Cold-water corals in Skarnsundet and Tauterryggen

Occurrences, fisheries-related impact and management zonation

Technical compilation 2020–2025

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Technical basis for the County Governor of Trøndelag

Contents

Ctrl+click an entry to jump to it. The table of contents updates automatically in Word. If the page numbers are missing or incorrect, right-click the list and select 'Update field'.

Contents 2
Summary 4
1. Introduction 6
1.0 Role clarification and impartiality 6
1.1 Underlying data and method 7
1.2 Classification method – the framework and evidence levels 10
1.3 Uncertainty and limitations 11
2. Scientific background: why the corals are vulnerable 13
2.1 How the corals are built, and why they are fragile 13
2.2 Ecological interactions and associated species 14
2.3 Species-specific growth rates 14
2.4 Key scientific message 15
2.5 Red List status of the coral species in the area 15
3. Fishing gear that affects the corals 16
4. Documented damage 17
4.1 NINA Report 2229 – key findings (Järnegren et al., 2024) 17
4.2 Bare Dykk AS – field observations (2020–2025) 17
5. Damage types and damage causes 17
5.1 Non-fisheries-related impacts observed in the material 18
6. Why Skarnsundet is particularly exposed 19
6.1 Differing damage mechanisms between zones – a working hypothesis 20
7. Water-mass condition 2025 (Multiconsult) 21
7.1 Oxygen in deep water (cf. Section 8 of the Nature Diversity Act) 21
7.2 Temperature at coral depths 22
7.3 Turf algae and freshwater runoff – a relevant context factor (cf. Section 10 of the Nature Diversity Act) 23
7.4 Thermal stress and reduced resilience (cf. Section 10 of the Nature Diversity Act) 25
7.5 Integrated assessment 26
8. Management assessments 28
9. Overall assessment (Part 1) 29
10. Photographic documentation 30
10.1 Coral types and habitat structure 30
10.2 Gear impact and damage 33
10.3 Habitat variation and context 44
10.4 Video documentation 45
Zone overview with map material 49
Skarnsundet SOUTH 52
S1: The Mosvik side – Brufoten 53
S2: The Inderøy side – Brufoten 57
S3: Vangshylla 61
S4: Ørdalsneset 64
S5: Between Øsneset and Staurlia (the western side of Skarnsundet) 67
S6: Between Ørdalsneset and Brufoten (the Inderøy side) 70
Skarnsundet NORTH 73
N1: The northern side of Hoøygrunnen (Hoøya) 73
N2: Hoøyskjeret – the Grandørin ridge (south-west of Hoøya) 75

N3: Skallen north-east – the sill area at 48 m 77
N4: At Noremsflata 78
N5: Vennesodden 81
N6: Bruraskjeret 81
N7: Kvennavika 83
N8: At Norem 83
Tauterryggen marine protected area 85
The protected area 85
Coral occurrences 85
Selligrunnen – among the shallowest documented *Desmophyllum pertusum* occurrences 86
Fishing-gear impact 86
Value assessment 86
Recommendation for Tauterryggen 86
About this part 88
1. Integrated pattern of damage for the entire survey area 88
2. Value classification and prioritisation 89
2.1 Criteria for prioritisation 89
2.2 Zone table 90
3. Indicative classification (preliminary classification) for priority zones 91
4. Anchoring in the Nature Diversity Act 94
5. The user perspective – the survey 95
5.1 Area use and gear choice 95
5.2 Snagging and gear loss 96
5.3 User-reported coral bycatch 96
5.4 Coral knowledge and scope for action 97
5.5 Links to the observed pattern of damage 98
5.6 Social acceptance and management scope for action 99
6. Recommendations 101
6.0 Categorisation of measures – process needs 101
6.1 Tier 1 – Knowledge- and guidance-based measures 102
6.2 Tier 2 – Area-specific restrictions 108
7. The 'Preferably don't fish here' initiative 109
7.1 Purpose and scope 111
7.2 User guidance from the map 112
7.3 Management value 112
7.4 Connection with ongoing knowledge-gathering 112
8. Uncertainty matrix per zone 113
9. Conclusion 115
References 117
Glossary and terms 121
Annex A: Quality checklist 124

Summary

Skarnsundet and Tauterryggen contain some of the most species-rich and ecologically valuable benthic habitats in the Trondheimsfjord. The areas host both reef-forming stony corals (*Desmophyllum pertusum* (formerly *Lophelia pertusa*), *Madrepora oculata*) and large populations of gorgonian corals (*Paragorgia arborea*, *Primnoa resedaeformis*, *Paramuricea placomus*). These structures form three-dimensional habitats that support a very rich community of fish, filter-feeding organisms and crustaceans.

The compilation draws on three main sources for the damage and impact assessment: field observations from Bare Dykk AS (2020–2025), NINA Report 2229 (Järnegren et al., 2024) and a survey of 809 fishers (Sentio Research, 2026). In addition, the Trondheimsfjord population survey in Trøndelag (Trøndelag County Authority, 2025) and Multiconsult's 2025 water-mass survey (Multiconsult, 2026) are used as supplementary context for social acceptance and water-mass status respectively. Damage observations are classified according to the technical framework *Damage types in cold-water corals* (Slapgård, 2026, rev. 2.4), which defines systematic classification keys for damage mechanism, severity, evidence level (the strength of the documentation), reversibility (the potential for natural recovery) and measures.

Key findings: The compilation shows that the coral occurrences in Skarnsundet and Tauterryggen display documented signs of mechanical impact most consistent with fishing gear, across several surveyed zones and depth strata. The damage pattern includes, among other things, snagged fishing lines, gillnet remnants, crushed colonies and torn-off coral structures. Where gear has been observed in physical contact with corals, there is directly documented gear impact. For the remaining observations, the damage pattern is assessed as consistent with mechanical gear impact, without causation being unambiguously established for each individual observation. It is assessed as particularly significant because cold-water corals grow very slowly, and because physical damage may be long-lasting or in practice irreversible (not recoverable within a relevant management timeframe). Of the five documented coral species in the area, *D. pertusum* and *Paragorgia arborea* are classified as 'Near Threatened' (NT) on the Norwegian Red List for species (Tandberg and Mortensen, 2021), while *Madrepora oculata* is classified as 'Data Deficient' (DD). Management of the area therefore directly concerns Red-Listed species and their habitats. Multiconsult's oxygen measurements in the deep water of Skarnsundet show condition class 'Very good' (cf. Section 7.1); the measurements do not support hypoxia as the main explanation for the observed damage pattern in 2025, but do not rule out other stressors or seasonal variation. Existing protection status provides little protection against fisheries-related impact.

Scientific background

Cold-water corals are habitat-forming keystone species (species that create living space for other species) in Norwegian coastal ecosystems. Coral reefs formed by cold-water corals – particularly *Desmophyllum pertusum* (formerly *Lophelia pertusa*) – are among the most complex and species-rich habitats in Norwegian sea areas (Fosså et al., 2002; Buhl-Mortensen et al., 2010; Roberts et al., 2009). The species grow very slowly, from millimetres to a few centimetres per year, and reef structures can be thousands of years old (Järnegren et al., 2024). Physical impact can cause

lasting structural damage that in practice cannot be reversed within management-relevant timescales (Buhl-Mortensen, 2017; OSPAR, 2022).

The coral occurrences function as nursery grounds, refuges and a food base for a range of other species, and the loss or degradation of corals therefore has consequences for the entire ecosystem they build. From a European perspective, the condition of both coral reefs and coral forests is assessed as poor and in decline (OSPAR, 2022), with bottom-set fishing gear identified as the most important threat. This makes the documentation, monitoring and management of Norwegian cold-water corals, particularly within marine protected areas, a high-priority management task.

Purpose and scope of the document

The document has been prepared as a technical basis for decision-making for the County Governor of Trøndelag, not as a complete survey of all coral occurrences in the area. The recommendations are formulated as technical assessments and proposals. The management decision rests with the County Governor, in cooperation with the Directorate of Fisheries and the Institute of Marine Research.

The document is structured in three parts

1. **Part 1 – Damage and impact.** Scientific basis, gear types, damage types, management context.
2. **Part 2 – Zonation.** Detailed description of 14 zones in Skarnsundet SOUTH and NORTH. Tauterryggen is treated separately as its own protected area at overview level.
3. **Part 3 – Overall assessment and recommendations.** Summary and management recommendations.

Short version of the report's assessment

The report documents direct gear impact where fishing gear has been observed in contact with corals. For the remaining damage, the damage pattern is assessed as most consistent with mechanical impact, but without individual causes being established for each observation. The recommendations are therefore stepwise and build on the precautionary principle, the knowledge base and cumulative environmental effects.

PART 1

Damage and impact

Fisheries-related damage to coral occurrences in Skarnsundet and Tauterryggen

1. Introduction

The coral occurrences in Skarnsundet and Tauterryggen make up a complex coral ecosystem extending from approx. 20 m to more than 180 m depth. The combination of steep topography, strong tidal current and high species richness creates favourable conditions for filter-feeding coral communities, but at the same time makes the areas particularly vulnerable to mechanical impact from fishing gear.

This document compiles the available knowledge on fishing-gear impact, recorded damage types and management assessments. The basis is observations from Bare Dykk AS's survey dives (2020–2025), compiled together with NINA's field surveys in Skarnsundet in 2022, published as NINA Report 2229 (Järnegren et al., 2024). It is a field-based compilation of the best available knowledge, own observations and existing research, prepared as a basis for decision-making for further scientific and management assessment.

> *'It is, however, a matter of concern that all the areas, to a greater or lesser degree, are affected by fishing'*
>
> — Järnegren et al. (2024), NINA Report 2229

NINA's assessment broadly agrees with Bare Dykk's field observations. Both data sources point to a pattern of damage dominated by mechanical impact from fishing gear, but they cover different depths, methods (diving vs. remotely operated vehicles) and time periods (Bare Dykk 2020–2025; NINA autumn 2022).

1.0 Role clarification and impartiality

Bare Dykk AS is a local field operator and commercial diving operator in Skarnsundet, with more than 20 years of experience from the area. The company provides survey and documentation services on assignment from the County Governor of Trøndelag, and has a vested interest in the sound management of the coral occurrences in the area, both commercially and in terms of the values at stake.

This dual role is treated openly. To reduce the risk of biased interpretation, the report is organised according to the following principles:

- **Clear source separation:** Own observations (Bare Dykk AS) are consistently kept separate from independent sources (NINA Report 2229, Multiconsult's water-mass report, Sentio Research / Trøndelag County Authority's Trondheimsfjord survey, peer-reviewed literature).

- **Explicit evidence levels:** Each assessment is classified according to the framework's evidence scale (1–3, cf. Section 1.2), so that the reader can see how strong the documentation is for each individual claim.
- **Inclusion of non-fisheries-related impact:** The report also documents observations that are consistent with dive-related damage (Section 5.1), that is, impact from Bare Dykk's own line of business. This is done to avoid selective reporting.
- **Separation of supplier / authority:** Bare Dykk AS provides the technical basis, observations and recommendations. The final assessment of the requirements of the law, decisions on measures and prioritisation rest with the County Governor and cooperating authorities (the Directorate of Fisheries, the Institute of Marine Research, the Norwegian Environment Agency).

The declaration of impartiality is included to make the report more verifiable, not because the author considers the technical documentation to be weakened by the company's role as an interested party.

In parallel with submission to the County Governor, the report has been shared with selected external scientific communities at NINA and NTNU for technical feedback. This process is ongoing at the time of delivery. The feedback does not constitute formal approval or peer review of this compilation, but contributes to quality assurance of claims linked to existing research sources and strengthens the verifiability of the document.

There has also been ongoing dialogue with contacts at the County Governor of Trøndelag and Trøndelag County Authority in connection with the preparation and delivery of the document.

1.1 Underlying data and method

The compilation draws on three main sources for the damage and impact assessment: Bare Dykk's field observations, NINA Report 2229 and the survey among fishers. In addition, the Trondheimsfjord survey and Multiconsult's water-mass survey are used as supplementary context for social acceptance and water-mass status respectively.

Main sources for the damage and impact assessment:

Bare Dykk AS (2020–2025)

Method: Visual survey by diving, photo and video documentation, GPS positioning.

Coverage: Dive transects in 14 zones in Skarnsundet, primarily 20–70 m depth.

Focus: Shallow gorgonian-coral occurrences, topographic detail, gear observations.

NINA Report 2229 (Järnegren et al., 2024)

Method: Remotely operated vehicles (ROV), video transects, habitat-type classification.

Field period: August–December 2022 (Rødberget Aug.–Sept., Tauterryggen Sept., Skarnsundet Oct.–Dec., two ROV cruises + AUV/LAUV surveys). Report published September 2024.

Bare Dykk AS (2020–2025)

Method: Visual survey by diving, photo and video documentation, GPS positioning.

Coverage: Dive transects in 14 zones in Skarnsundet, primarily 20–70 m depth.

Focus: Shallow gorgonian-coral occurrences, topographic detail, gear observations.

Coverage: A total of 33 km of transect and approx. 80,000 m² covered in three marine protected areas (Skarnsundet, Tauterryggen, Rødberget). 28 polygons with coral occurrences mapped (1,571 daa).

Focus: Deeper strata (typically 30–185 m), habitat-type delineation, condition assessment.

Survey (Sentio Research, 2026)

Method: Web-based survey among 809 people who fish in Skarnsundet and/or Tauterryggen. The main sample (n=766) from the municipalities of Indre Fosen, Steinkjer, Inderøy and Frosta; supplemented by 43 respondents via an open link. Field period: 8 December 2025 – 5 January 2026.

Coverage: Self-reported data on area use, gear types, depth use, snagging incidents, coral knowledge and perceived problems.

Focus: User perspective on fishing activity and fisheries-related impact. Margins of error: ± 2.1 to 3.4 percentage points.

Supplementary context:

The Trondheimsfjord survey (Trøndelag County Authority, 2025)

Method: Sentio Research, population survey among the inhabitants of Trøndelag on attitudes to the Trondheimsfjord, fishing bans, protection and management.

Coverage: Trøndelag-wide sample, n ≈ 1000.

Use in this report: Social acceptance and legitimacy for a stepwise strategy of measures (cf. Part 3, Section 5.6).

Multiconsult's water-mass survey (Multiconsult, 2026)

Method: 16 stations, 8 measurement rounds March–September 2025, parameters: oxygen, temperature, salinity, nutrients, chlorophyll fluorescence, Secchi depth.

Coverage: TRF-VB5 (south of Skarnsundet, main reference), TRF-VB3 (Beistadfjorden, inner proxy), TRF-VB18 (Ytterøya, mid-fjord) and TRF-VB20 (Strindfjorden, nearest proxy for the Tauterryggen sill).

Use in this report: Context for water-mass condition supporting the assessment that observed damage is of mechanical origin from fishing gear (cf. Part 1, Section 7).

Synthesis

The three main datasets cover complementary dimensions of the same phenomenon: Bare Dykk's dive transects document observed damage in shallow water, NINA's ROV data document observed damage in deep water, and the survey documents fishing activity, snagging incidents and gear loss that are consistent with a risk of mechanical impact in the same areas where coral damage has been observed. The survey is an impact and risk indicator, not independent proof of damage – it does not document direct damage to corals, but quantifies the extent and frequency of activity known to cause mechanical impact. Together, the three datasets give a vertically and socially coherent picture of the coral occurrences and the fisheries impact from approx. 20 m to more than 180 m depth. The context sources deepen the picture with social acceptance and water-mass status.

Anchoring the knowledge base in Section 8 of the Nature Diversity Act

Section 8 of the Nature Diversity Act requires that public decisions affecting biodiversity be based on scientific knowledge of the population status of species, the distribution of habitat types and their ecological condition. The second paragraph of Section 8 of the Nature Diversity Act specifies that the authorities shall furthermore give weight to knowledge based on experience through the use of and interaction with nature. The preparatory works (Ot.prp. no. 52 (2008–2009); Innst. O. no. 100 (2008–2009)) and guidance T-1554 (the Ministry of Climate and Environment) specify that this includes information arising through reports and experience-based knowledge from users, fishers and people with local knowledge.

The underlying data in this report consist of two complementary levels, both anchored in Section 8 of the Nature Diversity Act:

- **Scientific knowledge (the first paragraph of Section 8 of the Nature Diversity Act):** NINA Report 2229 (Järnegren et al., 2024), Multiconsult's water-mass report (2026), peer-reviewed literature (Roberts et al., 2009; Buhl-Mortensen et al., 2010; Buhl-Mortensen, 2017; Mogstad et al., 2022; Fosså et al., 2002; Rinde et al., 2024) and Trøndelag County Authority's Knowledge Status Trondheimsfjord 2023.
- **Experience-based knowledge (the second paragraph of Section 8 of the Nature Diversity Act):** Bare Dykk's systematic dive observations and photo/video documentation from 2020–2025 (comprising more than 20 years of continuous field familiarity with the area), together with a survey among 809 recreational fishers conducted by Sentio Research on assignment for the County Governor of Trøndelag (Sentio Research, 2026), including 271 open free-text responses with self-reported experiences from the users of the area. The Trondheimsfjord survey (Trøndelag County Authority, 2025) similarly contributes experience-based knowledge from a broader sample of the population of Trøndelag.

Both types of knowledge form complementary parts of the knowledge base in this report, but with different methodological strength and different roles in the assessment. Scientific transects, ROV data and peer-reviewed literature have higher methodological precision for quantifying impact, while experience-based knowledge from field operators and users provides broader temporal and

spatial coverage and captures phenomena that are rarely the subject of research funding. It is precisely the interplay between independent observations from three channels – ROV surveying (science), dive observation (experience from a field operator) and user reporting (experience from recreational fishers) – that makes the pattern of damage robust and applicable for management. Each source alone has its limitations; together the material constitutes a systematic and verifiable contribution to the knowledge base under Section 8 of the Nature Diversity Act.

1.2 Classification method – the framework and evidence levels

Damage assessments in this report have been carried out in accordance with the technical framework *Damage types in cold-water corals* (Slapgård, 2026, rev. 2.4), which has been prepared for the County Governor of Trøndelag and builds on established scientific literature, operational field methodology and legal applicability. The framework is methodologically anchored in international standards for the assessment of vulnerable marine ecosystems (VMEs) and fisheries impact on cold-water corals: the FAO International Guidelines for the Management of Deep-sea Fisheries (FAO, 2009) establish five VME criteria, of which cold-water coral habitats systematically meet at least three (vulnerability/fragility, a life history that impedes recovery, and structural complexity); OSPAR's Quality Status Report 2023 assesses *Lophelia* reefs as 'in poor condition' in all OSPAR regions, with fishing as the primary pressure factor; and Baco et al. (2023) establish a global consensus for image-based VME identification based on the same principles applied here. Slapgård (2026) is a local application of these frameworks adapted to the Skarnsundet context, with more granular damage-type classification at colony level. The framework operates with five systematic classification keys (Section 10, clavis):

- **Key 1 – Primary damage mechanism** (codes A–H)
- **Key 2 – Damage severity** (I–IV: an increasing scale from minor damage to complete destruction)
- **Key 3 – Evidence level** (1–3)
- **Key 4 – Reversibility and progression potential** (R1–R4)
- **Key 5 – Assessment of measures under the Nature Diversity Act** (T1–T5)

Status and use of the framework: The framework is not a formal public classification standard, but an operational working tool for structuring observation, interpretation and uncertainty. It has been developed for concrete application in Skarnsundet/Tauterryggen and builds on established literature and guidance practice. Should any conflict arise between the framework and established public classification systems (e.g. the Guidance for classification of environmental status, Guidance M-1941 on assessments under the Nature Diversity Act, the Norwegian Red List for habitat types), the public systems shall prevail.

The framework's basic principle is to distinguish clearly between observation and interpretation, and to make uncertainty visible. Classification codes such as E-II-2-R3a-T2 (mechanism E, damage severity II, evidence level 2, reversibility R3a – partially reversible with regeneration over 5–20 years, measure T2) represent structured working hypotheses, not validated conclusions. Indicative classifications (preliminary classifications) for the highest-priority zones are compiled in Part 3 (Chapter 3).

Evidence levels (Key 3)

The framework defines three evidence levels used for all impact assessments in this report:

Evidence levels according to the framework (Slapgård, 2026)

Level 1 – Directly documented damage: Directly observed or documented exposure or damage event with corresponding damage (or robust before/after data). Temporal co-variation alone belongs to Level 2. High interpretive strength; can be used as a basis in decisions.

Level 2 – Consistent mechanism: The damage pattern is consistent with established literature, with no more plausible alternative explanations. May be 'strengthened' (supporting parameters agree) or 'basic' (visual observations only).

Level 3 – Hypothetical link: A biologically plausible connection, but insufficient data. Low interpretive strength; requires further analysis.

For the observations in this report, level 1 is relevant where fishing gear has been directly observed in corals (documented contact), while level 2 is relevant where the damage pattern is consistent with mechanical gear impact without the specific contact being documented. The report uses the following standard wording for evidence level 2 (probable, but not fully confirmed):

> *'The observations are assessed as consistent with [mechanism], but there is insufficient data to establish unambiguous causation.'*
>
> — Slapgård (2026), Section 15, recommended decision-oriented wording

1.3 Uncertainty and limitations

The document is not a complete survey of all coral occurrences in the area. The following reservations should be taken into account:

Underlying data and coverage

- **Unsurveyed depth strata.** Between approx. 70 m and 30 m (the transition between diving and ROV) there are sections that are only partially documented.
- **Extent.** Several zones (including N3 the Skallen sill, N4 Noremsflata and S5 Øsneset–Staurlia) have a documented extent beyond what has been surveyed. The zone boundaries in Part 2 are therefore minimum delineations.
- **Time dimension.** The observations represent snapshots; accumulated damage development (repeated impact building up over years) can only be assessed indirectly through overgrown and older gear.
- **Tauterryggen, observed damage.** Bare Dykk's survey does not include the Tauterryggen area; observed damage there is based solely on NINA (Järnegren et al., 2024). The survey, however, covers both areas and provides a user perspective from Tauterryggen as well.
- **Visiting recreational fishers not represented.** The survey (Sentio Research, 2026) is directed at residents of the Trøndelag municipalities around the Trondheimsfjord. Visiting recreational fishers from other parts of the country and foreign tourists are by definition

not captured by the sample. In its fieldwork, Bare Dykk AS observes a significant proportion of visiting recreational fishers during the summer season, particularly at launch ramps such as Vangshylla, Kjerringvika and Venneshamn. The self-reported figures therefore probably represent a lower-bound estimate of the actual volume of use, and reinforce the need for information material in several languages as part of Tier 1 measures.

Missing supporting parameters

The assessments in the report are based on visual observations from diving and ROV. The framework (Slapgård, 2026, Sections 10.4 and 11.5) requires that quantitative supporting parameters be stated explicitly in order to distinguish between evidence level 2 ‘strengthened’ and 2 ‘basic’ (probable, but not fully confirmed). The following supporting parameters have not been collected as part of Bare Dykk's own field survey. Some relevant environmental data are nevertheless available from external sources, particularly Multiconsult's 2025 water-mass survey, but these do not cover all localities, depths or seasons at the resolution required to raise all visual damage observations to evidence level 2 ‘strengthened’:

- **Oxygen level (O_2)** – relevant for assessing bottom-water quality and its combination with organic load.
- **Sedimentation rate and TOC** – necessary to differentiate mechanical damage from sediment-induced stress (mechanism E in the framework).
- **Current conditions** – quantitative measurements for assessing gear drift and sediment transport.
- **LMS (lysosomal membrane stability)** – a quantitative health indicator that documents sublethal stress (a load that weakens the organism without killing it directly). b-MBI may be included as a supplementary indicator under development, but it has not been regionally validated for Norwegian conditions and does not on its own raise the evidence level.

The consequence is that impact assessments in the report as a rule lie at evidence level 2 (basic), not evidence level 2 (strengthened). Access to such parameters could raise the evidence level without further fieldwork.

Interpretive limitations

- **Assessments are based on visual observations.** This gives access to acute and structural damage, but not to sublethal stress processes without visible signs (cf. Dunlop et al., 2026, cited in Slapgård, 2026).
- **Causation is not established.** The report applies the framework's evidence levels; in the absence of directly observed impact, wordings such as ‘consistent with’ or ‘most consistent with’ are used, not ‘caused by’.
- **Alternative explanations.** Where relevant, alternative explanations (natural variation, historical impact, other stressors) are mentioned explicitly.

2. Scientific background: why the corals are vulnerable

The cold-water corals that form the habitats in Skarnsundet are among the slowest-growing animals in Norwegian nature. This chapter describes first how the corals are built and why they are physically vulnerable, then the ecological role they play, and finally how slowly they grow.

Note on terminology

In this document, the term ‘gorgonian corals’ (Norwegian hornkoraller) is used in a broad, taxonomic sense for the species of the order Alcyonacea (formerly Gorgonacea), including *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus*. This is in line with the habitat-type designation ‘Gorgonian corals (l0902)’ (the Norwegian Biodiversity Information Centre, 2018) and NINA's terminology in the introduction of Järnegren et al. (2024). In this report, the Norwegian name ‘sjøbusk’ is used as the main name for *Paramuricea placomus*; the alternative Norwegian name ‘viftekorall’ (fan coral) occurs in parts of the management and Red-List documentation and may therefore appear in cited contexts.

The term ‘stony corals’ (Norwegian steinkoraller) is used for *Desmophyllum pertusum* (formerly *Lophelia pertusa*) and *Madrepora oculata* – species of the order Scleractinia, which form a calcareous skeleton and can build reefs. This corresponds to the habitat-type designation ‘Stony corals (l0901)’ – a designation covering *Desmophyllum pertusum* and *Madrepora oculata*, i.e. reef-building cold-water corals.

2.1 How the corals are built, and why they are fragile

What actually is a coral? Corals are cnidarians (phylum Cnidaria) – the same animal group as jellyfish and sea anemones. More precisely, they belong to the class of coral animals (Anthozoa), which also includes sea anemones and sea pens. Whereas a sea anemone usually lives as a single polyp, corals are colony-forming – many small polyps with tentacles live together and make up one continuous colony. Corals are thus not plants or dead rock structures, but living animals closely related to the sea anemones many people know from the shore.

A scientific curiosity: *Paragorgia arborea* (bubblegum coral) has recently been documented as bioluminescent, whereby the colony can emit blue light on mechanical stimulation (Bessho-Uehara et al., 2020, based on samples from Monterey Bay, California). The finding has not been directly verified in Norwegian waters, but is an example of corals still surprising researchers. Bioluminescence (self-produced light) must be distinguished from fluorescence (which requires external illumination). For the other species discussed in this report, bioluminescence or fluorescence is not documented as a main trait in the available knowledge.

A shared skeleton or supporting axis is what binds the polyps together into a continuous colony. In stony corals, such as *D. pertusum* and *Madrepora oculata*, the polyps build a calcareous skeleton. In gorgonian corals, such as *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus*, the colony grows as branched structures with an inner proteinaceous supporting axis (gorgonin) covered by living tissue.

The living coral tissue lies as a thin layer on the outside of the colony. The polyps capture small particles and plankton from the water column using tentacles, and the colonies therefore depend on good water exchange and exposure to current. The same exposure that makes the areas

suitable for coral growth also leaves the colonies exposed to fishing line, gillnets, hooks and sinkers that drift or are drawn through the structure.

The fragility of the corals is therefore due to both biological and physical structure. The thin living tissue can be scraped off on contact. Branched colonies act as natural catch points for line and gillnets. Large colonies can break or topple if gear becomes snagged and is loaded with drag. When living tissue is removed, the skeleton or supporting axis is exposed, and damaged surfaces can become an entry point for secondary fouling, infection or further tissue loss.

Corals are sessile organisms. They cannot move away from an impact, and they have a limited capacity for rapid repair. A small mechanical injury can therefore have lasting significance, particularly if the colony is at the same time weakened by sedimentation, temperature stress, reduced food supply or repeated physical contact (cf. Section 7.4 on thermal stress and reduced resilience).

2.2 Ecological interactions and associated species

The cold-water corals in Skarnsundet are azooxanthellate – they lack photosynthetic symbionts and obtain energy by filtering particulate organic material and zooplankton from the water column. The ecological significance of the corals therefore lies not in algae-driven primary production, as in many tropical corals, but in their building of three-dimensional habitats for other species.

The branched coral structures serve as shelter, attachment substrate, nursery and hunting ground for a range of organisms, including fish, crustaceans, polychaetes, brittle stars, sponges, hydroids and bryozoans (Buhl-Mortensen et al., 2010; Roberts et al., 2009). The surface of living corals also hosts microorganisms that form part of the coral's surface-associated microbiome. When tissue is scraped away or the skeleton is exposed, this balance can be disturbed. Damaged surfaces can be colonised by opportunistic species, and this can delay or prevent the regrowth of living coral tissue.

Mechanical damage to corals is therefore not merely damage to a single colony. It may also involve the loss of microhabitats and a changed basis of life for species tied to the coral structure. This is an important part of the ecological vulnerability of the coral occurrences in Skarnsundet and Tauterryggen, and is relevant to the management objectives for habitat types and species under Sections 4 and 5 of the Nature Diversity Act.

2.3 Species-specific growth rates

***Desmophyllum pertusum* (formerly *Lophelia pertusa*)**

- Annual polyp growth: 1–2 mm/year
- Maximum documented growth: < 5 mm/year
- Net growth of reef structures: 0.5–1 mm/year
- Age records in Norway: > 9,000 years

This means that 1 cm of damage to a *Desmophyllum* head corresponds to 10–20 years of lost growth. Larger structural damage cannot be restored within a human timeframe.

***Paragorgia arborea* (bubblegum coral)**

- Branch elongation: 1.2–3.0 cm/year
- Highly vulnerable to mechanical breakage
- Particularly exposed in shallow water (36–60 m), as in Skarnsundet

Primnoa resedaeformis

- Branch growth: 0.6–1.4 cm/year
- Documented in particularly dense occurrence in several zones in Skarnsundet
- The damage potential from longline fishing is correspondingly high

Paramuricea placomus

- Annual growth: 1–2 cm/year
- Often forms continuous 'walls'
- Highly exposed to snagging of fishing line

2.4 Key scientific message

Even a single pull from a fishing line can cause damage that requires several generations of colonies to restore.

Hard-bottom corals can stand intact for centuries, but can be destroyed in seconds.

This is a central scientific premise for treating gear impact in the protected areas as *high-risk impact* in management assessments (cf. Sections 9 and 10 of the Nature Diversity Act).

2.5 Red List status of the coral species in the area

The Norwegian Red List for species (Tandberg and Mortensen, 2021) classifies the coral species occurring in Skarnsundet and Tauterryggen as follows:

Species	Norwegian name	Red List category
Desmophyllum pertusum (formerly Lophelia pertusa)	Øyekorall	NT – Near Threatened
Paragorgia arborea	Sjøtre	NT – Near Threatened
Madrepora oculata	Sikksakkorall	DD – Data Deficient
Primnoa resedaeformis	Risengrynkorall	LC – Least Concern
Paramuricea placomus	Sjøbusk	LC – Least Concern

Of the five coral species that are the main focus of this report, two are classified as *Near Threatened* (NT), one as *Data Deficient* (DD), and two as *Least Concern* (LC). Category NT means that the species is close to qualifying for a threatened category under the Red List criteria. The reason varies between species and may include population decline, limited distribution or other criteria. Category DD means that the uncertainty about the correct category placement spans the entire range from LC to *Critically Endangered* (CR), and that the precautionary principle therefore carries particular weight for the species.

Note: In the Norwegian Red List the categories operate in the following order of increasing severity: LC (Least Concern) → NT (Near Threatened) → VU (Vulnerable) → EN (Endangered) → CR (Critically Endangered). The coral species in this report are classified as NT or LC. Wolffish (*Anarhichas lupus*) is classified as Least Concern (LC) in the Norwegian Red List 2021, but is nevertheless discussed in Sections 4 and 6.1.5 because of its ecological role as a predator and its habitat association with structurally rich hard-bottom communities. In the report's text the word ‘vulnerable’ is also used in its general sense, for habitats and species that are physically sensitive to mechanical impact, and must not be confused with the Red List category VU.

In its species-group account for coral animals, the Norwegian Biodiversity Information Centre explicitly points out that fishing with bottom-set longlines and gillnets is a documented cause of damage to corals, particularly on rugged hard bottom where bottom trawling does not normally occur (Buhl-Mortensen and Tandberg, 2021). This description corresponds directly to the damage pattern observed in Skarnsundet and Tauterryggen.

3. Fishing gear that affects the corals

The table below shows the most common gear types recorded in Skarnsundet, how frequently they occur, and their damage potential to the coral occurrences.

Gear	Occurrence in the area	Recorded damage potential
Fishing lines (light handline fishing, recreational)	Very common	Snags in corals, drags across bottom fauna, forms tangles
Gillnets	Sporadic; poorly suited to strong current	Can settle over coral forest, work into structures
Pots	Less frequent, but occurs	Can destroy colonies during retrieval and hauling
Lost gear (‘ghost gear’)	Common on deeper edges	Long-lasting erosion and abrasion of coral structures

Both Järnegren et al. (2024) and Bare Dykk (2020–2025) have documented snagged fishing gear in corals. NINA records fishing line and crushed coral as the main impact at Tauterryggen, and fishing line, gillnets, fish hooks and sinkers at Skarnsundet (Järnegren et al., 2024, pp. 22 and 33).

Note on gillnets as gear: The gillnet and gillnet-remnant finds observed in Skarnsundet appear mainly to be old, and the survey among 809 fishers (Sentio Research, 2026) shows that only 4% report gillnets as gear used in the area. The strong tidal currents in the sound itself make gillnet fishing impractical in practice. It is therefore not known whether the observed gillnets originate from active gillnet fishing in recent times or from earlier use and loss; regardless of origin, such finds represent documented gear exposure for the coral occurrences.

4. Documented damage

4.1 NINA Report 2229 – key findings (Järnegren et al., 2024)

The following forms of damage were recorded in Skarnsundet and Tauterryggen:

- Crushed coral colonies
- Toppled colonies of stony corals
- Gillnets and fishing lines fastened in corals and hanging through *Paragorgia arborea* colonies
- Fishing sinkers that have knocked off coral heads
- Areas of dead coral skeleton resulting from physical damage

Of particular significance is the discovery of a large *Madrepora oculata* reef in the north-western part of the sound – a type of reef not previously recorded to such an extent in the Trondheimsfjord. Large parts of this reef are damaged by fishing.

Tauterryggen shows the same pattern, with clear dominance of *D. pertusum* and crushed colonies recorded in all surveyed transects.

4.2 Bare Dykk AS – field observations (2020–2025)

Dive data from Bare Dykk show a pattern of damage that closely coincides with NINA's deep-water records:

- Large amounts of fishing line in almost all denser coral fields
- Lines lying crossed over rock walls and into the coral forest
- Overgrown, older lines that indicate long-lasting impact
- Torn-off colonies of *D. pertusum*
- *Primnoa* colonies that are bent or broken after line impact
- Impact increases with topographic complexity (ledges, crevices, edges)

Overall, Bare Dykk's field observations agree with NINA's assessment of Skarnsundet as ‘strongly affected by fishing’. The observations from diving and ROV point in the same direction, but individual instances of damage cannot be linked to one specific event or gear type without supplementary documentation.

5. Damage types and damage causes

Cold-water corals are exposed to both natural and human-induced impacts that produce characteristic damage patterns. The damage types in the project area are classified according to a structured operational framework developed for this project (*Damage types in cold-water corals:*

Technical framework, Slapgård, 2026). The framework describes diagnostic criteria, damage mechanisms and assessments of measures, and is used to ensure consistent reporting across survey methods and observers.

The framework 'Damage types in cold-water corals' – seven main categories

1. Mechanical breaks – snapping of branches or top structures
2. Toppled colonies – drag from gear or current loosens the attachment to the substrate
3. Line entanglement – line or filament covers the colony, causing necrosis
4. Long-lasting abrasion (file) effect – a taut line in motion causes serial, localised tissue loss
5. Dive-related damage – fin or equipment contact, small white tips
6. Chronic micro-abrasion – vibration against substrate, evenly distributed tissue loss
7. Secondary colonisation – hydroids, bryozoans or sponge on dead surfaces

Each category is described in more detail below, with its main characteristics:

1. **Mechanical breaks.** Snapping of branches or top structures as a result of strong physical impact (jigs, gillnets, pots).
2. **Toppled colonies.** Drag from fishing gear or strong currents can topple entire colonies and weaken the attachment to the substrate.
3. **Line entanglement.** Line or filament can settle over the colony and cause local necrosis and impaired filtration.
4. **Long-lasting abrasion (file) effect.** A taut line moving back and forth causes serial, sharply delimited tissue loss without breakage.
5. **Dive-related damage.** Fin or equipment contact produces irregular, small white tips and localised tissue loss, particularly on the front-facing parts of the colony.
6. **Chronic micro-abrasion.** Natural vibration against rock substrate produces evenly distributed white tips and small tissue loss, often in the lower part of the colony.
7. **Secondary colonisation.** Dead surfaces are taken over by hydroid colonies, bryozoans or sponge. This can amplify the extent of damage if the primary injury recurs.

For detailed damage mechanisms, diagnostics and assessments of measures, reference is made to the accompanying technical framework (Slapgård, 2026).

5.1 Non-fisheries-related impacts observed in the material

To avoid selective reporting, this compilation also includes observations that cannot be attributed to fishing gear, including observations that are consistent with dive-related damage. This applies to a limited proportion of the material, and the main pattern of impact in the area is still most consistent with fishing gear. The fact that Bare Dykk AS, being itself a commercial diving operator, explicitly documents possible dive-related damage is done to ensure the report's balance and credibility (cf. Section 1.0). The assessment of dive-related damage has been carried out systematically at all dive sites Bare Dykk has surveyed in Skarnsundet (2020–2025), and is not limited to Vangshylla. The damage pattern described below has to date only been observed at

Vangshylla Sub-zone B; a corresponding pattern has not been recorded in the other southern or northern zones, even though several of these are also visited by local and visiting divers. This is an empirical observation, not a claim that other zones are unaffected, but it is consistent with Vangshylla having a combination of high diver traffic and shallow, exposed coral occurrences that makes the site particularly vulnerable. This is discussed further in the evidence basis per zone in Part 2 and summarised in the uncertainty matrix in Part 3.

Possible dive-related damage – Vangshylla Sub-zone B

Location: One delimited zone (Vangshylla Sub-zone B; cf. Part 2). The damage pattern is consistent with diver contact (mechanism A – mechanical contact, possibly dive-related).

Characteristics: Round, delimited areas of exposed skeleton on coral tips; damage primarily on the front of colonies and within typical depths for recreational diving (shallower than 40 m); absence of torn-off branches or other mechanical traces of fishing equipment; coincidence with a zone known to be frequented by visiting divers.

Evidence level: 2 (basic). The damage pattern is consistent with an established mechanism, but alternative explanations (disease processes, predation, secondary overgrowth that has later detached) cannot be fully ruled out without supplementary investigation.

Measures: Bare Dykk AS has drawn up diving code-of-conduct rules requiring a pre-dive briefing (Bare Dykk AS, 2026b) as an internationally established measure to reduce diver-caused damage. This is included in the recommended measures in Part 3 (Section 6).

Scope: This impact constitutes a minor part of the total pattern of damage. The main pattern in the documented mechanical damage is most consistent with fishing gear as the dominant impact factor.

6. Why Skarnsundet is particularly exposed

Skarnsundet has a combination of topography, current conditions, species richness and human activity that together make the area particularly vulnerable to impact on the coral occurrences. Key factors are:

- **Topographic complexity.** Steep rock walls, overhangs, ledges and crevices form natural ‘catch points’ where fishing gear easily snags and accumulates.
- **Strong tidal current.** Favours filter-feeding coral communities, but at the same time draws gear into the structures.
- **High species richness and vertical distribution.** Corals occur continuously from approx. 20 m to more than 180 m depth, which expands the volume exposed.
- **Short distance to fishing activity.** Both recreational and commercial fishing take place directly over the coral occurrences, particularly in the upper 60–70 m.
- **Shallow occurrences of particularly vulnerable species.** The area hosts one of the shallowest documented occurrences of *Paragorgia arborea* known from the available literature (approx. 36 m; Mogstad et al., 2022).

These conditions contribute to a damage frequency in Skarnsundet that is higher than in many other parts of the Trondheimsfjord, and should be included in a cumulative-effects assessment

(an assessment of the total impact from several sources over time) under Section 10 of the Nature Diversity Act.

6.1 Differing damage mechanisms between zones – a working hypothesis

Field observations and comparison with the survey (Sentio Research, 2026) indicate that the damage mechanisms may vary systematically between different parts of Skarnsundet. This provides the basis for a working hypothesis of differing damage mechanisms between zones, with direct consequences for the choice of measures:

Hypothesis A: The Brufoten zones (S1 and S2) – damage from fishing in the water column

The observations around the Skarnsund Bridge, particularly in S1 the Mosvik side and S2 the Inderøy side, are assessed as mainly driven by fishing in the water column for species such as saithe (*Pollachius virens*), cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). The damage mechanism is indirect:

- **Step 1:** The fisher wants to position the hook/jig at a particular depth, usually in the upper water column (20–60 m).
- **Step 2:** In fast-flowing water such as Skarnsundet, heavy sinkers (often 300–800 g) are needed to keep the gear stable.
- **Step 3:** The sinker is dropped to the bottom before being drawn up to the desired fishing depth, or drops down and ‘knocks’ against the bottom during drag or current changes.
- **Step 4:** When the sinker strikes corals, particularly vulnerable gorgonian structures and stony-coral occurrences, mechanical damage occurs (crushing, tearing).

This hypothesis is supported by the survey: 89% fish for saithe and 66% for cod/haddock, while 49% do not consistently try to prevent the sinker from reaching the bottom (Sentio Research, 2026). The damage pattern in S1 and S2 is thus to a large extent *unintended bycatch damage* from fishing that is not actually directed at bottom species or corals.

Hypothesis B: The northern zones (N2, N3) – damage from targeted bottom fishing

The observations in the northern zones, particularly N2 Hoøyskjeret and N3 the Skallen sill, are assessed as having a larger element of targeted bottom fishing for species such as wolffish (*Anarhichas lupus*), tusk (*Brosme brosme*) and ling (*Molva molva*). These species live in or close to hard-bottom structures – precisely the same structures the corals grow on. The damage mechanism here is direct: the gear is deliberately set near or on the bottom, and snagging or damage to corals is an expected, but unwanted, consequence.

The survey shows that 6% fish specifically for wolffish and 10% for tusk/ling (Sentio Research, 2026). Although the proportions are low in number, the geographical concentration of this activity in the northern parts of Skarnsundet is assessed as significant. Snagging of gillnets, pots and line is probably more frequent here than in the Brufoten zones.

Implications for measures

If the hypotheses hold, they have concrete implications for the choice of measures (cf. Part 3, Section 6):

- **For the Brufoten zones (S1, S2):** Measures should prioritise *method adjustment* – reduced sinker weight, a dropper rig, avoiding bottom contact. These are low-threshold measures that can be achieved through guidance and information work (Tier 1).
- **For the northern zones (N2, N3):** Measures should prioritise *spatial restriction* – gear restriction or zones closed to bottom fishing. Method adjustment alone is not sufficient where the gear is directed straight at the bottom.

This is for now a working hypothesis based on field observations and the user survey. Systematic documentation of fishing activity at zone level (e.g. through fishing-ground data from the Directorate of Fisheries, AIS tracking or a supplementary user survey) can confirm or refine the hypothesis.

7. Water-mass condition 2025 (Multiconsult)

On assignment for Trøndelag County Authority (the Clean Trondheimsfjord project), Multiconsult carried out a survey of water masses in the Trondheimsfjord from March to September 2025 (Multiconsult, 2026). The survey comprised 16 stations with eight measurement rounds, and covers Secchi depth, chlorophyll fluorescence, nutrients, oxygen, temperature and salinity throughout the water column. The dataset constitutes a new and important context for the assessment of coral health in Skarnsundet.

Stations relevant to this report:

- **TRF-VB5** (south of Skarnsundet, area 4 – the mid-fjord): main reference for Skarnsundet south, vertical profiles down to 135 m eight times in 2025. Represents the water mass flowing in from the mid-fjord towards Skarnsundet.
- **TRF-VB3** (Beistadfjorden, area 2): supplementary reference on the inner side of Skarnsundet. Vertical profiles down to 236 m. Represents the water mass flowing out from Beistadfjorden through Skarnsundet at low tide.
- **TRF-VB18** (Ytterøya, area 4 – the mid-fjord): supplementary proxy station for Tauterryggen. Multiconsult has no station on Tauterryggen itself. Represents the water mass flowing out from the inner basins towards the outer fjord.
- **TRF-VB20** (Strindfjorden–Flakkfjorden, area 5): the geographically nearest available proxy for the Tauterryggen sill. Vertical profiles down to 189 m. Represents the water mass in the outer basin that is lifted up over the sill at high tide.

7.1 Oxygen in deep water (cf. Section 8 of the Nature Diversity Act)

The oxygen condition in the deep water has been measured at four stations covering the water masses around Skarnsundet and Tauterryggen, representing both inflowing and outflowing water masses at tidal changes (Multiconsult, 2026, Table 5-2):

- **TRF-VB5 (Skarnsundet south, 135 m):** minimum 4.6 mL/L (71.0% saturation). Condition class I ‘Very good’

- **TRF-VB3 (Beistadfjorden, 236 m):** minimum 4.3 mL/L (65.5% saturation). Condition class II ‘Good’
- **TRF-VB20 (Strindfjorden, 189 m):** minimum 4.7 mL/L (73.1% saturation). Condition class I ‘Very good’
- **TRF-VB18 (Ytterøya, 425 m):** minimum 4.3 mL/L (65.9% saturation). Condition class II ‘Good’

Condition class I requires DO > 4.5 mL/L for salinity > 18. All four stations show oxygen values well above the critical thresholds for cold-water corals (typically > 3 mL/L). Multiconsult's oxygen measurements therefore do not support hypoxia as the main explanation for the observed damage pattern in 2025, but the dataset does not necessarily cover a true winter-minimum period and therefore does not rule out seasonal variation or other stressors.

This is an important finding for the interpretation of the pattern of damage: Multiconsult's oxygen measurements do not support hypoxia as the main explanation for the observed damage pattern in 2025. This strengthens the mechanical interpretation as most consistent with the data (mechanism A in the framework, Slapgård, 2026), but does not rule out other stressors or seasonal variation. The absence of documented hypoxia in a single partial measurement series is not in itself proof that environmental stress does not contribute to the pattern of damage.

Reservation: *Multiconsult explicitly flags that ‘it is not certain that the dataset reveals the true minimum value’ (Multiconsult, 2026, Table 5-2). Under the Guidance for classification of environmental status in coastal and fresh waters, the classification of oxygen in bottom water shall be based on the minimum value in the period September–April/May – a period not covered in the 2025 dataset. Multiconsult therefore recommends year-round monitoring over a minimum of three years. The preliminary interpretation that oxygen does not appear as a contributing damage factor in Skarnsundet should be strengthened with winter data from later monitoring rounds.*

7.2 Temperature at coral depths

Skarnsundet (TRF-VB5, south of the sound itself) shows a stable temperature pattern in the depth strata where corals occur (Multiconsult, 2026, Section 5.5):

- **Pycnocline:** at around 10 m depth throughout the measurement period at the station, protecting deeper water layers from surface warming.
- **20–50 m layer** (where gorgonian corals such as *Paramuricea placomus*, *Paragorgia arborea* and *Primnoa resedaeformis* grow): 8–12 °C depending on season; 9–12 °C in late summer.
- **80–135 m layer** (where stony corals such as *D. pertusum* and *Madrepora oculata* grow): stable at around 8 °C throughout the year.

Reservation on the stability of the pycnocline in areas of strong current: TRF-VB5 lies south of the narrow sound, where current conditions are moderate. Both Skarnsundet and Tauterryggen are areas of strong current. NINA describes Skarnsundet as ‘very strong-flowing’ and documents ‘strong current’ in all four surveyed polygons on Tauterryggen. The current was also the reason NINA itself did not manage to cover the entire planned area on Tauterryggen in 2022 (Järnegren et al., 2024, pp. 11 and 25–26). Through field dives in both areas (2020–2025), Bare Dykk has

confirmed that the tidal current regularly affects dive operations and that the practical working window is limited to periods around slack water. Strong mechanical mixing, particularly at spring tides, could in theory weaken or locally collapse the pycnocline and produce a more homogeneous temperature profile in periods of strong current. Any differences between spring and neap periods are not quantitatively documented in the 2025 dataset. The pycnocline description above therefore strictly applies to the measurement station, not necessarily to the entire water column in the sound itself or over the moraine ridge. This is included as a knowledge gap (cf. Part 3, Section 6.1.5 on ADCP and local temperature sensors).

The measurements at 20–50 m depth show seasonally higher temperatures than in the deep water. The temperature response of *D. pertusum* and *Paramuricea placomus* varies between species, colonies, acclimatisation history and exposure time, and published optimum ranges differ (cf. Büscher et al., 2022). The data therefore provide a basis for assessing temperature as a possible contributing stressor in the shallowest occurrences, but not for establishing a local threshold for damage or physiological collapse. The pycnocline at 10 m protects against the direct effect of surface warming.

The SINTEF Munkholmen buoy recorded surface temperatures >20 °C in July 2025, significantly higher than the 16–18 °C of 2022–2024 and approx. 16 °C in 2001 (Multiconsult, 2026, Figure 6-3). This indicates a trend towards increasing surface temperatures that over time may push the pycnocline deeper and affect shallower coral colonies.

7.3 Turf algae and freshwater runoff – a relevant context factor (cf. Section 10 of the Nature Diversity Act)

Observation: In the summer of 2025, dense occurrences of turf algae (filamentous macroalgae) were reported in the mid-fjord, including in the eelgrass meadow off Levanger (Adresseavisen, Sept. 2025; Multiconsult, 2026, Section 6). ‘Lurv’ is a collective Norwegian term for annual, fast-growing filamentous macroalgae that respond quickly to changes in environmental conditions such as nutrient input and a lack of grazing by top predators (Rinde et al., 2024).

The mechanism documented by Multiconsult:

- **The spring flood (April–July):** establishes a 5–10 m thick layer of lower salinity at the top of the water column, with a pycnocline between 5 and 10 m depth (Multiconsult, 2026, Section 5.6).
- **End of June 2025:** a relatively prolonged period of precipitation → increased runoff from land → possible input of nutrients to the surface layer in limited areas. Multiconsult documents that the average concentration of nutrients in the surface layer of the main fjord was low during the summer period, but records an increase in the mid-fjord from June to July that may be connected to the period of precipitation (Multiconsult, 2026, Section 5.3). The report writes that it cannot be ruled out that there have been locally high concentrations in the areas where dense stands of turf algae were found. Elevated nitrite+nitrate values corresponding to moderate status (class III) were recorded only in Rissabotn and Hjellbotn (Multiconsult, 2026, Section 5.3, Table 5-1).

- **Reduced visibility and particle transport:** Multiconsult documents that the Secchi depth in the fjord is largely affected by freshwater runoff, and that visibility decreases in connection with the spring flood and periods of heavy precipitation (Multiconsult, 2026, Section 5.1). Several stations in the Trondheimsfjord are classified in condition class III ('Moderate visibility') for Secchi depth in 2025. Reduced visibility indicates an increased amount of particles in the water column, which can lead to increased sedimentation and particle load on filter-feeding organisms such as gorgonian corals.
- **July 2025:** an unusually dry and warm month → surface temperatures well above 20 °C along the shore in virtually the entire fjord. This is the documented anomalous factor in 2025.
- **Result:** Multiconsult assesses that a combination of high sea temperatures in July and local inputs of nutrients via runoff is the most likely cause of the dense turf-algae occurrences observed in the mid-fjord (Multiconsult, 2026, Section 6). The documented anomalous factor is the unusually high sea temperature; local nutrient input is a possible contributing effect that cannot be ruled out, but was not directly measured in the turf-algae areas concerned.

For Skarnsundet (TRF-VB5) specifically: The station south of Skarnsundet shows the same general pattern as the other mid-fjord stations. Surface salinity decreases from approx. 28 in March to 20–26 in April–July, before rising again in August–September. The pycnocline lies at 5–10 m depth throughout the measurement period, and below 40 m depth the salinity is stable at around 34 (Multiconsult, 2026, Section 5.6). The coral occurrences in Skarnsundet typically lie from 20 m and deeper, and the dominant species mostly stand in a depth interval where salinity is stable and within the tolerance range. Salinity in itself is therefore not assessed as a likely contributing damage factor, but is included as context in the overall water-mass assessment.

Climate perspective – secondary impact on the corals: Climate change is expected to bring more frequent episodes of extreme precipitation in Trøndelag (Trøndelag County Authority, 2023). The chain of reasoning is as follows: increased runoff from land → increased input of nutrients and particles into the surface layer → a greater basis for turf-algae blooms in the surface layer → more dead organic material sinking → increased sedimentation that over time may reach down to the shallowest coral colonies (approx. 20–40 m). The mechanism is gradual and cumulative rather than acute.

What this may mean for the gorgonian corals: It is the gorgonian corals (*Paragorgia arborea*, *Primnoa resedaeformis*, *Paramuricea placomus*) that stand shallowest in Skarnsundet (typically from approx. 20 m downwards) and that are therefore most exposed to secondary effects from surface processes. Turf algae are light-dependent, fine-filamentous/opportunistic macroalgae primarily tied to the euphotic part of the coastal zone (Rinde et al., 2024). There is no documentation that turf algae establish themselves directly on the coral structures at the relevant coral depths in Skarnsundet. The mechanism assessed as relevant here is therefore not direct turf-algae growth on the coral colonies, but the possible input of organic material and particles when algal biomass detaches, breaks down and is transported downwards in the water column. Cold-water corals are azooxanthellate; they lack photosynthetic symbionts and obtain their energy

mainly through filtering and capturing particulate organic material and zooplankton in the water column (Roberts et al., 2009). Increased sedimentation and particle transport can therefore act through physical mechanisms: smothering that impedes polyp function and filtration, increased microbial load on the coral surface, and general weakening of the colony. Experimental studies show that *Desmophyllum pertusum* (formerly *Lophelia pertusa*) can actively remove sediment from living tissue, but that sediment particularly accumulates on dead skeleton and that burial can damage the colony (Larsson and Purser, 2011), and that long-term exposure to suspended particles reduces skeletal growth (Larsson et al., 2013). Bilan et al. (2023) show a corresponding vulnerability to sedimentary disturbance in several cold-water coral species, including *D. pertusum* and *Madrepora oculata*. Coral structures at the same time act as habitat-forming biological structure for associated species (Buhl-Mortensen et al., 2010), so weakening of the colony has ripple effects beyond the individual. This has not been directly documented on the corals in Skarnsundet in 2025, but is a known mechanism from peer-reviewed literature. An important point for cumulative effects is that such weakened colonies become more vulnerable to mechanical contact from fishing gear, so that the same impact that would otherwise cause minor damage can cause breakage or detachment.

Interpretation: The turf-algae occurrence in the mid-fjord in 2025 is not documented as a direct damage factor on the corals in Skarnsundet. Nor have measurements of turf algae been made on the coral structures in Skarnsundet or Tauterryggen. The phenomenon is nevertheless assessed as relevant in a cumulative-effects assessment (an assessment of the total impact from several sources), because an increased amount of filamentous algae and organic material can affect light conditions, sedimentation and the bottom environment in the same areas where the corals stand, and because climate change will probably increase the frequency of such episodes.

Management assessment: Turf algae and freshwater runoff may be additional contributing factors, but should not be treated as alternatives to fisheries-related mechanical damage. The link to coral health in Skarnsundet should be followed up through further monitoring before firm conclusions are drawn about its significance. The finding is consistent with Slapgård's (2025) wolffish annex, which documents a link between kelp forest loss, increased sedimentation and weakened coral health, and strengthens the importance of a cumulative-effects assessment under Section 10 of the Nature Diversity Act.

7.4 Thermal stress and reduced resilience (cf. Section 10 of the Nature Diversity Act)

Observation: Multiconsult's 2025 measurements document that the summer half-year produced surface and intermediate-layer temperatures in the upper part of the tolerance range for the gorgonian corals. In the 20–50 m depth interval, where the gorgonian corals are concentrated, 8–12 °C was measured depending on season, with late-summer levels in the upper part of the range. The SINTEF Munkholmen buoy recorded surface temperatures >20 °C in July 2025, significantly higher than the 16–18 °C of 2022–2024 and approx. 16 °C in 2001 (Multiconsult, 2026, Figure 6-3).

The ‘lost buffer’ mechanism – simultaneous stress reduces resilience: Cold-water corals have a low growth rate and spend a significant part of their energy budget on basic functions such

as filtration, mucus production and polyp function. When colonies are exposed to simultaneous stressors – elevated temperature, algal coating/turf, sedimentation – the physiological energy demand increases. This leaves less energy for repairing mechanical damage and resisting further load. The mechanism is established in peer-reviewed literature for cold-water corals (Roberts et al., 2009; Buhl-Mortensen et al., 2010).

What this may mean for the 'significant damage' assessment under Section 10 of the Nature Diversity Act: A coral colony in physiological balance can in many cases repair minor mechanical damage and maintain colony function. The same damage inflicted on a colony that is already under stress (heat + algal coating + reduced food supply) will have a significantly higher probability of leading to colony death or lasting weakening. The threshold for what should be regarded as significant damage may therefore be lower in years with simultaneous environmental stress. The Multiconsult data indicate that 2025 had several such stress factors, particularly elevated temperatures in the surface and intermediate layers and documented turf-algae occurrences in the mid-fjord. This is a known mechanism from cold-water coral research, and is an independent argument that cumulative effects (Section 10 of the Nature Diversity Act) should be considered as a possible interacting effect, not merely as the sum of individual impacts. The final assessment of whether the pattern of damage is 'significant' in the sense of the law rests with the authorities; the report provides the technical basis.

Management assessment: The resilience perspective strengthens the basis for considering measures now, rather than at a later point. More frequent years with simultaneous thermal stress and turf-algae blooms, as climate projections suggest (Trøndelag County Authority, 2023), mean that the corals' tolerance for fisheries-related mechanical impact decreases over time. The precautionary principle (Section 9 of the Nature Diversity Act) implies that such knowledge should not be used as a justification for postponing measures.

7.5 Integrated assessment

Water-mass condition in Skarnsundet 2025 (TRF-VB5) – summary

Oxygen in deep water (135 m): minimum 4.6 mL/L (April 2025). Condition class I 'Very good', with the reservation that the winter minimum has not been measured.

Temperature 80–135 m: stable at approx. 8 °C throughout the year.

Temperature 20–50 m: 8–12 °C depending on season. The temperature response varies between species, colonies, acclimatisation history and exposure time. The measurements therefore do not establish local thresholds for stress or damage, and do not rule out sublethal effects.

Turf-algae phenomenon in the mid-fjord 2025 + extreme precipitation June 2025: a relevant context factor for a cumulative-effects assessment. The climate perspective (increased runoff → nutrients → turf algae → algal coating/sedimentation) can weaken the gorgonian corals at 20–40 m and make them more vulnerable to mechanical contact from fishing gear (cf. Section 10 of the Nature Diversity Act).

Multiconsult recommends year-round monitoring over three consecutive years to capture the winter minimum and seasonal variation.

Geographical reservations regarding the location of the measurement stations: Multiconsult has no measurement station in Skarnsundet itself or on Tauterryggen itself. The main references are therefore TRF-VB5 (south of Skarnsundet, mid-fjord) and TRF-VB18 (Ytterøya, mid-fjord). To reduce the uncertainty associated with this, supplementary stations have been brought in: TRF-VB3 in Beistadfjorden represents the water mass on the inner side of Skarnsundet, and TRF-VB20 in Strindfjorden represents the water mass in the outer basin just outside the Tauterryggen sill. This approach gives better coverage of the water masses that pass through the area at changing tidal currents. The general water-mass characteristics – oxygen condition, temperature stratification and salinity – are consistent across the four stations, and appear representative of the hydrographically connected fjord system. Local variations in the sound itself and on the moraine ridge itself may nevertheless occur, particularly in temperature during the summer months and in mixing conditions during periods of strong current; this should be investigated further, and is treated as a knowledge gap in Part 3 (Section 6.1.5).

What the water-mass data say, and do not say: Multiconsult's survey is a chemical and physical water-mass report designed to assess eutrophication status and oxygen conditions in accordance with the ‘Guidance for classification of environmental status in coastal and fresh waters’. The dataset is well suited to assessing whether oxygen conditions and general water-mass condition appear a likely main explanation for the pattern of damage. The data do not support this in 2025, but are not designed to document the corals' actual feeding conditions, sediment load or physiological stress level. Nor is the dataset designed to capture specific physical stresses on individual corals (mechanical contact, gear contact, particle load from point sources), or to document sublethal stress (e.g. via lysosomal membrane stability or other cell- or tissue-based indicators). These assessments must therefore be based on direct observations of damage (cf. NINA and Bare Dykk) and the framework's evidence levels.

What does this mean for the case?

Multiconsult's water-mass data (2025) do not support oxygen, temperature, freshwater runoff or other chemical-physical water-mass factors being a likely main explanation for the documented pattern of damage in Skarnsundet and on Tauterryggen. The oxygen condition at coral depths is classified as 'Very good' (Condition class I, cf. Section 7.1), and the temperature conditions lie within what the species are known to tolerate (cf. Sections 7.2 and 7.4).

This means that main explanations such as 'oxygen deficiency' or 'thermal stress' are not supported by the 2025 data. **Mechanical impact, primarily consistent with fishing gear, therefore remains the scientifically most likely main explanation for the observed pattern of damage, and is further strengthened by directly observed gear contact in several zones.** The reservation is that the water-mass data represent the current situation: they do not rule out historical stress episodes, seasonal variation or sublethal effects not captured by oxygen, temperature and nutrient monitoring (cf. Section 7.5 and the knowledge gaps in Part 3).

Consequence for management: measures directed at mechanical impact (knowledge- and guidance-based measures in Tier 1; any area-specific restrictions in Tier 2, cf. Part 3, Section 6) are the course of action that scientifically addresses the most likely main cause. Measures directed at water-mass quality alone will not address the pattern of damage as it appears in 2025.

8. Management assessments

Both *Knowledge Status Trondheimsfjord 2023* (Trøndelag County Authority, 2023) and Järnegren et al. (2024) point out that:

- The coral areas in Skarnsundet and Tauterryggen are already clearly affected.
- The current protection provides little protection against fisheries-related impact.

The Knowledge Status report summarises that impact from fishing is the greatest threat to coral reefs in Norwegian fjords, and that protection status without fisheries-related restrictions does not fully satisfy international requirements for marine protection (Trøndelag County Authority, 2023).

The assessment is in line with Sections 4, 5 and 8–10 of the Nature Diversity Act, in particular:

- **Section 4 of the Nature Diversity Act – Management objectives for habitat types and ecosystems:** The diversity of habitat types shall be safeguarded within their natural range and with the species diversity and ecological processes that characterise the habitat type. The coral occurrences in Skarnsundet and Tauterryggen constitute vulnerable habitat types for which this objective is particularly relevant.
- **Section 5 of the Nature Diversity Act – Management objectives for species:** The species and their genetic diversity shall be safeguarded in the long term. The documented coral species have a low growth rate and high vulnerability to physical impact, which makes this management objective pertinent.

- **Section 8 of the Nature Diversity Act – The knowledge base:** The documentation from NINA, Bare Dykk and Multiconsult's 2025 water-mass survey constitutes a broad and consistent knowledge base. Multiconsult's oxygen measurements in the deep water of Skarnsundet (Condition class I, cf. Section 7.1) do not support hypoxia as the main explanation for the pattern of damage and therefore strengthen the mechanical interpretation, but do not rule out other stressors or seasonal variation.
- **Section 9 of the Nature Diversity Act – The precautionary principle:** Uncertainty about the recovery time of slow-growing corals calls for a strict risk approach.
- **Section 10 of the Nature Diversity Act – Cumulative environmental effects:** The combination of damage from fishing gear, sedimentation, physical interventions and context factors such as the turf-algae bloom in the mid-fjord in 2025 (cf. Section 7.3) should be included in a cumulative-effects assessment.

9. Overall assessment (Part 1)

The total pattern of damage for Skarnsundet and Tauterryggen can be summarised as follows:

- **Directly observed gear impact** (evidence level 1 – direct visual documentation) is documented in several of the surveyed zones, primarily as fishing lines, gillnets and sinkers in physical contact with coral structures.
- **Consistent damage patterns** (evidence level 2, basic, probable but not fully confirmed) are recorded in all surveyed areas, in the form of crushed colonies, torn-off branches and toppled structures. The damage pattern is consistent with mechanical gear impact (mechanism A in the framework, mechanical damage from fishing gear), but supplementary data (O_2, current, sediment) are not available to classify the evidence as 'strengthened'.
- **User-reported snagging** (Sentio Research, 2026, n=809) supports the finding that mechanical contact between fishing gear and bottom structures is a widespread phenomenon: 75% of rod fishers experience snagging at least rarely, and 19% of respondents report bringing up gorgonian coral at least rarely. This constitutes an independent third source supporting the pattern of damage from the field observations.
- **Accumulated and overgrown gear** document long-lasting impact, although the exact time horizon cannot be established.
- **Large, vertically complex structures** – including a rare *Madrepora oculata* reef in the north-western part of Skarnsundet – show directly documented gear damage.

Overall assessment: *The observations are consistent with persistent and widespread impact from fishing gear. Alternative explanations for individual observations (e.g. natural breakage, historical events) cannot be fully ruled out, but the overall pattern – documented through observation (diving + ROV) and independently supported by user-reported snagging – supports an indicative conclusion of fisheries-related mechanical damage as the dominant impact.*

This assessment corresponds to evidence level 2 (basic) under the framework's classification system (Slapgård, 2026, Section 10.4). The triple-source documentation (observation + ROV + user reporting) strengthens the robustness and makes the assessment sufficient as a basis for

precautionary assessments under Section 9 of the Nature Diversity Act. The evidence level can be raised to level 2 (strengthened) by collecting supporting data (cf. Section 1.3), or to level 1 by systematic documentation of gear incidents.

10. Photographic documentation

This chapter contains a selection of representative photographs from Bare Dykk's survey dives illustrating coral types, habitat structure and observed gear impact in Skarnsundet and Tauterryggen. The photographs were taken in the period 2020–2025 and document the patterns described in Part 1 and Part 2.

All photographs are the intellectual property of Bare Dykk AS and may be used by the client (the County Governor of Trøndelag) in accordance with the agreement entered into on 31 October 2025. Any further distribution of photographs and/or publication beyond the scope of the assignment requires the consent of Bare Dykk AS. To protect vulnerable coral occurrences, exact position data are not given in the captions; depths and zone affiliation are stated where relevant.

10.1 Coral types and habitat structure

Photograph 1 – Dense *Primnoa* forest



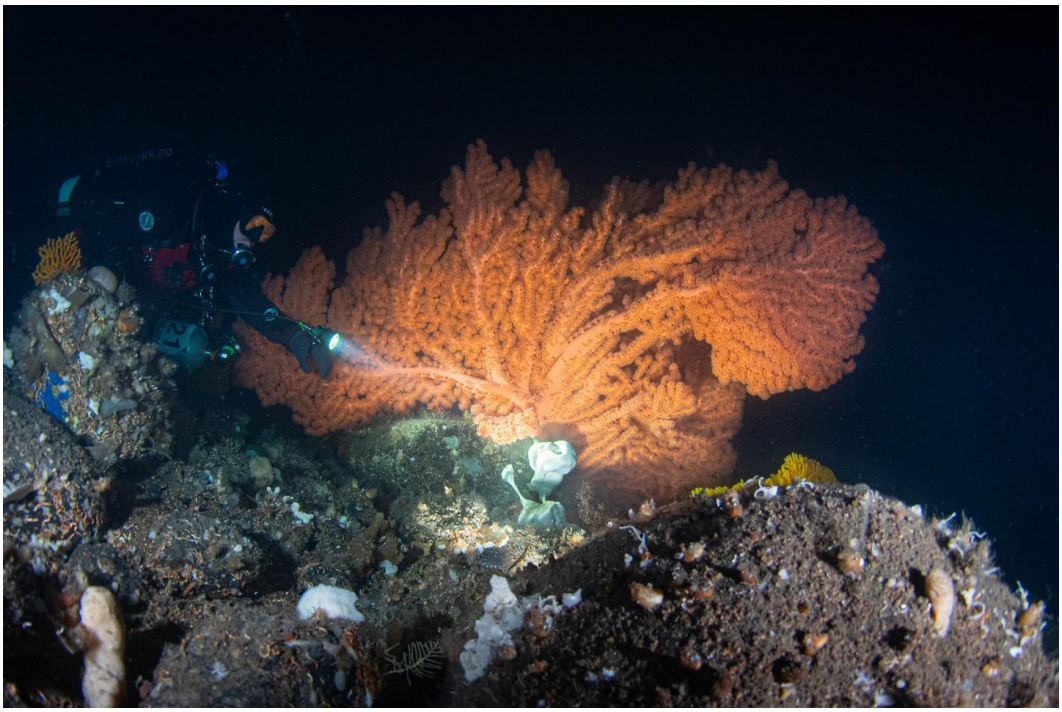
Caption: Dense hard-bottom coral forest dominated by *Primnoa resedaeformis*, Brufoten, the Inderøy side (S2). Dense *Primnoa* forest is typical of the most species-rich parts of Skarnsundet, where the colonies grow on rocky outcrops and sloping hard bottom with good current exposure. The photograph shows the high structural complexity that forms the habitat basis for a rich associated species community. Photo: Hans Dahle.

Photograph 2 – *Paramuricea placomus*



Caption: *Paramuricea placomus* at Verrastranda, the Trondheimsfjord. The site lies outside the Skarnsundet marine protected area (MPA), but documents the species' habitat preference within the same fjord system. The colonies are gorgonian corals and typically grow on strong-current rock strata, with a powerful filtering apparatus oriented into the current. The photograph is included as a reference for the species; corresponding habitats occur within Skarnsundet at the Inderøy side–Brufoten (S2) and Vangshylla (S3). Photo: Hans Dahle.

Photograph 3 – Large *Paragorgia arborea* at Hoøyskjeret



Caption: Exceptionally large *Paragorgia arborea* (red form), top at approx. 42 m depth, measured width approx. 3 m. The diver in the photograph provides a scale reference for the size of the individual. Documented by NINA in 2022 at approx. 40 m depth with a width of 2.6 m (Järnegren et al., 2024, SK411). Among the largest single individuals of *Paragorgia arborea* documented in shallow water in the Trondheimsfjord. The species is classified as 'Near Threatened' (NT) on the Norwegian Red List for species (Tandberg and Mortensen, 2021). Photo: Øystein Wisløff.

Photograph 4 – *Desmophyllum pertusum* occurrence



Caption: Coral occurrence in the Tauterryggen marine protected area, dominated by *Desmophyllum pertusum*. The colony covers approx. 10 m², with approx. 40% of the area now consisting of coral rubble, indicating earlier mechanical impact. The photograph also shows a Norway redfish (*Sebastes* sp.) and large calcareous sponges, documenting the naturally associated fauna in the habitat. The species is classified as 'Near Threatened' (NT) on the Norwegian Red List for species (Tandberg and Mortensen, 2021). Photo: Bare Dykk AS.

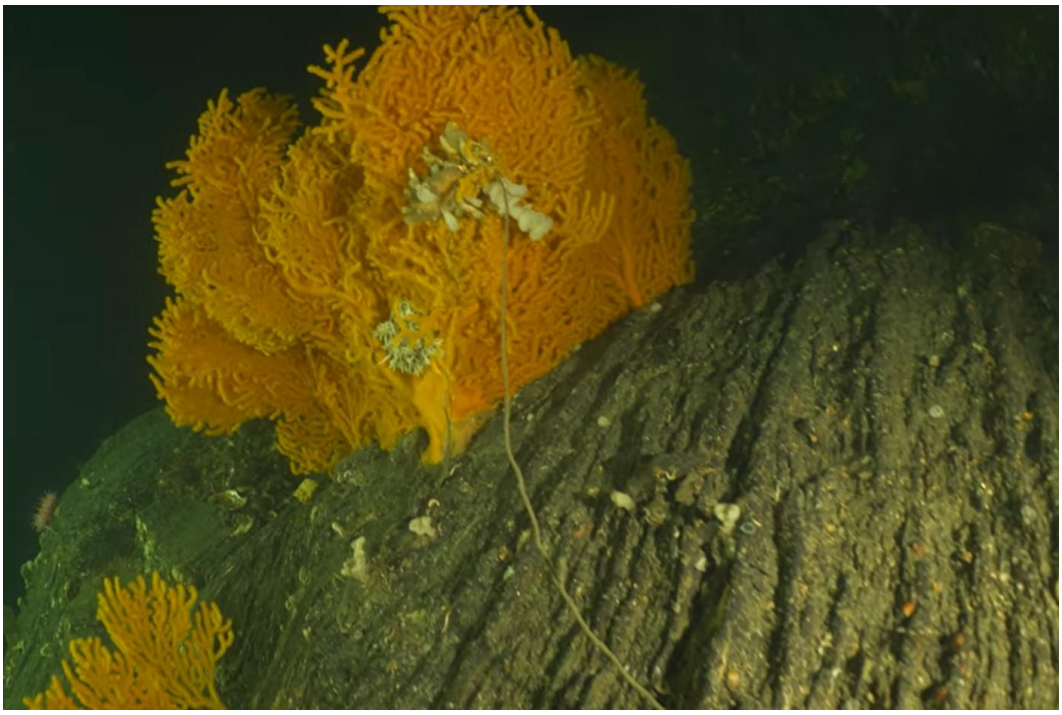
Photograph 5 – Dense occurrence of *Primnoa resedaeformis*



Caption: Dense occurrence of *Primnoa resedaeformis* at the upper edge of the reef, the Mosvik side–Brufoten (S1). The photograph shows the high structural complexity of the shallow coral forest in Skarnsundet. A thick tangle of several fishing lines is visible in the colony and illustrates that habitats with high structural complexity are particularly exposed to gear capture. The species is classified as 'Least Concern' (LC) on the Norwegian Red List for species (Tandberg and Mortensen, 2021), but the word 'vulnerable' is nevertheless used in the report's text in its general sense, for habitats or species that are physically sensitive to mechanical impact (cf. Section 2.5). Photo: Bare Dykk AS.

10.2 Gear impact and damage

Photograph 6 – Snagged fishing line



Caption: *Paramuricea placomus* with snagged fishing line in direct contact with living colony mass. Discolouration, local tissue loss and sponge growth at the contact point are consistent with mechanical abrasion over time and secondary impact. The observation documents direct gear contact. Photo: Bare Dykk AS.

Photograph 7 – Accumulated gear



Caption: *Primnoa resedaeformis* with several fishing lines crossing the colony. Several lines in the same colony indicate accumulated gear load and are consistent with repeated mechanical impact over time. Photo: Bare Dykk AS.

Photograph 8 – Torn-off/damaged coral colony



Caption: Damaged *Paramuricea placomus* colony at Brufoten, the Mosvik side (S1). The exposed, torn-off structure is consistent with mechanical impact. The damage is irreparable and permanent; the colony has no living tissue remaining. Photo: Bare Dykk AS.

Photograph 9 – *Primnoa resedaeformis* with line, parts torn off and dead structures



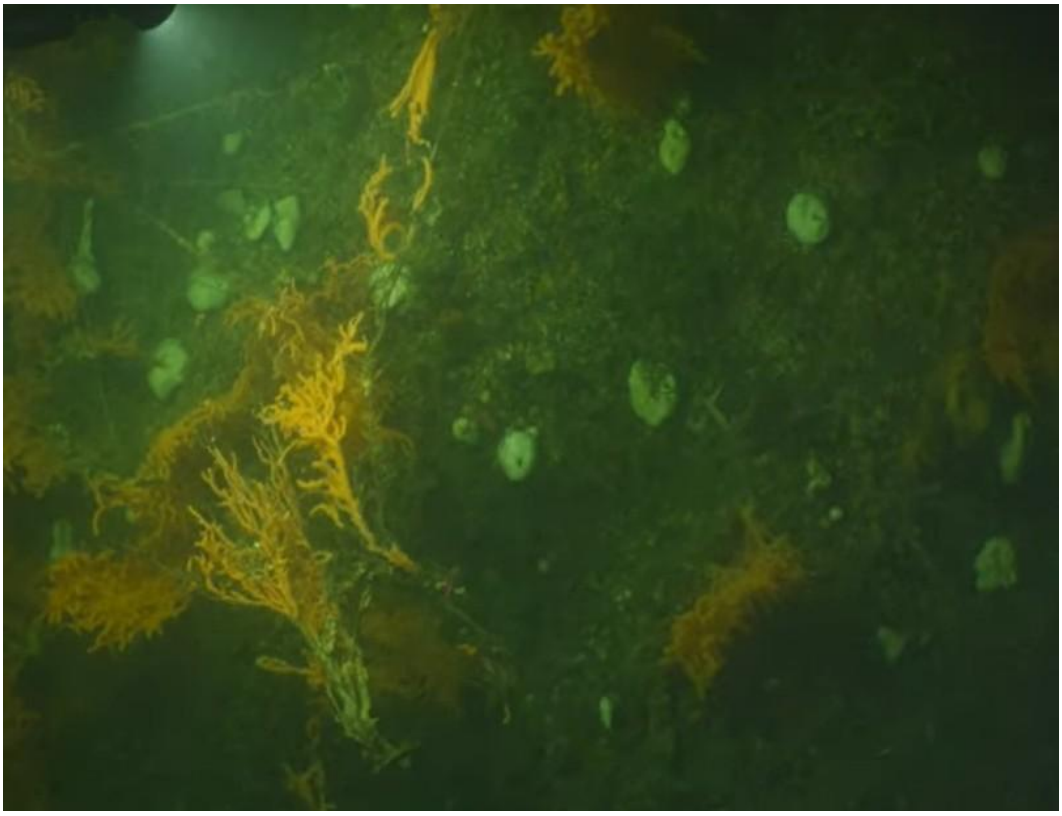
Caption: *Primnoa resedaeformis* with snagged fishing line. Parts of the colony appear torn off or without living tissue. The pattern of damage is consistent with mechanical gear contact and persistent abrasion from line in current. Photo: Bare Dykk AS.

Photograph 10 – *Paramuricea placomus* with several fishing lines and ecological context



Caption: *Paramuricea placomus* with several fishing lines lying over and through the colony. Several crossing lines are consistent with accumulated gear impact. This is a healthy colony with many relatively new lines. Photo: Bare Dykk AS.

Photograph 11 – *Primnoa resedaeformis* with fishing line through the central mass



Caption: *Primnoa resedaeformis* with snagged fishing line criss-crossing the central parts of the colony. The pattern of damage shows breaks and torn-off branches. Photo: Bare Dykk AS.

Photograph 12 – *Primnoa resedaeformis* with snagged line and a red marker element



Caption: *Primnoa resedaeformis* with snagged fishing line through the colony. A red marker element on the line makes the gear clearly visible. White sponge in the foreground shows associated fauna in the coral habitat. Photo: Bare Dykk AS.

Photograph 13 – *Primnoa resedaeformis* with damage to the branching system



Caption: *Primnoa resedaeformis* with snagged line and visible damage to the branching system. The photograph is part of a series showing corresponding gear impact on several occurrences. Photo: Bare Dykk AS.

Photograph 14 – *Primnoa resedaeformis* with exposed supporting axes after torn-off tissue



Caption: *Primnoa resedaeformis* with several snagged fishing lines through the colony and torn-off branches. White sponge in the foreground shows associated fauna in the coral habitat. Photo: Bare Dykk AS.

Summary assessment – Photographs 11–14: Photographs 11–14 show corresponding damage types on several independent *Primnoa* occurrences. The recurrence of the same pattern of damage strengthens the assessment that the gear impact is not merely isolated events, but part of a broader impact pattern in the area.

Photograph 15 – *Paramuricea placomus* with overgrown lines and secondary colonisation



Caption: *Paramuricea placomus* with several overgrown fishing lines and an area of visible secondary colonisation. Fouling on the fishing line indicates that the gear has been present for a longer period. Photo: Bare Dykk AS.

Photograph 16 – Torn-off *Paragorgia arborea* with regrowth from the base



Caption: *Paragorgia arborea* (bubblegum coral) at approx. 64 m depth in S3 Vangshylla, Subzone A. The colony is completely torn off from its original branching structure, but shows clear regrowth with new polyp formation from the base/root attachment. The damage type is consistent with mechanical tearing (cf. the framework for damage types, Slapgård 2026). In the same area, four further *Paragorgia* colonies have been observed (cf. Photograph 17). Photo: Heine Jensen.

Photograph 17 – Torn-off *Paragorgia arborea* with regrowth (parallel observation)



Caption: *Paragorgia arborea* (bubblegum coral) at approx. 64 m depth in S3 Vangshylla, Subzone A, the same area as Photograph 16. The colony is completely torn off, and clear new polyp growth and regeneration from the remaining base material is observed. Two independent tearing and regeneration events in the same depth zone support a chronic/historical impact rather than a single event. Photo: Heine Jensen.

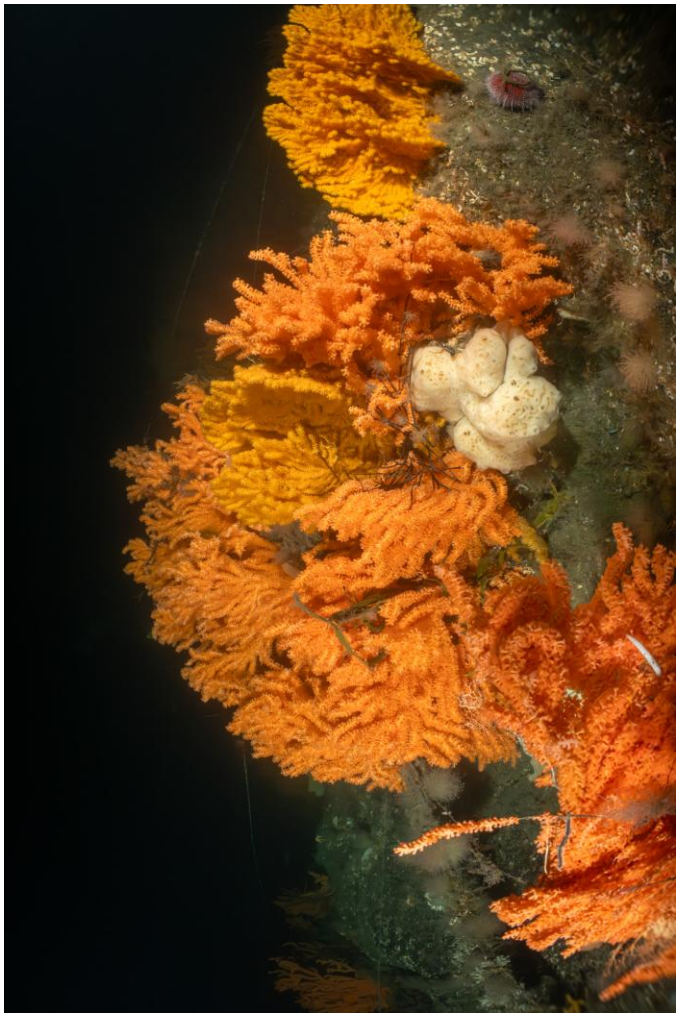
Photograph 18 – *Desmophyllum pertusum* fragmented into coral rubble



Caption: The stony coral (*Desmophyllum pertusum*, formerly *Lophelia pertusa*) at approx. 64 m depth in S3 Vangshylla, Sub-zone A. An estimated 70% of the colony is fragmented into coral rubble; intact living structure is limited to a small part of the branching system. The pattern of damage is consistent with mechanical crushing and subsequent fragmentation. The occurrence lies in the same delimited area as the torn-off *Paragorgia* colonies in Photographs 16–17, and supports the overall assessment that the area around 64 m in S3 Sub-zone A has been exposed to significant mechanical impact. Photo: Heine Jensen.

10.3 Habitat variation and context

Photograph 19 – *Primnoa resedaeformis* and *Paramuricea placomus* with fishing lines at various stages of overgrowth



Caption: *Primnoa resedaeformis* with *Paramuricea placomus* centrally in the image. Several fishing lines criss-cross the colony, and some of these are becoming heavily overgrown. Lines that become covered by fouling document that the impact has been ongoing over time. Photo: Bare Dykk AS.

10.4 Video documentation

The following video recordings from Bare Dykk's survey dives illustrate the pattern of damage and habitat conditions described in Part 1 and Part 2. The recordings supplement the photographic documentation in Sections 10.1–10.3.

- *Desmophyllum pertusum – Brufoten, the Inderøy side (S2), approx. 64 m.* A local colony the size of a basketball; approx. 30–40% of the structure is torn off or damaged. The damage pattern is consistent with heavy gear (sinker/jig). https://youtu.be/OgM7wbQT5P8 Film: Graeme Bruce

- *Primnoa resedaeformis – Brufoten, the Inderøy side (S2).* Heavily affected by fishing gear; several fishing lines lie within and over the coral colonies. Documents mechanism A (mechanical gear contact with abrasion/file effect). https://youtu.be/iPN3yt4GkeU
- *Paramuricea placomus – Vangshylla, Sub-zone A (S3).* Fishing line is entangled in several *Paramuricea* colonies. The pattern is not unusual in the zone and illustrates mechanism A (entanglement with abrasion/file effect) typical of *Paramuricea* occurrences in areas of strong current. https://youtu.be/3NlA8w5PoP0 Film: Veronica Roel

PART 2

Zonation

Detailed area description of Skarnsundet SOUTH and NORTH

The following chapter describes 14 surveyed zones in Skarnsundet, divided into a southern and a northern part. For each zone, the habitat type, species occurrences, depth distribution, topography, condition, fishing-gear impact and overall assessment are given. Where NINA has documented the same rock structure at greater depths, their findings are integrated to give a complete picture of the vertical distribution.

Note on delineation and uncertainty

The zones in Part 2 constitute minimum delineations based on observed distribution; several zones have coral occurrences that extend beyond what has been documented.

Depth layers between the dive transects (typically 20–70 m) and the ROV transects (typically 30–185 m) are partly unsurveyed.

Where relevant, it is stated explicitly which parts of a zone are not fully documented.

The status of the zonation – an important clarification

The zonation in Part 2 is an operational, management-oriented division based on observed patterns and technical assessments.

The zones do NOT represent a direct delineation of documented impact or of causation.

Each zone is defined geographically from Bare Dykk's survey transects and/or NINA's locality codes (SK codes), and serves to structure observations, value assessment and any measures.

The link to the ‘Preferably don't fish here’ map and NINA's polygons will be finally established in the QGIS project (cf. Part 3, Chapter 5).

Conservation value is a relative assessment, not an absolute value assessment. All sub-zones with documented occurrences of cold-water corals are considered vulnerable and important for management. The grading ‘moderate’, ‘high’ and ‘very high’ is based on relative density, species diversity, documented habitat complexity and observed impact, not on an absolute value assessment. No zone is characterised as ‘low value’. If fishing pressure or other human activity shifts between zones as a result of measures, ‘moderate’ zones must be actively monitored, because increased load may trigger a need for further measures (cf. Sections 9 and 10 of the Nature Diversity Act).

Red-Listed species documented in the majority of the zones: Of the 14 surveyed zones, 8 zones have documented occurrences of at least one Red-Listed coral species, classified on the Norwegian Red List for species (Tandberg and Mortensen, 2021): S1, S2, S3, S4, S5, N2, N3 and N4. Three zones (S1, S2 and S5) have documented occurrences of all three Red-Listed species – *Desmophyllum pertusum* (NT), *Paragorgia arborea* (NT) and *Madrepora oculata* (DD) – and thus constitute management core areas. A final overview of Red-Listed species per zone should be established in a QGIS compilation of map data. The management significance of these occurrences is discussed in Section 2.5 and in the assessment under Section 5 of the Nature Diversity Act in Part 3, Chapter 4.

Zone overview with map material

The following four map extracts provide a geographical orientation for the 14 surveyed zones in Skarnsundet before the detailed zone description. The maps have been produced in QGIS and show the location of the zones, their approximate delineation and their relationship to depth contours and known landmarks. The zone polygons are preliminary sketches; exact coordinates and polygon boundaries will be formalised in a separate QGIS project that compiles NINA polygons (SK codes), Bare Dykk zones and HIFH polygons (cf. Part 3, Section 6.1.1). The maps supplement, and do not replace, the detailed per-zone descriptions in the following chapters.

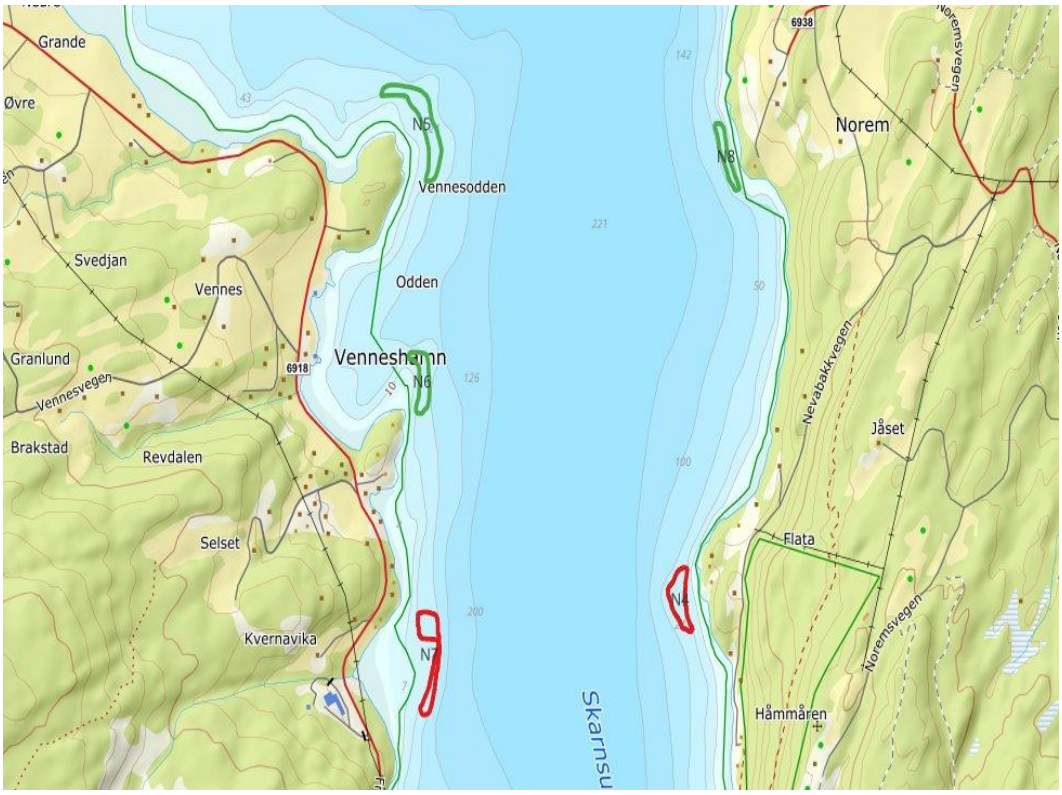
Colour coding in the maps: A red polygon marks zones included in Bare Dykk AS's 'Preferably don't fish here' map (HIFH; cf. Part 3, Chapter 7): S1, S2, S3, S4, S6, N2, N3, N4 and N7. A green polygon marks zones with documented coral occurrences not currently included in the HIFH map: S5, N1, N5, N6 and N8. A blue polygon marks a subsidiary sub-zone (Sub-zone B; cf. S3 Vangshylla). The colour coding reflects HIFH status, not directly the ecological value assessment per zone, which is shown in the Zone table (Part 3, Section 2.2).

Map 1 – Skarnsundet NORTH: the Hoøya area



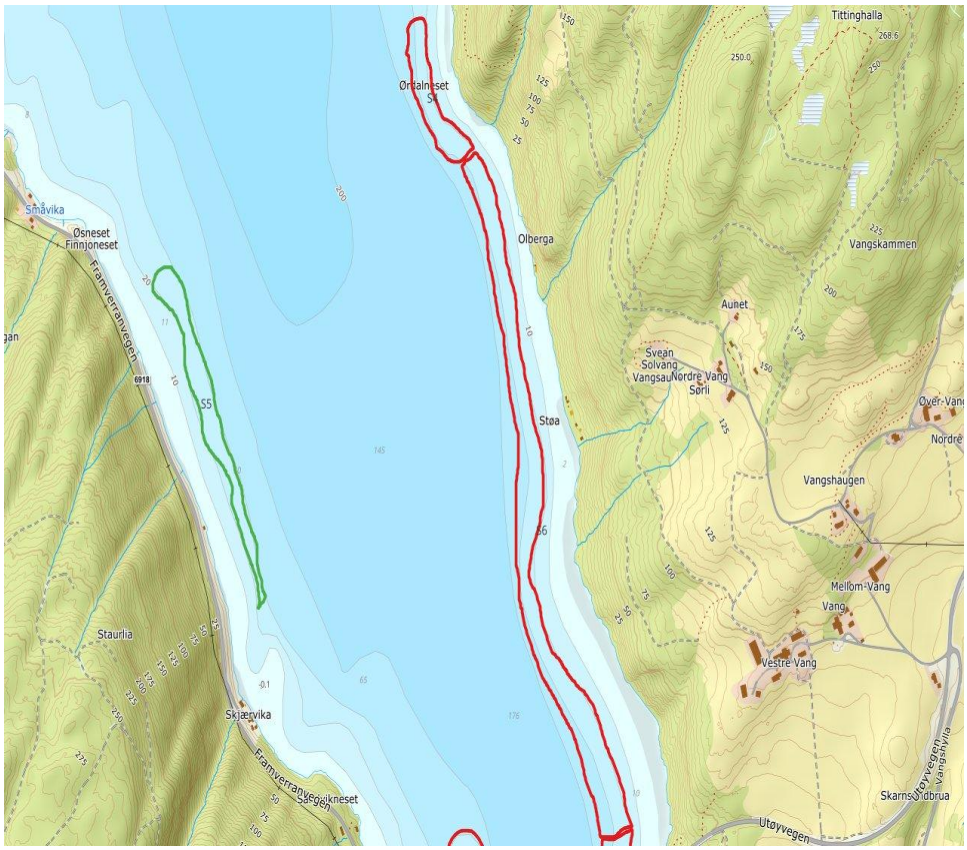
Map description: Skarnsundet NORTH – the Hoøya area. The zones are marked with polygons: N1 Hoøygrunnen (green, north of Hoøya), N2 Hoøyskjeret–the Grandørin ridge (red marking at 33 m south of Hoøya) and N3 Skallen (red, west of Hoøya). Depth contours in metres. Base map: QGIS extract based on the Norwegian Mapping Authority's nautical charts.

Map 2 – Skarnsundet NORTH: the Inderøy side (N4–N8)



Map description: Skarnsundet NORTH – the Inderøy side, with the zones N5 Vennesodden (green, the Finsvika area), N6 Bruraskjeret (green), N7 Kvennavika (red), N4 Noremsflata (red, larger polygon at Noremsflata/Flata) and N8 Norem (green, smaller polygon at Norem). The colour-coded polygons are preliminary sketches; the exact delineation remains to be formalised with GPS coordinates and reconciliation against NINA's SK polygons in the area.

Map 3 – Skarnsundet SOUTH: Ørdalsneset–Staurlia (S4, S5, S6)



Map description: Skarnsundet SOUTH, southern part, with the zones S4 Ørdalsneset (red, top of the eastern side), S5 Between Øsneset and Staurlia (green, western side) and S6 Between Ørdalsneset and Brufoten (red, along the eastern side from Ørdalsneset past Olberga and Støa). S6 and S4 appear as one continuous red polygon on the map; the actual boundary between the two zones must be formalised with GPS coordinates (cf. the knowledge-gaps table for S6).

Map 4 – Skarnsundet SOUTH: the Brufoten/Vangshylla area (S1, S2, S3)



Map description: Skarnsundet SOUTH, the Brufoten/Vangshylla area by the Skarnsund Bridge. S1 the Mosvik side, Brufoten (red) is shown as two polygons – one north and one south of the bridge. On the eastern side of the bridge, S2 the Inderøy side, Brufoten is marked as a red polygon at Kjellhammåren. S3 Vangshylla is shown as two polygons: the main sub-zone (Sub-zone A, red) at Vangshylla and a smaller sub-zone (Sub-zone B, blue) at Storskjæret.

Skarnsundet SOUTH

Six zones have been surveyed on the southern side of Skarnsundet: the Mosvik side–Brufoten, the Inderøy side–Brufoten, Vangshylla, Ørdalsneset, Øsneset–Staurlia and Between Ørdalsneset and Brufoten (the Inderøy side).

About the structure of the zone descriptions

Each zone is structured in three technical levels in line with the methodological requirements for verifiability (cf. Section 8 of the Nature Diversity Act):

Observation: What has actually been seen/measured, with time, place and observer (typically under ‘Condition and depth distribution’, ‘Species occurrences’, ‘Topography’ and ‘Fishing-gear impact’).

Interpretation: What the observations probably mean, and why (typically under ‘Summary’).

Assessment: Management consequence and recommendation (typically under ‘Delineation and uncertainty’ and in Part 3).

The zones conclude with a structured block stating knowledge gaps, uncertainty level (low/medium/high) and measures to strengthen the evidence base.

Criteria for the ‘Very high value’ assessment

About the structure of the zone descriptions

Each zone is structured in three technical levels in line with the methodological requirements for verifiability (cf. Section 8 of the Nature Diversity Act):

Observation: What has actually been seen/measured, with time, place and observer (typically under 'Condition and depth distribution', 'Species occurrences', 'Topography' and 'Fishing-gear impact').

Interpretation: What the observations probably mean, and why (typically under 'Summary').

Assessment: Management consequence and recommendation (typically under 'Delineation and uncertainty' and in Part 3).

The zones conclude with a structured block stating knowledge gaps, uncertainty level (low/medium/high) and measures to strengthen the evidence base.

When a zone is assessed as 'Very high value', this is based on an overall technical assessment of the following criteria:

Species richness: The number of coral species and the overall biodiversity at the site.

Habitat-forming corals: The presence of species that create habitats for other species (particularly *Desmophyllum pertusum*, *Paragorgia arborea*, *Primnoa resedaeformis*).

Vertical distribution: How large a part of the water column is colonised (typically from 20–30 m and deeper).

Documented occurrence of vulnerable coral types: Stony corals (reef-forming), particularly shallow occurrences, or individuals of unusual size.

The assessment is qualitative, but is justified for each zone based on Bare Dykk's observations and NINA Report 2229 (Järnegren et al., 2024). The classification is not linked to a formal condition classification under the Guidance for classification of environmental status in coastal and fresh waters, but is used as an operational value assessment for zone prioritisation.

South zone 1

S1: The Mosvik side – Brufoten

SK402 • **Very high value**

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902), in the shallower parts we have surveyed (20–60 m). NINA's surveys west of the bridge foundation document that deeper parts of the same rock structure also qualify as Hard-bottom coral forest (NT) and contain areas of Stony corals (I0901) down to approx. 175 m. This makes the Mosvik side–Brufoten one of the most vertically complex and biologically rich coral areas in the whole of Skarnsundet.

Condition and depth distribution

Bare Dykk (20–60 m)

- Very many fishing lines on rocky outcrops and into the corals throughout the area.
- Several torn-off coral sections, particularly where lines have accumulated.
- The habitats start at around 34 m, with the densest concentrations from 40 m and deeper.
- The area has been surveyed from 20 to 60 m; the coral occurrences continue deeper.
- 30–60 m: dense hard-bottom coral forest of *Paramuricea* and *Primnoa* from approx. 38 m.

NINA (30–155 m, west of the bridge foundation)

- 30–65 m: dense hard-bottom coral forest of *Paramuricea* and *Primnoa*.
- 70–130 m: dominated by anemones (*Urticina eques*), with elements of *Primnoa*, *Paramuricea*, *Paragorgia* and *Desmophyllum*.
- 130–140 m: dense occurrences of *Paragorgia arborea* (NT).
- 140–175 m: large colonies of *D. pertusum* (NT), *Madrepora oculata* (DD) and larger quantities of dead stony-coral fragments.

Both Bare Dykk and NINA document finds of wire, concrete remnants and objects from the construction of the bridge from approx. 34 m depth.

Species occurrences

Primnoa resedaeformis

- Three large main sections with particularly dense occurrence.
- A continuous carpet over rocky outcrops, in crevices and up along walls.
- Strongly affected by fishing gear, lying both around and inside the colonies.
- *Paragorgia arborea* stands in the upper part of one of the belts, nearest the bridge foot.

This agrees with NINA's documentation of dense *Primnoa* forests from 30–65 m.

Paragorgia arborea **(bubblegum coral; red form)**

- **36 m – approx. 1 m in diameter:** Among the shallowest documented occurrences of the species known from the available literature. Found by Ella Smevik-Slapgård. Standing on a rock wall with a stand of *Primnoa* and *Paramuricea*. Large amounts of fishing gear in the area, but the *Paragorgia* colony is not entangled.
- **51 m – large individual:** Standing in the lower part of the coral belt, near areas of line accumulation.

NINA documents dense communities of *Paragorgia* from 130–140 m, as well as scattered individuals in the 70–130 m layer. This suggests that the Mosvik side has an unusually shallow occurrence of *Paragorgia*, in addition to the deep ones, which increases the conservation value.

Paramuricea placomus

- *Paramuricea* occurs between and above the *Primnoa* belts, particularly densely near the bridge foot.
- The occurrences continue several hundred metres southwards, but are more dominant between 30 and 60 m around the bridge foot.

NINA documents that *Paramuricea* also dominates the 30–65 m layer on the western side in the area around the bridge foot.

Topography

The area has very varied terrain with outcrops, steep rock sections, deep crevices and sloping walls. This topography means that fishing gear snags very easily, and creates pockets where large line knots can accumulate and remain.

Fishing-gear impact

Bare Dykk

- Very much fishing line in all parts of the area.
- Many large clusters of fishing line lie directly in the corals.
- Clear signs that parts of the reefs have been torn off, probably by line or grapnel.
- One of the most exposed and damaged coral fields in the whole of Skarnsundet.

NINA

- The site is assessed as ‘strongly affected by fishing’.
- Numerous lines are stuck in the corals.
- The greatest amount of gear in the upper approx. 65 m.
- Large stony corals and *Paragorgia* colonies lie torn loose at approx. 175 m.

The findings broadly agree with NINA's assessments.

Summary

The Mosvik side–Brufoten appears as one of the most species-rich and most vulnerable coral areas in Skarnsundet, and one of the most exposed to fishing-gear damage. The combination of:

- very dense *Primnoa* and *Paramuricea* forest
- an unusually shallow occurrence of *Paragorgia arborea*
- extensive gear impact
- varied and exposed topography
- continuous coral occurrence from approx. 34 m to deeper than 150 m

… provides the basis for assessing the site as a high priority for further follow-up through systematic monitoring and targeted measures.

Delineation and uncertainty

The area has been surveyed by Bare Dykk down to 60 m and by NINA down to approx. 175 m, but the vertical distribution probably continues deeper than 175 m. The intermediate depth layer (approx. 60–70 m) is only partially documented.

Knowledge gaps and uncertainty, S1 the Mosvik side, Brufoten	
Knowledge gaps	Temporal resolution of when individual gear has affected corals; distribution of sinker weights in ongoing fishing; vertical distribution below 60 m in Bare Dykk's data; physiological stress assessment without quantitative supporting parameters (O_2, sediment).
Uncertainty level	**Low** (L) – A large amount of direct observations over five years (2020–2025), agreement with NINA's independent survey (SK402), high gear density documented from two sources.
Measures to strengthen the evidence base	Systematic gear counting and removal, establishment of fixed photo points for a time series, supplementary ROV survey in the 60–100 m interval, coupled environmental data.

South zone 2

S2: The Inderøy side – Brufoten

SK401 • **Very high value**

The most species-rich shallow coral area in Skarnsundet.

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902), in the shallower parts (30–70 m), and qualifies as Hard-bottom coral forest (NT) on the Red List (2018). In deeper strata (80–155+ m), corals occur in the designation Stony corals (I0901), documented by Järnegren et al. (2024).

Condition and impact

Both dive data and NINA's surveys show that the area is:

- very species-rich, with a large vertical distribution of corals (30–155+ m)
- heavily affected by fishing gear across large parts of the site
- exposed to line setting because of steep walls, overhangs and a complex current pattern

Bare Dykk observes fishing lines lying crossed over the rock, hanging down from overhangs, woven into the corals, and in large clumps in pockets and outcrops. Several areas contain older, overgrown lines, indicating that the impact is long-lasting. This agrees with NINA's assessment of the site as ‘strongly affected by fishing’, with both lines and gillnet remnants present.

For divers, the area constitutes a hazard section, as lines hang down from, over and behind the corals and are often difficult to see.

Depth conditions and surveyed area

Bare Dykk (20–70 m)

- Gorgonian-coral forest (*Paramuricea* + *Primnoa*) from 24 m and further below 65 m
- *Paragorgia arborea* in the upper and middle strata (42–61 m)
- *Desmophyllum* at approx. 64 m

NINA (30–155+ m)

- Dense coral forest dominated by gorgonian corals (*Primnoa* and *Paramuricea*) from 30–50 m
- *Paragorgia* dominance 90–110 m
- Large *Desmophyllum* colonies from 80–155+ m
- Dead and living stony corals observed down to 160 m

This shows that the area is a vertically composite coral system, where Bare Dykk covers the upper half, while NINA's data document the lower, deep part of the same rock structure.

Species occurrences

Paramuricea placomus

- Bare Dykk (24–40 m): dense and continuous gorgonian-coral forest across the whole active rock flank.
- A fully covered plateau (~40–50 m²) around 40 m.
- Limited distribution further south owing to sand/gravel bottom.
- NINA (30–50 m): *Paramuricea* dominates together with *Primnoa* in the upper coral forest.

Primnoa resedaeformis

- Bare Dykk (38–70 m): a continuous carpet of *Primnoa* from 38 m and downwards.
- Particularly dense occurrences in the overhangs (45–65 m).
- NINA (30–50 m): *Primnoa* dominates the upper gorgonian-coral forest together with *Paramuricea*.

Paragorgia arborea (bubblegum coral; red form)

- Bare Dykk: a small individual at 42 m (sheltered in the rock wall).
- A large individual (approx. 2 m in diameter) at 61 m.
- A third individual – position remains to be verified.
- NINA (90–110 m): dense and large *Paragorgia* populations. The area is classified as *Paragorgia* forest at this depth.

Overall assessment: This is one of very few places in the Trondheimsfjord with a clear vertical gradient belt of *Paragorgia*, from shallow to deep sections.

Zigzag coral (*Madrepora oculata*)

- Bare Dykk (60 m): scattered colonies in the transition to deep walls.
- NINA (south of the area): large, continuous structures of orange *Madrepora* in adjacent deep sections (80–120 m).

D. pertusum (stony coral)

- Bare Dykk (64 m): approx. basketball-sized colony – 30–40% torn off or damaged (heavy gear).
- NINA (80–155 m): large colonies of *Desmophyllum* dominate the walls, with *Paragorgia*, *Primnoa* and *Paramuricea* as elements. Both living and dead colonies observed on the bottom below the wall (approx. 160 m).

This indicates that the *Desmophyllum* system Bare Dykk has documented is probably part of the same overarching colony structure.

Topography

Bare Dykk

- A marked S-curve in the rock.
- Several overhangs between 50–70 m.
- A deep crevice system beyond 65 m.
- Terrain forms that effectively catch fishing line.

NINA

- A continuous steep rock wall from 30 to 155 m.
- Overhangs with rich occurrences of gorgonian-coral forest and stony corals.
- Large dead *Desmophyllum* blocks at 160 m.

This shows a continuous, deep rock wall with very high biological potential.

Fishing-gear impact

Bare Dykk

- Large amounts of line at all levels.
- Lines hanging down in overhangs.
- Old and new damage and overgrown line.

NINA

- ‘Strongly affected by fishing’.
- Many lines fastened in the corals.
- Gillnet remnants that ghost-fish.
- Most gear in the upper 60 m.

Both sources show very high vulnerability and a high degree of impact.

Summary

Zone 2 at Brufoten/the Inderøy side appears as one of the most species-rich and most vulnerable coral areas in Skarnsundet, and one of the most exposed to fishing-gear damage, and at the same time as Skarnsundet's vertically most complex coral area, with a continuous ecosystem from approx. 24 m to more than 150 m depth. The area contains:

- dense gorgonian-coral forest (*Paramuricea* + *Primnoa*)
- several *Paragorgia* colonies (red form) at various depths
- both small and large *Desmophyllum* colonies
- scattered *Madrepora*
- very varied fauna (saithe, rabbitfish, sponge, basket stars, sea urchins)

At the same time, the site is one of the most line-affected in the whole fjord, with a significant risk of further damage. On the basis of documented species richness, vertical distribution from 24 to more than 150 m, extensive gear impact and high vulnerability, the site is assessed as a high priority for further follow-up. Relevant follow-up points are targeted information to users,

systematic monitoring and consideration of area-specific measures if voluntary measures do not have sufficient effect.

Delineation and uncertainty

One of the documented *Paragorgia* individuals has a position that remains to be verified. The full extent of the *Desmophyllum* system below 155 m has not been surveyed. The intermediate stratum around 70–80 m is only partially documented.

Knowledge gaps and uncertainty, S2 the Inderøy side, Brufoten	
Knowledge gaps	The position of one *Paragorgia* individual remains to be verified; the full extent of the *Desmophyllum* system below 155 m has not been surveyed; the 70–80 m intermediate stratum is partially documented; the hypothesis of fishing in the water column (cf. the fact box below) requires quantitative confirmation.
Uncertainty level	**Low** (L) – Documented from two independent sources (Bare Dykk + NINA SK401). Vertical distribution from approx. 24 m to more than 155 m documented. *Paragorgia arborea*, *Paramuricea placomus*, *Primnoa resedaeformis*, *Desmophyllum pertusum* and *Madrepora oculata* all recorded in the area.
Measures to strengthen the evidence base	Verification of the *Paragorgia* position by follow-up dive; ROV supplement in the 70–155 m interval; AIS or Directorate of Fisheries data to test the hypothesis of fishing in the water column; fixed photo points for a time series.

Hypothesis: damage mechanism around the Brufoten zones (S1 and S2)

The pattern of damage around the bridge foot (the Mosvik side and the Inderøy side) is assessed as mainly driven by fishing in the water column (i.e. fishing for species that mainly stay above the bottom, such as saithe and cod/haddock).

The mechanism is that heavy jigging sinkers are dropped towards the bottom before being drawn up again; the sinker strikes the bottom and crushes or tears off corals in the process.

This differs from the assumed damage pattern in the northern zones (N2, N3), which is assessed as more driven by targeted bottom fishing for species such as wolffish, tusk and ling.

The hypothesis is elaborated in Part 1, Section 6 and has consequences for which types of measures are relevant for each zone category.

South zone 3

S3: Vangshylla

Two sub-zones

Sub-zone A – Continuous field of *Paramuricea placomus*

Three main sections of *Paramuricea placomus* (yellow form). Starting at approx. 28 m, with increasing density down towards 45+ m. Between the sections there are small gaps, but the overall impression is a nearly continuous coral belt.

Condition

- The *Paramuricea* colonies appear healthy; several colonies are large and well developed.
- Impact from fishing gear is present, but so far limited.

Impact

- Fishing lines are regularly picked up in the area, which shows persistent impact and a risk of increasing damage if the fishing pressure continues.

Note

- The corals become larger, denser and more impressive the closer one moves towards the bridge foot.

New observations (2026) – Paragorgia arborea and Desmophyllum pertusum at approx. 64 m

- Six *Paragorgia arborea* colonies documented at approx. 64 m depth in Sub-zone A. Four of these appear healthy, while two are torn off at the root (cf. Photographs 16 and 17 in Section 10.2). In the same area and at the same depth level, the stony coral (*D. pertusum*) has also been documented (cf. Photograph 18 in Section 10.2). The area below 50 m is only partially surveyed; the findings indicate that further undiscovered corals may be present at deeper levels, and that the torn-off colonies corroborate gear exposure in the deeper parts of the zone as well.

Topography and current

- The coral plate in Sub-zone A lies as a sloping rock slab of solid rock and gravel, with markedly stronger current towards Brufoten during the tidal periods.
- Strong-current sections expose corals to increased sediment and particle transport; some colonies show signs of sediment impact (cf. Part 1, Section 6.2).

Sub-zone B – *Paramuricea placomus* with significant damage in the deepest part of the wall

Occurrences of *Paramuricea placomus* (yellow form) from approx. 28 m down to around 50 m.

Below 50 m

- The area appears as an almost completely degraded structure.

- Only scattered colonies in poor condition.

Structure

- Three main sections running like a ‘tie’ down the rock wall.
- Each stripe is approx. 15–20 m wide.

Condition

- Varies between moderate and poor (previously referred to as grade 2–3).

Impact

- Snagged fishing lines are concentrated in Sub-zone A; in Sub-zone B significantly fewer lines are observed, and little boat activity is recorded in the area over the year. Nevertheless, several colonies below 50 m in Sub-zone B are significantly damaged. The degree of fouling and the wear on the damage surfaces suggest that the events lie several years back in time, probably historical gear impact that cannot be dated precisely with the current data.

Observation of possible dive-related damage

Observation: In Sub-zone B, delimited damage to coral tips has been recorded at typical recreational-diving depths. The damage pattern differs from typical gear damage: no torn-off branches, line contact or sinker marks in direct association.

Diagnostic characteristics

- Damage located on coral tips, primarily on the upper side of the coral (facing open water).
- Round, delimited areas of exposed skeleton without mechanical traces of fishing equipment.
- Coincidence between the depth interval (< 40 m) and the area's most frequented dive zone.

Interpretation: The damage pattern is consistent with mechanical contact from divers (fin strokes, loss of buoyancy, contact during photography). Evidence level 2 (basic), probable but not confirmed (Slapgård, 2026); alternative explanations such as disease or predation cannot be ruled out without supplementary data.

Management assessment: The location, damage type and depth interval provide the basis for assessing dive-related damage as a relevant impact factor in Sub-zone B. Preventive measures directed at divers will in any case have an effect on coral damage at divable depths.

Measures

Bare Dykk AS has drawn up diving code-of-conduct rules for the area (Bare Dykk AS, 2026b):

- A ban on touching, bottom contact and attaching equipment to corals.
- Requirements for good buoyancy control and streamlined equipment.
- Particular attention during photo and video diving.

- A pre-dive briefing is particularly recommended for first-time dives, guided dives and in current-swept areas.

The pre-dive briefing is internationally established as one of the most effective single measures for reducing diver-caused damage in vulnerable coral areas.

Knowledge gaps and uncertainty – S3 Vangshylla	
Knowledge gaps	A lack of quantitative supporting data for dive-related damage (traffic counts, temporal analysis); alternative explanations for round, delimited damage (disease, predation) not fully ruled out; the cause of the significant damage below 50 m in Sub-zone B has not been unambiguously determined and may reflect historical gear impact that cannot be dated precisely; the area below 50 m in Sub-zone A is only partially documented by individual transects, and the discovery of *Paragorgia* at 60 m indicates that deeper levels probably contain further undiscovered corals.
Uncertainty level	**Medium** (M) – Three sub-zones systematically documented by Bare Dykk; condition varies from good (Sub-zone A) to significantly damaged (Sub-zone B below 50 m). Dive-related damage in Sub-zone B is consistent with mechanism A (mechanical contact, possibly dive-related), but is not quantitatively validated.
Measures to strengthen the evidence base	Traffic counts of dive visits; experimental verification of the damage mechanism; fixed photo points to follow the development in Sub-zone B; comparison with similar sites without diver traffic; systematic deep survey of Sub-zone A between 50–80 m to determine the extent of *Paragorgia* and other coral occurrences.

South zone 4

S4: Ørdalsneset

SK408 (40–110 m) and SK406 (120–140 m) • **Very high value**

A large, complex coral area with high ecological value.

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902), and parts of the site qualify as Hard-bottom coral forest (NT) on the 2018 Red List for habitat types. In deeper strata (approx. 97–110 m), Stony corals (I0901) also occur. The zone coincides geographically with two of NINA's polygons: SK408 (40–110 m, approx. 11 daa) covering the shallower and middle part, and SK406 (120–140 m, approx. 18 daa) covering the deeper belt with dense *Paragorgia* forest. Both polygons qualify as Hard-bottom coral forest (NT) (Järnegren et al., 2024, p. 31).

Species occurrences and depth

Bare Dykk (30–70 m)

The area has a massive coral forest:

- *Paramuricea placomus* – from approx. 30–45 m. Dense stands on hard bottom and in sloping terrain, particularly in the shallower zones.
- *Primnoa resedaeformis* – from approx. 40 m and downwards. A broad and continuous belt extends over approx. 100 m, forming one of the most extensive coral carpets in Skarnsundet.
- *Paragorgia arborea* (bubblegum coral; white form) – a large individual at 51 m, estimated at 2–3 m in diameter. Among the largest individuals recorded in the shallower water layers in Skarnsundet.
- *D. pertusum* – a smaller but distinct reef at approx. 65 m, just below the *Paragorgia* colony.

NINA (40–110 m) – SK408

- *Primnoa*-dominated gorgonian-coral forest from 45–86 m
- *Paramuricea* in the shallower strata (40–50 m)
- *Paragorgia arborea* in the deeper zones (97–110 m)
- Relatively large *Desmophyllum* colonies between 97–110 m
- Sponge fauna: *Geodia*, *Phakellia ventilabrum* and others.
- Anemones (*Urticina eques*)
- Fish: rabbitfish, saithe, blackmouth catsharks

Bare Dykk's observations cover the upper part of the same rock structure, and show that the coral forest is both larger and more complexly composed than previously documented.

NINA (120–140 m) – SK406

- Dense *Paragorgia* forest dominated by *Paragorgia arborea* (NT) with several large colonies of 1–2 m height in dense concentrations.
- Elements of *Primnoa resedaeformis*, *Paramuricea placomus* and *D. pertusum* (NT); much sponge (*Geodia* sp., *Phakellia ventilabrum*) and anemones (*Urticina eques*).

SK406 is not specifically described as 'affected by fishing' by NINA (Järnegren et al., 2024, p. 31); the fishing-gear impact in S4 is primarily documented in SK408 and in Bare Dykk's transects at 30–70 m.

Topography

The area consists of marked S-shaped walls, several crevices and overhangs, steep cliffs and deep channels, as well as rocky outcrops that create pockets, rock ledges and projections. This provides very good conditions for filter-feeding coral species, high structural complexity and many points where line can snag. This agrees well with NINA's descriptions of the same site.

Condition

- The corals appear large, healthy and at very high density in the surveyed strata (30–70 m).
- NINA documents both living and dead stony corals in deeper strata, indicating long-lasting impact.
- *Desmophyllum* reef at 65 m is intact, but vulnerable because of its proximity to fishing gear already observed in the area, and the potential input of new fishing gear if fishing activity continues.

Fishing-gear impact

Bare Dykk (30–70 m)

- Much fishing gear in the large *Primnoa* forest.
- Line is easily caught in crevices and projections.
- The terrain predisposes to accumulation in several natural 'pockets'.

NINA (40–110 m)

- Many fishing lines are stuck in corals.
- Several corals hang in lines without attachment.
- Ghost nets observed.
- The site is assessed as 'affected by fishing' by NINA.

The overall picture is that the area's steep structure and strong current make it highly exposed to further gear loss and continued damage to the corals.

Summary

The area constitutes a highly complex coral ecosystem with:

- dense gorgonian-coral forest
- large and small *Paragorgia* colonies
- *Desmophyllum* in both shallower and deeper strata
- significant topographic complexity
- high species richness throughout the water column from approx. 30–110 m

Together this gives very high ecological value, but also high vulnerability as a result of significant gear impact and demanding current conditions.

Knowledge gaps and uncertainty – S4 Ørdalsneset	
Knowledge gaps	Vertical distribution below 140 m has not been surveyed (NINA covers to 140 m via SK406); the temporal resolution of gear loss is unknown; the exact extent of the *Desmophyllum* occurrences towards the deep has not been delineated; the transition depth between SK408 (40–110 m) and SK406 (120–140 m) is not separately documented.
Uncertainty level	**Low** (L) – Confirmed by both Bare Dykk and NINA (SK408 'affected by fishing'). Depth interval 30–140 m systematically documented (Bare Dykk 30–70 m, NINA via SK408 and SK406). Ghost nets directly observed.
Measures to strengthen the evidence base	ROV supplement below 110 m; systematic removal of ghost nets with before/after documentation; fixed photo points; linkage to AIS or Directorate of Fisheries data for local fishing intensity.

South zone 5

S5: Between Øsneset and Staurlia (the western side of Skarnsundet)

SK404 • **High value**

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902), in the shallower strata surveyed (35–45 m). NINA's deeper surveys (SK404) show that the site also qualifies as Hard-bottom coral forest (NT) and contains areas of Stony coral (I0901) in deeper zones (85–185 m). This makes the area a vertically composite coral habitat with very high ecological value.

Species occurrences and depth

Bare Dykk (35–45+ m)

- Three larger coral reefs starting at around 35 m and continuing to at least 45 m, probably deeper.
- Each reef has a width of approx. 10 m.
- The reefs follow the rock wall as parallel belts downwards.
- The corals show good growth, varied size and moderate density.

The species observed in this stratum are primarily:

- *Primnoa resedaeformis*
- *Paramuricea placomus*

The occurrences are stable, but limited to the hard rock sections.

NINA (55–185 m) – same site, deeper strata

- 55–80 m: dominated by *Primnoa resedaeformis* and *Paramuricea placomus*.
- 85–185 m: dominated by *Paragorgia arborea* (bubblegum coral; red form) – NT. Elements of *Primnoa* and *Paramuricea*.
- Up to approx. 130 m: scattered colonies of *D. pertusum* and *Madrepora oculata*.
- At approx. 175 m (the foot of the wall): both living and dead colonies of *D. pertusum*.

NINA's deeper surveys (Järnegren et al., 2024) document that the area surveyed by Bare Dykk in shallower water constitutes the upper part of an extensive coral ecosystem extending continuously from approx. 35 to 185 m depth.

Topography

The terrain surveyed by Bare Dykk consists of marked crevices, S-shaped rock walls, hard sloping faces and ledges, as well as fracture structures and outcrops. These formations create pockets and projections where corals attach, but also areas where fishing gear easily snags. NINA's

deeper surveys show that the wall continues steeply downwards to more than 180 m depth, with several overhangs and vertical drops.

Condition

Bare Dykk (35–45 m)

- The corals appear healthy and vital.
- The reefs are stable, but not very dense.
- No clear damage observed.

NINA (55–185 m)

- Large *Paragorgia* colonies and *Desmophyllum* indicate long-term stability.
- Some dead coral material at 175 m.
- The site probably has a greater extent than documented.

Fishing-gear impact

Bare Dykk

- Some fishing gear recorded, mainly line.
- The reefs appear largely little affected at present.
- The terrain has several natural ‘catch points’ that can accumulate line if fishing pressure increases.

NINA

- Fishing lines are stuck in corals in deep sections.
- Indication of moderate impact throughout the depth column.
- High vulnerability to further gear damage.

Summary

The area between Øsneset and Staurlia represents a continuous coral ecosystem extending from 35 m to more than 180 m depth.

Bare Dykk's findings

- Three stable shallow-water reefs in the 35–45 m stratum
- Good growth and healthy corals
- Moderate to low impact from gear in the shallow sections

NINA's findings

- Dense *Primnoa–Paramuricea* forest 55–80 m
- *Paragorgia*-dominated forest 85–185 m
- *Desmophyllum* and *Madrepora* in deep zones
- Rich fauna and high biological value

This is an area recommended for ongoing monitoring, particularly if fishing shifts as a result of increased compliance with the ‘Preferably don't fish here’ zones.

Delineation and uncertainty

NINA explicitly notes that the area probably has a greater extent than documented. The three shallow-water reefs surveyed by Bare Dykk probably continue deeper than 45 m, but the transition between 45 m (dive data) and 55 m (NINA data) is not documented.

Knowledge gaps and uncertainty – S5 Between Øsneset and Staurlia	
Knowledge gaps	Missing documentation of the 45–55 m depth interval (the Bare Dykk / NINA transition); NINA notes a greater extent than documented; the effect of any shift in fishing due to measures in other zones is unresolved.
Uncertainty level	**Medium** (M) – Confirmed vertical distribution 35–185 m from two sources. At present moderate-to-low impact from gear, but high vulnerability to increase. The 45–55 m depth interval is not documented.
Measures to strengthen the evidence base	Completion of the 45–55 m interval by ROV or diving; baseline survey of gear density before any shift; fixed photo points to capture change in impact over time.

South zone 6

S6: Between Ørdalsneset and Brufoten (the Inderøy side)

Includes NINA's SK403 (50–150 m, the eastern side at Brufoten) • **High value**

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902). The dominance of *Paramuricea placomus* with elements of *Primnoa resedaeformis* is consistent with Hard-bottom coral forest. The zone coincides geographically with NINA's polygon SK403 (50–150 m, the eastern side of Skarnsundet at Brufoten, approx. 11 daa), which qualifies as Hard-bottom coral forest (NT) and documents Red-Listed species in deeper layers: *Paragorgia arborea* (NT), *Desmophyllum pertusum* (formerly *Lophelia pertusa*, NT) and the white gorgonian *Swiftia pallida* (VU) (Järnegren et al., 2024, pp. 30–31).

Species occurrences and depth

Bare Dykk (30–60 m in the hotspot at Brufoten; 30–50 m in the other parts of the zone)

- *Paramuricea placomus* – the dominant species in the zone.
- *Primnoa resedaeformis* – several sections in the zone.
- The distribution within the zone is heterogeneous: in places dense coral occurrence, in places sections without corals.

Topography

Varied rock formations with steep walls and elements of sand bottom. Approx. 200 m north of Brufoten there is a particularly steep wall that slopes inwards (an overhang structure), surveyed by Bare Dykk from approx. 40 m down to approx. 60 m. Here *Primnoa resedaeformis* occurs as a continuous belt along the wall – described by Bare Dykk as a *Primnoa* forest standing like ‘a tie on the rock’ when approaching the site from shallow depths. The heterogeneous substrate type gives variation in the colonisation pattern: dense coral sections alternate with areas without corals along the stretch.

Condition

The condition in S6 is heterogeneous, with a clear centre of gravity for damage approx. 200 m north of Brufoten. In this sub-area, where *Primnoa resedaeformis* forms a continuous forest along a steep wall that slopes inwards, Bare Dykk has dived from approx. 40 m down to approx. 60 m and documented the most extensive pattern of damage observed in the entire survey area. The pattern of damage comprises a large number of damaged colonies, a high density of snagged fishing lines across the whole area, and a large number of torn-off colonies and coral branches. The pattern is consistent with persistent and significant mechanical impact from fishing gear as the primary mechanism. The area is so heavily affected that Bare Dykk AS, out of consideration for visitors, does not use it for guided dives. In the more northern parts of S6 (towards Ørdalsneset), Bare Dykk's transects are limited to approx. 30–50 m; here the corals appear in

better general condition, but with documented individual damage (torn-off branches) consistent with fishing-gear impact. NINA documents that deeper layers in SK403 (50–150 m) contain well-developed coral occurrences with Red-Listed species, but also characterises the polygon as 'affected by fishing', with fishing lines stuck in the corals (Järnegren et al., 2024, pp. 30–31).

Fishing-gear impact

The impact is very different between the hotspot area at Brufoten and the rest of the zone. In the hotspot area approx. 200 m north of Brufoten, very strong fishing-gear impact is observed, with a high density of snagged fishing lines and a large number of torn-off colonies and coral branches. In the other parts of S6, northwards towards Ørdalsneset, moderate damage is observed with torn-off branches on individual colonies, consistent with fishing-gear impact as the primary mechanism. Two gillnets were retrieved from the area approx. four years ago (around 2022) through Bare Dykk's clean-up activity. NINA's ROV observations confirm that fishing-gear impact also affects deeper layers in SK403 (50–150 m): fishing lines are stuck in the corals, and 'corals hanging in the lines without attachment' are documented – a sign of persistent load over time (Järnegren et al., 2024, p. 30). Overall, S6 is assessed as very heavily affected, driven primarily by the extent in the hotspot area, with documented gear exposure in the deeper layers as well.

Summary

S6 is a heterogeneous site with a dominance of *Paramuricea placomus* and significant occurrences of *Primnoa resedaeformis*, particularly as a continuous forest along a steep wall approx. 200 m north of Brufoten. This sub-area represents the most extensive pattern of damage documented in the entire survey area (Skarnsundet and Tauterryggen combined), with a high density of snagged fishing lines and torn-off colonies. Here Bare Dykk has gone down to approx. 60 m to document the pattern of damage; the rest of the zone is surveyed at 30–50 m. The zone is therefore assessed as a management core area with the highest priority. Two older gillnets have been salvaged in the area (approx. 2022); it is not known whether these originate from active gillnet fishing or from earlier use, but the find confirms historical gear exposure in the zone. NINA additionally documents Red-Listed species in deeper layers within the zone – *D. pertusum*, *Paragorgia arborea* (both NT) and the white gorgonian *Swiftia pallida* (VU) – and fishing-gear impact in SK403 as well. This extends the zone's overall ecological value to cover the entire depth gradient from divable wall (30–60 m in the hotspot) to deeper layers (50–150 m), and underlines the need to protect the structure as a whole.

Knowledge gaps and uncertainty – S6 Between Ørdalsneset and Brufoten	
Knowledge gaps	Bare Dykk has surveyed 30–60 m in the hotspot area at Brufoten and 30–50 m in the other parts of S6; depths below 60 m (respectively 50 m) are not documented directly. NINA's SK403 (50–150 m) extends deeper and overlaps with Bare Dykk's hotspot depth in the 50–60 m interval, but the habitat quality in the transition depth (50–60 m) is not separately compiled between the two datasets. Quantification of gear density and damage extent is so far qualitative. The exact geographical boundary towards S2 (south) and S4 (north) should be formalised with GPS coordinates.

Knowledge gaps and uncertainty – S6 Between Ørdalsneset and Brufoten	
Uncertainty level	**Medium** (M) – Preliminary assessment. Bare Dykk's transects cover 30–60 m in the hotspot area at Brufoten and 30–50 m consistently in the other parts of the zone; deeper depths are not documented directly. Final values for the uncertainty matrix in Part 3 follow.
Measures to strengthen the evidence base	Completion of 50–110+ m by ROV; formalisation of zone boundaries with GPS coordinates; quantitative gear recording; fixed photo points at known damage colonies for development follow-up; coordination with NINA on the boundary towards SK403.

Skarnsundet NORTH

Eight zones have been surveyed on the northern side of Skarnsundet: Hoøygrunnen, Hoøyskjeret–Grandørin, Skallen (the sill area), Noremsflata, Vennesodden, Bruraskjeret, Kvennavika and Norem.

North zone 1

N1: The northern side of Hoøygrunnen (Hoøya)

Moderate value

Species occurrences and depth

Several sections of *Paramuricea placomus* from approx. 30–40 m, with medium-sized colonies following the rocky outcrops before the terrain gives way to sand.

Topography

Gently sloping sand bottom with rocky outcrops of varying size. The corals stand on the solid rock sections around the area.

Condition

The colonies appear healthy and well established.

Fishing-gear impact

Little gear observed in the area.

Summary

A smaller but stable coral area with little impact.

Previously assumed record occurrence – now clarified as *Filograna implexa*

From older observations (discussed in secondary literature), Hoøya in Skarnsundet was described as one of the shallowest known occurrences of *D. pertusum* at 37 m depth. NINA's re-survey in 2022 (Järnegren et al., 2024, p. 33; figures 14, 15 and 16) tested this by examining the exact locality given in the earlier secondary literature. No trace of *D. pertusum* was found, only small fragments of what NINA assumes to be *Filograna implexa* – a calcareous tubeworm that forms white calcareous tubes in colonies and can easily be confused with *D. pertusum* in brief passing video footage. NINA concludes that the original identification was probably erroneous, and that Selligrunnen at Tauterryggen (39 m) is still regarded as among the shallowest documented *D. pertusum* occurrences known from the available literature (Järnegren et al., 2024).

The finding illustrates the importance of systematic verification of individual video-based observations, and is a good example of how knowledge develops through re-examination (cf. Section 8 of the Nature Diversity Act on the knowledge base).

Knowledge gaps and uncertainty – N1 Hoøygrunnen	
Knowledge gaps	Missing NINA data for comparison; vertical distribution below divable depth has not been surveyed; condition over time is not documented by a time series.
Uncertainty level	**Medium** (M) – Bare Dykk's own dive-based observations; the area has a limited extent and appears stable. NINA data from deeper strata are not available for this site.
Measures to strengthen the evidence base	Supplementary ROV survey deeper than 50 m; establishment of fixed photo points; linkage to Mareano data where relevant.

North zone 2

N2: Hoøyskjeret – the Grandørin ridge (south-west of Hoøya)

NINA SK411 • **Very high value**

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902). Several sections qualify as Hard-bottom coral forest (NT) on the 2018 Red List for habitat types.

Depth and delineation

- Documented coral occurrences from approx. 40–160 m depth (NINA).
- Local dive observations from 30–60 m, with particularly high density below approx. 55 m.
- The area covers about 34 daa.

Species occurrences

Primnoa resedaeformis

- The dominant species in deeper sections.
- Occurs densely on steep rock walls and under overhangs.

Paragorgia arborea (bubblegum coral; red form) – large individual at Hoøyskjeret

During the fieldwork in 2022, NINA documented an exceptionally large bubblegum coral in the area, described as *'one bubblegum coral at approx. 40 m depth measuring 2.6 m in width'* (Järnegren et al., 2024, SK411). This is the same individual that Bare Dykk has recorded in later dive observations. The top of the colony lies at approx. 42 m depth, and the width has been measured at approx. 3 m, with possible variation depending on which branches and which angle the measurement is taken from.

- The individual stands in a small crevice on the rock ridge, clearly visible as a depression on the nautical chart.
- Surrounded by smaller colonies of *Primnoa resedaeformis* and *Paramuricea placomus*.
- Among the largest single individuals of *Paragorgia arborea* documented in shallow water in the Trondheimsfjord.

NINA additionally documents several other individuals in the area, with heights up to approx. 1.5 m.

Paramuricea placomus

- Occurs in the shallower belt from approx. 40–60 m.
- Some individuals also around the *Paragorgia* colony.

D. pertusum (stony coral)

- A smaller reef observed at approx. 60 m, mainly under overhangs.

- NINA documents several occurrences in deeper zones, particularly under the overhangs.

Topography

- The area consists of a steep rock wall with several overhangs, crevices and projections.
- The main outcrop lies at approx. 35–40 m depth, with a clear depression where the *Paragorgia* colony stands.
- The terrain slopes steeply towards the south-west, down into deeper sections with *Primnoa* and *Desmophyllum* colonies.

Condition

- The *Paragorgia* colony appears in very good condition.
- The corals in the surrounding areas show both healthy colonies and some damage to *Desmophyllum*, probably from contact with gear.
- The area has high ecological value as a result of great species richness and the combination of several coral types.

Impact from fishing gear and activity

- NINA documents fishing lines snagged in corals in the area.
- In dive observations from the shallower parts (30–60 m) there was little fishing gear right at the *Paragorgia* colony, but several lines in adjacent sections.
- The eastern part of the area is popular among divers; NINA documented, among other things, a lost diving cylinder.

Summary

The area is one of the most species-rich and structurally complex coral areas in Skarnsundet. The combination of large *Paragorgia* colonies, dense *Primnoa*, *Desmophyllum*, gorgonians and rich sponge fauna makes the area a priority natural environment.

The large *Paragorgia* colony at approx. 42 m depth is, in our assessment, one of the most impressive single individuals recorded in the whole fjord.

Knowledge gaps and uncertainty, N2 Hoøyskjeret, the Grandørin ridge	
Knowledge gaps	The depth interval below divable depth has been ROV-surveyed by NINA, but fine-scale details of the gorgonian-coral-forest condition between the dive and ROV data are only partially linked; sinker-contact intensity (central to Hypothesis B) has not been quantified.
Uncertainty level	**Low** (L) – Confirmed by two independent sources (Bare Dykk + NINA SK411). The large *Paragorgia* colony identified by both at 40–42 m depth with approx. 2.6–3 m width – time-series documentation over two years.
Measures to strengthen the evidence base	Close linkage between dive and ROV data at synchronised times; targeted documentation of sinker-contact damage; fixed photo points for the *Paragorgia* individual.

North zone 3

N3: Skallen north-east – the sill area at 48 m

Transition towards NINA SK412 • **Very high value (based on NINA data)**

Habitat type

- Coral occurrence (I09) → Stony corals (I0901).
- The area lies in the transition to the large coral reef SK412, documented by NINA south-west of this position (Järnegren et al., 2024). The zone is presented here mainly on the basis of NINA's survey, supplemented by limited observations from Bare Dykk on the sill top itself.

Depth and delineation

NINA SK412 (Järnegren et al., 2024)

- Continuous reef structure approx. 650 × 400 m, south-west of the sill.
- NINA's survey stopped just south of the sill; the area around the 48-metre contour was therefore not investigated.

Bare Dykk observation

- Limited survey down to approx. 55 m, only on the sill top itself (‘Skallen’). The area below 55 m, and the areas outside the sill top itself, have not been surveyed by Bare Dykk.

Species occurrences

Bare Dykk observation (the sill top, down to 55 m)

- A small *D. pertusum* colony on the sill top, roughly the size of a pickup-truck bed.

NINA documentation (SK412, Järnegren et al., 2024)

- Large, continuous reef structures of *Madrepora oculata* in the southern part of SK412.
- Other species described in NINA's report (not shown in detail here – see Järnegren et al., 2024).

Possible connection with SK412 – working hypothesis

- The small colony on the sill top may constitute a north-eastern extension of the SK412 main site. The hypothesis is not verified. An unambiguous link presupposes systematic survey of the sill between Bare Dykk's observation point on the sill top and NINA's south-western position.

Condition and fishing-gear impact

NINA's description of SK412 (Järnegren et al., 2024)

- Strongly affected by fishing: many fishing lines stuck in the corals, visibly crushed coral in several places, sinkers on the bottom and a larger gillnet approx. 200 m south of the coral reef.
- Parts of the reef described as dead or in apparently poor condition.

Bare Dykk observation (the sill top)

- So far, no detailed observations of gear impact on the sill top itself can be documented with sufficient certainty to be presented here.

Delineation and uncertainty

- Bare Dykk's own observations are limited to the sill top (Skallen) down to approx. 55 m. Occurrences, condition and impact below 55 m, and outside the sill top itself, are only documented through NINA's survey of SK412.
- The hypothesis of a connection between the sill colony and SK412 is not verified.
- A compilation of NINA's polygons and Bare Dykk's GPS data in QGIS is a prioritised follow-up (cf. Part 3, Section 4.2).

Knowledge gaps and uncertainty, N3 Skallen north-east, the sill area	
Knowledge gaps	Bare Dykk's observations are limited to the sill top (Skallen) down to 55 m; the geographical transition/connection to SK412 is not verified; the area below 55 m and outside the sill top has not been surveyed by Bare Dykk.
Uncertainty level	**Medium** (M) – Bare Dykk's dive-based observations document coral occurrences north-east of NINA's surveyed SK412 area. The sill colony at 48 m is documented through Bare Dykk's observations, but the exact extent and connection to SK412 is not verified.
Measures to strengthen the evidence base	Prioritised ROV survey of the north-eastern side of the sill; QGIS compilation of NINA polygons and Bare Dykk observations; verification of the connection between the sill colony and SK412.

N4: At Noremsflata

SK405 • **High value (overall)**

Habitat type

The area falls within the habitat type Coral occurrence (I09), designation Gorgonian corals (I0902), in the shallower parts surveyed (approx. 30–40 m). Deeper parts of the same rock formation form part of NINA locality SK405, described with an extent of 55–185 m (Järnegren et al., 2024). NINA's survey line in SK405 covered 100–120 m and documented *Paragorgia arborea* (red form), *Primnoa resedaeformis* and *Desmophyllum*. NINA notes that the site probably has a greater extent than recorded so far.

Species occurrences and depth

Bare Dykk (30–40 m)

- Scattered colonies of *Paramuricea placomus* from approx. 30 m.
- The colonies vary in size and stand with large distances between the individuals.
- The occurrence is sparse and fragmented, with single individuals on solid rock sections.

NINA – survey line 100–120 m (SK405, extent 55–185 m)

- *Paragorgia arborea* (bubblegum coral) – dominant, both large and small individuals
- *Primnoa resedaeformis* – scattered colonies
- *D. pertusum* – several colonies
- Sponge fauna: *Geodia* sp., *Phakellia ventilabrum* and others.

NINA notes that the site probably has a greater extent than recorded so far, and that the species occurrences between 55–100 m and between 120–185 m are not fully documented.

Topography

The terrain surveyed by Bare Dykk consists of a mixture of sand bottom, small rock sections and rock faces, where the gorgonian corals stand on hard substrates that give good attachment. Deeper parts of the same rock wall (the SK405 site, extent 55–185 m) give way to a steep, current-exposed wall with overhangs, where the larger coral species dominate according to NINA's documentation in the 100–120 m transect. This shows that the site has a clear vertical gradient with different species communities at different depths.

Condition

Bare Dykk

- Scattered *Paramuricea* colonies appear healthy, but have a limited extent.

NINA

- Large *Paragorgia* colonies and *Desmophyllum* observations document a mature, deeper coral habitat, although not the whole area has been surveyed.

Fishing-gear impact

Bare Dykk (30–40 m)

- No impact from fishing gear recorded in the shallower parts of the area.

NINA (survey line 100–120 m)

- Several corals hang in fishing lines or have lost their attachment.
- Indications of impact from fishing activity, particularly in deeper sections.

Overall assessment: The shallower parts surveyed by Bare Dykk appear little affected, while the deep part of the same rock structure is moderately affected, mainly by longline fishing.

Summary

In shallower water, the area at Noremsflata appears as a small and scattered coral area, dominated by isolated gorgonian corals with no signs of impact from gear.

Deeper parts of the same rock wall are documented by NINA as a far more complex and species-rich coral habitat with *Paragorgia arborea*, *Primnoa resedaeformis* and *Desmophyllum*.

Overall, this indicates that the site has greater ecological significance than the shallow observations alone show, and that the area forms part of a vertically continuous coral ecosystem.

Delineation and uncertainty

NINA explicitly notes that the site probably has a greater extent than recorded so far. NINA's actual survey line in SK405 covered 100–120 m, while the site in total extends from 55 to 185 m. The species occurrences in the 55–100 m and 120–185 m strata are therefore not fully documented. The transition between the surveyed shallow sections (30–40 m) and NINA's deeper data (from 100 m) is also not documented.

Knowledge gaps and uncertainty – N4 At Noremsflata	
Knowledge gaps	The 55–100 m and 120–185 m strata are not fully documented; the transition area between 40 and 100 m is missing; NINA notes that the total extent is probably greater than documented.
Uncertainty level	**Medium** (M) – Confirmed by two sources (Bare Dykk shallow strata 30–40 m, NINA SK405 deeper strata 100–120 m). The vertical connection is established, but not fully surveyed.
Measures to strengthen the evidence base	ROV survey of the 55–100 m and 120–185 m strata; fixed photo points for both shallow and deep sections; compilation of Bare Dykk and NINA data in QGIS.

North zone 5

N5: Vennesodden

Moderate value

Species occurrences and depth

Several small colonies of *Paramuricea placomus* occur from approx. 30–40 m. The colonies stand scattered and vary from small to medium-sized. Down towards 45 m, no further corals were found.

Topography

The lower side of the lighthouse area consists of rocky outcrops broken up by sand flats and small cliffs. The corals stand mainly on hard sections towards the north-east and in towards Finsvika.

Condition

The corals appear healthy, but the occurrence is small and fragmented.

Fishing-gear impact

No clear impact from fishing gear observed.

Summary

A small and scattered coral area that is not large in itself, but relatively significant in shallow water in the Trondheimsfjord.

Knowledge gaps and uncertainty – N5 Vennesodden	
Knowledge gaps	Missing NINA or Mareano data for comparison; condition over time not documented; vertical distribution below 45 m not surveyed; the degree of fragmentation and ecological connectivity to larger occurrences is unresolved.
Uncertainty level	**Medium** (M) – Bare Dykk's dive-based observations. The occurrence is small and fragmented; without direct comparison against NINA data.
Measures to strengthen the evidence base	Time-series documentation at fixed photo points; ROV supplement below 45 m; comparison with Mareano data if available.

North zone 6

N6: Bruraskjeret

Moderate value

Species occurrences and depth

Colonies of gorgonian coral occur from approx. 20–35 m, concentrated on the eastern part of the rock ridge. The colonies are small to medium-sized, with a few larger individuals. Below approx. 35–40 m the area consists mainly of sand bottom and a few rock blocks without coral occurrences.

Topography

A rock ridge that plunges down towards the east, with a marked sloping section where the corals stand. The area is well exposed to current.

Condition

The colonies appear healthy and stable.

Fishing-gear impact

Little.

Summary

A small but stable coral field, consisting mainly of *Paramuricea placomus*.

Knowledge gaps and uncertainty – N6 Bruraskjeret	
Knowledge gaps	No comparison against NINA data or Mareano; vertical distribution below 35–40 m not surveyed; whether the area is connected to other coral occurrences is unresolved.
Uncertainty level	**Medium** (M) – Bare Dykk's observations show a stable and healthy field of *Paramuricea placomus*. The area is well exposed to current, which favours coral health.
Measures to strengthen the evidence base	ROV supplement in deeper strata; fixed photo points; map analysis of topographic connection with adjacent occurrences.

North zone 7

N7: Kvennavika

High value

Species occurrences and depth

A larger, continuous field of *Paramuricea placomus* from approx. 30–45 m. Some scattered colonies are found by the outfall pipe in the south of the area, while the largest concentration lies northwards towards the crevice, where the colonies have grown together into a large, composite structure.

Topography

The area consists of rock walls, a crevice structure and a few ledges. The corals stand densely on the rock wall, particularly in the northern part where the crevice begins.

Condition

The colonies appear healthy and in good growth, especially in the northern parts.

Fishing-gear impact

Little to moderate gear impact; some lines may occur, but no larger accumulation has been observed.

Summary

Kvennavika has a very fine area of gorgonian corals that is easily accessible. The size and density of the occurrence mean that the area is included among the zones in the 'Preferably don't fish here' map (see Part 3, Chapter 5 for a more detailed description of the map and user guidance).

Knowledge gaps and uncertainty – N7 Kvennavika	
Knowledge gaps	Vertical distribution below 45 m has not been surveyed; the amount of lost gear in the area has not been quantified; the effect of any increased fishing intensity from measures in other zones is unresolved.
Uncertainty level	**Low** (L) – Bare Dykk's documentation shows a continuous field of *Paramuricea placomus* in good growth, particularly in the northern part towards the crevice. Included in the HIFH map on the basis of size and density.
Measures to strengthen the evidence base	ROV supplement below 45 m; baseline survey (a baseline measurement against which later changes can be compared) of gear density; time series at fixed photo points; follow-up in connection with the HIFH evaluation.

North zone 8

N8: At Norem

Moderate value

Species occurrences and depth

A small area with about ten colonies of *Paramuricea placomus* and a few small *Primnoa resedaeformis* colonies around 40 m. No corals observed deeper than approx. 47 m.

Topography

Vertical rock wall with small ledges.

Condition

The colonies appear small but healthy.

Fishing-gear impact

No gear observed.

Summary

A small field of gorgonian corals in good condition.

Knowledge gaps and uncertainty – N8 At Norem	
Knowledge gaps	Small area with relatively few individuals (approx. ten); missing comparison against NINA data; condition over time not documented; no survey below 47 m.
Uncertainty level	**Medium** (M) – Bare Dykk's observations show a small but healthy field around 40 m. No gear observed.
Measures to strengthen the evidence base	Time-series documentation to capture change; ROV supplement below 47 m; baseline status for the gear-free condition established.

PART 2C

Tauterryggen marine protected area

Brief overview compilation

About this section

Tauterryggen is discussed in less detail than Skarnsundet, in accordance with the agreement of 31 October 2025 with the County Governor of Trøndelag, which specifies that Skarnsundet is to be the main focus.

Bare Dykk's survey at Tauterryggen has been limited. The main basis for the section is NINA's survey (Järnegren et al., 2024) supplemented by Bare Dykk's observations.

A more detailed survey of Tauterryggen is part of the County Governor's ongoing assignment to NINA/NTNU (cf. Part 3, Section 7.4).

The protected area

The Tauterryggen marine protected area (established 2013, regulation FOR-2013-06-21-693) is located at the moraine ridge extending from Tautra towards Frosta. The area is known to contain among the shallowest documented occurrences of the stony coral known from the available literature (*D. pertusum*) at Selligrunnen at approx. 39 m depth (Mogstad et al., 2022; Järnegren et al., 2024).

Water-mass condition: Multiconsult's 2025 survey (Multiconsult, 2026) has no station on Tauterryggen itself. Station TRF-VB18 at Ytterøya (area 4 – the mid-fjord) is a supplementary proxy representing the water mass flowing out from the inner basins towards the outer fjord. Station TRF-VB20 in Strindfjorden (area 5) is the geographically nearest station to the sill itself, and represents the water mass in the outer basin that is lifted up over the moraine ridge at high tide. Both stations show temperature and oxygen patterns consistent with the other mid-fjord stations: stable ~8 °C in deep water and oxygen condition class I–II (Multiconsult, 2026, Table 5-2). Detailed water-mass monitoring at Tauterryggen is recommended as part of the County Governor's ongoing assignment (cf. Part 3, Section 7.4).

Coral occurrences

NINA's survey in 2022 identified four polygons with coral occurrences at Tauterryggen, with a combined area of approx. 100 daa (Järnegren et al., 2024). The main character can be summarised as follows:

- **Dominance of the stony coral** (*D. pertusum*), particularly on the sill itself.
- **Elements of** *Paragorgia arborea* (bubblegum coral) on the sill, with large colonies extending up between the stony corals. NINA documents bubblegum coral at approx. 74 m depth (Järnegren et al., 2024, figure 7).
- **Dense forests of *Primnoa*** (*Primnoa resedaeformis*) on the steep walls on the northern side.

- **The corals appear in good condition** – the diversity is not as great as at Rødberget, but the quantity and condition are assessed as generally good (Järnegren et al., 2024).

Selligrunnen – among the shallowest documented *Desmophyllum pertusum* occurrences

Selligrunnen is internationally known as among the shallowest documented occurrences of *D. pertusum* known from the available literature (formerly *Lophelia pertusa*), at approx. 39 m depth (Mogstad et al., 2022; Järnegren et al., 2024). NINA's re-survey in 2022 confirmed NTNU's comprehensive survey from 2012, and corals were found in the same places as previously recorded (Järnegren et al., 2024, p. 21). Selligrunnen's status as one of the shallowest documented occurrences therefore remains valid.

The site is of international significance and has historically been the subject of scientific interest because of its unusually shallow depth for the species. Tauterryggen as a whole was comprehensively surveyed by NTNU in 2012 using three complementary methods (synthetic aperture sonar, multibeam echosounder and hyperspectral underwater camera), and this dataset constitutes a strong basis for time-series analyses in the area.

Fishing-gear impact

NINA documents (Järnegren et al., 2024):

- Impact from fishing visible in all surveyed transects at Tauterryggen.
- Main impact: crushed corals, consistent with jig fishing where sinkers strike the bottom.
- Fishing lines observed lodged around the corals on the steep walls.
- Several smaller boats were fishing in the northern part of the protected area during the fieldwork.

Bare Dykk's dive observations are consistent with this picture. Tauterryggen's combination of strong current, varying bottom profile and shallow coral occurrences creates risk patterns similar to those in Skarnsundet (cf. Part 1, Section 6).

Value assessment

Tauterryggen – overall assessment

Ecological value: Very high. The Selligrunnen site is internationally recognised as one of the shallowest documented *Desmophyllum pertusum* occurrences known from the available literature.

Extent: NINA has mapped four polygons totalling approx. 100 daa; the site probably has a greater extent than recorded.

Observed impact: Visible fisheries-related damage in all surveyed transects (Järnegren et al., 2024). At the same time, most of the coral occurrences appear in good condition.

Knowledge status: Tauterryggen has an extensive history of surveys (NTNU 2012 via SAS, MBES, UHI – Mogstad et al., 2022; NINA 2022 via ROV). Further monitoring is particularly relevant for the Selligrunnen occurrence.

Recommendation for Tauterryggen

Tauterryggen is part of the same stepwise strategy of measures as Skarnsundet, but with different underlying data: the assessments build primarily on NINA Report 2229 (Järnegren et al., 2024) and NTNU's earlier survey (Mogstad et al., 2022), supplemented by limited observations from Bare Dykk. Measures particularly relevant for Tauterryggen are:

- **Time series at Selligrunnen.** The Selligrunnen site is internationally unique and should be prioritised for systematic time-series documentation. NTNU's detailed survey from 2012 (Mogstad et al., 2022) provides a strong reference basis against which new documentation can be measured.
- **Inclusion in the HIFH map.** Consider whether the most vulnerable parts of Tauterryggen (the sill area and the northern side) should be included in the 'Preferably don't fish here' map.
- **Coordination with NTNU's existing data.** NTNU's comprehensive survey from 2012 (Mogstad et al., 2022) constitutes a strong basis for time-series measurements and should be included in further management work.

Knowledge gaps and uncertainty – Tauterryggen marine protected area	
Knowledge gaps	Bare Dykk's own data from Tauterryggen are limited; the full development in condition for the Selligrunnen site since NTNU's 2012 survey and NINA's 2022 re-survey has not been mapped at fine scale; the vertical and lateral extent of the four NINA polygons is not fully delineated; the effect of the observed fisheries-related damage on the site's long-term development is unresolved.
Uncertainty level	**High** (H) – Tauterryggen is discussed at overview level in accordance with the agreement, not through systematic field survey by Bare Dykk. The main basis is NINA Report 2229 (Järnegren et al., 2024) supplemented by Bare Dykk's limited observations. NTNU has a comprehensive survey from 2012 (Mogstad et al., 2022) which NINA confirmed in 2022, but the fine-scale development since 2012 has not been mapped.
Measures to strengthen the evidence base	A detailed survey of Tauterryggen is part of the County Governor's ongoing assignment (cf. Part 3, Section 7.4). The Selligrunnen site should be prioritised for systematic time-series documentation linked to NTNU's 2012 data; vertical profiles by ROV; fixed photo points established.

PART 3

Overall assessment

Compilation, priorities and management recommendations

About this part

Purpose and status of the document

This part constitutes a technical basis for decision-making for the County Governor of Trøndelag and cooperating agencies (the Directorate of Fisheries, the Institute of Marine Research).

The document is not a complete survey of all occurrences in the area. The recommendations are formulated as technical assessments – the management decision on any measures, regulations or extended protection rests with the responsible public authority.

The assessments are anchored in Sections 4, 5 and 8–10 of the Nature Diversity Act (management objectives for habitat types and species, the knowledge base, the precautionary principle and cumulative environmental effects).

Part 3 is structured in eight parts: (1) the integrated pattern of damage, (2) value classification and prioritisation of zones, (3) indicative classification (preliminary classification) according to the framework, (4) anchoring in the Nature Diversity Act, (5) the user perspective from the survey among fishers, with a concluding subsection on social acceptance from the broader Trondheimsfjord survey, (6) the stepwise strategy of measures, (7) the 'Preferably don't fish here' initiative, and (8) the conclusion.

1. Integrated pattern of damage for the entire survey area

The survey by Bare Dykk AS (2020–2025), compiled with NINA Report 2229 (Järnegren et al., 2024), Knowledge Status Trondheimsfjord 2023 (Trøndelag County Authority, 2023) and the survey among 809 fishers (Sentio Research, 2026), shows a consistent and robust pattern of damage:

- Most of the surveyed zones show impact from fishing gear, ranging from little to very strong. In some smaller zones (particularly N5 Vennesodden and N8 Norem), no clear gear impact has been observed in the current survey, but these are nevertheless included in the overall assessment because of the vulnerable habitat type and the possible displacement of fishing pressure.
- **Damage occurs in all depth zones** where corals are present, from approx. 20 m to more than 180 m.
- **User-reported indication** from the survey (n=809): 75% of rod fishers experience snagging at least rarely; 19% of respondents bring up gorgonian coral at least rarely.

- **Accumulation over time** is documented through overgrown and older lines in several zones.
- **The most species-rich areas** (Brufoten on both sides, Ørdalsneset, Hoøyskjeret–Grandørin) are at the same time the most damaged.
- **Rare structures**, particularly a continuous *Madrepora oculata* reef, are directly damaged by fishing.
- **Other impact**: in one delimited zone (Vangshylla Sub-zone B), observations consistent with dive-related damage are also documented (evidence level 2, basic, probable but not fully confirmed). This is a substantially smaller extent than fisheries-related damage, but is documented as a separate impact source in line with the Norwegian Environment Agency's assignment (2 February 2026) to assess ‘any other activities/factors that affect the conservation values in a negative direction’.

The pattern of damage is qualitatively consistent across survey method (diving, ROV, self-reporting), depth, zone and time of survey. In our assessment, this provides a broad and management-relevant knowledge base under Section 8 of the Nature Diversity Act.

2. Value classification and prioritisation

The table below summarises the 14 zones with an overall assessment of ecological value, degree of impact and management priority.

2.1 Criteria for prioritisation

The prioritisation is an overall technical assessment based on four dimensions. It does not represent a formal algorithmic score, but a structured expert assessment in which the four factors are weighed together:

- **Ecological value:** species composition, colony biomass, the extent of the habitat type, the significance of the occurrence as habitat for other species and the relative rarity of the site (scale: moderate, high, very high). The scale does not include the grade ‘low’, because all documented coral occurrences in the area represent a vulnerable habitat type with inherent conservation value (cf. the introductory principle in Chapter 6).
- **Documented or observed impact:** the extent and type of fisheries-related or other mechanical impact observed during fieldwork or ROV survey (scale: none, little, moderate, strong, very strong).
- **Vulnerability and recovery time:** species-specific growth rate, colony structure and capacity for natural recovery within a relevant management timeframe. Gorgonian corals generally have a longer recovery time than stony corals with a corresponding degree of damage.
- **Data quality and knowledge status:** how well the zone is documented (NINA ROV, Bare Dykk dive transect, supplementary sources). Lower data quality gives higher priority to monitoring rather than formal measures.

The priority categories have the following meanings:

- **Highest:** very high ecological value combined with documented impact – measures are prioritised first.
- **High:** high value and/or moderate impact – measures are considered; monitoring where the underlying data are weak (‘monitor.’).
- **Moderate:** decreasing priority based on the overall assessment. Areas in this category are still part of the overall management and are actively monitored, but are not the focus of stepwise measures. If fishing pressure or other human activity shifts here as a result of measures in higher-priority zones, the category may be revised upwards.
- **Lower priority:** moderate ecological value with no observed gear impact in the current survey (cf. the Zone table, Section 2.2). The zone is monitored as part of the overall management, but is not prioritised for stepwise measures. The category may be revised upwards if fishing pressure shifts here as a result of measures in higher-priority zones (cf. Sections 9 and 10 of the Nature Diversity Act).

2.2 Zone table

No.	Zone	NINA code	Ecol. value	Observed gear impact (indicative)	Priority
S1	The Mosvik side – Brufoten	SK402	Very high	Very strong	Highest
S2	The Inderøy side – Brufoten	SK401	Very high	Very strong	Highest
S3	Vangshylla	–	Moderate–high	Moderate, increasing	High (monitor.)
S4	Ørdalsneset	SK408, SK406	Very high	Strong	Highest
S5	Øsneset–Staurlia	SK404	High	Moderate	High (monitor.)
S6	Ørdalsneset–Brufoten (Inderøy)	SK403	High	Very strong (hotspot)	Highest
N1	Hoøygrunnen	–	Moderate	Little	Moderate
N2	Hoøyskjeret – Grandørin	SK411	Very high	Moderate, local	Highest
N3	Skallen – 48 m sill	(SK412 ext.)	Very high	Strong in adjac.	Highest
N4	Noremsflata	SK405	High (overall)	Moderate (deep)	High
N5	Vennesodden	–	Moderate	None	Lower priority
N6	Bruraskjeret	–	Moderate	Little	Moderate

No.	Zone	NINA code	Ecol. value	Observed gear impact (indicative)	Priority
N7	Kvennavika	–	Moderate–high	Little–moderate	High (‘Preferably don't fish here’)
N8	Norem	–	Moderate	None	Lower priority

The observed gear impact indicates an indicative assessment based on field records at the time of survey, and does not express a formal impact classification under Chapter 10 of the framework. ‘Priority’ reflects an overall technical assessment of value, vulnerability and the need for management measures, and does not replace ordinary management discretion. Some zones are given the highest priority even with moderate observed impact, where ecological value, vulnerability, documented coral distribution and the risk of bottom contact together indicate high management significance.

3. Indicative classification (preliminary classification) for priority zones

The classification codes below are a working tool for describing the pattern of damage in a consistent way between zones. The codes indicate the damage mechanism (how the damage probably arose), damage severity (how serious the damage is), evidence level (the strength of the documentation), reversibility (the potential for natural recovery) and the recommended type of measure. The codes represent structured working hypotheses based on the available observations, not conclusions with definitively established causation.

The table below compiles indicative classification codes according to the framework (Slapgård, 2026, Chapter 10) for the seven highest-priority zones. The codes follow the format *Mechanism–Severity–Evidence level–Reversibility–Measure*, where:

- **Mechanism A:** Acute mechanical damage (primarily gear contact)
- **Severity I–IV:** Indicative proportion of functional loss (I: < 30%, II: 30–<70%, III: 70–<85%, IV: ≥85%)
- **Evidence level:** 1 = directly documented, 2 = consistent mechanism (basic/strengthened), 3 = hypothetical
- **Reversibility R1–R4:** R1 (months), R2 (1–5 years with measures), R3a (partially reversible, 5–20 years), R3b (accelerated collapse, 20–50 years or accelerating development towards R4), R4 (practically irreversible, > 50 years or not within a management timescale)
- **Measures T1–T5:** T1 = immediate measures should be considered (Sections 4 and 5 of the Nature Diversity Act; Section 9 of the Nature Diversity Act where the knowledge base is insufficient and the damage potential makes the provision relevant; Section 12 of the Nature Diversity Act where the measure concerns technique, method of operation or siting), T2 = active measures should be considered (Sections 4 and 5 of the Nature

Diversity Act; Section 9 of the Nature Diversity Act where the conditions apply; Section 10 of the Nature Diversity Act in cases of cumulative loading; Section 12 of the Nature Diversity Act for mitigating technique; Section 11 of the Nature Diversity Act only where the operator and cost liability are legally relevant), T3 = a cumulative-effects assessment is recommended (Section 10 of the Nature Diversity Act, assessed against Sections 4 and 5 of the Nature Diversity Act), T4 = monitoring and knowledge-gathering are recommended (Section 8 of the Nature Diversity Act), T5 = passive monitoring (Section 8 of the Nature Diversity Act). The legal anchoring is case-specific and not automatic; Sections 8–12 of the Nature Diversity Act are assessed specifically by the competent management authority, cf. Section 7 of the Nature Diversity Act.

No.	Zone	Classification code	Mechanism	Reversibility	Measure
S1	The Mosvik side – Brufoten (SK402)	A-III-1/2-R3b-T1	Acute mechanical damage – directly documented in several parts	R3b (accelerated collapse, 20–50 years or accelerating development towards R4)	T1 (immediate measures)
S2	The Inderøy side – Brufoten (SK401)	A-III-1/2-R3b-T1	Acute mechanical damage – documented in several depth layers	R3b (accelerated collapse, 20–50 years or accelerating development towards R4)	T1 (immediate measures)
S4	Ørdalsneset (SK408, SK406)	A-II-2-R3a-T2 / A-III-2-R3b-T1	Acute mechanical damage – consistent mechanism, documented in the *Primnoa* belt	R3a at Grade II, R3b at Grade III	T2, T1 at Grade III
S6	Ørdalsneset–Brufoten (SK403)	A-III/IV-1/2-R3b/R4-T1	Acute mechanical damage – documented hotspot approx. 200 m N of Brufoten with high gear density	R3b at Grade III, R4 at Grade IV	T1 (immediate measures)
N2	Hoøyskjeret – Grandørin (SK411)	A-II-2-R3a-T2	Acute mechanical damage – local documented impact	R3a (partially reversible, 5–20 years)	T2 (active measures)

No.	Zone	Classification code	Mechanism	Reversibility	Measure
N3	Skallen – 48 m sill	Not classifiable	Gear impact is not documented on the sill itself, and the possible spatial connection with SK412 is not verified. There is no observed analysis unit that can be graded.	Not assessed	T4 (further survey)
N7	Kvennavika	A-I-2-R1/R2-T4	Acute mechanical damage – low to moderate, consistent mechanism	R1 without persistent load, R2 with	T4 (monitoring within the HIFH regime)

The codes are indicative and express structured working hypotheses, not validated classifications. '1/2' or 'T1/T2' indicates that several classifications are consistent depending on which parts of the zone are assessed. Damage severity is stated as a qualitative, indicative assessment at zone level; the percentage intervals in the framework are defined with a single colony as the analysis unit and are not measured areal proportions for the zone as a whole. A strengthened classification and greater interpretive weight require relevant supporting parameters (cf. Part 1, Chapter 1.3).

Interpretation of the classification

Three zones are classified directly as R3b or R4 (S1, S2 and S6), while S4 may fall in R3b if damage severity III is taken as the basis. These zones require immediate measures, and may pass into R4 (practically irreversible, > 50 years) under persistent or increasing load. According to the framework (Slapgård, 2026, Section 10.6), this supports the T1–T2 category of measures for the zones with the most documented mechanical impact (S1, S2 and the S6 hotspot area at Brufoten), anchored in Sections 4 and 5 of the Nature Diversity Act (management objectives for habitat types and species). Section 9 of the Nature Diversity Act is assessed specifically where the knowledge base is insufficient and the damage potential makes the precautionary principle relevant.

As a suggested technical formulation for the authorities' further assessment (adapted from Slapgård, 2026, Chapter 15):

> *'The observations are most consistent with acute mechanical damage from fishing gear (mechanism A), damage severity II–III (moderate to significant), evidence level 1–2 (directly documented to consistent basic), reversibility category R3a–R3b (partially reversible over 5–20 years to accelerated collapse over 20–50 years) with the potential for R4 (practically irreversible) under persistent load. Alternative explanations cannot be fully ruled out without supplementary data. Pursuant to Sections 4, 5 and 10 of the Nature Diversity Act, it is considered relevant to consider active measures (T1–T2), including method guidance and area-specific measures in the highest-priority zones. Section 9 of the Nature Diversity Act is assessed specifically where the knowledge base is insufficient and the damage potential makes the precautionary principle relevant.'*
>
> — Suggested technical formulation – Bare Dykk AS (2026a), based on the framework Slapgård (2026). The final management assessment rests with the County Governor.

4. Anchoring in the Nature Diversity Act

The assessments above are to be anchored explicitly in Sections 4, 5 and 8–10 of the Nature Diversity Act:

Section 8 of the Nature Diversity Act – The knowledge base

The compilation of NINA Report 2229 (Järnegren et al., 2024), Bare Dykk AS's surveys (2020–2025), Knowledge Status Trondheimsfjord 2023 (Trøndelag County Authority, 2023), Multiconsult's 2025 water-mass survey (Multiconsult, 2026) and the technical framework 'Damage types in cold-water corals' (Slapgård, 2026) constitutes a broad, documentable and concordant knowledge base. Multiconsult's oxygen measurements in the deep water of Skarnsundet (Condition class I, cf. Part 1, Section 7.1) do not support hypoxia as the main explanation for the observed pattern of damage in 2025, and therefore strengthen the mechanical interpretation as most consistent with the data, but do not rule out other stressors or seasonal variation. Uncertainty is clearly marked where it exists (e.g. for unsurveyed depth layers and for the winter minimum of oxygen).

Section 9 of the Nature Diversity Act – The precautionary principle

Very slow growth and recovery times of several hundred to a thousand years for damaged colonies mean that uncertainty about damage development should be interpreted in the corals' favour. Continued fishing activity in the most exposed zones entails a real risk of further irreversible damage.

Section 4 of the Nature Diversity Act – Management objectives for habitat types and ecosystems

The diversity of habitat types shall be safeguarded within their natural range and with the species diversity and ecological processes that characterise the habitat type. The coral occurrences in Skarnsundet and Tauterryggen constitute vulnerable habitat types ('Coral occurrence (I09)' with the designations 'Gorgonian corals (I0902)' and 'Stony corals (I0901)') for which Section 4 of the Nature Diversity Act is particularly relevant. The assessment of measures shall reflect the objective of conserving these habitat types within their documented distribution.

Section 5 of the Nature Diversity Act – Management objectives for species

The species and their genetic diversity shall be safeguarded in the long term. The documented coral species in the area – *Desmophyllum pertusum* (NT), *Madrepora oculata* (DD), *Paragorgia arborea* (NT), *Primnoa resedaeformis* (LC) and *Paramuricea placomus* (LC) – have a low growth rate and high vulnerability to physical impact, which makes this management objective pertinent. Two of these species are classified as 'Near Threatened' (NT) on the Norwegian Red List for species (Tandberg and Mortensen, 2021), and the authorities' assessment under Section 5 of the Nature Diversity Act must therefore take into account that continued pressure on these species may affect the Red List category negatively at the next assessment. Zigzag coral (*Madrepora oculata*) in the 'Data Deficient' (DD) category requires particular caution under Section 9 of the Nature Diversity Act, the precautionary principle, because the knowledge base does not rule out that the species may be far more threatened than the current category suggests. Wolffish (*Anarhichas lupus*, Norwegian Red List 2021: LC – Least Concern) is an ecologically important predator species in hard-bottom systems; a reduced population may contribute to weakened predator control of sea urchins and thereby indirectly affect kelp forest and sedimentation conditions, and is thus a species of particular management relevance in this area.

Section 10 of the Nature Diversity Act – Ecosystem approach and cumulative environmental effects

The combination of damage from fishing gear, sedimentation, physical interventions and context factors such as the turf-algae bloom in the mid-fjord in 2025 (Multiconsult, 2026, cf. Part 1, Section 7.3) should be included in a cumulative-effects assessment. The same zones most heavily affected by fishing gear are also those with the greatest biological value, and where any additional impacts have the greatest consequence. Turf algae are not directly documented as a damage factor on the corals in Skarnsundet, but may represent an additional factor in the same water-mass system and should be followed up through further monitoring. A cumulative-effects assessment is a necessary part of the authorities' basis for assessing measures.

5. The user perspective – the survey

In December 2025 – January 2026, a web-based survey was carried out among 809 people who fish in Skarnsundet and/or Tauterryggen (Sentio Research, 2026). The survey was conducted by Sentio Research on assignment for the County Governor of Trøndelag, which holds the rights to the data. The survey constitutes empirical user-perspective data (attitudes, behaviour, self-reported practice) and is not scientific validation of the pattern of damage, but provides a representative snapshot that complements the field observations. Key findings are summarised below and constitute an independent user-based source of evidence for the report's assessments.

5.1 Area use and gear choice

- **Area use.** 69% fish in Skarnsundet, 17% in Tauterryggen and 14% in both. Skarnsundet is clearly the most used area, which supports the prioritisation of the Skarnsundet zones in this report.
- **Platform.** Boat fishing dominates overall (67%), but there is a clear difference between the areas: in Skarnsundet 23% fish from land, against only 2% at Tauterryggen.

- **Gear use** (multiple answers possible): rod fishing (75%), trolling/jigging/handline (47%), line/handline on the bottom (16%), gillnet (4%), pot/trap (3%).
- **Depth use.** 50% fish in the 30–100 m depth interval, which overlaps significantly with the documented coral habitats (20–70 m for gorgonian corals, 40–185+ m for stony corals).
- **Target species.** Saithe (89%) and cod and haddock (combined survey category: 66%) dominate. Tusk/ling (10%) and wolffish (6%) are tied to hard bottom and structurally rich areas that overlap with the coral occurrences.

5.2 Snagging and gear loss

User-reported snagging (n=809)

Rod fishing (n=589): 75% experience snagging at least rarely (52% rarely, 19% occasionally, 4% often).

Trolling/jigging/handline (n=376): 68% experience snagging at least rarely (53% rarely, 14% occasionally, 1% often).

Line/handline on the bottom (n=122): 70% experience snagging at least rarely.

When gear becomes snagged: 8% lose the gear / have to cut it, 37% free it, 55% experience both from time to time.

Reported causes of snagging

Respondents report the following main causes (n=573, multiple answers possible):

- Uneven bottom / rock ridges: 63%
- Strong current: 28%
- Unfamiliar terrain: 22%
- Old gear / rope / trawl on the bottom: 14%
- **‘Other’ (open answers):** seaweed/kelp and some explicit mentions of ‘coral/coral reef’ and ‘corals’ as a cause of snagging.

These figures are in strong agreement with the observed pattern of damage from diving and ROV: uneven bottom and strong current are natural factors that concentrate the gear impact precisely on the topographies where the corals grow (cf. Part 1, Section 6). 14% of respondents cite lost gear on the bottom as a cause of snagging; this must be interpreted with caution, since users cannot necessarily distinguish between lost gear, rock structure and corals. Nevertheless, the proportion supports the finding that ghost gear constitutes a relevant part of the impact picture, as dive-based finds of overgrown line, gillnet remnants and line also indicate.

5.3 User-reported coral bycatch

Respondents were asked how often they bring up gorgonian coral, coral or similar organisms with their gear:

- Never: 76%
- Rarely (0–1 times per trip/day): 19%

Although 76% report never, the 19% who report rarely represent a significant quantifiable indicator that mechanical contact between fishing gear and coral structures does actually occur. The user data provide an independent, user-based indication that snagging, bottom contact and coral retrieval occur. They support the assessment of mechanical impact risk, but do not constitute independent verification of the specific damage observations in Part 2.

What 'rarely' may mean in a larger picture – a frequency assessment: 'Rarely' may at first glance appear of little seriousness, but an important perspective is lost when the figure is not set against the volume of use for the area. A rough, illustrative conversion gives a clearer picture of what 19% actually implies for cumulative load:

- **Conservative estimate based on the sample alone:** Of the 809 respondents, 19% amounts to approx. 154 people. If each of these 'rarely' corresponds to approx. 1 event per year, that gives on the order of 150 events per year where coral or gorgonian coral is removed/damaged – within the sample alone.
- **Realistic estimate for the area overall:** The actual number of fishing trips annually in Skarnsundet and Tauterryggen is probably several thousand. If an illustrative level of 5,000 fishing trips per year is assumed – a conservative estimate based on the reported frequency of use (cf. Section 5.1) – and the proportion reporting coral bycatch is assumed representative, this could correspond to on the order of 950 individual events per year where coral or gorgonian coral is mechanically touched. Each event represents either the direct removal of a colony branch, or at least a mechanical contact that potentially causes damage.

Assumptions and reservations: The figures are illustrative and build on the assumptions that 'rarely' corresponds to approx. 1 event per fisher per year, and that the fishing-trip frequency in the survey is representative of the whole area. The actual number of events may be either lower (if 'rarely' means less than annually for some) or higher (if the volume of use is underestimated). Even conservative estimates nevertheless give a level that is management-relevant.

Management significance: The conversion is central to the assessment under Section 5 of the Nature Diversity Act (management objectives for species) and Section 10 of the Nature Diversity Act (cumulative environmental effects). A single fisher who 'rarely' brings up coral will naturally perceive their own impact as negligible, but the sum of thousands of fishing trips gives an accumulated annual damage pressure of a magnitude that is management-relevant. This is precisely the logic of Section 10 of the Nature Diversity Act: individual events assessed in isolation may seem small, but the cumulative load from many independent actors over time can threaten the conservation values.

5.4 Coral knowledge and scope for action

- **74%** of respondents report being aware that there are vulnerable corals in the area.
- **26%** report not being aware of the coral occurrences. This group particularly includes visitors and users without local knowledge.
- **50%** always try to prevent the sinker from striking the bottom; 27% do so sometimes; 22% do not.

- **51%** never use an echosounder/chartplotter.

The high level of coral knowledge (74%) provides considerable scope for voluntary and information-based measures. At the same time, the proportion who do not prevent sinker contact (49%) and the proportion without an echosounder (51%) show that there is concrete room for improvement, both methodologically and in terms of information.

5.4.1 Willingness to conserve – the 'fisher's dilemma'

The Trondheimsfjord survey 2025 (Trøndelag County Authority, 2025) includes a question on how relevant it is for the respondent to 'fish less in vulnerable areas, e.g. coral reefs and spawning grounds' (s25_1). The distribution of answers is:

- Relevant: 25.2%
- Very relevant: 34.0%
- **Total: 59.2%** report that it is relevant or very relevant to fish less in vulnerable areas.

Interpretation – the fisher's dilemma: A majority of the population is motivated to take vulnerable areas into account, but several indicators show that users lack the tools to do so in practice. The thematic fisher survey shows that 74% are aware that there are vulnerable corals in the area (Sentio Research, 2026), while the broader Trondheimsfjord survey shows that the level of knowledge about corals in the population generally is low – only 3.3% report much or very much knowledge (Trøndelag County Authority, 2025). At the same time, 51% of the fisher respondents never use an echosounder or chartplotter (Sentio Research, 2026). A 'fisher's dilemma' thus arises – the willingness to conserve is present, but the mapping tool to put that willingness into practice is missing.

Management significance: This makes the 'Preferably don't fish here' map (HIFH; cf. Section 6.1.1) more than a technical proposal from the supplier – it is the most sought-after management measure measured against the users' own expressed motivation. A formalised HIFH map, integrated into digital map solutions and made visible at launch ramps (cf. Section 6.1.6), addresses this gap between willingness and tools directly. Communication work therefore probably has high efficiency in this area, because the recipients are pre-motivated.

5.5 Links to the observed pattern of damage

The survey provides several independent observations that are consistent with the observed pattern of damage in Part 2:

- **Topographic concentration:** Snagging occurs most often at uneven bottom/rock ridges (63%), which are precisely the physical forms the corals grow on.
- **Gear loss as an ongoing process:** 8% lose gear / have to cut it – documenting that ghost gear accumulates continuously.
- **Differentiation between Skarnsundet and Tauterryggen:** 17% of Skarnsundet fishers experience snagging 'never', against 34% of Tauterryggen fishers. Skarnsundet thus appears as the more heavily loaded area – in line with the observations.

- **Wolffish as an ecologically important predator species:** 6% target wolffish (*Anarhichas lupus*, Norwegian Red List 2021: LC – Least Concern). Wolffish is an ecologically important predator species in hard-bottom systems; a reduced population may contribute to weakened predator control of sea urchins and thereby indirectly affect kelp forest and sedimentation conditions. The recommendation of protection is discussed in Section 6.1.5 and builds on Slapgård (2025).

5.6 Social acceptance and management scope for action

In December 2025, Sentio Research, in cooperation with NTNU and on assignment for Trøndelag County Authority, carried out a broad survey about the Trondheimsfjord. The results are published via Trøndelag i tall (Trøndelag County Authority, 2025). The survey covers the entire population in municipalities with a shoreline to the fjord, not only fishers as in the thematic survey among 809 fishers discussed in Sections 5.1–5.5. The figures complement the fisher survey by showing the population's general attitudes to fjord management, and have direct management significance for assessments under Sections 4, 5, 9 and 10 of the Nature Diversity Act.

Key figures from the Trondheimsfjord survey 2025 (Trøndelag i tall)

A precautionary approach to caring for the fjord: 85.8% answer important or very important.

A long-term plan for safeguarding the fjord: 86.0% answer important or very important.

A fishing ban in vulnerable areas as a measure: 71.5% support (positive + very positive).

Stricter rules in marine protected areas: 64.8% support.

Personal willingness to fish less in vulnerable areas (coral reefs, spawning grounds): 59.2% relevant or very relevant.

Difficult to find information about rules in protected areas: 41.9% agree or strongly agree.

Much knowledge about corals: only 3.3% report much or very much knowledge; 69.8% have little or very little knowledge.

The precautionary principle and cumulative environmental effects (cf. Sections 9 and 10 of the Nature Diversity Act)

85.8% of the population support a precautionary approach, and 86.0% agree that there should be a long-term plan for safeguarding the Trondheimsfjord. This documents broad social acceptance of management based on the precautionary principle, and strengthens the authorities' basis for assessing load cumulatively under Section 10 of the Nature Diversity Act. When the population overwhelmingly wants a precautionary approach, the authorities have a clear mandate from residents to act on this basis.

Management objectives for habitat types and species (cf. Sections 4 and 5 of the Nature Diversity Act)

71.5% support ‘A fishing ban in vulnerable areas’ as a management measure, and 64.8% support ‘Stricter rules in marine protected areas’. Although knowledge about corals is low in the population (only 3.3% report much or very much knowledge, while 69.8% have little or very little knowledge), the willingness to protect them is great. This gives the authorities a broad mandate when

considering measures aimed at conserving the habitat type coral occurrences (Section 4 of the Nature Diversity Act) and the species diversity of vulnerable coral species and wolffish (Section 5 of the Nature Diversity Act).

Personal willingness to change behaviour – support for Tier 1

59.2% of respondents report that it is relevant or very relevant to 'fish less in vulnerable areas, e.g. coral reefs and spawning grounds'. This supports the finding that a voluntary, knowledge-based approach in Tier 1 (cf. Section 6.1) has realistic potential for effect – users are disposed to change behaviour if they receive sufficient information.

The information gap as an operational justification for the HIFH map

41.9% of respondents report that it is difficult to find information about the applicable rules in protected areas. Together with the low knowledge about corals, this documents a clear information gap. Users want to protect the corals, but do not know where they are or which rules apply. This is the direct operational justification for the 'Preferably don't fish here' map (Section 7) and for targeted method guidance (Sections 6.1.1 and 6.1.2).

Voices from the free-text responses

Of 271 free-text responses, several give direct support to measures aimed at protection, control and information. A representative selection:

> *'Fishing takes place in the protected area. Signage and enforcement are called for.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025

> *'Protection of vulnerable areas/species must be respected by the authorities. Violations should be punished more severely.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025

> *'Well-balanced plans and regulations should be established and maintained that safeguard reasonable access to natural areas.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025

The last quotation illustrates a significant dimension of nuance in the free-text material: several respondents emphasise the need for *balanced* management that safeguards both conservation concerns and legitimate use. This agrees well with the stepwise strategy of measures (Section 6), where Tier 1 prioritises knowledge and guidance over restrictions.

Overall assessment

The survey documents a significant gap between the population's willingness to protect the fjord (85.8% support the precautionary principle) and their actual knowledge about corals (only 3.3% have much knowledge). This gap constitutes a risk of unintended damage to vulnerable species (Section 5 of the Nature Diversity Act) and habitat types (Section 4 of the Nature Diversity Act). At the same time, the high support for a fishing ban in vulnerable areas (71.5%) gives the authorities a solid mandate to consider targeted measures where the

cumulative load (Section 10 of the Nature Diversity Act) is too high. The population's wish for balanced management aligns well with the report's stepwise strategy of measures: Tier 1 prioritises closing the information gap and strengthening the knowledge base; Tier 2 keeps restrictive measures open as a possibility if follow-up shows that Tier 1 is not sufficient.

6. Recommendations

The recommendations below are technical proposals directed at the County Governor of Trøndelag, in cooperation with the Directorate of Fisheries and the Institute of Marine Research. *The management decision on the implementation, form and extent of measures rests with the responsible authority.*

The survey and the user survey show that users largely call for better map-based information and clearer method guidance (Sentio Research, 2026). On this basis, a stepwise approach to measures is recommended.

In the first tier, measures are proposed that strengthen the knowledge base and provide guidance to users, and that can be implemented without changes to the regulations. If follow-up later shows that these measures do not have sufficient effect, area-specific restrictions may be considered in a second tier.

This approach safeguards both the need for protection and the consideration of legitimate use, and ensures that the choice of measures, methods of operation and siting are assessed together, in line with the principles in Sections 8–10 of the Nature Diversity Act.

6.0 Categorisation of measures – process needs

To give the authorities a clear picture of what can be implemented quickly and what requires a formal process, the recommendations are grouped into two main categories:

Category A – Low-conflict measures that can be introduced relatively quickly

Map-based information and formalisation of the HIFH map (Section 6.1.1).

Method guidance for recreational fishers – sinker weight, bottom contact, gear loss (Section 6.1.2).

A voluntary ‘coral-friendly fishing’ scheme and cooperation with rental operators (Section 6.1.3).

Information boards, signage and QR-coded posters at launch ramps and harbours (Section 6.1.6).

Pre-dive briefings and diving code-of-conduct rules for sport diving in vulnerable areas (Bare Dykk AS, 2026b).

Knowledge exchange and dialogue with the Directorate of Fisheries and the Institute of Marine Research (Section 6.1.7).

Establishment of evaluation indicators and photo points for later follow-up (Section 6.1.8).

Common to Category A: The measures do not require changes to legislation or regulations, and can largely be implemented within existing resource frameworks and management authority. They do not directly affect the operating conditions of the fishing industry.

Category B – Measures that require a formal process

Area-specific gear restrictions in priority zones (Section 6.2.1).

A possible bottom-fishing ban in selected zones (Section 6.2.1).

Amendment or extension of the existing protection regulations for Skarnsundet or Tauterryggen (Section 6.2.1).

Formal establishment of zone regulations with enforcement authority (Section 6.2.1).

Visible SNO/inspection presence during the season (Sections 6.1.6 and 6.2 – requires resource clarification and coordination with the Norwegian Nature Inspectorate).

A possible protection of wolffish in Skarnsundet and Tauterryggen under Section 16 c of the Marine Resources Act (Section 6.1.5; a process already initiated through the County Governor's approach to the Directorate of Fisheries).

Common to Category B: The measures require formal consultation, clarification of legal authority, a possible decision process in consultation with the Directorate of Fisheries and/or the Ministry of Climate and Environment, and entail changes to the operating conditions of legitimate use. They presuppose that the Category A measures have been attempted and evaluated (cf. the Tier 1 → Tier 2 logic in Sections 6.1.8 and 6.2).

The relationship between the categories: Category A and Category B are not to be understood as alternatives, but as sequentially dependent: Category A is implemented first, evaluated after 12–24 months against defined success criteria (Section 6.1.8), and Category B is activated if the evaluation shows that the A measures do not have sufficient effect. The stepwise strategy is consistent with Section 12 of the Nature Diversity Act in that the choice of measures, methods of operation and any siting are assessed together with a view to avoiding or limiting damage and achieving the best overall societal outcomes.

6.1 Tier 1 – Knowledge- and guidance-based measures

Objective: Reduce fisheries-related impact through map-based guidance, method improvement and voluntary cooperation.

6.1.1 Map-based guidance (formalisation of HIFH)

1. **Formalisation of the ‘Preferably don't fish here’ map.** It is recommended that the County Governor, in cooperation with Bare Dykk AS, formalise the existing HIFH map as an information tool, linked to a digital map solution with zones and a recommended method per zone.
2. **Compilation in a QGIS project.** It is recommended that NINA's polygons (SK codes), the Bare Dykk zones and the HIFH polygons be gathered in one common map tool that can be used for management, monitoring and user information.
3. **Communication via several channels.** 51% of respondents never use an echosounder/chartplotter (Sentio Research, 2026). Information should be provided through digital channels (QR/mobile/app), physical signs at launch sites and harbours, and integration into commonly used chartplotters (Navionics, C-MAP).

6.1.2 Method guidance

1. **Area-specific method guide.** 49% of respondents do not consistently prevent the sinker from striking the bottom (Sentio Research, 2026). A short, illustrated guide is recommended, with concrete techniques, e.g. the use of droppers, sinkers without a hook, adjusted sinker weight, adapted to local conditions with a varied bottom profile and current.
2. **Targeted information for visitors and rental operators.** Open answers in the survey show that visitors without local knowledge experience snagging more often. A standardised information package should be distributed through fjord centres, rental operators and tourism channels.

6.1.3 Voluntary cooperation

1. **Voluntary 'coral-friendly fishing' scheme.** The fact that 74% of respondents report knowledge of corals provides a legitimate basis for a voluntary label/recognition scheme, linked to the method guide and the HIFH map.
2. **Targeted effort against lost gear.** 8% of respondents lose gear when snagged and 55% experience both. Cooperation with diving clubs, volunteers and fishing organisations is recommended for the systematic recording and removal of lost gear in exposed zones.

6.1.4 Diving ethics and pre-dive briefing

In addition to fisheries-related impact, in one delimited zone (Vangshylla Sub-zone B) observations consistent with dive-related damage are documented (cf. Part 1, Section 5.1 and Part 2). Although the extent is substantially smaller than for fisheries-related damage, the following measures are recommended to reduce the potential impact of diving activity:

1. **Formalisation of diving code-of-conduct rules as a standard.** Bare Dykk AS has produced a publication with diving code-of-conduct rules and a recommendation for a pre-dive briefing (Bare Dykk AS, 2026b). It is recommended that the County Governor take these as a starting point, possibly in cooperation with the Norwegian Diving Federation and relevant diving clubs, to establish a site-specific standard for diving in the protected areas.
2. **Pre-dive briefing as recommended practice.** The pre-dive briefing is internationally established as one of the most effective single measures for reducing diver-caused damage in vulnerable coral areas. It is particularly recommended for guided dives, courses, photo/video dives and first-time dives in the area.
3. **Information at dive sites.** Information boards or QR-coded posters at the main dive-use points, coordinated with the HIFH map (cf. Section 6.1.1) and any guided dive operators. This will also reach visiting divers without local knowledge.

6.1.5 Knowledge base and monitoring

1. **Complete survey of the Skallen sill (N3).** NINA's survey stopped just south of the sill; it is recommended that the north-eastern side be fully surveyed with ROV or diving.
2. **Confirmatory survey at Vangshylla (S3).** It is recommended that changes in Sub-zone B, where significant damage has already been recorded below 50 m, be documented, including through further verification of any dive-related damage.
3. **Monitoring of Øsneset–Staurlia (S5) and Noremsflata (N4).** Particularly if fishing shifts as a result of any measures in other zones.
4. **Fixed monitoring points according to the framework.** A minimum of one point per priority zone, with defined photo points, annual documentation and classification according to 'Damage types in cold-water corals' (Slapgård, 2026). Fixed-point photography and repeated video transects are established methodology in international marine monitoring (cf. Reef Check, AGRRA, PISCO; MAREANO uses a similar principle for Norwegian shelf fauna), and is practically feasible in Skarnsundet with standard diving equipment at the shallower sites. It is recommended that such monitoring be organised through a local scientific community with continuity over time, to ensure consistent methodology, the accumulation of time series and inter-observer reliability through independent classifications of the same material. This is included as a T4 measure (monitoring and knowledge-gathering; cf. Section 8 of the Nature Diversity Act) in the stepwise strategy of measures.
5. **Coral-relevant nutrient flux – a knowledge gap in the current water-mass monitoring.** Multiconsult's 2025 water-mass monitoring (Multiconsult, 2026) provides a good basis for assessing chemical water quality and oxygen conditions, but does not measure parameters directly relevant to the food supply of the cold-water corals. The corals obtain energy from particulate organic matter (POM) and zooplankton filtered out of the water, not from dissolved nutrients. It is recommended that future monitoring be extended with coral-relevant parameters:

- **Particulate organic carbon and nitrogen (POC/PON):** water samples from coral depth (typically 30–50 m and 80–120 m), filtered and analysed on an elemental analyser. A direct measure of the 'coral food' available for filtration.
- **Chlorophyll a (quantitative):** filter samples with spectrophotometric or fluorometric analysis. More precise than fluorescence-probe measurements and can be linked to particle-flux assessment.
- **Zooplankton density and species composition:** vertical net hauls at coral depth, or modern methods such as FlowCAM or eDNA. The polyps capture zooplankton actively – density and composition affect growth directly.
- **Sediment traps:** a moored rig over 6–12 months to measure vertical particle flux (mg/m²/day). Combines food supply and sediment load in one measure.
- **Current measurements (ADCP):** an Acoustic Doppler Current Profiler on the bottom in central zones – Skarnsundet is characterised by strong tidal currents, and the current

strength governs both the food flux to the polyps and how fishing gear becomes lodged in colonies.

- **Local current conditions and temperature in the sound and over the moraine ridge (proxy extension):** Multiconsult's measurement stations cover the water masses around Skarnsundet (TRF-VB5 on the southern side and TRF-VB3 on the inner side towards Beistadfjorden) and Tauterryggen (TRF-VB18 at Ytterøya and TRF-VB20 in Strindfjorden). Although this double approach strengthens representativeness under changing tidal currents, none of the stations lie in the narrow sound itself or on the moraine ridge itself. NINA documents that both areas have strong currents. Skarnsundet is described as ‘very strong-flowing’ and ‘strong current’ is reported in all four Tauterryggen polygons (Järnegren et al., 2024, pp. 11 and 25–26). Bare Dykk's dive observations (2020–2025) confirm that the practical working window in both areas is limited to periods around slack water. ADCP current measurements and temperature sensors placed in the current zone itself would document whether turbulence and mixing conditions give different local temperature and oxygen patterns than those measured at the general mid-fjord and inner-fjord stations. A central question is whether the strong tidal current in the sound itself and over the moraine ridge weakens or locally collapses the pycnocline in periods of strong current, and whether this varies between spring and neap periods. This is particularly relevant for the assessment of thermal stress in the 20–50 m zone (cf. Part 1, Section 7.4), where shallower colonies are most exposed.

Scientific basis: Compiling water-mass data with coral-relevant nutrient-flux data is an established method in cold-water coral research (Roberts et al., 2009; Buhl-Mortensen et al., 2010), and has been carried out in research studies on, among others, the Tautra reef by NTNU and IMR. It is not a new or experimental field, but a standard extension that would give the authorities a significantly strengthened knowledge base (cf. Section 8 of the Nature Diversity Act) for assessing the cumulative load (Section 10 of the Nature Diversity Act) on the coral occurrences. Bare Dykk AS does not itself have the expertise or equipment for such analyses, but can contribute diving services and locally informed field logistics for any cooperation with scientific communities such as NTNU, IMR or NIVA.

6. **Wolffish – recommended protection as a measure.** Wolffish (*Anarhichas lupus*, Norwegian Red List 2021: LC – Least Concern) is an ecologically important predator species in Skarnsundet and Tauterryggen. A reduced population may contribute to weakened predator control of sea urchins and thereby indirectly affect kelp cover and sedimentation conditions. Bare Dykk's observations of sea urchins and kelp cover over ten years (2015–2025) – a longer time series than the coral survey (2020–2025) – document a high sea-urchin population and reduced kelp cover in shallow areas of Skarnsundet during this period. A local experiment in 2021, in which manual sea-urchin removal at Vangshylla gave 30–50% kelp cover in the same season (Slapgård, 2025), demonstrates that the substrate and light conditions support kelp growth when grazing pressure is reduced, but documentation of historical kelp density in Skarnsundet before 2015 is not available in the accessible source material. Although the species is classified as LC nationally, it is under local pressure from fishing activity, and its disappearance is

associated with trophic cascades. Bare Dykk has therefore prepared a separate technical basis for the protection of wolffish under Section 16 c of the Marine Resources Act (Slapgård, 2025) as an annex to this report. Protection is assumed to be coordinated with the Directorate of Fisheries (cf. Section 6.2.4).

6.1.6 User feedback on control and signage

A recurring theme in the open free-text responses from the Trondheimsfjord survey 2025 (Trøndelag County Authority, 2025) is the absence of visible enforcement presence and a demand for clearer information in the field. This is input from the population itself and strengthens the basis for physical information measures under Tier 1. Examples of free-text responses:

> *'Ensure that Norwegian law is followed! SNO. More staff!'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025
>
> *'More and better inspections of fishing…'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025
>
> *'Fishing takes place in the protected area. Signage and enforcement are called for.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025
>
> *'The chance of being caught and fined when breaking Norwegian law, the Outdoor Recreation Act and protection regulations should be much greater.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025
>
> *'Continuous automatic monitoring of the whole fjord.'*
>
> — Anonymous respondent, Trondheimsfjord survey 2025

Interpretation: The population itself calls for both increased presence/enforcement and clearer guidance to be able to comply with the protection provisions. This means that physical signage, information boards and visible enforcement presence are not only technically justified recommendations – they correspond to an expressed expectation from the users of the area. For the County Governor, this provides support for stricter enforcement: it is not experienced as an intrusion on users, but as a response to a request from them.

Concrete measures under Tier 1:

1. **Physical signage at launch ramps and main harbours.** Information boards are recommended at all launch ramps around Skarnsundet (typically Vangshylla, Kjerringvika, Venneshavn, the Norem area, and ramps on the Mosvik/Inderøy side) and at nearby harbours used by visiting fishers. The boards should show the boundaries of the protected area, the position of the coral occurrences (cf. the HIFH map, Section 6.1.1), the applicable recommendations and a contact point for tips/reporting.

2. **Information boards in the Tauterryggen area.** Corresponding boards at relevant access points to the Tauterryggen marine protected area, particularly where launch ramps are used by recreational fishers covering both Skarnsundet and Tauterryggen.
3. **Coordination with SNO and the Norwegian Nature Inspectorate.** Dialogue with the Norwegian Nature Inspectorate is recommended on the possibility of a visible enforcement presence in the seasons with the highest fishing activity, especially in June–August. A visible enforcement presence has a documented preventive effect and is consistent with the population's call for control.
4. **A low-threshold reporting/tip channel.** Establishment of a simple reporting channel (QR code, short number or email) on the information boards, where both users and passers-by can report observations of activity contrary to the conservation purpose or finds of lost gear. Such channels complement formal inspection by allowing the local community to contribute to situational awareness.

6.1.7 Coordination with other agencies

1. **Dialogue with the Directorate of Fisheries** on information work and any gear-related regulation.
2. **Knowledge exchange with the Institute of Marine Research** on monitoring methodology and compilation against Mareano data.

6.1.8 Success criteria and evaluation of Tier 1

The Tier 1 measures should be evaluated against concrete, measurable criteria so that the County Governor has an empirical basis for assessing whether information-based measures are sufficient, or whether Tier 2 should be activated. An evaluation is recommended 12–24 months after implementation, based on the following indicators:

1. **Reduction in self-reported snagging and coral bycatch.** It is recommended that the County Governor of Trøndelag repeat the survey in 2027 (in cooperation with Sentio Research) with the same set of questions as 2025/26, so that snagging frequency, coral bycatch and depth use can be compared directly. Success criterion: a measurable reduction in the proportion reporting snagging and coral bycatch, particularly in the priority zones.
2. **Fixed photo points with visual evaluation of new lost gear.** Bare Dykk AS establishes fixed photo points (a minimum of one per priority zone) documented annually with the same method (cf. Section 6.1.5). Success criterion: no net increase in the number of observed new snagged fishing lines, gillnet remnants or other lost gear between the documentation years. A reduction is assessed as an indication of effect.
3. **Indicators of knowledge and attitudes.** From the 2027 survey: the proportion of respondents aware of the coral occurrences (baseline 74%), the proportion who try to prevent the sinker from striking the bottom (baseline 50%), and the proportion who have seen the HIFH map or information boards. Success criterion: a measurable increase in all three indicators.

4. **Indicators of presence and enforcement.** The number of information boards established, the number of recorded responses via the reporting channel (cf. Section 6.1.6), and visible SNO presence during the season. Success criterion: active establishment and use; not a final figure, but an ongoing activity.
5. **Ecological indicators (long-term).** Results from the County Governor's ongoing assignment (deadline November 2026) and any further monitoring provide a basis for tracking the condition of the coral occurrences themselves over time. These will typically have a longer response time than 12–24 months, but are included in a rolling evaluation.

Decision logic: If the evaluation after 12–24 months shows that two or more criteria are not met, or that an increase in fisheries-related damage is observed at the fixed photo points, activation of Tier 2 (Section 6.2) is recommended for the priority zones. If the criteria are on the way to being met, Tier 1 can be continued with any adjustments. This gives the County Governor a predictable and documentable basis for deciding between continuation and escalation of measures.

6.2 Tier 2 – Area-specific restrictions

Objective: Implement targeted area restrictions if follow-up shows that Tier 1 does not have sufficient effect, or if surveying reveals core areas of particularly high vulnerability.

Tier 2 is not activated automatically, but is considered by the County Governor in cooperation with the Directorate of Fisheries and the Institute of Marine Research on the basis of an evaluation of the effect of Tier 1. The evaluation should be based on baseline indicators (a baseline measurement against which measures can be evaluated) from the 2025/26 survey (Sentio Research, 2026) and a follow-up survey after sufficient time for the measures to take effect.

6.2.1 Relevant measures under Tier 2

1. **Area restrictions in the highest-priority zones.** Gear restrictions may be considered in zones S1, S2, S4, S6 and N2, or corresponding measures with the same effect. These zones combine high to very high ecological value with strong to very strong documented impact.
2. **Extension of the protected area to include N3 (the Skallen sill).** The area represents a documented north-eastern extension of SK412 and is not included in the existing survey or protection.
3. **Formalisation of certain HIFH zones with formal status.** Where compliance with the voluntary scheme is not sufficient, formal status may be considered for Kvennavika (N7) and possibly other zones of moderate value.

6.2.2 International management practice

Area-specific restrictions on bottom-contact gear in vulnerable coral habitats are a well-established management principle internationally. Examples include:

- **Oculina Bank (USA, NOAA):** Area protection with a ban on several types of bottom-set fishing gear (trawl, bottom longline, fish traps/pots), justified by damage to fragile corals.

- **Deep-Sea Coral Protection Areas (NOAA, north-eastern USA):** A ban on the use of certain gear with direct bottom contact in delimited areas to reduce the risk of physical impact on deep-sea corals.
- **FAO Vulnerable Marine Ecosystems (VME):** An international framework in which corals and sponges are typical examples; it recommends area-specific measures and closures to prevent significant adverse effects from bottom fishing.

These examples show that if Tier 1 does not have sufficient effect, there is solid international management practice for considering area-specific restrictions as Tier 2.

6.2.3 Basis for evaluation

To ensure a verifiable basis for decision-making for any transition to Tier 2, the following indicators for measuring effect are recommended. The figures are given as a baseline (a baseline measurement against which measures can be evaluated) from 2025/26:

- **The proportion bringing up gorgonian coral/coral with gear** (76% never, 19% rarely).
- **The proportion trying to prevent sinker contact** (50% always, 27% sometimes, 22% never).
- **Coral knowledge** (74% aware of vulnerable corals).
- **Condition at the fixed monitoring points** classified according to the framework (Slapgård, 2026).
- **The amount of recorded lost gear** in exposed zones.

6.2.4 Sector coordination and legal authority

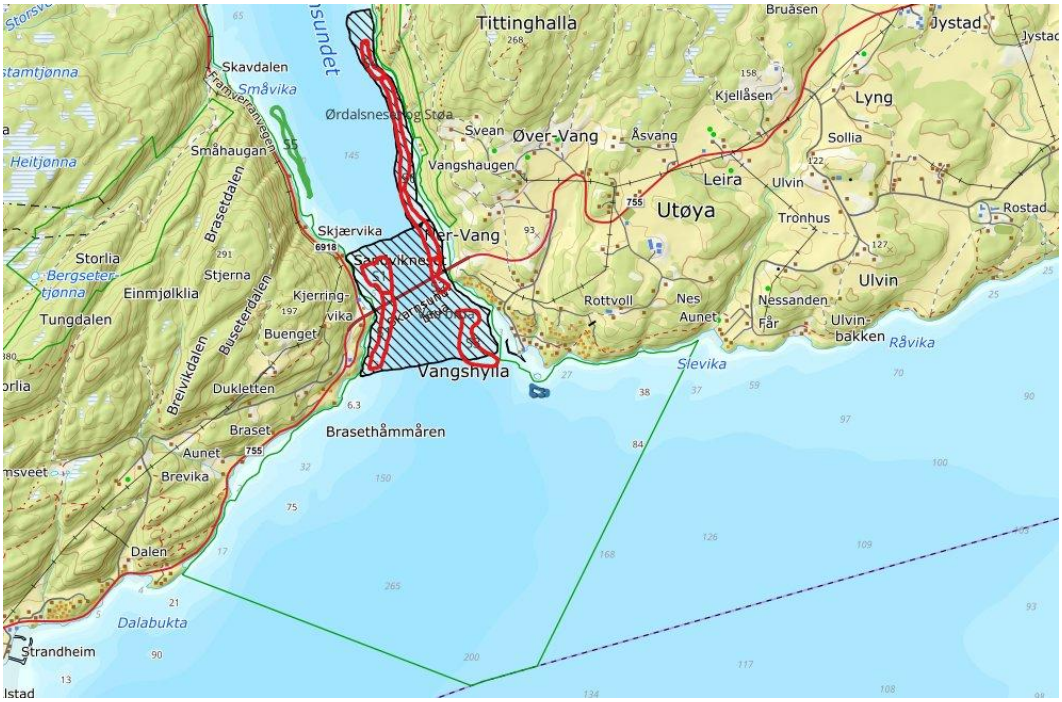
The measures described in Tier 2 affect areas of management that fall under several sector authorities. The applicable legal framework requires the County Governor, when exercising its authority, to take account of the management objectives in Sections 4 and 5 of the Nature Diversity Act and to apply the principles in Sections 8–12 of the Nature Diversity Act, cf. Section 7 of the Nature Diversity Act. Any gear restrictions, protection measures or changes to conservation provisions require a basis in the relevant protection regulations, the Marine Resources Act or other sector legislation. Measures directed at the harvesting of marine resources – including the protection of wolffish (cf. Section 6.1.5 and Slapgård, 2025) and area-specific gear restrictions – are assumed to be coordinated with the Directorate of Fisheries in accordance with the Marine Resources Act and established management practice. Consultation is also assumed with the Institute of Marine Research for the technical basis, and with the Ministry of Climate and Environment for any changes to the protection regulations. This division of work is normal management practice and does not mean that any of the measures are excluded, but provides a clearer basis in law and facilitates the implementation of measures through the correct sector process.

7. The ‘Preferably don't fish here’ initiative

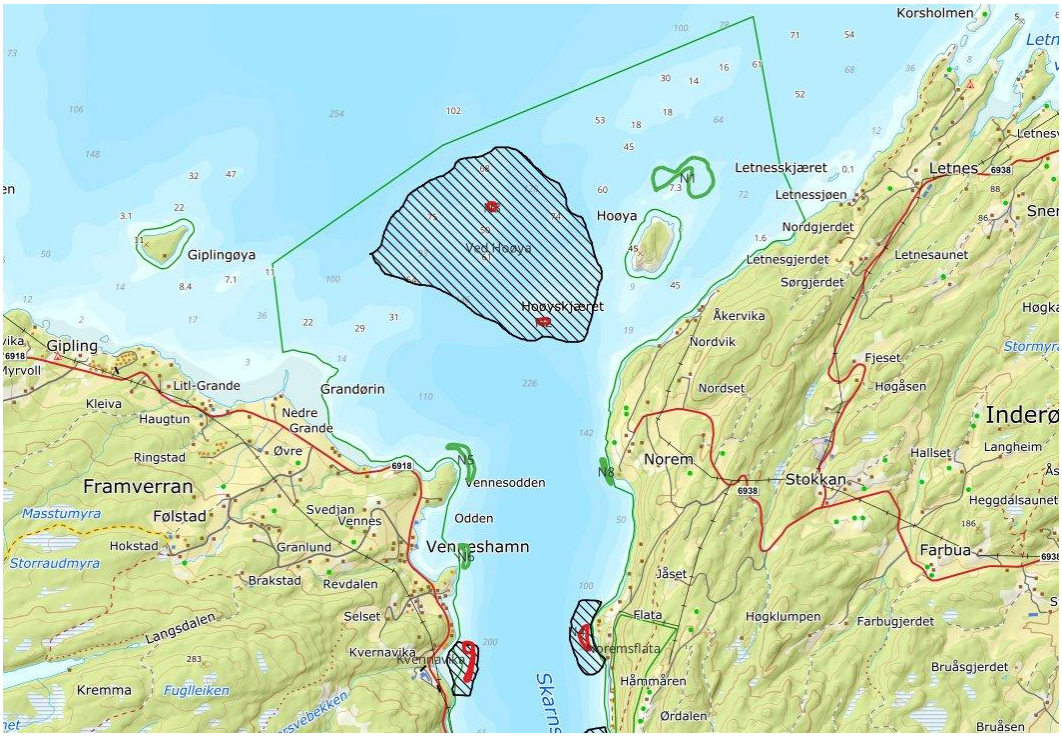
In addition to formal management and any regulation, a voluntary information tool aimed at recreational fishers and the general public has been established: *Helst ikke fisk her / Preferably do not fish here* (Bare Dykk AS, 2025). The map is available as a Google My Maps service and a KML export.

QR code with a direct link to the 'Preferably don't fish here' map in Google My Maps.

The two map extracts below show the 'Preferably don't fish here' polygons together with Bare Dykk's zone polygons for Skarnsundet SOUTH and NORTH respectively. The HIFH polygons have been made partly transparent in the map layout, so that Bare Dykk's zones stand out clearly within the HIFH delineation. The maps provide a quick visual basis for seeing which of the zones are included in HIFH (red polygon, cf. the colour key in the Zone overview) and how these are spatially distributed along the sound.



'Preferably don't fish here' polygons (hatched/semi-transparent areas) compiled with Bare Dykk's zone polygons in Skarnsundet SOUTH: Brufoten, Vangshylla, Ørdalsneset and the Mosvik side down towards Brasethåmmåren.



'Preferably don't fish here' polygons (hatched/semi-transparent areas) compiled with Bare Dykk's zone polygons in Skarnsundet NORTH: the Hoøya area, Letnesskjæret, Vennesodden, Kvennavika and Noremsflata.

7.1 Purpose and scope

The map visualises areas (red polygons) where vulnerable corals and uneven bottom are documented, and where the probability of gear snagging and damage to corals is high. The map covers Skarnsundet and Tauterryggen, and serves as a low-threshold supplement to formal protection by making the spatial distribution of vulnerable areas immediately available to users at sea.

The HIFH polygons comprise the following of the 14 Bare Dykk zones from Part 2: in Skarnsundet SOUTH, zones S1 the Mosvik side–Brufoten, S2 the Inderøy side–Brufoten, S3 Vangshylla, S4 Ørdalsneset and S6 Between Ørdalsneset and Brufoten (Inderøy); in Skarnsundet NORTH, zones N2 Hoøyskjeret–Grandørin, N3 Skallen, N4 Noremsflata and N7 Kvennavika; as well as the Tauterryggen marine protected area. These are the areas Bare Dykk AS recommends that recreational fishers avoid. Zones S5 Between Øsneset and Staurlia, N1 Hoøygrunnen, N5 Vennesodden, N6 Bruraskjeret and N8 Norem are surveyed in Part 2, but are not yet included in the HIFH map.

Note: The polygons from the HIFH map and the 14 surveyed Bare Dykk zones (cf. Part 2) are expected to overlap to a significant degree, but the exact spatial link remains to be established.

This will be documented in a QGIS project that compiles NINA's polygons (SK codes), the Bare Dykk zones and the HIFH polygons, and will be addressed in a later revision of this document.

7.2 User guidance from the map

The map conveys the following concrete advice to recreational fishers and other users of the sea, all of which have a direct damage-reducing effect:

- **Avoid bottom-set fishing gear and heavy sinkers** in or near the red areas.
- **Use a weaker leader than the main line** – if the gear becomes snagged, it breaks near the hook instead of the whole rig being torn loose together with the coral.
- **Fish with only one hook or lure** to reduce the risk of snagging.
- **Be careful with anchoring** near coral areas.
- **Take litter and lost equipment with you** if possible – ghost gear is a long-lasting source of damage.
- **Remember that corals here grow very slowly** and can be hundreds of years old.

7.3 Management value

The ‘Preferably don't fish here’ map has several properties that make it valuable as a supplement to formal management:

- **Rapid implementation.** The map can be put into use without amending regulations and serves as an immediate measure pending any regulation.
- **User-friendliness.** The zones are shown as red polygons in Google Maps; the blue position dot shows whether the user is within a zone.
- **Low threshold.** Voluntary compliance is easier to achieve than enforcement of a ban, and the map can raise awareness in the recreational fishing community.
- **Complementarity.** The map does not weaken the argument for formal regulation, but can document a pre-established warning boundary that the authorities can build on.

The map is not a decision document and does not replace the provisions of the protection regulations or the Nature Diversity Act's management objectives for habitat types (Section 4 of the Nature Diversity Act) and species (Section 5 of the Nature Diversity Act). The map is a central instrument in Tier 1 of the strategy of measures (cf. Section 6.1), and supplements any later assessment of Tier 2 measures. The authorities' assessments under the principles in Sections 8–12 of the Nature Diversity Act presuppose an explicit weighing linked to these provisions; the assessment basis in this report is structured with this in mind.

7.4 Connection with ongoing knowledge-gathering

On 2 February 2026, the Norwegian Environment Agency assigned the County Governor of Trøndelag to gather further knowledge and documentation of how recreational fishing affects the conservation values in the marine protected areas of Rødberget, Tauterryggen and Skarnsundet. The assignment is to include, among other things, analysis of existing video material from NINA's 2022 survey, new surveys of particularly at-risk coral occurrences, assessment of other impact factors, and a technical discussion with proposals for any changes to the current protection

regulations. The County Governor's deadline for responding to the assignment is 1 November 2026.

The present document has been prepared by Bare Dykk AS on the basis of its own fieldwork in Skarnsundet (2020–2025), and is intended as a technical supplement to the ongoing process. Bare Dykk's contribution builds on many years of local field knowledge – site-specific familiarity with topography, current conditions, diving conditions and specific coral occurrences, which complements remotely operated ROV surveying. The document compiles observations, operational zones, damage documentation and the user perspective in a form that can feed into the further build-up of knowledge work.

8. Uncertainty matrix per zone

This matrix summarises evidence strength and data coverage per zone in a single overview, together with the main alternative explanations considered for the observed patterns. The purpose is to make the uncertainty in the assessment basis per zone transparent for the authorities, so that precautionary assessments (cf. Section 9 of the Nature Diversity Act) can be calibrated to the actual underlying data at each site. The matrix is a structured compilation of the uncertainty assessment contained in the zone blocks in Part 2; it does not replace them, but provides an overall picture for use in sorting measures.

Scale explanation:

7. **Evidence strength (1–5):** 1 = weak basis (few or unsystematic observations); 3 = moderate (consistent observation from one primary source); 5 = strong basis: consistent documentation across several sources/methods, possibly with quantitative supporting parameters.
8. **Data coverage (1–5):** 1 = a few dives/observations; 3 = moderate coverage (several visits, but limited depth or temporal coverage); 5 = a systematic time series + several independent methods (ROV + diving).
9. **Uncertainty index (1–5):** Derived from the sum of evidence strength + data coverage. 1 = low uncertainty (the basis is strong); 5 = high uncertainty (the basis should be strengthened before heavier measures are considered, but cf. Section 9 of the Nature Diversity Act: low data coverage shall not in itself be a reason to postpone measures where the observed impact is significant).

Zone	Site	Evidence strength (1–5)	Data coverage (1–5)	Main alternative explanations	Uncertainty index (1–5)
S1	The Mosvik side – Brufoten	5	5	Historical fishing before the survey	1
S2	The Inderøy side – Brufoten	5	5	Historical fishing before the survey	1

Zone	Site	Evidence strength (1–5)	Data coverage (1–5)	Main alternative explanations	Uncertainty index (1–5)
S3	Vangshylla	4	5	Diver impact (the only zone with such an observation); historical fishing	2
S4	Ørdalsneset	3	3	Natural variation, lack of data on depth coverage	3
S5	Between Øsneset and Staurlia	3	2	Lack of data, possible sedimentation from runoff	4
S6	Between Ørdalsneset and Brufoten (Inderøy)	3	3	Lack of data below 50 m; the exact zone boundary towards S2/S4 not formalised; no separate NINA coverage	3
N1	Hoøygrunnen (northern)	4	4	Natural variation on the sill; current-related mechanical damage	2
N2	Hoøyskjeret – the Grandørin ridge	4	4	Current-related mechanical damage; historical fishing	2
N3	Skallen NE – 48 m sill	4	4	Natural variation; current dynamics	2
N4	Noremsflata	3	2	Lack of data; possible displacement of fishing from measures in other zones	4
N5	Vennesodden	2	2	Lack of data; uncertain depth coverage	5
N6	Bruraskjeret	2	2	Lack of data; uncertain depth coverage	5
N7	Kvennavika	2	2	Lack of data; uncertain depth coverage	5
N8	Norem	2	2	Lack of data; uncertain depth coverage	5
TT	Tauterryggen (overall overview)	4	3	Current-related knowledge gap (NINA itself did not cover the whole planned area); limited Bare Dykk coverage	3

Interpretation: Zones with a high uncertainty index (4–5) should be prioritised for further survey and monitoring (cf. Section 6.1.5). Zones with a low uncertainty index (1–2) provide a sufficiently strong basis for assessing measures without further data collection. Vangshylla (S3) stands out as the only zone where diver impact is identified as the main alternative explanation for part of the pattern of damage; this is discussed explicitly in Part 1, Section 5.1. For the peripheral northern zones (N5–N8), the high uncertainty index primarily reflects that Bare Dykk's own survey activity has been concentrated on known core areas; any extended survey would probably move these zones up the evidence scale.

Reservation: The scale is qualitative-numerical and not a formal statistical assessment. It expresses technical judgement based on the overall material in this report and is intended as decision support for the authorities, not as research-standard uncertainty quantification. A future inter-observer reliability assessment (cf. Section 6.1.5) would strengthen the calibration of the scale.

9. Conclusion

The coral occurrences in Skarnsundet and Tauterryggen constitute a complex and vulnerable coral ecosystem of very high ecological value. The compilation of NINA Report 2229 (Järnegren et al., 2024), Bare Dykk AS's surveys (2020–2025), the survey among 809 fishers (Sentio Research, 2026), the Trondheimsfjord population survey in Trøndelag (Trøndelag County Authority, 2025) and Multiconsult's 2025 water-mass survey (Multiconsult, 2026) provides a broad, consistent and multi-source knowledge base. The main pattern in the documented mechanical damage is most consistent with fishing gear as the dominant impact factor in several surveyed zones and depth layers, with long-lasting accumulation of damage. Where gear has been observed in physical contact with corals, there is directly documented gear impact. Multiconsult's oxygen data (Condition class I in Skarnsundet) do not support hypoxia as the main explanation for the pattern of damage and therefore strengthen the mechanical interpretation, but do not rule out other stressors.

Given the very slow growth of cold-water corals and the several hundred to a thousand years of age of the coral structures, continued gear impact entails a real risk of irreversible damage to nationally and regionally important habitat-type occurrences. Existing protection provides little protection against this impact.

The survey among fishers shows that users have a high level of coral knowledge (74%) and call for map-based guidance and method improvement. The broader Trondheimsfjord survey shows that the inhabitants of Trøndelag overwhelmingly support a precautionary approach (85.8%), long-term management (86.0%) and a fishing ban in vulnerable areas (71.5%). This gives the authorities a solid mandate from both recreational fishers and the wider population to begin measures through knowledge- and guidance-based instruments (Tier 1), before any area-specific restrictions are considered (Tier 2).

It is recommended that a stepwise strategy of measures be considered, with formalisation of the ‘Preferably don't fish here’ map, method guidance and targeted information work in Tier 1, combined with ongoing monitoring and evaluation. If the evaluation shows insufficient effect, or if

new surveys reveal particularly vulnerable core areas, there is solid international management practice (Oculina Bank, NOAA Deep-Sea Coral Protection Areas, FAO VME) for considering area-specific restrictions as Tier 2. Targeted measures directed at the cause are considered, in line with the Nature Diversity Act's management objectives for habitat types and species (Sections 4 and 5 of the Nature Diversity Act) and the principles in Sections 8–10 of the Nature Diversity Act, to be the most cost-effective and scientifically grounded means of conserving these rare and valuable marine habitats in the Trondheimsfjord.

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Relevant international works

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Glossary and terms

An alphabetical list of abbreviations, technical concepts and terminology used in the document. At the first occurrence in each paragraph, a short explanation is also given in the text.

- **Accumulated damage** – repeated impact that builds up over years. In cold-water corals this is particularly critical because of the low growth rate.
- **Alcyonacea** – the scientific name for the order comprising gorgonian corals (formerly Gorgonacea). In this document: *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus*.
- **Baseline** – a baseline measurement against which measures can be evaluated. Used as a starting point for measuring change over time.
- **DD** – Data Deficient (Norwegian Red List for species 2021). A species for which the knowledge base is not sufficient to assess threat status.
- **Evidence level 1** – direct visual documentation. Damage or impact has been observed with one's own eyes and/or documented with photo/video.
- **Evidence level 2**, probable but not fully confirmed. A distinction is made between ‘strengthened’ (with quantitative supporting data) and ‘basic’ (without quantitative supporting data).
- **Evidence level 3** – an indication without complete documentation. Alternative explanations cannot be ruled out.
- **The precautionary principle** – Section 9 of the Nature Diversity Act. Where there is a risk of serious or irreversible damage to biodiversity, the lack of knowledge shall not be used as a reason for postponing or refraining from management measures.
- **Gorgonacea** – an older scientific name for gorgonian corals, today included in the order Alcyonacea.
- **Habitat-forming species** – species that create three-dimensional structures other species live in and off. Cold-water corals are habitat-formers.
- **Hard-bottom coral forest (NT)** – a habitat type on the 2018 Red List for habitat types, assessed as Near Threatened (NT). A structured community of gorgonian corals on hard bottom.
- **IMR** – the Institute of Marine Research (Norwegian: Havforskningsinstituttet).
- **HIFH** – the ‘Preferably don't fish here’ map (Bare Dykk AS, 2025). A voluntary information tool aimed at recreational fishers.
- **Gorgonian corals** – a collective term for corals of the order Alcyonacea (formerly Gorgonacea). Comprises *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus*. Habitat-type designation ‘Gorgonian corals (I0902)’ in the Norwegian Biodiversity Information Centre's system.

- **I0901** – habitat-type code for ‘Stony corals’ in the Norwegian Biodiversity Information Centre's habitat-type system. Comprises reef-building cold-water corals such as *Desmophyllum pertusum* and *Madrepora oculata*.
- **I0902** – habitat-type code for ‘Gorgonian corals’ in the Norwegian Biodiversity Information Centre's habitat-type system. Comprises *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus*.
- **Indicative classification** – preliminary classification. A technical assessment according to an established framework, based on observation and expert judgement, not on systematic quantitative measurement. Requires further monitoring to become ‘final’.
- **Cold-water corals** – corals that live in cold sea areas (below approx. 14 °C), often in deeper water. They grow very slowly and can be thousands of years old.
- **Coral occurrence (I09)** – a habitat type in the Norwegian Biodiversity Information Centre's habitat-type system comprising all forms of cold-water coral communities.
- **Cumulative effects** – the total load from various impacts. Several stress factors acting together often produce a greater effect than the sum of each individually.
- **Mechanism A**, mechanical damage from fishing gear (a damage mechanism in the framework, Slapgård, 2026). Examples: torn-off branches, crushed colonies, snagged lines.
- **Mechanism B** – sedimentation and silting (a damage mechanism in the framework).
- **Mechanism A (dive-related)** – mechanical contact from a diver. Classified as acute mechanical damage (code A) in the framework, with diver contact stated as the source. Examples: fin strokes, loss of buoyancy against a wall, touching.
- **Mechanism D** – pollution and chemical impact (a damage mechanism in the framework).
- **Mechanism E** – sediment-induced stress and oxygen impact (a damage mechanism in the framework).
- **NINA** – the Norwegian Institute for Nature Research.
- **NDA** – the Nature Diversity Act (Norwegian: naturmangfoldloven, LOV-2009-06-19-100).
- **NT** – Near Threatened (Norwegian Red List). A species or habitat type at risk of becoming threatened in the near future.
- **Keystone species** – species of particularly great ecological significance for the community they live in. The loss of keystone species can change the entire ecosystem.
- **R1** – reversibility category: damage that can be repaired within months.
- **R2** – reversibility category: damage that can be repaired within 1–5 years with active measures.
- **R3a** – reversibility category: partially reversible, regeneration over 5–20 years.
- **R3b** – reversibility category: accelerated collapse, 20–50 years or accelerating development towards R4. Immediate measures are indicated.

- **R4** – reversibility category: practically irreversible on a management scale.
- **The framework** – 'Damage types in cold-water corals: Technical framework' (Slapgård, 2026). A systematic tool for classifying damage, stress and measures on cold-water corals.
- **Reversibility** – the potential for natural recovery after damage. Classified in R1–R4 according to the framework.
- **ROV** – Remotely Operated Vehicle. Used for video-based surveying at depths beyond safe diving depth.
- **Cumulative load** – Section 10 of the Nature Diversity Act. The principle that the impact on an ecosystem shall be assessed on the basis of the total load to which it is or will be subjected.
- **Scleractinia** – the scientific name for the order comprising stony corals. In this document, comprises *Desmophyllum pertusum* and *Madrepora oculata*.
- **Damage mechanism** – how damage arises. Classified in A–E (possibly more) according to the framework.
- **Damage severity**, how serious the damage is. An increasing scale from I (very minor) to IV (very serious / complete destruction).
- **SK code** – NINA's locality code for coral occurrences in Skarnsundet (e.g. SK401, SK412).
- **Stony corals** – a collective term for reef-building cold-water corals of the order Scleractinia. In this document, *Desmophyllum pertusum* and *Madrepora oculata*. Habitat-type designation 'Stony corals (I0901)'.
- **T1–T5** – measure categories in the framework (Slapgård, 2026, Section 10.6). T1 = immediate measures should be considered (Sections 4 and 5 of the Nature Diversity Act; Section 9 of the Nature Diversity Act where the knowledge base is insufficient and the damage potential makes the provision relevant; Section 12 of the Nature Diversity Act where the measure concerns technique, method of operation or siting), T2 = active measures should be considered (Sections 4 and 5 of the Nature Diversity Act; Section 9 of the Nature Diversity Act where the conditions apply; Section 10 of the Nature Diversity Act in cases of cumulative loading; Section 12 of the Nature Diversity Act for mitigating technique; Section 11 of the Nature Diversity Act only where the operator and cost liability are legally relevant), T3 = a cumulative-effects assessment is recommended (Section 10 of the Nature Diversity Act, assessed against Sections 4 and 5 of the Nature Diversity Act), T4 = monitoring and knowledge-gathering are recommended (Section 8 of the Nature Diversity Act), T5 = passive monitoring (Section 8 of the Nature Diversity Act).

Annex A: Quality checklist

A checklist for quality assurance of the document in accordance with the project's methodological requirements. Each point is confirmed at the time of preparation and shown with a short justification for verifiability.

Role and perspective

- ✓ **Bare Dykk AS is unambiguously positioned as a technical supplier, not a public authority.** Recommendations are formulated as 'assessments' and 'proposals for assessment', never as decisions. The management decision rests with the County Governor of Trøndelag (cf. Purpose and scope of the document).

The three-level distinction (observation / interpretation / assessment)

- ✓ **Observation level:** Actual field data from Bare Dykk AS (2020–2025), NINA Report 2229 (Järnegren et al., 2024) and the survey (Sentio Research, 2026). Each observation attributed with source, time and place (cf. the orientation box in Part 2).
- ✓ **Interpretation level:** Technical compilation and indicative classification according to the framework (Slapgård, 2026). Classifications are formulated as 'most consistent with', not categorical conclusions.
- ✓ **Assessment level:** Management assessments anchored in Sections 4, 5 and 8–10 of the Nature Diversity Act (Part 3, Sections 4 and 6).

The Nature Diversity Act

- ✓ **Anchoring in Sections 4, 5 and 8–10 of the Nature Diversity Act.** Section 4 of the Nature Diversity Act (management objectives for habitat types): the coral occurrences are vulnerable habitat types. Section 5 of the Nature Diversity Act (management objectives for species): corals and wolffish are species with a low growth rate / high vulnerability. Section 8 of the Nature Diversity Act (the knowledge base): three main sources, two supplementary context sources + the framework. Section 9 of the Nature Diversity Act (the precautionary principle): explicitly used where uncertainty is high and the damage potential significant. Section 10 of the Nature Diversity Act (cumulative environmental effects): focus on cumulative effects (cf. Part 1, Section 6 and Part 3, Section 4).

Explicit uncertainty

- ✓ **Structured uncertainty blocks per zone.** All 14 zones in Skarnsundet, as well as Tauterryggen, have a standardised block stating knowledge gaps, uncertainty level (low/medium/high) and measures to strengthen the evidence base (cf. Part 2 and Part 2C).
- ✓ **Evidence levels stated.** Damage is classified according to the framework's evidence levels (1, 2 strengthened/basic, 3) with explicit reservations where relevant.

Source hierarchy

- ✓ **The source hierarchy is clear.** Independent technical reports (NINA Report 2229; Multiconsult, 2026; Knowledge Status Trondheimsfjord 2023), peer-reviewed literature (including Roberts et al., 2009; Buhl-Mortensen et al., 2010; Larsson and Purser, 2011; Larsson et al., 2013; Bilan et al., 2023), public datasets (Mareano, Naturbase, the Norwegian Biodiversity Information Centre/Norwegian Red List for species), own field observations (Bare Dykk AS, 2020–2025) and user-perspective data (Sentio Research, 2026; the Trondheimsfjord survey) are kept separate and given different methodological weight.
- ✓ **Data sources clearly categorised.** Bare Dykk's own field documentation (2020–2025) is clearly identified as own field observations / experience-based primary data, and presented with time, place and observer.
- ✓ **User-perspective data epistemically clarified.** The survey (Sentio Research, 2026; n=809) is explicitly identified as user-perspective data, not as scientific validation of the pattern of damage (cf. Part 3, Section 5).

Tone and language

- ✓ **Unnecessary rhetorical language avoided.** Wordings such as ‘dramatic’, ‘catastrophic’, ‘alarming’, ‘enormous’ and ‘frightening’ are not used as argumentative intensity words.
- ✓ **Non-committal wordings avoided.** No ‘it is conceivable’, ‘possibly’ or other weakening wordings that are not followed up by concrete assessments.
- ✓ **The authority's voice not borrowed.** No wordings of the type ‘the County Governor should therefore decide…’. Bare Dykk provides the technical basis, not decisions.

Verifiability

- ✓ **Empirical data sourced.** Bare Dykk's field data attributed with time period (2020–2025) and locality. NINA data refer to specific SK codes. The Sentio survey states n=809 and the period of conduct.
- ✓ **Generalisations flagged.** Findings from Skarnsundet are not generalised uncritically to the whole Trondheimsfjord or other marine protected areas. Tauterryggen is treated as its own overview compilation with clear delimitation (cf. Part 2C).

Format and delivery

- ✓ **Technical basis for decision-making.** The document is structured for direct use in management cases, with clear chapter divisions, references, a glossary and this checklist.
- ✓ **Clear visual hierarchy.** The Bare Dykk AS layout is applied consistently. Fact boxes, uncertainty blocks and tables have recognisable formatting.
- ✓ **Referenceable sections.** All main sections and chapters are numbered (Part 1, Part 2, Part 3 + sub-chapters), so that management cases can refer to them precisely.

Map and GIS basis

- ✓ **Map material flagged as indicative.** Map extracts and zone polygons are clearly marked as indicative/preliminary where relevant. The maps do not replace formal GIS data or Naturbase/NINA polygons. Exact coordinates and final polygon boundaries are to be formalised in a separate QGIS project.

Level of measures and proportionality

- ✓ **Stepwise structure of measures.** Measures are formulated as stepwise recommendations and proposals for further assessment. Knowledge and guidance measures, voluntary measures and area-specific restrictions are kept separate, so that the decision-maker can assess proportionality, legal authority and process needs separately.

Privacy and user data

- ✓ **User data at aggregate level.** The survey is used at aggregate level. Free-text responses and user-perspective data are not presented in a way that identifies individuals, and the material is used as risk and user-perspective data, not as direct proof of damage.

References and cross-references

- ✓ **References and cross-references checked.** The reference list, internal chapter references, figure names, map descriptions, SK codes, zone names and annex references have been checked against the main text and the table of contents. References to external reports and datasets have been checked for consistent author name, year and title.

This checklist documents that the report has been prepared in accordance with the methodological requirements for a technical basis for decision-making in the management of marine protected areas. Any discrepancies should be flagged by the reader; feedback is requested to be directed to Bare Dykk AS for revision.

Einar Morten Slapgård

Technical lead / author

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