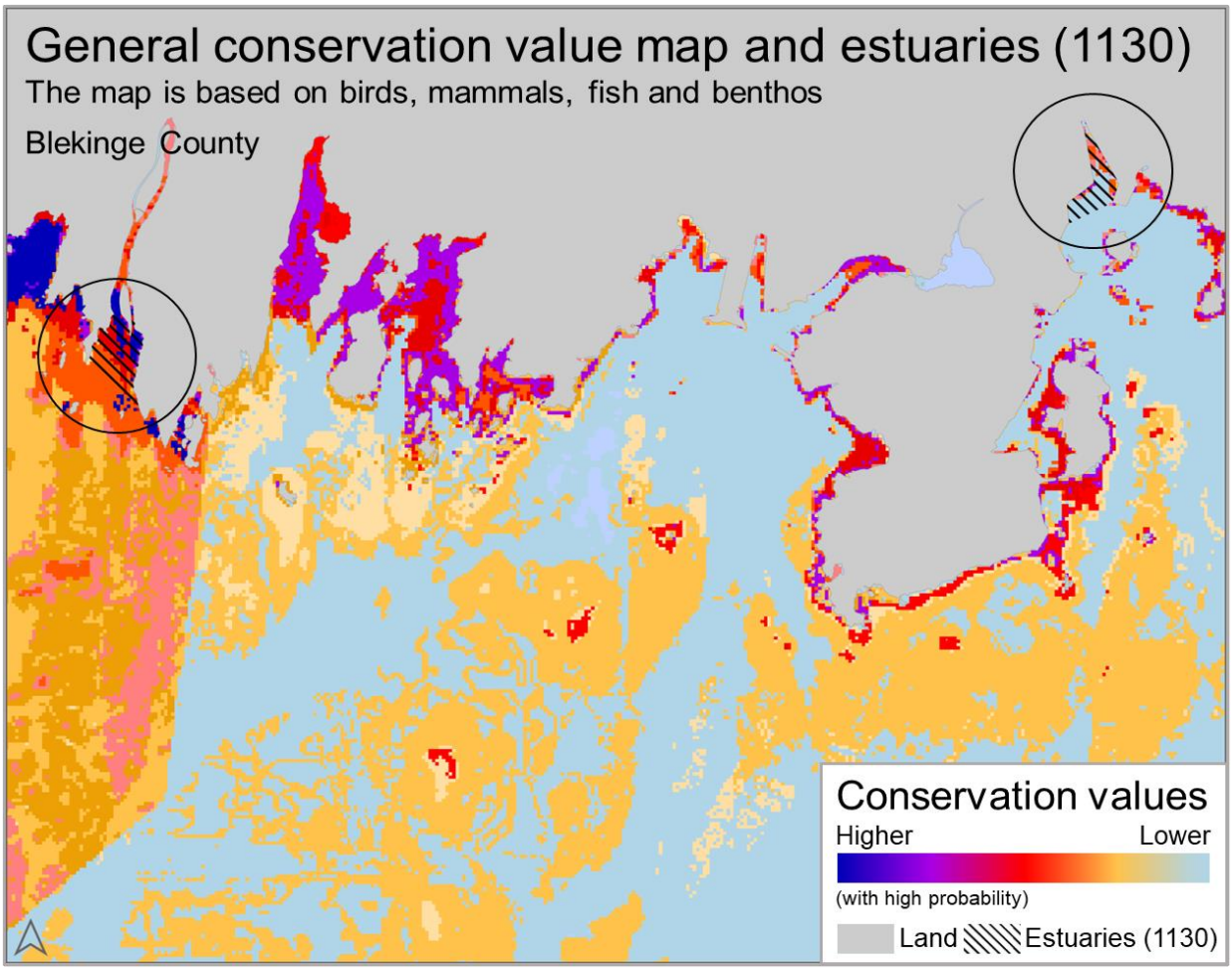
Conservation values from a seascape perspective

User manual for MOSAIC, version 1



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Conservation values from a seascape perspective

User manual for MOSAIC, version 1

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This report has been developed by the Swedish Agency for Marine and Water Management.
The agency is responsible for the content and conclusions of the report.

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Preface

The Swedish Agency for Marine and Water Management are responsible for promoting the sustainable management and planning of our marine areas. Part of this includes developing methods for a well-functioning green infrastructure and environmental protection.

To improve knowledge on the conservation value of marine areas, the Swedish Agency for Marine and Water Management have developed MOSAIC.

MOSAIC (dnr 1592-20) is a tool to identify the conservation value of marine areas, in particular their importance for biodiversity and ecosystem services in coherent (viable and ecologically representative) networks. The tool can be used for spatial management such as marine spatial planning, designation of protected areas, restoration planning and management of fisheries.

MOSAIC is based on ecosystem components that have been identified and developed by researchers and regional experts within the tool's framework. The *list of ecosystem components* and their associated conservation value provides a structure for handling, compiling, evaluating, and prioritizing ecosystem components for spatial management.

This report provides a step-by-step user manual for MOSAIC.

It is the Swedish Agency for Marine and Water Management's hope that this user manual will aid users in implementing MOSAIC.

MOSAIC's target groups are primarily those involved in the management and physical planning of coastal and marine areas, from national agencies to county administrative boards and municipalities – but even other marine operators and consultancies.

A large debt of gratitude is directed to all the people that have contributed with information and viewpoints during the tool's development. The report has been developed by AquaBiota Water Research and the Swedish Agency for Marine and Water Management, with support from SLU Swedish Species Information Centre and the County Administrative Boards for Västerbotten and Västra Götaland. The project leader from the Swedish Agency for Marine and Water Management is Ingemar Andersson.

Göteborg April 2020,

Mats Svensson Head of the Department of Marine and Water Management

As part of international knowledge sharing, the Swedish version of the report (2020:14) has been translated into English (HaV dnr 1572-22). The translation has been done in collaboration with Douglas Jones (AquaBiota Water Research).

Gothenburg February 2024,

Johan Kling, Head of the Department of Water Management

Contents

1 Introduction

Effective ecosystem-based management of marine and coastal environments requires an integrated approach across administrative areas. A standardized approach for the assessment of marine green infrastructure can ensure that the right management measures occur in the right place. MOSAIC is a tool to identify the conservation value of marine areas, in particular their importance for biodiversity and ecosystem services in coherent (viable and ecologically representative) networks. The intention is to provide a standardized and integrated framework for marine management, such as which areas should be prioritized for protection, restoration, physical planning or other types of management where spatial issues are to be addressed (including fisheries management and goals set out in the Marine Strategy Framework and Habitat Directives). This manual gives a step-by-step description of how to identify areas with high conservation values in ecologically coherent networks using the first version of MOSAIC.

MOSAIC is divided into two parts (Figure 1) a *preparatory part* and an *implementation part*. The Swedish Agency for Marine and Water Management coordinates the *preparatory part* and county administration boards, or other users, carry out the *implementation part* (Figure 2). Some exceptions to this division occur as explained in detail in chapters 2 and 3.

A comprehensive description of MOSAIC, its different parts and its development can be found in the Swedish Agency for Marine and Water Management report 2020:13[1]. However, users do not have to read the report in order to use MOSAIC – all the practical information needed is contained in this user manual.

The idea behind MOSAIC is to create an inclusive tool that can be used as a basis for several different management processes providing a uniform structure and high common benefit. The intention is however not to create a parallel process shadowing existing management activities. Furthermore, the purpose is to promote a functional, ecosystem based and adaptive spatial management of our marine and coastal areas. A number of subgoals based on the Malawi principles (UN 2008) for an ecosystem approach are included, but they are adapted to the prerequisites of marine management and limited to MOSAIC's purposes. As such, MOSAIC should:

- be ecosystem based
    - account for a range of interactions and components
    - be based on local to global scientific knowledge
    - account for nature's variation in time and space
    - have a seascape perspective
    - include site-specific details
    - include anthropogenic aspects such as ecosystem services and human impacts
- be adaptive
    - be easy to revise and update (to track temporal change and include new knowledge)
    - be able to take future scenarios into account
    - be useful for evaluations

[1] Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1*.

- be functional
    - based on internationally accepted criteria
    - minimize subjective assessments
    - be transparent and comparable
    - be easy to use and, for example, not require specific software
    - be distributed at the right organizational scale *i.e.* decentralized where appropriate
    - support functional and effective field surveys

MOSAIC has been divided into *preparatory* and *implementation parts* in order to meet the multiple and often divergent objectives set out in the subgoals (for example “including nature’s variation in space” with “transparent and comparable”) (Figure 2). A more detailed description of, and discussion around, the subgoals can be found in Swedish Agency for Marine and Water Management report 2020:13.

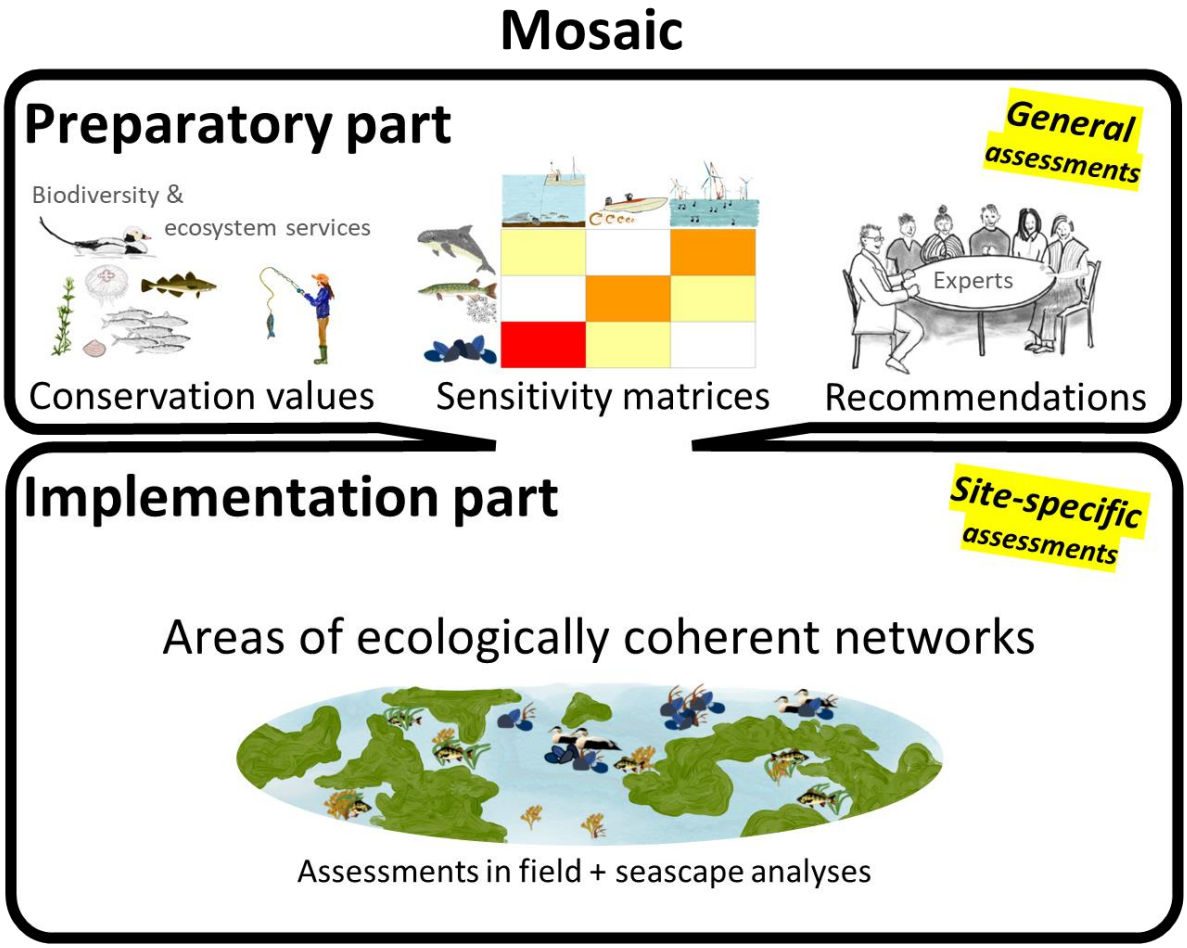


Figure 1. MOSAIC is divided into two parts, a preparatory and an implementation part. In the preparatory part, experts create a platform which supports subsequent seascape analyses in the implementation part.

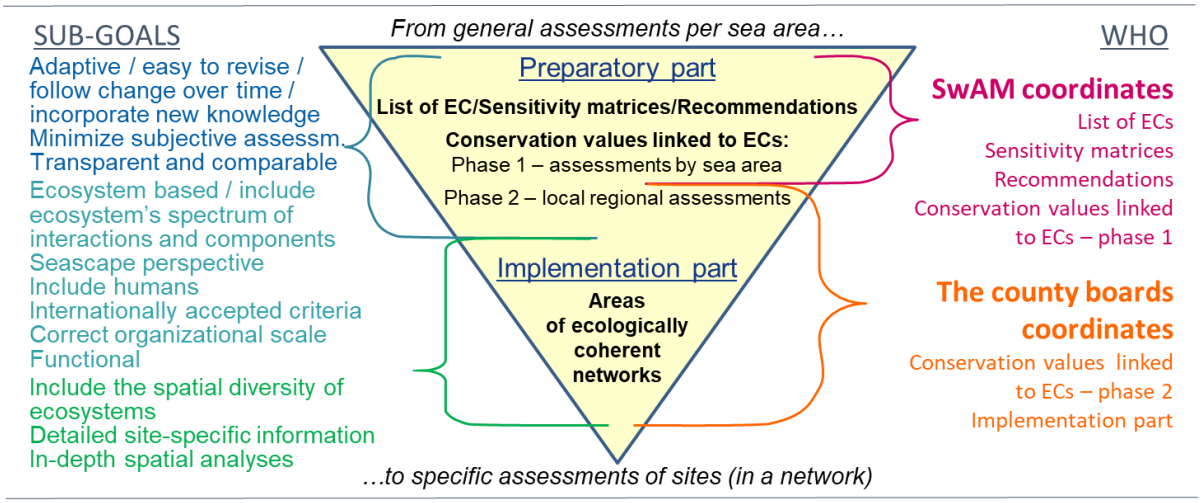


Figure 2. MOSAIC is divided into two parts to better achieve disparate needs laid out in its subgoals. The Swedish Agency for Marine and Water Management coordinate the *preparatory part* and users, such as county administration boards, coordinate the *implementation part*. However, some exceptions to this division occur and are discussed in chapters 2 and 3. EC = ecosystem component.

1.1.1 Preparatory part

In the *preparatory part*, marine ecological knowledge is synthesized and made available in a logical and simple format. This is done by combining the knowledge of scientific and local marine experts to create information and assessments on ecosystem components relevant to spatial management (Figure 3). These assessments form the basis for conservation value assessments, and are used in MOSAIC's *implementation part* together with site-specific and seascape information. Assessments in the *preparatory part* include which conservation values different ecosystem components generally contribute (not site-specific), which human activities/pressures they are sensitive to (*sensitivity matrices*) and recommendations on *ecological representativity* for the different ecosystem components (Figure 3). More information and guidelines for the preparatory part can be found in Swedish Agency for Marine and Water Management report 2020:13.

Lists of ecosystem components, prepared by over 50 marine experts, have been published in conjunction with this user manual and the report 2020:13 (version 1). The lists consist of defined and delimited ecosystem components and the conservation values they are associated with in four large sea areas (Kattegat/Skagerrak, the Baltic Proper, the Bothnian Sea and the Bothnian Bay)[2]. The lists provide experts' justifications and trade-offs for the conservation value points assigned to ecosystem components. This manual describes how these assessments can be applied in MOSAIC's *implementation part*.

Detailed guidelines and assessments for the *sensitivity matrix* and recommendations for *ecological representativity* are not available in version 1 of MOSAIC (Figures 3 and 4).

[2] The lists are found in an Excel document, *MOSAIC – ecosystem component lists and conservation values, version 1*, that can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

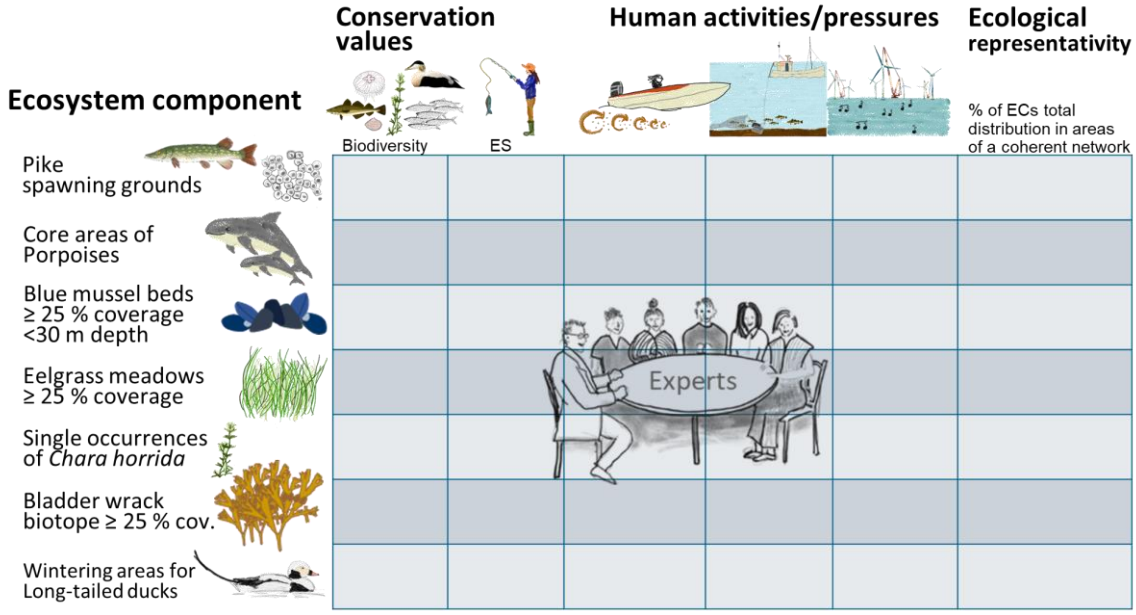


Figure 3. In the *preparatory part*, assessments are linked to ecosystem components in a manner that allows the information to be applied in MOSAIC's *implementation part*.

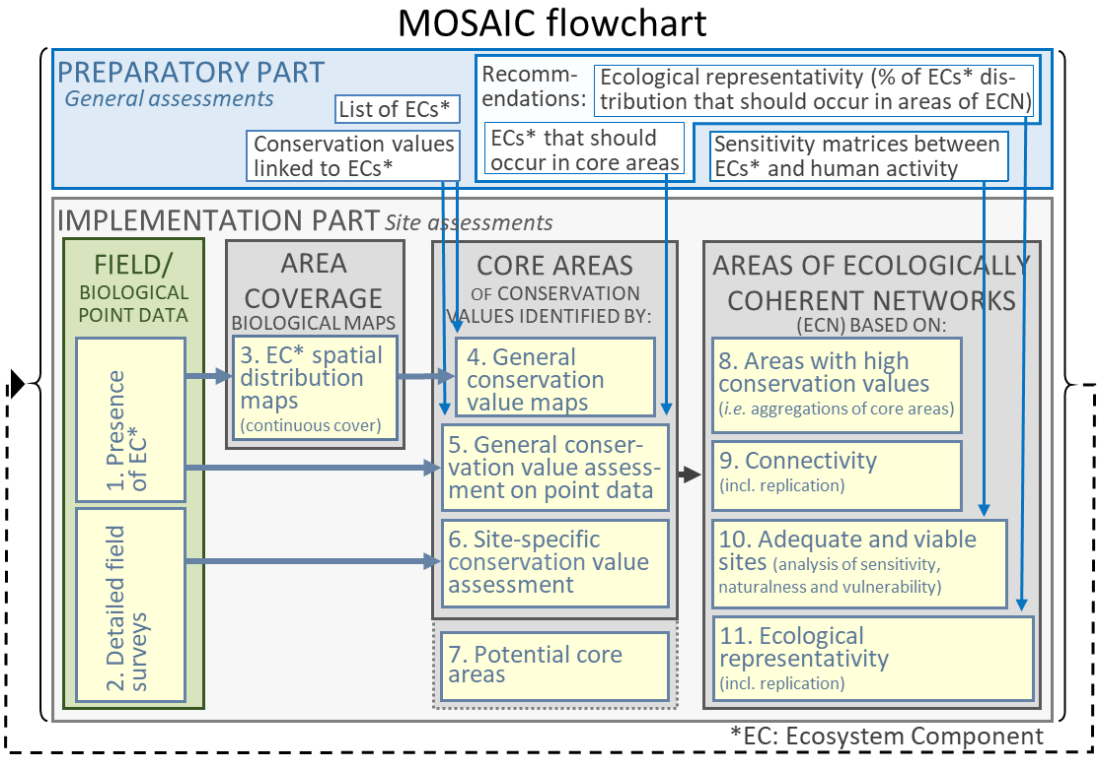


Figure 4. Flow chart showing the steps carried out in the *preparatory* and *implementation parts* of MOSAIC. The *preparatory part* is coordinated by the Swedish Agency for Marine and Water Management. In this part general assessments are linked to ecosystem components. These assessments are used in the *implementation part*, which are carried out by the user (often county administrative boards). In this part, site-specific information is collected through field studies and seascape analyses. The various steps listed in the flow chart are under different stages of development. In the first version of MOSAIC, complete guidelines are available for *list of ecosystem components*, *conservation values linked to ecosystem components*, recommendations for which *ecosystem components that should occur in core areas* and steps 1, 3, 4, 5, 8 and 11. The *sensitivity matrix*, recommendations for *ecological representativity* and steps 2, 6, 7, 9 and 10 require further development. Despite the need for development in some of the steps the tool can be used and implemented. EC = ecosystem component.

1.1.2 Implementation part

Both detailed and seascape knowledge is required to account for an ecosystem's spatial complexity.

The identification of *core areas*[3] of conservation values, is preferably done by combining *detailed field surveys* and *site-specific conservation value assessments* with *ecosystem component spatial distribution maps* and *general conservation value maps* (Figure 5). This approach balances site-specific knowledge with a comprehensive but less detailed seascape perspective when determining an areas conservation value.

In addition, *areas with high conservation values* (*i.e.* aggregations of *core areas*) should be identified in *ecologically representative* networks with well-functioning *connectivity*[4] (Figure 4). In other words, after completion of the *implementation part*, users should be able to identify *areas of ecologically coherent networks*.

A checklist of the steps to be carried out in the *implementation part* can be found in chapter 4. The rationale behind recommendations can be found in the Swedish Agency for Marine and Water Management report 2020:13.

Some of the steps in the implementation part can be developed further but this does not hinder the use of MOSAIC in its current form (version 1). Complete guidelines are available for steps 1, 3, 4, 5, 8 and 11, but steps 2, 6, 7, 9 and 10 require further development (Figure 4).

[3] See chapter 5 (terminology) for definition.

[4] See chapter 5 (terminology) for definition.

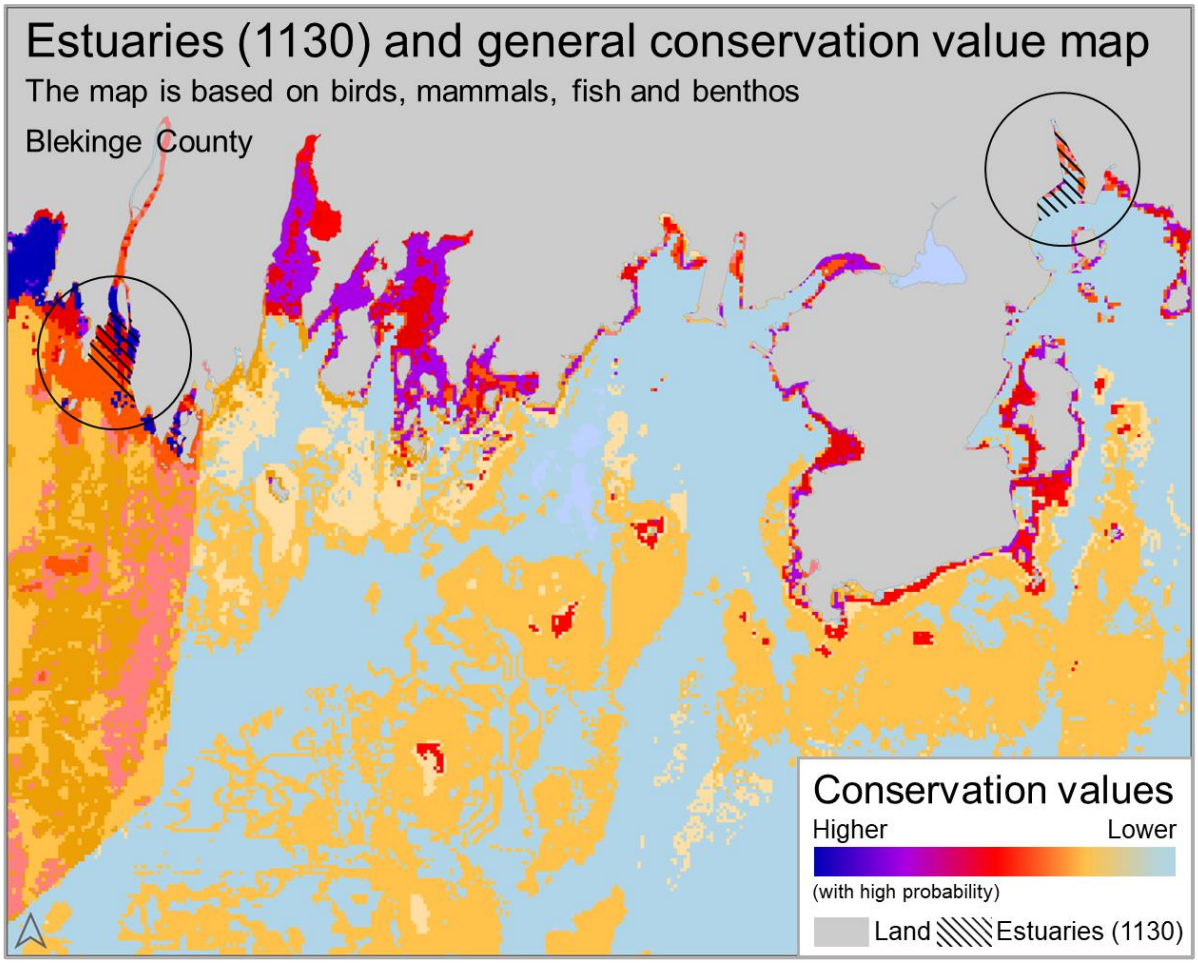


Figure 5. A *general conservation value map* of an area of southern Sweden (Blekinge) including two estuaries. The map is based on the occurrence of biotic ecosystem components and their assigned conservation value. The western estuary has a higher conservation value than the eastern estuary because of a higher probability of containing extensive areas of bladder wrack, and meadows of "tall underwater vascular plants" as well as providing an overwintering habitat for a range of bird species. Criteria for *areas of ecologically coherent networks* (besides the criterium *areas with high conservation values*) have however not been assessed in this map. For example could the criteria *connectivity* modify the relative value of the two estuaries.

1.1.3 Target group

This user manual is primarily aimed at county administration boards, but also municipalities and other users who – to prioritize management decisions – need well-founded knowledge of the green infrastructure. It should serve as a basis for various types of spatial management such as protected areas, coastal zone planning, marine spatial planning, fisheries, restoration measures, as well as helping to achieve goals set in the EU Marine Strategy Framework and the Habitat Directives.

1.1.4 Maintenance of the MOSAIC tool

This user manual is one of three published documents that relate to MOSAIC, version 1[5]. Detailed descriptions for some of the steps are still lacking and the ambition is that parts, or all, of

[5] The other two documents are the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1* that covers all parts of MOSAIC including theory and rationale, and an Excel document, *MOSAIC – ecosystem component lists and conservation values, version 1*, which includes a summary of assessments carried out in MOSAIC's preparatory part and is used in the implementation part. The documents can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

MOSAIC are updated, developed and adapted as it is used. Synergies should be found with parallel spatial management, for example, area protection, monitoring, fisheries, and work relating to the EUs Nature Directives and Marine Strategy Framework Directive, which run in six-year cycles.

1.1.5 Limitations

It should be noted that MOSAIC is a tool to support the identification and prioritization of ecosystem components and areas for spatial management with respect to a number of predefined conservation values. MOSAIC does not assess the *entire* conservation value of either ecosystem components or areas. För example, MOSAIC does not assess the degree of loss to an ecosystem if an ecosystem component were to disappear from an entire sea area, nor the total effect of the loss of conservation values from an area. The assessments in MOSAIC aim to determine which ecosystem components should be prioritized, and where, to maximize conservation values, based on the best prevailing knowledge and with respect to local and regional environmental conditions.

2 Lists of ecosystem components and their associated conservation values

As mentioned previously, the combined knowledge of over 50 marine experts has been used to delimit ecosystem components, that are suitable for spatial management, and their associated conservation values in four large sea areas (Figures 3 and 4). Ecosystem components, and their associated conservation values, are the building blocks of MOSAIC and provide a structure for MOSAIC's subsequent parts. As such, they are the most comprehensive part of the tool.

There are separate ecosystem component lists for the four large sea areas Kattegat/Skagerrak, the Baltic Proper, the Bothnian Sea and the Bothnia Bay because of the large differences between the species and ecosystems found in these major areas. The lists are presented in an Excel document, *MOSAIC – ecosystem component lists and conservation values, version 1,* which can be downloaded from the Swedish Agency for Marine and Water Management website.

2.1 Ecosystem components

In the *preparatory part* ecosystem components (and their associated conservation values) are not assigned to a specific location. For example, the ecosystem component "bladder wrack biotope" does not refer to bladder wrack biotope in a specific bay but to all bladder wrack biotopes in the entire region. However, since the tool is developed for use in spatial management, ecosystem components must be defined so it is possible to geographically delimit them and assign them to a defined area. For example, the ecosystem component "cod" is not suitable because it is difficult to delineate spatially for a highly mobile species. Instead, suitable ecosystem components such as "spawning area for cod" and "high frequency of adult cod" are used. These two ecosystem components also need to be managed differently even though they relate to the same species. MOSAIC focusses on biological ecosystem components (populations, species, groups of organisms and habitats) because they are more likely to be associated with higher conservation values and are often more susceptible to negative anthropogenic effects making them a priority for spatial management. This means that MOSAIC can provide detailed information that can be used as a basis for decision making within coastal and offshore planning and management.

2.2 Conservation value associated with ecosystem components

Assigning conservation values to ecosystem components is done via a points system and divided into two phases. Figure 6 shows the geographical division of conservation value assessments between phases 1 and 2.

2.2.1 Phase 1, assessments per sea area

In phase 1 regional experts have assessed the conservation value ecosystem components generally contribute to a sea area according to a set of criteria. This phase is coordinated by the Swedish Agency for Marine and Water Management and presented in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1.* By "generally" we mean the conservation value an ecosystem component *usually* contributes, for example if bladder

wrack mostly contributes to a higher or a lower biodiversity, compared with other ecosystem components in the sea area.

Criteria used to score the conservation value of ecosystem components relate partly to ecological/biological values (including indirect ecosystem services) (phase 1a)[6] and partly to values associated with direct ecosystem services (phase 1b) (Tabel 1). More information on criteria and guidelines for assessments can be found in the Swedish Agency for Marine and Water Management report 2020:13.

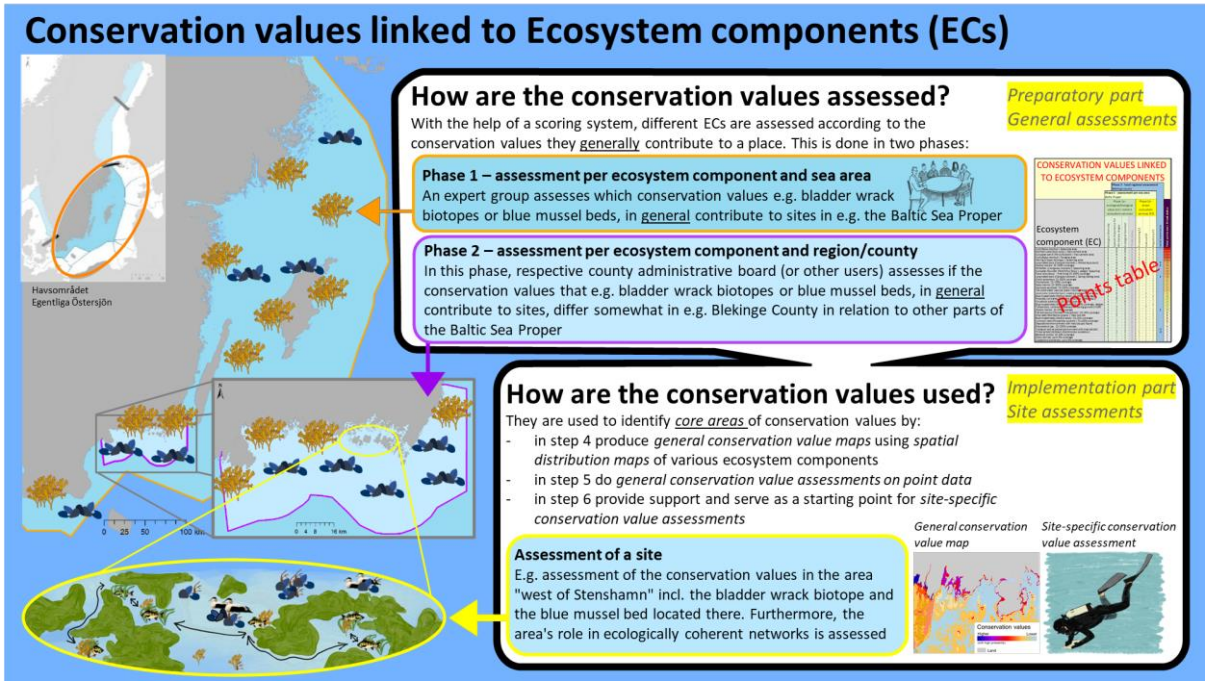


Figure 6. Assessments of which conservation values that are associated with ecosystem components is done in two phases in the *preparatory part*. In phase 1 assessments are based on sea areas and are carried out by a larger group of marine experts coordinated by the Swedish Agency for Marine and Water Management. In phase 2 local regional assessments are done by users (such as relevant county administrative boards). Assessments are then ready to be used in MOSAIC's *implementation part* to identify *core areas* of high conservation value.

[6] Three of four criteria are based on criteria set by the UN Convention on Biological Diversity (CBD) for designating so called EBSAs (Ecologically or Biologically Significant Marine Areas) (Appendix 1, Decision IX/20, 2008)

Table 1. Example showing how conservation value points can be assigned to various ecosystem components in MOSAIC. Points are based on the conservation value an ecosystem component generally contributes to a sea area.

CONSERVATION VALUES LIKED TO ECOSYSTEM COMPONENTS

Ecosystem Component	Phase 1a – ecological/biological values (incl. indirect ES*): Biological Diversity	Special importance for life history stages	Ecological function	Threat status	Phase 1b – direct ecosystem services (ES): Provisioning ES*	Cultural ES*	Regulating ES*	Local importance (±3)	Total score, without threat status	Total score with threat status
	Phase 1 – assessment per sea area: *Baltic Proper*							Phase 2 – local regional assessment: *Blekinge county*		
Northern pike (*Esox lucius*): Recruitment area	2	8	8	0	1	4	4	0	27	27
Long-tailed duck (*Clangula hyemalis*): Wintering ground, Oct-Mar	1	8	4	8	0	4	0	2	19	27
Blue mussel bed (*Mytilus edulis*) 25-100% coverage, deeper than 30 m	4	0	4	0	0	1	4	0	13	13
Cladophora glomerata , single occurrences to 9% coverage	1	0	1	0	0	0	0	0	2	2
…	.	.	.	.	.	.	.	.	.	.
…	.	.	.	.	.	.	.	.	.	.

* ES = Ecosystem Services

Every assessment (point/score) has been carefully considered and is motivated according to a defined structure (Figure 7). Both the points and justifications for each ecosystem component can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*.

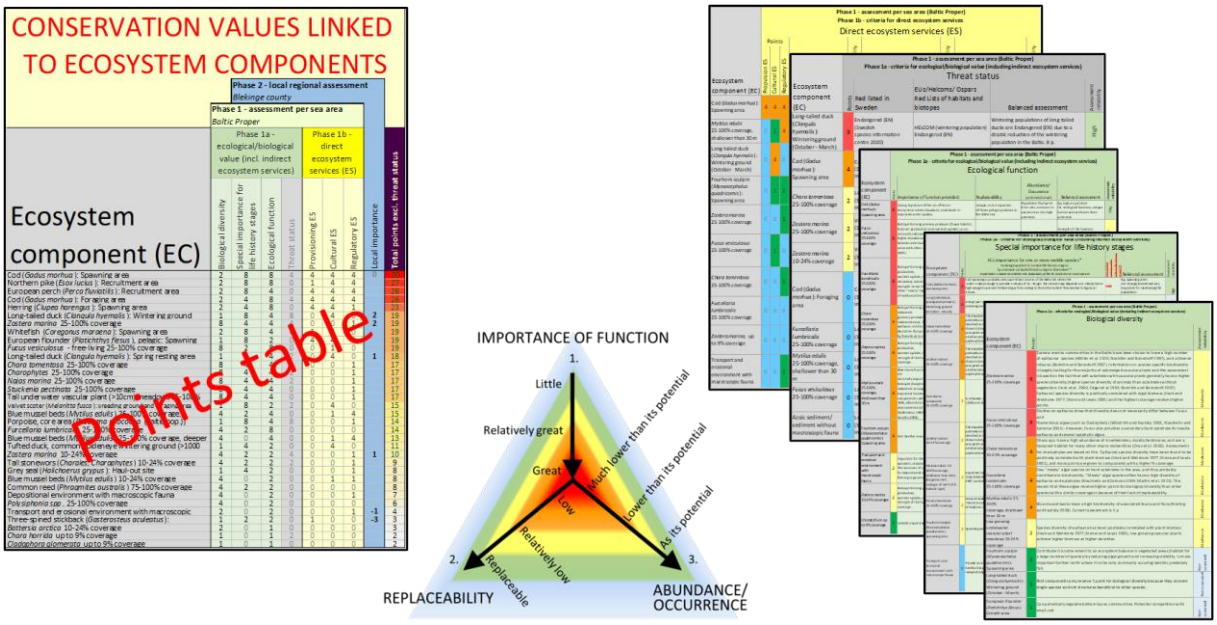


Figure 7. MOSAIC provides strict guidelines on how each criterion should be assessed and how the motivation for the assessments should be reported. More information on guidelines can be found in the Swedish Agency for Marine and Water Management report 2020:13[7]. This figure only provides a glimpse of the process.

[7] Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1*.

2.2.2 Phase 2, local regional assessments

In phase 2, points are assigned to reflect the ecosystem components local importance in relation to the rest of the sea area. Assessments in phase 2 are carried out by the user – and we suggest that county administration boards coordinate this. Local regional assessments are not part of the lists published in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*, but there are designated columns where the information can be included.

More information on how these assessments can be carried out are found in the next chapter.

2.3 Using the ecosystem component lists

Lists of ecosystem components are found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*, and each sea area has its own worksheet (Figure 8)

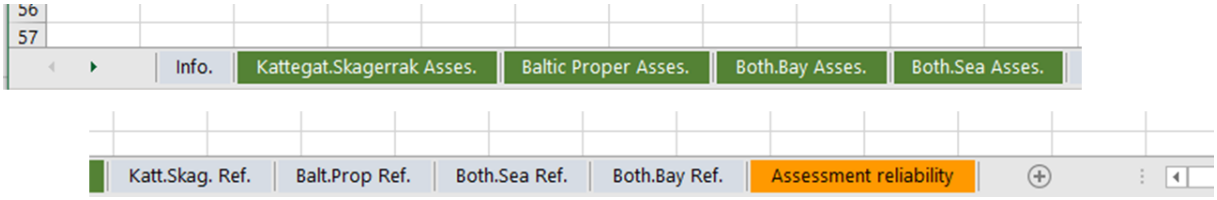


Figure 8. The figure shows the different worksheets contained in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*. Information on how the lists were developed including references and contact details for feedback can be found in one of the worksheets (called “Info.”). The green tabs contain lists and information for each sea area and the grey tabs contain the respective references for the information found in the lists (note this is not complete for Kattegat/Skagerrak). The orange tab contains information on how the reliability of assessments was determined.

Every row consists of an ecosystem component. Information on the conservation value assigned to each ecosystem component including its score (points) and justification are presented in columns after the ecosystem component (Figure 9). Additional information can be found in the lists, such as TaxonId (Dyntaxa namnochslaktskap.artfakta.se) whether the ecosystem component contains a priority species, a cross reference to HELCOM HUB, if the ecosystem component contains a species that is typical to a Natura 2000 habitat type etc.

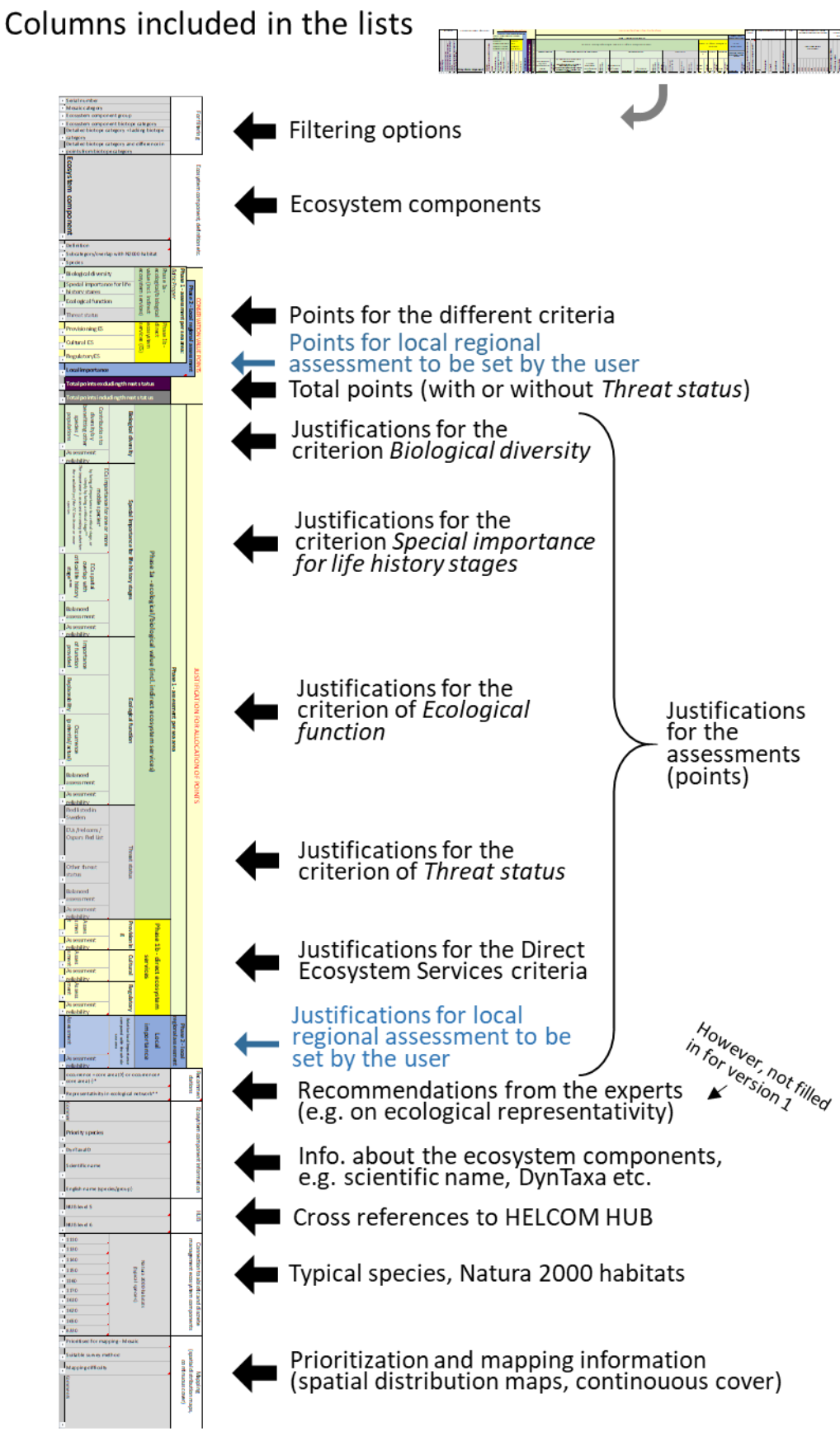


Figure 9. Columns included in the lists of ecosystem components and their conservation value. Guidelines for how this should be done (and have been done) can be found in the Swedish Agency for Marine and Water Management report 2020:13.

3 Preparation

3.1 Conservation values linked to ecosystem components

3.1.1 Choice of criteria to include from the assessments made per sea area, phase 1

Users can choose which criteria (and associated points) to use from phase 1 in the *preparatory part*. As standard, we recommend using criteria (and points) found in both phases:

- phase 1a – ecological/biological criteria (including indirect ecosystem services) and
- phase 1b – direct ecosystem services

However, if the focus for the management application is limited to ecological and biological conservation values, then phase 1b (and the associated points) can be excluded. One can also choose to exclude, for example, the criterion *threat status*, because knowledge of the criterion is very uneven between ecosystem components. For a thorough description, read the Swedish Agency for Marine and Water Management report 2020:13.

3.1.2 Local regional assessments, phase 2

The *preparatory part* of MOSAIC includes a step that should be completed by the user (*e.g.* county administrative boards). This step relates to the conservation value of ecosystem components from a local regional perspective.

The score for each ecosystem component can be adjusted (points added or deducted) according to their relative local importance compared with its importance in the whole sea area (see Figure 6); the criterion has the somewhat longwinded title *relative local importance compared with the whole sea area*.

We recommend that *local regional assessments* take place at the county level but further separation within counties can be made, such as at the municipal or water district levels. Division of the assessments is especially relevant if there are large ecological differences within a county, such as those occurring between the inner and outer areas of an archipelago.

Local regional assessments should be based on the same criteria as in phase 1, but from a more local/regional perspective. A species may, for example, occur less frequently in a county compared with the entire sea area, which could increase the value for its *ecological function*. However, in the local regional assessments only a single value is given which should reflect all the criteria, and by doing so, the score from phase 1 is marginally increased or decreased (see Table 1). A maximum of 3 points per ecosystem component can be added or deducted from the score deduced in phase 1[8].

Note that whilst phase 2 accounts for local/regional variation it is not to intended to reflect site-specific conditions (these are accounted for later, in the *implementation part*). In other words, assessments in phase 2 are still general to a larger geographic area and do not account for an ecosystem components occurrence at a site. An example of *local regional assessments* for an

[8] With the exception of Öresund where 5 points can be added or deducted. More information on the point system design can be found the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1* chapter 2.3.2.5.1.

ecosystem component is the conservation value of a bladder wrack biotope (coverage ≥ 25 percent) in the county of Blekinge regardless of where in Blekinge it is found (see Figure 6).

The excel lists[9] contain a blank column where local regional assessments can be added (blue column in Tabel 1 and in Figure 9). Table 2 provides guidelines on how criteria should be scored (increase or decrease) and examples are provided in Table 3.

Table 2. Guidelines for assessments in phase 2 – points are based on *local regional assessments* and a criterions *relative local importance compared with the whole sea area*. Examples of how this can be applied to ecosystem components can be found in Table 3. EC = ecosystem component.

Phase 2 - local regional assessment	
	Criteria for local importance
Points	Relative local importance compared with the whole sea area
+3	The EC's local importance is much greater in the assessed area compared with the larger sea area (based on criteria in phase 1)
+2	The EC's local importance is greater in the assessed area compared with the larger sea area (based on criteria in phase 1)
+1	The EC's local importance is marginally greater in the assessed area compared with the larger sea area (based on criteria in phase 1)
0	The EC's local importance in the assessed area is the same as in the larger sea area (based on criteria in phase 1)
-1	The EC's local importance is smaller in the assessed area compared with the larger sea area (based on criteria in phase 1)
-2	The EC's local importance is marginally smaller in the assessed area compared with the larger sea area (based on criteria in phase 1)
-3	The EC's local importance is much smaller in the assessed area compared with the larger sea area (based on criteria in phase 1)

[9] Excel document *MOSAIC – ecosystem component lists and conservation values, version 1,* can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

Table 3. Examples of the rationale behind *local regional assessments* carried out in phase 2. In this example *local regional assessments* of ecosystem components in Blekinge are made relative to the whole of the Baltic Proper sea area. The criteria do not need to be carried out by a whole expert group and do not need to be based on extensive literature (as in the first stage of the *preparatory part*). The table is only intended to demonstrate the rationale behind how *local regional assessments* can be carried out. For a description of how the various points should be set, see Table 2.

Example of how assessments can be carried out			
	Phase 2 - local regional assessment, exemplified using Blekinge county		
	Criteria for local importance		
Ecosystem component (EC)	Points	Relative local importance compared with the larger sea area	Assessment reliability
Long-tailed duck (*Clangula hyemalis*): Wintering ground (October - March)	2	Blekinge provides a very important wintering area for long-tailed duck (Hanöbukten)	Not assessed
Zostera marina 25-100% coverage	2	Eelgrass is more common in Blekinge than in the northern parts of the Baltic Proper, but other tall vascular plants are less common here. Therefore functions associated with tall vascular plants on soft substrates are primarily provided by eelgrass in Blekinge and management of these habitas should be prioritized in the county.	Not assessed
Mytilus edulis 25-100% coverage, shallower than 30 m	2	Blue mussels are very important for the wintering birds in Blekinge. Hence local importance is higher for Blekinge than the larger sea area (Baltic Proper) and the score increased.	Not assessed
Zostera marina 10-24% coverage	1	Eelgrass is more common in Blekinge than in the northern parts of the Baltic Proper, but other tall vascular plants are less common here. Therefore functions associated with tall vascular plants on soft substrates are primarily provided by eelgrass in Blekinge and management of these habitas should be prioritized in the county. The functions provided by eelgrass with a coverage of 10-24% is considered lower than coverage between 25-100%, therefore only 1 p awarded	Not assessed
Cod (*Gadus morhua*): Spawning area	0		Not assessed
Chara tomentosa 25-100% coverage	0	TEST	Not assessed
Furcellaria lumbricalis 25-100% coverage	0		Not assessed
Fucus vesiculosus 25-100% coverage	0		Not assessed
Cod (*Gadus morhua*): Foraging area	0		Not assessed
Transport and erosional environment with macroscopic fauna	0		Not assessed

Assessment reliability

The reliability of a local regional assessment should be reported for each ecosystem component and guidelines for this can be found in Table 4. The reliability of assessments is set by the user and should be based on a combination of the amount of scientific evidence that exists and its relevance to the ecosystem component. We anticipate that scientific support for *local regional assessments* will often be low due to the low number of studies exploring regional differences within a sea area.

Table 4. Guidelines showing how to evaluate the reliability of local regional assessments. EC = ecosystem component.

Assessment reliability

	Scientific evidence	**Relevance (for specific EC and region)**	**Concensus between studies**
High	Based on reliable studies (peer reviewed or grey literature from established / reputable sources)	Based on relevant studies carried out on specific EC and region	High level of concensus on EC significance
Moderate	Based on a number of reliable studies and expert opinion	Based on relevant studies carried out on similar/comparable EC or region	Majority of studies in agreement on EC significance
Low	Based primarily on expert opinion but also on a few reliable studies	Based on relevant studies carried out on partly similar EC or region	Conflicting studies but a majority for EC significance
Very low	Based on expert opinion	Not based on relevant studies carried out on specific EC or region	No concensus
Not assessed			

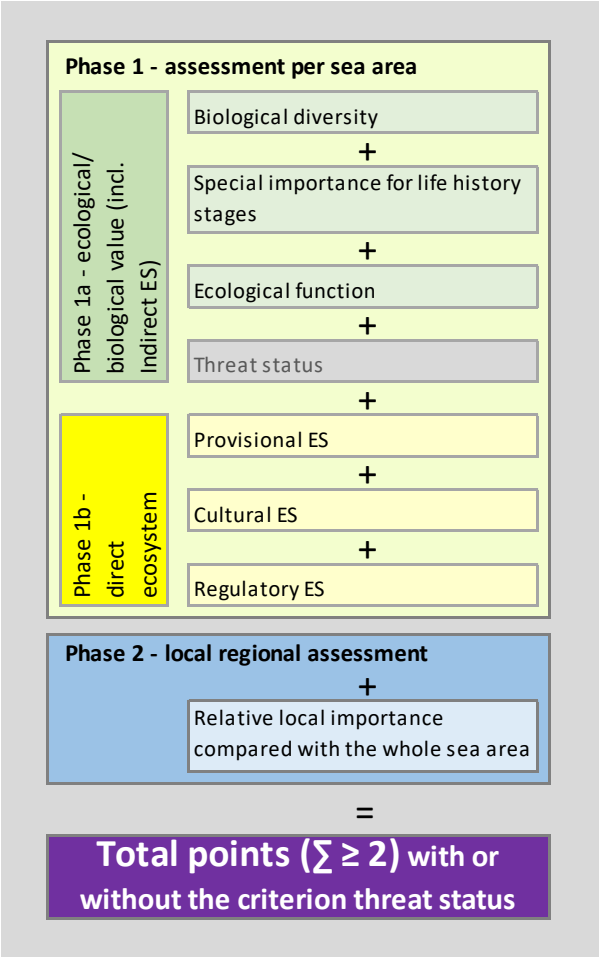
3.1.3 The combined conservation value of ecosystem components

The points from phases 1a, 1b and 2 are combined to give a conservation value for each ecosystem component. Phase 2 can contain a negative number reducing the combined score, but ecosystem components containing a native species cannot have a combined score below two points, since the points they receive for each of the criteria *biological diversity* and *ecological function* in phase 1a are fixed. Ecosystem components containing alien invasive species[10] can have a combined conservation value below 2, but never lower than 0. More information on how the points system works can be found in the Swedish Agency for Marine and Water Management report 2020:13, section 2.3.2. Table 5 demonstrates how points are summed. The combined points indicate the conservation value an ecosystem component generally contributes to a site in region (i.e., a county) based on the best available knowledge and the prevailing regional environmental conditions (Table 6)[11].

[10] This manual defines invasive alien species according to the European parliament and Councils Regulation (EU) No 1143/2014 from the 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Specifically alien species are species that are introduced through human activity and that threaten or adversely impact an areas biological diversity and related ecosystem services (European parliament 2014). The allocation or deduction of points for alien species that are not considered as invasive should be made on a case-by-case basis.

[11] More information can be found in the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1* chapter 2.3.2.

Table 5. The total conservation value (points) of each ecosystem component is obtained by summing the points in phase 1a + phase 1b + phase 2. Ecosystem components with native species cannot receive a combined value lower than 2 (1 point each for the criteria *biological diversity* and *ecological function*, which are fixed). Alien, invasive species[12] can damage biodiversity *and can receive a combined score of 0.*



[12] This manual defines invasive alien species according to the European parliament and Councils Regulation (EU) No 1143/2014 from the 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Specifically alien species are species that are introduced through human activity and that threaten or adversely impact an areas biological diversity and related ecosystem services (European parliament 2014). The allocation or deduction of points for alien species that are not considered as invasive should be made on a case-by-case basis.

Table 6. Example of a points table showing associated conservation values of ecosystem components for the Baltic Proper and with local regional assessments for Blekinge county. Assessments reflect the conservation value an ecosystem component generally contributes. Ecosystem components can be based on coverage or number of individuals per area. Assessments in phase 1 (a and b) are carried out by a group of marine ecology and organism experts, coordinated by the Swedish Agency for Marine and Water Management. The local regional assessments in phase 2 are done per region (such as counties) and based on the *relative local importance* (in Blekinge) *compared with the whole sea area* (*i.e.* Baltic Proper). Phase 2 is carried out by the user (often county administration boards). Assessments can be made exclusively using ecological/biological conservation values (including indirect ecosystem services), columns marked in green; ignoring the points from phase 1b (direct ecosystem services (yellow columns). However, we do not recommend excluding ecological/biological conservation values (including indirect ecosystem services) from assessments because direct ecosystem services are completely dependent on indirect ecosystem services. The table also contains other information relevant for MOSAIC's *implementation part* (four columns on the left of table) such as whether the presence of an ecosystem component automatically qualifies the site as a *core area*, the proportion (i.e. *representativity*) of an ecosystem components distribution that should be included in *areas of ecologically coherent networks*, whether the ecosystem component contains a priority species and what category the ecosystem component belongs to. Further information on ecosystem components can be found in the lists presented in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*[13], including motivations for points allocated.

				CONSERVATION VALUES LINKED TO ECOSYSTEM COMPONENTS										
												Phase 2 - local regional assessment *Blekinge county*		
					Phase 1 - assessment per sea area *Baltic Proper*									
					Phase 1a - ecological/biological value (incl. indirect ecosystem services)				Phase 1b - direct ecosystem services (ES)					
Occurence = core area (X)*	Representativity in ecological network**	Conservation species***	Mosaic category****	Ecosystem component (EC)	Biological diversity	Special importance for life history stages	Ecological function	Threat status	Provisioning ES	Cultural ES	Regulatory ES	Local importance	Total points excl. threat status	Total points incl. threat status
X	90%	R; T	F&C	Cod (*Gadus morhua*): Spawning area	2	8	8	4	4	4	4		30	34
	75%	T	F&C	Northern pike (*Esox lucius*): Recruitment area	2	8	8	0	1	4	4		27	27
	75%	T	F&C	European perch (*Perca fluviatilis*): Recruitment area	2	8	4	0	4	4	4		26	26
	5%	R; T	F&C	Cod (*Gadus morhua*): Foraging area	2	4	8	4	4	4	4		26	30
	25%	T	F&C	Herring (*Clupea harengus*): Spawning area	2	4	8	0	4	4	1		23	23
X	90%	D: R; P	B&M	Long-tailed duck (*Clangula hyemalis*): Wintering ground (Oct-Mar)	1	8	4	8	0	4	0	2	19	27
	75%	R; T; NM	Bent	*Zostera marina* 25-100% coverage	8	4	4	4	0	0	1	2	19	23
	75%	D; T; P	F&C	Whitefish (*Coregonus maraena*): Spawning area	2	8	4	0	1	4	0		19	19
	50%	T	F&C	European flounder (*Platichthys flesus*), pelagic: Spawning area	1	8	2	0	4	4	0		19	19
	30%	T	Bent	*Fucus vesiculosus* - free-living 25-100% coverage	8	2	8	0	0	1	0		19	19
	50%	P;D;T	B&M	Long-tailed duck (*Clangula hyemalis*): Spring resting area (April - May)	1	8	4	2	0	4	0	1	18	20
X	75%		Bent	*Chara tomentosa* 25-100% coverage	8	4	4	2	0	0	1		17	19
X	75%		Bent	*Charophytes* 25-100% coverage	8	4	4	2	0	0	1		17	19
X	40%	T	Bent	*Najas marina* 25-100% coverage	8	4	4	2	0	0	1		17	19
	30%	T	Bent	*Stuckenia pectinata* 25-100% coverage	8	4	4	0	0	0	1		17	17
	40%		Bent	Tall underwater vascular plant (>10cm) meadows 25-100% coverage	8	4	4	0	0	0	1		17	17
	75%	D; R; P; T;	B&M	Velvet scoter (*Melanitta fusca*): Breeding ground and foraging area during breeding	1	8	2	2	0	4	0		15	17
	5%	T	Bent	Blue mussel beds (*Mytilus edulis*) 25-100% coverage, shallower than 30 m	4	2	4	0	0	1	4		15	15
X	90%	D; P; R; NM	B&M	Porpoise, core area (*Phocoena phocoena* (Baltic pop.))	1	8	4	8	0	0	1		14	22
	10%	T	Bent	*Furcellaria lumbricalis* 25-100% coverage	4	2	8	0	0	0	0		14	14
	5%	T	Bent	Blue mussel beds (*Mytilus edulis*) 25-100% coverage, deeper than 30 m	4	0	4	0	0	1	4		13	13
X	50%	D;P;	B&M	Tufted duck and common goldeneye: Wintering ground (>1000 individuals)	1	4	2	0	0	4	0		11	11
	25%	R; T; NM	Bent	*Zostera marina* 10-24% coverage	4	2	2	4	0	0	1	1	10	14
	25%		Bent	Tall stoneworts (*Charales, Charophytes*) 10-24% coverage	4	2	2	2	0	0	1		9	11
	25%	D	B&M	Grey seal (*Halichoerus grypus*): Haul-out site	1	4	2	0	0	0	1		8	8
	-	T	Bent	Blue mussel beds (*Mytilus edulis*) 10-24% coverage	4	0	2	0	0	1	1		8	8
	10%		Bent	Common reed (*Phragmites australis*) 75-100% coverage	4	2	2	0	0	0	0		8	8
	-		Bent	Depositional environment with macroscopic fauna	4	0	2	0	0	0	1		7	7
	-		Bent	*Polysiphonia spp* . 25-100% coverage	4	0	2	0	0	0	0		6	6
	-		Bent	Transport and erosional environment with macroscopic fauna	2	0	2	0	0	0	1	-1	4	4
	-		F&C	Three-spined stickback (*Gasterosteus aculeatus*): Recruitment area	1	2	2	0	1	0	0	-3	3	3
	-	T	Bent	*Battersia arctica* 10-24% coverage	2	0	1	0	0	0	0		3	3
X	0.5	R; NM	Bent	*Chara horrida* up to 9% coverage	1	0	1	2	0	0	0		2	4
	-		Bent	*Cladophora glomerata* up to 9% coverage	1	0	1	0	0	0	0		2	2

* Presence of EC which automatically qualifies an area as core area (X). Example, not recommendations.

** Minimum proportion of the EC required in ecological networks to be considered acceptably represented. Example, not recommendations.

***Conservation species: Protected (P); Typical species (T); Red listed (R); Priority (Prio); Indicator (I); with a National program of Measures (NM); Directive species (D).

***Categories: birds and mammals (B&M); fish and large crustaceans (F&C); benthos (Bent).

[13] Excel document *MOSAIC – ecosystem component lists and conservation values, version 1,* can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

4 Checklist for MOSAIC's implementation part, version 1

This section provides a checklist of steps to be taken in order to carry out MOSAIC's *implementation part* and identify areas with high conservation value in viable and ecologically representative networks, in other words *areas of ecologically coherent networks*. For a more detailed description of the theory behind the steps found in this chapter please see the Swedish Agency for Marine and Water Management report 2020:13.

4.1 Field/biological point data[14]

The field/biological point data comprises 2 steps (Figure 10) designed to collate spatial information from different locations. These steps include the general *presence of an ecosystem component* (step 1) and more detailed information from *detailed field surveys* (step 2; this information could for example be used to calculate diversity indexes). There is no sharp division between the two steps and the same information could be used in both steps.

4.1.1 Step 1: *Presence of ecosystem components*

How complete are the guidelines for step 1?

There is a general description for this step, but recommendations for a gap analysis are lacking. The gap analysis should include information on, for example, which ecosystem components presence data are missing. Recommendations on possible gap analyses in step 1 may fall outside of the scope of MOSAIC.

The first step of MOSAIC's implementation part involves collecting data on where different ecosystem components can be found in the area of interest (Figure 10). The quality of the information dictates how it can be used. If the quality of the data allows, it could for example be used to model *ecosystem component spatial distribution maps* (step 3) which are then used to create *general conservation value maps* (step 4). Information can also be used directly to estimate the conservation value associated with the sampling locations (points) (step 5).

[14] In this manual point data refers to discrete data points (in contrast to continuous coverage data). Even data from transects, or that is spatially limited (such as from video surveys), are regarded as point data.

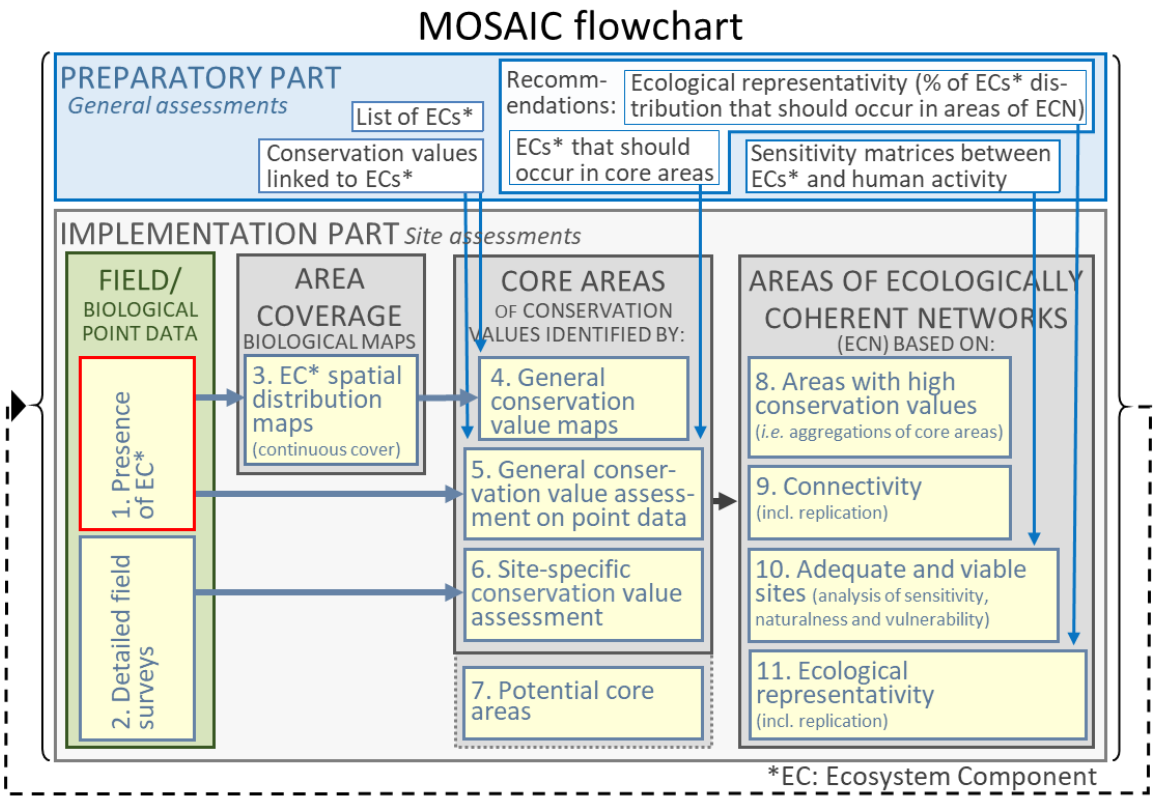


Figure 10. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Gather all available point data relating to ecosystem components in the area of interest.
- ✓ Note which ecosystem components have sufficient high-quality information in order to analyze their occurrence for the entire region, i.e. estimate their spatial distribution (continuous cover) for the entire area of interest (see below).
- ✓ If possible: Evaluate the data and create a list of prioritized actions. Which ecosystem components lack occurrence and spatial distribution data? Is a certain biotope underrepresented compared to others? What field surveys need to be prioritized?
  - × Use/collect information from step 3 (this requires MOSAIC to have been operational for at least one management period).

We recommend that point data meets the following criteria in order to be of sufficient quality to be used in spatial management from a seascape perspective:

- The exact position of the sampled point should be known and accurate.
- The size of the survey area should be known.
- The ecosystem components that can and cannot be surveyed with a given method should be noted. What is possible to reliably survey with the survey method used? Are there, for example, species that are not recorded but are possible to detect using the method?
- The time and date that data collection was carried out should be known, this is especially important for species that have a variable distribution (e.g. seasonal or between years). Where a species distribution varies greatly over time a survey done far back in time can also give an inaccurate picture of the actual distribution.
- Over-representation of certain biotopes or organisms should be avoided. The survey data should be well balanced.

If point data is to be used to model spatial distribution maps we also recommend:

The full gradient of environmental variables should be sampled so that the total spatial occurrence of ecosystem components is represented. For example, one should include sampling from the deepest to the shallowest, or the most exposed to the most protected occurrence of an ecosystem component.

4.1.2 Step 2: *Detailed field surveys*

How complete are the guidelines for step 2?

Guidelines for detailed field surveys have not been developed. These should be developed in combination with step 6, site-specific conservation value assessments.

In the second step of MOSAIC's *implementation part*, *detailed field surveys* (Figure 11) are carried out to collect information on a site's conservation value. There are currently no guidelines for this step and, until these are available, it is up to the user to decide on suitable methods. This step is closely linked to step 6, *site-specific conservation value assessments*. For the time being we recommend a method that meets the internationally accepted criteria set by the UN Convention on Biological Diversity (CBD) for designating so called EBSAs (Ecologically or Biologically Significant Marine Areas) (Appendix 1, Decision IX/20, 2008) (see fact box). More information on these criteria can be found in step 6, *site-specific conservation value assessment*.

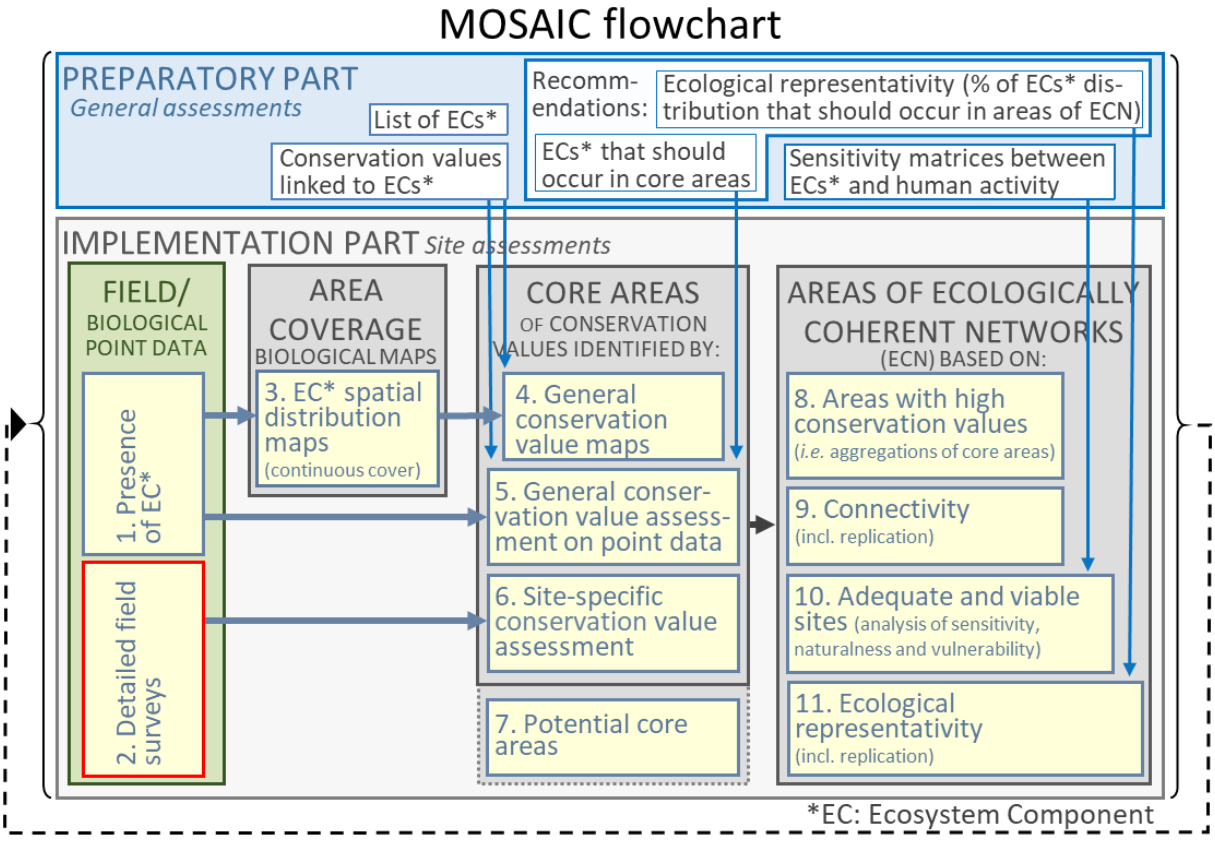


Figure 11. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Collect data on completed *detailed field surveys* that have been carried out in the region of interest.
- ✓ Plan the location of new *detailed field surveys*.

- × Collect information on which areas are prioritized for field surveys in order to fulfill steps 4, 9 and 10 (this requires MOSAIC to have been operational for at least one management period).
- ✓ Specify methods to be used for *detailed field surveys* (until MOSAIC's guidelines are available).
- ✓ Carry out *detailed field surveys*.

CBDs scientific criteria for Ecologically or Biologically Significant Marine Areas (EBSASs) are as follows:

1. uniqueness or rarity
2. special importance for life-history stages of species
3. importance for threatened, endangered or declining species and/or habitats
4. vulnerability, fragility, sensitivity, or slow recovery
5. biological productivity
6. biological diversity
7. naturalness.

Annex 1, decision IX/ 20, CBD 2008

4.2 Area coverage – biological maps

4.2.1 Step 3: *Ecosystem component spatial distribution maps* (continuous cover)

How complete are the guidelines for step 3?

A brief description of how ecosystem component spatial distribution maps can be produced is available in the Swedish Agency for Marine and Water Management report 2020:13. More detailed recommendations are not currently planned within MOSAIC and for the time being it is considered outside the scope of the tool. However, gap analysis guidelines need to be produced for spatial distribution maps (for example specify the minimum number of maps needed for a certain management process or a list of mandatory ecosystem components).

The third step of MOSAIC's implementation part (Figure 12) involves collecting existing maps or producing new maps that show the spatial distribution of ecosystem components (continuous cover) in an area. The purpose of this is to get an overview of ecosystem components from a seascape perspective.

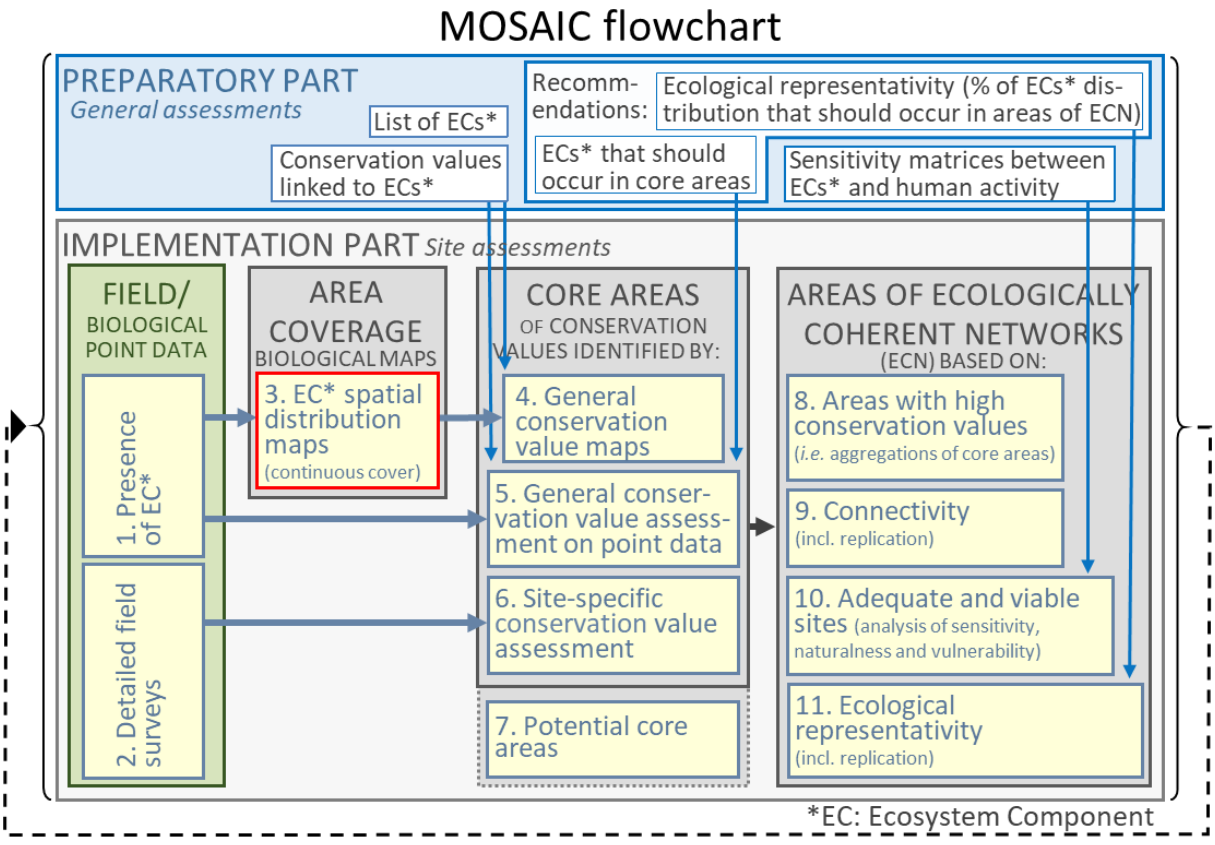


Figure 12. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Collect existing spatial distribution maps containing biological information for the area of interest.

- ✓ If possible, and according to your own chosen method: evaluate what data is missing and should be prioritized in order to produce *ecosystem component spatial distribution maps*.
- ✓ Evaluate options for collecting missing data. For example, consider if available point data on *presence of ecosystem components* can be combined with other environmental variables to model *ecosystem component spatial distribution maps*. See the quality requirements for step 1. Uncertainties in modelled maps should also be taken into account and reported.
- ✓ Before the next management period:
  - × Note which ecosystem components are prioritized for surveying.
  - × Note which *ecosystem component spatial distribution maps* are prioritized.

4.3 Identifying *core areas* of conservation value

The definition of a marine *core area* is: An area with a high conservation value with respect to biodiversity and the provision of ecosystem services.

In order to identify *core areas*, you should ideally use both spatial distribution maps and point data, preferably from *detailed field surveys*. Both these data sources are important because they complement each other by providing a seascape perspective (spatial distribution maps) and valuable detailed information on specific locations.

4.3.1 Step 4: *General conservation value maps*

How complete are the guidelines for step 4?

Guidelines are available in version 1 of MOSAIC. However, guidelines on how to report deficiencies in the data are lacking.

In the fourth step of MOSAIC's implementation part, *core areas* are identified using *general conservation value maps* (Figure 13). The aim is to identify where conservation values accumulate in the seascape. The maps are produced by combining *conservation values linked to ecosystem components* (points) from the *preparatory part*[15], with the presence of ecosystem components from *ecosystem component spatial distribution maps* (step 3 in the *implementation part*) (Figure 14). Since two-dimensional maps are based on a 3-dimensional world[16], several ecosystem components can occur in the same 2-dimensional space (Figure 15). To make a map of conservation values the points awarded to all ecosystem components (recorded in each cell of the map) are weighed together.

[15] Points assigned to ecosystem components can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1,* can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

[16] The "fourth dimension" – time – is handled in MOSAIC through reoccurring revisions. Seasonal variations are not accounted for in version 1 of MOSAIC (an area will be pointed out as having high conservation value even if it is only for a limited time over the course of a year). It is hoped that future versions of MOSAIC will better account for season variation.

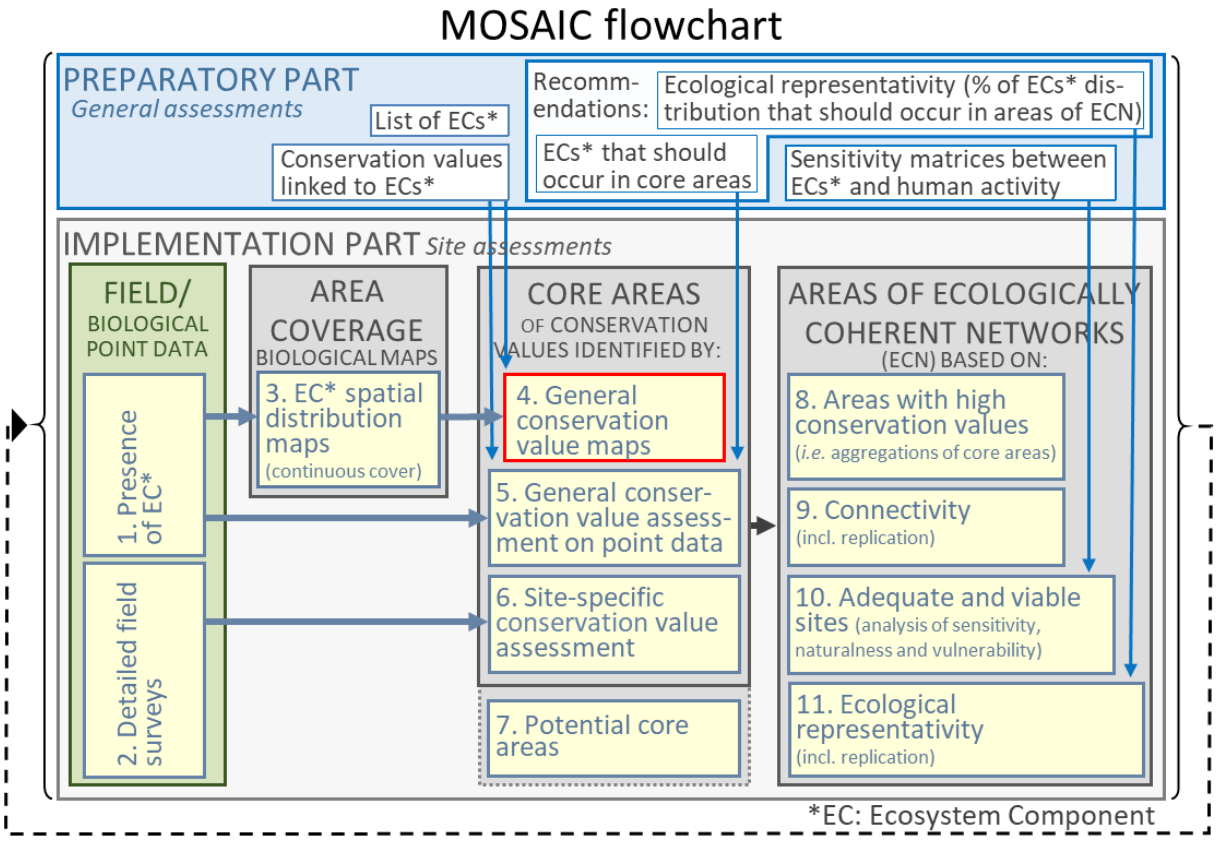


Figure 13. The red outline in the flow chart denotes the relevant step described in this section.

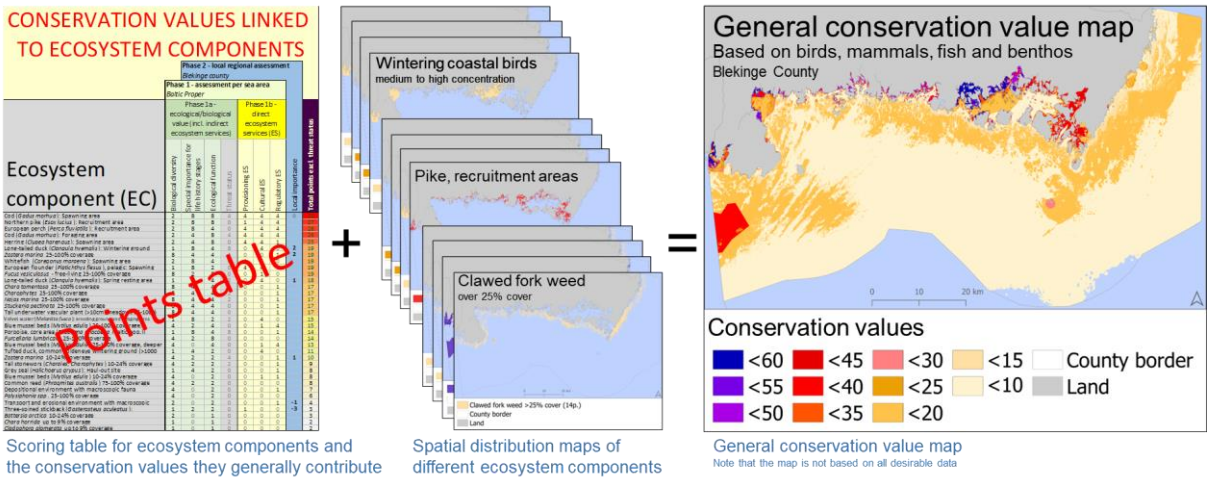


Figure 14. *General conservation value maps* are created by using the conservation value points assigned to ecosystem components in the *preparatory part*[17], together with *ecosystem component spatial distribution maps* (step 3).

[17] These can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1,* which can be downloaded from the Swedish Agency for Marine and Water Managements webpage. See chapter 2 for details.

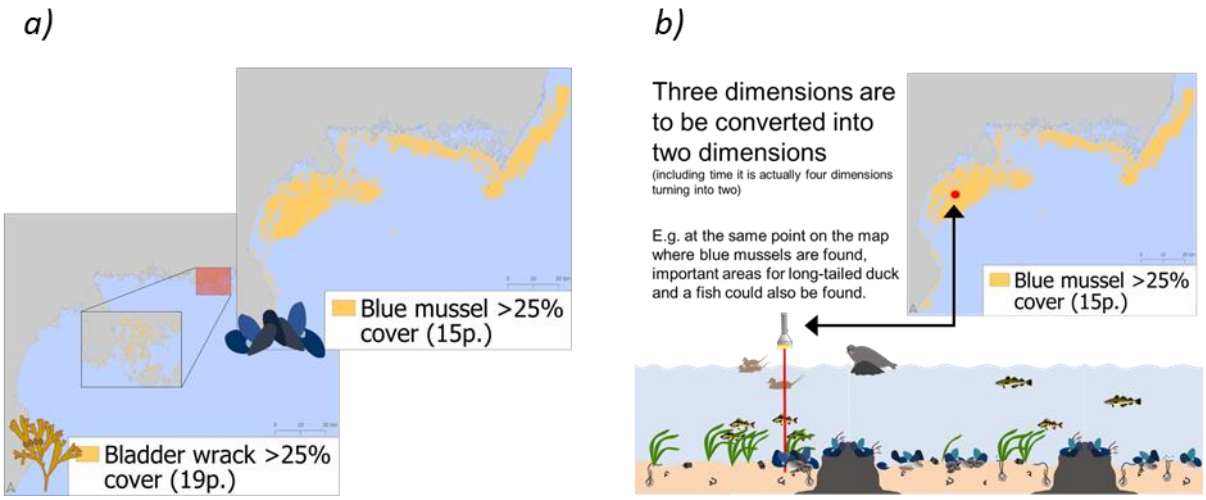


Figure 15. a) An example of spatial distribution maps showing two different ecosystem components. b) Since two-dimensional maps are created from a 3-dimensional reality, several ecosystem components can occur on the same point/cell of a map.

To do

- ✓ Divide the area of interest into a raster or grid. Every cell in the grid is the "smallest assessment unit" that should be used when producing *general conservation value maps* (Figure 16). We recommend a grid size between 10 x 10 m (100m^2) and 50 x 50 m (2500m^2) for coastal zones. Offshore areas might be up to a few km^2, depending on their ecological/biological homogeneity, if smaller cells are too numerous to process.
- ✓ Divide the biological ecosystem components into the categories:
  - × birds and mammals
  - × fish and large crustaceans
  - × benthos (Figure 17b)

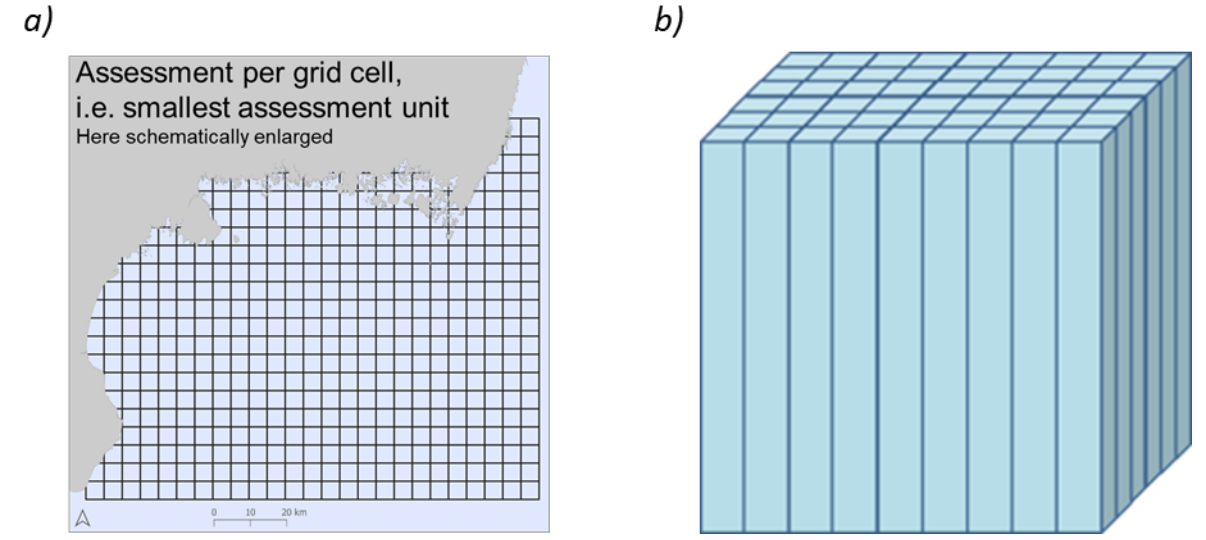


Figure 16. An area of interest can be divided into a grid or raster (a) where every cell represents the entire water column (b) and is the smallest assessment unit.

Large crustaceans include large decapods, with a certain mobility, that are often valuable for commercial and recreational fisheries: species include European lobster (*Homarus gammarus*), langoustine (*Nephrops norvegicus*), prawns (*Pandalus borealis*) and edible crab (*Cancer pagurus*).

- ✓ Produce *general conservation value maps* for each category (birds and mammals, fish and large crustaceans, benthos) using the ecosystem component with the highest conservation value points[18] (maximum value) in each category and grid cell (smallest evaluation unit). (Figures 17 and 18).
- ✓ Combine the *general conservation value maps* from each category (birds and mammals, fish and large crustaceans, benthos) into a single general conservation value map by summing points from each category (*i.e.* sum the points for birds and mammals, fish and large crustaceans and benthos for each cell) (Figures 17 and 19).
- ✓ Define *core areas* in the *general conservation value maps* by identifying aggregations of cells with high conservation values. *Core areas* are identified either by category (birds and mammals, fish and large crustaceans, benthos) or their combined conservation value. For example, the 10% of cells with the highest conservation value might be chosen (Figure 20).
- ✓ Important: High conservation value areas identified on the *general conservation value maps* that have not been thoroughly surveyed should be verified in the field (step 2) before the next management period.

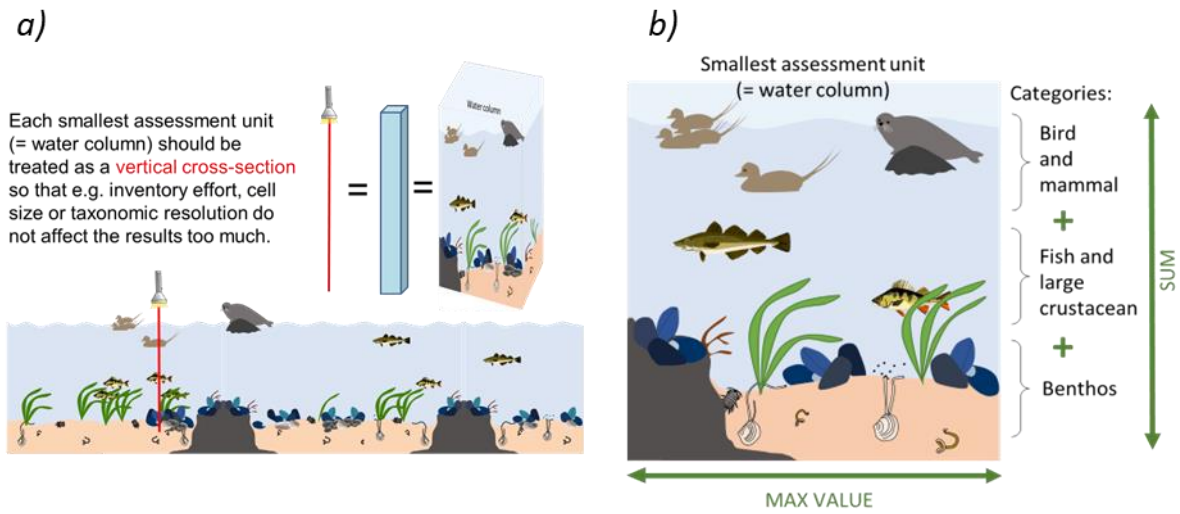


Figure 17. Every cell, or minimum assessment unit, should be treated as a vertical cross-section through the water (a). For this reason, ecosystem components are divided into categories that are usually separated vertically through the water column (b). If a cell contains several ecosystem components from the same category only the points from the ecosystem component with the highest value should be used (the maximum value within a category) (Figure 18). If a cell contains ecosystem components from several categories, the category values should be summed to give an overall conservation value score for that cell or minimum assessment unit (Figure 19). This is a highly simplified illustration of reality, but important in order to avoid significant errors. More information on why we recommend this approach can be found in section 2.4.3.1.1 of the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1*.

[18] These can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1, which* can be downloaded from the Swedish Agency for Marine and Water Managements webpage. See chapter 2 for details.

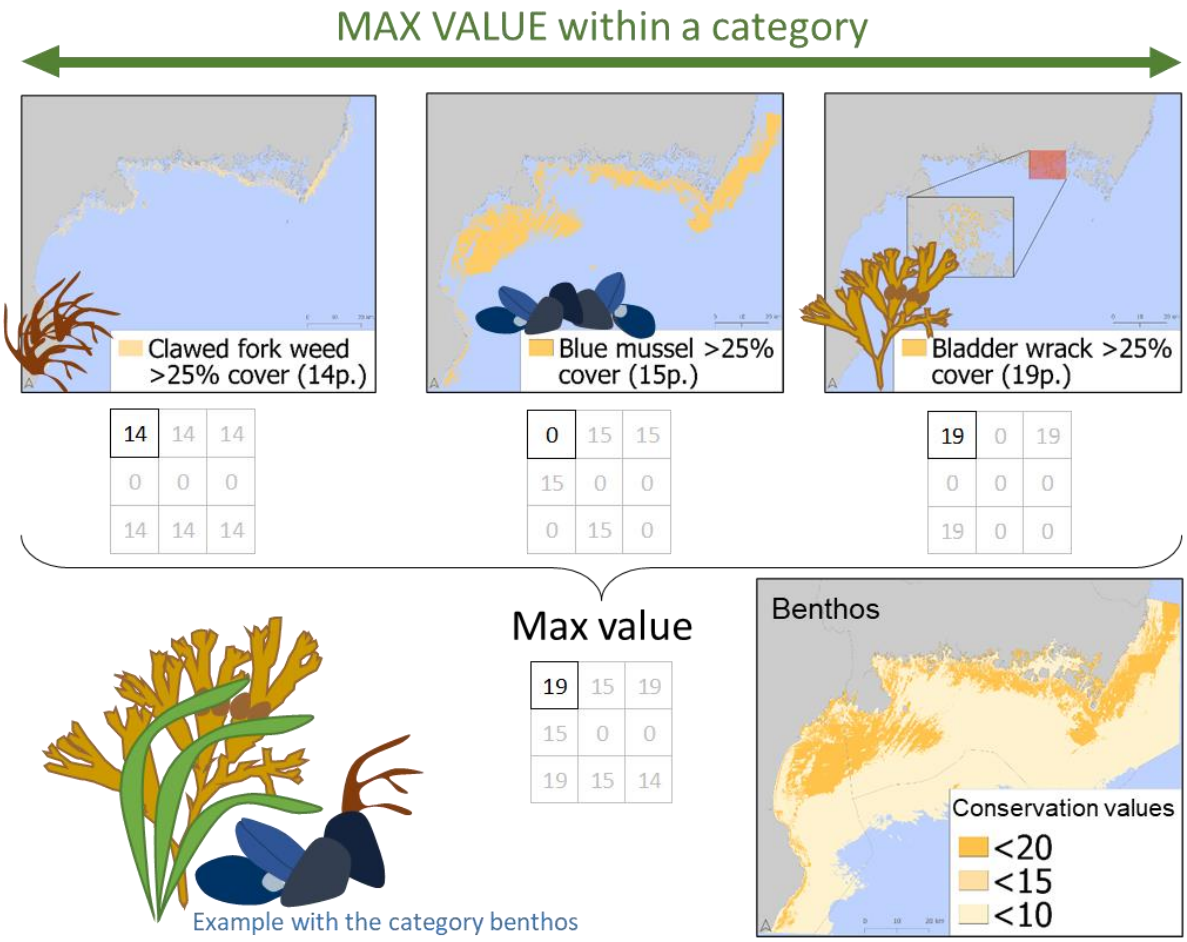


Figure 18. An example from southern Sweden (Hanö bay). The three uppermost maps show ecosystem components belonging to the same category (benthos): *Furcellaria* with 25-100 % coverage, blue mussel beds with 25-100 % coverage and bladder wrack with 25-100 % coverage. From Table 6 we can see that each ecosystem component has been awarded 14, 15[19] and 19 points respectively. To compile points within a category (here benthos) the ecosystem component with the highest points (maximum value) is selected in each cell (i.e. minimum assessment unit). See also Figure 17b. Ecosystem components that are present but not included in step 4 (where only include the highest scoring components per category) are accounted for under the criterion *ecological representativity* (step 11, described later in this manual)[20]. The maps shown in this example have been produced following extensive field surveys which were used to model the presence of ecosystem components in 25 x 25 m grid cells. The maps were then further verified in the field. This example does not, however, contain data on all possible ecosystem components and should not be considered as the final general conservation value map.

[19] Note that when comparing with Table 6, criteria accounting for local importance (blue column in Table 6) are not used because the maps represent the whole of Hanö bay, not just Blekinge county. Blue mussel beds with a coverage > 25% are therefore scored 15 and not 17 points.

[20] See step 11, chapter 4.4.4

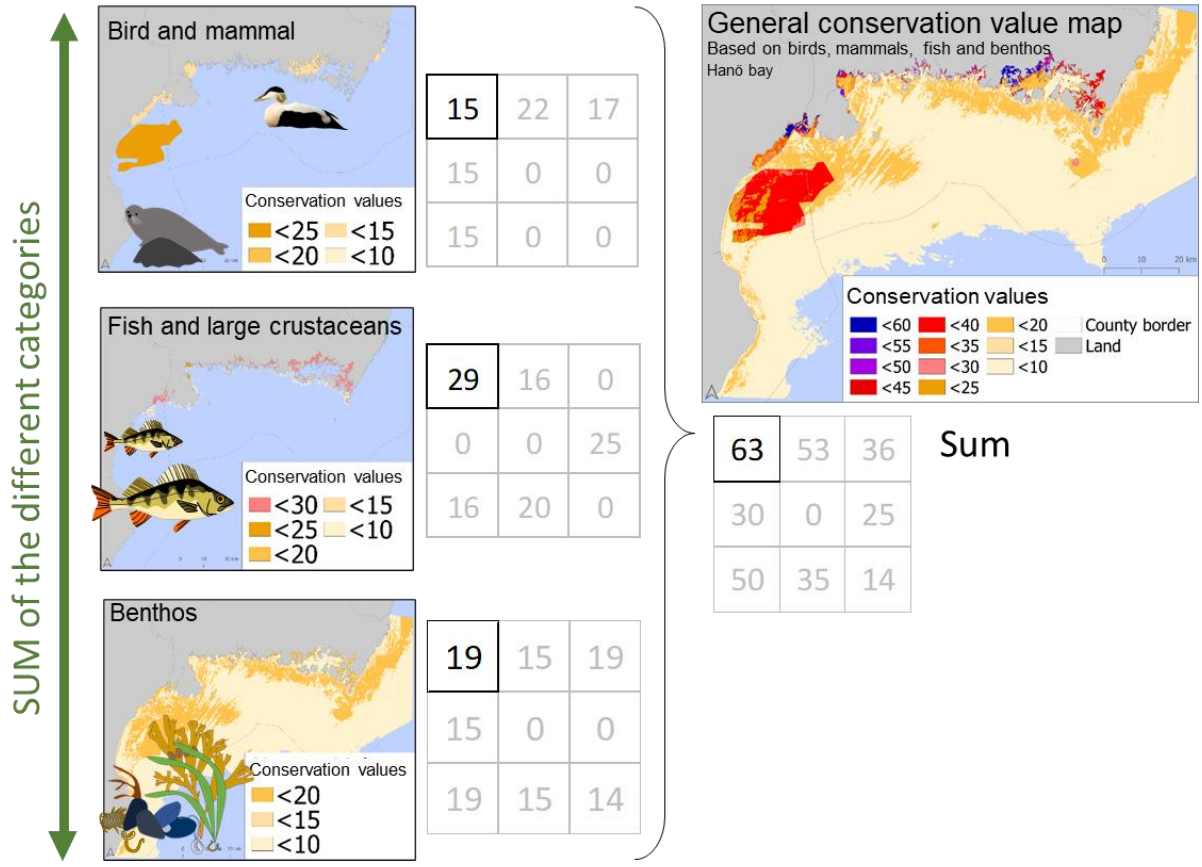


Figure 19. An example from southern Sweden (Hanö bay). The three maps on the left show the conservation value points for birds and mammals, fish and large crustaceans and benthos for the area. The values from each category are summed in each cell (i.e. minimum assessment unit) to produce *general conservation value maps* (map on the right). The maps shown in this example have been produced following extensive field surveys which were used to model the occurrence of ecosystem components in 25 x 25 m grid cells. The maps were then further verified in the field. This example does not, however, contain data on all possible ecosystem components and should not be considered as the final general conservation value map.

Step 4 of MOSAIC's *implementation part* describes a method to produce *general conservation value maps*. However, no method that attempts to systematically produce maps of conservation values is flawless and it is important to remain critical when analyzing the maps. And, as always, the results depend on the amount and quality of data available.

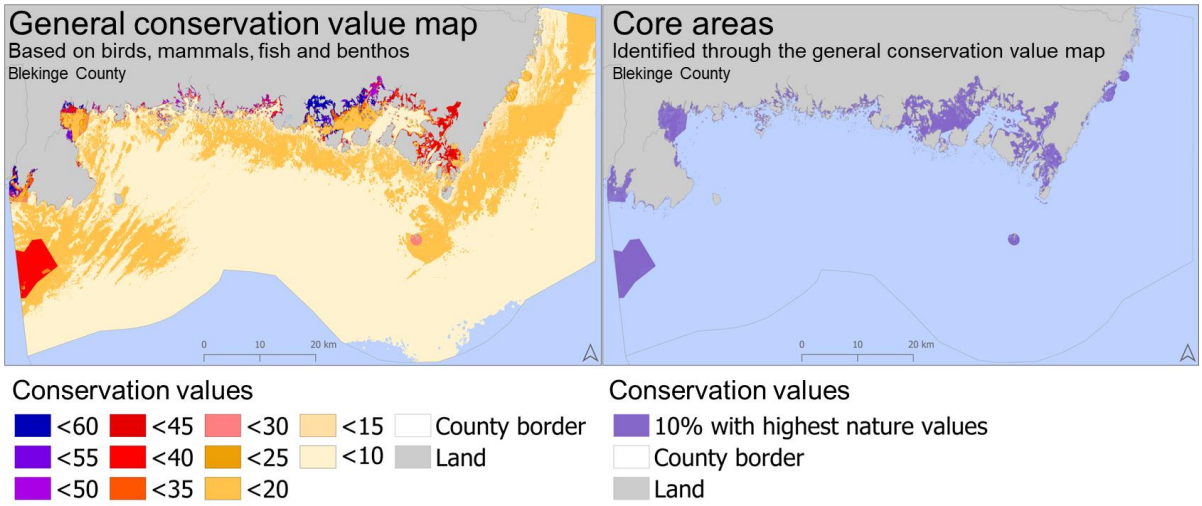


Figure 20. The figure on the left shows a map of conservation values for Blekinge county. The figure on the right shows the 10 % of area with the highest conservation value. These can be designated as *core areas*.

Step 5: *General conservation value assessments on point data*

How complete are the guidelines for step 5?

Guidelines are available for general conservation value assessment on point data. However, a method to establish how valuable an area should be to be classified as a core area, has not yet been specified. Until more detailed guidelines are available, assigning core areas from general conservation value assessments on point data should be overseen by respective county administrative boards.

The fifth step of MOSAIC's implementation part identifies *core areas*[21] from *general conservation value assessments on point data* (Figure 21). In this manual the term point data it used to describe data that is discrete (not related to coverage). Point data includes transects or data from confined areas (such as data generated from drop video surveys).

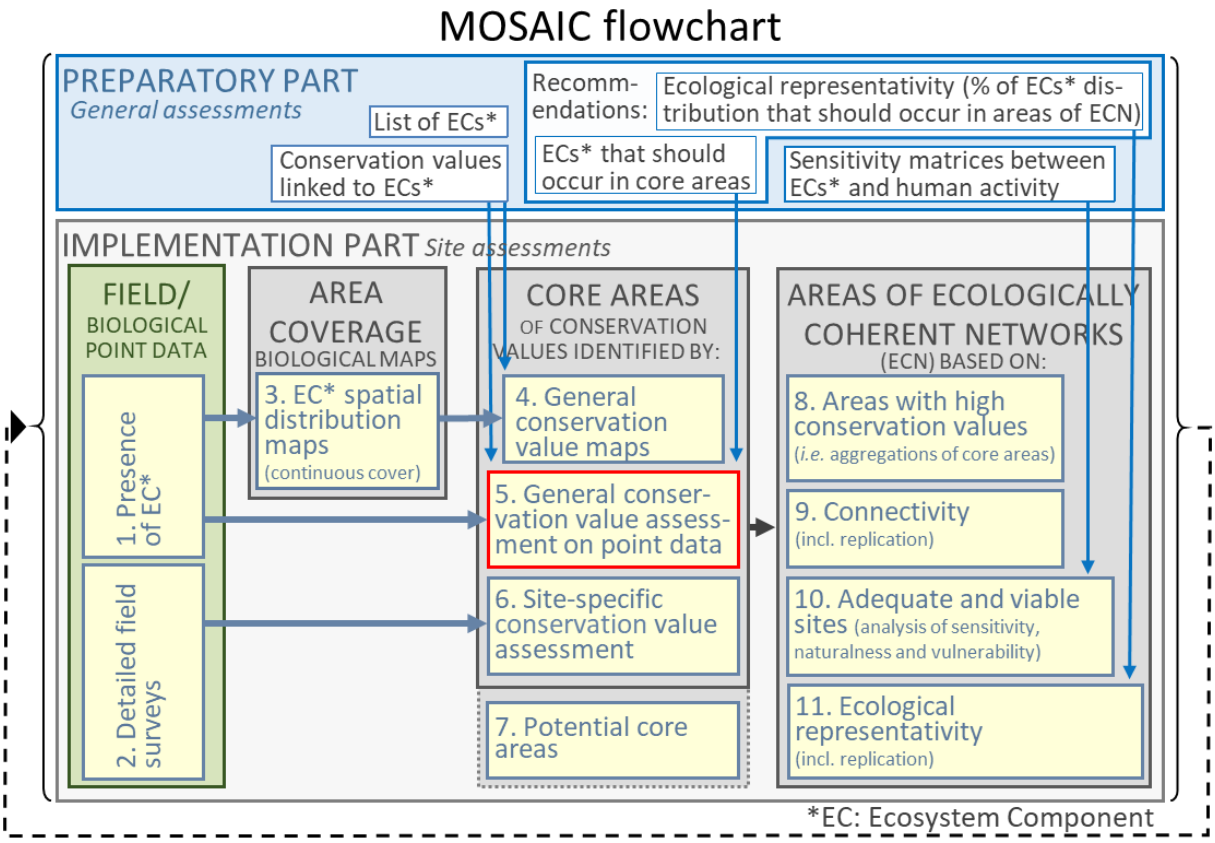


Figure 21. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Decide which ecosystem components automatically qualify a site as a *core area* and note where they are present.
  - × Marine experts (coordinated by the Swedish Agency for Marine and Water Management in the *preparatory part*) will provide recommendations as to which

[21] See chapter 5 (terminology) for definition.

ecosystem components that should occur in core areas – i.e. which ecosystem components that qualify a site as a *core area*, while county administrative boards make the final decision for their county. At the time of writing, recommendations have not been made except for ecosystem components containing species or habitats that are classed as endangered (EN) or critically endangered (CR) in Sweden's Red List 2020 (Artdatabanken 2020), the EUs Red List of Marine Habitats (European Red List of Habitats Gubbay et al. 2016), the HELCOM Red List of Baltic breeding and wintering birds (HELCOM 2012), the HELCOM Red List of Baltic Sea biotopes, habitats and biotope complexes (HELCOM 2013), or in OSPAR's list of threatened and/or declining species and habitats for the Greater North Sea, region II (OSPAR 2008). For highly mobile or migratory species this only applies to areas that have high potential to act as a limiting factor for the species (such as the core area for Baltic Sea porpoises).

- ✓ Information on areas that contain unique or special conservation values, should be processed in step 6, *site-specific conservation value assessments*. In step 6, an individual assessment of a location is made according to known site-specific values. Assessing a site's uniqueness using *conservation values linked to ecosystem components* (regardless of where they are located in the area) may be inappropriate. Instead, individual assessments based on known site-specific conservation values should be carried out. This includes sites:
  - × with rarities
  - × with a unique conservation value
  - × containing essential passage[22] for one or more species
  - × with unusual combinations of species/habitats
  - × whose geographical location adds extra value to one or more ecosystem components[23].

  These places should be noted in step 6.

- ✓ Compile the conservation value points of ecosystem components (awarded in the preparatory part[24]) present at a site according to guidelines set out in step 4 (to produce *general conservation value maps*):
  - × Compile the points according to the categories:
    - birds and mammals
    - fish and large crustaceans
    - benthos (Figure 17b)
- ✓ Compile the conservation value points present in the sampling location (Figure 17a) by:
  - × Extracting the points for the ecosystem component with the <u>highest</u> value (maximum value) <u>within</u> each category (birds and mammals, fish and large crustaceans, benthos) (Figure 18).
  - × <u>Summing</u> the highest values from each of the three categories (Figure 19).
  - × Locations that receive high scores (i.e. high conservation value) can be designated *core areas*. We have not specified a limit or range for this value. Ideally, there should be several data points that show a high conservation value score. *Core areas* are identified either by category (birds and mammals, fish and large crustaceans, benthos) or their combined conservation value.

[22] An area important for *connectivity* of one or more species. For example, river deltas are often essential passages, as are important resting places for migrating birds. For mobile species that are only able to travel short distances (restricted spread/movement), essential passages might include habitats that allow for movement between areas.

[23] Examples of these and reasons for evaluating locations case-by-case are given in the Swedish Agency for Marine and Water Management report 2020:13, chapter 2.4.3.3, step 6, *site-specific conservation value assessments*.

[24] These can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1,* which can be downloaded from the Swedish Agency for Marine and Water Managements webpage. See chapter 2 for details.

See Figure 22

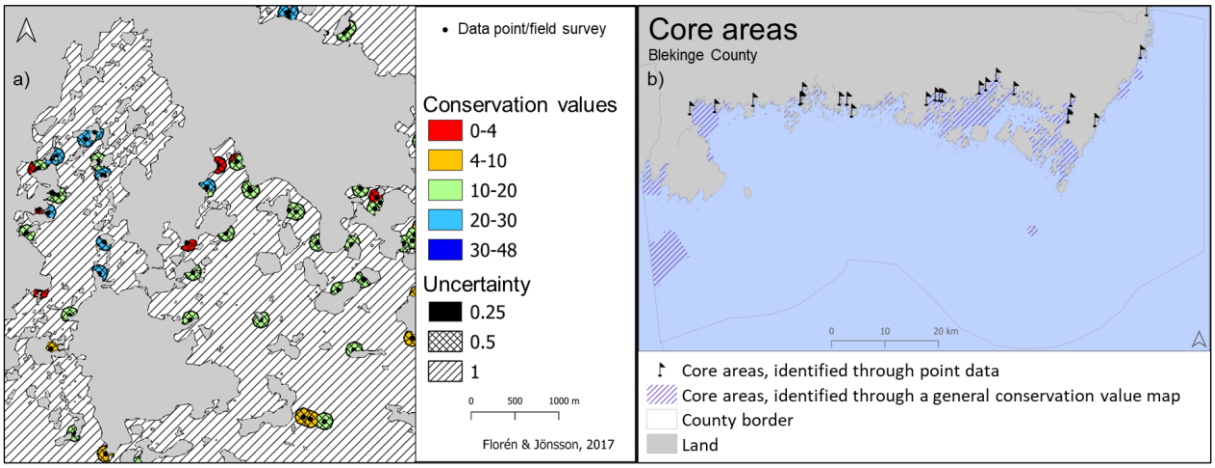


Figure 22. In map a) general conservation value assessments have been done on point data according to the presence of ecosystem components. Note that the uncertainty around conservation values in the hatched areas is 100 % (50 % in the cross-hatched areas and 25 % at the survey point; Florén and Jönsson 2017). Map b) demonstrates how *core areas* can be pinpointed on a map after they have been identified using *general conservation value assessments on point data* (step 5) or through *site-specific conservation value assessments* (step 6) (black flags). As a comparison, purple hatched areas denote *core areas* based on *general conservation value maps* (step 4) with continuous cover.

- ✓ If all data points meet a range of requirements (listed below), the sum of conservation values associated with all relevant ecosystem components can be used - instead of using the maximum value associated with an ecosystem component from each category. If the point data do not meet the following requirements we strongly advise against this method, the requirements are:
  - × The same survey techniques and methods should be used for each data point.
  - × What should and should not be surveyed must be specified.
    - For example, it should be explicit if something is not present (despite targeted surveys) or not recorded.
    - Division of ecosystem components is important.
      - For example, to avoid double scoring. “Seagrass” can also be included in “underwater vascular plants” resulting in points for both ecosystem components for the same species. This inflates the score and leads to an incorrect assessment of conservation value.
      - The ecosystem component resolution is also important and can highly affect the valuation (scores) of a site. By using sum instead of maximum value when the scores are put together, groups with higher taxonomical resolution will dominate the results and the valuation will be skewed. For example, if only one ecosystem component was used for birds (e.g. “resting place for seabirds”) but ecosystem components for fish were divided into each species and life stage, the overall value of the site would be based mainly on the fish scores.
  - × The area surveyed must be known and recorded.
  - × The survey date must be recorded.
  - × All survey sites should be selected randomly using the same procedure; for example, sites can be selected using a random stratified approach.
  - × Those carrying out the surveys must have a similar level of taxonomical knowledge and experience.

4.3.2 Step 6: *Site-specific conservation value assessments*

How complete are the guidelines for step 6?

As for step 2 (detailed field surveys), guidelines for site-specific conservation value assessments have not been established. These two steps should be developed together. However, we recommend several aspects that should be considered in step 6.

In the sixth step of MOSAIC's implementation part, *site-specific conservation value assessments* (Figure 23), *core areas*[25] are identified by carrying out in-depth assessments of individual sites. Until guidelines for this step have been developed users are free to decide on which methods to use. This step is closely linked to step 2, *detailed field surveys* (Figure 23).

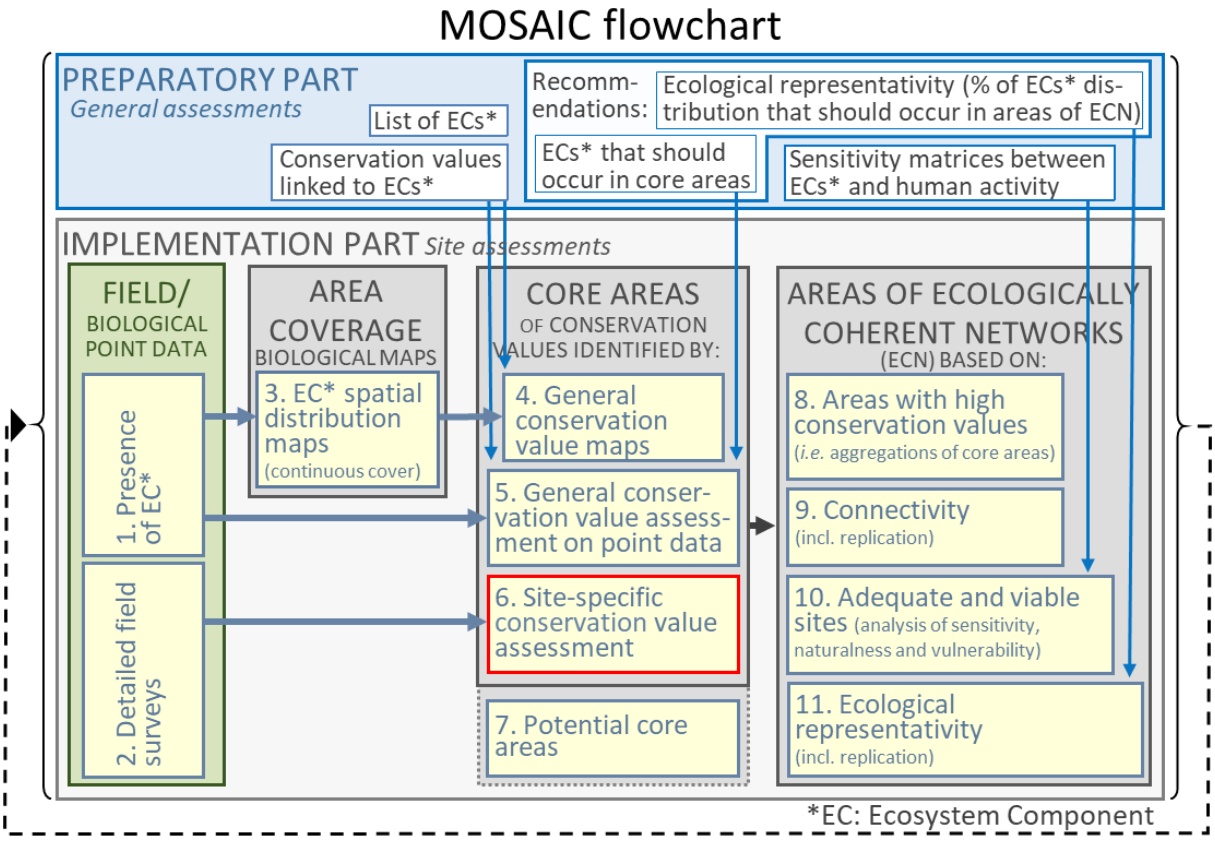


Figure 23. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ If possible, and according to your own chosen methods and criteria: note which places qualify as *core areas* from *detailed field surveys* (step 2).

[25] See chapter 5 (terminology) for definition.

- ✓ Apply *conservation values linked to ecosystem components* (phase 1, *preparatory part*, presented in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1*) and adjust according to site-specific values[26].

Until guidelines are developed for this step, we recommend using methods that meet the internationally accepted criteria set by the UN Convention on Biological Diversity (CBD) for designating so called EBSAs (Ecologically or Biologically Significant Marine Areas) (Appendix 1, Decision IX/20, 2008) (see the fact box below, left). Three of the CBD's criteria are included in MOSAIC's *preparatory part* linking conservation values to ecosystem components (but in an abbreviated form; see the criteria in the fact box below, right). To reduce subjectivity, assessments should be based on *conservation values linked to ecosystem components* (*preparatory part*) for these criteria – but site-specific values must also be accounted for. Criteria must be assessed at sites using methods that provide detailed information not available when simply associating conservation values with the site's ecosystem components. If ecosystem services are to be included in the assessment, criteria in phase 1b (direct ecosystem services) can be included (see the fact box, right and section 2.4.3.3 in the Swedish Agency for Marine and Water Management report 2020:13).

CBDs scientific criteria for Ecologically or Biologically Significant Marine Areas (EBSASs) are as follows:

1. uniqueness or rarity
2. special importance for life-history stages of species
3. importance for threatened, endangered or declining species and/or habitats
4. vulnerability, fragility, sensitivity, or slow recovery
5. biological productivity
6. biological diversity
7. naturalness.

Annex 1, decision IX/ 20, CBD 2008

MOSAIC's criteria for linking conservation values to ecosystem components, phase 1: assessments by sea area:

Phase 1a) Ecological/biological criteria and criteria for indirect ecosystem services:
- biological diversity
- special importance to life-history stages
- ecological function
- (threat status)
Phase 1b) Criteria for direct ecosystem services:
- supporting ecosystem services
- cultural ecosystem services
- regulating ecosystem services

Section 2.3.2 Swedish Agency for Marine and Water Management report 2020:13

[26] More information on criteria can be found in the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1* chapter 2.3.2.1. Criteria assessments (scores) can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1.* Both documents can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

- ✓ Carry out individual assessments on locations that were recognized as unique or special in the previous step (step 5), note the method(s) used and demarcating locations that qualify as *core areas*. More details on this can be found in section 2.4.3.3 in the Swedish Agency for Marine and Water Management report 2020:13.

4.3.3 Step 7: *Potential core areas*

How complete are the guidelines for step 7?

This step has not been developed.

In the seventh step of MOSAIC's implementation part, *potential core areas*[27] are identified (Figure 24). *Potential core areas* are places that, if restored or remediated, could regain their conservation value and become *core areas*. This step has, however, not yet been developed.

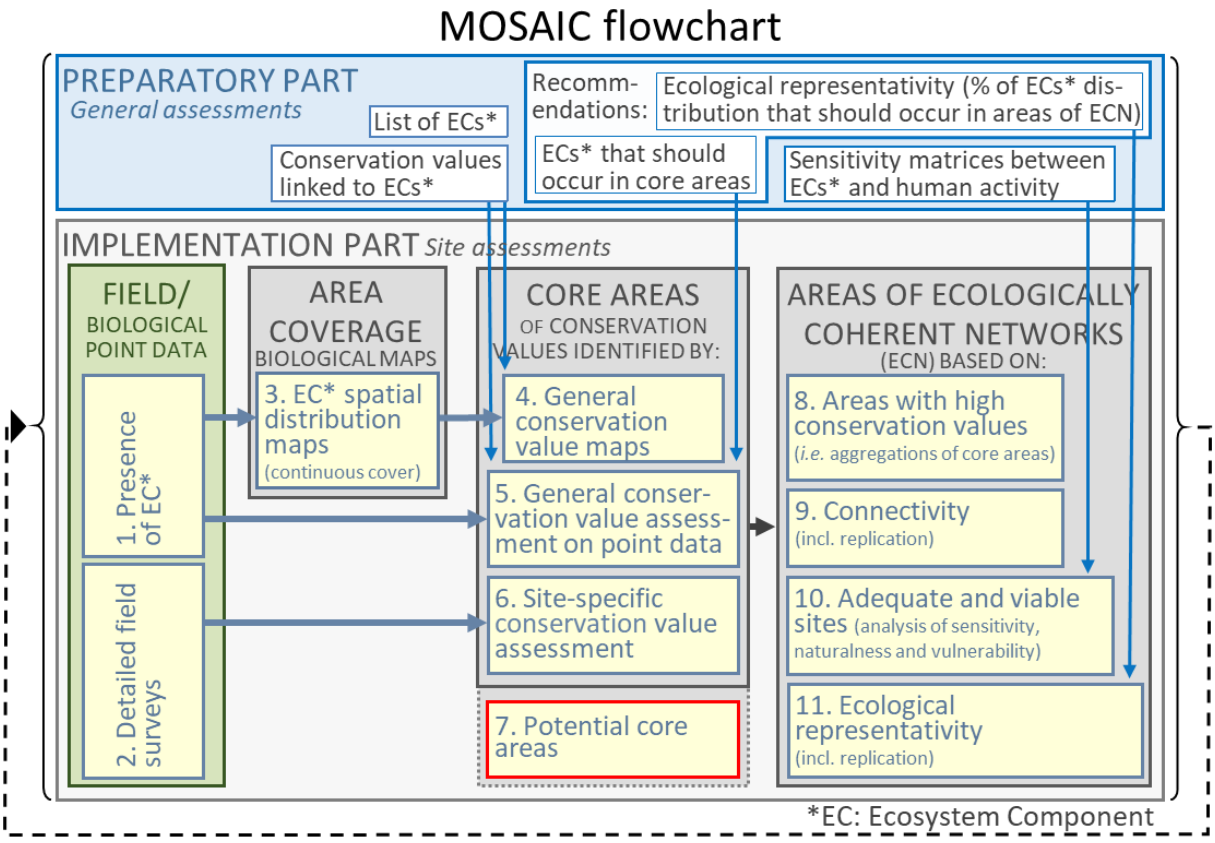


Figure 24. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ If possible: note sites that have lost valuable ecosystem components due to human activities.
- ✓ If possible: assess, according to your own chosen method(s), if a location or area can be designated as a *potential core area*.

The next point is not possible until the criteria *adequate and viable sites* (step 10) has been assessed and validated in the field. This information might be available from the previous

[27] See chapter 5 (terminology) for definition.

management period or after carrying out step 10 in the current management period. When carrying out an assessment of *suitable and viable sites*, one should analyze and identify whether ecosystem components at a site may have been negatively affected by human activities (see point 4 under the “to do” list in step 10). If this is further investigated in field, the following applies:

- ✓ If possible: use you own methods to determine if a place can be designated as a *potential core area*, or if conservation values persist despite human activities.

4.4 Identifying *areas of ecologically coherent networks*

The definition of a marine *area of ecologically coherent networks* is: A viable marine area with high conservation values (i.e. aggregations of *core areas*) in ecologically representative networks with well-functioning connectivity.

Each area should contribute to a larger network of high conservation value, at *adequate and viable sites*, that are *ecologically representative* and ensure species connectivity.

The criteria for *areas of ecologically coherent networks* are:

- *areas with high conservation values* (i.e. aggregations of *core areas*)
- *connectivity* (including replication)
- *adequate and viable sites* (analysis of sensitivity, naturalness and vulneralbility) and
- *ecological representativity* (including replication)

A practical approach to identifying *areas of ecologically coherent networks* is to preliminary identify areas based on one criterion, then adapt the boundaries of the areas according to the next criterion – until all the criteria are covered. A description of how this can be done can be found below. The criteria do not have to be examined in the order presented here.

4.4.1 Step 8: *Areas with high conservation values* (i.e. aggregations of *core areas*)

How complete are the guidelines for step 8?

A simple suggestion has been developed.

In the eighth step of MOSAIC's implementation part, *areas with high conservation values* are identified and included in *areas of ecologically coherent networks* (Figure 25). This is done by simply identifying aggregations of *core areas* (see section 4.3 and steps 4 – 6).

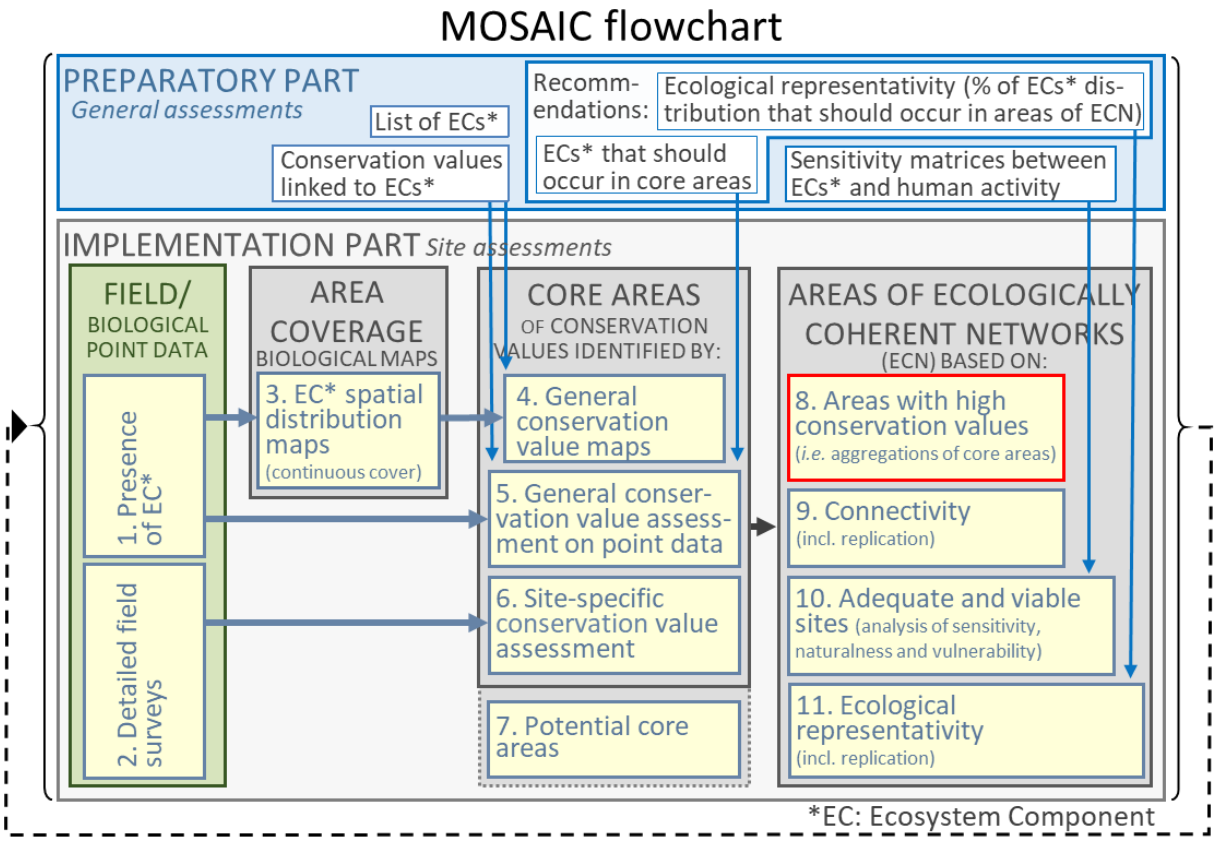


Figure 25. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Identify *areas with high conservation values* by identifying aggregations of *core areas* (Figure 26).
- ✓ Demarcate these as *preliminary areas of ecologically coherent networks* for further analysis.
  - × With the aid of geographic information systems (GIS) *core areas* can be grouped if they are close to one another, and particularly where areas are not separated by a land mass.

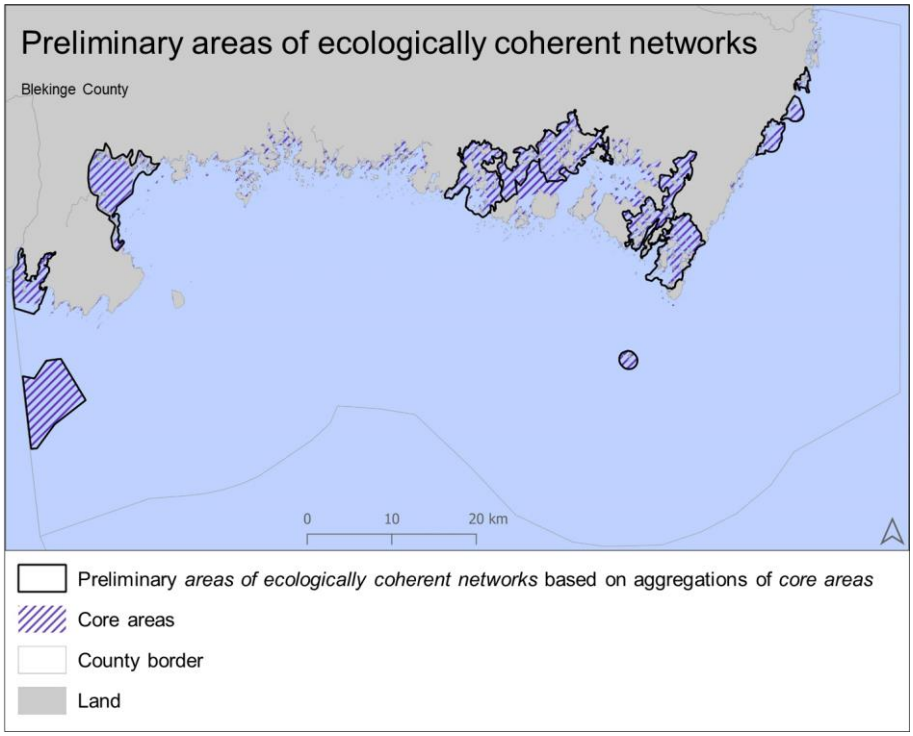


Figure 26. *Preliminary areas of ecologically coherent networks* based on *areas with high conservation values* (aggregations of *core areas*), step 8. The *preliminary areas of ecologically coherent networks* should be further assessed and adapted using criteria in the following sections (steps 9 - 11).

4.4.2 Step 9: *Connectivity*

How complete are the guidelines for step 9?

Recommendations and suggestions for analyses in step 9 have not been developed. Even when guidelines are available, users will likely have to use their own initiative to account for the movement patterns of multiple species, and to include new and updated methods. Guidelines should not limit the methods chosen by users.

In the ninth step of MOSAIC's implementation part, areas that are important for species *connectivity* are identified (Figure 27). Guidelines are not yet available for step 9.

Replication is a sub-criterion under *connectivity* (and also a sub-criterion under *ecological representativity*, step 11).

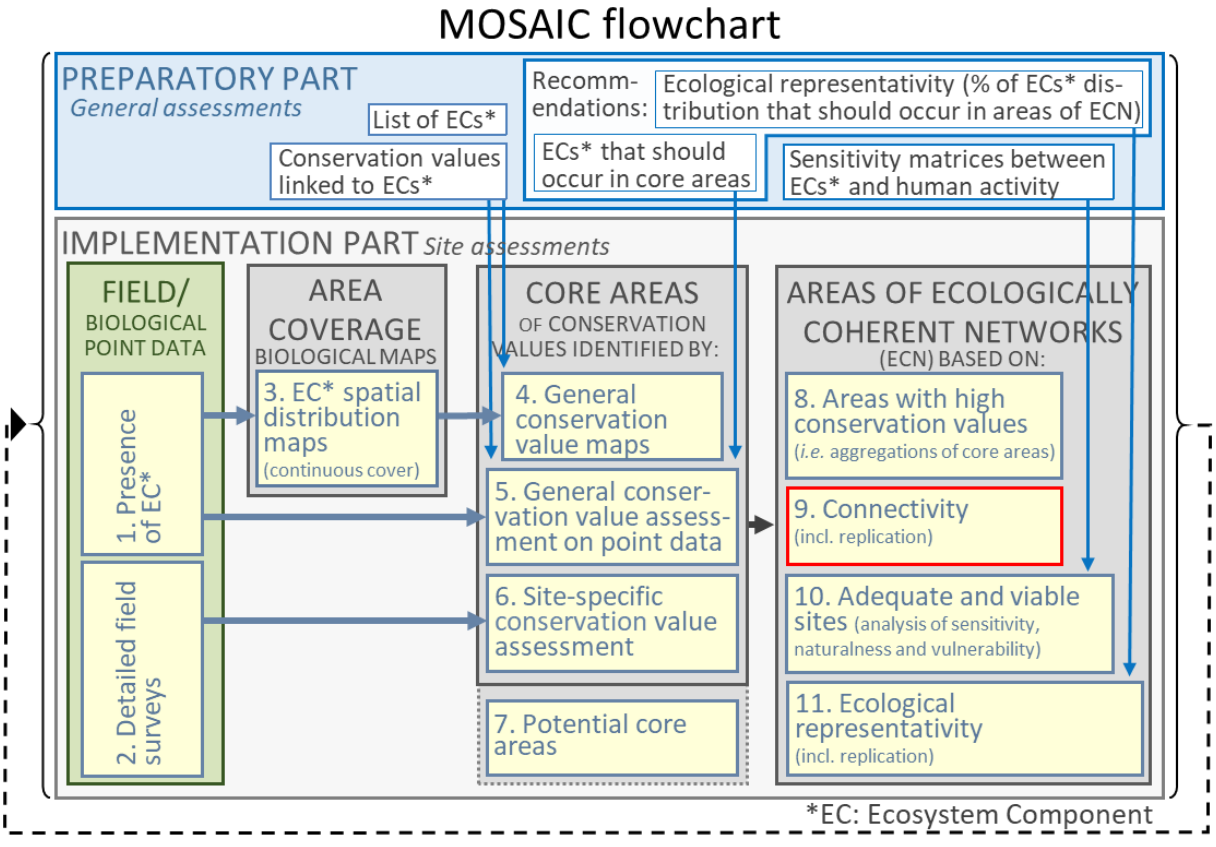


Figure 27. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ Ensure that *core areas* known to be important to a species' movement and dispersal are included in *preliminary areas of ecologically coherent networks*[28].
- ✓ If possible: Analyze the movement and dispersal biology of several species using a method(s) of your choice.
    - × A simple approach would be to study the distances between habitats that are important for a species and prioritize areas used for movement between these habitats. This is particularly relevant for highly mobile or migratory species[29]. Information on the distances species move between habitats and dispersal patterns are required for this analysis (see Berkström et al. 2019). In figure 26, for example, there are large distances between some of the *preliminary areas of ecologically coherent networks* along the coast, which could be problematic for some species.
    - × If possible: specify how often an ecosystem component relevant to *connectivity* should be replicated (an example might be resting areas for migratory birds; is a single occurrence of the ecosystem component in an area sufficient or should there be several occurrences within a short distance of each other?).
    - × If possible: review the criterion again, after potential human impacts have been analyzed (see criterion *adequate and viable sites,* step 10) to identify possible disruption to movement/dispersal.
    - × If possible: note areas identified as potentially important to *connectivity*, but which lack verification in the field.

[28] See chapter 5 (terminology) for definition.

[29] Highly mobile or migratory species are primarily birds, mammals and fish – species with individuals that frequently move between areas.

4.4.3 Step 10: *Adequate and viable sites*

How complete are the guidelines for step 10?

A general structure for step 10 has been specified, but details are lacking. To provide detailed guidelines in this step requires recommendations on which sensitivity matrices to use in MOSAIC's preparatory part. Sensitivity matrices provide the basis for analyses in step 10 because they contain general assessments on how sensitive ecosystem components are to different types of anthropogenic pressure.

In the tenth step of MOSAIC's implementation part, *adequate and viable sites* are assessed (Figure 28). This is primarily carried out by analyzing a locations sensitivity, naturalness and vulnerability. The size of the *areas of ecologically coherent networks* should also be considered.

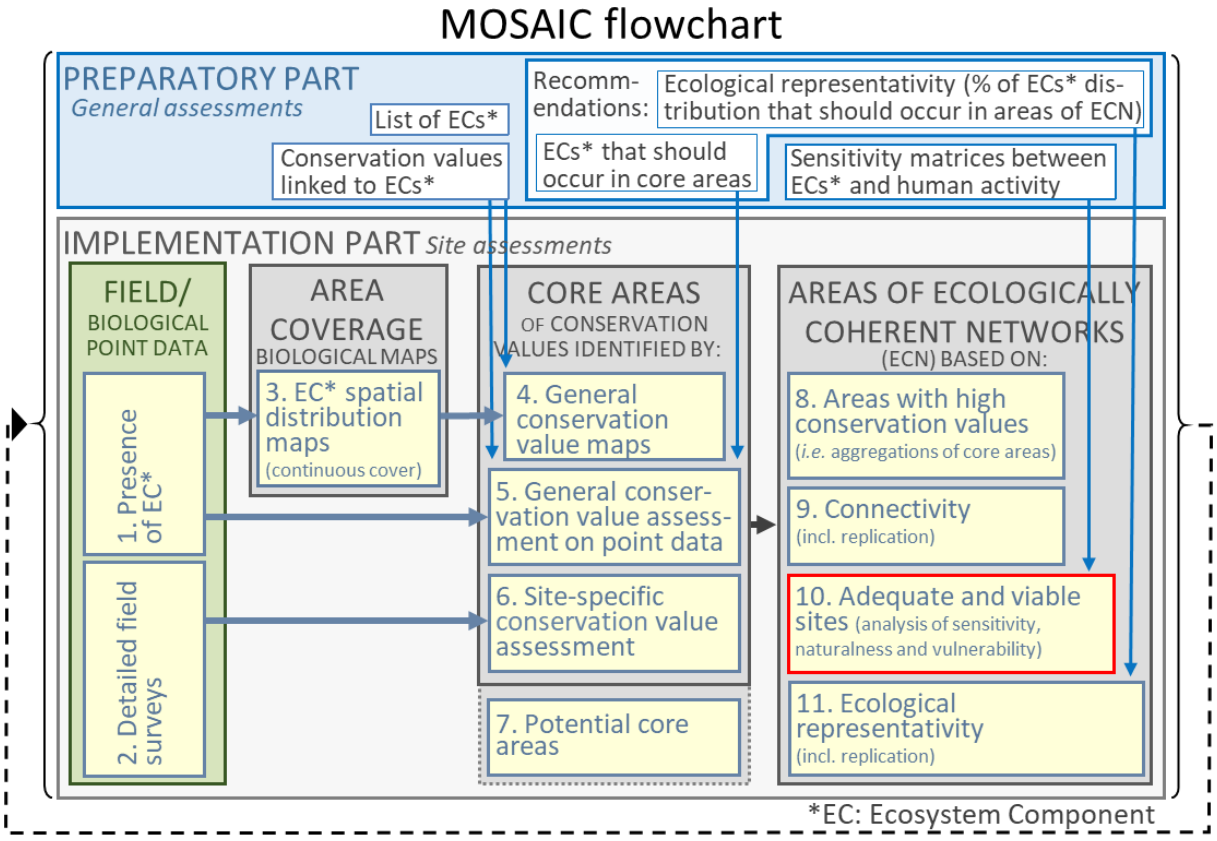


Figure 28. The red outline in the flow chart denotes the relevant step described in this section.

To do

- ✓ If possible: Choose one or several *sensitivity matrices* to carry out the assessment. *Sensitivity matrices* indicate how sensitive different ecosystem components are to anthropogenic pressures. Examples of *sensitivity matrices* include SYMPHONY (Swedish Agency for Marine and Water Management 2018), HELCOM Holas II (Helcom 2018),

Kraufvelin et al. (2020) and MarLIN/MarESA (Tyler-Walters et al. 2018). Development or recommendation of suitable *sensitivity matrices* should be carried out in MOSAIC's *preparatory part* (coordinated by the Swedish Agency for Marine and Water Management) but has not yet been done.

- ✓ If possible: produce maps showing which areas are known to be sensitive to different types of human activity/pressure by combining *ecosystem component spatial distribution maps* (steps 1 – 3) and *sensitivity matrices*. This information is important for spatial planning. Note, maps only show locations where sensitive areas might be; the absence of a sensitivity score does not mean sensitivity to human pressures do not exist at a location. There is generally insufficient knowledge to prove the absence of sensitivity to human pressure. However, there is a greater chance of the location being robust to human pressures where the sensitivity score is low. The maps should not be used as a replacement for detailed environmental impact assessments.
- ✓ Produce maps (point data and spatial distribution maps) of human activities/pressures.
- ✓ If possible: produce maps showing where ecosystem components are affected by human impacts. The maps should be produced by carrying out an overlap analysis using sensitivity maps and maps of human activities/pressures (see previous two points) (Figure 29).
    - × Summarize which *core areas* and *areas of ecologically coherent networks*[30] that are exposed to human activities or pressures that can negatively affect their ecosystem components.
    - × Note *core areas* or locations that should be prioritized for *detailed field surveys* (step 2) prior to the next assessment period. This is most important for locations where *general conservation value maps* indicate a high conservation value that have a high probability of being negatively affected by human activity according to the overlap analysis. This can indicate if a location should be identified as a *core area* or a *potential core area* in the next management cycle.
    - × Consider that size of the area can affect how viable the area is because the viability of populations and their recruitment is often related to habitat size.
    - × If possible: include likely future scenarios when identifying *adequate and viable sites*. For example, climate refuges can be identified by including modelled maps showing future distributions of ecosystem components.
    - × Adjust the selection or boundaries of *preliminary areas of ecologically coherent networks* so that they include *adequate and viable sites*.
- ✓ If possible: analyze the extent to which different ecosystem components are exposed to human impacts/pressures (from a spatial perspective). This information is important when assessing how much (spatially) an ecosystem component should be represented in ecological networks in step 11 – *ecological representativity*.

[30] See chapter 5 (terminology) for definition.

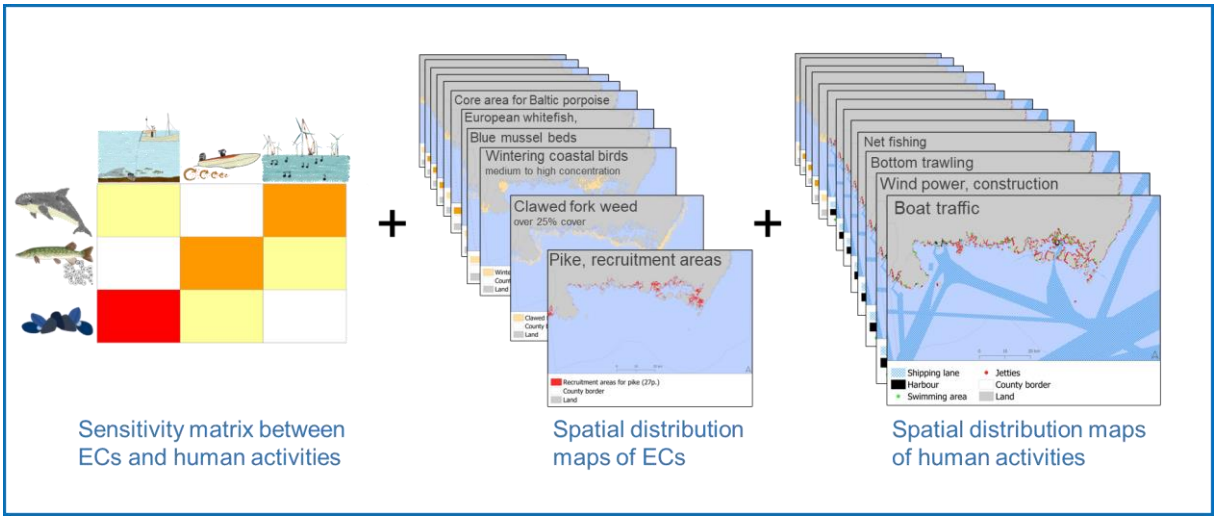


Figure 29. *Adequate and viable sites* are identified using *sensitivity matrices* and spatial information on where different ecosystem components and human impacts/pressures occur. The schematic table represents a sensitivity matrix showing the sensitivity of harbour porpoise to underwater noise (from windfarm construction), that pike spawning areas are probably sensitive to turbidity (resuspension of sediment from small boat traffic; Hansen et al. 2019) and that blue mussels are sensitive to bottom trawling. The sensitivity matrix should also include information on how, for example, distance from human activity affects the impact on ecosystem components.

4.4.4 Step 11: *Ecological representativity*

How complete are the guidelines for step 11?

The workflow is complete for version 1. However, parts that are dependent on previous steps that lack guidelines (i.e. steps 9 and 10), have not been specified in detail. Furthermore, recommendations on the ecological representativity of ecosystem components in the preparatory part *have not yet been carried out. Approaches used in this step can be developed in updated versions of MOSAIC.*

In the eleventh step of MOSAIC's implementation part, the *ecological representativity* of *areas of ecologically coherent networks*[31] is established (Figure 30). Replication is a sub-criterion under *ecological representativity* (and also a sub-criterion under *connectivity*, step 9).

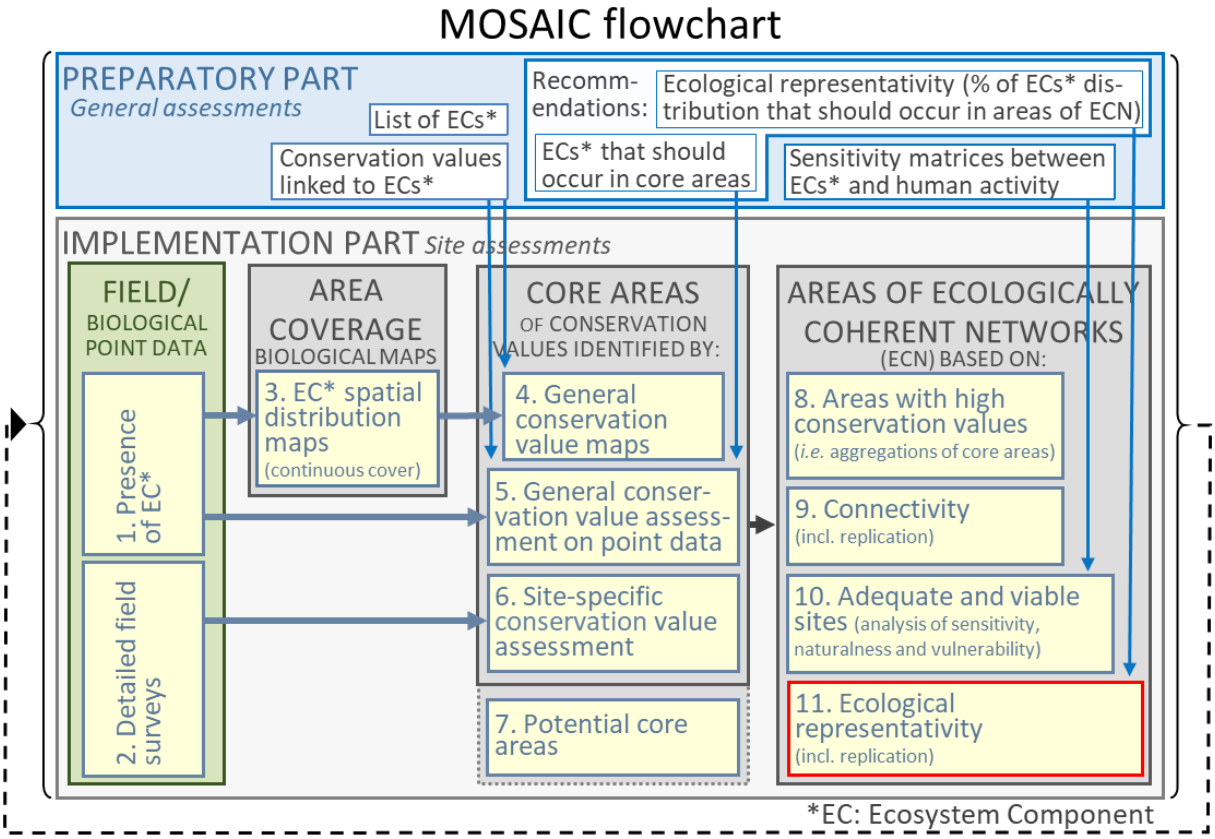


Figure 30. The red outline in the flow chart denotes the relevant step described in this section.

Ecosystem components should be well represented in *areas of ecologically coherent networks*. Ecosystem components should primarily be represented in the *core areas*[32] which are included in *areas of ecologically coherent networks* to provide good site-specific information for planning and

[31] See chapter 5 (terminology) for definition.

[32] See chapter 5 (terminology) for definition.

management (Figures 31 and 32). However, it is not always possible to fully achieve representativity within *core areas* alone. In this case, representation outside the *core areas*, but still within *areas of ecologically coherent networks*, can suffice (Figure 31).

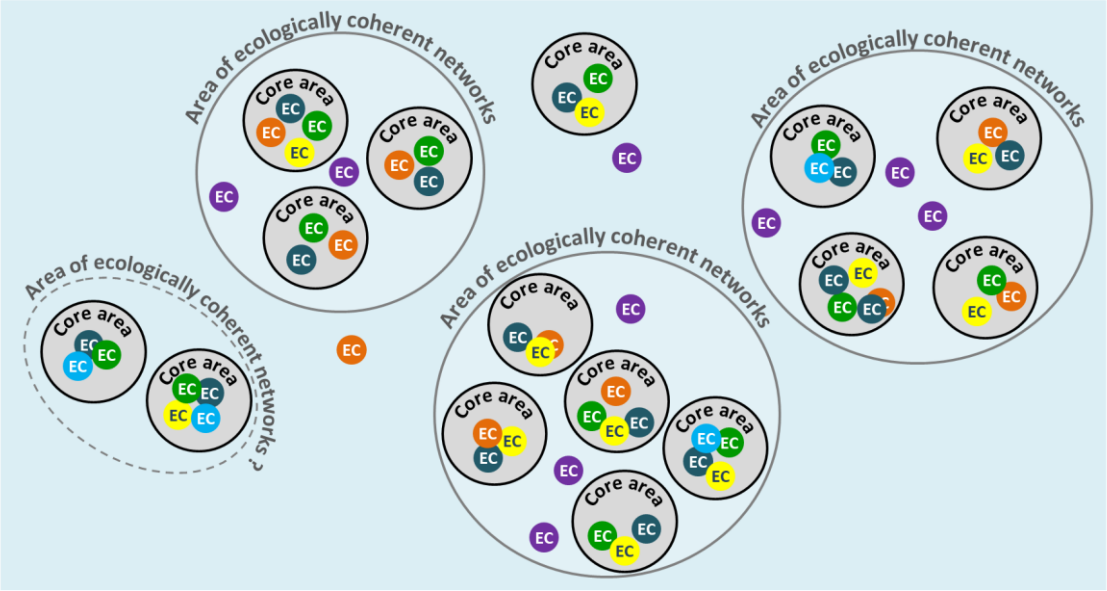


Figure 31. The aim is to achieve *ecological representativity* of ecosystem components in *core areas* which are within *areas of ecologically coherent networks*. However the presence of ecosystem components outside of *core areas* but still within *areas of ecologically coherent networks* can suffice.

The coloured circles symbolize different ecosystem components, grey circles (with black borders) symbolize *core areas* and the larger, colourless circles symbolize *areas of ecologically coherent networks*. To achieve full representativity of the light blue ecosystem components, an *area of ecologically coherent networks* should be formed comprising the two *core areas* on the left of the figure (dashed line). Moreover, the purple ecosystem components fall outside of *core areas*. However, the ecosystem component is represented within *areas of ecologically coherent networks* which can be considered acceptable.

One of the primary reasons for focusing on *core areas* within *areas of ecologically coherent networks* (for example within protected areas) can be found in the report *Skydd av marina miljöer med höga naturvärden* (*The protection of marine environments with high conservation values*; The Swedish Environmental Protection Agency; Naturvårdsverket, 2007a) which states (freely translated):

> *It is not always possible or justifiable to protect large coastal/archipelago areas. Instead, protection can be established in zones such as core areas, with surrounding areas afforded less stringent or short-term protection. … For example, an activity (i.e. dredging or building a new jetty) might be forbidden inside a core area but allowed, after seeking permission, outside of core areas.*

Furthermore, the report suggests that buffer zones around core areas should be sufficient to protect the species, habitats or functions for which the core area is designated (Figure 32).

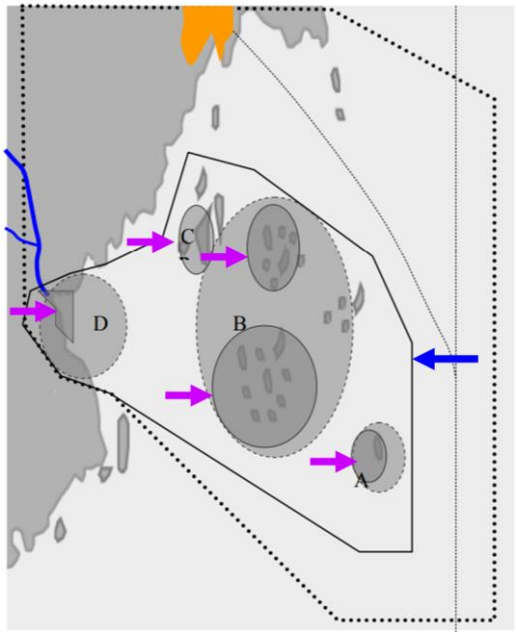


Figure 32. A figure modified from the Swedish Environmental Protection Agencies report Skydd av marina miljöer med höga naturvärden (The protection of marine environments with high conservation values, 2007a). The purple arrows point to core areas, the blue arrow to a nature reserve and A, B, C and D represent zones with different levels of protection. The report suggests that different regulations can apply to the different zones within the reserve - depending on the specific needs of the core areas. For example, A=boat traffic and disembarkation/landing forbidden. B=exploitation and physical disturbance forbidden. C=restricted outdoor/leisure activities. D=nature reserve regulations are supplemented with fishing regulations.

To do

- ✓ For respective ecosystem components: specify <u>the proportion of their distribution</u> that should be included in *areas of ecologically coherent networks*. Note and justify the proportion chosen. Consider the following[33]:
  - × The conservation value points assigned to an ecosystem component in the *preparatory part*.
  - × Expert recommendations from the *preparatory part*.
  - × How exposed the ecosystem component is to negative human impacts (information from step 10). If exposure is high, try to estimate the proportion of its distribution needed to ensure the ecosystem component is viable for itself, associated species, the ecosystem as a whole and for the provision of ecosystem services.
  - × If the ecosystem component is associated with a recognized nature conservation species (e.g. protected species, typical species, priority species, indicator species, red listed species or threatened species with national program of measures).
- ✓ Specify <u>where</u> ecosystem components should be represented and adjust the boundaries of the preliminary *areas of ecologically coherent network* accordingly. If possible, consider the following:
  - × The proportion of each ecosystem component's distribution that should be represented/included in *areas of ecologically coherent networks* (see previous point).
  - × Where ecosystem components are most valuable. Choose:

[33] Much of the information needed here can be found in the Excel document *MOSAIC – ecosystem component lists and conservation values, version 1* which can be downloaded from the Swedish Agency for Marine and Water Managements webpage.

    - Places where an ecosystem components presence is important for *connectivity* (step 9).
    - Places where the conservation value of an ecosystem component is especially high (often identified in *site-specific conservation value assessments*, step 6).
    - *Adequate and viable sites*, step 10, for an ecosystem component.
    - Places where other valuable ecosystem components occur.
  - × How often an ecosystem component should be replicated.
    - How often an ecosystem component should be replicated is primarily determined by aspects relating to their dispersal and movement requirements (which are assessed in step 9, *connectivity*) but the precautionary principle should also be applied. An ecosystem component should be found (replicated) in several places in an area to minimize the risk of its disappearance due to a local accident or environmental change.
  - × If climate change is likely to affect an ecosystem components presence and distribution.[34]

A simple approach to ensure ecosystem components are well represented is to begin with the *preliminary areas of ecologically coherent networks* identified in the previous steps (starting with step 8). Starting with the ecosystem components that should have the majority of their distribution represented, evaluate for respective ecosystem components:

- ✓ If places important for dispersal and movement of the ecosystem components (and its associated species) (*connectivity*, step 9) are included in the *preliminary areas of ecologically coherent networks*.
  - × Adjust the boundaries of the *areas of ecologically coherent networks* accordingly.
- ✓ If *core areas* with especially high conservation value connected to the ecosystem component in question and assessed from *site-specific conservation value assessments*, step 6, are included in preliminary *areas of ecologically coherent networks*.
  - × Adjust the boundaries of the *areas of ecologically coherent networks* accordingly.
- ✓ If the ecosystem component is now sufficiently represented in the *core areas* of the *preliminary areas of ecologically coherent networks*.
  - × If not, adjust the boundaries of the *areas of ecologically coherent networks* to include *core areas* with the desired ecosystem components (Figure 31). Begin with *adequate and viable sites*.

If there are still ecosystem components that are insufficiently represented in the *core areas* that are within *areas of ecologically coherent networks:*

- ✓ Assess if ecosystem components are sufficiently represented outside of *core areas*, but within *preliminary areas of ecologically coherent networks*.
  - × If not, adjust the preliminary boundaries so that ecosystem components are represented within *areas of ecologically coherent networks*. Begin with *adequate and viable sites*.

[34] Read more on this in the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1* chapter 2.5.

4.5 Finalization

To do

- ✓ Note identified *core areas*.
- ✓ Identify *areas of ecologically coherent networks* by weighing up all the criteria. Note the boundaries.
- ✓ Summarize the trade-offs and assessments used in each of the previous steps. Use *general conservation value maps* as a starting point to discuss and motivate decisions. Discuss, for example, if *areas of ecologically coherent networks* occur in areas that are well surveyed and the extent to which modelled maps represent the conservation value of those areas.
- ✓ Note which field surveys should be prioritized in the next management period:
    - × Which areas should be prioritized for *detailed field surveys*, step 2 (information from steps 4, 9 and 10)?
    - × Which ecosystem components should be prioritized for field surveys and step 1, *presence of ecosystem components*?
    - × Should field surveys be undertaken to enable modelling of ecosystem components´ spatial distribution?

Note which ecosystem components (if any) should be prioritized for modelling before the next management period (i.e. modelling to provide spatial information on where an ecosystem component has a high likelihood of occurring).

Terminology

MOSAIC uses several terms and phrases. This section provides a list of these terms and their definition with respect to MOSAIC and this user guide. The text is not designed to be read from start to finish but to be referred to by the reader as and when guidance on terms is needed.

Area of ecologically coherent networks: A viable marine area with high conservation values (i.e. aggregations of *core areas*) in ecologically representative networks with well-functioning connectivity.

Connectivity: The degree to which a seascape supports or hinders individuals or species from moving between suitable habitats. Movement might be daily, seasonal, small or large scale, or dependent on life-history traits (the need for different habitats at different life stages) and allow for the transfer of genetic material between populations (gene flow). *Connectivity* is a criterion used when identifying *areas of ecologically coherent networks*. The aim of good connectivity is to maintain an areas conservation value with respect to, for example, *biological diversity* and *ecological function*.

Because many marine species can travel over long distances using currents, we suggest using **dispersal/migration routes** as a term to describe connectivity in marine environments. Migration routes are areas that facilitate the movement of one or several species between habitats.

Conservation value: The term conservation value is often primarily related to biodiversity. For conservation values relating to biodiversity MOSAIC uses internationally accepted criteria included in the UN Convention for Biological Diversity (CBD; 2008) for ecologically or biologically significant areas (EBSAs). However, in MOSAIC the term *conservation value* may also include ecosystem services. Because ecosystem services can be included in the evaluation, *nature value* is an alternative term (in future versions this may be favoured over *conservation value*).

Conservation value assessment: The assessment of a location or area according to its conservation value (see previous term). In MOSAIC there are three ways to do this:

- *In step 4, general conservation value maps* are produced by combining *conservation values linked to ecosystem components* (assessed in the preparatory part) with *ecosystem component spatial distribution maps* (step 3).
- In step 5, *general conservation value assessments on point data* are assessed by combining *conservation values linked to ecosystem components* (assessed in the *preparatory part*), with the *presence of ecosystem components* (step 1) from point data.
- In step 6, *site-specific conservation value assessments* are carried out based on *detailed field surveys* (step 2). Guidelines for this have, however, not yet been developed.

Core area: An area with a high conservation value with respect to biodiversity and the provision of ecosystem services.

Direct ecosystem services: Direct ecosystem services are closely linked to ecosystem goods and benefits used by humans (Fisher et al. 2009). The difference between direct and indirect

ecosystem services can be difficult to define and the same ecosystem service might provide goods or benefits directly and indirectly. Direct ecosystem services include *provisional*, *cultural* and certain *regulatory services* (according to the Millennium Ecosystem Assessment (2005)).

Dispersal/migration routes: see connectivity

Ecological function: A criterion that assesses how ecosystem components contribute to the functioning of the entire ecosystem such as importance for the survival of other species and resilience of the ecosystem. *Ecological function* is a part of larger ecosystem processes. This criterion includes many of the indirect ecosystem services (i.e. supporting and most regulatory ecosystem services). The *ecological functions* might, for example, be related to the provision of food or habitat for other species, "top-down" regulation, significant water purifying or filtering ability or significant water or sediment chemical functions such as oxygenation of bottoms or sediment binding characteristics. For example, mussels are very important from an ecological perspective because they filter the water and are an important food source for fish and birds.

The criterion can be compared with the keystone species concept. A keystone species is a species that is of important for the survival of other species in an ecosystem (Paine 1995). Keystone species is a selection criterion for HELCOM MPAs (marine protected areas). Keystone species are defined as species which are important for maintaining the resilience of the ecosystem. In MOSAIC, however, we intend to assess the significance of species as well as other ecosystem components such as habitats.

Ecological representativity: *Ecological representativity* is achieved in a network when the *areas of ecologically coherent networks* contain the diversity of biota and habitats that occur in that region's marine ecosystem. *Ecological representativity* is achieved by 1) maximizing the number of biotic ecosystem components in the network and 2) ensuring an appropriate proportion of each ecosystem component is included.

Ecosystem component (EC): A central term in MOSAIC. Ecosystem components are primarily biological in the MOSAIC tool, but some abiotic ecosystem components are included. Biological ecosystem components are defined by and bound to living organisms, such as populations, species, organism groups or habitats. Examples include wintering grounds for long-tailed ducks, seal haul out points, perch spawning areas, seagrass meadows, mussel beds and single occurrences of the charophyte *Chara horrida*. Abiotic ecosystem components are defined by and bound to the physical environment, such as depth, bottom substrate, salinity and coastal topography. Examples of abiotic ecosystem components include deep areas with soft sediments, shallow areas over hard substrates and submerged offshore sandbanks.

Throughout MOSAIC, ecosystem components are defined independently of their exact geographical position. An ecosystem component may be a habitat defined by how dense its coverage is (for example, mussel beds with a coverage over 50 percent). However, even if the definition should be independent of location, it should be specific enough to allow one to easily identify locations where the ecosystem component occurs. For example, places with the ecosystem component "Cod" are vague. Does it refer to places where cod sometimes occur or to

spawning grounds for cod? Places with occurrences of cod and spawning areas for cod need different considerations and management; vaguely defined ecosystem components are inappropriate for spatial management.

When linking conservation values to ecosystem components it is important that assessments are based on the value an ecosystem component generally contributes to a site. For example, not all places where there are blue mussels can be valued according to the full value that the sea area has blue mussels at all. The final conservation values are partly determined by its occurrence/distribution in the whole sea area. If the ecosystem component is common and its ecological function is not limited, the value of each site where it is present is lower than if it is rare or its ecological function is impaired. The relative semi-quantitative evaluation must reflect the conservation value loss of blue mussels disappearing from a site (through exploitation, for example) according to the current state of knowledge about mussels, and their general occurrence and distribution in a sea area. If blue mussels were to decrease substantially in the Baltic Proper, for example, the conservation value of each site with blue mussels there would change (increase) and would have to be adjusted during the next management cycle.

Ecosystem component spatial distribution maps: Maps with information on the presence or absence of ecosystem components in each grid cell or minimum assessment unit.

Essential passage: An area important for connectivity of one or more species.

Expert assessment: Assessments based on the best available knowledge, used in cases where standard assessments or procedures cannot be applied (Naturvårdsverket 2007b).

General conservation value maps: Maps produced by combining the conservation value points associated with ecosystem components (from MOSAIC's *preparatory part*) and their presence in an area (from *ecosystem component spatial distribution maps*).

Importance for life-history stages: A criterion used to assess if an ecosystem component is important for critical life-history stages for one or several mobile/migratory species (see term below). Examples include reproduction, growth, resting or foraging.

Indirect ecosystem services: Also called intermediate services. Services that do not directly produce goods or benefits used by humans, but which are a prerequisite for the existence and function of direct ecosystem services. Indirect ecosystem services often consist of complex interactions (Fisher et al. 2009). The difference between direct and indirect ecosystem services can be difficult to define and the same ecosystem service might provide goods or benefits directly and indirectly. Indirect ecosystem services include supporting and certain regulatory services (according to the Millennium Ecosystem Assessment (2005)).

Marine green infrastructure: An ecologically functional network of habitats. The network supports the preservation of biodiversity and ecosystem services.

Minimum assessment unit: The smallest area on a map (grid cell) containing conservation values. Conservation values in the assessment unit include the entire water column in the grid

cell. In this manual the smallest assessment unit is 25 x 25 meters, and we recommend an area between 10 x 10 meters to 50 x 50 meters in coastal areas. The minimum assessment unit of offshore areas can be a few km^2 depending on how homogenous the area is. Furthermore, we recommend that the water column in the minimum assessment unit is treated as a vertical cross-section as far as possible to reduce problems of scale (see section 2.4.3.1.1).

Mobile / migratory species: Species with individuals that move between areas or habitats (often large distances). Primarily birds, mammals and fish.

Point data: Information relating to discrete data points (in contrast to spatial distribution maps with information on continuous cover; see *ecosystem component spatial distribution maps* above). Even data from transects, or that is spatially limited (such as from video surveys), are regarded as point data in this manual.

Potential core area: A location or area that, with remediation or restoration, has the potential to be categorized as a *core area*.

Preliminary area(s) of ecologically coherent networks: A practical approach to identifying *areas of ecologically coherent networks*, according to steps 8-11, is to delineate areas based on one criterion, then adapt the boundaries of areas according to the next criterion. Until all the criteria are fulfilled the areas are called *preliminary area(s) of ecologically coherent networks*.

Sea area: Swedish marine territory divided into four large areas, the Bothnian Bay, Bothnian Sea, Baltic Proper and Kattegat/Skagerrak. Divisions follow those used for national maritime spatial planning, except for the Gulf of Bothnia which is divided into the Bothnian Bay and Bothnian Sea because of the large differences in species between the two areas. Sea areas extend to and include shorelines.

Sensitivity, naturalness and exposure to pressure: Analysis of “sensitivity, naturalness and exposure to pressure” is used to assess where conservation values are, and are not, affected negatively by human activity. It combines an assessment of biological ecosystem components “naturalness” with their “exposure” to activities that they are known to be “sensitive” to.

Threat status: A criterion in MOSAIC. This criterion aims to assess conservation values according to if a species, sub-species, population, habitat or biotope in an ecosystem component is threatened or declining. The criterion is primarily assessed using national and international red lists.

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Conservation values from a seascape perspective

User manual for MOSAIC, version 1

Effective ecosystem-based management of marine and coastal environments requires an integrated approach across administrative areas. A standardized approach for the assessment of marine green infrastructure can ensure that the right management measures occur in the right place. MOSAIC is a tool to identify the conservation value of marine areas, in particular their importance for biodiversity and ecosystem services in coherent (viable and ecologically representative) networks. The intention is to provide a standardized and integrated framework for marine management, such as which areas should be prioritized for protection, restoration, physical planning or other types of management where spatial issues are to be addressed (including fisheries management and goals set out in the Marine Strategy Framework and Habitat Directives). This manual gives a step-by-step description of how to identify areas with high conservation values in ecologically coherent networks using the first version of MOSAIC. A comprehensive description of the tool including the theory behind it, trade-offs made and discussions held during its development can be found in the Swedish Agency for Marine and Water Management report 2020:13 *MOSAIC – A tool for ecosystem based spatial management of marine conservation values, version 1*.

Havs och Vattenmyndigheten