NATUR VÅRDS VERKET

Good acoustic environment...

... more than just freedom from noise

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Preface

This report is a summing up of several reports about acoustic quality in natural and cultural environments. In this report we present a proposal for definitions relating to environmental objectives and acoustic quality. In addition, we present a proposal for an inventory method for use in surveying and assessing the quality of acoustic environments. The work was carried out in cooperation with several authorities and government agencies.

Contents

PREFACE 3

CONTENTS 5

1. BASIC PRINCIPLES IN ACOUSTIC QUALITY 7
The acoustic environment affects our 7
experience 7
Silence – not always a good acoustic 8
environment 8
The significance of nature and the cultural 8
environment 8
Different claims and expectations 9

2. HOW DOES THE ACOUSTIC ENVIRONMENT AFFECT NATURAL AND CULTURAL ENVIRONMENTS? **10**

3. REQUIREMENTS FOR INDICATORS AND INVENTORY METHOD **11**
Indicators usable in practice 11
Noise sources 11
Assessing the acoustic quality of an area 12

4. PROPOSALS FOR QUALITY LEVEL **13**

5. INDICATORS AND MEASURED VALUES **14**
Proposals for indicators 14
Proposals for measured values 14
Noise class A 14
Noise class B 14
Noise class C 15
Noise class D 15
Noise class E 15
Proposals for requirements for freedom from noise in different areas 15
Areas without any community noise 15
Areas with limited occurrence of community noise 15
Outdoor activity areas 16
Recreational areas close to conurbations 16
Parks 16

6. PROPOSALS FOR INVENTORY METHOD **17**

Stages of work 18
a) Criteria for choice of areas 18
b) Identification of the area(s) to be described 19
c) Which sounds “belong” in the area? 20
d) What indicators and measured values are relevant to the area? 20
e) Selection of the noise sources expected to be most widespread 21
f) Overall calculation of the propagation of the noise sources 21
g) Supplementing with other relevant noise sources 21
h) Supplementing with more detailed calculations where necessary 22
i) Presentation of the results with suitable degree of detail 22
Reports in the cooperation project 23

1. Basic principles in acoustic quality

The acoustic environment is an important aspect of quality in the experience of the natural and cultural environment. At the same time, freedom from noise is becoming increasingly rare. The need for "freedom from noise" is increasing for many people. It is becoming ever clearer that noise is a major health problem. Now a coordination group has developed definitions of environmental objectives and acoustic quality in natural and cultural environments, with indicators and measured values. It has also drawn up a proposal for an inventory method to survey and assess the quality of acoustic environments.

The Swedish Environmental Protection Agency and the National Road Administration have been involved in administering the project. The work has been carried out in two phases.

In the first phase the coordination group comprised representatives of Banverket, the National Board of Housing, Building and Planning, the Swedish Armed Forces, the Swedish Civil Aviation Authority, the Västra Götaland County Administrative Board, the Swedish Environmental Protection Agency, the National Heritage Board, the National Maritime Administration, the City of Stockholm and the National Road Administration.

In the second phase the coordination group has comprised representatives of Banverket, the Swedish Armed Forces, the Swedish Civil Aviation Authority, the Stockholm County Administrative Board, the Swedish Environmental Protection Agency, the Municipality of Nynäshamn, the City of Stockholm, the Office of Regional Planning and Urban Transportation of Stockholm County Council and the National Road Administration.

The acoustic environment affects our experience

Noise – unwanted sound – is becoming an increasingly widespread problem. We seek quiet in our leisure time, away from our noisy everyday environment. Walks in the forests, picking berries and mushrooms, hunting and fishing, skiing, swimming and boating - silence is an important part of the experience. Many sounds "form part" of the experience. Birdsong, the rustle of leaves, skis cutting through the crust of snow and the many different sounds of water enrich our stay in the countryside.

The acoustic environment can affect us without us being aware of it. We can become stressed and suffer high blood pressure because of noise, without the noise bothering us. The acoustic environment is therefore emphasised in the Swedish Government's environmental quality objectives. What would "Flourishing Coastal Areas and Archipelagos", "A Magnificent Mountain Landscape" or "Flourishing Lakes and Streams" be without the screech of gulls, the babbling of streams or the crashing of waves?

But if it is to be possible to deal with acoustic environments in planning, there is a need for specific definitions in order to identify areas and assess their quality. This definition is also needed so that goals can be set and measures planned and implemented to improve acoustic quality.

Silence – not always a good acoustic environment

Absolute silence is not always the best acoustic environment. In an acoustic laboratory we may experience a very low level of sound, but then the body's own sounds become almost terrifying. We hear our heart beat and our blood coursing through our arteries and veins. The quietest situation we can experience in nature is a winter's day with no wind, far away from buildings and roads. There the level of sound can approach the situation in a laboratory. But we like to hear nature's own sounds, the babbling of streams, the rustling of leaves or the dripping of melting snow. Nor is silence the only thing we look for in nature. If an area is to be attractive, it has to be able to offer something more than just silence. This "something more" is often associated with sound. The ski lift, the snow guns, the piste grooming machine and skiers mean that we hear that we are on a ski slope and can enhance the experience for the downhill skier. When we go walking in the mountains, we like to pitch camp alongside water, so that we can hear the quiet murmur of the mountain stream or the splashing of the waves on the shore of the lake.

The significance of nature and the cultural environment

Nature provides opportunities to unwind from our everyday lives. Nature can be a source of information and experiences that can influence our everyday habits. In nature people can learn to fend for themselves and control their existence. It is considered to develop self-esteem, independence and benefit mental health. But noise can destroy the opportunities nature presents. The significance of nature and the cultural environment for humans is in many respects identical. Nature often plays an important role as a symbol of cultural assets. Particular areas may also be important to local or even national identify and symbolise a glorious past or a future filled with hope. The cultural heritage and cultural assets in the countryside represent identity, quality and tradition. They are important factors in bringing about a good environment in which to live and for people's attachment to their home district.

Different claims and expectations

We generally make do with utilising nature and culture close to where we live. It is therefore important that the recreational areas that exist close to built-up areas are preserved and developed. But often areas close to where people live are the ones that are most under threat. The small, heavily used patches of green in or near residential areas tend to be developed in various ways.

What is experienced as an acceptable acoustic environment in a recreational area is greatly influenced by the type of area concerned and people's expectations. In parks and nearby areas, we do not expect complete freedom from community noise. If we venture further afield, we often do so precisely in order to find a quieter environment.

There must therefore be different degrees of silence. Someone who goes to the trouble of travelling a long way to experience silence must also be able to rely on escaping unwanted sound.

A particular problem is that noise is often heard most clearly when it bothers people most. On clear, calm days sound travels far. Noise is propagated many times further over water than over land. Noise is therefore often loudest on the shoreline, which is also the place that is most appealing to visitors.

2. How does the acoustic environment affect natural and cultural environments?

It is likely that the experience of nature is affected more by an increase in sound level in the low sound level ranges than for example the experience of disturbance from community noise in a residential area. We have looked at existing studies of noise and the experience of sound in natural areas, national parks etc. in places such as the United States, New Zealand and Norway. However, in most studies there is insufficient information to allow conclusions to be drawn on quantitative dose-response relationships.

Some studies show that there are strong correlations between physical sound level indicators (LAeq, LDEN) and reported disturbance. But other studies show that it is of no significance for how long, how many times or how loudly the sound is heard. There are also differences in how various types of noise sources are assessed from the point of view of disturbance and how legitimate various activities/noise sources are perceived as being (e.g. air ambulances).

Some of the studies show that the degree of disturbance with the same dose indicator can vary greatly between different places in the natural environment. Visitors who venture further away from car parks demand greater quiet. People who spend time outdoors have stricter requirements for natural silence in national parks and areas of nature.

The coordination group carried out four different studies in 2004 to increase knowledge on the link between sound level and experience.

The reports are on the Swedish EPA website, www.naturvardsverket.se. Search on “Ljudkvalitet” (“Acoustic Quality”). Also available on that site are the report from 2002, a summary of the four studies and a review of indicators, measured values and inventory method.

It has, for the most part, not been studied how experienced assets in cultural environments are affected by the acoustic environment. But it is likely that noise reduces the value of the experience for many people. For cultural environments it is a matter of finding the right balance between desirable and unwanted sound.

We do not know of any studies that shed light on the effect of noise on the ecology of an area in isolation. We know that numbers of certain bird species are reduced when a road is driven through an area previously unaffected. But it is unclear to what extent this is due to increased noise.

3. Requirements for indicators and inventory method

Indicators of sound/noise and inventory method are required in order to be able to determine the qualities of an area with regard to acoustic environment and noise. The qualities can describe the existing situation or express targets, and also describe what measures need to be taken to attain these targets.

- Basis in municipal comprehensive planning – reporting acoustic qualities in different areas and thus also being able to utilise and develop the areas more actively.
- Indicators of sound/noise put into practical form important parts of the Swedish Government's environmental objectives "A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos", "A Magnificent Mountain Environment", "Flourishing Lakes and Streams" and "A Good Built Environment". The indicators are also necessary in order to be able to determine interim targets for natural and cultural environments in transport-policy objectives.
- Indicators and an inventory method for sound and noise and natural and cultural environments are required in the planning of infrastructure and activities that produce noise.

Indicators usable in practice

The methods used to describe the noise situation in natural areas and areas used for recreation vary with level of aspiration, purpose and type of area. But it is important to agree now on joint, national indicators and inventory methods, for comparisons and to facilitate development.

The indicators and methods must be easy to understand, carry out, communicate and use in the various contexts that may come into question. It is also important to have physical indicators closely linked to disturbance. Indicators of disturbance are often difficult to manage and necessitate extensive data gathering.

Noise sources

The following noise sources can be described in relatively great detail, as they are quite common and often cause disturbance in natural and cultural environments and areas used for recreation.

- Road traffic
- Rail traffic
- Air traffic (airports)
- Shipping and boating
- Cross-country vehicles
- Firing ranges and shooting galleries
- Industrial activity
- Motor sport
- Wind power

When surveying the noise situation in an area, consideration should also be given to what other noise sources may affect the acoustic quality of the area. The following list can serve as a checklist. Other noise sources may also occur in a specific area.

- Overflying aircraft
- Agricultural machinery, hay driers etc.
- Forestry machinery
- Building and construction activity
- Quarrying
- Piste grooming machines, snow guns
- Other machinery
- Horticultural machinery

Assessing the acoustic quality of an area

Good acoustic quality in an area means that the impact of desirable sounds outweighs the impact of noise.

The acoustic qualities of an area can be estimated by describing the impact of the sound. It may be a deliberate impact, such as acoustic experiences of pleasant sound, or disturbance from noise. It may be a case of an unconscious impact, for example enhanced or impaired performance or increased or reduced stress, blood pressure or risk of disease. If acoustic disturbance is only studied using interviews, this means that positive sounds are not considered and that unconscious disturbances do not emerge. If impacts as a whole are to be covered, conscious and unconscious positive and negative impact must be studied together.
A fundamental way of assessing acoustic quality for an area on the basis of the reasoning described may be to:

- determine the occurrence and audibility of different sounds of significance in the environment under consideration for impact in the total acoustic picture (acoustic landscape).
- determine which sounds are experienced as positive. Estimate the conscious impact of the sound and try to also include unconscious impact.
- determine which sounds are experienced as negative. Estimate the conscious impact of the sound and try to also include unconscious impact.
- assess the overall acoustic quality by weighing together the impacts of positive and negative sounds. Classify the quality on some scale, which includes at least the grade of “good quality”.

A threshold for good acoustic quality may be a certain degree of freedom from noise. This means that only the third of the items above is considered and the implication is that a sufficient positive impact of desirable sounds means that the overall acoustic quality is good. Note that the greater the freedom from noise is, the more desirable sounds can be heard. This state of affairs means that freedom from noise is the most important requirement to be met for good acoustic quality.

4. Proposals for quality level

When we discuss what freedom from disturbance (good acoustic quality) is with regard to sound levels in natural and cultural environments and areas used for recreation, we should bear in mind that:

- the acoustic environment is one of several qualities in an area. The description of the various qualities should make it possible to relate them to one another. Good quality for the acoustic environment should be at a level that is reasonable in relation to "good quality" with respect to other quality aspects.
- good quality for the acoustic environment should be based on those who spend time in the area not being disturbed. The same degree of disturbance should provide the same level of quality for different environments and types of noise, situations and affected category of people during the time they are in the area.
- a certain proportion of people disturbed should be accepted even at the quality level of good acoustic quality.

A limit for freedom from noise should be specified so that a recreational environment can be regarded as sufficiently free from noise to attain good acoustic quality.

For the time being we propose that in a good acoustic environment at least 80% of visitors in an area should feel after their visit that they have experienced a good acoustic environment, although this limit can be discussed.

5. Indicators and measured values

We wish to try to find some indicator in the form of a physical sound level that can be used to indicate expected experience of disturbance in various types of environments. The experience of noise is strongly tinged by expectations and attitude to the noise source. If it is felt that it is ill-mannered behaviour or something that is of no benefit that it is behind the noise, people are also more bothered by it. If the noise source can be associated with a benefit to the area, people are less bothered by it. Often, however, a person exposed to the noise finds it difficult to judge whether the noise is "useful" or not.

Indicators and measured values for noise must be adapted to the circumstances in the area and to the expectations people who use the area have. The actual quality aspect is the experience of disturbance among visitors. But a problem in only studying experience among those who visit the area is that people with strict demands for freedom from noise do not return to an area they find to be too noisy. Another problem is that it is difficult to measure the experience of disturbance.

Proposals for indicators

The indicator for freedom from noise is a sound level at which the sound can be considered to start to become disturbing and the length of time for which disturbing sound levels can be accepted.

This indicator is a combination of instantaneous sound level and the time during which the instantaneous sound level exceeds the threshold value for the noise class concerned. In the quietest classes all audible community noise is judged to be disturbing and the threshold value is therefore low. In the less quiet classes the expectations of complete freedom from noise are not so great and the threshold value has therefore been set higher.

Proposals for measured values

Noise class A

It is proposed that the threshold value for freedom from noise should be 25 dB A (A-weighted instantaneous sound level). At this low level we are far from the potential sound sources, and each noise event lasts 2-3 minutes. The exceeding time should be limited to no more than 5 minutes per week (1-2 noise events).

Noise class B

It is proposed that the threshold value for freedom from noise should be 35 dB A (A-weighted instantaneous sound level). At this low level we are far from the potential sound sources, and each noise event lasts 1-2 minutes. The exceeding time should be limited to no more than 5 minutes per day (3-4 noise events).

Noise class C

It is proposed that the threshold value for freedom from noise should be 45 dB A (A-weighted instantaneous sound level). At this low level we are closer to the potential sound sources, and each noise event lasts 30-60 seconds. The exceeding time should be limited to no more than 1 hour per day (6 am – 10 pm; 60-120 noise events).

Noise class D

It is proposed that the threshold value for freedom from noise is 45 dB A (A-weighted instantaneous sound level). At this low level we are closer to the potential sound sources, and each noise event lasts 30-60 seconds. Exceeding time should be limited to no more than 2 hours per day (6 am – 10 pm; 120-240 noise events).

Noise class E

In noise class E we approach a noise level where the noise events are so frequent that it is no longer meaningful to distinguish individual noise events. For noise class E we therefore propose use of the equivalent sound level. An equivalent sound level of 45-50 dBA, or 10-20 dBA lower than the surroundings, means that noise class E is fulfilled provided the maximum sound levels are not too high or do not occur too often.

Proposals for requirements for freedom from noise in different areas

Areas without any community noise

Such areas may be the more inaccessible parts of the mountains, certain areas of the archipelago, quiet national parks and perhaps some other areas of forest outside the mountain chain.

At least 80 per cent of those who visit the area are to feel after their visit that they have not been disturbed by noise. Visits may often last several days, and quite a few people are disturbed if they hear any noise at all. This means that audible community noise should occur no more than once or twice per week. The distance from major roads and railway lines should therefore be at least 4 km. Our assessment is that noise class A provides sufficiently good acoustic quality in these areas.

Areas with limited occurrence of community noise

Areas with limited occurrence of community noise may be the more easily accessible parts of the mountain chain, areas of the archipelago and larger areas of forest with high recreational assets far from major towns and cities.

At least 80 per cent of those who visit the area are to feel after their visit that they have not been disturbed by noise. Visits may often last one to two days, and quite a few people are disturbed if they hear any perceptible noise. This means that audible community noise should occur no more than once or twice per day. The distance from major roads and railway lines should therefore be at least 2 km. Our

assessment is that noise class B provides sufficiently good acoustic quality in these areas.

Outdoor activity areas

Outdoor activity areas with high natural and cultural assets at a reasonable distance from major towns and cities are used for recreation and outdoor activities mostly on day trips at weekends. At least 80 per cent of those who visit the area are to feel after their visit that they have not been disturbed by noise.

Disturbing community noise should occur no more than a few times per hour. This means that the distance from major roads and railway lines should be at least 1 km. But on still days it is possible at this distance to hear the hum from major roads for most the day. Our assessment is that noise class C provides sufficiently good acoustic quality in these areas.

Recreational areas close to conurbations

Recreational areas close to conurbations are open spaces within walking or cycling distance of major conurbations. These areas are used for recreation and outdoor activities both during weekends and in the afternoon and evening. These areas are also used in daytime on weekdays, for instance by schools. At least 80 per cent of those who visit the area are to feel after their visit that they have not been disturbed by noise.

In recreational areas close to conurbations it should be possible to accept that audible community noise occurs during a large part of the time. Distance from major roads and railways should be at least 0.5 km for a good acoustic environment to be experienced. Our assessment is that noise class D provides sufficiently good acoustic quality in these areas.

Parks

What a good acoustic environment is in a park depends greatly on how noisy the surrounding town is. Our assessment is that noise class E provides sufficient freedom from noise for parks.

6. Proposals for inventory method

An inventory of noise-free areas should aim to survey the acoustic environment as one of several qualities in the areas studied. Areas with natural, cultural or recreational assets are often more valuable if they are, in addition reasonably free of noise. An area with moderate other assets may be of value if it is free from noise. An area of high other assets, on the other hand, is still of value if it is noisy. An inventory should therefore be initiated by a discussion on the purpose of the inventory and what the inventory is actually to cover.
Three principal motives behind a noise inventory may be:

- General planning material to describe what acoustic environments prevail in a municipality or county.
- Part of a description of the qualities in a particular area, as material on which to base decisions on how the area is to be developed/used.
- As part of the impact assessment for a specific development project (road, railway, industry etc.) to clarify the extent to which the project affects the acoustic environment in nearby areas.

Determining which sounds "belong" to the area and which sounds are alien to it represents an important part of the inventory work. The assessment must be based on the area's specific features and how it is used or has the potential to be used. This means that the description of the area should also include an assessment of the acoustic environment.

The actual inventory work should be initiated by utilising the knowledge that already exists. There is generally good knowledge in municipalities, the county administrative board and various organisations on areas that have good qualities and the noise situation in the areas, at least at a broad level. The Association for the Promotion of Outdoor Life, the Swedish Society for Nature Conservation, the Scouts and orienteering clubs may be among the organisations that have knowledge of natural and cultural environments with more or less good acoustic conditions.

The inventory can usefully be carried out in stages. Areas that are affected by "large" noise sources, such as major roads, airports and railways, are first identified. It is then studied how other areas are affected by "small" noise sources. One way to find possible, otherwise unknown noise sources is to study night-time photographs of the area concerned. Where there is light it may be suspected that there is also noise.

The inventory should generally be presented on a map. It is advantageous if the reporting can be done using GIS tools. That makes it easier to use it in other planning contexts.

Stages of work

a) The method contains nine stages:
b) criteria for selection of areas
c) identification of the area(s) to be described
d) discussion of what sounds “belong, do not belong” in the area
e) discussion of what indicators and measured values are relevant for the area
f) selection of the noise sources expected to have the greatest propagation
g) overall calculation of the propagation of the noise sources
h) supplementation with other relevant noise sources
i) supplementation with more detailed calculations and measurements if required
j) presentation of the results with suitable degree of detail

These steps are sufficient to describe the condition of an area. To find the areas that are free of noise today, it is sufficient to conduct an inventory of “minor” noise sources solely in the areas not already covered by “major” noise sources and an inventory of which has been made earlier in the model.

But it is sometimes of interest to know what happens if a “major” noise source is removed, as all the noise sources in the whole area then have to be counted on. It may sometimes be of interest to study combinations of different noise sources. These in-depth examinations are required in goal formulation and in the planning of measures relating to noise.

A calculation model should be used that contains a frequency-dependent attenuation factor. This must make it possible to calculate noise propagation over long distances and under different weather conditions, for example NORD 2000.

a) Criteria for choice of areas

An inventory should be initiated by a discussion on the purpose of the inventory and what the inventory is actually to cover. It is then determined what areas it is relevant to cover in an inventory.

If the purpose is to draw up general planning documentation to report noise conditions in the municipality or county, it may be appropriate for the inventory to cover the whole of the geographical area, or perhaps those parts of the area that are not densely populated. But it may also be wise, for general planning material, to limit the inventory to the areas which in other contexts have been identified as valuable in some respect (natural environment, cultural environment, recreational environment or other).

The areas identified as of value to the natural environment, cultural environment or recreation should also be assessed with respect to acoustic environment. A description of all the qualities in areas of value may be useful as a basis for decisions on how the areas are to be developed and utilised.

If there is no description of the acoustic environment in different areas, it may be necessary in specific planning cases to conduct an inventory. As part of the

impact assessment for a specific project (road, railway, industry etc.) it may be necessary to clarify the extent to which the project affects acoustic environments of value. Looking only at the areas directly affected by the relevant location alternatives may, however, be too limited. In order to be able to assess the consequences of a previously noise-free area being exposed to noise, it may be necessary to know whether there are other areas that have qualities such that they can, to some extent, replace the area affected. But there should be an awareness of the risk of carrying out an inventory for its own sake. Before deciding to conduct an inventory of noise-free areas, the purpose and benefit of the inventory should be clearly assessed. A comparison should also be made of what it costs to carry it out. Here too only those areas that have other qualities from the point of view of the natural or cultural environment and where it is judged that the acoustic environment is important should be the subject of inventory.

b) Identification of the area(s) to be described

When the criteria for the selection of area(s) have been determined, the areas that are concerned in practice are identified. It may be wise not to narrow them down too much. Studying a larger area from the start generally entails moderate extra work.

GENERAL PLANNING MATERIAL

As general planning material in the municipality or county, it is valuable to know which sound sources affect different areas. That makes it easier to avoid problems with new noise sources. In order not to need to conduct an inventory of the geographical area, it is possible to confine oneself to:

- areas that are not densely populated
- areas that are not affected by major noise sources, such as roads or railways
- areas where changes are planned
- areas within a certain distance of major conurbations
- areas where acoustic conditions are unclear and difficult to assess
- areas identified in nature, culture, leisure or other inventories

DESCRIPTION OF SPECIAL AREAS

If a general inventory is restricted to the areas identified as valuable to the natural environment, cultural environment or recreation, it is of the second main type. To obtain planning material concerning how valuable areas are to be preserved, developed and utilised, it is important to know about the areas' other qualities, including the acoustic environment. Choose areas that are threatened for example by new noise sources. Some form of plan can be drawn up for the areas or their qualities can be developed to make them more attractive and usable. Another motive may be to inform the population of the municipality or other potential visitors about the acoustic quality of an area.

DESCRIPTION OF SPECIFIC PROJECT

In connection with development projects (roads, railways, wind power installations etc.), the noise impact on residential environments and possibly also designated recreational areas are generally calculated and reported. On the other hand, the total effect of a project on the acoustic environments in the surrounding countryside is rarely reported. Our acoustic environment has therefore increasingly been filled up with unwanted sound. There may therefore be reason to make the noise descriptions in development projects more comprehensive and not just to describe the propagation of equivalent sound levels down to different measured values for good acoustic quality. Note, however, as stated under stage 1 above, that thought should be given to how much is to be covered by an inventory.

c) Which sounds "belong" in the area?

Which sounds "belong" or "do not belong" in an area depends on the historical background of the area, present-day circumstances and how it is used. There are usually also several different groups of people who make use of the area in different ways. Conflicts between snowmobile users and skiers are just one example of sound that "belongs" for some uses being noise for others.

In natural environments most visits consider all forms of engine sounds to be undesirable. Nature's own sounds, on the other hand, are positive and enrich the acoustic environment. Some "social sounds", such as human voices and the barking of dogs, are sometimes experienced as positive, sometimes as negative. Other social sounds, such as mobile phones or music from portable players, are usually experienced as negative.

In cultural environments it is more obvious that some sounds belong to the area. In agricultural areas sound is expected from livestock and agricultural machinery. In a fishing village the chug of a fishing vessel is regarded as a pleasant sound. A good acoustic environment is about striking the right balance between desirable and undesirable sounds. If the undesirable sounds mask the sounds one wishes to hear, the disturbance is doubled. But if the desirable sounds are loud, the acoustic environment "tolerates" a large amount of undesirable sound without disturbance.

d) What indicators and measured values are relevant to the area?

No general measured values for acoustic quality in natural and cultural environments and recreational areas have been established. On the other hand, we have presented five noise classes judged to give such freedom from noise that good acoustic quality could be attained in different types of areas. The measured values for freedom from noise for the five noise classes are indicated firstly as a sound level at which the sound can be considered to start to become disturbing and secondly as the length of time for which disturbing sound levels can be accepted. The measured values are adapted to the special circumstances of different areas and the expectations of freedom from noise that visitors may be assumed to have.

e) Selection of the noise sources expected to be most widespread

Start with the noise sources expected to have the greatest effect. These are often major roads and railway lines and airports. Select the noise sources in stages, by first selecting the ones thought to be most important and make a standard assessment of their areas of influence. Then make the more definitive selection and proceed to stage 6. But if the aggregate effect of several noise sources is to be assessed, or if a basis is to be obtained on which to assess how the acoustic environment can be improved if one or more noise sources is eliminated, all relevant noise sources for each part of the area studied must be considered.

f) Overall calculation of the propagation of the noise sources

In stage 6 the propagation of sound from the sound sources judged to be most important is calculated in turn. The sound levels near the noise source are calculated and a broad description is then given of how the noise is propagated before it has fallen to the level established as relevant in stage 4. It is therefore not necessary to take account of screening conditions, reflections or other factors that affect noise propagation, but when noise is propagated long distances over water there may be justification for differentiating between this and propagation over land. In hilly areas it may also be reasonable to take account of large-scale screening.

A method of calculation should be used that enables calculations to be made at varying values of ground attenuation. It is generally sufficient to distinguish between land and water. If there are large hard-surfaced areas (gravel, asphalt or similar material), there may be justification for taking account of this.

Consideration should also be given to how to take account of meteorological conditions. As the aim is to describe acoustic quality at times when the area is most heavily visited, the weather conditions that can be assumed to prevail at these times should be taken as a basis. This means that the calculations should be made when there is no wind or a slight following wind. If the calculations relate to winter conditions, there may be justification for including inversion, that it is to say when the air is coldest closest to the ground and warmer further up.

g) Supplementing with other relevant noise sources

In those areas that are still “noise-free” after the largest noise sources have been clarified, continue with other relevant noise sources. There may also be a need to calculate the total impact of several noise sources in the areas near to the limit of “freedom from noise” to check that taken together they do not become too large. This applies in particular in areas where the limit for freedom from noise is relatively high.

Certain noise sources that are relevant vary between different areas. Common noise sources are minor roads, recreational craft, sea scooters and snowmobiles, shipping, aviation, wind power generators, firing ranges, industrial plans and motor sport race tracks. An attempt should sometimes also be made to take account of social sound sources such mobile phones, barking dogs, portable music systems and voices.

Road traffic can be counted relatively easily by automatic methods. This means that it should be possible to obtain data for noise calculations for roads. Boat traffic is more difficult to count. There are some data on traffic levels for commercial shipping. Small recreational craft are also counted at locks. Figures for the number of berths, visitors' moorings etc. can give some indication of the volume of boat traffic. To obtain reliable data it is necessary to count manually at the place of interest.

It is also difficult to obtain input data for air traffic. Information is stored on virtually every aircraft movement, times, aircraft types, altitudes etc. It is also possible to obtain figures at airports on the number of take-offs and landings, and to some extent on flight directions. But it is difficult to describe the flight activity as a basis for a survey of noise without detailed analysis that is heavy on resources. Here too it is necessary to resort to manual counts to obtain reliable input data.

How accurate one has to be with input data depends on the purpose of the calculation. Caution should be exercised with costly inventories of input data if it is not extremely important to obtain accurate calculations. Standard assumptions are often adequate.

h) Supplementing with more detailed calculations where necessary

In some cases more detailed calculations are required to obtain a sufficiently good description of noise conditions in an area. This may apply to parts of the area just outside the disturbance zone for several other noise sources, see above. It may be necessary to think about this if interaction between different noise sources may mean that the area is disturbed. This may apply to parts of the area that are particularly sensitive in some respect, and where it is therefore important to know the noise situation particularly well. It may also apply to parts of the area where rough calculation may lead to particularly great errors. There may for example be justification for taking account of long and deep cuttings or long and high banks for roads and railway lines.

i) Presentation of the results with suitable degree of detail

It is important that the results of the inventory are not presented in too much detail. The accuracy of the calculations should generally not allow a disturbance-free distance to be determined with a greater precision than a few hundred metres. This inaccuracy should be reported, and the circumstances on which the calculations are based should also be clarified. Calculations should usually be done with meteorological conditions that mean that the sound is dispersed far. This means that during most of the year it is quieter than the calculations indicate. But it is often precisely when the noise is most audible that the conditions are such that many people visit the area (clear and still days, in both summer and winter).

The results should be presented on a map and preferably be available in GIS format. That makes it easier to use them in other planning.

Reports in the cooperation project

The coordination group carried out several different studies to increase knowledge on the link between sound level and experiences. The cooperation project resulted in the following reports:

- Ljudkvalitet i natur- och kulturmiljöer. Förslag till mått, mätetal och inventeringsmetod (Acoustic quality in natural and cultural environments. Proposals for indicators, measured vales and inventory method) (Report 5439),
- Ljudkvalitet i natur- och kulturmiljöer, Utvärdering och utveckling av mått, mätetal och inventeringsmetod (Acoustic quality in natural and cultural environments. Evaluation and development of indicators, measured vales and inventory method) (Report 5440),
- Stockholms tysta gröna områden – ljudnivåer och inventering (Stockholm's quiet open spaces – sound levels and inventory) (Report 5441),
- Upplevd ljudmiljö i stadsnära grönområden och stadsparker (Experienced acoustic environment in open spaces near towns and town and city parks) (Report 5442),
- Djupintervjuer om ljudmiljöer i tätortsnära naturområden (In-depth interviews on acoustic environments in natural areas close to conurbations) (Report 5443),
- Kartläggning av bullerfria områden inom Nynäshamns kommun (Survey of noise-free areas in the municipality of Nynäshamn) (Report 5444), and
- Kompletterande kartläggning av bullerfria områden inom Nynäshamns kommun (Supplementary survey of noise-free areas in the municipality of Nynäshamn) (Report 5620).

The reports can be downloaded from the Swedish EPA website, www.naturvardsverket.se, or can be purchased form the Swedish EPA literature service.

Good acoustic environment...

... more than just freedom from noise

REPORT 5708

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In this report we present a proposal for definitions relating to environmental objectives and acoustic quality in natural and cultural environments. In addition, we present a proposal for an inventory method for use in surveying and assessing the quality of acoustic environments.

The report is a summing up of several reports from a unique project carried out in cooperation with several authorities and government agencies.

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