Sweden
National report
Biodiversa+ Governance Sub-pilot

1. Name of the country / sub-national region

Sweden

List of abbreviations
SEPA – Swedish Environmental Protection Agency (Naturvårdsverket)
SWAM – Swedish Agency for Marine and Water Management (Havs- och vattenmyndigheten)
NRM – Swedish Museum of Natural History (Naturhistoriska riksmuseet)
CAB – County Administrative Board (Länsstyrelse)
SLU – Swedish University of Agricultural Sciences (Sveriges lantbruksuniversitet)
SFA – Swedish Forest Agency (Skogsstyrelsen)
SBA – Swedish Board of Agriculture (Jordbruksverket)
SMHI – Swedish Meteorological and Hydrological Institute (Sveriges meteorologiska och hydrologiska institut)

2. Governance structure and solutions (Objective 1)

Overview

Sweden does not currently have a designated national biodiversity monitoring centre, as defined. Instead, biodiversity monitoring responsibilities are distributed among various entities, including the Swedish Environmental Protection Agency (SEPA), Swedish Agency for Marine and Water Management (SWAM), County Administrative Boards (CABs), universities, and citizen science organisations.
To establish a national biodiversity monitoring centre, negotiations and collaboration among these organisations could be one way in Sweden. Key steps would include defining a clear mandate, securing funding, developing data infrastructure, ensuring legal compliance, and promoting collaboration.
The current governance model in Sweden involves multiple levels of monitoring, with SEPA and SWAM overseeing national environmental monitoring. Regional monitoring is the responsibility of CABs. Challenges include overlap in monitoring schemes and fragmented responsibility, with ongoing efforts to coordinate and harmonise monitoring activities.

2.1 Current situation with a national biodiversity monitoring centre

Currently there is no single definition for a national biodiversity monitoring centre, but Biodiversa+ seeks to facilitate that development. A national biodiversity monitoring centre could be understood as a concept to coordinate biodiversity monitoring on a national level, and to act as a national point of contact for international cooperation on biodiversity monitoring. A national biodiversity monitoring centre could be anything from a website that provides access to national biodiversity monitoring schemes, to a staffed institute that coordinates and develops biodiversity monitoring nationally.

Against this backdrop, does your country have a biodiversity monitoring coordination centre?

☐ Yes. Please answer question 2.1.1
☒ No. Please answer question 2.1.2

2.1.2. Possible pathways and timeline for establishing a national biodiversity monitoring centre

Sweden does not have a designated national biodiversity monitoring centre according to the definition above however it does have many of the components described but spread across different entities. Firstly, SEPA and SWAM have a general responsibility to coordinate environmental monitoring, which includes biodiversity monitoring, and a responsibility for international reporting. Furthermore, information surrounding national biodiversity monitoring schemes are available via SEPA and SWAM's websites but also CAB's. However, there are several other actors that also have a mandate to conduct biodiversity monitoring and this usually complements national environmental monitoring, but in some cases overlaps.

Secondly, the Swedish University of Agricultural Sciences - Swedish Species Information Centre (SLU ADb) is also an important actor having the mandate to collect, store, analyse, and present data and information on Swedish biodiversity.

Finally, there are currently two platforms/infrastructures that could be used to provide access to harmonised biodiversity data particularly species observation data:
- Swedish Biodiversity Data Infrastructure (SBDI) hosted by the Swedish Museum of Natural History (NRM), which includes the Swedish node of the Global Biodiversity Information Facility (GBIF), is backed by a consortium including eleven partner organisations and funded by the Swedish Research Council. SBDI has three focus areas:
1. Mobilising Swedish biodiversity data according to FAIR data and Open Science principles
2. Maintaining and developing a sophisticated platform for integrative analyses of Swedish ecosystems
3. Providing user support for data driven biodiversity and ecosystems research

-Species Observation System API (SOS API) developed and hosted by SLU ADb is an open-source application platform for aggregating and sharing datasets of species observations.

The challenges with multiple platforms concern, among other things, which users these actors/infrastructures address and the possibilities for more needs-adapted services it allows. But also, that two similar infrastructures create additional costs.

Establishing a national biodiversity monitoring hub would be a significant undertaking that would require substantial effort, resources, and support to make a meaningful contribution to the BMCC. One notable challenge is that, according to Swedish law, government agencies fundamentally operate independently, and one government agency therefore does not have the authority to control another government agency. This means that there is an absence of shared objectives regarding the information management for a national centre, given the complex landscape of biodiversity monitoring in Sweden. This complexity involves multiple stakeholders and sources of funding at the national, regional, and local levels. Collaboration

and harmonisation of information management must, because of the independent authorities, occur voluntarily, through clear mandates or guidance from the government or the EU. These mandates and guidance could focus on enhanced coordination, increased collaboration, and clearer definitions of data structures and models.

Various critical resources and forms of support are therefore essential for the success of such a hub. These include for example securing sufficient funding for its establishment and ongoing operations, ensuring robust data and technology infrastructure, fostering effective communication and outreach efforts, complying with legal requirements, fostering increased community involvement, implementing quality control mechanisms, fostering collaboration with experts and researchers, and sharing best practices with existing monitoring entities.

2.2 Current governance model

2.2.1 General description of the governance model

Environmental monitoring is a part of Swedish environmental policy, which is a policy area in which the central government governs, and national authorities, CABs, municipalities and private actors conduct and perform the monitoring activities (Larsson 2020). Sweden has a long history of environmental monitoring and some uniquely long monitoring datasets. Prior to 1978 these were of a more sporadic nature and conducted by educational institutions and certain government agencies. In 1978 SEPA received a more comprehensive task to drive environmental monitoring (Statens offentliga utredningar 2019 p 41). The foundation for central government funded environmental monitoring was laid in 1991 through the government bill “A good living environment” (Proposition 1990/91:90). In 1993 SEPA presented a program for environmental monitoring. In 1996, SEPA presented a central government assignment to develop a new program for coordinated environmental monitoring and in the same year a special appropriation for environmental monitoring was established to be disposed of by SEPA.

In the 1980s, 1990s and 2000s Sweden signed onto a substantial number of international conventions on air, waste, mercury and protection for animals and plants. The conventions entailed increasing demands on environmental monitoring and international reporting. Furthermore, the central government’s decision, in 1999, to adopt national environmental quality objectives entailed increased requirements for environmental monitoring, because information from environmental monitoring is an important basis for assessing progress in achieving national environmental quality objectives. The current design of Swedish environmental monitoring is based largely on a program with 10 (from the beginning 11) areas (program areas) that SEPA proposed and the then Environmental Monitoring Board adopted in 1999. The program includes long-term recurring systematic surveys/schemes that aim to provide information on the state of the environment (Statens offentliga utredningar 2019 pp 41-42). From the beginning of 2000, biodiversity monitoring has also been developed to assess the conservation status of species and habitats in the EU habitats directive.

The general aims of Swedish environmental monitoring are to:

- Describe the state of the environment.
- Identify new environmental risks.
- Provide data to be used as a basis for action.
- Monitor the implementation and effects of action.
- Analyse the environmental impact of various emission sources.

Sweden's environmental monitoring program has been designed to provide information to assess the progress in achieving Sweden's national and regional environmental quality objectives and as a basis for Sweden's international reporting obligations within international directives and conventions (Statens offentliga utredningar 2019 p 31).

Funding, responsibility, and structure

SEPA has an overall administrative responsibility for the coordination of environmental monitoring and shall, in consultation with SWAM, allocate funds for environmental monitoring, assess progress in achieving environmental quality objectives and international reporting and, after consultation with other relevant authorities, be responsible for the implementation of environmental monitoring and describe and analyse the state of the environment within its area of responsibility. SWAM is correspondingly responsible within its area of responsibility which is the aquatic environment (Naturvårdsverket & Havs- och vattenmyndigheten 2022 and references therein).

Environmental monitoring, which includes biodiversity monitoring, is funded by the central government through a specific environmental monitoring appropriation (1:2 environmental monitoring etc.) as well as other appropriations (e.g. 1:3 actions for valuable nature and 1:11 Actions for valuable marine and aquatic environment) that are disposed of by SEPA, SWAM, and CABs (since 2022) to other actors. Furthermore, other government agencies and universities receive direct funding from the central government for specific environmental monitoring activities or use their appropriations frames to fund certain monitoring activities. Coupled to biodiversity monitoring these organisations include the Swedish University of Agricultural Sciences (SLU), NRM, the Swedish Forest Agency (SFA), the Swedish Board of Agriculture (SBA), and the Swedish Meteorological and Hydrological Institute (SMHI) (Statens offentliga utredningar 2019).

General governance structure

Environmental monitoring in Sweden can be broadly divided into three levels: National monitoring, Regional monitoring (county level) and Local monitoring (municipality level). This report focuses on the former two as they have the most relevance to biodiversity monitoring. Environmental monitoring funded through the central government's environmental monitoring appropriation is divided into ten program areas. Planning and running of national level program areas is the responsibility of SEPA, for the terrestrial environment, and SWAM, for marine and freshwater environments. There are currently eleven national program areas of which 10 are funded through the central government's environmental monitoring appropriation. One program area, the Biogeographical monitoring of species and habitats listed in the EU Habitats directive (henceforth Biogeographical monitoring of species and habitats) is funded through the actions for valuable nature appropriation. These programs are ongoing and revised every 6-10 years. Regional level program areas are the responsibility of CABs and revised every 5-6 years in consultation with SEPA and SWAM (Naturvårdsverket 2019; Statens offentliga utredningar 2019; Naturvårdsverket & Havs- och vattenmyndigheten 2022).

SEPA has primary responsibility for nine program areas of which six include some form of biodiversity monitoring (in bold):

-Landscape
-Mountains
-Forests
-Agricultural land
-Wetlands
-Air

-Coordination on environmental toxins
-Health-related environmental monitoring
-Biogeographical monitoring of species and habitats

SWAM has primary responsibility for two program areas both of which include some form of biodiversity monitoring:
-Sea and coastal areas
-Fresh water

Environmental monitoring within the ten program areas funded through the central government's environmental monitoring appropriation is conducted through national sub-programs and regional sub-programs. To increase cooperation in areas where several CABs carry out the same type of environmental monitoring, there are so-called joint regional sub-programs that are co-financed by the CABs involved in the sub-program plus financing for project management from SEPA or SWAM. In addition, the CABs run their own sub-programs specific to their region.

Each program area consists of several sub-programs which in turn consist of one or more surveys /schemes that should be carried out to answer specific questions within the program area. The division into sub-programs is meant to provide an overview and ensure that the sub-programs combined give a full picture of the state of the Swedish environment. The criteria for sub-program division varies between program areas. A survey/scheme is designed according to one or more standardised method(s) called monitoring manuals. Monitoring manuals are important for coordination and quality assurance within environmental monitoring (see Fig. 1.) (Naturvårdsverket_1 no date; Statens offentliga utredningar 2019 pp 50-56).

The program area Biogeographical monitoring of species and habitats collects information in Sweden's biogeographical regions to assess conservation status and trends for species and habitats listed in the EU habitats directive and is divided into 14 sub-systems for major groups of habitats and species (Fig. 1.). Other examples of biodiversity monitoring that are not included in the above model regarding funding and structure include monitoring of invasive alien species, monitoring of game, monitoring of predators, assessment of actions programs for threatened species and habitats (Naturvårdsverket 2019).

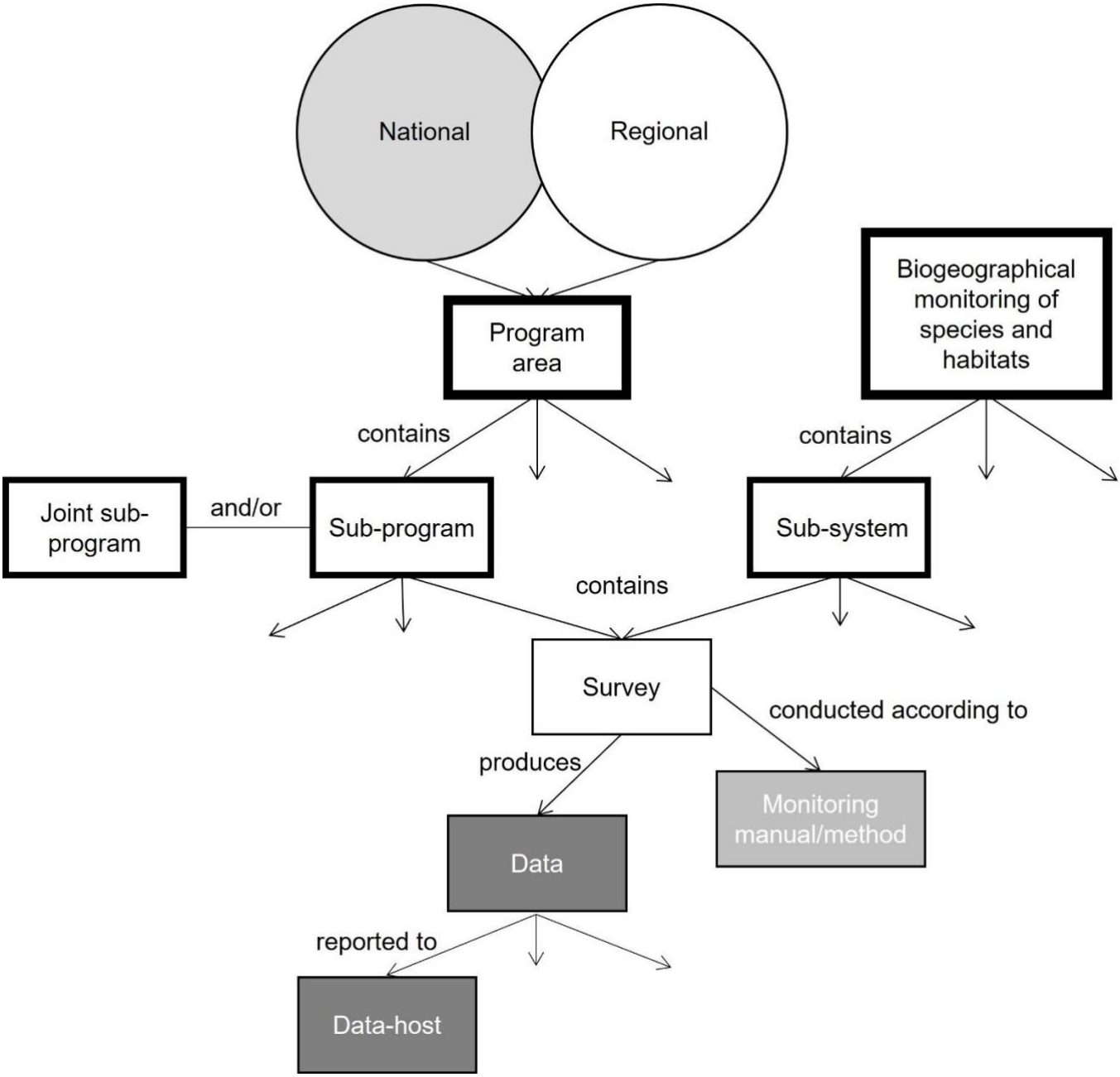

Fig. 1. Schematic representation of Swedish national and regional environmental monitoring.

Regional environmental monitoring

Regional environmental monitoring forms an important part of the coordinated environmental monitoring by considering regional conditions, predominantly but not exclusively aimed at providing a picture of the state of the environment at a county level. Regional monitoring captures more large-scale regional impacts and effects, and contributes to regional and municipal needs in, for example, nature conservation and social planning, as well as capturing regional variations. It provides a basis for assessing progress in achieving regional environmental objectives and for daily case management and is of great importance as a basis for social planning (Naturvårdsverket 2019; Naturvårdsverket & Havs- och vattenmyndigheten 2022 and references therein).

The 21 CABs are responsible for regional environmental monitoring, coordinating monitoring for local actors as well as cooperating with national environmental monitoring. Regional environmental monitoring programs for all counties, financed via the central government environmental monitoring appropriation, have existed since the mid-1990s. Prioritisation of the respective CAB's regional environmental monitoring has previously been governed by annual grants from SEPA and SWAM. Allocation of grant contributions were based on regional monitoring programs spanning six-year periods, established by the respective CABs, in consultation with- and often according to guidelines from SEPA and SWAM. However, starting from 2022, CABs received their own right of disposition directly from the central government's environmental monitoring appropriation (Naturvårdsverket & Havs- och vattenmyndigheten 2022 and references therein). Work is ongoing surrounding how to best coordinate regional and national monitoring programs considering the new funding model.

Regional environmental monitoring programs form an important basis for the planning and enforcement of the counties' environmental monitoring activities. These programs are anchored with the county's actors through dialogue in existing reference groups or other groupings where representatives for different actors are included. While environmental monitoring operates in a long-term perspective, there is a need for continuous adaptation to meet the demands and wishes of the outside world. Therefore, regional environmental monitoring programs have been revised every 5-6 years in consultation with SEPA and SWAM. Revision has generally been in accordance with guidelines developed by SEPA and SWAM but also based on environmental questions/issues prioritised within the county. (Naturvårdsverket 2019; Naturvårdsverket & Havs- och vattenmyndigheten 2022)

The coordination of the regional environmental monitoring may also include, in addition to what is financed by the environmental monitoring appropriation:

- Other central government-funded environmental monitoring (e.g. monitoring of protected areas and biogeographical monitoring of species and habitats, monitoring of game, monitoring of invasive alien species via 1:3, 1:11 appropriations).
- Non-central government-funded environmental monitoring, (e.g. coordinated recipient control run by water conservation associations and monitoring of air quality in urban areas through air conservation associations, etc.).
- Co-financed environmental monitoring with other national authorities, regions, municipalities and non-profit organisations.

Who conducts biodiversity monitoring?

Biodiversity monitoring is conducted by third parties i.e. not SEPA and SWAM. These include other government authorities, CABs, universities, citizen science including non-profit organisations (e.g. ornithological associations, botanical associations, dive clubs), and consultants. Within some sub-programs efforts from citizen science including non-profit groups are crucial to the success of the sub-program (e.g. Swedish Butterfly Monitoring Scheme, Swedish Bird Survey and Biogeographical monitoring of species and habitats).

SEPA has the general responsibility for species monitoring in terrestrial environments and SWAM for marine and freshwater environments. However, responsibility for biodiversity elements within different environmental quality objectives is spread across several different government agencies. This has led to overlap between some biodiversity monitoring schemes conducted by different authorities within similar areas that are not well coordinated and lack harmonisation (e.g. forest, agricultural land, grasslands). This in turn has led to biodiversity data being spread across several different actors and infrastructures making it more difficult to

combine the data for other uses. In general, responsibility for biodiversity monitoring is fragmented and includes different levels and actors and requires better coordination (Statens offentliga utredningar 2019 pp 251, 256, ch 7). Since 2019, several efforts have been made to coordinate and harmonise monitoring, e.g. National Inventories of Landscapes in Sweden (NILS) sub-program has been altered to reduce the degree of overlap with the Swedish National Forest Inventory (focusing on deciduous forests in NILS).

SLU is a central actor in biodiversity monitoring as well as data management in marine, freshwater and terrestrial environments. SLU conducts a substantial amount of biodiversity monitoring contracted predominantly by SEPA and SWAM but also CABs and other government agencies. SLU Department of Forest Resource Management (SLU SRH) receives direct central government funding to conduct the Swedish National Forest Inventory. This department also conducts national monitoring within NILS. Furthermore, SLU ADb has substantial central government funding as well as funding from other sources to collect, store, analyse, and present data and information on Swedish biodiversity. Several central important activities include:

- Artfakta, a web application that provides knowledge about Swedish species and allows users to compile and search for information about species including some of the ecological groups the species belong to.
- Species Observation System (SOS Artportalen), a system for reporting on species observations.
- SOS API, application programming interface (API) for species observation data used for making data available to different users.
- Swedish Taxonomic Database (Dyntaxa), providing the names and relationships of Swedish organisms, with a goal to house information on all Swedish multicellular species.
- The red list, compilation of Swedish species at risk of extinction.

Furthermore, SBA has responsibilities for quality monitoring of biodiversity in meadows and pastures and SFA conducts monitoring of biodiversity in forests. Other universities, besides SLU, such as Lund University, Gothenburg University and Stockholm University conduct biodiversity monitoring with funding from SEPA and SWAM. Lastly, CABs conduct biodiversity monitoring funded through SEPA and SWAM, for example of wild game and predators.

Data management

To manage the extensive amount of data collected within environmental monitoring, Sweden has established several national data hosts for different types of data. SEPA and SWAM are responsible for establishing the national data hosts. National data hosts are placed at national authorities and institutions at universities, to secure long-term data management and for the data to be handled by experts who can assess and be responsible for quality. Financing is through the central government's environmental monitoring appropriation and regulated through two-year agreements between the data host and either SEPA or SWAM.

A national data host, according to SEPA's definition, is a long-term function that is established with central-government funds for the purpose of being the national node for environmental data in a thematic area. Data hosts are responsible for receiving data, storing data and making data available to different users. International reporting is often included as part of making data available. SEPA and SWAM have the following vision for national data hosting:

- All data collected with the help of tax funds is publicly available.
- Data is used and useful.

- All collected data is delivered to a data host, i.e. national monitoring, regional monitoring, co-financed monitoring as well as data from base inventories and nature conservation follow-up.
- All data is collected using common methods.
- All data is available via the web.
- Information pertaining to data quality is available for all data.

Data that is collected within environmental monitoring should be delivered to the relevant data host if one exists for the purpose.

2.2.2 Examples of governance models

Here are two examples of biodiversity monitoring sub-programs that vary in governance with respect to volunteers versus professional staff:

Swedish Bird Survey is a national environmental monitoring sub-program that consists of eight different surveys/schemes. Inventories are conducted largely by volunteers according to standardised methods. In all, approximately 700 people are involved per year. The Department of Biology, Lund University coordinates the sub-program via funding from SEPA. Support and cooperation are also provided by all 21 CABs.

National Inventories of landscapes (NILS) is a national sub-program including six different surveys/schemes. NILS is operated by the Landscape Analysis division within SLU SRH. Inventories are conducted by permanent staff as well as hired seasonal field staff from across Sweden. Inventories are commissioned by SEPA and SBA.

2.2.3 Is there any specific information/data for which you see an added value to integrate with the BMCC?

2.2.4 Besides data coordination, is there any other coordination from the BMCC that you would like to be established (e.g., knowledge exchange, sampling design, indicator development, monitoring facilities, storage of collected specimens)

2.2.5 What kind of long-term support would you foresee from the BMCC?

3. Data management, interoperability solutions and standardisation (Objectives 2 and 3)

3.1 Data management and interoperability in biodiversity monitoring

3.1.1 Current national model for data collection (e.g., harmonised collection methods, what to monitor).

As described in 2.2.1, data collection within biodiversity surveys/schemes should be in accordance with monitoring manuals (method descriptions). Monitoring manuals should be available publicly at SEPA, SWAM, or CABs (Naturvårdsverket & Havs- och vattenmyndigheten 2022). While many monitoring manuals within different biodiversity monitoring sub-programs are available there are some that do not follow a standard template,

need to be updated, or are not publicly available. Some are not specific enough when it comes to requirements for supporting parameters. Furthermore, synchronisation between requirements in monitoring manuals and requirements for data reporting are sometimes lacking.

Joint sub-programs carried out within regional monitoring programs rely on coordinated monitoring methods, planning, data storage, and assessments involving CABs and central authorities. These programs are presented in a clear and consistent manner, offering insights into the surveys/schemes, participating actors, methods employed, and more. The primary goal is to enhance the reliability of environmental assessments through joint evaluations, thereby optimising resource investments.

Data that is collected within environmental monitoring should be reported to a relevant data host if one exists for the purpose. Within biodiversity monitoring, data hosts have existed for biological data within the marine and freshwater environment albeit split between three different data hosts. However, for terrestrial biodiversity monitoring data from structured monitoring surveys/schemes this has not been the case. Infrastructure for reporting species observations has long existed through SOS Artportalen at SLU ADb. However, formal data hosts have only recently been established for structured terrestrial biodiversity monitoring data, meaning that much of the data was stored, and in some cases is still stored with organisations that have conducted the monitoring, e.g. CABs, universities, and other government authorities. In fact, many CABs have their own databases for regional environmental monitoring data as a data host does not exist for a particular type of monitoring data or existing data hosts haven't had the capacity, mandate, or funding to receive the data, or reporting is difficult and time-consuming (Statens offentliga utredningar 2019 ch 13).

Data hosts that handle marine and freshwater biodiversity data include:

- Data host for Oceanography and Marine Biology at SMHI.
- Data host for Freshwater at SLU Department of Aquatic Sciences and Assessment (includes chemical and biological data (except fish) in lakes and water courses).
- Data host for Fish at SLU Department of Aquatic Resources (includes data on fish in lakes, water courses, and the marine environment as well as crayfish).

Data hosts that handle terrestrial biodiversity data under the umbrella Data hosts for Nature Data include:

- Data host for Birds and Butterflies at Lund University
- Data host for Species at SLU ADb
- Data host for Landscape at SLU SRH

3.1.2 Current national governance model for data reporting (e.g., field collection apps, data portals)

Sweden does not have a centralised data portal for reporting of biodiversity data. Data from national and regional biodiversity monitoring surveys/schemes should be reported to a data host if available, in accordance with their respective monitoring manuals. Monitoring manuals should specify where and how data should be reported (Statens offentliga utredningar 2019 p 424). However, in some cases monitoring manuals do not synchronise with reporting requirements or templates of the data host.

Many data hosts use Excel templates for data reporting however data reporting formats, terminology and semantics can vary substantially between data hosts. Internet-based apps for reporting as well as field collection apps exist but are not as common.

Here are some examples of variation in biodiversity data reporting portals and field apps:
-SOS Artportalen hosted by SLU ADb has long been used for reporting of species observations of plants, animals and fungi from private individuals as well as data from structured biodiversity monitoring surveys/schemes, e.g. data from sub-systems within biogeographical monitoring of species and habitats. Reporting can be conducted via a field app however larger data sets need to be reported via an Excel template.
-BioCollect is a web-based tool to collect field observations for monitoring biodiversity. The Department of Biology at Lund University has adapted this tool for surveys/schemes within the national sub-program Swedish Bird Survey and Swedish Butterfly Monitoring Scheme to better interact with those who carry out inventories. The tool allows field workers to book inventory routes, create inventory routes and report inventory data. This inventory relies on a mixture of volunteers, CABs with different levels of digital knowledge so there is still the possibility to report data via Excel templates and even field protocols in pdf format.
-SLU SRH have developed a swathe of field apps for data collection within the NILS sub-program. These apps are designed according to relevant field manuals. Field workers are assigned tracts for in situ sampling, sampling data is entered into the app and sent to a cloud-based database which is then imported daily into a database. Data is validated at the office directly and any data errors are sent back to the field team for correction.

3.1.3 Current national governance model for data quality (e.g., data validation, data formats)

Data quality recommendations exist via guidelines published by SEPA and SWAM. However, the organisation that carries out the collection of monitoring data (often through agreements with SEPA and SWAM) are responsible for reporting quality-assured data to the data host. Data hosts are responsible for conducting a so-called delivery check that involves, e.g. validating data format, logical consistency, and controlled vocabularies within various fields. Formats and controlled vocabulary lists are generally defined within the data reporting template for each respective data host.

Data hosts generally have developed their own data reporting format and validation. A centralised support system for data validation was established for other types of environmental monitoring data i.e. toxins in the environment and air quality, however these validation services have been, or are in the process of being, incorporated with their respective data hosts. Like other data hosts, responsibility for validation of biodiversity data lies with each data host and each has their own validation method and controlled vocabulary lists. Validation varies from manual validation to relatively automated systems.
Support systems do exist, e.g. the national station register, national environmental codes list. However, these repositories need to be expanded in order to support validation and promote harmonisation of terms that are common across data hosts and surveys/schemes.

3.1.4 Current national governance model for data storage (e.g., data-hosts, databases)

Data hosts are responsible for long-term storage of environmental monitoring data. Data hosts can include several different databases where data is quality controlled. As pointed out in section 3.1.1. not all biodiversity monitoring data is reported to a data host with a number of different databases in existence at different government authorities and institutions.

Other examples of biodiversity data that do not have a formal data host:

-SFA has made forestry data produced from their own monitoring activities available through their own Base Forest Data Portal.
-NRM coordinates, administrates and is responsible for the database for The Bird Ringing Centre. The Bird Ringing Centre is where all scientific ringing of wilds birds in Sweden is administrated.
-SBA is responsible for The Meadow and Pasture Inventory that monitors biologically valuable meadows and pastures. Data is stored in the TUVA database and made available via SBA's website.
-CABs conduct inventories on predators predominantly bears, wolverines, wolves, lynx. Data is reported to Rovbase which is managed by SEPA and Norwegian Environmental Agency (Miljødirektoratet) furthermore Skandobs is an internet-service for public reporting of observations.

3.1.5 Current national governance model for data security (as considered relevant, e.g., red-listed species, diffusion coordinates, GDPR, other laws surrounding national security)

Data hosts are responsible for data security and in some cases act on the behalf of SEPA or SWAM with respect to GDPR. Certain laws may also limit biodiversity data being made publicly available. For example, biodiversity monitoring data in the aquatic environment can be subject to secrecy if the data is deemed to reveal sensitive information on the seafloor within territorial waters. Data therefore needs to be assessed by the Swedish Armed Forces (via application to the Swedish Maritime Administration) prior to being reported to a data host.

Regarding species observation data SLU ADb conducts continuous work surrounding access to data on sensitive species. Species that are judged to be most exposed to threats in the form of disturbance, collection and mistreatment end up on SLU ADb's list of protected species (for birds, as a rule, limited to breeding data). Access to data for these species is handled very restrictively and is only shown to the reporter, any co-observers and, under certain conditions, authorised persons for nature conservation purposes and research. Access to this information is limited geographically and/or taxonomically to certain administrators at relevant authorities as well as to the most closely affected persons among non-profit associations and is always regulated with the caveat not to spread sensitive information further. In individual cases where species observation information, after a confidentiality review, is disclosed to e.g. consultants or researchers, the sampling is always limited taxonomically and/or geographically to avoid unnecessary exposure of sensitive species (read more on the SBDI website, SLU ADb website, and CABs website)

3.1.6 Current national governance model for data sharing (e.g., APIs, harmonisation, data product specification)

Data hosts are responsible for making monitoring data publicly available. Biodiversity data can be accessed via each data host in several different formats (e.g. csv, json, xlsx) as well as via APIs.
For example, SMHI SharkWeb (Svensk HavsARKiv/Swedish Ocean Archive) is a web application where it is possible to search and download data from the Data Host for Oceanography and Marine biology. SMHI Sharkdata is where the same data can be accessed via an API.

Species observations from a number of data sources (including data hosts) are compiled via the SOS API and made available through a number of different platforms such as:
SBDI Bioatlas – Sweden's Living Atlas (LA) instance which is the main analysis and visualisation platform provided by SBDI.
Artfakta, Fyndkartor – Search for species observations.
Artsök – A GIS add-in established by CABs for direct connection to up to date species observations within a personal GIS environment.

Here the same data are compiled and can be shared for different user groups on different platforms.

Data product specification
The three terrestrial data hosts within Data hosts for Nature Data have only recently been established so datasets from terrestrial biodiversity monitoring are only slowly being made publicly available. However, work has been conducted regarding harmonisation and interoperability for species observation data between these three data hosts. Together they have produced a data product specification (DPS) for systematic species observations following ISO standard 19131. This DPS contains definitions of concepts, vocabulary lists which have guided the development of a joint API specification. Having common descriptions of data structures, concepts, terms, vocabularies means that data should be interoperable between data hosts and facilitate the sharing of both open and protected data.

Data sets from habitat monitoring surveys/schemes that are being made available by the Data host for Landscape are currently being investigated with respect to harmonisation of concepts and terms. SEPA together with the Data host for Landscape are working to produce a data product specification for reporting terrestrial habitat data focussed on reporting obligations for article 17 of the habitats directive.

Swedish National Data Service
Swedish National Data Service (SND) operated by a consortium of Swedish universities, serves as a vital platform for ensuring the availability, preservation, and usability of research data and associated materials. In collaboration with approximately 40 universities and public research institutes, SND establishes a nationwide framework for unrestricted access to research data. The overarching aim is to provide access to research data that is as open as possible, while being as restricted as required.

3.1.7 Please evaluate the maturity of the implementation of FAIR principles in your country

A strategy for environmental data management, which includes biodiversity data, has been jointly developed by SEPA, SWAM, CABs and Water Authorities and was signed in 2015. The purpose was to create a joint infrastructure for environmental information. The Environmental data management strategy is important for driving and developing the presentation of environmental monitoring information. However, it was not designed to include data collection. The strategy contains ten guidelines:

1. Make environmental data well known.
2. Make environmental data easy to find.
3. Make environmental data directly accessible in forms that are requested.
4. Ensure that environmental data are well described and easy to understand.
5. Make environmental data available as quickly as possible.

6. Provide environmental data and services free of charge and subject to conditions that encourage further use.
7. Ensure that environmental data has clear management.
8. Use established standards.
9. Make it easy to use environmental data for co-processing.
10. Retain environmental data for future reuse.

These 10 guidelines mirror many of the FAIR guiding principles. A large amount of particularly species observation data is available and adheres to FAIR principles. However, a substantial amount of work is still required to make more biodiversity data sets available with correct metadata, correct documentation (e.g. methods) as well as harmonised and well described concepts and terms. Work is currently underway to create centralised repositories with e.g. monitoring manuals, controlled vocabulary lists from different data sources. This work should hopefully lead to identification and harmonisation of common concepts and terms, e.g. between data hosts, reducing the effort to report, validate, and combine data, leading to improved interoperability and understanding of available data.

3.1.8 Examples of data workflows

SOS API is an open-source application platform that collects species observations from a number of data sources and gives the user an opportunity to search for those observations using a single API. The system contains over 100 million species observations. SOS API is developed and hosted by SLU ADb. System development follows internationally accepted standards and principles and aims to be easily interoperable with LA and GBIF systems. SOS API supports mainly Occurrence Data and Sampling Event Data but can also accommodate metadata about data resources. Currently SOS API provides for only limited metadata but is developed to support metadata following the Ecological Metadata Language (EML) specification.

All data resources are published in DwC-A format. The registration of data providers is currently done by system developers.

Data in the system can be obtained manually or automatically via SOS API, with secure data sharing. The process involves harvesting original observations and processing them with additional data. Taxonomic matching is ensured using the Swedish Taxonomic Database (Dyntaxa), and discrepancies are reported for correction. The SOS API allows direct access to data, with DOI assignment for citing. Data can be synchronised with the Integrated Publishing Toolkit (IPT) and published to GBIF. This synchronisation ensures consistent open data available via both IPT and SOS. GBIF harvests from the IPT due to seamless integration, simplifying data flow for SBDI (For a visual representation (in Swedish) see SOS API Data flow diagram, more detailed information on SOS API can be found at SBDI and SLU ADb).

3.2 Data standardisation and case description

3.2.1 Are Darwin Core (DwC) and Ecological Metadata Language (EML) used for biodiversity monitoring data in your country?

☐ Yes
☐ No
X To some extent

If yes or to some extent, please describe the situation. How widely and by whom are they used?

Data collected within biodiversity monitoring surveys/schemes are not necessarily reported in DwC format but rather converted to Darwin Core format via SOS API or data is uploaded to the IPT server via GBIF (see section 3.1.8).

3.2.2 Does your country use standards other than DwC and EML for biodiversity monitoring data?

☒ Yes
☐ No

If yes, please list these standards, and if possible, provide links to standards

Data specifications – Standards used for data exchange are:

- DwC
- INSPIRE

Metadata standards – The following standards are currently used to document metadata:

- EML
- DCAT-AP-SE
- ISO 19115
- DublinCore
- DataCite
- The Data Documentation Initiative (DDI)

If no, please describe why standards are not used and what could be done to make it happen.

3.2.3 Case description

The selected case was THUF Seashore inventory that is part of the NILS sub-program. The inventory aims to estimate the occurrence and status of specific Annex 1 habitat types found along the Swedish coast, either on the seashore itself or directly connected to it. The field manual can be found here. It is possible to fit THUF Seashore inventory data into the Darwin core format despite it being a relatively complex design. Darwin core allows a lot of flexibility particularly within the eMoF table (measurementType, measurementValue, measurementUnit) meaning a greater variety of data can be published. However, this flexibility means that in theory one can create whatever term one wants to within these fields. If this is not controlled early on between different monitoring schemes, countries etc. it could lead to a reduction in interoperability at a higher level of detail, reducing the ability to combine information provided in the eMoF data tables. It is therefore important that metadata describing these terms for example via a linked sampling protocol, a published list of terms with definitions or by using terms from existing controlled vocabulary lists (e.g. Environmental Agency's Eionet Data Dictionary , International Council for Exploration of the Sea (ICES) vocabulary server, National Environmental Research Council (NERC) Vocabulary Server. This should hopefully lay a foundation for more combined usage of data from different sources or at least lay the foundation to combine datasets.

4. Any other issues / final remarks

n/a

References

Larsson, M. (2020) Effekter av miljöövervakning och användning av miljöövervakningsdata. https://www.diva-portal.org/smash/get/diva2:1588199/FULLTEXT01.pdf

Naturvårdsverket & Havs- och vattenmyndigheten (2022) Systematiskt kvalitetsledningsarbete för samordnad miljöövervakning. https://www.naturvardsverket.se/4918ce/globalassets/vagledning/miljoovervakning/handledning/systematiskt-kvalitetsledningsarbete-for-samordnad-miljoovervakning.pdf

Naturvårdsverket_1 (no date) Environmental monitoring program areas. Available at: https://www.naturvardsverket.se/en/international/environmental-monitoring/environmental-monitoring-program-areas/ (Accessed: 23 October 2023)

Naturvårdsverket (2019). Riktlinjer för regionala miljöövervakningsprogram 2021–2026. https://www.havochvatten.se/download/18.5c0fea4b1723b163a2f46c/1590131816749/riktlinjer-regionala-miljoovervakningsprogram-2021-2026.pdf

Statens offentliga utredningar (SOU 2019:22) (2019) Sveriges miljöövervakning – dess uppgift och organisation för en god miljöförvaltning. https://www.regeringen.se/contentassets/f6e362b4a31941818c1b0e3220e13534/sveriges-miljoovervakning--dess-uppgift-och-organisation-for-en-god-miljoforvaltning-sou-201922/