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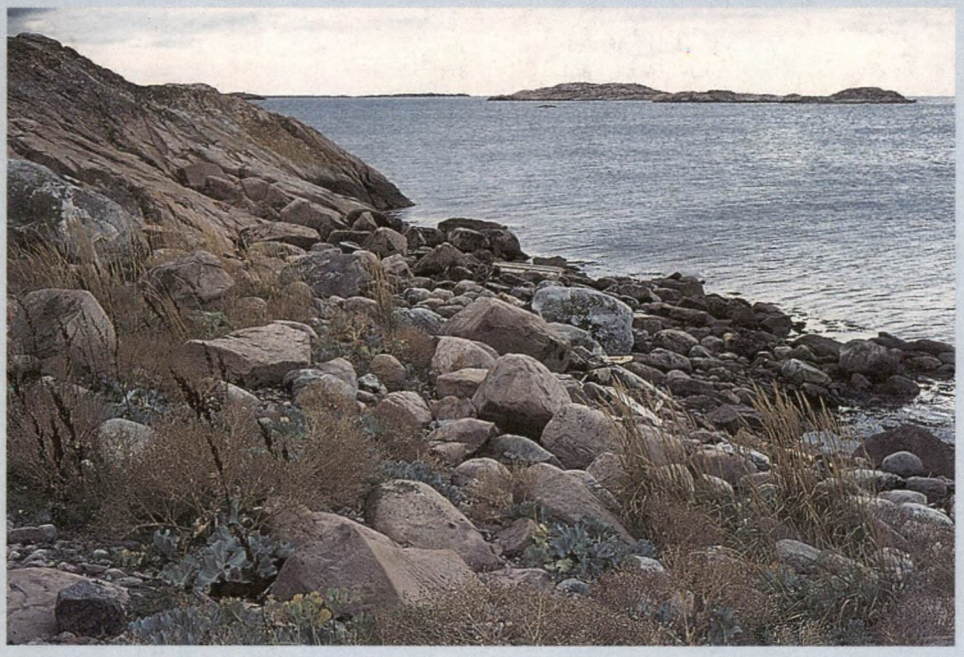

Criteria for the selection of marine protected areas

– an analysis

Per Nilsson

REPORT 4834

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ISBN 91-620-4834-1
ISSN 0282-7298

Print run: 800 Copies
Printed by: ELANDERS GOTAB, STOCKHOLM, 1998

Preface

The purpose of this report is to summarise and analyse the criteria used in Sweden to determine whether marine areas are worthy of protection, to compare Swedish systems of criteria with internationally used systems of criteria and to indicate alternatives or complementary views on the selection of marine protected areas (MPAs).

The protection of marine areas has not reached the same stage as the protection of land areas, whether in Sweden or internationally, although there is an intensive debate today in international fora on how marine environments can best be protected. Sweden's Environmental Protection Agency has long been involved in identification of which areas in the country are most worthy of protection, and has suggested which of them should be set aside as protected areas (Naturvårdsverket, 1980). It was stated in the Agency's Action Plan for Biological Diversity (Naturvårdsverket, 1995; Swedish EPA, 1996) that the work of establishing marine reserves must continue (Action 17). This report is a part of that work.

The report analyses the criteria used for the selection of *marine* protected areas. Sweden has considerably more nature reserves and conservation areas on land than in the sea, and nature conservation on land has a considerably longer history. The criteria for the selection of protected areas on land and the representativity of the selection have been analysed in a series of articles by Frank Götmark (Gothenburg) and Christer Nilsson (Umeå) (Götmark, 1992; Götmark and Nilsson, 1992; Götmark and Åhlund, 1987; Götmark et al., 1986; Nilsson and Götmark, 1992).

Swedish criteria (as presented in the Environmental Protection Agency's report *Utredning om skyddsvärda områden längs Sveriges kust – Marina reservat 1980* [Investigation of areas worthy of protection along Sweden's coast – Marine reserves 1980], and in the Nordic Council of Ministers' report *Marina reservat i Norden, 1995* [Marine protected areas in the Nordic countries, 1995]) largely follow the criteria recommended by the World Conservation Union (IUCN) in Kelleher and Kenchington (1992). The criteria consider a large number of environmental, cultural, economic and practical bases for evaluation, which are discussed in the Council of

Ministers' report. Most systems of criteria (whether Swedish or international) are concerned primarily with the question of how to evaluate different areas, but are more vague on how to determine priorities between areas if not all of them can be designated. However, the Swedish criteria system makes certain important additions in respect of how priorities should be assigned to suggested areas, based on such factors as the degree of threat to the areas, whether they suit present actions, and general feasibility.

This report has been prepared by PER NILSSON, of the Tjärnö Marine Biological Laboratory (TMBL), on behalf of the Environmental Protection Agency's Section for Research into the Aquatic Environment, Research Department.

The working group for the investigation into criteria for the selection, designation and management of marine reserves has included LARS AFZELIUS, Tjärnö Marine Biological Laboratory; BENGT FRIZELL, Environment Department, Gothenburg and Bohus County Council; GURLI GRÖNQVIST, Natural Resource Department, Environmental Protection Agency; GEIR HARDENG, Environment Department, County Councillor of Østfold, Moss, Norway; CATHY HILL and SIF JOHANSSON, Research Department, Environmental Protection Agency; TOMAS LUNDÄLV, Tjärnö Marine Biological Laboratory; MATTIAS SKÖLD, Environment Department, Gothenburg and Bohus County Council; and LARS THORELL, Natural Resource Department, Environmental Protection Agency. The working group has reviewed the manuscript, but the views expressed in it are solely those of the author.

This is a translation of the original Swedish Report 4750 (Nilsson, 1997a).

Stockholm, December 1997.

Contents

Summary

This report summarises and analyses the criteria applied in Sweden to determine whether marine areas are worthy of protection. I compare the Swedish system with internationally used systems, and indicate alternative or complementary ways of looking at the selection of marine protected areas.

The Swedish system that is used in, for example, the report "Marine Reserves in Sweden" (Grönqvist, 1997), is a modification of the system developed by IUCN (Kelleher and Kenchington, 1992). It comprises criteria within the categories of naturalness, ecological/biogeographical value, research/educational value, international/national value, economic value, social value and practicality/feasibility.

The process of selecting areas employs criteria for two purposes:

1. Evaluation criteria: used to identify and value areas that may be considered.
2. Criteria for determination of priorities: used to rank areas in order to prepare a list of priorities.

Most systems (for example, the Swedish system, as well as international systems) place the emphasis on evaluation criteria. In the Swedish system, they have been complemented by certain priority assignment criteria: fragility, threat, feasibility and pragmatism.

The areas that have hitherto been put forward by the Environmental Protection Agency as marine protected areas have such a high protection value that they would presumably also be high up on a ranking list of Swedish areas, regardless of the method of determining priorities used. However, there may be a greater need for priority criteria if several areas are to be designated – areas that are not as immediately spectacular as those that have hitherto been proposed. I present examples of systems for priority determination in the report, and emphasise how the process of setting priorities depends on the objectives set for the protected areas.

As the objectives can vary from case to case, it is necessary also for the criteria employed for selection (or the importance attached to different criteria) to vary. The selection of areas can vary, for example, if the areas are to be individually isolated or related in a larger system. If a single area is to be

designated, attempts should be made to find one that fulfils the greatest number of evaluation criteria. If a system of areas is to be designated, different areas should complement each other, regardless of the value of any one individual area.

The importance of different criteria also changes depending on the purpose for which the area is being protected. I give examples in the report of which criteria are best suited to which type of purpose, and how this can be incorporated in a system that can be used in practical work with protected areas.

The following factors are particularly important for marine protected areas (as compared with protected areas on land):

- As marine systems are so open, the marine protection should be concentrated on protecting biotopes and ecosystem functions rather than on individual species. It is therefore particularly important that marine protected areas should include intact biological systems.
- Our knowledge of the occurrence and biology of individual species is also less in marine systems. This also means that protection should be concentrated on habitats and/or processes, rather than on individual species.
- Marine (coastal) areas are heavily affected by activities on land. Marine protected areas are therefore, in practice, protected only if they are complemented and supported by active coastal and land use planning.
- Marine protected areas are often designated on account of biological resources, or for economic or ecological reasons that can be difficult for the public to understand. There is therefore a particularly strong need for information on marine protected areas.

Summarising, the system of criteria used in Sweden has the following advantages:

- It comprises many different types of criteria (ecological, biogeographical, economic, social etc.).
- It accords with internationally recognised systems.
- It has been developed for, and takes particular consideration of, conditions specific to marine systems.

Weaknesses of the Swedish system (which it shares with most other systems) are:

- It is not particularly comprehensive in its treatment of determining priorities between different areas.

- It is vague in its discussion of whether protected areas should be regarded individually or as parts of a system.
- It does not discuss the use of the criteria in relation to the purpose of protection.

What are criteria?

Objectives and criteria

A public authority starts by formulating an environmental objective. The Swedish Environmental Protection Agency, for example, has set a number of environmental objectives aimed at maintaining the biological diversity of Swedish marine areas (Swedish EPA, 1996; Hill et al., 1997). There are several ways in which these objectives can be achieved. One of these is to designate protected areas, i.e. areas subject to special rules for protection of the values to be preserved. However, environmental objectives are usually expressed in general terms and can be regarded as primarily being expressions of an aspiration. Clarification – regulations that set out what the overall objectives mean in practice – is needed in order to translate the objectives into practical action.

The directives that translate the objectives into practical regulations concerning what is to be valued, and how it is to be valued in connection with the establishment of protected areas, are referred to as criteria. By this I mean that criteria are not independent and autonomous, but are intended to reflect objectives that have been established within, or as part of, environmental policy. If the objectives are changed, then the criteria must also be changed. Criteria, in other words, change with time, and they can also vary from country to country (or on other geographical scales). Changes in criteria need not be a drawback: on the contrary, they are an essential element of the criteria in extending them to meet specific objectives.

Criteria are also practical features: they are intended to facilitate a concrete selection process. This means partly that they must translate the objectives into something that really has a corresponding element in nature, and partly that they must capture the aspects to be saved. This again means that criteria can and should differ from one environment to another (e.g. land, lakes or the sea), and also from one country to another.

A practical reality is that decisions concerning the establishment of a marine protected area (MPA) often have to be based on limited background knowledge, often made at short notice and often by persons who are not

specialists in all details involved in the process. This requires that the criteria should be such that it is realistic to be able to obtain data for their use, and that they should be sufficiently self-explanatory for non-specialists to be able to evaluate them.

CRITERIA MUST THEREFORE FULFIL THE FOLLOWING THREE REQUIREMENTS:

1. they must accurately reflect the (environmental) objectives
2. they must be relevant to the environment in which they are to be used
3. they must be sufficiently easy to use to ensure that they really are of value to the process of selection.

SWEDISH OBJECTIVES FOR MARINE PROTECTED AREAS

As I said above, I feel that it is the objectives for protected areas that are decisive in assessing and determining the criteria. I would therefore like to describe how Sweden has formulated these objectives in a number of earlier investigations and proposals, particularly in the Environmental Protection Agency's reports *Utredning om skyddsvärda områden längs Sveriges kust* –

Marina reservat 1980 (Investigation of areas worthy of protection along the Swedish coast – Marine reserves 1980), and *Marina reservat i Sverige* (1997) (Marine reserves in Sweden [1997]), in the Nordic Council of Ministers' report *Marina reservat i Norden*(1995) (Marine protected areas in the Nordic countries [1995]) and in the Swedish Environmental Protection Agency's report *Action plan on biological diversity* (1996).

1. Objectives of marine reserves as set out in the Environmental Protection Agency's Report No. 4693, "Marina reservat i Sverige" (Marine reserves in Sweden) (Grönqvist, 1997)

In the introduction to the report, on page 6, we read:
"The purpose of marine reserves is to protect valuable marine environments, ecosystems, species and processes, both unique and representative. Marine reserves with monitoring programmes can serve as reference areas when assessing areas in which environmental destruction has occurred. Marine reserves can also be areas of high biological productivity, e.g. nursery areas for fish species or areas for research. In addition to their scientific interest, many marine reserves are areas of considerable interest for different forms of recreational activities."

In addition, the report says:
"The establishment of marine reserves may sometimes be a necessary prerequisite for the long-term utilisation of marine resources, either within or in the vicinity of the protected area."

2. Objectives of marine reserves as set out in the Environmental Protection Agency's report "Utredning om skyddsvärda områden längs Sveriges kust – Marina reservat 1980" (Investigation of areas worthy of protection along the Swedish coast – Marine reserves 1980) (Naturvårdsverket, 1980)

In Section 2, General, we read:
"... reserves/protected areas must be designated in order to prevent further impoverishment of the richness of variety in the seas while there is still time."

The report states that the purpose of marine reserves is to:

- Protect and preserve marine reference areas, i.e. areas where natural processes can proceed without interruption.
- To protect individual plant and animal species, plant and animal communities and their habitats from becoming extinct, impoverished or destroyed. Particular importance is attached to biological production values.
- To protect areas where research, investigations and education have been practised and are still practised.

3. Objectives of marine reserves as set out in the Nordic Council of Ministers' report "Marina reservat i Norden" (Marine protected areas in the Nordic countries) (1995)

The report adopts the IUCN purpose of marine protected areas:
"To provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of marine protected areas and through the management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment."

It is stated in Chapter 1 that work on protecting valuable marine environments in the Nordic coastal and sea areas should be set in an international context, partly because the marine territories of a number of countries can be involved in the life cycle of a single animal species, and partly because various environmental threats can act over extensive areas, in some cases even over national boundaries.

4. Objectives of marine reserves as set out in the Environmental Protection Agency Report No. 4567 "Action plan on biological diversity" (1996)

The action plan names marine reserves as an important element in the protection of biological diversity but, apart from mentioning the importance of marine reserves as reference areas, does not directly say what role marine protected areas have to play in this protection.

Evaluation criteria and priority criteria

Criteria are employed for two purposes in the process of selecting areas:

1. Evaluation criteria: used to identify and value areas that may be considered.
2. Criteria for determination of priorities: used to rank areas in order to prepare a list of priorities.

Most of the criteria that appear in publications are evaluation criteria. However, in practice, priority criteria are equally important, as there are generally more areas to which we would like to give extended protection than can actually be protected.

Priority criteria can be a quantitative grouping of evaluation criteria, i.e. the evaluation criteria are pooled in some way in order to decide which areas are the most valuable (Pressey et al., 1993). Alternatively, they can also extend beyond evaluation criteria, e.g. when they allow for other areas that have been, or are to be, selected, or when they consider the feasibility of establishing a particular area at the site being considered. This is discussed in more detail in the section on alternative criteria.

It is fairly safe to say that the evaluation criteria are generally the less controversial, and thus easier to reach agreement upon than are the priority criteria. The evaluation criteria include translation of environmental objectives and relating them to the biological reality (in terms of geological, historical and other factors etc.), the selection of what is to be investigated and how it is to be evaluated. It is particularly in these areas that the biologists and other scientists become involved in order to suggest appropriate evaluation scales, quantitative methods, the identification of habitats, analysis of components etc. In its way, this a positive process: it is concerned with sorting, analysing and evaluating factors to find the most valuable areas.

The priority criteria are part of a more painful process, involving consideration of a number of areas, all of which are valuable, but of which some must be selected and some rejected. This involves factors other than those related purely to the environment, such as how realistic it is to designate a marine protected area in some particular area, the necessary protective measures, what the economic effects would be, how it would be regarded by the public etc. This requires input from planners, public authorities, users, the public, economists etc. However, it does not mean that there are not appropriate scientific priority criteria and methods: different areas can have different values (see the section on alternative criteria [Section 7, page 21] for examples of methods of determining priorities as seen from a biological point of view).

The role of the criteria in the selection of marine protected areas

There are three stages that should be considered right from the start when selecting areas to be protected:

1. Selection of preliminarily interesting areas, using appropriate criteria.
2. Formulation, i.e. assessing the size of the protected area in order to achieve the required objectives, the types of protection needed to guard against various threats, the type of monitoring required etc.
3. Management and practical implementation, i.e. deciding how protection is to be applied and monitored, who is to manage and supervise the area, how the economics are to be met etc.

The evaluation criteria for a selection generally apply only to Stage 1. However, it must be possible to fulfil certain requirements in all three stages: if not, this is an indication to look for another site. Both the formulation (Stage 2) and practical considerations (Stage 3) should be included, together with the priority criteria, when drawing up a list of priorities.

The evaluation criteria indicate which areas are worth protecting. However, even though an area may be worth protecting, it must be possible to draft or provide the appropriate protection rules for it, with regard to size, continuity etc. so that its valuable features really are protected. In addition, even though it may be possible to define the protected area well, it must also be possible to manage it and to be sure that the various rules and regulations really are obeyed. It is important in all stages (but particularly in Stages 2 and 3) to initiate a dialogue with the authorities, owners and other parties concerned. It is not until there are realistic solutions for all these three stages that the particular area can really be selected.

The last two stages are considered in the Swedish system (e.g. by the Swedish EPA's report "Marine reserves in Sweden" [Grönqvist, 1997]) under the heading "further criteria/priority criteria", i.e. under "feasibility" (see page 21 of this report).

Swedish and international criteria

The report "*Utredning om skyddsvärda områden längs Sveriges kust – Marina reservat 1980*" *[An investigation of areas worthy of protection along the Swedish coast – Marine reserves 1980]* from the Swedish EPA describes a system of criteria that provide the basis for a list of proposed reserves. The 1980s saw intensification of the international debate, and several publications provided alternative lists of criteria, either general or intended particularly for marine areas.

The Swedish criteria were modified somewhat (expanded) in the report from the Nordic Council of Ministers (1995), bringing them more into line with those published by IUCN in 1992 (Kelleher and Kenchington, 1992). The IUCN criteria were those to which reference was most often made in international publications. The Nordic report also includes explanatory comments on how certain criteria are to be interpreted and applied. The same system is also described in the Swedish EPA's report "*Marina reservat i Sverige*" *[Marine reserves in Sweden]* (Grönqvist, 1997).

The Swedish and Nordic system

On the following pages, I go through the list of criteria set out in Chapter 2 of *Marina reservat i Norden – Del 1 [Marine protected areas in the Nordic countries – Part 1]* (Nordic Council of Ministers, TemaNord 1995:553), complemented with comments.

1. Naturalness

- **No/negligible exploitation/activities in or in the vicinity of the area having adverse effects on the marine biological values.**

Comments: As pointed out in the Council of Ministers' report, most (all?) systems today have been affected by man in one way or another, with the result that the "natural" state can be difficult to define. Although this problem is most severe for terrestrial systems (in which many types of nature have even been created by man [Götmark, 1992]), the same also applies for marine systems. In Sweden, we can hardly speak of undisturbed sea areas at all. A further problem is the fact that all natural environments are subject to natural change. The difficulty of being able to distinguish between changes caused by man and those caused by nature is one of the most difficult problems of the present environmental debate (compare, for example, with the debate on the greenhouse effect). This does not mean that we should abandon the objective of undisturbed environments, but that a more pragmatic approach might be to accept that there will be disturbances, but that they must be as small as possible.

2. Ecological/Biogeographical value

- **A large number of plant and animal species, plant and animal communities etc.**

Comments: If the objective of protected areas is to preserve biological diversity, then this is perhaps the most important criterion. In addition, other values such as aesthetic values, high natural production, economically important species, recreationally important areas etc. are often correlated with many species and habitats. However, there are also problems associated with excessive concentration on hot spots (i.e. areas with many species): in general, they are not typical (which is just why they have been noticed!), many less diverse systems have higher productivity (e.g. shallow soft bottoms, eelgrass meadows) and are more threatened etc.

- **Heterogeneous bottom sediment and bottom topography**

COMMENTS: The variation of bottom substrates can be an excellent indicator of biological diversity in two ways: a more heterogeneous bottom sediment can result in a greater diversity of species, although it can also be caused by the high diversity of species, as the organisms in turn modify their bottom environment. If it is more difficult to survey the species diversity than to determine the heterogeneity of the sediment (which is probable in certain areas, but not necessarily in all areas), then the variation in the bottom sediment can provide a short cut to assessing biodiversity. Soft-bottom fauna are emphasised as an important group worthy of conservation in the Swedish EPA's "Action plan on biological diversity" (1996).

- **Substantial variation richness of species, biotopes and ecosystems**

COMMENTS: This criterion overlaps with the earlier criterion that emphasises the importance of a large number of species, biotopes etc. The difference (as I interpret it) lies in the term *variation richness*: this implies that an area would be more valuable if it had many different types of species and not simply many species (or biotopes and ecosystems). It is not completely clear how variation richness should be quantified (e.g. how different must the species be in order to be regarded as different?).

- **Representative species, biotopes and ecosystems**

COMMENTS: This is often one of the most important criteria. Note that, in general, it has a completely different objective than the criterion that values areas possessing many different species and habitats, and can sometimes have completely the opposite emphasis. According to this criterion, a homogeneous area with few species can be more worthy of protection than an area with many species.

- **Rare plant and animal species, plant and animal communities, biotopes etc.**

COMMENTS: The main point here is the definition of what is rare, as the rareness of a species will depend on the extent of the area concerned. This is particularly important for Swedish conditions, as our marine environment constitutes a long gradient on which almost every species found along the west coast would be worthy of protection if it occurred in the Baltic. The two following criteria (species at the limits of their distribution and relict species) are therefore important for Swedish (Nordic) conditions.

- **Plant and animal species at the limits of their distribution**

COMMENTS: One reason often cited for the preservation of species at the limits of their distribution is the fact that such peripheral populations can have a special genetic make-up which is worthy of protection for such reasons as the maintenance of genetic variety within the species (Lesica and Allendorf, 1995). However, this again can be problematic in Sweden, where almost all species have peripheral populations.

Another reason which is put forward for the preservation of peripheral populations is that there are many indications that they can significantly contribute to the creation of new species (geographical speciation). The preservation of peripheral populations is therefore one way of maintaining evolutionary opportunities, which is an object of conservation in many contexts.

- **Relict species**

COMMENTS: The same reasons for preservation, and the same problems, apply here as for species at the limits of their distribution.

- **Species, biotopes and ecosystems threatened with extinction**

COMMENTS: This is one of Sweden's international undertakings. One problem in the marine environment is that we know very little about the true extent of rare species. The literature refers to many species of which examples have been found on only one or a few occasions. Are these species therefore threatened with extinction, naturally uncommon or simply incorrectly classified?

In general, we know of only a few habitats or marine organisms (with the exception of birds, turtles and mammals) that are threatened with extinction. However, there are species and habitats that have become rarer, even in Sweden (Hill et al., 1997).

- **Feeding, refuge, breeding and nursery areas**

COMMENTS: This is a criterion which links to the system approach that we attempt increasingly to incorporate in environmental work: that of protecting not only certain species or environments, but also the other environments and conditions that are necessary for their survival (and which has also been particularly emphasised in the Council of Ministers' report from 1995).

Feeding areas, refuge areas etc. are areas that need to be protected for the maintenance of the functions that they provide during certain stages of the life cycles of organisms, whose main habitat may be far away. As far as marine systems are concerned, it is naturally primarily vertebrates (fish, birds and seals) of which we have enough knowledge to be able to apply this criterion, although for these groups it has been one of the most important criteria that has been employed in the designation of protected areas to date (e.g. shallow soft bottoms for the protection of birds and fish fry).

- **Representative biogeographical and geological conditions with associated plant and animal species, biotopes and ecosystems**

COMMENTS: What is being emphasised here are conditions such as beaches in areas of postglacial uplift, archipelagos and other specifically Nordic conditions. In its way, this is a repetition of the earlier criterion concerning representative types of nature. The reason for it being given its own heading is presumably to emphasise that there are special Nordic conditions that are not included in a number of international lists, with the result that it is important to provide a reminder that they should be considered.

- **Rare or unique biogeographical and geological conditions with associated animal species, biotopes and ecosystems**

COMMENTS: As for the criterion above.

3. RESEARCH/SCIENTIFIC VALUE

- **Documentation of results from such work as investigations of species or biotopes, or research from earlier years**
- **Regular investigations**
- **Continuous measurements/monitoring programmes**
- **Current research projects**

COMMENTS: All these criteria emphasise the importance of reference areas, i.e. areas in which there is a knowledge of environmental variations with time, and which can be used for comparisons with environmental investigations. Bearing in mind the amount of money spent on a long series of measurements, a break in the series resulting from the environment (the habitat) being destroyed by exploitation is also an economic factor that must be considered.

4. International/national significance

- **Included on an international list of areas worthy of protection**
- **Proposed as a possible area for international protection**

Comments: Sweden has international obligations (e.g. HELCOM, OSPAR, IUCN, Natura-2000, the Ramsar Convention) which it strives to fulfil.

- **Forming a link in a series of areas worthy of protection across national boundaries**

Comments: This is an important point: nature often is no respecter of national boundaries: migrating organisms provide an example. Several of the proposed protected areas in Sweden (the Koster area, Haparanda archipelago) are dependent on areas in neighbouring countries also being protected. The same logic applies also at more local levels, e.g. across county boundaries.

5. Economic importance

- **Feeding areas/foraging areas**
- **Breeding areas/spawning areas**
- **Nursery areas**
- **Areas of importance for part(s) of the life cycle of one or more species**
- **Biotopes of importance for the prey of particular species**

Comments: These criteria bring human aspects into the picture of what is worth protecting: an area can be worth protecting if it contains resources that are economically valuable (or which can be valuable if protected).

This is a view to which the majority of people would presumably subscribe, although there is less agreement as to how it should be interpreted and how it should be valued in relation to other criteria. In general, criteria such as these seem to be increasingly important in the international debate, while the boundary between "protection for the sake of nature" and "protection for the sake of man" is becoming steadily more diffuse: there is greater awareness of the "services" provided by nature but to which an economic value is normally not assigned. One of the objectives of the somewhat diffuse concept of ecosystem management – that of introducing an ecosystem approach to nature conservation – is to attempt to see all human activities in the nature conservation context and, conversely, to show how most natural processes affect man (Grumbie, 1994).

This is a type of criteria that is important and which, whether one likes it or not, will become even more important in motivating nature protection. Further development of these criteria is therefore necessary.

6. Social value

- **Easily accessible, robust and providing a potential through their structure for information on the marine biological values – their marine plant and animal species**

Comments: Information, tourism and ecotourism are becoming increasingly important, not least in economic terms. The use of the area for local recreation and other purposes is an important part of the quality of life in the area. Making sure that the right conditions for these activities exist and continue to exist will become increasingly important.

- **The maintenance of traditional fishing**

Comments: In Sweden, the possibility of an area being set aside for the main purpose of protecting traditional fishing methods is rarely considered, although this is not unusual on the international level. There is resistance not only from nature conservationists (who, in general, regard protected areas as a means of stopping fishing), but also from those groups of fishermen who oppose any and every restriction on their right to free fishing. There are at least three reasons for wanting to retain traditional fishing: to retain cultural traditions, to provide local fishermen with a chance to compete with large-scale fishing and because traditional fishing methods are often regarded as less harmful (which is not necessarily the case).

- **The areas contain cultural artefacts, e.g. old wrecks**

Comments: The report mentions this criterion for only one of the proposed protected areas. This may be an example of the dominance of biological/natural science considerations within environmental conservation, but if so it provides an argument for why cultural scientists (in addition to sociologists, economists etc.) must be heard more in the nature conservation debate.

7. Further considerations/priority criteria

Given that areas have certain values that can be defined with the help of the criteria described above, which of them should be given priority? This section considers a number of factors that can play a part in deciding in which order areas should be protected.

- **Fragility/vulnerability**

COMMENTS: A more vulnerable area is in greater need of protection but, at the same time, it is less likely that it can be preserved. As I see it, it is not self-apparent how vulnerability should be evaluated.

- **Threat**

COMMENTS: An area which is facing an immediate threat (as a result of current or future activities), should be given preference. However, in this case, too, a threatened area can be evaluated in two ways: should it be saved quickly, or does the threat mean that it is less likely that it can be successfully saved? This depends on factors such as why we want to preserve the area: if it is something that is unique, there is no alternative to concentrating measures on the area as quickly as possible. On the other hand, if the area is to be preserved because it is representative, it may be more effective to look for another area that represents the same values but which is not under threat.

- **Feasibility**

COMMENTS: This innocent heading (and the next one) hides the most difficult assessments when deciding on the establishment of marine protected areas. Is it realistic to establish an MPA? What support is there for it from the public? Are there mechanisms (e.g. a conservation area on land) that can be linked to the proposed area? Can the threats really be countered in a reasonable manner? Can we reconcile utilisation and conservation interests? Are there other ways of protection (in addition to the establishment of, say, a nature reserve) that could achieve the same protection effects?

In the real world, it is problems in this respect that can cause nature conservation ambitions to grind to a halt, regardless of how many positive points an area may have collected from the evaluation criteria above. There are many problems resulting from our limited knowledge of the sea that retard the work of nature conservation, but if it was not for the various problems of feasibility there would presumably already be a widespread network of protected areas, not only in Sweden, but also internationally. This is an area in which much remains to be done, and it is here that the greatest degree of new thinking is required.

- **Practicability**

Is the protected area within, or adjacent to, other protected areas? I am not completely clear over the difference between this criterion and that of "feasibility" above.

Other systems

There are several precedents and alternative systems. Table 1 is an attempt to compare the Swedish/Nordic system (from the Nordic Council of Ministers' 1995 report) and three alternative systems of criteria. It can be seen from the table that the systems are all fairly similar: they consider approximately the same aspects. The system presented by Salm and Price (1996) differs somewhat by giving greater emphasis to the local perspective (e.g. the criteria on local and regional importance, health aspects etc.). Kelleher and Kenchington's system (1992) is recommended by IUCN, and variants of it will probably be used in many countries.

Table 1: A comparison of four systems of criteria for the selection of marine protected areas

Nordic council of Ministers, 1995	Kelleher & Kenchington, 1992	Salm & Price, 1996	Swedish EPA, Marine reserves 1980 (Naturvårdsverket, 1980)
Naturalness • No/negligible exploitation/activity in or close to the area, having adverse effects on the marine biological values.	**Naturalness** • The extent to which the area has been protected from, or has not been subject to human-induced change.	**Ecological Criteria** • Naturalness – the lack of disturbance or degradation	• Undisturbed – areas protected from pollution, exploitation or other activities – reference areas.
Ecological/biogeographical value • Large number of plant and animal species, plant and animal communities etc. • Heterogeneous bottom sediment and bottom topography • High variation richness of species, biotopes and acosystems. • Representative species, biotopes and ecosystems. • Rare plant and animal species, plant and animal communities, biotopes etc. • Plant and animal species at their geographical limits. • Relict species • Threatened species, biotopes and ecosystems. • Feeding, refuge, breeding and nursery areas. • Representative biogeographical and geological conditions, with associated plant and animal species, biotopes and ecosystems. • Rare or unique biogeographical and geological conditions, with associated plant and animal species, biotopes and ecosystems.	**Biogeographical importance** • Either contains rare biogeographic qualities or is representative of a biogeographic "type" or types. • Contains unique or unusual geological features. **Ecological importance** • Contributes to maintenance of essential ecological processes or life-support systems. • Integrity. • The degree to which the area either by itself or in association with other protected areas, encompasses a complete ecosystem. • Contains a variety of habitats. • Contains habitats for rare or endangered species. • Contains nursery or juvenile areas. • Contains feeding, breeding or rest areas. • Contains rare or unique habitat for any species. • Preserves genetic diversity i.e. is diverse or abundant in species terms.	• Diversity – the variety or richness of ecosystems, habitats, communities and species. • Dependency – the degree to which a species depends on an area, or the degree to which an ecosystem depends on ecological processes occurring in the area. • Representativeness – the degree to which an area represents a habitat type, ecological process, community, physiographical feature or other natural characteristic. • Uniqueness – whether an area is "one of a kind", habitats of endangered species occurring only in one area are an example. • Integrity – the degree to which the area is a functional unit – an effective, self-sustaining ecological entity. • Productivity – the degree to which productive processes within the area contribute benefits to species or to humans.	• Multiplicity – areas with a multiplicity of species combinations of species, plant and animal communities, biotopes, development stages or ecosystems. • Rarity – areas with unique species etc. • Representativity – areas with species etc. typical of the area, region or country. • Genetic diversity value – areas with species, races etc., having specific genetic properties worthy of protection. • Survival – areas essential for the life cycle and survival of species. • Oceanography/hydrography – areas with representative and/or rare/unique conditions – typical features, reference sites or unique features. • Geoscience – areas with representative and/or rare/unique conditions – typical features, reference sites or unique features.

Nordic council of Ministers, 1995	Kelleher & Kenchington, 1992	Salm & Price, 1996	Swedish EPA, Marine reserves 1980 (Naturvårdsverket, 1980)
Economic importance • Feeding areas/foraging areas. • Breeding areas/spawning areas. • Nursery areas. • Areas of value as part of the life cycle of one or more species. • Biotopes of importance for the prey of particular species.	**Economic importance** • Existing or potential contributions to economic value by virtue of its protection e.g. protection of an area for recreation, subsistence, use by traditional inhabitants, appreciation by tourists and others or, as a refuge, nursery or source of supply for economically important species.	**Economic criteria** • Importance to species – the degree to which certain commercially important species depend on the area. • Importance to fisheries – the number of dependent fisherman and the size of the fishery yield. • Nature of threats – the extent to which changes in use patterns threaten the overall value to people. • Economic benefits – the degree to which protection will affect the local economy in the long term. • Tourism – the potential value of the area to tourism development.	• Fishery biology – areas of importance for feeding, breeding, spawning and nursery areas for species of fish of economic importance.
Social value • Easily accessible, robust and, through its structure, providing an opportunity for information on the marine biological values – the marine plant and animal species. • The maintenance of traditional fishing methods. • Containing cultural artefacts, e.g. wrecks.	**Social importance** • Existing or potential value to the local, national or international communities because of its heritage, historical, cultural, traditional aesthetic, educational or recreational qualities.	**Social criteria** • Recreation – the degree to which the area is, or could be, used for public recreation. • Culture – the religious, historic, artistic or other cultural value of the site. • Aesthetics – a seascape, landscape, or other area of exceptional scenic beauty. • Accessibility – the ease of access across both land and sea. • Public awareness – the degree to which monitoring, research, education or training within the area can contribute knowledge and appreciation of environmental values and conservation objectives.	• Education – areas of importance for education.

Nordic council of Ministers, 1995	Kelleher & Kenchington, 1992	Salm & Price, 1996	Swedish EPA, Marine reserves 1980 (Naturvårdsverket, 1980)
Research/ scientific value • Documentation of results from such work as investigations of species or biotopes, or research from earlier years. • Regular surveys/investigations. • Continuous measurements/ monitoring programmes. • Current research projects.	**Scientific importance** • Value for research and monitoring.	• Research and education – the degree to which an area represents various ecological characteristics and can serve for research and demonstration of scientific methods. • Benchmark areas – the degree to which the area may serve as a "control site" for scientific research or for ecological monitoring.	
International/national significance • Included on an international list of areas worthy of protection. • Proposed as a possible area for international protection. • Constitutes a link in a series of areas worthy of protection across national boundaries.	**International or national significance** • Is or has the potential to be listed on the World (or national) Heritage List, or declared as a Biosphere Reserve, or included on a list of areas of international or national importance, or is the subject of an international or national conservation agreement.	**Regional criteria** • Regional significance – the degree to which the area represents a characteristic of the region, whether a natural feature, an ecological process or a cultural site. • Subregional significance – the degree to which an area fills a gap in the network of protected areas from the subregional perspective.	• Areas internationally recognised from the point of view of protection or preservation.
Further considerations/priority criteria • Fragility/vulnerability. • Threat. • Feasibility. • Practicability.	**Practicality/feasibility** • Degree of insulation from external destructive influences. • Social and political acceptability, degree of community support. • Accessibility for education, tourism and recreation. • Compatibility with existing use, particularly by locals. • Ease of management, compatibility with existing management regimes.	• Social acceptance – the degree to which the support of local people is assured. • Public health – the degree to which the creation of a MPA may serve to diminish pollution or other disease agents that contribute to public health problems. • Conflicts of interest – the degree to which area protection would affect the activities of local residents.	• Conservation value – areas linked either naturally or by scientific factors in common with general conservation values on land.

Nordic council of Ministers, 1995	Kelleher & Kenchington, 1992	Salm & Price, 1996	Swedish EPA, Marine reserves 1980 (Naturvårdsverket, 1980)
		• Safety – the degree of danger to people from strong currents, surf, submerged obstacles, waves and other hazards. • Vulnerability – the area's susceptibility to degradation by natural events or the activities of people. • Size – which and how much of the various habitats need to be included in the protected area. • Urgency – the degree to which immediate action must be taken, lest values within the area be transformed or lost. • Degree of threat – present and potential threats from direct exploitation and development projects. • Effectiveness – the feasibility of implementing a management programme. • Opportunism – the degree to which existing conditions or action already under way may justify further action. • Availability – the degree to which the area is available for acquisition or can be managed satisfactorily by agreement with the owners. • Restorability – the degree to which the area may be returned to its former natural state.	**General priority criteria** • Areas that fulfil several evaluation criteria. • Areas that are of particular value in the light of some individual evaluation criterion. • Areas facing a current, planned or threatened (acute) threat. **Specified priority criteria** • Areas containing specific species, objects or conditions (not only the unique features).

How are the criteria used in Sweden?

Criteria have been used as the basis for selection of the areas proposed for designation as marine protected areas in such reports as *Marina reservat – 1980 [Marine reserves – 1980]* (Swedish Environmental Protection Agency, 1980) and *Marina reservat i Norden [Marine protected areas in the Nordic countries]* (Nordic Council of Ministers, 1995). Which criteria have been specifically used, and why have they been regarded as particularly important? *Marina reservat i Norden, del II [Marine protected areas in the Nordic countries, Part II]* (Nordic Council of Ministers, 1996) presents a review of 15 selected Swedish areas and of the criteria employed in their selection.

Table 2 is a summary of the criteria employed in the analysis of the proposed areas. It shows the criteria named in the report: in those cases where I am not certain which criteria have been used, I have interpreted the context. I have, in other words, not made any assessment of the bases on which an area can be regarded as of value.

Table 2. Criteria used to select Swedish areas for protection, as cited in the report from the Nordic Council of Ministers (Tema Nord 1996:546).

1. Naturalness, 2. Ecological/biogeographic importance, 3. Educational/scientific importance,
4. International/national significance, 5. Economic importance, 6. Social value,
7. Further considerations, priority criteria.

Hap = Haparanda archipelago. Bju = Bjuröklubb area. Hol = Holmö islands. Ulv = Trysunda/Ullånger/Ulvö islands/Ulvödeep.
Grä = Gräsö/Singö archipelago. Sto = Storö/Bockö/Stora Nassa/Svenska Högarna/Svenska Björn. Lan = Landsort/Askö/Hartsö/
Landsort deep.
S:t A = S:t Anna/Missjö archipelago. Kop = Kopparstenarna/Gotska Sandön/Salvo reef. Tor = Torshamns archipelago/Utklippan.
Fal = Falsterbo peninsula/Måkläppen. Kul = Kullaberg. Nid = Nidingen/Sönnerbergen/Mönster. Gul = Gullmars fjord.
Kos = Koster trench/Koster archipelago/Tjärnö archipelago/Väderö islands

	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
TOTAL NUMBER OF CRITERIA	8	7	10	10	9	13	10	8	12	10	13	9	9	12	14
1. Naturalness						x		x	x	x			x		

2. Ecological/biogeographical value	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• many species etc.		x	x	x	x	x		x		x	x	x	x	x	x
• heterogeneous bottom						x	x		x					x	x
• rich variation of species etc.					x		x				x			x	x
• representative species etc.		x	x	x	x	x	x				x	x	x	x	x
• rare species etc.	x					x			x		x	x		x	x
• species at the limits of their distribution			x	x	x				x			x			
• relict species															
• threatened with extinction															
• feeding, refuge, breeding, nursery areas	x					x	x		x	x	x		x		x
• representative conditions	x	x	x	x		x	x	x	x	x			x	x	x
• rare conditions	x			x		x	x	x	x		x	x		x	x

3. Research/scientific value	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• documentation from previous years															
• regular surveys/investigations			x	x			x		x	x	x	x	x	x	x
• continuous measurements															
• current research projects															

4. International/natonal significance	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• on an international list	x	x	x	x	x	x	x	x	x	x	x	x	x		
• proposed international											x				
• cross-border links	x														

5. Economic importance	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• feeding areas									x						x
• breeding areas/spawning areas		x	x		x				x	x	x			x	
• nursery areas		x	x		x					x	x			x	
• important in life cycle															
• important for prey															

6. Social value	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• easily accessible etc.	x		x	x	x	x	x	x		x	x	x		x	x
• traditional fishing						x		x							x
• cultural aspects													x		

7. Further considerations/ priority criteria	Hap	Bju	Hol	Ulv	Grä	Sto	Lan	S:t A	Kop	Tor	Fal	Ku	Nid	Gul	Kos
• fragility/vulnerability				x		x									x
• threat	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
• feasibility															
• practicability															

Figure 1 shows that it is the ecological/biogeographical values and social values that are the evaluation criteria that are employed in most cases. Of the social criteria, it is ease of access that is most generally cited, which parallels nature conservation on land, where one of the motivations for most protected areas is that they are suitable for recreation (Götmark and Nilsson, 1992). Naturalness (i.e. the absence of human interference) is mentioned in five cases, which presumably reflects the fact that most of the areas are close to the coast, and are therefore intensively used by man.

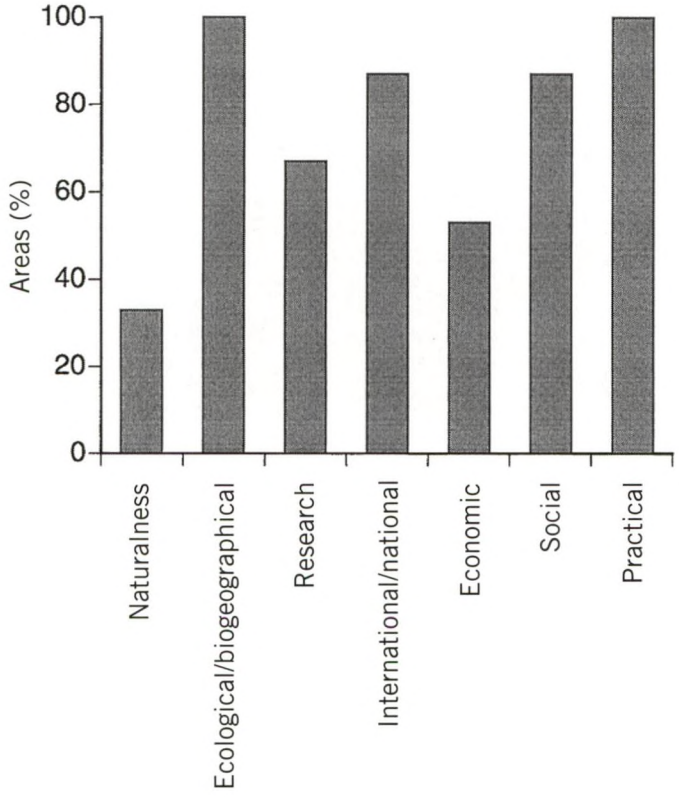

Figure 1. Frequency of different criteria used for selecting Swedish marine areas to be protected (*Nordic Council of Ministers, TemaNord 1996:546*).

Are there special marine criteria?

The difference between land and sea

The density of water makes it an excellent transport medium. This simple fact means that, in general, the marine environment is more open than terrestrial environments, and that it is less local. This substantial openness has effects on the transport of nutrients, toxins etc. The more large-scale transport of the sea means that it is important to consider the effects of processes in the environment surrounding a protected area. In addition, the spread of larvae in the sea is such that many species have no local populations at all: instead, they are dependent on the inflow of larvae from other areas in order to maintain their population levels.

Dispersal biology is therefore very important. Many of the species that are important in terms of economics and productivity spread their larvae in the body of the water, and cannot therefore be protected by designating only a limited area. Dispersal by means of free-swimming larvae in the majority of marine organisms results in less geographical isolation than for terrestrial organisms.

On land, an area is often protected because it contains a habitat that is critical for a rare, and perhaps threatened, species. In the sea, on the other hand, it is less likely that a particular species is dependent on a special location: its habitat is often found in many places. In addition, there are often several types of habitat that are critical for marine species (e.g. for larval dispersal; see the previous paragraph). The exceptions to this are mainly larger marine creatures such as mammals, birds and turtles.

Marine systems are less often protected because of the presence of some particular threatened species. Rather it is because they are important for commercially important species, are good representatives of some particular habitat or (using a concept that is popular at present) because the area fills some other important ecological function. Because of this, it is even more important for marine protected areas that they should be part of a larger integrated policy for large-scale environmental protection. *Marine protected areas are protected only if they are supported by an active coastal and land planning policy.*

Which of these criteria differ between terrestrial and marine systems?

Many of the criteria mentioned in the section on Swedish and Nordic criteria (page 16) incorporate a restriction in that they are concerned with a particular site or species, and thus with how it is to be protected. *In many cases (for which I put forward supporting arguments below), it is really not a species or site that we want to protect, but rather a process or a system.* If so, we need to consider which elements are included in this process, and what is needed if the process or system is to operate as intended. The process often includes the physical and chemical environment, one or more species, and the exchange of resources between the process in this area and in other areas.

This is what is often referred to as a more system-related approach. In the context of this report, I am not using the term in the meaning of the branch of ecology that concentrates on energy flows (systems ecology), and which gives the system certain inherent characteristics. Instead, I mean that we need to consider all components that contribute to the process to be protected (or which allow the threatened species to remain in this particular area).

In the example of the Koster fjord in the Skagerrak, the uniquely high diversity of species (for Swedish conditions) is one of the features that we wish to preserve. Most of the species are also found elsewhere in Sweden, but certain of them are found only here: these are mainly species that live at considerable depths and on hard bottoms (Nilsson, 1997b). Put simply: are we to preserve the hard bottoms? This means that we need to keep them free of sediment, as otherwise they would no longer be hard bottoms. However, it can also mean that we need to maintain the existing currents, as it is the currents that supply nutrients. It is also possible that the currents supply larvae (although we do not know this at present), and which if so is just as important to maintain the populations. It is not sufficient just to make sure that the individuals can survive today: we must also make sure that we do not prevent new individuals from arriving.

A particular problem with evaluating marine systems is that we know so little about threatened species in the sea. Being able to refer to one or more threatened species is a concrete reason for designating a protected area. If a species is found only at a particular site, it is simple to explain why just this particular site should be protected. This has the additional benefit of providing other species and natural mechanisms with protection in the shadow of the species concerned, as has occurred in the USA where the acutely threatened spotted owl, *Strix occidentalis*, has been a key species in stopping clear felling of large areas of forest. It is seldom that acutely threatened species in the sea can be identified (which may be due either to the fact that there are few threatened species or to the fact that we are unaware of their statuses), which means that this criterion is generally less important when evaluating marine environments.

A criterion that is extremely important in marine systems is whether the area is an intact system and whether its future is protected by designating it as a protected area. As a result of the sea's openness, many marine protected areas are entirely dependent on processes outside the actual area, to a degree that is considerably greater than for the corresponding terrestrial areas. We need to analyse whether the threats to the value of an area will be reduced by making it a protected area. This also often means that the protected area must be larger than what might, at first sight, appear to be necessary, and it is important to ensure that the public understands this. For the same reason, zoning within marine protected areas is also important. It is also necessary to consider what other measures that might need to be carried out in adjacent areas or on land.

Bearing in mind how important water exchange within marine systems often is, it is essential to ensure that water exchange with a protected area is maintained intact, not only to maintain transport of various substances, but also to ensure that there are no impediments to new recruitment and migration. This is perhaps particularly important when designating small inlets and estuaries based on their high production (nursery areas for fish etc.). A highly productive area in marine systems will affect other areas outside the system. This means that one difference between priority determination of protected areas on land and in the sea is that individual species have lower priorities in the sea, but that habitats with high productivity or diversity have higher priority.

On land, it is often aesthetically attractive areas that are designated (and quite correctly), but this will hardly be common in the case of sea areas, as most people will not be able to see or experience the natural values that have been the reason for designating the marine area. As a result, marine areas will not have the same benefit of aesthetic attraction as land areas frequently have, although there are often aesthetically attractive areas in the environment around the marine protected areas which make them popular as recreational areas. Marine areas will therefore need to be justified by other reasons, e.g. economic or ecological. *There is therefore an even greater need for information on marine protected areas than for protected areas on land.*

On land, protected areas are often somewhat inaccessible, and are of tradition little affected by man. For the same reason, there are fewer conflicts. However, this does not apply for the majority of marine areas: they are generally along the coast and are therefore easily accessible and well used. In actual fact, it is exactly this that makes them worthy of protection, with high production and a diversity of habitats, and which means that they are also intensively used today, often subject to considerable user pressure.

It might be thought that the fact that many sea areas (and particularly those away from the coast) belong to the State would make it easier to establish marine protected areas than to establish nature reserves on land. On the other hand, this general utilisation means that many persons often use marine areas, including their use for such purposes as making their living. There is also a well-established tradition that the use of the seas should be free, as opposed to the use of the land. All this means that although it may be easier initially to set up a marine protected area, it can be more difficult to obtain

social acceptance for it than for a protected area on land. *The criterion that a protected area must be accepted among the local population is therefore particularly important in respect of marine protected areas.*

Summarising, it can be said that many of the criteria described in the section on Swedish and Nordic criteria (page 16) are important for both marine and terrestrial systems. This applies, for example, in respect of:

- Diversity of species, biotopes etc.
- Variation richness of species, biotopes etc.
- Certain priority criteria, e.g. fragility, threats
- Representativity of species, biotopes etc.

Certain criteria are more important for nature conservation on land:

- Naturalness
- Species threatened with extinction
- Unique species
- Relict species
- Cultural relics

Other criteria are more important for marine conservation (or apply only in aquatic environments):

- Feeding areas etc. (from an ecological viewpoint)
- Economic criteria, e.g. feeding areas, breeding areas, nursery areas etc.
- A heterogeneous bottom
- Certain priority criteria, e.g. feasibility.

Complementary criteria and approaches

The size of the area

The SLOSS debate (SLOSS: Single Large Or Several Small) has been in progress in environmental circles for many years (Lomolino, 1994). Its content is that, if only a certain total area can be protected, should this be one large area or several small areas?

The arguments in favour of a single large protected area are primarily that the populations in the area will be large, which reduces the risk of inbreeding and random extinction; that it will include many types of habitat, and thus many species; that the relationship between area and circumference will be large, reducing migration from the area; and that species that are large are also ecological key species, and that they require a large area.

The arguments for several small areas include the ability to preserve more species and habitats per unit area; that they better reflect the natural genetic variation; that many species are dependent on moving between areas; and that there is less risk of a catastrophe wiping out the entire protected area.

Although there is no simple answer that suits all species and all systems, a lesson that can be learnt is that if the purpose of a national (international) system of protected areas is to preserve a representative selection of habitats/ecosystems, then it is likely that they can be protected with the expenditure of the least possible total area if these areas are provided in the form of many small areas, although each individual area must be sufficiently large to ensure that it has a reasonable chance of survival intact. It is also important that the most interesting species (if there are such) should be present in sufficiently large populations to ensure that there is no great risk of them dying out as the result of purely random circumstances. With certain background knowledge of the ecology of the interesting species, there are methods for the calculation of such risks (Burgman et al., 1992).

The size of the area is also important from a system point of view: it needs to be sufficiently large to ensure that the functions of the system are not threatened purely physically by activities outside the area (see, for example, Grumbie, 1994; Nordic Council of Ministers, 1995).

Several areas of the same type?

Is it sufficient to preserve an area of a particular type, if it can be protected from harmful human activities and is "sufficiently" large? This is related to the question concerning the size of a protected area. Over the last 20 years, ecology has tended increasingly to depart from the idea of equilibria and stability in nature, and tended instead to emphasise the variations and randomness (Christenson et al., 1996; Mangel et al., 1996). It is realistic to believe that all areas change and all populations vary. If we preserve an area because of its representativity of a particular type, it will very likely change in due course, so that it is no longer representative of that for which it was originally selected. *The consequence of this is that if we are attempting to designate areas that represent more than just themselves, it is necessary to designate several of each type.*

Should protected areas be assessed individually or in a context?

There are two approaches: we either assess each protected area on the basis of its own values, or we set up a series of protected areas that together optimally fulfil certain objectives.

It should really be this second alternative that is better, but there can be several reasons in practice for why protected areas should be assessed individually:

1. Marine protected areas can be set up only one by one. Under such conditions it is then natural (at least, at first) to select areas that are each the most worthy of their type.
2. Different authorities establish protected areas in different regions. If one county is about to set up its first, and perhaps only, protected area, its authorities will naturally want it to be as valuable and attractive as possible, regardless of what protected areas there may be elsewhere (in other counties).

3. The prime purpose of the area is not to preserve a particular type of nature, but to preserve an attractive area at that particular site, because it is important as a recreational area or due to its biological productivity etc. The area will then have an inherent value, regardless of other protected areas that may have been established.

However, if the objective is to preserve a particular type of nature, habitat, species or ecological functions, there is naturally much that can be won by considering all the protected areas and ensuring that they *together* preserve as much of the natural values as possible. However, this can mean that, when deciding between two areas, the decision may be made in favour of the less attractive or less species-rich area, because a better area of that type of nature has already been designated. After all, different types of nature contain different species and habitats.

There are now computer programs and mathematical methods of producing ranking lists of combinations of areas, based on how they represent the total biodiversity or other values (Pressey et al., 1993). This may seem far too theoretical and unnecessarily complicated when considering only a dozen or few dozen areas throughout the country. However, such methods can be of considerable help to a county council official who is suddenly required to cut down the number of grants for liming lakes from 100 to 25 or who perhaps can provide set-aside grants to only 20 farmers out of 300 applicants. Which of them should be chosen? By selecting a number of characteristics (species, types of habitat or other criteria) and preparing a list of the characteristics that different areas possess, these programs can quickly provide a suggestion for a combination of sites to be chosen (see Turpie 1995, for a practical example of selection of coastal areas).

Criteria based on indices: individual or aggregated

Indices are mathematical distributions that weigh several variables into one value. Examples of indices used in nature conservation are given in Götmark et al. (1986) and in Turpie (1995). This type of criteria is often used when the objective of preservation is purely biological, i.e. to retain as many species or as many types of nature as possible. Indices can then help in the quantification of otherwise difficult concepts such as species richness, biodiversity or

natural variety. This makes things easier for those who are not specialists: if he/she can obtain the necessary data from a specialist, he/she can then perform the analysis. This also removes some element of subjectivity in the analysis: with access to the relevant data, anyone can repeat the analysis.

The drawback is that each and every index naturally represents a simplification of reality. It is also important to understand that each index (each mathematical algorithm) possesses certain characteristics that can produce unexpected results. This means that it is necessary to check and assess the results, which re-introduces an element of subjectivity to the process. Although they are used mostly for assessing criteria for biodiversity and similar parameters, there is nothing to prevent the construction of similar indices for other criteria, such as productivity, aesthetic values, geological values etc.

Several indices require good knowledge of organisms (or types of nature). This means that they can be used only on certain types of organisms, which means that they are generally unrealistic for use in marine systems. Other indices are based on semi-quantitative scales (such as Rare-Common-Dominant), which means that they can be used even in environments of which there is poor knowledge (marine environments).

Pressey and Nicholls (1989) and Turpie (1995) give examples of how different types of indices relate to each other and to iterative methods.

Areas of research that are important for conservation biology

I intend, in this section, to point out areas of current research and debate. It can be expected that these are areas that will affect our view of nature conservation, and thus also result in changes in the criteria we use today.

Metapopulation ecology

Metapopulation ecology is that sector of population ecology that is concerned with analysis of how geographically scattered populations work (Hanski and Gilpin, 1991). Different species have different requirements in respect of how large an area needs to be designated for them, how great the risk of them dying out in a particular area is, etc. It is important to realise that species can die out in an area or become greatly reduced in numbers as a result of natural

causes, and this must be realised when selecting MPAs. If there are several areas with particular characteristics, it can be a good idea to designate several that are not too close to each other, as this reduces the risk of all of them suffering some natural or man-made catastrophe.

Knowledge from metapopulation investigations will presumably change our views of such aspects as how protected areas should be designed (they may, for example, need to be split up into several parts), how large the population should be (how large the protected area needs to be), and perhaps also provide a means of making better forecasts of the development of a population in the future (Burgman et al., 1992).

Critical population size: genetics and demography

What will be the effect of a population size falling below a particular level? There are both genetic and ecological risks associated with populations falling too low (Burgman et al., 1992; Nunney and Campbell, 1993; Soulé, 1987). This can set a limit for how small a marine protected area can be and yet still be meaningful in terms of fulfilling its purpose. Better knowledge of critical population levels is important for such considerations as determining how small a protected area can be and how genetic resources can best be preserved.

Landscape ecology

Another area that can be of importance in determining our views of conservation biology, and in which considerable research is therefore being carried out today, is that of landscape ecology. The aim is to understand how different types of landscapes (types of habitats) affect each other, and how chemical, biological and physical factors interact. One of the new approaches to this is to investigate the spatial distribution of types of nature. The use of geographical information systems (GIS) and computer programs that integrate databases and maps will mean that a landscape ecology approach to nature conservation will become increasingly common.

Landscape ecology will become increasingly important for a number of reasons, including the facts that it is of value when determining large-scale strategies, that it can be a means of finding representative environments and that it is a practical tool that can facilitate the work of decision-makers.

Genetic markers

As I have already mentioned, many important decisions in connection with the protection of biodiversity and conservation biology are dependent on knowledge of the boundaries of populations, migration and genetic exchange or isolation. Within the field of marine biology, there is even less knowledge in this area that there is for terrestrial ecology.

However, new methods in molecular genetics (Avise, 1994) can revolutionise our knowledge of the boundaries between populations and even between species, which is invaluable in helping us to identify what is worth protecting (what is unique?) and to help us decide which protective measures should be applied (which areas are net producers of larvae, which populations are dependent on others?).

Criteria in practice

The importance of the criteria varies with their objectives – not all assessments are equally complex

It is understandable if decision-makers despair when they are faced with lists of relevant criteria for selection. When the Swedish Environmental Protection Agency made its selection of the highest priority areas, it was done through a long and careful process, involving analysis of the areas in respect of all (or most) of the criteria described in the chapter entitled "Swedish and international criteria" (page 15). These areas are also those of which quite a lot is known, which therefore permitted detailed analysis. How can corresponding analyses be made at "lower" levels, e.g. within regions, counties or municipalities? First and foremost, such analyses need a basis of facts, but perhaps also specialist knowledge that may not be available in every case. One of the answers may be that perhaps not all criteria need to be used. On the following pages, I intend to show how decision-makers must assess which criteria are relevant in each individual case. In some cases, it can be valuable if the areas also fulfil other requirements, while in other cases this may be unimportant (or even disadvantageous, if various criteria oppose each other). As I have previously mentioned, it is the objective of protection that determines the criteria that are relevant.

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Example 1

An area is (or can become) a popular bathing, fishing and recreational area. Is there justification for designating it as a marine protected area? What protective/management measures will be needed? What criteria should be used?

1. Naturalness

- **No/negligible exploitation/activity in or in the vicinity of the area with adverse effects on the marine biological values?**

Comments: Absolute naturalness, in the meaning that humans have not made any impact, is not essential in this context. On the contrary, important activities can require intervention (bathing jetties, nature trails, jellyfish nets etc.).

2. Ecological/biogeographical value

- **A large number of plant and animal species, plant and animal communities etc.**
- **Heterogeneous bottom sediment and bottom topography**
- **Substantial variation richness of species, biotopes and ecosystems**
- **Representative species, biotopes and ecosystems**
- **Rare plant and animal species, plant and animal communities, biotopes etc.**
- **Plant and animal species at the limits of their distribution**
- **Relict species**

Comments: Important only if it is these qualities that make the area popular.

3. Research/scientific value

- **Documentation of results from such work as investigations of species or biotopes, or research from earlier years**
- **Regular investigations**
- **Continuous measurements/monitoring programmes**
- **Current research projects**

Comments: Presumably unimportant in this case.

4. International/national significance

- **Included on an international list of areas worthy of protection**
- **Proposed as a possible area for international protection**
- **Forming a link in a series of areas worthy of protection across national boundaries**

Comments: Presumably unimportant in this case.

5. Economic importance

- **Feeding areas/foraging areas**
- **Breeding areas/spawning areas**
- **Nursery areas**
- **Areas of importance for part of the life cycle of one or more species**
- **Biotopes of importance for the prey of particular species**

Comments: Important for the fishing that contributes to making the area popular.

6. Social value

- **Easily accessible, robust and providing a potential through their structure for information on the marine biological values – their marine plant and animal species**

Comments: One of the main reasons for designating the area.

- **The maintenance of traditional fishing**

Comments: Presumably unimportant in this case.

- **The area contains cultural artefacts, e.g. old wrecks**

Comments: Can be important in this case, if it contributes to the popularity of the area.

7. Further considerations (priority criteria)

- **Fragility/vulnerability**

Comments: Important.

- **Threat**

Comments: Important.

- **Feasibility**

Comments: Important.

- **Practicality**

Comments: Important.

Comments:

Only certain of the criteria are important here. It would, of course, be better if the area also was of biogeographical and international importance, but this is not the reason for designating the area. Instead, it is its accessibility and aesthetic values that are important. The threats facing it are those that can threaten its quality as the destination of an outing (commercialisation, litter, water quality) and the attitude of the general public (accessibility, social acceptance). If a number of different areas exist, it will presumably be the feasibility of designating them as MPAs that will be the strongest priority criterion, rather than whether a particular area fulfils a greater number of evaluation criteria. Should the area then be protected at all? Answer: yes, if there is reason to believe that it is under threat today, or that it may be threatened by activities that cannot be prevented by normal local authority or other rules.

Example 2

The region (county?) is intending to designate areas that contain all "typical" marine habitats in order to preserve biodiversity and ecosystem functions within the region.

1. Naturalness

- **No/negligible exploitation/activity in or in the vicinity of the area with adverse effects on the marine biological values?**

Comments: Important in most cases, although certain areas can be affected by human activities without loss of their ecosystem functions. Certain areas may also have been created by human activities (e.g. artificial hard bottoms).

2. Ecological/biographical value

- **A large number of plant and animal species, plant and animal communities etc.**
- **Heterogeneous bottom sediment and bottom topography**
- **Substantial variation richness of species, biotopes and ecosystems**
- **Representative species, biotopes and ecosystems**

- **Rare plant and animal species, plant and animal communities, biotopes etc.**
- **Plant and animal species at the limits of their distribution**
- **Relict species**

COMMENTS: In this case, it is important primarily to retain "typical" biogeographical qualities, rather than rare ones.

3. RESEARCH/SCIENTIFIC VALUE

- **Documentation of results from such work as investigations of species or biotopes, or research from earlier years**
- **Regular investigations**
- **Continuous measurements/monitoring programmes**
- **Current research projects**

COMMENTS: Presumably unimportant in this case.

4. INTERNATIONAL/NATIONAL SIGNIFICANCE

- **Included on an international list of areas worthy of protection**
- **Proposed as a possible area for international protection**
- **Forming a link in a series of areas worthy of protection across national boundaries**

COMMENTS: Presumably unimportant in this case.

5. ECONOMIC IMPORTANCE

- **Feeding areas / foraging areas**
- **Breeding areas / spawning areas**
- **Nursery areas**
- **Areas of importance for part of the life cycle of one or more species**
- **Biotopes of importance for the prey of particular species**

COMMENTS: Not important in this case, but can be indirectly important if the objective of protecting the habitat types is to ensure that economic functions remain available in the future.

6. SOCIAL VALUE

- **Easily accessible, robust and providing a potential through their structure for information on the marine biological values – their marine plant and animal species**

- **The maintenance of traditional fishing**
- **The area contains cultural artefacts, e.g. old wrecks**

COMMENTS: Not important in this case.

7. FURTHER CONSIDERATIONS (PRIORITY CRITERIA)

- **Fragility/vulnerability**

COMMENTS: Important.

- **Threat**

COMMENTS: Important. Destructive activities may not occur to the degree that there is a risk of changing the area so much that it no longer represents a particular type of nature.

- **Feasibility**

COMMENTS: Important, particularly if local communities are affected by creation of the MPA. As in most cases, protection from destructive activities is probably dependent on social acceptance.

- **Practicality**

COMMENTS: Important.

COMMENTS:

The criteria that are important here are very different from the case of the recreation area. There is, of course, some overlap, mainly in respect of the criteria relating to practical implementation, which is hardly surprising: it is difficult to think of a case for which practical implementation would not be an important consideration. However, if an area really was unique (in this case, the only one of its kind remaining), the practical difficulties would carry less weight in deciding whether or not to create a protected area: there would be no alternative.

In this case, the process of determining priorities is presumably more difficult than the process of evaluation. An important question is also that of how many areas of each habitat type are to be preserved. However, this is an archetypical example of a conservation objective where the value of an area depends both on its inherent value and on other areas.

Recommendations

The real problems for the decision-maker presumably do not arise when the objective of protection is recreation or other social/economic objectives. In such cases, it is primarily implementation aspects (together with threats, existing protection etc.) that determine the ranking of evaluation and priority criteria. The more difficult criteria are presumably those that are related to more classical environmental considerations: unique environments, species etc. and/or representativity.

How do we know if an area is unique? First of all, of course, it will depend on the level to be assessed: whether it is unique for the county, unique for the country or what? In the best cases, there will be biological or geological surveys that can provide guidance. Topographical maps can also help: are there areas of geological/topographical/physical features (depth, currents etc.) that indicate that they might contain uncommon types of nature? It does not necessarily have to be a particularly marked feature that is sought (the largest cliff, the greatest depth, the longest beach etc.): it can be just as important to look for diversity of areas, such as varying topography or many different types of nature within a certain area.

How do we know if the area is representative? The greatest difficulty is to know which types of nature need to be represented. The Environmental Protection Agency is drafting a proposal for a system for classification of biotopes, as are several international programmes, e.g. within the European Union. Hopefully, this system will provide considerable help: each county (or other unit) should then prepare an (outline?) survey of the incidence of biotope types within its jurisdiction. This should be done using the methods at present being developed by the Agency. The results of these surveys will provide a map of the incidence of various habitats. How can a representative selection then be made in the most effective manner? One way of simplifying the work for the person concerned is to present the results of the surveys in the form of a Geographical Informations System database.

Practical methods of working are:

1. To give priority to connected areas that contain several habitat types. Habitat types are often dependent on each other, so the protection of adjacent habitats improves the chances of protecting a continuous system of biological functions.
2. To give priority to areas where there are threats to adjacent areas, in order to form a kind of buffer zone around the protected area.
3. To attempt to find several areas for each type of habitat. This is facilitated by looking for areas that contain several types of habitats (Item 1 above). The designation of several areas provides a way of spreading the risk of random or other events that might threaten the survival of a single area.
4. Distribute the areas over a large area, i.e. do not put too many different areas close to each other for the same reason as mentioned in Item 3, spreading the risk. On the other hand, we should avoid areas that are excessively isolated from other similar areas, as the exchange of individuals or resources between areas is characteristic for many marine systems and species. For the same reason, avoid areas that may be isolated as the result of human activities.

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REPORT 4834

Criteria for the selection of marine protected areas

– an analysis

THE OBJECTIVE OF THIS REPORT is to summarise and analyse the criteria used in Sweden for determining whether marine areas are worthy of protection, to compare Swedish systems of criteria with internationally employed systems of criteria and to indicate alternatives or additional ways of selecting marine protected areas.

ISBN 91-620-4834-1
ISSN 0282-7298

NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY