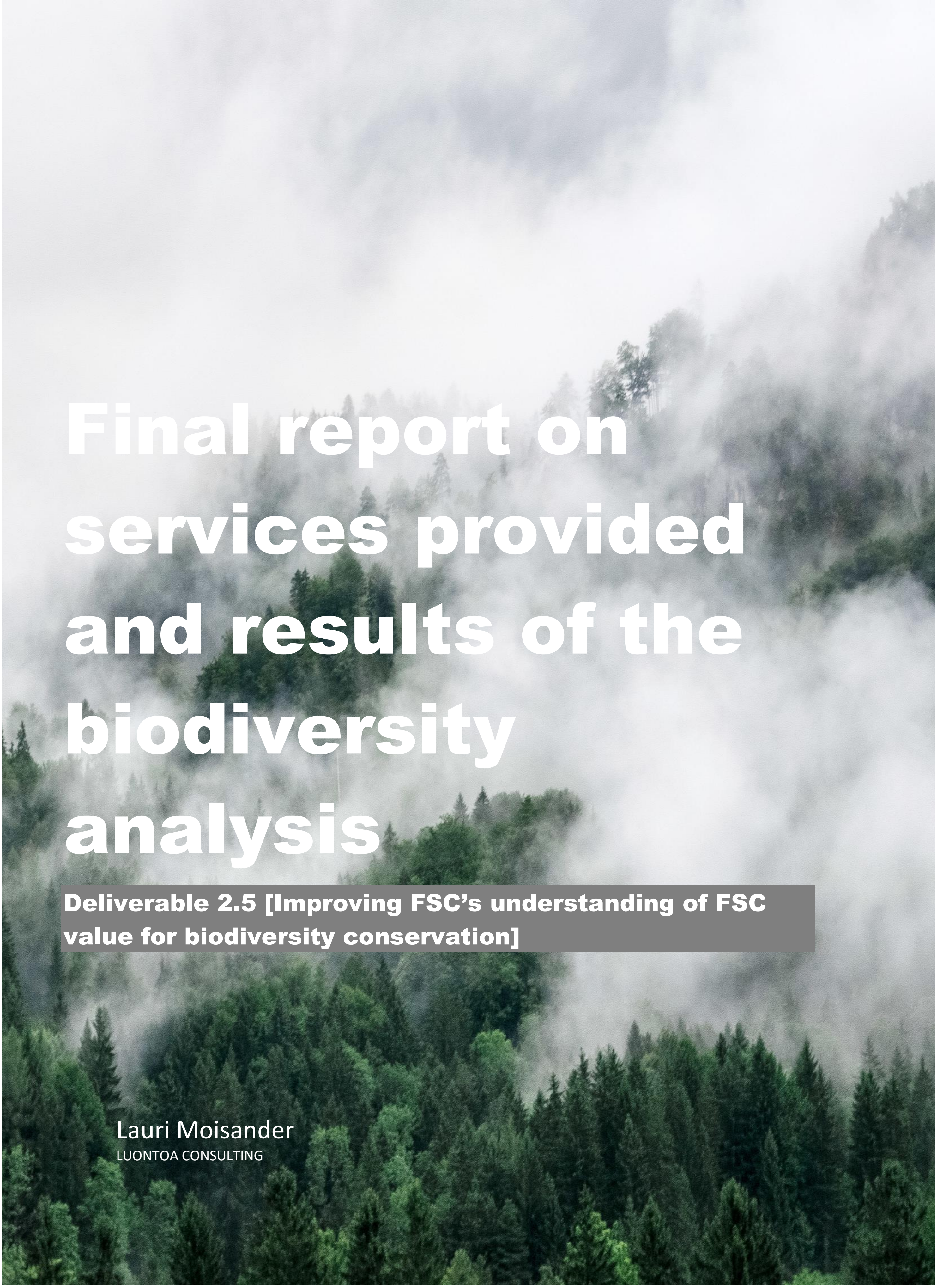

Final report on services provided and results of the biodiversity analysis

Deliverable 2.5 [Improving FSC’s understanding of FSC value for biodiversity conservation]

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CONTENTS

1. Purpose and background

1.1. Scope of the deliverable

The final report provides an overview of the work conducted for the successful delivery of deliverables (D1.1-D2.5) of the service agreement, means and methods of work and the outcomes of the data analysis work. The final delivery of D2.1 (Datasets) has been agreed to be done on March 15 at the latest, but the report already provides an overview of the process of acquiring data for the purposes of the data analysis, whilst the actual submission of data is expected to take place later.

The final report will focus on producing a description of how the data analysis was conducted and present the results of it (D2.4).

The final report is also used to reiterate the key findings from the previous deliverables – including any gaps identified in the current monitoring and data compilation methodologies, accuracy, quality and representativeness of data, access to relevant data, etc.

The final report will provide FSC with recommendations to the potential ways for further developing means for conducting meaningful monitoring activities that could be used to produce better data for monitoring and evaluation (more accurate or higher quality data, establishment of new data types or sources, etc.).

Based on the discussion between the service provider and FSC, this report will also produce recommendations related to the further development of FSC FM certification framework, in relation to possibilities related to developing the certification framework towards more an outcome-based implementation as opposed to the current rules-based application. This has been understood the be a cornerstone of FSC's upcoming fundamental revision work on the FSC Principles and Criteria, International Generic Indicators, and relevant normative documents regarding the application of FSC forest management certification.

1.2. Background and chronogram of service provider activities

The initial timeline for submission of all deliverables, as agreed between the FSC and the service provider, was for December 18, 2023. Due to unforeseen issues in acquiring data from Finnish CHs and the need to carefully frame and justify the sharing of raw data with FSC, the timeline has been mutually extended and a revised contract established between the FSC and the service provider.

During the project, there have been multiple changes to the initial contents of the initial service proposal. Most of the changes have been easy to implement and include into the activities. Some of the changes (as the data sharing with FSC), have required extensive resources to implement.

The chronogram below provides a timeline perspective into the activities undertaken by the service provider during the project and illustrates key information on the contents of each activity.

DESCRIPTION OF ACTIVITIES	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Project kick-off • Outline of expectations and agreeing on the mode of work with FSC • Contacting of FSC CHs and outline of participation							
D1.1 – Initiating interviews and survey on monitoring activities • Interviews of participating CHs and compilation of input regarding monitoring methods and drivers							
D1.1 – Analysis of interview and survey input, development and submission of report							
D2.1 – Data submission requests and data acquisition: • FinBIF (RTE species data) • Finnish Forest Center (MU/stand polygons and metadata) • (+ scoping of additional public data sources for the analysis)							
D2.1 – Scoping of relevant data to be gathered from the CHs • Iteration between service provider, CHs and FSC • Ensuring data validity, compatibility and comparability of data from multiple CHs							
D2.2 - Summary table of FSC added value • Legislative review • Industry standard practice review • Summarization and description of key differences between NFSS and Finnish legislation/industry practice • Submission of report to FSC							
D2.3 - Plan for biodiversity data analysis • Ensuring access to relevant datasets (D2.1) • Finalization of the data analysis methodology • Content and parameters for the data analysis • Submission of the analysis plan for FSC							
D2.4 – Biodiversity data analysis • Data clean up and curated datasets • Applying the data analysis to the whole dataset • Quantitative analysis results compiled • Selecting areas for qualitative analysis (data visualizations) • Qualitative analysis results compiled							
D2.5 – Final report • Key findings from work conducted by the service provider • Gaps and recommendations for monitoring and data compilation • Recommendations for FSC's further development (outcome-orientation, P&C revision)							
D2.1 – Submission of datasets *(anticipated submission)* • Service provider submits publicly available data • Service provider produces a description of how FSC may request access to confidential data (e.g., RTE species data) • Service provider facilitates and mediates an agreement between CHs and FSC for data sharing							

1.3. Limitations of the report

The most obvious limitation of this report relates to the scope of the analysis conducted. The scope of the analysis does not cover the whole of Finland, but selected municipalities in which prominent FSC certificate holders have been requested to provide desired data to allow for the data analysis to be conducted. The certificate holders invited to share data for this data analysis were (1) UPM-Kymmene, (2) Metsäliitto Osuuskunta, (3) Stora Enso, and (4) Tornator. All certificate holders were willing to share data on certain selected municipalities, but the analysis would still benefit from having a more comprehensive dataset from the certificate holders – ideally, covering the whole of Finland and all certified forest areas.

The data analysis itself has been treated as a first iteration of what may be analyzed and what type of conclusions may be made based on the data currently available to be used for such an analysis in Finland. The report, along with the prior deliverables (D1.1, D2.2 and D2.3) provide an outline of the data currently available for analysis, but also the critical gaps that exist when establishing a methodology for analyzing potential outcomes and impacts to biodiversity in Finnish forests.

The lack of data regarding species diversity, abundance, population sizes and distribution in Finland hinders the potential of deducing a baseline, let alone impacts to biodiversity stemming from forest management and application of FSC certification with a perspective on forest-based species.

The high accuracy forest inventory and topography data and availability of public and restricted access data repositories (such as the FinBIF repository on RTE species data) are excellent tools, however, for designing an analysis to evaluate impacts on biodiversity that is based on metrics regarding suitable habitats.

Designing and implementing a data analysis based on static data and no real baseline information is, however, a starting point that will hinder possibilities of making accurate cause analysis, and much of the results are based on gross assumptions. Relevant references to scientific articles have been provided in the section outlining the results of the analysis for this reason.

Designing and implementing an FSC system-wide monitoring and impact analysis methodology would require a strong baseline information on the state of key metrics related to biodiversity. These metrics would need to be carefully designed so that they are locally applicable and relevant for an international evaluation framework. Some insights on this topic are provided in the chapter regarding recommendations to FSC towards the end of the report.

2. Summary of the means and methods of work

This section provides an overview of the approach the service provider has taken to successfully complete necessary tasks and activities to ensure a smooth and successful delivery of deliverables specific to the service agreement and the finalization of the deliverable D2.5.

2.1. Deliverable 1.1 – Report on current monitoring efforts

The report that constitutes the deliverable 1.1 provides an overview of the various monitoring efforts undertaken by FSC forest management certificate holders in Finland. It produces a description of the various drivers and themes that influence the need for the companies to conduct monitoring and provides an overview of the various methodologies and structures for compiling and utilizing data for monitoring purposes. Furthermore, the report provides some recommendations for FSC in relation to potential future monitoring related requirements and access to data.

The most prominent FSC FM/CoC certificate holders in Finland were contacted, informed about the expected outputs, and invited to partake in the project in its entirety. Each of the contacted certificate holders agreed to share information and participate in the project.

The certificate holders were interviewed according to a predetermined structure to understand what type of monitoring activities are undertaken, what type of methodologies are deployed, what are the drivers behind each monitoring activity and if the monitoring would yield any data applicable for FSC. Each certificate holder was invited to fill-out a survey, share it with relevant staff from other business units (incl. monitoring, compliance, chain-of-custody, etc.).

The input gathered from interviews and surveys was analyzed and a summary report composed for FSC to satisfy the expectations regarding D1.1.

2.2. Deliverable 2.1 – Datasets

The service provider secured access to the Finnish forest inventory data from the Finnish Forest Centre and requested access to restricted access datasets concerning the occurrence points of RTE species in Finland from the Finnish Biodiversity Information Facility.

To secure crucial data from the Finnish FSC forest management certificate holders, the service provider began discussions over potential data submission. The discussions involved also FSC, and ultimately the certificate holders agreed to share data for the specific purpose of conducting this analysis – granted that all data would be anonymized and solely used for the purposes of this analysis.

The delivery of the datasets for FSC’s use is still in a discussion stage with the certificate holders. Securing access to Finnish forest inventory data and to the RTE species occurrence data should not be a problem, but without the certificate holders’ data, a similar analysis will not be applicable to be conducted.

2.3. Deliverable 2.2 – Report on FSC added value for biodiversity

The service provider conducted a review of the relevant NFSS requirements offering benefits for biodiversity enhancement and conservation in certified forests. The review was followed with a comparison of those requirements with (1) relevant legislation and (2) industry practices. In cases where the requirements offered additional value as compared with the aforementioned, these were outlined for FSC in the report corresponding to D2.2.

A summary and conclusions over the perceived benefits of FSC to biodiversity maintenance and enhancement were illustrated in the report.

2.4. Deliverable 2.3 – Description of the data analysis plan

The service provider and FSC have held bi-weekly meetings throughout the project to discuss progress, relevant outcomes of interactions with certificate holders, preliminary plans for the data analysis, availability of data and matters regarding the publication and visualization of results from the analysis. During the development of the data analysis plan, a tentative agreement for data submission from the certificate holders to the service provider had been reached. There was, however, no agreement in place for the certificate holders to further submit their data for FSC's own use.

The service provider held discussions with both FSC and the certificate holders on the anticipated focus areas of the data analysis and relevant iteration of parameters for the analysis, until a final iteration of the data analysis plan was concluded.

The service provider shared additional descriptions on the project scope, objectives and data needs and use descriptions with all four certificate holders, as well as FSC. Data use and management policy was shared with the certificate holders alongside the above description, and ultimately the datasets were submitted by the certificate holders to the service provider.

2.5. Deliverable 2.4 – Results of the data analysis

The service provider worked closely with its data analysis partner on the data analysis. There were multiple iterations of the data analysis plan's research questions and parameters throughout the analysis phase.

Due to data discrepancies, certain anticipated analysis topics were revised and data across the certificate holders was needed to clipped, cleaned and curated into formats that would ensure compatibility within the analysis.

The data cleaning and curation exercise took much longer than originally anticipated, which is a key learning also for FSC when approaching any future data analysis exercises with no clear data format requirements for certificate holders. The level of detail, especially with the metadata accompanying the polygons, has huge discrepancies between certificate holders that may be traced back to how companies utilize data in their own forest management and planning systems.

Results of the analysis were finalized on the third week of February, the results of the analysis and the final report compiled and submitted for FSC.

3. Summary of key findings from past deliverables

The final report reiterates the key findings from the previous deliverables – including for example the identification of gaps in the current monitoring and data compilation methodologies, accuracy, quality and representativeness of data and limitations regarding access to relevant data. The below table produces a summary of the key findings from past deliverables.

Deliverable		Summary of key findings
D1.1	**Report on current monitoring efforts**	Although, in general, there is relatively stringent monitoring conducted on forest management performance, conformity and compliance issues, the Finnish CHs do not generate a lot of data regarding their impacts to biodiversity.
		Main drivers for monitoring are: • Compliance with legislation • Compliance with upcoming regulation (e.g., CSRD) • Conformance with certification requirements • Corporate sustainability targets and voluntary corporate sustainability frameworks • Quality management and occupational health and safety • Forest health and risk management
		The CHs rely heavily on open data repositories both for planning and for monitoring efforts. The main data repositories include: • Forest inventory data repository • Species occurrence data repository • Environmental information repository (includes e.g., statutory conservation areas)
		The CHs utilize proxy data that provides them with an aggregated outlook onto the impacts of forest management.
		Monitoring activities regarding species richness, distribution and diversity relies on specific sample areas/research projects.
D2.1	**Datasets**	*To be delivered 03/2024* Deliverable includes: - Process description for obtaining relevant datasets to run the analysis described under D2.3 and D2.4 - Publicly available data utilized for the data analysis - Description of RTE species data and guidance for FSC on how to obtain access to the data (restricted access that needs to be requested from Finnish Biodiversity Information Facility as the data may not be shared from entity to another, but needs to be directly requested from FinBIF) - Mediation between FSC and Finnish CHs related to data submission from CHs to FSC (the process requires action from FSC)
D2.2		In the report, various likely impacts of FSC have been highlighted. It is relatively easy to deduce that FSC carries an

	Report on FSC added value for biodiversity	impact, but the impact is not currently quantified nor attributed to FSC. The report summarizes likely themes where positive impact may be achieved through FSC. The themes include: • Maintenance of continuous forest cover • Improved forest structure (diversity, age, diameter of trees) • Increased deadwood volume • Maintenance/conservation of valuable habitats • Conservation of species • Maintenance and improvement of resources for species • Increased set-aside areas (conservation), improved connectivity and widening of conservation area networks • Avoiding disturbances to breeding and nesting Concrete data allowing the detection of impacts at the level of individual stands or management units is largely missing and not likely to emerge without CHs becoming active in surveying nature inventories and producing data on relevant metrics. There are upcoming tools available that will allow efficient ways to monitor environmental performance, including possibilities to better detect deadwood, improved ability to produce harvest site data from harvest machine-mounted LiDAR and operator-based qualitative input on retention elements. The new remote sensing data analysis and modelling solutions may allow for improved capabilities to demonstrate impacts of FSC. Equally, the emergence of more information on retention elements and qualitative input from harvest machine operators may allow for better monitoring of desired outcomes and impacts of FSC related to forest management activities.
D2.3	**Description of the data analysis to be conducted**	The data analysis plan was devised through iterations between the service provider and its data analysis partner, FSC and the participating CHs. The data analysis plan was established based on the availability and quality of data (D1.1 and D2.1) from public and restricted data repositories as well as certificate holder data sources. The data analysis plan was built on top of the identified prospective impacts to be detected (D2.2). *Note: Final structure and implementation of the data analysis plan was slightly revised during the actual analysis work, as certain data discrepancies were detected.* The analysis plan focused on evaluating potential impacts of selected criteria from the Finnish NFSS (based on P&C V4). The selected criteria included: C6.2, C6.3, C6.4 and C6.5. Additionally, the analysis included a subset of HCV areas (P9). The analysis plan included the following prevalent themes and expectations for outlining impacts:

	• Increase in conservation area network coverage attributable to FSC • Improved connectivity of conservation area networks in management unit and at the landscape level • Improvements related to the conservation of high conservation values and RTE species occurrence points and relevant habitats • Landscape level connectivity of special harvest sites with FSC attributable conservation areas and statutory conservation areas
	The analysis was envisioned to produce two types of results: • Quantitative results that provide an overview of aggregated outcomes and impacts • Descriptive results of the analysis in the form of data visualizations to provide a more descriptive outline of outcomes and impacts of FSC in a specified area
	The scope of the analysis was agreed with FSC and the CHs to cover selected municipalities in Finland, whereby the CHs would submit relevant data, as outlined in D2.1 for the service provider to conduct the analysis. The minimum feasible area coverage was agreed with FSC to be 25.000 hectares of FSC certified forest land.

4. Overview of the data analysis

This section provides an overview of the process of conducting the data analysis and the relevant results obtained from it.

4.1. Description of the analysis and expected outputs

QGIS was selected as the software upon which the data analysis would be conducted in. The data analysis methodology and expected outputs is generally described in Annex 2.

In case FSC would request a summary of the work conducted for the data cleaning and curation, this may be provided as part of the submission of D2.1 Datasets in 03/2024.

4.2. Description of the data used for the analysis

The typification of the data used for the analysis is showcased in Annex 3 (Data sources).

The data compiled from CHs covered a total forest area of 71,556 hectares in 8 municipal areas in Finland. The datasets utilized for this data analysis exercise are planned to be incorporated as part of the Deliverable 2.1 – but the submission of data from the CHs to FSC is still under discussion and warrants an explicit approval from each CH (and likely a data use agreement and NDA between the certificate holders and the FSC). The service provider is supporting FSC in its efforts to secure the transfer of data from the CHs.

4.2.1. Data analysis preparation and development of analysis approaches

The preparation phase included several meetings between the service provider and its data analysis provider CollectiveCrunch. Many iterations over a suitable approach in terms of scope and focal points for the analysis were developed, additionally impacted by the requests of the CHs.

The development of an analysis framework entailed that a set of research questions was needed to be established. Expected positive impacts of FSC were identified already during the development of D2.2 '*Report on FSC's added value on biodiversity*', and this report was used as a starting point for determining a feasible set of research questions and parameters for conducting the analysis. The availability, quality and accuracy of the data provided by the CHs posed an additional layer of complexity into this development phase, as not all of the expected impacts from the implementation of the NFSS were observable through existing and available data.

A set of research questions and hypotheses were developed, and a list of parameters, data comparison prompts, and guidance were established for initiating the data analysis. A more detailed outlook on this work may be seen from Annex 2 of this document.

During the analysis phase, additional amendments to the data analysis plan were made due to some data discrepancies that became apparent during the analysis. Additionally, some changes were made during the analysis due to iterations on the analysis goals and evaluation of relevance of certain expected outputs.

4.2.2. Cleaning and (re)structuring of the data obtained from CHs

The data obtained from the CHs included roughly the same items from each, but the actual datasets from each CH were not in a same format and composition across the CHs. The data clean-up and structuring of the raw data into layers and format that would allow a satisfactory data analysis to be conducted, took more time than initially anticipated.

Additionally, the structure of the CH data obtained meant that some of the research questions would not be applicable to be evaluated as part of the data analysis. This was due to the fact that some of the stand level information requested from the CHs were lumped into a single layer, and dividing an aggregated layer of information regarding e.g., NFSS indicator 6.3.5 (special harvest sites), would not be feasible. The meta data accompanying the stand level polygons was often insufficient in quality, precision and there was no coherence between the CHs in how much detail each company produces to the meta data. A more detailed outline of the discrepancies and gaps in data is outlined below.

A key challenge in cleaning of CH data were overlapping areas within polygons provided by the CHs, and particularly between the CH data and public data sets (statutory conservation areas and HCV area). To avoid double-counting of such overlapping areas during the analysis, all overlaps were removed during the cleaning phase, whereby areas declared as FSC conservation areas took precedence over statutory conservation areas.

4.2.3. Identified discrepancies in data

The following table illustrates some key discrepancies and shortcomings related to data that were identified during the data analysis exercise.

Summary of discrepancy	Problem description	Potential remedies in the future
Insufficient distinction related to areas managed according to indicator 6.3.5 of the Finnish NFSS	Some CHs did not distinguish in the data they submitted what is the specific environmental objective of stand management according to NFSS indicator 6.3.5. • This is a key weakness in data quality and prohibited certain predefined data analysis objectives from being included into the analysis.	NFSS development: • Establishing specified intended environmental objectives and outcomes for i6.3.5; • Monitoring and data submission requirements for capturing intended environmental objectives and outcomes of i6.3.5; Data quality/format requirements: • Clear requirements for stand-level data delineation between desired outcomes; (e.g., polygon data for each specific stand, incl. conservation areas and watercourse buffer zones)

Submission of areas of non-productive forests	Some CHs submitted polygon data including areas that were designated as non-productive forest areas (such as bogs and swampland). • As these habitats often coincide with RTE species occurrence points, this may skew the analysis results slightly.	Data quality/format requirements: • FSC's monitoring requirements should include specification of the required format and quality of data to be submitted by the CHs
Clipping the data and removing overlaps	The data provided by the certificate holders was not directly compatible across the CHs. The clipping of the data and the removing of overlaps existing between the CH datasets with public data (e.g., in terms of statutory conservation areas) required extensive working time.	It is advised that if FSC implements monitoring and data requirements for CHs, that there would be clear requirements related to the format for the data to be submitted.
Insufficient scope of submitted data	One certificate holder shared insufficient data, and the whole dataset became inapplicable for the purposes of the analysis, as the data did not cover the FSC certified MU polygons, but only included stand level data and boundary data.	It is advised that if FSC implements monitoring and data requirements for CHs, that there would be clear requirements related to the format for the data to be submitted.

4.3. Qualitative analysis (data visualizations)

The data visualization examples have been compiled into a separate document that include visual examples accompanied with relevant legend for map layers and a narrative of the context and relevance of findings. The examples are intended to provide FSC with an understanding of what type of impacts may be demonstrated as attributable to FSC based on the available data and how these visualizations could be prepared for FSC's purposes.

The qualitative analysis was prepared in conjunction with the quantitative analysis, and the objective was to produce visual examples of the outcomes and impacts of FSC that are grounded in the quantitative analysis results, but provide a visual illustration as well as a descriptive narrative to further explain FSC's impacts. The provided examples were selected nonrandomly by Luontoa, and while they are to be considered representative, they mostly showcase the situation in large landholdings where landscape level planning has been possible, and some RTE species inventories have been made. The qualitative analysis was designed to produce results across all themes prevalent in the quantitative analysis (5.1).

5. Results from the data analysis

This section provides a summary of the results of the data analysis. The report focuses on the quantitative results, and outlines the basis for the development of the narratives for the qualitative results. A more detailed description and tentative data visualizations for the qualitative results are provided in a separate document.

The below table provides information on the terminology used for presenting the results. The terminology has been developed in order to provide relevant information on the typification of certain areas and to justify certain bundling of datasets for the purposes of the data analysis.

TERM	DEFINITION IN THE CONTEXT OF THE ANALYSIS
Statutory conservation area	Includes all distinct statutory conservation areas derived from the NLS data repository.
FSC5%	All FSC attributable conservation/set-aside areas (C6.4). *NOTE: Overlap with statutory conservation areas have been removed and overlap areas have been attributed to FSC5%, as private conservation areas may be assigned to meet with the minimum 5% conservation requirement, and any area sold to the state as a statutory conservation area would first need to be assigned as meeting with C6.4 requirements.*
FSC10%	All FSC special harvest sites (C6.3).
Conservation area	Generic term used for either statutory or FSC attributable conservation/set-aside areas without distinction over one or another.
Adjacency of area / Connectedness of areas	10m proximity threshold has been established for signifying that an area is adjacent to another area of interest in the analysis. *NOTE: The proximity threshold of 10m was applied to take into account and resolve any topographic data or other deviations (e.g., discrepancy in data layers, stand demarcation, roads or small waterways).*
Certified forest area	Area included as certified polygons into the datasets provided by the CHs
Uncertified forest area	Area outside of the datasets provided by the CHs. *NOTE: Some of the uncertified forest area may be in fact FSC certified, but as there is no data indication of this and no relevant FSC attributes available, all forest areas not included into the datasets provided by the CHs have been labelled as 'uncertified forest area'.*
RTE species	All species included into the list of IUCN red listed species in Finland in the following categories: NT – near threatened VU – vulnerable EN – endangered CR – critically endangered

5.1. Quantitative results

The quantitative results are showcased as per the objects of analysis highlighted in Annex 2 (data comparison and structure of analysis). Annex 2 provides an overview of each object of analysis with a reference to the relevant data used to run the analysis and the research questions onto which the analysis has been based.

NOTE: The results illustrated in this section of the report may be shared with FSC in an Excel spreadsheet. There are additional background information and justification of the results included into the below sections that do not exist in the spreadsheet.

5.1.1. Increase in conservation area

Relevant NFSS requirement (excerpt):	
NFSS reference: C6.4 Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources. Under this Criterion, there are both quantitative and qualitative requirements related to conservation areas. Firstly, a minimum threshold of 5% is established, that requires forest owners and managers to set aside a minimum of 5% of the total MU area for conservation purposes. Additionally, a comprehensive list of qualitative and trigger clauses require the conservation of certain areas and suggest conservation of 'important' and at times, 'rare or endangered' habitats.	
Summary of results	
1. Existing statutory conservation area in the scope of the analysis	1638,9 ha
2. FSC attributable conservation area in the scope of the analysis (C6.4)	7531,5 ha
3. Conservation area addition through the application of FSC certification inside certified polygons	460%
Why is this meaningful?	
It is widely accepted that, although there are a relatively high number of 'protected' areas in Finland (2.94 million ha / 13% of total forest area), more conservation measures and more stringent focus of those measures are needed[1,2]. Increase in conservation area network size alone is important, and any conservation area will over time contribute also to qualitive needs of species towards old-growth forest habitats, but	

[1] Kouki, J., Junninen, K., Mäkelä, K., Hokkanen, M., Aakala, T., Hallikainen, V., Korhonen, K. T., Kuuluvainen, T., Loiskekoski, M., Mattila, O., Matveinen, K., Punttila, P., Ruokanen, I., Valkonen, S. & Virkkala, R. 2019: Forests. – In: Kontula, T., Raunio, A. (eds.), Threatened habitat types in Finland 2018. Red List of habitats. Part I: Results and basis for assessment: 113–124. Finnish Environment Institute and Ministry of Environment, Helsinki.

[2] Monkkonen, Mikko & Aakala, Tuomas & Blattert, Clemens & Burgas, Daniel & Duflot, Rémi & Eyvindson, Kyle & Kouki, Jari & Laaksonen, Toni & Punttila, Pekka. (2022). More wood but less biodiversity in forests in Finland: a historical evaluation. Memoranda - Societatis pro Fauna et Flora Fennica. 98. 1-11.

additionally the qualitative aspects should be considered when allocating conservation areas across forest landscapes in the first place. FSC requires the forest owners to allocate representative sample areas as set-asides, but means of verifying this are relatively difficult to obtain.

Takeaways for FSC

- ► It may be worthwhile capturing data from CHs on which areas have been designated as conservation or set-aside areas based on trigger criteria established in Criterion 6.4;
- ► Additionally, capturing information on rationale and justification for conservation designation on other types of habitats (not triggered by C6.4) could be worthwhile;
- ► It would be important to capture information on key elements for the conservation decision-making, such as:
  - o Abundance (and volume) of deadwood;
  - o Key characteristics (e.g., topographic information);
  - o Any legal protection measures and triggers (e.g., the stand meets the Forest Act §10 criteria)

5.1.2. Increase in size of and connectivity between conservation areas

Relevant NFSS requirement (excerpt):

No relevant requirements related to improving the size of existing conservation areas.
No relevant requirements related to improving connectivity between conservation areas.

Summary of results

1.	Total amount of conservation areas connected with FSC attributable conservation areas in the scope of the analysis	559 statutory conservation areas connected through the designated FSC attributable conservation / set-aside areas (C6.4)
2.	Average increase in size of a connected statutory conservation area	6,4 ha
3.	Number of statutory conservation areas connected with one another	210 (number of statutory conservation area clusters which were at least 50 m apart before being interconnected via an FSC conservation area)

Why is this meaningful?

The volume of conservation areas is not sufficient on its own. Species diversity, prosperity and necessary habitat functions and resources often require larger and connected areas[3]. Conservation of a specific specie may become redundant if the conservation solution does not consider adequately the resource needs of the specie in question, as well as the parameters for a

3 Lehtomäki J, Tuominen S, Toivonen T, Leinonen A (2015) What Data to Use for Forest Conservation Planning? A Comparison of Coarse Open and Detailed Proprietary Forest Inventory Data in Finland. PLOS ONE 10(8): e0135926.

specific ecosystem to survive. Low connectivity between conservation areas may present a huge barrier for increasing species diversity and biodiversity as a whole[4].

Riparian buffer zones are a prevalent requirement of FSC in Finland. They contribute to reducing nutrient and soil run offs to watercourses, but they also provide set-aside/conservation areas that are rich in biodiversity[5]. For the purposes of this analysis, their role in also producing connectivity between statutory and FSC attributable conservation areas has been evaluated.

Takeaways for FSC

- Conservation area networks are an important part of the FSC certification framework, yet the need and a concept for establishing connected, larger conservation area networks is not sufficiently established in the FSC normative framework.
- FSC is a certification scheme where the objective of certification is always the management unit. For ecological functions and maintenance and enhancement of environmental values and ecosystem services to be fully incorporated into the FSC certification system, a landscape approach would be needed to be considered. Connectivity of conservation area networks across the landscape, and importantly across management units, is a theme that would benefit the planning of conservation efforts inside the FSC system.

5.1.3. RTE species occurrence distribution

Relevant NFSS requirement (excerpt):

NFSS references: C6.2, C7.1
Safeguards shall exist which protect rare, threatened and endangered (RTE) species and their habitats (*e.g.*, nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.

Additionally, the NFSS requires the forest owner to possess plans for the identification and protection of RTE species as part of its forest management and planning.

Summary of results

1.	Total number of RTE species occurrence points within the certified MUs scope of analysis	645	
2.	RTE species occurrence points inside statutory conservation areas	112	17,53 % of total occurrence points

[4] Santangeli, A., Weigel, B., Antão, L.H. et al. Mixed effects of a national protected area network on terrestrial and freshwater biodiversity. Nat Commun 14, 5426 (2023).

[5] Mykrä, H., Annala, M., Hilli, A., Hotanen, J.H., Hokajärvi, R., Jokikokko, P., Karttunen, K., Kesälä, M., Kuoppala, M., Leinonen, A., Marttila, H., Meriö, L.J., Piirainen, S., Porvari, P., Salmivaara, A., Vaso, A. GIS-based planning of buffer zones for protection of boreal streams and their riparian forests, Forest Ecology and Management, Volume 528, (2023).

3.	RTE species occurrence points inside FSC attributable conservation areas	293	45,85 % of total occurrence points
4.	RTE species occurrence points outside of any conservation area (inside FSC certified MU polygons)	234	36,62 % of total occurrence points
5.	Increase in RTE species occurrence points distribution in areas with a conservation status	262 % increase in occurrences inside conservation areas	

Why is this meaningful?

Although the determination of causality between the RTE species occurrence and the establishment of a conservation status for its habitat is not feasible, it is clear that due to FSC the presence of RTE species occurrences in areas with a conservation purpose is increasing greatly. This may be a result of extensive forest management planning and surveying requirements related to the identification of environmental values. The NFSS requires the conservation of areas based on e.g., abundance of deadwood, maturity of trees and other observable characteristics of high conservation value areas (e.g., large and old individual trees). These conservation values often coincide with characteristics and resources required by e.g., deadwood dependent RTE species for feasible habitats. Therefore, it may deduced that allocation of conservation areas based on the criteria suggested by the NFSS (especially C6.4) may correlate with the plausible presence of RTE species.

Takeaways for FSC

- The relatively high share of RTE species occurrence points inside FSC attributable conservation/set-aside areas (45,85%) suggests that the application of C6.4 is having a meaningful contribution to conserving valuable habitats suitable for the emergence of RTE species in Finnish forests.
- The results do suggest that there is an extremely high increase in RTE species occurrence point existence inside areas with a conservation status (especially FSC attributable conservation areas).
- The RTE species occurrence points differ in quantity and density across Finnish municipalities, and there is a possibility that the relatively small sample of municipalities and overall coverage of FSC certified forests (~70 000 hectares) included into the scope of the analysis might skew the results in one way or the other.

5.1.4. RTE species located inside FSC special harvest sites (C6.3)

Relevant NFSS requirement (excerpt):

The Finnish NFSS introduces a concept of special harvest sites under Indicator 6.3.5. The intent of Indicator 6.3.5 is to supplement the establishment of conservation areas and the conservation of areas with high conservation values, where specific environmental objectives are attached to managed forest areas.

In the Finnish NFSS a list of potential ways for managing ‘special harvest sites’ are introduced. The NFSS requires forest owners to have a minimum 10% of their forest assets managed under a specific environmental management objective. This 10% threshold consists of :

- minimum set-aside area of 5% (6.4);

- allocated special harvest sites (6.3.5) + set-aside areas (6.4) together accounting for a minimum of 10% of the total management unit area.

For the purposes of this analysis, a subset of possible special harvest sites has been selected that includes stands were the environmental objective is to:

1. manage the stand with an aim of permanently maintaining >10m³ volume of deadwood;
2. manage the stand with continuous cover forestry regime; OR
3. manage the stand with a permanent deciduous tree majority.

Summary of results		Share of the total RTE occurrence points in the scope of the analysis
1. RTE species occurrence points inside stands with deadwood objective (>10m³)	14	2,2 %
2. RTE species occurrence points inside continuous cover forestry stands	0	0,0 %
3. RTE species occurrence points inside deciduous tree dominated stands	2	0,3 %

Why is this meaningful?

The selected special harvest site environmental objectives are seen to represent critical elements that should be considered in productive forests. It is accepted that in productive forests conservation of forest areas is important, yet additional measures are needed also in actively managed stands to promote biodiversity. Managed forests account for more than 90% of Finnish forest landscapes, and therefore actions to promote biodiversity in managed forests is crucial for enabling biodiversity recovery[6].

The selected special harvest site objectives are chosen due to their expected delivery of fundamental resources and enabling conditions for the occurrence of RTE species populations that are dependent on deciduous trees, deadwood succession or require a continuous forest cover.

Takeaways for FSC

- ► Although the observed number of RTE species occurrence points is scarce in special harvest sites in the scope of this analysis, it is worth acknowledging the expected plausibility of these stands to provide a suitable habitat for a number of rare and endangered species.
- ► A future application of outcome-orientation in the context of FSC could involve a requirement to conduct species inventory work in special harvest sites to determine the effectiveness of establishing this type of stands with a permanent environmental management objective (e.g., in stands where there is a prescribed objective for establishing deadwood in volumes).

[6] Mönkkönen, M., Aakala, T., Blattert, C., Burgas, D., Duflot, R., Eyvindson, K., Kouki, J., Laaksonen, T., & Punttila, P. (2022). More wood but less biodiversity in forests in Finland: a historical evaluation. Memoranda Societatis pro Fauna et Flora Fennica, 98(Supplement 2), 1–11.

5.1.5. RTE species trends

Relevant NFSS requirement (excerpt):

The requirements from the Finnish NFSS do not directly require that each RTE species occurrence would need a conservation area to be established around the occurrence point, but C6.2 states that "conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources." This requirement has been a constant source of confusion as to whether or not a permanent conservation zone should be established for an RTE species occurrence point.

Summary of results		
1. How much RTE species occurrences occur in FSC certified polygons as compared with uncertified? (compared with proportional average)	45,02 %	Change in RTE species per km² in FSC certified polygons vs. uncertified forest area
1.a RTE occurrences per km² in FSC certified polygons	0,76	2,9 %
1.b RTE occurrences per km² in uncertified private forests (across all other forests inside the municipalities included into the scope of the analysis)	1,69	97,1 %
2. How many of the RTE species occurrences inside FSC certified polygons occur inside conservation areas?	293	45 %
3. How many of the RTE species occurrences inside FSC certified polygons occur inside special harvest sites?	16	2 %

Why is this meaningful?

On average, it was observed that the distribution of RTE species occurrence points inside FSC certified polygons is much scarcer than in uncertified forests. This is potentially due to multiple contributing factors and no immediate conclusions should be made about this result.

The most prominent factor that was detected during the analysis was the unusually high number of RTE species occurrence points in two municipalities: Kuopio and Somero. The RTE density in those municipalities was 4 occurrence points per km² in Kuopio, and >6 occurrence points per km² in Somero. Within those two municipal areas, the share of FSC certified polygons in the analysis was low. When those two municipalities were left out of the analysis, within the remaining six municipalities, the RTE occurrence points in FSC certified MU polygons was 37% higher than in uncertified forests.

Additional factors may include that the number and distribution of RTE species occurrence points is dependent on the application of species inventory work, and the occurrence data is always skewed towards areas where more inventory work has been conducted (e.g., research forests, statutory conservation areas, etc). The potential contributing factors to the surprising result may include:

- RTE species data is congested to areas where specific research has been conducted that has required species surveys and extensive field work.
- Overall, the data regarding RTE species occurrence points has an insufficient coverage of occurrences across productive forest lands.

- There is an observable variation between municipalities in relation to the density of RTE species occurrence points which is likely due to varying levels and intensity of conducting species inventory work by research organizations, NGOs and other organizations and individuals.

Takeaways for FSC

- ► Reliance on publicly available RTE species data is not a sufficient starting point to detect meaningful impacts of FSC to RTE species population size, distribution, abundance and diversity.
- ► Species data is often costly to generate and requires field work when conducted with customary research methodologies. One potential way to compile representative data on species would be to implement eDNA analyses as part of (1) NFSS standard setting/revision process and (2) monitoring activities regarding the established desired outcomes incorporated into the NFSS.

5.1.6. Adjacency of special harvest sites with conservation areas

Relevant NFSS requirement (excerpt):

There are no adjacency requirements, nor are there guidance or suggestions of designating areas adjacent to conservation areas to conform with the C6.3 special harvest site requirements.

Summary of results		
1. How much adjacent special harvest sites are detected to conservation areas?	319	total amount of adjacent special harvest sites (C6.3)
2. How much does a conservation area "grow" on average as a result of special harvest sites?	4,5	ha

Why is this meaningful?

Special harvest sites as per C6.3 under the Finnish NFSS require certain stands to be managed with a prescribed environmental objective. For the purposes of the analysis, the service provider chose to include areas where the environmental objective is related to (1) maintaining a permanent forest cover through continuous cover forestry, (2) maintenance of a minimum deadwood quantity (>10m^3/ha), and (3) maintenance of a deciduous tree majority within the stand.

All of the above environmental objectives contribute to specific needs in improving Finnish forest diversity and supporting functions to improving biodiversity.

Conservation area network size is a key metric of the importance and value of any conservation area. By default, conservation areas should be as large and as connected with one another as possible[7]. Habitat conditions and values inside established statutory conservation areas are impacted by management activities in adjacent forest areas, and establishing buffer zones may reduce a reflection impact of e.g., harvesting to the adjacent statutory conservation areas.

Takeaways for FSC

[7] Lehtomäki J, Tuominen S, Toivonen T, Leinonen A (2015) What Data to Use for Forest Conservation Planning? A Comparison of Coarse Open and Detailed Proprietary Forest Inventory Data in Finland. PLOS ONE 10(8): e0135926.

- The allocation and determination of an applicable environmental objective for special harvest sites has been a topic of confusion in the application of the NFSS in Finland over the past 10+ years. A more stringent set of requirements/recommendations onto the expected function of special harvest sites and contribution/enhancement to surrounding observed values (e.g., HCVs, statutory conservation areas, RTE species occurrences) would provide needed structure to the application of C6.3.
- The establishment of special harvest sites could be triggered by RTE species occurrence points (e.g., if a specie is dependent on deadwood succession, the stand would automatically be allocated with a minimum deadwood objective of >10-20m^3).

5.1.7. Areas managed with prescribed burning

Relevant NFSS requirement (excerpt):

NFSS reference: 6.2.8
Large forest owners (>10.000ha) shall use prescribed burning to maintain habitats of species dependent on forest fires. The minimum total area of prescribed burnings performed annually shall be 3% of the regeneration felling area of suitable sites (MT and poorer sites) during a 5-year period.
NOTE: There are no corresponding requirements from legislation or other certification schemes currently in Finland.

Summary of results

Number of prescribed burning sites in the scope of the analysis	6
Combined total area of prescribed burning sites	34,6 ha
Average area of a prescribed burning site	5,8 ha

Why is this meaningful?

More than half of Finnish forests had been managed with slash and burn techniques between 1700-1900[8]. As the slash and burn forest/agricultural management of Finnish forests resided, and a more customary productive forest management regime was adopted that aimed at establishing measures to managing forests with rotation forestry and improving and establishing sustained timber yields, the share of burnt habitats has dramatically decreased.

In order to maintain and improve conditions for fire-dependent species, especially rate or threatened, and habitat types, the introduction of prescribed burning requirements have been seen as especially important in the Finnish NFSS in 2011. Additionally, the sites where prescribed burning is applied often lead to favorable conditions for deadwood dependent species[9].

The results from the analysis depict a relatively small sample of the total areas that have been treated with prescribed burning since the inception of the Finnish NFSS in 2011.

Takeaways for FSC

[8] Parviainen, J. 1996. Impact of fire on Finnish forest in the past and today.

[9] Korhonen, K.T., Huuskonen, S., Kolström, T., Kurttila, M., Punttila, P., Siitonen, J. & Syrjänen, K. 2021. Closer-to-nature forest management approaches in Finland. Natural resources and bioeconomy studies 83/2021. Natural Resources Institute Finland. Helsinki. 25 p.

- Easily included into mandatory monitoring framework.
- Relatively easy requirement to monitor and establish data on.
- Could be useful to include a requirement to conduct specie surveillance on e.g., year 10-15 after prescribed burning (studies suggest expected RTE species occurrences)

5.1.8. High conservation value (HCV 1&3) areas – Natura2000 and IBA/FINIBA areas

Relevant NFSS requirement (excerpt):

NFSS reference: C9.1 and C9.2, Annex 9

The NFSS requires forest owners to acquire information on the presence of HCVs in their forests, consider and survey the impacts to existing high conservation values. The forest owner is required to obtain information from relevant authorities on the presence of HCV areas.

The forest owner shall ensure the maintenance or enhancement of the applicable conservation attributes of high conservation value areas by implementing the measures determined in the management plan.

Summary of results		
1. How much connected conservation areas are established through FSC for internationally recognized Natura 2000 and IBA/FINIBA habitats?	33	amount of connected conservation areas including Natura 2000/IBA/FINIBA
2. How much does a connected Natura 2000 area "grow" on average as a result of FSC?	31,3	ha
3. How much does a connected IBA/FINIBA area "grow" on average as a result of FSC?	14,0	ha

Why is this meaningful?

The inclusion of Natura2000 and IBA/FINIBA areas into the analysis were chosen to allow a perspective to be had on important habitats that are based on international agreements and in the case of Natura2000, are rooted to European Commissions decisions. Through FSC, the implementation of these agreements is put into spotlight, and through FSC's accreditation requirements, there is a continuous monitoring of performance and impacts onto those areas.

Furthermore, the service provider decided to incorporate an element into the analysis that would evaluate the direct effects of FSC's set-aside requirements (C6.4) in supplementing and expanding the connectivity of Natura2000 and IBA/FINIBA areas across landscapes.

The results of the analysis suggest a relatively small contribution to improving connectedness of Natura 2000 and IBA/FINIBA areas with FSC attributable conservation/set-aside areas with 33 areas (Natura 2000/IBA/FINIBA) being directly connected with FSC set-asides. However, the observed average increase of the total conservation area size for both Natura 2000 and for IBA/FINIBA areas as a result of FSC is significant (31,3 ha for Natura 2000 and 14,0 ha for IBA/FINIBA).

Takeaways for FSC

► Further consideration over the designation of FSC set-aside/conservation areas adjacent to existing conservation areas could be taken in future NFSS revisions. Improving connectivity of existing statutory conservation areas and FSC attributable conservation areas could be strengthened and positive outcomes outlined as some of FSC's key contributions towards improving biodiversity conservation and enhancement in productive forest areas.

5.2. Qualitative results and data visualizations

The results of the qualitative analysis and the resulting data visualizations have been developed as a result of careful consideration by the service provider. The aim has been to develop visual examples of FSC's key contributions towards safeguarding biodiversity in productive forests, and to allow FSC to evaluate the possibilities associated with the available data for producing data visualizations. The results of the qualitative analysis build on from the quantitative analysis (5.1) and extend the description of the positive outcomes.

The visualization examples are provided in a separate document. The document includes six examples with a following structure:

Map visualizations	Ratio between 1:25000 to 1:100000
Map layers	• Base map layer • FSC certified MU polygons • FSC certified MU stand boundaries • Statutory conservation areas • FSC attributable conservation areas (C6.4) • FSC special harvest sites (C6.3) • RTE species occurrence points (C6.2) • Riparian buffer zones (C6.5) • Watercourses
Narrative	A theme for each visualization is established. For each theme, a description of relevant map layers is highlighted, RTE species identified and a description about the expected dependencies and contributions between map layers and elements is provided. The description of variables and layers included into each visualization are designed to act as the basis for producing a narrative to accompany the visualization.
Themes	The six visualizations include the following themes: 1. Improved connectivity across conservation areas at a landscape level; 2. Connectivity established across existing statutory conservation areas; 3. Riparian buffer zones establish eco-corridors across the landscape; 4. Intact riparian buffer zone around a lake with connected conservation areas; 5. Consolidated conservation efforts in areas of high conservation value;

	6. Consolidated conservation efforts in areas of high conservation value + Osprey nesting site + prescribed burning site.
Recommendations	The map visualizations provide FSC with recommendations on the format and description to accompany the visualizations of FSC's contributions to maintaining and enhancing biodiversity in Finland based on the available data.

The service provider proposes for a dedicated discussion to be held over the example data visualizations with FSC. No certificate holder data may be used without prior and written agreement with relevant certificate holders.

6. Recommendations for FSC

The final report will provide FSC with recommendations to the potential ways for further developing means for conducting meaningful monitoring activities that could be used to produce better data for monitoring and evaluation (more accurate or higher quality data, establishment of new data types or sources, etc.).

Based on the discussion between the service provider and FSC, this report will also produce recommendations related to the further development of FSC FM certification framework, in relation to possibilities related to developing the certification framework towards more an outcome-based implementation as opposed to the current rules-based application. This has been understood the be a cornerstone of FSC's upcoming fundamental revision work on the FSC Principles and Criteria, International Generic Indicators, and relevant normative documents regarding the application of FSC forest management certification.

6.1. Ensuring access to relevant data

There are evident gaps in terms of FSC's ability to gather monitoring data on performance and impacts of FSC on the ground. These gaps exist firstly in relation to FSC's claim to any data from certificate holders. There are no contractual obligations for certificate holders to share any data with FSC. The only obligations for the organization revolve around the certified status and conformity with applicable certification requirements. If FSC were to require monitoring efforts and data from certificate holders, this would need to be directly included as certification requirements.

As the understanding is that some monitoring requirements would likely accompany current FSC certification requirements, the question arises where these requirements should be housed. As is likely going to be one of the findings from this ongoing project, abilities to conduct monitoring and generate data from across the world are quite different. This poses a problem when designing monitoring requirements or drafting a set of generic data submission requirements for an international certification scheme. It would be worthwhile having comparable data across countries about FSC's performance and impacts to biodiversity and other topics, but it might not be possible.

A rather more applicable route could be to instate national monitoring and data requirements that would be grounded on outcomes and impacts that have been identified critically important to a given country. Secondly the monitoring and data requirements should be something that do not pose unbearable strain on the certificate holders but would in an ideal situation be aligned with existing monitoring activities and revolve around data already utilized by the certificate holders. Including monitoring and data requirements to the NFSS would allow FSC to begin including prescribed desired outcomes and communicate about the system's expected outputs and impacts in selected countries. Ultimately this would open avenues for certificate holders to gain access to unprecedented impact claims from the world's most trusted forest certification scheme. This would further elevate FSC's relevance and likely attract new organizations.

6.2. Ensuring data compatibility and relevance for analysis

This recommendation is grounded very much on the data analysis conducted on the data provided by the Finnish CHs. In order for FSC to gain access to compatible and comparable data across CHs in Finland, the following suggestions would likely support this endeavor:

- The CH's should provide their compartment-level data for FSC certified areas as a single GIS layer in a commonly used vector file format (e.g. ESRI shape file, or GeoPackage), with one polygon (or multi-polygon) per compartment/stand plus metadata. A single layer has the big advantage that it is less likely to have overlaps or inconsistencies between the various FSC categories and sub-categories.
- The compartment-level metadata should comprise at least a unique, immutable ID for each compartment (stand); the ID of the management unit (e.g. cadastral parcel) it belongs to; the land cover type (forest, swamp, agriculture, ...) and FSC category (e.g. watershed buffer zones, set-aside areas, special harvest site type A/B/C, ...)
- The possible values for the stand metadata (land cover type and FSC category) should be standardized by FSC and not freely chosen by the CH's, otherwise gaps and inconsistencies are almost guaranteed. Preferably, numeric codes should be used rather than alphanumeric text/acronyms
- The CH's management units, each representing a group of spatially related FSC certified compartments (e.g. cadastral parcel), should be provided as a separate set of polygons. Each management unit should have a unique, immutable ID (e.g. cadastral ID).

6.3. Revising the core of FSC

National policies and legislation may change quickly to either proactively managing identified land-use risks or reacting to risks manifesting themselves into economic, environmental and social damages. Additionally, there is an increase in the pace in which e.g., European Union publishes new regulative requirements for member nations to implement. Nature and ecosystem services related risks are prevalent topics in most recent regulatory changes at the level of the EU, and more changes are anticipated to tackle unsustainable land-use regimes. Maintaining relevance of a static and rules-based approach in a regulatory environment that is in constant turbulence is difficult.

Outcome-orientation could allow FSC to more nimbly adapt the system’s implementation to meet the needs of sustainable forest management – all from an environmental, economically sustainable and regulatory perspectives. Climate change induced risks (biotic and abiotic) can quickly become a reality and set the scene for forestry in a country or region. Rules-based systems have the advantage of being very predictable and relatively easy to implement. However, the modus operandi of FSC is that standards (incl. NFSS) are static and not adept in adapting to changing realities.

The upcoming revision of FSC’s very core – the FSC Principles and Criteria – as well as the International Generic Indicator standards presents the organization with a make or break opportunity to change the way sustainable forest management certification operates. It is vital that the opportunity is seized to adopt ways to being more data-driven and outcome-oriented in how standards are developed and implemented. This needs to translate into the organization being better equipped in administering impactful standards for national application that produce desired impacts that the organization itself can keep monitoring over time. And if need be, implement changes to the normative framework with increased agility.

The design of such outcome-oriented requirements for the implementation of FSC on the ground needs to be based on solid scientific basis. The development of FSC's standards currently relies heavily on the use of chamber-balanced or technical working groups, where the core decision-making body often comprises of solely interest-holders, rather than people that objectively evaluate and decide upon the needs for change. Therefore, a crucial element of designing science-based, outcome-oriented and effective standards in FSC would greatly benefit from the incorporation of researchers, forest management/ecology/pathology/modelling experts into the decision-making process.

Additionally, if conformity assessment of FSC certification would include the notion of monitoring of key metrics regarding certain desired outcomes, it could greatly impact the design of FSC's accreditation standards for forest management evaluations. Currently conformity assessments are based largely on field observations (in some cases remote observations), where conformity against rules and restrictions posed on forest management operations are being witnessed by third-party auditors. To make the evaluation methodology more fluid, utilization of data on metrics and the monitoring of progress against desired outcomes could produce a more effective case for conducting conformity assessments for forest management evaluations.

A good system that strives for outcome-orientation can anticipate and design a system that sets out clear, achievable desired outcomes and a theory of change that drives the implementation of the system. However, in the context of forests and certification of natural resources, outcome-orientation is equally important in relation to anticipating and preparing for unwanted, negative and progress-hindering impacts that may require swift adaptation from landowners, forest managers, policy makers and industries. Outcome-orientation is crucial, whether from a positive and desired outcomes perspective, to the anticipation and preparation of potential accumulation and likelihood of risks and negative impacts.

Annex 1 – Data description for the analysis

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Data layer ID	Data subject	Source	Data publicity	Notions about data
#1	**Forest inventory data**	Forest Centre	Public	To include demarcation of Forest Act, §10 sites.
#2	**Statutory conservation areas**	NLS Forest Centre (ETE)	Public	Includes all established and permanent conservation areas with legal conservation area status. Any overlap between NLS and Forest Centre data was removed.
#3	**RTE species occurrence data**	FinBIF	Restricted	All RTE species occurrence points to be included into the analysis.
#4	**FSC watershed buffer zones (C6.5)**	CH	CH - restricted	Expectation that all CHs provide polygon data (delineated stands).
#5	**Automated watershed buffer zones [*in case #4 missing from CH data*]**	N.A.		In case watershed buffer zones are missing from any CH dataset, an automated demarcation exercise would be undertaken.
#6	**FSC set-aside areas (C6.4)**	CH	CH - restricted	FSC designated set-aside areas may also include statutory conservation areas in some cases (duplication between #2 and #6 is to be removed).
#7	**FSC special harvest sites (C6.3) - deadwood objective (>10m³)**	CH	CH - restricted	Sites with a specific objective of permanent deadwood volume of >10m³
#8	**FSC special harvest sites (C6.3) - continuous cover forest areas**	CH	CH - restricted	Sites where continuous cover forestry regime is implemented, and the stand is assigned to conform with the indicator 6.3.5 of the Finnish NFSS.
#9	**FSC special harvest sites (C6.3) - permanent deciduous tree majority**	CH	CH - restricted	Stands where a permanent deciduous tree majority is maintained across all management activities.
#10	**Natura 2000 areas**	NLS	Public	All Natura 2000 areas (HCV1).
#11	**FSC certified (cadastral) management unit polygon data**	CH	CH - restricted	Cadastral forest management unit boundaries in a requested format.
#12	**FSC compartment level data - areas treated with prescribed burning**	CH	CH - restricted	All areas where prescribed burning has been applied according to indicator 6.2.8.
#13	**Rivers and water areas**	NLS	Public	All waterbodies from the NLS data repository, including small rivers and streams.
#14	**High conservation value (HCV) areas**	CH/Public	Public	IBA and FINIBA areas (HCV3).
#15	**Unspecified FSC 5% Area (*any combination of #4 and #6*)**	CH	CH - restricted	Any combination of #4 and #6. *Established due to some discrepancies in CH data.*
#16	**Unspecified FSC 10% Area (*certain CHs did not distinguish between #7/#8/#9*)**	CH	CH - restricted	Any combination of #7, #8, #9. *Established due to some discrepancies in CH data.*

Annex 2 – Data comparison and structure of analysis

Theme	Object of analysis	Comparison of data layers (specification of data layer IDs)	Output
A1	**Increase in 'conservation' area networks**	How much additional FSC attributable conservation areas (#4, #5, #6) are established as compared with the mere statutory conservation areas (#2)	**Area** (increase in hectares)
A2	**Increase in average size of and connectivity between conservation areas**	Interconnectedness of (#2) with (#4, #5, #6). 1. How much connected conservation areas are established through FSC? (connected = #2 + #4/5/6) 2. How much does a connected statutory conservation area "grow" on average as a result of FSC? 3. How many inter-connected statutory conservation areas are established through FSC?	1. **Area/number of connected** vs. disconnected 2. **Area** (area comparison w/o FSC) 3. **Number** (of inter-connected statutory conservation areas)
A3	**RTE species habitats inside conservation areas**	How many RTE species occurrence points are detected: 1. Inside statutory conservation areas (#2) 2. Inside FSC attributable conservation areas (#4, #5, #6) 3. Outside of any conservation area	**Number** (RTE species distribution ratio)
A4	**Increase in RTE species occurrence points in conservation areas**	How much of an increase in the share of RTE species occurrence point existence in conservation areas? x = (A3.2 / A3.1) * 100	**Number** (share of RTE species habitats inside conservation designated areas)
A5	**RTE species located inside FSC special harvest sites**	How many RTE species occurrence points are detected: 1. Inside compartments with deadwood objectives >10m³ (#7) 2. Inside continuous cover forestry compartments (#8) 3. Inside broadleaf dominated stands (#9)	**Number** (RTE species occurrence points in special harvest sites)
A6	**RTE species trends**	1. How much of the RTE species occurrences occur in FSC certified polygons as compared with uncertified? (weighted average) 2. How many of the RTE species occurrences inside FSC certified polygons occur inside conservation areas? (#2, #4, #5, #6) 3. How many of the RTE species occurrences inside FSC certified polygons occur inside special harvest sites (#7, #8, #9)	1. **Number** (ratio of RTE occurrence points in FSC/non-FSC areas) 2. **Number** (ratio) 3. **Number** (ratio)

Annex 2 – Data comparison and structure of analysis

A7	**Adjacency of special harvest sites with conservation areas (special harvest sites as buffers to conservation areas)**	Interconnectedness of (#7, #8, #9) with (#2, #4, #5, #6). 1. How much adjacent special harvest sites are detected to conservation areas? 2. How much does a conservation area "grow" on average as a result of special harvest sites?	1. **Number** 2. **Area**
A8	**Areas managed with prescribed burning**	1. How many prescribed burning sites are detected? 2. How large is the total area managed with prescribed burning? 3. How large is the average area for prescribed burning?	1. **Number** (of prescribed burning sites) 2. **Area** (of prescribed burning sites and average) 3. **Area** 4. **Number**
A9	**High conservation value (HCV) areas**	Interconnectedness of (#14) with (#2, #4, #5, #6). 1. How much connected conservation areas are established through FSC for internationally recognized Natura 2000 and IBA/FINIBA habitats? (connected = #14 + #2/4/5/6) 2. How much does a connected Natura 2000/IBA/FINIBA area "grow" on average as a result of FSC (adding #2/4/5/6)?	1. **Area/number of connected** vs. disconnected 2. **Area** (area comparison w/o FSC)

Annex 3 – Data sources

Public and restricted access data repositories			
Layer	**Type**	**Source**	**Attributes**
Forest inventory data – open forest stand-level data	Polygon	Finnish Forest Centre (Metsäkeskus)	• Forest inventory and cadastral data
Forest inventory data – open forest stand-level data	Polygon	Finnish Forest Centre (Metsäkeskus)	• Areas protected under the Forest Act §10
RTE species occurrence	Point	FinBIF	• Name of the RTE species
Conservation areas (non-managed)	Polygon	National Land Survey of Finland, Topographic Database – data merge and buffer rules	• Statutory conservation areas
Conservation areas (managed cover)	Polygon	Finnish Environmental Institute (SYKE)	• Natura 2000 areas
Conservation areas (managed cover)	Polygon	BirdLife	• IBA/FINIBA
Sentinel-2 - or other background map	Raster	Background map	

NOTE: There were certain data sources that were dropped from the initial data analysis plan, as they were deemed irrelevant during the data analysis work. The data from certificate holders provided for example riparian buffer zones, which pre-emptied the need to run the analysis for watercourses, thus rendering the data source not needed for the analysis.

Annex 3 – Data sources

Certificate holder data		
Layer	**Type**	**Attributes**
FSC certified area	Polygon	• Relevant forest inventory and cadastral unit data
Compartment level data:		
RTE species occurrence	Point	• Name and occurrence point of the RTE specie *(additional occurrence points, if not included into the FinBIF database)*
Special sites	Polygon	• Continuous cover stands • Stands with objectives to increase the volume of deadwood (>10m³) • Stands managed with permanent deciduous tree majority cover • Area managed with prescribed burning
Set-aside	Polygon	• Areas protected by legislation • FSC conservation areas • Areas conserved to meet the 5% minimum set-aside area cover
Buffer zones	Polygon	• Water course buffer zones (delineated stands)

NOTE: Certain data was not applicable for the certificate holders, and was left out of the analysis. This included for example the RTE species habitat data (none of the CHs had any data on this), and the retention elements (there was insufficient amount and quality of data related to individual retention elements, such as retention trees and individual trees conserved based on the NFSS requirements).


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