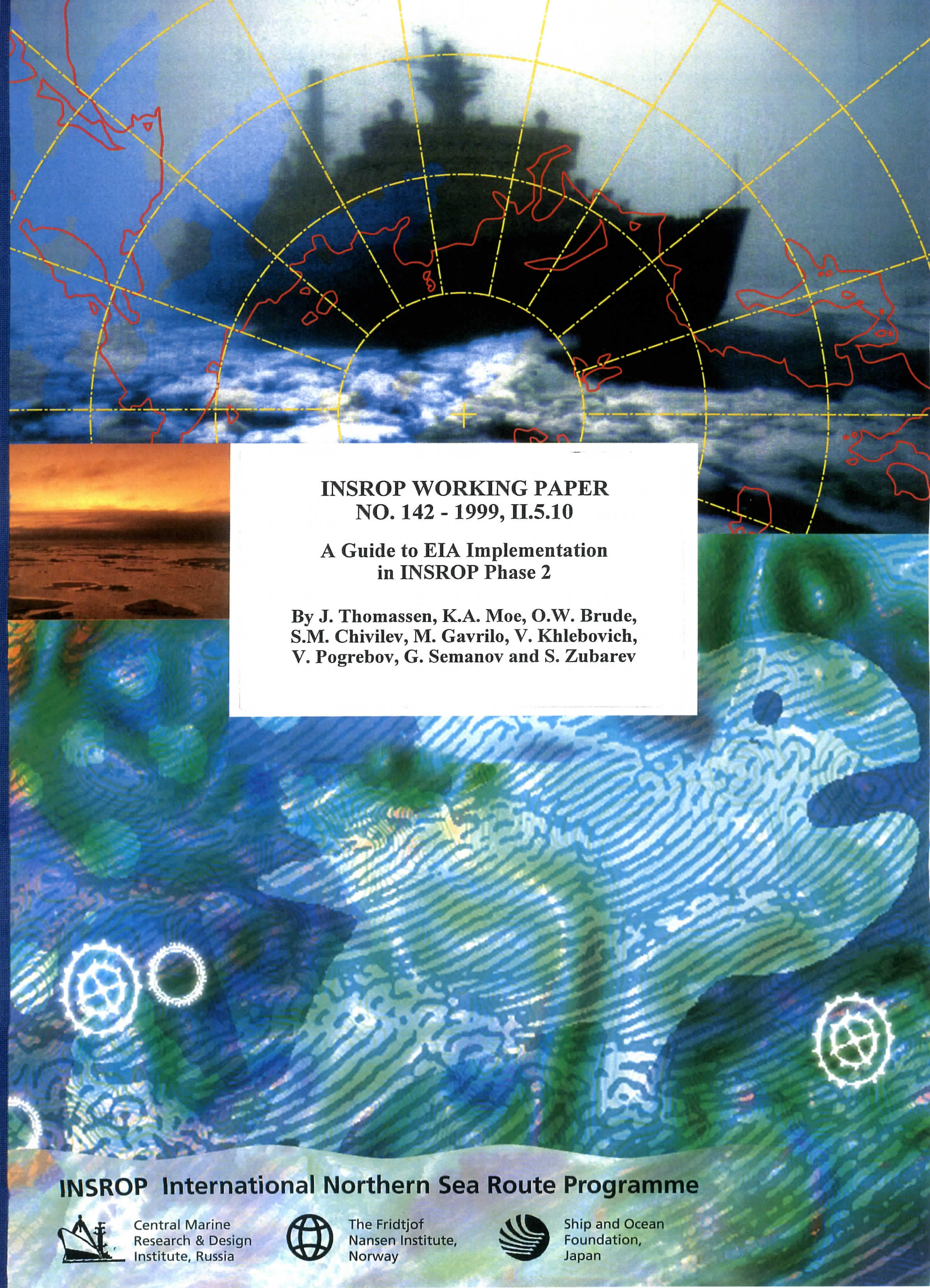

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A Guide to EIA Implementation in INSROP Phase 2

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INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship and Ocean Foundation, Japan

International Northern Sea Route Programme (INSROP)

Central Marine Research & Design Institute, Russia

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Sub-Programme II: Environmental Factors

Project II.5.10: Environmental Impact Assessment

Supervisor: Jørn Thomassen

Title: **A Guide to EIA Implementation in INSROP Phase 2**

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What is an INSROP Working Paper and how to handle it:

This publication forms part of a Working Paper series from the **International Northern Sea Route Programme - INSROP**. This Working Paper has been evaluated by a reviewer and can be circulated for comments both within and outside the INSROP team, as well as be published in parallel by the researching institution. A Working Paper will in some cases be the final documentation of a technical part of a project, and it can also sometimes be published as part of a more comprehensive INSROP Report. For any comments, please contact the authors of this Working Paper.

FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the successor state to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

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- Nippon Foundation/Ship & Ocean Foundation, Japan
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- Murmansk Shipping Company, Russia
- Northern Sea Route Administration, Russia
- Arctic & Antarctic Research Institute, Russia
- Norwegian Polar Research Institute
- SINTEF (Foundation for Scientific and Industrial Research - Civil and Environmental Engineering), Norway.

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PREFACE

The INSROP Sub-programme II: Environmental Factors, is principally an assessment of the potential environmental impacts of shipping, navigation and related activities on the NSR (e.g. EIA, Hansson 1992, 1993, Hansson & Moe 1996). Faced to the transitional state of Russian environmental management strategies during the 90's, a call for a flexible approach was early recognised. One-off solutions should be avoided – re-use of the findings should be emphasised. Consequently, the concept of baseline environmental data integration, tailored routines for damage analyses and a systematic process for implementation, makes the INSROP assessment system – the NSR *Environmental Assessment & Planning System (EAPS)* - complementary to basic elements in strategic environmental assessments (e.g. SEA, cf. Hansson & Moe 1996, Moe et al. 1997, Moe & Semanov 1999, Thomassen et al. 1998a, b).

In the NSR EAPS one of the main objectives has been to build up methods and routines for carrying out an Environmental Impact Assessment (EIA). Baseline environmental information generated and stored in the INSROP Dynamic Environmental Atlas (INSROP DEA), and significant information from the other INSROP sub-programmes, are integrated in a tailored geographical information system (INSROP GIS) for analyses within the EIA-component.

The results of the EIA is considered as the basis for public information, recommendations, decision-making and environmental management strategies in line with the INSROP overall aims (Østreng 1993, Hansson & Moe 1996, Thomassen et al. 1996a, b).

This INSROP Working Paper is the guide to EIA implementation in INSROP Phase II. It summarises the main results from Phase I and II, and presents the step by step procedure towards area and VEC specific Potential Impact Level (PIL) indices. The paper is closely linked to other INSROP Working Papers, in particular Thomassen et al. (1996b) which deals with methods used in the assessment system, and Brude et al. (1998) which summarises the baseline information stored in INSROP DEA.

It has never been the aim of INSROP EIA to run through and present a full EIA which meets all the Russian requirements - legislative or in practice. The concept has, however, been accepted among scientific communities in Russia and Norway and has proven to be in line with Russian regulations on Preliminary EIA. The main objective of INSROP EIA has been to build up a system for storing significant environmental information, and to design an operative dynamic assessment system which can be used in EIA work given concrete development plans (this Working Paper). The final INSROP Environmental Impact Statement (EIS) following this work summarises the assessments possible so far. The EIS is the concluding environmental statement, including recommendations for mitigating measures, monitoring etc.

Trondheim 3 March 1999

Jørn Thomassen
Supervisor

Table of contents

1. Executive summary

There are two main objectives in INSROP EIA:

1. To build up a dynamic EIA - system that can handle different types of information and is flexible in use when new information is available or when plans or scenarios are altered.
2. By using this system, make a limited EIA for selected environmental components (Valued Ecosystem Components) for coarse scenarios in NSR, all based on present available information.

This Working Paper is organised in two parts:

Part I deals mainly with general background information, the assessment system and results obtained in INSROP Phase I where significant baseline data were collected and systematised for later use in the impact assessment system. Potential NSR activities and scenarios are further described, and the main impact factors following this are identified. The main elements of the Adaptive Environmental Assessment and Management (AEAM), namely the Valued Ecosystem Components (VECs) and the impact hypotheses are also discussed, including important questions concerning biological effects and vulnerability.

Part II is a *step by step* description of the information technology (IT) and geographical information system (GIS) based assessment tools and procedure in INSROP EIA, including the accompanying methods for assessing vulnerability. Methods have earlier been developed for semi-quantitative assessments of vulnerability and analyses of environmental impact by Anker-Nilssen (1987), Isaksen et al. (1998), Gavrilo et al. (1998), Moe et al. (1998a, b). These models however require input data of a certain quality and quantity. In the INSROP EIA such models will be used for selected VECs such as shoreline oil vulnerability, seabirds and marine mammals. For other VECs a more qualitative assessment approach has been developed and is described in Part II. Both methodological approaches end up with a VEC and area specific indication of potential effects of NSR, so called Potential Impact Level (PIL) - indices. Part II also includes an example of how the assessment system will work given defined impact factors and a specified VEC.

The limited INSROP EIA is published in a separate paper (Thomassen et al. 1999).

PART I

2. Introduction

2.1 What is INSROP

INSROP is multidisciplinary and multinational research programme organised by three co-operating partners: The Central Marine Research and Design Institute (CNIIMF) in St. Petersburg, The Ship and Ocean Foundation (SOF) in Tokyo and The Fritjof Nansen Institute in Oslo. According to Østreng (1996) the purpose of INSROP is solely *«to build up a scientifically based knowledge foundation encompassing all relevant aspects concerning the Northern Sea Route problem complex, to enable public authorities and private interests to make rational decisions based upon scientific insight rather than upon mythology and insufficient knowledge»*.

2.2 The INSROP Phase I

To cover all these relevant aspects concerning NSR, INSROP was in Phase I split into four sub-programmes: I) Natural Conditions and Ice Navigation, II) Environmental Factors, III) Trade and Commercial Shipping Aspects of the NSR, and IV) Political, Legal and Strategic Factors. Each of these headings consisted of several projects.

Sub-programme II: Environmental Factors, was designed to produce the foundation for political and commercial decision making regarding environmental conditions in the NSR area - to reflect national and international concerns for the Arctic environment and for Northern Indigenous peoples (Hansson & Moe 1996). Briefly, baseline information are stored in the Dynamic Environmental Atlas (DEA) (Brude et al. 1998), and will together with information generated by The Environmental Safety of Ships and Navigation, as well as the other INSROP sub-programmes, be analysed in the Environmental Impact Assessment, which subsequently will form the basis for public information, recommendations and decision making.

In INSROP Phase I, the platform for the EIA was constructed (Thomassen et al. 1996b). The objectives in Phase II is to implement the work carried out in Phase I in the Environmental Impact Assessment of the Northern Sea Route.

2.3 The INSROP Phase II

INSROP Phase II is organised with project groups addressed in three boxes. Box A contains integration projects and GIS projects while Box B deals mainly with simulation projects. Box C contains continuation projects from Phase I and are divided into the four traditional INSROP sub-programmes listed in chapter 2.2. The environmental projects in INSROP, and consequently also the Environmental Impact Assessment is part of Box C.

2.4 Environmental Impact Assessment (EIA) - aims and objectives

In the Arctic Environment Protection Strategy (1997) EIA is defined as *«a process of identifying, communicating, predicting and interpreting information on the potential impacts of a proposed action or development on the environment, including humans, and to propose measures to address and mitigate these impacts»*. The decision making part of the process is more clearly pointed out by Wathern (1988) who states that *«EIA is a process having the ultimate objective of providing decision makers with an indication of the likely consequences of their actions»*.

An EIA is multidisciplinary of nature with consequences projected normally related to both the environment as well as to the society, and consequently different actors will be involved in different phases of the process. Obviously, communication between decision makers, authorities, management and scientists should be established in a very early stage of an EIA, with the objective to focus on important issues in each specific EIA context.

EIA therefore calls for communication and cooperation between different interests of a development. As the ultimate objective of an EIA is to give indications of possible consequences of an environmental encroachment or activity, the great challenge will be to give an objective view into the future. Environmental impacts should therefore be addressed through the difference between the environment with and without the proposed activity. This also means that one ideally should make scenarios of the development in the particular area or region of concern without the encroachment or activity (see Figure 2.1).

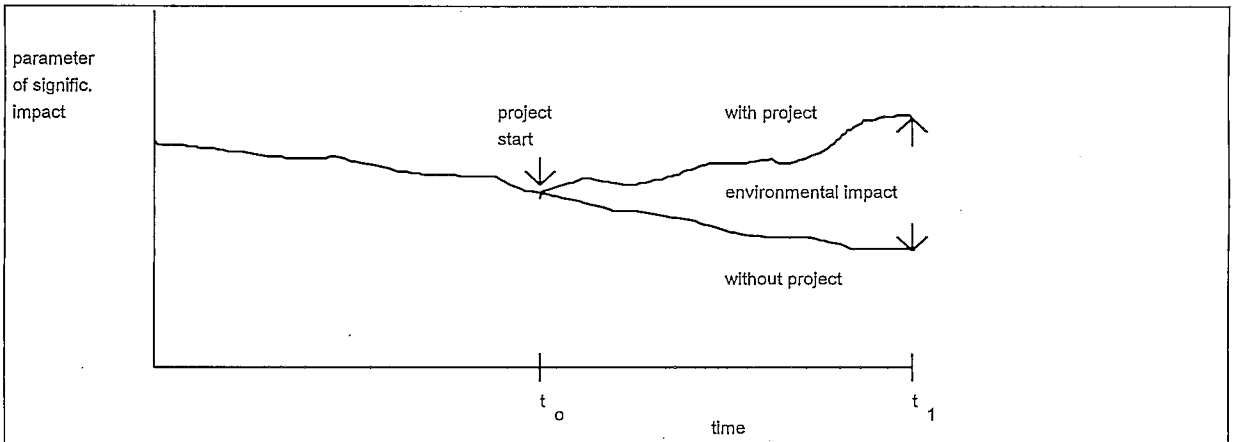


Figure 2.1. A hypothetical impact based on scenarios with and without the project (zero-alternative). After Wathern (1988).

Decisions are normally taken on the background of a limited number of important issues, and consequently the importance of focusing on these priority issues in the EIA process should therefore be obvious. However, in addition to the traditional basis for making decisions, which not always is the optimal environmental solution, the EIA process should also feed the decision makers with information on additional subjects which should be given priority in the decision making process. This selection of a limited number of priority issues is called the scoping phase in the EIA-process, and is critical for an optimal use of limited resources in the perspective of time, economy and professionals.

2.5 Strategic Environmental Assessment (SEA)

An EIA is mainly a tool for assessing the likely consequences of a development or an action. That means normally a concrete project where the project activities more or less are easy to describe. The further development of the Northern Sea Route as an international traffic route, however, is a multi-complex question dependent on numerous factors like Russian and international policy, economy, environment, technology etc.

The future impact assessments of INSROP is therefore rather a question of future policy plans and politics than of concrete activities within the traditional frames of an EIA. Consequently it will be of significant value to look at the environmental consequences from a more strategic point of view in follow up studies after the termination of INSROP. Sadler & Verheem (1996) have a core definition of SEA: *«SEA is a systematic process for evaluating the environmental consequences of a proposed policy, plan or programme initiative in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision making on par with economic and social consideration».*

The problem - and the challenge - concerning NSR, will be to identify adequate, probable and stable proposed policy plans and/or programmes concerning an extended use of NSR in the future.

2.6 Bilateral cooperation

The INSROP concept is based on a main cooperation between Russia, Japan and Norway. In the environmental work a bilateral cooperation was established from the beginning between Russia and Norway. The cooperation was further extended in the EIA work in Phase I, and are presently operative in two EIA initiatives: This work (project II.5.10) where Norway is responsible, and in an preliminary EIA (project WP7) carried out by the Russian EIA experts. Exchange of information and knowledge is essential in both projects.

Most countries have adopted EIA as an environmental planning tool, anchored in the legislative frames of each country. Attempts have been made to harmonise EIA practise and legislation across borders both within the EU system in Europe (Directive 337/85/EEC, Directive 11/97/EEC) and in Arctic areas (Arctic Environmental Protection Strategy 1997). Within the Norwegian-Russian bilateral cooperation, work has been actuated to find common ecological guidelines to EIA work and monitoring programmes for petroleum offshore developments.

3. National and international legislation and practice

3.1 Russian legislation, implementation and practice

In the former USSR, two parallel, but quite different EIA development paths took place: The State Ecological Review (SER, or a state ecological expertise) and the Assessment of Environmental Impacts (abbreviated, in Russian, to OVOS). Recent reviews of the current procedures, practice and regulations of EIA in Russia are given by Anon. (1995), Cherp & Lee (1997).

The further overview and discussions in chapter 3.1 is mainly from Moe & Semanov (1999). Applied to scenarios for NSR navigation, Ivanov et al. (1998) present a preliminary EIA (PEIA) in line with the appropriate Russian legislation. The INSROP EIA concept, including the DEA, has been used as basis for the work by Ivanov et al. (1998). The overall aims and objectives are easily recognised in these papers and reports, but some deviations open for the assumption that the EIA practise in Russia is still influenced by prolonged effects of the transition process. Some elements are virtually more obscure and obviously subjected to inconsistent implementation. For communication within and in the wake of INSROP, and of interest to potential NSR stakeholders, a simplified scheme of the EIA-process is briefly outlined in the following sections.

Procedure and organisation of any kind of industrial activities in Russia are governed by the *«Ecological examination law» (1995)*. The law aims directly at protection of the environment from adverse effects of industrial activities and ensuring ecological safety. The concept of the ecological examination is mainly based on:

- presumption of potential ecological risks of all kinds of industrial activities (Article 3)
- obligatory ecological examination before taking decision to start implementation of the project
- comprehensive examination
- consideration of ecological safety requirements
- true and full information
- independent experts
- scientific substantiation of conclusions
- public participation and communication
- responsibility of experts for the quality of the examination.

In accordance with the legislation shipping and development on the NSR is to be considered as a project requiring examination on the Federal level as it is to be implemented on the territory of several Federation subjects (Article 11). The federal level can be accounted for by international character of shipping along the NSR. A number of articles contain requirements for examination practice, including the definition of ecological expertise, their authorisation and responsibilities. A positive conclusion of the ecological examination is required before starting financing and realisation of the development project. Liability is provided for by legislation for infringement of the law. Instructions for EIA came into force in 1994 by the order of the Ministry of the Environment and Natural Resources Protection (presently The Environment Protection Committee). This includes a list of activities, which should undergo ecological examination. Among them is coastal navigation including ports and terminals called by vessels of more than 1,350 t/dw.

When evaluating shipping impact on the NSR environment, it is necessary to take into account about 40 laws that currently are in force in Russia. The most important laws are:

- Environment protection law
- Atmosphere protection law
- Protection and use of fauna law
- Specially protected territories law
- Continental shelf law
- The Code of Water
- Production division law

According to the Russian legislation, the EIA (OVOS) is to be made simultaneously with the feasibility report. The environmental assessment includes two phases. A preliminary feasibility assessment of the particular activities corresponds to the first stage. This PEIA is necessary (obligatory) for taking decision to start the project development or not. During the second stage, a detailed assessment of influence on the environment is to be carried out. The EIA forms in turn the basis for the Environmental Declaration, as outlined in Figure 3.1 below.

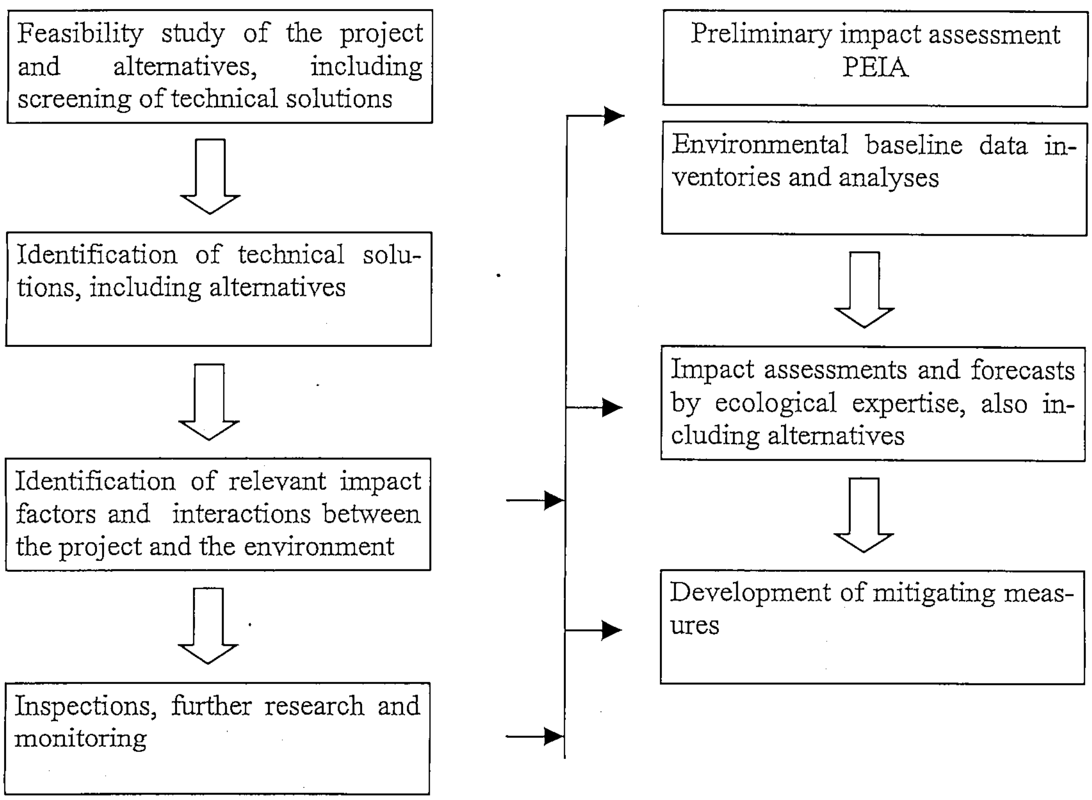


Figure 3.I. A simplified scheme of the Russian OVOS process.

This scheme does not differ significantly from the INSROP EIA concept, which has been tailored for assessing shipping, and related activities on the NSR. The main difference is the methodological approach to the solution of problems identified by the OVOS (and EIA). For example, OVOS contrary to the INSROP EIA concept requires more detailed description of natural conditions as well as detailed investigations of social aspects, before the project can start and corresponding economic evaluation of damage to the environment can be made. The INSROP EIA concept has no environmental cost compensation component *.

Both OVOS and EIAs provide a multidisciplinary approach, taking into account the different kinds of technical, environmental and socio-economical factors and processes. In this respect INSROP is a perfect example, the combined results of the sub-programme research provide significant parts of the necessary OVOS-information concerning:

- natural conditions
- social and economic characteristics of the NSR
- relevant industrial activities, also including alternatives
- the corresponding sources and objects of pollution
- quantitative and qualitative assessment of impact factors like oily mixtures, sewage, garbage, and emissions to air as well as noise.

It is the overall intention of the Sub-programme II participants that the results obtained should be used as basis for further assessment work. The implementation of the INSROP EIA concept has proven to be a key in dialogues across legislative, political and cultural boarders, and is highly recommended for use in future development project on the NSR.

3.2 Institutional practice

Institutional practice concerning the EIA process and content of the EIA document vary (e.g. World Bank, European Bank, Asian Development Bank, EU or Arctic Environmental Protection Strategy (1997)), but the main components and objectives of the directives are generally based on the same principles. As an example, a short summary of the main components in the World Bank practice is presented below.

3.2.1 World Bank

According to the World Bank Operational Directive (World Bank 1991) the purpose and nature of environmental assessment is to ensure that the development options under consideration are environmentally sound and sustainable, and that any environmental consequences are recognised early in the project cycle and taken into account in project design. EAs identify ways of improving projects environmentally, and minimising, mitigating, or compensating for adverse impacts. By alerting project designers, implementing agencies, and borrower and Bank staff to issues earlier, EAs:

a) enable them to address environmental issues in a timely and practical fashion,

* The differences are easily explained. INSROP is a multidisciplinary research programme of 3+2 years duration. Due to the economical framework, field surveys was defined beyond the Sub-programme II work in an early phase. Consequently, the assessments should be based on historical data, but the data should be systematised for re-use and up-grading in parallel to NSR development. NSR covers a zone extending from latitude 60E to latitude 170W, from the Kara port to the Bering strait, and the resolution of the INSROP DEA was harmonised towards the volume and significance of the baseline data identified during the screening and scoping phase. Decisions were also made on what type data that was nice to have and the data that was needed. Socio-economical analyses have been carried out within INSROP Sub-programme IV. This work was carried out for special topics and regions, and unfortunately, not harmonised to any EIA standard. The cost compensation component were considered irrelevant to the INSROP EIA because of the common understanding among most western nature scientist is that environmental damage cannot be measured in hard currency, and consequently, considered entirely a matter of Russian concerns.

b) reduce the need for project conditionality, because appropriate steps can be taken in advance or incorporated into project design, and
c) help avoid costs and delays in implementation due to unanticipated environmental problems.

EAs also provide a formal mechanism for inter agency co-ordination and for addressing the concerns of affected groups and local non governmental organisations (NGOs). In addition, they can play a major role in building environmental capability in the country.

Further, a project specific EA should normally cover:

a) existing environmental baseline conditions
b) potential environmental impacts, direct and indirect
c) systematic environmental comparison of alternatives
d) preventive, mitigatory, and compensatory measures given by an action plan
e) environmental management and training, and
f) monitoring plan

If possible, capital and recurrent costs, environmental staffing, training, and monitoring requirements, and the benefits of proposed alternatives and mitigating measures should be quantified.

The EA report should, according to the World Bank, include:

- Executive summary
- Policy, legal, and administrative framework
- Project description
- Baseline data
- Environmental impacts
- Analysis of alternatives
- Mitigation plan
- Environmental Management and training
- Monitoring plan
- Appendices (List of EA preparers, references, record of inter-agency/forum meeting)

The World Bank has in addition prepared a checklist for potential issues which should be addressed by the EA if applicable:

- Agrochemicals
- Biological diversity
- Coastal and marine resource management
- Cultural properties
- Dams and reservoirs
- Hazardous and toxic materials
- Induced development and other socio-cultural aspects
- Industrial hazards
- International treaties and agreements on the environment and natural resources
- International waterways
- Involuntary resettlement

- Land settlement
- Natural hazard
- Occupational health and safety
- Tribal peoples
- Tropical forests
- Watersheds
- Wetlands
- Wildlands

3.3 International agreements and conventions

The sensitive and vulnerable Arctic and Sub-Arctic environment call for special attention in development plans and encroachments. In the recognition of this fact, international agreements and programs have been established to meet these requirements. In addition, special attention must be taken when the actual NSR area or NSR activities are regulated by international agreements and conventions, of which the most actual concerning the NSR and adjacent areas are:

- The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)
- Guidelines for Environmental Impact Assessment (EIA) in the Arctic
- Guidelines for offshore petroleum activities in Arctic
- Other agreements and conventions, important, but not basically made for the Arctic.

3.3.1 The Espoo Convention

The *Espoo Convention (1991),* which is an UN ECE convention on EIA in a transboundary context, entered into force in September 1997. The main objective of the convention is to ensure that any encroachment of a certain size within a country, with potential transboundary impacts in an other country, should undergo an assessment on the impact in the affected country. If the proposed project may lead to significant impacts in the other country, the country of origin and the responsible developer in that country should ensure that the affected country has the possibility to participate in the EIA-process on all stages. Concrete details can be anchored in bi- or multilateral agreements on the EIA work, which also can include harmonisation of methods, collecting of baseline data, common understanding of legislative framework and practice, and the accomplishment of the EIA.

The ECE Convention includes a list of activities for which transboundary impact assessment is mandatory, but according to Arctic Environment Protection Strategy (1997) additional attention should be made because of the sensitivity of the Arctic environment. This may for example lead to lower threshold levels than on lower latitudes.

Further, Arctic Environment Protection Strategy (1997), puts focus on large scale operations in the Arctic, like development of oil and gas resources and extensive exploitation of other natural resources, as developments which may cause transboundary environmental impact. In special, they mention other planned activity like the opening of new sea routes in the high Arctic and their required port facilities as likely to cause transboundary impacts.

3.3.2 Arctic EIA guidelines

The Arctic Environmental Protection Strategy (AEPS) is an initiative, approved by all Arctic countries, with the objective to protect the Arctic environment. Sustainable development should naturally be a leading guide in Arctic, as well as in other environments. Consequently, AEPS has worked out special EIA guidelines to be used in the development planning in Arctic (Arctic Environment Protection Strategy 1997). The guidelines will not replace national laws and regulations, but rather give examples on how an EIA can be accomplished with special attention to the Arctic.

3.3.3 Guidelines for offshore petroleum activities in Arctic

In March 1996 the *Third Ministerial Conference on Protection of the Arctic Environment* decided to conduct a government designated expert meeting to develop *«Guidelines for offshore petroleum activities in the Arctic»*. The aim of the guidelines is to make a set of operative recommendations concerning human health and safety and protection of the environment in the Arctic, to be used by those responsible for offshore petroleum developments. One central point in the guidelines is to integrate environmental issues from the very beginning of the petroleum development, through the EIA-process.

3.3.4 Other agreements/conventions

The Bern Convention

The purpose of the *Bern Convention (1979)* is primarily to conserve wild flora and fauna and their natural habitats (Bern Convention, article 1 and 2):

1. The aims of this Convention are to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the cooperation of several States, and to promote such cooperation.
2. Particular emphasis is given to endangered and vulnerable species, including endangered and vulnerable migratory species.

The Russian Federation has not ratified the Bern Convention.

The Ramsar Convention

The *Ramsar Convention (1971)* deals with protection of wetlands and the ecology, botany, zoology, limnology and hydrology of such habitats. Particular attention are given to waterfowl of international importance throughout the year (Ramsar Convention, article 1, paragraph 1 and 2):

1. For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

2. For the purpose of this Convention waterfowl are birds ecologically dependent on wetlands.

The Russian Federation has ratified the Ramsar Convention, and put it into force in February 1977. Thirty-five sites in the Ramsar list, consisting of a total of more than 10 million hectares of designated sites are located within the Russian Federation. The Russian Federation has informed UNESCO that it continues to exercise the rights and carry out the obligations of the former USSR under the Ramsar Convention.

Convention on Biological Diversity

The main objectives of the *Convention on Biological Diversity (1992)* is to protect biological diversity (Convention of Biological Diversity, article 1):

1. The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The Russian Federation ratified the Convention on Biological Diversity in April 1995.

4. The overall concept of INSROP-EIA

4.1 Aims and objectives for INSROP-EIA

INSROP is definitely more a research and development programme for the mapping of future possibilities in the NSR area, than it is a programme of actual activities to be started in the near future. On this background, one of the main objectives for the INSROP-EIA has been to design an assessment system capable to handle different options concerning future use of the NSR. That means that we had to develop a dynamic and flexible system, where different activities or scenarios can be handled in a scientific sound matter, and with the presentation of conclusions and recommendations designed against decision making.

The aims and objectives for INSROP-EIA is simply to use different environmental knowledge collected and systematised during INSROP Phase I, combine this with other relevant knowledge, and make an assessment of the likely consequences of the proposed future NSR scenarios on the environment and society. These impact assessments should form the basis for recommendations and possible mitigating measures as a platform for public authorities and private interests to make rational decisions concerning NSR.

According to Russian (and Norwegian) legislation a number of issues should be treated to fulfil an EIA. In INSROP EIA several of these issues have not been accounted for simply because the goals have been to:

1. To build up a dynamic EIA - system that can handle different types of information and is flexible in use when new information is available or when plans or scenarios are altered.
2. By using this system, make a limited EIA for selected environmental components (Valued Ecosystem Components) for coarse scenarios in NSR, all based on present available information.

For a total EIA concerning concrete NRS activities, several other issues in accordance with Russian legislation have to be treated.

4.2 The INSROP-EIA process

In November 1993 Russian and Norwegian environmental experts met on a screening and focusing workshop in Oslo. This was the first contact in INSROP sub-programme II: Environmental factors. Cultural and scientific differences as well as time consuming activities in building up institutional, scientific and personal links resulted in the establishment of limited number, but important mechanisms for future cooperation (see Hansson et al. 1994).

Concerning the EIA process the most important agreements was to focus on a selected number of important issues and to use an adjusted form of the Adaptive Environmental Assessment and Management (AEAM) - concept (derived from Holling 1978) as the leading methodological process in the EIA work. The importance of focusing on a few, but probably most significant factors for decision making, should be obvious when we look at the huge NSR-area and the time schedule for INSOP. Another important decision was to use a Geographical Information System (GIS) in the storage and processing of the collected information. This enables us to have a dynamic system which easily can be updated and also have the flexibility for a multipurpose use.

Figure 4.1 presents schematic the INSROP-EIA, Phase I, or the assessment design and the collection and storage of baseline information.

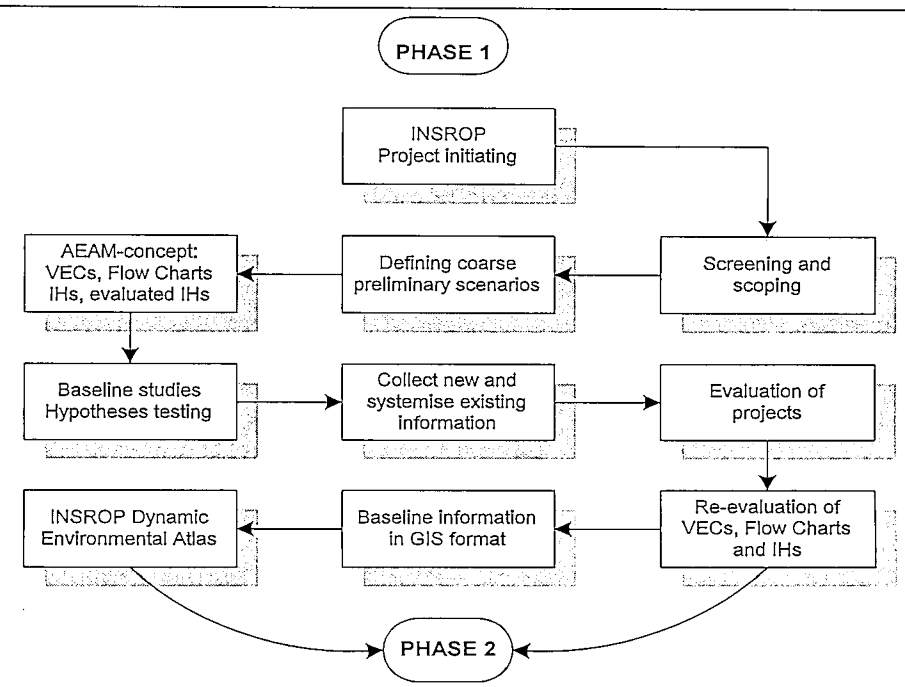


Figure 4.1. The INSROP EIA-AEAM process, Phase 1.

The AEAM methodology also formed the basis for the assessment system for the environment and industrial activities in Svalbard (Hansson et al. 1990), and has been used for more than ten years in the Canadian hydrocarbon development in the Beaufort Region, i.e. the Beaufort Environmental Monitoring Project (BEMP), the Mackenzie Environmental Monitoring Project (MEMP) and the Beaufort Region Assessment and Monitoring Program (BREAM), see Indian and Northern Affairs Canada (1992a, 1992b, 1993).

Using the AEAM methodological approach, communication is essential from the very beginning. Through workshops and working groups, resource people with different interests in the NSR meet to scope the dimensions of the important issues. In AEAM the impact predictions are derived from a procedure which includes the selection of VECs (Valued Ecosystem Components) that can be affected by the NSR activities. The methodology also identifies major linkages between different components in the system by preparing Schematic Flow Charts including impact factors, which form the basis for the Impact Hypotheses (IHs). Key statements in every scientific work are the documentation of the process and the choices made. In the EIA process, it is important that the reasons for decisions are visible and transparent, particularly when it involves the rejection of proposed impact scenarios. More detailed information about this process can be found in recent INSROP publications (Bakken et al.1996, Larsen et al. 1995, 1996, Thomassen et al. 1996b, Wiig et al. 1996).

4.2.1 INSROP preliminary scenarios

To be able to describe impact factors on the components given priority in Phase I, proposed and probable NSR activities were discussed (Thomassen et al. 1994, 1996b). Transit routes and sailing to and from harbours, including the large rivers Ob, Jenisei and Lena, were included in these scenarios.

4.2.2 Impact factors

Five major impact factors were identified from the INSROP preliminary scenarios: *pollution, noise, waste, physical disturbance* and *change of development patterns* (initially named social and cultural factors) (see chapter 6 for further information). Notice that these impact factors have later in INSROP Phase II been partly changed and also given a higher resolution.

4.2.3 Valued Ecosystem Components (VECs)

A *Valued Ecosystem Component* is defined as *a resource or environmental feature that: is important (not only economically) to a local human population, or has a national or international profile, or if altered from its existing status, will be important for the evaluation of environmental impacts of industrial developments, and the focusing of administrative efforts* (Hansson et al. 1990).

The selection of VECs is probably the most important and at the same time the most difficult step in the process. The critical point is to focus upon decision making, and the VEC concept therefore should include social, political and economic qualities. Moreover, only a limited number of VECs can be used, which in turn calls for critical evaluation in the selection process.

4.2.4 Schematic Flow Charts

A S*chematic Flow Chart* is a diagram of boxes and arrows indicating in which context each of the VECs appears. It illustrates how a proposed activity may affect the VEC and how the impact may occur. Each linkage is explained in a brief text following the chart. Hansson et al. (1990) described the content of the flow chart to include the main categories of the physical, biological and possibly also social and political factors influencing the VEC, so-called *system components*, and impacts from the NSR activities, called *developments*.

4.2.5 Impact Hypotheses (IHs)

An *Impact Hypothesis* is a hypothesis for testing the possible impact arising from a given activity on the VEC. The impact hypothesis is illustrated by the schematic flow chart and should be explained and described preferably in scientific terms. The IH is also the basis for recommendations for research, investigations, monitoring and management actions, including mitigating measures.

4.3 Results obtained during Phase I and Phase II

4.3.1 Phase I: Valued ecosystem components and corresponding impact hypotheses

Given the preliminary INSROP scenarios and the corresponding impact factors, 15 VECs with a total numbers of 59 impact hypotheses were identified. The impact hypotheses have been evaluated through a categorisation being placed in one of the following four categories:

A. *The hypothesis is assumed not to be valid.*
B. *The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possibly be recommended.*
C. *The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.*
D. *The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.*

In the Phase I selection of VECs and the corresponding 59 impact hypotheses, 4 were found not to be valid (category A) and 14 were found not worth testing. Further, 14 of the hypotheses were found valid and already verified through a scientific documentation and 27 were assumed to be valid, but further investigations were recommended for validation. See chapter 7 for a listing of all VECs and their impact hypotheses.

4.3.2 Phase II: Valued ecosystem components and corresponding impact hypotheses

Four additional VECs where identified in Phase II. The impact hypotheses are currently under evaluation and will be published in a separate paper (Thomassen et al. 1998c).

5. Baseline information

5.1 Introduction

Often the baseline information needed for an EIA study is scarce, and great emphasis is put into the collecting of new information through field sampling, which is both time consuming and often account for a large part of the total costs in an EIA. Because many EIA baseline studies often results in valuable and new information, but not significant for the decision making, the importance of a clear and defined scoping process should be clear. Or as Beanlands (1988) states: *«Perhaps the most glaring inadequacy of many baseline studies is that they do not reflect the ultimate needs of the decision maker involved in the project planning»*.

Attempts have been made by many authors to give a clear an concise definition of baseline studies or baseline information without success. The reason can be that baseline information is characterised by different origin, type and format, from strictly quantitative as the occurrence, of a species in time and space, to information of socio-cultural content or traditional ecological knowledge (TEK) holded by indigenous people (see Sallenave 1994). Baseline information can therefore have several sources. However, the importance of a problem focused baseline information should be obvious, as a basis for assessing impacts and alternatives, and for the important recommendations and mitigating measures. Further, we will stress the importance of baseline information in the environmental monitoring work following an EIA (see also Sadler 1996, Arctic Environmental Protection Strategy 1997).

5.2 Baseline information in INSROP

The baseline information in INSROP is of different types and origin. The first step in INSROP-EIA was to focus on the most important components which should be given priority in the assessment procedure. This scoping was carried out at a workshop held in Oslo in November 1993 (Hansson et al. 1994) and several Valued Ecosystem Components (VECs) were selected (se chapter 7). The VEC data base is based primarily on existing information, and to a lesser extent on new collected information. The INSROP Dynamic Environmental Atlas (DEA) presents the distribution and abundance of VEC information stored in the DEA database (Brude et al. 1998).

Other important information sources which will be of significant value in the assessment of impacts from NSR activities have been the recent international work concerning the Conservation of Arctic Flora and Fauna (CAFF) and the Arctic Monitoring and Assessment Programme (AMAP) organised under the Arctic Environmental Protection Strategy (AEPS) umbrella.

Source	Focus on	Description	Information storage
INSROP	Valued Ecosystem Components	Temporal and spatial abundance along the NSR area	INSROP DEA
CAFF	Habitats	Mapping of circumpolar existing and proposed protected areas	GRID Arendal
AMAP	Pollutants	Measure levels and assess the effects of anthropogenic pollutants in the Arctic environment	GRID Arendal

5.2.1 INSROP Dynamic Environmental Atlas (DEA)

Information on spatial and temporal distribution of the selected VECs in the NSR area, collected and systematised during three years of data inventory, are stored and integrated in the INSROP Dynamic Environmental Atlas (Brude et al. 1998). To a large extent, these data have been data collected and systematised from a survey of existing Russian data sources (Gavrilo & Sirenko 1995). In addition, some new information have been collected through field sampling in special areas of the NSR. The database contains more than 4000 georeferenced individual registrations. The standard tabular information include attributes like species name, observation counts (mean, minimum and maximum number, observation time, trend, reference etc. The DEA database will provide a convenient tool for the subsequent analyses in the INSROP EIA, described further on in this paper.

It is however important to notice that the content of INSROP DEA is incomplete to fill the recent requirements in the Russian EIA legislation. Within the time and economical frames of INSROP the reason for this is obvious. NSR covers a zone extending from latitude 60E to latitude 170W, from the Kara Gates to the Bering strait, and extensive field work was defined beyond the scope of Sub-Programme II, as was for example socio-economic analysis and the cost compensation component required in the Russian EIA legislation. The INSROP DEA is a dynamic system which easily can be upgraded to fill the Russian needs, given sufficient economical and time frames.

5.2.2 AMAP

The AMAP assessments are intended to accomplish the following (from www: AMAP homepage):

- Summarise and analyse the contemporary state of knowledge of the sources, levels, distributions, trends, fate and effects of contaminants and other anthropogenic influences on the environment and human health,
- Assess the relative magnitude of damage and threats to the environment and human health based on existing information,
- Recommend actions to reduce assessed damages and threats,
- Identify deficiencies and gaps in information and data required to improve the reliability of evaluations of such damage and threats that would warrant rectification through further scientific and social studies.

This process of evaluation is based on the acquisition and analyses of all existing sources of information and any data being acquired through national and international survey, monitoring and research activities that are relevant to the area and focus of the specific assessment being conducted.

The AMAP assessments were not designed to fill the needs of the Russian EIA legislation, and the information collected are rather sparse from the NSR area, especially concerning an EIA. However, AMAP information is important when assessing the overall pollution picture in Arctic in general, and when identifying deficiencies and gaps for the EIA work. The main report on the state of Arctic pollution was published in 1998 (AMAP 1998).

5.2.3 CAFF

CAFF's Mandate (from www: CAFF homepage):

The Program for the Conservation of Arctic Flora and Fauna (CAFF) was established to address the special needs of Arctic species and their habitats in the rapidly developing Arctic region. CAFF's main goals, which are achieved in keeping with the concepts of sustainable development and utilisation, are:

- To conserve Arctic flora and fauna, their diversity and their habitats.
- To protect the Arctic ecosystem from threats.
- To seek to develop improved conservation management, laws, regulations and practices for the Arctic.
- To collaborate for more effective research, sustainable utilisation and conservation.
- To integrate Arctic interests into global conservation fora.

The majority of CAFF's activities are directed at species and habitat conservation and at integrating indigenous peoples and their knowledge into CAFF. Its work is grouped under several main themes including habitat conservation, species conservation, biodiversity conservation in the Arctic region, integrating indigenous people and their knowledge and program management. Two main reports on the conservation of Arctic flora and fauna have been published, one for the state of protected areas (CAFF 1994), and one for proposed protected areas (CAFF 1996).

As for AMAP, CAFF was not designed to meet the requirements in the Russian EIA legislation. CAFF data is important for the overall conservation picture in Arctic, and consequently further efforts have to be made to fill gaps concerning an EIA along the NSR. Nevertheless, CAFF data is one of the main sources of information concerning protected areas in INSROP EIA.

6. NSR scenarios/activities and impact factors

6.1 Preliminary descriptions of possible NSR scenarios/activities

6.1.1 Introduction

When assessing the potential impacts from an activity, it is important to describe the planned activities as detailed as possible. The Northern Sea Route opens for several different activities, of which some are more likely to occur than other. The proposed activities, or scenarios, should be as probable and representative as possible. Three main scenario components can be identified:

- The NSR activities, what types of cargo will be transported in the NSR area?
- The geographical limitations, where to sail in the NSR area?
- The temporal limitations, when to sail in the NSR area?

The description of various NSR-activities, and the identification of the geographical and temporal characteristics of each type of NSR activity will together form the NSR scenarios. Each scenario will have impacts on the environment and it is important to clarify the main impact factors from the NSR activity, which can be divided into two main categories: impacts from normal operational traffic and from possible accidents. The accidental scenarios will involve a risk assessment of the operational scenarios to determine high risk areas and seasons.

The difficulties in making probable scenarios for the development in the NSR is obvious. It is important to stress the importance of well defined and detailed scenarios for an optimal use of the AEAM method in an EIA process. This is also the experience from various Canadian studies using AEAM, summarised by David Stone, chairman of the Environmental Factor Session at the INSROP Symposium Tokyo -95 (IST'95): «AEAM is most effective when the development scenario (in this case the shipping activity) can be described in detail and with a fair degree of certainty. This enables the impact hypotheses to be focused rather than dispersed, and consequently the degree of objectivity applied in the evaluation process can be very high». A more detailed discussion of the scenario components have been presented earlier in INSROP Phase I (see Thomassen et al. 1994, 1996b).

6.1.2 NSR activities

Shipping and navigation include a number of activities that in one way or another interact with the environment (Moe et al. 1996). The interaction however are entirely activity specific, e.g. for each type of activity a corresponding set of impact factors can be identified (cf. section 6.2). Basically, from an environmental point of view, the sea-borne transportation in NSR involves the following main types of activity:

- The individual ship, including ice-breaker support

- Harbour facilities for storing cargo, on and off-loading of cargo, support of fuel and crew, waste reception facilities etc.
- Infrastructure for cargo and crew support.

The first activity is considered entirely sea-bound, the infrastructure is considered land-based, while harbour facilities are considered an intermediate between sea and land. For all types of activity, the operational aspects as well the accidental events, are included when identifying impact factors.

The sea-borne operations, e.g. the *ships*, are a point source of emissions to air as well as discharges to sea. The types and levels of the releases are a function of the type of engine, size of ship, etc., and the standard operational procedures, i.e. attributes directly linked to the ship itself.

For the *harbour facilities*, the environmental interactions are closely related to the size of the harbour constructions, number of port calls, cargo handling and storage capacity, waste reception facilities etc., i.e. each site-specific attributes of the harbours.

Such relationship is obvious for the *infrastructure* as well, in terms of the size of cities, types of industry, number and length of roads and pipelines, etc. However, the maintenance and development of infrastructure are not entirely linked to sea-borne support (e.g. direct links), there is also an unknown, variable part of the land-based activity that are independent of the seaway activity (e.g. indirect links).

In case of serious accidents, directly at sea or more indirect on land, contingency plans will come into action and clean-up operations will be actuated. Clean-up operations in the NSR area face huge logistic challenges, which are dependent on several factors like: what type of accident (oil, nuclear etc.), the magnitude, the location and the time of the accident, which also is critical for the response time. Clean-up operations and subsequent impact factors are covered under accidental events.

Consequently, the three main types of activity can be broken down into sub-activities, e.g. the specific activities *in situ*, to provide the resolution required for identification of the corresponding activity-specific impact factors (cf. section 6.2). These are specified in Table 6.1 below, in terms of main types of impact factors corresponding to operational aspects and accidental events.

Table 6.1. The link between NSR-activity (ship, harbour facilities and infrastructure) and impact factors on operational and accidental level.

Main type of activity Key parameters	Specific (*in situ*) activities	Main type of impact factors	
		Operational	Accidental
Ship Identification of ship: • Type of ship • Year of building • Class, class notation (incl. hull type, single, double, ice-strengthened) • Nationality of ship/ flagstate			
Size of ship: • Dead-weight (dw) • Gross tonnage • Wetted surface or outer dimensions • Length (overall), width, depth	Ship in operation	Physical disturbance Noise Introduction of alien species	Physical disturbance Introduction of alien species
Engine specifications: • Type of engine(s) • Fuel consumption	Ship operation Energy production • Main engines • Auxiliary engines • Boilers, incinerators, refrigerating systems	Emissions to air: • Exhaust gases Noise	Releases of: • Fuel • Radioactive material Human activity: • Clean-up operations
Fuel specifications: • Fuel type • Volume of fuel	Ship operation Energy production	Emissions to air: • Exhaust gases	Releases of: • Fuel • Radioactive material Human activity: • Clean-up operations
Cargo: • Type of cargo (UN number) • Volume of cargo	Cargo operation • Liquid cargo • Dry cargo	Emissions to air: • Evaporation of cargo Discharges to sea: • Loss of cargo	Releases of: • Cargo Human activity: • Clean-up operations
General standards and procedures: • Handling of ballast water, shifting routines, tanks segregation, and volume) • Handling of waste and spill • Anti-fouling, type of paint	Handling of ballast water: • Shifting • Tank washing Handling of waste and, spill: • Cargo residues • Fuel residues and sludge • Bilge • Waste Anti-fouling treatment of hull/wetted surface	Emissions to air: • Combustion of waste Discharges to sea: • Ballast water • Cargo residues • Fuel residues and sludge • Bilge water • Garbage and litter • Sewage Releases of anti-fouling paint	Releases of: • Ballast water • Cargo residues • Fuel residues and sludge • Bilge water • Garbage and litter • Sewage Human activity: • Clean-up operations
Ship support: • Helicopter • Airplane	Support routines	Noise	Physical disturbance • Clean-up operations Releases of: • Cargo • Fuel

Main type of activity Key parameters	Specific (*in situ*) activities	Main type of impact factors	
		Operational	**Accidental**
Harbour facilities Identification of port: • Name and position of port • Population • Local settlements			
Use (land-based): • Cargo types-volumes • (export/import) • Cargo storage capacity • Shore reception facilities	Energy production Cargo operation: • Liquid cargo • Dry cargo • Oily waste/water	Emission to air: Discharges to sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others Physical disturbance Noise	Releases to air: Releases to land and sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others • Oily waste/water Human activity: • Clean-up operations
Use (sea-borne) • No. port calls • Cargo types-volumes (export/import)	Energy production Cargo operation: • Liquid cargo • Dry cargo • Oily waste/water	Emission to air: Discharges to sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others Physical disturbance Noise	Releases to air: Releases to land and sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others • Oily waste/water Human activity: • Clean-up operations

Main type of activity Key parameters	Specific (*in situ*) activities	Main type of impact factors	
		Operational	**Accidental**
Infrastructure Identification of constructions: • Type of industry • Human activity			
Development activities: • Petroleum development • Mining industry • Tourism and outdoor recreation	• Construction of pipelines • Physical structures • Other infrastructure constructions like power plant • Transportation system • Hunting and fishing	• Emission to air • Discharges to terrestrial and limnic environment • Discharges to sea • Physical disturbance/barriers • Increased population/human activity • Disturbance of habitats and reduced animal populations	• Emission to air • Discharges to terrestrial environment • Discharges to sea • Human activity • Clean-up operations

6.1.3 Geographical limitations

Where is the most probable geographical area that NSR will be operating in the future? The possibilities are: transit routes, rivers, harbours and corresponding land areas. A secondary influence zone can be calculated as a consequence of primary impacts (Table 6.2).

Table 6.2. Identification of influence zones as a consequence of NSR activities.

Level 1	**Level 2**	**Level 3 (primary influence zone)**	**Level 4 (secondary influence zone)**
Transit route	Transit route divided into segments	Width of segment, dependent of season	Affected land (islands) and marine area as a consequence of NSR activity
To and from coastal harbours	Segments from transit route to harbours	Width of segment, dependent of season	Affected land and marine area as a consequence of NSR activity
Rivers	Segments from coastal harbours to river harbours in Ob, Jenisei and Lena	Width of segment, dependent of season	Affected land and marine area as a consequence of NSR activity

Seven operational sub areas in the NSR area from the Kara port to the Bering Strait have been defined: Kara Sea, Laptev Sea, East Siberian Sea, Chukchi Sea, and the rivers Ob, Jenisei and Lena.

For the VECs: Domestic reindeer, Wild reindeer, Protected areas and Indigenous people additional areas have to be defined (Table 6.3):

Table 6.3. Areas to be included as influence zones for the VECs Domestic reindeer, Wild reindeer, Protected areas and Indigenous people.

VEC	**Areas**	**Comments**
VEC Domestic reindeer	• Summer pasture land • Winter pasture land • Migration corridors between summer and winter pasture lands	Linked with VEC Indigenous people
VEC Wild reindeer	• Summer pasture land • Winter pasture land • Migration corridors between summer and winter pasture lands	
VEC Protected areas	• Protected areas	
VEC Indigenous people	• Living areas	Linked with VEC Domestic reindeer Additional rivers to be considered: Taz, Kheta, Yana, Indirka, Kolyma

6.1.4 Temporal limitations

Which time of the year is it most probable that NSR will be sailed? For the NSR activity three seasons have been proposed: summer season (based on historical data), prolonged summer season (when favourable ice conditions or when practical needs makes it necessary) and winter season. To satisfy the needs for the ecological factors, which very well can be dependent of a more detailed time resolution, it is however more appropriate to use a monthly time scale for use in the EIA:

- Summer season: July, August, September, October
- Prolonged summer season: June, November
- Winter season: December, January, February, March, April, May

6.2 Possible impact factors from different activities

Apparently, maritime operations and environmental impacts are associated with ship accidents and spillage of oil in coastal areas. There is no doubt about oil spills making acute damage to the marine organisms, and for larger spills, impact on local ecosystems are traced for years. However, the complexes of shipping and maritime operations (cf. section 6.1.2) include a number of activities that either directly or indirectly interact with the environment. Some interactions may be harmful while others are considered environmentally harmless.

In each case, the potential environmental impact can be derived from the causal connection between the nature of the given activity and the biophysical attributes of the receiving environment. Consequently, activity-specific dose-response relationships are recognised (*cf. section 7.3.1 for the details on the relationship between the fate and significance of impact factors and the environmental effects and impact, respectively*). This means that the activity-specific impact factors, in terms of the environmental stress factors, must be assessed individually, and the corresponding specific impact factors must be identified and systematically applied to the impact analyses.

Given the overall organisation of the NSR activity in three main types (cf. section 6.1.2) and the two categories: regular operations and accidental events, the corresponding specific activities and Impact Factors, respectively, can be organised as shown in Table 6.4.

Table 6.4. Possible impact factors from different NSR activities given for regular operation and accidental events.

Specific (in situ) activities	**Specific impact factors**	
	Regular operation	**Accidental event**
Ship		
Ship in operation:	Physical disturbance Noise from ice-breaking (to sea) Introduction of alien species	Physical disturbance Introduction of alien species
Ship operation: • Energy production	Emissions to air: • NOx • SOx • CO_2 • SOx • Particles • Residues from combustion • Freon Noise from engine (to sea and air)	Releases of: • Fuel oil (bunker) • Diesel oil • Radioactive material Clean-up operations: • Disturbance from helicopter traffic, ship, motor vehicles, humans • Temporary changes in local communities/local economy • Area occupation
Cargo operation: • Evaporation of cargo • Loss of cargo	Emissions to air: • Volatile organic components (VOC) • Halon Discharges to sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others	Releases of: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others Clean-up operations: • Disturbance from helicopter traffic, ship, motor vehicles, humans • Temporary changes in local communities/local economy • Area occupation
Handling of ballast water: • Shifting • Tank washing Handling of waste and spill: • Cargo residues • Fuel residues and sludge • Bilge • Waste Anti-fouling treatment of hull/ wetted surface	Emissions to air: • Waste residues Discharges to sea: • Ballast water • Cargo residues • Oily water, fuel residues, sludge, bilge water • Garbage and litter • Sewage Releases of: • Organo-tin compounds Introduction of alien species	Releases of: • Ballast water • Cargo residues • Oily water, fuel residues, sludge, bilge water • Garbage and litter • Sewage Introduction of alien species Clean-up operations: • Disturbance from helicopter traffic, ship, motor vehicles, humans • Temporary changes in local communities/local economy • Area occupation
Support routines	Noise from helicopter (to air)	Physical disturbance Releases of: • Cargo • Fuel oil

Harbour facilities		
Use (land-based) • Energy production • Cargo operation • Cargo storage • Shore reception facilities	Emission to air: • NOx • SOx • CO_2 • SOx • Particles • Residues from combustion Discharges to sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others Physical disturbance Noise	Releases to air: Discharges to land and sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Others Physical disturbance Noise Clean-up operations: • Disturbance from helicopter traffic, ship, motor vehicles, humans • Temporary changes in local communities/local economy • Area occupation
Use (sea-borne) • Energy production • Cargo operation	Emission to air: • NOx • SOx • CO_2 • SOx • Particles • Residues from combustion • Freon Discharges to sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Physical disturbance Noise	Releases to air: Discharges to land and sea: • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Physical disturbance Noise Clean-up operations: • Disturbance from helicopter traffic, ship, motor vehicles, humans • Temporary changes in local communities/local economy • Area occupation

Infrastructure		
• Construction of pipelines • Physical structures • Other infrastructure constructions like power plants • Rural development • Transportation system • Hunting and fishing	Emission to air: • NOx • SOx • CO_2 • SOx • Particles • Residues from combustion • Freon Discharges to terrestrial and limnic environment: • Deposition from air • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Discharges to sea: • Deposition from air • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Physical disturbance/barriers: • Pipelines • Roads/railways Noise Change of development patterns: • Increased population/human activity • Area occupation/habitat destruction/reduced animal populations • Outdoor recreation, hunting, fishing • Tourism • Harvesting	Emission to air: • NOx • SOx • CO_2 • SOx • Particles • Residues from combustion • Freon Discharges to terrestrial and limnic environment: • Deposition from air • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Discharges to sea: • Deposition from air • Hydrocarbons • Chemicals • Minerals • Dry goods • Oily waste/water • Others Physical disturbance/barriers: • Pipelines Noise Change of development patterns: • Increased population/human activity • Outdoor recreation, hunting, fishing Clean-up operations: • Area occupation/habitat destruction • Noise • Transportation

7. Valued Ecosystem Components (VECs)

7.1 Status

7.1.1 Selection of VECs

The selection of VECs have been a 2-step process so far starting with the «Screening and focusing workshop» held in Oslo in November 1993 (Hansson et al. 1994). At this first meeting Russian and Norwegian specialists discussed the most significant components to be focused on in the INSROP-environmental sub-programme, and ended up with 13 VECs which were brought forward in the work. One year later the supervisors met for an evaluation of the VECs. The cooperation between the Russian and Norwegian specialists gave a somewhat different list of VECs. Most of the VECs had the same content, while some, mainly marine mammals, were new. A total of 15 VECs were given priority for further data collection and storage in the Dynamic Environmental Atlas, and for further use in the EIA. See Thomassen et al. (1996b) for a summary of the VECs, and Bakken et al. (1996), Larsen et al. (1995, 1996) and Wiig et al. (1996) for a more detailed discussion of the selection of VECs in Phase I, and Dallmann (1997) and Thomassen et al. (1998c) in Phase II (see Table 7.1).

During Phase II, additional issues have been given status as VECs: Indigenous people (which is part of VEC Human settlements), VEC Domestic reindeer, VEC Wild reindeer and VEC Protected areas. These four VECs have been documented in Thomassen et al. (1998c).

Table 7.1. Valued Ecosystem Components identified in INSROP.

No	Valued Ecosystem Components	When identified	Documentation
A1	VEC Benthic invertebrates	1993	Hansson et al. 1994, Larsen et al. 1996
A2	VEC Marine estuaries and anadromous fish	1993	Hansson et al. 1994, Larsen et al. 1996
A3	VEC Plant and animal life in polynyas	1993	Hansson et al. 1994, Larsen et al. 1996
B1	VEC Seabirds	1993	Hansson et al. 1994, Bakken et al. 1996
B2	VEC Marine wildfowl	1993	Hansson et al. 1994, Bakken et al. 1996
B3	VEC Waders in resting and feeding areas	1993	Hansson et al. 1994, Bakken et al. 1996
C	**Marine mammals**	**1993**	Hansson et al. 1994, Wiig et al. 1996
C1	VEC Polar bear	1993	Wiig et al. 1996
C2	VEC Walrus	1993	Wiig et al. 1996
C3	VEC Bearded seal	1995	Wiig et al. 1996
C4	VEC Ringed seal	1993	Wiig et al. 1996
C5	VEC White whale	1993	Wiig et al. 1996
C6	VEC Gray whale	1995	Wiig et al. 1996
C7	VEC Bowhead whale	1995	Wiig et al. 1996
D1	VEC Human settlement	1993	Hansson et al. 1994, Larsen et al. 1996
D2	VEC Water/land border zone	1993	Hansson et al. 1994, Larsen et al. 1996
E1	VEC Protected areas	1997	Thomassen et al. 1998a (this issue), Thomassen et al. 1988c
F1	VEC Indigenous people	1997	Dallmann 1997, Thomassen et al. 1998a (this issue), Thomassen et al. 1998c
G1	VEC Domestic reindeer	1998	Thomassen et al. 1998a (this issue), Thomassen et al. 1998c
G2	VEC Wild reindeer	1998	Thomassen et al. 1998a (this issue), Thomassen et al. 1998c

7.1.2 The collection of data on each VEC

The NSR area is enormous with different amount of information available, both temporal and spatial, on the selected VECs. Within the time- and economical frames of INSROP we had to choose the best available information from several sources as a basis for the DEA, and later for the EIA. That means a combination of a collection and systematisation of existing Russian information (see Gavrilo & Sirenko 1995), combined with field collection of data. More than 4000 georeferenced individual registrations on VEC occurrence are integrated in the data base. Table 7.2 summarises the standard possible tabular information collected for each VEC. The complete design and development of the information system can be found in Løvås. et al. (1994).

Table 7.2. Key attributes to each VEC in INSROP Phase I.

Attribute type	Attribute description	Attribute domain
Topical	Species	
	Family	
	Class	
	Order	
	Trophic level	
	Status	
	Distribution & Population size	
	Habitats	
	Food habits	
	Human use	Vary from VEC to VEC
	Interaction with NSR activities	
Features	Numbers	
Spatial	Datum	
	Coordinate units	
Temporal	Year	
	Month	
	Day	
	Hour	
	Minute	

7.1.3 VEC data quality

Due to varying circumstances the VEC data quality are varying. The data quality question is treated in the INSROP Dynamic Environmental Atlas (Brude et al. 1998). Careful use of data has been necessary, and in some instances only trends or indications are the only contribution to the assessment.

7.1.4 The documentation of VECs

Except for this working paper, the INSROP-EIA documentation process so far consists of:

1. VECs in the EIA process:
   Thomassen et al. (1994)
   Thomassen et al. (1996a,b)
2. Selection of VECs:
   ⇒ Screening and focusing workshop
   Hansson et al. (1994)
   ⇒ Supervisors reports on their work with VECs
   Bakken et al. (1996)
   Dallmann (1997)
   Larsen et al. (1995, 1996)
   Wiig et al. (1996)
   Thomassen et al (1998c)
3. Collecting of VEC baseline information:
   Dallmann (1997)
   Gavrilo et al. (1995)
   Larsen et al. (1996)
   Wiig et al. (1996)
   Thomassen et al. (1998c)
4. VECs and corresponding schematic flow charts and impact hypotheses:
   Bakken et al. (1996)
   Larsen et al. (1995, 1996)
   Wiig et al. (1996)
   Thomassen et al. (1998c)
5. VECs and vulnerability assessments
   Gavrilo et al. (1998)
   Thomassen et al. (1998b)
6. VECs in the INSROP Dynamic Environmental Atlas:
   ⇒ GIS design and implementation of data
   Løvås et al. (1994)
   Løvås & Brude (1996)
   ⇒ INSROP Dynamic Environmental Atlas
   Brude et al. (1998)

7.2 Dynamic Environmental Atlas

The Dynamic Environmental Atlas forms the baseline environmental data sets for the impact analyses and the assessments. The term *best available data* is introduced to indicate the level of baseline data resolution. Except for individual studies (Bakken & Gavrilo 1995), field surveys have been beyond the Sub-programme scope. The historical data however may be obtained for different purposes, the temporal and spatial resolution may be coarse and in some areas even absent, and a more pragmatic approach – developing reasonable combinations of the data available – may be more convenient. In such approaches, the results are not necessarily of less value, but the question is how they can be validated. If carefully considered in terms of quality control of all steps, the results could provide valuable information even though stringent scientific requirements are not necessarily met.

Focusing on the natural environment, Sub-programme I on a geophysical approach - Sub-programme II from an ecological point of view, the sub-programmes have a common foundation for their study. Consequently, joint effort has been placed on baseline data inventories and development of convenient information systems for storage, retrieval, integration and analyses of the information obtained.

The INSROP GIS is a result of such sub-programme collaboration. The system is intended to serve two correlated purposes: a) during INSROP, to serve as a IT-tool for organisation and storage of INSROP data and for project-related analytical work, and b) to grow into a computerised up-to-date realisation of the INSROP knowledge base (Løvås & Smith 1996).

The INSROP EIA is concentrated on a limited number of priority issues, - Valued Ecosystem Components (VECs), which have been carefully selected from a large and complex biogeographical region and potential NSR activities-impact relationships (Thomassen et al. 1996a, b). In this context, indigenous peoples form an individual component, in terms of their regional and local distribution, current status, development, and subsistence/ utilisation of natural resources, respectively (Dallmann 1997).

The first step of the baseline data inventory on the selected VECs was carried out in 1993-94, in form of a pilot survey on identification of existing Russian and other relevant data (Gavrilo & Sirenko 1995). All the references are stored in a database, including 963 titles of Russian monographs and papers, each supported by key words for taxa, geographical area and main ecological issues discussed.

The INSROP GIS design was developed in parallel (Løvås et al. 1994), with outlines on system infrastructure, data format specifications, and the thematic integration. The organisation of data flow is discipline oriented. The institutions responsible for the five DEA-projects have also been responsible of supplying the baseline data, including information of the data itself (metadata). The Russian co-partners of these projects are key personnel in the data flow, and personnel and institutional network building is emphasised (Bakken et al. 1996). In the second step of the data inventory (1994-96), significant effort was devoted to mapping of the selected VECs, i.e. collecting data on the temporal and spatial distribution of coastal zone attributes, invertebrates, fish, birds and marine mammals.

In the course of preparing the materials and their entering into INSROP Dynamic Environmental Atlas some difficulties became visible. To represent the information concerning species inhabitancy along land, the suggested GIS formats appeared to be sufficient, and the proposed formats such as points, lines and polygons have been used. However, when dealing with the information about distribution of species in sea, the data often lack exact geographic location. Consequently, the basis for overlay analyses between the VEC and NSR activity is limited. This is connected both with the possibilities of getting sufficient information, and with the fact that distribution in sea often is determined by dynamic factors like currents, dissemination of water masses, ice situation etc. The distribution of species in time and space therefore change within a season and from season to season.

Moreover, available information regarding distribution of migrating species in sea is often represented as follows: "a species is found in the water area free from ice" or "in the area of spread of certain water masses" or "in the area of ice edge", etc. A certain assistance in mapping species distribution in water areas (provided data concerning connection between species distribution and certain ocean factors are available) might be rendered by maps (average and extreme) of distribution of relevant parameters of an abiotic medium. Unfortunately, we failed to use such a support due to the absence of the requested data.

7.3 EIA implementation, main components and interactions

"*Sola dosis fecit venum*" (Poison is purely a question of dose, Paracelsus 1493-1541). This truism forms a basic element of the "dose-response relationship", which is considered to be the fundamental principle of toxicology (Amdur et al. 1991, Rand 1995). The principle is easily recognised in the numerous studies on single species exposed to single toxicants under controlled conditions in the laboratory. The conditions *in situ* however, are characterised by the significant temporal and spatial variability of the receiving environment. Exposure to a single chemical in a static state is rare, the interactions of "many impact factors - many organisms at risk", are more apparent. Applied to this kind of dynamic, multiple component systems, the dose-response relationship is more obscure, but still recognised, in the interface of contaminant fate, the exposure and tolerance, biological effects and possible environmental impact.

Complicated by the same multiple component dynamics, the environmental impact predictions will rely on the ability to *identify* and *harmonise* the understanding of the key elements and the processes of certain causal connections. In terms of the necessary *simplification*, *generalisation* and *standardisation* of selected elements interacting in the conflict matrix, environmental assessments should be based on the four main elements:

- The fate and significance of contaminant and environmental stress
- Biological effects
- The vulnerability of species
- Environmental damage and impact

The causal connection between these elements, i.e. the integration of impact factors and biological effects, organism's sensitivity and vulnerability, identification of conflict areas, and the concluding assessment of damage and impact, are outlined in the following sections. This contribution aims to harmonise the technical terms and improve the stringency of selected elements in the INSROP EIA process.

7.3.1 Fate and significance of impact factors

The unique toxicity of a contaminant depends entirely on its physical and chemical properties, with regard to effects on biological resources. Released to the environment, contaminants will immediately undergo a series of changes as a result of physical and chemical processes in the receiving environment. These changes will significantly affect the toxicant properties, exposure and the response of the receiving environment in the short and the long term.

In this respect, the environmental impact factors are specific (unique) for the given contaminant, group of contaminants, as well as contaminant state. The effect is also a function of the environment to which a contaminant is released. Behaviour of a certain contaminant may be different in the Arctic and in temporal zone. Self-recovery ability of ecosystems of different zones are also different. This means that an experience of environmental impact of a given contaminant for example in temperate regions cannot automatically be applied to Arctic regions due to lack of information and knowledge. Consequently, the following conclusions can be made:

- Assessments should be made on reliable assumptions which reflect the current status of the understanding with regard to contaminant dynamics, - in the short term towards the contaminant state at the moment of release, - in long term towards the contaminant's disintegration and fate in the receiving environment. In cases where our understanding of the effects and impacts are too scarce to reach the necessary level for assessment, recommendations should be made to reach the minimum level of understanding the impacts.
- Applications shall be made towards the principles of "dose-response" relationship, e.g. *that the environmental effects is considered to be specific for the given contaminant, or group of contaminant in the actual environment.* This means that each impact factor shall be treated individually, harmful agents and substances shall be identified, and systematically applied to the analyses. The concept is also relevant for impact factors like physical disturbance, noise, etc.

7.3.2 Biological effects – species sensitivity

Contaminants, physical disturbance, noise etc. can cause biological effects, or deviations from previously existing circumstances, both directly and indirectly. The pathways of the given contaminant or impact factor, including the ability to accumulate and/or excrete the material, is species specific.

In the scientific community (Bayne et al. 1985, Underwood & Peterson 1987, Bayne et al. 1987, Amdur et al. 1991, Rand 1995), it is an often stated and sound maxim that unless pollution effects occur or are likely to occur at the population level, it is arguable whether pollution effects can be truly said to have occurred (Bayne 1985). This necessary link between effects in the individual and consequences for the population was incorporated by Bayne (1975) into a definition of stress response, subsequently formulated by McIntyre et al. (1978) as follows: "*....from a strictly biological point of view it is the population and not the individual that is important and it is argued that unless an effect has consequences at the population level it is insignificant.*"

This statement is widely accepted (Gray & Brattegard 1979, Clark 1984), and is applied to the Norwegian national standard for criteria to identify areas/ ecosystem components of particular sensitivity to oil pollution (Moe et al. 1995), and also including community level, in line with international and national programmes on regular environmental regular (Anon. 1980, 1989, Bakke et al. 1994, 1995).

It is, however, important not to forget that impacts on single individuals can be of significant importance even though the impacts on the population as a hole is on insignificant value. The VEC concept also captures up such species, species which have a more or less charismatic nature exemplified by the polar bear and whales. Even if the impacts on these species can be of insignificant value for the population, it can be highly relevant for the decision makers.

Applied to the understanding of population and community dynamics, environmental impact of a contaminant can be described as a combination, or function, of the two parameters:

- the immediate extent (or amount) of damage
- the duration of damage

The immediate damage refers to the initial response of the contaminant exposure, while the duration of damage (e.g. the recovery period) is equivalent to the period from maximum damage until the population (or community) structure, has developed into a state corresponding to similar uncontaminated system components/ environment, both regarding species composition and age distribution (Southward & Southward 1978, Gray & Brattegard 1979, Moe et al. 1995). This process - from the time when the contaminant "strikes" the ecosystem component to the recovery is completed - is illustrated in Figure 7.1.

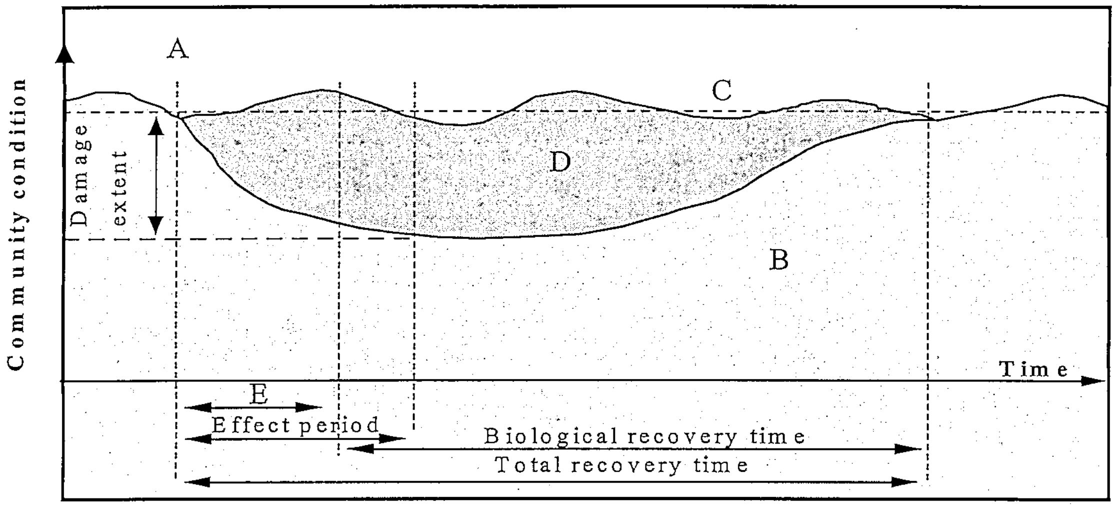


Figure 7.1. The impact of an oil spill on the condition of the community (or population). The sensitivity is expressed as the shaded area (D). A: the time at which the contaminant strikes the resource, B: recovery process after the initial exposure, C natural conditions, including fluctuations without contamination, E: initial impact period. Modified after Lein et al. (1992), Moe et al. (1998a).

It is important, however, to recognise the trends and dynamics in the population, recovery does not necessarily mean a recovery measured in comparison with the state at the time of damage, but rather at the level the population would have been at in the future without the damage.

The geographical range of the area affected contributes a third dimension to the algorithm. It should be stressed, that even if all kind of biological resources have a potential for recovery, the realisation of this potential is primarily a function of, *i) abiotic factors,* e.g. type and fate of contaminants, exposure time and dosage, occurrence of other natural impacts, for example, severe weather or unfavourable ice conditions may add impact which will be enough to decrease the recovery ability of the population dramatically, and *ii) biotic factors* (e.g. intrinsic factors: physiological adaptive responses, tolerance and resistance, behaviour, fecundity, reproduction strategy, and extrinsic factors: food access, interspecific competition and coexistence dynamics etc.). The intrinsic factors are species-, population-, and community-specific, which evidently form the basis for an *individual* (unique) tolerance/ sensitivity to the given contaminant. In extreme situations, e.g. in case of individual number being dramatically reduced, the population capability to restore may be lost. In such cases, the population declination state could be permanent.

Consequently, the following statements on the concept and role of biological effects can be made:

- Environmental effects correspond to the deviations from previously existing circumstances, both regarding direct-indirect effects, and lethal-sublethal effects.
- Environmental effects (cf., item 1) should be measured by the two factors, - the immediate extent of damage, and, - the duration of damage, and related to the organisational levels of populations and communities.
- The organisms tolerance to stress, or stress sensitivity, should be considered as species specific (unique) for the given contaminant or impact factor, in the actual environment.

7.3.3 Vulnerability

The vulnerability to harmful substances and environmental stress (or susceptibility to injury) is technically the term indicating the potential damage on a given ecosystem component which can be generated by a given impact factor (Moe et al. 1995).

This imply that the additional factor - ability to be exposed - is introduced to the conflict matrix. The introduction allows also a distinction between the terms *hazard* and *risk*, with the former circumscribing the properties, including toxicity, of a substance, and the latter depending on the combination of hazard and exposure. This approach is in line with the IMO/ UNEP standards (GESAMP 1989), and international scientific communities working on method development for environmental risk analyses (van Leeuwen & Hermens 1995). In such work, environmental risk can be defined as the product of probability/ frequency to be exposed and the possible consequences.

Primarily, the tolerance to withstand exposure to toxicants and environmental stress in the short and the long term is an unique attribute of the given organism at the different organisational levels (see previous section, and results obtained in numerous short term exposure experiments like toxicity screening studies on LC_{50} and EC_{50}). Correspondingly, the organisms ability to be exposed is highly species specific (unique). Once contaminants are introduced to a habitat, the initial exposure mechanisms are *a priori* a function of the organism's behaviour. Mobile organisms have the capability to escape - the question is rather if this actually happens - while the sessile organism definitely do not have this ability, and tend to stay in the contaminated area.

Given this causal connection, mathematical models have been developed to reflect the vulnerability to certain types of contaminant. In the SIMPACT model for seabirds and oil pollution developed by Anker-Nilssen (1987), nearly 20 vulnerability parameters are identified and their importance are related to a relative scale. Of these parameters, the temporal and spatial co-occurrence of seabirds and oil pollution is given significant importance.

Skeie et al. (1996) presents corresponding methods, where the species sensitivity is combined with the temporal and spatial distribution of the organisms, to produce vulnerability statistics and maps. In a subsequent step, oil drift statistics are applied, indicating potential impact and environmental risk. In these approaches (Anker-Nilssen 1987, Skeie et al. 1996) the species specific sensitivity is considered to be unique for the given impact factor (e.g. marine oil pollution), and the sensitivity is given by indices on a relative scale.

Mathematical vulnerability models could probably be developed for most conflict areas between environmental stress factors and ecosystem components, given enough economical, personnel and time resources. This is however not the situation, and for most conflict areas more qualitative assessments have to be done. Based on Canadian experience (Indian and northern affairs 1992a,b) we have therefore developed a qualitative assessment procedure to be used in the assessment of potential impact level in INSROP (see chapter 13 for further details).

In line with the above stated, the following conclusions can be made:

- The vulnerability indicates the potential damage on a given ecosystem component which can be generated by a given impact factor, and imply integration of the "ability to be exposed" in the conflict matrix. In all aspects, the organisms ability to be exposed is species specific (unique).
- The integration of the term "ability to be exposed" allows the introduction of environmental risk, both regarding direct-indirect effects, and lethal-sublethal effects.
- Applications of the organisms ability to be exposed should be considered as species specific (unique) for the given contaminant.
- Vulnerability indices should be developed for the selected VECs, by integration of organisms sensitivity and the ability to be exposed.

7.3.4 Environmental impact

The INSROP EIA concept is derived from the causal connection between an impact factor (cf. section 6.2) and the receiving environment. This implies *inter alia*:

i) to generate biological effects and environmental impact, a contaminant/stress factor and an ecosystem component must interact over periods of time (i.e. an exposure must occur).

ii) The impact factor and ecosystem components however are temporally and spatially changing, reflecting the state of "contemporaneous disequilibrium". Hence, the impact potential will correspond to the state of the impact factor and ecosystem components at the moment of interaction - primarily as long as both parts co-exist within the given influence area - in successions as long as deviations in environmental parameters between the influence area and the uncontaminated/ undisturbed area are observed.

iii) The ultimate measure of damage can therefor be derived by combining the two parameters, - *the extent of damage*, and, - *the duration of damage*. In all aspects the contaminant and ecosystem component attributes with regard to potential impact are unique / species specific.

In the INSROP GIS – DEA, standard routines are developed to:

i) Identify the temporal and spatial distribution of the selected VECs

ii) Identify the impact factor and influence area (influence zone) of the given NSR activity, primarily ship operation and accidental oil spills

iii) Apply vulnerability indices to the resource component in the standard attribute tables

iv) Calculate and quantify the conflict area, e.g. overlapping area between the VEC and the given impact factor and corresponding influence zone, for qualitative assessment of the damage and impact.

Item (i) is directly derived from the DEA. Item (ii) is based on the general knowledge and environmental concerns of international shipping activity. The vulnerability indices are activity- as well as species-specific, and are developed by the Norwegian and Russian scientists and experts in line international experience and scientific results. The final step of item (iv) is entirely a matter qualified estimates. All factors in the conflict matrix are highly variable and the variation is hardly measurable. In addition, the resolution of the baseline data is quite coarse, and do not allow for quantitative calculations of the interactions and the impact. The process and examples of the results obtained are outlined in Step by Step in Part II.

8. Impact hypotheses

On the background of preliminary NSR scenarios and the identified impact factors, a number of VEC specific impact hypotheses have been described and evaluated in INSROP Phase I (and Phase II for some of the VECs).

8.1 VECs, impact factors and impact hypotheses

For the EIA purpose impact factors have been identified on the basis of generally described INSROP activities or scenarios, and corresponding impact hypotheses have been described and evaluated through a categorisation (see Hansson et al. 1990) in one of the following four categories:

A. *The hypothesis is assumed not to be valid.*
B. *The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possibly be recommended.*
C. *The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.*
D. *The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.*

Due to new information and more detailed scenario descriptions, a re-evaluation of all impact hypotheses were done in INSROP Phase II. Even if this re-evaluation is part of the Phase II work, we find it appropriate to summarise the Phase I and Phase II hypotheses and their categorisation in Part I of this paper (Table 8.1). However, see Appendix 2 for a more complete overview of Table 8.1, also including impact factors and old/new impact hypotheses. Notice that several of the hypotheses still are identical with the original version. Notice also that some hypotheses are quite general while others are specific. The reason for this will vary:

- Precise activity descriptions or scenarios, gives better possibilities to identify precise impact factors and consequently precise impact hypotheses. Along NSR such precise activity descriptions are often lacking.
- If the objective is to assess impacts of a more general nature, the hypotheses will also be of a general nature.
- Lack of baseline information and/or sparse knowledge on how a VEC will react upon an impact factor can also lead to hypotheses of a general nature are often lacking.

In general, however, the more specific impact factors/impact hypotheses, the better basis you will have for assessing impacts and vulnerability. This is especially important when fully implemented for case studies or concrete developments.

Further explanations and documentation of VECs, hypotheses and categorisation from INSROP Phase I (dealt with in Table 8.1 and Appendix 2) can be found in several INSROP Working Papers: Bakken et al. (1996), Dallmann (1997), Gavrilo et al. (1995), Thomassen et al. 1988c, Larsen et al. (1995, 1996), Wiig et al. (1996). The additional VECs identified in Phase II, VEC Indigenous people (which is part of VEC Human settlements), VEC Wild reindeer and VEC Domestic reindeer and VEC Protected areas are documented in Thomassen et al. (1998c).

Table 8.1 Valued Ecosystem Components (VEC), impact hypotheses and their categorisation in INSROP-EIA. Impact hypotheses placed in category B or C are brought further to the analysis of impact assessments in INSROP EIA. See Appendix 2 for a more complete overview.

Valued Ecosystem Components	VEC No	IH No	Impact hypotheses (IH)	Category
VEC Benthic invertebrates	A1	A1-11	• Accidental discharges of radioactive material from ships will affect benthic invertebrates*	B
VEC Benthic invertebrates	A1	A1-12	• Accidental discharges of bunker or diesel oil will cause increased mortality in shallow water benthic invertebrates	B
VEC Benthic invertebrates	A1	A1-13	• A major oil spill arising from a tanker accident will affect benthic invertebrates, measures as changes in community structure and biomass, and on the sub-acute level increase hydrocarbon body burdens.	B
VEC Benthic invertebrates	A1	A1-14	• Accidental release of iron ore (pellets) will cause alterations in substrate granulometry, and thereby change species diversity in benthic invertebrate communities	C
VEC Benthic invertebrates	A1	A1-15	• Accidental release of fertiliser form a ship wreck will through stimulation of primary production cause increased availability of food particles for benthic invertebrates	C
VEC Benthic invertebrates	A1	A1-16	• Chemical dispersants used in clean up operations will increase mortality in benthic invertebrates	B
VEC Benthic invertebrates	A1	A1-2	• Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., as well as chemical dispersants used in clean-up operations, will affect survival of pelagic larvae of benthic invertebrates at certain times of the year.	C
VEC Benthic invertebrates	A1	A1-3	• Chronic pollution with e.g. anti-fouling paint, fuel residues etc., will cause accumulation of pollutants in benthic invertebrates.	B
VEC Benthic invertebrates	A1	A1-4	• Hardbottom epifaunal organisms can access new substrates by colonising the surface of dumped waste.	D
VEC Benthic invertebrates	A1	A1-5	• Releases/discharges of anti-fouling paint, like TBT, will affect reproduction in benthic invertebrates.	B
VEC Marine, estuarine and anadromous fish	A2	A2-11	• Accidental discharges of oil will increase mortality in pelagic eggs and larvae of marine fish	B
VEC Marine, estuarine and anadromous fish	A2	A2-12	• Accidental discharges of radioactive material will increase mortality in fish.	C
VEC Marine, estuarine and anadromous fish	A2	A2-13	• Physical disturbance from e.g. ice floes being overturned during shipping will increase mortality in marine fish species.	C
VEC Marine, estuarine and anadromous fish	A2	A2-21	• The Whitefish (Coregonidae sp.) is a key fish group in most rivers and coastal waters along the NSR. Operational discharges affecting reproduction, migration and survival in Coregonids will cause major impacts in the rest of the food chain.	C
VEC Marine, estuarine and anadromous fish	A2	A2-3	• Accidental discharges of radioactive materials, fuel or certain types of cargo, e.g. hydrocarbons, ore etc., in fresh water along the coastal NSR area will cause increased mortality and reduced production in anadromous fish populations.	C
VEC Plant and animal life in polynyas	A3	A3-1	• Any effects of NSR traffic will be manifested to a greater extent in polynyas than in other areas.	C

VEC Plant and animal life in polynyas	A3	A3-2	• Noise from ice-breaking, engines and propellers will scare fish, mammals and seabirds away from important feeding, resting and breeding areas in and near polynyas.	C
VEC Plant and animal life in polynyas	A3	A3-3	• Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., in polynyas will affect primary production, and thus the whole feeding network.	C
VEC Plant and animal life in polynyas	A3	A3-4	• Even minor accidental oils spills in polynyas, will cause suffering and death to seabirds and marine mammals.	B
VEC Plant and animal life in polynyas	A3	A3-5	• Chronic pollution of polynyas, with e.g. anti-fouling paints and/or hydrocarbons from fuel, affects reproduction and survival of individuals at all trophic levels.	C
VEC Seabirds	B1	B1-1	• Accidental and operational releases of hydrocarbons to ice, sea or shore may cause increased mortality and reduced reproduction of the seabird populations.	B
VEC Seabirds	B1	B1-2	• Disturbance in or near nesting colonies and feeding areas resulting from the NSR activity (traffic of ships, helicopters and aeroplanes) will cause reduced reproduction and/or the abandonment of areas.	C
VEC Seabirds	B1	B1-3	• An increase in the population of large gulls, skuas and Arctic Fox resulting from increased food availability (dumping of edible waste etc.) will cause increased predation on seabirds and their eggs and chicks.	C
VEC Seabirds	B1	B1-4	• Increased human presence due to an increase in ship traffic and number and size of harbours and other settlements will result in reduced local seabird populations due to increased hunting pressure and egg harvesting.	C
VEC Seabirds	B1	B1-5	• Emission of toxic or other harmful substances (other than oil components) from ships or other activity related to the NSR will cause increased mortality and reduced reproduction of seabirds.	D
VEC Seabirds	B1	B1-6	• Oil pollution will cause increased mortality and reduced reproduction in the seabirds' food organisms. Reduced availability of food will result in a reduction in seabird populations.	D
VEC Seabirds	B1	B1-7	• Increased human activity in connection with NSR (e.g. pollution, hunting and noise) can reduce the population of large gulls, skuas and Arctic Fox. This will reduce the predation on other seabirds and their eggs and chicks, and have a positive effect on the seabird population.	A
VEC Seabirds	B1	B1-8	• Increased ice-breaker traffic in ice filled waters will make the access to food organisms easier for seabirds and result in a population increase.	D
VEC Seabirds	B1	B1-9	• The propellers on the ship will whirl up sand and mud from the bottom and reduce the visibility for diving seabirds. This will reduce feeding efficiency of foraging seabirds.	A
VEC Seabirds	B1	B1-10	• Ship traffic (ice-breaking and propeller action) will cause increased mortality and reduced reproduction in the seabirds' food organisms. Reduced availability of food will result in a decrease in seabird populations.	D
VEC Marine wildfowl	B2	B2-1	• Disturbance near breeding areas can result in reduced reproduction of marine wildfowl through increased predation and reduced egg and chick survival, and may lead to abandonment of breeding areas.	B
VEC Marine wildfowl	B2	B2-2	• Disturbance in resting, moulting and feeding areas will result in increased energy expenditure, less time for food intake and accordingly increased mortality of adult wildfowl and reduced reproductive success.	B
VEC Marine wild-	B2	B2-3	• Accidental and operational releases of hydrocarbons to ice,	

fowl			sea or shore may cause increased mortality and reduced reproduction of the wildfowl populations.	B
VEC Marine wild-fowl	B2	B2-4	• Toxic substances discharged into the sea may be accumulated in, and will possibly kill, benthic fauna forming part of the diet of marine ducks. This may result in reduced access to food and possibly poisoning of birds, and accordingly reduced reproduction and increased mortality.	C
VEC Marine wild-fowl	B2	B2-5	• An increase in the populations of large gulls, skuas and arctic fox resulting from increased dumping of edible waste will cause increased predation on wildfowl and their eggs and chicks.	C
VEC Marine wild-fowl	B2	B2-6	• Increased human presence due to an increase in ship traffic and number and size of harbours and other settlements will result in reduced local seabird populations due to increased hunting pressure and egg harvesting.	C
VEC Marine wild-fowl	B2	B2-7	• Extensive disturbance in breeding areas will reduce the number of suitable breeding areas and lead to reduced reproduction and reduced population sizes of marine wildfowl.	D[1)]
VEC Marine wild-fowl	B2	B2-8	• Increased impact from human activity in connection with NSR (e.g. pollution, hunting and noise) can reduce the population of large gulls, skuas and Arctic Fox. This may result in decreased mortality and increased reproduction of wildfowl.	A
VEC Waders in resting and feeding areas	B3	B3-1	• Disturbances in resting and feeding areas can result in reduced possibility for the waders to store enough energy for the autumn migration.	C
VEC Waders in resting and feeding areas	B3	B3-2	• Discharged toxic and harmful substances that affects the feeding areas of waders may accumulate in, and possibly kill, organisms which are normally preyed upon by waders. This can lead to direct poisoning or reduced access to food for the waders.	C
VEC Waders in resting and feeding areas	B3	B3-3	• Oil spills affecting concentrations of waders in resting and feeding areas will cause increased mortality resulting both from direct oiling and habitat degradation.	C
VEC Marine mammals	C	C-1	• *For all marine mammals:* Accidental and operational releases of hydrocarbons and radioactive material to ice, sea and shore can be accumulated through the food chain and reach such high concentrations in marine mammals as to have toxic effects.	C
VEC Polar bear	C1	C1-1	• Oil pollution in polar bear habitats will cause suffering and death for the affected polar bears and may result in a decrease of the population.	B
VEC Polar bear	C1	C1-2	• Discharges of edible waste from harbour facilities and ships will cause a local increase in the polar bear population.	B
VEC Polar bear	C1	C1-3	• Reduced seal occurrence resulting from disturbance and pollution from activity will cause a decrease in the polar bear population in the area.	D
VEC Polar bear	C1	C1-4	• Installations and traffic of ships, helicopters, aeroplanes and other motorised vehicles in or near denning areas will cause reduced reproduction in the polar bear population	C
VEC Polar bear	C1	C1-5	• Disturbances and obstacles caused by ship traffic, ship support and infrastructure in polar bear migration and feeding areas will result in a reduced population	C
VEC Polar bear	C1	C1-6	• Activity in the ice creating artificial leads will cause a local increase in polar bear prey and accordingly a local increase in the occurrence of polar bears	D
VEC Walrus	C2	C2-1	• Installations and traffic of ships, helicopters and aeroplanes, especially near haul-out sites, will result in disturbance and reduction in the walrus population.	C

VEC Walrus	C2	C2-2	• Oil pollution from ships will reduce the walrus population.	C
VEC Bearded seal	C3	C3-1	• Traffic of ships, helicopters and aeroplanes will result in disturbance and reduction in the local bearded seal populations.	D
VEC Bearded seal	C3	C3-2	• Oil pollution from ships will cause suffering and death for affected bearded seals and reduction in local bearded seal populations.	C
VEC Ringed seal	C4	C4-1	• Traffic of ships, helicopters and aeroplanes will result in disturbance and reduction in the local ringed seal populations.	C
VEC Ringed seal	C4	C4-2	• Oil pollution from ships will cause suffering and death for affected ringed seals and reduction in local ringed seal populations.	C
VEC Ringed seal	C4	C4-3	• Activity causing changes in local predator populations will affect the ringed seal population of the area.	D
VEC White whale	C5	C5-1	• Oil pollution from ships will cause suffering and death for affected white whales and reduction in the white whale population.	C
VEC White whale	C5	C5-2	• Traffic of ships and ice breaking will result in disturbance and reduction in the local white whale populations.	C
VEC Gray whale	C6	C6-1	• Oil pollution from ships will cause suffering and death for affected gray whales and reduction in the gray whale population.	D
VEC Gray whale	C6	C6-2	• Traffic of ships will result in disturbance and reduction in the local gray whale populations.	C
VEC Bowhead whale	C7	C7-1	• Oil pollution from ships will cause a reduction in the bowhead whale population.	D
VEC Bowhead whale	C7	C7-2	• Ice-breaking and traffic of ships will result in disturbance and reduction in the local bowhead whale populations.	C
VEC Human settlements	D1	D1-1	• Accidental discharges of radioactive materials, fuel, or certain types of cargo, like hydrocarbons, fertilisers, ore etc. will affect the resource base for local people.	B[2)]
VEC Human settlements	D1	D1-2	• Breaks in the ice render traditional routes for livestock and fishermen/hunters inaccessible.	C[2)]
VEC Human settlements	D1	D1-3	• Noise from e.g. ice-breaking, engines, propellers, will scare fish, seabirds and marine mammals away from polynyas or other congregation areas, and thus affect the indigenous peoples hunting and fishing activities.	D[2)]
VEC Human settlements	D1	D1-4	• Accidental discharges of radioactive materials, fuel and certain types of cargo, e.g. hydrocarbons, ore etc., will interfere with the indigenous peoples .hunting and fishing activities.	C?[2)]
VEC Water/land border zone (sensitive areas)	D2	D2-1	• Activities related to construction of necessary harbour facilities, such as area occupation, land-filling etc., will cause major local changes in the coastal zone.	B
VEC Water/ land border zone (sensitive areas)	D2	D2-2	• Floating waste will accumulate in protected areas of the coastal zone, causing aesthetic disturbance and providing substrates that will be colonised by invertebrates.	B
VEC Water/ land border zone (sensitive areas)	D2	D2-3	• Accidental pollution with radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., will cause major disturbances in the coastal zone, and under certain meteorological conditions also in inland areas (evaporation, precipitation).	B
VEC Protected areas	E1	E1-1	• Normal NSR operational traffic adjacent to protected areas will come in conflict with Russian legislation, regulations and aim of protection of protected areas.	C
VEC Protected areas	E1	E1-2	• Accidents in the vicinity to protected areas will come in conflict with Russian legislation, regulations and aim of protection of protected areas.	C
VEC Protected areas	E1	E1-3	• Normal NSR operational traffic adjacent to protected areas will disturb the wilderness quality of the areas significantly.	B

VEC Protected areas	E1	E1-4	• Accidents in the vicinity to protected areas can lead to extensive discharges of cargo, fuel an ballast water, which will reduce the wilderness quality of the areas extensively.	B
VEC Protected areas	E1	E1-5	• Normal NSR operational traffic adjacent to protected areas will disturb selected VECs, especially marine mammals.	C
VEC Protected areas	E1	E1-6	• Accidents in the vicinity to protected areas can lead to extensive discharges of cargo, fuel an ballast water, which will cause extensive damage to populations of VECs in vulnerable seasons.	B
VEC Protected areas	E1	E1-7	• Clean-up operations following an ship accident will lead to physical disturbance and noise, which will cause serious disturbance to selected VECs in vulnerable seasons.	C
VEC Protected areas	E1	E1-8	• Increased industrial development, with constructions of pipelines and transportation systems will disturb selected VECs in the terrestrial, aquatic and marine environment by making barriers and disturbance.	C
VEC Protected areas	E1	E1-9	• Pipeline accidents will destroy terrestrial, aquatic and marine habitats severely and reduce the environmental quality of protected areas.	B
VEC Protected areas	E1	E1-10	• Increased use of NSR will lead to increased population, tourism, hunting and fishing in protected areas, which will be a threat to selected VECs in special and to biological diversity in general.	C
VEC Indigenous people	F1	F1-1	• Boat traffic on frozen rivers disturbs migration of wild reindeer (and other wildlife) and affects the effectiveness of hunt as a major subsidence.	B
VEC Indigenous people	F1	F1-2	• Boat traffic on frozen rivers disturbs migration of domestic reindeer and affects the ecological basis of reindeer breeding	C
VEC Indigenous people	F1	F1-3	• Intensive traffic in coastal waters may cause emigration of marine mammals (as a resource of indigenous subsistence).	C
VEC Indigenous people	F1	F1-4a F1-4b	• Pollution from ships affects the habitat of sea mammals and other marine resources causing relocalisation of feeding, breeding, and/or resting areas or decrease of populations, leading to loss of resources for indigenous subsistence.	C
VEC Indigenous people	F1	F1-5	• Accidental pollution from shipwreck affects the habitat of sea mammals and other marine resources causing relocalisation of feeding, breeding, and/or resting areas or decrease of populations, leading to loss of resources for indigenous subsistence.	B
VEC Indigenous people	F1	F1-6	• Littering of beaches (waste from shipping) may lead to depletion of coastal gathering grounds.	C
VEC Indigenous people	F1	F1-7	• The NSR will favour hydrocarbon development, industry development and mining in northern areas, leading to land devastation and loss of hunting, fishing and breeding grounds.	B
VEC Indigenous people	F1	F1-8	• Oil/gas pipelines connecting hydrocarbon fields with northern harbours may lead to area segmentation as a hinder for wildlife migration and a general decrease of wildlife resources.	B
VEC Indigenous people	F1	F1-9	• The NSR will favour hydrocarbon development, industry development and mining in northern areas, leading to toxic spills that may destroy spawning areas and fishing grounds.	B
VEC Indigenous people	F1	F1-10	• Oil pipelines connecting oil fields with northern harbours may have accidental leakage and spills causing local degradation or destruction of subsistence areas.	B
VEC Indigenous people	F1	F1-11	• The NSR will favour industry development leading to SO_2 and other air pollution which will degrade or destroy subsistence areas.	B

VEC Indigenous people	F1	F1-12	• With an increased infrastructure, commercial fishing and hunting tourism may take subsistence areas from indigenous population.	B
VEC Indigenous people	F1	F1-13	• Increased infrastructure, through consequent alien settlement and industrialisation, will forward cultural decay among indigenous people.	B
VEC Indigenous people	F1	F1-14	• Increased infrastructure, alien settlement and industrialisation will lead to an increase of criminal acts against the indigenous population, and partly against their resource base and their means to use the resources (e.g. reindeer theft, robbery, threat).	B
VEC Indigenous people	F1	F1-15	• With increased accessibility and transport facilities, commercial fisheries and hunters may take the resource basis for indigenous subsidence.	B
VEC Indigenous people	F1	F1-16a F1-16b	• With an increased infrastructure, increased protection interests may lead to the closure of certain areas for indigenous subsidence. • With an increased infrastructure, increased protection interests may lead to an increased protection of indigenous resources from alien devastation. *(The option depends on the law regulation of the protected areas.)*	B B
VEC Indigenous people	F1	F1-17	• A possible economic rehabilitation of the northern areas supported by an increased infrastructure may create a marked for indigenous products and thus help to raise indigenous peoples' economic situation.	C
VEC Indigenous people	F1	F1-18	• Tourism may induce a renovation of traditional indigenous arts and crafts and thus increase the economic base for indigenous subsistence.	C
VEC Domestic Reindeer	G1	G1-1	• Disturbances and traffic will cause increased energy expenditure and reduced grazing time of reindeer, and accordingly reduced survival and calf production in the affected local populations.	C
VEC Domestic Reindeer	G1	G1-2	• Physical encroachment and installations will obstruct the movements of reindeer, may hinder their access to grazing and calving areas and increase their energy needs so that local populations may decrease.	C
VEC Domestic Reindeer	G1	G1-3	• Increased ship traffic and industrial activity will lead to increased illegal hunting and decreased reindeer populations.	B
VEC Domestic Reindeer	G1	G1-4	• Pollution from ship traffic and industrial activity will be accumulated in grazing vegetation and will affect the health condition of local reindeer populations.	B
VEC Wild Reindeer	G2	G2-1	• Disturbances and traffic will cause increased energy expenditure and reduced grazing time of reindeer, and accordingly reduced survival and calf production in the affected local populations.	C
VEC Wild Reindeer	G2	G2-2	• Physical encroachment and installations will obstruct the movements of reindeer, may hinder their access to grazing and calving areas and increase their energy needs so that local populations may decrease.	C
VEC Wild Reindeer	G2	G2-3	• Increased ship traffic and industrial activity will lead to increased illegal hunting and decreased reindeer populations.	B
VEC Wild Reindeer	G2	G2-4	• Pollution from ship traffic and industrial activity will be accumulated in grazing vegetation and will affect the health condition of local reindeer populations.	B

1) Increased land based activities can alter the categorisations.
2) See VEC Indigenous people for further explanation and documentation.
*) Impacts marked * are experienced in the past, but will depend on future laws and law enforcement

9. Potential impact levels

What will be the likely consequences of a more extensive use of the Northern Sea Route? As we lack detailed descriptions of proposed NSR activities as well as baseline environmental information for many of the selected ecological components (VECs), this question will at present be hard to give a probable answer on. Some analyses can be done with reasonable confidence, while others should wait until necessary information exist. Important, however, is the possibilities to run analyses and give assessments when needed. The INSROP-EIA therefore aim to fulfil two goals:

1. To build up a dynamic EIA-system that can handle different sort of information and is flexible in use when new information is available or when plans or scenarios are altered.
2. By using this system, make a limited EIA for selected and coarse scenarios in NSR, based on present available information.

Part II in this paper presents the step by step procedure to run the INSROP EIA analysis, and also to assess potential impact levels from the proposed NSR activities.

10. Acknowledgements

The authors wish to thank all scientists and their institutions working with the VEC baseline data - information which is essential for the INSROP EIA. The collaboration with Central Marine Design and Research Institute in St. Petersburg and SINTEF in Trondheim have also given valuable contribution to the work. We also want to give a special honour to Dr. Rasmus Hansson, the founder of INSROP Sub-Programme II. He placed the EIA as a central theme on the INSROP map.

PART II

11. INSROP - EIA: Step by step

The intention of *INSROP-EIA: Step by step* is to present the assessment system as built up using the combination of :

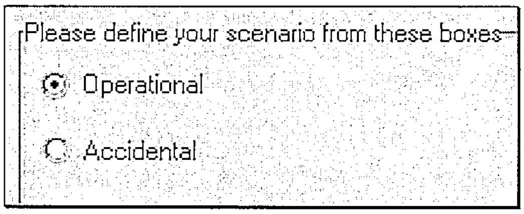
- Adaptive environmental assessment and management (AEAM)
- Baseline environmental information stored in INSROP Dynamic Environmental Atlas
- Geographical Information System (GIS)
- Semi-quantitative vulnerability assessment models
- Qualitative vulnerability assessments

Part II is organised in four sections with several steps as shown in Figure 12.1. Each section contains a step box with possible options, a short description and an example of a choice box as shown in the active GIS window when running the analyses.

11.1 Section I: Scenario in time

No	Step	Options
I-1	Specify NSR-activity level	Operational - path 1 Accidental - path 2

Description: NSR operational traffic is defined as normal sailing along the NSR, transit or/and to and from harbours/rivers. NSR accidental scenarios are understood as major discharges to the marine or terrestrial environment as a direct consequence of the NSR activities. Volume of discharges should be defined.



Choice box: Select scenario type

No	Step	Options
I-2	Select time	July, August, September, October (summer season) June, November (prolonged summer season) December, January, February, March, April, May (winter season)

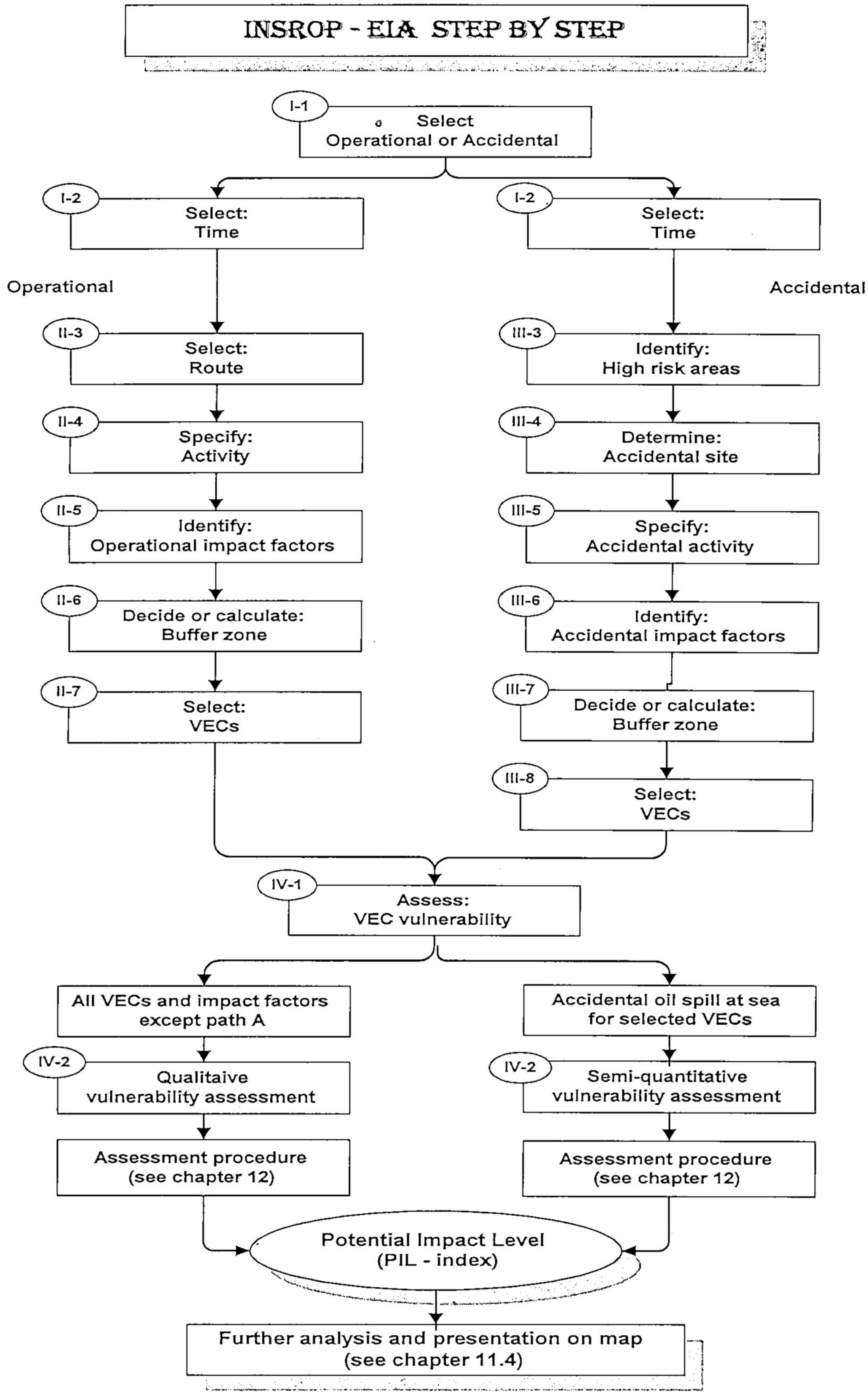
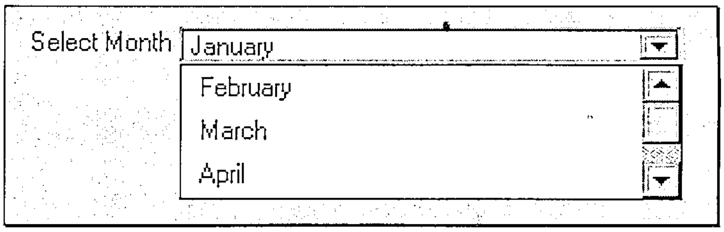


Figure 11.1. INSROP EIA Step by step procedure. Section I is common for operational and accidental activities. In Section II and III respectively operational and accidental activities are split, while section IV deals with vulnerability assessments for selected VECs.

Description: Sailing time as well as sailing routes must be probable and representative. Most sailing along NSR occur naturally in the summer season, but sailing is possible any time of the year given necessary powerful ice breaker assistance.

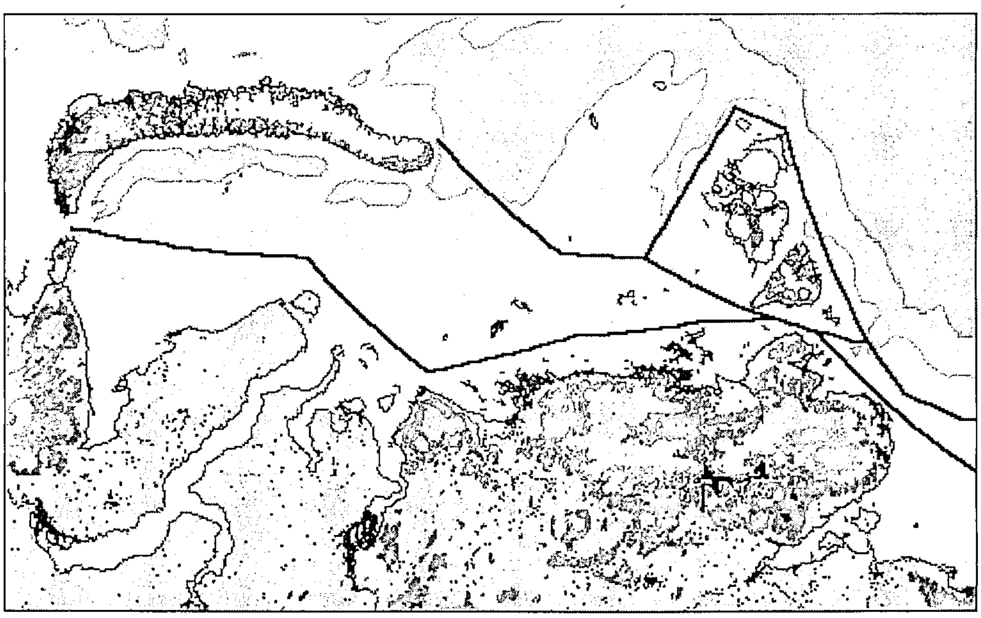


Choice box: Select time of year

11.2 Section II: Operational - path 1

No	Step	Options
II-3	Select route	T - segments: Transit segments H - segments: Segments from transit route to harbours R - segments: River segments

Description: Operational path was selected in step 1. The NSR sailing routes are predefined, divided into segments and stored in the INSROP GIS system. A number of segments will together form the selected route. Options are T: transit segments, H: segments from the transit route to coastal harbours, and R: river segments. The length of the segments will vary.



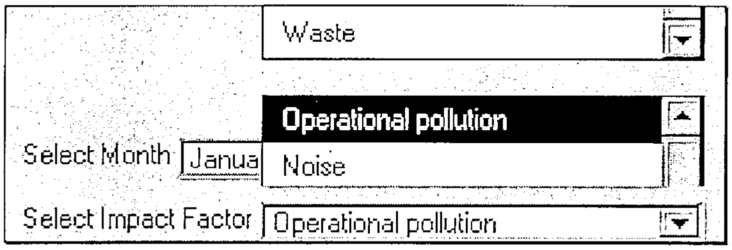
Choice: Select sailing route (example from the Kara Sea)

No	Step	Options
II-4	Specify NSR operational activity	See chapter 6.1.2 for an overview of the different operational activities. New activities can be added if required.

Description: A specification of the NSR operational activities of current interest must be made. The system opens for varying degree of resolution concerning NSR activities. It is however important to stress that detailed descriptions can lead to more specific impact factors, which in turn can lead to more precise formulated impact hypotheses. There is a strong link between NSR activities and impact factors.

No	Step	Options
II-5	Identify impact factors	On a coarse level the impact factors are: *operational pollution, noise, waste, physical disturbance* and *change of development patterns*. See chapter 6.2 for a more detailed listing of the different impact factors.

Description: The impact factors are linked with the NSR activity chosen, but the potential impact level can vary according to the ecological components affected. Given a NSR-activity, a list with potential impact factors will be given automatically. Selection of impact factors can be done from this list.

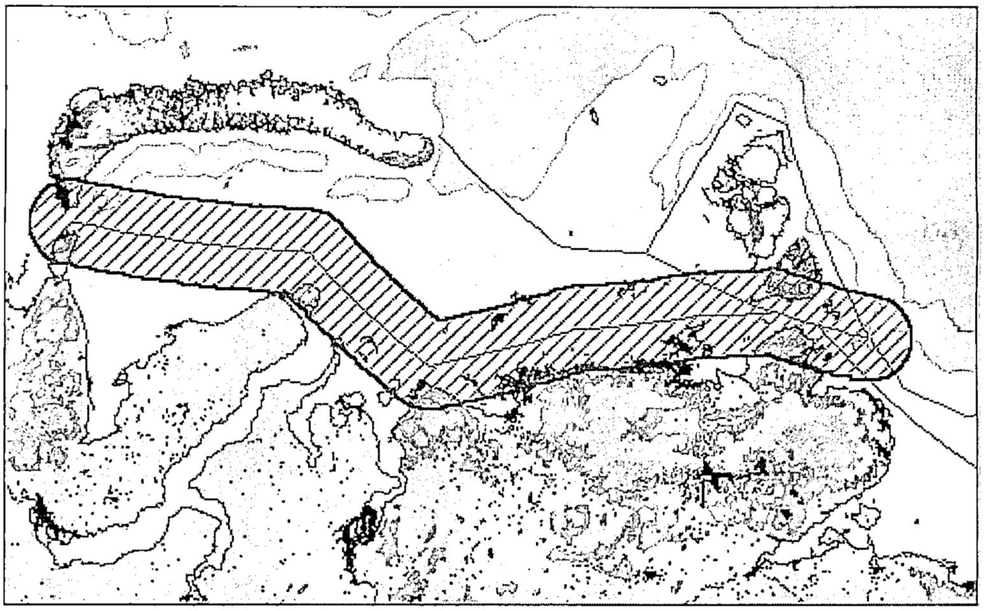


No	Step	Options
II-6	Decide or calculate influence zone	Given a sailing route, the influence zone consist theoretically of three dimensions: width, depth and altitude. In INSROP only the width dimension will be used for the determination of the influence zone. Three default values will automatically be calculated by the system. Users own choices are optional.

Description: The influence zone will actually differ according to different impact factors, time of the year (wider in winter because of more unfavourable ice conditions and consequently more unpredictable navigation), and also to different resources (VECs). Furthermore, it will be dependent on varying topography along the NSR.

To simplify the system we have chosen a conservative influence zone for sailing in open waters on 50 nautical miles (nm) all year around. This is a default value which will be calculated by the system and used in further analyses if not decided otherwise in step II-6. In the real world, however, each specific impact factor can have different impacts on selected resources and consequently different influence zones. For specific use it is therefore optional in the assessment system to decide the influence zone (step II-6).

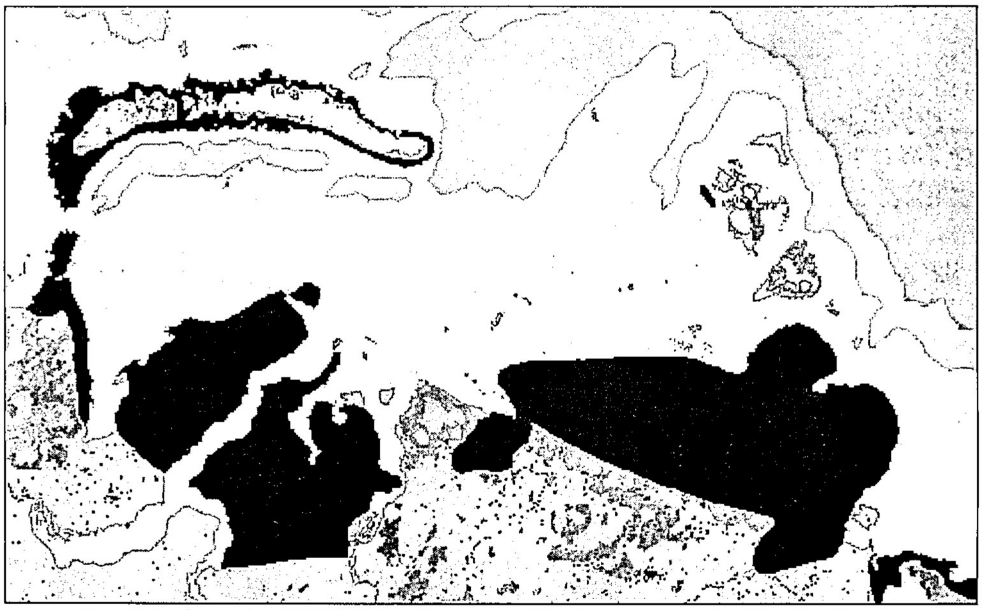
Also for river sailing, the influence zone must be decided from case to case dependent on the impact factor. For releases of pollutants to the river, for example, the influence zone will be of varying length downstream dependent of the type of pollutants, quantity and season.



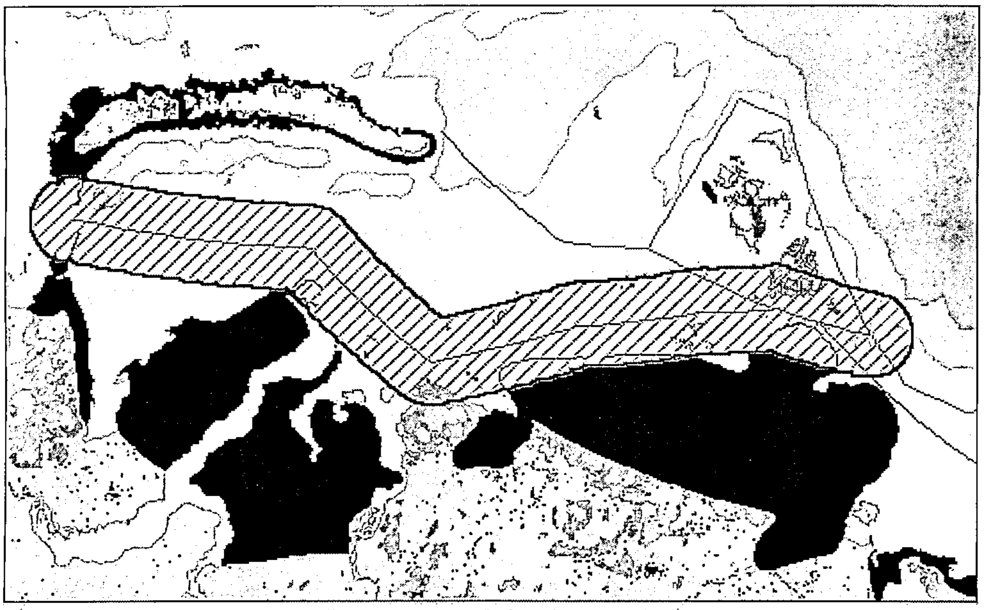
Example of calculated influence zone given the sailing route.

No	Step	Options
II-7	Select VECs	All VECs stored in the DEA (see chapter 7) for the particular season.

Description: Step II-7 will identify the VECs that have a possibility to come in contact with the NSR activity as expressed through the influence zone. Potential conflict areas are defined as the overlap between the calculated influence zone and the distribution of VECs, and will be calculated by the system.



Example from the VEC distribution maps. Dark areas are the distribution for the particular VEC in the particular season (or month).



Potential conflict areas are defined as overlap between the influence zone and the VEC distribution.

No	Step	Options
II-8	Assess resource (VEC) vulnerability	The vulnerability of selected VECs will vary according to time and impact factors. The vulnerability of VECs will be assessed by a qualitative vulnerability system (**see chapter 12**), ending up with Potential Impact Level indices (PIL-index)

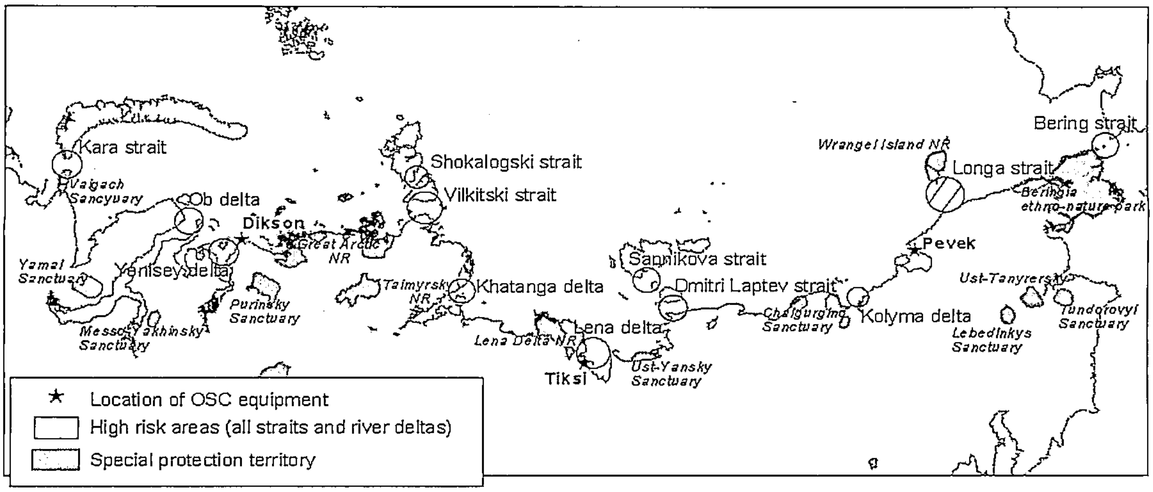
11.3 Section III: Accidental - path 2

No	Step	Options
III-3	Identify «High risk areas»	Number of ship accidents Month or season Cargo type

Description: Historical sailing data can give us at least a picture of accidents and frequency, and thereby a possibility to give a rough calculation of «high risk areas», probability of accidents, at which time of year, etc. Output will be maps showing «high risk areas» based on numbers of accidents, or relative probability of accidents compared with other areas of the NSR. When running the accidental scenario assessments, this information can be used as a guidance for determining the accidental site (and/or time).

No	Step	Options
III-4	Determine accidental site	High risk areas identified in step III-3

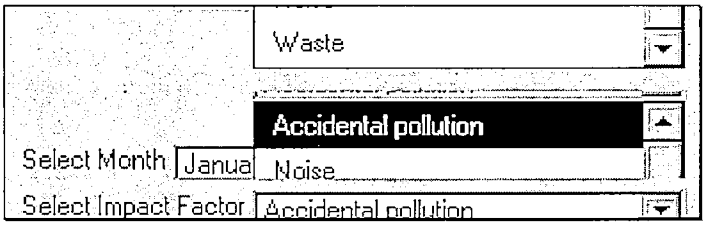
Description: Accidental site will normally be determined within a high risk area. In case of oil spill at sea, it is important to determine accidental site in areas where oil drift simulation model exist or can be made.



High risk areas along NSR

No	Step	Options
III-5	Specify NSR accidental activity	See chapter 6.1.2 for an overview of the different accidental activities. New activities can be added if required.

Description: A specification of the NSR accidental activities of current interest must be made. The system opens for varying degree of resolution concerning NSR activities. It is however important to stress that detailed descriptions can lead to more specific impact factors, which in turn can lead to more precise formulated impact hypotheses. There is a strong link between NSR accidental activities and impact factors.

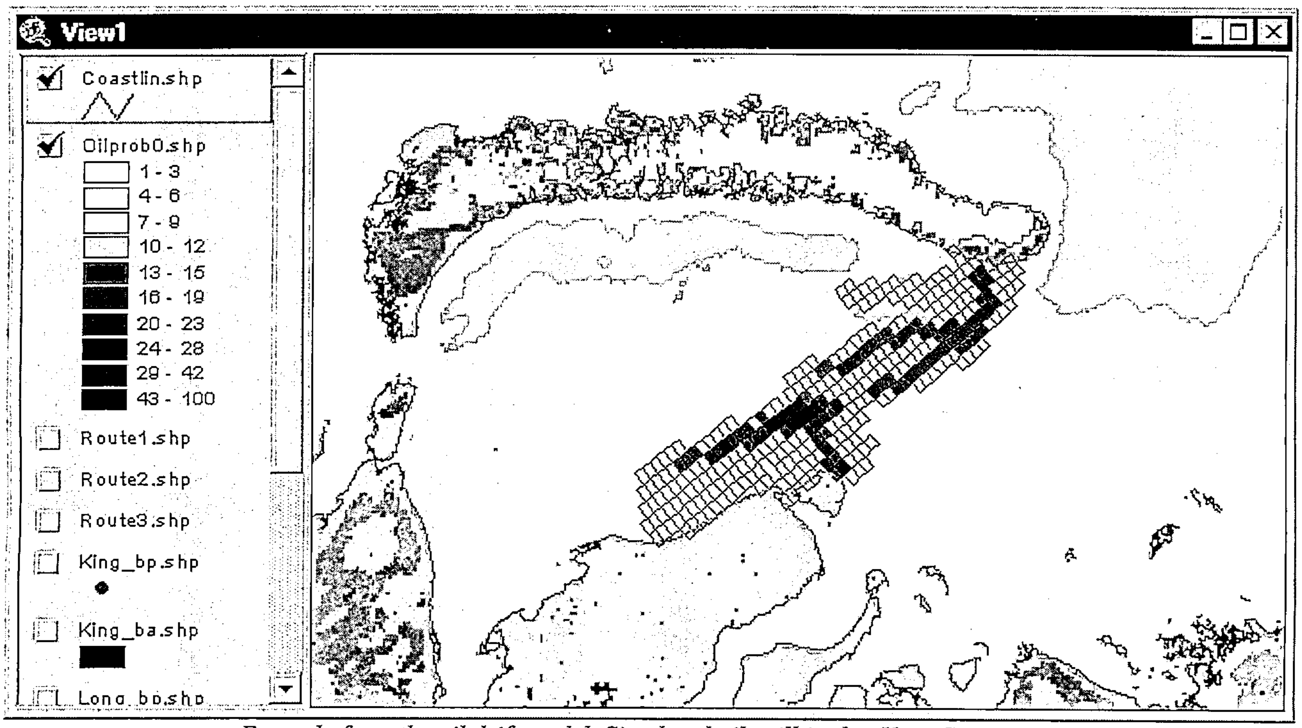


No	Step	Options
III-6	Identify impact factors	On a coarse level the impact factors are: *accidental pollution, noise, waste, physical disturbance* and *change of development patterns*. The most important impact factor from the accidental path is probably *oil spill* at sea or in ice covered waters. See chapter 6.2 for a more detailed listing of the different impact factors.

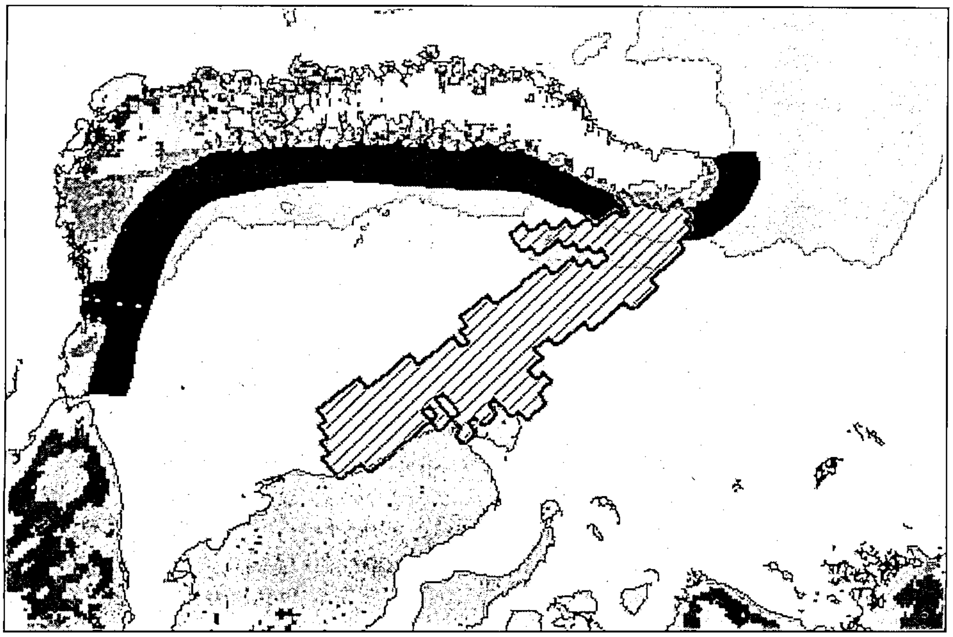
Description: The impact factors are linked with the NSR accidental activity chosen, but the potential impact level can vary according to the ecological components affected. Given a NSR accidental activity, a list with potential impact factors will be given automatically. Selection of impact factors can be done from this list.

No	Step	Options
III-7	Decide influence zone	Given an accidental site, the influence zone consists theoretically of three dimensions: width, depth and altitude. In INSROP only the width dimension will be used for the determination of the influence zone. Options are results from oil drift simulation models, or influence zones defined by the system user.

Description: The influence zone will differ according to different impact factors and also to different resources (VECs). As noted earlier, oil spill at sea or in ice covered waters will probably be the most important type of accidental. Amount of oil must be specified. Oil drift simulations will be important in the assessment of damage, and when deciding the potential influence zone. Unfortunately, oil drift simulations are not available for most of the NSR areas, and expert assessments have to be done when deciding the influence zone in such cases. It is important to notice that the NSR activities also can have impacts in an depth dimension (for example on benthos).



Example from the oil drift model. Simulated oil spill in the Kara Sea.



Potential conflict are defined as overlap between influence zone (shaded area) and the VEC distribution (dark area).

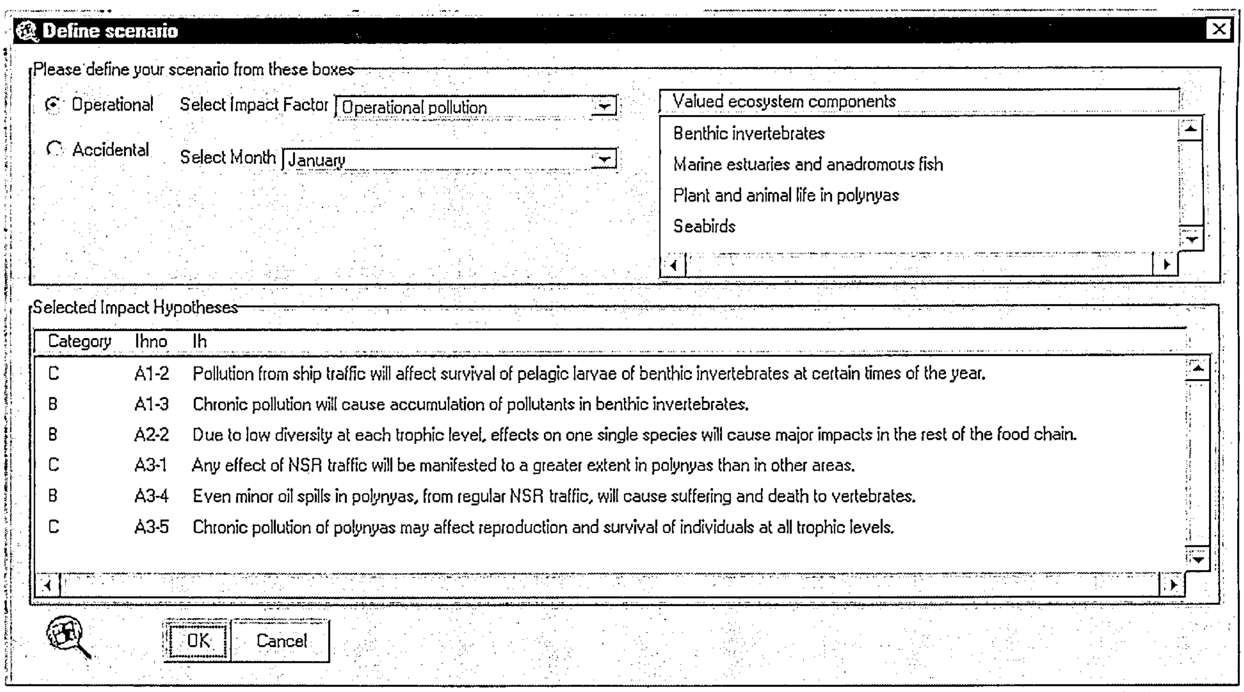
No	Step	Options
III-8	Select VECs	All VECs stored in the DEA (see chapter 7) for the particular season.

Description: Step III-8 will identify the VECs that have a possibility to come in contact with the NSR accidental activity as expressed through the influence zone. Potential conflict areas are defined as the overlap between the calculated influence zone and the distribution of VECs, and will be calculated by the system.

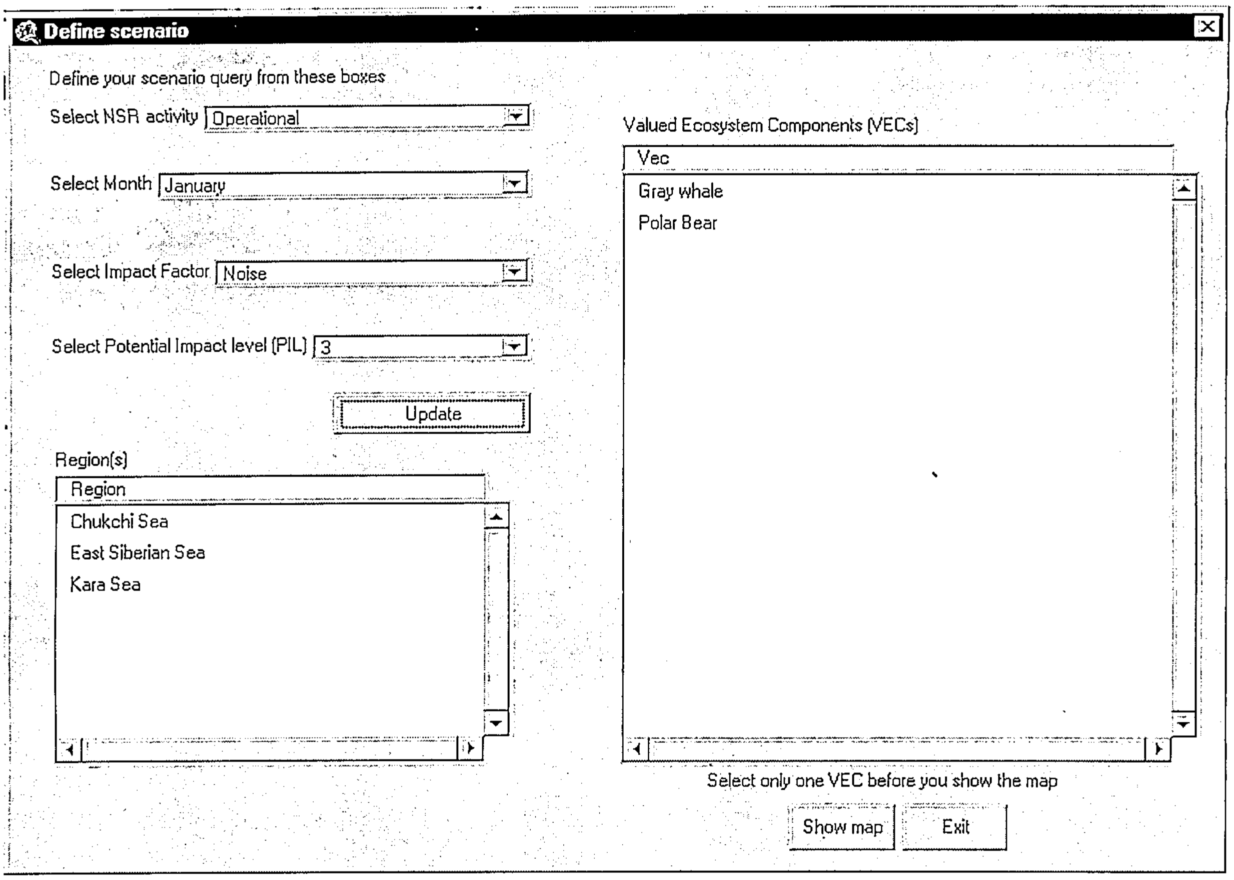
No	Step	Options
III-9	Assess resource (VEC) vulnerability	The vulnerability of selected VECs will vary according to time and impact factors. The vulnerability of VECs will be assessed by a qualitative or semi-quantitative vulnerability system (see **chapter 12**), ending up with Potential Impact Level indices (PIL-index).

11.4 User interface

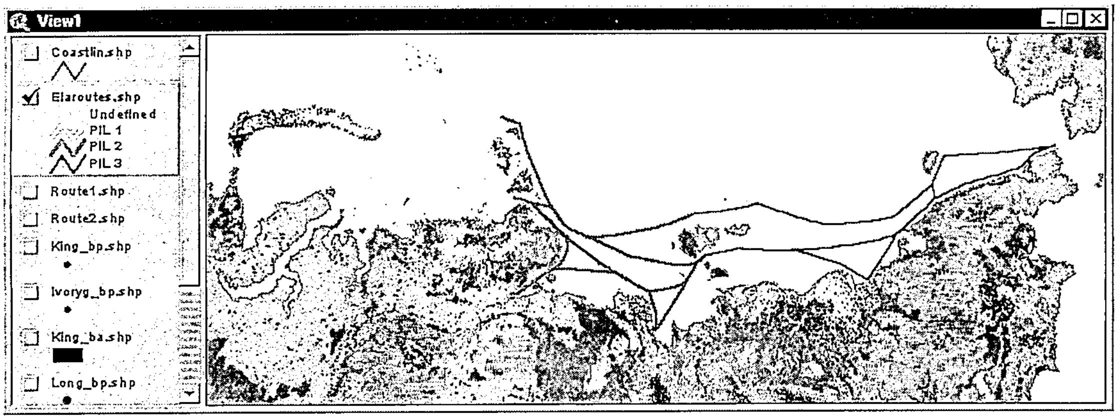
Throughout the step by step procedure several active assessment windows are shown, and several options are possible. The step by step procedure described so far ends up with Potential Impact Level indices (PIL-index) to be used further on in the assessment system. Below are shown two examples of the many active assessment windows in the system. The first one is from the step by step procedure on the way towards PIL indices. The second one shows options when PIL indices already have been assessed, including one way of presenting the results on maps.



Example on how the active window is built up: The scenario builder dialog with user options (top of the window) and resulting impact hypothesis to be tested (bottom of the window).



Example on how the active window is built up: When PIL indices already have been assessed several options are possible (above) ending up with the results presented on a map (below).



12. Evaluation of vulnerability

12.1 Introduction

Methods have been developed to give a semi-quantitative assessment of the vulnerability for some resources (Anker-Nilssen 1987, Gavrilo et al. 1998, Isaksen et al. 1998). However, these assessments require data input of a certain quality and quantity. In INSROP such assessments have been made only for some VECs in some areas (the vulnerability to accidental oil spills of seabirds in the whole NSR-area and marine mammals in the Kara Sea only). For the remaining VECs a more qualitative approach is necessary. Objectivity should be an aim in the qualitative assessment and we propose to use a common methodological approach, developed from the ESSA procedure (Indian and Northern Affairs Canada 1992b), for the VECs in this category.

Figure 12.1 illustrates the principal procedure of the vulnerability assessment in INSROP, where two paths (A or B) are possible: semi-quantitative or qualitative assessment. The semi-quantitative path is described in detail by Anker-Nilssen (1987), Gavrilo et al. (1998) and Isaksen et al. (1998), and will not methodologically be discussed any further here.

12.2 Platform

The basis for the vulnerability assessments are:

- NSR-area or NSR sub-areas: Kara Sea, Laptev Sea, East Siberian Sea, Chukchi Sea, Ob, Jenisei, Lena (for the VECs: Domestic reindeer, Wild reindeer, Protected areas and Indigenous people additional areas have to be defined, see chapter 6.1.3)
- Operational activities with impact factors
- Accidental activities with impact factors
- VECs with complementary impact hypotheses

12.3 Vulnerability dependent factors

The vulnerability of a VEC as a consequence of an impact factor is dependent on four factors (generalised after Anker-Nilssen 1987, and Isaksen et al. 1998):

1. The VEC must be in the area where the impact factor occurs. Factor 1: <u>*Representation*</u> *(time in the area)*.
2. The VEC must have the possibility to come in contact with the impact factor. Factor 2: <u>*Exposure*</u> *(probability of contact with the impact factor when the VEC and the area overlap)*.
3. The impact factor must have an effect on the VEC. Factor 3: <u>*Influence*</u> *(probability of effect if in contact)*.
4. The impacts must be of significant value to important features of the VEC. Factor 4: <u>*Impact level*</u> *(features will differ according to type of VEC, and can be like: Population level (example: seabirds, sea mammals), reduced value of habitats (example: protected areas, hunting grounds for indigenous people)*.

Vulnerability of a VEC requires a positive value on each of these factors, and the factors should consequently be regarded as equal important.

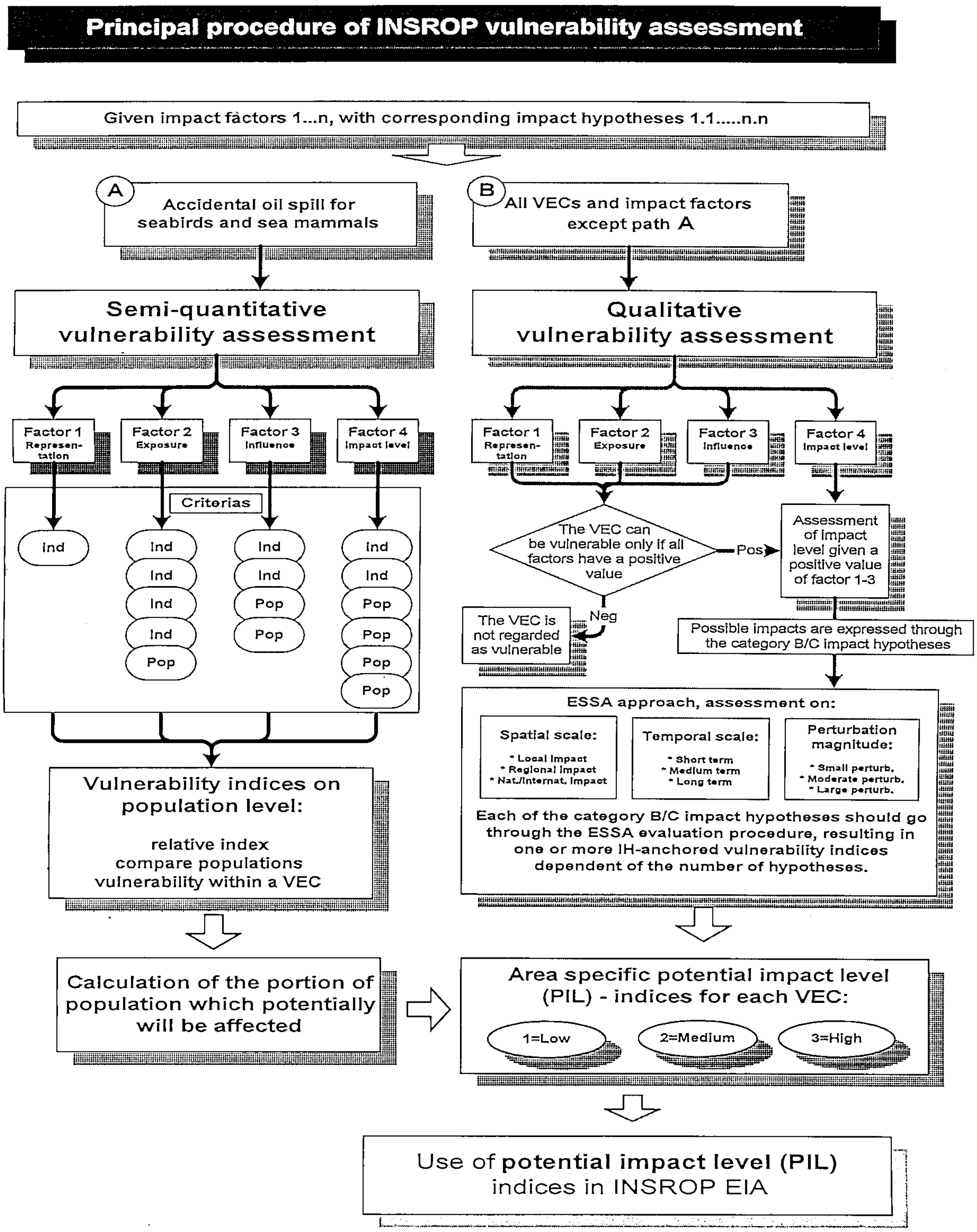


Figure 12.1. Principal procedures of INSROP EIA vulnerability assessment. Two paths (A or B) are possible: semi-quantitative or qualitative assessment.

In the qualitative assessment, factor 1, 2 and 3 can be regarded as questions with possible answers YES or NO. All three questions must have a YES answer if the VEC should be regarded as vulnerable. Factor 4 deals with impact level and the impact hypotheses are anchored here. Only B and C hypotheses are subject for vulnerability assessment.

Notice that a category C hypothesis is assumed to be valid, and that research, monitoring or surveys are recommended to validate or invalidate the hypothesis. This means that only category C hypotheses which have been validated (and thereby have turned into category B), or have a large probability of being valid, are used in the assessment.

Notice also that if the impact hypothesis is assumed to be of minor environmental influence only or of insignificant value for decision making, the categorisation would have been D. Consequently category B and C hypotheses are per definition of significant importance to the VEC.

12.4 Vulnerability and potential impact level

12.5 Basic approach

Three scale parameters for assessing the significance of vulnerability on each VEC, measured through B and C hypotheses, are used: spatial scale, temporal scale and perturbation magnitude. Each of the scale parameters consists of three categories (modified after Indian and Northern Affairs Canada 1992b):

Value	Spatial scale [1]	Time scale [2]	Perturbation magnitude [3]
1	Local effect	Short term	Small perturbation
2	Regional effect	Medium term	Moderate perturbation
3	National/international effect	Long term	Large perturbation

1) Spatial scale:
Local effect: The effect is on a large proportion of a single relatively independent and unconnected resource or value. Other, similar resources or values may or may not exist in the region, but these are unaffected if they do exist.
Regional effect: The effect is on a group of similar resources or values. Other, similar resources or values may exist in the region, but these are unaffected. Alternately, the effect is on a single resource which has a regional distribution.
National/international effect: Anything larger than a regional effect.
2) Temporal scale:
Short term: The effect can/will occur over a time period less than one generation of the resource or value being considered. For resources that are defined with the word «quality» such as for example «water quality», it is appropriate to use the generation time of the medium, in this case the water turnover.
Medium term: The effect can/will occur over a time period approximately equivalent to one generation of the resource or value being affected. The «quality» issue described above applies equally here.
Alternatively, recovery of the resource or value after removing the influence of the project activity(ies) will take approximately one generation of the resource or value. The «quality» issue described above applies equally here.
Long term: The effect can/will occur over a time period greater than one generation of the resource or value being affected. The «quality» issue described above applies equally here.
Alternatively, recovery of the resource or value after removing the influence of the project activity(ies) will take more than one generation of the resource or value. The «quality» issue described above applies equally here.
3) Perturbation magnitude:
Small perturbation: The effect is judged to be of an order of magnitude that cannot be detected statistically (under normal assessment budgets, given enough resources, any perturbation can be detected).
Moderate perturbation: The effect is judged to be of an order of magnitude that can be detected statistically, provided sufficient basis data, and ascribed to the influence of the project.
Large perturbation: Statistics are not required to observe the effect.

For each VEC, an assessment of each category B and «valid» C hypotheses should be done using the scale parameters, which in this context must be considered as equal important.

Each of the values obtained can then be combined, giving a vulnerability score for each IH. A total of 27 combinations of the values are possible (Table 12.1). A vulnerability score is obtained by multiplying the values. We have chosen a conservative approach to categorise the vulnerability scores into a **potential impact level index (PIL-index)**:

Table 12.1. The combinations of vulnerability scale parameters into potential impact level (PIL) indices.

Possible combinations STP	Vulnerability score *)	PIL -index
111	1	1 (low)
112	2	1 (low)
113	3	1 (low)
121	2	1 (low)
122	4	1 (low)
123	6	2 (medium)
131	3	1 (low)
132	6	2 (medium)
133	9	2 (medium)

Possible combinations STP	Vulnerability score *)	PIL -index
211	2	1 (low)
212	4	1 (low)
213	6	2 (medium)
221	4	1 (low)
222	8	2 (medium)
223	12	3 (high)
231	6	2 (medium
232	12	3 (high)
233	18	3 (high)

Possible combinations STP	Vulnerability score *)	PIL - index
311	3	1 (low)
312	6	2 (medium)
313	9	2 (medium)
321	6	2 (medium)
322	12	3 (high)
323	18	3 (high)
331	9	2 (medium)
332	18	3 (high)
333	27	3 (high)

*) Vulnerability score 1, 2, 3, 4: Low vulnerability (10 combinations). PIL - index = 1
Vulnerability score 6, 8, 9: Medium vulnerability (10 combinations). PIL - index = 2
Vulnerability score 12, 18, 27: High vulnerability (7 combinations). PIL - index = 3

12.6 Potential impact level (PIL)

12.6.1 Semi-quantitative or qualitative PIL

Two approaches are possible to obtain the potential impact level for each VEC: the semi quantitative path or the qualitative path.

VEC specific vulnerability indices on population level are obtained from the semi-quantitative vulnerability assessment path. Where possible, these indices can be area specific. To gain an overall picture of the impacts, it is necessary to calculate the portion of the population in the given area which potentially will be affected (part of the GIS routines), giving the VEC specific PIL-indices from the semi-quantitative path (in the qualitative path this assessment is included in the spatial scale assessment).

The impact hypotheses tell us how we believe that the impact factor will affect the VEC. Consequently, it is important to use the IHs when assessing the potential impact level. Theoretically, each impact factor has anchored one or more B- and valid C- hypotheses. However, detailed IFs will reduce the number of complementary IHs, such that the normal picture will be one IH for each IF and VEC. Accomplishing the qualitative assessment procedure, each hypothesis will end up with a PIL-index for each month. Where possible, this index can be area specific.

12.6.2 An overall PIL-index for each VEC

Since each category B or C hypothesis per definition is assumed to be of significant importance for the impacts on the VEC, we use the highest PIL index as a criterion for the assessed impacts. Consequently, if only one impact hypothesis for a proposed NSR activity ends up with a PIL index of 3 (high potential impact level), the overall potential impact level is assumed to be high, for the particular area and month (season).

The qualitative vulnerability assessment shall be accomplished in operational activities and in accidental activities, for each category B and C hypothesis, in each area, and for each month. Using the semi-quantitative or the qualitative path for assessing the vulnerability, we now can produce PIL -indices for each VEC:

- in operational scenario
- in accidental scenario
- in each specific area (where possible)
- for each month (where possible)

A brief description and documentation of the potential impact level for each VEC should also be given. Each impact hypothesis assessed through this system shall be documented by filling out the standard report form - one form for each hypothesis (Appendix 1). The assessed impact picture can differ from area to area and/or from month to month, or be assessed as equal within the area and/or month.

12.7 Use of PIL - indices

PIL-indices are relative values, and can primarily be used to:

1. Ranking of different areas within a VEC
   Assumption: Defined NSR sub-areas with PIL-indices
2. Identify the most vulnerable months for each VEC.
   Assumption: Month specific PIL-indices
3. A combination of 1 and 2.
4. Areas (or segments of NSR) with «higher content» of vulnerable VECs can be ranked higher in an impact picture than other areas. Two ways to combine VECs appears possible:
   - All VECs have equal weight, and can be summarised, a picture which from a decision makers point of view probably is wrong.
   - Ranking of VECs in the recognition of the fact that decision makers will rank VECs different.
5. Identification of mitigating measures.
6. Others

Consequently the PIL-indices obtained in INSROP EIA will be used as an indication of the potential consequences of increased use of NSR, which will be published in the final *INSROP Environmental Impact Statement.*

12.8 INSROP Environmental Impact Statement

The INSROP Environmental Impact Statement (EIS) is the synthesis of INSROP EIA, including recommendations and mitigating measures (see Thomassen et al. 1999). A standard report form for reporting assessments and analysis results for each impact hypotheses has been developed (see Appendix 3).

13. Main options in the assessment system

There are two main approaches to the assessment system. Either you wish to see the consequences of one single impact factor (impact focused), or it is necessary to have the general impression of a specific NSR activity, where cargo, route and time are defined (activity focused). In both instances it should be possible to see the likely impacts from already done assessments, or from selections and assessments done by the present user.

13.1 Impact focused

Question: What will be the likely consequences of a selected impact factor?

Steps:

1. Select operational or accidental
2. Select impact factor
3. Select impact hypotheses (all valid impact hypotheses will be listed)
4. Assess impacts through PIL-indices on VEC(s) of current interest
5. Draw map

13.2 Activity focused

Question: What consequences are likely to occur given specifications of the cargo and the sailing route in time and space?

A NSR activity consists of several impact factors, and consequently the activity focused option is in principle similar to the impact focused option.

Steps:

1. Select operational or accidental
2. Select cargo, sailing route and time of the year
3. Select VEC(s) (all influenced VECs will be listed)
4. All actual impact factors are listed
5. All valid impact hypotheses are listed
6. Area dependent vulnerability indices are listed
7. All assessed impacts from the specific activity are listed
8. Maps are drawn

14. List of acronyms

AEAM	Adaptive Environmental Assessment and Management
AEPS	Arctic Environmental Protection Strategy
AMAP	Arctic Monitoring and Assessment Programme
CAFF	Conservation of Arctic Flora and Fauna
CNIIMF	Central Marine Research & Design Institute, St.Petersburg, Russia
CO_2	Carbon dioxide
DEA	Dynamic Environmental Atlas
EA	Environmental Assessment
EAPS	Environmental Assessment and Planning System
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EU	European Union
FNI	Fridtjof Nansen Institute, Oslo, Norway
GIS	Geographical Information System
IF	Impact factor
IH	Impact hypothesis
IMO	International Maritime Organisation
INSROP	International Northern Sea Route Programme
IT	Information Technology
NGO	Non-governmental Organisation
nm	Nautical miles
NO	Nitrogen oxide
NSR	Northern Sea Route
OVOS	Russian abbreviation of Assessment of Environmental Impacts
PEIA	Preliminary Environmental Impact Assessment
PIL	Potential Impact Level
SEA	Strategic Environmental Assessment
SER	The State Ecological Review
SO	Sulphur oxide
SOF	Ship and Ocean Foundation, Tokyo, Japan
TEK	Traditional Ecological Knowledge
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
VEC	Valued Ecosystem Component
VOC	Volatile Organic Component

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Appendix 1

OPERATIONAL vulnerability assessment - Standard report form

Basic information obtained through Step I-2 to II-7

VEC:		Month:	
		Area:	

1 Screening of vulnerability dependent factors

Vulnerability dependent factors	Yes	No	Comments
1. The VEC must be in the area where the impact factor occurs. Factor 1: *Representation (time in the area).*			
2. The VEC must have the possibility to come in contact with the impact factor. Factor 2: *Exposure (probability of contact with the impact factor when the VEC and the area overlap).*			
3. The impact factor must have an effect on the VEC. Factor 3: *Influence (probability of effect if in contact).*			If yes, list valid impact factors.

Potential vulnerability of the VEC requires a positive value (yes) on each of the factors

Vulnerability dependent factor 4 will be assessed through point 2 below.

2 Assessment of vulnerability significance

IH no.	Valid impact factor (from 3 above):	Category
Impact hypothesis:		

Scale parameters											
Spatial scale			Temporal scale			Perturbation magnitude			Vulnera-bility score	Vulnera-bility	PIL index
L	R	N/I	S	M	L	S	M	L	Product of S, T and P	Low/Medium/High	1-3

Rationale:

Appendix 1

ACCIDENTAL vulnerability assessment - Standard report form

Basic information obtained through Step I-2 to III-8.

VEC:		Month:	
		Area*):	

*) Influence zone determined by oil drift models

NB! For vulnerability assessed by using the semi-quantitative model, only the fields «Vulnerability», «PIL-index» and «Rationale» shall be filled in. Process shall be documented elsewhere.

1 Screening of vulnerability dependent factors

Vulnerability dependent factors	Yes	No	Comments
1. The VEC must be in the area where the impact factor occurs. Factor 1: *Representation (time in the area).*			
2. The VEC must have the possibility to come in contact with the impact factor. Factor 2: *Exposure (probability of contact with the impact factor when the VEC and the area overlap).*			
3. The impact factor must have an effect on the VEC. Factor 3: *Influence (probability of effect if in contact).*			If yes, list valid impact factors.

Potential vulnerability of the VEC requires a positive value (yes) on each of the factors

Vulnerability dependent factor 4 will be assessed through point 2 below.

2 Assessment of vulnerability significance

IH no.	Valid impact factor (from 3 above):	Category
Impact hypothesis:		

Scale parameters											
Spatial scale			Temporal scale			Perturbation magnitude			Vulnera-bility score	Vulnera-bility	PIL index
L	R	N/I	S	M	L	S	M	L	Product of S, T and P	Low/Medium/High	1-3

Rationale:

Appendix 2

Valued Ecosystem Components (VEC), Impact factors, Impact hypotheses (old and new) and their categorisation to be used in INSROP EIA.

Valued Ecosystem Components	VEC No	Impact factor	Act	IH No	Impact hypotheses (IH)	Category
VEC Benthic invertebrates	A1	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers • ore Spill treatment residues	A	A1-1	Old: Accidental discharges of pollutants will affect benthic invertebrates. • Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., as well as chemical dispersants used in clean-up operations, will affect benthic invertebrates. **New revised:**	B
				A1-11	• Accidental discharges of radioactive material from ships will affect benthic invertebrates	B
				A1-12	• Accidental discharges of bunker or diesel oil will cause increased mortality in shallow water benthic invertebrates	B
				A1-13	• A major oil spill arising from a tanker accident will affect benthic invertebrates, measures as changes in community structure and biomass, and on the subacute level increase hydrocarbon body burdens.	B
				A1-14	• Accidental release of iron ore (pellets) will cause alterations in substrate granulometry, and thereby change species diversity in benthic invertebrate communities	C
				A1-15	• Accidental release of fertiliser form a ship wreck will through stimulation of primary production cause increased availability of food particles for benthic invertebrates	C
				A1-16	• Chemical dispersants used in clean up operations will increase mortality in benthic invertebrates	B
VEC Benthic invertebrates	A1	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers	A	A1-2	Old: Pollution from ship traffic will affect survival of pelagic larvae of benthic invertebrates at certain times of the year. • Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., as well as chemical dispersants used in clean-up operations, will affect	C

		• ore Spill treatment residues			survival of pelagic larvae of benthic invertebrates at certain times of the year.	
VEC Benthic invertebrates	A1	Old: Pollution New: Discharges/releases to ice, sea or shore: Fuel: • fuel oil • diesel oil Anti-fouling paint: • TBT	O	A1-3	Old: Chronic pollution will cause accumulation of pollutants in benthic invertebrates. New: • Chronic pollution with e.g. anti-fouling paint, fuel residues etc., will cause accumulation of pollutants in benthic invertebrates.	B
VEC Benthic invertebrates	A1	Old: (no changes):	O	A1-4	Old (no changes): • Hardbottom epifaunal organisms can access new substrates by colonising the surface of dumped waste.	D
VEC Benthic invertebrates	A1	New: Anti-fouling paint: • TBT	O	A1-5	New: • Releases/discharges of anti-fouling paint, like TBT, will affect reproduction in benthic invertebrates.	B
VEC Marine, estuarine and anadromous fish	A2	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • ore Spill treatment residues	A	A2-1 A2-11 A2-12 A2-13	Old: Accidental pollution will cause reductions in certain fish stocks if it affects areas with high concentrations of fish, such as migration, nursing or feeding areas. New: • Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, ore etc., as well as chemical dispersants used in clean-up operations, will cause reductions in certain fish stocks if it affects areas with high concentrations of fish, such as migration, nursing or feeding areas. New revised: • Accidental discharges of oil will increase mortality in pelagic eggs and larvae of marine fish • Accidental discharges of radioactive material will increase mortality in fish. • Physical disturbance from e.g. ice floes being overturned during shipping will increase mortality in marine fish species.	C
VEC Marine, estuarine and anadromous fish	A2	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • ore	O & A	A2-2 A2-21	Old: • Due to low diversity at each trophic level, effects on one single species will cause major impacts in the rest of the food chain. New: • The Whitefish (Coregonidae sp.) is a key fish group in most rivers and coastal waters along the	B

		Spill treatment residues			NSR. Operational discharges affecting reproduction, migration and survival in Coregonids will cause major impacts in the rest of the food chain.	
VEC Marine, estuarine and anadromous fish	A2	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • ore	A	A2-3	Old: Discharges of oil or other pollutants in fresh water along the coastal NSR area will cause increased mortality and reduced production in anadromous fish populations. w: • Accidental discharges of radioactive materials, fuel or certain types of cargo, e.g. hydrocarbons, ore etc., in fresh water along the coastal NSR area will cause increased mortality and reduced production in anadromous fish populations.	C
VEC Plant and animal life in polynyas	A3	All	O and A	A3-1	Old (no changes): • Any effects of NSR traffic will be manifested to a greater extent in polynyas than in other areas.	C
VEC Plant and animal life in polynyas	A3	Old: Noise New: Noise: • ice-breaking • engines • propellers	O	A3-2	Old: Noise from ship traffic will scare fish, mammals and seabirds away from important feeding, resting and breeding areas in and near polynyas. New: • Noise from ice-breaking, engines and propellers will scare fish, mammals and seabirds away from important feeding, resting and breeding areas in and near polynyas.	C
VEC Plant and animal life in polynyas	A3	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers • ore	A	A3-3	Old: Oil spills in polynyas will reduce primary production, and thus affect the whole feeding network. w: • Accidental discharges of radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., in polynyas will affect primary production, and thus the whole feeding network.	C
VEC Plant and animal life in polynyas	A3	Old: Pollution New: Discharges/releases to ice, sea or shore: Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons	A	A3-4	Old: Even minor oil spills in polynyas, from regular NSR traffic, will cause suffering and death to vertebrates. New: • Even minor accidental oils spills in polynyas, will cause suffering and death to seabirds and marine mammals.	B
VEC Plant	A3	Old: Pollution	O	A3-5	Old: Chronic pollution of polynyas	

and animal life in poly-nyas		New: Discharges/releases to ice, sea or shore: Fuel: • fuel oil • diesel oil Anti-fouling paint: • TBT			affects reproduction and survival of individuals at all trophic levels. w: • Chronic pollution of polynyas, with e.g. anti-fouling paints and/or hydrocarbons from fuel, affects reproduction and survival of individuals at all trophic levels.	C
VEC Sea-birds	B1	Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	O/A	B1-1	Old: Oil slicks at sea may cause increased mortality and reduced reproduction of the seabird populations. New: • Accidental and operational releases of hydrocarbons to ice, sea or shore may cause increased mortality and reduced reproduction of the seabird populations.	B
VEC Sea-birds	B1	• Noise - Engine • Moving objects? • Physical disturbance - Permanent constructions	O/A	B1-2	Old: Disturbance in nesting colonies and feeding areas resulting from the NSR activity will cause reduced reproduction and/or the abandonment of areas. New: • Disturbance in or near nesting colonies and feeding areas resulting from the NSR activity (traffic of ships, helicopters and aeroplanes) will cause reduced reproduction and/or the abandonment of areas.	C
VEC Sea-birds	B1	• Discharges to ice, sea & land: - Municipal/ household wastes	O	B1-3	Old (unchanged): • An increase in the population of large gulls, skuas and Arctic Fox resulting from increased food availability (dumping of edible waste etc.) will cause increased predation on seabirds and their eggs and chicks.	C
VEC Sea-birds	B1	• Harvesting	O	B1-4	Old: Increased ship traffic will result in reduced local seabird populations due to increased hunting pressure and egg harvesting. New: • Increased human presence due to an increase in ship traffic and number and size of harbours and other settlements will result in reduced local seabird populations due to increased hunting pressure and egg harvesting.	Old: A# New:C
VEC Sea-birds	B1	Discharges/ releases to ice, sea and shore of: • Radioactive material • Liquid cargo - Chemicals	O/A	B1-5	Old: Emission of toxic substances (other than oil components) from ships or other activity related to the NSR will cause increased mortality and reduced reproduction of sea-	

		• Fuel residues, sludge & bilge - Radioactive material			birds. **New:** • Emission of toxic or other harmful substances (other than oil components) from ships or other activity related to the NSR will cause increased mortality and reduced reproduction of seabirds.	D
VEC Seabirds	B1	Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	O/A	B1-6	Old (unchanged): • Oil pollution will cause increased mortality and reduced reproduction in the seabirds' food organisms. Reduced availability of food will result in a reduction in seabird populations.	D
VEC Seabirds	B1	Pollution, noise and hunting	O/A	B1-7	Old (unchanged): • Increased human activity in connection with NSR (e.g. pollution, hunting and noise) can reduce the population of large gulls, skuas and Arctic Fox. This will reduce the predation on other seabirds and their eggs and chicks, and have a positive effect on the seabird population.	A
VEC Seabirds	B1	Physical disturbance: • Ice-breaking	O	B1-8	Old (Unchanged): • Increased ice-breaker traffic in ice filled waters will make the access to food organisms easier for seabirds and result in a population increase.	D
VEC Seabirds	B1	Physical disturbance: New: • Propeller action	O	B1-9	Old: The propellers on the ship will whirl up sand and mud from the bottom and reduce the visibility for diving seabirds. **New:** • The propellers on the ship will whirl up sand and mud from the bottom and reduce the visibility for diving seabirds. This will reduce feeding efficiency of foraging seabirds.	A
VEC Seabirds	B1	Physical disturbance: • Ice-breaking • Propeller action	O	B1-10	Old: Ship traffic will cause increased mortality and reduced reproduction in seabirds food organisms. Reduced availability of food will result in a decrease in seabird population. **New:** • Ship traffic (ice-breaking and propeller action) will cause increased mortality and reduced reproduction in the seabirds' food organisms. Reduced availability of food will result in a decrease in seabird populations.	D
VEC Marine wildfowl	B2	• Noise - Engine • Moving objects • Physical disturbance	O/A	B2-1	Old (unchanged): • Disturbance near breeding areas can result in reduced reproduction of marine wildfowl through	B

		- Permanent constructions			increased predation and reduced egg and chick survival, and may lead to abandonment of breeding areas.	
VEC Marine wildfowl	B2	• Noise - Engine • Moving objects • Physical disturbance - Permanent constructions	O/A	B2-2	Old (unchanged): • Disturbance in resting, moulting and feeding areas will result in increased energy expenditure, less time for food intake and accordingly increased mortality of adult wildfowl and reduced reproductive success.	B
VEC Marine wildfowl	B2	Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	O/A	B2-3	Old: Oil slicks in marine areas may cause increased mortality and reduced reproduction of the wildfowl population. New: • Accidental and operational releases of hydrocarbons to ice, sea or shore may cause increased mortality and reduced reproduction of the wildfowl populations.	B
VEC Marine wildfowl	B2	Discharges/ releases to ice, sea and shore of: • Radioactive material • Liquid cargo - Chemicals • Fuel residues, sludge & bilge - Radioactive material	O/A	B2-4	Old (unchanged): • Toxic substances discharged into the sea may be accumulated in, and will possibly kill, benthic fauna forming part of the diet of marine ducks. This may result in reduced access to food and possibly poisoning of birds, and accordingly reduced reproduction and increased mortality.	C
VEC Marine wildfowl	B2	• Discharges to ice, sea & land: - Municipal/ household wastes	O	B2-5	Old: An increase in population of large gulls, skuas and Arctic Fox resulting from increased dumping of edible waste will cause increased predation on wildfowl and their eggs and chicks. New: • An increase in the populations of large gulls, skuas and Arctic Fox resulting from increased dumping of edible waste will cause increased predation on wildfowl and their eggs and chicks.	C
VEC Marine wildfowl	B2	Harvesting	O	B2-6	Old: Increased ship traffic will result in reduced local populations of wildfowl due to increased hunting pressure and egg harvesting. New: • Increased human presence due to an increase in ship traffic and number and size of harbours and other settlements will result in reduced local seabird populations due to increased hunting pressure and egg harvesting.	Old: D# New: C

VEC Marine wildfowl	B2	• Noise - Engine • Moving objects • Physical disturbance - Permanent constructions	O/A	B2-7	Old (unchanged): • Extensive disturbance in breeding areas will reduce the number of suitable breeding areas and lead to reduced reproduction and reduced population sizes of marine wildfowl.	D#
VEC Marine wildfowl	B2	Pollution, noise and hunting	O/A	B2-8	Old: Increased human activity in connection with NSR (e.g. pollution, hunting and noise) can reduce the population of large gulls, skuas and Arctic Fox. This will result in a reduction in predation of breeding marine wildfowl. This will give reduced mortality and increased reproduction of wildfowl. New: • Increased impact from human activity in connection with NSR (e.g. pollution, hunting and noise) can reduce the population of large gulls, skuas and Arctic Fox. This may result in decreased mortality and increased reproduction of wildfowl.	A
VEC Waders in resting and feeding areas	B3	• Noise - Engine • Moving objects • Physical disturbance - Permanent constructions	O/A	B3-1	Old (unchanged): • Disturbances in resting and feeding areas can result in reduced possibility for the waders to store enough energy for the autumn migration.	C
VEC Waders in resting and feeding areas	B3	Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Radioactive material • Liquid cargo - Hydrocarbons - Chemicals • Fuel residues, sludge & bilge - Hydrocarbons - Radioactive material	O/A	B3-2	Old: Toxic substances released into feeding areas may accumulate in, and possibly kill, organisms which are normally preyed upon by waders. This can lead to direct poisoning or reduced access to food. New: • Discharged toxic and harmful substances that affects the feeding areas of waders may accumulate in, and possibly kill, organisms which are normally preyed upon by waders. This can lead to direct poisoning or reduced access to food for the waders.	C
VEC Waders in resting and feeding areas	B3	Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	O/A	B3-3	Old (unchanged): • Oil spills affecting concentrations of waders in resting and feeding areas will cause increased mortality resulting both from direct oiling and habitat degradation.	C
VEC Human settlements	D1	Old: Pollution New: Discharges/releases to ice, sea or shore: Radioactive materials Fuel:	A	D1-1	Old: Pollution (especially accidental) will affect the resource base for local people. New: • Accidental discharges of radio-	B

		• fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers • ore			active materials, fuel, or certain types of cargo, like hydrocarbons, fertilisers, ore etc. will affect the resource base for local people.	
VEC Human settlements	D1	Old: Physical disturbance **New:** Physical disturbance: • ice-breaking	O	D1-2	Old (no changes): • Breaks in the ice render traditional routes for livestock and fishermen/hunters inaccessible.	C
VEC Human settlements	D1	Old: Noise **New:** Noise: • ice-breaking • engines • propellers	O	D1-3	Old: Disturbance of fish, mammals or birds in polynyas and other major congregation areas affect indigenous hunting and fishing activities. **New:** • Noise from e.g. ice-breaking, engines, propellers, will scare fish, seabirds and marine mammals away from polynyas or other congregation areas, and thus affect the indigenous peoples hunting and fishing activities.	D
VEC Human settlements	D1	**New:** Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers • ore	A	D1-4	**New:** • Accidental discharges of radioactive materials, fuel and certain types of cargo, e.g. hydrocarbons, ore etc., will interfere with the indigenous peoples hunting and fishing activities. (See VEC Indigenous People)	C?
VEC Water/ land border zone (sensitive areas)	D2	Old: Physical disturbance **New:** Physical disturbance: • area occupation • land-fill activities	O	D2-1	Old: Construction of necessary harbour facilities will cause major local changes in the coastal zone. New: • Activities related to construction of necessary harbour facilities, such as area occupation, land-filling etc., will cause major local changes in the coastal zone.	B
VEC Water/ land border zone (sensitive areas)	D2	Old (unchanged): Waste	O	D2-2	Old (no changes): • Floating waste will accumulate in protected areas of the coastal zone, causing aesthetic disturbance and providing substrates that will be colonised by invertebrates.	B
VEC Water/ land border zone (sensitive areas)	D2	Old: Pollution **New:** Discharges/releases to ice, sea or shore: Radioactive materials Fuel: • fuel oil • diesel oil Cargo: • hydrocarbons • fertilisers	A	D2-3	Old: Oil and other pollution will cause major disturbances in the coastal zone, and at certain times also in inland areas. **New:** Accidental pollution with radioactive materials, fuel or certain types of cargo, like hydrocarbons, fertilisers, ore etc., will cause major disturbances in the coastal zone, and under certain meteorological condi-	B

					tions also in inland areas (evaporation, precipitation).	
VEC Marine mammals	C	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Radioactive material • Liquid cargo - Hydrocarbons - Chemicals • Fuel residues, sludge & bilge - Hydrocarbons - Radioactive material	A/O	C-1	New: • *For all marine mammals:* Accidental and operational releases of hydrocarbons and radioactive material to ice, sea and shore can be accumulated through the food chain and reach such high concentrations in marine mammals as to have toxic effects.	C
VEC Polar bear	C1	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C1-1	Old (no changes): • Oil pollution in polar bear habitats will cause suffering and death for the affected polar bears and may result in a decrease of the population	B
VEC Polar bear	C1	New: Discharges to ice, sea & land: • Municipal/ household wastes	O	C1-2	Old: Waste from installations and traffic will cause a local increase in the polar bear population. New: • Discharges of edible waste from harbour facilities and ships will cause a local increase in the polar bear population.	B
VEC Polar bear	C1	New: • Noise - Ice-breaking - Engine • Physical disturbance - Ice-breaking (Discharges/ releases to ice, sea and shore of:) • Fuel oil • Diesel oil • Radioactive material • Liquid cargo - Hydrocarbons - Chemicals • Fuel residues, sludge & bilge - Hydrocarbons - Radioactive material	A/O	C1-3	Old (no changes): • Reduced seal occurrence resulting from disturbance and pollution from activity will cause a decrease in the polar bear population in the area.	D
VEC Polar bear	C1	New: • Noise - Ice-breaking - Engine • Physical disturbance - Permanent constructions	O	C1-4	Old: Installations and traffic in or near denning areas will cause reduced reproduction in the polar bear population New: • Installations and traffic of ships, helicopters, aeroplanes and other motorised vehicles in or near denning areas will cause reduced reproduction in the polar bear population	C

VEC Polar bear	C1	New • Noise - Ice-breaking - Engine • Physical disturbance - Permanent constructions - Ice-breaking	O	C1-5	Old: Disturbances and obstacles caused by ship traffic in polar bear migration and feeding areas will result in a reduced population **New:** • Disturbances and obstacles caused by ship traffic, ship support and infrastructure in polar bear migration and feeding areas will result in a reduced population	C
VEC Polar bear	C1	New: • Physical disturbance - Ice-breaking	O	C1-6	Old (unchanged): • Activity in the ice creating artificial leads will cause a local increase in polar bear prey and accordingly a local increase in the occurrence of polar bears	D
VEC Walrus	C2	New: • Noise - Ice-breaking - Engine • Physical disturbance - Permanent constructions	O	C2-1	Old: Disturbances resulting from traffic and installations will reduce the walrus population. **New:** • Installations and traffic of ships, helicopters and aeroplanes, especially near haul-out sites, will result in disturbance and reduction in the walrus population.	C
VEC Walrus	C2	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C2-2	Old: Oil spills caused by traffic will reduce the walrus population. **New:** • Oil pollution from ships will reduce the walrus population.	C
VEC Bearded seal	C3	New: • Noise - Ice-breaking - Engine	O	C3-1	Old: Disturbance (traffic, ice breaking) will result in a reduction in the local bearded seal populations. **New:** • Traffic of ships, helicopters and aeroplanes will result in disturbance and reduction in the local bearded seal populations	D
VEC Bearded seal	C3	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C3-2	Old: Oil spills in the sea will cause suffering and death for affected bearded seals and reduction in local bearded seal populations **New:** • Oil pollution from ships will cause suffering and death for affected bearded seals and reduction in local bearded seal populations.	C
VEC Ringed seal	C4	New: • Noise - Ice-breaking - Engine	O	C4-1	Old: Disturbance (traffic, ice breaking) will result in a reduction in the local ringed seal populations. **New:**	

		• Physical disturbance - Ice-breaking			• Traffic of ships, helicopters and aeroplanes will result in disturbance and reduction in the local ringed seal populations.	C
VEC Ringed seal	C4	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C4-2	Old: Oil spills in the sea will cause suffering and death for affected ringed seals and reduction in local ringed seal populations. New: • Oil pollution from ships will cause suffering and death for affected ringed seals and reduction in local ringed seal populations.	C
VEC Ringed seal	C4	New: Occurrence of polar bear (see VEC Polar bear)	A/O	C4-3	Old (unchanged): • Activity causing changes in local predator populations will affect the ringed seal population of the area.	D
VEC White whale	C5	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C5-1	Old: Oil spills caused by traffic will reduce the white whale population.. New: • Oil pollution from ships will cause suffering and death for affected white whales and reduction in the white whale population.	C
VEC White whale	C5	New: • Noise - Ice-breaking - Engine	O	C5-2	Old: Disturbance (traffic, ice breaking) will result in a reduction in the local white whale populations. New: • Traffic of ships and ice breaking will result in disturbance and reduction in the local white whale populations.	C
VEC Gray whale	C6	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge - Hydrocarbons	A/O	C6-1	Old: Oil spills caused by traffic will reduce the Gray whale population. New: • Oil pollution from ships will cause suffering and death for affected gray whales and reduction in the gray whale population.	D
VEC Gray whale	C6	New: • Noise - Engine	O	C6-2	Old: Disturbance (traffic, ice breaking) will result in a reduction in the local Gray whale populations. New: • Traffic of ships will result in disturbance and reduction in the local gray whale populations.	C
VEC Bowhead whale	C7	New: Discharges/ releases to ice, sea and shore of: • Fuel oil • Diesel oil • Liquid cargo - Hydrocarbons • Fuel residues, sludge & bilge	A/O	C7-1	Old: Oil spills caused by traffic will reduce the bowhead whale population. New: • Oil pollution from ships will cause a reduction in the bowhead whale population.	D

		- Hydrocarbons				
VEC Bow-head whale	C7	New: • Noise - Ice-breaking - Engine • Physical disturbance - Ice-breaking	O	C7-2	Old: Disturbance (traffic, ice breaking) will result in a reduction in the local bowhead whale populations. New: • Ice-breaking and traffic of ships will result in disturbance and reduction in the local bowhead whale populations.	C
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	O	E1-1	• Normal NSR operational traffic adjacent to protected areas will come in conflict with Russian legislation, regulations and aim of protection of protected areas.	C
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	A	E1-2	• Accidents in the vicinity to protected areas will come in conflict with Russian legislation, regulations and aim of protection of protected areas.	C
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	O	E1-3	• Normal NSR operational traffic adjacent to protected areas will disturb the wilderness quality of the areas significantly.	B
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	A	E1-4	• Accidents in the vicinity to protected areas can lead to extensive discharges of cargo, fuel an ballast water, which will reduce the wilderness quality of the areas extensively.	B
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	O	E1-5	• Normal NSR operational traffic adjacent to protected areas will disturb selected VECs, especially marine mammals.	C
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	A	E1-6	• Accidents in the vicinity to protected areas can lead to extensive discharges of cargo, fuel an ballast water, which will cause extensive damage to populations of VECs in vulnerable seasons.	B
Protected Areas	E1	Ship in operation: • Physical disturbance • Noise • Discharges to sea	A	E1-7	• Clean-up operations following an ship accident will lead to physical disturbance and noise, which will cause serious disturbance to selected VECs in vulnerable seasons.	C
Protected Areas	E1	Infrastructure: • Petroleum development on-shore and off-shore • Mining industry	O	E1-8	• Increased industrial development, with constructions of pipelines and transportation systems will disturb selected VECs in the terrestrial, aquatic and marine environment by making barriers and disturbance.	C
Protected Areas	E1	Infrastructure: • Petroleum development on-shore and off-shore • Mining industry	A	E1-9	• Pipeline accidents will destroy terrestrial, aquatic and marine habitats severely and reduce the environmental quality of protected areas.	B
Protected	E1	Infrastructure:	O	E1-10	• Increased use of NSR will lead	

Areas		• Rural development • Tourism			to increased population, tourism, hunting and fishing in protected areas, which will be a threat to selected VECs in special and to biological diversity in general.	C
VEC Indigenous people	F1	Physical disturbance: • Ice-breaking on rivers	O	F1-1	Boat traffic on frozen rivers disturbs migration of wild reindeer (and other wildlife) and affects the effectiveness of hunt as a major subsidence.	B
VEC Indigenous people	F1	Physical disturbance: • Ice-breaking on rivers	O	F1-2	Boat traffic on frozen rivers disturbs migration of domestic reindeer and affects the ecological basis of reindeer breeding	C
VEC Indigenous people	F1	• Human activity near shore (noise and all sorts of physical disturbance combined)	O	F1-3	Intensive traffic in coastal waters may cause emigration of marine mammals (as a resource of indigenous subsistence).	C
VEC Indigenous people	F1	Discharges to air: • Exhaust gasses Discharges to sea: • oil-polluted water • anti-fouling paint • spill water (please specify if needed)	O	F1-4a F1-4b	Pollution from ships affects the habitat of sea mammals and other marine resources causing relocalisation of feeding, breeding, and/or resting areas or decrease of populations, leading to loss of resources for indigenous subsistence.	C
VEC Indigenous people	F1	Releases to ice, sea and shore: • Fuel oil • diesel oil • radioactive material • cargo oil • other liquid cargo	A	F1-5	Accidental pollution from shipwreck affects the habitat of sea mammals and other marine resources causing relocalisation of feeding, breeding, and/or resting areas or decrease of populations, leading to loss of resources for indigenous subsistence.	B
VEC Indigenous people	F1	Discharges / releases to shore: • dry cargo • garbage and litter	O/A	F1-6	Littering of beaches (waste from shipping) may lead to depletion of coastal gathering grounds.	C
VEC Indigenous people	F1	Physical disturbance: • aerial occupation • land devastation	O	F1-7	The NSR will favour hydrocarbon development, industry development and mining in northern areas, leading to land devastation and loss of hunting, fishing and breeding grounds.	B
VEC Indigenous people	F1	Physical disturbance: • pipeline corridor	O	F1-8	Oil/gas pipelines connecting hydrocarbon fields with northern harbours may lead to area segmentation as a hinder for wildlife migration and a general decrease of wildlife resources.	B
VEC Indigenous people		Discharges and release to land, rivers and lakes: • toxic spills, undifferentiated	O	F1-9	The NSR will favour hydrocarbon development, industry development and mining in northern areas, leading to toxic spills that may destroy spawning areas and fishing grounds.	B
VEC Indigenous people		Release to land, rivers and lakes: • oil spills (hydrocarbons)	A	F1-10	Oil pipelines connecting oil fields with northern harbours may have accidental leakage and spills causing local degradation or destruction of subsistence areas.	B
VEC Indigenous people		Emission to air: • SO_2 and other air pollution	O	F1-11	The NSR will favour industry development leading to SO_2 and other air pollution which will degrade or	B

					destroy subsistence areas.	
VEC Indigenous people		• tourism	O	F1-12	With an increased infrastructure, commercial fishing and hunting tourism may take subsistence areas from indigenous population.	B
VEC Indigenous people	F	• alien cultural impacts		F1-13	Increased infrastructure, through consequent alien settlement and industrialisation, will forward cultural decay among indigenous people.	B
VEC Indigenous people		• crime		F1-14	Increased infrastructure, alien settlement and industrialisation will lead to an increase of criminal acts against the indigenous population, and partly against their resource base and their means to use the resources (e.g. reindeer theft, robbery, threat).	B
VEC Indigenous people		• alien commercial interests		F1-15	With increased accessibility and transport facilities, commercial fisheries and hunters may take the resource basis for indigenous subsidence.	B
VEC Indigenous people		• nature protection interests		F1-16a F1-16b	With an increased infrastructure, increased protection interests may lead to the closure of certain areas for indigenous subsidence. With an increased infrastructure, increased protection interests may lead to an increased protection of indigenous resources from alien devastation. *(The option depends on the law regulation of the protected areas.)*	B B
VEC Indigenous people		• economic rehabilitation		F1-17	A possible economic rehabilitation of the northern areas supported by an increased infrastructure may create a marked for indigenous products and thus help to raise indigenous peoples' economic situation.	
VEC Indigenous people		• tourism		F1-18	Tourism may induce a renovation of traditional indigenous arts and crafts and thus increase the economic base for indigenous subsistence.	
VEC Domestic Reindeer	G1		O/A	G1-1	• Disturbances and traffic will cause increased energy expenditure and reduced grazing time of reindeer, and accordingly reduced survival and calf production in the affected local populations may decrease.	C
VEC Domestic Reindeer	G1		O	G1-2	• Physical encroachment and installations will obstruct the movements of reindeer, may hinder their access to grazing and calving areas and increase their energy needs so that local populations.	C
VEC Domestic Rein-	G1		O	G1-3	• Increased ship traffic and industrial activity will lead to in-	B

deer					creased illegal hunting and decreased reindeer populations.	
VEC Domestic Reindeer	G1		O/A	G1-4	• Pollution from ship traffic and industrial activity will be accumulated in grazing vegetation and will affect the health condition of local reindeer populations.	B
VEC Wild Reindeer	G2		O/A	G2-1	• Disturbances and traffic will cause increased energy expenditure and reduced grazing time of reindeer, and accordingly reduced survival and calf production in the affected local populations.	C
VEC Wild Reindeer	G2		O	G2-2	• Physical encroachment and installations will obstruct the movements of reindeer, may hinder their access to grazing and calving areas and increase their energy needs so that local populations may decrease.	C
VEC Wild Reindeer	G2		O	G2-3	• Increased ship traffic and industrial activity will lead to increased illegal hunting and decreased reindeer populations.	B
VEC Wild Reindeer	G2		O/A	G2-4	• Pollution from ship traffic and industrial activity will be accumulated in grazing vegetation and will affect the health condition of local reindeer populations.	B

Appendix 3

INSROP Environmental Impact Statement: Standard report form (exemplified by VEC Seabirds and an impact hypotheses assessed to give a high PIL-index):

<table>
<tr><td colspan="5">VEC Seabirds</td></tr>
<tr><td colspan="5">Impact factor: Hunting</td></tr>
<tr><td colspan="2">Impact hypothesis:
B1-4: Increased human presence due to an increase in ship traffic and number and size of harbours and other settlements will result in reduced local seabird populations due to increased hunting pressure and egg harvesting.</td><td colspan="3">Rationale for this assessment:
Hunting is an old tradition in Russia. Especially with establishment of new settlements along the NSR route, it is possible that the hunting pressure on seabirds will increase, including egg harvesting.</td></tr>
<tr><td>Results based on:</td><td>semi-quantitative assessment:</td><td></td><td>qualitative assessment:</td><td>X</td></tr>
<tr><td colspan="5">Direct effects and their significance:
Hunting and egg harvesting will influence directly on the survival and breeding success. The effect on the population will mainly depend on which age groups of birds which are hunted. In general, hunting for adult birds will have a more serious effect to the population than hunting for the juvenile birds.</td></tr>
<tr><td colspan="5">Indirect effects and their significance:
Hunting and egg harvesting will also disturb the birds. Possible effects may be that birds are scared away from their traditional areas and access to important feeding areas may be limited. Egg harvesting may lead to disturbance in the breeding colonies which may lead to reduced breeding success.</td></tr>
<tr><td colspan="5">Cumulative effects and their significance:
Hunting and increased traffic in the vicinity of settlements may have significant negative effects locally to the seabird populations.</td></tr>
</table>

<table>
<tr><td>Conclusions VEC Seabirds:
Hunting may have a significant negative effect in the vicinity of settlements. Russia has quite strict regulations for hunting and egg harvesting, but by experience it is known that a lot of illegal hunting is occurring.</td></tr>
<tr><td>Recommendations VEC Seabirds:
☛ With establishments of new settlements information about hunting regulations should be given. In addition, inspections of the hunting activities should be initiated. The hunting regulations and information about the wildlife should also be distributed to all ships in the NSR area.</td></tr>
</table>

NORTHERN SCIENCE AND CONTAMINANTS RESEARCH DIRECTORATE

NATURAL RESOURCES AND ENVIRONMENT BRANCH, NORTHERN AFFAIRS PROGRAM, DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS, LES TERRASSES DE LA CHAUDIERE ● OTTAWA, ONTARIO
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February 1, 1999

Claes Lykke Ragner
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Dear Claes:

Review of INSROP Discusion Paper "A Guide to EIA Implementation in INSROP Phase II

This paper reviewed here is a comprehensive guide to a procedure designed for Environmental Impact Assessment (EIA) and issue identification in relation to development of the northern sea route (NSR) (as defined by INSROP). I have therefore focussed my review on the methodology rather than on any particular conclusions or decisions taken.

As an overall comment I believe that the authors have completed an impressive achievement. They have taken further steps in advancing the fundamental ways in which the Adaptive Environmental Assessment Methodology (AEAM) can be used and the project therefore has a potential to influence EIA activities in general (beyond the context of INSROP). I therefore hope that the authors are encouraged to make their work more generally available. Having used AEAM myself, I am very aware of the rewards, but also painfully recall that it is not a simple technique to use or to describe. The paper is not an easy read, but I have seen no description of this process that is. The authors have provided a sound comprehensive description of the background, and have describe well how they have applied the methodology. Their reasons for following particular paths are generally well argued and detailed and they have not hesitated to point out limitations or weaknesses.

I have no significant concerns with the paper and recommend that it can be published. Before this occurs however, the authors may wish to consider the points described in the remainder of my review given below.

I found there were some occasions where the English used has given rise to some difficulties in understanding what is intended. This does not frequently occur and I have noted more important instances in the attached annex with some suggested alternative language. In one or two of these cases, I was unable to guess at the intent and I have also indicated when this occurs. I also found a few instances where the paper appears to be incomplete or in draft and again these are noted. Finally, I did find that perhaps the single most common feature which makes the paper a challenge to read is the preponderance of acronyms and jargon. This occurs both with terms of a generic nature and with ones confined to INSROP. Although in most cases the authors have provided definitions, they follow the usual practice of placing the definition beside the first use of the acronym or jargon. Since the paper is intended to function as a sort of "manual" to guide environmental impacts assessment and decisions, it may be helpful if all the acronyms and jargon are defined in an annex.

The authors have done particularly well at describing how the methodology may be used by decision makers associated with a future development of the northern sea route for international shipping. Their work should help guide and focus attention upon the primary information needs. I learned a good deal while reviewing this paper and I look forward to seeing it utilized.

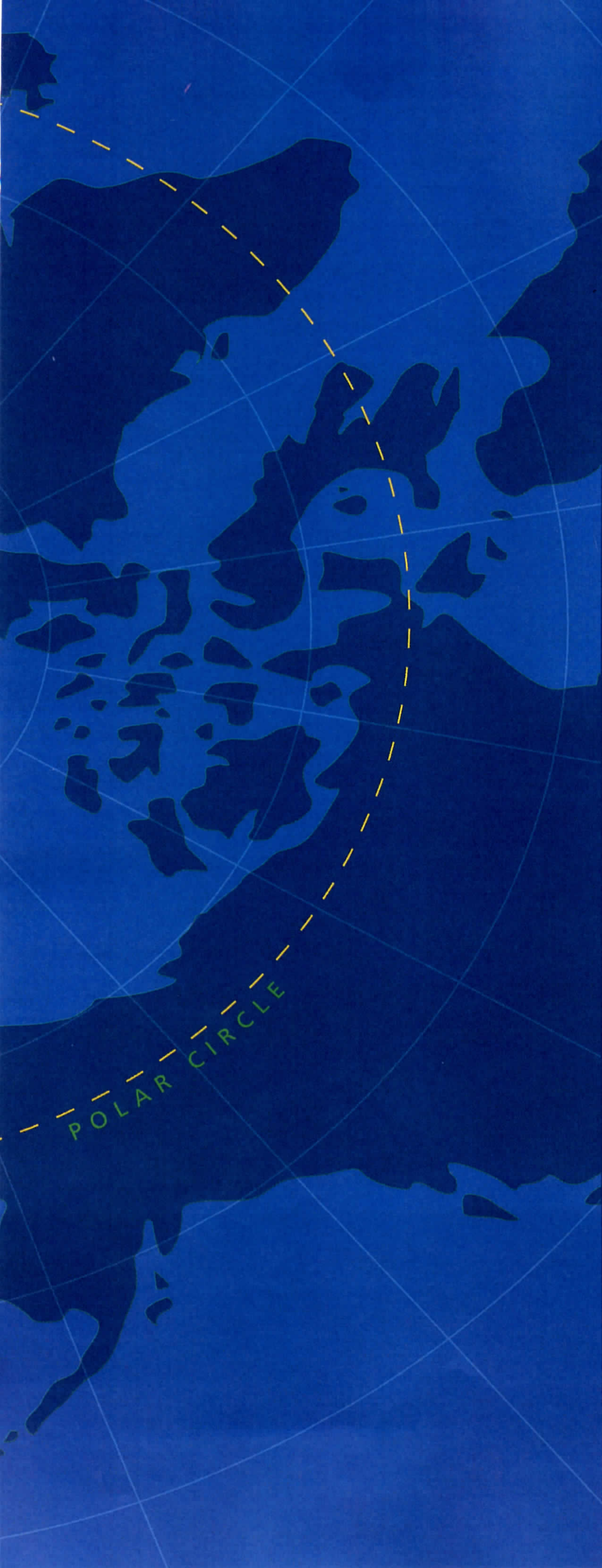
Yours sincerely

DAVID P STONE
Director: Northern Science and Contaminants Research

The authors response to the review:

We would like to thank David P. Stone for his valuable comments to this guide, which has been revised in accordance with his review.

The authors



The three main cooperating institutions of INSROP

Ship & Ocean Foundation (SOF), Tokyo, Japan.
SOF was established in 1975 as a non-profit organization to advance modernization and rationalization of Japan's shipbuilding and related industries, and to give assistance to non-profit organizations associated with these industries. SOF is provided with operation funds by the Nippon Foundation, the world's largest foundation operated with revenue from motorboat racing. An integral part of SOF, the Tsukuba Institute, carries out experimental research into ocean environment protection and ocean development.

Central Marine Research & Design Institute (CNIIMF), St. Petersburg, Russia.
CNIIMF was founded in 1929. The institute's research focus is applied and technological with four main goals: the improvment of merchant fleet efficiency; shipping safety; technical development of the merchant fleet; and design support for future fleet development. CNIIMF was a Russian state institution up to 1993, when it was converted into a stock-holding company.

The Fridtjof Nansen Institute (FNI), Lysaker, Norway.
FNI was founded in 1958 and is based at Polhøgda, the home of Fridtjof Nansen, famous Norwegian polar explorer, scientist, humanist and statesman. The institute spesializes in applied social science research, with special focus on international resource and environmental management. In addition to INSROP, the research is organized in six integrated programmes. Typical of FNI research is a multi-disciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.