SCIENCE AND INFORMATION DIVISION

STRATEGIC PLAN

1995-1999

SYNOPSIS OF ACHIEVEMENTS OF ANTICIPATED OUTPUTS AND OUTCOMES

May 2000

FOREWORD

I am delighted to make publicly available this report, which demonstrates the extent to which the Science and Information Division of the Department of Conservation and Land Management met its goals as stated in the 1995-9 Strategic Plan.

The following tabulation shows that SID has met its stated commitments very satisfactorily, with 92% of objectives, strategies, immediate benefits and outcomes having being realized.

Component	Achieved	Achieved (ongoing)	Partially achieved (ongoing)	Partially achieved	Not achieved	Not achieved (ongoing)	Not assessable
Division	16			3			
Bio-resources	2		3	2			
CRS	15		14	2	3		
SRS	12	2	10	8	3		
Bio-conservation	6	2					
CCS	12	1	12		8		
SCC	12		12	1	1		
Sustainable Resources	4		1				
NPS	16	2	16	1	3	1	
RS	7	10	5	1	1		
Science Services	3						
ISS	17	14	1	3			
BS	7			1	2		2
FS	9		1	2			
SP	8			3			
TFSC	11		2	1			
VHS	5	1		1	3		
TOTAL	**162**	**32**	**77**	**29**	**24**	**1**	**2/327**

Some of the research performed by Science and Information Division is long-term in nature and has a quasi-program status. This is reflected in the categories *Achieved (ongoing)*, *Partially achieved (ongoing)* and *Not achieved (ongoing)*.

I should like to take this opportunity to thank all of the members of Science and Information Division whose sustained effort has helped to make the research program of the past five years so successful.

Dr Neil Burrows
DIRECTOR

DIVISIONAL

Objectives

1 To provide a scientifically objective and independent source of reliable knowledge and understanding about conserving species and ecological communities in Western Australia, managing the public lands and waters entrusted to CALM, and carrying out CALM's other legislative responsibilities.

Achieved: Group Managers continued to scrutinize all planned research for an objective approach, and all members of the Science Management Council ensured that other senior officers of CALM were aware of important advances in knowledge and understanding.

2 To ensure that Science and Information Division is responsive to the needs of policy makers and managers in CALM by bringing science to bear on the solution of the State's most pressing problems relating to conservation and land management.

Achieved: Consultation between scientific staff and policy makers and managers in other Divisions of CALM has taken place both formally and informally.

3 To advise CALM on sustainable resource development opportunities and to promote the conservation of biological resources through their sustainable utilization

Achieved: Scientists have played a lead role in developing bioprospecting opportunities and in underpinning ecological sustainable management of biological resources, particularly native forests, with factual information.

4 To communicate to managers in CALM the knowledge, information and other insights obtained through scientific investigation in Western Australia and elsewhere.

Achieved: 32 seminars were presented to CALM staff and 7 technology transfer workshops were held.

5 To attain for CALM a world-wide reputation for excellence in science by publishing knowledge obtained through scientific research in the premier national and international scientific journals.

Achieved: 86 scientific papers have been published in international journals and 61 scientific papers were published in national journals (published outside WA).

6 To show that the Division, as an integrated part of CALM, contributes to meeting the need for knowledge on conservation and land management matters by the public of Western Australia.

Achieved: 73 educational articles have been published in Landscope magazine.

Strategies

7 Publicize within CALM the contribution of Science and Information Division to attaining CALM's Mission and gain the endorsement of CALM's Corporate Executive.

Achieved: Director participated in 53 meetings held of Corporate Executive.

8 Develop and project the Science and Information Division's reputation as a credible and dependable source of sound knowledge about conservation, land management and sustainable utilization matters.

Achieved via publications, seminar presentations, and technology transfer workshops of key issues.

9 Collaborate with Regional, District and other staff in developing and implementing practical solutions to high priority problems.

Achieved via technology transfer workshops.

10 Increase CALM's commitment to obtaining scientifically sound information through improved resourcing of Science and Information Division.

Partially achieved: The number of permanent FTE's decreased from 119.9 (9.8% of CALM's workforce) in 1994-5 to 110.3 (9.1%) in 1998-9. The allocated Divisional budget increased from $7.3M in 1994-5 (3.9% of CALM's budget) to $9.8M (5.0%).

11 Continue to seek the most cost-efficient means of carrying out research by employing contract consultant staff where possible.

Achieved: The number of FTE contract staff has increased by an average of 8.

12 Maximize the acquisition of external funds in order to enhance the knowledge-base of CALM's operations.

Achieved: An annual average of $2.7M was won competitively from external sources.

13 Carry out a balanced program of short-term and long-term research consisting of:

- projects initiated by the Division to address very high priority issues ('task force' approach).
- projects directly related to high-profile management issues that are more informally initiated by scientists or managers.
- projects initiated by scientists to provide a basis for future management decisions.

Achieved.

14 Maintain support services such as high standards of herbarium curation, computer support and library support.

Partially achieved: Fully achieved with herbarium curation and computer support, but libraries remain inadequately funded to acquire the ever increasing number of scientific journals and books published.

15 Reward staff, on the basis of performance and experience, eg through criteria progression and workplace agreements.

Achieved: Of the 21 staff applying for criteria progression, 19 were successful.

16 Provide staff with opportunities to reach higher levels of self-development.

Achieved: Two staff studied for the PhD degree. All staff were formally appraised.

17 Develop project co-ordination and people management skills of staff

Achieved: Encouraged staff to take responsibility for managing sections and to participate in training courses.

18 Collaborate with other Government agencies, universities, industries, other interest groups or the public to conduct or co-ordinate research when such interaction will benefit CALM's objectives.

Achieved: SID staff are involved with co-operative research centres (Vertebrate Bio-control, Marsupial, Tropical Savannas), and with supervising honours, masters and PhD students at universities.

19 Avoid any unnecessary or counter-productive competitiveness with kindred institutions.

Achieved through consultation with senior scientists in universities and CSIRO.

BIO-RESOURCES

Objectives

20 To establish a State resource centre for conservation and economic information on the flora and, in collaboration with other institutes, the fauna of the State.

Partially achieved: The CALM Herbarium has already achieved Department-wide recognition for this role. This has been largely due to oral presentations, increasing effective contact with CALM managers, and the ready availability of electronic information systems.

Progress on fauna has been slow because of the huge task of databasing the State's faunal data, which is only at a relatively early stage. CALMScience, especially Herbarium-based IT staff, have developed close liaison with the WA Museum to progress this objective.

21 To develop and co-ordinate the inventory of geographic, systematic and ecological data concerning the biota and ecosystems of Western Australia.

Partially achieved (ongoing): Excellent progress has been made with State flora information on systematics and ecological data. This has been accomplished through the taxonomic program, publication of regional floras and the development of FloraBase, a compilation of names, descriptions and habitat information of WA vascular plants.

Strategies

22 Establish priorities for research and develop co-operation to ensure that projects and field studies are co-ordinated.

Partially achieved: The two Groups (Bio-resources, Bio-conservation) co-ordinated taxonomic research and field studies as far as practical. This strategy was hampered by long-standing commitments for ecological surveys of large geographic areas.

23 Develop relational databases for information on taxonomy and distribution of biota, their economic values, conservation values, ecological preferences and landscapes to ensure that the results of research are practical and contribute directly to the solution of conservation problems.

Partially achieved (ongoing): FloraBase has been developed to present current and non-current taxonomic names, geographic distribution, conservation status and ecological preferences. Data on economic values and landscapes have yet to be gathered and added to databases.

24 Gather and store data in a manner, which conforms to Australian and international standards.

Achieved: The CALM Herbarium has been a leader in the development of an Australian-wide standard for data capture. The HISPID standard for data exchange has been adopted by all Australian herbaria, and several overseas.

25 Maintain a high standard of international publications, reports and advice.

Achieved: The taxonomic journal Nuytsia is a thriving internationally accepted journal and has improved its taxonomic coverage and increased its standard.

Reports on flora and advice are increasingly more reliable as data have become electronically available.

26 Communicate outcomes of survey and research so that they contribute directly and effectively to conservation, land management and sustainable utilization.

Partially achieved (ongoing): The Group continues to effectively contribute to knowledge of conservation taxa. A sustained effort to classify and delimit conservation taxa has been completed to a high degree; the remaining problem taxa need techniques other than classical taxonomy or more fieldwork or both to elucidate remaining taxonomic problems. Regular users of CALMScience systems and sources of advice include Wildlife Conservation and Licensing staff, Regional Ecologists, and staff involved in broadscale projects such as the RFA.

Community Resources Section

Objectives

27 To design a representative, adequate and comprehensive conservation reserve scheme based on properly discriminated and documented plant and animal communities.

Partially achieved (ongoing): Commenced the design of such a system in the Carnarvon Basin.

28 To identify those communities with high conservation significance such as those that are rare or sensitive to consequences of human activity and therefore threatened.

Partially achieved (ongoing): Communities of high conservation significance identified in the Carnarvon Basin, wheatbelt, and Swan Coastal Plain; vegetation types of high conservation significance identified throughout the state at a scale of 1:250 000.

29 To implement a basis for measuring change in ecosystems across the State so that determination of management priorities is explicit.

Partially achieved (ongoing): Basis for measuring change set up in the Carnarvon Basin, Little Sandy Desert and in the wheatbelt.

Strategies

30 Assess and refine existing environmental maps by field surveys or using existing information.

Achieved: Beard's 1: 250 000 vegetation boundaries refined; IBRA regions finalized (input to ANCA).

31 Continue to establish the system of permanent benchmark quadrats.

Partially achieved (ongoing): Permanent benchmark quadrats and wetland sites set up in the Carnarvon Basin, Little Sandy Desert and in the wheatbelt.

32 Collect and database benchmark quadrat attributes appropriate for quantitative analysis of patterns in the species composition of assemblages.

Partially achieved (ongoing): Data collected in the Carnarvon Basin, Little Sandy Desert and in the wheatbelt.

33. Further develop and continue to apply quantitative methods for modelling patterns of occurrence of plant and animal assemblages.

Partially achieved (ongoing): Procedures for using GLIM modelling have been developed.

Immediate Benefits

34 Floristic classification of the plant communities and assessment of the conservation status of plant taxa and communities of the Swan Coastal Plain.

Achieved: Report produced documenting 43 community types and subtypes recognized on the Swan Coastal Plain; 10 of these were not known from conservation reserves and 11 were known only from a single nature conservation reserve. Report produced documenting the conservation status of all 1750 native plant taxa on the Swan Coastal Plain.

35 Floristic classification of the coastal plant communities and assessment of the conservation status of plant taxa and communities of the Warren botanical subdistrict.

Achieved: Report in press in CALMScience, documenting conservation status of the 2200 vascular plant species of the Warren botanical subdistrict.

36 Evaluation of the representativeness and comprehensiveness of the conservation estate in the Perth metropolitan region, on the basis of distribution of native earthworm species.

Not achieved.

37 An explicit basis for setting priorities among conservation management options through much of the Goldfields and South Coast Regions.

Achieved: Data from regional and local biological surveys have been used to provide input to a wide range of land management decisions.

38 Improved management and monitoring of rainforest patches in the Kimberley.

Achieved: CALM's Kimberley Region has taken on management recommendations and monitoring of selected rainforest patches.

39 Assessment of the conservation values of the islands of the Buccaneer Archipelago.

Partially achieved: Two reports on the flora and fauna of Koolan Island have been published; remainder of project deferred.

40 Increased usefulness of ecological surveys through better design.

Achieved: Analysis of site-specific data through use of GLIM and other procedures has helped provide improved predictive power and more explicit recommendations for reserve system design.

41 Increased sensitivity in ecological monitoring techniques used in WA.

Achieved: Establishment of hundreds of geo-coded sampling sites for vascular plants and an array of vertebrate and invertebrate animals will allow significantly increased sensitivity in future monitoring.

42 A world-class nature reserve representing the western margin of the Great Sandy Desert, including a RAMSAR wetland and environments associated with the mouth of a major palaeoriver.

Not achieved: Nature Reserve not acquired – still part of Anna Plains pastoral lease.

43 Development of guidelines for monitoring of Australia's Wetlands of International Importance will permit assessment of effectiveness of management and Landcare measures in halting and reversing degradation.

Achieved: Project completed, work undertaken by consultant and now being implemented.

44 Documentation of the nature conservation values of the Central Pilbara Uplands within the Karijini National Park and the Barlee Range Nature Reserve, providing a more explicit basis on which to manage these and other nature conservation areas in the Pilbara.

Achieved: Input provided to Karijini Management Plan, and to the inter agency task force into extensions to Karijini National Park; funding obtained for claypan management in the Barlee Range Nature Reserve; addition of two Barlee Range wetlands to the Register of the National Estate; a regional perspective provided for recent landuse decisions in the central Pilbara.

45 Documentation of the nature conservation values of the Boonanarring Nature Reserve and an improved basis on which to develop planning and management objectives for this part of Swan Region.

Achieved: Nature conservation values (including 10 vegetation associations, 573 species of vascular plants and >100 vertebrate species) and management recommendations for rare flora and fauna documented in published report.

46 Documentation of the nature conservation values of Cape Arid National Park and an improved basis on which to develop planning and management objectives for this part of South Coast Region.

Achieved: Survey of vascular plants and vertebrate fauna completed and implications for management communicated to CALM regional staff.

47 Documentation of the nature conservation values of the northern Irwin and southern Carnarvon Phytogeographic Districts and an improved basis on which to prioritise efforts to improve and manage the conservation reserve system and to manage wildlife in the region between Kalbarri and Lake McLeod (an area of about 7.5 million hectares).

Partially achieved: Survey of vascular plants and vertebrate and selected invertebrate fauna completed and implications for management communicated to CALM regional staff. Recommendations for improving reserve system design are being acted on currently.

48 Documentation of the nature conservation values of the Coolcalalaya area and an improved basis on which to make land use decisions for this part of Midwest Region.

Achieved: High species richness documented in the vascular flora, recommendations made for re-interpretation of phytogeographic boundaries in this area.

49 Quantitative data on the regional distribution of several hundred vascular plant taxa in the Kent, Hay, Bow and Denmark River catchments and the facility to relate distribution data of species to a range of field based data sets.

Achieved: Report published and management recommendations formulated.

50 Improvements in the application of geographic information and remote sensing technology to forest databases for land-use planning and conservation management.

Not achieved: The project officer (Grant Wardell-Johnson) left CALM before completion of the project.

51 A regional classification of greenstone woodland communities and an assessment of their reservation status. Identification of regionally rare and/or threatened communities.

Achieved: Five reports produced and three papers published, documenting conservation status of plant communities; results communicated to relevant management staff.

52 An improved scientific basis for management of the Lesueur National Park and the basis for management of rare flora in the region.

Partially achieved (ongoing).

Outcomes

53 Advice to Government on:

- gaps in the reserve system using available data;
- the distribution and conservation status of communities;
- the occurrence of exotic species and other sources of disturbance in indigenous communities; and
- ecological survey design standards.

Achieved: Advice provided on numerous occasions concerning gaps in the reserve system, the distribution and status of plant and animal communities, occurrence of disturbance agents and standards of design and implementation of ecological surveys.

Several of the plant communities identified in the Swan Coastal Plain survey are now listed as Critically Endangered and recovery plans are being implemented.

54 An adequate inventory of the State's biological communities.

Partially achieved (ongoing): Significant advances (new taxa and communities discovered, increased knowledge of distribution) throughout the State, but particularly in the Carnarvon Basin, Little Sandy Desert and wheatbelt.

55 Predictive models identifying boundaries of communities and of other ecological or biogeographic entities.

Partially achieved (ongoing): Predictive models developed for aquatic systems throughout the State; progress made for models concerning terrestrial systems in the Carnarvon Basin.

56 Refined ecosystem maps.

Partially achieved (ongoing): Beard's 1: 250 000 vegetation maps refined and digitized, and a report produced. IBRA regions finalized.

57 Quantitative assessment of the adequacy of existing nature conservation reserve systems in each district with identification of any gaps.

Partially achieved (ongoing): Commenced for Carnarvon Basin, Little Sandy Desert and the Warren Region.

58 Optimal locations for any additional reserves needed to attain a representative, adequate and comprehensive reserve system.

Partially achieved (ongoing): Recommendations have been made in several areas, resulting in moves to change vesting or, in other cases, the purchase by CALM of pastoral and other properties.

59 A quantitative context for assessing the conservation status of taxa and communities.

Partially achieved (ongoing): Quantitative contexts provided in the Carnarvon Basin, Little Sandy Desert and Warren Region; commenced in the wheatbelt.

60 A basis for the quantitative appraisal of change in ecosystem elements.

Partially achieved (ongoing): Basis now available for terrestrial systems in the Carnarvon Basin, Little Sandy Desert and parts of the wheatbelt, and for aquatic systems in various wetlands and rivers throughout the State.

Species Resources Section

Objectives

61 To undertake systematic research to discriminate, describe and classify Western Australian taxa with particular reference to those with:

- conservation value;
- economic importance and which can be sustainably utilized.

Partially achieved (ongoing): Two taxonomist staff positions were allocated to clarify the systematic status of all 2203 State Conservation plant taxa. This was achieved using standard taxonomic methods. The list of taxa published by the Minister each year is now an accurate record of current taxonomic knowledge.

Limited progress has been made on taxa with economic importance, although the correct name for some native taxa has been started. Considerable curatorial effort has been directed to the nomenclature of WA naturalized flora.

62 To develop and maintain appropriate interconnected database systems for the capture and manipulation of taxonomic and biological data.

Partially achieved (ongoing): FloraBase brings together in a very user-friendly environment the current highly developed names, descriptive and specimen information based databases. Progress in the central capture and storage of corporate data sets relating to biological surveys was curtailed by insufficient resources.

Strategies

63 Establish appropriate systems for effective capture and manipulation of descriptive taxonomic data.

Achieved: The DELTA (Descriptive Language for Taxonomy) software has been adopted in order to capture all taxonomic information. This system is most appropriate for capturing, storing and presenting systematic information. All Group Regional flora research and systematic work on conservation taxa utilizes DELTA. In addition the externally funded Descriptive catalogue project has captured a more limited data set from all 12000 recorded WA taxa.

64 Produce descriptive accounts of the biota focusing on taxa, communities and geographic areas of conservation significance.

Partially achieved (ongoing): FloraBase enables access to brief descriptions of all taxa including conservation taxa and weeds; it is now possible to access information as to where weeds have been recorded as well as a brief description of each weed species with flowering times and habitat preferences, a distribution map, and an illustration of some species.

The RED (Rare and Endangered Species) database has complete descriptions of approximately half of the declared rare taxa but has not progressed because the project has not been able to attract external funding. Much of the electronic information was used in the production of a book on rare and endangered plants published in 1998.

65 Adopt relevant techniques to produce predictive systems that indicate taxonomic relationships and geographic patterns of occurrence, especially for taxa of conservation or economic significance.

Achieved: FloraBase now provides clear indication of the family relationships of all flowering plant species. Comprehensive Family and Genus descriptions have been prepared and are scheduled to go on line in 2000.

Significant input into predictive systems indicating geographic patterns of occurrence for species in the jarrah forest was completed by the Group as part of the RFA process.

66 Participate in development and maintenance of dynamic information systems for biota of conservation and economic significance.

Not achieved: Large amounts of data are now available for the development of a new database called WABIOTA. This will capture available biological and phenological observations such as mode of perennation and time needed to flower and set seed after a fire. All observations are voucher specimen based.

Immediate Benefits

67 Implementation of an integrated system, based on the DELTA suite of programs, enabling the capture and management of descriptive taxonomic data.

Achieved: See under 63

68 Completion of revisionary studies and the discrimination of new Western Australian plant taxa, especially in the families Asteraceae, Rhamnaceae, Rutaceae and Tiliaceae and the *genera Acacia, Actinodium, Chamelaucium, Chamaexeros, Darwinia, Hibbertia, Neurachne, Pultenaea, Stylidium, Thysanotus, Urodon* and *Wurmbea*.

Partially achieved: specimen holdings have been aligned with findings and 101 papers published published (e.g. on Asteraceae, Rhamnaceae, Rutaceae, Tiliaceae, Acacia, Chamaexeros and Wurmbea), others are in press (Acacia) and others are in advanced preparation (e.g. Neurachne). Some projects were suspended because of failure to obtain funding or because of postponement of the deadlines of the publishers (Pultenaea, Urodon); while in certain cases unexpectedly difficult variation patterns have extended the work (Thysanotus).

69 Elucidation of relationships, using cladistic methodology, of genera of Rutaceae and species of Acacia and the Pultenaea group.

Partially achieved. Rutaceae completed, Acacia ongoing and Pultenaea research has been curtailed from lack of external funds from ABRS.

70 Descriptions of new WA plant taxa with high conservation significance occurring in the southern forest region, the Perth region and the Irwin-Carnarvon region.

Partially achieved: New taxa from the forest and Perth regions have been described in Nuytsia; a number of species have been thoroughly checked and lists of conservation taxa now reliably reflect current taxonomic knowledge

71 Provision of an interactive identification and descriptive information retrieval tool, and publication of hardcopy descriptions, for WA Declared Rare and Priority flora.

Partially achieved: Book on threatened flora has been published; the development of an interactive tool has not yet succeeded to attract external funding so that it can be fully completed; information from the published book is being added to the databases as available resources permit.

72 Taxonomic clarification and discrimination of undescribed and poorly circumscribed species included on the Declared Rare and Priority Flora lists.

Achieved with respect to current listings; all conservation taxa have been investigated systematically and their accepted name and descriptions clarified and improved.

73 Descriptions of new species of Ostracoda and Calocera and definition of their ecological tolerances in order to better understand the impact of land management practices on wetlands.

Achieved: A review of the biogeography of WA Cladocera, showing that WA is a centre of crustacean radiation, with higher levels of endemism than elsewhere in Australia, has recently been accepted for publication in the international journal Hydrobiologia. Descriptions of new species of Copepoda have been published in local and

international journals, also showing the extraordinary richness of the WA crustacean fuans, especially in semi arid areas and salt lakes. A major paper describing how water chemistry controls the distribution of salt lake ostracods is about to be submitted for publication.

74 Description of a new species of Giardia and assessment of its impact on Straw-necked Ibis populations in south-west WA.

Achieved: The Giardia infecting birds in WA has been described in a paper in the Journal of Parasitology, but a study of Straw-necked Ibis breeding colonies showed that it has no direct detrimental effects on bird populations.

75 Publication of distributions and phylogenetic relationships of Australian terrestrial amphipods.

Partially achieved (ongoing): Drawings completed, descriptions to be finalized.

76 Publication and maintenance of a Census of Western Australian plant names (hardcopy and electronic version) in order to provide a stable nomenclatural basis for the WA flora.

Achieved: FloraBase has made all names available electronically to any user, obviating the need for a costly publication

77 Development of a database of biological information pertaining to the biota of the State.

Not achieved: The WABIOTA corporate database has been designed to house data gathered during the RFA process. Data on morphology and phenology are currently stored on specimen databases; funds are required to synthesize these data to enter into WABiota

78 Electronic prototype of the generic Flora of Western Australia providing keys and descriptions of these plant taxa.

Achieved: 1300 genera are comprehensively described in DELTA format.

79 Production of a user-friendly handbook Flora and associated publications pertaining to the lower south-west forest region of the State.

Partially achieved: Bushbooks on forest shrubs and trees published; manuscript text scanned; illustrations to be scanned by June 2000.

80 Completed contributions to the national Flora of Australia project for the genera *Acacia, Amphipogon, Crowea, Eriostemon, Neobyrnesia, Olearia* and *Stipa*.

Partially achieved: Olearia taxonomic research is awaiting ABRS funding for completion; Austrostipa (formerly Stipa) and Amphipogon manuscripts prepared and submitted for publication.

81 Provision of significantly better curated Herbarium collections through the use of external experts, eg. family Cyperaceae.

Partially achieved: External expertise has been commissioned and has resulted in updated curation of Cyperaceae and Myoporaceae.

82 Provision of corporate access to important DELTA databases containing descriptive information on the biota of Western Australia, for example, "Angiosperm families of the world" and "Grass genera of the world".

Not achieved: Focus has concentrated on FloraBase; Angiosperm families of the world will be added to FloraBase by mid-2000.

83 Assessment of potential usefulness of Acacia species in the dry subtropical region of the state.

Achieved: Publication of book "A key to useful Australian species of Acacia from the seasonally dry tropics" by Maslin and McDonald 1996.

84 Documentation of butterflies of conservation significance in WA National Parks and Nature Reserves.

Partially achieved (ongoing): Several descriptions of taxa and natural history notes made.

85 Maintenance of a database of information on breeding records of seabirds on islands of WA.

Partially achieved (ongoing): Information provided to Transport Dept for coastal planning purposes. Survey of Shark bay completed.

86 Maintenance and analysis of the database of terrestrial mammals and breeding seals on Australian islands to assess the conservation value of these islands.

Partially achieved (ongoing): Review paper published.

Outcomes

87 Review of databases to plan integration of WAHERB, WACENSUS, WALIB, "DELTA" and other relevant databases, including Geographic Information Systems.

Achieved: FloraBase integrates these databases; see under 62.

88 Implementation of appropriate database systems for capture and manipulation of information on the State's biota.

Partially achieved (ongoing): Current database systems such as WAHERB capture specimen-based biological information. The new WABiota database will be populated by taxon-based RFA data as funds become available.

89 Dissemination of current information on the names of WA biota.

Achieved: For 12,500 vascular plant taxa in the WACENSUS (Names) database, accessible through FloraBase.

90 Provision of accessible information on the identification and circumscription of taxa of WA biota, especially those with high conservation and economic significance.

Partially achieved (ongoing): FloraBase provides identification assistance; however, many more morphological characters need to be added to provide a comprehensive identification tool. Conservation taxa are comprehensively dealt with in the RED Database; data from this system was used extensively in hard copy publication of WA Threatened Flora.

91 Reduction of the number of taxa classified as poorly known.

Partially achieved (ongoing): Status information from many sources, including that gathered by survey staff of Biological Conservation group is added to FloraBase on an ongoing basis. During this period the number of taxa classified as priority species (all categories) was reduced from 2057 to 2033.

92 Development of a comprehensive database of biological information which aids land management.

Partially achieved. See under 62 and 77.

93 Provision of taxonomic, biological, and geographic data for the assessment of the conservation status of taxa.

Achieved (ongoing): close co-operation has been developed and maintained with flora conservation officers in Nature Conservation Division.

94 Extension of geographic and taxonomic coverage of the specimen databases of WA.

Achieved (ongoing): the external funded regional Herbaria project has increased the standards of collection data as well as geographic coverage.

95 Publications contributing to taxonomic and biological knowledge of the State's biota.

Achieved: A total of 244 publications from Biological Information Group staff have contributed to taxonomic and biological knowledge of the State's biota. These include scientific papers, books, reports, and popular articles. Additionally, a major on-line information system, FloraBase, presenting descriptive, specimen, nomenclatural and distribution data on all 12,500 flowering plants present in WA has been made publicly available via the Internet.

BIO-CONSERVATION GROUP

Objectives

96 To concentrate effort and resources on the most important (not necessarily the most topical) problems of biological conservation facing CALM.

Achieved: Formation of 12 project teams focused on core activities for biodiversity conservation research: Western Shield (fauna recovery and exotic predator control), flora conservation, aquatic ecosystems, rabbit calicivirus disease, CAR reserve system, disturbance ecology, monitoring river health, marine fauna management, remnant vegetation reconstruction, salinity action plan, and Carnarvon Basin survey.

97 To review scientific knowledge of topics that are relevant to biological conservation and pertinent to CALM.

Achieved: Scientists used comprehensive bibliographic search software, as well as CALMScience library services.

98 To deliver information and support to other sectors of CALM which require or will benefit from specialist advice and scientific data.

Achieved: At least 15 internal books or book chapters produced and contributions to 15 management plans for land and threatened wildlife.

99 To contribute to scientific knowledge and community appreciation of conservation biology and CALM's mission and achievements.

Achieved: More than 300 papers produced in refereed journals, books, popular articles and internal publications.

Strategies

100 Rigorously and regularly review priorities (when appropriate, with other Science Groups and/or Branches) and allocate human and financial resources accordingly.

Achieved: Process for triennial review of research with Regions and primary programs commenced in 1998.

101 Develop an effective and stimulating Centre of Expertise in Conservation Biology.

Achieved: Statewide and national recognition achieved for the value of the Group's work.

102 Recognize and emphasize within the Group the importance of pro-active and responsible communication.

Achieved (ongoing): Staff encouraged to communicate widely both within CALM and externally. Much research is collaborative with other State or Commonwealth agencies.

103 Through professional and popular channels, disseminate the values of biological conservation, CALM's commitment to it and the Department's achievements in this area.

Achieved (ongoing): Staff encouraged to publish, attend interstate conferences and outreach to the public. This is reflected in the staff performance appraisal system.

Community Conservation Section

Objectives

104 To understand the processes determining the structure and stability of terrestrial and aquatic biological communities and their resilience to change.

Achieved (ongoing): Fire impact studies, monitoring river health program, south west wetland monitoring.

105 To determine the impact of threatening processes and human-induced disturbances on the structure and function of biological communities, and define the technology and management practices required to ameliorate the effects of these agents.

Partially achieved (ongoing): Studies into the impact of timber harvesting and prescribed burning on vegetation and fauna commenced. Research into the use of phosphonate to control P.c underway. Monitoring the impacts of RCD on rabbit populations commenced.

106 To identify the ramifications of ecological impacts at the landscape and ecosystem level and develop the scientific basis for the conservation and rehabilitation of integrated landscape systems.

Partially achieved (ongoing): Salinity action plan biological survey commenced.

Strategies

107 Assemble data on the past and present distributions, disturbance regimes and conservation status of the major animal and plant communities in Western Australia and implement monitoring programs to assess their long-term stability.

Partially achieved (ongoing): Some assessments of threatened communities undertaken with WATSCU. Commenced bringing together the history of fire and logging treatments for the south west forests.

108 Undertake experimentally-based research and monitoring to acquire an understanding of the processes determining the resilience and vulnerability of biological communities to disturbance.

Partially achieved (ongoing): Commenced Kingston timber harvesting impact study and Batalling fire studies.

109 Develop integrated systems for the predictive modelling of response patterns and community sensitivity to disturbance.

Not achieved.

110 Research the biology and ecology of pathogens and weeds and develop the technology for their control or eradication.

Partially achieved (ongoing): Research into Phytophthora and Armillaria continued. Research into control of major environmental weeds commenced.

111 Undertake experimentally-based research and monitoring on various rehabilitation strategies to identify and develop the most cost-effective protocols.

Not achieved.

112 Using community resource information and GIS systems, highlight processes and procedures that will enable conservation and rehabilitation at the landscape and ecosystem level.

Not achieved.

113 Through regionally-based units and regular workshops, advise operations personnel on the likely impacts of proposed operations, advise on monitoring procedures and assist in the analysis of outcomes (experimental management).

Partially achieved (ongoing): Internal workshop held to disseminate knowledge gained from the Kingston study. Operations staff participated in threatened species recovery teams where progress on actions was discussed and future work planned.

Immediate Benefits

114 Definitive assessment of the efficacy of phosphonate to control the disease caused by *Phytophthora megasperma*.

Not achieved: Research is continuing on determining appropriate phosphonate dose rates.

115 Resolution of the taxonomic affinity of WA isolates of *P. megasperma*.

Achieved: An allozyme identification system was developed for P. megasperma and other Phytophthora taxa.

116 Information on the microdistribution of phosphonate will help in establishing the mechanism of action of phosphonate.

Achieved: Promising results on the persistence of phosphonate in a number of species of Proteaceae and the protection of these species from P. cinnamomi infection. A draft manual on phosphonate application techniques was prepared.

117 Improved information base available to CALM and the Stirling Range Planning Advisory Group for prescribing fire regimes within the park, in conjunction with the development of a draft management plan.

Achieved: Fire behaviour research incorporated into the draft Stirling Range and Porongurup National Parks Management Plan (1997).

118 Preparation of preliminary fire management options for consideration by Goldfields Region staff.

Not achieved: However some publications on earlier research on fire behaviour in arid zones produced.

119 Published paper on direct seeding research which should provide farmers and CALM staff with more information on direct seeding than previously available so as to minimize the risk of establishment failure.

Achieved: Paper published (Pigott, Brown and Williams 1994).

120 Provision to CALM staff and members of community groups of up-to-date information about the ecology and control of *Watsonia* spp. and related weeds in Family Iridaceae.

Achieved: Workshop held on the biology and control of* Watsonia, *proceedings published.

121 Determination of factors governing local endemism in four species of forest eucalypts from near Walpole.

Achieved: Two papers published (Wardell-Johnson and Horwitz 1996, Wardell-Johnson and Williams 1996).

122 Design of a user interface to provide a tool for people untrained in the operation of Arc/Info to making data on *Phytophthora* disease accessible to managers.

Achieved: The first phase in the development of an expert system for assisting managers in identifying taxa and ecological communities under immediate threat from Phytophthora was completed.

123 Results of a study of the role of the Vasse-Wonnerup floodplain in maintaining waterbird populations will assist in land-use planning and land management decisions and the preparation of a conservation strategy for the Busselton wetlands.

Achieved: A report on the waterbird use of the Vasse-Wonnerup wetlands was produced and this information is being used for the ongoing management of the Busselton wetlands. Production of the conservation strategy is not the role of CALMScience.

124 Guidelines for design of effective buffers for wetlands on the Swan Coastal Plain will provide guidance for land-use planners and wetland managers on design and management of buffers to protect wetlands.

Achieved: A report on the design of effective wetland buffers on the Swan coastal plan was prepared.

125 Establishment of pilot monitoring projects in 3-4 districts.

Not achieved.

126 Empirical data regarding the effects of fire and various management practices on terrestrial animal and plant communities throughout Western Australia.

Achieved: Published in Friend and Williams (1996).

127 Model for predicting fuel dynamics and fire spread in heathlands and mallee shrublands and examination of the application of fuel modification techniques such as scrub rolling and burning.

Achieved: Published in McCaw (1995).

128 Fire behaviour and fuel models for hummock grasslands and appropriate techniques for prescribing patch burns in desert reserves and national parks.

Achieved. Report completed and distributed to Operations staff for implementation.

129 Model to predict the impact of disturbance on small vertebrates, based on life-history criteria.

Not achieved: Draft paper yet to be finalized.

130 Database on the responses of vascular plants and small vertebrates to disturbance.

Not achieved.

Outcomes

131 A knowledge of the changes that are occurring in the various biological communities in Western Australia and an understanding of the processes or factors that are causing change. This will assist the Group to focus research on the most pressing issues in conservation of biological communities and will enable CALM to prioritize allocation of resources to management of biological communities.

Partially achieved (ongoing): Systematic biological survey of the State is underway. Liaison with WATSCU over identification and management of threatened communities.

132 An understanding of the processes determining the resilience and vulnerability of biological communities to disturbance and prediction of response patterns. This will enable the improvement of present management prescriptions and the development of better ones.

Partially achieved (ongoing): See 131 above.

133 CALM will be better able to control or eradicate pathogens and weeds.

Partially achieved (ongoing): Phosponate application techniques developed for the control of Phytophthora cinnamomi in threatened plant populations and communities. Participation in production of a State Environmental Weed Strategy.

134 CALM will be able to apply the most cost-effective methods available for rehabilitation of degraded communities.

Partially achieved (ongoing): The identification of threatened ecological communites for specific protection; collecting biodiversity data for the Salinity Action Plan; management guidelines for the monitoring and management of Western Australian wetlands, e.g. Vasse-Wonnerup wetlands; reporting and assessing river health.

135 CALM will be able to apply the most effective methods available to conservation at the landscape and ecosystem levels.

Partially achieved (ongoing): Biological surveys and results applied in the West Midlands Program; reserve system design as part of the National Reserve System Program; Gascoyne Murchison Reconstruction.

136 CALM will improve management operations by applying the lessons learned from experimental management.

Partially achieved (ongoing): Ongoing feral predator control and management on the Peron Peninsula at Shark Bay; Experimental research in the Kingston forest area in response to CALM's silvicultural guidelines.

Species Conservation Section

Objectives

137 To develop the protocols required for the conservation of threatened and other priority conservation taxa in WA.

Achieved: Protocols developed and implemented for translocations, exotic predator control and control of some weeds.

138 To identify the processes that detrimentally impact on the native biota and develop strategies for the control of these processes.

Achieved: Fox and feral cat predation identified as primary cause of mammal declines. Vegetation clearing, weeds, grazing and inappropriate fire regimes identified as primary causes for plant declines. Baiting and weed control programs developed.

Strategies

139 Undertake the population biology research required to determine the conservation status of indigenous taxa.

Partially achieved (ongoing): Population biology research underway on most threatened vertebrates and critically endangered plants.

140 Participate with other relevant CALM sections, units and branches in the development of methodologies for threatened taxa ranking, preparation and revision of threatened and priority taxa lists and in the setting of departmental priorities for species conservation research.

Partially achieved (ongoing): Participation with WATSCU and Wildlife Branch in ranking threatened taxa and determining research priorities.

141 Assist in the preparation of recovery plans, interim management guidelines or area-based wildlife management programs for threatened taxa.

Partially achieved (ongoing): Prepared 29 annual reports to funding agencies on progress of recovery actions for threatened taxa.

142 Develop and undertake field trials of survey, monitoring and other techniques relevant to the management of native taxa, and develop operational guidelines for their implementation. Participate in training programs where appropriate.

Partially achieved (ongoing): Continued development of fauna and flora research and monitoring techniques, participated in the development of the Batalling fauna management course.

143 Undertake research into the biology of exotic species of predators and competitors, and determine their impact on threatened and priority conservation taxa.

Partially achieved (ongoing): Commenced research into the most effective broadscale fox and feral cat baiting regimes, developed the Western Shield program, and commenced research into impacts of weeds on threatened flora.

144 Participate in the research required to determine the impact of management activities on the native biota and develop operational prescriptions relevant to the conservation of threatened and priority taxa.

Partially achieved (ongoing): Continued with the Kingston project, and research into fire impacts on invertebrates and vertebrates in the jarrah forest and mallee shrublands.

145 Assess other processes which may affect threatened taxa and develop strategies which eliminate or minimize the threat.

Partially achieved (ongoing): Participated in the national RCD monitoring program.

Immediate Benefits

146 Participation with WATSCU in the development of a ranking system for threatened flora and fauna in WA.

Achieved.

147 Completion of Wildlife Management Programs for all DRF and priority flora taxa in CALM's southern regions.

Achieved: Publication of 3 threatened flora recovery plans. Publication of 2, and draft publication of 3, District threatened flora management programs.

148 Preparation and implementation of Recovery Plans or Interim Wildlife Management Guidelines for all Critical fauna taxa.

Achieved: Prepared Interim Recovery Plans for Gilbert's Potoroo and participated in the development of IRPs for all other critically endangered vertebrate fauna taxa.

149 Continuation in the development of, and implementation of research components in Wildlife Management Programs for at least 40 percent of the State's threatened fauna.

Partially achieved (ongoing): Of the 28 currently listed threatened mammals in WA, research is being undertaken on 22 species. Recovery Plans or IRPs have been prepared for 9 mammal species and 4 bird species. Draft management programs have been prepared for marine turtles and dugong.

150 Completion of, or significant progress on distribution and population biology studies of threatened *Lambertia, Stylidium, Dryandra, Banksia, Eremophila* and orchid species.

Achieved for 19 endangered plants from these genera: four* Lambertia *taxa, one* Stylidium *taxa, three* Dryandra *taxa, two* Banksia *taxa, five* Eremophila *taxa and six orchid species.

151 Development of the most effective baiting regime for control of foxes over large areas.

Partially achieved (ongoing): Recommendations made to increase fox baiting frequencies on the interface of forest – agricultural land.

152 Development of an effective feral cat control method.

Partially achieved: Cat bait and trapping techniques developed, co-operative research with Victoria underway on the development of a felid specific toxin.

153 Development of an effective method to eradicate the black rat on semi arid islands.

Achieved: Rat control successfully implemented on several NW islands.

154 Involvement of District staff in the implementation of Wildlife Management Programs for threatened taxa.

Achieved: Ongoing process, with District participation in recovery teams.

Outcomes

155 An improved knowledge of the conservation status of the State's biota.

Achieved: Work on selected priority flora, thought to be critically endangered, over the last three years has resulted in the addition of 55 new taxa to the WA threatened plant listings. Of these some 80% have been ranked on IUCN criteria as critically endangered. A survey of Cape Range for the critically endangered Central Rock-rat failed to find this species and it is presumed extinct in WA. Four species of mammal (Woylie, Quenda, Tammar and Pebble-mound Mouse) are now known to be abundant and have been removed from the State's threatened fauna list.

156 The development of rigorous methods for ranking threatened taxa and an ability to provide and update CALM and the community with a scientifically based listing of the threatened and priority conservation taxa of WA.

Achieved: Provided WATSCU and Wildlife Branch with recommendations regarding listings and rankings of various threatened species of flora and fauna, and participated in the Threatened Species Scientific Advisory Committee.

157 A completed area-based threatened flora survey and population census for the State and publication of Wildlife Management Programs for rare and threatened flora in all of CALM's Regions/Districts.

Partially achieved (ongoing): Publication of two District threatened flora Wildlife Management programs (Merredin and Albany). Draft preparation of three District threatened flora Wildlife Management Programs (Morra, Geraldton, Esperance). Provided advice and assisted the Districts and Regions in the preparation of four Wildlife Management programs (Katanning, Narrogin, Southern Forest, Central Forest).

158 The publication of Wildlife Management Programs for threatened fauna for which recovery plans are being implemented.

Partially achieved (ongoing): Publication of seven recovery plans or IRPs for threatened fauna.

159 The completion of operational guidelines for the control of the fox, feral cat and black rat.

Partially achieved (ongoing): Fox control manual produced, feral cat control research still underway, and black rat control is now operational but not yet incorporated into guidelines.

160 A better understanding of the impact of CALM's management activities on threatened taxa and the development of prescriptions to enhance the conservation of threatened taxa in all of CALM's estate.

Achieved: Establishment and ongoing involvement in the Kingston timber harvesting impact study and the Batalling fire studies. Recommendations on the number of retained habitat trees adopted by FMB.

161 The development of guidelines to maintain adequate control over human-induced processes shown to detrimentally impact threatened and other native taxa.

Not achieved.

162 The provision of the relevant information and protocols to all CALM staff necessary to ensure the competent management of the State's native biota, particularly threatened and priority taxa.

Achieved: Publication of two District threatened flora Wildlife Management Programs. Draft preparation of three District threatened flora Wildlife Management Programs. Provision of advice and assistance to the Districts and Regions in the preparation of four Wildlife Management programs. Development of Western Shield fauna monitoring protocols with Wildlife Branch.

SUSTAINABLE RESOURCES GROUP

Objectives

163 To provide science-based information which will enable CALM to expedite its role in the sustainable utilization of resources in the most cost-effective manner with the least possible disturbance to the environment.

Achieved: Information provided to a large number of groups within the Department. CALMScience has made a substantial contribution to major initiatives such as the Western Shield project, Project Eden, the Regional Forest Agreement, Maritime Pine project and the Bluegum project. Information on tree breeding and fire management and plantation and native forest silviculture is made available on a continuous basis in both formal and informal ways.

164 To identify, evaluate and participate in the development of new products from natural resources of Western Australia.

Achieved: Although the Wood Utilization Research Centre is no longer part of CALMScience Division, the work initiated while the unit was a part of the Division has contributed strongly to the improvement in timber utilization and value adding to WA timber products. The Division has also contributed to the new tree planting initiatives undertaken by the Department. Research on both WA sandalwood (Santalum spicatum) and Indian Sandalwood (S. album) has contributed to a better understanding of the resource availability for WA sandalwood and has led to the development of an irrigated sandalwood industry in the Ord river Irrigation area.

Strategies

165 Contribute to the identification and utilization of new resources.

Achieved: Valwood® development, improved timber utilization, S. album establishment and silviculture, Maritime pine project (tree breeding, silviculture), Bluegum project.

166 Devise methods that enable resources to be utilized sustainably and with a minimum of environmental disturbance.

Partially achieved (ongoing): Kingston project, Western Shield, improved fire management.

167 Improve the cost-effectiveness of resource utilization including the development and growing of tree crops.

Achieved: Pine silviculture (nutrition, tree breeding, silviculture), Maritime pine project, Bluegum project.

Natural Products Section

Objectives

168 To evaluate and initiate the development of existing and new natural products, industries and markets.

Achieved: Demonstrated the potential of value adding to regrowth and plantation eucalypts. Ongoing research in assessing other laminated products using thinner sections. This research is now undertaken by Forest Resources Division (Timber Technology).

169 To provide the scientific information and to develop techniques to optimize the production and sustainable utilization of natural products.

Achieved: Completion of studies into prescribed burning of regrowth karri stands, development of dieback resistant jarrah clones to a stage suitable for operational planting on degraded sites, completion of the establishment of a comprehensive system of thinning experiments in regrowth karri stands, publication of the results of studies investigating the relationship between outbreaks of Jarrah Leafminer and forest management practices, and development of a model to predict allowable harvest of Brown Boronia.

170 To research the impacts of utilization on the resource and on the ecosystem in which it occurs.

Achieved: Establishment of the Kingston project, completion of data collection in a major investigation of tree hollows, comprehensive analysis of results from the Gray forest block bird study.

171 To develop the most effective and efficient management practices for utilizing the resource.

Partially achieved (ongoing): Commenced a major study into the effect of fuel age on fire behaviour in jarrah forest.

172 To develop protocols for monitoring environmental impacts and sustainability of management practices.

Achieved: Development of a technique for measuring fire history from grass-tree stems continues.

Strategies

173 Determine the distribution, abundance, ecology and genetic resource of species from which natural products are derived and develop methods to optimize their regeneration and growth.

Partially achieved (ongoing): Well understood for commercial species such as jarrah, karri, marri and sandalwood.

174 Research and monitor the long-term environmental and social impacts of CALM's management of natural products and determine the sustainability of the resource under this management. Develop science-based management practices which optimize the environmental and social impacts of CALM's management of natural products and which ensure the sustainability of these products.

Partially achieved (ongoing): Silvicultural systems and fire management systems for the forest areas are well developed and are sustainable.

175 Determine silvicultural or management practices to optimise the production of natural products. Optimise production by selection of superior breeding stock where this is economical.

Partially achieved (ongoing): Production/silvicultural systems for karri forest continue to be researched. Dieback resistant strains of jarrah are being developed to improve both the disease resistance and productivity of jarrah on affected sites.

176 Explore the potential for commercial uses of plant and animal species that are presently not used. Develop and promote methods of optimizing the use of natural products.

Partially achieved (ongoing): Significant advances have been made in the use of timber products through better utilization technologies and the development of new products. However, much remains to be done in utilizing the vast array of natural products.

177 Determine the potential losses due to damaging agents such as fire, pests and diseases, and develop efficient and effective methods to minimize these losses.

Partially achieved (ongoing): Significant advances have been made in understanding the influence of insect pests in native forests and on the influence of armillaria in the karri forest.

Immediate Benefits

178 Prescriptions for thinning and fertilizer regimes for karri regrowth that will optimize wood production from these stands.

Not achieved (ongoing): Four comprehensive experiments have been established and annual growth measurements completed for up to 10 years post-thinning.

179 Fuel and fire behavior studies to protect karri regrowth stands from damage by wildfire.

Achieved: Results from a series of experimental fires in unthinned and thinned stands have been published in scientific journals and prescriptions included in the CALMfire Operations Manual.

180 Jarrah forest regeneration and silviculture prescriptions that will provide for ongoing timber production while maintaining biodiversity.

Partially achieved (ongoing): A 3 year study of the characteristics and availability of hollows in jarrah and marri trees was completed. Preliminary findings have provided the basis for revision of the prescription for retention of habitat trees. Results from a study of the long term fate of hollow bearing trees were included in the Comprehensive Regional Assessment Report for the Regional Forest Agreement. An integrated experimental study of timber harvesting impacts on soils, vegetation and fauna was commenced at Kingston block in 1994.

181 Fire regimes for jarrah forests which provide protection from wildfires and injurious pests such as Jarrah Leafminer whilst maintaining the biodiversity of the jarrah forest ecosystem.

Partially achieved (ongoing): Monitoring of long term fire ecology plots has continued. Results from investigations into the role of fire in outbreaks of Jarrah Leafminer have been published in scientific journals. A technique for studying fire history from the stems of grass trees has been developed and applied widely in the jarrah forest. Results from a survey of fire history at 50 sites were included in the Comprehensive Regional Assessment Report for the Regional Forest Agreement.

182 Evaluation of the effectiveness of phosphonate in improving the health and growth of jarrah in the presence of *Phytophthora cinnamomi*.

Achieved: This technique has been demonstrated to be useful in protecting jarrah.

183 A system for assessing the impact of the disease caused by *Phytophthora cinnamomi* in relation to operations in jarrah forests.

Not achieved.

184 Production and field evaluation of strains of jarrah resistant to *Phytophthora cinnamomi*.

Achieved: Clonal seedlings selected from dieback resistant strains have shown superior survival and growth after 7 years in field validation trials planted on dieback-infested sites. Further operational plantings have been undertaken. Seed orchards of dieback resistant jarrah have been established.

185 An early warning system for outbreaks of the insect pest Gumleaf Skeletonizer.

Partially achieved (ongoing): GLS populations were monitored annually up to 1996 on 45 sample trees spanning a range of sites in the southern jarrah forest.

186 Improved production and utilization of wood.

Achieved (ongoing): Improved utilization has occurred as a result of the use of fine kerf saws, and improved handling and drying practices. Use of feature grade timber that

was previously discarded as defective. Research done by WURC is now separate from CALMScience.

187 Sustainable quotas for harvesting wildlife which will ensure the conservation of commercial species and economic viability of the industry.

Achieved: A spreadsheet model has been developed to predict the allowable harvest of Brown Boronia from southern forests.

188 Discovery and development of pharmaceutical products from native flora which will ensure the conservation of these species and of their habitat and provide economic benefits to the State.

Partially achieved (ongoing): Bioprospecting has become an important activity for CALMScience Division and the Department. An agreement with a bioprospecting company for CALM to supply extracts of vascular plant material for screening has been reached. The CALMScience Division herbarium is responsible for collection of specimen samples to ensure that there are no adverse conservation impacts caused by any collecting activities on public lands. The Department will be able to recoup collecting costs, enhance its knowledge of the State's flora and can fund conservation activities from any future discoveries of commercial pharmaceuticals.

189 Drying of eucalypts using an experimental batch kiln and the development of efficient drying schedules for regrowth karri and marri.

Partially achieved (ongoing): Some progress made, however drying of karri and marri is more difficult than jarrah. Research done by WURC is now separate from CALMScience.

190 Improvement of solar kiln drying from computer modeling.

Not achieved: Empirical methods are now considered more reliable and more suitable. Research done by WURC is now separate from CALMScience.

191 Improved penetration of CCA preservative in regrowth karri transmission poles.

Achieved: Karri is now the most widely used transmission pole in WA. Research done by WURC is now separate from CALMScience.

192 Assessment of stability of 30 mm regrowth jarrah Valwood® coated with different exterior finishes when exposed to outdoor conditions. (Valwood® has potential for external use in patio furniture which may have some exposure to weather).

Achieved: Demonstrated advantage of resorcinol formaldehyde adhesive for external use. Research done by WURC is now separate from CALMScience.

193 Relationship between branch size, success of occlusion and branch angle to recovery for regrowth karri grown under wide spacing.

Achieved: Paper in press. Research done by WURC is now separate from CALMScience.

194 Assessment of chemical means of preventing sapstain and Lyctus attack in Tasmanian blue gum Valwood® boards.

Achieved: Demonstrated the effect of Hylight and NP1 in reducing the incidence of sapstain. Research done by WURC is now separate from CALMScience.

195 Impact of wood boring insects, brownwood, decay and tree growth patterns on wood quality in regrowth karri.

Partially achieved (ongoing): The incidence of wood boring insects has been surveyed in 13 karri regrowth stands spanning a range of site quality and rainfall. Results from a

study of the incidence of borers at contrasting low and high quality sites have been analyzed. Commencement of a major integrated study of wood decay and insect damage was delayed due to staff changes.

Outcomes

196 Improved timber utilization by advanced timber drying schedules and installation of kiln drying controls and CALM developed timber dryers for local and interstate sawmillers.

Achieved (ongoing): Large advances have been made in the area of value adding to local hardwood species. Over 50 kilns have been installed Australia wide. Research done by WURC is now separate from CALMScience.

197 Technical support provided for licensees manufacturing Valwood® in Western Australia.

Achieved: Information supplied as required; however, with the downturn in the timber industry there was little interest in taking up the technology. As noted above the WURC is now part of Forest Resources. Research done by WURC is now separate from CALMScience.

198 Improved utilization of regrowth karri timber.

Achieved: Timber has been supplied to several furniture manufacturers as part of a promotion of value adding for karri timber. Research done by WURC is now separate from CALMScience.

199 Identification, evaluation and development of new natural products of economic and social benefit to Western Australia.

Achieved: Valwood has been successfully developed. Involvement in the Goldfields Timber research project which assessed the wood properties and utilization of the major species from this region. Research done by WURC is now separate from CALMScience.

200 Seed orchards and planting stock of *Phytophthora cinnamomi* resistant strains of jarrah.

Achieved: Extensive trials have been established and evaluated. Seed orchards have been established.

201 Improved forest fire danger rating and fire behavior prediction systems.

Partially achieved (ongoing): Systems have been developed to predict fuel consumption during prescribed fires in karri thinning slash, and to predict rate of spread and intensity of fires in shrubland fuel types. A major experimental study to determine the effect of fuel loading on fire behaviour in dry eucalypt forest (Project Vesta) commenced in 1996.

202 Silvicultural systems and management practices which:
- are cost effective, efficient and which maximize the sustainable yield and economic benefits derived from natural products;
- are ecologically sustainable, ie. which ensure the long term maintenance of essential biological characteristics, processes, dynamics and productivity of forest ecosystems;
- Minimize the impact of fungal and insect pests on wood quality and quantity.

Partially achieved (ongoing): The ecological sustainability of silvicultural systems has become a major focus of research activity, with emphasis currently on the Kingston project and investigations into the relationship between thinning and the incidence of Armillaria root rot in karri regrowth stands. Trials to test the efficacy of stump removal during thinning operations have been initiated.

203 Process-based predictive model of the impacts of logging and fire on jarrah and karri forest ecosystems.

Partially achieved (ongoing): The response of forest bird communities following timber harvesting in karri forest has been interpreted in relation to changes in stand structure which take place as regrowth stands develop with age.

204 *Phytophthora cinnamomi* hazard rating system for the northern jarrah forest.

Not achieved.

205 Ecologically sustainable harvest levels and appropriate management prescriptions for commercially important wildlife such as *Boronia megastigma*, kangaroos and crocodiles.

Partially achieved: Research data on Boronia was used as the basis for a predictive model to set allowable harvest levels (see item no. 187).

206 Survey and monitoring procedures for assessing the sustainability of timber and wildlife utilization management practices.

Partially achieved (ongoing): Survey and monitoring of vegetation and fauna undertaken for the Kingston project are providing baseline information for assessing the sustainability of timber harvesting operations in the jarrah forest. Monitoring of long term fire ecology plots is providing information about plant community response to a range of fire regimes.

Tree Crops Section

Objectives

207 To develop tree crops as integral, multiple purpose components of sustainable land management systems in the diverse environments found in southern WA.

Partially achieved (ongoing): A range of tree crop options are available for the south west. The development of appropriate silvicultural systems and other species options is an ongoing area of work.

208 To provide the scientific information necessary to optimise production, and maximize on-site and off-site environmental benefits from all tree crop plantings.

Achieved (ongoing): Where information is available it has been made accessible to plantation and tree crop managers.

209 To evaluate and initiate the development of new tree crop species, products industries and markets.

Partially achieved: A range of species have been evaluated for their suitability as tree crops. This is a large area of work that needs to be tackled systematically. A new NHT project with Farm Forestry Group is concentrating on this.

210 To provide support for other programs within CALM (eg. resource information, materials analysis) to aid planning and management in parks, forests, and plantations.

Achieved (ongoing): Where required, information has been provided to all parts of CALM, particularly plantation and tree crop managers.

Strategies

211 Predict the capability of sites to produce tree products and to determine how species differ in their growth and response to climatic and edaphic variation.

Achieved (ongoing): Improved systems for predicting the performance of E. globulus are now in place. Research continues on the new P. pinaster site assessment project in conjunction with Plantations Group and UWA.

212 Determine the optimum silvicultural regimes (establishment, pruning, thinning, fertilization, pest and disease control) for production and sustainability. Ensure that these regimes are compatible with other concurrent land use (eg. water yield, honey production, recreation use, agricultural production).

Achieved (ongoing): Silvicultural regimes for P. radiata are in place as a result of extensive research over the last 30 years. The situation is the same for P. pinaster on the coastal plain. Research is continuing to develop silvicultural systems for P. pinaster and E. globulus in the newer plantation areas.

213 Develop practices for integrating tree crops into productive and sustainable land use systems. This will include the development of suitable site preparation, plant selection, revegetation techniques and on-going management practices for a wide range of sites including degraded land that requires rehabilitation.

Partially achieved (ongoing): Completion of bluegum site survey (NLP). Extensive research on nutrient supply and water use is now being used to manage these plantations.

214 Optimize the quantity and quality of production and disease tolerance of all tree crop species by the selection, breeding and production of superior genotypes.

Achieved (ongoing): Significant advances have been made with all commercial species; however genetic improvement is an ongoing area of research for the three main commercial species, sandalwood (S. spicatum), oil mallees and a number of other introduced eucalypt species.

Immediate Benefits

215 As a result of work on the selection, breeding, flowering cycles and propagation techniques, it is anticipated that by 1997 the *Eucalyptus globulus* seedlings produced by CALM will have the potential to produce 40% more volume than the seedlings used to establish the *early E. globulus* plantations. The benefits of this program will begin to be incorporated into the program from 1994 onwards.

Not achieved: There have been problems with incorporating the genetic gains of the breeding program into the seedlings produced from the nursery. In particular seed orchard management and synchronization of flowering to ensure sufficient outcrossing have not been resolved.

216 Investigation of the performance of *E. globulus* now planted on a wide range of sites both in plantations and as integrated plantings on farmland will result in improved site selection criteria for *E. globulus*. This will result in improved tree growth and few problems with the establishment of trees on unsuitable sites.

Achieved: Guidelines have been formulated and the final report is in preparation.

217 Seasonal variation of arthropods including beneficial arthropods and pest insect loads in three plantations of young *E. globulus* will be documented. This will show how the pest insect load and propensity for rapid increase in insect damage change over seasons and as the canopy enlarges. This research will show the optimum sampling time for assessing the load of insect pests on young *E. globulus*. This information will be used to investigate insect resistance *of E. globulus* cultivars.

Achieved: Project successfully completed.

218 The development of radiata pine HAPSO (hedged artificially pollinated seed orchard) will dramatically improve the rate at which gains in tree growth rates, tree form and disease resistance are incorporated into the seedlings produced by CALM.

Achieved: HAPSOS have been established. Although some management problems have reduced the effectiveness of this orchard, it is an important part of CALM's plant propagation system.

219 The culmination of three decades of selection and breeding will result in the collection of over 80kg of high quality pinaster pine seed from the Manjimup seed orchard. This seed will be the highest genetic quality pinaster seed available anywhere in the world.

Achieved.

220 Data on the growth and water use by radiata pine from long term experiments examining the response to fertilization and to fertilization and thinning will enable the development of strategies for thinning and fertilization that will increase wood yields. Maximizing wood yield is likely to be important given the projected increase in softwood demand in Western Australia.

Achieved: Trials have been successfully established measured and monitored and results implemented.

221 The funding by the Farm Forestry Program of the establishment of three large-scale timberbelt demonstration areas at Dandaragan, Boyup Brook and Busselton will allow the development of a pine timberbelt package. This package will cover site assessment, farm planning, sharefarming contracts, promotion and training. The package will provide the basis for a commercial pine timberbelt scheme.

Achieved: This is now the responsibility of the Farm Forestry Group (Forest Resources Division).

Outcomes

222 Land capability assessment and growth prediction procedures for plantations and tree crops by relating climatic and edaphic factors to the survival and growth of tree species in southern WA.

Achieved (ongoing): Trained staff now perform site evaluations as part of the routine property evaluation for tree crop establishment. The improved site selection system for E. globulus is in its final draft. Research on P. pinaster site requirements is ongoing in conjunction with Plantations Group.

223 Optimum thinning, pruning and fertilization strategies for sawlog and water production from *Pinus pinaster* stands on the coastal plain.

Achieved: Trials on the Swan Coastal Plain have allowed improved prescriptions for thinning and fertilization strategies for coastal plantations.

224 Optimum fertilizer applications for *P. radiata* and *E. globulus* at all stages of the rotation on the range of sites on which they are grown, and understanding of the interaction between water supply plantation density and response to fertilization.

Partially achieved (ongoing): Work is nearing completion on the trials examining the interaction between nutrition and water use in P. radiata. Trials looking at the nutrient requirements of E. globulus are also nearing completion. A project to study the interaction between nitrogen supply and water use over a wide climatic range was initiated currently.

225 Quantification of the production and landcare benefits of tree crops integrated with agriculture to ameliorate land and water degradation (eg. salinization and eutrophication), and development of techniques to maximize these benefits.

Partially achieved (ongoing): A series of trials in maritime pine plantings has been established to investigate growth rates and water use across a climatic gradient. Funds have been gained from NHT to expand this work.

226 Establishment techniques and silvicultural management practices, which optimize the economic returns for eucalypt pulpwood plantations and from, oil eucalypt crops.

Achieved (ongoing): The Farm Forestry Group is now responsible for research on oil mallees. Most of the bluegum research has been done within the Plantations group. Nutrition and water use studies in bluegums are nearing completion. A project to study the interaction between nitrogen supply and water use over a wide climatic range was initiated.

227 Introduction, selection and breeding of *P. radiata* and *P. pinaster* so as to ensure that the genotypes used in pine plantations provide the best possible growth rates, wood quality and disease resistance.

Achieved (ongoing): The extensive radiata and pinaster breeding programs continued. In particular the pinaster (maritime pine) program has been reinvigorated. Membership of the STBA has also led to considerable research on the radiata-breeding program.

228 A diverse and robust breeding population from the complete natural distribution of *E. globulus*.

Achieved (ongoing): A large number of trials covering a wide genetic range have been established. Research on growth rates, tree form and drought tolerance will continue for a number of years.

229 Expanded range of species and improved genetic potential of planting stock available for revegetation and plantation tree crops.

Partially achieved (ongoing): Provenance trials have been measured and analysed. Funding from NHT has been received in conjunction with the Farm Forestry to investigate the selection of appropriate species for the medium to low rainfall zone

230 Seed orchard and vegetative propagation techniques to ensure the supply of improved genotypes for plantation and tree crop establishment.

Achieved (ongoing): Current seed orchards have been maintained and new seed orchards were established. The vegetative propagation work is now the responsibility of the Plant Propagation Unit within Plantation Group.

SCIENCE SERVICES

Objective

231 To ensure that essential financial, computing, biometrical, publishing, germplasm facilities, and vegetation health services are provided to support the Mission of Science and Information Division.

Achieved.

Strategies

232 Review at the start of each fiscal year the effectiveness of the support given in the previous fiscal year, and plan the support required for the following fiscal year.

Achieved: Continued efficient support has been provided to support the Science Services Group (SID Directorate). Suggestions and advice are continually provided resulting in balanced SID budgets.

233 Re-organize the existing Dieback Disease Detection Service and Plantation Health Service into a more integrated Vegetation Health Service, and formulate the objectives, strategies and outcomes of this Service.

Achieved: The Vegetation Health Service (VHS), formed in 1993, formulated its objectives, strategies and outcomes. Monies earned through the processing of samples have been used to improve the facilities, including new equipment and techniques. An electronic key for the identification of Phytophthora species was developed.

Information Science Section

Objectives

234 To develop the methodology and provide the mechanisms for utilizing new technology and to adapt current technology to satisfy the specialized needs of the Division.

Achieved (ongoing): Information systems are widely utilized and the Division has access to up-to-date technology, especially in relation to presentation of seminars and training programs.

235 To research and develop new approaches in integrating information and systems across hardware and software platforms as well as geographical locations.

Achieved (ongoing): Development of a prototype web-site for CALMScience to serve as an example of what might be achieved by the adoption of this technology department - wide; development of innovative strategies for two distributed corporate information systems, WASPP and TARIS; further development of electronic collecting book and species editing tool (MAX); and development of the prototype of the DELTA Database Engine, a tool for the uptake of taxonomic descriptive data to be transformed to DELTA format, and for the management of corporate DELTA data sets.

236 To collaborate with scientists on science projects requiring a high level of analytical sophistication.

Achieved (ongoing): Participation in Phytophthora-related research projects; participation in ecological and monitoring projects with CALMScience ecologists; and design and development of DELTA database systems including interactive identification and information retrieval systems for Phytophthora species of the world,

flowering plant genera of WA, Asteraceae genera of the world, threatened flora of WA Olearia species of Australasia and grasses of Australia.

237 To raise and maintain standards of research, planning and analysis and to ensure efficient design, information management and analysis in the Division.

Achieved (ongoing): Design, development and ongoing management of a number of corporate information systems including WACensus, WAHerb, WALib, CALMLib, DesCat; and design of a prototype of a biological information system (WABiota).

238 To develop new and/or improved research methods appropriate to the Division's requirements.

Achieved (ongoing): Data uptake and analysis in a number of RFA-related projects requiring familiarization and further refinement of a number of GIS analytical tools and a critical examination of the underlying methodologies; and exploration of the possible application of time series analysis to ecological projects.

239 To provide an integrated environment for the capture, processing, analysis and dissemination of information at Centre, Divisional & Departmental levels.

Achieved (ongoing): Project management for the deployment of Internet/Intranet technology throughout CALM; participation in systems design for TARIS system and for CALMScience's specialized project management tool WASPP; and the establishment of an integrated botanical information (FloraBase) and its deployment on the Internet.

240 To increase computer literacy and expertise amongst research staff and to introduce them to new products so that they benefit from new technology.

Achieved (ongoing): Adoption of sophisticated GIS analytical techniques in connexion with the RFA process; courses given on the use of the DELTA system; courses given on the use of MAX (beta test version); and presentations given on the use of the prototype DELTA Database Engine.

241 To communicate and integrate with other groups within CALM and other appropriate external organisations to allow for exchange of research findings, ideas, data, software and other products.

Achieved (ongoing): Participation in the work of CALM's IT Executive Committee; participation in various phases of the RFA process including data uptake, analysis and integration; assistance provided to Corporate Relations and their consultants on initial design and functionality of NatureBase and CALMWeb; ongoing liaison with WA Museum staff on IT matters of mutual interest, especially during the RFA process; ongoing liaison with Kings Park staff on IT matters of mutual interest, especially further development of DesCat; and participation in work of HISCOM, especially in connexion with developing the HISPID standard.

242 To provide and maintain the necessary infrastructure to support the above.

Achieved (ongoing): Provision and management of LANs at all major research centres; establishment of a new LAN at Busselton; and management of a GIS, Herbarium and applications development servers.

Strategies

243 Develop objectives, identify areas, set direction, establish medium and long-term goals and develop a phased implementation schedule.

Achieved: The strategic planning process used was approved by management.

244 Identify and prioritize tasks and areas requiring attention, maintain a pro-active approach, keep up-to-date with developments in technology.

Achieved: Via an Action Plan approved by management.

245 Provide an integrated networked environment for information management, analysis and dissemination.

Achieved: LAN's provided and maintained at CALMScience Centres at Woodvale, Herbarium/Como, Busselton and Manjimup. Staff at the Observatory and smaller centres were connected via LANs maintained elsewhere in CALM.

246 Develop and establish protocols for maintaining a uniform approach in each of the key areas (eg. a set of information technology and data custodianship guidelines in SID).

Partially achieved: Guidelines developed for corporate data systems (eg WASPP, WAHERB, WACENSUS, WALib); general data custodianship guidelines under development.

247 Develop and provide intelligent systems, which are capable of performing analysis or automating processes (eg. biological identifications).

Achieved: A number of identification tools were developed using the DELTA technology (see above). FloraBase includes an identification module (Search Descriptions). Semi-automated systems for management of CALMScience Web pages using Frontier Server were developed.

248 Develop the mechanisms for corporatizing SID data and providing access to corporate data across SID centres.

Partially achieved: LANs maintained at all major centres, which serve as data-repositories available to staff as required; data from major corporate datasets are available directly via Telnet. CALMLib developed and maintained. WABiota is under development (see above).

249 Develop the mechanisms for providing access to data across the various hardware and software platforms as well as across centres.

Achieved: Prototype of CALMWeb developed, assistance with development of production version given. Data from major corporate datasets available via Intranet, Internet, including FloraBase.

250 Increase skill levels of SID staff, level of usage of current technological tools, new products and methods and their understanding of the underlying concepts by providing consultation and training.

Achieved: Consultation and training provided on an ongoing basis (see above for examples).

251 Recruit and maintain specialist staff with background in research, electronics, communications, biology, computing, physics, environmental sciences and other relevant research areas.

Achieved: Specialist staff retained as required via contract, including programming, applications development, data uptake, and hardware and systems maintenance.

252 Collaborate with scientists on specialized projects requiring a high degree of analytical sophistication.

See under 251.

253 Perform ongoing evaluation of new technology and its applications in the Science & Information Division.

Achieved (ongoing).

254 Establish and maintain Networks (LANs) and facilitate communications across all the major SID centres and extend these to other centres where possible (in co-operation with Information Services Branch).

Achieved: LANs established and maintained at all major centres (see above).

Immediate Benefits

255 Instant / intelligent electronic communications across the major SID centres as well as other CALM offices.

Achieved: LANs developed and maintained.

256 Electronic access to other organizations (scientific institutions) through INTERNET.

Achieved: Establishment of Intranet and Internet services in which ISS has played a major role.

257 Higher level of collaboration with specialist staff to increase scope of research and level of efficiency within SID.

Achieved: Participated in projects across the Division.

258 Implementation of intelligent systems and development of interfaces to them (eg. interface to the DELTA system).

Achieved: DesCat/FloraBase (all WA Flowering plants at a basic level).

259 Access to SID's corporate data across centres, providing a better framework for research and increasing our ability to respond to managerial needs.

Achieved: LANs, Intranet, Internet, FloraBase, Telnet, etc.

260 Improved productivity and efficiency associated with maintaining LAN and WAN connectivity throughout SID.

Achieved: In large measure communication within CALMScience is now dependent on LAN/WAN/Internet connectivity and tools.

261 Benefits associated with a total integrated environment with seamless communications across hardware and software platforms and the ability to have local intelligence in the field.

Partially achieved: Bringing the large corpus of ecological and tree-crops data into a corporately managed environment and of gaining access to zoological descriptive data via WAM was not completed.

262 Ability to take advantages and benefit from new developments in technology (ie. multi-media and other information technology areas).

Achieved: Examples include CD-ROM burners, slide and flat-bed scanners, digitizing tables, map printing equipment, modems, digital projectors, field data-loggers, etc.

Outcomes

263 Establishment and continued upgrading of a network for electronic communications within SID, with other CALM Divisions, and with other scientific organizations.

Achieved (ongoing): An efficient and reliable electronic communication system is available to all Divisional staff and between these and other administrators and researchers.

264 Introduction of multi-media technology.

Achieved (ongoing): Up-to-date equipment is now widely used in the Division.

265 Arrange online access to key corporate data sets required by the Division.

Achieved (ongoing): FloraBase is widely accessed by CALM staff.

266 Integration of corporate databases maintained by the Division.

Partially achieved (ongoing): Plant-based information sets have been integrated. Ecological and other datasets are being catalogued.

267 Development and implementation of Geographical Information Systems to generate distribution maps, perform spatial analysis, and allow predictive modelling.

Achieved: Distribution maps for all WA vascular plant species are available and it is possible to generate lists of plant species recorded for any designated geographic area of the State; spatial analysis and predictive modelling was achieved for the RFA effort.

268 Assessment of new products, ensuring that the most appropriate cost effective and up-to-date hardware & software is used in the Division.

Achieved (ongoing): Technical advice provided.

Biometrical Services

Objectives

269 To raise and maintain standards of research planning and analyses.

Achieved: Formal procedures for assessing statistical standards of project plans and draft publications have been established and effectively implemented. There has been extensive collaboration with other scientists on research projects requiring a high level of analytical sophistication, resulting in co-authorship of eighteen publications.

270 To ensure efficient experimental design.

Partially achieved: Documenting of experimental designs has been effectively implemented; however, routine use of power analysis for designed experiments remains to be put in place.

Strategies

271 Assess science project proposals in the design stage, detect errors, suggest improvements and amend as appropriate.

Achieved: All new science project proposals have been assessed in a timely manner.

272 Research new and improved biometrical methods relevant to the Division's requirements.

Achieved: Three scientific papers have been published in international journals, and one major report prepared, documenting new and improved methods.

273 Conduct biometrical courses and workshops for staff.

Not achieved: There has been a change in priority towards more involvement in joint projects.

274 Collaborate with scientists on research projects requiring a high level of analytical sophistication.

Achieved: Between 1995 and 1999 26 publications have been prepared in collaboration with other scientists, comprising 18 co-authored refereed scientific papers (11 published, one in press and six in preparation), three conference paper and five major reports to funding agencies.

Outcomes

275 Number of Science Project Plans (SPP) assessed and decrease in the number requiring amendment to the design and statistical analysis proposed.

Not assessed: see #277 below.

276 Assessment of each SPP within 5 working days.

Achieved: Currently, all SPPs have been assessed within this period.

277 Increased ratio of expert advice provided before SPP submission to that provided after data collected.

Not assessed: Data are not available to objectively determine whether there has been a change in this indicator. For manuscripts, 83% have been found to be suitable for publication with no or minor amendment to the statistical methods. This figure will provide a baseline with which to judge future performance.

278 Workshops or courses run for Divisional staff.

Not achieved: There has been a change in priority towards more involvement in joint projects.

279 Co-authorship of scientific papers as a result of contribution to analysis of complex data sets collected by other scientists in the Division.

Achieved: Between 1995 and 1999 eight such co-authored refereed scientific papers have been published, including five in international journals.

280 Preparation of a report on the above indicators by 1 July each year.

Achieved: Achieved by documenting these outcomes in the annual performance appraisal produced in June each year.

Financial Services

Objectives

281 To design and maintain Revenue and Expenditure Account structures which are effective and efficient.

Achieved: Revenue and Expenditure account structures have been maintained effectively and have met Corporate and SID requirements.

282 To provide regular financial reports within five days of an accounting period, as required.

Achieved: Financial reports have been provided on a regular basis and on request.

283 To match expenditure within set budgetary targets for SID within CALM.

Achieved: All budgets/expenditure targets set for SID were met.

284 To authorize and process accounts within three days of receipt.

Partially achieved: Majority of accounts were processed within three days of receipt.

Strategies

285 Develop and streamline accounting systems to speed up response time in reporting procedures.

Partially achieved (ongoing): Continuous development took place to streamline accounting systems.

286 Implement changes to meet the challenges and new priorities as set by the Director.

Achieved: Changes were implemented to accommodate new priorities as set by the Director.

287 Provide standards and training for administration staff within SID administration staff.

Achieved: Ongoing training was provided for SID administration staff to ensure high standards are maintained.

288 Provide constant review of departmental accounting and administrative systems.

Achieved: Departmental and administrative system was reviewed via the Department "Financial User Group".

Outcomes

289 Budgets are balanced within set targets.

Achieved: SID budgets were all balanced within set targets during this period.

290 Financial reports are provided within five days of an accounting period.

Partially achieved: Financial reports have been provided on a regular basis.

291 Historic financial information is retrievable at short notice.

Achieved: Historical information has been retrieved within the required time span on request.

292 Full financial report on the year's accounts is provided by 16 July each year.

Achieved: Detailed analysis of SID expenditure for preceding years were provided within required timeframes.

Science Publications

Objectives

293 To increase awareness of CALM scientific research and technical investigations by publishing and disseminating that work in a clearly identifiable CALM journal, jointly managed with CALM's Corporate Relations Division.

Achieved: CALMScience (journal) published (details below).

294 To enhance the status of CALM's scientific research and technical investigations by publishing and disseminating that work in a manner commensurate with international journal standards and principles.

Achieved: Consistent editorial standards maintained.

295 To publish and disseminate papers reporting CALM's scientific research and technical investigations in a cost-effective and market-oriented manner.

Achieved: Nuytsia and CALMScience exchanged for journals published by other kindred agencies.

Strategies

296 Publish CALMScience and Nuytsia, CALM's journals of scientific research.

Achieved.

297 Maintain an Editorial Advisory Board to address pertinent issues of editorial policy, standards, and financial support.

Achieved.

298 Employ relevant expertise to manage and administer publication of this journal.

Achieved.

299 Develop cost-effective production and marketing measures.

Partially achieved. Marketing measures not developed.

Outcomes

300 Editing and preparation for publishing of at least 2 issues of CALMScience and of Nuytsia per annum.

Partially achieved: The following science publications were produced.

1995
Nuytsia Vol. 10, No.1. published 11 Jan 1995
Nuytsia Vol. 10, No. 2. published 25 Jul 1995

CALMScience Vol. 1, No. 3. published Jan 1995
CALMScience Supplement No. 2. published Feb 1995
CALMScience Supplement No. 3. published Mar 1995
CALMScience Supplement No. 4. published June 1995
CALMScience Vol. 1, No. 4. published June 1995
CALMScience Vol. 2, No. 1. published Dec 1995

1996
Nuytsia Vol. 10, No. 3. published 25 Jan 1996
Nuytsia Vol. 11, No. 1. published 31 July 1996

CALMScience Vol. 2, No. 2. published Dec 1996
Insufficient manuscripts received to produce another issue of CALMScience in 1996

1997
Nuytsia Vol. 11, No. 2. published 10 Mar 1997
Nuytsia Vol. 11, No. 3. published 10 Oct 1997

CALMScience Vol. 2, No. 3. published Nov 1997
Insufficient manuscripts received to produce another issue of CALMScience in 1997

1998
Nuytsia Vol. 12, No. 1. published 17 Feb 1998:

1999
CALMScience Vol. 3 No. 1. published Jan 1999
CALMScience Supplement No. 5. published Oct 1999

Nuytsia Vol. 12 No. 3. published 8 June 1999
Nuytsia Vol. 13 No. 1. published 17 Dec 1999

301 Processing of all manuscripts at every stage, other than editing, within 10 working days.

Partially achieved: Processing of all CALMScience manuscripts at every stage administered by SPU, prior to editing, has been completed within 10 working days, with one exception: this was a manuscript by Brennan et al., submitted in April 1995. Initial processing was completed in 11 days: a delay in locating available referees, combined with a very heavy editing load at the time, contributed to this circumstance.

302 Delays with handling of manuscripts by referees and authors monitored and minimized as far as possible.

Achieved: Handling of CALMScience manuscripts by referees and authors is monitored. Tardy referees are followed up; and very carefully considered for any subsequent refereeing requests. Tardy authors are occasionally followed up with a reminder `phone call. SPU has recently made a decision to incorporate a timely reminder to all tardy authors. It is the authors' responsibility to return the revised manuscript within the specified time.

303 Preparation of a report on the above indicators by 1 July each year.

Achieved: Outcomes of Science Publishing Unit reported to management each year.

Threatened Flora Seed Centre

Objectives

304 To develop a comprehensive seed based germplasm collection for rare and threatened plant taxa in Western Australia with the initial aim of capturing 75-80% of all genetic variation within each taxon.

Achieved: A comprehensive seed-based germplasm collection was developed for more than 400 rare and threatened plant taxa with the initial capture of 75-80% of the genetic variation for most taxa.

305 To utilize appropriate protocols for the medium and long term storage of seed from rare, threatened plant taxa in Western Australia and maintain an integrated database on seed provenance and seed biology for each taxon.

Achieved: Appropriate protocols for the medium and long term storage of seed from rare and threatened plant taxa have been adopted. An integrated database (WASEED) on seed provenance and seed biology for each taxon has been established.

Strategies

306 Prioritize rare and threatened plant taxa for seed collection based on the level of threat with particular reference to Phytophthora, weed invasion and small population size.

Achieved: Using the available information seed collections have been prioritized based on their level of threat of loss of genetic diversity or extinction.

307 Collect sufficient quantities of seed from each taxon, based on within and between population sampling strategies, to ensure the initial capture of 75-80% of the total genetic variation within each taxon.

Achieved: On the basis of limited knowledge of the genetic variation between and within taxa, sufficient quantities of seed from the majority of taxa is likely to have ensured the capture of 75-80% of the genetic variation within each taxon.

308 Develop population based sampling strategies based on genetic system studies on appropriate priority taxa.

Achieved: Population based sampling strategies have been developed that have been based on limited genetic system studies on appropriate, but representative, threatened taxa.

309 Develop seed storage protocols for medium (4-25 years) and long term storage (25-100+ years) and maintain collections under appropriate storage regimes.

Achieved: Appropriate medium and long-term seed storage and maintenance protocols have been developed according to international standards.

310 Carry out regular seed viability testing on all provenances and develop and maintain a database, integrated with WAHERB and CALM's declared rare flora database, on seed provenance and biology.

Partially achieved: Regular seed viability testing is conducted on all accessions of seed in medium and long term storage. An integrated database (WASEED) has been developed for the seed storage facility and is regularly maintained with information on seed provenance, viability and storage details, seed moisture content and monitoring details. The integration of WASEED with WAHERB and CALM's declared rare flora database has not been achieved.

Immediate Benefits

311 Establishment and maintenance of a seed-based gene bank for rare and threatened flora in Western Australia.

Achieved: A genebank containing 571 accessions representing 205 taxa of rare and threatened WA flora has been established at the WA Herbarium

312 Provision of information on the seed biology of rare and threatened plant taxa.

Achieved: Information on seed biology of rare and threatened taxa is provided to WATSCU for the preparation of Interim Recovery Plans and to other CALM staff to assist management actions.

313 The long-term cold storage of broad genetically based germplasm collections for critically endangered taxa.

Partially achieved (ongoing): Two hundred and fifteen accessions representing 56 critically endangered taxa are held in long term cold storage.

314 The availability of germplasm material for species recovery and reintroduction.

Partially achieved (ongoing): Material from 7 taxa has been provided for CALM's translocation programs in 1998. Further material will be provided over the ensuing 2 years with stored material from a total of ten taxa being used in the recovery process.

Outcomes

315 Storage of sufficient genetic resources (75-80%) of each taxon to ensure its successful re-introduction and establishment in the wild following extinction from natural populations.

Achieved: Storage of sufficient genetic material from the majority of taxa held in storage provides for successful reintroduction and establishment should population extinction occur.

316 Provision of seed material for biochemical, physiological and molecular research on rare and threatened plant taxa.

Achieved: Seed and green shoot material from a range of provenances from 11 taxa in the genus Lambertia, Banksia, Verticordia and Chorizema has been provided to CALM for biochemical, physiological and molecular research.

317 Provision of material for ex situ propagation as required in recovery programs or for educational purposes.

Achieved: Material from seven critically endangered taxa has been provided to KPBG for cultivation for CALM's recovery programs in 1998.

Vegetation Health Service

Objectives

318 To help maintain and protect the State's vegetation resource by providing accurate diagnosis of the cause of plant disorders and advice on cost-effective remedial measures.

Achieved: See below for details.

Strategies

319 Devise a better system for funding the various types of work done.

Achieved: A user pay system was put in place and fees ($20.00 for CALM's Business Unit samples, $40.00 for Recoup samples and $60.00 for Private samples) were collected until CALM's Business Units withdrew from the scheme. The current fee is $70.00 for both Recoup and Private samples.

320 Liaise with officers in CALM Districts, Regions, Environmental Protection Branch and Wildlife Branch to identify and prioritize plant health problems, and publicize to them the services available.

Partially achieved: The general plant disease diagnosis service was used infrequently probably because the fee was considered prohibitive. Workshops were organized to inform CALM's Dieback Interpreters on matters relating to Phytophthora.

321 Collaborate with research scientists in Science and Information Division in undertaking short-term research to improve diagnosis and understanding of plant health problems.

Not Achieved: Scientists tended to do their own diagnosis probably because the $20.00 fee was considered prohibitive.

322 Ensure that all plant pathogens that need to be identified with help from other research institutes are first vouchered through the WA Herbarium.

Not Achieved.

Immediate Benefits

323 Completion of a comprehensive computerized database on the distribution and hosts of Phytophthora species.

Achieved (ongoing): The database currently totals 15 034 records.

324 Production of maps at various scales showing distribution of Phytophthora species in CALM's estate.

Achieved: Information from the database has been used for a chapter entitled "Development of GIS-Based Decision Support Tools and The Databasing of Phytophthora-Sensitive Taxa" written by Gioia et al. and published in the final report to

the Threatened Species and Communities Unit, Biodiversity Group Environment Australia in May 1997. Other information was also used for a poster paper by Stukely et al. entitled "Phytophthora Species in Natural Vegetation in Western Australia" presented at the 11th Biennial Conference of the Australasia Plant Pathology Society in Perth 1997.

Outcomes

325 Workshops in Regions at which latest information will be shared with field staff.

Achieved: Workshops were held at the VHS laboratory, Como.

326 A herbarium collection of diseased material and a fungal culture collection of causal organisms.

Achieved: A fungal culture collection mainly of Phytophthora species is housed in the VHS laboratory, Como. A herbarium collection of diseased material related to Phytophthora has not been collected because CALM's Dieback Interpreters regarded it as unnecessary.

327 A user-friendly manual of important plant diseases in WA for distribution to each CALM District office but saleable to the general public.

Not Achieved: Information is still being gathered and is currently insufficient to produce a manual.