Global International Waters Assessment

GIWA METHODOLOGY

S TAGE 1: Scaling and Scoping

Guidance to the Methodology and its Use

10th July 2001

TABLE OF CONTENTS

List of Tables

INTRODUCTION

The overall objective of the GIWA Project is "to develop a comprehensive strategic assessment that may be used by GEF and its partners to identify priorities for remedial and mitigatory actions in international/transboundary water bodies, designed to achieve significant environmental benefits at national, regional and global levels". The assessment is to be undertaken, taking into account "scenarios of future conditions, based on projections of demographic, economic and social changes associated with the process of human development".

In order to achieve this objective, the GIWA Assessment Protocol is divided into three main stages:

Stage 1: This has two main components.

I) Defining the geographic boundaries of the aquatic system/s that are to be investigated in each of 66 sub-regions (called S*caling*).

II) Identifying, on the basis of a preliminary assessment, those impacts within each system that should be prioritised for further examination in subsequent stages of the project (called *Scoping*).

Stage 2: This involves a more detailed analysis of the impacts that have, as a result of the Scoping assessment, been prioritised in each sub-region (called *Detailed Impact Assessment*).

Stage 3: The final stage in the protocol uses information gained through the Detailed Impact Assessment and aims to determine the *root* causes of priority impacts identified by the GIWA Assessment Protocol (called *Causal Chain Analysis*).

This document contains methodological guidance for *Stage 1: Scaling and Scoping*. It also takes into consideration the overall objective of the GIWA project and the likely methodological requirements for the successful completion of *Stages 2* and *3* of the project.

This *Guidance to the methodology and its use* has been prepared for three types of users: *members of Sub-regional Task Teams, Leaders of Sub-regional Task Teams,* and *members of the GIWA Core Team* and is divided into three parts.

- Part A is intended for all users.
- Part B contains supplementary material for Sub-regional Task Team Leaders and members of the GIWA Core Team.
- Part C contains all the Report Sheets necessary to record and report the results of the Scaling and Scoping.

The *Guidance to the methodology and its use* has been prepared assuming that all Sub-regional Scaling and Scoping are to be completed in a Task Team Meeting lasting approximately two and a half to three days.

PART A

GENERAL GUIDANCE FOR STAGE 1 PARTICIPANTS

PART A1: GEOGRAPHIC SCALING

Task I: Geographic Scaling

Background information

An expert group has already divided the world into 66 sub-regions that will be the basic geographic units to be used in the GIWA study. They are listed in Table I and illustrated on the GIWA web site http://www.giwa.net/areas/giwamap.htm. The main determining factor in defining each of these geographic units is that it should encompass the major causes and effects of environmental problems associated with each transboundary water area (whether river basin, groundwater table, lake and/or sea). In many cases (but not all cases), drainage areas and their associated marine basins define the most appropriate geographic units for this purpose.

To assist in the following geographic scaling tasks, the Sub-regional Task Team leader has prepared, in consultation with the GIWA Core Team, a larger scale *Sketch Map* of the sub-region being studied that will be supplied to each member of the task team. This sketch map shows, inter alia, the proposed geographic boundaries of the sub-region, the marine/lake area, the principal features of its river and drainage system and the locations of significant population concentrations and major types of economic activities.

Tasks to be undertaken by the team

The following geographic scaling tasks should be undertaken by the *Sub-regional Task Team*, under the supervision of the task team leader. These tasks should be completed through group discussion. Clear conclusions should be reached within the time allocated (approximately ½ day). These should be recorded, together with supporting explanations and justifications, by the task team leader/facilitator, on the *Geographic Scaling Record Sheet* (**Report Sheet I**) provided, to which the *Sub-regional sketch map* (as finalised) should be attached.

Task Ia Check the proposed boundaries of the sub-region and aquatic system (http://www.grid.no/giwa/) to ensure that these are appropriate and that there are no important overlaps (or gaps) with neighbouring sub-regions and their water systems and, if necessary, amend the *sub-regional Sketch Map*.

Task Ib Check the other main features shown on the Sketch Map relating to a) the principal features of the marine/lake and river and drainage systems and b) the locations of significant population concentrations and major types of economic activities. Identify any important errors or omissions but avoid excessive detail at this stage of the work and, if necessary, amend the *Sketch Map.*

Task Ic Identify those components of the aquatic system within the sub-region that are to be regarded as *'international waters'* for the purposes of the GIWA project. These should include those components which a) have *international status* and/or b) those that are a source or recipient of potentially significant *transboundary environmental impacts*. Clearly show which components are *international waters* on the *Sketch Map.*

Task Id Determine whether the sub-region contains a single international waters system or whether it contains two or more independent systems. For practical purposes, it will be easier, when carrying out subsequent tasks, if the sub-region can be treated as a single system. If not, it is recommended that two (or exceptionally three) sub-regional water systems be distinguished and defined. Also clearly show the boundaries of any sub-regional water systems recommended for separate analysis, and the principal components of the international waters system of each on the *Sketch Map.*

PART A2: IMPACT SCOPING

Background information

Scoping is the major task to be undertaken during Stage 1 of the GIWA project. Its overall purpose is to make a preliminary assessment of the relative importance of the different impacts on the 'international' aquatic system within the sub-region. As previously mentioned, this information is needed to help in selecting those impacts that will be submitted to further examination during Stages 2 and 3 of the Project.

Scoping involves three main tasks:

II. Assessment of environmental and socio-economic impacts under *present* conditions.

III. Assessment of likely environmental and socio-economic impacts under *future* conditions.

IV. Assessment of *overall* impacts and *priorities* for further analysis.

Each task is explained below, assuming the sub-region contains a single 'international waters' system. If it contains more than one aquatic system, the assessment will need to be undertaken and recorded separately for each system.

Tasks to be undertaken by the team

The following Scoping tasks should be undertaken by the *Sub-regional Task Team*, under the supervision of the *Task Team Leader*. The tasks should be undertaken in the sequence shown.

Task II is first undertaken separately by each team member whose findings (and supporting explanations) should be recorded on the *Individual Scoping Worksheets* provided. The individual Scoping should preferably be completed before the Team Meeting. The individual findings will be collated by the Team Leader and discussed in the Task Team Meeting. Clear Team conclusions should be reached, within the time allocated, before proceeding to the next task. These Team conclusions should be recorded, together with supporting explanations and justifications, by the Task Team Leader, on the *Team Scoping Report Sheets* provided. It is intended that Scoping tasks undertaken at Task Team Meetings should be completed within 2 to 2½ days.

Tasks III and IV are to be undertaken only at the *Task Team* level.

Task II Assessment of environmental and socio-economic impacts under present conditions.

Environmental impacts are to be assessed first. The overall objective is to assess the environmental impacts associated with the *current* degradation of international waters and their associated living systems within the sub-region. The types of impacts to be investigated cover five *Major Concerns* which, in total, contain 22 *Environmental Issues*.

Environmental Issues	Major Concerns
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radio nuclide 11. Spills	**II Pollution**
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**
14. Over-exploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fisheries and other living resources**
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**

The impact of each environmental issue and concern is to be assessed on a four point scale, where:

0 = no known impact
1 = slight impact
2 = moderate impact
3 = severe impact

All impacts are assumed to be negative unless prefaced by a positive sign (e.g. +1).

First, the environmental impact associated with *each issue* should be scored by each team member and be recorded on **Report Sheets IIa.I - IIa.V** *Individual Scoping for Environmental Impacts under Present Conditions* for Major Concerns I to V, together with a brief justification for each score. Guidance on scoring criteria for environmental impacts is provided in **Tables IIa.I - IIa.V** for Major Concerns I to V. Sub-regional Task Teams should adapt and simplify these criteria, where local circumstances and/or limitations in available data justify, and indicate on the Report Sheets where this has occurred. For *Issues 12 and 13* of *Major Concern II, Habitat and Community Modification*, environmental impacts will be scored by major habitats existing in the

Sub-region (**Report Sheet IIa.III**). These habitats may be selected from the list given in **Appendix I**.

Second, the environmental impact associated with each *Major Concern* should also be scored by each team member and be recorded on the **Report Sheets IIa.I - IIa.V**. If each *Issue* within the same *Major Concern* is considered of equal importance, the score for the concern should be the arithmetical mean of the individual scores. If the Issues are considered of different importance, then a weighted average approach may be considered more appropriate (Details on this calculation method are obtainable from the team leader). The method chosen to derive scores for each *Major Concern* (e.g. arithmetical average, weighted average etc.) should also be clearly stated on the **Individual Scoping Report Sheets IIa.I - IIa.V**.

Once the *individual* scoring of current environmental issues and concerns has been completed and recorded, each expert should proceed to score the *Socio-Economic* impacts, under present conditions. The socio-economic impacts are grouped into three broad categories, as follows:

- *Economic impacts*: these include the impacts of all changes to the aquatic environment on:
    - long-term levels of output in key economic sectors (e.g. fisheries, agriculture, drinking water, tourism and other water-using industries); and
    - costs incurred by economic sectors and public authorities in water pollution abatement, water treatment and supply.
- *Health impacts*: these include the impacts of changes in the quantity, quality and accessibility of water on the health of inhabitants and visitors within the sub-region.
- *Other social and community impacts*: these include impacts of changes to the aquatic environment on resettlement and migration, levels of employment, the well-being of vulnerable groups within society (the very poor, women, children, indigenous peoples and other minority groups) and on the overall quality of community life and its cultural heritage within the sub-region.

First, the economic, health and other social and community impacts associated with *each Major Concern* should be scored by each team member on **Report Sheets IIb.I - IIb.V** *Individual Scoping for Socio-Economic Impacts under Present Conditions* for Major Concerns I to V. A brief justification for each score should also be provided on the Record Sheet. Each socio-economic impact is to be assessed on the same four point scale, 0-3, as used when scoring environmental impacts (see above). Guidance on scoring criteria for socio-economic impacts is provided in **Table IIb**.

Once the *individual* scoring of current environmental and socio-economic impacts has been completed and recorded, the expert team should reassemble and, through discussion, reach a consensus on the *Team* scores on current environmental and socio-economic impacts. These should be recorded on **Report Sheets IIc.I - IIc.V** *Team Scoping for Environmental Impacts under Present Conditions* and **Report Sheets IId.I - IId.V** *Team Scoping for Socio-Economic Impacts under Present Conditions* for Major Concerns I to V. A brief justification for each team score should also be provided on each Report Sheet.

Task III Assessment of likely environmental and socio-economic impacts under future conditions

The *future* levels of environmental and socio-economic impacts may differ from the *current* levels, assessed in Task II above, because of demographic, economic, technical and other changes over time. It is important that likely changes of these kinds, which affect the aquatic environment and their consequential effects on the levels of environmental and socio-economic impacts, are assessed. These projections are needed so that, during Stage 3 of the GIWA study, the identification and appraisal of potential remedial and mitigating measures take account of the likely future situation and are not based on outdated analyses.

Task III, which is to be undertaken as a team exercise, involves a two-stage approach:

a) Construction of a 'most likely' scenario relating to demographic, economic, technical and other relevant changes, which may influence the aquatic environment within the sub-region by Year 2020;
b) Assessment of the 'most likely' changes in environmental and socio-economic impacts likely to result, under this scenario, within the sub-region by Year 2020.

a) Preparation of the 'most likely' scenario

The key features of the 'most likely' scenario for the sub-region should be recorded on **Report Sheet IIIa**. They should include 'most likely' changes in the sub-region, 2000-2020, in the following:

- Population size and geographic distribution;
- Sub-regional output, consumption and sectoral composition;
- Technical changes likely to alter the quantities of natural resources extracted from, and pollutants discharged into, the sub-regional aquatic system;
- Any other important variables, including existing national and international policy commitments, which may change the environmental pressure on international waters within the sub-region.

Internationally recognised, medium-term projections should be used, where available, when preparing this scenario. The team leader, with assistance from others, should assemble basic data for use by team members. Where there is considerable uncertainty, in the projections, the team may choose to produce a range of values and/or construct two alternative scenarios and then, see below, examine the likely environmental and socio-economic changes of both alternatives.

b) Assessment of 'most likely' environmental and socio-economic impacts

The likely *environmental impacts* in 2020 should be recorded in **Report Sheet IIIb** *Team Scoping for Environmental Impacts under Future Conditions*. The likely impacts are to be assessed, using the assessment of environmental impacts under present conditions in **Report Sheets IIc.I - IIc.V** as base-lines. Then, using the information relating to the 'most likely' scenario for 2020 in **Report Sheet IIIa**, the likely changes from the base-line for each *Major Concern* should be assessed and *recorded* in two forms:

- The likely *direction* of the change over the period, deterioration (-) or improvement (+); and

- The likely *score* (0-3) for each Major Concern, in 2020.

Both assessments should be briefly justified on the Report Sheet for each of the five *Major Concerns*. Where it is feasible and meaningful to do so, the specific *issues* within each environmental concern, which are mainly responsible for any likely significant change in environmental impacts, should be indicated as part of the justification on the Report Sheet.

The likely socio-economic impacts in 2020 should be recorded in **Report Sheet IIIc** *Team Scoping for Socio-Economic Impacts under Future Conditions*. The approach to be followed is similar to that described above for environmental impacts. The likely future impacts are to be assessed, using the assessment of socio-economic impacts under existing conditions in **Report Sheets IId.I - IId.V** as base-lines. Then, using the information relating to the 'most likely' scenario for 2020 in **Report Sheet IIIa** and the predicted likely changes in environmental conditions in **Report Sheet IIIb**, the likely changes from the base-line economic, human health and other social and community impacts should be assessed and recorded for each environmental concern in two forms:

- The likely *direction* of the change, by 2020, in the economic, human health and other social and community impacts in each area of environmental concern (- or +);
- The likely *score* (0-3) for each of the three types of socio-economic impact, in each area of environmental concern in 2020.

The assessments, of economic, human health and other social and community impacts respectively, should be briefly justified on the Report Sheet for each of the five Major Concerns.

Task IV Assessment of overall impacts and priorities for further analysis

The *Team* scores in **Report Sheets IIIb** and **IIIc** summarise the estimated degree of severity of the environmental and socio-economic impacts, for each of the five *Major Concerns*, in *present* and in *future* (Year 2020) conditions. The final task for the team is to use this combined information to prioritise *Major Concerns* for further analysis during Stages 2 and 3 of the GIWA project. The main criterion to be used is the likely severity of the impacts associated with each *Major Concern* (and its constituent *issues*) as determined during Stage 1. The following step-by-step approach is recommended.

Task IVa

Complete the **Report Sheet IVa** by listing in separate columns environmental, economic, human health and social & community impacts under present and future conditions for each of the five *Major Concerns.* Examine the extent to which the information contained in this Report Sheet enables an *overall* prioritising of *Major Concerns* to be made (for example, is one concern associated with the most severe (highest score) impacts in *all* impact categories, under *both* present and future conditions?). If so, this should be recorded in **Report Sheet IVd** *Overall Impacts and Priorities for Further Analysis.* Where this is not possible, additional analysis and interpretation will be needed (see below).

Task IVb

Differences in the rankings of concerns may exist between present and future time periods and between different types of impact (environmental, economic, human health and social & community). If so, the team should discuss:

1. whether the same weight should be given to scores in each time period or greater weight should be given to scores in one of the periods and;
2. whether equal weights should be given to scores in each impact category or more weight should be given to scores in some categories than in others.

Based upon the conclusions reached by the team, weighted or unweighted average scores may be calculated and each concern may then be prioritised for further analysis on the basis of these. The method used, and the results obtained, should be summarised in **Report Sheet IVb**.

Task IVc

Certain *Major Concerns*, and their constituent *Issues*, may be linked to each other through their combined impacts and/or common causes. Where this increases their importance, for policy purposes, this should be taken into account in the prioritisation analysis. The team should identify, at least on a preliminary basis, any important linkages between different concerns and these should be briefly summarised in **Report Sheet IVc**.

Task IVd

Based on the above analysis, and any further analysis, which the team has undertaken, the team should finalise its prioritised list of concerns (including linked concerns) for further analysis during Stages 2 and 3. The list should be recorded in **Report Sheet IVd**, together with a short description and justification of the first and second priority concerns (or linked concerns) on the list.

Note: In some cases, the sub-region may have been divided into two or three separate *sub-regional water systems*. Where this is the case, concerns should first be prioritised within each *sub-regional water system* and then be combined for prioritising within the sub-region as a *whole*.

PART B

SUPPLEMENTARY GUIDANCE FOR SUB-REGIONAL TASK TEAM LEADERS AND CORE TEAM MEMBERS

Introduction

The success of Stage 1 of the GIWA project depends as much on the quality of the *assessment process* that is followed as on the specific *assessment methods* which are used. This is because the assessments are being undertaken at a strategic level where data are often incomplete and time and resources limited. The responsibility for quality assurance of the process is shared by Core Team Members and Sub-Regional Task Team Leaders.

Supplementary guidance, relevant to the quality of the assessment process, is provided below in relation to three phases of Stage 1:

1. The preparatory phase prior to the Sub-regional Task Team meeting.
2. During the Task Team meeting.
3. Post-meeting analysis and reporting.

1. The Preparatory Phase

The effectiveness of the preparatory phase is crucial to the overall effectiveness of Stage 1. The important tasks to be completed, *before* the Task Team meeting, include:

a) *Selection of members of Sub-regional Task Teams*
Ideally, the Task Team should:
   i) Possess sufficient working knowledge of the aquatic system with the sub-region;
   ii) Possess expertise within the key applied disciplines relevant to environmental *and* socio-economic appraisal;
   iii) Be familiar with current official policies and action plans for national and international waters within the sub-region.

b) *Preparation of briefing materials to be provided to task team members, preferably before the Task Team meeting, and other materials required during the meeting*.
These include:
   i) A briefing note on the GIWA study and the purpose of the meeting, and a copy of the Stage 1 Scaling and Scoping Methodology (Part A & C);
   ii) Other relevant background information, including the Sketch Map and other basic environmental and socio-economic data (including forecasts) required for use during the meeting (some of these can be found at http://www.grida.no/giwa/);
   iii) A checklist of the types of additional information that each participant should bring to the meeting.

***Note*:** Some of this documentation may need to be translated from English into a language that is more widely understood in the sub-region.

2. During the Task Team Meeting

The following suggestions elaborate and/or re-emphasise guidance already provided in Part A.

a) The overall objectives, structure and principal activities of the Task Team meeting should be briefly restated at the beginning of the meeting. The timetable for completion of each of the tasks should also be presented. It is important that this is followed, in order to ensure sufficient time for all tasks to be satisfactorily completed.

b) At the beginning of each new set of tasks, the team leader should provide a more complete explanation of each of the specific tasks to be completed and of the *Report Sheets* on which the findings are to be recorded. This is likely to be required when introducing:

Task I	Geographic scaling,
Task II	Assessment of environmental and socio-economic impacts under present conditions,
Task III	Assessment of likely environmental and socio-economic impacts under future conditions, and
Task IV	Assessment of overall impacts and priorities for further analysis.

c) Ideally, certain tasks are to be undertaken on an individual basis, but this may not be practicable if the meeting is very short. Most tasks are to be completed on a group basis. If there are a large number of task team members (15+), it may be preferable to divide the team into two representative groups, which then work in parallel but combine their findings in a final working session. The team leader should encourage all members to participate actively, so that the findings are representative of the analysis and views of the Task Team as a whole.

d) All findings should be documented, as the meeting proceeds. The satisfactory completion of the Report Sheets is central to this purpose. They should not only contain the 'scores' but also, in summary form, the justification and other supporting information for those scores. A copy of all the completed Report Sheets and the Sketch Map must be attached to the Team Leaders' Report (see below).

e) Team members may request guidance on specific technical points. One of these may relate to the calculation of weighted averages.

3. Post Meeting Analysis and Reporting

There should be two principal outcomes from the meeting on which the Team Leader should report to the GIWA Core Team:

a) A report of the principal findings of the Task Team meeting, the substantiation of these findings and a copy of the completed Report Sheets from which the findings and their substantiation have been derived. Particular care should be taken in recording findings relating to Task IV because of their importance to subsequent Stages of the GIWA Project. The Team Leader may wish to add observations of his own, which would be helpful in interpreting the findings of the Task Team.

b) A report on the effectiveness of the assessment process itself, and of the guidance methodology provided. Additionally, it would be helpful if the Team

Leader provides suggestions on how the assessment process and the guidance methodology might be strengthened in the future.

Table I. Geographic Sub-Regions in the GIWA Project (* indicates LME)

Arctic	1. Arctic
North Atlantic	2. Gulf of Mexico*
	3. Caribbean Sea*
	4. Caribbean Islands
	5. Southeast Shelf*
	6. Northeast Shelf*
	7. Scotian Shelf*
	8. Gulf of St. Lawrence
	9. Newfoundland Shelf*
	10. Baffin Bay, Labrador Sea, Canadian Arch.
	11. Barents Sea*
	12. Norwegian Sea*
	13. Faroe plateau
	14. Iceland Shelf *
	15. East Greenland Shelf*
	16. West Greenland Shelf*
	17. Baltic Sea*
	18. North Sea*
	19. Celtic-Biscay Shelf*
	20. Iberian Coastal*
	21. Mediterranean Sea*
	22. Black Sea*
	23. Caspian Sea
	24. Aral Sea
North Pacific	25. Gulf of Alaska*
	26. California Current*
	27. Gulf of California*
	28. East Bering Sea*
	29. West Bering Sea*
	30. Sea of Okhotsk*
	31. Oyashio Current*
	32. Kuroshio Current*
	33. Sea of Japan*
	34. Yellow Sea*
	35. Bohai Sea
	36. East-China Sea*
	37. Hawaiian Archipelago*
Eastern South America	
	38. Patagonian Shelf*
	39. Brazil Current*
	40. Northeast Brazil Shelf*
	40a. Brazilian Northeast
	40b. Amazon
Sub-Saharan Africa	
	41. Canary Current*
	42. Gulf of Guinea*
	43. Lake Chad
	44. Benguela Current*
	45. Agulhas Current*
	46. Somali Coastal Current*
	47. East African Rift Valley Lakes
Indian Ocean	48. Gulf of Aden
	49. Red Sea*
	50. The Gulf
	51. Jordan
	52. Arabian Sea*
	53. Bay of Bengal
Southeast Asia and South Pacific	
	54. South China Sea*
	55. Mekong River
	56. Sulu-Celebes Sea*
	57. Indonesian Seas*
	58. North Australian Shelf*
	59. Coral Sea Basin
	60. Great Barrier Reef*
	61. Great Australian Bight
	62. Small Island States
	63. Tasman Sea
Southeast Pacific	64. Humboldt Current*
	63. Eastern Equatorial Pacific
Antarctic	66. Antarctic*

Table IIa.I: Scoring Criteria for Environmental Impacts of Freshwater Shortage

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades."	• No evidence of modification of stream flow	• There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin > 40,000 km^2); or • There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or • There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or • Change in the occurrence of exceptional discharges (e.g. due to upstream damming	• Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of >250,000 km^2; or • Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or • Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or • Significant saline intrusion into previously freshwater rivers or lagoons	• Annual discharge of a river altered by more than 50% of long term mean; or • Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or • Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or • Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources"	• No evidence of pollution of surface and ground waters	• Any monitored water in the Sub-region does not meet WHO or national drinking water criteria, other than for natural reasons; or • There have been reports of one or more fish kills in the system due to pollution within the past five years.	• Water supplies does not meet WHO or national drinking water standards in more than 30% of the Sub-region; or • There are one or more reports of fish kills due to pollution in any river draining a basin of >250,000 km^2	• River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion • Sever pollution of other sources of freshwater (e.g. groundwater)

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	• No evidence that abstraction of water from aquifers exceeds natural replenishment	• Several wells have been deepened because of excessive aquifer draw-down; or • Several springs have dried up; or • Several wells show some salinisation	• Clear evidence of declining base flow in rivers in semi-arid areas; or • Loss of plant species in the past decade, that depend on the presence of ground water; or • Wells have been deepened over areas of hundreds of km^2;or • Salinisation over significant areas of the Sub-region	• Aquifers are suffering salinisation over regional scale; or • Perennial springs have dried up over regionally significant areas; or • Some aquifers have become exhausted

Table IIa.II: Scoring Criteria for Environmental Impacts of Pollution

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	• Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.	• There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.	• Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or • There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	• There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or • There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	• No visible effects on the abundance and distributions of natural living resource distributions in the area; and • No increased frequency of hypoxia[1] or fish mortality events or harmful algal blooms associated with enhanced primary production; and • No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and • No evident abnormality in the frequency of algal blooms.	• Increased abundance of epiphytic algae; or • A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or • Measurable shallowing of the depth range of macrophytes.	• Increased filamentous algal production resulting in algal mats; or • Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	• High frequency (>1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or • Significant changes in the littoral community; or • Presence of hydrogen sulphide in historically well oxygenated areas.

[1] hypoxia begins at 2.0 ml/l and extends to the point of anoxia (0.0 ml/l) (Diaz, R.J. & R. Rosenberg, 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanogr. Mar. Biol. Ann. Rev., 33: 245-303

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 6: Chemical pollution "The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating."	• No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and • No fisheries closures or advisories due to chemical pollution; and • No incidence of fisheries product tainting; and • No unusual fish mortality events. If there is no available data use the following criteria: • No use of pesticides; and • No sources of dioxins and furans; and • No regional use of PCBs; and • No bleached kraft pulp mills using chlorine bleaching; and • No use or sources of other contaminants.	• Some chemical contaminants are detectable but below threshold limits defined for the country or region; or • Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: • Some use of pesticides in small areas; or • Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or • Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or • Presence of other contaminants	• Some chemical contaminants are above threshold limits defined for the country or region; or • Large area advisories by public health authorities concerning fisheries product contamination <u>but</u> without associated catch restrictions or closures; or • High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: • Large-scale use of pesticides in agriculture and forestry; or • Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or • Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or • Presence of considerable quantities of other contaminants.	• Chemical contaminants are above threshold limits defined for the country or region; and • Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or • Large-scale mortalities of aquatic species. If there is no available data use the following criteria: • Indications of health effects resulting from use of pesticides; or • Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or • Known contamination of the environment or foodstuffs by PCBs; or • Known contamination of the environment or foodstuffs by other contaminants.

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	• No visible reduction in water transparency; and • No evidence of turbidity plumes or increased siltation; and • No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	• Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or • Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	• Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or • Extensive evidence of changes in sedimentation or erosion rates; or • Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	• Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (*i.e.*, grain-size composition/redox); or • Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	• No noticeable interference with trawling activities; and • No noticeable interference with the recreational use of beaches due to litter; and • No reported entanglement of aquatic organisms with debris.	• Some evidence of marine-derived litter on beaches; or • Occasional recovery of solid wastes through trawling activities; but • Without noticeable interference with trawling and recreational activities in coastal areas.	• Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or • High frequencies of benthic litter recovery and interference with trawling activities; or • Frequent reports of entanglement/suffocation of species by litter.	• Incidence of litter on beaches sufficient to deter the public from recreational activities; or • Trawling activities untenable because of benthic litter and gear entanglement; or • Widespread entanglement and/or suffocation of aquatic species by litter.

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	• No thermal discharges or evidence of thermal effluent effects.	• Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	• Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or • Evidence of reduced migration of species due to thermal plume.	• Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or • Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	• No radionuclide discharges or nuclear activities in the Sub-region.	• Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	• Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms *but* without situations or levels likely to warrant large scale intervention by a national or international authority.	• Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or • Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	• No evidence of present or previous spills of hazardous material; or • No evidence of increased aquatic or avian species mortality due to spills.	• Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	• Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or • Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	• Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or • Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

Table IIa.III: Scoring Criteria for Environmental Impacts of Habitat and Community Modification

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 12: Loss of ecosystems or ecotones "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats (see Appendix I) over the last 2-3 decades."	• There is no evidence of loss of ecosystems or habitats	• There are indications of fragmentation of at least one of the habitats.	• Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30 % during the last 2-3 decades.	• Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats (see Appendix I) in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	• No evidence of change in species complement due to species extinction or introduction; and • No changing in ecosystem function and services.	• Evidence of change in species complement due to species extinction or introduction	• Evidence of change in species complement due to species extinction or introduction; and • Evidence of change in population structure *or* change in functional group composition or structure	• Evidence of change in species complement due to species extinction or introduction; and • Evidence of change in population structure *or* change in functional group composition or structure; and • Evidence of change in ecosystem services[2]

[2] Constanza, R. *et al.*, (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

Table IIa.IV: Scoring Criteria for Environmental Impacts of Unsustainable Exploitation of Fisheries and Other Living Resources

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Over-exploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	• No harvesting exists catching fish (with commercial gear for sale or subsistence)	• Commercial harvesting exists but there is no evidence of over-exploitation	• One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits	• More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	• Current harvesting practices show no evidence of excessive by-catch and/or discards.	• Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	• 30-60% of the fisheries yield consists of by-catch and/or discards.	• Over 60% of the fisheries yield is by-catch and/or discards; or • Noticeable incidence of capture of endangered species
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	• No evidence of habitat destruction due to fisheries practices.	• Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or • Trawling of any one area of the seabed is occurring less than once per year.	• Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or • Trawling of any one area of the seabed is occurring 1-10 times per year; or • Incidental use of explosives or poisons for fishing.	• Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or • Trawling of any one area of the seabed is occurring more than 10 times per year; or • Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	• No evidence of increased incidence of fish or shellfish diseases	• Increased reports of diseases without major impacts on the stock	• Declining populations of one or more species as a result of diseases or contamination.	• Collapse of stocks as a result of diseases or contamination.

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 18: Impact on biological and genetic diversity "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	• No evidence of deliberate or accidental introductions of alien species; and • No evidence of deliberate or accidental introductions of alien stocks; and • No evidence of deliberate or accidental introductions of genetically modified species.	• Alien species introduced intentionally or accidentally without major changes in the community structure; or • Alien stocks introduced intentionally or accidentally without major changes in the community structure; or • Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	• Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or • Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	• Extinction of native species or local stocks as a result of introductions (intentional or accidental); or • Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

Table IIa.V: Scoring Criteria for Environmental Impacts of Global Change

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 19: Changes in hydrological cycle and ocean circulation "Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO."	• No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	• Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or • Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	• Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or • Extreme events such as flood and drought are increasing; or • Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	• Loss of an entire habitat through desiccation or submergence as a result of global change; or • Change in the tree or lichen lines; or • Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or • Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or • Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	• No evidence of sea level change	• Some evidences of sea level change without major loss of populations of organisms.	• Changed pattern of coastal erosion due to sea level rise has became evident; or • Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).	• Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or • Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 21: Increased UV-B radiation as a result of ozone depletion "Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades."	• No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	• Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.	• Aquatic community structure is measurably altered as a consequence of UV/B radiation; or • One or more aquatic populations are declining.	• Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	• No measurable or assessed changes in CO_2 source/sink function of aquatic system.	• Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	• Some evidences that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the Sub-region by at least 10%.	• Evidences that the changes in source/sink function of the aquatic systems in the Sub-region are sufficient to cause measurable change in global CO_2 balance.

Table IIb. Guidance on Scoring Criteria for Socio-Economic Impacts

The following broad criteria should be taken into consideration when scoring the degree of severity (0-3) of the *Economic*, *Human Health* and *Social & Community Impacts* in the sub-region, associated with each of the five *Major Concerns*. This guidance should be used when completing **Report Sheets IIc.I - IIc.V** (relating to present conditions) and **Report Sheets IId.I - IId.V** (relating to future conditions).

Three broad criteria are to be considered:

a) The *size* of the population or economic and public sectors affected (categorised as very small, small, medium and large);
b) The *degree of severity* of the economic, health or social & community impacts experienced (minimum, small, moderate, severe);
c) The likely *duration* of the impacts (ranging between very occasional/very short term to continuous/long term).

In order to achieve consistency in its socio-economic appraisal, the task team should define the boundaries of each of the categories to be used in a), b) and c) above, and summarise these when presenting their findings. These are not expected to be defined in precise, numerical terms but to be sufficiently clear for broad appraisal purposes and be appropriate to local conditions in the sub-region.

When appraising *Economic Impacts*, the key economic and public service sectors that are affected by the degradation of the aquatic environment, should be identified and their relative importance to the sub-regional economy assessed. The degree to which the quantity and quality of their output has been reduced and their costs of operation increased should be similarly assessed. Finally, the frequency and direction of the impacts should be determined.

When appraising *Human Health Impacts*, the approximate numbers and types of people affected should be identified, the nature and degree of severity of the health impacts should be assessed and the frequency/duration of the impacts should be determined.

When appraising *Social & Community Impacts*, the number, size and principal characteristics (e.g. presence of vulnerable groups) of the affected communities should be determined as well as the aspects of community life affected. The extent to which these aspects of community life are affected should be assessed as well as the frequency of these impacts.

Where, for example, the impacts are described under a) as very small/small, under b) as minimal/small and c) as very occasional/short term, the score *in that particular case* is likely to be 0 or 1. On the other hand, where impacts are described under a) as large, under b) as severe, and under c) as continuous/long term, the score is likely to be 3.

Where, in any particular case, the assessments are more variable–for example, a) small, b) severe, c) medium term duration–the study team will have to consider carefully the relative importance to be attached to the three criteria in determining whether a score of 1, 2 or 3 is most appropriate. It is especially important in these cases that a brief explanation and justification of the chosen score is provided on the *Report Sheet*.

Examples of the socio-economic criteria to be considered when scoring the overall socio-economic impact of each Major Concern are listed in the **Reporting Sheets IIb.I-V and IId.I-V** and in the GIWA Project Document. The task team should independently review these criteria taking local, sub-regional issues into consideration.

Part C

Report Sheets

Report Sheet I: Geographic Scaling Record

This sheet should be used to record the key findings and supporting reasons of the Task Team relating to Tasks 1a, 1b, 1c and 1d below. Supplementary sheets of paper should be used to complete the *Report Sheet* where these are needed. A copy of the *Sketch Map* that clearly displays the additional information and amendments requested below should be attached to this *Report Sheet*.

Sub-region No.: _____ Sub-region Name: _____ Date:_____

a) Are the proposed boundaries of the sub-region, as shown on the *Sketch Map*, agreed by the Task Team? If not, indicate below any agreed changes and the main reasons for these. Clearly show any changes on the *Sketch Map*.

b) Are the other principal features shown on the *Sketch Map*, agreed by the Task Team? If not, what changes or additions have been agreed by the Task Team and for what reasons? Clearly show these changes on the *Sketch Map*.

c) Briefly list the main components of the sub-regional aquatic system which the Task Team agrees are *international waters* and briefly indicate the main reasons for their inclusion. Clearly indicate these components of *international waters* on the *Sketch Map*.

d) Does the Task Team agree to study the sub-region as a single *international waters* system? If not, the boundaries of each sub-regional aquatic system recommended for separate analysis, and its principal components, should be clearly shown on the *Sketch Map* and the main justification for these should be summarised below.

Report Sheet IIa.I: Individual Scoping Worksheet for Environmental Impacts of Major Concern I: Freshwater Shortage under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
1. Modification of stream flow			**I Freshwater shortage**	
2. Pollution of existing supplies				
3. Changes in the water table				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IIb.I: Individual Scoping Worksheet for Socio-economic Impacts of Major Concern I: Freshwater Shortage under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert:_____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern I Freshwater Shortage**
1. Loss of agricultural uses (crops, livestock, aquaculture)
2. Loss of human drinking water supplies
3. Loss of recreational use or aesthetic values
4. Loss of hydro-electric power production
5. Loss of coastal harbours and inland transport
6. Loss of industrial uses
7. Increased potential for upstream/downstream conflicts
8. Reduced availability of fish as food
9. Loss of waste assimilative capacity
10. Increased costs of alternative water supplies
11. Reduction in future use options
12. Human health impacts
13. Reduced agriculture productivity (crops, livestock, aquaculture)
14. Increased intake treatment cost
15. Increased damage to water-related equipment
16. Damage to infrastructure
17. Increased costs of deepening wells and pumping
18. Population migration
19. Transboundary implications
20. Increased vulnerability to sea level rise

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIa.II: Individual Scoping Worksheet for Environmental Impacts of Major Concern II: Pollution under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert:_____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
4. Microbiological			**II Pollution**	
5. Eutrophication				
6. Chemical				
7. Suspended solids				
8. Solid wastes				
9. Thermal				
10. Radio nuclide				
11. Spills				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IIb.II: Individual Scoping Worksheet for Socio-economic Impacts of Major Concern II: Pollution under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern II Pollution**
1. Increased risks to human health
2. Increased costs of human health protection
3. Loss of water supplies (e.g. potable water)
4. Increased costs of water treatment
5. Costs of preventive medicine
6. Costs of medical treatment
7. Costs of clean-up
8. Loss of tourism or recreational values
9. Loss of aesthetic values
10. Loss in fisheries
11. Costs of increased fisheries product processing
12. Change in fisheries value
13. Reduced options for aquaculture development
14. Risk to aquaculture
15. Loss of property values
16. Costs of weed control
17. Loss of wildlife sanctuaries
18. Costs of increased navigational clearance, navigational survey or dredging activities
19. Increased costs of fish surveillance in the case of toxin incidence
20. Costs of reduced fish marketability due to aesthetic perceptions
21. Loss of protected areas
22. Reduction in options of other uses of freshwater
23. Potential for international conflicts
24. Loss of reservoir storage capacity
25. Damage to equipment (e.g. particle impacts)
26. Increased costs of coastal protection from waves/storm surges/erosion
27. Costs of cleaning intakes
28. Endangerment of species
29. Increased costs of animal protection (esp. endangered species)
30. Displacement of valued species
31. Avoidance of amenities and products due to perceptions of effects of contamination
32. Costs of public reassurance
33. Maintenance of monitoring and radiological protection activities for public reassurance purposes
34. Costs of preventive measures (e.g. tanker design/construction)
35. Costs of contingency measures
36. Costs of litigation
37. Costs of insurance
38. Costs of disruption to shipping, marine reserve and marine scientific activities during survey and clean-up of spills

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIa.III: Individual Scoping Worksheet for Environmental Impacts of Major Concern III: Habitat and Community Modification under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
12. Loss of ecosystems *Habitats*			**III Habitat and Community Modification**	
13. Modification of ecosystem *Habitats*				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IIb.III: Individual Scoping Worksheet for Socio-economic Impacts of Major Concern III: Habitat and Community Modification under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern III Habitat and Community Modification**
1. Reduced capacity to meet basic human needs (food, fuel) for local populations
2. Changes in employment opportunities for local populations and associated changes in social structures
3. Loss of aesthetic values / recreational values for local populations
4. Loss of existing income and foreign exchange from fisheries, tourism, etc.
5. Loss of opportunity for investment income and foreign exchange from former ecosystem (e.g. loss of materials for potential pharmaceutical products)
6. Human conflicts, national and international
7. Loss of educational and scientific values
8. Increased risks to human population and capital investment
9. Loss of land due to loss of physical protection
10. Costs of responding to risks
11. Intergenerational inequity
12. Modification or loss of cultural heritage
13. Costs of controlling invasive species
14. Costs of restoration of modified ecosystems

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIa.IV: Individual Scoping Worksheet for Environmental Impacts of Major Concern IV: Unsustainable Exploitation of Fisheries and Other Living Resources under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
14. Over-exploitation			**IV Unsustainable Exploitation of Fisheries and Other Living Resources**	
15. Excessive by-catch and discards				
16. Destructive fishing practices				
17. Decreased viability of stock through pollution and disease				
18. Impact on biological and genetic diversity				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IIb.IV: Individual Scoping Worksheet for Socio-economic Impacts of Major Concern IV: Unsustainable Exploitation of Fisheries and Other Living Resources under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern IV Unsustainable Exploitation of Fisheries and Other Living Resources**
1. Reduced economic returns
2. Loss of employment / livelihood
3. Potential new employment possibilities
4. Improved catch/earnings
5. Conflict between user groups for shared resources including space
6. Loss of food sources (e.g. sources of protein) for human or animal consumption
7. Reduced earnings in one area by destruction of juveniles in other (migrating populations)
8. Loss of protected species
9. Reduced commercial value resulting from tainting
10. Increased risks of predation, competition and/or disease for commercially valuable species
11. Inter-generational equity issues (access to resources)
12. Possible human health impacts

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIa.V: Individual Scoping Worksheet for Environmental Impacts of Major Concern V: Global Change under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
19. Changes in hydrological cycle and ocean circulation			**V Global Change**	
20. Sea level change				
21. Increased UV-b radiation as a result of ozone depletion				
22. Changes in ocean CO_2 source/sink function				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major concern* from the *Issue* scores.

Report Sheet IIb.V: Individual Scoping Worksheet for Socio-economic Impacts of Major Concern V: Global Change under Present Conditions

Sub-region No.: _____ Sub-region Name: _____

Name of Expert: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern V Global Change**
1. Freshwater availability
2. Food security
3. Employment security
4. Changes in productivity of agriculture, fisheries and forestry
5. Changes in resources distribution and political jurisdiction over them
6. Human migration
7. Damage to human life and property
8. Response costs for extreme events
9. Costs for avoiding navigation hazards
10. Increased cost of coast protection and emergency response/forecast
11. Loss of income and employment
12. Loss of property & capital assets
13. Loss of incomes and foreign exchange from fisheries
14. Loss of opportunity for investments (both domestic and foreign)
15. Increased costs of human health care

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIc.I: Team Scoping for Environmental Impacts of Major Concern

I: Freshwater Shortage under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
1. Modification of stream flow			**I Freshwater shortage**	
2. Pollution of existing supplies				
3. Changes in the water table				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IId.I: Team Scoping for Socio-economic Impacts of Major Concern

I: Freshwater Shortage under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern I Freshwater Shortage**
1. Loss of agricultural uses (crops, livestock, aquaculture)
2. Loss of human drinking water supplies
3. Loss of recreational use or aesthetic values
4. Loss of hydro-electric power production
5. Loss of coastal harbours and inland transport
6. Loss of industrial uses
7. Increased potential for upstream/downstream conflicts
8. Reduced availability of fish as food
9. Loss of waste assimilative capacity
10. Increased costs of alternative water supplies
11. Reduction in future use options
12. Human health impacts
13. Reduced agriculture productivity (crops, livestock, aquaculture)
14. Increased intake treatment cost
15. Increased damage to water-related equipment
16. Damage to infrastructure
17. Increased costs of deepening wells and pumping
18. Population migration
19. Transboundary implications
20. Increased vulnerability to sea level rise

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIc.II: Team Scoping for Environmental Impacts of Major Concern II: Pollution under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
4. Microbiological			**II Pollution**	
5. Eutrophication				
6. Chemical				
7. Suspended solids				
8. Solid wastes				
9. Thermal				
10. Radio nuclide				
11. Spills				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IId.II: Team Scoping for Socio-economic Impacts of Major Concern II: Pollution under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern II Pollution**
1. Increased risks to human health
2. Increased costs of human health protection
3. Loss of water supplies (e.g. potable water)
4. Increased costs of water treatment
5. Costs of preventive medicine
6. Costs of medical treatment
7. Costs of clean-up
8. Loss of tourism or recreational values
9. Loss of aesthetic values
10. Loss in fisheries
11. Costs of increased fisheries product processing
12. Change in fisheries value
13. Reduced options for aquaculture development
14. Risk to aquaculture
15. Loss of property values
16. Costs of weed control
17. Loss of wildlife sanctuaries
18. Costs of increased navigational clearance, navigational survey or dredging activities
19. Increased costs of fish surveillance in the case of toxin incidence
20. Costs of reduced fish marketability due to aesthetic perceptions
21. Loss of protected areas
22. Reduction in options of other uses of freshwater
23. Potential for international conflicts
24. Loss of reservoir storage capacity
25. Damage to equipment (e.g. particle impacts)
26. Increased costs of coastal protection from waves/storm surges/erosion
27. Costs of cleaning intakes
28. Endangerment of species
29. Increased costs of animal protection (esp. endangered species)
30. Displacement of valued species
31. Avoidance of amenities and products due to perceptions of effects of contamination
32. Costs of public reassurance
33. Maintenance of monitoring and radiological protection activities for public reassurance purposes
34. Costs of preventive measures (e.g. tanker design/construction)
35. Costs of contingency measures
36. Costs of litigation
37. Costs of insurance
38. Costs of disruption to shipping, marine reserve and marine scientific activities during survey and clean-up of spills

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIc.III: Team Scoping for Environmental Impacts of Major Concern III: Habitat and Community Modification under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
12. Loss of ecosystems *Habitats*			**III Habitat and Community Modification**	
13. Modification of ecosystem *Habitats*				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IId.III: Team Scoping for Socio-economic Impacts of Major Concern III: Habitat and Community Modification under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern III Habitat and Community Modification**
1. Reduced capacity to meet basic human needs (food, fuel) for local populations
2. Changes in employment opportunities for local populations and associated changes in social structures
3. Loss of aesthetic values / recreational values for local populations
4. Loss of existing income and foreign exchange from fisheries, tourism, etc.
5. Loss of opportunity for investment income and foreign exchange from former ecosystem (e.g. loss of materials for potential pharmaceutical products)
6. Human conflicts, national and international
7. Loss of educational and scientific values
8. Increased risks to human population and capital investment
9. Loss of land due to loss of physical protection
10. Costs of responding to risks
11. Intergenerational inequity
12. Modification or loss of cultural heritage
13. Costs of controlling invasive species
14. Costs of restoration of modified ecosystems

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIc.IV: Team Scoping for Environmental Impacts of Major Concern IV: Unsustainable Exploitation of Fisheries and Other Living Resources under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
14. Over-exploitation			**IV Unsustainable Exploitation of Fisheries and Other Living Resources**	
15. Excessive by-catch and discards				
16. Destructive fishing practices				
17. Decreased viability of stock through pollution and disease				
18. Impact on biological and genetic diversity				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IId.IV: Team Scoping for Socio-economic Impacts of Major Concern IV: Unsustainable Exploitation of Fisheries and Other Living Resources under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern IV Unsustainable Exploitation of Fisheries and Other Living Resources**
1. Reduced economic returns
2. Loss of employment / livelihood
3. Potential new employment possibilities
4. Improved catch/earnings
5. Conflict between user groups for shared resources including space
6. Loss of food sources (e.g. sources of protein) for human or animal consumption
7. Reduced earnings in one area by destruction of juveniles in other (migrating populations)
8. Loss of protected species
9. Reduced commercial value resulting from tainting
10. Increased risks of predation, competition and/or disease for commercially valuable species
11. Inter-generational equity issues (access to resources)
12. Possible human health impacts

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIc.V: Team Scoping for Environmental Impacts of Major Concern

V: Global Change under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Score	Weight %	Environmental Concerns	Weight-Averaged Score
19. Changes in hydrological cycle and ocean circulation			**V Global Change**	
20. Sea level change				
21. Increased UV-b radiation as a result of ozone depletion				
22. Changes in ocean CO_2 source/sink function				

1. Provide a brief explanation and justification for the score given to each *Issue.*

2. Provide a brief explanation and justification for the method used to derive the score for the *Major Concern* from the *Issue* scores.

Report Sheet IId.V: Team Scoping for Socio-economic Impacts of Major Concern V: Global Change under Present Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

You may use this list of the general socio-economic impacts of this Major Concern as a guideline to identify more specific impacts on economy, health and other social/community aspects of the Sub-region.

Socio-economic Impacts of **Major Concern V Global Change**
1. Freshwater availability
2. Food security
3. Employment security
4. Changes in productivity of agriculture, fisheries and forestry
5. Changes in resources distribution and political jurisdiction over them
6. Human migration
7. Damage to human life and property
8. Response costs for extreme events
9. Costs for avoiding navigation hazards
10. Increased cost of coast protection and emergency response/forecast
11. Loss of income and employment
12. Loss of property & capital assets
13. Loss of incomes and foreign exchange from fisheries
14. Loss of opportunity for investments (both domestic and foreign)
15. Increased costs of human health care

1. Economic Impacts Score

Criteria	Raw Score	Weight %
Size of Economic or Public Sectors Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Impact (cost, output changes, etc.)	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Economic Impacts	

Provide a brief explanation and justification for the score given to *Economic Impacts*, particularly the key economic and public service sectors affected, the degree to which quantity and quality of the output of these sectors has been reduced, any increases in the operation cost, and frequency/duration of the impacts.

2. Health Impacts Score

Criteria	Raw Score	Weight %
Number of People Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Health Impacts	

Provide a brief explanation and justification for the score given to *Health Impacts*, particularly the approximate numbers and types of people affected, the nature and degree of severity of health impact, and frequency/duration of the impacts.

3. Other Social and Community Impacts Score

Criteria	Raw Score	Weight %
Number and/or Size of Community Affected	Very Small ----------> Very Large 0 1 2 3	
Degree of Severity	Minimum ----------> Severe 0 1 2 3	
Frequency/Duration	Occasion/Short ----------> Continuous 0 1 2 3	

Weight Average Score for Other Social and Community Impacts	

Provide a brief explanation and justification for the score given to *Other Social and Community Impacts*, particularly the number, size and principal characteristics of the affected communities, the aspect of social and community life affected, the extent and duration/frequency of the impacts.

Report Sheet IIIa: 2020 Development Scenarios for the Sub-Region

Sub-region No.: _____ Sub-region Name: _____ Date:_____

1. What is the most likely annual percentage rate of population change (decrease/increase) in the sub-region up to 2020?

2. What are the most likely changes in the geographic distribution of population and economic activity within the sub-region by 2020 (for example, between urban and rural areas, between regions, between coastal areas/river basins and other areas of the sub-region)?

3. What is the expected annual percentage rate of output change (increase/decrease) in the sub-region up to 2020?

4. What are the most likely changes in the composition of output and consumption in the sub-region by 2020 (for example, which types of activities are likely to increase and which are likely to decline in relative importance by 2020)?

5. Which technical changes and other types of changes (including regulatory changes) are likely to take place by 2020, which may substantially increase or reduce the pressure on the aquatic system?

6. Taking all of the above changes into account, do you think that the total pressures on the aquatic environment in the sub-region will greatly increase, moderately increase, remain approximately the same, modestly decrease or substantially decrease compared with the present situation? (Give a brief justification for your answer.)

Report Sheet IIIb: Team Scoping for Environmental Impact under Future Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Environmental Issues	Major Concerns	Present Score (From Report Sheets IIc)	Change (+/-)	Future Score
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**			
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radio nuclide 11. Spills	**II Pollution**			
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**			
14. Over-exploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fisheries and other living resources**			
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**			

Key: Change (2000-2020): deterioration (-); improvement (+); Score (2020): 0 = no known impact; 1 = slight impact; 2 = moderate impact; 3 = severe impact

Provide a brief explanation and justification for *each change* and *score* recorded. Where feasible and meaningful, indicate the specific *issues*, within each Major Concern, which are mainly responsible for any likely significant change in environmental impacts.

Report Sheet IIIc: Team Scoping for Socio-Economic Impacts under Future Conditions

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Major Concerns	Economic Impacts			Health Impacts			Other Social and Community Impacts		
	Present Score (From Report Sheets IId)	**Change (+/-)**	**Future Score**	**Present Score (From Report Sheets IId)**	**Change (+/-)**	**Future Score**	**Present Score (From Report Sheets IId)**	**Change (+/-)**	**Future Score**
I Freshwater Shortage									
II Pollution									
III Habitat and community modification									
IV Unsustainable exploitation of fisheries and living resources									
V Global change									

Key:
Change (2000-2020): deterioration (-); improvement (+).
Score (2020): 0 = no known impact; 1 = slight impact; 2 = moderate impact; 3 = severe impact
All impacts are assumed to be negative unless a positive sign (e.g. +1) is recorded.

Provide a brief explanation and justification for *each change* and *score* recorded. Where feasible and meaningful, indicate the specific *issues*, within each Major Concern, which are mainly responsible for any likely significant change in socio-economic impacts.

Report Sheet IVa: Comparative Environmental and Socio-Economic Impacts of Each Major Concern

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Types of Impacts									
	Environmental Score		Economic Score		Human Health Score		Social & Community Score		
Concern	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	Overall Score
I									
II									
III									
IV									
V									

From this table, does the information enable unambiguous *overall* score for each major concern (last column) to be made?

☐ No, proceed to **Report Sheet IVb**

☐ Yes, then please provide a brief justification and go to **Report Sheet IVd**

Report Sheet IVb: Weight Averaged Environmental and Socio-Economic Impacts of Each Major Concern

Sub-region No.: _____ Sub-region Name: _____ Date:_____

The task team should consider that:

a) The same weight (as per cent) should be given to scores in each time period (present and future) or that greater weight should be given to scores in one of these periods?

Present (%) (i)	Future (%) (j)	Total (%)
		100

b) Equal weight (as per cent) should be given to scores in each impact category or more weight should be given to scores in some categories than others?

Environmental (k)	Economic (l)	Health (m)	Other Social and Community (n)	Total (%)
				100

Based on team scores for environmental and socio-economic impacts in **Report Sheet IVa** (a, b, c, d, e, f, g and h) and the above weights (i, j, k, l, m and n), calculated

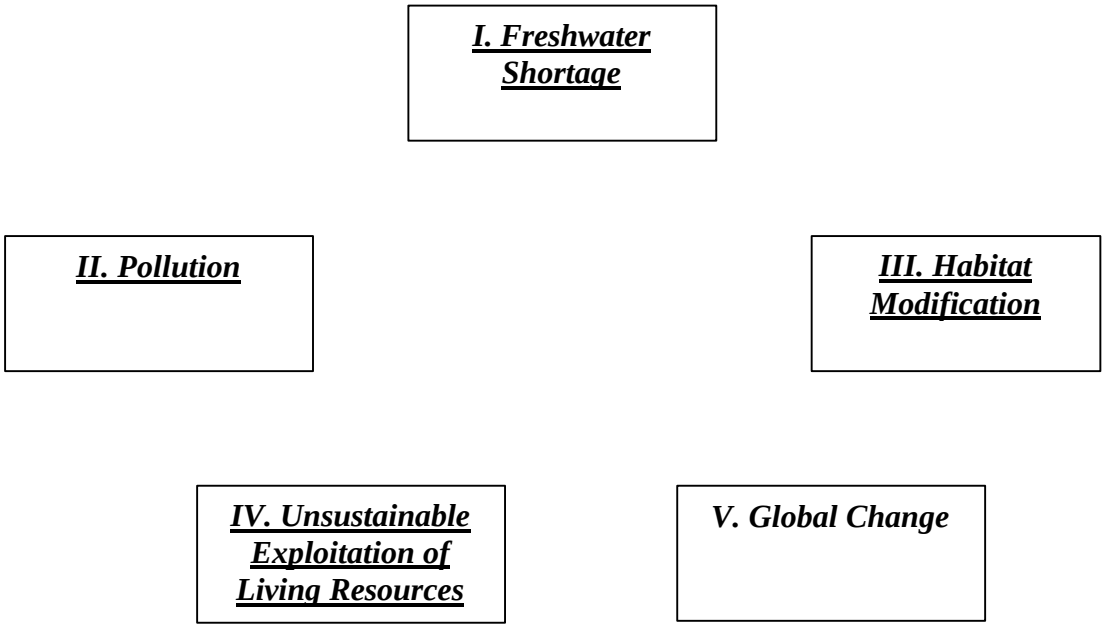
	Types of Impacts				
	Time Weight Averaged Environmental Score (o)	**Time Weight Averaged Economic Score (p)**	**Time Weight Averaged Human Health Score (q)**	**Time Weight Averaged Social & Community Score (r)**	**Overall Time and Impact Averaged Score**
Concern	**(a)×(i) + (b)×(j)**	**(c)×(i) + (d)×(j)**	**(e)×(i) + (f)×(j)**	**(g)×(i) + (h)×(j)**	**(o)×(k) + (p)×(l) + (q)×(m) + (r)×(n)**
I					
II					
III					
IV					
V					

Based on weight averaged scores of impacts in *this* Report Sheet the Task Team should prioritise each concern and summarise both the method used (including any assumptions, etc.) and the results obtained. The team should also consider if this provides a satisfactory resolution?

Report Sheet IVc: Linkages between Major Concerns

Sub-region No.: _____ Sub-region Name: _____ Date:_____

Identify, on a preliminary basis, any important linkages between concerns (and/or their constituent issues) which may justify proposing that two or more concerns should be linked together as a joint concern for the purpose of prioritising concerns for further analysis during Stages 2 and 3. The Task Team may use this box diagram to add arrows that link major concerns.



Please provide a short description and justification

Report Sheet IVd: Overall Impact and Priorities for Further Analysis

Based on information in **Report Sheets IVa - IVc** and any further analysis that the Task Team has performed, the team should finalise and record its prioritised list of concerns (including linked concerns) that it recommends for further analysis during Stages 2 and 3. It should also provide a short description and justification of the first and second priority concerns (or linked concerns) on its list.

APPENDIX I.

Description of pre-defined standard habitats to be used when selecting the habitats for Issue12 and Issue 13

FRESHWATER HABITATS

WETLANDS

1. **Peat bogs**
    a) **Ombrotrophic bogs**
        - Ombrotrophic bogs are fed only by precipitation.
        - In temperate zones they can only exist where annual rainfall is greater than 160 cm distributed evenly through the year.
        - Characterised by dome shaped 'raised bogs' dominated by sphagnum species.
        - Low in nutrients.
        - Acidic.

    b) **Soligenous bogs**
        - Soligenous bogs receive their water principally by run off from the surrounding land.
        - Peat lands are a good example of this group.
        - Low in nutrients but higher than ombrotrophic bogs.
        - Acidic.
        - *Eriophorium*, *Trichophorum caespitosa* and *Molinia caerulea* are important species.

2. **Marshland**
    a) **Marshes**
        - Dominated by herbaceous vegetation.
        - Fed from vertical movements of water table and in-flowing streams.
        - May occupy the littoral of lakes.
        - Little accumulation of peat.
        - Substrate usually mineral and/or organic.
        - Moderate to rich in nutrients.
        - Neutral to alkaline.
        - Marshes can progress into swamps with changes in substrate or water level.
        - *Phragmites* and *Typha* (*Cyperus* and *Nymphaea* in tropical regions).

    b) **Fens**
        - Intermediate in character between peat bogs and marshes.
        - Less acidic than bogs.
        - Substrate is composed of peat.
        - Water supply from ground water and precipitation.
        - Low O_2 levels.
        - Vegetation dominated by *Carex* species.

c) Swamps (and carrs)

- Wide range of vegetation types.
- Dominated by trees adapted to inundation.
- Generally broad leaved but some conifers.
- Generally neutral to acid conditions.
- Variable substrate (inorganic, decomposing organic, peat).
- Substrate often continually waterlogged.

3. Littoral belts alongside lakes and ponds

- Littoral belts are shallow inundation areas with perennial plants adapted to life in both water and air.
- The soil surface can be covered with water or become exposed for short periods but it will always be waterlogged.
- Such belts are characterised by helophytes which often grow in polycorms.
- Typical temperate species are from *Scirpus*, *Eleocharis*, *Typha* and *Phragmites*.
- Tall *Eleocharis* species may replace *Scirpus* in tropical littoral belts.
- Tropical species include *Cyperus papyrus* and *Aeschynomene elaphroxylon* in lakes of equatorial Africa.
- Species including *Scirpus maritimus*, *S. paludosus* or *S. acutus* occur in brackish and saline habitats.

4. Wetlands related to running water

a) Riparian belts

- Riparian belts are habitats whose existence depends on the presence of the associated aquatic environment.
- The riparian belt includes two zones, distinct in geomorphology and hydrology analogous to the littoral of standing waters and to the sub-littoral.
- The most important habitats for wetland vegetation along rivers are in the upper sub-riparian and lower riparian zones.
- Two types of river bank can be distinguished by amplitude of water level fluctuations: stenosalentic with a maximum annual water level fluctuation of approximately 0.6 m; and eurysalentic with fluctuations of at least 0.8 m but often between 1 to 5 m.
- The duration of flooding determines ecotopes ranging from submerged (always flooded) to emergent.
- Classically, banks have been classified according to the intensity of water current. The two bank types are: lentic banks, with either stagnant of slowly flowing water; and lotic banks, with water steadily or periodically flowing.
- Riparian banks in the tropics are often vegetated by forest right to the main river flow.

b) Springs, rills and flushes

- These are habitats with rapid and localised flow of drainage water near the ground surface that varies greatly in volume and flow rate according to rainfall.
- The amount of peat accumulation varies widely with true peats occurring only rarely.
- Water temperature is relatively constant.
- This wetland type is best represented in hilly regions.
- Vegetation usually consists of one layer of small herbs and one layer of bryophytes or two layers of both.

c) Wetlands in estuaries and deltas including tidal rivers

- This habitat type is related to littoral belts, reed swamps and reed lands but is often poorer in structure and composition.
- It is often adjacent to swampy woodland on only slightly higher ground.
- Vegetation may be intermediate between freshwater, saline or brackish habitats.

5. Periodic waters

a) Periodic standing waters with large amplitude fluctuations

- All standing water wetlands display some degree of periodicity (lakes, ponds, pools, oxbow lakes, lagoons and ditches) but the most variable water levels are in heath pools in oceanic regions, shallow lakes in dry or arid regions, fishponds and reservoirs.
- Periodic waters in oceanic regions usually depend on high precipitation during certain periods.
- Continental dry regions have high evaporation at the water surface coupled with low inflow during the dry season.

b) Periodic standing waters with long period fluctuations

- Standing waters with long period fluctuations have occasional limosal and terrestrial ecophases.
- Examples are oxbow lakes during flood periods, tree swamps during extreme dryness and summer drained fishponds.
- They are often inhabited by characteristic vegetation.

c) Floodplains

- Low-lying flat ground over which rivers' flood during high water.
- Predictable in regions with distinct wet and dry seasons.
- Can occur at any time in temperate zones where heavy rainfall is unpredictable.
- In many areas floodplains have been modified for farming (eg. Rice).
- Inundation of trees can vary dependent on height of flooding.

d) Rice paddy fields

- Rice paddies are shallow standing waters with rice as a crop.
- Littoral and limosal ecophases take place during the vegetative season of rice and a terrestrial ecophase is induced before and lasts until after the harvest.

- Two types of vegetation develop during one ecoperiod: Helophytic vegetation in competition with rice; and Pelochthopphytic vegetation growing shortly before and after harvest, which does not compete with rice.

6. Wetlands of saline habitats

a) Coastal marshes

- Coastal marshes dominated by helophytes are comparable in structure with littoral belts or saline riparian belts.
- Vegetation is generally poor in both structure and species diversity.
- Aeration of the soil usually takes place only at the surface or not at all.
- *Spartina* occur on mud flats subject to silt accumulation and erosion.
- Coastal marshes show vertical changes dependent on the balance between frequency and duration of flooding with seawater and leaching by rainwater and evaporation.

b) Brackish reedlands

- Helophyte stands may occur where conditions are suitable for peat accumulation and there is some contact with fresh water such as seepage or in brackish areas of deltas or estuaries.
- Vegetation is generally poor in both structure and species diversity.

c) Shoals

- Sheltered from wave action in the upper part of the eulittoral which may or may not be under tidal influence.
- Often strongly saline.
- Vegetation (such as *Salicornia*) is usually in monospecific stands.

d) Foreshores

- Foreshores are supralittoral habitats above the mean high water.
- In maritime regions this extends to the storm tide level.
- Vegetation, in contrast to all other wetland types, mainly consists of hemicryptophytes with some chamaephytes.

e) Inland salt marshes

- Inland salt marshes are usually temporary wetlands, drying out during dry periods.
- They usually occur in shallow depressions or in association with shallow water bodies.
- Characterised by high concentrations of salts in the water and/or in the upper soil horizons.
- Salt enrichment is due to capillary rise during the periods of high soil surface evaporation.
- The vegetation in these habitats generally belongs to the same genera as those growing in coastal salt marshes but the species or lower taxa may be different.
- Notable is the absence of *Spartina* in inland salt marshes.

OPEN OR RUNNING WATERS

1. Running water classification

The dominant feature of all lotic environments is the continuous movement of water and currents, which cuts the channel, molds the character of the stream and influences the chemical and organic composition of the water. Water running off the land follows courses of least resistance and develops these as distinct channels by erosion.

Young or rejuvenated streams, with a high velocity, erode more than they deposit.
Water in slow-moving rivers reflects the characteristic of the terrain with nutrient level and sediment load varying according to region. Slow moving streams often develop a floodplain, meanders, and associated features and terminate in a lake or estuary.

a) Fast flowing, stony bottomed

- Fast-flowing, young stages of streams will always be present as the river erodes the landscape.
- Over time, the young stage will mature into a slow-moving stream, but it can be rejuvenated when a geological obstacle (e.g. a waterfall) is encountered.
- In fast-moving streams, there is very little primary production in the open-water habitat, due to the velocity and turbulence of the current.
- Populations of consumer organisms (mainly particulate feeders) are low.
- Riffle areas provide valuable habitat for juvenile fish species.
- Pools are important resting areas for several fish species, including Salmon.
- The quality of these areas can be adversely affected when shade trees are removed from the banks.

b) Sandy/muddy, flood plain rivers

- In slow-moving steams, the development of habitat depends upon the depositional and erosional characteristics of the river.
- In mature streams, there is a progressive downstream movement of meanders, leaving shallow or deep pools, backwaters, braided channels and oxbow ponds. There is an associated change in the character of the open water.
- Plant and animal communities largely resemble those found in lentic (lake and pond) habitats.
- The significant phytoplankton populations that usually exist contribute to a higher rate of primary productivity than that found in fast-moving steams.
- The level of productivity is dependent upon water temperature and the amount of nutrient input received from the surrounding environment, and therefore subject to seasonal variation.
- The diversity of consumer organisms varies according to the physical conditions and vegetation. Planktonic populations are relatively high, although not as dense as those found in lakes.

- There are no plankton species unique to rivers; those found there originate mostly from back-waters or lakes.
- Several species of desmids and diatoms are present in slow-moving rivers, although abundance is much lower than in lakes.
- Some zooplankton species and rotifers can be found in slow-moving streams. Their abundance depends on the amount of the predation from invertebrates and small fish.

2. Standing water classification

a) Oligotrophic lakes

- Oligotrophic lakes are generally deep with steep sides and relatively small drainage areas, although some oligotrophic lakes are no more than shallow granite pans.
- Nutrient levels are low.
- Water is clear blue with high light penetration due to the low number of planktonic or attached algae that can be supported by the low nutrient levels.
- Water transparency (measured by Secchi disk) is typically over 8 m.
- Hypolimnetic and benthic 0_2 levels do not vary much from saturation throughout the year (10 + 10 %).
- Biomass at all trophic levels is low.

b) Eutrophic lakes

- Eutrophic lakes are often shallow, usually less than 10 m deep with gradually sloping edges and a large drainage.
- Nutrient levels are high.
- Primary productivity is also high with an abundance of planktonic or attached algae.
- Surface blooms of blue-green algae are common.
- Large variation in 0_2 levels. Depression in the hypolimnion (0-100 %) and supersaturation in the epilimnion (100-200%).
- Low water clarity with light penetration often not reaching the thermocline or lake bed. Water transparency (measured by Secchi disk) is typically less than 2 m and in extremely eutrophic conditions is only a few centimetres.
- Sediments of eutrophic lakes become enriched with nutrients as organic matter from the photic zone accumulates.
- Eutrophic lakes have a biomass at all levels of the food chain, including fish.
- Summer and winter fish kills are typical in eutrophic waters.

c) Mesotrophic lakes

- Mesotrophic lakes are intermediate between oligotrophic and eutrophic lakes.
- They can be defined as having a Secchi disk depth of 2 - 8 m.

d) Dystrophic lakes

- Dystrophic lakes contain humic acids leached from decaying aquatic vegetation in the watershed.
- Humic acid stains the waters a characteristic yellow-brown colour.
- They are usually shallow and unproductive although some are highly productive and contain high levels of floating blue-green algae.
- Small dystrophic lakes are common in mountain regions where leachate from pine forests and bogs provide a continuous supply of humic acids.

MARINE HABITATS

COASTAL MARGINS ECOTONES

1. Sandy foreshores

- The presence of sand as the dominant constituent of a beach indicates exposure to wave action (which may range from slight to severe).
- The geological description of sand (sedimentary particles of rock between 0.05 and 2.0 cm in diameter) provides an objective means of distinguishing sandy foreshores from coarser beaches of gravel or finer ones of mud.
- Sandy beaches are much flatter than those of shingle. They are seldom steeper than 1 in 25.
- They range in size from small pocket beaches of less than 100 m between tide marks to stretches of sand with intertidal distances of several hundred metres.

2. Shingle foreshores

- Shingle is the term applied to those sediments that are larger in diameter than sand and have negligible capillary forces.
- A predominant particle size of over 2 mm (0 f units) is usually held to separate sand from shingle.
- Shingle may be subdivided into the size fractions: boulders (over 200 mm); cobbles (60 - 200 mm); coarse gravel (20 - 60 mm); medium gravel (6 - 12 mm); and fine gravel (2 - 6 mm).
- Five categories of shingle structures have been recognized: (1) fringing beaches; (2) spits; (3) bars or barriers; (4) opposition beaches; (5) offshore barrier islands.

3. Lagoons

- Lagoons are shallow bodies of brackish or seawater partially separated from an adjacent coastal sea by barriers of sand or shingle that only leave narrow openings through which the seawater can flow.
- If fully isolated a lagoon can transform into a freshwater pond or lake if the lagoon receives river discharge.
- Coastal lagoons are usually found on low-lying coasts and are normally aligned with their largest diameter parallel to the seashore.
- They can also occur perpendicular to the shoreline where seawater has transgressed into an existing freshwater lake, during reclamation of salt marsh or where land below sea level has been invaded after storms.

4. Muddy foreshores

- Mud flats are formed by the deposition of finely inorganic material and organ debris in particulate form, which has been held in suspension in the sea or estuaries.
- They are formed in the sheltered parts of embayments, inlets, and estuaries or behind the protection of shingle spits or dune systems.
- Due to its adhesive quality, enhanced by organic matter, mud requires a strong tidal fore to scour it once it has been deposited.
- The process of accretion over level expanses of mud leads to the development of salt marsh.

5. Salt Marshes

- Salt marsh can be defined as natural or semi natural halophytic grassland and dwarf brushwood on the alluvial sediments bordering saline water bodies whose water level fluctuates either tidally or non-tidally.
- Salt marshes facilitate sedimentation by reducing local water velocity and by retaining many of the particles deposited.
- Salinity can vary from 38 ‰ to 5 ‰. If the salinity is below 5 ‰ salt marsh is replaced by reed and rush marshes, coppice and tall herbage etc.
- On coasts with high precipitation, landward penetration of salt marsh may be reduced. If coastal precipitation is low, salt marshes will continue inland due to relatively high evaporation.
- Salt marshes require sheltered conditions to ensure that sedimentation occurs and to prevent excessive erosion.
- Six types of salt marsh can be distinguished: (1) estuarine; (2) Wadden; (3) lagoonal; (4) beach plain; (5) bog; (6) polderland.

6. Estuaries

- An estuary can be defined as an enclosed region at the mouth of a river where freshwater from land drainage mixes to a greater or lesser extent with saline water from a tidal sea.
- Typical estuaries do not always form where a freshwater flow reaches the sea (e.g. on a mountainous coast where saline water may barely penetrate a river flowing fast down a steep bed.
- At the other extreme marshy creeks fringing a low, flat coast may be fully saline almost to the head.
- Classically, estuaries are classified into 4 basic types (Pritchard, 1967): (1) drowned river valleys; (2) fjords; (3) bar-built estuaries; (4) estuaries formed by tectonic processes.
- Due to the continually changing cycle of salinity, water level, temperature, abundant soft sediments and a constant supply of detritus or dissolved nutrients, estuaries are unique habitats.
- In estuaries, the addition of fresh water sets up a differential movement of water. As the upper, less-saline layer flows seaward, it mixes with the lower layer. This modifies the distribution of buoyancy forces in the estuary, so that the lower, more-salty layer flows landward, wells up near the head of the estuary and provides a portion of the upper water. This ongoing sequence of upwelling and stratification provides nutrients to the surface waters.

7. Rocky foreshores

- Rocky shores occur most extensively where the coastal region is rugged or mountainous.
- Topographically they are more variable than other coastal habitats (eg. Steep inaccessible cliffs, wide gently sloping platforms, fringing islets, smooth uniform slopes, extensive boulder beaches).
- The majority of rocky shores on open coasts experience relatively stable conditions of fully marine situations but some experience regular or intermittent low salinities and turbidities of estuaries.
- Rocky shores also experience variable wave action.

8. Mangroves

Mangroves (or mangals) are shrubs and trees that live in or adjacent to the intertidal zone. They are a polyphyletic group from a wide range of families comprised of approximately 69 taxa (62 species and 7 hybrids). Mangrove communities are largely restricted to the tropics between 30°N and 30°S, with extensions beyond this to the north in Bermuda (32°20'N) and Japan (31°22'N) and to the south in Australia (38°45'S) and New Zealand (38°03'S). They are only able to grow on shores that are sheltered from wave action. Mangrove forests are particularly well developed in estuarine and deltaic areas. They may also extend some distance upstream along the banks of rivers, for example as far as 300 km along the Fly River in Papua New Guinea.

Mangroves occur over a larger geographical area than coral reefs and, unlike reefs, are well developed along the western coasts of the Americas and Africa. They have a more restricted distribution than coral reefs in the South Pacific. There are two main centres of diversity, termed the eastern and western groups. The eastern group occurs in the Indo-Pacific (the Indian Ocean and western part of the Pacific Ocean) and is the most species-rich. The western group, although centred around the Caribbean, includes mangal communities along the west coast of the Americas and Africa.

Mangrove communities are unique: due to the vertical extent of the trees, true terrestrial organisms can occupy the upper levels and true marine animals can occupy the bases. A wide variety of organisms are associated with the mangrove system. These include among the flora a number of epiphytes, parasites and climbers, and among the fauna large numbers of crustaceans, molluscs, fishes and birds. It is estimated that more than 50% of the world's mangrove forest have already been destroyed by both human and natural causes.

OTHER BENTHIC MARINE HABITATS

1. Seagrass meadows

Seagrasses are flowering plants (not true grasses) that are adapted to live submerged in seawater. There are approximately 48 species found in shallow coastal areas between the Arctic and Antarctic. Seagrasses are placed in two families: Potamogetonaceae (9 genera, 34 species) and Hydrocharitaceae (3 genera, 34 species. They occur from the littoral region to depths of 50 or 60 m but appear to be most abundant in the immediate sublittoral area. The are more species in the tropics than in the temperate zones, and of the 12 seagrass genera, 7 are confined to tropical seas and 5 to temperate seas.

Most seagrass species are very similar in external morphology, with long thin leaves and an extensive rhizome root system that enables them to fasten to the substrate. A variety of substrates are occupied from sand and mud to granite rock, but the most extensive beds occur on soft substrates.

Seagrass beds have a very high productivity rate and contribute significantly to the total primary production of inshore waters. Seagrass beds serve a number of

important functions in inshore areas. They are a significant source of food for many organisms both by direct grazing and detritus feeding, including invertebrates, fishes, birds, the green turtles and aquatic mammals. The beds also serve as nursery grounds for many commercial species such as scallops and shelter the inhabitants from predators and adverse environmental conditions. They serve to protect coastlines from the erosive force of wave action.

2. Kelp systems

Algae lack vascular tissue (the transport system for water and nutrients) found in higher plants. They are almost exclusively aquatic; three of the four principal groups comprising of large-sized species are mainly marine in occurrence. These three, the green, brown and red algae ('seaweeds'), are all cosmopolitan in distribution and occur in a range of environments, although some constituent families have somewhat restricted ranges. In contrast to the prevailing pattern in many organisms, the cold and cool temperate regions of the world are rich in species. On present incomplete information, the region around Japan (north west Pacific), the North Atlantic, and the tropical and subtropical western Atlantic, hold the most species of marine algae. Southern Australia is not so species-rich but appears to have the highest proportion of endemic species. There are few species of larger algae in regions of cold water upwelling, such as western tropical Africa and the west coast of South America; small isolated islands and polar regions also have few species. There are more species of red algae (Rhodophyta) than the greens (Chlorophyta) and browns (Phaeophyceae) combined. The brown algae include the kelps (order Laminariales) distributed in temperate waters of both northern and southern hemispheres.

As noted above, coral reefs support a unique and generally diverse algal flora that includes many crustose coralline algae (more species of which are likely to be discovered). Mangrove areas are also restricted to the tropics and subtropics and support a well-defined and interesting algal vegetation, contrasting with that of salt marshes in the temperate zones, which are generally more species-poor. Sandy coastlines hold few species of large algae and often form barriers to seaweed dispersal. Some anthropomorphic changes to the coastline involving creation of additional habitats have locally enhanced species diversity; pollution, in contrast, has reduced species diversity, especially in lagoons, mangrove areas and coral reefs; in reef systems, pollution-tolerant weedy species tend to replace pollution-sensitive species. Land reclamation, rice-paddies and salt pan development have led to the loss of algal habitat in many coastal areas in the tropics.

Throughout a large part of the cold temperate regions of the world, hard sub-tidal substrates are occupied by very large brown algae collectively known as kelps. These associations are known technically as kelp beds if the algae do not form a surface canopy, and kelp forests where there is a floating surface canopy. These formations occur primarily in the cold currents of the Atlantic and Pacific oceans and may be found in tropical areas, typically in areas of upwelling and cold water surface currents. The extent of the kelp beds and forests on various coasts depends on several factors: kelps flourish with a hard substrate for attachment, moderate wave surge, cool, clear ocean water and high-nutrient waters.

Kelps are attached to the substrate by a structure called a holdfast. A stem arises from the holdfast, and this bears one or more broad flat blades. Kelps obtain their nutrients directly from the seawater and the main site of photosynthesis is in the blades. Kelp beds and forest are extremely productive and provide the framework for an associated community including many different species of algae, invertebrates, and fishes. Despite the enormous productivity of the kelp, relatively few herbivores graze directly on the plants. It has been estimated that only 10% of the net production enters the food web through grazing and the remaining 90% enters the food chain in the form of detritus or dissolved organic matter. The main causes of kelp mortality can be attributed to mechanical forces, mainly wave action, and nutrient depletion, mainly nitrogen. Adult plants are only occasionally destroyed by grazing herbivores.

3. Coral reefs

Corals are members of the phylum Cnidaria, which includes such diverse forms as sea anemones, jellyfish and hydroids. Within this phylum, corals and sea anemones comprise the class Anthozoa.

Corals may be categorised as hermatypic (reef building) or ahermatypic (non-reef building). The great majority of hermatypic corals belong to the order Scleractinia, the stony corals. They collectively deposit calcium carbonate to build colonies. The coral polyps have symbiotic algae (zooxanthellae) within their tissues that process the polyps' waste products. The zooxanthellae use the nitrates, phosphates and carbon dioxide produced by the coral, and through photosynthesis generate oxygen and organic compounds that provides much of the polyps' nutrition. The zooxanthellae give corals their colour. Ahermatypic, non-symbiotic corals do not form reefs and can exist in deeper colder waters. Not all reefs are constructed primarily by corals. Several genera of red algae in particular grow heavily calcified encrustations which bind the reef framework, forming structures such as algal ridges.

The term coral reef applies to a variety of calcium carbonate structures developed by stony corals and calcareous algae. Coral reefs are tropical shallow water ecosystems of high biodiversity largely restricted to the seas between the latitudes of 30°N and 30°S. They occur in around 110 countries. Coral reefs are most abundant in shallow, well flushed marine environments characterised by clear, warm, low nutrient waters that are of oceanic salinity and super-saturated with calcium carbonate. There are two basic categories:

Shelf reefs, which form on the continental shelves of large land masses and *oceanic reefs*, which are surrounded by deeper waters and are often associated with oceanic islands. Within these two categories there are a number of reef types:

Fringing reefs grow close to shore

Barrier reefs develop along the edge of a continental shelf or through land subsidence in deeper waters and are separated from the mainland or island by a relatively deep wide lagoon

Atolls are roughly circular reefs around a central lagoon and are typically found in oceanic waters, probably originating from the fringing reefs of long submerged islands.

Patch reefs form on irregularities on shallow parts of the seabed

Bank reefs occur in deeper waters, both on continental shelf and in oceanic waters.

Coral reefs are one of the most productive and diverse of all natural ecosystems. Around the world coral reefs have suffered a dramatic decline. In the past, severely stressed coastal ecosystems have been primarily temperate, but this is no longer true. The major human impacts (aside from fishing) on temperate coasts, such as heavy industrialisation, large coastal developments, dredging and pollutants including sewage and oil, are now affecting the coastal areas of developing tropical nations. Among other effects, these are damaging coral reefs: about 10% may already have been degraded beyond recovery and another 30% are estimated to decline seriously within the next 20 years.

Central parts of the Indo-West Pacific contain the highest number of reef fish species, and richness decreases with increasing distance from this core area. Most reef fish species are relatively rare in terms of individuals in the community. Thus, at Toliara (south-west Madagascar) only about 25% (136) of the total number of fish species present were ranked as abundant. Many families of coral reef fishes have a circum-tropical distribution, although there are pronounced differences at species level For example, the number of reef fish species within a single zoogeographic region varies between 100s and 1,000s. Most families in tropical seas include species that occur in the coral reef fauna, and some families are almost entirely restricted to reefs, such as Chaetodontidae, Scaridae, and Labridae. Within the demersal component (feeding on benthic organisms), the families Acanthuridae, Balistidae, Belennidae, Holocentridae, Ostraciodontidae, Pomacentridae (damselfish) and Serranidae tend to dominate. Principal pelagic families associated with reefs, other than the top predators such as Carangidae, *Sphyraena* and sharks, include Atherinidae (silversides), Pomacentridae and small lutjanids such as *Caesio* and its relatives. Small-sized species tend to predominate, although the range is from 2-3cm for some *Eviota* species to over 5m for some sharks.

4. Mud bottom

Sediments containing more than 10% dry weight of silt and clay fractions are commonly termed 'muddy sands'. If more than 30% of the deposit is silt or clay then the sediment is termed a 'sandy mud'. Deposits with silt and clay fractions exceeding 80% are generally described as mud.

A mud bottom usually contains varying proportions of silt and clay, as well as other constituents. Clay is finer and accumulates in relatively still conditions in basins and smaller depressions, and provides a flat terrain. Subtidal areas near river mouths typically have high proportions of silt. Infaunal species are most important on silt/clay bottoms, and the majority feed on particulate organic

matter sorted from the sediment or filtered from the water. These in turn support a variety of epifaunal carnivores and bottom-feeding fish. Species diversity and abundance are generally reduced as the sediment grades into fine, compacted clay deposits. Occasional stones and shells are colonized by an epifauna similar to that associated with rock and boulder bottoms. The mud-bottom infauna often includes burrowing sea anemones, sea pens (in deeper water); polychaete worms, bivalve molluscs, Tusk Shells, gastropods, Sea Cucumbers, brittlestars and starfish. Epifauna consists of hermit crabs, crabs, shrimps, sea spiders and bottom- feeding fish.

5. Sand and gravel bottoms

According to the Wentworth Classification of particle grades sand ranges from a particle size of 0.0625 to 2.0 mm. However marine sediments are never uniform in composition and contain particles of many grades and types. If the particles are mainly of one size, the sediment is well sorted. If there are many sizes of grain then it is a poorly sorted sediment. Sediments containing more than 10% dry weight of silt and clay fractions are commonly termed 'muddy sands'. If more than 30% of the deposit is silt or clay then the sediment is termed a 'sandy mud'.

Sand is usually a mobile bottom and generally provides a smooth (though frequently undulating) and rippled terrain. In areas of intense currents, a sand bottom can form a hard pavement, with small animal populations. Gravel and sand waves can have different animals in the crests and in the troughs, owing to the different grades of sediment found in each place. Small particles do not provide a habitat for attached epifauna, although small stones and shells of dead molluscs may be colonized by forms typical of the rock and boulder bottom. On sand bottoms, the infauna is important, but many species of hyperbenthos (living at the surface or in the lower water column) commonly occur here. Species typically occurring on subtidal sandy substrate include cumaceans, amphipods, small polychaete worms living between sand grains and tube-building species.

6. Rocky bottom

- Benthic habitats with rocky or stony substrates support communities that primarily live on the surface of the substrate (epiflora and epifauna).
- Fauna is mainly sessile or encrusting cnidarians, sponges, bryozoans, barnacles, tubicolous worms, mussels and sea squirts.
- Mobile species such as errant polychaetes, starfish, echinoids, gastropods and large crustaceans live amongst them.
- In shallow water, where sufficient illumination reaches the bottom macrophytes grow attached to rocks or stones heavy enough to give secure anchorage.
- Species diversity is usually high on rocky bottoms due to the variety of microhabitats.
- Rocky bottoms do not usually support a numerous infauna dwelling within the substrate although burrowing creatures will occur in accumulations of sediments in rock crevices.

7. Deep-sea communities

Approximately 51% of the earth's surface is covered by ocean over 3,000 m in depth. Deep-sea communities are thus prevalent over a major proportion of the planet. All deep-sea habitat is in the aphotic zone, well below the distance sunlight can penetrate. As deeper and deeper levels are reached biomass falls exponentially.

Despite their enormous volume, the deep oceans appeared to be relatively simple ecosystems, and to make little contribution to global species diversity, but discoveries during the past decade have shown that in some regions, species diversity in the benthic community increases with increasing depth. This was revealed by novel sampling techniques, principally the epibenthic sled. Speculative extrapolation from sample data suggests that the deep sea may hold several million species. However it is uncertain to what extent results can reasonably be extrapolated. The rate of discovery of new species and the proportion of species currently known from only one sample suggest that a great number remain to be discovered.

In the megafauna, echinoderms of several classes are often the dominant mobile life forms on or in association with the sea bottom. Giant scavenging amphipods, growing up to about 18 cm in length, are also characteristic in many areas. However, the high mobility of these animals means they are rarely caught in trawls and have been less well studied than less active animals. Other arthropods include a variety of sea spiders (Pycnogonida) and decapods of several families. Mobile animals of several other taxa occur, including polychaetes, hemichordates, cephalopods and fish. Sponges (Porifera), especially the glass sponges, and coelenterates (Cnidaria), particularly anthozoans, are also well represented.

8. Ocean trenches

Ocean trenches are formed as a consequence of plate tectonic processes where sectors of expanding ocean floor are compressed against an unyielding continental mass or island arc, resulting in the crust buckling downwards (subducting) and being destroyed within the hot interior of the Earth. As oceanic crust ages and cools, it becomes denser and stiffer, resulting in a steeper angle of subduction and a deepening trench. Trenches along the western edge of the Pacific are deepest and oldest. Seismically, ocean trenches are highly active, as subduction is an episodic rather than continuous process. This results in an unstable and unpredictable habitat compared to the relative environmental stability of the adjacent abyssal plains.

Ocean trenches are typically close to landmasses and tend to have high rates of sedimentation, a significant amount of which is of organic origin and an important available food source for trench communities. Several trenches also underlie highly productive cold water upwelling zones, the organic fallout from which contributes greatly to their richness. The water within trenches generally originates from the surrounding bottom water, which is derived from cold surface water at high polar latitudes and is relatively well oxygenated.

Trenches tend to be isolated linear systems with high seismic activity; trench faunas are not rich in species but are often high in numbers of endemic species. There are some 25 genera restricted to the ultra-abyssal (hadal) zone, representing some 10-25% of the total number of genera present, and two known endemic hadal families; the Galatheanthemidae (Actinaria) and Gigantapseudidae (Crustacea). The latter family contains a single species: *Gigantapseudes adactylus*. The greatest number of endemic species known from a single trench is a sample of 200 from the Kurile-Kamchatka Trench; this may be compared with 10 endemic species known from the Ryukyu and Marianas Trenches.

9. Hydrothermal vents

Hydrothermal vent communities were first discovered in 1977, at a depth of 2,500 m on the Galapagos Rift. They are now known to be associated with almost all known areas of tectonic activity at various depths. These tectonic regions include ocean-floor spreading centres, subduction and fracture zones, and back-arc basins. Cold bottom-water permeates through fissures in the ocean floor close to ocean-floor spreading centres, becomes heated at great depths in the Earth's crust, and finds its way back to the surface through hydrothermal vents. The temperature of vent water varies greatly, from around 23°C in the Galapagos vents, to around 350°C in the vents of the East Pacific Rise, and they may be rich in metalliferous brines and sulphide ions. Most species live out of the main flow at temperatures of around 2°C, the ambient temperature of deep-sea water. The biomass of vent communities is usually high compared to other areas of similar depth, and dense colonies of tube-worms, clams, mussels and limpets typically constitute the major components.

Vent communities are separated by gaps of between one and 100 km, and although they may persist only for several years or decades, sites of vent activity move relatively slowly allowing dispersal of vent organisms. Vent communities could be part of a unique ecosystem as old as plate tectonic activity on Earth. Hydrothermal vent communities are of particular interest in that they flourish in the dark at high pressures and low temperatures, and unique in that they are supported by a non-photosynthetic source of organic carbon, i.e. chemosynthetic primary production. The enriched hydrothermal fluid supports large numbers of bacteria (predominantly *Thiomicrospira* species) which form dense bacterial carpets, and are capable of deriving energy from reduced compounds such as hydrogen sulphide. Many of the vent species filter-feed on these bacteria, whilst others rely on symbiotic sulphur bacteria for energy.

The overall species diversity at vents is low compared with other deep-sea soft-sediment areas, but endemism is high. More than 20 new families or sub-families, 50 new genera and nearly 160 new species have been recorded from vent environments, including brine and cold seep communities.

10. Other seeps

There are two further seep patterns. Cold sulphide and methane-enriched groundwater seeps occur near the base of the porous limestone of the Florida Escarpment, as well as in the Gulf of Mexico. The seeps support a dense faunal community associated with a covering or mat of bacteria on the sediment

surface. These communities are strikingly similar in taxonomic composition to the hydrothermal vents of the east Pacific, a fact which points to a common origin and evolutionary history for both community types. The community consists of large mussels and the vestimentiferan worm *Escarpia laminata*, as well as galatheid crabs, serpulid worms, anemones, soft corals, brittle stars, gastropods and shrimps. Methane-rich seeps occur in the North Sea, the Kattegat, and elsewhere.

Tectonic subduction zone seeps are more diffuse and lower in temperature than hydrothermal vent seeps, and are rich in dissolved methane. They are known to occur off Oregon, where the fauna includes species of Lamellibrachia and large vesicomyid bivalves, and in the Guaymas Basin in the Gulf of California, where thick bacterial mats cover the sulphide and hydrocarbon-coated sediment. The cold Japanese subduction zone seeps occur at a depth of 1,000 m in Sagami Bay near Tokyo and in the subduction zones of the trenches off the east coast of Japan. The communities vary, but include dense benthic assemblages dominated by *Calyptogena* clams associated with a stone crab *Paralomis* sp., sepulid worms, sea anemones, galatheid crabs, swimming holothurians and amphipods.

PELAGIC

1. Neritic systems

The pelagic zone can be divided into the neritic zone (extending from low tide to the outer edge of the continental shelf and/or the waters < 200 m deep in areas of coastal submarine slopes) and the oceanic zone (below 200 m).

This zone is an area of extremely high productivity representing up to 95% of marine harvest and is generally within the exclusive economic zone.

The neritic zone is inhabited by comparatively large number of species. It can be characterised by intense, violent interactions between land and sea.

2. Oceanic systems

Given that the oceans cover some 71% of the globe, and that the shelf area is relatively narrow, the oceanic pelagic zone is by far the most extensive ecosystem on Earth.

The oceanic pelagic zone is dominated by the activity of the plankton in the surface waters where sunlight penetrates. Plankton are by definition drifting or weakly swimming organisms, and comprise microscopic photosynthetic organisms (e.g. diatoms, dinoflagellates), the animals that consume them, and the bacteria that consume their organic debris. Plankton tends to be unevenly distributed - concentrated along major circulation currents (gyres), contact zones and upwellings. Species richness appears to vary with depth and latitude.

Free-swimming pelagic organisms, predominantly fishes but also cetaceans and cephalopod molluscs (squid) are collectively termed nekton. These organisms, when adult, are predators of plankton or smaller nekton. They in turn, as vertically migrating fishes or larvae and as dead organic material, provide food for deep sea and

benthic (bottom living) organisms. With few exceptions, the only other food source for creatures in the aphotic zone is the 'rain' of organic matter, such as faeces, moulted crustacean exoskeleton and a variety of other organic material derived from plankton in the surface waters of the ocean.