



**15th meeting of the Conference of the Contracting Parties
to the Convention on Wetlands**

**“Protecting wetlands for our common future”
Victoria Falls, Zimbabwe, 23-31 July 2025**

COP15 Doc.22.3

**Consolidation of existing Resolutions:
Draft consolidated resolution on inventories**

Note from the Secretariat:

In paragraph 10 of Resolution XIV.5 on *Review of Resolutions and Recommendations of the Conference of the Contracting Parties*, regarding the review and consolidation of current Resolutions, the Conference:

“10. DECIDES to establish, subject to available resources, an iterative process for the consolidation of Resolutions of the COP, as follows:

- a) the general objective of the consolidation is to facilitate the understanding and implementation of Resolutions by combining into a single Resolution the texts from existing Resolutions that deal with the same subject, or sub-subject, using the words from the existing Resolutions as far as possible, while eliminating discrepancies and inconsistencies, clarifying the meaning, standardizing the terms used, correcting grammatical errors, updating parts that are out of date and eliminating parts that are defunct;
- b) after each meeting of the COP, the Standing Committee will select a small number of subject categories (generally two to four) from the list of categories of Resolutions in Annex 2 of the present Resolution, for which the Secretariat (or its consultant) will prepare draft consolidated resolutions for consideration at the following COP;
- c) the document presenting each draft consolidated resolution will indicate the origins of the texts presented and explain any differences from the existing Resolutions;
- d) draft consolidated resolutions will not include any new concepts, policies, rules or guidance that have not previously been agreed by the COP;
- e) the text of each draft consolidated resolution will indicate that it repeals the Resolutions that are being consolidated and that it is designed to replace;
- f) each draft consolidated resolution prepared by the Secretariat will be presented to the Standing Committee, which will guide the Secretariat and approve the draft to be

submitted for adoption by the Conference of the Parties when it is satisfied that the draft has been correctly prepared;

- g) as the process of consolidation of Resolutions is not intended to revise the substance of decisions previously made by the Conference of the Parties, the Rules of Procedure for considering and adopting draft consolidated resolutions will be different from those for consideration of other draft resolutions in the sense that, as a general rule, the substance should not be presented for discussion as it has in principle already been agreed by the Parties. The primary decision to be made by the Conference is whether the consolidation has been correctly done; and
- h) the process of consolidation of Resolutions will continue until the Contracting Parties are satisfied with the consolidation work done and can be continued when the Parties have identified a need for more consolidation work.”

Pursuant to paragraph 10.b) of the Resolution, the Standing Committee at its 62nd meeting (SC62) selected through Decision SC62-25 “Inventories” among the categories for which draft consolidations would be prepared for consideration at SC63.

The Secretariat accordingly submitted in document SC63 Doc.16.5¹ the draft consolidated resolution for the Committee to approve as having been correctly prepared and to be submitted for adoption by the Conference of the Contracting Parties at its 15th meeting (COP15).

Pursuant to paragraph 10.c) of the Resolution, the Secretariat included as Annex A of document SC63 Doc.16.5 an explanatory table indicating the origins of the texts presented and explaining any differences from the existing Resolutions.

In Decision SC63-22, the Standing Committee approved the draft consolidated resolution, and instructed the Secretariat to submit it for consideration and adoption at COP15.

As noted in document SC63 Doc.16.5, the Annexes to this draft consolidated resolution are as follows:

- Annex 1 is the Annex to Resolution VIII.6, “A Framework for Wetland Inventory”; however, in accordance with Resolution XIV.5, Table 2 of the Annex to Resolution VIII.6 is replaced with Table 2 under para. 35 of the Annex to Resolution X.15.
- Annex 2 is Annex E to Resolution IX.1, “An Integrated Framework for wetland inventory, assessment and monitoring”.
- Annex 3 is Annex Ei to Resolution IX.1, “Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity”.
- Annex 4 is the Annex to Resolution X.15 “Describing the ecological character of wetlands, and harmonized data formats for core inventory”.

¹ See <https://www.ramsar.org/document/sc63-doc165-review-consolidation-current-resolutions-consolidation-resolutions-inventories>.

Draft consolidated resolution on inventories

1. RECALLING Recommendation 1.5 on *National wetland inventories* and Recommendation 4.6 on *Establishment of national scientific inventories of potential Ramsar sites* adopted by the Conference of the Contracting Parties at its first and fourth meetings respectively; and Resolution VI.12 on *National Wetland Inventories and candidate sites for listing*, Resolution VII.20 on *Priorities for wetland inventory*, Resolution VIII.6 on *A Ramsar Framework for Wetland Inventory*, Resolution VIII.7 on *Gaps in and harmonization of Ramsar guidance on wetland ecological character, inventory, assessment, and monitoring* and Resolution X.15 on *Describing the ecological character of wetlands, and data needs and formats for core inventory: harmonized scientific and technical guidance*, adopted at the sixth, seventh, eighth and tenth meetings; as well as Resolution XIV.6 on *Enhancing the Convention's visibility and synergies with other multilateral environmental agreements and other international institutions*, and Resolution XIV.16 on *Integrating wetland protection, conservation, restoration, sustainable use and management into national sustainable development strategies*, adopted at the fourteenth meeting;
2. RECALLING also the numerous references to the value and importance of inventories in other Resolutions of the Conference of the Contracting Parties, including Resolution 5.3, adopted at the fifth meeting, and Resolution IX.15, adopted at the ninth meeting; and NOTING that these remain on the record;
3. NOTING the value of comprehensive inventories of wetland resources as an aid to implementing the wise use obligation under the Convention, improving the general level of knowledge of the world's wetlands and identifying wetlands suitable for inclusion in facilitating the designation of sites for the List of Wetlands of International Importance (the Ramsar List);
4. RECALLING the *Guidelines for developing and implementing National Wetlands Policies* (Resolution VII.6), the *Wetland Risk Assessment Framework* (Resolution VII.10), the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* (Resolution VII.11), and Resolution VII.17 on *Restoration as an element of national planning for wetland conservation and wise use*, all of which would be greatly assisted by the availability of national scientific inventories; and
5. RECOGNIZING that various methodologies for national inventory can in general be applied also to local, subnational (e.g. provincial) and transboundary international scales;

THE CONFERENCE OF THE CONTRACTING PARTIES

Regarding establishment and maintenance of wetland inventories and inventory methodology

6. ADOPTS the "*Framework for Wetland Inventory*" contained in Annex 1 to this Resolution;
7. RECOGNIZES that it is appropriate to apply different wetland inventory approaches, methods and wetland classifications for different purposes and objectives, but that common standards can be achieved by ensuring consistency in the collection of a core (minimum) dataset, as provided in the Framework;
8. URGES all Contracting Parties that have yet to complete comprehensive national wetland inventories to continue to give a high priority to the compilation of such inventories, utilizing the *Framework for Wetland Inventory* to ensure that their inventory design appropriately addresses

their purpose and objectives, in order that their activities that require the sound basis of wetland inventory, such as policy development and Ramsar site designations, can be carried out on the basis of the best possible information;

9. ADOPTS the *Integrated Framework for wetland inventory assessment and monitoring*, attached as Annex 2, and the *Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity*, attached as Annex 3; and INVITES Contracting Parties to make good use of them as appropriate, adapting them as necessary to suit national circumstances; and URGES Contracting Parties to draw the framework and guidelines to the attention of all relevant stakeholders;
10. URGES that, in undertaking inventory activities, Contracting Parties give consideration to affording highest priority to those wetland types identified as at greatest risk or with poorest information in the *Global review of wetland resources and priorities for wetland inventory* report;
11. ENCOURAGES Contracting Parties initiating development of a national wetland inventory to consider the application or adaptation of an existing inventory methodology and data management system, including the updated inventory methodology developed by the Mediterranean Wetlands Initiative (MedWet), the Asian Wetland Inventory and other appropriate methodologies, so as to ensure consistency in inventory data and information collected;
12. CALLS UPON all Contracting Parties and others who have undertaken, or are undertaking, wetland inventories to document information about the inventory, its data holdings, management and availability using the standard metadata record provided in the *Framework for Wetland Inventory*, so as to make this information available as widely as possible;

Describing the ecological character of wetlands, and harmonized data formats for core inventory

13. WELCOMES the guidance on “Describing the ecological character of wetlands, and harmonized data formats for core inventory” provided in Annex 4 to this Resolution, and URGES Contracting Parties to make good use of it as appropriate, adapting it as necessary to suit national conditions and circumstances, within the frameworks of existing regional initiatives and commitments and in the context of sustainable development;
14. URGES Contracting Parties to draw this guidance to the attention of relevant stakeholders, including in particular those responsible for the management of Ramsar sites and other wetlands;
15. INVITES Contracting Parties and those responsible for the management of Ramsar sites to apply this guidance in the preparation of ecological character descriptions of Ramsar sites, and as part of their management planning processes, so that these descriptions constitute a complementary basis to the Information Sheets on Ramsar Wetlands (RIS) for detecting and notifying changes in ecological character, as established through Article 3.2 of the Convention; and RECOMMENDS that Contracting Parties provide any completed descriptions of the ecological character of Ramsar sites to the Secretariat as a supplement to the information provided in the RIS;
16. ENCOURAGES Contracting Parties to strengthen their efforts to complete their national wetland inventories and to report on wetland extent to report on SDG indicator 6.6.1; and FURTHER

REQUESTS the Secretariat to continue working with Contracting Parties to actively support these efforts;

17. RECOMMENDS that Contracting Parties conduct systematic national wetland inventories, using the *New Toolkit for National Wetland Inventories* of 2020², assess the status and trends of wetlands, analyse national needs and gaps in wetland conservation, develop integrated, systematic and adaptive conservation and restoration planning, and develop integrated national management actions for wetlands and other associated ecosystems as appropriate;
18. REPEALS the Recommendations and Resolutions or parts thereof listed hereunder:
 - a) Recommendation 1.5 (Cagliari, 1980) - *National Wetland Inventories*;
 - b) Recommendation 4.6 (Montreux, 1990) - *Establishment of national scientific inventories of potential Ramsar sites*;
 - c) Resolution VI.12 (Brisbane, 1996) - *National Wetland Inventories and candidate sites for listing*;
 - d) Resolution VII.20 (San Jose, 1999) - *Priorities for wetland inventory*;
 - e) Resolution VIII.6 (Valencia, 2002) - *A Ramsar Framework for Wetland Inventory*;
 - f) Resolution VIII.7 (Valencia, 2002) - *Gaps in and harmonization of Ramsar guidance on wetland ecological character, inventory, assessment, and monitoring*;
 - g) Annexes E and E.i) of Resolution IX.1 (Kampala, 2005) - *Additional scientific and technical guidance for implementing the Ramsar wise use concept*;
 - h) Resolution X.15 (Changwon, 2008) - *Describing the ecological character of wetlands, and data needs and formats for core inventory: harmonized scientific and technical guidance*;
 - i) Resolution XIV.6 (Wuhan and Geneva, 2022) - *Enhancing the Convention's visibility and synergies with other multilateral environmental agreements and other international institutions*, paragraph 49; and
 - j) Resolution XIV.16 - *Integrating wetland protection, conservation, restoration, sustainable use and management into national sustainable development strategies*, paragraph 16;
19. DECIDES to revise Resolution IX.1, paragraph 7, to eliminate reference to Annexes E and Ei; and
20. INSTRUCTS the Secretariat to make any necessary consequential changes to the Annexes or to other Resolutions, only for the purpose of correcting grammar or references, or to ensure accuracy without changing the intent or substance.

² See <https://www.ramsar.org/document/new-toolkit-national-wetlands-inventories>.

Annex 1

A Framework for Wetland Inventory

Background and context

1. In Resolution VII.20 (1999) the Contracting Parties recognised the importance of comprehensive national inventory as the vital basis for many activities necessary for achieving the wise use of wetlands, including policy development, identification and designation of Ramsar sites, documentation of wetland losses, and identification of wetlands with potential for restoration (see also Resolutions VII.16 and VIII.17). It also encouraged the collection of information for the management of shared wetlands, including those within river basins and/or coastal zones (see also Resolutions VII.18 and VIII.4) as appropriate. Furthermore, Operational Objective 1 of the Convention's Strategic Plan 2003-2008 is devoted to wetland inventory and assessment, with a series of concrete actions to achieve this Operational Objective.
2. The *Global Review of Wetland Resources and Priorities for Wetland Inventory* (GRoWI), prepared in 1999 for the Ramsar Convention by Wetlands International and the Environmental Research Institute of the Supervising Scientist, Australia, indicated that few countries have comprehensive national inventories of their wetland resources, and lack this essential baseline information on their wetlands. In addition, the National Reports submitted to Ramsar COP8 indicated that insufficient progress has been made in wetland inventory.
3. The GRoWI review concluded that a clear identification and statement of purpose and objectives is fundamental to the design and implementation of effective and cost-efficient inventory, but found that the purpose and objectives for many existing inventories were poorly, if at all, stated.
4. In Resolution VII.20 the COP urged Contracting Parties which had yet to complete national inventories of their wetland resources to give the highest priority to the compilation of comprehensive wetland inventories, and requested the Convention's Scientific and Technical Review Panel (STRP) to review and further develop existing models for wetland inventory and data management, including the use of remote sensing and low-cost and user-friendly geographic information systems.
5. This *Framework for Wetland Inventory* has been developed by the STRP, working with the Ramsar Bureau, Wetlands International, the Environmental Research Institute of the Supervising Scientist (Australia) and others, in response to Resolution VII.20. The Framework provides guidance on a standard approach to designing a wetland inventory program. It includes information on determining appropriate remote sensing techniques to apply, wetland classifications and existing standardised inventory methods, and recommends standards for core data fields and data and metadata recording.
6. The Framework provides guidance for designing wetland inventory at multiple scales from site-based to provincial, national and regional. The extent of detail that can be compiled in the inventory will generally decrease as the geographical area of coverage increases, unless large resources can be allocated for the program.
7. The data fields included in any particular inventory will be based on the specific purpose and scale of the inventory. A core data set is recommended as a minimum, but with the option of adding further data fields as required.

8. The Framework uses the definition of “inventory” agreed in Workshop 4 on *Wetland Inventory, Assessment and Monitoring – Practical Techniques and Identification of Major Issues* held during the 2nd International Conference on Wetlands and Development, Dakar, Senegal, 8-14 November 1998 (Finlayson *et al.* 2001). The definition is provided below along with those for the inter-connected concepts of assessment and monitoring:

Wetland inventory: The collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities.

Wetland assessment: The identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities.

Wetland monitoring: Collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. (Note that the collection of time-series information that is not hypothesis-driven from wetland assessment should be termed *surveillance* rather than monitoring, as outlined in Resolution VI.1.)

9. It is important to distinguish between inventory, assessment and monitoring when designing data gathering exercises, as they require different categories of information. Wetland inventory provides the basis for guiding the development of appropriate assessment and monitoring, but wetland inventories repeated at given time intervals do not constitute ‘monitoring’.

A framework for wetland inventory

10. A structured framework for planning and designing a wetland inventory is summarized in Table 1. The framework comprises 13 steps that provide the basis for making decisions in relation to the purpose (and objectives), and the available resources, for an inventory.
11. All steps in the Framework are applicable to the planning and implementation of any wetland inventory, and all steps should therefore be followed during the design and planning process. The framework does not provide prescriptive guidance on particular inventory methods; rather it provides guidance to the Contracting Parties and others who are planning to undertake wetland inventory by drawing attention to different methods and wetland classifications already in use and of proven utility under different circumstances.
12. The framework should be used as a basis for making decisions for undertaking a wetland inventory under the circumstances particular to each inventory program. Guidance on the application of each step is provided.

Table 1. A structured framework for planning a wetland inventory

Step	Guidance
1. State the purpose and objective	State the reason(s) for undertaking the inventory and why the information is required, as the basis for choosing a spatial scale and minimum data set.
2. Review existing knowledge and information	Review the published and unpublished literature and determine the extent of knowledge and information available for wetlands in the region being considered.
3. Review existing inventory methods	Review available methods and seek expert technical advice to: a) choose the methods that can supply the required information; and b) ensure that suitable data management processes are established.
4. Determine the scale and resolution	Determine the scale and resolution required to achieve the purpose and objective defined in Step 1.
5. Establish a core or minimum data set	Identify the core, or minimum, data set sufficient to describe the location and size of the wetland(s) and any special features. This can be complemented by additional information on factors affecting the ecological character of the wetland(s) and other management issues, if required.
6. Establish a habitat classification	Choose a habitat classification that suits the purpose of the inventory, since there is no single classification that has been globally accepted.
7. Choose an appropriate method	Choose a method that is appropriate for a specific inventory based on an assessment of the advantages and disadvantages, and costs and benefits, of the alternatives.
8. Establish a data management system	Establish clear protocols for collecting, recording and storing data, including archiving in electronic or hardcopy formats. This should enable future users to determine the source of the data, and its accuracy and reliability. At this stage it is also necessary to identify suitable data analysis methods. All data analysis should be done by rigorous and tested methods and all information documented. The data management system should support, rather than constrain, the data analysis. A meta-database should be used to: a) record information about the inventory datasets; and b) outline details of data custodianship and access by other users.
9. Establish a time schedule and the level of resources that are required	Establish a time schedule for: a) planning the inventory; b) collecting, processing and interpreting the data collected; c) reporting the results; and d) regular review of the program. Establish the extent and reliability of the resources available for the inventory. If necessary make contingency plans to ensure that data is not lost due to insufficiency of resources.
10. Assess the feasibility & cost effectiveness	Assess whether or not the program, including reporting of the results, can be undertaken within under the current institutional, financial and staff situation. Determine if the costs of data acquisition and analysis are within budget and that a budget is available for the program to be completed.
11. Establish a reporting procedure	Establish a procedure for interpreting and reporting all results in a timely and cost effective manner. The report should be succinct and concise, indicate whether or not the objective has been achieved, and contain recommendations for management action, including whether further data or information is required.
12. Establish a review and evaluation process	Establish a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust or even terminate the program.

13. Plan a pilot study	Test and adjust the method and specialist equipment being used, assess the training needs for staff involved, and confirm the means of collating, collecting, entering, analysing and interpreting the data. In particular, ensure that any remote sensing can be supported by appropriate “ground-truth” survey.
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Step 1 State the purpose and objective

13. Wetland inventory has multiple purposes. These include:

- a) listing particular types, or even all, wetlands in an area;
- b) listing wetlands of local, national and/or international importance;
- c) describing the occurrence and distribution of wetland taxa;
- d) describing the occurrence of natural resources such as peat, fish or water;
- e) establishing a baseline for measuring change in the ecological character of wetlands;
- f) assessing the extent and rate of wetland loss or degradation;
- g) promoting awareness of the value of wetlands;
- h) providing a tool for conservation planning and management; and
- i) developing networks of experts and cooperation for wetland conservation and management.

14. An inventory should contain a clear statement of its purpose and objective. This should identify the habitats that will be considered, the range of information that is required, the time schedule, and who will make use of the information.

15. A clear statement of the purpose(s) will assist in making decisions about the methods and resources needed to undertake the inventory.

Step 2 Review existing knowledge and information

16. Past investigations have resulted in the provision of broad-scale wetland inventory information for many parts of the world. Other, more detailed, but localized inventory may have been undertaken, restricted either geographically or to particular wetland habitats or ecosystems in the region under consideration.

17. Valuable information may be held in many different formats and/or by many different organizations (e.g., waterbird, fisheries, water quality and agricultural information bases, and local peoples' information and knowledge).

18. A comprehensive review of existing data sources may be necessary and its relevance to the proposed inventory work ascertained.

Step 3 Review existing inventory methods

19. A number of established methods for wetland inventory exist. The characteristics of five examples in current use are summarized in Appendix I. Further sources of information are listed in Appendix VI. The techniques and habitat classifications used in these methods have been successfully adapted for use in a number of locations.

20. The review should determine whether or not existing established inventory methods are suitable for the specific purpose and objectives of the inventory being planned.
21. Some inventory methods use a linked hierarchical approach, in which inventory may be designed at different spatial scales for different purposes.
22. Many inventories have been based on ground-survey, often with the support of aerial photography and topographical maps and, more recently, satellite imagery. The development of Geographic Information Systems (GIS) and the enhanced resolution of satellite imagery have resulted in greater use of spatial data.
23. A procedure for determining which remotely sensed datasets are the most appropriate for particular purposes, including their use in GIS, is given in Appendix II. A summary of currently available remote sensing data sets that can be applicable to wetland inventory is provided in Appendix III.

Step 4 Determine the scale and resolution

24. The spatial scale used for wetland inventory is inseparable from its objective and greatly influences the selection of the method to be used.
25. Wetland inventory has been carried out at a number of spatial scales, with specific objectives at each scale. When choosing the scale it is necessary first to determine the objective and then assess how this can be achieved through a chosen scale.
26. Suitable scales for wetland inventory within a hierarchical approach are:
 - a) wetland regions within a continent, with maps at a scale of 1:1,000,000 – 250,000
 - b) wetland aggregations within each region, with maps at a scale of 1:250,000 – 50,000
 - c) wetland sites within each aggregation, with maps at a scale of 1:50,000 – 25,000.
27. The choice of scale is also related to the size of the geographic area involved and to the accuracy required and achievable with available resources.
28. Each of the scales needs a minimum mapping unit that reflects the minimum acceptable accuracy for that scale. This is done by first determining what is the minimum size of feature that can be clearly delineated at that scale, to acceptable standards, and by then determining what measures are required to describe the accuracy/confidence of defining the unit. For example, a land systems map compiled to a scale of 1:250,000 typically involves taking one on-the-ground site observation for every 600 ha surveyed.

Step 5 Establish a core or minimum data set

29. A core or minimum data set sufficient to describe the wetland(s) should be determined. The specific details of this data set are inseparable from the level of complexity and the spatial scale of the inventory.
30. It is recommended that sufficient information (the core, or minimum, data set) should be collected so as to enable the major wetland habitats to be delineated and characterized for at least one point in time.

31. The core data can be divided into two components:
- that describing the biophysical features of the wetland; and
 - that describing the major management features of the wetland.
32. The decision whether to undertake an inventory based only upon core biophysical data or also to include data on management features will be based on individual priorities, needs, and resources. The second component is likely to provide information that can immediately be used for assessment purposes, but it may require more extensive data collection and analyses. Care should be exercised to ensure that the inclusion of this information does not detract from the primary purpose of obtaining sufficient information to enable the delineation and characterization of the wetland(s).
33. Recommended core data fields for the collection of biophysical and management features of wetlands are listed in Table 2.

Table 2. Revised core wetland inventory data and information fields

Revised core wetland inventory fields (Harmonized with Ramsar ecological character description sheet)	
Site name:	Official name of site and catchment/other identifier(s) (e.g., reference number)
Area, boundary and dimensions:	Site shape (cross-section and plan view), boundaries, area, area of water/wet area (seasonal max/min where relevant), length, width, depth (seasonal max/min where relevant)
Location:	Projection system, map coordinates, map centroid, elevation
Geomorphic setting:	Setting in the landscape/catchment/river basin - including altitude, upper/lower zone of catchment, distance to coast where relevant, etc.
Biogeographical region:	
Climate:	Overview of prevailing climate type, zone and major features (precipitation, temperature, wind)
Soil:	Geology, soils and substrates; and soil biology
Water regime:	Water source (surface and groundwater), inflow/outflow, evaporation, flooding frequency, seasonality and duration; magnitude of flow and/or tidal regime, links with groundwater
Water chemistry:	Temperature; turbidity; pH; colour; salinity; dissolved gases; dissolved or suspended nutrients; dissolved organic carbon; conductivity
Biota:	Plant communities, vegetation zones and structure (including comments on particular rarity, etc.); Animal communities (including comments on particular rarity, etc.); Main species present (including comments on particular rare/endangered species, etc.); population size and proportion where known, seasonality of occurrence, and approximate position in distribution range (e.g., whether near centre or edge of range)
Land use:	Local, and in the river basin and/or coastal zone
Pressures and trends:	Concerning any of the features listed above, and/or concerning ecosystem integrity

Land tenure and administrative authority: For the wetland, and for critical parts of the river basin and/or coastal zone
Conservation and management status of the wetland: Including legal instruments and social or cultural traditions that influence the management of the wetland; and including protected area categories according to the IUCN system and/or any national system
Ecosystem services: (for a list of relevant ecosystem services, see the Ramsar ecological character description sheet)]
Management plans and monitoring programs: In place and planned within the wetland and in the river basin and/or coastal zone (see Resolutions 5.7, VI.1, VII.17, and VIII.14)

Step 6 Establish a habitat classification

34. Many national wetland definitions and classifications are in use (Appendix IV). These have been developed in response to different national needs and take into account the main biophysical features (generally vegetation, landform and water regime, sometimes also water chemistry such as salinity) and the variety and size of wetlands in the locality or region being considered.
35. The Ramsar Classification System for Wetland Type (Resolution VI.5) is increasingly being used as a classification basis for national wetland inventories. However, when it was first developed it was not anticipated that the Ramsar classification would be used for this inventory purpose, so its usefulness as a habitat classification for any specific wetland inventory should be carefully assessed. Whilst the Ramsar Classification System has value as a basic habitat description for sites designated for the Ramsar List of Wetlands of International Importance, it does not readily accommodate description of all wetland habitats in the form and level of description that are now commonly included in many wetland inventories.
36. A classification based upon the fundamental features that define a wetland – the landform and water regime – is considered to be superior to those based on other features (Resolution VII.20). The basic landform and water regime categories within such a classification can be complemented with modifiers that describe other features of the wetland, for example, for vegetation, soils, water quality, and size.
37. As it is unlikely that a single classification can be globally acceptable, not least because different classification systems are required by some national legislations, a classification should be chosen that suits the purpose of the inventory. The core biophysical data recommended to be collected in an inventory (Table 2) may be used to derive a classification that suits individual needs.

Step 7 Choose an appropriate method

38. Many inventory methods are available (see Appendices I and IV for examples). When assessing which method (or methods) is appropriate for an inventory, it is necessary to be aware of the advantages and disadvantages of the alternatives in relation to the purpose and objective of the proposed inventory work. This applies particularly to the use of remotely sensed data (as listed in Appendix III).
39. To assist in determining which remote sensing data is most useful for a particular inventory, a simple decision-tree is provided in Appendix II. The decision-tree is also presented pictorially

and contains six steps to assist in determining which data are most suitable. Importantly, the extent of “ground-truth” survey required to validate the remote sense data should be assessed when considering such techniques.

40. Physico-chemical and biological sampling should be undertaken whenever possible by standard laboratory and field methods that are well documented and readily available in published formats. There is a variety of acceptable methods in use. The bibliographical details of those used should be recorded and any departures from standard procedures clearly justified and documented.
41. As a general rule, the inventory method chosen should be sufficiently robust to ensure that the required data can be obtained within the constraints imposed by the terrain, resources, and time period available. Where adequate methods do not exist, well-directed research is needed to develop or identify specific techniques.
42. The use of Geographic Information Systems (GIS) for managing spatial data, in particular, is encouraged, noting that low-cost GIS platforms are increasingly available and widely-used.

Step 8 Establish a data management system

43. Increasing use of databases and Geographic Information Systems ensure that a large amount of data can be stored and displayed, but these capabilities will be undermined if the data are not well managed and stored in formats that are readily accessible.
44. Potential data management problems can be overcome by establishing clear protocols for collecting, recording and storing data, including archiving data in electronic and/or hardcopy formats. The protocols should enable future users to determine the source of the data, as well as its accuracy and reliability. The protocols should also ensure effective recording and reporting of data and information.
45. The data management system should support analysis of the data. Details of all analytical methods should be recorded along with the data and made available to all users. This includes details of statistical techniques and any assumptions about the data.
46. In addition, a meta-database should be used to record basic information about individual inventory data sets. These meta-data records should include a description of the type of data and details of custodianship and access. A standard metadata format has been developed specifically for recording wetland inventory (Appendix V), and further guidance on the use of this inventory metadata standard will be issued by the Ramsar Bureau.
47. General good practice guidance on meta-data and data custodianship, ownership and access is also available in a handbook produced for the Biodiversity Conservation Information System (BCIS) (Biodiversity Conservation Information System 2000).
48. The meta-data records should be an integral part of the data management system and not treated as a separate entity from the data files, even if these have been archived.

Step 9 Establish a time schedule and the level of resources that are required

49. It is necessary to determine the time schedule for planning the inventory, as well as for collecting, processing and interpreting the data collected during an inventory. This is particularly

important if field sampling is required, in which case a sampling schedule that takes into account any special features of the terrain and sampling techniques will be necessary.

50. The schedule should be realistic and based on firm decisions about funding and resources. This will determine the extent and duration of the inventory. The schedule should also include time to prepare for the inventory, especially if a team of experts needs to be gathered, and extensive background investigation and review has to be undertaken.
51. The extent and reliability of the resources available for the inventory will eventually determine the nature and duration of the inventory. The funding to secure and train suitable personnel and obtain appropriate technical resources, such as field equipment and remote sensing data, should be confirmed and steps taken to ensure that these are available when required.

Step 10 Assess the feasibility and cost effectiveness of the project

52. Once a method has been chosen and a time schedule determined, it is necessary to assess whether or not it is feasible and cost effective to undertake the project. This assessment is essentially a review of the entire inventory method, including the time schedule and costs.
53. Factors that influence the feasibility and cost effectiveness of the project include:
 - availability of trained personnel;
 - access to sampling sites;
 - availability and reliability of specialized equipment for sample collection or analysis of samples;
 - means of analyzing and interpreting the data;
 - usefulness of the data and information derived from it;
 - means of reporting in a timely manner; and
 - financial and material support for any continuation of the project.

Step 11 Establish a reporting procedure

54. The results obtained in the inventory should be recorded and reported in a timely and cost effective manner. The records should be concise and readily understood by others involved in the program or similar investigations. Where necessary the records should be cross-referenced to other documentation from the inventory.
55. It is important to keep in mind that the data may be useful for further analyses in the future – the analysts involved should be able to readily access and interpret the data records and be aware of any constraints on their usefulness for such purposes. In this respect the reporting procedure should incorporate reference to the meta-database and archived data.
56. A report on the inventory should be prepared at pre-determined intervals. It should be succinct and concise and indicate whether or not the purpose and objective of the inventory is being achieved, and whether there are any constraints on using the data (e.g. changes to the sampling regime such as lack of replication or concerns about its accuracy).
57. The core data should be made available to interest groups in appropriate formats along with details of the methods used. Reports may present the data collected and/or contain specific recommendations for further inventory and data collection, or for management action.

58. At the same time, a meta-data record of the inventory should be made and added to a centralized file using a standardized format.
59. All reports should be made available to interested parties and other agencies in the shortest possible time through appropriate electronic and hardcopy formats.

Step 12 Review and evaluate the inventory

60. Throughout the inventory it may be necessary to review progress and make adjustments to the sampling regime, data management, and program implementation. The review and evaluation process should be developed and agreed as part of the planning and design phase of the inventory. The review procedures should establish that when changes are made they should be recorded and made known to all involved in the inventory.
61. The review procedures should also establish that at the end of the inventory, or after a predetermined time period, the entire process should be re-examined and necessary modifications made and recorded. The evaluation procedures should be designed to illustrate both the strengths and the weaknesses of the inventory, including necessary reference to the sampling regime and/or the data quality.
62. The evaluation can also be used to justify a request for ongoing funding. If the inventory has been a success and achieved its purpose and objective, this should be clearly stated and the program brought to an end. Conversely, if the inventory has not achieved its purpose and objective, this also should be clearly stated along with a recommendation as to whether it should continue, possibly in a revised form, or halted.

Step 13 Plan a pilot study

63. Before launching an inventory a pilot study is essential. The pilot study provides the mechanism through which to confirm or alter the time schedule and the individual steps within the chosen method. It also provides the opportunity to develop individual workplans for all personnel.
64. The pilot study phase is the time to fine-tune the overall method and individual steps and test the basic assumptions behind the method and sampling regime. Specialist field equipment should be tested and, if necessary, modified, based on practical experience. It is also the opportunity to assess training needs. The amount of time and effort required to conduct the pilot study will vary considerably – its importance will be shown by the improvements made to the schedule and design of the inventory.
65. The pilot study provides the final step before commencing the wetland inventory itself. Lessons learnt during the pilot study should be incorporated into the inventory method.

Implementation of the inventory

66. Once the method has been agreed by following all steps in the above Framework the inventory can be implemented with some confidence. Importantly, that confidence is dependent upon a suitable pilot study being undertaken and confirmation of all individual sampling and data management protocols. Any further changes to the agreed protocols should be recorded and, where necessary, discussed and formalized.

67. It should be expected that collection of the data for the full inventory will consume most of the time and resources available for the inventory. The steps in the Framework are designed to guide development an overall method and ensure that the inventory can be competently implemented.
68. All data collected during the inventory should be contained within the agreed data management system, which may include both hardcopy and electronic files and records. Steps should be taken to ensure that the data records are secure and duplicate copies kept in safe locations.
69. Whilst the steps in the Framework provide the basis for designing an inventory project for specific purposes and with specified resources available, it does not ensure that an inventory will be effective. This can only be done by the personnel engaged to undertake the inventory – the Framework provides an outline of the method, including necessary training and contingency in support of the method.
70. It must be stressed that all steps in the Framework are necessary, with the pilot study step providing an important feedback and an opportunity to refine the inventory before the main sampling effort commences. Similarly, the review and evaluation step provides an important check on progress and a formal opportunity to adjust or even halt the inventory.

Appendix I

Inventory methods

71. Standardized inventory methods are available and have been successfully used in different circumstances, countries or regions. Notable amongst these are the Mediterranean Wetlands Initiative (MedWet) inventory, the United States Fish and Wildlife Service national wetland inventory, the Ugandan national wetland inventory, the Asian wetland inventory, and the Ecuador national wetland inventory.
72. The characteristics of these examples are summarised below in terms of each of the 13 Framework steps. These examples have been chosen principally as they were considered comprehensive examples of existing methods, but also because they illustrate differences in approaches that could be used in different locations, for different purposes, and at different scales. The need for different methods and wetland classifications (see also Appendix IV) that enable local and national needs to be met must be stressed: this is illustrated by the range of examples below.

Mediterranean Wetlands Initiative (MedWet) inventory

73. This is a set of standard but flexible methods and tools, including a database for data management, for inventory in the Mediterranean region. Although not intended as a pan-Mediterranean wetland inventory, it has provided a common approach that has been adopted, and adapted, for use in several Mediterranean countries and elsewhere.

1. Purpose and objective	To identify where wetlands occur in Mediterranean countries and ascertain which are priority sites for conservation; to identify the values and functions for each wetland and provide a baseline for measuring future change; and to provide a tool for planning and management and permit comparisons between sites.
2. Information review	A process of consultation with an advisory group of experts from the Mediterranean and elsewhere. This group considered the experience and knowledge gained from other inventory and various Ramsar guidelines on managing wetlands.
3. Review methods	Considered database methods used elsewhere in Europe, United States and Asia. Compatibility with wetland databases being used in Europe was a key consideration, e.g. the CORINE Biotopes program. The method was designed to include both a simple and a complex data format.
4. Scale and resolution	Multiple scales for river basins, wetland sites and habitats have been adopted.
5. Core data set	Standard data sheets have been established for river basins, wetland sites (identification, location, description, values, status), habitat, flora, fauna, activities and impacts, meteorological data, and references.
6. Habitat classification	Ramsar classification can be used at a broad scale. For detailed information on sites the United States National Wetland Inventory classification has been adapted.
7. Method	Five steps: i) site selection; ii) Site identification through cartographic means or remote sensing with field assessment; iii) habitat classification; iv) data collection and management through standard data sheets and database; and v) map production using standard conventions.
8. Data management	Based on a standard database, initially developed in FoxPro in MS-DOS, and updated in 2000 in Microsoft Access. [Note. A further updated

	database, using MS Visual Basic software, and including mapping/GIS capability, due for release 2002.]
9. Time schedule and resources	Dependent on the complexity of the inventory. A simple inventory can be done with minor resources while a detailed inventory requires greater human and financial resources.
10. Feasibility & cost effectiveness	Assessed in France before being made available for on-ground pilot studies. The feasibility of the program is built around having a flexible approach that reflects the resources that are available for the inventory.
11. Reporting	Standardized data sheets provided for storing information and a database for ease of reporting. Specific formats for reports can be determined and included.
12. Review and evaluation	An inventory working group has been established to assess progress with undertaking and using the information from inventories using this approach, and to update the information and methods as necessary.
13. Pilot study	Undertaken in Portugal, Morocco, Greece, Spain and France.
Further information	Costa, Farinha, Tomas Vives & Hecker 1996 & 2001; Hecker, Costa, Farinha & Tomas Vives 1996. http://www.wetlands.org/pubs&/wetland_pub.html

United States national wetland inventory

74. A long running national program that has developed a classification and methodology for producing a map-based inventory.

1. Purpose and objective	To conduct a natural resource inventory of wetlands for use in wetland planning, regulation, management and conservation.
2. Information review	Reviewed the extent of wetland survey and inventory to determine the status of wetland protection and the availability of maps of wetlands.
3. Review methods	Reviewed existing wetland inventory and consulted with state and federal agencies to determine what inventory techniques were being used.
4. Scale and resolution	Maps produced at a scale of 1:80 000 or 1:40 000.
5. Core data set	Standardized data collection is undertaken in line with the information required for the habitat classification and production of standard maps for each state.
6. Habitat classification	Hierarchical classification developed as an integral part of the inventory to describe ecological units and provide uniformity in concepts and terms.
7. Method	Based on interpretation of color infrared aerial photographs, initially at 1:24 000 and more recently at 1:40 000 to 1:80 000 scale. The mapping unit varies according to the region and ease of identifying wetlands. The method includes field checking and stereoscopic analysis of photographs. Other remote sensing techniques are being tested.
8. Data management	Maps and digital data are made available online at www.nwi.fws.gov . Data is analyzed through GIS using ARC-INFO.
9. Time schedule and resources	Ongoing program since 1974. Maps are updated as needed and when funding is available.

10. Feasibility & cost effectiveness	Large scale program was extensively funded and a large proportion of the country is now mapped. A statistical design was incorporated to provide valid representative figures for selected areas.
11. Reporting	National wetland trends are produced periodically, based on statistical sampling. Mapping targets have been set through legislation that has periodically been revised.
12. Review and evaluation	The inventory has been under regular review and its outputs evaluated and new targets and priorities established.
13. Pilot study	An extensive phase of method development was undertaken before the inventory was considered operational. The classification system which underpins the inventory was extensively tested in the field.
Further information	Cowardin, Carter, Golet & LaRoe 1979; Cowardin & Golet 1995; Wilen & Bates 1995 www.nwi.fws.gov

Uganda National Wetlands Programme

75. The inventory is a component of an ongoing National Wetlands Program. It is largely carried out at the local level, using standard formats, and includes a training component.

1. Purpose and objective	To survey, describe, quantify and map all wetlands and provide decision-makers and planners, especially at district level, with information for management planning; to support policy implementation; to support economic valuation; and to support overall natural resource management planning.
2. Information review	Undertook literature review prior to the onset of the inventory.
3. Review methods	Carried out a review prior to the onset of the inventory process.
4. Scale and resolution	Uses SPOT imagery at 1:50 000 to cover the country.
5. Core data set	Bio-physical data encompassing site name, area, location, general description, seasonality, biota (vegetation types and animals present) and management data covering land-use, land tenure, conservation status, values, threats.
6. Habitat classification	Derived from landform, water regime and vegetation.
7. Method	GIS-based map analyses based on remotely sensed data alongside topographic maps of similar scale (1:50 000) as well as ground surveys. Uses standard data sheets. All wetlands are coded. Methods are documented in a wetland inventory guide. Activity is carried out on district basis with personnel from the district being designated to carry out the fieldwork and compile reports.
8. Data management	A computerized database using Microsoft Access was based on the standardized field data sheets. This database will be linked to the ArcView map database using wetland codes. The linkage between the two databases forms the National Wetland Information System (NWIS) which is already developed with ongoing data entry.
9. Time schedule and resources	An ongoing process with regular updates. The inventory is one of the main activities of a donor-funded National Wetlands Program with a number of partners.

10. Feasibility & cost effectiveness	Feasibility assessed through pilot studies. Cost effectiveness related to the complexity of the wetland systems, extent of areas being assessed, availability of remotely sensed images and capacity.
11. Reporting	Standardized data sheets used for storing information in a database for ease of reporting. Individual reports prepared at district level. These will be consolidated into a National Wetland Inventory.
12. Review and evaluation	Done within the project in consultation with a few external experts.
13. Pilot study	Undertaken in a few wetlands and then districts..
Further information	National Wetlands Programme 1999; Pabari, Churie & Howard 2000. www.iucn.org/themes/wetlands/uganda.html

Asian Wetland Inventory (AWI)

76. This approach has been developed in response to the recommendations contained in the Global Review of Wetland Resources and Priorities for Wetland Inventory report and presented in Resolution VII.20. The method is a hierarchy that can be implemented at four spatial scales. The method is based largely on a draft protocol developed in Australia, and has been tested in a pilot study in Japan. The pilot study has resulted in a manual being produced.

1. Purpose and objective	To provide a hierarchical database on coastal and inland wetlands in Asia
2. Information review	Undertaken in the extensive global review of wetland inventory conducted on behalf of the Ramsar Convention (see Resolution VII.20)
3. Review of methods	Undertaken in the extensive global review of wetland inventory conducted on behalf of the Ramsar Convention and refined through the development of a manual.
4. Scale and resolution	Hierarchical multi-scalar approach with four levels of analysis: level 1 at 1:10 000 000 to 1:5 000 000; level 2 at 1:1 000 000 to 1:250 000; level 3 at 1: 250 000 to 1:100 000; and level 4 at 1:50 000 to 1:25 000.
5. Core data set	Hierarchical multi-scalar minimum data at each level of analysis: level 1 – broad geology, land cover and climate for river basins; level 2 – geology, landforms, climate for wetland regions; level 3 – hydrological, climate, landform, physico-chemical, and biological detail for wetland complexes; and level 4 information on management issues and procedures included, in addition to site descriptions as per level 3
6. Habitat classification	Derived from minimum data on landform and water regimes and possibly supplemented with information on vegetation, areal size and water quality.
7. Method	GIS-based map analyses using remotely sensed imagery and maps augmented with ground surveys that are more intensive at levels 3 and 4. Prescribed data sheets and fields with agreed codes are available for each level of analysis.
8. Data management	The data management system is built on a computerized database engine with web, user/data interface and GIS capabilities. This serves as the primary data management/storage/retrieval component of the project. The system is based on the Windows platform using MS Visual Basic and Access 97 software. The website (www.wetlands.org/awi) serves as the main communication node for data collection, announcements and discussions.

9. Time schedule and resources	An ongoing process with regular updates of information obtained through national or local analyses. The program has been devolved through the regionalized structure of Wetlands International and its partners.
10. Feasibility & cost effectiveness	Feasibility assessed through project meetings and submission of funding applications that required targeted outputs etc. Cost effectiveness related to the extent of the areas being assessed and the extent of pre-existing inventory information, maps and remotely sensed images. The procedure was based on the Ramsar Convention's review of wetland inventory that found many inventories did not achieve their purpose through being over-ambitious and/or not applying tight data management and reporting procedures – all features that have been addressed.
11. Reporting	Standardized data sheets provided for storing information in a database for ease of reporting. Individual reports are provided through the devolved projects and where appropriate copies filed by Wetlands International on its web page (www.wetlands.org/awi/).
12. Review and evaluation	Provided at the Wetlands International seminar "Wetlands in a Changing World" held in Wageningen, The Netherlands, 30 November 2001.
13. Pilot study	Undertaken in Japan – Hokkaido and Kushiro Marsh with maps produced in a GIS format.
Further information	Finlayson, Howes, Begg & Tagi 2002; Finlayson, Howes, van Dam, Begg & Tagi 2002 www.wetlands.org/awi/

Ecuador wetland inventory

77. This is a national wetland inventory nearing completion that has been developed by the Ministry of the Environment, the Ramsar Bureau, and the EcoCiencia Foundation, and is designed to support Ecuador's implementation of the Ramsar Convention and the wise use of wetlands.

1. Purpose and objective	To provide information to assist in the management of globally important biodiversity in Ecuadorian wetlands, supporting Ecuadorian wetlands conservation through the identification, characterization and prioritization of wetlands for management and conservation.
2. Information review	Published documents and material on the internet and held by universities, research organisations and from a national workshop on the identification and status of wetlands was assessed.
3. Review of methods	Inventory methods used in Canada, Venezuela, Brazil and parts of Argentina were reviewed. Each method was considered to have limitations for application in Ecuador, including too resource and capacity demanding, too little background information available in Ecuador, lacking an ecosystem (catchment)-scale approach, or only reliant on secondary information sources.
4. Scale and resolution	Information was collected at 1:50,000 scale. As some wetlands were too large to use maps at this scale, large individual sites are presented at different scales but information on them held in the database at 1:50,000 scale.

5. Core data set	The data was collected using a quadratical-based matrix that included five selected general criteria, each validated through a series of analysed variables. Information was gathered on social, economic, zoological, botanical, limnological, ecological (including aquatic and terrestrial) features.
6. Habitat classification	The habitat classification followed two existing systems being used in Ecuador.
7. Method	The method includes the following steps: information collected using remote sensing; validation and delineation of zones using a numerical matrix; information on socio-economical and ecological aspects of wetlands derived from interviews; published information reviewed; primary information on ecological and social aspects of wetlands generated. Data was entered into a GIS containing physiographic layers so as to permit the production of recommended land-use strategy and management proposals for the wetlands within their catchments.
8. Data management	Cartographic information is managed by the department of Geographical Information Systems (GIS). Other information is maintained in digital formats by individual researchers. A database of wetland photographs is also maintained.
9. Time schedule and resources	The project began in 1996 with pilot studies in two provinces. Nation-wide coverage was intended to be completed by July 2002 but has now been extended to early 2003 for financial reasons. The total project cost is US\$ 1 million over the seven years of the project, with funding from the Ramsar Bureau, the World Bank, the Global Environment Fund, the MacArthur Foundation and the Ecuadorian Government.
10. Feasibility & cost effectiveness	Feasibility and cost effectiveness was assessed in the project development phase through the World Bank's incremental costs assessment procedures.
11. Reporting	Published reports will be produced, and data held electronically in the GIS database.
12. Review and evaluation	Six-monthly World Bank evaluation of the process and progress in achievements of targets. Final report will have pre-publication review by the Ramsar Bureau. The Ecuador National Wetlands Working Group will consider the final publication.
13. Pilot study	A pilot study was undertaken in 1996 of the lentic wetlands, in the Provinces of Esmeraldas and Manabí.
Further information	Briones, E., Flachier, A., Gómez, J., Tirira, D., Medina, H., Jaramillo, I., & Chiriboga, C. 1997. Inventario de Humedales del Ecuador. Primera parte: Humedales Lénticos de las Provincias de Esmeraldas y Manabí. EcoCiencia/ INEFAN/ Convención de Ramsar. Quito, Ecuador. Briones, E., Gómez, J., Hidalgo, A., Tirira, D., & Flachier, A. 2001. Inventario de Humedales del Ecuador. Segunda parte: Humedales Interiores de la Provincia de El Oro. Convención de Ramsar/ INEFAN/ EcoCiencia. Quito, Ecuador.

Appendix II

Determining the most appropriate remotely sensed data for a wetland inventory

78. The following steps provide an outline procedure for assessing which is the most appropriate remote sensing technique for a particular inventory. The procedure is summarized graphically in Figure 1. Available remote sensing data sets applicable to wetland inventory are listed in Appendix III.

79. Much of the information required for this specific determination concerning use of remote sensing can be acquired by following the inventory Framework steps that lead to the choice of an inventory method.

I. Define the purpose and objective

80. Explicitly define the purpose and objective for the inventory (e.g., distribution of specific plant species on a floodplain wetland, baseline data for areas inundated by floodwaters, type of habitats to be mapped, etc.).

II. Determine if remote sensing data is applicable

81. Assess whether remote sensing technology can be applied successfully as a tool to the wetland issues defined previously. This decision will be based on a combination of wetland habitat structure and sensor characteristics and explicitly relates to the spatial and spectral resolution of the remote-sensing device. Expert advice may be needed.

III. Define the wetland characteristics within a remote sensing context

82. Determine the spatial scale most suitable for the habitat structure, the season for data collection, the spectral characteristics and resolution that are critical to sensor choice, and what data and sensors are already available. If multiple surveys are required, determine at the outset the most appropriate temporal scale (e.g., annually or over much longer time periods).

IV. Choose appropriate sensor(s)

83. Assess the spatial and spectral resolution of likely sensors and ensure that they can obtain the environmental information that is required for the defined problem/issue. In some cases several sensors may be required (e.g., Landsat TM fused with polarimetric AirSAR for the identification of salt-affected areas on floodplains dominated by tree species).

84. For each sensor ascertain whether or not it can revisit the site at necessary intervals and whether its application is dependent on seasonal conditions (e.g. optical or RADAR sensors) and that the costs of the image and its analysis are within the allocated budget.

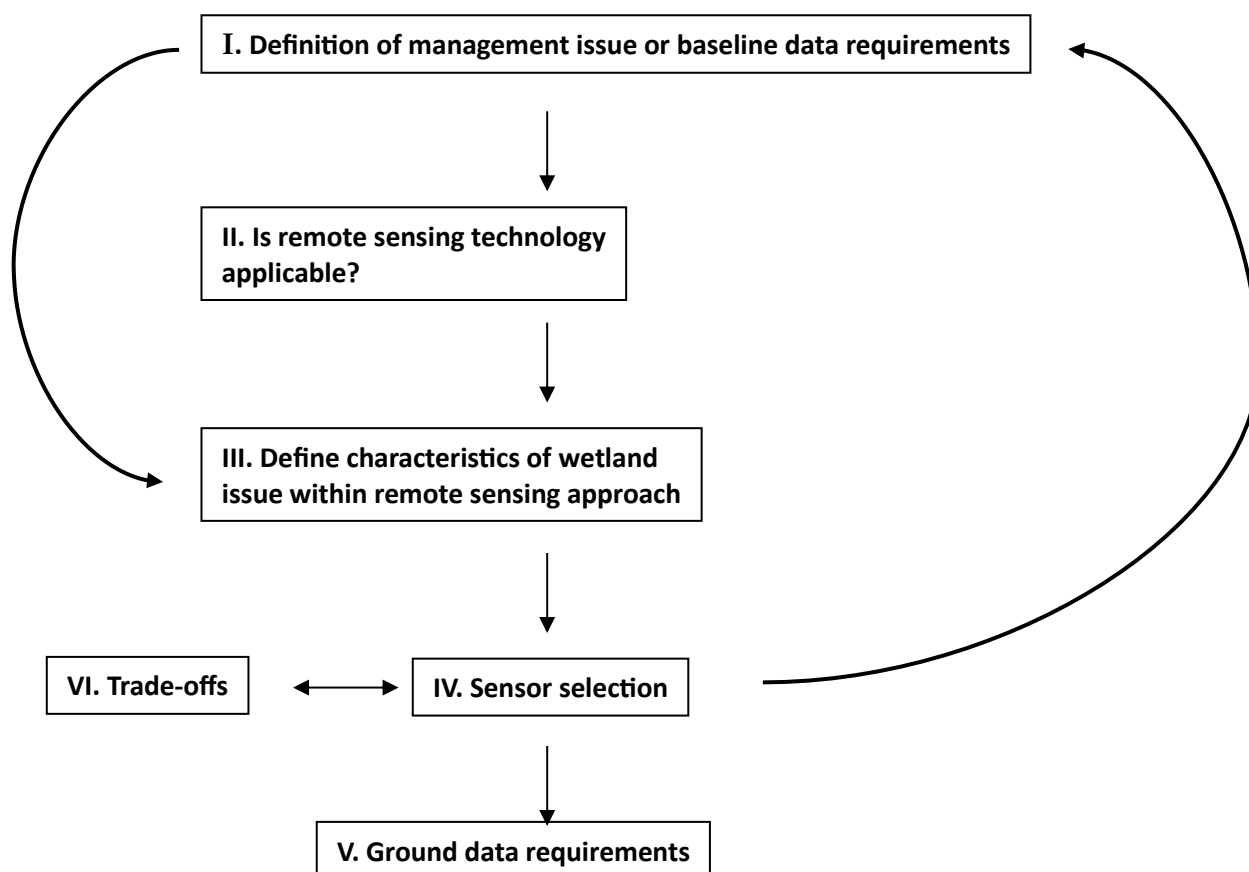
V. Ground data requirements

85. Determine a ground sampling strategy suitable for the sensor selected, including whether or not the collection of ground data should be done simultaneously with the acquisition of data from the sensor. Also determine any potential issues that may influence extrapolation from the ground data, such as scaling-up.

VI. Trade-offs

86. Ascertain if there are any trade-offs when using particular sensors (e.g., what advantages and disadvantages does one data source offer?) and whether these will affect the study (as defined at step I above).

Figure 1. Recommended steps in determining the most appropriate remotely sensed data for use in a wetland inventory.



Appendix III

Summary of remotely sensed data sets applicable to wetland inventory

SATELLITE DATA

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
IKONIS	1m panchromatic 4m multispectral	100km ² (minimum)	Band 1 (blue) = 0.45-0.53µm Band 2 (green) = 0.52-0.61µm Band 3 (red) = 0.64-0.72µm Band 4 (NIR) = 0.77-0.88µm	1-3 days Not routinely collected Data capture must be ordered	Space Imaging http://www.spaceimaging.com/
Landsat 7 ETM	Bands 1-5 & 7 = 30 m Band 6 = 60m Band 8 = 15m	Typical full scene = 184 x 185km (Super scenes up to 60,000km ² and small scenes 25 x 25km are available)	Band 1 (blue) = 0.45-0.52µm Band 2 (green) = 0.52-0.60µm Band 3 (red) = 0.63-0.69µm Band 4 (NIR) = 0.76-0.90µm Band 5 (MIR) = 1.55-1.75µm Band 6 (TIR) = 10.40-12.50µm Band 7 (MIR) = 2.08-2.35µm Band 8 (pan) = 0.52-0.90µm	Every 16 days Data available since April 1999	EROS Data Center of the U.S. Geological Survey http://landsat7.usgs.gov/
Landsat 5 TM Due to be decommissioned	Bands 1-5 & 7 = 30m Band 6 = 120m	Typical full scene = 184 x 185km (Super scenes up to 60,000km ² and small scenes 25 x 25km are available)	Band 1 (blue) = 0.45-0.52µm Band 2 (green) = 0.52-0.60µm Band 3 (red) = 0.63-0.69µm Band 4 (NIR) = 0.76-0.90µm Band 5 (MIR) = 1.55-1.75µm Band 6 (TIR) = 10.40-12.50µm Band 7 (MIR) = 2.08-2.35µm		U.S. Geological Survey http://edcns17.cr.usgs.gov/EarthExplorer/
SPOT	Multispectral = 20m PAN = 10m	60 x 60km	Band 1 (green) = 0.50-0.59µm Band 2 (red) = 0.61-0.68µm Band 3 (NIR) = 0.79-0.89µm Band 4 (SWIR) = 1.58-1.75µm* <u>PAN</u> = 0.51-0.73µm/0.61-0.68* * = SPOT4 only	Every 26 days Data available since 1990	SPOT Image http://www.spot.com/

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
RADAR-SAT	10 – 100m (varies with angles and # of looks)	50 x 50km – 500 x 500km (varies with angles and # of looks)	Single frequency C Band 56 nm HH polarisation variety of beam selections	Data available since 1995 revisit times approx. 6 days at mid-latitudes	Canadian Space Agency (CSA) Canadian Center for Remote Sensing (CCRS) distributed by Radarsat International http://www.rsi.ca/
JERS 8 optical bands SAR L band Bands 3 and 4 provide stereo coverage	18m pixels	75 x 75km	<u>Eight optical bands</u> Band 1 (green) = 0.52-0.60µm Band 2 (red) = 0.63-0.69µm Bands 3 & 4 (NIR) = 0.76-0.86µm Band 5 (MIR) = 1.60-1.71µm Band 6 (MIR) = 2.01-2.12µm Band 7 (MIR) = 2.13-2.25µm Band 8 (MIR) = 2.27-2.40µm SAR BAND = L band 235nm <u>HH polarisation</u>	Data available covering years 1992-1998	EOC Earth Observation Centre, National Space Development Agency of Japan http://hdsn.eoc.nasda.go.jp/
ALI	10 m – PAN 30 m – MSS	37 km swath	PAN – 0.48-0.69µm Band 1 – 0.48 – 0.69µm Band 2 – 0.433 – 0.453µm Band 3 – 0.45 – 0.515µm Band 4 – 0.525 – 0.606µm Band 5 - 0.63 – 0.69µm Band 6 – 0.775 – 0.805µm Band 7 – 0.845 – 0.89µm Band 8 – 1.2 – 1.3µm Band 9 – 1.55 – 1.75µm Band 10 – 2.08 – 2.35µm	Data captured since November 1990 Captures must be requested Operation expected until 2002(?)	GSFC NASA's Goddard Space Flight Center http://eo1.gsfc.nasa.gov/
HYPER-ION	30 m resolution	7.5 km x 100 km	<u>220 spectral</u> bands covering 0.4 – 2.5µm	Data captured since November 1990 Captures must be requested Operation expected until 2002(?)	GSFC NASA's Goddard Space Flight Center http://eo1.gsfc.nasa.gov/

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
ASTER Advanced Spaceborne Thermal Emission and Reflection Radiometer	VNIR (bands 1-3) 15m pixels SWIR (bands 4-9) 30m pixels TIR (bands 10-14) 90m pixels	60 km swath	Band 1 - 0.52 - 0.60µm Band 2 - 0.63 - 0.69µm Band 3N - 0.78 - 0.86µm Band 3V - 0.78 - 0.86µm Band 4 - 1.600 - 1.700µm Band 5 - 2.145 - 2.185µm Band 6 - 2.185 - 2.225µm Band 7 - 2.235 - 2.285µm Band 8 - 2.295 - 2.365µm Band 9 - 2.360 - 2.430µm Band 10 - 8.125 - 8.475µm Band 11 - 8.475 - 8.825µm Band 12 - 8.925 - 9.275µm Band 13 - 10.25 - 10.95µm Band 14 - 10.95 - 11.65µm	Coverage is sporadic Data can be downloaded free of charge	NASA / Earth Observing Data Gateway http://edcimswww.cr.usgs.gov/pub/ims/welcome/
AVHRR Advanced Very High Resolution Radiometer	1.1km pixel	2700km swath width	5 bands 0.58-12.50um (varying bandwidths)	daily images	NOAA: Online requests for these data can be placed via the U.S. Geological Survey Global Land Information System (GLIS) http://edc.usgs.gov/Webglis/glisbin/glismain.pl
Orbview-4 Due for launch in 2001	Multispectral 4m pixel Hyperspectral 8m pixel Panchromatic 1m pixel	Multispectral 8km swath width Hyperspectral 5km swath width Panchromatic 8km swath width	Multispectral 4 bands VIS/NIR Hyperspectral 200 bands 0.4-2.5um Panchromatic 1 band in VIS	revisit 2-3 days	Orbital Science Corporation Army,Navy,Airforce, NASA http://www.orbimage.com/
ERS-1 SAR	12.5m pixel	100 km x 102 km	Single frequency C Band (5.3 GHz), Wave length: 5.6 cm; VV polarisation	Data available since 1991 to 1999 revisit times approx.: 3-day, 35-day and 176-day depending on the mode of operation	European Space Agency (ESA) http://www.esa.int

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
ERS-2 SAR	12.5m pixel	100 km x 102 km	Single frequency C Band (5.3 GHz), Wave length: 5.6 cm; VV polarisation	Data available since 1995 revisit times approx.: 3-day, 35-day and 176-day depending on the mode of operation	European Space Agency (ESA) http://www.esa.int
ERS-1 ATSR	1 km pixel	512 km x 512 km	4 bands: 1.6µm (visible) and three thermal bands at 3.7µm, 11µm, and 12µm.	Data available since 1991 to 1999 revisit times approx.: 3-day, 35-day and 176-day depending on the mode of operation	European Space Agency (ESA) http://www.esa.int
ERS-2 ATSR2	1 km pixel	512 km x 512 km	7 bands: four bands in the visible: 0.55µm, 0.67µm, 0.87µm; 1.6µm and three thermal bands at 3.7µm, 10.8µm, and 12µm.	Data available since 1995 revisit times approx.: 3-day, 35-day and 176-day depending on the mode of operation	European Space Agency (ESA) http://www.esa.int
ENVISAT ASAR	30 m, 150 m or 1km depending on the operational mode	Swath width of < 100km, > 400km and in 5km x 5km vignette, depending on the operational mode	Single frequency C Band (5.3 GHz), HH and VV polarisation	Data available in 2002	European Space Agency (ESA) http://www.esa.int
ENVISAT MERIS	300 m (full resolution) and 1200 m (reduced resolution)	1150km wide swath	15 spectral bands in the 390 - 1040 nm range of the electromagnetic spectrum	Data available in 2002	European Space Agency (ESA) http://www.esa.int
ENVISAT AATSR	1 Km	512 km x 512 km	7 bands: four bands in the visible: 0.55µm, 0.67µm, 0.87µm; 1.6µm and three thermal bands at 3.7µm, 10.8µm, and 12µm.	Data available in 2002	European Space Agency (ESA) http://www.esa.int

AIRBORNE DATA

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
HyMap	Typically 2.5m or 5m	Varies with pixel size 5m = 2.5km swath 2.5m = ~1.3km swath	<u>124 bands</u> covering 0.44-2.4µm	Unreliable – user defined and sensor availability	Integrated Spectronics Pty Ltd http://www.intspec.com/
HyMap MK1 (AIS)	Usually 5m	Varies with pixel size 5m = 2.5km swath	<u>98 bands</u> covering 0.50-1.1µm, 1.45-1.80µm, 1.95-2.45µm	Unreliable – user defined and sensor availability	Integrated Spectronics Pty Ltd http://www.intspec.com/
CASI Compact Airborne/ Spectrographic Imager	Typically 1m	Depends on spatial resolution 1m pixel = ~500m swath	Variable bands (~19-288) (~2-12nm wide) 0.40-1.0µm Typically 96 bands covering visible to NIR	Unreliable – user defined and sensor availability	Manufactured by Itres Research Ltd. http://www.itres.com/ BallAIMS www.ballaerospace.com.au
Daedalus	Spatial resolution determined by aircraft flying height. A 1000 metre increase in flying height = 2.5 metre pixel size increase.	Image swath = Flying Height x 1.6	Band 1 – 0.42-0.45µm. Band 2 – 0.45-0.52µm. Band 3 – 0.52-0.60µm. Band 4 – 0.605-0.625µm. Band 5 – 0.63-0.69µm. Band 6 – 0.695-0.75µm. Band 7 – 0.76-0.90µm. Band 8 – 0.91-1.05µm. Band 9 – 1.55-1.75µm. Band 10 - 2.08-2.35µm. Band 11 - 8.5-13.0µm. Band 12 Band 11 X0.5 or X2 Gain.	Unreliable – user defined and sensor availability	Air Target Services http://www.airtargets.com.au/index.html
AIRSAR Airborne Synthetic Aperture Radar	Slant range resolution of 10m Azimuth resolution of 1m	Ground swath = 10-15km	P, L, C bands Interferometric with L and C Runs in several modes including high resolution 80MHz SAR, TOPSAR (data coregistered with DEMs, ATI mode (C and L bands along track)	Unreliable, see PACRIM missions	JPL/NASA http://airsar.jpl.nasa.gov/

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
MASTER Modis ASTER airborne simulator	5-50m pixel (depending on flight height)	Swath varies with flying height	50 bands 0.40-13.0um	Unreliable, see PACRIM missions	JPL/NASA http://masterweb.jpl.nasa.gov/
AVIRIS Advanced Visible/ Infra-Red Imaging Spectrom_r	20m pixel	11.5km swath width	224 bands (10nm wide) 0.40-2.50um		NASA-JPL http://makalu.jpl.nasa.gov/
Airborne Digital Cameras	Spatial resolution determined by aircraft flying height. Typically 0.5 – 1 m resolution.	Swath of image depends on aircraft flying height	Typically colour (RGB) or colour infrared (IR, R, G)	Unreliable – user defined	Contact local companies. Example Specterra Systems Pty Ltd http://www.specterra.com.au/
Airborne CIR / Colour / Black and White photos	Spatial resolution determined by aircraft flying height.	Swath of image depends on aircraft flying height	Typically colour (RGB), colour infrared (IR, R, G), or black and white	Unreliable – user defined	Contact local companies. Example FUGRO Airborne Surveys http://www.fugro.com/
LIDAR	Absolute elevation accuracy of 15 cm.	User defined	Varies, depending on type of laser selected.	Unreliable – user defined.	A number of different LIDAR systems made by different manufacturers.

FIELD BASED

Data Type	Spatial Resolution	Coverage	Spectral Resolution	Temporal Resolution	Contact
Spectro- meters	Varies – typically nanometres - metres	Varies – typically millimetres - metres	Continuous spectral curve. Range varies from UV-SWIR Typically 0.4 - 2.5µm	Unreliable – user defined and sensor availability	For hire contact local companies. For purchase contact Analytical Spectral Devices Inc http://www.asdi.com/

Appendix IV

Wetland classifications

87. A wide range of different wetland classifications are in use around the world. An annotated summary of some of these wetland classifications is given below, listed in order of their date of publication.
88. No single classification is likely to meet all needs of different wetland inventories. Rather it is recommended that a classification suited to the purposes of a particular inventory should be chosen or developed.
89. In some cases it may be possible to derive a classification from the core information collected in the inventory, such as proposed for the Asian Wetland Inventory, or to establish a mechanism to compile and present information on wetland types under several different classifications, as has been done for the MedWet inventory. However, it should not be assumed that an existing classification will suit all inventory purposes.

Name/title	USA national wetland classification
Description	Hierarchical classification containing 5 levels that describe the components of a wetland, namely, vegetation, substrate composition and texture, water regime, water chemistry and soil. It contains vegetated and non-vegetated habitats.
Reference	Cowardin, Carter, Golet & LaRoe 1979; Cowardin & Golet 1995
URL	wetlands.fws.gov/Pubs_Reports/Class_Manual/class_titlepg.htm and www.nwi.fws.gov/atx/atx.html

Name/title	Hydrogeomorphic classification – Australia
Description	Based on landforms and water regimes with further sub-divisions based on areal size, shape, water quality and vegetation features. A binary format for describing wetland habitats is provided.
Reference	Semeniuk 1987; Semeniuk & Semeniuk 1997.

Name/title	Classification of wetlands in the countries of Western European: CORINE BIOTOPES (1991) Classification of Palearctic Habitats (1996) EUNIS Habitats Classification (2002) (EUropean Nature Information System)
Description	European standard for hierarchical description of natural or semi-natural areas, including wetland habitats. Habitats are identified by their facies and their flora. EUNIS Habitat classification (2002) integrates earlier classifications (CORINE-Biotopes, Palearctic Habitat Classification) and establishes links with other Classification types (CORINE-Land-Cover typology, Habitats Directive Annex I, Nordic classification system, and other national systems).
Reference	European Communities 1991; Devillers, & Devillers-Terschuren 1996; Davies & Moss 2002.
URL	http://nature.eionet.eu.int/activities/EUNIS/harmo/eunis_habitat http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html

Name/title	Ramsar Classification System for Wetland Type
Description	Hierarchical listing of wetland habitats loosely based on the USA national wetland classification. It has been modified on several occasions since introduction in 1989 so as to accommodate further habitats of interest to the Contracting Parties to the Ramsar Convention.
Reference	Scott & Jones 1995; Ramsar Bureau 2000.
URL	http://www.ramsar.org/key_ris_types.htm

Name/title	MedWet Mediterranean wetland classification
Description	Hierarchical listing of wetland habitats loosely based on the USA national wetland classification with modifications made to reflect the range of wetland habitats around the Mediterranean. Software that accompanies the methodology enables other classifications commonly used in the region to be generated from the database.
Reference	Hecker, Costa, Farinha & Tomas Vives et al 1996
URL	http://www.wetlands.org/pubs&/wetland_pub.html

Name/title	Canadian wetland classification
Description	Hierarchical listing of habitats based on broad physiognomy and hydrology, surface morphology and vegetation physiognomy. Further characterisation is based on the chemical features of the habitat.
Reference	National Wetlands Working Group 1997; Zoltai & Vitt 1995.
URL	www.fes.uwaterloo.ca/research/wetlands/Publications.html

Name/title	South African wetland classification
Description	Adaptation of the "Cowardin" wetland classification developed in the USA. Includes adaptations to reflect the functional aspects of wetlands based on geomorphic and hydrologic features. It is hierarchical and able to accommodate all wetland types in the region.
Reference	Dini & Cowan 2000
URL	www.ccwr.ac.za/wetlands/inventory_classif.htm

Name/title	Asian wetland classification
Description	Based on landforms and water regimes. Classification can be derived from the core data fields and augmented with information on vegetation, areal size, and water quality.
Reference	Finlayson, Howes, Begg & Tagi 2002 Finlayson, Howes, van Dam, Begg & Tagi 2002.
URL	Web-based information not yet available

Appendix V

Recommended standard metadata record for the documentation of wetland inventories

90. The following figure and table summarize the standard structure of a wetland inventory metadata record, designed to assist all those undertaking wetland inventory in documenting and making publicly available information about their inventory, in line with Resolution VII.20.
91. The inventory metadata record is based on, and consistent with, global standards for metadata recording, (e.g. ISO/DIS 9115 Geographic Information Metadata), and has been prepared for the Ramsar Convention by the Environmental Research Institute of the Supervising Scientist, Australia, with the financial support of the government of the United Kingdom, to support the development of the next phase of the *Global Review of Wetland Resources and Priorities for Wetland Inventory* (GRoWI 2).
92. Further guidance on the application and use of this inventory metadata standard record for reporting wetland inventory has been prepared and will be issued by the Ramsar Bureau.

Figure 2. Diagrammatic representation of the wetland inventory metadatabase framework.

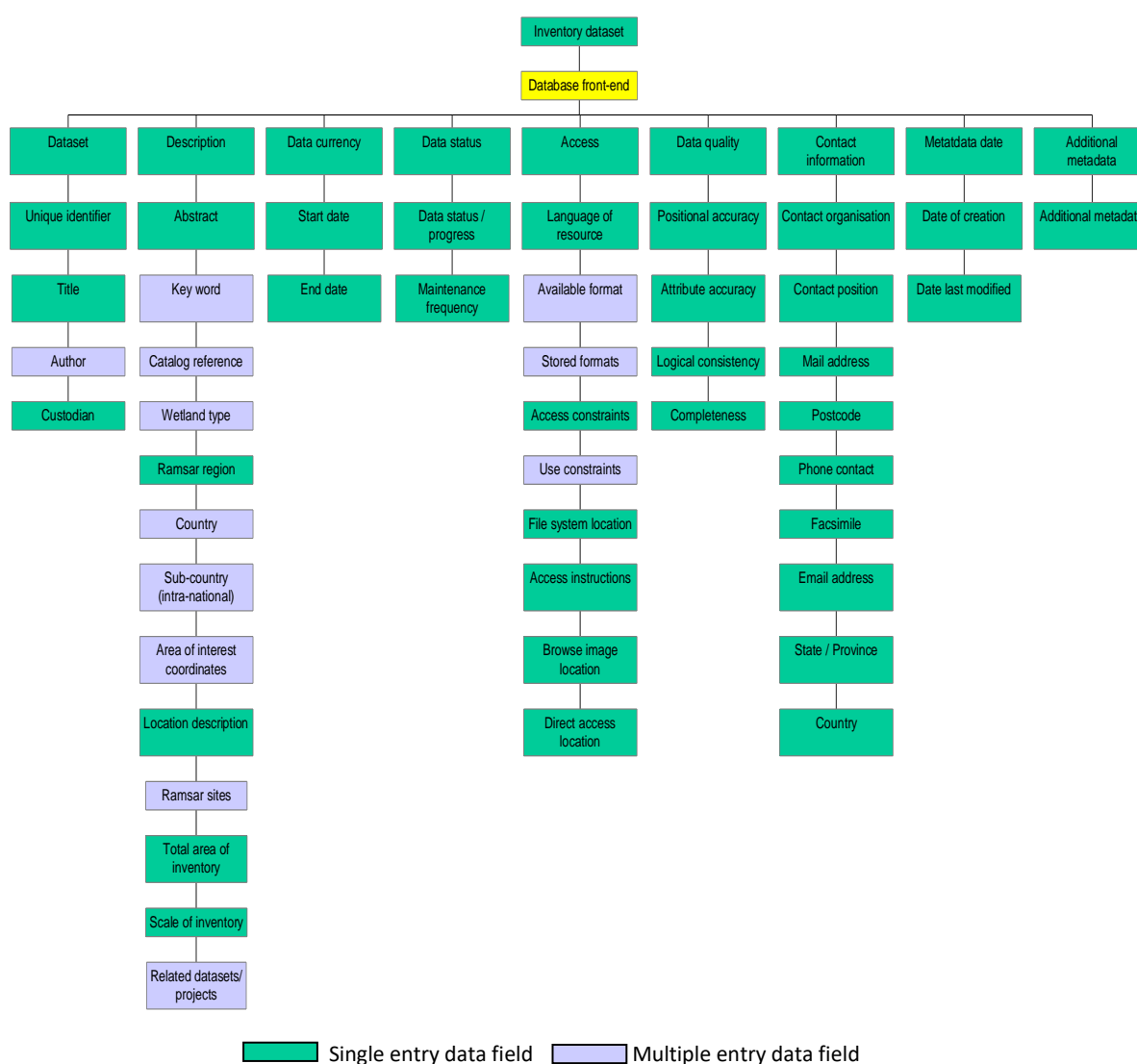


Table 3. Description of the fields of the wetland inventory metadatabase

FIELDNAME	FIELD DESCRIPTION
UNIQ_ID	Unique identifier for each wetland inventory dataset
TITLE	Title of Inventory/ Dataset
AUTHOR	Author / dataset creator
CUSTOD	Organisation/ individual with custodial rights to the data
ABSTRACT	Abstract – summary or short description of the contents of dataset / inventory activity
KEYWORD	Words that may be used to search for a particular dataset. Choose three-five words that describe the key inventory activities i.e. remote sensing – vegetation, and which can be used to search on in database;
CAT_REF	Library catalog reference – e.g. ISBN number – if applicable to dataset
WETL_TYP	Type(s) / nature of wetland(s) being described in inventory
RAMSAR_R	Ramsar region – choose from standard Ramsar 4 letter codes i.e. EEUR; AFRI; etc
COUNTRY	Countries in area of inventory dataset – choose from standard 3-letter ISO country code http://www.bcpl.net/~jspath/isocodes.html
SUB_COUN	Intra-national regions, described in free text; corresponds with sub_nation field in Wetland Inventory metadatabase
COORDS	Bounding coordinates of area – entered as degrees-minutes-seconds for upper left hand, and lower right hand areas; alternatively, could put in series of coordinates which define the perimeter of the inventory area
LOC_DESC	Freehand description of area
RAMSAR_L	Name of Listed Ramsar sites in area – if appropriate
INV_AREA	Total area covered by inventory i.e. a few hectares; '000s of kilometres ²
SCALEINV	Textual descriptions to complement the inventory area values – for example, “large scale”; “small scale” inventory, which could be used as search features to locate particular datasets.
REL_DATA	Related datasets. Names of related files / datasets within the overall inventory.
INV_START	First date of information in the inventory dataset
INV_END	Last date of information in the inventory dataset
INV_STAT	Status of progress on the process of creation of the inventory dataset – complete / incomplete
FREQ_MAIN	Frequency of maintenance / changes / updates to the dataset – regular / irregular/ none planned
LANG_RES	The language in which the dataset was created in i.e. English; Spanish; Vietnamese
AV_FORM	The formats in which the inventory dataset is available in, specifically identifying whether the data is available in digital and/or hard copy formats; in the former case, including a list of forms it is available in i.e. Access database; ArcInfo coverage; Text file etc.
STORFORM	The form or formats in which the dataset is stored by the custodian.
ACC_CONS	Access constraints – e.g. may not be available to general public; use may require a license agreement to be signed

FIELDNAME	FIELD DESCRIPTION
USR_CONS	User constraints – e.g. may not reproduce data without payment of royalty or signing of a license that outlines agreed usage of information
NFS_LOC	Dataset network file system locations – may be entered as a URL address
ACC_INST	Data Access instructions on how to access dataset
IMG_LOC	The location of a browseable image – if applicable to dataset
DIR_LOC	Locations on network from which dataset may be directly accessed – if applicable
DATA_LIN	Data quality – lineage. A brief description of the source(s) and processing / analytical steps and methodology which were used in the creation of the dataset.
POS_ACC	Positional accuracy – a brief assessment and description of the location of spatial features in the dataset relative to their true position on the earth. Information could include whether a differential GPS was used, for instance.
ATTRIB_ACC	Attribute accuracy – a brief assessment of the reliability assigned to features in the dataset, relative to their real world values. For example, was a particular sampling intensity utilized in mapping an area
LOGIC_CON	Logical consistency. A brief description of the logical relationships between items in the dataset. For spatial datasets, this may take the form of a topological consistency check, to ensure that all polygons are closed, nodes are formed at the end of lines, and that there is only one label within each polygon.
DATA_COM	Completeness. A brief assessment of the completeness of the dataset, classification, and verification.
CONT_ORG	Contact organisation (option of adding new organisation, or choosing from existing list of organisations)
CONT_POS	Contact position
MAIL_ADD	Mailing / Postal address for contact position and organisation
POSTCODE	Postcode of mailing address
CONT_PH	Phone number of contact position – should include international direct dial code (IDD), and specify whether local code includes a zero or not when using IDD (e.g. ++ (IDD) (0) xx xxxx xxxx)
CONT_FAX	Facsimile of contact position – should include international direct dial code(IDD), and specify whether local code includes a zero or not when using IDD
CONT_EM	Electronic mail address of contact position.
CONT_STA	State / Province in which contact organisation located.
CONT_COU	Country of contact organisation.
META_NEW	Date metadata was created (automatically generated when file created)
META_MOD	Date metadata last modified (automatically generated when file modified)
META_CIT	Citations for metadata; list of other documents, products which cite or use the products described in the metadata record
ADD_META	Additional metadata – reference to other directories or systems that contain additional information about the dataset.; links to additional metadata records, particularly for GIS and remotely sensed products.

Appendix VI

Reading list

- Biodiversity Conservation Information System 2000. *Framework for Information Sharing: Executive Overview*. Busby, JR (Series Editor). Includes CD-ROM with full text of 8 Handbooks. Available from BCIS Program Manager (for contact details see: <http://www.biodiversity.org>)
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- National Wetlands Programme. 1999. Uganda Wetlands Inventory Guide, version 4. Ministry of Water, Lands and Environment, Kampala, Uganda.

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- Phinn S, Hess L & Finlayson CM 1999. An assessment of the usefulness of remote sensing for wetland monitoring and inventory in Australia. In CM Finlayson & AG Spiers (eds), *Techniques for Enhanced Wetland Inventory, Assessment and Monitoring*. Supervising Scientist Report 147, Supervising Scientist Group, Canberra. pp 44-82.
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Annex 2

An Integrated Framework for wetland inventory, assessment and monitoring (IF-WIAM)

Contents

- I. Background
- II. The importance of identifying, assessing and reporting the status of Ramsar sites and other wetlands in the implementation of the Convention
- III. The relationship between wetland inventory, assessment, monitoring and management
- IV. Multi-scalar approaches to wetland inventory, assessment and monitoring
- V. The Ramsar 'toolkit' of guidance available to Ramsar Parties for implementing the integrated wetland inventory, assessment and monitoring framework
 - The Ramsar *Framework for Wetland Inventory*
 - Metadata records for wetland inventory
 - Types of wetland assessment
 - Rapid assessment of wetlands
 - Indicator assessment
 - The relationships among the different wetland assessment tools available through the Convention
 - Monitoring wetlands
 - Applying wetland inventory, assessment and monitoring tools in the context of the wise use of wetlands
- VI. Gaps in Ramsar's 'toolkit' of inventory, assessment and monitoring guidance
- VII. Priorities for improving integrated wetland inventory, assessment and monitoring

I. Background

1. Considerable attention has been paid by the Convention on Wetlands (Ramsar, Iran, 1971) to the importance of wetland inventory, assessment and monitoring as tools for the conservation and wise use of wetlands, as well as to their use through management planning processes to maintain and enhance the ecological character of Ramsar sites and other wetlands under Article 3 of the Convention.
2. This has led to the adoption of a substantial suite of guidelines and other technical guidance on these matters by the meetings of the Conference of the Parties to the Convention, materials which have been designed to assist Contracting Parties and others in implementing these key Convention processes. Guidance adopted up to and including COP8 (Valencia, Spain, 2002) have been incorporated into Ramsar Wise Use Handbooks (2nd edition) 7 (*Designating Ramsar sites*), 8 (*Managing wetlands*), 10 (*Wetland inventory*) and 11 (*Impact assessment*).
3. Furthermore, the Contracting Parties called in several COP8 Resolutions for the Scientific and Technical Review Panel (STRP) to prepare further guidance on different aspects of wetland inventory and assessment in order to fill gaps in the current toolkit. These include the "Ecological 'outcome-oriented' indicators for assessing the implementation effectiveness of the Ramsar Convention" (Resolution IX.1 Annex D), and "Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity" (Resolution IX.1 Annex E i.). Further detailed methodological guidance on several types of wetland assessment is being prepared by the STRP for publication as *Ramsar Technical Reports*.

4. Parties at Ramsar COP8 also requested the STRP to undertake and report on assessment of the status and trends in the ecological character of Ramsar sites, as far as possible within the wider context of the status and trends of inland, coastal and marine wetlands (Resolution VIII.8), including through the work of the Millennium Ecosystem Assessment (MA) and through contributing to the work of the Convention on Biological Diversity (CBD) in developing and reporting on indicators of the status and trends for inland waters and coastal and marine biodiversity (Resolutions VIII.7 and VIII.8).
5. At COP8 Contracting Parties recognized that, with this increasingly large suite of guidance on different aspects of wetland inventory, assessment and monitoring, there is a need to provide overall guidance to Parties and others on when and for what purposes to use the various different inventory, assessment and monitoring tools and guidelines, and in Resolution VIII.7 the Parties requested the STRP to consider the consolidation of the Convention's guidance in the form of an integrated framework for wetland inventory, assessment and monitoring.
6. The integrated framework provided here focuses on the purposes of and interrelationships among the different aspects and tools for wetland inventory, assessment and monitoring and provides summary information on each aspect of the relevant guidance adopted by the Convention. It also includes additional aspects of guidance requested by Resolution VIII.7.
7. The integrated framework provides a rationale for applying the mechanisms of the Convention for inventory, assessment and monitoring in order to increase public and political awareness and understanding of the critical values and functions of wetlands in supporting sustainable development and human well-being; provides general guidance for further steps to be taken to improve inventory, assessment and monitoring processes; and recognizes some key topics requiring further guidance and elaboration under the Convention to support full implementation of the framework.
8. The related Resolution VIII.7 request for harmonization of definitions and terms throughout the suite of Ramsar guidance on inventory, assessment, monitoring and management of the ecological character of wetlands is addressed by Resolution IX.1 Annex A as part of the "Conceptual Framework for the wise use of wetlands and the maintenance of their ecological character".

II. The importance of identifying, assessing and reporting the status of Ramsar sites and other wetlands in the implementation of the Convention

9. The delivery of the conservation and wise use of wetlands, in line with the commitments embodied in the Ramsar Convention, entails:
 - a) establishing the location and ecological characteristics of wetlands (baseline inventory);
 - b) assessing the status, trends and threats to wetlands (assessment);
 - c) monitoring the status and trends, including the identification of reductions in existing threats and the appearance of new threats (monitoring); and
 - d) taking actions (both *in situ* and *ex situ*) to redress any such changes causing or likely to cause damaging change in ecological character (management).
10. At the site scale, the Convention's guidance on management planning, including the *New Guidelines for management planning for Ramsar sites and other wetlands* (Resolution VIII.14; Ramsar Wise Use Handbook 8, 2nd edition), stresses that establishing the ecological character

features of a site, and the factors that are positively or adversely affecting or likely to affect this character, is essential to the implementation of an effective management planning process.

11. At regional and global scales an understanding of the status and trends of wetland ecosystems has been recognized as an essential basis for the establishment of national and international policies, strategies and priorities for actions.
12. Monitoring and reporting the conservation status of designated Ramsar sites and other wetlands will also provide an indication of the success of the Ramsar Convention as an international treaty and its mechanisms for achieving wetland conservation and wise use. Resolution VII.11 is explicit in Objective 4.1 of the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance*: “To use Ramsar sites as baseline and reference areas for national, supranational/regional, and international environmental monitoring to detect trends in the loss of biological diversity, climate change, and the processes of desertification.” The Convention’s “Ecological ‘outcome-oriented’ indicators for assessing the implementation effectiveness of the Ramsar Convention” (Resolution IX.1 Annex D) have been designed to address this issue, for which reporting and assessment mechanisms will be established during the 2006-2008 triennium (Resolution IX.2 Annex 1).
13. A number of studies have drawn together available information on the distribution, status and trends of wetland ecosystems and have shown substantial gaps in available information:
 - i) The *Global Review of Wetland Resources and Priorities for Wetland Inventory*, undertaken by eriss (Australia) and Wetlands International for the Convention in 1999, found that at that time only 7% of countries had adequate national wetland inventory and 25% of countries had no available national wetland inventory. Parties’ National Reports to COP8 indicated that although this situation had somewhat improved – 28 Parties indicated that they have comprehensive wetland inventory with national coverage (24%) and a further 51 that they had partial inventories (COP8 DOC.5) – there remain large gaps in the baseline information about the location and characteristics of wetlands.
 - ii) The MA’s synthesis report for the Ramsar Convention (*Ecosystems and Human Well-being: Wetlands and Water. Synthesis*), published in 2005, has concluded that “there is insufficient information on the extent of all wetland types such as inland wetlands that are seasonally or intermittently flooded and some coastal wetlands to document the extent of wetland loss globally”. Nevertheless this report has concluded that on available evidence past losses and present rates of loss and decline of inland and coastal wetland ecosystems and their wetland-dependent species are greater than those in marine and terrestrial ecosystems.
14. By 2002, management plans, including monitoring programmes, were in place for all designated Ramsar sites in only 24 Contracting Parties (20%) (COP8 DOC. 6), and the use of the Ramsar sites network as a national and international network for monitoring the status and trends of wetland ecosystems, as envisaged by Objective 4.1 of the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* (Resolution VII.11), had not yet been established.
15. There is thus a need to ensure more comprehensive collection and reporting of such information essential for determining future policies and priorities for wetland conservation and wise use, underpinned by a clearer understanding of the purposes and objectives of inventory, assessment and monitoring.

16. A number of inventory and assessment initiatives that have recently been developed or are ongoing support Convention implementation of different aspects of this integrated framework. These include:
- i) further development and elaboration of the Mediterranean Wetlands Initiative (MedWet) inventory methodology through European Union-funded SUDOE (see http://www.medwet.org/medwetnew/en/03.PROJECTS/03.proj_04sudde02.html) and CODDE (see http://www.medwet.org/medwetnew/en/03.PROJECTS/03.proj_02codde01.html) projects;
 - ii) the development of the Asian Wetland Inventory methodology, a multiple purpose and multi-scalar approach (see also section 4 below), now being prepared for implementation in several parts of Asia (Finlayson C.M., Begg G.W., Howes J., Davies J., Tagi K. & Lowry J. 2002. A manual for an inventory of Asian wetlands (version 1.0). *Wetlands International Global Series 10*, Wetlands International, Kuala Lumpur, Malaysia. 72 pp. Downloadable in English and five Asian languages from: <http://www.wetlands.org/awi/default.htm>);
 - iii) the first phase of a Pan-European wetland inventory project, undertaken by Wetlands International and RIZA, the Netherlands (see <http://www.wetlands.org/inventory&/pewi.htm>), which expanded and updated the European component of the 1999 *Global Review of Wetland Resources and Priorities for Wetland Inventory*;
 - iv) the preparation through the STRP of a wetland inventory metadatabase model (in response to Resolution VIII.6) for a creation of a standardised record of information about each wetland inventory (see also section 5), now being developed within the Ramsar Sites Information Service by Wetlands International;
 - v) the European Space Agency's TESEO and GlobWetland projects, which are developing demonstration products based on earth observation (remote sensing) to improve the ability of wetland managers to better monitor and assess the condition of wetlands within their respective countries (see <http://www.globwetland.org/>);
 - vi) The methodologies and results of the Millennium Ecosystem Assessment (MA), focusing on assessment of ecosystem services and human well-being (reports, in the three Convention languages and several others, available on: <http://www.millenniumassessment.org/en/index.aspx>); and
 - vii) The CGIAR Comprehensive Assessment of Water and Agriculture, led by the International Water Management Institute (IWMI), Sri Lanka, which is preparing a special report on wetlands, water and agriculture for the Ramsar Convention, based on a series of questions developed by the STRP.

III. The relationship between wetland inventory, assessment, monitoring and management

17. Working definitions for wetland inventory, assessment and monitoring are incorporated into Ramsar's *Framework for Wetland Inventory* (Resolution VIII.6). They are:

Wetland Inventory: the collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities.

Wetland Assessment: the identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities.

Wetland Monitoring: the collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. The collection of time-series information that is not hypothesis-driven from wetland assessment is here termed *surveillance* rather than monitoring (refer to Resolution VI.1).

18. The approach and the scope of activity for inventory, assessment and monitoring as separate components of the management process differ substantially, but these are not always well distinguished in implementation projects.
19. Importantly, wetland inventory and wetland monitoring require different types of information. Whilst wetland inventory provides the basis for guiding the development of appropriate assessment and monitoring, wetland inventories repeated at given time intervals do not in themselves constitute monitoring.
20. Essentially, wetland (baseline) inventory is used to collect information to describe the ecological character of wetlands; assessment considers the pressures and associated risks of adverse change in ecological character; and monitoring, which can include both survey and surveillance, provides information on the extent of any change. All three are important and interactive data gathering exercises. They should be considered as linked elements of this overall integrated framework which, when implemented, provides for identification of key features of the character of wetlands. Taken together, they provide the information needed for establishing strategies, policies and management interventions to maintain the defined wetland ecosystem character and hence ecosystem benefits/services.
21. However, in practice a clear distinction between inventory and assessment is hard to draw, and many projects and initiatives described as wetland inventory also include elements of assessment of the status of, and pressures and threats to, wetlands.
22. The data and information collected through inventory, assessment and monitoring are essential parts of an overall wetland management planning process, at site, catchment, national or regional scales. The management planning process provides the mechanisms for maintenance of the ecological character of the wetlands, drawing on the data and information provided by inventory, assessment and monitoring, as is set out in the Convention's *New Guidelines for management planning for Ramsar sites and other wetlands* adopted by COP8 (Resolution VIII.14).

IV. Multi-scalar approaches to wetland inventory, assessment and monitoring

23. Key issues in implementing wetland inventory, assessment and monitoring are the choice of the scale at which to undertake the work and the choice of appropriate methods for each scale.
24. Wetland assessment, as with inventory and monitoring, can be undertaken at discrete spatial scales using (different) appropriate techniques for each. Whenever possible, an integrated inventory, assessment and monitoring programme should be developed and conducted at a single appropriate scale. This can be achieved when an integrated analysis encompassing inventory, assessment and monitoring components is planned and implemented. However, these components are typically planned or undertaken separately. Wetland assessment should

be undertaken at a spatial scale compatible with the scale of information contained within the wetland inventory. Subsequent monitoring should also be undertaken at a scale compatible with the assessment.

25. Since much wetland inventory, assessment and monitoring will be constrained by the scale and availability of information, practitioners are encouraged to aggregate data wherever possible rather than attempt to disaggregate data. This is possible when subsequent analyses draw on data from larger scales (e.g., combining data collected at 1:10,000 scale to represent a composite image at 1:50,000 scale) rather than smaller scales where issues of accuracy and precision will likely constrain effective analysis.
26. The issue of scale has so far been most fully addressed in methodologies for wetland inventory, and this is summarized below, using the Asian Wetland Inventory method as an example. However, many of the scale issues for inventory are equally relevant for the application of wetland assessment and monitoring, but further evaluation of options for these elements of the overall process may be necessary.
27. Wetland inventory has been carried out at a number of spatial scales, with specific purposes at each scale. These cover:
 - i) global – purpose: presence/absence of wetlands in continents and islands;
 - ii) continental – purpose: distribution of regions dominated by wetlands within continents or islands;
 - iii) regional – purpose: range of specific wetland types;
 - iv) local – purpose: characteristics of individual wetlands; and
 - v) site – purpose: variability within individual wetlands.
28. Some wetland inventory methodologies, notably the Mediterranean Wetland Inventory and, more recently, the Asian Wetland Inventory (AWI), have been developed as multi-scalar approaches and have been recognized by the Ramsar Convention as appropriate for application for a variety of purposes. Depending on particular local, national and regional needs and priorities, they can be implemented at one or more scales, and their methods may be applied also to other regions of the world.
29. The Asian Wetland Inventory has been developed with multiple purposes in mind. These take into account the need for information at multiple scales (local to global) and include the need to:
 - i) develop standardised field data collection sheets; and
 - ii) provide core data/information on wetlands to support international conventions and treaties on wetlands, climate change, biodiversity, migratory species and desertification, and their implementation by governments;

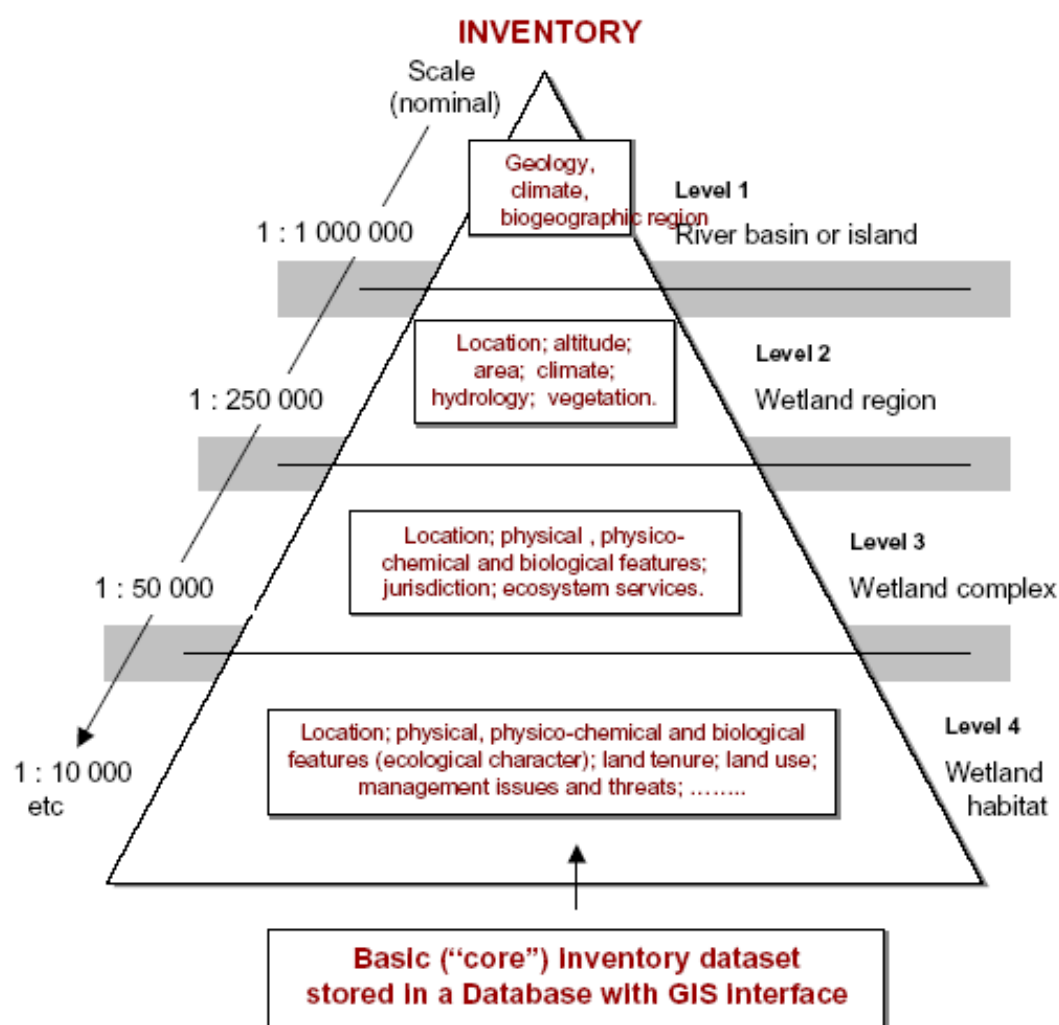
in order to:

 - i) analyse long-term trends in wetlands and their natural resources;
 - ii) enable regular revisions and updates of information on wetlands of national and international importance; and
 - iii) disseminate these analyses for wider consideration and use in sustainable development and conservation of wetland resources.

30. The key feature of the AWI is the production of hierarchical and map-based outputs at four levels of detail. The level of detail is related to the scale of the maps that are contained within a standardised GIS format with a minimum core data set. The hierarchical approach comprises a progression in scale from river basins to individual sites (see Figure 1).
31. The initial analysis (level 1) involves delineation of geographical regions (major river basins and islands) in Asia and encompasses a description of the geology, climate and ecology of each based on existing information sources. Level 2 analysis concerns delineation of wetland regions within each geographic region. This is done on the basis of similar climatic, geologic, hydrologic and vegetation features. Level 3 analysis undertakes grouping and description of wetland complexes within each region on the basis of more detailed information. Finally, level 4 analysis makes detailed descriptions of individual wetland habitats.
32. This approach results in the production of more detailed information on wetlands as the inventory progresses from levels 1 to 4, and it is anticipated that in many cases the implementation of an inventory will initially be undertaken at levels 1 and 2, followed, as resources become available, by levels 3 and 4.
33. While a hierarchical framework has been developed, it is not essential for all purposes to work through all levels of detail. The hierarchical approach is designed to respond to existing needs to obtain information at different levels and detail. A key point of this approach, however, is the adoption of compatible data fields and data management procedures to allow maximum use of the data, whether this is immediately planned or not for the particular purpose of an inventory exercise. However, for such reuse for different purposes, it is important to recognize the limits or constraints on interpretation of the original data.
34. At all levels of analysis the usefulness of existing information is first assessed and used as a basis for determining whether or not further analysis or collection of information is necessary. In many instances, analyses will be undertaken as follows:
- Level 1 – desk study to describe the broad geologic, climatic and ecological features of each geographic region using existing datasets, increasingly available on the Internet;
- Level 2 – desk study to identify the wetland regions within each geographic region using information already collated on geology, climate, hydrology, and vegetation;
- Level 3 – fieldwork and analysis to identify the physical, physico-chemical and biological features of wetland complexes within each wetland region; and
- Level 4 – detailed fieldwork and analysis to describe the physical, physico-chemical and biological features of each wetland habitat within each wetland complex. This includes information on plant and animal assemblages and species, land and water use and wetland management.
35. Data collection and analysis is based on standardised procedures and data management formats, although flexibility is not discouraged where necessary. Proforma data sheets for each level of analysis have been developed and are accompanied by guidelines for collecting the required information.

Figure 1. The hierarchical approach to wetland inventory

Data fields most appropriate for each level are shown with the most data being collected at level 4 (shown at the base of the triangle).



36. Similar multi-scalar procedures can be developed for wetland assessment and monitoring. These procedures will most likely build on the multi-scalar information collected under the inventory process and provide managers and others with analyses suitable for the scale of investigation.
37. However, detailed monitoring at broad scales is usually not possible because of its high cost, and thus monitoring at this scale must be cost-effective and sufficiently rapid to generate adequate first-pass data over large areas. The data may be adequate for management purposes or they may help managers to decide what type of further information may be required.
38. Typically, rapid assessment methods, including rapid biological assessment (see also Appendix 1) and remote sensing, are applied at broad scales. For specific sites, however, more detailed, quantitative monitoring may be required, utilising designs that provide stronger inference about a putative impact.

V. The Ramsar ‘toolkit’ of guidance available to Ramsar Parties for implementing the integrated wetland inventory, assessment and monitoring framework

39. A substantial set of Ramsar guidance already exists for wetland inventory, assessment, monitoring, and management. Guidance adopted up to and including COP8 has been compiled in Ramsar Wise Use Handbooks (2nd Edition) 8, 10 and 11. Key guidelines, definitions and other relevant guidance is listed in Table 1. Key aspects and features of the Convention’s guidance on wetland inventory, assessment and monitoring are summarized in the following sections of this integrated framework.

Table 1. Guidance available through the Ramsar Convention for implementing wetland inventory, assessment, monitoring and management

Note that a number of the wetland management guidances include aspects related to wetland inventory and assessment techniques.

COP Resolution and other sources	Guidance compiled in Ramsar Handbooks (2nd Edition, 2004)
Wetland inventory, assessment & monitoring	
Definition of “Wise Use” (Recommendation 3.3) [now updated in Resolution IX.1 Annex A]	1. Wise use of wetlands
Definitions of “ecological character” and “change in ecological character” (Resolution VII.10). [now updated in Resolution IX.1 Annex A]	8. Managing wetlands
<i>Conceptual Framework for the wise use of wetlands and the maintenance of their ecological character</i> (Resolution IX.1 Annex A)	-
<i>Integrated framework for wetland inventory, assessment and monitoring</i> (this document)	-
<i>Gaps and harmonization of Ramsar guidance on wetland ecological character, inventory, assessment and monitoring</i> (Resolution VIII.7)	10. Wetland inventory
<i>Guidelines for Global Action on Peatlands</i> Resolution VIII.17)	14. Peatlands
Guidance for GIS applications for wetland inventory, assessment and monitoring (<i>Ramsar Technical Report</i> in preparation)	-
Wetland inventory	
<i>A Framework for Wetland Inventory</i> (Resolution VIII.6)	10. Wetland inventory
Wetland assessment	
<i>Wetland risk assessment framework</i> (Resolution VII.10)	8. Managing wetlands
<i>Assessing and reporting the status and trends of wetlands, and the implementation of Article 3.2 of the Convention</i> (Resolution VIII.8)	8. Managing wetlands
<i>Guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes and in strategic environmental assessment, adopted by the Convention on Biological Diversity, and their relevance to the Ramsar Convention</i> (Resolution VIII.9)	11. Impact assessment

COP Resolution and other sources	Guidance compiled in Ramsar Handbooks (2nd Edition, 2004)
Strategic Environmental Assessment (SEA) (COP7 Technical Session IV)	11. Impact assessment
<i>Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity</i> (Resolution IX.1 Annex E i.)	-
<i>Ecological 'outcome-oriented' indicators for assessing the implementation effectiveness of the Ramsar Convention</i> (Resolution IX.1 Annex D)	-
A framework and guidelines for valuing wetland benefits/services (<i>Ramsar Technical Report</i> in preparation)	-
Methodologies for assessing the vulnerability of wetlands to change in their ecological character (<i>Ramsar Technical Report</i> in preparation)	-
Methodologies for assessing the environmental water requirements of wetlands (<i>Ramsar Technical Report</i> in preparation)	-
Wetland monitoring	
<i>A Framework for designing a wetland monitoring programme</i> (Annex to Resolution VI.1)	8. Managing wetlands
Wetland management	
<i>New Guidelines for management planning for Ramsar sites and other wetlands</i> (Resolution VIII.14)	8. Managing wetlands
<i>Principles and guidelines for wetland restoration</i> (Resolution VIII.16)	8. Managing wetlands
<i>Guidelines for establishing and strengthening local communities' and indigenous people's participation in the management of wetlands</i> (Resolution VII.8)	5. Participatory management
<i>Participatory Environmental Management (PEM) as a tool for the management and wise use of wetlands</i> Resolution VIII.36	5. Participatory management
<i>Guidelines for integrating wetland conservation and wise use into river basin management</i> (Resolution VII.18)	4. River basin management
<i>Principles and guidelines on integrated coastal zone management</i> (Resolution VIII.4)	13. Coastal management
<i>Guidelines for the allocation and management of water for maintaining the ecological functions of wetlands</i> (Resolution VIII.1)	12. Water allocation and management
<i>Guidelines for Global Action on Peatlands</i> Resolution VIII.17)	14. Peatlands
<i>River basin management: additional guidance and framework for analysis of case studies</i> (Resolution IX.1 Annex C i.)	-
<i>Guidelines for the management of groundwater to maintain wetland ecological character</i> (Resolution IX.1 Annex C ii.)	-

40. In addition, there are a number of other ecosystem and wetlands and water-related global assessment initiatives currently underway, whose methodologies may be of relevance to any further development and implementation of this integrated framework. These include, *inter alia*, the Millennium Ecosystem Assessment (MA), the Global International Waters Assessment (GIWA), UN Waters' World Water Assessment Programme (WWAP), the CGIAR Comprehensive Assessment of Water and Agriculture, and the IUCN Species Survival Commission's Freshwater Biodiversity Assessment Programme.
41. Furthermore, the assessment results of these and other synthesised assessments such as UNEP's Global Environmental Outlook (GEO) and CBD's Global Biodiversity Outlook (GBO) will provide assessment information helpful for decision-making and identification of priorities for the future conservation and wise use of wetlands in their broader landscape/seascape context.

The Ramsar Framework for Wetland Inventory

42. The *Framework for Wetland Inventory* was adopted by COP8 in Resolution VIII.6. It provides a 13-step structured framework, supported by guidance on each step, for planning a wetland inventory. These steps are:
 1. State the purpose and objective
 2. Review existing knowledge and information
 3. Review existing inventory methods
 4. Determine the scale and resolution
 5. Establish a core or minimum data set
 6. Establish a habitat classification
 7. Choose an appropriate method
 8. Establish a data management system
 9. Establish a time schedule and the level of resources that are required
 10. Assess the feasibility & cost effectiveness
 11. Establish a reporting procedure
 12. Establish a review and evaluation process
 13. Plan a pilot study
43. This planning framework is supported by examples of successfully applied standardized inventory methodologies from different regions, guidance on determining the most appropriate remotely-sensed data for a wetland inventory, a summary of different widely-used wetland classifications, and a standard metadata record for the documentation of wetland inventories.
44. The *Framework for Wetland Inventory* identifies a set of core (minimum) data fields for biophysical and management features of wetlands (Table 2) which should be collected in each inventory, depending on the specific purpose of the inventory.

Table 2. Core (minimum) data fields for inventory of biophysical and management features of wetlands

(derived from the Annex to Resolution VIII.6)

<p><i>Biophysical features</i></p> <ul style="list-style-type: none"> • Site name (official name of site and catchment) • Area and boundary (size and variation, range and average values) * • Location (projection system, map coordinates, map centroid, elevation) * • Geomorphic setting (where it occurs within the landscape, linkage with other aquatic habitat, biogeographical region) * • General description (shape, cross-section and plan view) • Climate – zone and major features • Soil (structure and colour) • Water regime (periodicity, extent of flooding and depth, source of surface water and links with groundwater) • Water chemistry (salinity, pH, colour, transparency, nutrients) • Biota (vegetation zones and structure, animal populations and distribution, special features including rare/endangered species)
<p><i>Management features</i></p> <ul style="list-style-type: none"> • Land use – local, and in the river basin and/or coastal zone • Pressures on the wetland – within the wetland and in the river basin and/or coastal zone • Land tenure and administrative authority – for the wetland, and for critical parts of the river basin and/or coastal zone • Conservation and management status of the wetland – including legal instruments and social or cultural traditions that influence the management of the wetland • Ecosystem benefits/services derived from the wetland – including products, values, functions and attributes (see Resolution VI.1) and, where possible, their relevance to human well-being (see Resolutions VI.23 and VII.8) • Management plans and monitoring programs – in place and planned within the wetland and in the river basin and/or coastal zone (see Resolutions 5.7, VI.1, VII.17, and VIII.14) <p>* These features can usually be derived from topographical maps or remotely sensed images, especially aerial photographs.</p>

45. The *Framework for Wetland Inventory* recognizes that wetland inventory has multiple purposes, including:

- a) listing particular types, or even all, wetlands in an area;
- b) listing wetlands of local, national and/or international importance;
- c) describing the occurrence and distribution of wetland taxa;
- d) describing the occurrence of natural resources such as peat, fish or water;
- e) establishing a baseline for measuring change in the ecological character of wetlands;
- f) assessing the extent and rate of wetland loss or degradation;
- g) promoting awareness of the value of wetlands;
- h) providing a tool for conservation planning and management; and

- i) developing networks of experts and cooperation for wetland conservation and management.
46. The *Framework* also stresses that an inventory should contain a clear statement of its purpose and objective. This should identify the habitats that will be considered, the range of information that is required, the time schedule, and who will make use of the information. A clear statement of the purpose(s) will assist in making decisions about the methods and resources needed to undertake the inventory.
47. Unlike the use of wetland assessment techniques (see below), there is less likelihood that more than one inventory technique will be applied simultaneously. Since wetland inventory can be carried out at different levels of detail, it is far more likely that sequential inventory, starting simply and subsequently undertaking more detailed work, will be undertaken.

Metadata records for wetland inventory

48. The *Framework for Wetland Inventory* also stresses the importance of establishing a publicly-accessible and standardized metadata record for each inventory undertaken, and it includes a standard model for wetland inventory metadata. Metadata has many elements that can include information describing the age, accuracy, content, currency, scale, reliability, lineage, authorship and custodianship of an individual dataset. Recording and describing this information enables data to be easily located, identified, understood and managed. It also enables data to be used more efficiently and effectively.
49. Whilst 'metadata' is not a new concept, it has gained added significance through the increasing recognition of data collections and associated information as assets which need to be managed and maintained efficiently. A *metadatabase* can be viewed as the mechanism which links all of these data descriptions together to provide a comprehensive description of the dataset. The metadatabase stores descriptions of the data, not the actual data itself. Where possible, the data fields should be populated with values representing established international standards, to ensure consistency and quality in the data entry. The extent of subjective individual interpretations or descriptions should be minimised where possible, to avoid confusion or inconsistency. This is a particular concern when data are exchanged between organizations. By identifying the fields required for the metadatabase and recommending the parameters and file formats, it is intended that the metadatabase could be produced on a range of database platforms. Using standardized parameters should assist with the transfer of data between platforms.

Types of wetland assessment

50. There is a wide range of different types and methods of wetland assessment relevant to different aspects of Convention implementation, with each suited to, and designed for, different purposes and situations. These include:
- i) Environmental Impact Assessment (EIA)
 - ii) Strategic Environmental Assessment (SEA)
 - iii) Risk Assessment (RA)
 - iv) Vulnerability Assessment (VA)
 - v) Change (status and trends) assessment
 - vi) Species-specific assessment
 - vii) Indicator assessment

- viii) Resource (ecosystem benefits/services) assessment
- ix) Assessment of values of wetland benefits/services
- x) Environmental water requirement (environmental flows) assessment

51. The Ramsar Convention has adopted guidance on a number of these types of assessments, and further guidance has been adopted by COP9 in 2005 or is being prepared by the STRP for publication as *Ramsar Technical Reports* (see Table 1). Summary information on a number of these types of assessment guidance available to the Convention is provided in COP9 DOC. 24.

Rapid assessment of wetlands

52. "Rapid assessment" of wetlands is an approach which, depending on the purpose of the assessment, involves one or more of the different types of wetland assessment listed in paragraph 50 above, but where the methods are adapted to permit the adequate collection, analysis and presentation of the assessment information when this information is urgently needed. It may also involve the rapid collection of 'baseline' wetland inventory information. Rapid assessment methods can be particularly useful in the assessment of the impacts of natural disasters such as storm surges, tsunamis and hurricanes.
53. Guidelines for the rapid assessment of inland water, coastal and marine biodiversity have been jointly developed by the Convention on Biological Diversity and the Ramsar Convention. A consolidated version of this guidance, covering the range of wetland types in the Ramsar Classification System, has been included in Resolution IX.1 Annex E i. This guidance focuses on assessments at the species level of biodiversity, and it recognizes that there is a need to develop rapid assessment guidance for wetland ecosystems further.
54. The guidance recognizes that the purposes for rapid assessment of wetlands include:
- a) collecting general biodiversity data in order to inventory and prioritize wetland species, communities and ecosystems; obtaining baseline biodiversity information for a given area;
 - b) gathering information on the status of a focus or target species (such as threatened species); collecting data pertaining to the conservation of a specific species;
 - c) gaining information on the effects of human or natural disturbance (changes) on a given area or species;
 - d) gathering information that is indicative of the general ecosystem health or condition of a specific wetland ecosystem; and
 - e) determining the potential for sustainable use of biological resources in a particular wetland ecosystem.
55. The rapid assessment guidance in Resolution IX.1 Annex E i. includes a five-step procedure for designing a rapid assessment, modified from Ramsar's structured framework for wetland inventory (Annex to Resolution VIII.6). Summary information on this approach to rapid assessment is also provided in COP9 DOC. 24.

Indicator assessment

56. The development and use of indicators are designed to assess temporal patterns in the status and trends of ecosystems, habitats and species, the pressures and threats they face, and the responses made to address these pressures and threats. Such indicators are not designed to provide a complete and comprehensive assessment of all aspects of wetland ecosystems and their dynamics: rather they are intended to give a series of related pictures of these patterns, in

order to guide further design and the focusing of decision-making for addressing unwanted change. Such indicators are also generally components of hypothesis-driven wetland monitoring programmes (see below).

57. Ramsar has worked closely with the Convention on Biological Diversity in its development of a set of indicators designed to assess the progress towards achieving the 2010 target of significantly reducing the rate of loss of biodiversity. The results of assessment of many of these indicators, which will be reported through the CBD's *Global Biodiversity Outlook*, will have relevance to the delivery of wetland conservation and wise use under the Ramsar Convention. The CBD's 2010 global indicators for immediate testing (UNEP/CBD/COP/7/20/Add.3) are:

- i) trends in extent of selected biomes, ecosystems and habitats;
- ii) trends in abundance and distribution of selected species;
- iii) change in status of threatened species;
- iv) trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance;
- v) coverage of protected areas;
- vi) criteria and indicators for sustainable management of ecosystems;
- vii) biodiversity used in food and medicine;
- viii) water quality in aquatic ecosystems;
- ix) trophic integrity of ecosystem;
- x) nitrogen deposition; and
- xi) numbers and cost of alien invasions.

58. For Ramsar, and in response to Resolution VIII.26, the STRP has developed "Ecological "outcome-oriented" indicators for assessing the implementation effectiveness of the Ramsar Convention", which are provided in Resolution IX.1 Annex D. These indicators seek to go beyond the assessment and reporting of the status and trends of different aspects of wetlands and their conservation and wise use (such as the CBD 2010 indicators), and they are formulated in such a way as to yield insights into the Convention's effectiveness, in conjunction with analysis of certain 'process-oriented indicators' such as those in the COP9 National Report Format.

59. An initial tranche of eight effectiveness indicators, some with one or more sub-indicator, has been developed, with a further five indicators recommended for further consideration and development. The initial eight indicators are:

Indicator	Sub-indicator(s)
A. The overall conservation status of wetlands	i. Status and trends in wetland ecosystem extent ii. Trends in conservation status – qualitative assessment
B. The status of the ecological character of Ramsar sites	i. Trends in the status of Ramsar site ecological character – qualitative assessment
C. Trends in water quality	i. Trends in dissolved nitrate (or nitrogen) concentration ii. Trends in Biological Oxygen Demand (BOD)
D. The frequency of threats affecting Ramsar sites	i. The frequency of threats affecting Ramsar sites – qualitative assessment
E. Wetland sites with successfully implemented conservation or wise use management plans	i. Wetland sites with successfully implemented conservation or wise use management plans

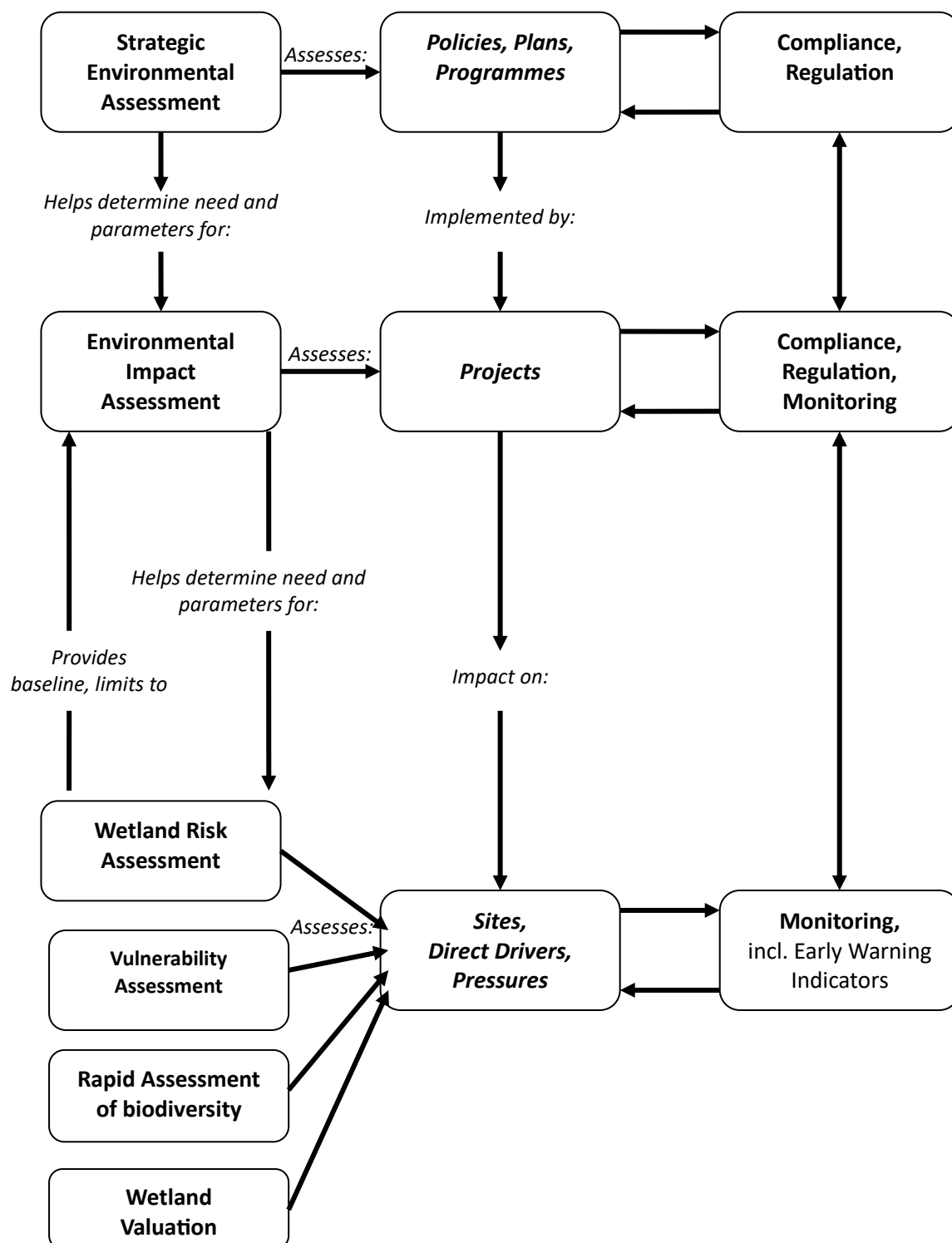
F. Overall population trends of wetland taxa	i. Trends in the status of waterbird biogeographic populations
G. Changes in threat status of wetland taxa	i. Trends in the status of globally-threatened wetland-dependent birds ii. Trends in the status of globally-threatened wetland-dependent amphibians
H. The proportion of candidate Ramsar sites designated so far for wetland types/features	i. Coverage of the wetland resource by designated Ramsar sites

60. A priority task for the STRP during 2006-2008 is the development of mechanisms for the implementation and assessment of these effectiveness indicators (Resolution IX.2 Annex 1).

The relationships among the different wetland assessment tools available through the Convention

61. Figure 2 illustrates the relationships among various assessment tools as a flow diagram that shows the linkages between the tools and the choices that may need to be made when assessing the condition of or change in a wetland.
62. The specific applications of each these individual assessment tools are summarized in COP9 DOC. 24. It is important to recognize that whilst each assessment tool has a specific application there can exist considerable overlaps between tools under some circumstances. In some instances, one or more specific tools can be used as part of a broader form of assessment. Practitioners need to consider the choice of tool or tools in relation to the specific purpose of the assessment they need to undertake.

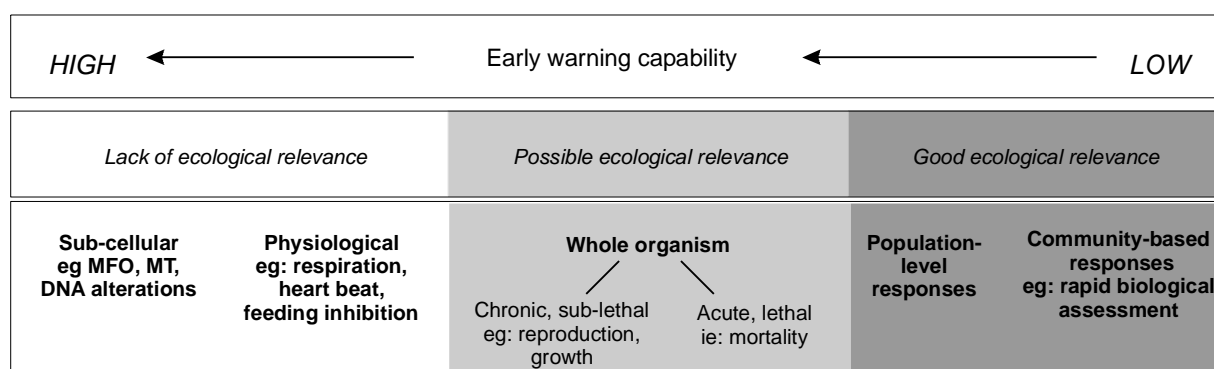
Figure 2. The relationships among the different wetland assessment tools available through the Convention



63. The assessment tools and approaches shown in Figure 2 and described further in COP9 DOC. 24 are relevant in one way or another to assessing change or potential change in wetlands. These can be effectively integrated in a hierarchical decision-making framework, so that there is an efficient flow of information and influence from one to the other. Some of the ways in which this can occur are:
- *Strategic Environmental Assessment* can provide a framework or context which helps to determine the need for, and the parameters of, relevant project-specific *Environmental Impact Assessments*, focusing on key issues, priority risks and opportunities.
 - *Environmental Impact Assessment* can help determine the need for, and the parameters of, *Vulnerability and Risk Assessments* and *Wetland Valuations*.
 - *Vulnerability and Risk Assessments* help define baselines, tolerance limits and other elements to feed in to *Environmental Impact Assessment*, as well as potential measures for reducing the risk of wetland degradation.
 - *Risk Assessment* can also quantify the magnitude and likelihood of impacts, as part of an *Environmental Impact Assessment*.
 - *Wetland Valuation* (of ecosystem provisioning, regulating, cultural and supporting benefits/services) can provide information to assist in articulating the benefits obtained from a wetland and hence support the concepts provided in *Vulnerability and Risk Assessments*.
 - Information on impacts collected in the *Environmental Impact Assessment* process and through subsequent monitoring activities can feed into the *Strategic Environmental Assessment* process, as well as informing *Vulnerability and Risk Assessments* and *Wetland Valuations*.
 - *Rapid Assessment* of biodiversity provides information that can guide *Environmental Impact Assessment* and support *Vulnerability and Risk Assessment*, and identify elements of biodiversity that could be used within *Wetland Valuation*.
64. Thus Strategic Environmental Assessment, Environmental Impact Assessment, and Vulnerability and Risk Assessment will help define the scope of monitoring for policies/plans/programmes, for projects and for site management, respectively.
65. The Convention's *Wetland Risk Assessment Framework* (Resolution VII10; Ramsar Handbook 8) includes a substantial component addressing early warning indicators. Measurement of these indicators will draw on data from site management and monitoring and will feed back to adjustments in that management. Rapid Assessment of biodiversity can also provide early warning of impending change, but as illustrated in Figure 4 there is an inverse relationship between the extent of the ecological relevance of an indicator and the extent of early warning. Early warning indicators can also provide data to the monitoring stimulated in relation to projects by Environmental Impact Assessment.

Figure 3. The relationship between ecological relevance and early warning capability to measure biological responses

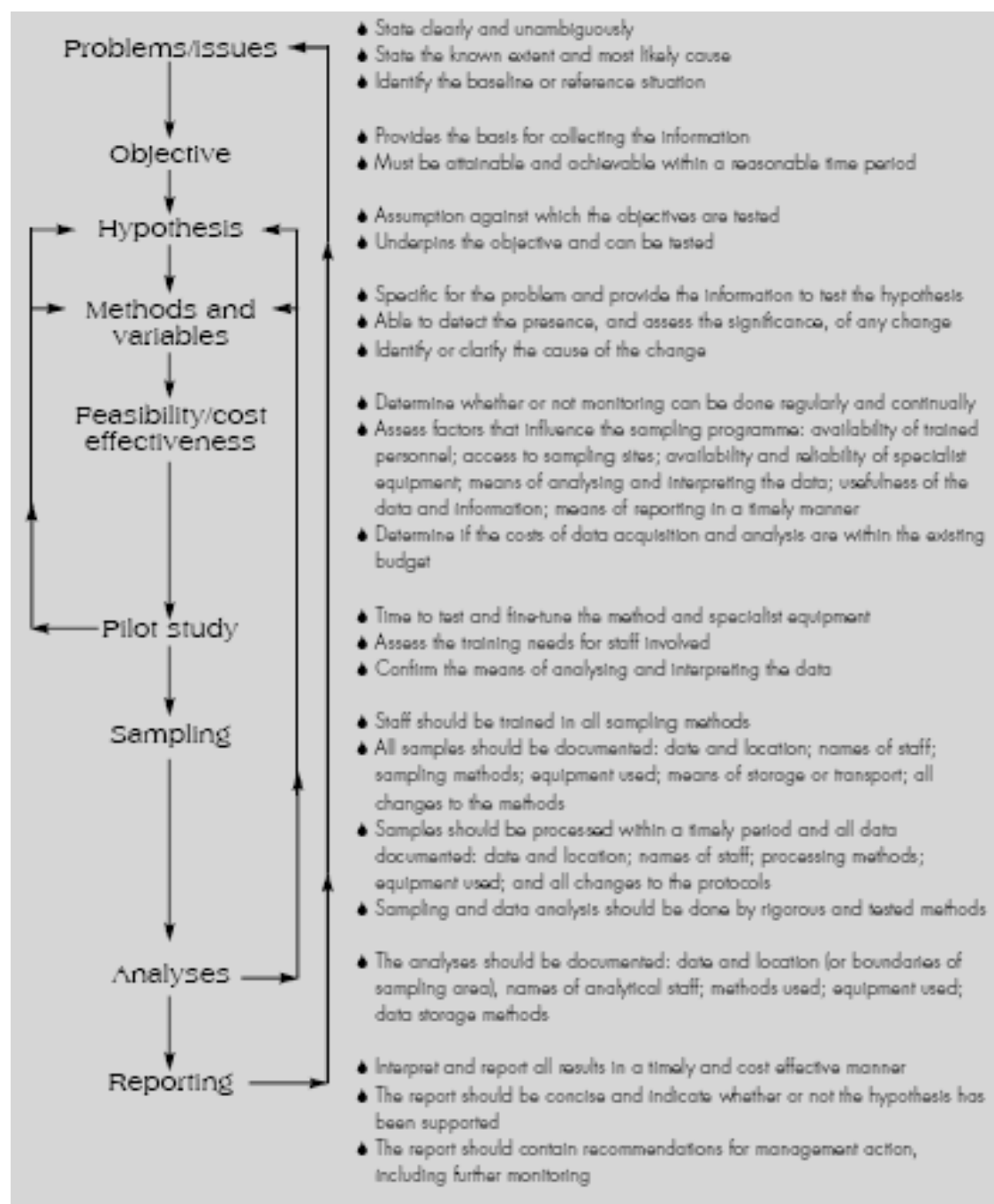
(from Annex to Resolution VII.10 Wetland Risk Assessment Framework).



Wetland monitoring

66. A framework for designing a wetland monitoring programme was adopted by COP6 (Resolution VI.1) in 1996 and is incorporated into Ramsar Wise Use Handbook 8 "Managing Wetlands". This monitoring framework is summarized in Figure 5.
67. The framework is not a prescriptive recipe for any particular monitoring programme. It simply provides a series of steps that can be used by wetland managers and planners, working in partnership with local users and managers, to design a monitoring programme based on their particular circumstances and needs.
68. When designing a monitoring program it is necessary to consider a number of principles that ensure valid results, analysis and interpretation (see also Downes *et al.* 2002. *Monitoring Ecological Impacts: Concepts and Practice in Flowing Waters*. Cambridge University Press, Melbourne, Australia).
69. Many monitoring techniques are also available in the MedWet monitoring manual, which provides a listing and guidance on specific approaches (Tomas Vives, P. (ed). 1996 *Monitoring Mediterranean Wetlands: A Methodological Guide*. MedWet Publication, Wetlands International, Slimbridge, U.K. & ICN, Lisbon, Portugal) (downloadable from: http://www.wetlands.org/pubs&/wetland_pub.html).

Figure 4. Framework for designing a wetland monitoring programme (from Ramsar Wise Use Handbook 8. 2nd Edition, 2004). The arrows illustrate the feedback which enables assessment of the effectiveness of the monitoring programme in achieving its objective(s).



Applying wetland inventory, assessment and monitoring tools in the context of the wise use of wetlands

70. This integrated framework for wetland inventory, assessment and monitoring, and the tools and methodologies it covers, forms one of several framework guidances developed by the STRP to assist Contracting Parties and others in more readily selecting and applying each of the increasing range of the Convention's wetland conservation and wise use guidelines.

71. The STRP has also recognized the significance of the Millennium Ecosystem Assessment's Conceptual Framework for Ecosystems and Human Well-being in providing an overarching framework for the delivery of Ramsar's wise use of wetlands (Resolution IX.1 Annex A). It provides a multi-scalar approach which indicates how and where policy and management interventions, including the different components of the Convention's toolkit of Wise Use Handbooks, can be made (see Figure 2 in Resolution IX.1 Annex A).
72. Within this conceptual framework, most of the Convention's tools for inventory, assessment and monitoring concern the maintenance of the ecological character of wetlands through interventions within wetland ecosystems themselves – between the components and processes of wetlands and the ecosystem benefits/services these deliver. Others, notably Environmental Impact Assessment, Risk Assessment, and Vulnerability Assessment concern addressing the interactions between "Direct Drivers of Change" to wetlands and the wetlands themselves. However, since Strategic Environmental Assessment is concerned with policies, plans and programmes, it acts as an intervention between Indirect and Direct Drivers of Change.

VI. Gaps in Ramsar's toolkit of inventory, assessment and monitoring guidance

73. Although this *Integrated Framework for wetland inventory, assessment and monitoring* now includes a large number of different tools and approaches, a number of gaps in methodological guidance remain before it provides a comprehensive Ramsar framework for implementation by Contracting Parties and others. These are identified in the schedule of actions for the scientific and technical implementation of the Convention, 2006-2011 (Annex 2 to Resolution IX.2). They include:
 - i) development and testing of a hydro-geomorphically-based system of classification of wetland types, including an evaluation of how this relates to other possible systems and to the current Ramsar classification system;
 - ii) further development of the Web-based wetland inventory meta-database;
 - iii) a review of data and information needs for Ramsar sites and other wetlands, including guidance for the description of the ecological character of wetlands, and harmonisation of the Information Sheet on Ramsar Wetlands (RIS) with the wetland inventory core data fields and the description of ecological character;
 - iv) advice on delineating and mapping wetlands (in conjunction with the description of ecological character);
 - v) further consolidated guidance on detecting, reporting and responding to change in the ecological character of wetlands; and
 - vi) establishment and implementation of mechanisms for the ecological 'outcome-oriented' indicators of effectiveness of the implementation of the Convention and development of further such indicators.
74. In addition to these methodological developments, Resolution IX.2 also recognizes that regular assessment and reporting on the status and trends of the ecological character of Ramsar sites and other wetlands will need to ensure that the results of national wetland inventory and assessments are made fully accessible, as is called for in Resolution VIII.6.

75. There is also a need, recognized in the work of the Millennium Ecosystem Assessment (see Finlayson, D'Cruz & Davidson. 2005. *Ecosystems and Human Well-being: Wetlands and Water. Synthesis*. World Resources Institute, Washington D.C.), for more case studies and more widespread and comprehensive assessments of the socio-economic value of wetland ecosystem benefits/services, particularly in relation to the potential conversion of wetlands to other land uses, as the basis for sound decision-making.

VII. Priorities for improving integrated wetland inventory, assessment and monitoring

76. The following practical steps for improving integrated wetland inventory, assessment and monitoring are recommended.
- i) All countries that have not yet conducted a national wetland inventory should do so, preferably using an approach that is comparable with other large-scale wetland inventories already underway or complete. These should focus on a basic data set that describes the location and size of the wetland and the major biophysical features, including variation in the areas and the water regime – see the further guidance in the Convention's *Framework for Wetland Inventory* (Resolution VIII.6).
 - ii) Once the baseline data have been acquired and adequately stored, more management-oriented information on wetland threats and uses, land tenure and management regimes, benefits and values should be added. When such assessment information is recorded, it should be accompanied by clear records that describe when and how the information was collected and its accuracy and reliability.
 - iii) Each inventory and assessment program should contain a clear statement of its purpose and the range of information that has been collated or collected. This extends to defining the habitats being considered and the date the information was obtained or updated.
 - iv) Priority should be given to improving the global inventory for wetland habitats that are currently poorly covered in most parts of the world, i.e. seagrasses, coral reefs, saltmarshes and coastal tidal flats, mangroves, arid-zone wetlands, rivers and streams, and artificial wetlands.
 - v) The effectiveness of all aspects of wetland inventory and assessment should be increased through the use of a standardised framework and a generic wetland inventory core dataset (as provided in Resolution VIII.6), designed to be as flexible as possible for use in all regions of the world and to accommodate various inventory and assessment objectives.
 - vi) Models for effective wetland inventory, assessment and monitoring, using appropriate remote sensing and ground techniques, should be compiled and widely disseminated. These should outline useful habitat classifications (e.g., those based initially on landform and not vegetation parameters) and methods and means of collating and storing the information, in particular Geographic Information Systems (GIS) for spatial and temporal data that could be used for monitoring purposes.
 - vii) Wetland monitoring systems should build upon the information provided in wetland inventory and assessment activities. Specific monitoring should be based on a hypothesis derived from the assessment data and be contained within a suitable management structure.

77. These and other issues will be taken into account in the comprehensive review of data and information needs of the Convention, proposed to be undertaken by the STRP as a priority task in its 2006-2008 programme (Resolution IX.2 Annex 1).

Annex 3

Guidelines for the rapid assessment of inland, coastal and marine wetland biodiversity

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1. Background and introduction

1. The Ramsar Convention’s Strategic Plan 2003–2008 (action 1.2.3) requests the STRP, Ramsar Secretariat and Convention on Biological Diversity (CBD) to “develop guidelines for rapid assessment of wetland biodiversity and functions and for monitoring change in ecological character, including the use of indicators, for both inland and coastal and marine ecosystems, for consideration by COP9”.
2. This echoes the call in CBD Decision IV/4 on its inland waters programme of work (for which the Ramsar Convention acts as a lead implementation partner) for the development and dissemination of regional guidelines for rapid assessment of inland water biological diversity for different types of inland water ecosystems. Similarly, CBD SBSTTA Recommendation VI/5 requested “development of methodologies . . . for scientific assessments, including those relating to marine and coastal biological diversity.”
3. The CBD guidance for inland waters was drafted by Conservation International and further developed by an expert meeting convened jointly by the CBD and Ramsar Secretariats and involving both CBD and Ramsar experts nominated by national focal points. The guidance is specifically intended to meet the needs of both CBD and Ramsar Convention, in line with the CBD/Ramsar 3rd Joint Work Plan. Marine and coastal guidance, developed through an electronic working group, was modelled on that for inland waters, and its approach and general structure is consistent with the inland waters guidance.
4. The original CBD guidelines were made available to the eighth meeting of CBD’s Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and are available for download from

the CBD Web site [<http://www.biodiv.org/convention/sbstta.asp>] as CBD/SBSTTA/8/INF/5 (inland waters) and CBD/SBSTTA/8/INF/13 (marine and coastal), plus a short supplementary marine and coastal paper (CBD/SBSTTA/9/INF/25).

5. Concerning the inland waters guidelines, CBD COP7 in 2004 (Decision VII/4) welcomed the guidelines, recognized their usefulness for creating baseline or reference data sets for inland water ecosystems of different types and for addressing the serious gaps that exist in knowledge of taxonomy, distribution, and conservation status of freshwater species, and invited its Parties, other governments and relevant organizations to use and promote the application of the guidelines, in particular in the circumstances of small island developing states and in the territories of states in which inland water ecosystems suffer from ecological disaster.
6. In 2004, Ramsar's Scientific and Technical Review Panel (STRP) considered how best to incorporate the various components of the CBD rapid assessment guidelines into the suite of Ramsar guidances on inventory, assessment and monitoring. The Panel determined that, given that the Ramsar definition of "wetlands" covers both inland waters and marine and coastal systems, it is most appropriate for its application by Ramsar Contracting Parties to make the guidance available as a single consolidated guidance document, with the relevant material from all three inland waters and marine and coastal CBD papers merged. These present guidelines are thus a compiled and edited version of the CBD materials, prepared by the Ramsar Secretariat and the STRP, working with the CBD Secretariat. Throughout this Ramsar version of the guidelines, the CBD terms "inland waters" and "marine and coastal ecosystems" are as appropriate replaced by the term "wetlands" *sensu* Ramsar.
7. The CBD rapid assessment guidelines documents also contain a number of detailed methodological tables, and case studies, supporting implementation of the general rapid assessment guidance. Not all of these lengthy and detailed tables are included in this present document. It is planned to further compile and make available to Ramsar Contracting Parties and others the full set of these CBD Appendices, tables and case studies, in the form of a *Ramsar Technical Report*.

2. Scope and approach of the wetland rapid assessment guidelines

8. These guidelines focus on the assessment of biological diversity at the species and community level. However, reference is also made to tools which will assist in the assessment of wetland ecosystems. In addition, information is also included in these guidelines on rapid assessment methodologies for assessing change in coastal ecosystems in the aftermath of natural disasters. These methodologies have been developed to assist in the assessment of the impacts to coastal ecosystems of the Indian Ocean tsunami of December 2004.
9. The present guidelines do not provide methodological guidance for rapidly assessing the full range of socio-economic or cultural values of the biological diversity of wetland ecosystems. CBD COP7 (Decision VII/4) recognized this and requested further collaborative work between CBD, the Ramsar Convention and other relevant organisations to develop a complementary set of tools to assess the function and health of inland water ecosystems and the socio-economic and cultural values of biological diversity of inland waters. In addition, the guidance on the economic valuation of wetlands being prepared by the Scientific and Technical Review Panel for publication as a *Ramsar Technical Report* provides a contribution to these aspects, since it includes information on economic valuation methods which may be considered as 'rapid'.

10. The present rapid assessment guidelines draw heavily on, and are consistent with, the general guidelines for selecting appropriate wetland inventory methods in Ramsar's "A Framework for Wetland Inventory" (COP8 Resolution VIII.6). As is set out in the rapid assessment guidelines, rapid assessment methods can be applied for a number of types and purposes of wetland inventory and assessment. Hence this guidance is relevant to the implementation of a number of aspects of the Ramsar "Integrated Framework for Wetland Inventory, Assessment and Monitoring" (Resolution IX.1 Annex E).
11. The guidelines are designed to serve the needs of Contracting Parties of both the Ramsar Convention and the Convention on Biological Diversity. Rapid assessment methods are placed in the context of more comprehensive inventory, assessment and monitoring programmes, and a conceptual framework for their design and implementation is included. They are intended to provide advice and technical guidance that is useful to wide range of Parties with different circumstances, including geographic size, wetland types, and institutional capacities.
12. The guidelines stress the importance of clearly establishing the purpose as the basis for design and implementation of the assessment in each case. They also emphasize that before deciding on whether a new field survey using rapid assessment methods is necessary, a review of existing knowledge and information, including information held by local communities, should be undertaken.
13. Subsequent steps are then presented in the form of a "decision tree" to facilitate the selection of appropriate methods to meet the purpose of the assessment. An indication of the categories of information which can be acquired through each of the rapid assessment methods is provided. Summary information on a range of appropriate and available methods suitable for each rapid assessment purpose is included, as is information on a range of different data analysis tools.

3. What is "rapid assessment"?

14. **Rapid assessment**, for the purpose of this guidance, is defined as: "a synoptic assessment, which is often undertaken as a matter of urgency, in the shortest timeframe possible to produce reliable and applicable results for its defined purpose".
15. It is important to note that rapid assessment methods for wetlands are not generally designed to take into account temporal variance, such as seasonality, in ecosystems. However, some rapid assessment methods can be (and are) used in repeat surveys as elements of an integrated monitoring programme to address such temporal variance.
16. Rapid assessment techniques are particularly relevant to the species level of biological diversity, and the present guidance focuses on assessments at that level. Certain other rapid assessment methods, including remote sensing techniques, can be applicable to the ecosystem/wetland habitat level, particularly for rapid inventory assessments, and it may be appropriate to develop further guidance on ecosystem-level rapid assessment methods. However, assessments at the genetic level of biological diversity do not generally lend themselves to "rapid" approaches.
17. The complex nature and variability of wetland ecosystems means that there is no single rapid assessment method that can be applied to the wide range of wetland types and for the variety of different purposes for which assessments are undertaken. Furthermore, the extent of what is possible in a given case will depend on the resources and capacities available.

18. In the detailed guidance that follows, five specific purposes for undertaking rapid assessment are distinguished: *baseline inventory* (called *inventory assessment* in the CBD version of the guidelines), *specific-species assessment*, *change assessment*, *indicator assessment*, and *economic resource assessment*.

4. Issues to consider when designing a wetland rapid assessment

19. The following nine issues should be taken into account when designing any rapid assessment:
- i. **Types of rapid assessments.** Rapid assessments can range from desk studies, expert group meetings and workshops to field surveys. They can include compiling existing expert knowledge and information, including traditional knowledge and information, and field survey approaches.
 - ii. Assessments can be divided into three stages: design/preparation, implementation, and reporting. **“Rapidity” should apply to each of these stages.** Rapid assessments provide the necessary results in the shortest practicable time, even though preparatory and planning work prior to the survey may be time-consuming. In some circumstances (for example, when taking seasonality into account) there may be a delay between the decision to undertake the assessment and carrying it out. In other cases (for example, in cases of disturbances and disasters), the assessment will be undertaken as a matter of urgency, and preparation time should be kept to a minimum.
 - iii. **Inventory, assessment and monitoring.** It is important to distinguish between inventory, assessment, and monitoring (see Box 1) when designing data-gathering exercises, as they require different types of information. Baseline wetland inventory provides the basis for guiding the development of appropriate assessment and monitoring. Wetland inventories repeated at intervals do not automatically constitute “monitoring”.
 - iv. **Rapid assessment entails speed, but it can be expensive.** Costs will increase particularly when assessing remote areas, large spatial scales, high topographic resolution, and/or a large number of types of features. Undertaking an assessment rapidly can mean a higher cost owing to the need, for example, to mobilize large field teams simultaneously and support them.
 - v. **Spatial scale.** Rapid assessments can be undertaken at a wide range of spatial scales. In general, a large-scale rapid assessment will consist of the application of a standard method to a larger number of localities or sampling stations.
 - vi. **Compilation of existing data/access to data.** Before determining whether further field-based assessment is required, it is an important first step to compile and assess as much relevant existing data and information as readily available. This part of the assessment should establish what data and information exists, and whether it is accessible. Data sources can include geographic information systems (GIS) and remote sensing information sources, published and unpublished data, and traditional knowledge and information accessed through the contribution, as appropriate, of local and indigenous people. Such compilation should be used as a “gap analysis” to determine whether the purpose of the assessment can be satisfied from existing information or whether a new field survey is required.

- vii. For any new data and information collected during a subsequent rapid assessment field survey, it is essential to create an **audit trail to the data**, including any specimens of biota collected, through the establishment of a proper metadata record for the assessment.
- viii. **Reliability of rapid assessment data.** In all instances of rapid assessment of biological diversity it is particularly important that all outputs and results include information on the confidence associated with the findings. Where practical, error propagation through the analysis of data and information should be evaluated to provide an overall estimate of confidence in the final results of the assessment.
- ix. **Dissemination of results.** A vital component of any rapid assessment is the fast, clear and open dissemination of its results to a range of stakeholders, decision-makers and local communities. It is essential to provide this information to each group in an appropriate form of presentation and appropriate level of detail.

Box 1. Ramsar definitions of inventory, assessment and monitoring

Ramsar COP8 has adopted, in Resolution VIII.6, the following definitions of wetland inventory, assessment and monitoring:

- *Inventory*: The collection and/or collation of core information for inland water management, including the provision of an information base for specific assessment and monitoring activities.
- *Assessment*: The identification of the status of, and threats to, inland waters as a basis for the collection of more specific information through monitoring activities.
- *Monitoring*: Collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. (Note that the collection of time-series information that is not hypothesis-driven from wetland assessment should be termed *surveillance* rather than monitoring, as outlined in Ramsar Resolution VI.1.)

Note that “inventory” under this definition covers baseline inventory, but in many cases, depending on specific purpose, priorities and needs, can include not only core biophysical data but also data on management features which provide “assessment” information, although this may also require more extensive data collection and analyses.

5. When is rapid assessment appropriate?

- 20. Rapid assessment is one of a suite of tools and responses that Parties can use for assessing wetlands. Not all types of data and information needed for full wetland inventory and assessment can be collected through rapid assessment methods. However, it is generally possible to collect some initial information on all generally used inventory and assessment core data fields, although for some, rapid assessment can only yield preliminary results with a low level of confidence. Such types of data and information can, however, be used to identify where more detailed follow-up assessments may be needed if resources permit.
- 21. A summary of core data fields for inventory and assessment of biophysical and management features of wetlands, derived from that in Ramsar Resolution VIII.6, and the general quality of information for each which can be gathered through rapid assessment, is provided in Table 1.

Table 1. Adequacy of data and information quality which can at least partly be collected through “rapid assessment” field survey methods for wetland inventory and assessment core data fields for biophysical and management features of wetlands
(Derived from Ramsar Resolution VIII.6)

<i>Biophysical features</i>	<i>Adequacy of data quality collected through “rapid assessment”</i>
Site name (official name of site and catchment)	✓
Area and boundary (size and variation, range and average values) *	✓
Location (projection system, map coordinates, map centroid, elevation) *	✓
Geomorphic setting (where it occurs within the landscape, linkage with other aquatic habitat, biogeographical region) *	✓
General description (shape, cross-section and plan view)	✓
Climate – zone and major features	(✓)
Soil (structure and colour)	✓
Water regime (e.g. periodicity, extent of flooding and depth, source of surface water and links with groundwater)	(✓)
Water chemistry (e.g. salinity, pH, colour, transparency, nutrients)	✓
Biota (vegetation zones and structure, animal populations and distribution, special features including rare/endangered species)	✓
<i>Management features</i>	
Land use – local, and in the river basin and/or coastal zone	(✓)
Pressures on the wetland – within the wetland and in the river basin and/or coastal zone	(✓)
Land tenure and administrative authority – for the wetland, and for critical parts of the river basin and/or coastal zone	(✓)
Conservation and management status of the wetland – including legal instruments and social or cultural traditions that influence the management of the wetland	(✓)
Ecosystem benefits/services derived from the wetland – including products, functions and attributes and, where possible, their benefits/services to human well-being	(✓)
Management plans and monitoring programmes – in place and planned within the inland water and in the river basin and/or coastal zone	(✓)

** These features can usually be derived from topographical maps or remotely sensed images, especially aerial photographs.*

22. **Addressing socio-economic and cultural features of biodiversity.** This guidance chiefly covers assessment of the biotic components of biological diversity. For many assessment purposes, it is also important to collect information on socio-economic and cultural features of biological diversity, although full economic valuation assessment is generally well outside the scope of rapid assessment. Nevertheless, as part of a rapid inventory assessment or risk assessment it may be useful to compile an initial indication of which socio-economic and cultural features are

of relevance in the survey site. This can provide an indication of the likely changes to the natural resource base, and may be used to indicate which features should be the subject of more detailed follow-up assessment.

23. For an indicative list of the socio-economic benefits/services of inland waters which are derived from biological diversity, see annex II of UNEP/CBD/SBSTTA/8/8/Add. 3. For further information on ecosystem benefits/services, see also the Millennium Ecosystem Assessment's *Ecosystems and Human Well-being* (Island Press, 2003).
24. Cultural functions and values of inland waters (derived from Ramsar COP8 DOC. 15, *Cultural aspects of wetlands*) that should be taken into account include:
 - a) Palaeontological and archaeological records;
 - b) Historic buildings and artefacts;
 - c) Cultural landscapes;
 - d) Traditional production and agro-ecosystems, e.g., ricefields, salinas, exploited estuaries;
 - e) Collective water and land management practices;
 - f) Self-management practices, including customary rights and tenure;
 - g) Traditional techniques for exploiting wetland resources;
 - h) Oral traditions;
 - i) Traditional knowledge;
 - j) Religious aspects, beliefs and mythology;
 - k) "The arts" – music, song, dance, painting, literature and cinema.
25. **Assessing threats to wetland biodiversity.** In many rapid assessments it will not be possible fully to assess the threats to, or pressures on, biological diversity. Nevertheless, as for socio-economic and cultural features, it may be useful, for identifying where the focus of any further assessment may be needed, to make a provisional assessment of threat categories. For this purpose, a checklist of threat categories such as that being developed by the IUCN Species Survival Commission (SSC) as part of their Species Information Service (SIS) may be helpful (see <http://www.iucn.org/themes/ssc/sis/authority.htm>.)

6. Rapid assessment in relation to monitoring

26. Hypothesis-based research for monitoring purposes needed for management of systems may require more comprehensive tools and methodologies than rapid assessment can provide. However, some rapid methods, although originally developed for monitoring, can equally be applied for the purposes of rapid assessment. Similarly, certain rapid assessment tools/methodologies can also be applied for longer term hypothesis-driven monitoring by repeated surveys. This can be a particularly valuable technique for addressing seasonality issues.
27. **Rapid assessment and trends in biological diversity.** Rapid assessment designed to assess trends in biological diversity implies that more than one repeat survey will be required. For gathering such information, regular time-series data may be necessary, and in such circumstances this can be considered as rapid assessment if each survey is undertaken using a rapid assessment method, although the resulting overall assessment will generally take shape over a longer time period.

28. **Seasonality.** Most rapid assessments involve a single “snapshot” survey of a locality. However, the seasonality of many wetlands and of the biota dependent upon them (for example, migratory species) means that surveys of different taxa may need to be made at different times of year. The timing of a rapid assessment in relation to seasonality is a critically important issue to take into account if the assessment is to yield reliable results.
29. Other types of temporal variations in inland wetlands may also need to be taken into account, notably variations in flow regimes of different types of inland water ecosystems, which may include:
- a) perennial systems which experience surface flow throughout the year and do not cease to flow during droughts;
 - b) seasonal systems which experience flow predictably during the annual wet season but may be dry for several months each year;
 - c) episodic (periodic or intermittent) systems, which experience flow for an extended period but are not predictable or seasonal. These systems usually have flow contribution from rainfall as well as groundwater. At times, surface flow may occur in some segments only, with subsurface flow in other segments. The fauna can differ considerably depending on the duration of flow, colonization succession of different species, proximity of other water sources, and extent of time during which previous flow occurred; or
 - d) ephemeral (short-lived) systems, which experience flow briefly and rarely and return to dry conditions in between. Their flow is usually sourced entirely from precipitation. Only aquatic biota able to complete their life cycles very rapidly (within a few days) are able to exploit such flow conditions.

7. Special considerations relating to small island states

30. **Priority types of rapid assessment in small island states.** Given the importance of often limited inland wetlands in small island states, the importance of their coastal and marine systems, a general lack of information about their biodiversity, and limited institutional capacity, rapid assessment methods are particularly valuable in small island states. Priority purposes of assessment include:
- a) qualitative and quantitative aspects of water quality and quantity;
 - b) causes of biodiversity loss and water pollution, including deforestation, pesticide flows, and other unsustainable exploitation; and
 - c) pressures of unsustainable land uses (e.g., tourism, agriculture, fisheries, industry).
31. FAO has provided detailed information on the more important fisheries and aquaculture issues in small island developing states (see <http://www.fao.org/figis/servlet/static?dom=root&xml=index.xml>) and also operates the Fisheries Global Information System (<http://www.fao.org/fi/default.asp>). The Plan of Action on Agriculture in Small Island Developing States also recognizes the particular fisheries needs of small island developing states and provides guidance on the sustainable management of inland water and other natural resources.

8. A conceptual framework for rapid assessment

32. This conceptual framework is derived from, and consistent with, the Ramsar Framework for Wetland Inventory (Resolution VIII.6). Certain modifications concerning the sequence and titling of its steps have been made to take account of the specific element of minimizing time scales which is inherent in rapid assessment.
33. The process of applying the conceptual framework is summarized in Figure 1. Steps in the conceptual framework and guidance for the application of each step are listed in Table 2.
34. The framework is designed to provide guidance for planning and undertaking the initial wetland rapid assessment. Follow-up assessments, and those for new areas using a proven procedure and method, need not go through the entire process, although a review of methodology should be undertaken in relation to possible differences in local conditions such as different wetland ecosystem types.
35. In assessments undertaken in response to an emergency, e.g., a natural or human-induced disaster, the steps of the conceptual framework should be followed as far as possible. However, it is recognized that under such circumstances the need for a very rapid response can mean that shortcuts in applying the framework may be essential (see also paragraph 53 of this guidance).

Figure 1. Summary of the key steps in applying the conceptual framework for rapid assessment (see Table 2 for further details).

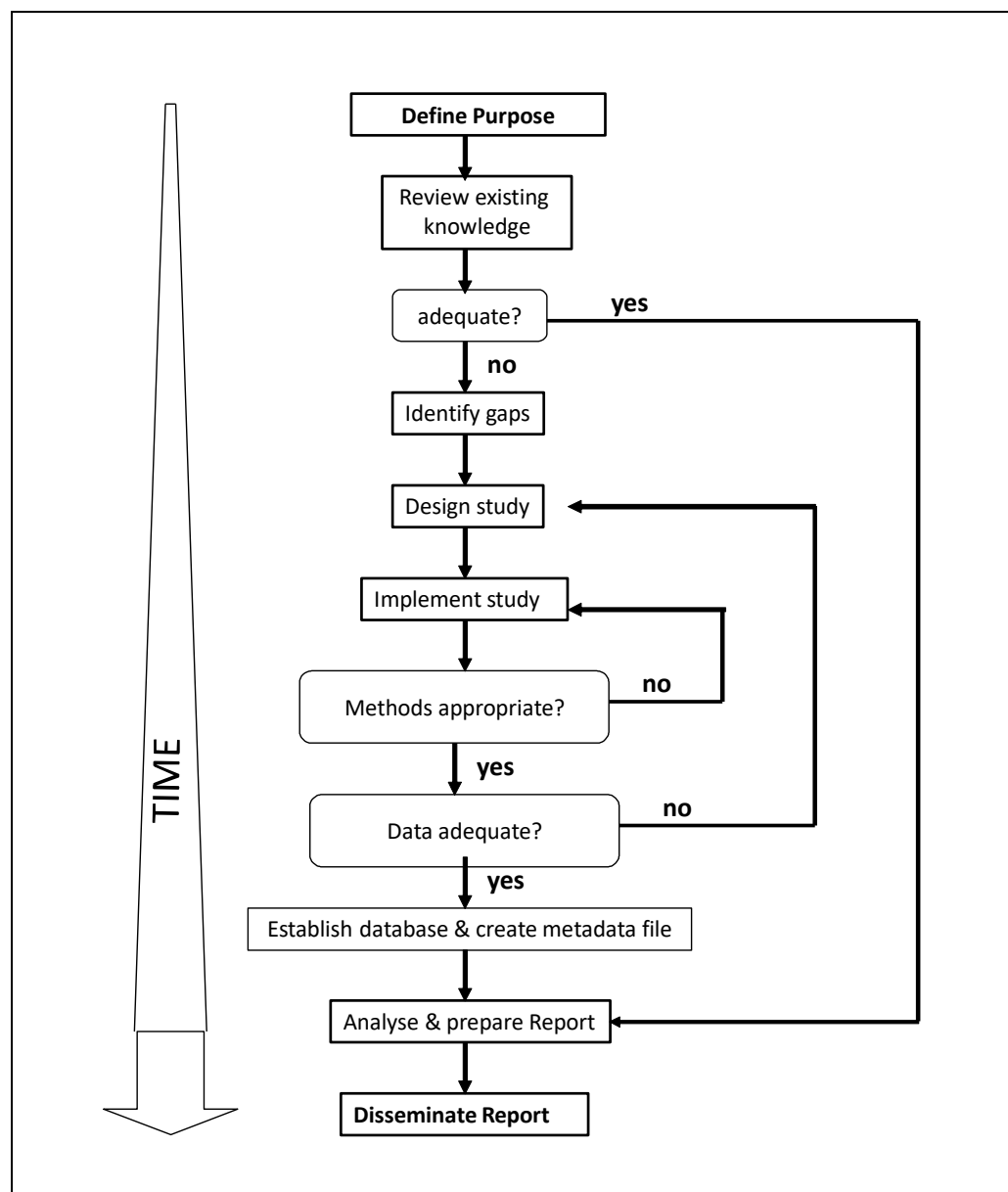


Table 2. Conceptual framework steps for designing and implementing a rapid assessment of wetland biodiversity

Step	Guidance
1. State the purpose and objective	State the reason(s) for undertaking the rapid assessment: why the information is required, and by whom it is required.
a. Determine scale and resolution	Determine the geographical scale and resolution required to achieve the purpose and objective.
b. Define a core or minimum data set	Identify the core, or minimum, data set sufficient to describe the location and size of the inland water(s) and any special features. This can be complemented by additional information on factors affecting the ecological character of the wetland and other management issues, if required.
2. Review existing knowledge and information – identify gaps (if done, write report, if not, design study)	Review available information sources and peoples' knowledge (including scientists, stakeholders, and local and indigenous communities), using desk-studies, workshops, etc., so as to determine the extent of knowledge and information available for inland water biodiversity in the region being considered. Include all available data sources ¹ ; and prioritize sites ² .
3. Study design	
a. Review existing assessment methods, and choose appropriate method	Review available methods and seek expert technical advice as needed, to choose the methods that can supply the required information. Apply Table 3 (rapid assessment types for different purposes), and then choose appropriate field survey methods.
b. Establish a habitat classification system where needed	Choose a habitat classification that suits the purpose of the assessment, since there is no single classification that has been globally accepted.
c. Establish a time schedule	Establish a time schedule for: a) planning the assessment; b) collecting, processing and interpreting the data collected; and c) reporting the results.
d. Establish the level of resources required, assess the feasibility & cost-effectiveness that are required	<p>Establish the extent and reliability of the resources available for the assessment. If necessary make contingency plans to ensure that data are not lost due to insufficiency of resources.</p> <p>Assess whether or not the programme, including reporting of the results, can be undertaken within under the current institutional, financial and staff situation.</p> <p>Determine if the costs of data acquisition and analysis are within budget and that a budget is available for the programme to be completed. [Where appropriate, plan a regular review of the programme.]</p>
e. Establish a data management system and a specimen curating system	<p>Establish clear protocols for collecting, recording and storing data, including archiving in electronic or hardcopy formats.</p> <p>Ensure adequate specimen curating. This should enable future users to determine the source of the data, and its accuracy and reliability, and to access reference collections.</p>

Step	Guidance
	<p>At this stage it is also necessary to identify suitable data analysis methods. All data analysis should be done by rigorous and tested methods and all information documented. The data management system should support, rather than constrain, the data analysis.</p> <p>A meta-database should be used to: a) record information about the inventory datasets; and b) outline details of data custodianship and access by other users. Use existing international standards (refer to the Ramsar Wetland Inventory Framework – Resolution VIII.6)</p>
f. Establish a reporting procedure	<p>Establish a procedure for interpreting and reporting all results in a timely and cost effective manner.</p> <p>The reporting should be concise, indicate whether or not the objective has been achieved, and contain recommendations for management action, including whether further data or information is required.</p>
g. Establish a review and evaluation process	<p>Establish a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust the assessment process.</p>
4. Perform study and include continuous assessment of methodology (go back and revise design if needed)	<p>Undertake study method. Test and adjust the method and specialist equipment being used, assess the training needs for staff involved, and confirm the means of collating, collecting, entering, analysing and interpreting the data. In particular, ensure that any remote sensing can be supported by appropriate “ground-truth” survey.</p>
5. Data assessment and reporting (was purpose of the study achieved? If not, go back to step 3)	<p><i>Undertake a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust or even terminate the program.</i></p> <p>Results should be provided in appropriate styles and level of detail to, <i>inter alia</i>, local authorities, local communities and other stakeholders, local and national decision-makers, donors and the scientific community.</p>

¹ It is important to include identification not just of local data and information but also other relevant national and international sources, which can provide supplementary data and information to underpin the rapid assessment (for example, the UNEP-GEMS/Water programme for water quality and quantity).

² IUCN has developed a methodology for prioritizing important sites for conservation of biodiversity of inland waters. See <http://www.iucn.org/themes/ssc/programs/freshwater.htm> for further information.

Choosing rapid assessment types and outputs for different purposes

36. The primary purpose of this guidance is to be a practical reference for deciding on appropriate methods for the rapid assessment of wetland ecosystems. Table 3 provides a schematic guide to a number of available methods used for rapid assessment of wetland ecosystems. It is meant to enable the selection of appropriate assessment methods, based on a structured framework of selection criteria. These are organized in a progression of the most important factors of assessment of wetlands. Further information on rapid assessment data collection and analysis methods are provided in Appendices 1 and 2, and further consolidated information for wetlands on choices of rapid assessment methods in relation to different resource limitations (particularly of time, money and/or expertise) and the scope of the assessment will be provided in a forthcoming *Ramsar Technical Report* (separate detailed guidance for inland waters and for coastal and marine systems is also available in the CBD materials (CBD/SBSTTA/8/INF/5 and CBD/SBSTTA/8/INF/13 respectively)).
37. Choosing an appropriate method for the rapid assessment purpose should begin with the most basic and broad elements of an assessment, and then advance through progressively more selective criteria. Eventually a general framework of the necessary assessment should emerge, taking the amalgamated form defined by its purpose, output information, available resources, and scope. The idea is to meld informational parameters, like output and purpose, with logistical parameters such as time frame, available funding, and geographical scope, in order to present a realistic assessment model and determine what methods are available for its implementation.
38. Defining the **purpose** is the first step of an assessment. Table 3 provides three general purposes corresponding to five specific purposes, which will determine the assessment type. The five specific **assessment types** used in the decision tree are: **baseline inventory**, **specific-species assessment**, **change assessment**, **indicator assessment**, **resource assessment**. The assessment types are explained in detail below.
39. Once the purpose and assessment type have been determined, a step-wise approach should be taken through the more specific components of the assessment. These include the **resource limitations** and **scope** of the various elements of the assessment. This section begins with an appraisal of the resources available for the assessment. **Time, money, and expertise** are the critical resource components considered in the tree; availability of or limitations on these resources will determine the scope and capacity of any rapid assessment. There are then six more specific parameters (*taxa, geography, site selection, methods, data collection, analysis*) to consider in determining the scope of each of those relative to the resource limitations of the assessment. Variable combinations of resource limitations and scope criteria give shape to the assessment project.

Purpose

40. The approach starts with the supposition that any rapid wetland assessment ought to be performed with the overriding goals of conservation and wise use in mind. The methods used should augment knowledge and understanding in order to establish a baseline of wetland biological diversity, assess changes in, or the health of, wetland ecosystems, and support the sustainable use of the wetland resource. There are five specific reasons within this context to undertake a rapid assessment of wetlands. These cover the breadth of possible reasons for rapid assessment:

- a) Collect general biodiversity data in order to inventory and prioritize wetland species, communities and ecosystems. Obtain baseline biodiversity information for a given area.
- b) Gather information on the status of a focus or target species (such as threatened species). Collect data pertaining to the conservation of a specific species.
- c) Gain information on the effects of human or natural disturbance (changes) on a given area or species.
- d) Gather information that is indicative of the general ecosystem health or condition of a specific wetland ecosystem. And
- e) Determine the potential for sustainable use of biological resources in a particular wetland ecosystem.

41. The five purposes are numbered according to the assessment type to which they correspond. The columns in Table 3 are related to the three objectives of the Convention on Biological Diversity. Columns I and II (Inventory assessment and species assessment) are related to the conservation of biodiversity. Columns III, IV and V (Change, indicator, and resource assessments) address sustainable use while column V (Resource assessment) also refers to the equitable sharing of the benefits arising out of the utilization of genetic resources.

Table 3. Rapid Assessment types and possible outputs for different purposes

General purpose	Biodiversity baseline		Disturbance and ecosystem health		Resource sustainability and economics
Specific purposes	Baseline inventory; prioritization; conservation; identification	Conservation of specific species; status of alien species	Change detection	Overall ecosystem health or condition	Sustainable use of biological resources
Assessment type	Baseline inventory	Species-specific assessment	Change Assessment	Indicator assessment	Resource assessment
Types of data and analyses possible	1. Species lists/inventories. 2. Habitat type lists/inventories. 3. Limited data on population size/structure, community structure and function, and species interactions 4. Abundances, distribution patterns, and ranges. 5. Genetic information. 6. Important species: threatened, endangered, endemics, migratory, invasive alien species, other significance: cultural, scientific, economic, nutritional, social. 7. Diversity indices. 8. Water quality data. 9. Hydrological information.	1. Status of a focal species: distribution, abundance, population size/structure, genetic, health, size, species interactions, nesting, breeding and feeding information. 2. Ecological data on focal species; habitat, symbionts, predators, prey etc. 3. Threats to focal species and habitats. 4. Life history table. 5. Water quality data. 6. Hydrological information.	1. Monitoring data. 2. Effects of an activity or disturbance on habitat/species/communities: diversity loss, genetic issues, habitat changes or loss. 3. Monitor impacts. 4. Determine changes in ecological character. 5. Impact reduction options. 6. Biotic indices. 7. Habitat indices. 8. Water quality data. 9. Hydrological information. 10. Early warning indicators.	1. Data on health or condition of inland water systems. 2. Water quality data. 3. Hydrological information. 4. Biological parameters. 5. Biotic indices.	1. Presence, status and condition of economically, culturally, nutritionally, and socially important species. 2. Information on sustainability of use of a species. 3. Limited monitoring data: stock assessment data, habitat status. 4. Limited information relevant to resource management. 5. Water quality data. 6. Hydrological information.
May also depend on:		Inventory assessment	Inventory assessment (recommended)		Species-specific assessment

Assessment types

42. In order to choose an adequate method for the assessment of wetland biodiversity, five types of rapid assessment are recognized that apply to wetlands. These assessment types vary according to the purpose and desired output of a particular assessment project. Each assessment type has specific outputs and applies to specific purposes. It is therefore important to determine the goals and overall purpose of any assessment relating to diversity, conservation, and management. Any particular project, defined by its purpose and output goals, should fall within the range of one or more of these five assessment types. The assessment types are briefly described below.

Baseline Inventory

43. Baseline inventories focus on overall biological diversity rather than extensive or detailed information about specific taxa or habitats. The goal is to gather as much information as possible about the wetland ecosystem through extensive and, as much as possible, comprehensive sampling of its biological constituents and related features (see also Ramsar Wise Use Handbook 10, *Wetland Inventory*). Species and habitat type lists are likely to be the most important form of data, but other relevant baseline data could include: species richness, abundances, relative population sizes, distribution and ranges, cultural significance in addition to biodiversity significance, and other relevant biological information pertaining to water quality (see e.g. DePauw & Vanhooren 1983 and USGS National water quality assessment program on <http://water.usgs.gov>), hydrology and ecosystem health. Data on geography, geology, climate, and habitat are also important. Local communities can be a valuable source of information concerning species richness of a habitat. For example, through community and consumption surveys information can be gathered in a short time span.
44. A full species baseline inventory involves an intense sampling effort to take inventory of the species present in an area. This inventory can then be used to determine the conservation value of an area in terms of its biodiversity. The goal is to sample as many sites and list as many species as possible in the short amount of time allotted for the assessment. Ideally, the species lists would correspond to specific sampling sites within the survey area. Separate lists of species for each taxonomic group observed/collected at each sampling site are useful in order to distinguish among different habitats and localities in the survey area. Taxonomic data would likely include sampling of fish, plankton, epiphytic and benthic invertebrates, aquatic and terrestrial plants, and algae.
45. Wetland habitat types can be inventoried through field survey or analysis of Geographic Information Systems (GIS) and remote-sensing data (see also Appendices II and III of the Ramsar "Framework for Wetland Inventory" (Resolution VIII.6); and the planned *Ramsar Technical Report* "Guidance for GIS applications for wetland inventory, assessment and monitoring"). To inventory habitat types in the field, several sites need to be sampled in order to get a range of habitat types of the area and the ecological gradations within it. If GIS is available, classification of wetland habitat types is possible using spatial data such as elevation, physiography, and vegetative cover. Ideally, information gathered during the assessment on wetland species and ecosystems should be geo-referenced.
46. A baseline inventory provides initial information about a defined area of interest. The output information could be useful in prioritizing species or areas of particular concern for conservation, identifying new species, and developing a broad view of the overall biodiversity of an area. For conservation and management, this information is especially pertinent in the

prioritization of species and areas. Prioritized species should then be assessed according to species-specific assessment methods. If localities or habitats are prioritized for particular human stresses on them, then they should be considered for assessment according to the change assessment methods.

47. Possible outputs from an inventory assessment include:

Data:

- Baseline wetland biodiversity data: species lists/inventories, habitat type lists/inventories, limited data on population size/structure, abundances, distributional patterns and ranges
- Ecological data pertaining to the area: important wetland habitats, communities and their relationships
- Background information on geology, geography, water quality, hydrology, climate, and habitat zones for greater ecological context

Applications:

- Species prioritization: identify and prioritize any species of special concern or interest
- Area/habitat prioritization: identify and describe important habitats or areas
- Conservation recommendations
- Basic data and diversity indices (see also Appendix 1)

Species-specific assessment

48. A species-specific assessment provides a rapid appraisal of the status of a particular wetland species or taxonomic group in a given area. The assessment provides more detailed biological information about the focus species within the context of its protection, use, or eradication (e.g., in the case of invasive species). Thus, this assessment type generally pertains to ecologically or economically important species and can provide rapid information about an important species in an area where its status is unknown or of particular interest. Likewise, the assessment can be used to confirm the status of species as threatened, endangered, or stable in a certain area (if the assessment is repeated more than once).

49. Possible outputs from a species-specific assessment include:

Data:

- Data pertaining to the status of focal species: distribution, abundance, population size/structure, genetics, health, size, nesting, breeding and feeding information
- Ecology and behaviour, information pertaining to focal species: habitat, range, symbionts, predators, prey, reproductive and breeding information

Applications:

- Conservation recommendations
- Identification of economic possibilities/interests
- Identification of threats and stresses to focal species and habitat
- Assessment of status of alien species
- Habitat classifications and similarity/comparative indices (see Appendix 1)

Change assessment

50. Often an assessment is needed in order to determine the effects of human activities (pollution, physical alterations, etc.) or natural disturbances (storms, exceptional drought, etc.) on the

ecological integrity of a wetland area. The information collected in this type of assessment can be either retrospective or predictive in nature. Such predictive assessments are often undertaken in Environmental Impact Assessment of projects (see also Ramsar Wise Use Handbook 11, Impact assessment).

51. A retrospective approach aims to assess actual disturbances or alterations of various projects or management practices as they apply to biodiversity and biological integrity. In terms of biodiversity, this approach can be difficult without pre-disturbance (baseline) data for comparison, and it may therefore require trend analyses or the use of reference sites or environmental quality standards (EQS). Reference sites are areas of the same region that parallel the pre-disturbance condition of the impacted area in order to provide data for comparative analysis.
52. Four approaches to rapid assessment of change can be distinguished:
 - a) Comparing two or more different sites at the same time;
 - b) Comparing the same site at different times (trends);
 - c) Comparing the impacted site to a reference site;
 - d) Comparing the observed status to environmental quality standards. Most existing rapid assessment methods are designed for this purpose; some of these (either biological, physical-chemical or eco-toxicological) may also be used as “early warning indicators” (see also Ramsar’s risk assessment guidance - Annex to Resolution VII.10 & Ramsar Wise Use Handbook 8: Section E; and guidance on vulnerability assessment [*Ramsar Technical Report*]).
53. Rapid change assessment methods can be particularly helpful for assessing the impacts of natural (and other) disasters such as floods, storm surges, and tsunamis. Several methods for the rapid assessment of coastal wetland systems for the aftermath of disasters have been developed specifically as response tools for the Indian Ocean tsunami of December 2004. These include:
 - i) A “Field protocol for the rapid assessment of coastal ecosystems following natural disasters”, using a coastal transect approach to assess if certain types of wetlands, (including mangroves and coral reefs, tidal flats, and saltmarshes) measurably reduced the damaging effects of the tsunami on people and infrastructure and to determine how wetland benefits/services and ecological restoration can help to recover lost livelihoods (available on: <http://www.wetlands.org/Tsunami/data/Assessment%20v3.doc>); and
 - ii) “Guidelines for Rapid Assessment and Monitoring of Tsunami Damage to Coral Reefs”, prepared by the International Coral Reef Initiative (ICRI) and the International Society for Reef Studies (ICRS) (available on: http://www.unep-wcmc.org/latenews/emergency/tsunami_2004/coral_ass.htm; <http://www.icriforum.org/> and <http://www.ReefBase.org/>
54. A predictive approach would assess the *potential* consequences of a particular project, such as a dam or development, and also establish a baseline of biodiversity data for long-term monitoring of the changes. This approach allows for “before and after” assessment data, as well as for identification of species and habitat areas likely to be affected by the impending changes. Comparative analysis of areas where changes have already occurred can be used to predict potential impacts. This is the field of environmental impact assessment (EIA) (see also Ramsar Resolution VIII.9 and Ramsar Wise Use Handbook 11), trend- and scenario-analysis, and modelling (in terms of predictions). It relies to a large extent on the results of a retrospective

approach, specifically early warning indicators. There is a direct link between the predictive approach and policy responses. However, most of these methods are not generally very “rapid”.

55. Special attention must be paid to changes at a biological community level, which may occur even when habitat conditions remain the same. This is the case with fast-spreading pioneer species adapted to the post-disturbance ecological conditions, which replace naturally occurring species. This presents a difficult question concerning the condition of the system, which may become more species-rich compared to its ecological history. The situation is especially complex when new species are considered more desirable than those that made up the original ecological system. Change assessment outputs are grouped below depending on whether they pertain to existing or potential changes.

56. Possible outputs from a change assessment include:

Data:

- Baseline biodiversity data for long-term monitoring of changes. Species lists, abundances, distribution, densities
- Geology, geography, water quality, hydrology, climate, and habitat information pertinent to the particular impact on the greater ecological context of the area
- Basic information for wetland risk assessment and EIA, and
- Data on specific taxa, changes in water quality, hydrological alterations and habitat structure (requires baseline or reference site data)

Applications:

- Identify and prioritize species and communities within the impact range
- Identify and prioritize important habitats within the impact range
- Predict potential impacts through comparison of existing impacts in similar sites
- Determine effects of human pressures and natural stresses on biodiversity and habitat structure
- Identify specific pressures and stresses related to impact
- Identify possible management practices to mitigate pressures and stresses
- Make conservation recommendations
- Determine biotic indices, scores and multimetrics (see Appendix 1; and Fausch et al. 1984; Goldstein et al. 2002; and Karr 1981)

Indicator Assessment

57. An indicator assessment assumes that biological diversity, in terms of species and community diversity, can tell us a great deal about the water quality, hydrology and overall health of particular ecosystems. Biomonitoring is often associated with this type of assessment – this traditionally refers to the use of biological indicators to monitor levels of toxicity and chemical content, but recently this type of approach has been more broadly applied to monitoring the overall health of a system rather than its physical and chemical parameters alone (see Nixon et al. 1996). The presence or absence of certain chemical or biological indicators can reflect environmental conditions. Taxonomic groups, individual species, groups of species, or entire communities can be used as indicators. Typically, benthic macro-invertebrates, fish, and algae are used as organismic indicators (see Rosenberg & Resh 1993; Troychak 1997). It is therefore possible to use species presence/absence, and in some instances abundances and habitat characteristics, to assess the condition of wetland ecosystems.

58. Possible outputs from an indicator assessment include:

Data:

- Presence/absence/abundance of species or taxa
- Taxonomic diversity
- Physical/chemical data (e.g., pH/conductivity/turbidity/O₂/salinity)

Applications:

- Assess the overall health or condition of a given inland water ecosystem
- Assess water quality and hydrological status
- Make conservation recommendations
- Indices of diversity and ecosystem health, habitat classification, physical-chemical assessment methods and basic data on biological assessment (see Appendix 1 for further details on biomonitoring indices)

Resource assessment

59. A resource assessment aims to determine the potential for sustainable use of biological resources in a given area or water system. Data pertain to the presence, status and condition of economically important species, species on which livelihoods depend, or those with a potential market value. Ideally a resource assessment can facilitate the development of ecologically sustainable development as an alternative to destructive or unsustainable activities.
60. Thus, a major objective of the resource assessment is to develop or determine sustainable use practices as viable economic options in areas with rich biological resources. For this reason, an important factor of resource assessment is the full involvement of local communities and governments, for example through community biodiversity surveys (see NSW National Parks and Wildlife Service 2002). This is especially important in relation to the needs, capacity and expectations of all involved parties. This integrative approach is important to the successful implementation of any sustainable harvesting system. Another extension of a resource assessment may be to provide baseline information used to monitor the health of fisheries and other resources.
61. The use of methods for the economic valuation of wetlands are highly relevant to resource assessment, and a number of such methods can be considered as “rapid”. (Further information on available wetland economic valuation methods is available in a forthcoming *Ramsar Technical Report* and in the Ramsar publication *Economic Valuation of Wetlands: a Guide for Policy Makers and Planners* (1997).
62. Possible outputs from a resource assessment include:

Data:

- Determine the presence, status and condition of socio-economically important species
- Identify important parties
- Identify interests, capacity, and expectations of all involved parties
- Collect baseline monitoring data such as stock assessments, and
- Assess the socio-economic consequences of different resource management options.

Applications:

- Fishery and other aquatic resources sustainability, habitat status, stock assessments, information for fishermen/resource users
- Options for sustainable development and recommendations for management.

9. Design considerations

A. Resources

63. The methods available for rapid wetland biodiversity assessment are contingent on the purpose and output of specific projects. Equally important is a consideration of available resources and limitations, especially as they apply to the scope of the assessment. **Time, money** and **expertise** are resource limitations that determine the methodologies available to a particular assessment project. Furthermore, they define the project in terms of its scope in the following areas: **taxa, geography, site selection, analysis, data, and sampling methods**. These are important components of a wetland biodiversity assessment, and the scope or capacity of each vary depending on the project needs and its resource limitations.
64. Time, money and expertise are the key factors to consider in a rapid wetland biodiversity assessment. In abundance, these resources allow for a great deal of flexibility, while insufficiency limits nearly all aspects of a potential assessment project. However, in some cases abundance in one area can compensate for limitations in another. The availability of these resources will, to a large extent, determine the scope and capabilities of the assessment.

i) Time

65. Time is a fundamental consideration for any *rapid* assessment.
66. Scientifically, long-term monitoring and research offer statistical advantages over rapid assessment. With these, more detailed and thorough sampling is possible, which can measure change over time and produce more statistically rigorous results. However, the short time frame implicit in a rapid assessment is what makes this type of survey appealing; it allows for a snapshot or overview allowing fast judgment about the condition of an area. Thus, rapid assessment can provide information when informed decisions need to be taken urgently. Rapid assessment can also be a good way to establish baseline data that can then be used for further study if warranted. The amount of time available for the assessment is an important resource, and adequate planning should determine how it will be spent. Rapid assessment can never replace long-term monitoring and research.
67. There is flexibility in the definition of “rapid” but the term implies that time is of the essence. The time frames for rapid assessment are broadly based on typical lengths of *rapid* assessments and are separated as follows: *short* (1-7 days), *medium* (8-30 days), and *long* (30+ days). This refers to the amount of time to complete the entire project from start to finish, including transport, data collection, and preliminary analysis. Final analysis and results may take more time, but preliminary conclusions are important and need to be available quickly – otherwise the purpose of a *rapid* assessment is lost.

ii) Money

68. The amount of funding available for an assessment will, along with time, determine the capabilities and scope of a rapid wetland assessment. Because monetary amounts are relative, and broad categories cannot account for the fluid nature of currency values, a simple categorization is used. This is not based on values or actual monetary amounts, but rather on the relative amount of funding available to carry out the assessment. Therefore, the available capital for a given assessment is either *limited*, meaning that it can be considered limiting, or

less than the amount desired to carry out the objectives of the project, or *ample*, meaning that there is enough money to carry out all elements of the assessment in a scientifically sound and usable way.

iii) Expertise

69. An expert is someone who, for example, can identify specimens of a taxonomic group to the species level, is familiar with current sampling and collection methods, can analyse data, and is familiar with the taxonomic group within a larger biological and ecological context. It does not refer to people with a general understanding or basic knowledge in the field. It is important to determine the availability of experts on a local, regional and international level. Local expertise is a great resource when it is available. Often local experts will have a good understanding of local geography, ecology, and community issues. However, if there is no local expert, an expert from outside the locality or region may need to be brought in. In highly specialized cases there may only be a small number of people, or even just one person, who can be considered an expert in the area of study.
70. Institutional support refers to the use of technical facilities for analysis, storage of data, and other forms of support. Determination of the available expertise should include a consideration of the institutional support that is available, as this may present a limitation to the capacity and scope of any project. In deciding on what form of rapid assessment is feasible, it is important to determine whether individuals who are experts in the field of study (including local experts) are or are not available for the assessment project.

B. Scope

71. The scope requires a consideration of the scale of various elements of an assessment. How much area does the assessment cover? How many species will be sampled? How much data will be collected? How many sites will be sampled?
72. In general the scope of a rapid assessment is contingent upon the purpose and resources of the assessment. Ample resources allow for proportional increases in the scope of various parts of an assessment. It is difficult to have an extensive geographic scope for a two-day assessment on a tight budget. In this respect some aspects of the scope are related to one another as well. For example, it *could* be possible to survey a broad geographic area in two days if the scope of the site selection and data collection were both highly reduced. In general, if the resources for an assessment are ample, the scope becomes entirely dependent on the purpose and objectives of the project.
73. The scope of an assessment can vary internally in the following areas: ***taxa, geography, site selection, sampling, and data analysis***. Each of these should be considered separately. For example, a given assessment project may have a broad geographical scope, covering an expansive area, while the taxonomic scope could be quite focused, concentrating on a limited number of taxonomic groups.

i) Taxonomic scope

74. The taxonomic scope depends upon how many and which taxonomic groups will be involved in the study. Some surveys may focus solely on aquatic invertebrates, while others may include several taxonomic groups. Typically the purpose of the assessment will determine which groups are pertinent to the study, as certain taxonomic groups will be more or less useful in certain

assessment types. For example, benthic macro-invertebrates are often used in impact assessments of rivers and streams because they are sensitive to water conditions and are relatively easy to sample. Some types of aquatic mammals or bird species are also affected by changes in water conditions, but they are more difficult to sample and are not good indicators of these changes since the response is more subtle and takes place over a longer time frame.

75. It is important to consider that in any given assessment, certain species or taxonomic groups will be more easily sampled than others. The cost (in terms of time and money) of including a taxonomic group that is particularly difficult to survey must be weighed against the benefits of including that group. In some cases it may be better to forego certain groups if time and money would be better spent on other groups. Related to this is the relative size of the taxonomic group involved. In a given area, the taxonomic scope of a survey of, for example, caddisflies (Trichoptera) may be greater than a survey focusing on aquatic mammals, birds and fish species.

ii) Geographic scope

76. The geographic scope of an assessment depends upon the taxonomic groups involved and/or the size of the area relevant to the project. The geographic scope can vary depending upon the range of a particular species, the extent of a particular ecosystem or habitat, or the area affected by an impact. This could range from small microhabitats such as a specific sediment type or it may extend across relatively large geographical areas, such as entire watersheds, lake systems, basins or coastal zones.
77. The geographic scope will also vary depending on how large an area must be studied in order to obtain statistically sound data. Therefore, it is important to determine the geographic scope in terms of the range or size of the surveyed area, and also the number of habitats to be studied. The ability to assess these different levels of geographic scope is dependent on the resources available to the project.

iii) Site selection

78. Site selection refers to the number and type of wetland sites needed for the assessment. As for geographic scope, site selection is highly dependent on other aspects of the assessment. A baseline inventory requires a relatively broad assessment of the biodiversity at several sites with variable habitats. A species-specific assessment would concentrate on habitats used by the target species and may forego several sampling sites in order to provide greater depth of study in fewer sites. Site selection for an impact assessment would concentrate on sites associated with the impact in question. Resource-assessment sites focus on areas that could be used for exploitation. An indicator assessment would include as many sites as are needed to produce the necessary data.
79. In considering the type of sites to be selected, one possible question is whether sites should be chosen by virtue of being characteristic or distinct. Characteristic sites are representative of the typical habitat of a given area. However, in most areas, habitat is not continuous, and localized gradations in habitat create a mosaic of related but distinct communities that grade into one another. Selecting distinct sites allows for surveys of these unique and specialized habitats.
80. Choosing between distinct versus representative habitats often depends on the resources and purpose of the assessment. If time is short, it may be best to quickly survey representative areas in order to get a good general picture of the situation before trying to assess more unique

sites. If more time is available, and the purpose is to survey as many species as possible, or to describe habitat types, then distinctive habitats may deserve more attention.

81. Consideration should also be given to site accessibility, taking into account factors such as remoteness, restrictions due to land use (e.g. military zones), land tenure, susceptibility to flood/fire events, and seasonal/weather conditions.

C. *Sampling and data analysis*

82. The type of sampling method used is determined according to the objective of the assessment and should be more or less the same for all nations, including small island states. The sampling methods used will vary according to the need to be standardized, whether they can or cannot be technical, the time limitations, and the type of equipment available. Most importantly, the methods should strive to provide insightful, statistically sound data that can be applied to the purpose of the assessment.
83. For most studies, a variety of water quality variables should be measured. These can include temperature, electrical conductivity (EC, a measure of the total dissolved salts), pH (an measure of the water's acidity or alkalinity), chlorophyll A, total phosphorous, total nitrogen, dissolved oxygen, and water transparency (Secchi depth). These variables can be measured with individual instruments or with one combination instrument that includes several types of probes.
84. Macrophytes can be searched visually from above or under the water surface (scuba) or by means of special samplers. Fishes can be sampled using a wide variety of methods (see Appendix 2), keeping in mind the applicable legislation. Asking local fishermen and examining their catches can be a helpful method as well. Aquatic invertebrates can be sampled from the water column (plankton), from emergent, floating-leaved, and submerged vegetation (epiphytic fauna), and from the bottom sediments (benthic invertebrates) by appropriate sampling technique. Reptiles and amphibians are generally sampled using nets, traps or by visual search during day and night.
85. Appendix 2 lists a wide range of sampling methods for different wetland features and taxa which can be used in rapid assessments. Some other useful general reference sources for sampling methods include: Merritt et al (1996); James & Edison (1979); Platts et al (1983); Nielsen & Johnston (1996); and Sutherland (2000). Useful websites for reference include: the United States Environmental Protection Agency (www.epa.gov/owow/monitoring), the World Conservation Monitoring Centre (www.unep-wcmc.org), the World Biodiversity Database provided by the Expert Center for Taxonomic Identification (ETI) (www.eti.uva.nl), and the Ecological Monitoring and Assessment Network (Canada; <http://www.eman-rese.ca/eman/intro.html>).
86. In the context of rapid assessment, data used should be of the appropriate type and quality for their intended use. If more resources are available in time, money and expertise, the possibilities of obtaining reliable data and sound statistical results are higher. In addition, it is important to gather pre-existing information on the site, the species, the habitats to gain better insight on the types of data, sampling designs and analyses needed in the assessment.
87. The following seven questions should be addressed in collecting data:

- a) **What are the types of data?** The variables of concern are determined by the purpose of the assessment. They can be qualitative such as lists, classes or categories used for example in inventories and ecological description or they can be quantitative, numerically based, such as counts and measurements used for example in population densities, abundances, etc. The variables needed to be collected to calculate specific metrics are well documented (see e.g. Barbour et al 1999);
- b) **How to collect data?** There are two types of sampling designs: probability sampling based on randomness and targeted design that focuses on site-specific problems. Probability sampling design allows making inference about an entire region based on estimates on the sample sites. Simple random sampling defines the population and then randomly selects from the entire population. When there is variability associated with groups or habitats, stratified random sampling can lower the error associated with population estimates. Cluster sampling is designed for very large populations, first grouping sampling units into clusters which are often based on geographic proximity, then clusters are randomly selected and data are only collected from sampling units within these clusters. The use of GIS reduces the effort and time in randomly selecting the assessment sites. Finally, sampling should follow protocols such as those established for sampling fish, macroinvertebrates and periphyton. The Ecological Monitoring and Assessment Network hosted by Environment Canada provides detailed information on monitoring protocols for various taxa (<http://eqb-dqe.cciw.ca/eman/ecotools/protocols/freshwater>).
- c) **How much data to collect?** The sample size depends on factors such as the resources available, the geographic and temporal scope of the assessment, and the confidence levels. The number and type of sites should provide an adequate sampling for quantitative or qualitative analysis. In general, the greater the number of sites sampled, the greater coverage of the area. Choosing fewer sites allows for more in-depth survey at each site. For some assessments, an increased number of sampling sites may be beneficial, where as others may warrant more time spent at each site for more intense sampling. The choice is not “either/or”, and consideration should be given to reach the best compromise between coverage and intensity. Replicates are needed to account for variance associated with measurement error in an assessment;
- d) **How to enter data?** Using bioinformatics (software, database applications, etc.) to manage data is very reliable and useful. The application can be developed to serve the specific needs of the assessment. Field data sheets or forms can be printed out and filled on site. Biodiversity informatics allows for more efficient analysis, dissemination and integration of the results with other databases. Examples of field data sheets for inland wetlands are provided by the EPA program on Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers (<http://www.epa.gov/OWOW/monitoring/techmon.html>);
- e) **How to analyse data?** Depending on the data collected and the purpose of the assessment, methods used for analyses could be simple descriptive, univariate, EDA (exploratory data analysis), or multivariate (clustering, similarity analysis, ordination, MANOVA). Two approaches have been used: multimetrics used by most water resource agencies in the United States or multivariate used by several water resource agencies in Europe and Australia (for further details on measurements of ecological diversity see Magurran 1988); and
- f) **How to integrate data and report on it?** It is important to integrate data from one assemblage to those of other assemblages to complement the assessment at a larger

spatial and temporal scale and to provide more complete assessment of biological diversity. Assessment reports should contain the scientific information, results and recommendations for further action to guide authorities, scientists, but also to reach a broader, non-scientific audience by adding graphical displays, and presentation on multimedia tools. Finally, depending on the ownership of the information, the database collection and the results should be disseminated through the internet and relevant networks of biological information to serve the needs of diverse user groups.

10. References

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Appendix 1

Assessment analysis methods and indices

This Appendix provides a non-exhaustive and indicative list of analysis methods and indices relevant to different aspects of wetland rapid assessment, as well as reference sources to reviews or key papers for further information. For 'Application': IW = inland wetlands; MC = coastal/marine wetlands.

Assessment method	Application	References
<i>Habitat assessment methods</i>		
Habitat classifications		
River Habitat Survey (RHS)	IW	Raven et al. (1998)
CORINE Biotopes classification	terrestrial, aquatic	Nixon et al. (1996)
Ecological Systems Classification	aquatic, terrestrial	Groves et al. (2002)
Huet's Fish zones	IW	Nixon et al. (1996)
Davidson's aquatic communities	estuaries	Nixon et al. (1996)
EUNIS habitat classification	MC	http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html
US NOAA habitat classification	MC: Pacific and Caribbean	http://biogeo.nos.noaa.gov/benthicmap/
Predictive systems		
RIVPACS	rivers, benthic macroinvertebrates	Nixon et al. (1996)
AUSRIVAS	IW: macroinvertebrates	http://www.deh.gov.au/water/rivers/monitoring.html http://ausrivas.canberra.edu.au/main.html Schofield & Davis (1996)
HABSCORE	rivers, salmonids	Nixon et al. (1996)
Ecopath with Ecosim	Ecosystem effects of fishing, management applications	http://www.ecopath.org/
<i>Physical-chemical assessment methods</i>		
AUSRIVAS geoassessment	IW	http://www.deh.gov.au/water/rivers/monitoring.html Parsons et al. (2002)
Prati Index	IW/MC	Prati et al. (1971)
<i>Biological assessment methods</i>		
Basic data		
Abundance of individuals of given taxa	IW/MC	Hellawell (1986)
Total numbers of individuals (without identification)	IW/MC	Hellawell (1986)
Species richness	IW/MC	Hellawell (1986)
Diversity Indices		
Simpson's index	IW/MC	Washington (1984), Hellawell (1986)
Kothé's Species Deficit	IW/MC	Washington (1984)
Odum's 'species per thousand'	IW/MC	Washington (1984)
Gleason's Index	IW/MC	Washington (1984)
Margalef's Index	IW/MC	Washington (1984), Hellawell (1986)

Assessment method	Application	References
Menhinick's Index	IW/MC	Washington (1984), Hellawell (1986)
Motomura's geometric series	IW/MC	Washington (1984)
Fisher's 'alpha' (= William's alpha)	IW/MC	Washington (1984), Hellawell (1986)
Yules 'characteristic'	IW/MC	Washington (1984)
Preston's log-normal	IW/MC	Washington (1984)
Brillouins H	IW/MC	Washington (1984)
Shannon-Wiener H'	IW/MC	Washington (1984), Hellawell (1986)
Pielou Eveness	IW/MC	Washington (1984)
Redundancy R	IW/MC	Washington (1984)
Hurlbert's PIE encounter index	IW/MC	Washington (1984)
McIntosh's M	IW/MC	Washington (1984), Hellawell (1986)
Cairns Sequential Comparison Index (SCI)	IW/MC	Washington (1984), Persoone & De Pauw (1979), Hellawell (1986)
Keefe's TU	IW/MC	Washington (1984)
Biotic indices, scores and multimetrics		
Saprobic systems		
Kolkwitz & Marsson's Saprobic System	IW/MC: bacteria, protozoa	Washington (1984)
Liebmann	IW/MC	Persoone & De Pauw (1979)
Fjerdingsstad	IW/MC	Persoone & De Pauw (1979)
Sladecsek	IW/MC	Persoone & De Pauw (1979)
Caspers & Karbe	IW/MC	Persoone & De Pauw (1979)
Pantle & Buck	IW/MC	Persoone & De Pauw (1979)
Zelinka & Marvan	IW/MC	Persoone & De Pauw (1979)
Knöpp	IW/MC	Persoone & De Pauw (1979)
Algae		
Palmer's Index	IW/MC: algae	Washington (1984)
Plants		
Haslam & Wolsley's Stream Damage Rating and Pollution Index	IW	Nixon et al. (1996)
Plant Score	IW	Nixon et al. (1996)
Newbold & Holmes' Trophic Index	IW	Nixon et al. (1996)
Fabienne et al.'s Macrophyte Trophic Index	IW	Nixon et al. (1996)
Macroinvertebrate systems		
Wright and Tidd's 'oligochaete indicator'	Oligochaeta	Washington (1984)
Beck's index	macroinvertebrates	Washington (1984)
Beak et al.'s 'lake' index	IW: lakes	Washington (1984)
Beak's 'river' index	IW: macroinvertebrates	Washington (1984)
Woodiwiss' Trent Biotic Index (TBI)	macroinvertebrates	Washington (1984)
Chandler's Biotic Score	macroinvertebrates	Washington (1984)
Biological Monitoring Working Party Score (BMWP)	macroinvertebrates	Metcalfe (1989)
Average Score Per Taxon (ASPT)	macroinvertebrates	Metcalfe (1989)
Tuffery & Verneaux's Indice Biotique de Qualité Générale	macroinvertebrates	Persoone & De Pauw (1979) Metcalfe (1989)
Indice Biologique Global (IBG)	macroinvertebrates	Metcalfe (1989), AFNOR T90-350

Assessment method	Application	References
		(http://www.afnor.fr/portail.asp?Lang=English). Standard available for purchase from: http://www.boutique.afnor.fr/Boutique.asp?lang=English&aff=1533&url=NRM%5Fn%5Fhome%2Easp
Belgian Biotic Index (BBI)	macroinvertebrates	De Pauw & Vanhooren (1984)
Goodnights and Whitleys 'oligochaetes'	Oligochaeta	Washington (1984)
Kings and Balls' Index	tubificids, aquatic insects	Washington (1984)
Graham's Index	macroinvertebrates	Washington (1984)
Brinkhurst's index	Tubificids, Limnodrilus	Washington (1984)
Raffaelli and Mason's index	Nematodes, copepods	Washington (1984)
Sander Rarefaction method	Polychaetes & bivalves (marine)	Washington (1984)
Heister's modification to Beck's index	macroinvertebrates	Washington (1984)
Hilsenhoff's index	macroinvertebrates	Washington (1984)
EPT-index	Ephemeroptera, Plecoptera, Trichoptera	
Rafaelli and Mason's index		Washington (1984)
K135 Quality Index (Netherlands)	macroinvertebrates	Nixon et al. (1996)
Danish Fauna Index	macroinvertebrates	Nixon et al. (1996)
Wiederholm's Benthic Quality index (BQI)	IW: chironomids, oligochaetes (lakes)	Nixon et al. (1996)
Detrended Correspondence Analyses (DCA)	IW: lakes	Nixon et al. (1996)
Jeffrey's Biological Quality Index (BQI)	macroinvertebrates (estuaries, coastal waters)	Nixon et al. (1996)
Biotic Sediment Index (BSI)	macroinvertebrates (sediments)	De Pauw & Heylen (2001)
Fish		
Karr's Index of Biotic Integrity (IBI) (Fish index)	IW/MC: fish	Karr (1981)
Birds		
International Waterbird Census (IWC) for wintering waterbirds	IW/MC: birds	Nixon et al. (1996); http://www.wetlands.org/IWC/Manuals.htm
"all in"-systems		
Patrick's histograms	IW/MC: algae to fish; except bacteria	Washington (1984)
Chutter's index	IW/MC: all; except Cladocera & Copepoda	Washington (1984)
Similarity indices / Comparative indices		
Jaccard's index	IW/MC	Washington (1984), Hellawell (1986)
Percentage similarity (PSC)	IW/MC	Washington (1984)
Bray-Curtis dissimilarity	IW/MC	Washington (1984)
Pinkham and Pearson's Index	IW/MC	Washington (1984)
Euclidean or 'ecological' distance	IW/MC	Washington (1984)
Sorensen Quotient of similarity	IW/MC	Hellawell (1986)
Mountfort Index of similarity	IW/MC	Hellawell (1986)
Raabe's Comparative measure	IW/MC	Hellawell (1986)
Kulezynski's Coefficient of similarity	IW/MC	Hellawell (1986)
Czekanowski's Comparative measure	IW/MC	Hellawell (1986)

Assessment method	Application	References
Sokal's Distance measure	IW/MC	Hellawell (1986)
Ecosystem health		
AMOEBa	IW/MC	Nixon et al. (1996), Ten Brink et al. (1991)
Integrated or combined assessment systems		
TRIAD - Quality Assessment	IW/MC: BSI, ecotox., phys.-chem. (sediments)	http://www8.nos.noaa.gov/nccos/ccma/publications.aspx?au=Chapman http://www.ingentaconnect.com/content/klu/ectx/2002/00000011/00000005/05096179
EPA 's Rapid Assessment Protocols (RBP)	IW/MC	Barbour et al. (1999)
SERCON	IW/MC: Physical diversity, naturalness, representativeness, rarity, species richness	Boon et al. (2002) (see also: Parsons et al. (2002))

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Appendix 2

Sampling methods for wetland habitats, features and different wetland-dependent taxa

Note that cost estimates are for equipment, etc., and do not include costs of fees or salaries. Listing of a source of equipment does not imply endorsement of the supplier or the equipment.

Water Quality

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Wetland types	Required expertise	Possibility of collecting?	Equipment needed	Some sources of equipment	Reference sources for methods
physical probes	IW/MC	pH, O ₂ , electric conductivity, temperature, BOD, and flow rate	short- 10 -30 minutes	\$100-3000 depending on number of probes and quality	lakes, rivers, wetlands, all water bodies	none	no	pH probe, temperature probe, DO (dissolved oxygen) probe, conductivity meter, flow meter, BOD collection equipment, titration equipment	http://www.geocities.com/RainForest/Vines/4301/tests.html http://www.hannainst.com/index.cfm	English, Wilkinson and Baker (1997)
Secchi Disc	IW/MC	water transparency	short, 5-10 minutes	\$10	mostly standing water or slow flowing rivers; shallow coastal waters	none	no	secchi disc	http://www.nationalfishingsupply.com/	Wetzel & Likens (1991); English, Wilkinson and Baker (1997)
Water sample collection and Lab analysis	IW/MC	total phosphorus, total nitrogen, chlorophyll-a	10 minutes in field, 3 hours in laboratory per sample	high – laboratory equipment	all water bodies	training in using laboratory equipment	water samples	spectrophotometer, filters, bottles, water samples, net for reactive phytoplankton	http://www.hannainst.com/index.cfm	Wetzel & Likens 1991; Downing & Rigler 1984; Strickland & Parsons 1972
visual assessment of water colour	IW	water colour and type (black, white, clear, etc.), turbidity	fast- 1-5 minutes	0	all water bodies	none	no	water samplers for deeper water (can be used in conjunction with zooplankton sampling)		
visual assessment of sediment	IW/MC	sediment colour and type (organic, sandy clayish, etc)	fast- 1-5 minutes	0	all water bodies	none	sediment sample	grab sampler (can be done in conjunction with benthic invertebrate sampling)	http://www.elcee-inst.com.my/aboutus.htm	English, Wilkinson and Baker, 1997

Wetland habitat types

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Wetland types	Required expertise	Possibility of collecting?	Equipment needed	Some sources of equipment	Reference sources for methods
field habitat assessment	IW/MC	channel morphology, bank characteristics, discharge, velocity, sedimentation, evidence of disturbance, microhabitat structure (riffles etc), riparian attributes, water depth	1-3 hours	low	Any inland or coastal wetland habitats	training in field methods	no	flow meter, tape measure, camera, substrate sampler		www.usgs.gov/nawqa
spatial data analysis		land use, vegetation type and distribution, riparian corridor characteristics, valley morphology, size and shape of water bodies, channel gradient, water colour, hydrologic regime, slope	variable, depending on data resolution and availability	variable- depending on data resolution and availability	all wetland types	knowledge of reading data and GIS	no	satellite imagery, aerial photos, digital elevation models, land cover, hydrography, geology		www.freshwaters.org ; www.usgs.gov
Manta board survey		Mapping of lakeshore littoral habitats to complement simultaneous mapping of coastal topography, land form and land use	15 km of shoreline per day by team of 4-5 people	Boat, fuel	Any clear waters generally with depth of 3-10 m depending on water visibility	Can be acquired in 1-2 days	no	Manta board; snorkelling equipment; inflatable boat plus outboard; maps; underwater paper and pencils, GPS	The manta board can easily be constructed from marine ply	www.ltbp.org/PDD1.HTM Allison et al. (2000); Darwall & Tierney (1998); English, Wilkinson & Baker (1997)

Macrophytes (plants)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
visual search	IW/MC	note visible plants within certain areas ie. full river mark, high water mark; for qualitative analysis	variable depending on area searched	\$0	rivers, lakes, ponds, wetlands; any coastal/marine habitat	Species identification	yes	Basic	Everywhere	NSW National Parks and Wildlife Service (2002)
random sampling	IW/MC	qualitative, more unbiased than a visual search	1-5 hours	\$0	rivers, lakes, ponds, wetlands; any coastal/marine habitat	Species identification & knowledge of making random samples	yes	Basic	Everywhere	Downing & Rigler (1984), Moss et al. 2003 in press; NSW National Parks and Wildlife Service (2002)
Plots	MC	All coastal vegetation (plot size variable depending on vegetation type)	Variable: usually c. 1 hour/plot	Low	All coastal habitats, including mangroves	Species identification & survey design	Yes	Basic	Everywhere	NSW National Parks and Wildlife Service (2002)
grab	IW/MC	good, quantitative method	1-5 hours	\$350-1100	rivers, lakes, ponds, wetlands; soft bottom coastal/marine vegetation	Skill in grab use; knowledge on random of transect sampling	yes	Grab sampler, buoys, GPS, boat	http://www.elcee-inst.com.my/aboutus.htm	Downing & Rigler (1984)
Diving/snorkelling	IW/MC	allows investigating plants in deep water	Usually c. 1 hour, depending on repetition	Low (snorkelling) to high (Scuba)	rivers, lakes, ponds, wetlands; clear coastal/marine waters	diving certification	yes	diving equipment, scissors to collect specimens; underwater sheets, slates & pencils	http://www.mares.com	English, Wilkinson & Baker (1997)

Zooplankton (small invertebrates suspended in water)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise*	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
box samplers	IW/MC	for plankton crustaceans and rotifers	1-3 hours	\$100	rivers, lakes, ponds; all coastal/marine waters	skill in using samplers	yes	plankton (box) samplers	http://www.mclanelabs.com	Downing & Rigler (1984)

Epiphytic macroinvertebrates

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
various samplers, depending on type of vegetation	IW/MC	Any inland wetland; littoral (near shore) zone	1-4 hours	\$100-\$200/sampler	rivers, lakes, ponds, reservoirs, seagrass and macroalgal beds	skill in sampling	yes	tube or box samplers, sieves		Downing & Rigler (1984); Kornijów & Kairesalo (1994); Kornijów (1997)

Benthic macroinvertebrates

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
visual search/ snorkel/ dive (quadrats, intercept and band transects)	IW/MC	good for locating big animals (e.g. crustaceans); suitable for surveying clear waters and medium/large animals	Usually c. 1 hour, but variable depending on extent of repetition	Low (snorkelling) to high (scuba)	rivers, lakes, all clear coastal waters	diving certification	yes	snorkel/scuba gear, dip net, underwater sheets, slates and pencils, collecting material	http://www.nationalfishingsupply.com/seinenets1.html http://www.mares.com	English, Wilkinson & Baker (1997)
grabs, tube samplers	IW/MC	all invertebrates inhabiting soft or sandy sediments	Variable, generally about 1 hour/site	\$350- \$1100	good for sampling soft and sandy sediments	skill in using grab apparatus	yes	Grab samplers, wire mesh sieve, Rose Bengal stain, buoys, boat, sorting box, jars and preservatives	http://www.elcee-inst.com.my/limnology.htm http://www.elcee-inst.com.my/aboutus.htm	Downing & Rigler (1984); English, Wilkinson & Baker (1997)
kick net	IW/MC	all invertebrates inhabiting hard substrates	1-5 hours	\$55	good for wadable streams with gravel or stoney bottom	skill with kick nets	yes	kick net	http://www.acornnaturalists.com/p14008.htm http://www.greatoutdoorprovision.com/	Downing & Rigler (1984) http://www.wavcc.org/wvc/cadre/WaterQuality/kicknets.htm
dip net	IW/MC	suitable for sampling nectic (swimming) animals (e.g. beetles, water mites) in shallow waters	1-2 hours	\$5-\$20/ net	lakes, rivers, wetlands (incl Coastal)	skill in using dip nets	yes	dip net	http://www.sterlingnets.com/dip_nets.html http://www.seamar.com	Downing & Rigler (1984)
seine	IW	suitable for sampling big invertebrates (crustaceans) in shallow water without strong current	1-4 hours	\$10-\$20/ net	small rivers, possible in lakes with a boat	skill in seining	yes	seine net	http://www.nationalfishingsupply.com/seinenets1.html	Downing & Rigler (1984)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
sledge	MC	Semiquantitative epifauna sampling	About 1 hour/site	Not available	Soft-bottom habitats	Skill in sledging	Yes	Sledge, sieves, sorting box, buoys, GPS		English, Wilkinson & Baker (1997)
dredge	MC	Semiquantitative at best: useful for broad area surveys and inventories	About 1 hour/site	\$500-600 per dredge	Soft-bottom: samples deeper into substrate	Skill in dredging	Yes	Dredge, sieves, boat, sorting box, rope, GPS	http://wildco.com	English, Wilkinson & Baker (1997)
trawl	MC	Qualitative: larger epifauna and demersal nekton (complementary to other methods)	2-3 hours/site	\$1000 for nets, boat rental and field assistance	Soft-bottom substrates	Skill in trawling	Yes	Trawl, sieves, boat, sorting box, rope, GPS	http://www.seamar.com	English, Wilkinson & Baker (1997)
Surber sampler	IW/MC	all invertebrates inhabiting stony or gravel substrates	1-3 hours	\$200	gravel or stony bottom rivers and streams, standing waters	knowledge of using Surber and requirements to quantify data	yes	Surber sampler, bucket	http://www.kc-denmark.dk/public_html/surber.htm http://www.kc-denmark.dk	Downing & Rigler (1984)
aerial nets		for catching adult invertebrates	1-5 hours	\$35-\$50	land	skill in using aerial nets	yes	insect net	http://www.rth.org/entomol/insect_collecting_supplies.html http://bioquip.com/	Downing & Rigler (1984)

Fishes

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
seine nets		mostly smaller fishes	1-4 hours	\$10-250/net, depending on size	shallow water without strong current, small rivers, possible in lakes with a boat, (for big nets a boat can be needed for deployment and pulling)	skill in seining	yes, net does not kill fishes	seine net boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.nationalfishingsupply.com/seinenets1.html http://www.seamar.com	Bagenal (1978); English, Wilkinson and Baker (1997)
gill net	IW	all fish sizes and types	24 hours- leave out overnight	\$150-200/net	shallow to medium depth waters, standing waters or slow flowing rivers	none	yes, net kills fishes	gill nets	http://www.nationalfishingsupply.com/seinenets1.html ¹	Bagenal 1978
Kill nets	MC	all fish sizes and types, depending on mesh size	12-24 hours- leave out overnight	\$50-\$500/net	shallow to medium depth waters	Skill in setting the nets	yes	drift, trammel, block, encircling and/or gill nets, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)
fish traps (fykes)	IW/MC	all fish sizes and types, mostly bottom living fishes	24 hours- leave out overnight	\$50-100/trap	mostly shallow waters (for deeper waters a motorised winch is needed)	Skill on setting traps in right places. Fishermen assistance advised	yes, trap does not kill fishes	fish traps, (may need motorized winch), boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	Bagenal (1978); English, Wilkinson and Baker (1997)
Trap nets	MC	Most fish sizes and types, primarily in shallow waters	12-24 hours, based on tides (barrier and bag) Corrals are set up for longer and collect every 24 hours or so	\$50-\$500/nets, corral depending on size	shallow waters	Skill in setting the nets. Corral requires expert people (fishermen)	yes	Barrier, bag nets and/or fish corral, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
Trawl (various types: e.g. beam, Otter)	IW/MC	use only for deep water pelagic, schooling and bottom-dwelling fish, can be very destructive to the environment	1-4 hours	\$1000 for nets, boat rental and field assistance	only for deeper, large waters without obstacles on the bottom or surface debris	skill in trawling	yes, nets kill fishes	trawl net, boat, at least 2-3 people to help measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.fao.org/fiserv/vlet/org.fao.fi.common.FiRefServlet?ds=geartype&fid=103 http://www.seamar.com	Bagenal 1978 English, Wilkinson and Baker (1997)
Scoop and tray nets	MC	suitable for small fish near surface, use only against banks	1-5 hours	\$5-\$20/ net	Used in inaccessible areas, such as mangroves	Skill in using the nets but easy to learn	yes	Scoop and tray net, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)
Push net	MC	Catches only small organism	1-2 hours	\$5-\$20/ net	Most shallow waters	Skill in using the nets - but easy to learn	yes	Push net, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)
Cast net	MC	Suitable for small fish and prawns	1-2 hours	\$50-\$200/ net	Good for confined areas and shallow waters	Skill on cast. Operators vary in efficiency.	yes	Cast net, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.nationalfishingsupply.com/	English, Wilkinson and Baker (1997)
Drop net	MC	Small organisms	1-2 hours	\$50-\$100/ net	Good for small and shallow areas	Skills on construct and use. Labour intensive	yes	Drop net, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)
Lift net	MC	Small and rare species that must be concentrated	1-2 hours	\$50-\$100/ net	Good for small and shallow areas	Skills on use the net	yes	Lift net, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
Spear fishing (various types)	MC	Suitable for all species but used primarily for big and selective species (difficult to catch by other means)	1-6 hours	\$50-\$200/ spear gun	Any clear waters; difficult areas	Skill is obtained by practicing	Yes	Spear gun and gear, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://divebooty.com	English, Wilkinson and Baker (1997)
Longline (drift or bottom)	MC	Selective fish, according to bait used	12-24 hours - leave out overnight	\$100-\$300/ per line, depending of number of hooks	Any water, except high-relief hard bottom	Skill in long-lining	Yes	hook, line, bait, buoys, weights, boat, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.seamar.com	English, Wilkinson and Baker (1997)
dip nets	IW/MC	suitable for small fish near surface	1-5 hours	\$5-\$20/ net	limited area within rivers, lakes, other wetlands	skill in using dip nets	yes	dip net	http://www.sterlingnets.com/dip_nets.html	Bagenal 1978
hook and line	IW/MC	suitable for any fish type and any water, depending on bait used	variable depending on repetition	variable depending on repetition	rivers, lakes, other wetlands	skill in line fishing	yes	hook, line, bait, (boat), measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://www.nationalfishingsupply.com/	
Rotenone	MC	All fish of the encircle area. Kills all the fish. Permit could be required	Minutes per site	\$350/20 litres	Encircle area with a net in shallow-open area. For deep waters, use it in caves and crevices	Skill on setting net	Yes	Rotenone, net, scoop net, measuring boards, scales, sheets, pencils, slates, plastic bags, plastic labels, preservative, GPS	http://southernaquaculturesupply.com/index.php	English, Wilkinson and Baker (1997)
sonars	IW/MC	suitable for schooling, pelagic fish, not very precise data	depending on the size of the water body	\$100 - 1000	deep lakes and large rivers; all coastal waters, but mostly deep	skill in operating the sonars	No	Sonar, boat		

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
electrofishing	IW	optimal for sampling medium to big fish, better in colder water with some salinity	1-5 hours, variable depending on repetition and habitat type	\$500-2000	mostly shallow waters	training in electrofishing and license	yes, stuns fishes but does not kill them	electro-shocker set; collecting equipment	http://www.fisheriesmanagement.co.uk/electrofishing.htm	Bagenal 1978
dive/snorkelling (transects, stationary, roving)	IW/MC	suitable for surveying particular ecosystems that are difficult to locate or reach; clear waters	usually about 1 hr., but variable depending on repetition	low (101norkelling) to high (scuba), cost of equipment	lakes, rivers, all coastal clear waters	Snorkelling: none; diving needs certification. Identification of species and survey design	no	snorkel/scuba gear, dip net, underwater sheets, pencils and slates	http://www.mares.com	English, Wilkinson and Baker (1997)
questionnaire	IW/MC	ask local fishermen about the fishes they have observed and use	2-4 hours	low	all water bodies	Easy to apply but requires knowledge to prepare questionnaire	no	paper, pens, maybe refreshments for locals		

¹ The so-called "biological survey gill nets" can be ordered from: Fårup SpecialnetKastrupvej 3Velling6950 Ringkøbing Denmark or from: Lundgren Fiskefabrik A/BStorkyrkobrinken 12S-11128 Stockholm, Sweden Tel +45 97 32 32 31

Reptiles and Amphibians

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
dip nets (amphibians)	IW/MC	suitable for catching tadpoles	usually about 1 hour, but variable depending on repetition	\$5-\$20/ net	rivers, lakes, other inland wetlands, any coastal waters where species occur	skill in using dip nets	yes	dip net	http://www.sterlingnets.com/dip_nets.html http://www.seamar.com	NSW National Parks and Wildlife Service (2002)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
visual search (ambphibians/reptiles)	IW/MC	good for locating relatively visible organisms	variable	\$0	land and surface water	knowledge of microhabitats	no	None		NSW National Parks and Wildlife Service (2002)
vocalizations	IW/MC	listen for and sometimes record frog calls and identify species from call	variable, several hours depending on search and record time	low- tape recorder	any water bodies, riparian habitats, land	knowledge of frog calls and identify species from calls, habitats	no	tape recorder, cassettes, playback, flashlights,	Any good electronic shop	NSW National Parks and Wildlife Service (2002)
pitfall traps with drift fence (amphibians/reptiles)	IW/MC	good for collecting animals that are difficult to sight; estimate relative abundance and richness	should be left out 24-48 hours	\$0 if old buckets are used	land	skill in setting up pitfall traps with drift fences	yes	buckets, hand shovel, metal for fence,	http://www.agric.nsw.gov.au/reader/2730	NSW National Parks and Wildlife Service (2002)
litter search (amphibians/reptiles)	IW/MC	usually used for finding frogs in conjunction with quadrants	variable depending on repetition	\$0	land	minimal	yes		Everywhere	NSW National Parks and Wildlife Service (2002)
transects (amphibians/reptiles)	IW/MC	used to control sample area to quantify and standardize data	dependant on length and number of transects	\$0	Land	knowledge of establishing transects	yes	marking tape	http://www.npws.nsw.gov.au/wildlife/cbsm.html	NSW National Parks and Wildlife Service (2002)
Snorkelling/dive (reptiles)	IW/MC	used especially for looking for turtles	variable depending on repetition	low (snorkelling) to high (scuba)	rivers, lakes any coastal waters	diving certification	yes	snorkel/scuba gear, dip net, underwater sheets, slates and pencils	http://www.mares.com	NSW National Parks and Wildlife Service (2002)
nooses (reptiles)	IW/MC	suitable for lizards	depends on number of lizards sought	\$0 - can be made of grass	land	skill in making noose and spotting lizards	yes	long, flexible, but strong weed/ rope,	http://www.macnstuff.com/mcfl/1/lizard.html	NSW National Parks and Wildlife Service (2002)
turtle traps (reptiles)	IW/MC	used to trap turtles on land and water	at least 1 day	\$65-\$150/ trap	lakes, rivers, land, other inland and coastal wetlands	knowledge of setting turtle traps	yes	turtle trap, bait		Limpus et al. (2002); NSW National Parks and Wildlife Service (2002)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
questionnaire	IW/MC	ask local people, incl. fishermen about the species they have observed and use	2-4 hours	low	all water bodies	Easy to apply, but requires experience in questionnaire design	no	paper, pens, maybe refreshments for local people		NSW National Parks and Wildlife Service (2002)

Birds

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
airplane surveys	IW/MC	can get crude estimates of population numbers and relative population abundance; biased against certain species	1-4 hours	high- cost of hiring an airplane	any open areas; may also be only means for surveying densely vegetated wetlands	experience in quickly recognizing species	no	if possible, fly at height enabling naked eye identification; binoculars, tape recorder, maps, GPS gear	http://www.telescope.com	NSW National Parks and Wildlife Service (2002)
point counts	IW/MC	Terrestrial species: used in conjunction with transects to control sample area to quantify and standardize data - can be done on foot in dry season and canoe in wet season	1-5 hours	\$100	land, rivers, wetlands; all coastal habitats	knowledge of parameters for carrying out and recording point counts	no	binoculars, measuring tape, flagging	NSW National Parks and Wildlife Service (2002)	http://www.npws.nsw.gov.au/wildlife/cbsm.htm ; NSW National Parks and Wildlife Service (2002)

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
transects	IW/MC	Terrestrial & aquatic species: used to control sample area to quantify and standardise data – can be done on foot or by boat	1-5 hours, but depends on sampling area	\$100	Any open habitat	Knowledge of the species and of survey design		Binoculars, measuring tape	NSW National Parks and Wildlife Service (2002)	NSW National Parks and Wildlife Service (2002)
vocalizations	IW/MC	listen for and sometimes record bird calls and identify species from call	variable, several hours depending on search and record time	low- tape recorder (if needed)	any water bodies, riparian habitats, land; coastal habitats	knowledge of how to identify bird species from calls, habitats	no	tape recorder, cassettes, playback (if needed)g	Any good electronics shop	NSW National Parks and Wildlife Service (2002)
locate nesting sites	IW/MC	bird species nesting on or near water	1-5 hours	\$100	any water bodies	knowledge of nesting habitats and nesting ecology (to avoid disturbance	no	binoculars, maps	http://www.telescope.com	NSW National Parks and Wildlife Service (2002)

Mammals

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise*	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
sighting	IW/MC	look for mammals to surface	variable	\$0	rivers, lakes, wetlands; all coastal/marine habitats	minimal	no	binoculars if necessary	http://www.telescope.com	NSW National Parks and Wildlife Service (2002)
locate breeding sites	IW/MC	appropriate for aquatic mammals living also on land	1-5 hours	\$0	land	knowledge of breeding habitats	yes	None		

Method	Applies to inland waters (IW) and/or marine/coastal (MC)	Application	Field Time	Cost	Water type	Required expertise*	Possibility of collecting ?	Equipment	Some sources of equipment	References for details of methods
Traps	IW/MC	small and medium sized mammals (e.g. otters, minks)	12 hours- leave out overnight	\$20-50/trap	land, riparian, shallow water; all coastal habitats	Trap-setting and locating skill	yes, trap does not kill animals	Tomahawk trap, Sherman traps	http://www.thecatnetwork.org/trapping.html	NSW National Parks and Wildlife Service (2002)
Tracks	IW/MC	detecting mammal presence on land, riparian	1-4 hours- depends on search time	\$0	land and riparian areas	able to detect tracks and identify species from tracks	no	minimal- take photo or make plaster cast	Any camera supplier	NSW National Parks and Wildlife Service (2002)
transects	IW/MC	quantifies data if there are many sightings	1-5 hours	\$0	river, lakes, wetlands; open coastal habitats	knowledge of establishing transects	no	binoculars if necessary	http://www.telescope.com	http://www.npws.nsw.gov.au/wildlife/cbsm.htm !
Airplane surveys	MC	Crude estimates of population numbers and relative population abundance biased against certain species)	1-2 hours, but depends on size of survey area	High – airplane hire cost	All open areas	Experience in quickly identifying species	No	Binoculars	http://www.telescope.com	NSW National Parks and Wildlife Service (2002)

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Annex 4

Describing the ecological character of wetlands, and harmonized data formats for core inventory

CONTENTS

- 1) The ecological character concept and the need for methods for describing ecological character
- 2) A summary framework of data and information for core inventory, ecological character description, Ramsar site designation, and Article 3.2 reporting
- 3) How guidance on wetland ecological character description and harmonization with core inventory has been developed
- 4) A framework for describing the ecological character of wetlands
- 5) Change in ecological character and Article 3.2 reporting
- 6) Harmonizing the ecological character description and the core fields for wetland inventory

1) The ecological character concept and the need for methods for describing ecological character

1. The text of the Ramsar Convention includes in Article 3.2 the requirement that “each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change”. Through a series of COP decisions (principally the Strategic Plan adopted in 1996 and Resolution VIII.8 in 2002), the requirement in Article 3.1 to “promote the conservation” of Ramsar sites has been equated to “maintenance of the ecological character” of these sites.
2. Furthermore, the current description of “wise use” (paragraph 22 of Resolution IX.1 Annex A) makes explicit the link between maintenance of ecological character and wise use, such that the concept of maintaining ecological character can and should be applied to all wetlands, rather than only designated Ramsar sites:

“Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development.”

3. The current definition of “ecological character” (paragraph 15 of Resolution IX.1 Annex A) is:

“Ecological character is the combination of the ecosystem components, processes and benefits*/services that characterise the wetland at a given point in time.”

*Within this context, ecosystem benefits are defined in accordance with the MA [Millennium Ecosystem Assessment] definition of ecosystem services as “the benefits that people receive from ecosystems”.

4. Whilst a definition of “ecological character” is helpful, it is also important to be able to describe the particular ecological character of a wetland as a key element of an effective management planning process, including monitoring, as is set out in the wetland management planning guidance in Ramsar Wise Use Handbook 16 (3rd ed.). It also follows that if human-induced adverse change in the ecological character of a designated Ramsar site is to be detected and

reported under Article 3.2 of the Convention text, a baseline description of ecological character is needed against which to assess change.

5. The lack of guidance to Contracting Parties and wetland site managers on methods for describing ecological character was recognized in annex 2 to Resolution IX.2 (paragraph 52), which requested the Scientific and Technical Review Panel (STRP) to prepare “guidance for the description of the ecological character of wetlands”.
6. The guidance developed in response and provided here therefore moves beyond the *definition* of the concept to a treatment of the *constituent parts of what goes to make up* ecological character, and this can be applicable to any wetland in the context of documenting core aspects of an inventory of wetlands (see Resolution VIII.6) and to completing the Information Sheet on Ramsar Wetlands (RIS) for any given Ramsar site.
7. This work is key to the establishment of baselines against which Article 3.2 and relevant Convention indicators and other assessments (and reporting on these) will operate. It follows that, in order to make consistent and simplify the provision of information on Ramsar sites, which is closely linked to related core inventory and ecological character descriptions (see Section 2 below), revisions to the structure and content of the Information Sheet on Ramsar Wetlands (RIS) may prove to be appropriate and could potentially simplify the RIS data and information needs. Substantive review and recommendations on this matter are not included in this guidance, but will be the subject of further work to be undertaken by the STRP concerning different aspects of overall Ramsar data and information needs, and data and information management for Ramsar sites (see also Resolution X.14 *A Framework for Ramsar data and information needs*).
8. The development of this guidance has also found that, for harmonization of data and information collection purposes, there is a need to make some modifications to the structure, content and titling of the core fields for wetland inventory as adopted in the annex to Resolution VIII.6. A revised set of recommended core inventory data fields, compared with those for ecological character description, is provided in Section 6.
9. The preparation of the guidance on describing ecological character has also permitted some reflection on the Convention’s definition of ecological character (paragraph 3 above), referred to above. While it is certainly correct that the concept should embrace ecosystem components, processes and services, the definition makes clear that ecological character consists not simply of a *list* of these, but includes the additional idea of what they represent *in combination*. The dividing-line between what is counted as a component, or a process, or a service, may not always be sharply distinguished. For example, “water regime” is included in “components” in the scheme provided below, but might also be regarded as a “process”. Long debate on this would not be fruitful, however, since these categorizations are pragmatic expedients, and the key principle is that ecological character is a holistic rather than a reductionist concept.
10. In any guidance on ecological character description, there will be a need to map out the various different purposes for, and uses of, this description and how these differ from the purposes of core wetland inventory, as well as RIS and Article 3.2 reporting. For example, the uses of an ecological character description identified during the ongoing Australian work of developing ecological character descriptions (described below) include:
 - i) providing the basis for a summary ecological character description in the RIS;
 - ii) informing management planning; informing monitoring; and

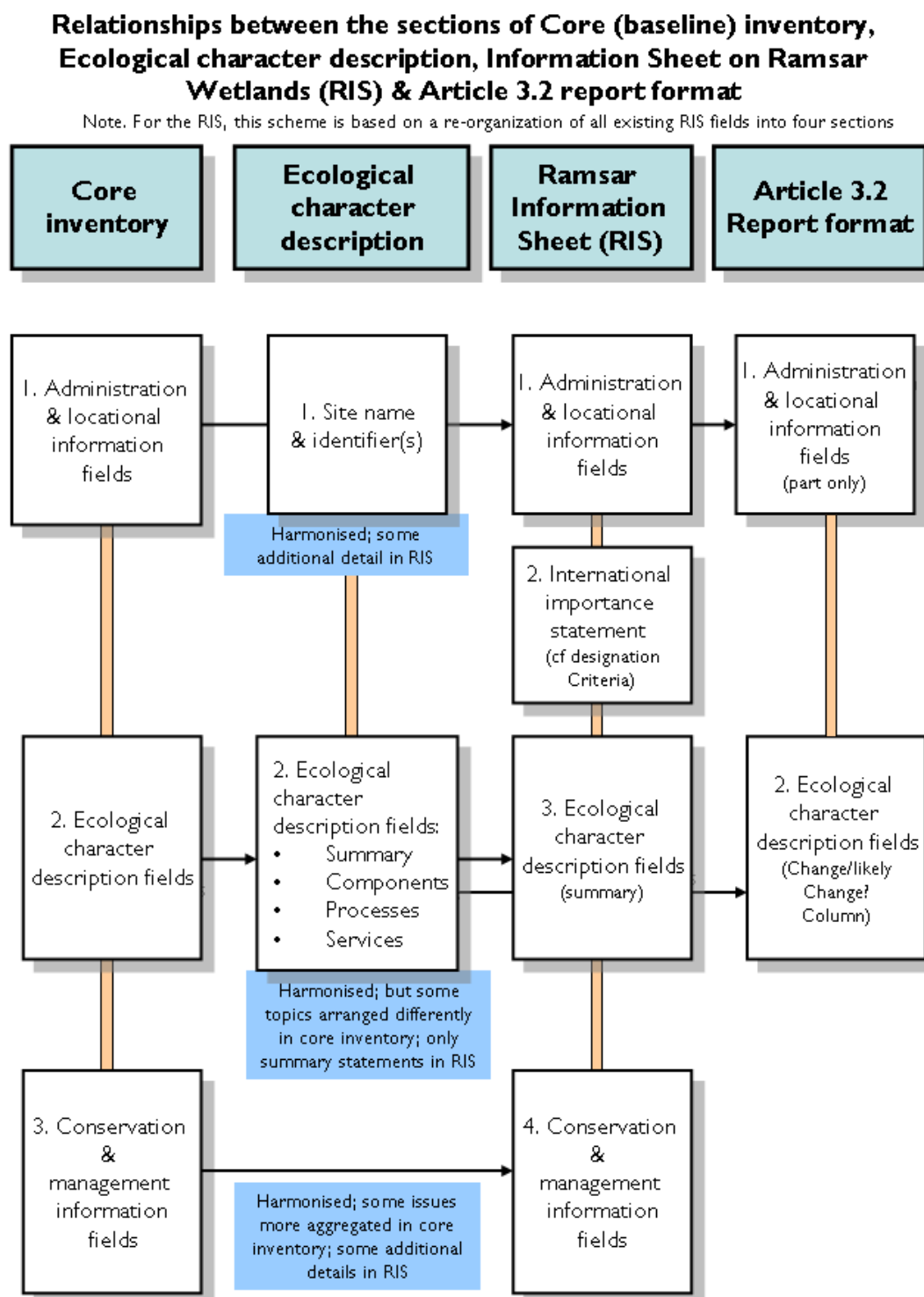
- iii) providing information to assist in implementing legislation such as EIA legislation that relates to Ramsar sites.

2) A summary framework of data and information for core inventory, ecological character description, Ramsar site designation and Article 3.2 reporting

11. There are close relationships between the types of data and information which are, and need to be, collected for the purposes of core inventory, ecological character description, Ramsar site designation, and Article 3.2 reporting.
12. Figure 1 provides a comparative framework of the major types of data and information required for each of these purposes. To this could be added a column for data and information needed for management plans, and the STRP anticipates reviewing this aspect in its future work.
13. All four of these purposes require a description of ecological character for the site, and through harmonization of these data and information fields this would then need to be done only once for all four purposes, hence avoiding a significant duplication of effort that may otherwise occur at present. Three of the purposes need similar administrative and locational details. Core inventory and the RIS need some conservation activity information, and although the level of detail might be different, again the same structure of data fields can be used.
14. The unique section of data and information needed for the RIS is its statement of the international importance of the wetland, made against each of the Criteria applied in the designation of the site, and the data and information provided to justify the application of these Criteria (Ramsar Wise Use Handbook 14 *Designating Ramsar sites*, 3rd edition 2007). This distinction between the description of the international importance of a Ramsar site and the description of its overall ecological character has not always been kept clear.
15. The comparative analyses of the structure and content of the data and information for Ramsar site designation in relation to core inventory and ecological character description outlined below have shown that all current RIS information fields, with the exception of the international importance statement, relate to one or other of the data and information fields for core inventory and ecological character description. However, the present sequence and grouping of information fields in the RIS, and the nomenclature used, differ in a number of respects from those in the ecological character description and core inventory fields.
16. Thus in many instances the data and information categories required are the same for these different purposes, and hence the main effort of data collation need only be undertaken once, rather than being duplicated. Any differences in the data and information needs for these various purposes can often be more a matter of the level of detail required. Actual needs will vary according to the individual circumstances of the sites and situations concerned. The tables in this guidance identify the full list of fields that may apply, but whether any of them does apply, or whether there is capacity to provide a full description, will vary from site to site. It is not expected that all the specific data fields will necessarily have to be filled out for all sites.
17. It is largely dependent on each Contracting Party's priorities and chosen purposes whether the relevant data and information is collected first for core wetland inventory, for ecological character description (e.g., for management planning purposes), or for the preparation of an RIS for Ramsar site designation. As indicated above, whichever the first purpose applied, much of the data and information collected can be used for the other purposes. Thus, for example,

completion of the ecological character description should directly provide the information (in summarized form) for core inventory and the RIS. Reports made under Article 3.2 would also be drawn directly from the data and information in the ecological character description.

Figure 1. A summary framework for data and information needs for core inventory, ecological character description, Ramsar site designation, and Article 3.2 reporting



3) How guidance on wetland ecological character description and harmonization with core inventory has been developed

18. To develop harmonized general guidance on wetland ecological character description, core inventory and related processes, a number of cross-tabulation comparison analyses were developed, including comparisons between:
 - i) core inventory fields (Resolution VIII.6) and RIS data and information fields;
 - ii) RIS data and information fields and the fields in a “framework for describing the ecological character of Ramsar wetlands” published in 2005 by the government of the State of Victoria (Australia);
 - iii) the fields in Victoria’s “framework for describing the ecological character of Ramsar wetlands” and the RIS fields;
 - iv) core inventory fields (Resolution VIII.6) and the fields in Victoria’s “framework for describing the ecological character of Ramsar wetlands”; and
 - v) Victoria’s “framework for describing the ecological character of Ramsar wetlands” fields and those in the draft (1 August 2007) Australia Commonwealth government’s “National Framework and Guidance for Describing the Ecological Character of Australia’s Ramsar Wetlands”.
19. These analyses revealed a number of issues that have been taken into account in the development of the ecological character description field structure provided in Section 4 below. One of these is that some of these schemes did not include a field for recording information on wetland type(s) present (in terms of the Ramsar classification of wetland type), which has been added as an ecological character description field. Similarly, the “pressures, vulnerabilities and trends” field (in the Resolution VIII.6 core inventory fields) has been added in the ecological processes section of the description. In general, however, the content and structure of the ecological character description below has been kept as close as possible to the various existing inventory and ecological character schemes.
20. In developing the framework below, the work by Australia in developing detailed methods for describing the ecological character of their wetlands proved particularly valuable, and Australia is to be congratulated on these initiatives. Further information on these approaches and their guidance for making ecological character descriptions can be found for the State of Victoria’s 2005 report at: <http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/25C78F0422CD4887CA25729D0000B8A048DB09C3A9A254C5CA257297001AE7C0> and for the draft (2007) National Framework and Guidance at: <http://www.environment.gov.au/about/publications/index.html>.
21. It is clear that no one scheme such as that provided in Section 4 for global applicability can possibly meet all the particular needs and differences of purpose, capacity, and available data and information. It should be used, however, as the basis for development of ecological character descriptions by Contracting Parties that fit their need, capacity and purpose.

4) A framework for describing the ecological character of wetlands

22. Taking account of the analyses described above, a global scheme for describing wetland ecological character in the context of the Ramsar Convention is provided in tabular format below. Some guidance on implementing the approach is provided below in paragraphs 25-28.

For an explanation of purposes relating to Article 3.2 reporting for the inclusion of the “Change/likely change?” column in the ecological character description, see Section 5 below.

23. In addition to the “Change/likely change?” column, a further refinement that Contracting Parties and wetland managers may wish to add, where appropriate and possible, is a further column identifying “Limits of acceptable change, where defined” (see also Section 5 below). This speaks to the role of the ecological character description in management planning, including monitoring, and also to determining when an Article 3.2 report of non-trivial change in ecological character would be needed. Further discussion on limits of acceptable change and trivial/non-trivial change in ecological character is provided in COP10 DOC.27.
24. In the description sheet below (Table 1), the bracketed codes (P), (R), (C) and (S) refer to the categorization of ecosystem services provided by the Millennium Ecosystem Assessment (MA), as follows: “provisioning” (P), “regulating” (R), cultural (C) or “supporting” (S).

Table 1. Ramsar ecological character description sheet

Ramsar ecological character description sheet		
Site name: Official name of site and catchment)/other identifier(s) (e.g., reference number)		
1. Summary statement		
Two or three narrative sentences giving a statement of what is ecologically <i>distinctive</i> (not necessarily <i>important</i>) about the site, based on the details below. (With reference to the COP 9 definition, this concerns <i>the combination of</i> the components, processes and services that <i>characterise</i> the wetland (emphasis added)). Note. Supplementing the summary statement with simple conceptual models of the key characteristics of the wetland is encouraged.		Change/likely change? [include here a brief summary narrative of the overall changes to components, processes and services that characterises the wetland, as detailed below]
2. Ecological components		
		Change/likely change?
2.1 Geomorphic setting: Setting in the landscape/catchment/river basin - including altitude, upper/lower zone of catchment, distance to coast where relevant, etc.		
2.2 Climate: Overview of prevailing climate type, zone and major features (precipitation, temperature, wind)		

2.3 Habitat types (including comments on particular rarity, etc.) and Ramsar wetland types		
2.4 Habitat connectivity		
2.5 Area, boundary and dimensions: Site shape (cross-section and plan view), boundaries, area, area of water/wet area (seasonal max/min where relevant), length, width, depth (seasonal max/min where relevant)		
2.6 Plant communities, vegetation zones and structure (including comments on particular rarity, etc.)		
2.7 Animal communities (including comments on particular rarity, etc.)		
2.8 Main species present (including comments on particular rare/endangered species etc.); population size and proportion where known, seasonality of occurrence, and approximate position in distribution range (e.g., whether near centre or edge of range)		
2.9 Soil: Geology, soils and substrates, and soil biology		
2.10 Water regime: Water source (surface and groundwater), inflow/outflow, evaporation, flooding frequency, seasonality and duration; magnitude of flow and/or tidal regime, links with groundwater		
2.11 Connectivity of surface waters and of groundwater		
2.12 Stratification and mixing regime		
2.13 Sediment regime (erosion, accretion, transport and deposition of sediments)		
2.14 Water turbidity and colour		
2.15 Light - reaching the wetland (openness or shading); and attenuation in water		
2.16 Water temperature		
2.17 Water pH		
2.18 Water salinity		
2.19 Dissolved gases in water		
2.20 Dissolved or suspended nutrients in water		
2.21 Dissolved organic carbon		
2.22 Redox potential of water and sediments		
2.23 Water conductivity		
3. Ecological processes		
		<i>Change/likely change?</i>
3.1 Primary production (S)		

3.2 Nutrient cycling (S)		
3.3 Carbon cycling		
3.4 Animal reproductive productivity		
3.5 Vegetational productivity, pollination, regeneration processes, succession, role of fire, etc.		
3.6 Notable species interactions , including grazing, predation, competition, diseases and pathogens		
3.7 Notable aspects concerning animal and plant dispersal		
3.8 Notable aspects concerning migration		
3.9 Pressures, vulnerabilities and trends concerning any of the above, and/or concerning ecosystem integrity		
4. Ecosystem services		
		<i>Change/likely change?</i>
4.1 Drinking water for humans and/or livestock (P)		
4.2 Water for irrigated agriculture (P)		
4.3 Water for industry (P)		
4.4 Groundwater replenishment (R)		
4.5 Water purification/waste treatment or dilution (R)		
4.6 Food for humans (P)		
4.7 Food for livestock (P)		
4.8 Wood, reed, fibre and peat (P)		
4.9 Medicinal products (P)		
4.10 Biological control agents for pests/diseases (R)		
4.11 Other products and resources, including genetic material (P)		
4.12 Flood control, flood storage (R)		
4.13 Soil, sediment and nutrient retention (R)		
4.14 Coastal shoreline and river bank stabilization and storm protection (R)		
4.15 Other hydrological services (R)		
4.16 Local climate regulation/buffering of change (R)		
4.17 Carbon storage/sequestration (R)		
4.18 Recreational hunting and fishing (C)		
4.19 Water sports (C)		
4.20 Nature study pursuits (C)		
4.21 Other recreation and tourism (C)		
4.22 Educational values (C)		
4.23 Cultural heritage (C)		

4.24 Contemporary cultural significance, including for arts and creative inspiration, and including existence values (C)		
4.25 Aesthetic and “sense of place” values (C)		
4.26 Spiritual and religious values (C)		
4.27 Important knowledge systems, and importance for research (C)		
<i>Note. For nature conservation value as an ecosystem ‘service’ (S), see items under ‘components’ and ‘processes’ above)</i>		

25. **Start with available data and information.** In developing a description of the ecological character of a wetland, it is important to start with whatever data and information are currently available, even if information is not comprehensively available for all fields in the description sheet. Starting with compiling what is currently available also helps to identify gaps and priorities for further data and information collection to enhance the description.
26. **Start with qualitative description if quantitative data are not available.** Even if detailed quantitative data are not available, begin by compiling qualitative data and information and do not underestimate the value of expert and local knowledge as a source of such information. Often, bringing together those who know the wetland to share their knowledge can be an important and effective start to compiling the ecological character description.
27. **Simple ‘conceptual models’ can be a powerful tool.** Developing simple two- or three-dimensional ‘conceptual models’ accompanied by summary descriptions of key features, processes and functioning can be a powerful tool supporting the ecological character description. Further guidance on approaches to developing such conceptual models will be developed by the Scientific and Technical Review Panel. For one example of this approach for a Ramsar site, see Davis, J. & Brock, M. (2008) “Detecting unacceptable change in the ecological character of Ramsar Wetlands,” *Ecological Management & Restoration*, vol. 9 (1): 26-32 (downloadable from <http://www.blackwell-synergy.com/doi/pdf/10.1111/j.1442-8903.2008.00384.x>).
28. **Separate descriptions for different parts of large or complex wetlands can be a helpful start.** For large wetlands or wetland complexes where different parts of the system function differently or have very different characteristics, it may prove practically helpful to prepare separate descriptions initially for any distinctly different parts, supplemented by an overall summary ecological character description and conceptual models.

5) Change in ecological character and Article 3.2 reporting

29. A related aspect of Ramsar implementation concerning wetland ecological character involves detecting and reporting human-induced adverse change in the ecological character of a Ramsar-listed wetland. One of the tasks requested of the Ramsar Secretariat by the Conference of the Parties concerned assisting Contracting Parties when they need to make such a report to the Secretariat through the provision of a simple Article 3.2 reporting format.
30. Since it follows that identifying such a change is based on its detection by comparison with the description of the ecological character of the wetlands, and with any established limits of

unacceptable change in ecological character, the approach developed here is to use the ecological character description format and the additional column for describing “Change/likely change” to make such Article 3.2 reports.

31. Thus using a copy of the completed ecological character format for a given site, with relevant details entered into this column, can act as the simple alert mechanism required to trigger the processes (see Resolution X.16) for implementing Article 3.2 requirements and for submitting the Article 3.2 report to the Ramsar Secretariat.

6) Harmonizing the ecological character description and the core fields for wetland inventory

32. Core fields for wetland inventory were agreed by the Parties in 2002 in the annex to Resolution VIII.6. A further aspect of the STRP’s work on data and information needs for wetlands, including Ramsar sites (2006-2008 STRP work plan task 52), concerned “harmonization of the layout and information fields of the RIS with the core data fields of the Framework for wetland inventory and the description of ecological character”.
33. As noted above, further work by the STRP will address the RIS-related aspects of this task. This section of guidance provides advice only on the harmonization of core inventory and ecological character description fields.
34. The cross-comparison analyses described above in section 3 identified a number of aspects of the original core inventory fields where harmonization of terminologies and structure and content descriptions of data and information fields could be made, in order to facilitate the sharing of data and information between inventory and ecological character description processes.
35. Table 2 provides the revised core inventory fields, and these supersede those in the annex to Resolution VIII.6. Table 3 provides a comparison of how these revised core inventory fields relate to the ecological character description fields from Table 1.

Table 2. Revised core wetland inventory data and information fields

Revised core wetland inventory fields (Harmonized with Ramsar ecological character description sheet)	
Site name:	Official name of site and catchment/other identifier(s) (e.g., reference number)
Area, boundary and dimensions:	Site shape (cross-section and plan view), boundaries, area, area of water/wet area (seasonal max/min where relevant), length, width, depth (seasonal max/min where relevant)
Location:	Projection system, map coordinates, map centroid, elevation
Geomorphic setting:	Setting in the landscape/catchment/river basin - including altitude, upper/lower zone of catchment, distance to coast where relevant, etc.
Biogeographical region:	
Climate:	Overview of prevailing climate type, zone and major features (precipitation, temperature, wind)
Soil:	Geology, soils and substrates; and soil biology
Water regime:	Water source (surface and groundwater), inflow/outflow, evaporation, flooding frequency, seasonality and duration; magnitude of flow and/or tidal regime, links with groundwater
Water chemistry:	Temperature; turbidity; pH; colour; salinity; dissolved gases; dissolved or suspended nutrients; dissolved organic carbon; conductivity
Biota:	Plant communities, vegetation zones and structure (including comments on particular rarity, etc.); Animal communities (including comments on particular rarity, etc.); Main species present (including comments on particular rare/endangered species, etc.); population size and proportion where known, seasonality of occurrence, and approximate position in distribution range (e.g., whether near centre or edge of range)
Land use:	Local, and in the river basin and/or coastal zone
Pressures and trends:	Concerning any of the features listed above, and/or concerning ecosystem integrity
Land tenure and administrative authority:	For the wetland, and for critical parts of the river basin and/or coastal zone
Conservation and management status of the wetland:	Including legal instruments and social or cultural traditions that influence the management of the wetland; and including protected area categories according to the IUCN system and/or any national system
Ecosystem services:	(for a list of relevant ecosystem services, see the Ramsar ecological character description sheet)]
Management plans and monitoring programs:	In place and planned within the wetland and in the river basin and/or coastal zone (see Resolutions 5.7, VI.1, VII.17, and VIII.14)

Table 3. The relationship between ecological character description and core wetland inventory fields

Ramsar ecological character description sheet	Core inventory fields (revised)
Site name: Official name of site and catchment)/other identifier(s) (e.g., reference number)	
	Administrative and locational details
	Site name: Official name of site and catchment)/other identifier(s) (e.g., reference number)
	Area, boundary and dimensions: Site shape (cross-section and plan view), boundaries, area, area of water/wet area (seasonal max/min where relevant), length, width, depth (seasonal max/min where relevant)
	Location: Projection system, map coordinates, map centroid, elevation
	Biogeographical region Land tenure and administrative authority: For the wetland, and for critical parts of the river basin and/or coastal zone
	Ecological character
1. Summary statement	
Two or three narrative sentences giving a statement of what is ecologically <i>distinctive</i> (not necessarily <i>important</i>) about the site, based on the details below. (With reference to the COP 9 definition, this concerns <i>the combination of</i> the components, processes and services that <i>characterise</i> the wetland (emphasis added)).	(Not part of core inventory)
2. Ecological components	
2.1 Geomorphic setting: Setting in the landscape/catchment/river basin - including altitude, upper/lower zone of catchment, distance to coast where relevant, etc.	Geomorphic setting: Setting in the landscape/catchment/river basin - including altitude, upper/lower zone of catchment, distance to coast where relevant, etc.
2.2 Climate: Overview of prevailing climate type, zone and major features (precipitation, temperature, wind)	Climate: Overview of prevailing climate type, zone and major features
2.3 Habitat types (including comments on particular rarity, etc.), and Ramsar wetland types	Part of section on biota: Plant communities, vegetation zones and structure (including comments on particular rarity, etc.)
2.4 Habitat connectivity	

Ramsar ecological character description sheet	Core inventory fields (revised)
2.5 Area, boundary and dimensions: Site shape (cross-section and plan view), boundaries, area, area of water/wet area (seasonal max/min where relevant), length, width, depth (seasonal max/min where relevant)	[In administrative and locational details section above.]
2.6 Plant communities, vegetation zones and structure (including comments on particular rarity, etc.)	Part of section on biota : Plant communities, vegetation zones and structure (including comments on particular rarity, etc.); (See under administrative and locational details above)
2.7 Animal communities (including comments on particular rarity, etc.)	Part of section on biota : Animal communities (including comments on particular rarity, etc.);
2.8 Main species present (including comments on particular rare/endangered species etc); population size and proportion where known, seasonality of occurrence, and approximate position in distribution range (e.g., whether near centre or edge of range)	Part of section on biota : Main species present (including comments on particular rare/endangered species etc); population size and proportion where known, seasonality of occurrence, and approximate position in distribution range (e.g., whether near centre or edge of range) Part of section on biota : Animal communities (including comments on particular rarity, etc.);
2.9 Soil: Geology, soils and substrates; and soil biology	Soil: Geology, soils and substrates
2.10 Water regime: Water source (surface and groundwater), inflow/outflow, evaporation, flooding frequency, seasonality and duration; magnitude of flow and/or tidal regime, links with groundwater	Water regime: Water source (surface and groundwater), inflow/outflow, evaporation, flooding frequency, seasonality and duration; magnitude of flow and/or tidal regime, links with groundwater
2.11 Connectivity of surface waters and of groundwater	(Incorporated in "Water regime" above)
2.12 Stratification and mixing regime	
2.13 Sediment regime (erosion, accretion, transport and deposition of sediments)	
2.14 Water turbidity and colour	Part of section on Water chemistry : Turbidity; colour
2.15 Light - reaching the wetland (openness or shading) and attenuation in water	(Incorporate as appropriate in vegetation and chemistry sections above)
2.16 Water temperature	Part of section on Water chemistry : Temperature
2.17 Water pH	Part of section on Water chemistry : pH
2.18 Water salinity	Part of section on Water chemistry : Salinity
2.19 Dissolved gases in water	Part of section on Water chemistry : Dissolved gases

Ramsar ecological character description sheet	Core inventory fields (revised)
2.20 Dissolved or suspended nutrients in water	Part of section on Water chemistry: Dissolved or suspended nutrients
2.21 Dissolved organic carbon	Part of section on Water chemistry: Dissolved organic carbon
2.22 Redox potential of water and sediments	(Incorporate in chemistry section if appropriate)
2.23 Water conductivity	(Incorporate in chemistry section if appropriate)
3. Ecological processes	
3.1 Primary production (S)*	(Not included)
3.2 Nutrient cycling (S)*	
3.3 Carbon cycling	
3.4 Animal reproductive productivity	(Incorporate as necessary in section on biota)
3.5 Vegetational productivity, pollination, regeneration processes, succession, role of fire, etc.	
3.6 Notable species interactions, including grazing, predation, competition, diseases and pathogens	
3.7 Notable aspects concerning animal and plant dispersal	
3.8 Notable aspects concerning migration	
3.9 Pressures and trends concerning any of the above, and/or concerning ecosystem integrity	Pressures and trends: Concerning any of the features listed above, and/or concerning ecosystem integrity
4. Ecosystem services	
4.1 Drinking water for humans and/or livestock (P)*	Ecosystem services: (Derive summary, to length appropriate, of the aspects documented in the character description sheet as listed in fields 4.1 - 4.27 on the left)
4.2 Water for irrigated agriculture (P)*	
4.3 Water for industry (P)*	
4.4 Groundwater replenishment (R)*	
4.5 Water purification/waste treatment or dilution (R)*	
4.6 Food for humans (P)*	
4.7 Food for livestock (P)*	
4.8 Wood, reed, fibre and peat (P)*	
4.9 Medicinal products (P)*	
4.10 Biological control agents for pests/diseases (R)*	
4.11 Other products and resources, including genetic material (P)*	
4.12 Flood control, flood storage (R)*	
4.13 Soil, sediment and nutrient retention (R)*	
4.14 Coastal shoreline and river bank stabilization and storm protection (R)*	
4.15 Other hydrological services (R)*	

Ramsar ecological character description sheet	Core inventory fields (revised)
4.16 Local climate regulation/buffering of change (R)* 4.17 Carbon storage/sequestration (R)* 4.18 Recreational hunting and fishing (C)* 4.19 Water sports (C)* 4.20 Nature study pursuits (C)* 4.21 Other recreation and tourism (C)* 4.22 Educational values (C)* 4.23 Cultural heritage (C)* 4.24 Contemporary cultural significance, including for arts and creative inspiration, and including existence values (C)* 4.25 Aesthetic and “sense of place” values (C)* 4.26 Spiritual and religious values (C)* 4.27 Important knowledge systems, and importance for research (C)* <i>(For nature conservation value as an ecosystem ‘service’ (S)*, see items under ‘components’ and ‘processes’ above)</i>	
	Conservation and management Conservation and management status of the wetland: Including legal instruments and social or cultural traditions that influence the management of the wetland; and including protected area categories according to the IUCN system and/or any national system Management plans and monitoring programs: In place and planned within the wetland and in the river basin and/or coastal zone (see Resolutions 5.7, VI.1, VII.17, and VIII.14) Land use : Local, and in the river basin and/or coastal zone

* Ecosystem Services are categorised as “provisioning” (P), “regulating” (R), cultural (C) or “supporting” (S) according to the categorization in the Millennium Ecosystem Assessment. Some may appear in the “processes” section as well as the “services” section above.