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A Framework for Wetland Inventory

Adopted by Resolution VIII.6 (2002) of the Ramsar Convention

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.

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 baselines 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:

    a) that describing the biophysical features of the wetland; and
    b) 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. Core (minimum) data fields for biophysical and management features of wetlands

Biophysical features

- 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)

Management features

- 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 values and benefits (goods and services) derived from the wetland – including products, functions and attributes (see Resolution VI.1) and, where possible, their services 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)

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

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 2at 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.

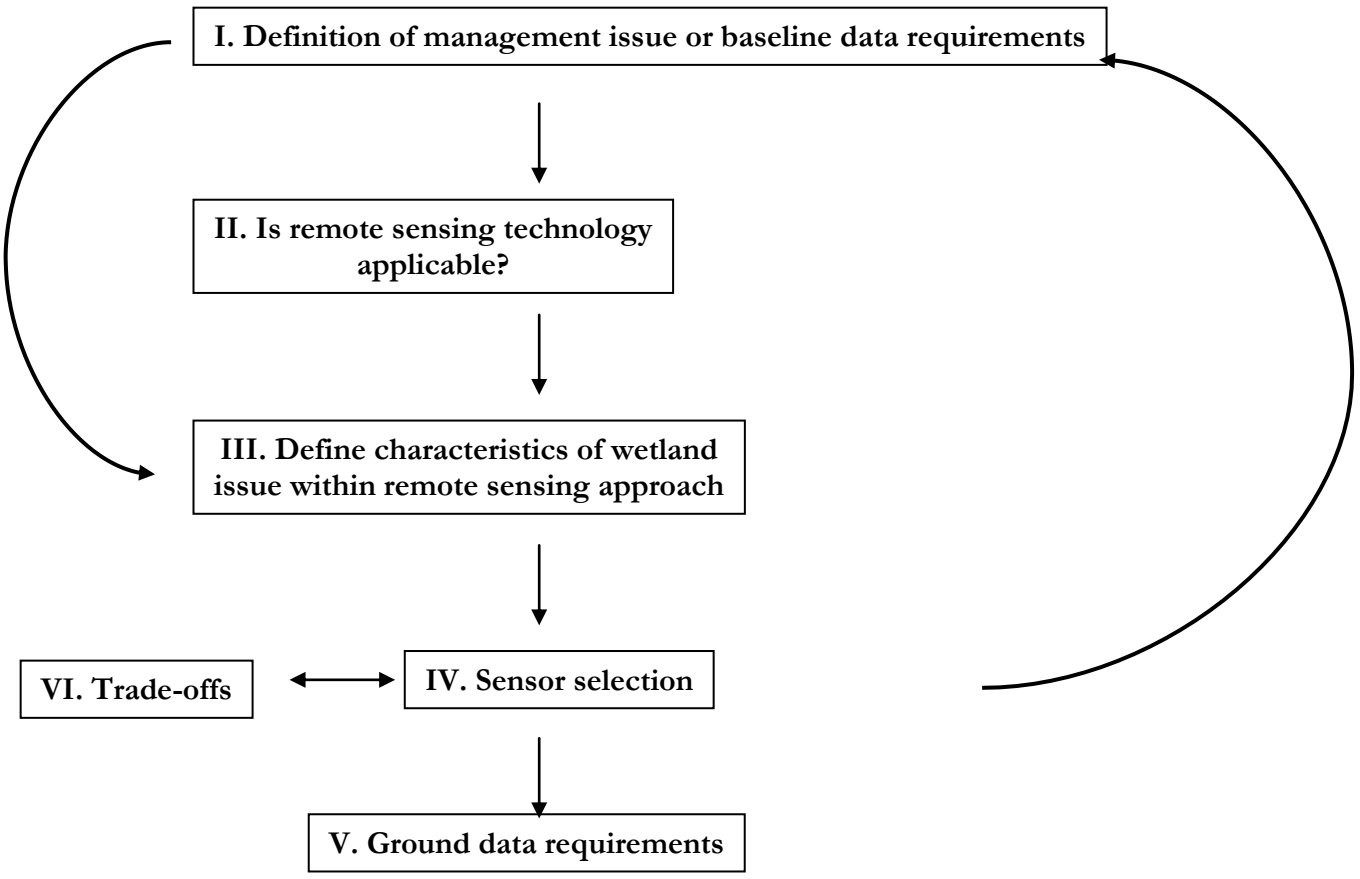
V. Ground data requirements

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	100km2 (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 60,000km2 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) = 0.63-0.69*µm* Band 4 (NIR) = 0.76-0.90*µm* 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 decomm-issioned	Bands 1-5 & 7 = 30m Band 6 = 120m	Typical full scene = 184 x 185km (Super scenes up to 60,000km2 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) = 0.63-0.69*µm* Band 4 (NIR) = 0.76-0.90*µm* Band 5 (MIR) = 1.55-1.75µm Band 6 (TIR) = 10.40-12.50µm *Band 7 (MIR)* = 2.08-2.35*µm*		**U.S. Geological Survey** http://edcsns17.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* PAN = 0.51-0.73μm/0.61-0.68* *= SPOT4 only	Every 26 days Data available since 1990	**SPOT Image** http://www.spot.com/

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	Eight optical bands 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 band235nm HH polarisation	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	220 spectral 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/
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/imswelcome/
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
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	Swat with of < 100km, > 400km and in 5km x 5km vignette, pedending 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 reesulution) 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

HyMap	Typically 2.5m or 5m	Varies with pixel size 5m = 2.5km swath 2.5m = ~1.3km swath	124 bands 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	98 bands 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/ Spectrograp-hic Imager	Typically 1m	Depends on spatial resolution 1m pixel = ~500m swath	**Variable bands (~19-288)** (~2-12nm wide) 0.40-1.0um 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/
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.

FIELDBASED

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, surfae 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.

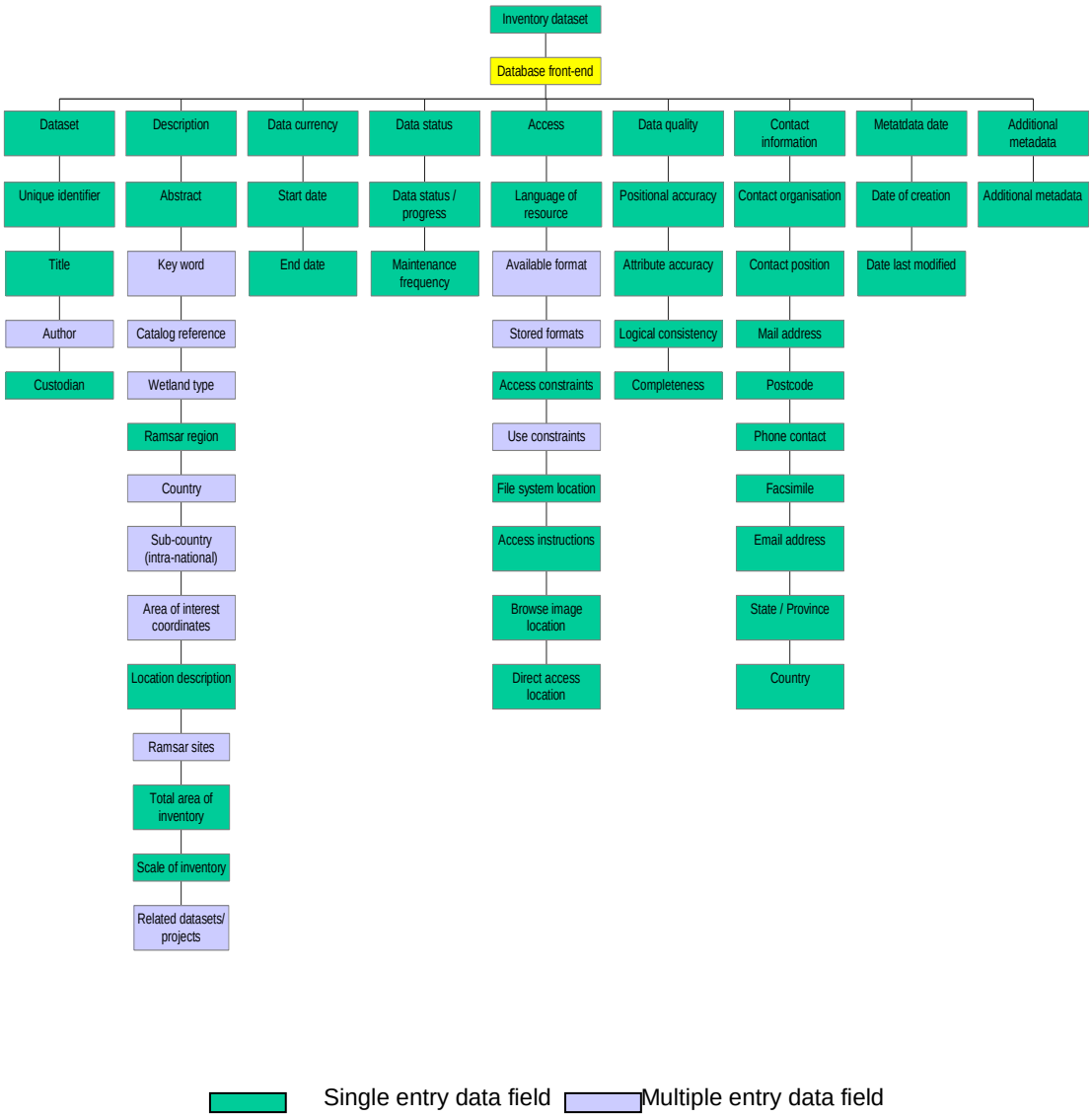


Figure 2. Diagrammatic representation of the wetland inventory metadatabase framework.

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
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 Overivew*. 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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