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Productivity of biologists in CALMScience Division: a preliminary benchmarking study

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EXECUTIVE SUMMARY

The number of books, book chapters and refereed papers published in science journals was obtained from official CALM**Science** Divisional records. The average productivity of each biologist in the latest triennium for which full information is available (1997-1999) was then computed. Comparable data were gathered for eight biology-based groups in Western Australian universities and three comparable public sector research groups (one each in WA, NSW and Tasmania). CALM**Science** Division ranked similar to the other public sector research groups studied in the arithmetic mean and the median number of publications/ scientist, but ranked low relative to most of the academic groups. CALM**Science** Division led all of the groups surveyed in its up-to-date and accurate publications and staff databases (staff bibliography database). Analysis based on these databases showed that the productivity of the Division in the period 1985-2000 was sustained at a high level, albeit unevenly among the scientific staff.

INTRODUCTION

The Director of CALM**Science** Division, Dr Neil Burrows, gave me the task of assessing the productivity of CALM**Science** Division biological scientists against that of relevant academic sectors. After scoping discussions with him, productivity was restricted to refereed books, book chapters and papers in science journals published in the triennium 1997, 1998 and 1999, and staff was defined to include permanently appointed research scientists (CALM**Science** Division) or academic staff in Western Australian universities, for the same period.

Two questions were investigated:

(1) Is the average number of publications produced per scientist in CALM**Science** Division comparable with that produced in the relevant disciplines (Schools, Departments, Groups etc) in WA universities and public sector research groups?

(2) Given that CALM**Science** Division scientists are expected, according to the CALM Corporate Plan 1998-2000, to produce 2 publications *per annum*, what proportion of staff are above or below this nominated output (i.e. 6 publications in the triennium), and how does this proportion compare with other research groups?

METHODS

Staff lists were obtained from university web pages, published annual reports, or by contact with academics. The Observatory, consisting of physical scientists, was not considered in this comparison. In order to make comparisons between public sector and academic groups as valid and realistic as possible, PhD students, post-doctoral fellows, research fellows, research associates, visiting research fellows, temporary lecturers and adjunct appointees were excluded. Contract staff in CALM**Science** Division were not included. In one university Department (UWA Geography), three social scientists were excluded from consideration, as CALM**Science** Division is not involved in social research.

Publication lists were obtained from published annual reports where available or by request from the academic group. These lists were checked carefully and conference presentations, conference proceedings, abstracts of papers, popular articles or books were excluded from consideration. Any reference without a specific volume number or pagination, or marked *'in press'*, was excluded. Some university Departments did not provide a full listing of author names of papers; I assumed that '*et al*.' referred to authors who were not staff of the Department.

Because some university web pages were out of date, information obtained in this way was checked through personal contact (telephone, email). All academic institutions approached were co-operative. I was only able to obtain a partial list of publications for staff in Biology and Biotechnology, Murdoch University, so this group was excluded from the analysis.

Relevant information was sought from public sector agencies with a significant biological research focus in WA (Agriculture WA, Fisheries WA) and those involved in nature conservation and/or forest research elsewhere in Australia (SA Dept of Environment and Natural Resources; Department of Natural Resources and Environment, Vic; Dept of Environment and Land Management, Tasmania; Forestry Tasmania; NSW National Parks and Wildlife Service; State Forests NSW; Dept of Natural Resources, Qld; Forestry Research Institute, Qld; Parks and Wildlife Commission, NT). Of these, comprehensive data were only obtainable for those agencies shown in Table 1. Other agencies were either unable or unwilling to provide data.

The calendar years 1997, 1998 and 1999 were selected for analysis, as these were the most recent years for which collation of publications could be expected to be complete. (This study commenced in December 2000 and was completed in May 2001).

Publications data were not collected in the form that universities are required to present to the Commonwealth Government via DETYA. The DETYA formula has a different purpose, namely to serve as a basis for Commonwealth funding to universities. It is arbitrary and complex (e.g. publications by undergraduate and postgraduate students are included; the contribution of authors to multi-authored book chapters are fractionalized; books receive a value five times that of book chapters and journal articles; conference publications are included). The labour involved in assembling such material for the present study was considered to be unjustified.

All authors of multi-authored publications were given credit, rather than just the first author.

RESULTS

The relevant data acquired were used to compute the average number of publications produced per scientist (See summary in Table 1).

Table 1

Group	No. publications 1997, 1998 & 1999	No. staff	Arithmetic mean – no. of publications/ scientist	Median - no. of publications/ scientist
CALM**Science**-biologists	166	51	3.25	2
Fisheries WA Research Division	79	33	2.39	1
State Forests NSW R&D Division	42	18	2.33	2
Forestry Tasmania R&D Division	40	12	3.33	2
Curtin-School of Environmental Biology	52	9	5.78	4
ECU-School of Natural Sciences	64	18	3.56	1.5
Murdoch-Environmental Science	97	25	3.88	2
UWA-Botany	88	9	9.78	9
UWA-Geography	46	6	7.67	7
UWA-Plant Sciences	101	10	10.10	11
UWA-Soil Science & Plant Nutrition	92	9	10.22	5
UWA-Zoology	88	11	8.00	9

Of the three public sector agencies for which data were available, CALM**Science** ranked second in arithmetic mean (3.25), slightly behind Forestry Tasmania (3.33). Of the twelve groups

compared, CALM**Science** ranked tenth in arithmetic mean and equal sixth in median. There was considerable variation between the university groups, in contrast to the public sector research groups. UWA departments stand out as high performers based on this indicator, with arithmetic means 2-3 times that of other agencies and tertiary institutions.

The proportion of staff in each group producing fewer or more than 6 publications in 1997-9 is shown in Table 2.

Table 2

Group	No. staff	No. scientists publishing # papers						
		0	1-5	**6**	7-10	11-15	16-20	21+
CALM**Science**-biologists	51	12	29	**1**	7	1	0	1
Fisheries WA Research Division	33	11	19	**1**	2	0	0	0
State Forests NSW R&D Division	18	5	11	**2**	0	0	0	0
Forestry Tasmania R&D Division	12	2	7	**0**	3	0	0	0
Curtin-School of Environmental Biology	9	1	5	**0**	1	0	2	0
ECU-School of Natural Sciences	18	7	7	**0**	2	0	2	0
Murdoch-Environmental Science	25	9	10	**2**	1	2	0	1
UWA-Botany	9	0	3	**1**	1	3	0	1
UWA-Geography	6	0	1	**1**	3	1	0	0
UWA-Plant Sciences	10	2	2	**0**	1	3	1	1
UWA-Soil Science & Plant Nutrition	9	1	5	**0**	0	0	1	2
UWA-Zoology	11	2	1	**0**	6	0	2	0

These data are presented in more simplified form, as percentages, in Table 3.

Table 3

Group	No. staff	Percentage* of scientists publishing # papers in 1997-9			
		0	1-5	**6**	7+
CALM**Science**-biologists	51	24	57	**2**	18
Fisheries WA Research Division	33	33	58	**3**	0
State Forests NSW R&D Division	18	28	61	**11**	0
Forestry Tasmania R&D Division	12	17	58	**0**	25
Curtin-School of Environmental Biology	9	11	56	**0**	33
ECU-School of Natural Sciences	18	39	39	**0**	22
Murdoch-Environmental Science	15	36	40	**8**	16
UWA-Botany	9	0	33	**11**	56
UWA-Geography	6	0	17	**17**	67
UWA-Plant Sciences	10	20	20	**0**	60
UWA-Soil Science & Plant Nutrition	9	11	56	**0**	33
UWA-Zoology	11	18	9	**0**	73

* rounded to nearest integer

Of the twelve groups compared, CALM**Science** Division had the third highest proportion of staff publishing no papers in 1997-9. CALM**Science** and five other groups had the highest proportions of scientists publishing 1-5 papers. Turning to the other extreme, of staff publishing 7 or more papers in 1997-9, CALM**Science** Division ranked eighth.

DISCUSSION

Benchmarking provides a comparison at a point in time and may identify a problem. This then allows managers to focus on the causes of the problem so that improvements can be made.

The conclusion reached from calculating a crude average (arithmetic mean) number of publications per scientist requires qualification because the frequency distribution of the number of publications produced is not Gaussian but highly skewed. Table 2 demonstrates that a number of CALM**Science** biologists did not meet the Director's stated expectation of 6 publications/triennium. Although it could be argued that the period 1997-9 was atypical, it seems more plausible to infer that some CALM**Science** biologists have not been able to manage the flow of their work in an efficient and business-like manner. That is, in each year the portfolio of science projects of each scientist should show a balance between planning, data collection, data analysis, manuscripts drafted, papers submitted, papers in press, and papers published. These matters are all capable of being addressed under the new Individual Development and Performance Enhancement System.

Other means of improving productivity could include participation in a time management course specially devised for scientists, criteria regression, regular monitoring by Group Managers and Program Leaders of progress of scientists in writing up their research results, and mentoring of junior scientists by senior, productive scientists.

However, a legitimate concern with this type of analysis is the validity of comparing academic and CALM**Science** biologists. Academics spend varying proportions of their time teaching undergraduate and postgraduate students and few spend 100% of their time on research. Academics, unlike CALM**Science** biologists, have the option of increasing their publication rate by co-authoring papers written by their Honours, Masters or Doctoral students or Post-Doctoral Fellows.

Public sector biologists are expected to spend various proportions of their time providing advice to senior managers on policies and prescriptions, contributing to management or recovery plans, drafting replies to Ministerial correspondence and Parliamentary questions, etc. Hence these scientists do not spend all of their time on research. In addition, some CALM**Science** biologists are poorly resourced in terms of dedicated technical support (the salary of one Technical Officer is currently equivalent to c. $50k *per annum*), and this may be hampering productivity.

Another limitation of this type of analysis is that it treats all publications equally, when in reality, some are more substantiail than others in terms of scientific complexity, volume and/or the extent to which they contribution to science and management.

Basing a benchmarking on a 3-year period may be too brief a time span. The obvious refinement would be to count the books, book chapters and refereed papers in science journals published during a longer period, but place these in the context of other written contributions to upholding CALM's mission. Table 4 summarizes the productivity of CALM**Science** Division scientists in the period 1985-2000.

Table 4

Type of product	No. items produced	Mean per scientist
Refereed journal papers, book chapters & books	826	17.2
Unrefereed conference abstracts and papers	600	12.5
Unrefereed reports (e.g progress reports)	645	13.4
Popular (e.g. Landscope)	561	11.7
Submitted for publication (peer review)	245	5.1
Major input into management plans	115	2.4
Species accounts	74	1.5

There were two surprising results of this benchmarking study. The first was how advanced CALM**Science**'s databases are relative to all other research groups surveyed. None could match our capacity to deliver up-to-date information on the various products written by scientists. Second, perhaps more sinister, was the unwillingness of many public sector groups to supply a reliable list of staff scientists with an indication of which were permanent or externally contracted. Such information can hardly be regarded as privileged.

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