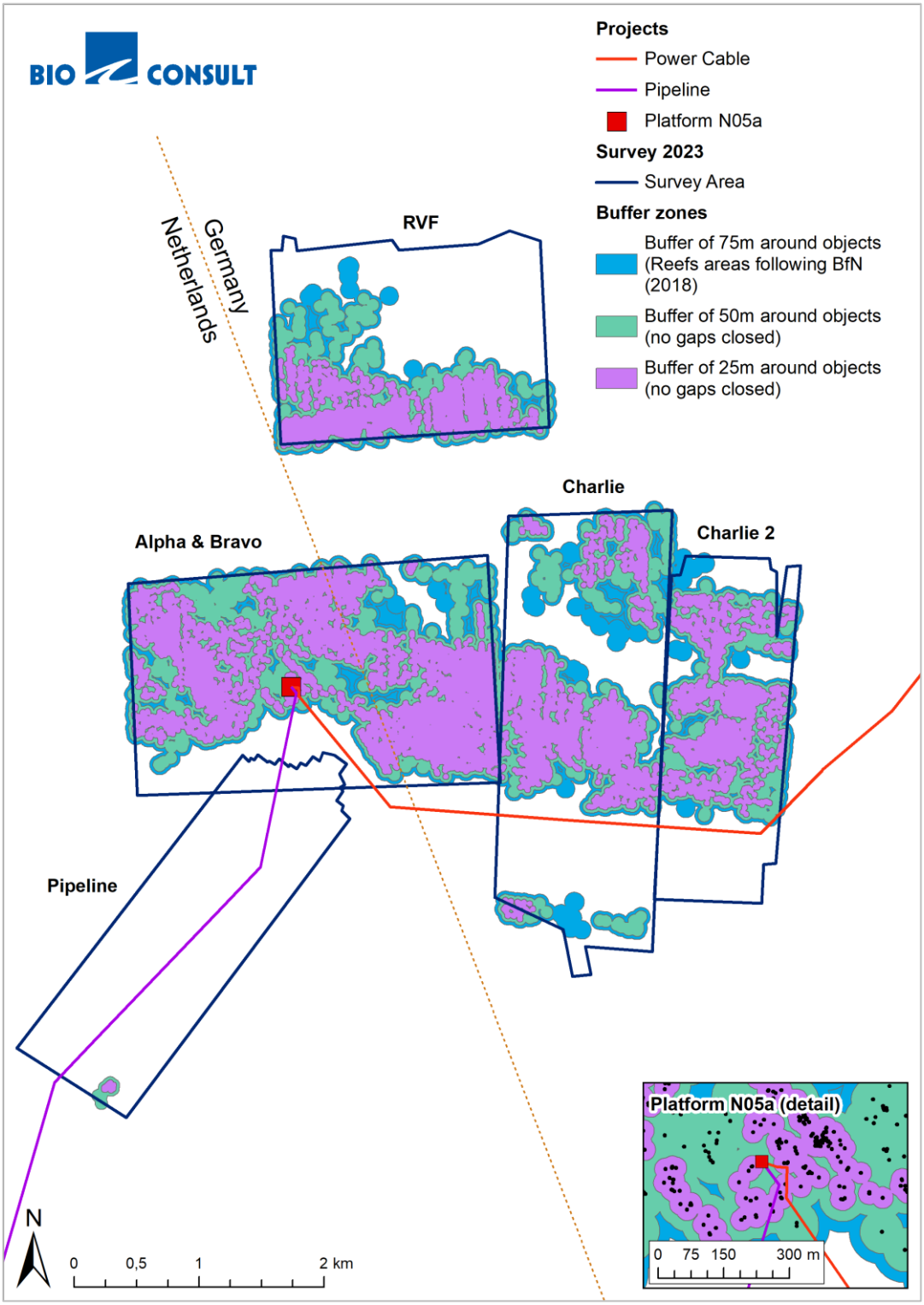


**Fig. 12:** Survey 2023: comparison of different buffer zones to show the core areas of the reefs.
The 2023 SSS objects have been given buffer zones of 75, 50 and 25 meters. Subsequently reefs have been determined according to criterion 2 for all different buffer zones. Whereas the 75m buffer zones have been treated according to criterion 3 and 4 additionally, the buffer zones of 50 and 25 meters are only determined until criterion 2 (i. e. no distance analysis for the single buffer zones has been done, and no gaps have been filled for the 50 and 25 meter buffer zones).

## 4.2 Dutch Mapping guideline

According to the methodology of the Dutch mapping guideline for the described in chapter 3.3.3, it is likely, that the small areas with "regular occurrence of objects <0.3 m" (Fig. 3) are reefs. The individual areas range in size from 327 m² to 27354 m² and are therefore larger than the minimum 100 m² required according to MANFQ (2014). However, a final classification of these small areas is only possible after a video examination of the areas, as no statements can be made about the stone densities within these areas based on the side scan data.

# 5. Comparison with existing data, literature and other sources

## 5.1 Platform and cable area 2019 and 2021 (MarineSpace 2022a, b)

In a first step, the data from 2023 were compared with those from 2019 and 2021 (reef delineation 2019 and 2021 see Fig. 13).

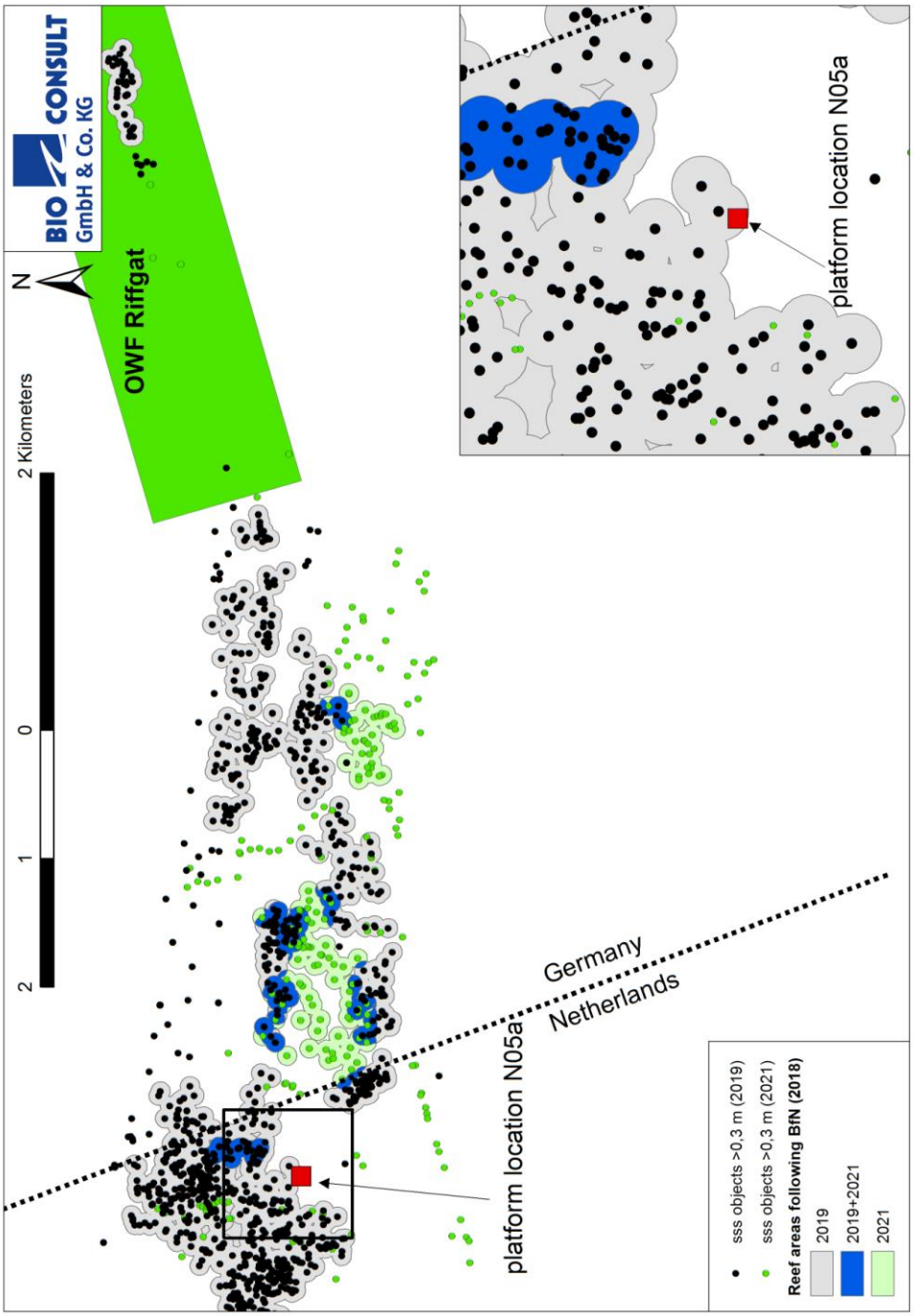


**Fig. 13:** 2019 and 2021: Reef areas following BfN (2018). Figure from Bioconsult (2022), data from MarineSpace (2022a, b).

To illustrate the differences between the years 2019, 2021 and 2023, the reef areas resulting from the buffer zones and their intersections are shown in different colors in Fig. 14. Fig. 14 only shows the areas that were examined in all three years. This is the only way to make reliable statements about the areas in which there is a high degree of certainty that no stones will occur. Accordingly, only relatively small areas are classified as the reef type "boulder field" in all years (deep red color). The intersections of the 2023 reef areas and at least one reef area of the other surveys (lighter red shades) result in relatively big areas, stretching over the entire intersected survey area from west to east. Finally, the areas that can only be classified as reefs based on the data from 2023 and 2019 / 2021 are shown in green and turquoise respectively.

Three large core areas should be highlighted within this reef belt. Firstly, the overall largest contiguous area in the west of the study area, which essentially results from the overlap of the reef areas from 2019 and 2023. A section of this area is characterized by the overlap of reef areas from the three years under consideration. Secondly, the accumulation of several sub-areas in the center of the observation area around the transition between the Alpha & Bravo and Charlie areas. This accumulation is made up of the reef areas of all years and contains the largest occurrence of areas classified as reef in all three years. The third core area, a contiguous area in the east of the observation area, is located almost entirely in the Charlie 2 area. As in the first core area described, this core area consists largely of overlaps between the reef areas from 2019 and 2023. In addition, there is a sub-area in the south of this area, which results from overlaps between the reef areas from 2021 and 2023. In the transition area between these two sub-areas, there is a small sector where reefs from all three years overlap.

Since the general distribution of boulders is roughly similar in all three years despite the lower number of boulders in the year 2021 and the higher number of boulders in 2023, it is likely that missing or (re-)appearing boulders are temporarily or periodically covered by sediment. Despite the relatively uniform distribution pattern of the rocks in the observation area, rocks that are not visible in individual years due to sediment cover can have a direct influence on the intersections of the reef areas from the three years. The large sub-areas of the core areas 1 and 3 described above, which are mainly characterized by overlaps of the reef areas from 2019 and 2023, are striking. Stones or reef areas from 2021 are possibly missing here due to sediment coverage of the stones in this year.

Another reason for the differences between the years could be due to varying methodology in collecting and evaluating the SSS. Especially the interpretation of SSS-data is dependent on the used technique (e. g. frequency) and the interpreter and not always distinct.

The two possible causes mentioned for the interannual differences between the three years are at this point attempts to explain the missing and (re-)appearing objects in the study area. While a combination of the two approaches presumably explains a large part of the differences, further investigations would be necessary for concrete statements in this regard.

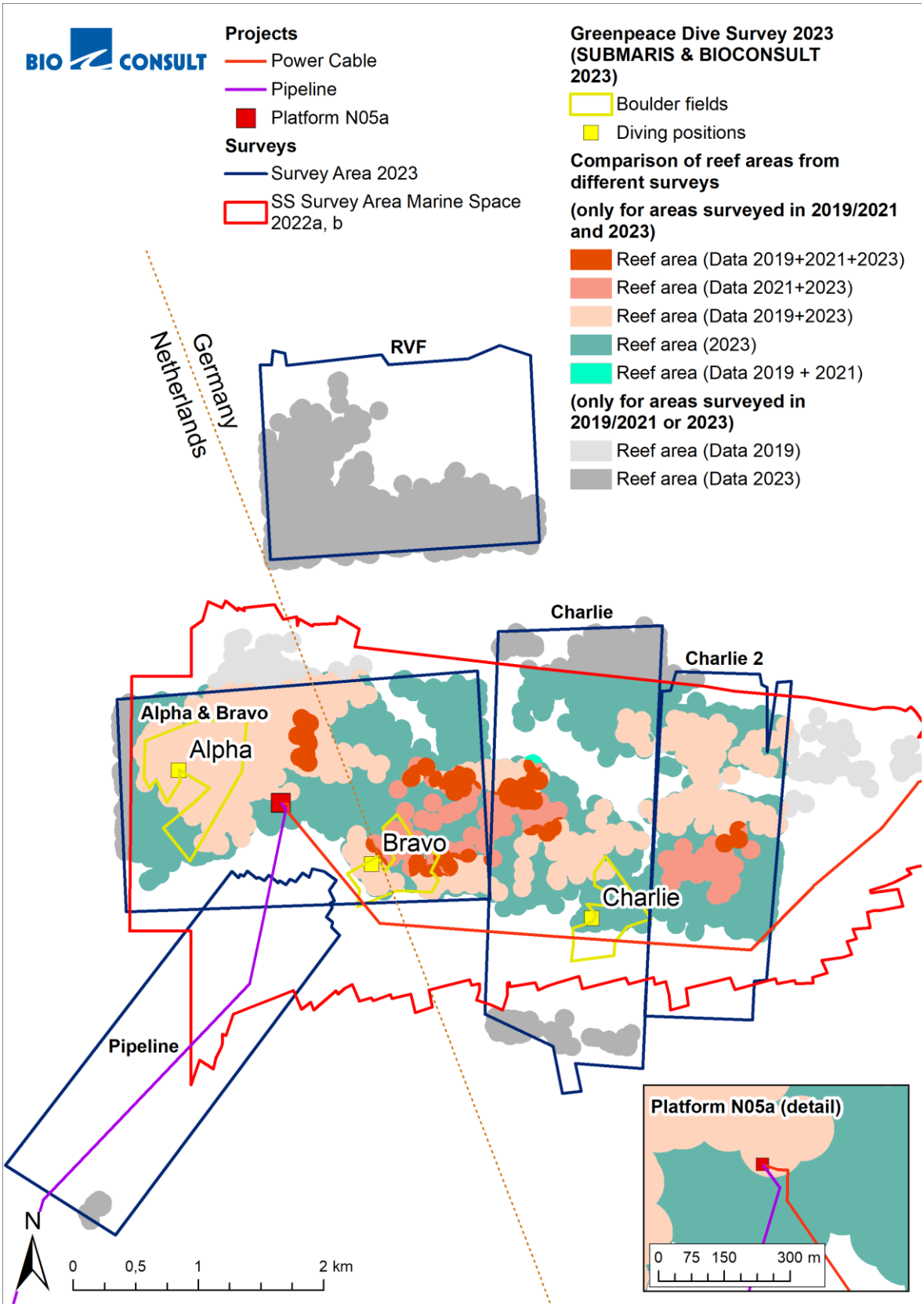


**Fig. 14:** Comparison of reef areas from 2019, 2021 and 2023 surveys.
Only reefs in the intersection of the survey areas of Marine Space 2022a, b and of the survey 2023 are displayed with colours (protruding areas due to the buffering are assigned to its objects origin area).

## 5.2 “Oases of Biodiversity” Report 2023 (submaris & BioConsult 2023)

Investigations were carried out by submaris & BioConsult (2023) in three areas near the platform and on the cable route. Stones were previously found in the three areas (Alpha, Bravo and Charlie) by Greenpeace using side scan. These three areas were examined more closely by divers with regard to the epibenthic fauna at the locations shown in Fig. 14. In comparison a particularly well-developed and known reef on the German side (Riffgat) was surveyed.

The investigated sites all had stone deposits, with the comparative site Riffgat being characterized by a particularly high stone density (often covering the entire area) and many very large stones. In comparison, Alpha, Bravo and Charlie were characterized by loose stone deposits with longer stone-free sections and smaller stones on average. At the Bravo site in particular, there were only a few but large stones. The large stones in particular were colonized by different animal species at all sites and there was a correlation between the density of vegetation and the stone density or stone size. Larger, densely packed stones are less affected by oversanding and abrasion due to sediment drift and therefore offer the epifauna a physically more undisturbed habitat than smaller and less dense stones. Accordingly, a better-developed epifauna community can develop there.

A total of 98 taxa (88 species) of invertebrates (93 taxa) and fish (5 taxa) were recorded using this combination of methods. 17 taxa are listed on the German Red List of Endangered Species. This means that significantly more species were recorded than, for example, by BOS et al. (2014). A total of 16 species were found, which are structure- and habitat-forming due to their size and upright growth habit. These include sponges (Porifera), moss animals (Bryozoa), flower animals (Anthozoa), hydroid polyps (Hydrozoa) and sea squirts (Ascidiacea), which colonized the stones with varying dominance or together and are assessed as characteristic of reefs. Due to their three-dimensional growth form, high-growing hydrozoa offer other (typical) species (nudibranchs, amphipods, isopod spiders, mussels) a settlement, feeding and/or spawning area and fulfill important structural and trophic functions in the habitat. Within the vagile megafauna (echinoderms, higher crustaceans, fish), reef-typical species such as the edible crab (*Cancer pagurus*), the common starfish (*Asterias rubens*), the ghost crab (*Macropodia rostrata*) and the devil's swimming crab (*Necora puber*) were also found at all sites.

The investigations by submaris & BioConsult (2023) thus complement the current study and highlight the ecological value of the reefs. The summarized assessment based on the criteria proposed in BioConsult & submaris (2021) for the assessment of reefs shows that the reef character at the three sites Alpha, Bravo and Charlie is to be assessed as less pronounced compared to the Riffgat site. However, a species-rich, reef-typical community was also observed at these three sites, which represents a spatially rare and special community within the sand-dominated areas of the German North Sea coast. The classification as a biotope (reef) worthy of protection is justified not only on the basis of the stone deposits, but also on the basis of the colonization and the ecosystem function for Alpha, Bravo and Charlie.

## 5.3 Literature

The most important summary study on the benthic habitats of the area "Borkumse Stenen" in which the platform location N05a is situated, is from BOS et al. (2014). The "Borkumse Stenen" is the area in Dutch waters that is directly connected to the German protected area Borkum Riffgrund. It is comprised of geogenic reef characteristics but not yet formally recognized as a protected area. As can be seen in Fig. 15, the platform location N05a is situated at the southern edge of an area classified potentially as a reef (H1170) by BOS et al. (2014). These results correspond to the reef demarcation according to the mapping guidelines of the BfN (see Fig. 13). In addition, the results shown in chapter 2 to 4 strongly suggest the presence of stony reefs worthy of protection in the area of Borkumse Stenen, following also the Dutch mapping guideline for reefs (Fig. 3), even though video assessment is needed for final classification.

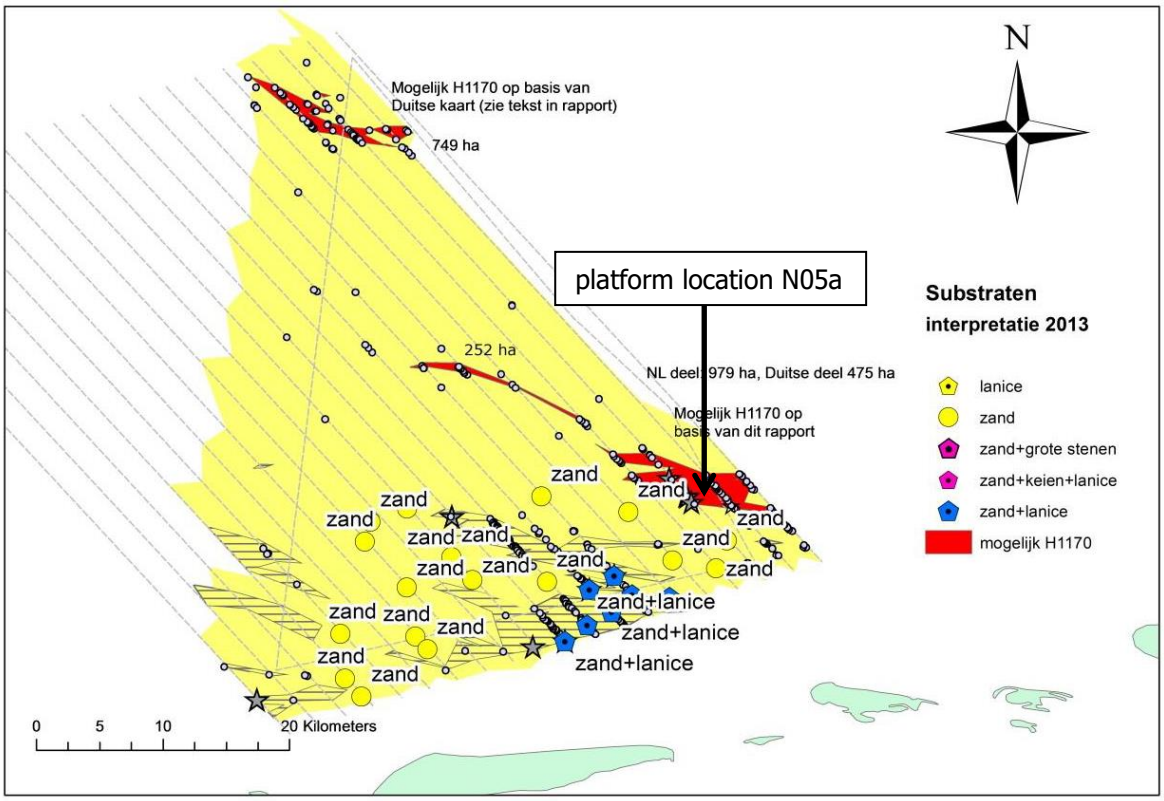


**Fig. 15:** Potential reefs "Borkumse Stenen" (from BOS et al. 2014) and platform location N05a.

# 6. Conclusion

According to the analysis of the available data following the mapping guidelines of the BfN (2018), large geogenic reefs of the type "boulder field" are present in all surveyed areas, i.e. also in the vicinity of the platform location N05a, in the vicinity of the planned power cable and in an area formerly described as a potential reef (RVF) area in German waters. In the survey area "pipeline" (only) a (very) small reef was found, yet the surveyed area only covers a short section of the planned pipeline area. The reefs are classified as stony reefs (H1170) following the Annex I habitats of the EU Habitats Directive (1992). The available data from 2019, 2021 and 2023 result in respectively different reef demarcation.

When interpreting the results, it should be noted that the side scan sonar contacts classified as "objects" in the Appendix are not all boulders. Since further differentiation is not possible based on the available data, all side scan sonar contacts are classified as "boulder" by precaution. This represents a precautionary approach. These uncertainties should be eliminated by a more comprehensive mapping combining side scan and video.

# Literature

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# Annex

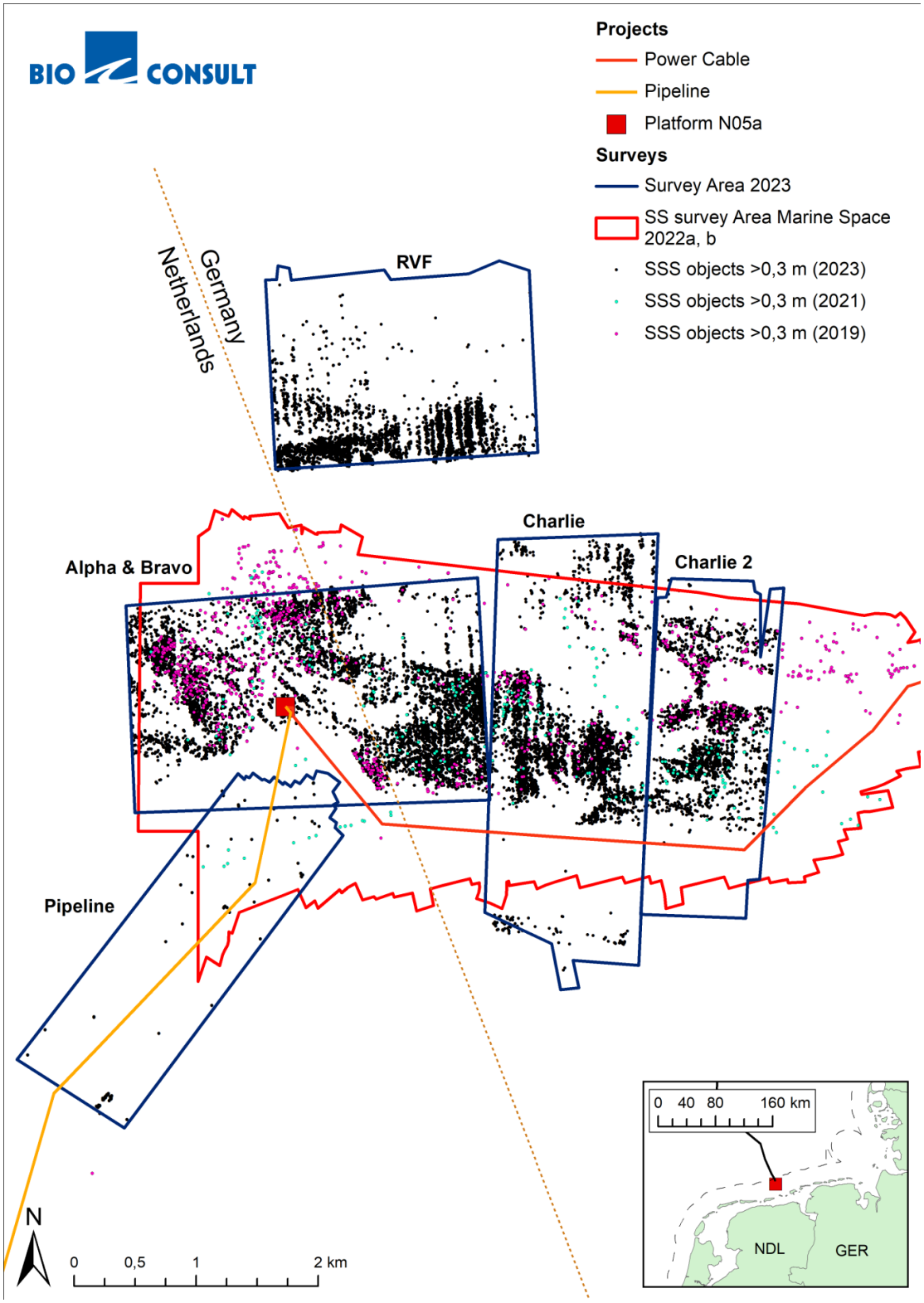


**Fig. 16:** Comparison of SSS objects from 2019, 2021 and 2023 surveys. Data 2019 & 2021 from MarineSpace (2022a, b)


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