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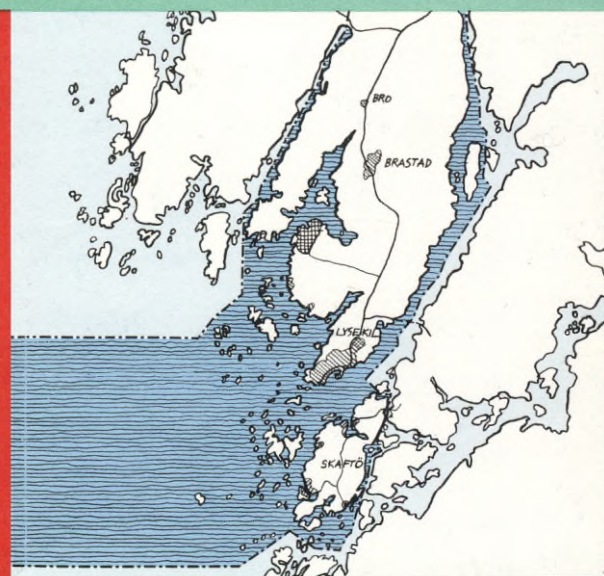
# Coastal Area Management in Sweden

Report on comprehensive  
coastal planning in the  
Municipality of Lysekil

prepared by  
Lars Johansson

June 1995

SWEDMAR Reports 1/95



Swedish Environmental  
Protection Agency



**SWEDMAR**

*A unit within the National  
Board of Fisheries*



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## **PREFACE**

This report has been prepared as a background document for the environmental cooperation around the Baltic Sea. The report focuses on coastal area planning as a process to include physical, biological and human components within a comprehensive management framework for the coastal zone.

One of the purposes of the report has been to provide demonstration material for use in the Swedish bilateral cooperation with countries in central and eastern Europe.

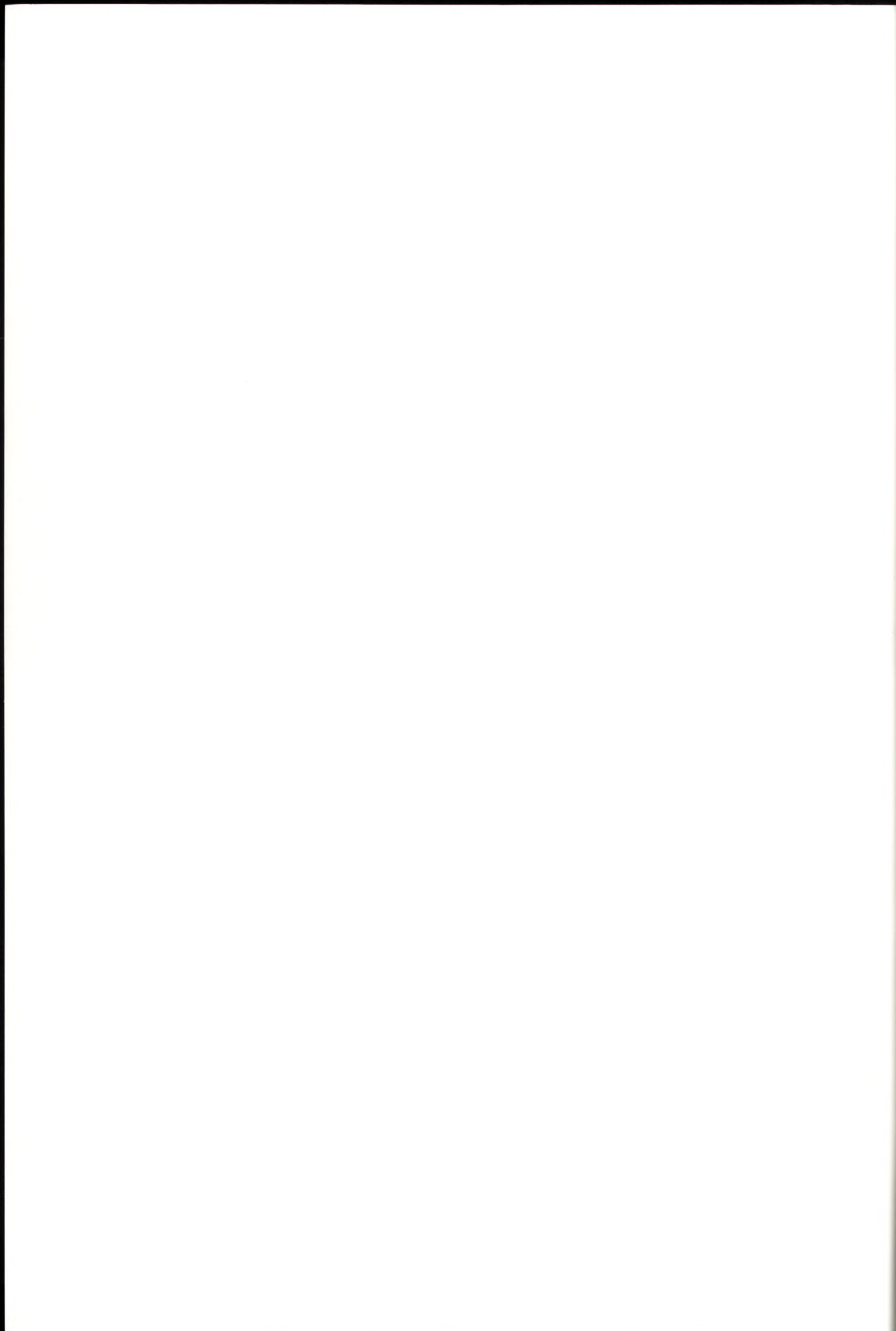
It should be underlined that the management and planning strategies must be developed within the framework of the cultural, legal and administrative system of each country. In developing these strategies the comprehensive plan of the Municipality of Lysekil could be seen as an example of the Swedish approach to coastal and marine management at municipal level.

The report has been prepared by Lars Johansson and Antonia Sánchez Hjortberg, Swedmar, the international consultancy group of the National Board of Fisheries.

The report has been compiled with the help of the Municipality of Lysekil and the County Administrative Board of Gothenburg and Bohuslän, which have kindly put their planning material and knowledge at disposal. Also the EFEM Architects in Gothenburg, the municipality's planning consultant, has provided valuable assistance.

This work was carried out at the request of the Swedish Environmental Protection Agency which also has funded the report.

Swedmar



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#### The Comprehensive Plan:

- The use of Land and Water Areas
- Regulations and Recommendations

Official map from the National Land Survey in Sweden. Permission no. 95.0186

## 1. THE MUNICIPALITY OF LYSEKIL

The municipality of Lysekil is located on the west coast of Sweden (Figure 1:1), some 100 km north of Gothenburg and has a population of approximately 15, 000, of which around 8, 000 live in the town Lysekil. Industry in the area is based, among others, on shipping, canning, heavy petrochemicals and extensive tourism. Quarrying and fishing were earlier of major importance.

The coastal area consists of several headlands, islands and peninsulas surrounded by bays and the Gullmarn threshold fjord and to the west, there is an exposed rocky archipelago.

The sea is one of the most valuable assets of the municipality. It provides work and recreation and is one of the reasons for people remaining in the area or for moving there despite the limited work opportunities.

During the latest decades, the marine resources have in many ways been exploited beyond their capacity. Eutrophication and pollutants from land have had a deteriorating impact on the water quality and the state of the sea bottoms in the municipality. Comprehensive coastal planning has been necessary.



**Figure 1:1** The municipality of Lysekil is located on the Swedish west coast some 100 km north of Gothenburg

### CORRECTION

Due to an unfortunate printing mistake at page 2,  
the texts of the photoes were shifted.

The first photo is actually showing the fishing  
village of Fiskebäckskil and the second photo,  
the City of Lysekil.



The City of Lysekil. Photo: Ragnar Bergman



The fishing village of Fiskebäckskil. Photo: The County Administrative Board

## **2. PRE-CONDITIONS FOR THE PLAN**

### **2.1 Legal framework**

Regulations for the exploitation of Swedish coastal and marine areas are included in the legislation addressing the planning and use of land areas. Within Swedish territory, Swedish legislation is in force on land as well as on water. Most laws regulating coastal and marine waters, encompass the whole water area, from the coastal line to the territorial water limit. Nevertheless, there are some exceptions.

#### **Rights of possession at sea**

In juridical terms, coastal and marine waters within the municipality, always have a proprietor. The rights of possession refer to the surface as well as to the bottom and the water volume in between. However, rights of possession do not interfere with the rights of free crossing nor the fishing rights. On the other hand, one needs the owner's permission to raise constructions in the water area. A permit from the Municipality and/or the County Administrative Board is necessary for example for installation of road embankments, marinas, and bridges or for dredge deposit.

Water areas are either private or public. Private waters extend 300 metres out from the mainland or larger islands. Public waters extend from the limit of private water to the territorial water limit. The public water area is of national property.

#### **The Natural Resources Act (NRA)**

The Natural Resources Act (NRA) covers, umbrella-like, all the legislation regulating how land and water areas are to be used. The demand for management of natural resources has been given a new and broader interpretation in the NRA. The Act provides a common basis for decisions, irrespective of who makes them and under what legislation.

The NRA also represents - in spite of its name - development interests, like the extraction of raw materials and road construction, if these are consistent with the long-term development of a good environment. It is also important not to develop areas which, in the long run, are suitable for purposes like harbours or wind power production.

The NRA states that water and land areas are to be used in the most appropriate manner. In the case of conflicting interests, priority shall be given, as far as possible, to that activity which is most important from the public point of view and with a long-term perspective.

The following acts are linked to the NRA (the umbrella act):

- The Planning and Building Act
- The Environment Protection Act
- The Water Act
- The Nature Conservancy Act
- The Road Act
- The Electrical Installations Act
- The Pipelines Act
- The Civil Aviation Act
- The Peat Deposits Act
- The Public Waterways and Harbours Act
- The Continental Shelf Act
- The Mineral Act

Regulations on Environmental Impact Assessments (EIA) are included in the NRA. An EIA should:

- be used for all projects that need a permit according to the NRA,
- be included as a part of the permit application,
- form the basis for a joint assessment of the impacts on the environment, the human health security and the management of natural resources,
- be carried out and financed by the "proponent".

### **The Planning and Building Act (PBA) - the Status of the Comprehensive Plan**

The Planning and Building Act (PBA) contains regulations on the planning of land and water areas. The purpose of these regulations is, with due regard to the freedom of the individual, to encourage the development of an egalitarian society as well as good living conditions for people today and for future generations.

It is a municipality's responsibility to plan the use of land and water areas. Each municipality shall draw up an up-to-date comprehensive plan covering the whole of the municipality's area out to the territorial boundary. The comprehensive plan shall indicate the main ways in which land and water areas are to be utilized and how physical development should take place. The municipal comprehensive plan is not binding to either authorities or individuals, but it gives guidelines for decision-making in accordance with the Natural Resources Act (NRA) legislation. When drawing up plans, the NRA shall apply.

This report aims at showing how integrated coastal area planning is carried out in Sweden through comprehensive physical planning at the municipal level.

## 2.2 Delimitations of the planning area

### Administrative boundary at sea

The sea is juridically divided into inner water, territorial sea and open sea. The boundary between inner water and territorial sea is formed by the so called base line, which binds the outer points, islets and skerries, or follows the low water line where the archipelago is missing. The boundary between territorial sea and open sea is the territorial boundary, which is situated 12 nautical miles outside the base line.

The middle line - a line which runs in between the base lines of two countries - divides the open sea between the two countries. If another division is agreed on between the countries, the line is called the delimitation line. On 1 January 1993, a Swedish economic zone (EEZ) was established outside Swedish territory reaching the middle line. When this zone, along with others, for instance fishing zones, is situated outside the territorial borderline it does not normally take part in the planning area of the municipality.

The municipality of Lysekil extends to the territorial borderline at sea (Figure 2:1). Geographical management regulations according to the Natural Resources Act apply as far as to three nautical miles from the base line. In the planning procedure, the areas must be looked upon in its entirety and in its context with coastal waters of Bohuslän. The administrative borderlines give an artificial division of the constantly moving water masses. The conditions within the watershed areas must also be considered. In the comprehensive planning of the municipality, the areas within the borderlines will be presented. The coordination with neighbouring municipalities is done at a regional level through the County Administrative Board.

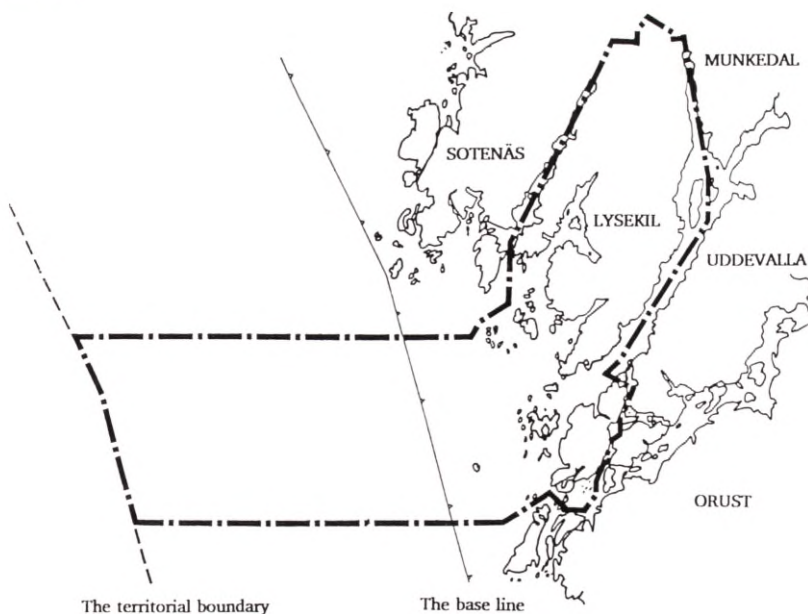


Figure 2:1 Boundaries of the municipality of Lysekil

### **3. PLAN ORIENTATION AND ORGANISATION**

#### **3.1 Orientation of the Comprehensive Plan**

##### **Directives from the politicians**

The planning was carried out following the directives the Municipal Council through the Executive Committee. The orientation was discussed in depth and finally formulated as follows:

- To reserve land for attractive housing and expansion of social services in all parts of the municipal area.
- To reserve land and water areas for factories and businesses.
- To reserve the Brofjorden industrial area for heavy industry.
- To respect the national needs for recreational areas in Bohuslän.
- To safeguard the quality of the Gullmarn fjord for research and nature conservation and at the same time provide the possibility to use the watershed area of the Gullmarn fjord for residential and recreational purposes.
- To limit negative impact on the land and water environment and propose concrete measures to be implemented by the municipal authority or private individuals.

##### **Related planning**

The municipality's objectives for population growth, industrial growth, social services, etc, were at the same time presented in a special programme document "General pre-conditions for planning". This programme forms a necessary complement to the comprehensive plan.

##### **The validity of the Comprehensive Plan**

The comprehensive plan is mainly a strategic land and water use scheme, i.e. it will show the use of land and water in a long-term perspective. It must be updated when necessary. A review of the plan is done approximately every fifth year.



### **3.2 Main issues**

As a result of the directives given by the local politicians in the municipality, a number of interesting questions had to be addressed during the planning process.

#### **Nature and Environment**

- What are the environmental conditions of the marine areas in the municipality for water quality, flora and fauna, etc?
- What affects water quality and biology?
- Can it be determined what the sea will endure?
- What competence will the municipality require in its planning?
- How are surveys and collected data interpreted?

#### **Preservation or exploitation**

- Is it possible to use the qualities of sea for living, working and leisure at the same time as one respects and cares for nature and environmental conditions?
- What areas should be preserved and where can changes of the natural environment be accepted?

#### **The Brofjord industrial area and harbour**

- How shall the area develop?
- Shall the inner parts of the bay Frommekilen be filled up and used for industrial and port purposes?

#### **Water and drain issues**

- How to proceed with sewage treatment for new buildings?
- How can water and sanitation issues in areas without municipal installations be arranged for new and already existing buildings?

### **Marinas**

- Where to expand these areas with regard to natural and cultural environments and to the requirements of the municipality?

### **Shallow and ecologically important water areas**

- How can these areas be preserved?
- How can the qualities of the river Broälven be secured?

### **Areas of importance according to the Natural Resources Act**

Beside the pure municipal interests, the interests presented by the Natural Resources Act must also be met. Within the municipality there are many areas of so called "National Interest" according to the NRA.

NRA emphasises that, among other things, the following areas shall be protected:

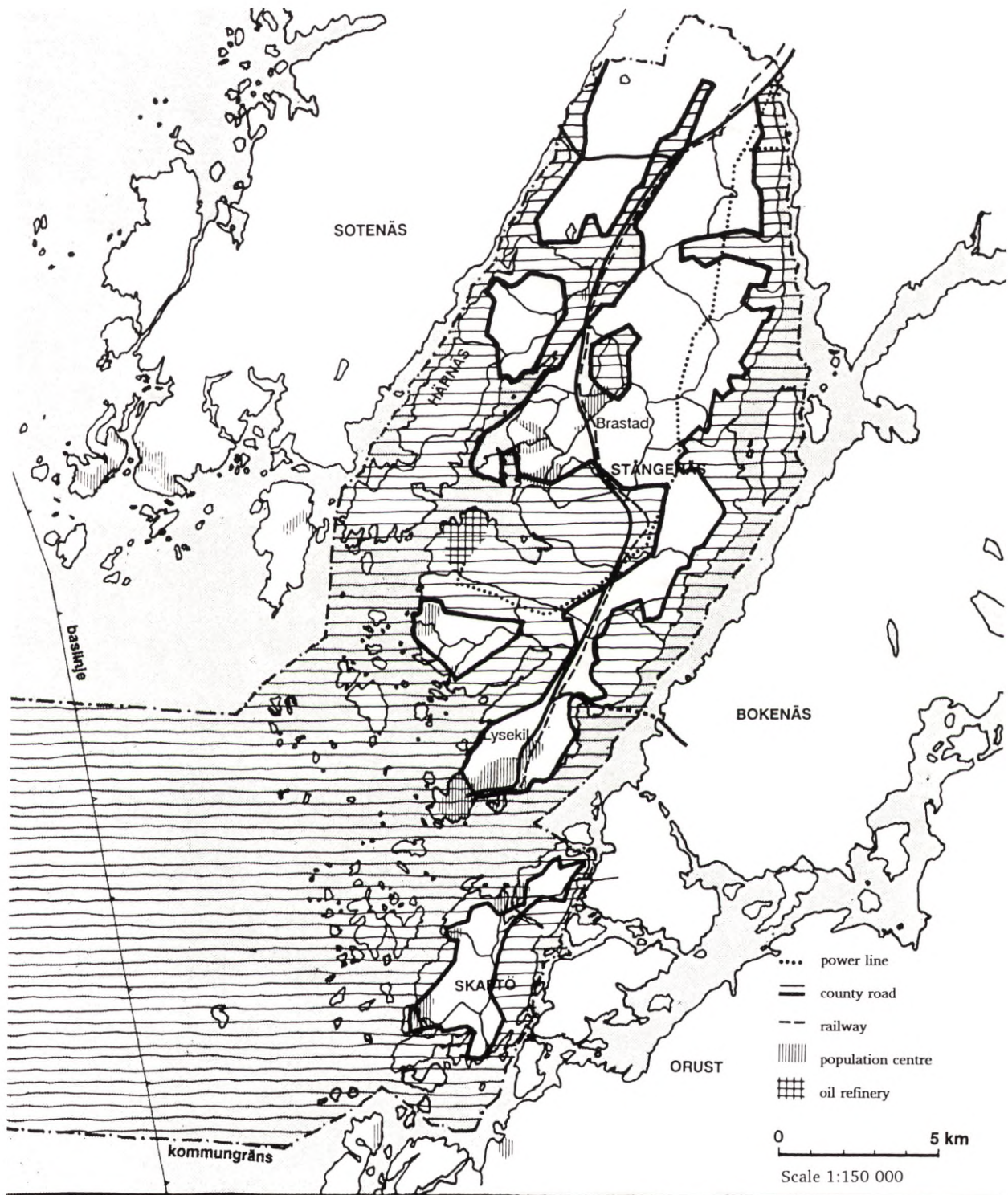
- Large unexploited areas and ecologically sensitive areas
- Natural and cultural environments of "national interest" for conservation, research, etc.
- Areas for outdoor and other recreational activities

The NRA stipulates also that certain areas shall be used for important activities of "national interest":


- Agriculture and forestry
- Fishing
- The extraction of raw materials such as minerals, iron ore, peat and sand
- Industrial production
- Energy supply and communications
- Water supply and waste treatment
- National defence

The geographical areas involved are described by the County Administrative Boards and presented to the Municipality on maps in scale 1:50, 000 (Figure 3:1 - shows a summary).

The municipality has also a possibility to, with support of the NRA and through its planning, influence the decisions of different sectors, authorities and courts regarding the management of land and water resources. This requires that the municipality has proceeded far enough within its planning procedure and that agreements realized between municipal and national interests have been accepted before the formal confirmation of the plan by the Municipal Council.



**LAND- AND WATER AREAS WITH ONE OR MORE "NATIONAL INTERESTS"**

 Nature- and culture concervancy, outdoor recreation, fishing, heavy industry, shipping, defense, energy distribution, roads, railways. The sectors are described in chapter 5

The Municipality of LYSEKIL

EFEM Architects

**Figure 3:1**

### **3.3 Organisation of the planning**

The highest decision-making body in a Swedish municipality is the Municipal Council. The Executive Committee is the main actor for the Comprehensive Physical Planning. The responsibility for the planning in Lysekil has in practice been divided between two groups; a political leading group with representatives of the Executive Committee, the Building Committee and the Environment and Health Protection Committee, and a work group including representatives of the Town Planning Office and the Environmental and Health Protection Office. The technical planning was carried out by a consultant - EFEM Architect's. Experts from the County Administrative Board were coopted to the work group as a consequence of the introduction of partly new topics in the planning concerning coastal and marine environment and resources.

#### **Cooperation with governmental authorities**

The main governmental partner to the municipality has been the County Administrative Board.

The County Administrative Board assembles surveys, programmes and other planning data of relevance to the management of natural resources in its county, and which are available from central and regional governmental bodies. The County Administrative Board coordinates the information on important land and water areas given by central authorities. When requested, the board provides the municipalities in its area, as well as other bodies applying the Natural Resources Act, with such planning data.

The County Administrative Board also prepares inventories of different water related interests, and demands and prepares environmental descriptions covering their coastal and marine waters. The reports and maps drawn up by the board have formed an important basis for the planning of the coastal and marine areas belonging to the municipality. A special "Nature and Environment Description" has been provided by the municipality of Lysekil. This is further described in chapter 4 below.

The County Administrative Board shall protect national interests and coordinate inter-municipal issues in a proper way. It shall also specifically consider health and security issues.

#### **Cooperation with universities and research institutes**

The municipality of Lysekil with its unique marine environment, is host for several marine research institutions. This extraordinary marine competence has been exploited. However, the cooperation has been limited to the exchange of experience at some introductory seminars.

Experiences of the municipality of Lysekil have shown that cooperation with the research institutions presuppose a relatively long-term planning programme. The research institutions do not work as authorities with responsibility to help the municipalities in their planning or to assist on short notice.

### **Relations to the Public**

The publicity process which accompanies the drafting of the plan means that everyone has an opportunity to influence the municipality's decisions through personal contacts, interest organizations or the local political parties. The most important supervision on land and water use is exerted by the local political parties.

According to the Swedish constitution there is free access to all documents in public bodies. The local press takes advantage of this constitutional right to give full publicity to ongoing municipal activities, including comprehensive physical planning.

The municipality has actively asked for the public opinion on the plan work and the political decision to accept the plan. Several public meetings have been held during the planning process. In order to get the public's opinion, they have sent the plan to local societal associations; fishing organisations, tourist organisations, marine sport organizations, associations for nature conservation and organizations which represent industrial and commercial interests. The plan has also been exposed to the public at the Town Hall and the Municipal Library.

## 4. NATURE AND ENVIRONMENT IN COASTAL AND MARINE WATERS

In order to weigh different interests against each other, there is a need for basic knowledge of the general environment conditions of coastal and marine waters. The "Nature and Environment Description" of Lysekil has been elaborated in cooperation between the municipality of Lysekil and the County Administrative Board of Gothenburg and Bohuslän. It presents all the county's coastal waters as well as the specific conditions prevailing in the municipality of Lysekil.

### 4.1 The County of Gothenburg and Bohuslän

#### 4.1.1 Oceanographic conditions

##### Currents

The water at the Swedish west coast originates from three different marine areas, the North Atlantic, the North Sea and the Baltic Sea. The water hits Bohuslän through two major flows; the Jutland coastal current with North Sea water, and the Baltic stream with water

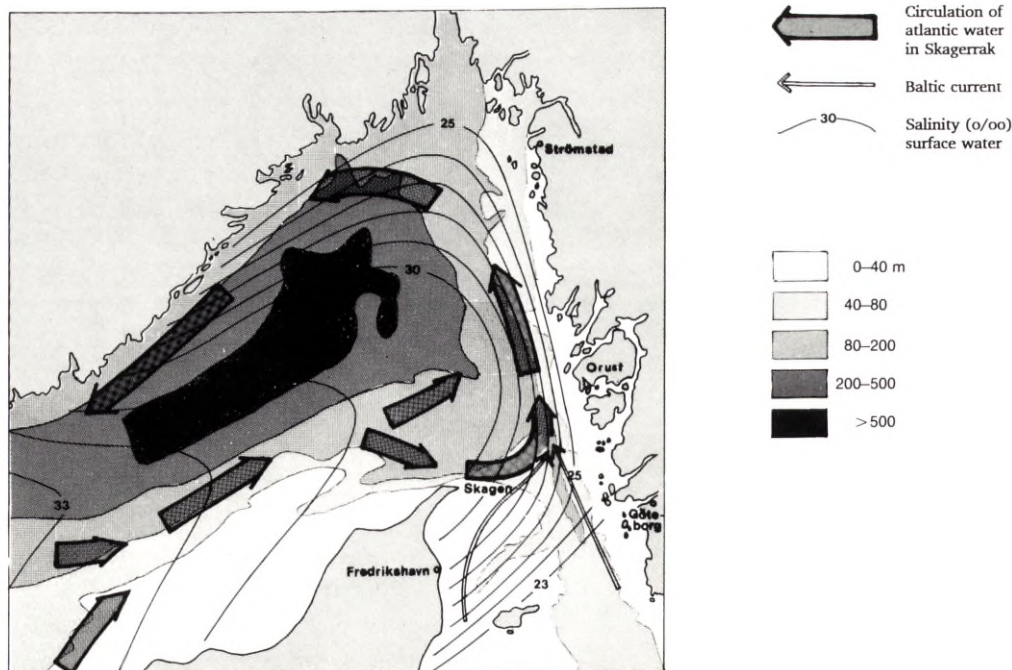


Figure 4:1 Depth, currents and salinity in Skagerrak

from the Baltic (Figure 4:1). It is slowly mixed with the saline water of Kattegatt and upon reaching Lysekil it has a salt content of more than 20 promille. The Baltic current runs, as a 10 to 20 metres deep brackish water river, along the coast and often reaches some 10 nautical miles outside the coast.

The different water masses from the Atlantic and the North Sea mix with the Baltic current before leaving via the Norwegian Coastal Current. Many factors affect the current systems, but the main influence is towards the north. This is significant for the distribution of nutrients, organic compounds and metals from different sources along the coast.

### **Winds**

The wind affects the watermixing processes and water transports at the surface level. The wind plays for instance a big part when it comes to the distribution of the surface water in the estuaries, where off-shore winds transfer surface water over huge archipelagic areas, while on-shore winds force the surface waters towards the coast.

On-shore winds from the southwest and the west are prevailing in the coastal areas of Bohuslän and Lysekil, especially during the summer season. During the winter it is more common with off-shore winds.

### **Variations in water level**

The variations in water level of Bohuslän is adjusted by the tidal water and atmospheric pressure. Tidal water movements are small in Bohuslän, there is an approximate difference of 20 cm between low and high water.

The variations of water level effected by atmospheric pression are more considerable than those effected by tidal water. Low atmospheric pressure and powerful west winds cause a high water level on the west coast. The difference between the lowest and highest water level recorded is approximately two metres.

### **Halocline movements**

The coastal waters of Bohuslän are mainly due to brackish water in the Baltic current divided into two strata; one light surface water stratum and another saline bottom water stratum. These are separated by the halocline. The movements along the halocline can be described as huge submarine waves slowly moving towards the coast of Bohus and bringing in saline water from Skagerrak. These movements of the halocline are of great importance to the water exchange process in the coastal areas of Bohuslän. The exchange of deep sea water below the threshold level of a threshold fjord, as the one of Gullmarn, is completely dependent on bottom water currents moving in from the outside.

## **Water temperature**

The temperature of the coastal water plays an important role in the stratification and mixing process of the water masses. Nevertheless in Bohuslän, it is the salinity of the water which is of greatest significance to the origin of a halocline. Therefore, the division of temperature in the water mass is adapted to the stratification of the salt content.

The water temperature is also important to the chemical and biological processes in the water and at the bottoms. For instance, cold water, dissolves more oxygen than warm water. Biological processes, such as production of phytoplankton and decomposition of organic material, are faster when the water is warm.

The variations in temperature during the year are considerably smaller in the water volume below the halocline than in the surface water layer. Bottom waters in Bohuslän reaches its lowest temperature, +4° C in January - February, while the highest temperature, 12-13° C, is reached in late summer. The surface water reaches its lowest temperature during December until February, when the water temperature can go below 0° C. Maximum surface water temperature, 19-20° C is reached in July - August.

### **4.1.2 Fresh Water Supply**

#### **Precipitation**

In the outer sea areas, the annual average precipitation is low, around 600 mm, while in the inner part of Bohuslän it reaches a 800 mm a year.

A factor which has been noticed during the last years is the increased atmospheric inputs of nutrients and heav metals to the North Sea area. Studies on the precipitation's content indicate among other things a considerable increase of nitrogen content in the rainwater since the 1950s. The atmospheric fallout of nitrogen in rainwater and particles on the sea surface is approximated to count for 35 % of the total nitrogen input to Skagerrak.

#### **Fresh water supplies**

The net flow of fresh water from the Swedish west coast and from southern Norway amount to around 2,500 m<sup>3</sup>/s. The most important fresh water source on this coastline is the Norwegian river Glomma, with an average flow of 650 m<sup>3</sup>/s. In some periods, the waters of Glomma do considerably affect the coastal waters in northern Gothenburg and Bohus county.

The largest fresh water supply in Gothenburg and Bohus county comes from the river Göta (and Nordre). Apart from this, Bohuslän has mainly smaller streams with a minor and local effect.



#### 4.1.3 Biology and biological production

During the last years, different studies have been carried out to measure the productivity of different marine ecosystems. Above all, the work has been concentrating on phytoplankton production or primary production in the sea, as well as on the production in the shallow coastal water areas (0-6 m).

##### **Phytoplankton - primary production**

Studies on phytoplankton have been carried out in a few places in Bohuslän, among others, in the fjords Gullmarn and Bro. It seems like the seasonal variations and the art composition, on the whole, are representative for all of Bohuslän.

The characteristic stratification of the coastal waters is of great importance. Since the phytoplankton production is light dependent, the growth of plankton algae will only take place in the surface stratum, where light is satisfactory, often between the surface and halocline on 10-15 metres depth.

In the open sea at our latitudes, the growth of plankton algae takes place in spring, already in February when the light intensity increases and the supply of nutrients, as phosphorus and nitrogen, is rich. The growth can sometimes be very fast, during the so called "algae blooms". These spring blooms are dominated by a special type of phytoplankton, the *Diatomophyceae*. The silicon algae are favoured by the good supply of nutrients into the sea water.

In the coastal waters of Bohuslän, especially in the inner parts of the archipelago, the store of nutrients is continuously filled up by the fresh water outflow from land. Often, as a consequence of this rich supply of nutrients, the archipelago has several algae blooms in summertime. However, a new and powerful bloom often appears even outside the archipelagic areas during the late summer season, in August to September. This is when nutrients once again have been released through the decomposition of organic material in the bottom zone, and when the water temperature is high enough and the sunlight still sufficiently strong. This algae bloom is dominated by a group of phytoplankton called dinoflagellates.

The toxic algae which have been striking the Bohuslän coast in the 1980s were different species of these dinoflagellates. They have affected the sea's ecosystem in different ways, with damaging impacts on both flora and fauna.

##### **Shallow areas in Bohus county - sea environments with high production.**

Earlier it was believed that shallow sea bays with soft bottoms were of no value, or at least of little importance to the life in sea. Consequently, the water movements of these areas have often been disturbed by the construction of road banks, thus blocking the water-flows from circulating. Dredging and building of marinas have also been carried out, without any consideration to the biological impacts.



**Shallow area with high primary production. Photo: The County Administrative Board**



**The outer archipelago. Photo: The County Administrative Board**

The importance of the shallow bottoms, as "pantry" and breeding place for fish, is now well known. Several factors make the bottoms productive:

- good access to nutrients from land runoff,
- good sunlighting and a small depth make phytoplankton production possible in the whole water mass, and
- the fast heating of the water in spring speeds up the primary production process.

Calculations based on investigations in the Lysekil municipality show that around 10 kg fish/hectare seek the shallow areas (0-3m) every night to feed.

### **Woods of seaweed at the Bohuslän coast - important to the production**

The hard bottoms in the depth level of 0-2 metres make up the base for different species of green, brown and red algae; ordinary speaking seaweed. The seaweed woods have, in the same way as the shallow eelgrass meadows, a considerable significance to the marine fauna as feeding and breeding place as well as protection and hiding-place. These submarine woods of algae extend from 5-20 metres depth and make up an extremely important environment for a great number of plants and animal species.

### **Bottoms of outer archipelagic areas**

Bottoms exposed to winds and waves are important for the fisheries. Lobster and crayfish are mainly fished on these bottoms. The lobster normally lives on stone and rock bottoms, on 6-30 metres depth, which also include shellsand and shellgravel where it can hide.

Among other bottoms worth protecting are the spawning-grounds of the herring. As opposed to most fish species, the eggs of the herring are laid directly on bottoms made of sand, gravel or stone, mostly on depths between 16 and 25 m. The spawning-grounds are threatened by extraction of sand and gravel, dredge depositing or other exploitation activities, as well as by oil discharge.

#### **4.1.4 Water quality in Bohuslän**

The coastal waters of Gothenburg and Bohuslän are, due to large currents in the area, to a great extent affected by the surrounding sea areas. Therefore, the quality of water is relatively similar along the Bohuslän coast, with the exception of areas directly affected by larger spot discharges from industry and rivers.

In the beginning of the 1950s, the water quality of Bohuslän was still good. As from the middle of the 1960s, a considerable reduction of the visibility depth was observed in the middle fjords of Bohuslän. Following this was a heavy decrease of the algae's expansion into the depth, which was caused by a poor light supply in the waters. During the 1970s and 1980s, these changes have been magnified and other changes have appeared such as, deterioration of fishing, oxygen depletion in bottom zones, toxic algae and death of seals.

In order to work with marine topics in a comprehensive way, the Swedish Environmental Protection Agency has appointed smaller work groups in the different coastal areas of Sweden. The so called action group "West" works with the west coast, i.e. Öresund, Kattegatt and Skagerrak. The group includes representatives from the County Administrative Boards of Malmöhus, Kristianstad, Halland, Gothenburg and Bohus counties. An action plan has been elaborated and implemented.

### **Nutrients - nitrogen and phosphorus**

Rough estimates have shown that the discharge of nitrogen into Kattegatt/Skagerrak has increased around 6 times and the provision of phosphorus around 10 times, compared to the situation in the beginning of this century. Most of the discharges originate from sources outside of Bohus county and are transferred by watercourses and atmosphere to Bohus coast. Sweden counts for approximately 35-40 % of today's nitrogen strain on Öresund and Kattegatt, and 3 % of the strain on Skagerrak. The remaining pressure comes from adjacent countries and from atmospheric fallout. More than 35 % of the total nitrogen discharge in Skagerrak originates from air transported nitrogen fallout directly on the sea surface.

There is a total annual discharge of around 700 metric tons of phosphorus and around 28,000 tons of nitrogen in the coastal waters of Gothenburg and Bohuslän, and the main sources are the transports via watercourses, for both phosphorus and nitrogen. Seen from a transportation point of view, the Göta River is without doubts the most important watercourse, but also the river of Örekil transports a lot of nutrients. Among the outlets to water courses in the county, the leakage from agriculture and wooded land is completely dominated by nitrogen. As for phosphorus, the discharges from private sewers are substantial, as is the leakage from the ground.

Among the immediate discharges from the Bohuslän coast the sewage-treatment plants let out about 130 tons of phosphorus respectively 2,510 tons of nitrogen per year.

### **Oxygene consuming organic material, BOD (Biological Oxygen Demand)**

In total (watercourses and direct coastal discharges), the discharges on the Bohuslän coast amount to around 4,500 tons BOD/year. The discharges give rise to local effects in form of low oxygen content in recipients with lower water circulation. A clear example of this is the fjord of Idre.

### **Firm organic substances, hydrocarbons and metals**

The known discharges of these materials from the industry as well as from purifying plants in Gothenburg and Bohuslän county are as follows: Hydrocarbon - about 1,000 tons/year, Mercury - 15 kg/year, Cadmium - 85 kg/year and Lead - 900 kg/year. The discharges from smaller sources are not included. The daily outlets of water containing lead should also have

been included, but these are not very well known today. The situation has continuously become better during the last years.

### **Regional programme for water quality control in Bohuslän**

In order to get a better regional insight of the quality of coastal waters in the whole of Gothenburg and Bohuslän, a coastal water protection federation was formed in 1985 with representatives from all the coastal municipalities in the county. The water protection federation is since 1986, realizing common sampling 12 times a year on 20 different places in the county. Measurements are being carried out regularly of temperature, salt content, oxygen content and resources of phosphorus, nitrogen and phytoplankton.

## **4.2 Nature and environment in Lysekil**

### **4.2.1 Division in geographical areas - criteria**

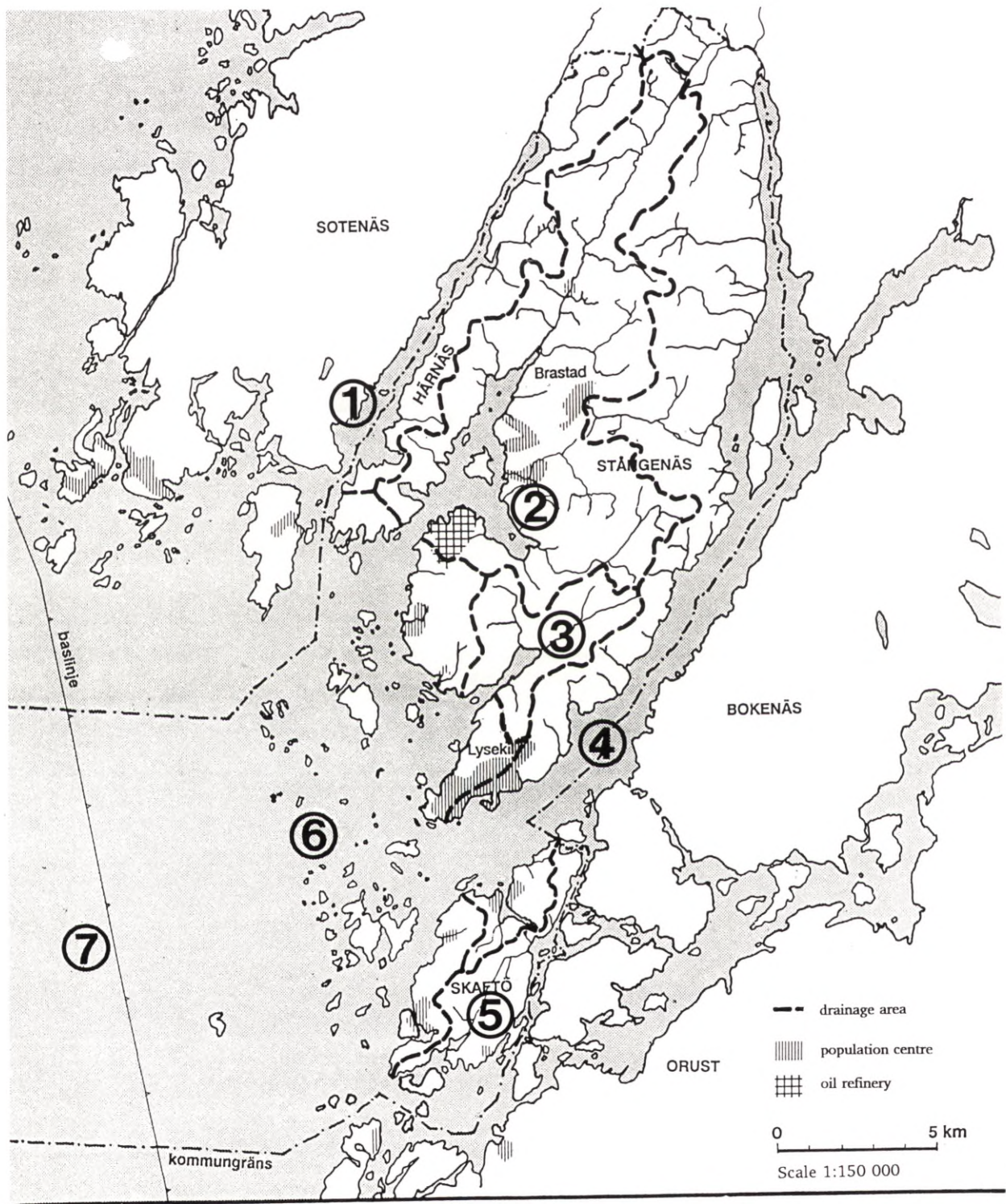
Most of the descriptions of the county (see part 4.1 above), are also applicable to the municipality of Lysekil. A detailed description of the seven sub-areas of the municipality is also done (Figure 4:2). The division into sub-areas has been based on the division in drainage areas, respectively on the specific qualities of the water areas. The most important factors characterizing these water areas are:

- water circulation
- bottom conditions (Figure 4:3)
- biological production (Figure 4:4)

Each sub-area is described with regard to:

- location,
- form,
- water circulation,
- bottom conditions,
- biology,
- water quality, and
- pollution and its origin.

To give an example, the sub-area of the Gullmarn fjord will be presented in the following chapter.



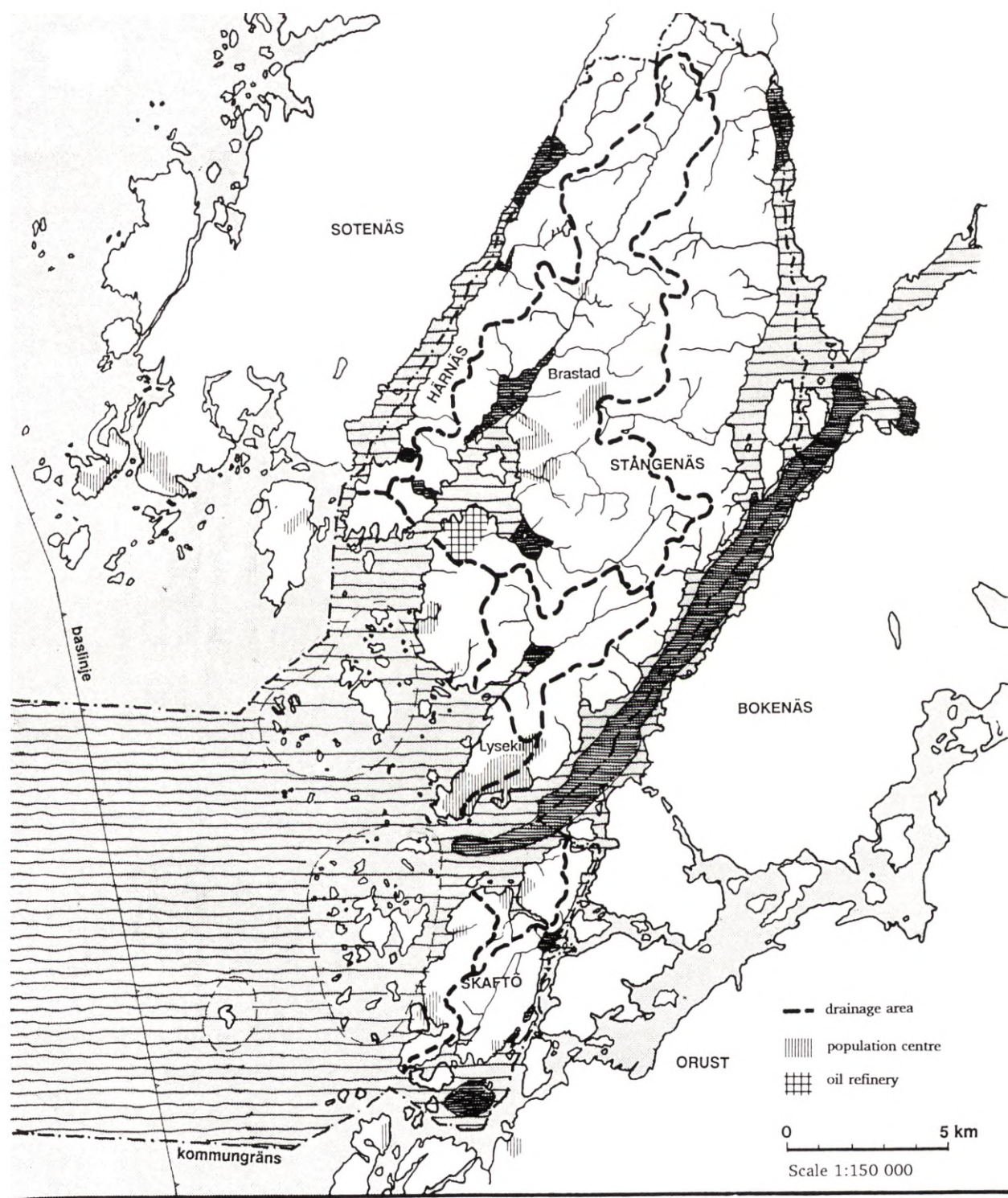
**DIVISION INTO SUB-AREAS**

- |                   |  |
|-------------------|--|
| 1. Åbyfjorden     | 5. Strömmarna, Snäckedjupet, and Ellösefjorden |
| 2. Brofjorden     | 7. The archipelago                             |
| 3. Trälebergskile | 6. The open sea                                |
| 4. Gullmarn       |  |




The Municipality of LYSEKIL

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Figure 4:2



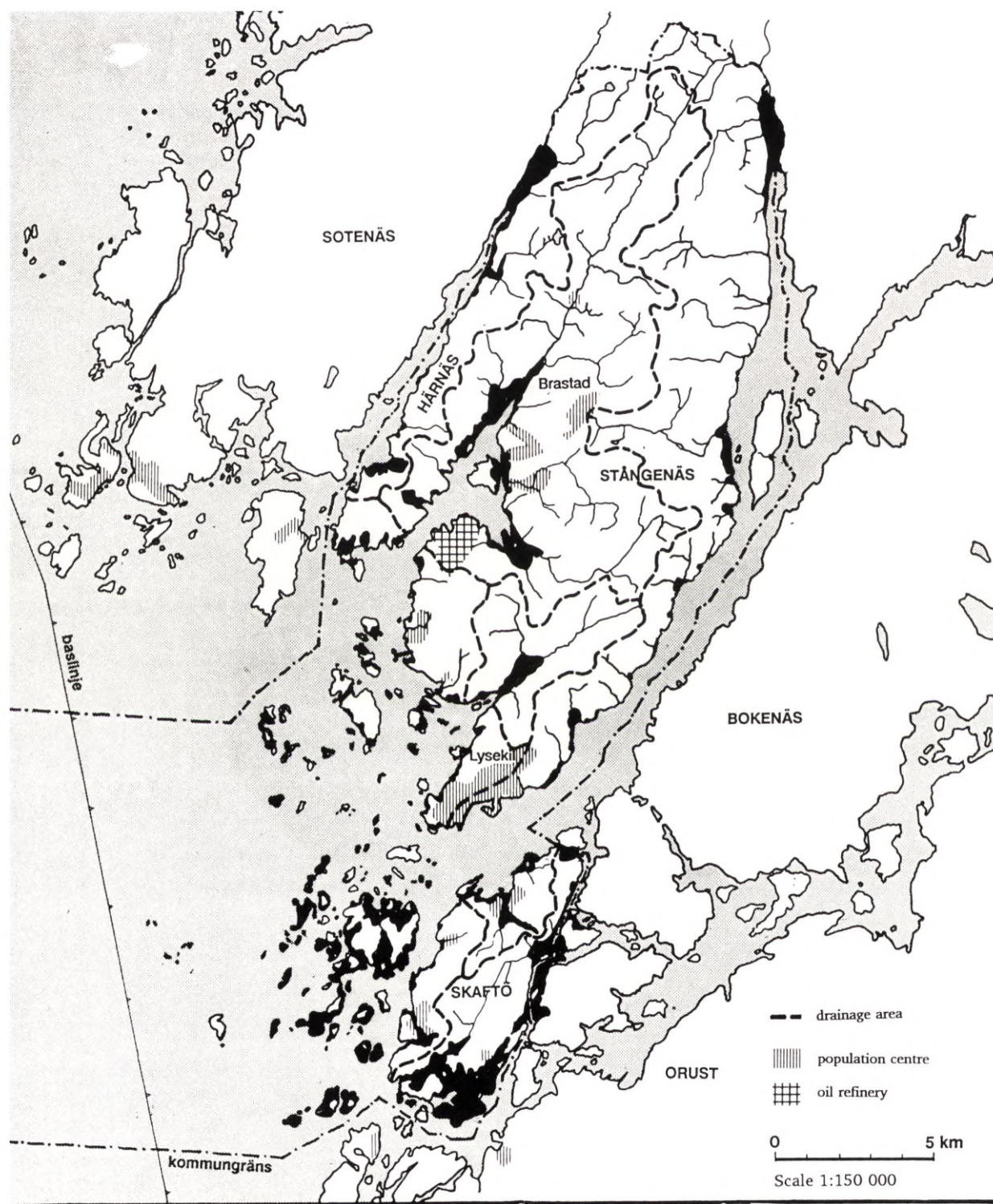
**BOTTOM CONDITIONS**

-  Accumulation bottom
-  Transportation bottom
-  Erosion bottom

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Figure 4:3



**SHALLOW SEA AREAS**

An overview

**■** 0-6 m depth, of national interest for the fishing

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Figure 4:4



#### 4.2.2 Description of sub-areas - the Gullmarn fjord as an example

Gullmarn is the only threshold fjord in Sweden. It borders on three municipalities: Lysekil, Munkedal and Uddevalla. The fjord's drainage area includes activities of different kinds. Parts of the city of Lysekil are found within the municipality's drainage area, as are also some industries and commercial ports, etc. Agriculture, summer houses and marinas make up a dominant feature in the inner parts of the fjord. The fjord has, due to its specific hydrographic conditions, a very rich flora and fauna. Scientific research in the fjord has been carried out for more than 150 years.

##### **Function and form**

Gullmarn extends some 30 km into the inland with a breadth of 1 to 3 km. North of the islet Bornö the fjord divides in two fjords; the Färlevfjord and the Saltkällefjorden. The deepest spot, around 125 m, is situated by Alsbäck in the center parts of the fjord. The threshold area, by the estuary, has a depth of around 40 metres and the surface amounts to approximately 50 square km.

The total catchment area of Gullmarn measures up to 1, 600 square km and extends all the way up into the county of Dalsland. The part within the municipality of Lysekil is quite small, some 80 square km. Other municipalities concerned are Munkedal, Uddevalla, Dals Ed and Färgelanda. The dispersion within the total drainage area of different soil types is not known, but in Lysekil around 16 % of the land is arable soil.

The water of the Gullmarn fjord can be divided in four strata:

- A thin surface stratum containing, more or less, mixed river water with low salt content.
- 1-15 metres. A water stratum with a large part of water originating from the Baltic coastal current, characterized by a strong salt stratification.
- 15-40 metres. A water stratum which, in terms of salt content, corresponds to the surface water of Skagerrak.
- 40-120 meters. Water with very high salt content, comparable to the bottom waters of Skagerrak.

##### **Bottom type**

The largest sediment accumulation bottoms of the municipality are found in Gullmarn's deep sea areas. These bottoms are covered with mud like sediment. Apart from this, there are predominantly sediment transportation bottoms with some elements of sediment accumulation bottoms, i.e. bottoms with high organic content mainly found in shallow areas. The threshold area/the archipelago has erosion/transportation bottoms.

### **Biological production**

Gullmarn is especially known for its deep sea fauna. In the deep sea basin of the fjord, at 60-125 m depth, the water has the same low temperature as at the depth of 200 m in Skagerrak. This allows some cold water species, normally found at this depth in Skagerrak or in arctic sea waters, to survive in the Gullmarn fjord. The water environment in the deep sea basin is very regular what regards temperature and salt content (approximately 4° C and 35 promille). But as it has a very limited oxygen content, it is strongly dependent on the Skagerrak water which contains a great deal of oxygen. This water comes in once or twice a year.

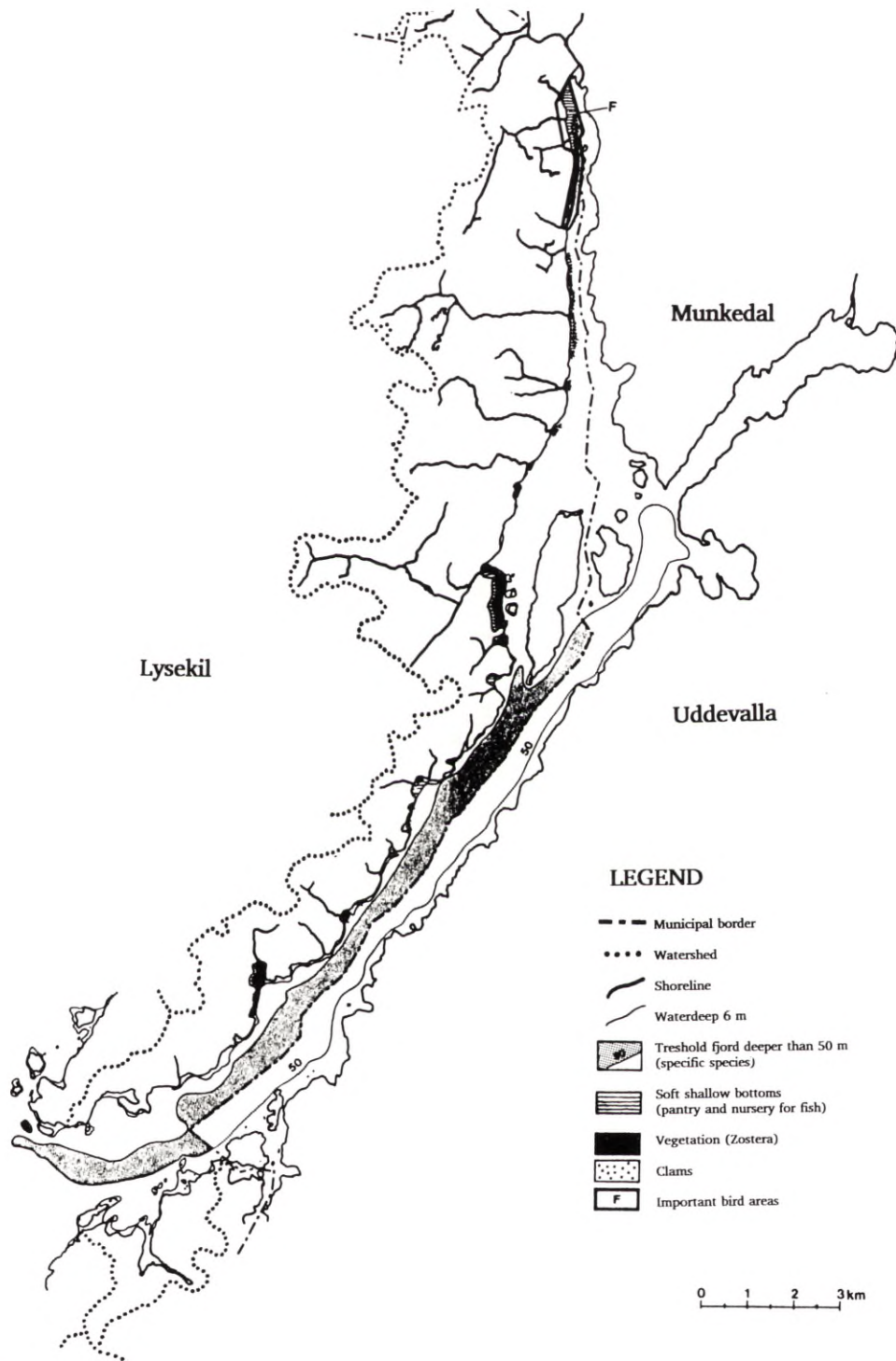
The biological production for the rest is characterized by:

- Phytoplankton production has during the last years increased considerably, which has probably led to the deteriorating state of oxygen content in the bottom waters.
- Hardly half of the fjord's 130 hectares of shallow soft bottoms (0-3 m) within the Lysekil municipality is covered by eelgrass meadows. The shallow areas in the fjord make up the breeding and feeding areas of cod, eel, flat-fish and trout.

### **Water quality**

Changes in the fjord's water quality, or in the flora and fauna, are regularly being surveyed since 1980 within the framework of Gullmarn's control programme. The control programme indicates an ongoing eutrophication in the fjord as well as along the whole of Bohuslän coastline. Increasing content of phosphorus and nitrogen, decreasing oxygen content and changes in the flora and fauna of the fjord are facts. Apart from the deep sea basin, the inner parts of Gullmarn are the most exposed parts to these changes.

Through the watercourses, the Gullmarn is annually supplied with 1, 260 ton of nitrogen and 52 tons of phosphorus, of which the main part is being transported by the Örekil river, situated in the municipality of Munkedal. The watercourses within the municipality of Lysekil (some 15) just have a local value. In the municipality of Lysekil, no municipally connected sewer runs out in the Gullmarn anymore. As for privately connected sewers, the water and sanitation inventory of the municipality points out some problem areas; Fiskebäck, Lysestrand and Sämstad. The leakage of nutrients from agricultural lands has been assessed in the preparatory work for the plan of Gullmarn. The share of Lysekil is small, mainly concentrated to the inner, sensitive parts of Gullmarn such as the fjord of Färlev. Only one larger industrial discharge affects the fjord, namely the paper-mill of Munkedal.



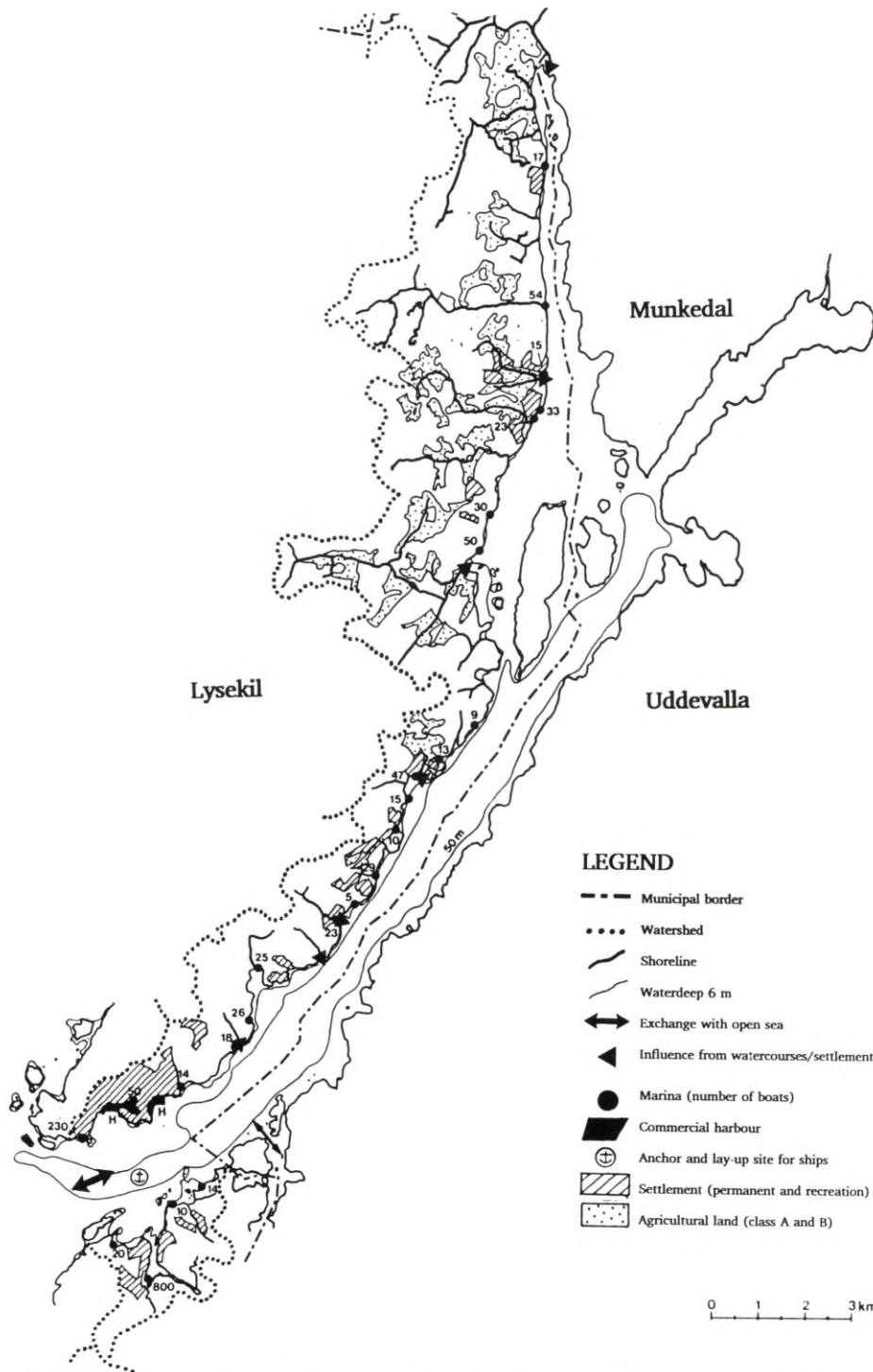
THE FJORD GULLMARN  
the drainage area within Lysekil

Biology

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Figure 4:5



**THE FJORD GULLMARN**  
the drainage area within Lysekil

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Water quality - the influence from land

Figure 4:6

## **5. CLAIMS ON LAND AND WATER AREAS**

### **5.1 Recipient use**

One of the largest claims on sea is as a recipient, swallowing pollution of different kinds. It can be sewage water from sewage-treatment plants or from private houses and summer cottages, surface water from urban areas (Figure 5:1), industrial discharges, watercourses with high content of nutrients from agricultural land, or sewage water from shipping and spill, etc.

The municipality of Lysekil has many sea areas with good water circulation and it is therefore believed to have good recipient potential for pollutants. On the other hand these possibilities are decreasing as the general state of the sea is deteriorating and the ecological balance is distorted. There are different opinions as on how the municipality's rather limited discharges should be weighed against the large scale changes of the sea. The environmental situation has been presented in the chapter 4 above.

The Municipality Council acts in many different ways to reduce the strain on the sea. The council tries to influence households, industry, agriculture and forestry so that they avoid using damaging substances. For instance by suggesting households to use the environmentally friendly products or by demonstrating good examples in its own activities.

#### **Nutrient strain from agricultural areas**

Beyond reducing the amounts of fertilizers used in agriculture, actions in the landscape itself can also reduce the nutrient strain on the sea. For example through the preservation or reconstruction of a vegetation zone along the watercourses, the supply of nitrogen and phosphorus can be reduced. A vegetation zone prevents erosion and absorbs some of the surplus nutrients in the soil. By its recommendations for land areas along appropriate watercourses, the Municipal Council clearly marks that they want a discussion with concerned land owners on this subject.

A more profound measure is to reconstruct a watercourse into the original shape, i.e. with meanders, wetlands and ponds. The waterflow is being slowed down and there will be time for a natural purification process to have an effect on the water during its way to the sea. Nitrogen and phosphorus is also absorbed by vegetation. Furthermore, valuable biotopes are reconstructed and thereby the biodiversity is being enhanced. However, often the land needed for reconstruction does not belong to the municipality, which makes it more complicated to actively address this issue through municipal planning.

## **5.2 Development of housing**

One important part of the comprehensive plan is to decide on areas for housing development. Based on the prognosis of population growth, a programme for provision of housing has been drawn up. The programme for provision of housing has then been transformed into housing plans in different municipal regions. Subsequent area regulations and detailed development plans regulate the construction process in detail.

## **5.3 Industry and constructions**

### **The industrial area of Brofjorden**

The industrial area of Brofjorden (Figure 5:2), with its ports and seaways, is of national interest to the heavy industry. The deep sea resource is one of the main assets of the area. The municipality started the planning of an industrial area by Brofjorden in 1968. The first oil refinery (Scanraff) with associated harbours started operating in 1975. The plan for Brofjorden was accepted by the Municipal Council in 1977 and it was based on assumptions that a huge petrochemical industry should be built in the area. At present, it is unsure which industrial constructions are to be realized in the Brofjorden area. An enlargement of the northern sector could be affecting large built-up areas north of the industrial area.

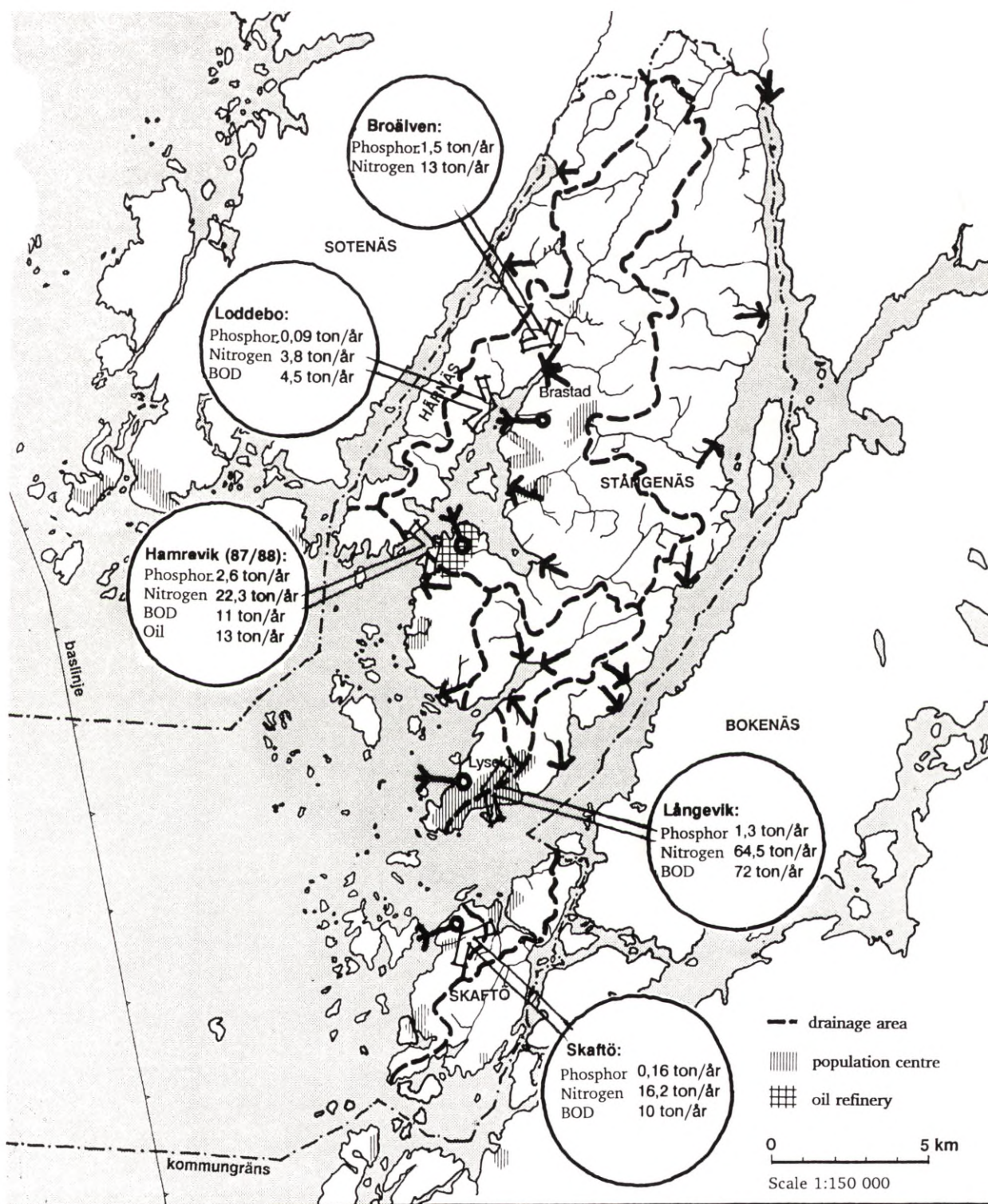
The Brofjord constitutes a considerable land resource and it has very good capacities for a deep sea harbour. However, it is doubtful whether it would be suitable for such a large concentration of environmental damaging industries which are shown in the Brofjorden plan. Changing pre-conditions give a great uncertainty towards future expansion. Economy, market situation, environment consideration, etc, have created new prerequisite conditions. Therefore, the municipality intends to revise the Brofjorden plan.

### **Harbours**

There are several significant harbours in the municipality. The oil ports at Brofjorden are of national interest. The southern harbour of Lysekil provides for commercial activities and fisheries and the harbour is of importance for the national defence. The municipality also holds a number of marinas of different sizes. At the estuary of Trommekilen within the Brofjord area, there are good extension possibilities for deep sea harbours. The stone deposit by the islets of Basteviken could be enlarged into a leisure craft harbour.

### **Dredge depositing**

Dredge deposits can be found in the north harbour, anstone deposits by the marina of Vallbodalen and by Grötö in Lysekil harbour. Blast stone from the constructions on the peninsula of Lyse has been deposited at Ramsvik. There is a clear need for new deposit areas for dredge material. Suggestions will be presented in future studies.



THE SEA AS A RECIPIENT

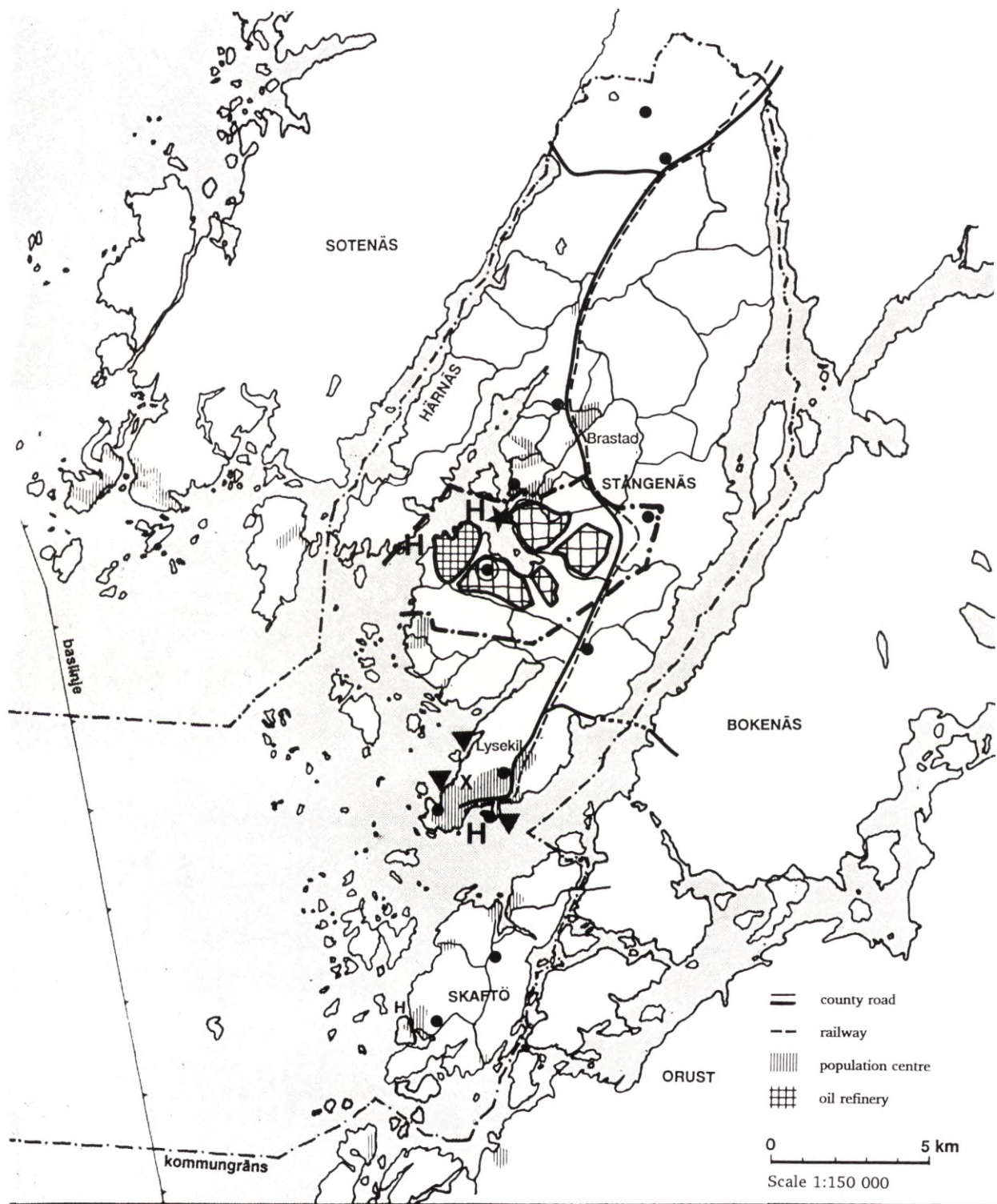


Sewage treatment works with outlet  
 Effected watercourse

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 of LYSEKIL

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Figure 5:1



**INDUSTRY, CONSTRUCTIONS, ETC**

- |                             |   |
|-----------------------------|---|
| <b>H</b> Commercial harbour | Industrial area of national interest for heavy industry |
| Oil refinery                | Planned industrial areas                                |
| Deposit site                | Industrial area   |
| Reparation of platforms     | Planned power station                                   |
| Waste-disposal              |   |

The Municipality of LYSEKIL

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Figure 5:2



### **Industrial areas**

Several industrial areas are placed outside the urban areas. Some important factors for location are good transport facilities and appropriate natural pre-conditions, as harbours. Industries may also cause disturbances which makes it inappropriate to locate them in direct contact with other buildings.

### **Energy production**

Prerequisite conditions for wind power at sea have been investigated, but the coast outside of Lysekil has a bottom which is too hilly for the techniques of today. Even other opposing interests (fishing, defence, etc) make wind power at sea unrealistic at present.

## **5.4 Shipping**

Shipping demands navigable routes, anchoring possibilities and good harbours. The inward route to Brofjorden is lively frequented (around 120 ships/month). Most ships carry hazardous goods (that is seen from an environmental point of view), importing crude oil and exporting refined products. Ships with a draught of 25 metres can enter the crude oil quay. Protected anchorages exist both in the interior and exterior part of the fjord.

The searoute to the industrial area of Brofjorden, the anchorages and the harbour, are all of national interest. The comprehensive plan also present other routes through the municipality (Figure 5:3).

## **5.5 Technical supply**

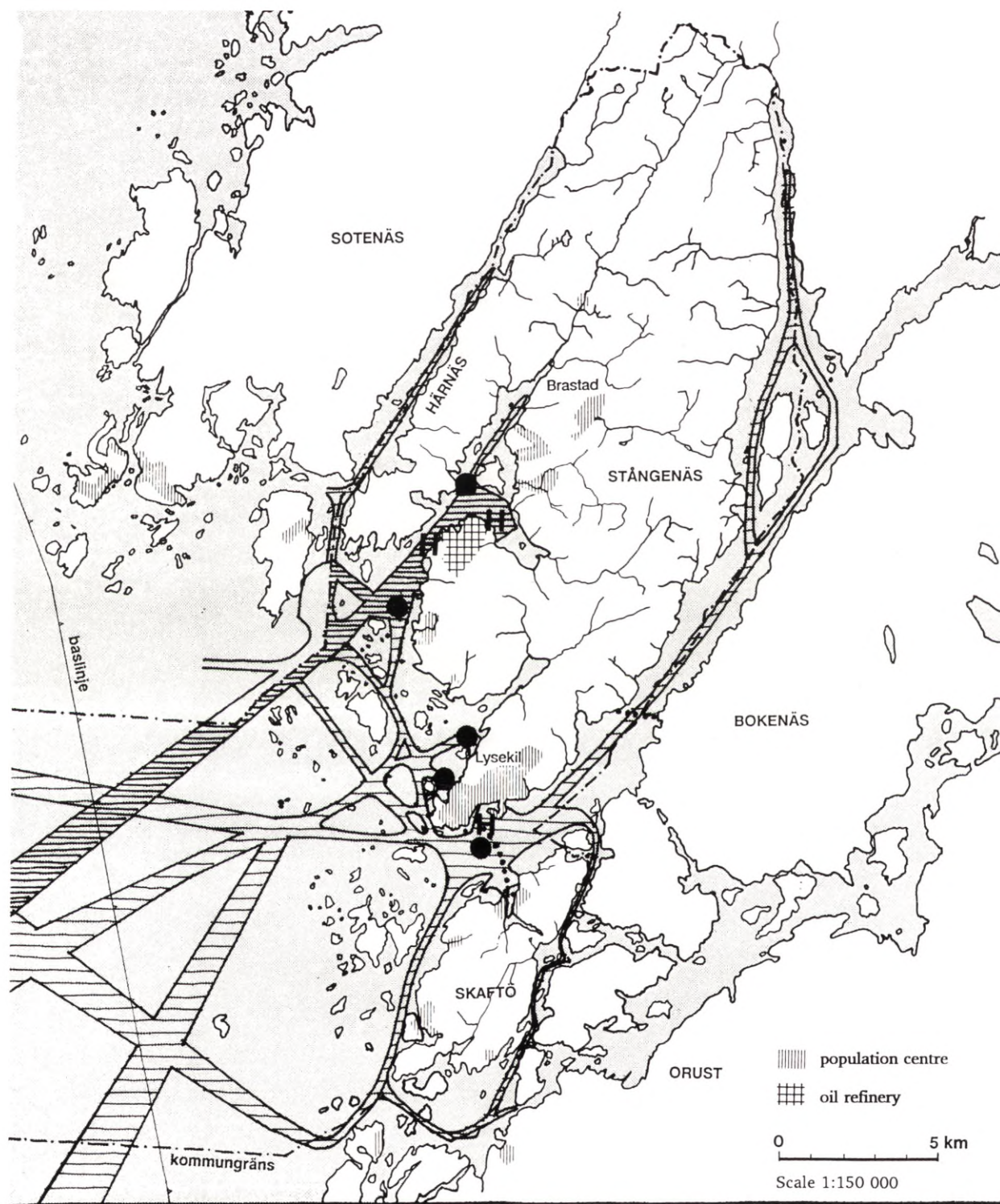
The comprehensive plan deals with sewage-treatment plants, purification plants, drinking-water resources and energy provision. Figure 5:4 points out the water and sewage system.

## **5.6 Communications**

The comprehensive plan also considers roads and railroad nets, public transports and ferry and boat traffic. The claims of shipping are exhibited in chapter 5:4 above.

## **5.7 National defence**

The national defence has interests within the land and water areas of the municipality. The interests involve for instance land possessions, noise extension areas and protected zones in connection with the military establishments. Defence interests at sea can be restricted areas, control areas, firing ranges, training areas, alternative channels, areas for underwater explosions, etc. The interests of the national defence can imply restrictions for fishing, shipping, outdoor activities and installment of wind power plants, etc.



**SHIPPING AND NAVIGATION**

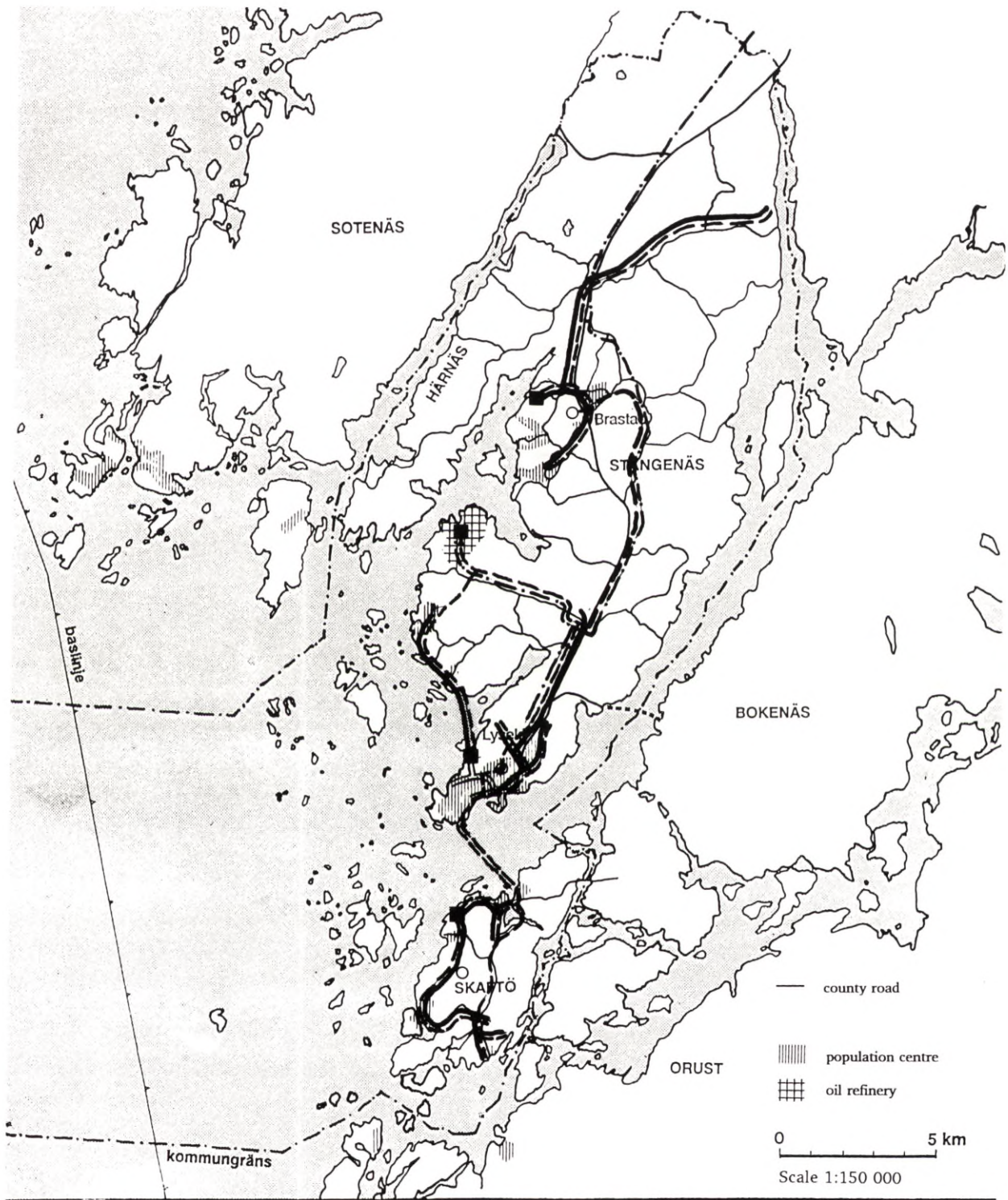
acc to the National Administration of Shipping and Navigation

- |  |                              |  |                       |
|--|------------------------------|--|-----------------------|
|  | Fairway of national interest |  | Commercial harbour    |
|  | Fairway                      |  | Anchor site           |
|  | Ferry                        |  | Lay-up site for ships |

The Municipality of LYSEKIL

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Figure 5:3



**WATER- AND SEWAGE SYSTEM**

- Sewer
- Water-mains
- Sewage tunnel

- Sewage treatment plant
- Water reservoir

The Municipality of LYSEKIL

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Figure 5:4

The air force's low flying activities can periodically disturb animal and bird life, as well as active recreational life. Underwater explosions associated with training, etc, restricts the possibilities for aquaculture and diving activities.

## 5.8 Nature Conservation

The interests for nature conservation in the Lysekil municipality are strong. According to the Natural Resources Act almost the whole community is covered by national management regulations. No interference which obviously injure natural values is allowed. Except for the proposed areas of national interest, there are other areas of great local interest. Most areas are covered by regulations for nature conservation or a proposal for such regulations.

As for the definition of marine areas it is not so easy or clear, because a good water quality, e.g. water with good conditions for the flora and fauna and recreational life, cannot be defined.

Especially in the Gullmarn fjord, the marine environment situation has been the main reason and basis for coastal planning. Research has been pursued since the end of the 19th century.

The water areas of national interest for nature conservation are:

- 1) The Gullmarn fjord with the currents on the inside of Skaftö and the archipelago outside of the estuary.
- 2) Bärfendalen-Åbyfjorden-Yttre Härnäset.
- 3) Broälven (the river of Bro)

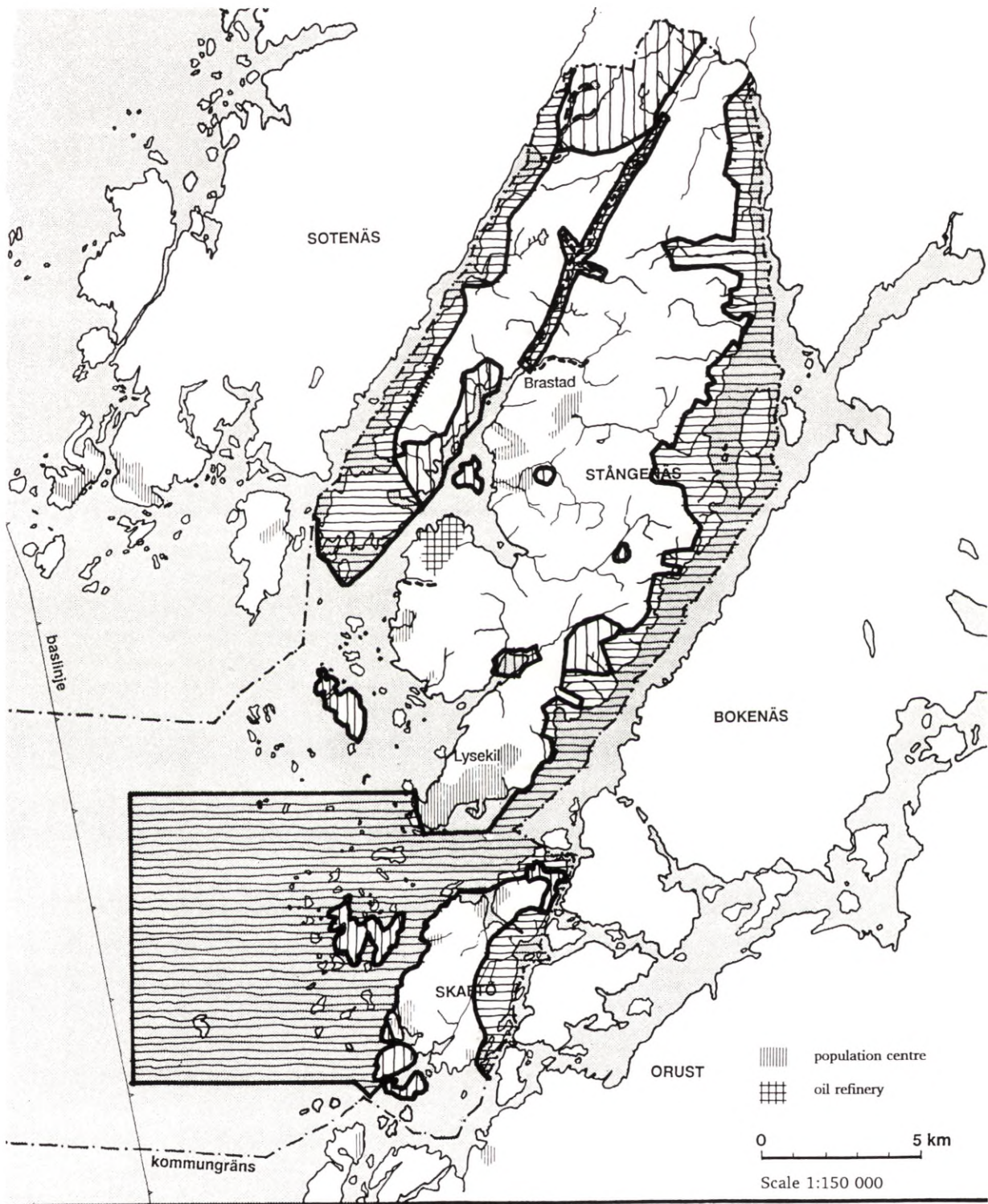
The nature conservation interests are presented in Figure 5:5. Many of these areas are protected by regulations in accordance with the Act of Nature Conservancy.

There has earlier been a single focus on marine pollution that has led to the fact that other activities in the coastal zone have been given less attention. These include impacts from fishery by overharvesting of commercial species and physical destruction of spawning-grounds and breeding places of major fish stocks and other habitats upon which vital marine resources are dependent. There is also a continuous conflict between wild animals as bird and mammals and the fishing industry, which clearly affect the marine biodiversity.




## 5.9 Ancient Culture Conservation

A programme for the conservation of ancient culture has been elaborated by the municipality. The comprehensive plan has selected some proposals from this programme (Figure 5:6).

The programme will be completed to involve also the conservation of marine historic monuments, referring to old wrecks, shipwreck areas, ports, etc. The knowledge of these remnants is incomplete and inventory work is under way.



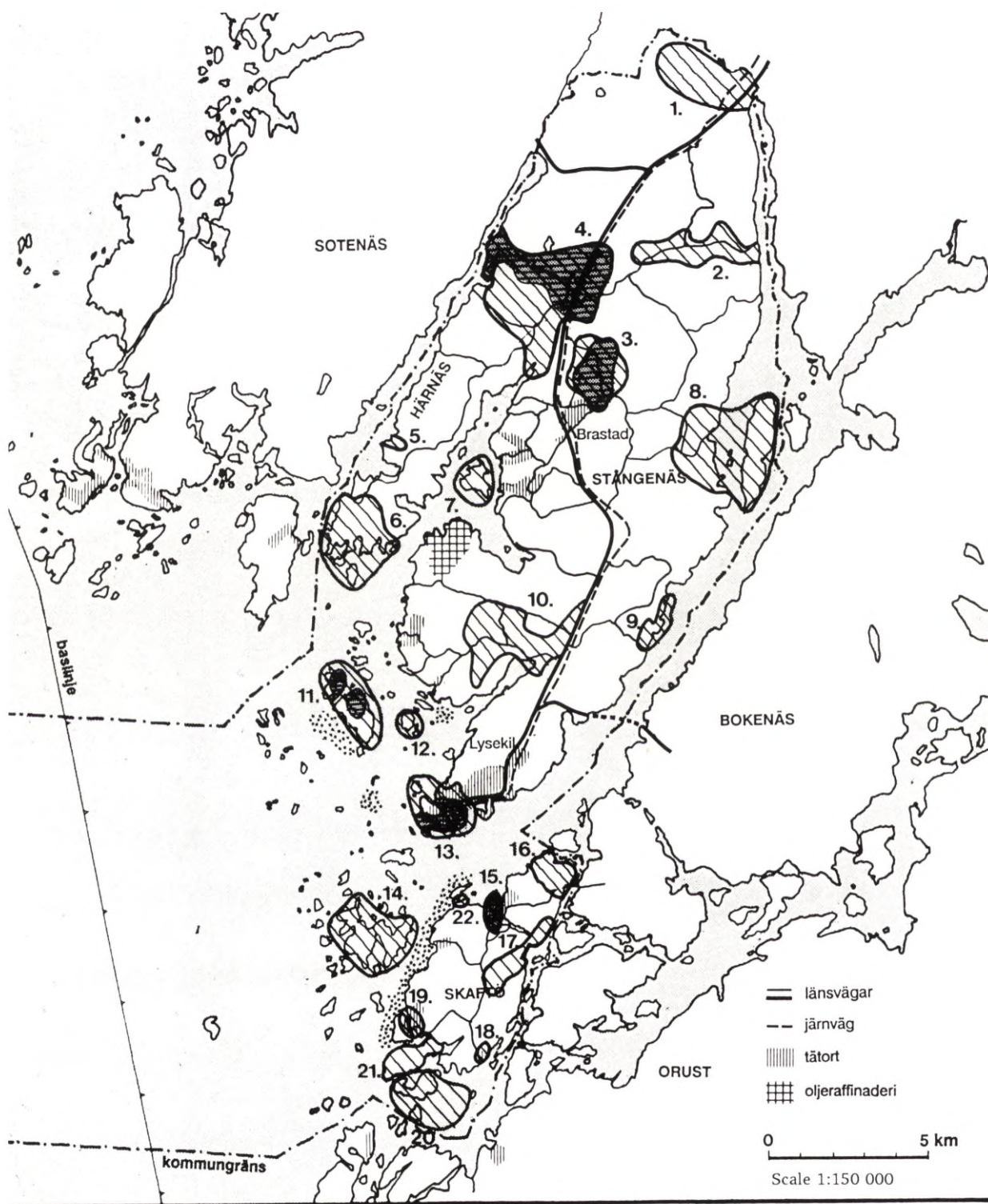
**NATURE CONSERVANCY**  
acc to the County Administrative Board

-  Area of national interest
-  Area of regional interest
-  Water course of regional interest




The Municipality  
of LYSEKIL

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Figure 5:5



CULTURE CONSERVANCY

-  Shipwreck area
-  Area of national interest
-  Areas acc to the culture concervancy inventory

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Figure 5:6

Wrecks which date 100 years or more are protected by the Act for Preservancy of Historical Monuments. Decisions of these kinds are handled by the County Administrative Board. Sportdivers must have a permit from the custodian office of national monuments to carry out smaller investigations or bringing up objects for dating.

### **5.10 Outdoor activities, recreation and tourism**

Tourism in different forms has since long existed in the municipality. The financially strong people have purchased private houses as summer cottages with belonging sheds and jetties which has lead to conflicts in the small archipelagic communities. The general public's vacational stays at the coast have sometimes also meant overcrowding and problems for the resident population. But at the same time, tourism offers a good source of income.

For the leisure life at the coast, the access to recreational areas, swimming, boatlife, fishing and nature experiences is generally of vital importance both to residents and visitors. During the summer months the pressure especially on shores is considerable. Different boat sports have developed strongly in the past 20 years. Also cultural environments of different kinds, like the old fishing-villages, have an important attractional power. Recreational installations like golf tracks, sport arenas, aquariums, etc, can be found in several places.

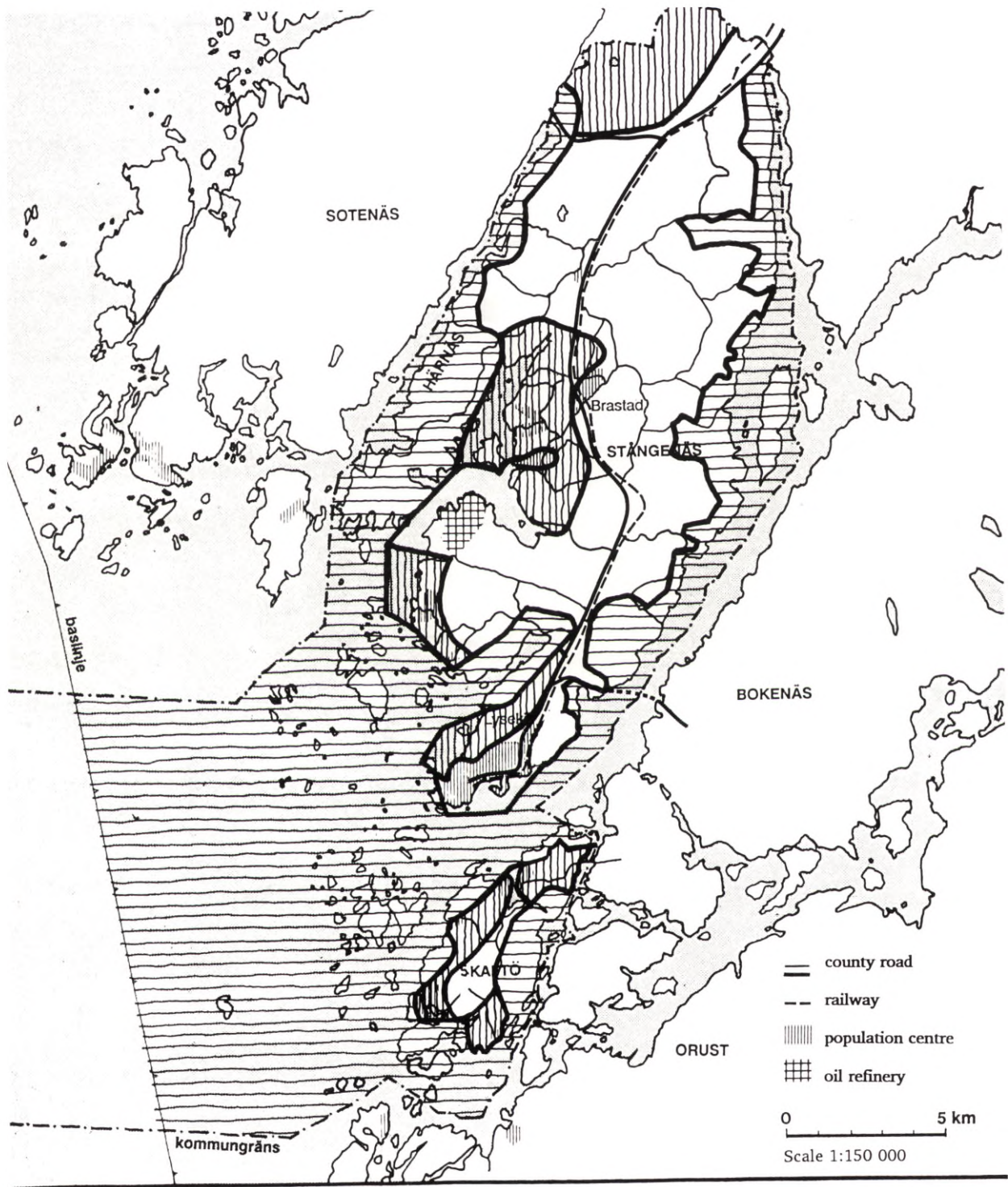
As noticed, good quality of sea water is of utmost importance. Other issues influencing tourism are communications, lodging facilities, guest harbours and service, etc. All marine areas are of national interest to sport fishing, except for some areas around certain villages and the Brofjorden area.

The interest areas for outdoor recreational activities are presented in Figure 5:7. Installations for recreational purpose and tourism appear in Figure 5:8.



#### **Marinas**

For local residents and summer visitors the supply of leisure craft and marinas is very important. The demand for permanent leisure craft sites is substantial. In the archipelago of Lysekil many lively frequented leisure craft passages run through, and there are plenty of nice natural harbours and picturesque fishing-villages.

Some types of boat sports conflict with other leisure activities and with interests for nature conservation. Noise from some larger fast-going motor craft disturb both people, animals and marine environment. Mooring by buoys, especially on soft bottoms, scrapes the bottoms and disturb the flora and fauna. The municipality's ambition is to satisfy local needs for permanent anchoring facilities and through this avoid the increase of buoy mooring .



**OUTDOOR LIFE**

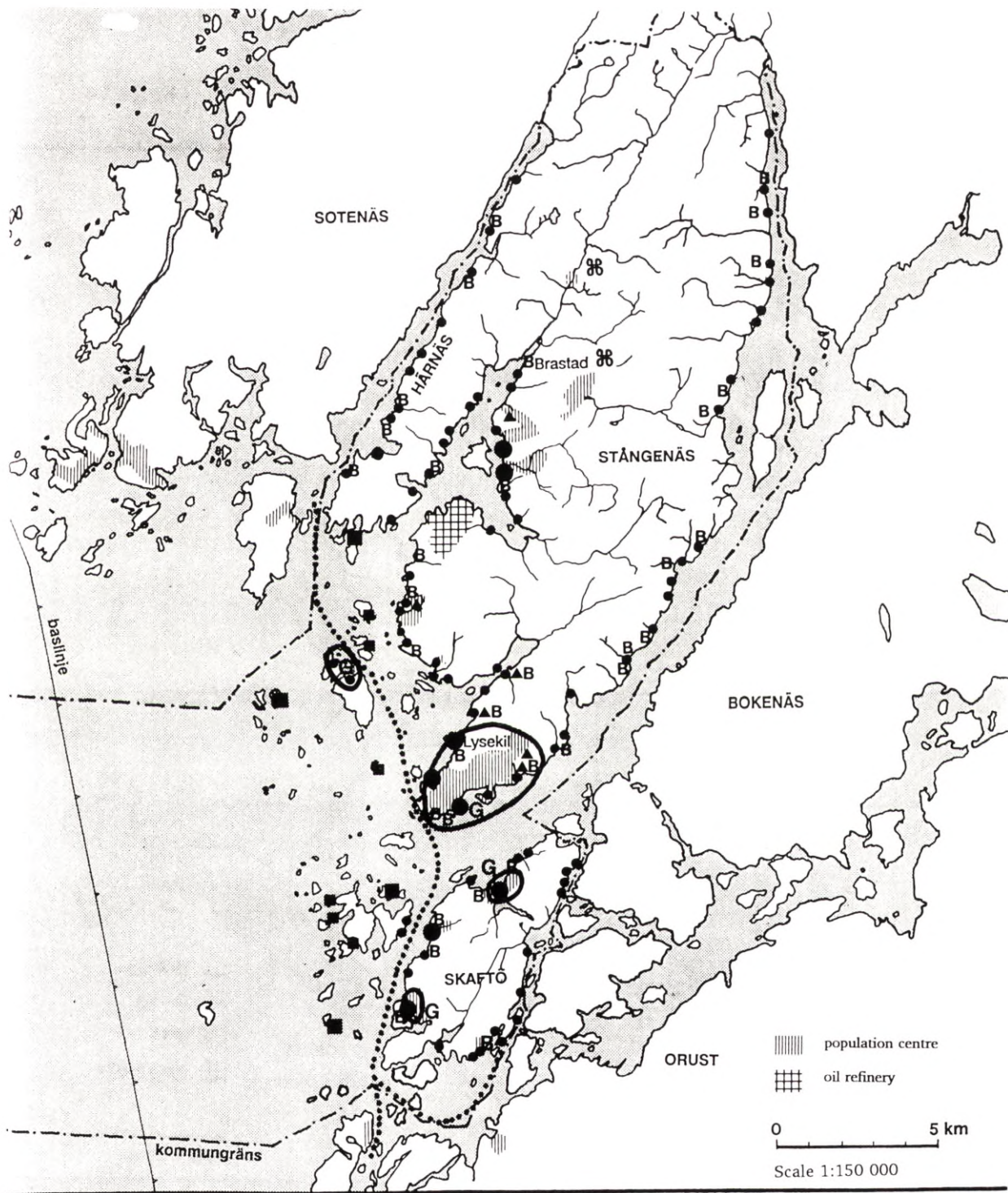
-  Area of national interest
-  Area of public interest for the Municipality

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Figure 5:7





RECREATION AND TOURISM

- Berths
- G Guest harbour
- Natural harbour
- B Bathing-place
- ▲ Camping ground
- Tourist resort with service
- ..... Popular fairway for leisure-crafts
- ⌘ Historical sight

The Municipality of LYSEKIL

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Figure 5:8

Establishment of marinas shall meet with several practical demands without clashing with nature conservation aims. A harbour should give protection for waves and wind, be situated close to attractive marine areas and close to the boat owners houses, offer car parkings, lay-up sites, stocks and crane, as well as services like sanitary installations. With regard to the environment, harbours should be sited in areas with adequate depth (>3 m), good water circulation and likely in areas where the water environment is already disturbed, for example close to already existing harbours or urban areas.

## **5.11 Fishing and aquaculture**

### **Commercial fishing**

The municipality of Lysekil has good fishing waters. Almost the whole water area is of national interest for fishing.

Mapping of catchment areas in the Gullarmarn fjord has been done by the Board of Fisheries in Gothenburg and Bohuslän. The mapping (1:50, 000) gives details on existing species, catch methods, restrictions and catchment areas (Figure 5:9).

In order to enhance a sustainable fishing, it is of utmost significance to allow the fish to reproduce and grow in a water environment clean from pollutants and toxics. Dredging, mud depositing and buoy mooring by boats in shallow areas lead to disturbance of vital reproduction areas. Anchorage, mooring of constructions at sea, wiring on the bottom, etc, interfere with fishing activities. Also military activities such as firing and underwater explosions disturb the animal life and restrict fishery.

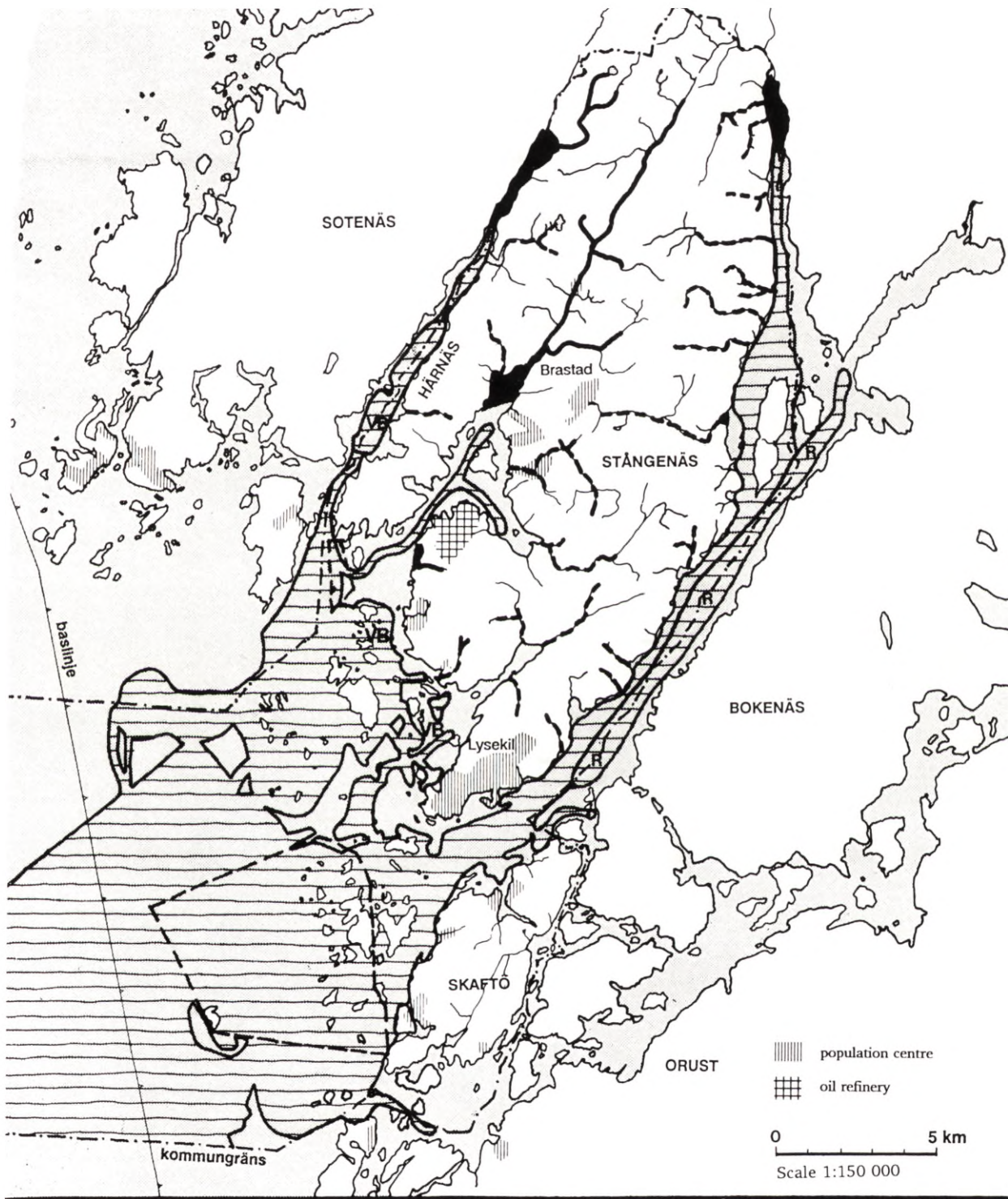
### **Shallow areas**

All the water areas within depth of between 0 and 6 metres are of national interest to fishery, with the exception of areas exploited by industry and ports, or which from other reasons are exploited or has low productivity. Upon exploitation, special studies could be necessary to evaluate the state of the shallow area.



Shallow sea areas, 0-6 metres depth, are shown in Figure 4:4






### **Watercourses**

The river Broälven, together with its tributaries Kvarnebäcken, Brobergsbäcken and Störrebergsbäcken, along with Fiskebäcken, Skårvebäcken and Bärfendalsälven are reproduction areas for sea trout. The watercourses must be protected from changes in the waterflow and from deteriorated water quality. The rivers Broälven and Bärfendalsälven are of national interest.



**FISHING**

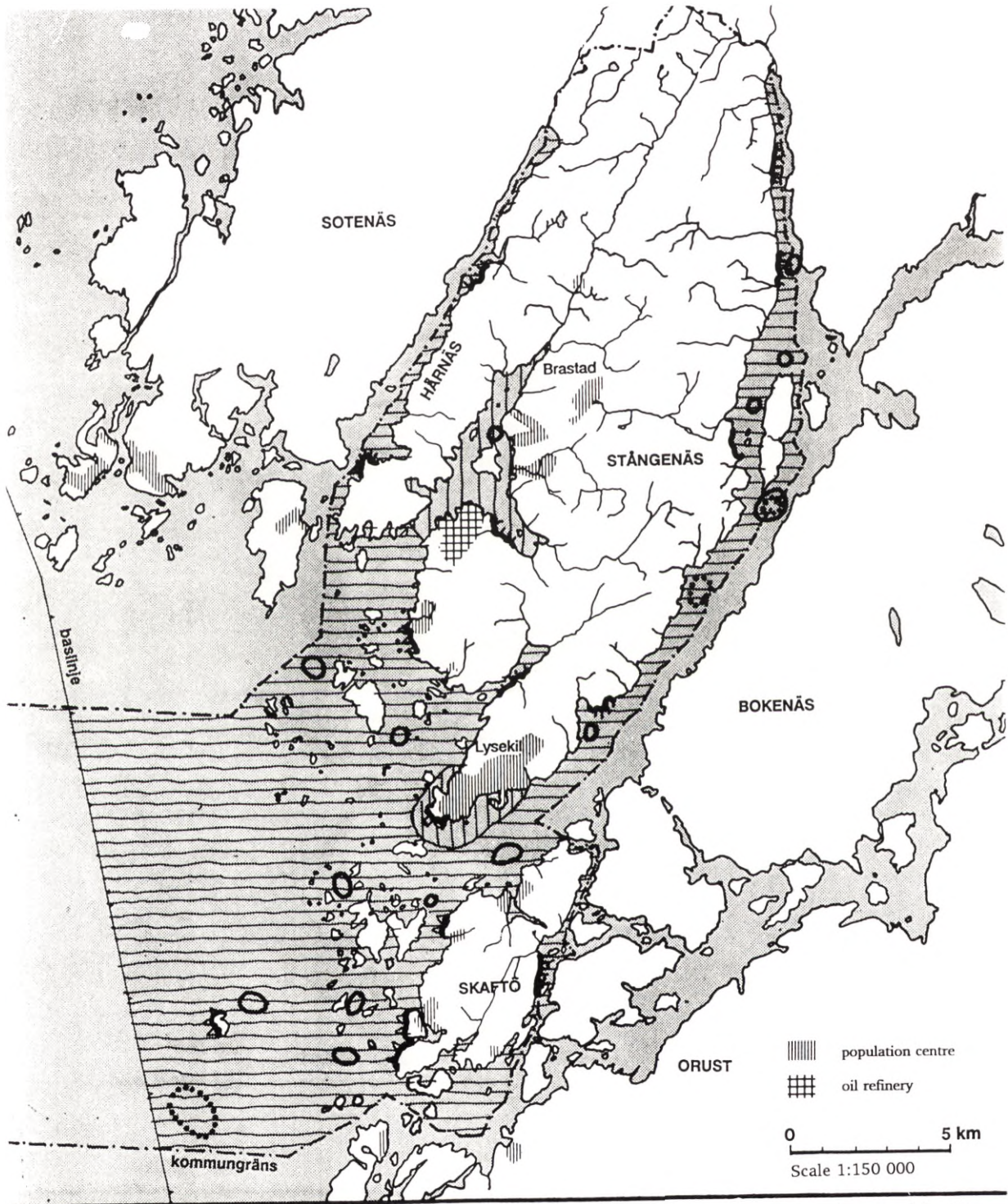
-  Fishing for crayfish, seine fisheries for herring and spret, reproduction areas for lobster, all of national interest
-  Fishing for shrimp, national interest

-  Watercourse with trout, Broälven of national interest
-  Watercourse of potential interest
-  Protected area for lobster
-  Protected area for salmon and trout
-  Area of value for aquaculture

The Municipality of LYSEKIL

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Figure 5:9



**SPORT FISHING**

acc to the regional Sport Fishermen Organisation

- |   |  |   |  |
|---|--|---|--|
|  | National interest for sportfishing         |  | Fishing ground, from boat (whiting, mackerel, etc)         |
|  | Regional interest for sportfishing         |  | Fishing ground, from shore (sea trout, garpike, cod, etc)  |
|  | Fishing ground, from boat (cod, ling, etc) |  | Fishing ground, from shore (cod, mackerel, flat-fish, etc) |

The Municipality  
of LYSEKIL

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Figure 5:10

A vegetation zone around the watercourses would give shadow and insects, i.e. the nourishment for fish would then gather around the stream. The vegetation, which absorbs nutrients, also prevents eutrophication of the watercourse. In addition, the edges of the watercourses remain firm. Vegetation shall grow wildly without any thinning or clearance, preferably it shall cover 25 metres on each side. Even a smaller vegetation zone, where slight thinning is effected, will favour the reproductional pre-conditions.

Watercourses with sea trout are presented in Figure 5:9.

### **Aquaculture**

The interest for cage culture of fish is weak due to the risk for water temperatures below 0°C in winter and poor profitability. Mussels and fish cultivations have been hit by toxic algae, leading to lesser interest in new establishments. However, the potential for mussel farming is very good. Seaweed cultivation has not been set up in the municipality.

The municipality started in 1983 an inventory work on suitable siting for aquaculture. The Board of Fisheries pointed out some areas of interest for aquaculture in the Åby fjord, as well as by Testholmen and Saltö.

When cultivating mussels and oysters the water depth must be at least 10 metres, for cage culture of fish at least 7 m. High salt content and current water are prerequisite conditions, as are relatively protected sites without strong heaving nor icedrift. There must be facilities to get rid of feed spill, fish rest products and offals either by taking care of it, composting or discard it in the sea. Except for the culture itself there must also be sufficient space for ropes, anchorage, buildings for slaughter and transport facilities on land, etc.

In the comprehensive plan only four areas are mentioned as being suitable for aquaculture. Except for smaller trial cultivations no other areas have yet come into use.

### **Recreational fishing**

In the municipality of Lysekil recreational fishing activities are exercised extensively. The recreational fishing, can be divided into two categories; sport fishing and fishing for private consumption. These categories sometimes come to conflict. Nevertheless, the main common interest is that good life conditions for the fish is sustained through guaranteeing good water quality and protecting reproduction areas to secure good catches in the future. Sport fishing is to a large extent practiced by tourists which are temporarily visiting the municipality. They mostly use hooks and fish cod, mackerel, sea trout and whiting. The fishing is done from shores or boats. The organisation "Sport Fishermen, Gothenburg and Bohuslän" has pointed out places which are easy to reach, offer good fishing opportunities and can take a large fishing pressure.

Fishing for consumption is important to many residents of the municipality. It is often done with nets and traps. The catches are, among others, cod, haddock, flat-fish, lobster and crab. Important recreational fishing areas are pointed out in Figure 5:10.

## 6. COMPREHENSIVE PLAN FOR THE USE OF LAND AND WATER AREAS

One of the main issues is whether an area is to be preserved or developed. For large parts of the municipality, it is assumed that the current land and water use will continue. Many areas are protected by nature conservation regulations or through the municipality's restrictive attitude to, and special demands on, dispersed development. Important natural environment and historic values are also protected by the special management regulations in the Natural Resources Act.

Development in urban areas will occur in all districts of the municipality and recreational developments are planned for certain areas. Leisure craft harbours will be constructed in a few places. Smaller industries and installations outside of urban areas will be permitted to a limited extent.

The plan is described below in **two maps** with the following texts:

**"The use of land and water areas"** (page 45). This map shows the future use of different areas as well as current land uses.

**"Regulations and Recommendations"** (page 51). This map shows where development will be permitted, where it can be altered or preserved, as well as the regulations for the different areas.

These maps (the comprehensive plan) serve the construction, environment and public health committees in their assessment of building and other permits. They also provide information to the public about regulations for the use and development of land and water areas.

### 6.1 Changes in the use of land areas

The rate and order in which development is to take place, the construction of schools and preschool facilities, communications, etc, are dealt with in a special study entitled "JPC-Joint Planning Criteria". This also includes the objectives for population growth, service levels, economic priorities, etc. The proposed housing provision programme notes the assumed increase in population and housing construction for 1990-1995.

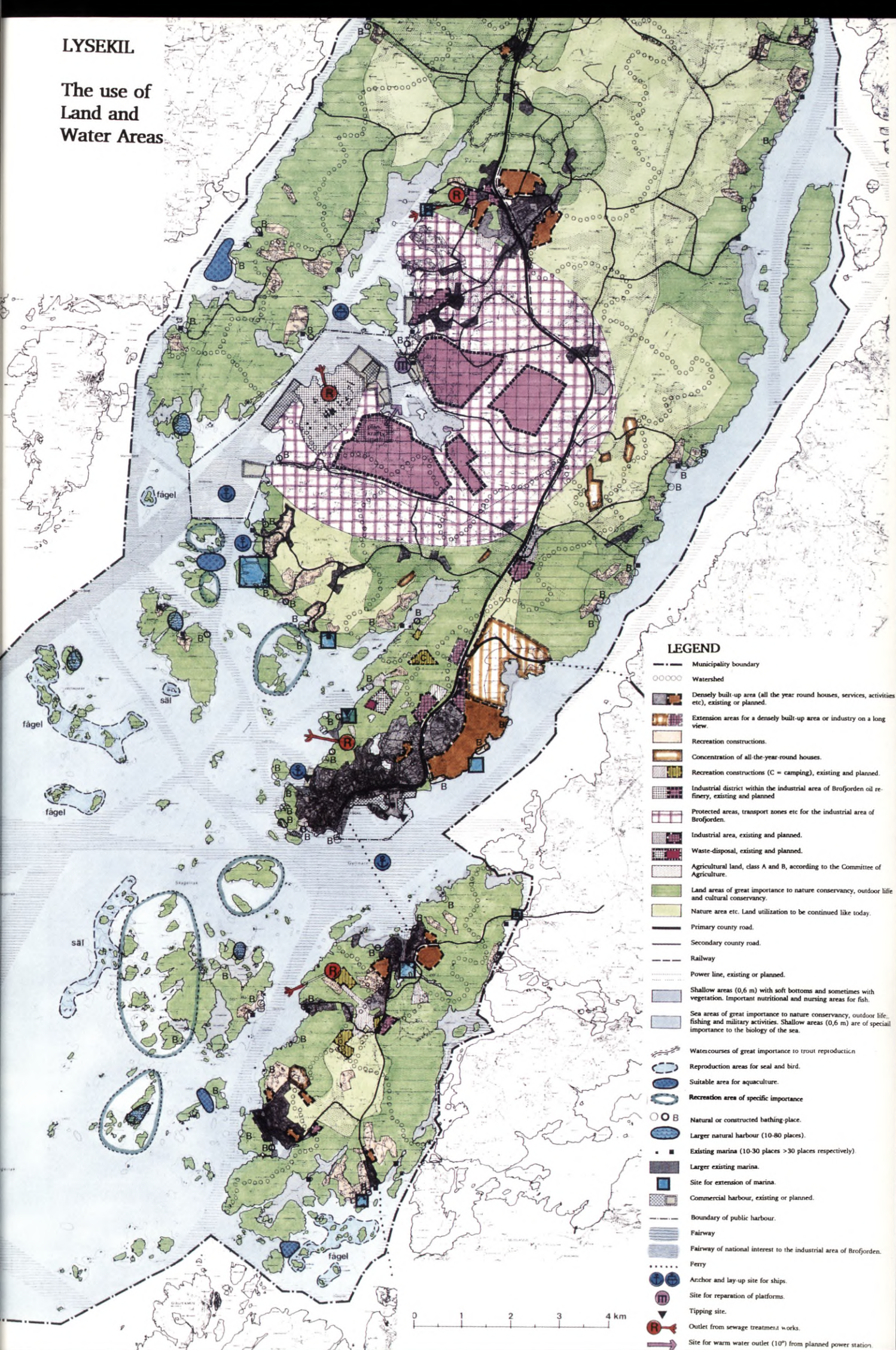
The description of changes in the use of land areas has been excluded in this report on coastal planning. The areas concerned can be found on the map entitled "The use of land and water areas".

### 6.2 Changes in the use of water areas (the sea)

This is a summary of the changes in use of water areas. The areas are depicted on the map entitled "The use of land and water areas".

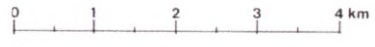
# LYSEKIL

## The use of Land and Water Areas



### LEGEND

- Municipality boundary
- Watershed
- Densely built-up area (all the year round houses, services, activities etc), existing or planned.
- Extension areas for a densely built-up area or industry on a long view.
- Recreation constructions.
- Concentration of all the year-round houses.
- Recreation constructions (C = camping), existing and planned.
- Industrial district within the industrial area of Brofjorden oil refinery, existing and planned
- Protected areas, transport zones etc for the industrial area of Brofjorden.
- Industrial area, existing and planned.
- Waste-disposal, existing and planned.
- Agricultural land, class A and B, according to the Committee of Agriculture.
- Land areas of great importance to nature conservancy, outdoor life and cultural conservancy.
- Nature area etc. Land utilization to be continued like today.
- Primary county road.
- Secondary county road.
- Railway
- Power line, existing or planned.
- Shallow areas (0,6 m) with soft bottoms and sometimes with vegetation. Important nutritional and nursing areas for fish.
- Sea areas of great importance to nature conservancy, outdoor life, fishing and military activities. Shallow areas (0,6 m) are of special importance to the biology of the sea.
- Watercourses of great importance to trout reproduction.
- Reproduction areas for seal and bird.
- Suitable area for aquaculture.
- Recreation area of specific importance
- Natural or constructed bathing place.
- Larger natural harbour (10-80 places).
- Existing marina (10-30 places >30 places respectively)
- Larger existing marina.
- Site for extension of marina.
- Commercial harbour, existing or planned.
- Boundary of public harbour.
- Fairway
- Fairway of national interest to the industrial area of Brofjorden.
- Ferry
- Anchor and lay-up site for ships.
- Site for reparation of platforms.
- Tipping site.
- Outlet from sewage treatment works.
- Site for warm water outlet (10°) from planned power station.



### **Water quality**

In the planning work, it has been stated that good water quality is of utmost importance to biological life in the sea. It is also important to people's well-being and to activities such as swimming, fishing, etc.

Attempts to limit the negative impacts on marine areas are described in the action programme, Chapter 7. The programme primarily regulates conditions on land. The actions proposed are for example reductions in discharges and restrictions on certain activities, etc.

### **Sewage-treatment plants**

There are four large sewage-treatment plants; Loddebo, Hamrevik at Scanraff, Långevik and Skaftö. Loddebo's existing capacity is insufficient and must be improved.

The establishment of the Brofjorden power station will involve the discharge of treated sewage water.

### **Cooling water**

Cooling water, resulting in a 10° C increase in temperature in the recipient area, is discharged into Brofjorden. Its location and possible heat utilization is being jointly studied in the work on the detailed development plan for the power station.

### **Protection of coastal waters**

Most of Lysekil's water areas are of national interest in terms of conservation. In many cases, this refers to the preservation of the landscape, public accessibility, etc. In other areas, it refers to the feeding and reproduction areas of seals and birds. Nature conservation regulations are the prime means of control. (See map entitled "Regulations and recommendations"). The major part of the coastal area is to be preserved. Changes may take place around the Lysekil urban area, at the Brofjorden industrial area and at several of the smaller settlements along the coast. (See map entitled "Regulations and Recommendations", areas Rv1, Rv2 and Rv4).

### **Marinas**

The development of marinas should primarily involve the extension of existing installations: Loddebo, Basteviksholmarna, Norra Grundsund, Vallbodalen, Norra Hamnen, Fiskebäckskil, Stockevik and Rågårdsvik.

A new marina may be established in the Fiskebäck area of the Lysekil urban area. It is motivated by the proposed expansion of the urban area and should provide an alternative to



existing buoy moorings and the uncontrolled construction of jetties. Expert studies and assessments of ecological, economic and social impacts will be carried out prior to possible harbour establishments. There will be minor extensions to existing harbours and maintenance work on existing installations.

### **Swimming**

Municipal swimming facilities are to be extended at Gullmarsbaden for the large housing areas at Fridhem and Mariedal and at Fiskebäck for the proposed housing developments in that area. The swimming facility south of the Grundsund church is this community's only facility suitable for small children. It is therefore suggested that it should remain, in spite of the fact that its water quality is sometimes poor owing to surrounding marinas.

### **Shallow water areas**

Shallow water areas (between 0-6 metres in depth) with mainly sedimentary beds, and in some cases with vegetation, are of great biological importance as feeding and breeding areas for fish. The areas selected in the plan exhibit high production and are relatively unaffected by other impact factors. For these reasons dredging or mud depositing should be prevented, and anchoring at buoys avoided, so that these favourable biological conditions do not deteriorate.

### **Watercourses**

The Broälven River, together with its tributaries Kvarnbäcken, Brobergsbäcken and Störrebergsbäcken, as well as Fiskebäcken, Skårvebäcken and Bärfendalssälven, are spawning areas for salmon trout. These watercourses should therefore be protected from changes in flow as well as from deterioration of water quality.

A vegetation zone around each watercourse provides shade for the insects on which fish feed. Vegetation also absorbs nutrients thus preventing watercourse overfertilization. Stabilization of watercourse banks is also achieved. Vegetations should preferably be wild, not requiring thinning out and form a 25 metres zone on each side. However, smaller vegetation zones, with minor thinning out as well as individual trees, will also favour spawning conditions.

### **Aquaculture**

The plan indicates four areas as suitable for aquaculture. At Grotö and Jonsborg offshore from Skaftö, at Flatholmen offshore from Skalthamn and at Åbyfjorden offshore from Styrsvik. Apart from a few, smaller fish-farming experiments, no areas have been exploited to this date.

### **Fishing**

Commercial fishing, according to the County Fishery Board's surveys, can be carried out except where other activities are in progress such as the fairway leading to the Brofjorden industrial area. In areas of importance to lobster spawning, dredge depositing should not be permitted. During the consultation phase, the suitability of and opportunities for establishing a fishing reef from waste stone rubble was studied.

### **Commercial harbours**

The harbours at Lysekil and Brofjorden are public harbours. Brofjorden can be expanded at the mouth of Trommekilen and south of Fiskebäcksvik. Until this takes place, dredging and mud depositing should be avoided.

Grundsund is a fishing harbour which in 1990 was transferred to municipal ownership.

### **Mud deposit**

The municipality's mud deposit in the northern harbour area will soon be filled. A suitable new site for mud depositing will be selected in the future.

### **Fairways**

Existing channels are shown in the plan. In these areas, shipping shall not be impeded by other activities or permanent installations.

### **Oil platform repairs, anchorages, etc.**

A suitable site for platform repairs is indicated offshore from Lahälla.

Places for anchoring or laying up of ships are indicated at Gullmarn in Lysekil, at the northern harbour and Vallbodalen, and also in the vicinity of the Brofjorden beyond the base line.

### **Military activities**

National defence interests are extensive within marine areas of the municipality. These include restricted areas, firing ranges, training areas, alternative channels, areas for underwater explosions, etc. These areas are not indicated, but the municipality supervises the possible risk of conflicts.

## 6.3 Regulations and recommendations

### Regulations

The different regulations and recommendations are shown on the map "Regulations and Recommendations" below.

The regulations include:

- Areas with an adopted detailed plan or where such work is ongoing (D on the map).
- Areas covered by ordinances or special regulations and requiring permit approval by the County Administrative Board (F on the map).

### 6.3.1 Recommendations for the use of land areas

Within the Lysekil municipality, considerable restriction is placed on new developments outside of areas covered by detailed development plans. Nearly the whole of the municipality area is covered by national interests and special management regulations in accordance with the Natural Resources Act. The pressures for new developments and the increase in property values are at times considerable. New development shall primarily be permitted through the drafting of detailed development plans. In that way, the interests of the public can be taken into consideration and jointly assessed so that a good level of services can be planned for the municipality's inhabitants. Too extensive, dispersed developments are regarded as unsuitable in relatively undisturbed areas of great natural environment and historic value.

For developments outside of areas covered by detailed development plans, clusters of dwellings or areas with area regulations, special regulations apply.

For the erection of buildings required for farming, fishing, forestry and similar livelihoods, it is not necessary to apply for a building permit in areas not covered by detailed development plans or regulations. However, development is not permitted if it prevents the use of valuable agricultural land except where a building is required for agricultural purposes.

When assessing the suitability of new developments, consideration shall be given to what other land use interests exist in the area. Other issues to be considered in the assessment of suitability are how road access is solved, how buildings are adapted to the site and the landscape; the availability of school bus services, general services and public transport; refuse collection, snow ploughing, geotechnical conditions, how water and sewage are to be solved, etc.

The recommendations concerning the use of land areas are not described in detail in this report on coastal planning.

### **6.3.2 Recommendations for the use of water areas**

(Rv1, etc, refers to the map on page 51)

#### **Rv1 Water areas where the municipality may wish to expand and install new marinas, swimming areas or other installations related to built-up areas.**

New installations are preceded by the preparation of detailed development plans. Special studies may be required where seabed areas are of national interest to fishing.

#### **Rv2 Water areas for port activities**

Measures which affect the future use of water areas shall be preceded by the drawing up of a detailed development plan.

#### **Rv3 Water area which is also a public harbour**

The owner of the harbour has a special right to acquire and utilize the water area. Lysekil's harbour is of national interest for national defence purposes.

#### **Rv4 Water area for port in connection with the Brofjorden industrial area**

Where there are biologically valuable, shallow seabed areas, these are protected until the harbour is expanded. New constructions are preceded by the preparation of a detailed development plan.

#### **Rv5 Water area of public interest for aquaculture**

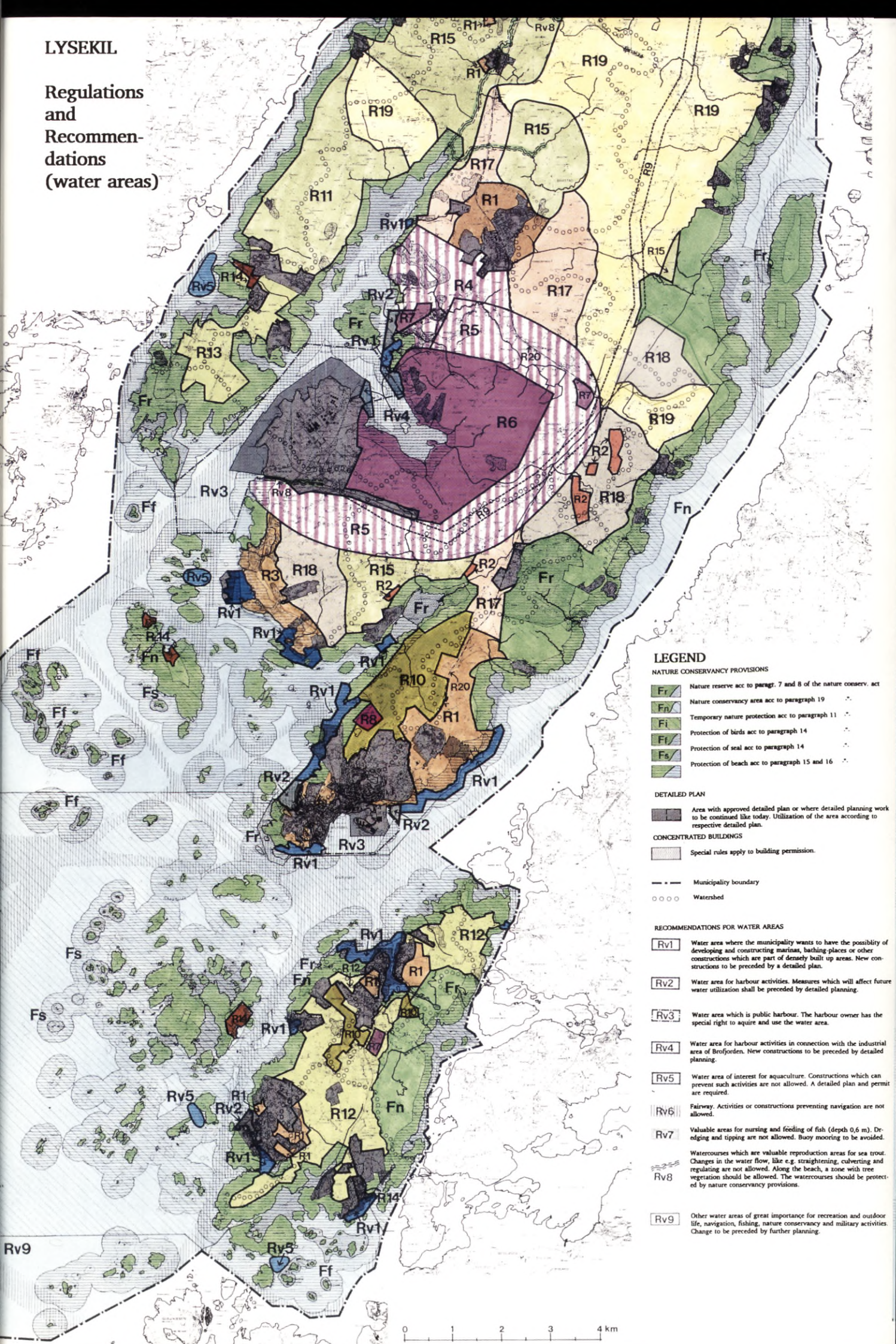
Installations which can prevent such activities are not permitted. A detailed development plan is required. Permits are also required from the National Board of Fisheries as well as the County Administrative Board.

#### **Rv6 Shipping channel**

Activities or installations which are an obstacle to shipping are not permitted. The channel leading to Brofjorden is of national interest.

# LYSEKIL

## Regulations and Recommendations (water areas)



### LEGEND

#### NATURE CONSERVANCY PROVISIONS

- Nature reserve acc to parag. 7 and 8 of the nature conserv. act
- Nature conservancy area acc to paragraph 19
- Temporary nature protection acc to paragraph 11
- Protection of birds acc to paragraph 14
- Protection of seal acc to paragraph 14
- Protection of beach acc to paragraph 15 and 16

#### DETAILED PLAN

- Area with approved detailed plan or where detailed planning work to be continued like today. Utilization of the area according to respective detailed plan.

#### CONCENTRATED BUILDINGS

- Special rules apply to building permission.

#### Municipality boundary

- Municipality boundary
- Watershed

#### RECOMMENDATIONS FOR WATER AREAS

- Rv1** Water area where the municipality wants to have the possibility of developing and constructing marinas, bathing-places or other constructions which are part of densely built up areas. New constructions to be preceded by a detailed plan.
- Rv2** Water area for harbour activities. Measures which will affect future water utilization shall be preceded by detailed planning.
- Rv3** Water area which is public harbour. The harbour owner has the special right to acquire and use the water area.
- Rv4** Water area for harbour activities in connection with the industrial area of Brofjorden. New constructions to be preceded by detailed planning.
- Rv5** Water area of interest for aquaculture. Constructions which can prevent such activities are not allowed. A detailed plan and permit are required.
- Rv6** Fairway. Activities or constructions preventing navigation are not allowed.
- Rv7** Valuable areas for nursing and feeding of fish (depth 0,6 m). Dredging and tipping are not allowed. Buoy mooring to be avoided.
- Rv8** Watercourses which are valuable reproduction areas for sea trout. Changes in the water flow, like e.g. straightening, culverting and regulating are not allowed. Along the beach, a zone with tree vegetation should be allowed. The watercourses should be protected by nature conservancy provisions.
- Rv9** Other water areas of great importance for recreation and outdoor life, navigation, fishing, nature conservancy and military activities. Change to be preceded by further planning.

0 1 2 3 4 km

**Rv7 Valuable growth and feeding areas for fish**

Dredging and dumping is not permitted. Anchorage to buoys shall be avoided. Productive shallows (0-6 m depth) are of national interest to commercial fishing. The most valuable areas may become protected according to the Nature Conservancy Act.

**Rv8 Watercourses which are valuable spawning areas for salmon trout**

Changes in water flow, as a result of the straightening out of a watercourse, the use of culverts and flow regulation, are not permitted. A zone of trees should be retained along the banks in the future. Watercourses may be protected by a nature conservation ordinance.

The Broälven and Bärfendalsälven rivers are of national interest for nature conservation.

**Rv9 Other water areas of great importance to recreation and outdoor activities, shipping, fishing, nature conservation and military activities**

Before making changes to these areas a planning survey must be carried out.

These areas are, for the most part, of national interest to outdoor life, commercial fishing and nature conservation.

The national defence interests are extensive and are not described here. The municipality supervises possible conflicts of interest. When such risks exist or are likely to arise, the matter is submitted, via the County Administrative Board, to the military commander for the defence area. Physical plans, etc are routinely submitted to the military authorities for consultations with the County Administrative Board.

## **7. ACTION PROGRAMME TO REDUCE THE STRAIN ON MARINE ENVIRONMENT**

A good water quality is absolutely necessary for a sustainable use of marine areas for outdoor life, tourism and fishing. Each municipality has its own prerequisite conditions for considering the discharge situation and protection of water areas. It is important to have a good knowledge about each municipality's special characteristics in order to proceed with a comprehensive planning and to take appropriate measures for reducing the strain on marine areas. Action towards reducing the municipality's discharge is important to the improvement of water quality in bays and in archipelagic areas, but also to enhance the national conservancy goals. To be able to influence large scale changes, actions must be coordinated through international agreements and national goals. The municipalities must coordinate their activities via county administrative boards.

### **7.1 National objectives and measures**

The Natural Resources Act expresses the national objectives for the use of coastal and marine areas and the Act aims at guaranteeing an optimal and sustainable use of land and water resources. The purpose of the comprehensive plan is in this context, to serve as some kind of agreement between the state and the municipality, as on how contributing to the fulfillment of national objectives.

Beyond the NRA objectives for land and water use, consideration must also be given to national environmental goals. The action programme of the Swedish Environmental Protection Board on marine pollutants states the following national objectives:

- ☐ Species which are by nature found in marine areas, shall be allowed to sustain healthy and balanced populations.
- ☐ There must be an ambition to keep a natural flora and fauna in marine areas.
- ☐ Zones, which are evidently lacking oxygen in the bottom waters, must not to be found.
- ☐ In marine areas, fishery activities must be carried out in a sustainable way.
- ☐ Fish and shellfish shall serve as food without endanger to health.
- ☐ Pollutants, in and on waters, shall not limit the recreational value of marine areas.

In order to meet with these environmental objectives, a number of objectives for discharges, within the framework of different international conventions, have been passed by an Act of Parliament for the period up to 1995:

- A 50 % reduction of the waterborne nitrogen and phosphorus discharge into the sea up to 1995, compared to the values of 1985.
- A 50 % reduction of the discharge of some stable organic environmental pollutants into the sea up to 1995, compared to the values of 1985.
- A 50 % reduction of the toxic metal discharge into marine areas up to 1995. As refers the metals mercury, cadmium and lead, the discharge is to be reduced by 70 %, compared to the values of 1985.
- As for oil - the work with finding appropriate discharge restrictions is under way.

The Swedish Environmental Protection Board has commissioned the County Administrative Boards in the coastal counties, to form three action groups; Actiongroup West, South and North, of which the task is to regularly present current discharge data, and propose measures to improve the marine environment as well as follow up the effects from these suggested measures.

Actiongroup West works with the environmental conditions in Skagerrak, Kattegatt and Öresund. The counties which border on these marine areas are Gothenburg and Bohuslän, and the counties of Halland, Kristianstad and Malmöhus. The following objectives and suggestions on actions have been presented:

- Annual inventory of discharges, presented every third year and summarized in environmental analyses for each county.
- Sewage-treatment plants: At least a 95 % phosphorus purification and 50 % nitrogen purification.
- Overflow from non purified waste water should be limited.
- Industrial discharges must be subject to the same demands as on municipal purification plants.
- Private sewage must be dissolved through infiltration.
- Manure-treatment plants must have 8 months capacity.
- Regulations on the spreading of manure out in the fields.
- Municipalities must make inventories of: Private sewers, daily water and overflow volumes, and manure-treatment plants.
- Action proposals for stable organic substances, metals and oil shall be ready by 1995.



## 7.2 Regional and intermunicipal cooperation

The municipalities in a drainage area are mutually responsible for keeping the effects on coastal water areas, where their common watercourse flows out, as minimal as possible. In Sweden, there are at present around 40 water protection federations, established in accordance with the Water Act, plus a number of voluntary water protection federations.

The work realised in the drainage area of the Gullmarn fjord in Bohuslän and Dalsland's county was committed within the framework of such a voluntary water protection federation. The purpose was to preserve unique marine environments of Gullmarn. In 1980, an intermunicipal and county covering collaboration between the municipalities and two counties was initiated. This collaborative work resulted in a plan for the drainage area of Gullmarn, which was divided into three zones. The first zone, closest to the fjord, has the most rigid regulations on what refers to the demand on sewage-treatment plants and measures taken towards direct discharges to the fjord.

Apart from intermunicipal cooperation in a drainage area, collaborative work can also include the coastal municipalities in a common coastal area. The collaboration is often formalised through a regional coastal water protection federation. These federations observe changes in the environment and water quality of coastal water areas. Through joint financing of sampling, the municipality obtains data on the conditions of coastal water areas which are useful in municipal coastal planning. The municipality of Lysekil takes part, together with the other municipalities of the county, in such a water protection federation.


## 7.3 Municipal action programme

In connection with the planning of Gullmarn's drainage area, the Lysekil municipality formulated an action programme aiming at reducing the strain on the marine environment. These actions have been followed up with regard to the comprehensive planning for the whole municipality. Examples of measures that have been taken or planned are:

- Inventory of private houses' sewers.
- Information to private homeowners on how they can improve their waste water installations.
- Mapping of risks and surveying of potential polluters among the industries.
- Improvement of the sanitary conditions for recreational installations and marinas.
- Information in the guest harbours on the environmental problems of the leisure traffic.
- Investigation on the need for new marinas.
- Investigation on the future protection of the Broälven river.

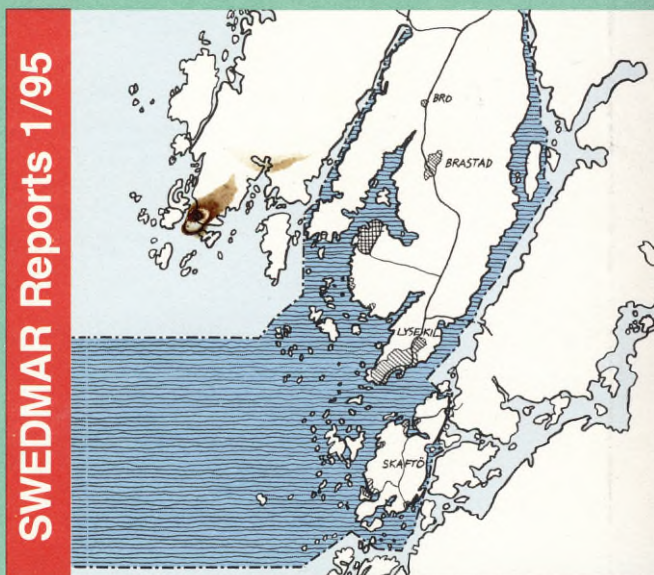
- Investigation on suitable siting for dredge deposit.
- Environmental survey for the industrial area of Brofjorden.
- Advanced comprehensive planning and area assessments for densely populated areas, etc.





**This report focuses on coastal area planning as a process to include physical, biological and human components within a comprehensive management framework for the coastal zone. The comprehensive plan of the Municipality of Lysekil could be seen as an example of the Swedish approach to coastal and marine management at municipal level.**

**The report has been prepared as a background document for the environmental cooperation around the Baltic Sea.**



**SWEDMAR**

*A unit within the National Board of Fisheries*

