Review of wetland inventory information in Oceania

D Watkins

Wetlands International–Oceania

GPO Box 787, Canberra, ACT, 2601, Australia

Contents

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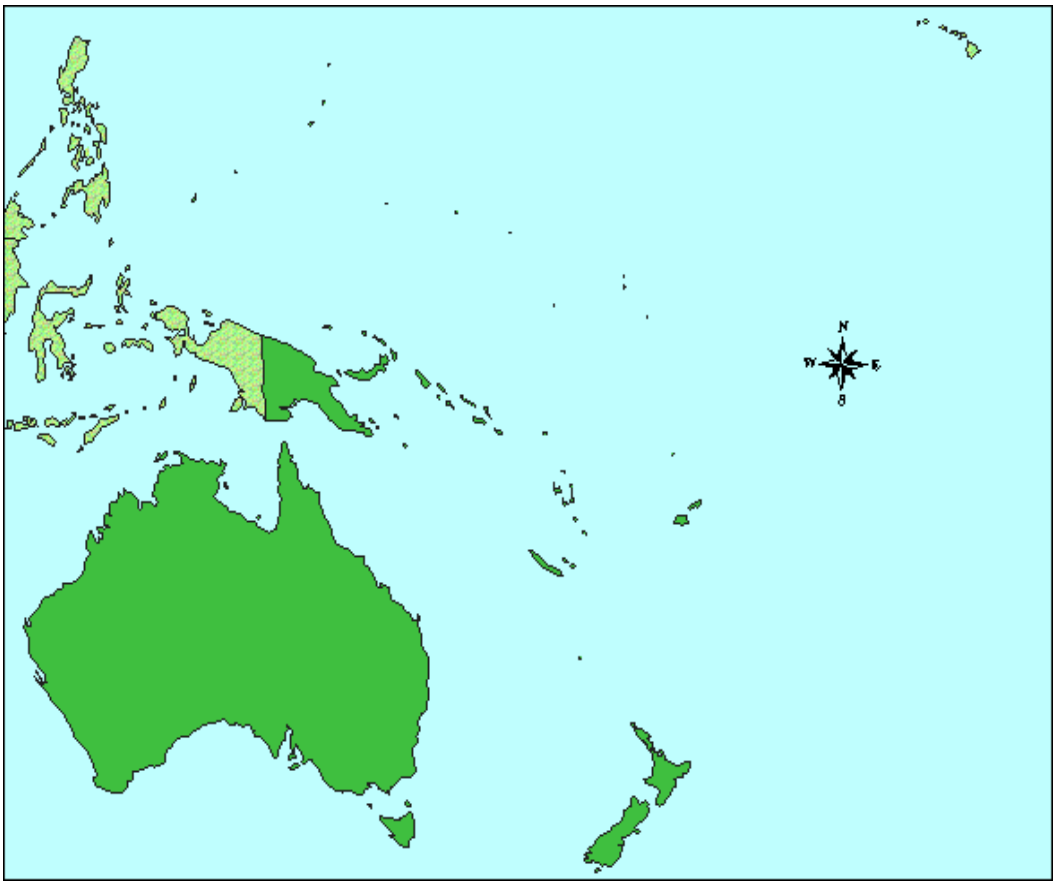
1 Introduction

This report analyses the extent and adequacy of wetland inventory information in the Oceania Region. The Oceania Region is defined as including Australia, New Zealand, Papua New Guinea and east into the Pacific to include a further 13 countries and 8 Territories (fig 1).

This report analyses the extent and adequacy of the wetland inventory information in the Oceania Region as defined by the Ramsar Bureau. Countries and Territories included in this region are listed in table 4.



Boundaries are not authoritative

Figure 1 Map of the Oceania region

2 Information sources

2.1 Methods used to obtain wetland inventory information

The objective of this project was to review published inventories of wetlands at the national and supra-national (regional) levels to determine their value as a baseline for studies on the trends of wetland degradation and loss. However, because most of the inventories examined did not give a complete picture on the area of wetlands in the countries considered, some supplementary reference material was also examined.

Four approaches were used to identify wetland inventories and other materials:

- review of materials held by Wetlands International–Oceania
- computerised library search in Australia
- Internet search
- correspondence and other communication with wetland experts in the region.

This analysis has been prepared by the Wetlands International–Oceania. The analysis is based on the available published inventories and the additional information obtained from correspondence during the short period of the review. The study focussed on material at the national and regional level. In the case of Australia, several examples of sub-national inventories were included.

2.2 Summary of information sources reviewed

Wetland inventory information at the national and supra-national scale was found to be very limited. In Oceania 26 sources of inventory information were reviewed (table 1). Three of these covered many countries. The total number of country reports reviewed was 56.

The analysis of information on wetland inventory shows the diversity of materials and approaches that have been used (Annex 2). Key points from the analysis are detailed in table 2 below. Most of the material analysed was of recent origin (since 1980) from published sources funded by both governmental and non-governmental organisations. A substantial proportion were stored in electronic form, thus facilitating access and reproduction.

Table 1 Inventory reports used in the analysis for the Oceania region

Inventory Title	States included (see Annex 1 for codes)	Year
Regional Inventories of Important Sites		
A Directory of Wetlands in Oceania	ASM,FSM,FJI,PYF,GUM,KIR,MHL,NRU,NCL,MNP,PLW,PNG,SLB,TON,TUV,VUT,WLF,WSM	1993
A Directory of Asian Wetlands	PNG	1989
Data Book on World Lake Environments – Asia and Oceania	NZL,AUS	1995
National Inventories of Important Sites		
A Directory of Important Wetlands in Australia Second Edition	AUS	1996
Australian Ramsar Sites	AUS	1997
A Directory of Wetlands of New Zealand	NZL	1996
WERI database (Wetlands of Ecological and Regional Importance)	NZL	1990
Sub-national Inventories of Important Sites		
Tasmanian Wetland Inventory Project	AUS	1991
Victorian Marine and Coastal Environment GIS	AUS	1995
Victorian Wetlands and Wetlands Systems Listed under the Ramsar Convention	AUS	1996
A Survey of the Coastal Wetlands South-eastern Victoria	AUS	1976
Wetland Resources of the South East of South Australia	AUS	1983
Wetlands Atlas of the South Australian Murray Valley	AUS	1996

Wetland Type Inventories		
World Mangrove Atlas	AUS,FSM,FJI,GUM,NCL,NZL,PNG,SLB,TON,VUT,WSM	1997
Conservation or Conversion of Mangroves in Fiji	FJI	1990
Fiji Lands Department Estimate of Mangroves (LD33/41)	FJI	1986
Freshwater Lakes of Papua New Guinea	PNG	1987
Other Wetland Inventories		
Coastal Resource Inventory	NZL	1990
SSWI (Sites of Special Wildlife Interest)	NZL	1986
Feasibility Report on a National Wetland Survey	AUS	1978
Aspects of Australian Wetlands	AUS	1985
Wetlands & Waterbirds in Northwestern NSW	AUS	1994
Victoria: Wetland _1788 & Wetland_1994	AUS	1997
Coastal Lands of Australia	AUS	1984
Inventory of Declared Marine and Estuarine Protected Areas in Australian Waters	AUS	1984
Terrestrial and Marine Protected Areas in Australia (1977)	AUS	1997

Table 2 Key attributes of the wetland inventories reviewed

Attribute	Analysis (n = 26)
Inventory type:	58% of the inventories were classified as site directories.
Publication date:	Half of the information has been published since 1990.
Publication format:	Information has been published by a diversity of organisations, the most common being government formal publications (31%) and other government reports (23%).
Language:	All of the information identified was available in English.
Publication format:	The most common format of the information source was paper documents (43%).
Availability of information:	Most of the information reviewed was from published sources (65%).
Data storage:	Most of the information is stored as paper products (43%). Electronic storage accounted for (39%).
Implementation agencies:	Inventory studies had been implemented by national governments (38%) and sub-national government agencies (30%).
Funding sponsor:	The most common primary funder of inventory information was national government organisations (46%).

3 Extent and adequacy of wetland inventory information

3.1 Objectives

The most important attribute of the inventories is their objective(s). The review found that inventories could be divided into four major categories based on their primary objective and hence the type and coverage of the data included. The four categories are discussed below (table 3).

Table 3 Summary of the number and types of inventories reviewed

Inventory type	Number reviewed	Number country records
Important site inventories	6	25
Wetland type inventories	6	17
Sub-national inventories (Australia)	6	6
Other inventories	8	8
Total	26	56

The first group is inventories that included wetlands primarily on the basis of their biodiversity value. These have been termed 'important site inventories'. This type of inventory has been published at the national level for New Zealand (Cromarty & Scott 1996) and Australia (Australian Nature Conservation Agency 1996). A third publication, *A Directory of Wetlands in Oceania* (Scott 1993), covers the other countries in Oceania.

In Oceania, 23% (n=26) of the inventory information reviewed were categorised as 'important site inventories'. The majority of these inventories were compiled to identify or describe wetlands of national and international importance based on the criteria of the Ramsar Convention. These inventories are presented in the form of 'site directories' which contain an account of each wetland site. Important site inventories include only a sample of the wetlands in the country and are biased towards larger less modified wetlands and protected areas.

The second group of inventories focus on a particular wetland ecosystem or habitat type such as mangroves (Spalding et al 1997), freshwater lakes (Chambers 1987) or coastal wetlands (Galloway et al 1984). Seven or 27% of the inventories reviewed are of this nature.

The third group included in the Oceania analysis are sub-national inventories from Australia. They were included because in Australia land and water management is the responsibility of sub-national governments. They were included as examples of information available at the sub-national level. Their inclusion also was appropriate because of the large land area of Australia, which is a small continent compared with the relatively small land areas of each of the Pacific Island countries and territories. Many sub-national inventories in Australia covered areas far greater than the areas of many of the Pacific Island countries.

The final category groups the remaining inventories into 'other'. This category includes a variety of approaches and objectives, with studies ranging from waterbird surveys (eg Kingsford et al 1994) to sites of special interest for wildlife (eg New Zealand Sites of Special Wildlife Interest database) and protected areas (eg Cresswell & Thomas 1997).

3.2 Wetland definitions and classifications

Definition of wetlands

Approximately half (57%) of the inventories contained a definition of the wetland resource, while in a further 19% of cases it could be inferred. The definitions and classifications used in the inventories varied according to the objectives and the implementing agencies.

The Ramsar Convention on Wetlands defines wetlands as:

> areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (Ramsar Convention Bureau 1997).

The Ramsar definition of wetlands was used in 38% of the inventories.

All of the inventories of important sites used the Ramsar definition of wetlands. This is to be expected as these inventories were developed in response to initiatives related to the Ramsar Convention. Other inventories adapted the wetland definition to the specific objective of the inventory.

For inventories based on map products (Paijmans 1978, Paijmans et al 1985, Chambers 1987) wetlands were defined by their topographic representation. For example, for the inventory of freshwater lakes of Papua New Guinea using 1:100 000 maps, Chambers (1987) indicated that all standing bodies of freshwater shown on the maps were included. Paijmans et al (1985), in their study of Australian wetlands, defined wetlands as land permanently or temporarily under water or waterlogged, but were reliant on the accuracy of air-photo interpretation used by the producers of the 1:250 000 maps on which the study was based.

Classification of wetlands

A wetland classification system was used in 11 of the 26 inventories reviewed.

In four cases the wetland classification is compatible with the 1990 Ramsar classification (Davis 1994). These inventories were developed as part of the Australian Government's activities related to implementation of the Ramsar Convention. The Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996) classified three additional wetland types to more fully describe Australian wetlands: non-tidal freshwater forested wetlands, rock pools and karst systems. In each inventory the classification was used to describe the range of wetland types at each site. No maps of the wetland types or information on the extent of each wetland type is presented in these inventories.

No wetland classification was used by the compilers of two of the inventories of important sites (Scott 1993, Cromarty & Scott 1996). No explanation was given in each case.

The assessment of coastal lands in Australia (Galloway et al 1984) examined a 3 km wide strip inland from the high tide mark and classified points on aerial photographs into geology, landform, vegetation and landuse categories.

The Australian wetland survey by Paijmans et al (1985) used the topographic classification details from 1:250 000 maps. This enabled six categories (lakes, swamps, land subject to inundation, rivers and creeks, tidal flats, coastal inshore waters) to be identified. These were further divided into classes based on permanency of water and frequency of flooding.

3.3 Geographic scale

The 'geographical scale' of inventory information varies widely. Information reviewed for Oceania in this study included:

- 1 global (covers global extent of wetland type)
- 3 supra-national (more than one country)
- 16 national (complete country)
- 6 sub-national (part of a country).

The global inventory examined the distribution and extent of mangroves, presenting information on a national basis (Spalding et al 1997). It is an example of an inventory that assessed the total extent of one wetland type within the geographic scope of the inventory. It draws to some extent on national or sub-national studies, eg Galloway (1982) for Australia.

This 'full assessment of the wetland resource' approach contrasts the other inventories reviewed. Most only assessed part of the wetland resource with the geographic scope of the

inventory. For example the *Data Book of World Lake Environments* (Kira 1995) has a geographic scope covering Oceania, however, it contains only two wetlands in Australia and two in New Zealand.

Presentation of information in supra-national and global inventories in the form of country reports (Scott 1989, 1993; Spalding et al 1997) is particularly valuable. It enables analysis of information at the global, regional and national level.

3.4 Inventory methods

The methods for undertaking the inventories differ markedly according to the objectives of the inventory.

Important site inventories

The important site inventories primarily used collation of existing information, topographic and other maps, and ground surveys at selected sites to supplement the available data. In one of the nine inventories (New Zealand Wetlands of Ecological and Regional Importance database), a systematic sample program was used to select the wetlands for inclusion.

In most cases inventories are in the form of site directories, using standard headings such as: location; area; elevation; wetland type; site description; significance; land tenure; current land use; disturbances and threats; conservation measures taken; management authority and jurisdiction; references; and compiler and date (Australian Nature Conservation Agency 1996). None of the important site inventories contain maps or information on the extent of the wetland types within each site. Review and collation has been the primary methodology used to prepare the inventories. A further limitation of this type of inventory is that the wetland component of listed sites may be only a small percentage of the total area of the site (see 4.1.1).

Wetland type inventories

Inventories of mangroves made extensive use of existing map products, aerial photography and satellite imagery. Aerial photography provided the information base for the assessment of Coastal Lands in Australia (Galloway et al 1984). In the case of the inventory of freshwater lakes in Papua New Guinea, wetlands were identified from 1:250 000 topographic maps (Chambers 1987).

Other inventories

A range of methodologies were used to develop other inventories. Two Australian studies identified wetlands from 1:250 000 map products (Paijmans 1978, Paijmans et al 1985). The GIS on wetlands of Victoria, Australia, was based on interpretation of aerial photographs (Department of Natural Resources and Environment 1997b). Information in inventories of protected marine and estuarine areas was limited to location and size (Ivanovici 1984, Cresswell & Thomas 1997).

3.5 Extent and adequacy according to inventory types (objectives)

3.5.1 Overview

No national or supra-national inventories were identified that included all wetlands within the geographic extent of the inventory. This reflects the tendency for inventories to have been developed for purposes (eg inventory of wetlands of high or special biodiversity value) that did not necessarily require all wetlands to be included. This lack of comprehensive inventories of the extent of wetland types at the national and supra-national level creates major difficulties for developing estimates of the extent of wetland resources.

The Directory of Wetlands in Oceania contains qualitative comments by the authors of country chapters on the comprehensiveness of the national account (Scott 1993). There are no qualitative assessments of the comprehensiveness of the national account.

A profile of the wetland inventory information reviewed according to main objectives (type) of the inventory is shown in table 4.

Table 4 Summary of wetland inventory information reviewed for the Oceania region

Country and Territories	Number of inventory records	Inventory type			
		Important wetlands	Wetland type	Sub-national	Other
American Samoa	1	1			
Australia	17	2	3	6	6
Cook Islands	1	1			
Fiji	4	1	3		
French Polynesia	1	1			
Guam	2	1	1		
Kiribati	1	1			
Marshall Islands	1	1			
Federated States of Micronesia	2	1	1		
Nauru	1	1			
New Caledonia	2	1	1		
New Zealand	6	2	2		2
Niue	1	1			
Northern Mariana Islands	1	1			
Palau	1	1			
Papua New Guinea	4	2	2		
Solomon Islands	2	1	1		
Tonga	2	1	1		
Tuvalu	1	1			
Vanuatu	2	1	1		
Wallis and Futuna	1	1			
Western Samoa	2	1	1		
Total	**56**	**25**	**17**	**6**	**8**

3.5.2 Important wetland site inventory

The major limitation with assessing the extent and adequacy of important site inventories is that they have not been developed from a systematic assessment of national wetland resources. A second difficulty arises from the criteria used to assess sites as internationally or nationally important (eg under the Ramsar Convention), as these tend to be qualitative in nature rather than quantitative. As such, it is not possible to determine the level of adequacy of important site inventories.

The New Zealand Wetlands of Ecological and Regional Importance database was based on an earlier systematic national survey of important ecological areas. The database is considered to have comprehensive coverage of palustrine and lacustrine wetlands in New Zealand (C Richmond pers comm).

Inventory work in Victoria, Australia, provides an example of the level of coverage of important site inventories (table 5). Sources of information for the three levels of inventory are the Ramsar Bureau Web site, Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996), and Wetlands_1994 database (Department of Natural Resources and Environment 1997b).

The data are not directly comparable because some of the Ramsar and national directory listed sites include non-wetland habitat. The sub-national inventory does not include shallow marine areas which constitute approximately 100 000 ha of the Ramsar and national directory listed sites. This example illustrates both the under-representation of smaller wetlands in national inventories and Ramsar listing, and the difficulty of making comparisons between inventories.

Table 5 Comparisons of the level of coverage of inventories in Victoria, Australia

Level of Inventory	No. sites	Area (ha)
Ramsar listed	10	252 893
National Directory	121	395 104
Sub-national inventory	13 114	535 453

3.5.3 'Wetland type' inventory

Wetland type inventories tended to be more comprehensive in coverage. The World Mangrove Atlas (Spalding et al 1997) provide estimates for the extent of mangroves in most countries of Oceania. Comprehensive coverage is also a feature of the two national assessments of mangrove extent (Watling 1985, Lal 1990).

The inventory of coastal land around Australia also has comprehensive coverage within its limited scope. This inventory was restricted to the coastal lands within a 3 km strip inland of the mid-tide mark (Galloway et al 1984).

The inventory of freshwater lakes in Papua New Guinea includes all lakes shown on 1:100 000 topographic maps.

Sub-national inventories

Half of the sub-national inventories reviewed covered all of the wetland resources within their defined geographic scope. These inventories tended to become more comprehensive as the size of the geographic area decreased. These are primarily wetland resource assessments rather than wetland site inventories (eg Jensen et al 1996).

Other inventories

Only one inventory attempted to estimate the number of wetlands at a national scale (Paijmans et al 1985). The methodology used in this inventory was to identify wetlands from 1:250 000 topographic maps. The approach was developed as part of a feasibility study for a national wetland survey in Australia in the mid-1970s (Paijmans 1978). A full survey has not been commissioned in Australia although it is an ongoing topic of discussion between State and Commonwealth Government agencies. Most of the problems for conducting a national wetland inventory identified in the 1978 report still remain (eg funding, nationally agreed methodology). Digital information on wetland features is now available from the 1:100 000 map sheets of Australia, but this information has yet to be presented as wetland inventory information.

3.6 Extent and adequacy of updating activities

Updating activities for wetland inventory takes two main forms. One is a reassessment of the area and condition of the wetland resource, and the second is an extension process to include additional sites or more information on existing sites.

No updating activities were identified that involved a reassessment of the extent and condition of the wetland resource. One activity did involve a retrospective study to predict the extent of wetlands in Victoria, Australia, at the time of European settlement (Department of Natural Resources and Environment 1997b).

Two of the important site inventories had been updated to include additional data on existing sites and to extend the number of sites included (Atkinson 1991, Australian Nature Conservation Agency 1996).

4 Use of inventory information to assess the status of wetlands

4.1 Extent and distribution

The availability of information on the extent and distribution of wetlands varies considerably according to the objectives of the inventories.

4.1.1 Important wetland sites

Inventories of important wetland sites can only yield information on the number and area of the identified important sites in a particular country (table 9). The number and extent will vary considerably according to the specific criteria used for the selection of sites and the resources available for the survey. Most inventories of important wetlands model their criteria on those of the Ramsar Convention.

A limitation common to all important site inventories reviewed was that information on the extent of wetlands referred to the total site. In many cases the sites include several wetland types and at times non-wetland habitat.

The inclusion of non-wetland habitat is exemplified by the case of the Kakadu listing in the Directory of Important Wetlands in Australia and Ramsar Convention 'List of Wetlands of International Importance'. While the area of the listed site is 1 375 940 ha the wetland component is only 16% (Australian Nature Conservation Agency 1996). This non-wetland habitat represents over 20% of the total area of Ramsar listed wetlands in Australia. Other large Ramsar listed sites in Australia in which non-wetland habitat contributes significantly to the total area of the site include Coongie Lakes.

4.1.2 Wetland type specific

Mangroves

Mangrove is the most comprehensively inventoried wetland type in the Oceania region. The key source of information was derived from a global mangrove atlas project by the International Society for Mangrove Ecosystems (Spalding et al 1997). Data were obtained from a wide variety of sources and entered into a GIS system at the World Conservation Monitoring Centre, Cambridge, United Kingdom. Previous national estimates of the extent of mangroves were also reviewed, along with details on the loss of mangroves at selected sites.

'Best estimates' of the area of mangroves in the countries and territories of the Oceania region are presented in table 8. The data are primarily from Spalding et al (1997), however, as this does not cover all of the countries and territories, it is supplemented with information from

Scott (1993). Spalding et al (1997) present new estimates of mangrove extent, based on GIS mapping, for eight countries. This estimate is considered the 'best estimate' in 5 cases (62%).

Table 8 Best estimates of mangrove extent for the Oceania region

Country or Territory	Best estimate (ha)	Reference
American Samoa	50	Cole et al (1988)[@]
Australia	1 150 000	Galloway (1982)[#]
Cook Islands	nil	Scott (1993)[@]
Fiji	38 500	Anon. (1993)[#]
French Polynesia	nil	Scott (1993)[@]
Guam	90	Spalding et al (1997)[#]
Kiribati	no info.	Scott (1993)[@]
Marshall Islands	no info.	Scott (1993)[@]
Federated States of Micronesia	8600	Ellison (1995)[#]
Nauru	2	Scott (1993)[@]
New Caledonia	45 600	Spalding et al (1997)[#]
New Zealand	28 700	Spalding et al (1997)[#]
Niue	nil	Scott (1993)[@]
Northern Mariana Islands	no info.	Stinson (1993)[@]
Palau	4710	Cole et al (1987)[@]
Papua New Guinea	539 900	Ellison (1995)[#]
Solomon Islands	64 200	Ellison (1995)[#]
Tonga	1000	Ellison (1995)[#]
Tuvalu	30	Scott (1993)[@]
Vanuatu	1600	Ellison (1995)[#]
Wallis and Futuna	nil	Scott (1993)[@]
Western Samoa	700	Ellison (1995)[#]
Total	**1 883 700**	

Note: [#] – best estimate made by Spalding et al (1997).

[@] – information from Scott (1993).

Freshwater swamp forest and forested peatlands

The extent of peat swamps in tropical Oceania has been reviewed by Rieley et al (1996):

Papua New Guinea	500 000–2 890 000 ha
Fiji	4000 ha
Australia (Queensland)	15 000 ha

The authors note that there are great variations in estimates for extent of peatlands mainly because estimates in large countries have been made from aerial photographs and, more recently, from satellite imagery. With these methods it is impossible to accurately determine the boundaries between peat and adjacent waterlogged mineral soils, since both support forests of similar structure and vegetation composition.

Lakes

Chambers (1987) estimated that there were 5383 lakes in Papua New Guinea, of which 22 had an area greater than 1000 ha. In Australia, Paijmans et al (1985) estimated that there are

5050 lakes covering an area of 520 000 ha. These estimates were both developed from the representation of lakes shown on topographic maps.

4.1.3 Sub-national and other inventories

Paijmans et al (1985) is the best example of an inventory with the objective of developing a national overview of wetlands. This study was based on analysis of 1:250 000 topographic maps. The study developed an estimate of the number of wetlands and produced a set of maps of wetland types at 1:2 500 000. However, there are many limitations to using this as baseline information for Australia, including:

- the scale of the study (1:250 000) which is too small to detect many wetlands
- the inherent inaccuracy of topographic representations of wetlands
- there is no information on the extent of wetlands.

In New Zealand a number of resource inventory databases have been developed from which estimates of wetland extent have been generated (Cromarty & Scott 1996). Estimates are given for rivers, lakes and wetland vegetation associations. However, this work has not generated information on the extent and boundaries of individual wetland types. A new national program to address this issue is being developed (C Richmond pers comm).

At the sub-national level, studies have generated more specific information on wetland extent and distribution. In Victoria, Australia, a GIS has been developed, at a scale of 1:25 000, on wetland distribution for the years 1788 and 1994 (Department of Natural Resources and Environment 1997b). This has generated estimates for 1994 of 13 114 wetlands covering 534 453 ha (Department of Natural Resources and Environment 1997a).

Extensive resource and land use studies have been conducted in the Murray-Darling River Basin in Australia (Crabb 1997). The region covers over 1 000 000 km^2 or approximately 14% of Australia. Estimates of the extent of wetlands have been developed for parts of the catchment (New South Wales 53 388 ha; Victoria 31 039 ha; South Australia 138 290 ha) and a comprehensive database is being developed.

Data are also available on wetland distribution for much smaller regions of Australia. This information has been generated to address specific resource management issues (eg Jensen et al 1996, Pen 1997). In the Busselton-Walpole region of south-western Australia, a systematic overview of environmental values of wetlands has been conducted to guide water resource allocation and management (Pen 1997). In the Darling system and adjacent areas of south-western Australia, Semeniuk (1988) has undertaken thorough mapping and classification of wetlands at a large scale. This approach is being used as a model for extending the work to other parts of the State.

4.2 Wetland benefits and values

The wetland inventories examined included very few overall quantitative estimates of wetland benefits or values of the wetlands described.

Directories for important sites did include categories for description of land-use, economic and social values, important fauna and special floral values. In most cases the entries are qualitative rather than quantitative, except in the case of numbers of waterbirds or endangered species. It is therefore not possible to make an overall assessment of the values of the wetlands or to extrapolate on their importance within a country. The only analysis possible would be to summarise the number of sites of importance for different benefits, but since the data sheets vary in the level of information, this may not yield meaningful outcomes.

A detailed economic evaluation of mangroves has been conducted in Fiji (Lal 1990). However, the assessment of changes in the extent of mangroves was apparently an incidental component of the study.

4.3 Land tenure and management structure

To obtain information on land tenure and management structures, inventories need to use a methodology that enables specific wetlands to be identified and for information to be collated on the individual sites. This type of information is contained in wetland directories.

The three major national and supra-national wetland directories all contain information on land tenure and management. One item of information from these inventories which can, to some extent, be extracted and analysed is the degree of protection (table 9).

Table 9 Number, area and protection status of sites in the key wetland directories that cover the Oceania region (Scott 1989, Scott 1993, Cromarty & Scott 1996, Australian Nature Conservation Agency 1996)

Country or territory	No. of sites/ systems in the directory[1]	Area of sites in the directory[2]	Area under some form of protection[3,4]	Area totally protected[5]
American Samoa	4	203	73	0
Australia	698	** 24 201 797	not analysed	not analysed
Cook Islands	5	** 550	0	0
Fiji	11	16 661	0	0
French Polynesia	14	** 8 901	2 750	2 750
Guam	19	836	17	0
Kiribati	11	** 76 366	70 653	70 653
Marshall Islands	0	0	0	0
Micronesia, Federated States	4	10 616	0	0
Nauru	1	3	0	0
New Caledonia	5	** 8 200	** 2 060	** 1 060
New Zealand	73	** 1 145 601	not analysed	not analysed
Niue	0	0	0	0
Northern Marianas	6	270	0	0
Palau	8	2 022	0	0
Papua New Guinea	33	10 123 861	599 556	0
Pitcairn Islands	3	5 620	3 700	0
Solomon Islands	9	** 130 600	1 000	1 000
Tokelau	1	10	0	0
Tonga	7	9 830	2 835	2 835
Tuvalu	1	40	0	0
Vanuatu	13	** 6 103	0	0
Wallis and Futuna	1	43	0	0
Western Samoa	7	** 720	0	0
Total	**934**	**35 748 853	***	***

1 Data for Papua New Guinea are from Scott (1989), data for Australia are from Australian Nature Conservation Agency (1996), data for New Zealand are from Cromarty and Scott (1996) and data for the others are from Scott (1993).

2 Area in some cases includes dry land, e.g. where whole catchments or whole islands are listed in the directory.

3 Categories for some form of protection include: National Natural Landmark, Special Management Area, Government Owned Land and Conservation Preserve (USA territories); Protected Area (New Caledonia, Tonga); World Heritage Area (Pitcairn/United Kingdom); and Wildlife Management Area (Papua New Guinea).

4 Some wetlands, including several in Pacific Island countries, have been included in 'conservation areas' since the directories were published.

5 Categories for total protection include: Strict Nature Reserve, Special Botanical Reserve and Special Faunal Reserve (French territories), Wildlife Sanctuary (Kiribati, Solomon Islands).

** indicates that the account for this country/territory includes wetland of unknown area; thus the area stated is a minimum.

*** Totals were not calculated for these columns because the project resources did not permit analysis of data in the Australian and New Zealand directories with respect to protected area status.

4.4 Rate and extent of wetland loss and degradation

None of the national or supra-national inventories reviewed provided quantitative information on changes in the extent of wetlands. This is to be expected because the inventories were of important sites (ie a different objective) or, in the case of the mangroves, the inventory aimed to develop a baseline against which future assessments could be made.

At the sub-national level, the Victorian wetland GIS has been used to assess the extent of wetland loss since European settlement (table 10). It shows that up to 70% of some wetland categories have been lost since 1788 (Department of Natural Resources and Environment (1997b).

Table 10 Extent of wetland loss in Victoria, Australia (adapted from Department of Natural Resources and Environment 1997a)

Wetland category	Pre-European area (ha)	1994 area (ha)	% loss
Deep Freshwater Marshes	154 800	46 440	70
Freshwater Meadow	172 700	98 439	43
Permanent Open Freshwater	79 100	74 354	6
Permanent Saline	142 200	139 356	2
Semi-Permanent Saline	61 300	57 009	7
Shallow Freshwater Marsh	15 800	6320	60

5 Discussion and conclusions

5.1 Adequacy of the information base

This project aimed to identify how national and supra-national wetland inventories could be used to establish global baseline information for considering trends in wetland conservation or loss. To develop this baseline it is necessary to have detailed information on the extent and distribution of wetland types in the region.

This review has found that regional and national wetland inventories in the Oceania region are limited in number and scope. In Australia and New Zealand the national environment agencies have recognised the inability of the existing inventory base to provide data on the extent and distribution of specific wetland types. Consequently, Environment Australia and the New Zealand Department of Conservation are developing new inventory initiatives to address this need (B Edgar pers comm, C Richmond pers comm). Existing State-based initiatives such as the coastal wetlands database being developed by the Australian Marine Conservation Society (E Hegerl pers comm) could provide a suitable model and/or data management system for a national inventory.

The key wetland inventories for the region, the Directory of Wetlands in Oceania (Scott 1993), Directory of Wetlands of New Zealand (Cromarty & Scott 1996) and the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996), were not designed to yield information on the extent and distribution of wetland types. These inventories are of limited value in providing a baseline (table 11) because:

- they cover only a portion of the wetland resources in a country
- the sites included are biased towards large wetlands in protected areas

- they do not contain site maps or details on the extent of wetland types
- some site extent information includes large areas of non-wetland habitat.

The only wetland type for which there is an appropriate inventory to provide a baseline on wetland extent is mangroves (table 11). This is attributable to the ability to readily identify mangrove stands from aerial/satellite imagery, interest in harvesting of mangrove timber and the focus of a number of international programs on this ecosystem over the past 20 years. The key mangrove inventory (Spalding et al 1997) was specifically designed to provide a baseline on the extent of mangroves. Even in this study Spalding et al (1997) defer to the estimates of other researchers in 38% of the countries of Oceania (table 8).

An economic interest in timber harvesting from freshwater and peat forests has contributed to the development of inventory material of these types of wetlands. However, estimates of the extent of swamp forest vary significantly (eg Papua New Guinea 500 000–2 890 000 ha) because of differing definitions and the difficulty of interpretation of remotely sensed data (Rieley et al 1996).

Sub-national inventories for Australia contain additional data on wetland extent (table 10). Normally this information cannot be integrated with information from other sub-national inventories. Some of the sub-national inventories for Australia have spatial information stored as digital data sets. While it may be possible to integrate the spatial data set, problems will exist due to the different wetland classification systems used.

Table 11 Summary of wetland extent information, Oceania

Inventory	Area (ha)	Key reference	Comments
mangrove	1 883 700	Spalding et al (1997) and other (table 8)	'best estimate'
peat swamps	519 000	Rieley et al (1996)	minimum estimate
inventories of important wetlands	35 748 853	table 9	qualification: these include a sample of the wetland resources; sample is biased towards wetlands of high biodiversity value; the areas include non-wetland habitat; inventories may overlap with 'wetland type' inventories
Ramsar-listed sites	5 730 548 (Australia: 5 096 756 ha; New Zealand: 38 868 ha; Papua New Guinea 594 924 ha)	Ramsar Bureau (D Peck) pers comm & site nomination data held by Environment Australia as at 13/11/98	qualification: these include a smaller sample of wetlands than the inventories of important wetlands; sample is biased towards wetlands of high biodiversity value; the areas include non-wetland habitat; inventories may overlap with 'wetland type' inventories

5.2 Methodologies

Three groupings of national and supra-national wetland inventories were identified in Oceania; important site, wetland type and other inventories.

The **important site inventories** presented information on a site by site basis. The strength of this approach was the ability to store information on site attributes such as tenure, management, benefits and values. The weaknesses of these inventories were:

- lack of a systematic assessment of the sites to be included
- no information on the comprehensiveness of coverage

- the sites included were biased towards large wetlands in protected areas
- they do not contain site maps or details on the extent of wetland types
- some site extent information includes non-wetland habitat.

While valuable for wetland conservation, the important site inventories do not yield the data needed on the extent of wetland types. The current wetland inventory dataset is inadequate for assessing changes to extent for almost all wetland types in Oceania. This information on wetland extent is essential to enable informed decisions on natural resource management. A new approach to wetland inventory is required.

The existing Ramsar-derived approach of developing inventories of important wetlands has been successful in promoting the conservation of individual sites. These directories should be maintained and extended to become comprehensive inventories of wetlands of national importance. In other parts of Oceania the socio-economic and cultural conditions are such that the publication of national wetland directories is likely to remain a low priority. A cost effective approach would be to continue the approach of a regional directory.

Wetland type inventories appear to be the most useful to determine a baseline for monitoring the loss in extent of wetlands. These inventories tend to use remote sensing techniques. The leading example is the World Mangrove Atlas (Spalding et al 1997).

Other inventories. A large number of sub-national inventories are available for Australia and a sample was reviewed for this report. There is a high demand from state government agencies, local government, community groups and private land holders for detailed wetland inventory information at the scale of 1:50 000. At present there are a number of initiatives (eg Jensen et al 1996, Pen 1997) to develop wetland maps for specific purposes. It may be possible to link these separate initiatives in order to provide information for a national inventory.

No inventories were identified in Oceania that involved elements of monitoring wetland condition. Developing components within inventory programs to monitor wetland condition would appear to greatly add to the complexity of an inventory program. Opportunities may exist, using remote sensing techniques, to collect data on particular attributes of wetland condition (ie water temperature, turbidity and quality in lake systems, or tree cover in forested wetlands; occurrence of major fires, flooding or drainage).

The lack of agreed wetland classification systems will present ongoing problems for the global quantification of wetlands. Additional attention needs to be given to ensuring that classification systems are hierarchical. This will enable national and sub-national inventories to have high levels of classification while maintaining the potential for global integration of data.

5.3 Use of inventory information as a baseline for monitoring wetland loss

The World Mangrove Atlas (Spalding et al 1997) was the only inventory identified at the national and supra-national level which provided an adequate baseline for monitoring future changes in wetland extent.

The sub-national wetland inventory for Victoria, Australia compared the current extent of wetlands with that at the time of European settlement (Department of Natural Resources and Environment 1997a). Future updates of this GIS based inventory would enable contemporary assessments of changes in wetland extent.

These inventories are generally prepared from remote sensing information and usually do not include information on wetland condition, so probably are not very useful for monitoring changes in condition.

Additional problems exist with the ability of remote sensing to determine wetland classes. Further evaluation of the optimum assessment methods for specific wetland types is needed.

6 Specific recommendations

Recommendation 1 Directories of important wetlands (New Zealand and Australia)

The directories of important wetlands in New Zealand and Australia should continue to be revised to increase the number of sites included and update/extend the information on sites.

Recommendation 2 Directories of important wetlands (other parts of Oceania)

The Directory of Wetlands in Oceania should be revised before the next Conference of Contracting Parties to the Ramsar Convention (2002) to increase the number of sites included and update/extend the information on listed sites.

Recommendation 3 Development of inventories of wetland extent

The Governments of Australia and New Zealand should develop inventory methodologies and programs to derive national assessments of the extent of individual wetland types.

Recommendation 4 Wetland classification

Classification systems used for wetland inventory should be consistent with the Ramsar classification to enable data to be used from global assessment of wetland resources.

Recommendation 5 Standard inventory techniques for wetland types

The Ramsar Bureau and Partner organisations should promote standardised inventory methods for specific wetland types.

Recommendation 6 Inventory data storage

Spatial data sets of wetland extent and distribution should be stored in Geographical Information Systems to facilitate ongoing assessment of changes in wetland extent. This is particularly important to enable the integration of data from sub-national inventories.

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Annex 1 Index to Country Codes in Oceania

ISO Code	Name	Long Name
ASM	American Samoa	Territory of American Samoa
AUS	Australia	Commonwealth of Australia
FSM	Federated States of Micronesia	Federated States of Micronesia
FJI	Fiji	Republic of Fiji
PYF	French Polynesia	Territory of French Polynesia
GUM	Guam	Territory of Guam
KIR	Kiribati	Republic of Kiribati
MHL	Marshall Islands	Republic of the Marshall Islands
NRU	Nauru	Republic of Nauru
NCL	New Caledonia	Territory of New Caledonia and Dependencies
NZL	New Zealand	New Zealand
MNP	Northern Mariana Islands	Commonwealth of the Northern Mariana Islands
PLW	Palau	Republic of Palau
PNG	Papua New Guinea	Independent State of Papua New Guinea
SLB	Solomon Islands	Solomon Islands
TON	Tonga	Kingdom of Tonga
TUV	Tuvalu	Tuvalu
VUT	Vanuatu	Republic of Vanuatu
WLF	Wallis and Futuna	Territory of the Wallis and Futuna Islands
WSM	Western Samoa	Independent State of Western Samoa

Annex 2 Analysis of the Wetland Inventory Data Set for Oceania

		Number	%
	Attribute	26	
Scale of Inventory of Material			
	Global Scale	1	4
	Supra-Regional Scale	2	8
	Regional Scale		
	Sub-Regional Scale	1	4
	National Scale	16	62
	Sub-National Scale	6	23
Source is a Directory			
	Yes	15	58
	No	11	42
Type of Source Material			
	Peer Review Journals	1	4
	Peer Review Books	2	8
	Chapters in Books		
	Conference or Keynote Presentation		
	Article in Conference Proceedings		
	Internal Government Reports	2	8
	Government Formal Publications	8	31
	Other Government Material	6	23
	NGO reports		
	NGO Formal Publications	2	8
	Consultancy Reports	4	16
	Newsletter Articles		
	Practitioner Periodical Article		
	Database Manual		
	Electronic Database		
	World Wide Web Article		
	Thesis		
	Other		
	Unknown		
Language of Study			
	English	26	100
	Other		
	Unknown		

Format of Study			
	Paper	11	43
	Electronic text	1	4
	Electronic Database	6	23
	Personal Communication		
	Web Presentation	2	8
	Part of GIS or GIS Output	1	4
	Map Based	2	8
	Other Format		
	More than one format	3	12
	NA		
Circulation of Study			
	Published	17	65
	Interdepartmental (unpublished)		
	Internal (unpublished)	8	31
	Restricted (unpublished)	1	4
	Unrestricted (unpublished)		
	Other Types		
	Unknown		
	More than one type		
	NA		
Data Storage Media			
	Paper	13	50
	Web (electronic)		
	Other Electronic (not web or DB)	3	6
	Electronic Database	5	19
	GIS	3	6
	Hard Copy Map		
	Digitised Map		
	Other		
	Unknown or Ambiguous		
	More Than One Medium	2	8
Study Implementation			
	International NGO	2	8
	National NGO	1	4
	Sub National NGO		
	Local NGO		
	Inter GO		
	National GO	10	38
	Sub National GO	7	30
	Local GO		
	Private Agency/Individual		

	Consultancy Agency		
	Academic Institution	2	8
	Other body		
	Unknown		
	More than one Agency or Body	4	16
Study Funding			
	International NGO		
	National NGO		
	Sub National NGO	5	19
	Local NGO		
	Inter GO	1	4
	National GO	12	46
	Sub National GO		
	Local GO		
	Private Agency/Individual	2	8
	Consultancy Agency		
	Academic Institution	1	4
	Other body		
	Unknown		
	More than one Agency or Body	5	19
Statement of Objectives			
	Objectives Explicitly Stated	22	85
	Objectives Not Explicitly Stated	1	4
	Unknown	3	11
Main Objective of Study			
	General Biodiversity		
	Biodiversity Research		
	Baseline Biodiversity	21	81
	Repeat Survey/Surveillance		
	Management Tool for Biodiversity		
	Biodiversity Monitoring		
	Wetland Products	1	4
	Geographical	1	4
	International Designation		
	Baseline Inventory		
	Academic Research		
	Land Use Planning	3	11
	Wetland Services		
	Public Education		
	Other Research		
	Other		
	NA		

Wetland Definition			
	Definition Provided	15	57
	Definition Implied	5	19
	No Definition Provided or Implied	3	12
	Unknown/Ambiguous	3	12
Ramsar Definition			
	Ramsar Definition Used	10	38
	Ramsar Definition NOT used	13	50
	Use of Ramsar Definition Unknown	3	12
Ramsar Classification			
	Ramsar Wetland Types Used	4	15
	Other Wetland Classification Used	9	35
	Wetland Classification Varies		
	Unknown	3	12
	Not Applicable	10	38
Extent of Coverage			
	All Wetlands		
	Part of Wetland Resource	26	100
	Ambiguous		
Basis of Selection			
	Geography / Jurisdiction	4	15
	Land Cover or RS Data	1	4
	Landform Type		
	Suprahabitat	1	4
	Habitat Type	4	15
	Floral / Faunal Groups or Species		
	Climate		
	Wetland Function		
	Hydrology		
	Biodiversity Value	11	42
	Cultural Value		
	Artefact of Data Collection	1	4
	Other Basis	1	4
	Unknown or Ambiguous		
	More than One Basis	3	11
Data Collection Methodology			
	Collation or Review	10	38
	Ground Survey		
	Remote Sensing	5	19
	Questionnaire Survey		
	More Than One Methodology	11	42
	Unknown Methodology		

Extent of Ground Survey (if remote?)			
	Total		
	Partial	5	19
	Unknown		
Type of Remote Sensing			
	Satellite Imagery	1	4
	Aerial Photography	3	11
	Videography		
	Radar Imagery		
	LIDAR Imagery		
	Map Product	1	4
	Unknown	1	4
Summary Provided			
	Summary Provided	15	58
	Summary NOT Provided	11	42
	Not Known if Summary Provided		
Extent of Wetlands			
	Yes	13	50
	No	12	46
	Not known	1	4
Area by Wetland Type			
	Full details on area per Wetland Type	3	11
	PARTIALLY on area per Wetland Type	8	31
	No info. on area values per Wetland Type	12	46
	Not known	3	11
Wetland Loss and Degradation			
	Sources providing info. on Loss &/or Deg.	5	19
	Sources NOT providing info. on Loss &/or Deg.	21	81
	Not known		
Wetland Status Description			
	Overall Wetland Status Description Included	6	23
	Overall Wetland Status Description NOT Included	20	77
	Unknown		
Values and Benefits			
	Some Level of Information	3	11
	Always		
	Most of the time		
	Commonly		
	Sometimes		
	Rarely		
	Never	18	69
	Unknown	5	20