1994 NZAS Survey of Scientists' Perceptions of New Zealand Science: Results

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This is the second article on the 1994 *NZAS survey of scientists' perceptions of New Zealand science.* The first paper described the background and objectives. This paper looks at some of the results. The Questionnaire began as a limited survey of NZAS membership (340 members). It was then sent to a broad group of 1000 scientists selected at random from 5000 members of selected professional societies affiliated with the Royal Society. Finally, 1229 scientists belonging to the Primary Production Group of the Royal Society, which includes nine professional societies, were circulated with the Questionnaire. Results from the Primary Production Group responses have been published separately (Kirton *et al*, 1995).

Government statistics (MoRST publication #12, 1994) indicate that in 1992 there were about 4000 scientists with degrees in government science and in the universities in New Zealand. Overall, the NZAS Questionnaire was circulated to 2569 individuals. The fact that 94% of respondents had a science degree and were employed in government science and the universities suggests that more than half of the targeted group of scientists in New Zealand were circulated. The response rate of the survey populations is summarised in Table 1.

Because there was an overlap between the groups, people were requested not to answer the Survey twice. However, members of the NZAS who received a second questionnaire were invited to pass the second one on to a colleague. We do not know how many did this. Nevertheless, when the possibility of people discarding a second questionnaire is allowed for, it is most likely that the actual response rate was a little higher than that presented, particularly with the Royal Society random list and the Royal Society Primary Production Group. We could identify those involved in primary production in the first two groups (n=105) which would increase the Primary Production Group response rate to 41%. Furthermore, when the presence of perhaps 25% non-scientists or non-working scientists in the Royal Society lists is taken into account, the response rate of the Royal Society random list would be increased to over 40%. Consequently, the overall response rate would be increased from 33% to over 40% by considering the overlap and a small non-scientist contribution to the Royal Society list.

The final sample of people responding to the survey is not a random sample of New Zealand scientists. NZAS members (and their colleagues) and Primary Production Group scientists are most likely over-represented. Other scientists, particularly those who tend not be on the Royal Society list will be under-represented. We decided that it would not be possible to compensate for the bias in the sample or carry out any re-weighting according to which group a respondent appeared to belong. So the results presented here should be seen as the views of a substantial number of New Zealand's scientists. While we doubt whether these views would be substantially different from the total scientist population, there is inevitably some bias.

1. Analysis and Interpretation of the Results

A database was constructed from the survey responses using a programme designed by Mr Wilford Lie, a programming consultant. The data was then subjected to various analytical procedures by Dr Mike Berridge, Dr Robert Davies and Ms Pamela Walker. Most of the raw data were tabulated and, where appropriate, bar graphs and box plots were used to represent the data. Box plots are a popular method of representing the location and spread of a set of observations. See Figure 2B. In a traditional box plot the upper and lower edges of the box represent the quartiles. That is, half the observations fall in the box and a quarter are above and a quarter below. The bar in the middle of the box represents the median, so half the observations are above it and half below. In the box plots given in this article, the whiskers show the highest and lowest observations. The traditional box plot is unsatisfactory when the observations can take on only a small number of discrete values. In Figures 3 to 8 we have used a slightly modified definition of a box plot. This is described in the Appendix (Page 18). The notches in the sides of the box plots show the accuracy. If the notches of two boxes don't overlap, or overlap by just a little, then there is probably a real difference.

2. Characteristics of Respondents

Overall, 82% of respondents were between the age of 35-65 years (Figure 1), and 84% were male, which is the same as the overall gender balance in R&D in New Zealand (MoRST publication #12, 1994). Of all respondents, 62% had a PhD degree which represents 35% of all doctoral degrees held in government science, the universities and in the business sector. The median respondent had spent 20 years in science and had published 20 papers in refereed journals. Half of the respondents had refereed FRST applications and 13% HRC applications.

Respondents were widely distributed throughout the different areas of science with 47% in primary production and processing (agriculture, forestry, horticulture and fisheries), 18% in earth, marine, atmospheric and environmental science, 15% in biology and medical sciences, 13% in

physics, technology, engineering and mathematical sciences and 5% in management and administration. These figures correspond closely to government and university spending in these sectors. By employment, 49% of respondents were employed in CRIs, 27% were university based and 10% were in the private sector (cf 32% of FTE researchers in R&D in CRIs, 39% in universities and 23% in business respectively).

Most respondents (72%) were employed mainly in scientific research while 18% were employed in other areas of science and 8% were working outside of science. Eighty five percent were employed full-time, 4% part-time and 6% were self-employed. The remainder were working unpaid (1.1%), retired (3.1%), or unemployed (0.4%). Thirty percent had spent five years or less in their current employment, 18% 6-10 years, 29% 11-20 years and 28% greater than 20 years.

Based on this information about the responding group, the major analysis which is reported here was carried out on a *filtered* group of 713 individuals referred to throughout as the 'Total' or 'All Sci' group. This consisted of those employed (full-time, part-time or self-employed) in scientific research or in other science. This group was then further divided into those employed in CRIs (n=355), those employed in the universities (n=185) and the remainder. Of the remainder (n=176), about 30% were in the private sector. Others were in other research or tertiary institutions. It would have been interesting to further subdivide this group but the small numbers in the present survey would not allow for this. The age distribution of the filtered group differed only marginally from that of the unfiltered group (Figure 1).

3. Work Content, Research Freedoms, Credit and Intellectual Property

When asked to estimate the percentage of time spent on various activities within their sphere of employment, those in CRIs spent, on average, 40% of their time on applied research and 24% on basic research. As applied and basic research were not defined in the survey, the results represent the respondents perceptions of their research. Administration and management accounted for 22% of their time while 7% was attributed to consulting (Figure 2A). Those in the universities spent less than half as much time as those in CRIs on research but this was complemented by teaching activities. More time was spent on administration and less on management. Surprisingly, university scientists spent more time on applied research than on basic research though the difference was less marked than in the CRIs. When group size is taken into account, it can be concluded that most basic research in New Zealand is being carried out in CRIs rather than in universities. Differing perceptions of basic science between CRI and university scientists may have contributed to the differences observed. Box plot analysis of the work content of individual scientists shows that many university staff contributed little or no time to research activities (Figure 2B).

The extent to which scientists felt that they were free to choose their own research programmes showed marked differences between CRIs, universities and the 'Other' group (Table 2). Whereas 64% of university scientists had total freedom of choice, only 14% of those in CRIs and 27% of those in the 'Other' group felt they had total freedom of choice. In contrast, 59% of those in CRIs needed prior project approval compared with 23% in the universities.

The extent to which scientists get credit and recognition for their research is shown in Table 3. Whereas the vast majority (82%) of scientists in the universities felt that they got full credit and recognition for their research, fewer respondents in CRIs (64%) and in the 'Other' group (60%) felt that they got all of the credit and recognition. Three to four times as many scientists in CRIs and in the 'Other' group felt that their institution claimed the credit for their work but rewarded them individually compared with those in the universities. A smaller but significant group, that was twice as large in the CRIs, felt that their research went unrecognised and unrewarded.

Scientists' perception of ownership of intellectual property rights from their research differed between CRIs and the universities (Table 4). Whereas 72% of those in CRIs believed that their institution owned the intellectual property from their research and that they had no rights, only 12% of those in the universities felt that they had no intellectual property rights from their research.

4. Job Satisfaction, Careers and Personal Development

Overall, job satisfaction had decreased over the 1989-94 period (Figure 3A). This was more evident in the CRIs than in the universities. With the 'Other' group, job satisfaction had improved. Despite decreased job satisfaction in the CRIs and universities, most felt that their qualifications and experience were nearly or fully utilised; greater than 80% scoring 4 or 5 on a 5 point scale (Figure 3B).

Regardless of the group considered, a majority of respondents felt neither well paid nor underpaid (Figure 3C): 7-13% felt underpaid while 10-14% felt well paid.

When asked whether they felt their jobs were secure or certain to disappear, 76% of respondents within universities felt secure or reasonably secure compared with 36% in the CRIs and 47% in the 'Other' group (Table 5 & Figure 3D). Those on short-term grants would naturally feel some degree of job insecurity as a result of uncertain funding, but some university staff, on so-called permanent tenure, also felt insecure in their jobs. The 18 individuals in this situation were two Tutors, three Lecturers, five Senior Lecturers, five Readers/Associate Professors, and two Professors. The age distribution of these was three below 35 years of age, five between 36-45, five between 46-55 and five between 55-60. Hence, across the grade and age spectrum in the universities there is significant job destabilisation of science positions. (Note that the American, but not British usage of the word 'tenure' implying permanence confuses the issue when describing job security in New Zealand science.)

Throughout the three groups, a similar percentage (24-30%) said that they were actively looking for another job. This contrasts with those in science in the private sector (n=47) where only 4% responded that they were looking for another job.

The issue of career paths in science is addressed in Table 6. The notable difference in perception of a career path in science between scientists in the CRIs (70% No), and those in the universities (20% No) and 'Other' group (25% No), point to a problem that needs to be addressed in the CRIs. Similar numbers of scientists in all groups (40-50%) believed that there was a clearly defined career path into management and administration.

When asked about institutional support for professional development, scientists in CRIs and in the 'Other' group had attended more formal courses and been supported for retraining more than those in universities, while scientists in the universities had been supported to attend international conferences and been on sabbatical leave more than those in CRIs and in the 'Other' group (Table 7). There was little difference between the groups with regard to attendance at conferences in Australia and New Zealand. Research time in other organisations was low in the 'Other' group.

5. Changes in Science and its Organisation over the Last Five Years

The effects of reorganisation of science over the last five years were extensive throughout both the CRIs and the universities (Table 8). Within the CRIs, 98% had been restructured and 85% had funding level decreases. Funding level increases were recorded by 23%. Relocation and disestablishment had been experienced by 57% and 50% respectively. As expected, reorganisation effects were less evident in the universities with 64% having been restructured and 74% having had funding level decreases. However, relocation and disestablishment were 19% and 18% respectively which is quite substantial. In contrast, restructuring, relocation and disestablishment was intermediate with the 'Other' group. With this group, funding level increases were greatest and funding level decreases least. With each group, funding level decreases and restructuring had the greatest effect on perceived job security (see also Table 5) with relocation having had little effect (<8%). Organisational changes were perceived to have had a significant effect on scientists leaving for jobs overseas, with 76% of respondents in CRIs supporting this view, 62% in universities and 48% in the 'Other' group.

An enforced shift in direction of research from basic -> applied-> development -> scientific services was perceived to have increased substantially between the five year 1985-89 period and the 1989-94 period in all groups. Overall, 348 respondents had experienced this shift in direction in the 1989-94 period compared with 197 in the 1985-89 period, a 77% increase. A much smaller number of respondents had shifted from scientific services -> development -> applied -> basic research, and overall this also appeared to have increased over the last five year period (103 respondents) compared with the 1985-89 period (35 respondents).

Despite a marked shift towards applied research and development, most respondents in each group (68-72%) thought that the ratio of applied to basic research was about right (Table 9).

Total research output and quality of research were perceived to have changed little in the last five years (Figure 4), although increases in both the quantity and quality of research output were evident in the 'Other' group. Changes in basic and applied research output reflected the shift from basic to applied research and this was most evident in the CRIs. Most respondents in each group (>80%) felt that their job content had changed 'substantially' or 'somewhat' over the last five years and this was also more evident in the CRIs where the job content of 95% of respondents had changed. Within the CRIs, 43% said that their change in scientific area in the last five years had been 'directed' or had been necessary to gain new employment. The corresponding figure for those in universities and in the 'Other' group were 17% and 36% respectively

6. Effects of Recent Changes in Science Organisation on the Quality of Science

Changes in science organisation over the last five years were perceived by working scientists to have resulted in less 'good' science and more 'bad' science both in the respondents own organisation (Figure 5A & B), and overall in science in New Zealand (Figure 5C & D).

These effects were much more pronounced in the respondents views of science in New Zealand overall than in their own organisation. Table 10 summarises responses of scientists to overall changes in New Zealand science with regard to the quality of science.

When asked to evaluate the effects of science restructuring on the support and provision of science by 'provider' organisations, responses were in general negative on all issues except access to international linkages which had improved in all groups and access to facilities which had changed little (Table 11 & Figure 6). In general, both CRIs and universities were more negative than those in the 'Other' group with respect to international regard, ability to attract and retain top scientists, access to support staff, salaries and other work conditions.

7. Management Issues

The views of scientists were sought on their perceptions of (a) the experience and attitudes of policy makers in their employing organisations, (b) current management systems in their organisation, and (c) the overall management style in their organisation. The results are summarised in Tables 12-14 and in Figure 7.

Overall, policy makers within the respondents' employing organisation were perceived to have adequate background in research and knowledge of research, and respondents were quite positive about their attitudes to research (Table 12). Positive attitudes to policy makers were more evident in universities than in CRIs but in the 'Other' group background in research and knowledge of research was perceived to be less than adequate, though attitudes to research were good.

Attitudes to management systems were negative in all groups (Table 13). In the CRIs, although 30% of scientists regarded their management as neither 'good' nor 'bad', three times as many respondents were negative as positive. Responses to management were less negative in the universities and in the 'Other' group.

Individual descriptors of management style provided detailed information on the major issues determining negative responses to management (Table 14). In the CRIs, management style was seen as hierarchical, authoritarian, somewhat inflexible, somewhat short-term focussed, secretive and suppressing of criticism. These attitudes to management style were less evident in the universities where management styles were seen to be more flexible and open, neither suppressing nor soliciting criticism. Whereas universities were characterised by individual focus, CRIs favoured team-focussed approaches. In the CRIs and universities, management styles were seen by approximately 1/3 as being conservative, 1/3 as progressive, with the remaining 1/3 in the middle. Some shift towards a progressive management style was seen in the 'Other' group.

8. Discrimination

When asked whether significant incidents of discrimination had been noticed at their current place of work, 24% responded that they had noted discrimination on the basis of age, 23% on the basis of gender, 10-11% on the basis of ethnicity and union affiliation (Table 15). Discrimination on the basis of religious affiliation, political affiliation and sexual orientation rated between 1-5% overall and within the different groups. Results were remarkably similar between the different groups. Within female respondents (n=100), 49% noted discrimination on the basis of gender.

9. Freedom of Expression

Issues concerned with freedom of expression are presented in Tables 16-19 and in Figure 8. In general, freedom of expression differed markedly between the CRIs and the universities. Only 3% of scientists in CRIs felt that their organisation would allow them to speak out freely on a public policy issue, whereas 55% of university scientists and 30% of the 'Other' group felt free to speak out (Table 16 and Figure 8A).

Most scientists within CRIs (91%) and within the universities (96%) felt reasonably free to submit their research for publication with few restrictions (Table 17). Total freedom to publish was largely the prerogative of scientists within the universities (81%) but 35% of those in CRIs felt free to submit their research for publication without restriction.

Most scientists within the universities (77%) felt free to share their ideas about science and work issues with people other than their immediate colleagues, whereas 35% of those in CRIs experienced this freedom, and those in the 'Other' group showed intermediate freedom to share ideas (Table 18). Most in CRIs (64%), felt that they had to be discreet or guarded in their interactions with others.

The ability of scientists to collaborate with other scientists within their own institution and outside their institution was perceived to have changed over the last five years (Table 19 and Figures 8 B,C). Overall, the ability of scientists to collaborate within institutions remained unchanged (CRIs) or had improved (universities and 'Other' group), whereas the ability to collaborate between institutions was unchanged with the universities but had declined with the CRIs and the 'Other' group.

10. Effect of 1994 Budget on Scientists and on Science in New Zealand

Prior to the third wave of Questionnaires being circulated, the Budget was tabled with positive implications for science in New Zealand. Firstly, the proposed establishment of the Basic Research Fund (Marsden Fund) addressed several imbalances in the current system resulting from science restructuring. Secondly, a major signal of the changing environment of science was the announcement of increased funding for the Public Good Science Fund over the following three years. We were able to include, in the third group of Questionnaires, an additional question on the perceived short-term and long-term effects of these changes on job security, scientists personal situation and overall effects on science. The results show a positive change in that scientists perceptions of their personal situation, although with little change in the short term (one year), improvement was expected in the longer term (three years). The environment of science was seen to have improved markedly both in the short term and in the longer term. Between 2 and 9% of respondents thought that the Budget announcement would have affected their responses to some questions in the Survey.

Discussion, Summary, and Conclusions

This survey of scientists perceptions of the changing science scene in New Zealand has provided valuable insight into the effects of the changes over the previous five to ten years on scientists, and of perceived deficiencies in the current science structures as they existed at the time of the Survey, June 1994. Of particular concern are the issues of career structure and the scientific workforce, science 'management' and the ability to carry out internationally competitive science in New Zealand.

The extent of the Survey, which was circulated to about half of the research scientist community in New Zealand, and where a response rate over 40% was recorded, when confounding duplications of circulation were taken into account, makes this a substantive survey, in fact, the only survey of scientist perceptions of science in New Zealand. Arguments, encountered when the Survey was presented to some interested parties, regarding bias of the responding population are inherent in the nature of all surveys of this type but many responses, compared within and between the groups, provide internal controls and argue against this undermining the main conclusions of the Survey.

One factor to be emphasised in interpreting the Survey results is that most of the questions were designed to elicit responses of perceptions rather than facts. Perceptions, when they do not correspond with fact, can be valuable indicators of failure to provide information and suggest that remedial action should be taken. Limitations include the non-random nature of the population surveyed, the less than rigorous nature of some of the questions, the length of the Survey which may have reduced the response rate, the limited resources available to support the Survey, and the consequent limited data analysis. In this context, cluster analysis of responses to some questions would have provided a clearer indication of the benefits and negative aspects of the changes in science and allowed better identification of those groups of scientists most affected by the changes. There is no doubt that a revised Survey needs repeating, perhaps at two-yearly intervals to monitor the changing perceptions of scientists under the new system of science accountability. This was the clear message from all interested parties spoken to, from the Minister of Research Science and Technology, Simon Upton to the PSA. To facilitate follow-up Surveys, a database of working scientists in New Zealand is urgently needed. NZAS has the undertaking of the Minister to explore ways of establishing a database that will better enable scientists and their perceptions to be monitored.

1. Scientists' Perceptions of their Research

Most scientific research in New Zealand is carried out in government science institutions (CRIs) and this applies to basic as well as applied science. While universities are involved in research, the time available for research is becoming increasingly limited by teaching and administrative responsibilities (see also following article by H. Offenberger). As expected, research freedoms were felt to be much greater in the universities than in CRIs. Those in the universities felt that they received greater individual credit and recognition for their research, and held the view that they, either individually or along with their employer or granting agency, owned the intellectual property rights from their research.

2. Scientists' Perceptions of their Jobs and Careers in science

Loss of job satisfaction was evident in the CRIs and in the universities but those in the 'Other' science category had improved job satisfaction. These changes were not correlated with strong negative feelings about pay levels. Whereas most (but not all) of those in the universities felt that their jobs were reasonably secure, only about one in three scientists in the CRIs felt some degree of job security. In addition, less than one in three scientists in CRIs felt that in their organisation there was a clearly defined career path in science, whereas 75-80% of those in the universities and in 'Other' science saw a clearly defined career path for themselves. Changes in job content have been analysed in the following article by H. Offenberger. Most scientists had access to some professional development through attendance at conferences and courses within the previous two years with only small differences evident between institutions. The opportunities to spend research time in other organisations, or on sabbatical leave (combined 7.6% of scientists per year), seems very low for a country whose scientists are distant from major research centres and are often isolated.

3. Changes in Science and its Organisation and the Effects of these Changes on Science

Scientists had experienced extensive changes in science and its organisation over the past five years, both in the CRIs and in the universities, as well as in 'other' science. A major shift from basic to applied science had occurred but overall most scientists were not unhappy about their present ratio of applied to basic research.

Changes in science organisation over the last five years were perceived by working scientists, in all groups, to have resulted in less 'good science' and more 'bad' science, and these effects were seen to be more pronounced in science in New Zealand overall than in the respondents own organisation. This is one of the Survey's most significant findings and indicates that urgent attention to these factors is needed.

The support and provision of science by 'provider' organisations was perceived to have declined in all criteria surveyed except international linkages which had improved and access to facilities which had changed little. Thus, international regard, ability to attract and retain top scientists, access to support staff, salaries and other working conditions had all declined as a result of restructuring and this had occurred in all groups surveyed.

4. Management Issues

Policy makers (eg directors, board members, CEOs, etc) within CRIs and universities were perceived to have adequate background in research and knowledge of research and, in general, respondents were positive about their attitudes to research. However in science outside the CRIs and universities, background in research and knowledge of research were perceived to be less than adequate though attitudes to research were good.

Attitudes to management systems within organisations were negative in all groups. In the CRIs, management styles were perceived to be hierarchical, authoritarian, somewhat

inflexible, somewhat short-term focussed, secretive and suppressing of criticism. These attitudes to management style were less evident in the universities where management styles were seen to be more flexible and open, neither suppressing nor soliciting criticism. Whereas universities were characterised by individual focus, CRIs and 'Other' science management favoured team-focussed approaches.

5. Freedom of Expression and Discrimination

Freedom of expression issues differed markedly between the CRIs and the universities, there being few in the CRIs who felt completely free to speak out on public policy issues. Although most scientists felt reasonably free to submit their research for publication, there was clear evidence of minor institutional restrictions within the CRIs and in the 'Other' group. Freedoms to share ideas about science was more restricted within the CRIs and the ability to collaborate with other scientists outside their institution had declined in the CRIs.

Discrimination was evident in all groups on the basis of age =gender >ethnicity = union affiliation > sexual orientation > political affiliation > religious affiliation.

Conclusions

The 1994 *NZAS Survey of Scientists' Perceptions of New Zealand Science* has provided valuable information on scientists and on the effects of changes in science organisation on the quality of science and the ability to carry out scientific research. It is concluded that the changes have had a marked effect on scientists and on scientific research in this country. Comparisons of the views of scientists in CRIs with those in the universities and in 'other' science in New Zealand has provided insight into those who have been most affected by the changes and those areas of science where restructuring has had the greatest impact. Science management was of great concern to most scientists as was the effect of the changes on the provision of science and on international regard.

Evidence suggests that recent Budget changes in favour of science have begun to change scientists' perceptions of science for the better after a decade or more of declining science funding and restructuring. It is hoped that this more optimistic view of science will be borne out in future commitments to science and that science providers and government, on behalf of the stakeholders in science, can work together for a brighter future with improved funding, better human resource management and fewer disruptive organisational changes.

References

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Tables and Figures on Pages 12 to 22

Table 1 Survey populations and response rates

	Circulation	Response	% Respondentts
NZAS membership	340	143	42
Royal Society random list (5000)	1000	297	30
Royal Society/Primary Production Group	1229	397	32
Corrected Primary Production Group	*1229*	*504*	*41*
Overall	2569	837	33

Table 2 Research freedom

"To what extent do you feel that you are able to choose your own research program?"

	Total	CRIs	Universities	Other
		(% respondents)		
Totally	31	14	64	27
With prior approval	45	59	23	43
With detailed approval	17	22	7	19
Subject to day-to-day direction	2	2	2	2
Not applicable	5	4	4	9
Number of Respondents	*647*	*335*	*182*	*130*

Table 3 Credit and recognition

"If your research yields significant results, to what extent do you get credit and recognition?"

	Total	*CRIs*	*Univ*	*Other*
		(% respondents)		
You get all the credit/recognition	68	64	82	60
Your supervisor/director gets the major credit	7	7	6	10
Your organisation claims the credit but rewards you	14	15	5	24
Your contribution is unrecognised and unrewarded	6	8	4	4
Not applicable	5	6	4	8
Number of Respondents	*618*	*319*	*180*	*119*

Table 4 Intellectual property rights

"Who owns Intellectual Property Rights from your research?"

	Total	*CRIs*	*Univ*	*Other*
		(% respondents)		
You alone or, you and collaborators	11	3	22	15
You, along with your employer and/or grant agency	32	21	61	25
Your employer only; you have no rights	51	72	12	52
Other	5	5	5	7
Number of Respondents	*610*	*317*	*169*	*124*

Table 5 Security of tenure

"Over the next five years I believe my job is:"

	Total	*CRIs*	*Univ*	*Other*
		(% respondents)		
(certain to disappear)				
1	5	5	5	5
2	13	16	6	14
3	34	44	13	34
4	29	28	35	24
5	20	8	41	22
(very secure)				
Number of Respondents	*692*	*349*	*182*	*161*

Table 6 Career path

"In the organisation that employs you, is there a clearly defined career path?"

	Total	*CRIs*	*Univ*	*Other*
		(% respondents)		
Working as a scientist in science	44	30	80	29
Number of Respondents	*544*	*279*	*158*	*167*
By moving into management and administration	55	58	59	47
Number of Respondents	*399*	*215*	*81*	*103*

Table 7 Professional development

"During the past two years, have you been funded for:"

(% respondents)	*Total*	*CRIs*	*Univ*	*Other*
Attendance at conferences in N Z	84	87	80	84
Attendance at conferences in Australia	34	33	37	34
Attendance at International conferences	39	31	52	40
Research time in other organisations	12	13	14	8
Attendance at formal courses	33	35	14	52
Sabbatical Leave	5	1	15	1
Retraining	3	3	1	6
Number of Respondents	*651*	*336*	*169*	*146*

Table 8 Reorganisation

"Which of the following types of reorganisation processes have occurred in your area of your employing organisation within the last five years?"

	Total		*CRIs*		*Univ*		*Other*	
	(% Yes) *(Number of Respondents)*							
Substantial funding level increases	24	*(571)*	23	*(193)*	17	*(94)*	32	*(84)*
Substantial funding level decreases	77	*(538)*	85	*(291)*	74	*(144)*	64	*(103)*
Restructuring	87	*(589)*	98	*(342)*	64	*(123)*	82	*(124)*
Relocation	45	*(386)*	57	*(218)*	19	*(90)*	40	*(78)*
Disestablishment	38	*(367)*	50	*(201)*	18	*(90)*	28	*(76)*

Table 9 Ratio of applied to basic research

"Do you think the ratio of applied to basic of your research is:"

	Total	*CRIs*	*Univ*	*Other*
		(% respondents)		
Too high	20	23	18	15
About right	70	68	72	72
Too low	11	10	10	13
Number of Respondents	*621*	*321*	*174*	*126*

Table 10 Effects of changes on the quality of science in New Zealand

"In your own field of science, do you feel that changes in the organisation of New Zealand science over the last five years have resulted in more or less (a) good (b) bad science in New Zealand?"

	Greatly Decreased			*Unchanged*		*Greatly Increased*		*Number of*
	-3	*-2*	*-1*	*0*	*+1*	*+2*	*+3*	*Respondents*
Total				*(% respondents)*				
(a) Good Science	7	23	28	19	17	6	1	*(581)*
(b) Bad Science	3	9	20	23	27	14	4	*(543)*
CRIs								
(a) Good Science	4	22	33	19	17	4	0	*(284)*
(b) Bad Science	4	9	21	21	28	15	3	*(268)*
Universities								
(a) Good Science	13	25	21	19	17	6	1	*(159)*
(b) Bad Science	1	7	13	26	29	17	8	*(151)*
Other								
(a) Good Science	6	22	26	18	18	9	2	*(143)*
(b) Bad Science	36	13	24	20	28	10	2	*(128)*

Table 11 Effects of changes on science and the provision of science

"How do you think your organisation has been affected by the restructuring of New Zealand science over the past five years in the following areas?"

	Greatly Decreased			*Unchanged*		*Greatly Increased*		*Number of*
	-3	*-2*	*-1*	*0*	*+1*	*+2*	*+3*	*Respondents*
Total				*(% respondents)*				
International regard	6	10	27	40	11	4	1	*(606)*
Ability to attract top-scientists	9	23	30	24	11	2	1	*(615)*
Ability to retain top-scientists	8	23	37	23	7	2	1	*(612)*
Access to International linkages	1	8	15	42	23	8	2	*(612)*
Access to facilities	3	11	22	40	18	5	0	*(618)*
Access to support staff	11	20	28	30	10	2	0	*(623)*
Salaries	8	20	32	33	5	1	0	*(617)*
Other work conditions	8	21	29	31	9	2	0	*(541)*
CRIs								
International regard	9	15	34	27	11	3	1	*(321)*
Ability to attract top-scientists	9	21	34	22	13	1	1	*(331)*
Ability to retain top-scientists	10	25	41	17	6	2	0	*(329)*
Access to International linkages	1	8	20	37	26	6	3	*(326)*
Access to facilities	3	10	22	38	23	4	0	*(333)*
Access to support staff	13	17	33	25	11	1	0	*(334)*
Salaries	9	23	37	28	3	0	0	*(334)*
Other work conditions	9	22	31	27	9	2	0	*(294)*
Universities								
International regard	2	5	26	56	8	3	1	*(158)*
Ability to attract top-scientists	11	30	29	22	6	3	0	*(158)*
Ability to retain top-scientists	6	21	44	22	6	1	0	*(156)*
Access to International linkages	0	8	12	50	20	10	0	*(157)*
Access to facilities	5	13	23	43	13	3	0	*(158)*
Access to support staff	7	25	26	35	5	1	0	*(156)*
Salaries	10	20	29	37	3	1	0	*(153)*
Other work conditions	10	19	31	32	6	2	0	*(127)*
Other								
International regard	2	7	15	49	16	7	2	*(127)*
Ability to attract top-scientists	6	20	20	35	16	2	0	*(126)*
Ability to retain top-scientists	4	22	21	37	10	3	1	*(127)*
Access to International linkages	3	6	6	47	21	12	2	*(129)*
Access to facilities	2	11	21	41	12	8	1	*(127)*
Access to support staff	8	24	15	35	12	5	0	*(133)*
Salaries	6	13	22	43	11	2	2	*(130)*
Other work conditions	4	17	24	39	10	3	1	*(120)*

Table 12 on Page 16

Table 13 Current management systems

"How would you rate the current management systems of your organisation?"

	Extremely bad				*Excellent*	*Number of*
	1	2	3	4	5	*Respondents*
			(% respondents)			
Total	9	36	34	19	2	*(642)*
CRIs	9	44	31	15	2	*(339)*
Universities	8	25	42	22	3	*(174)*
Other	6	34	31	27	2	*(127)*

Table 12 Experience and attitudes of policy makers

"Overall experience and attitudes of policy makers of your employing organisation, eg directors, board, CEO):"

	Nil/negative			*Extensive/positive*		*Number of*
	1	*2*	*3*	*4*	*5*	*Respondents*
Total			*(% respondents)*			
Background in research	10	29	27	22	12	*(626)*
Knowledge of research	8	30	27	24	10	*(627)*
Attitudes to research	6	18	24	33	20	*(626)*
CRIs						
Background in research	6	31	32	24	7	*(355)*
Knowledge of research	6	31	33	25	5	*(334)*
Attitudes to research	7	19	27	34	13	*(332)*
Universities						
Background in research	9	22	21	24	23	*(168)*
Knowledge of research	7	24	18	30	21	*(169)*
Attitudes to research	5	12	17	35	32	*(170)*
Other						
Background in research	26	32	19	13	7	*(103)*
Knowledge of research	14	37	23	15	8	*(124)*
Attitudes to research	6	21	25	25	21	*(124)*

Table 14 on page 17

Table 15 Discrimination

"At your current place of work, have you noticed any significant incidents of discrimination because of:"

	[Female]	Total	CRIs	Universities	Other
			(% Yes) *(# Respondents)*		
Age	[28]	24 *(558)*	25 *(304)*	25 *(145)*	17 *(109)*
Ethnicity	[17]	11 *(540)*	10 *(294)*	11 *(141)*	11 *(105)*
Gender	[49]	23 *(553)*	18 *(294)*	27 *(145)*	25 *(114)*
Political Affiliation	[0]	3 *(527)*	2 *(286)*	1 *(132)*	5 *(109)*
Religious Affiliation	[4]	2 *(523)*	1 *(283)*	2 *(134)*	4 *(106)*
Sexual orientation	[8]	4 *(522)*	*4 (283)*	4 *(133)*	4 *(106)*
Union Affiliation	[14]	10 *(538)*	9 *(290)*	8 *(134)*	14 *(114)*

Table 16 Public Policy issues

"If a public policy issue arose on which you had particular expertise, would your organisation allow you to speak out:"

	Not at all			*Freely*		*Number of*
	1	*2*	*3*	*4*	*5*	*Respondents*
			(% respondents)			
Total	9	20	21	26	24	*(665)*
CRIs	14	31	29	23	3	*(323)*
Universities	2	3	8	32	55	*(178)*
Other	10	15	21	25	30	*(164)*

Table 14 Style of management

"How would you describe the overall style of management in your organisation?"

		1	*2*	*3*	*4*	*5*	
Total				*(% respondents)*			
(626)	Consultative	5	17	24	38	17	Hierarchical
(627)	Team-focussed	6	27	33	24	10	Individual-focussed
(626)	Facilitative	3	22	34	29	12	Authoritarian
(635)	Flexible	4	23	37	29	7	Inflexible
(638)	Progressive	7	26	33	24	10	Conservative
(635)	Long-term focus	6	23	27	27	17	Short-term focus
(637)	Open	4	19	29	32	16	Secretive
(627)	Solicits criticism	3	15	42	24	16	Suppresses criticism
CRIs							
(337)	Consultative	2	13	26	40	19	Hierarchical
(333)	Team-focussed	5	33	32	21	8	Individual-focussed
(329)	Facilitative	1	19	35	32	13	Authoritarian
(332)	Flexible	2	18	40	32	9	Inflexible
(336)	Progressive	4	26	36	24	9	Conservative
(332)	Long-term focus	4	22	24	30	21	Short-term focus
(333)	Open	1	13	29	36	21	Secretive
(330)	Solicits criticism	1	10	42	25	23	Suppresses criticism
Universities							
(170)	Consultative	7	17	22	38	17	Hierarchical
(166)	Team-focussed	2	16	32	36	14	Individual-focussed
(167)	Facilitative	7	22	34	26	12	Authoritarian
(170)	Flexible	7	25	35	27	5	Inflexible
(169)	Progressive	8	23	34	21	14	Conservative
(169)	Long-term focus	5	22	37	23	14	Short-term focus
(171)	Open	6	30	27	25	11	Secretive
(165)	Solicits criticism	4	19	45	23	9	Suppresses criticism
Other							
(119)	Consultative	8	27	22	30	13	Hierarchical
(128)	Team-focussed	16	30	30	19	5	Individual-focussed
(130)	Facilitative	4	29	34	25	8	Authoritarian
(133)	Flexible	8	34	31	22	4	Inflexible
(133)	Progressive	12	33	23	27	5	Conservative
(134)	Long-term focus	12	30	23	23	12	Short-term focus
(133)	Open	11	24	30	28	8	Secretive
(126)	Solicits criticism	8	23	40	24	6	Suppresses criticism

Table 17 Freedom to publish

"Can you submit your research results for publication:"

	Total	*CRIs*	*Universities*	*Other*
		(% respondents)		
Freely	48	35	81	36
Subject to slight restrictions	32	57	15	42
Subject to severe restrictions	5	5	3	8
Not at all, because of commercial secrecy	2	1	0	7
Not at all for other reasons	0	0	0	1
Not Applicable	3	3	1	6
Number of Respondents	*699*	*351*	*183*	*168*

Table 18 Freedom to share ideas about science

"When you talk to people other than your immediate colleagues about your science or about work issues, are you able to share your ideas:"

	Total	*CRIs*	*Universities*	*Other*
		(% respondents)		
Freely	45	35	77	45
Discreetly	31	41	16	28
You have to be guarded	18	23	6	23
You have to be secretive	1	1	1	3
No such discussion is allowed	1	1	1	1
Number of Respondents	*702*	*351*	*184*	*170*

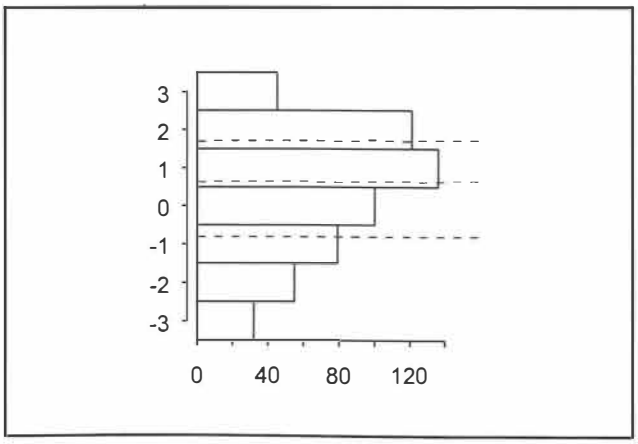
Table 19 Changes in freedom to collaborate within and between institutions

"Has your ability to collaborate with other scientists changed in the last five years?"

	Greatly Decreased			*Unchanged*		*Greatly Increased*		*Number of*
	-3	*-2*	*-1*	*0*	*+1*	*+2*	*+3*	*Respondents*
Total				*(% respondents)*				
Within your institution	3	7	12	43	18	12	2	*(673)*
Outside your institution	11	19	16	24	14	10	3	*(676)*
CRIs								
Within your institution	4	10	17	36	18	11	1	*(341)*
Outside your institution	11	22	20	21	14	7	2	*(339)*
Universities								
Within your institution	2	3	7	53	20	9	3	*(183)*
Outside your institution	9	17	10	29	17	11	5	*(177)*
Other								
Within your institution	5	3	9	45	17	11	3	*(152)*
Outside your institution	13	14	14	23	11	16	3	*(178)*

Appendix: Modified Box Plots

Standard box plots, showing the medians and quartiles, are unsatisfactory when the observations are on a five or seven-point integer scale as in this survey. Medians and quartiles will almost always fall on integer values so differences between groups will not usually show up on the box plots unless these differences are very large. The approach adopted here is best illustrated by means of an example. The figure, opposite, shows a histogram of the responses to the *Applied research output* question for *all scientists*. The length of each bar shows the number of responses falling into each category. The histogram has been divided into four equal areas as shown by the dotted lines. These lines determine the locations of the edges of the boxes and the central bar in the box plots.



The *whiskers* of the box plot show the extreme points.

One way of interpreting our box plot is as follows. Suppose that the respondents would really liked to have given a response on a continuous scale but we have rounded the results to integer values. In doing the analysis, we have tried to present the traditional box plot that would have resulted if we had used non-integer responses, assuming they were uniformly distributed around the integer values.

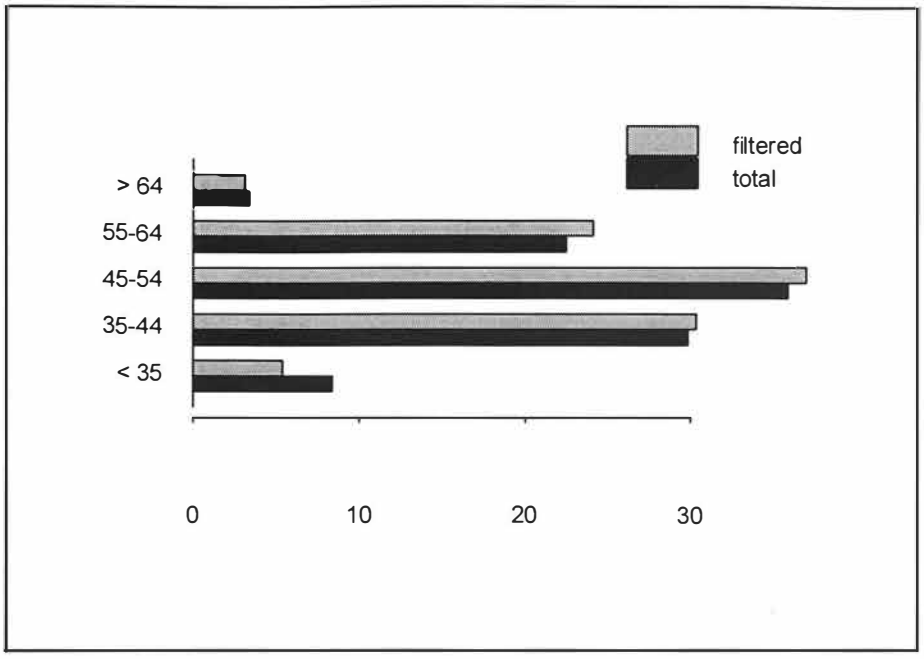


Figure 1 Age distribution of 'Total' respondents and respondents 'filtered' for those employed in scientific research and in other science.

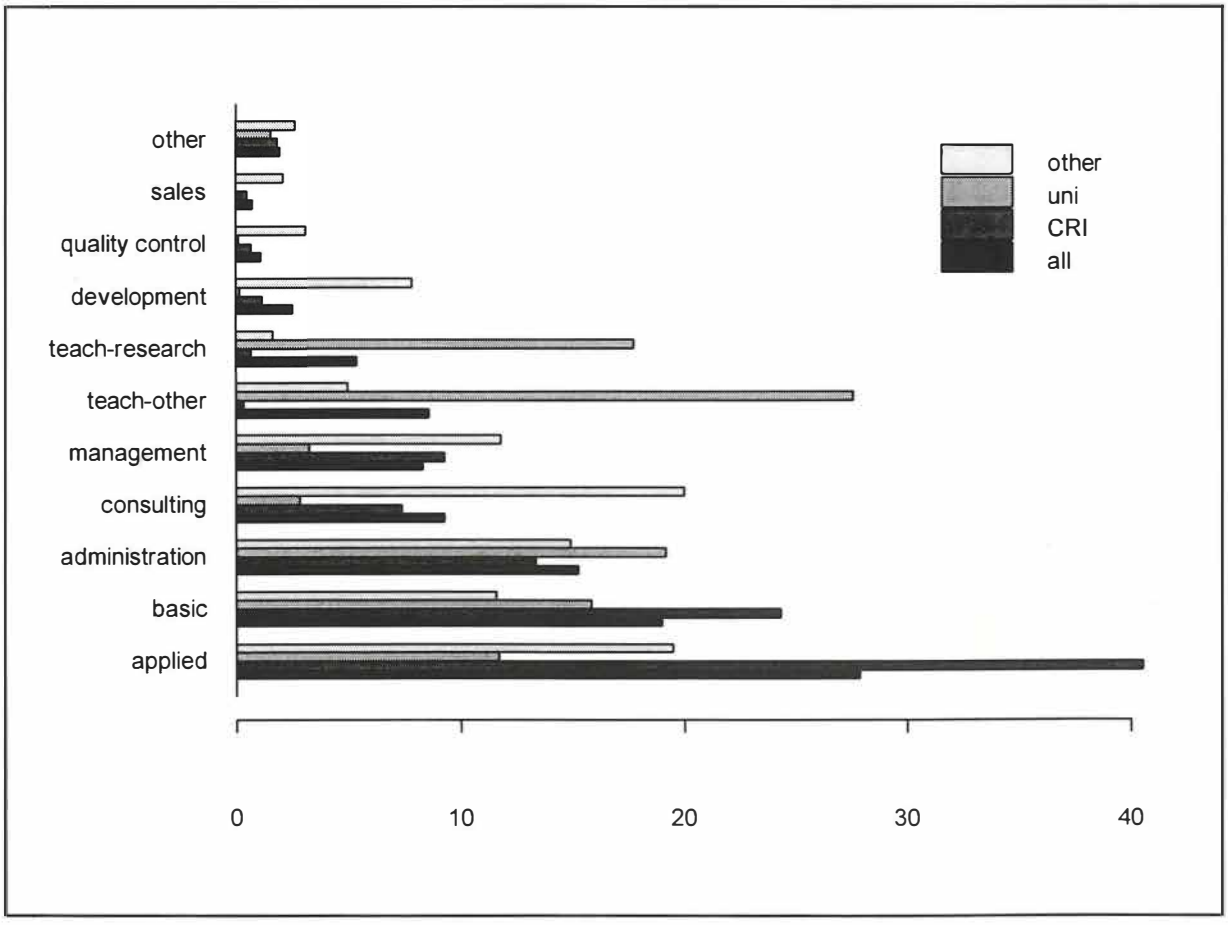


Figure 2 Work content of scientists. A: Bar graph and B: Box plot of work content of scientists in the 'Total' group, in CRIs, in universities and in the 'Other' group. In the figures, app(lied) = applied research; bas(ic) = basic research; adm = administration; con = consulting, advising; mng = management; t/o= teaching-other; t/r = teaching-research; dev = product development; q/c = quality assessment.

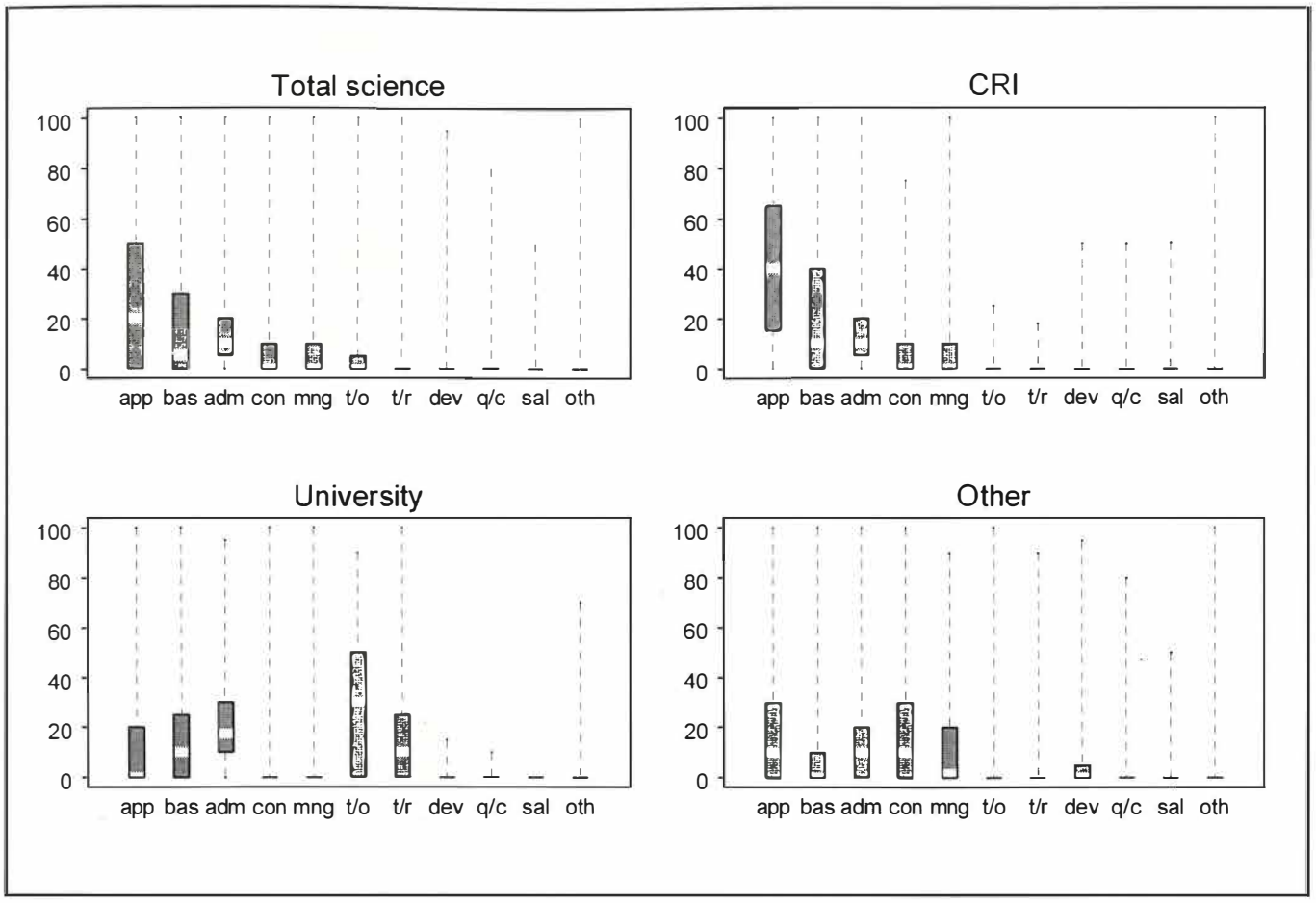


Figure 2B. See legend to Figure 2A on Page 19.

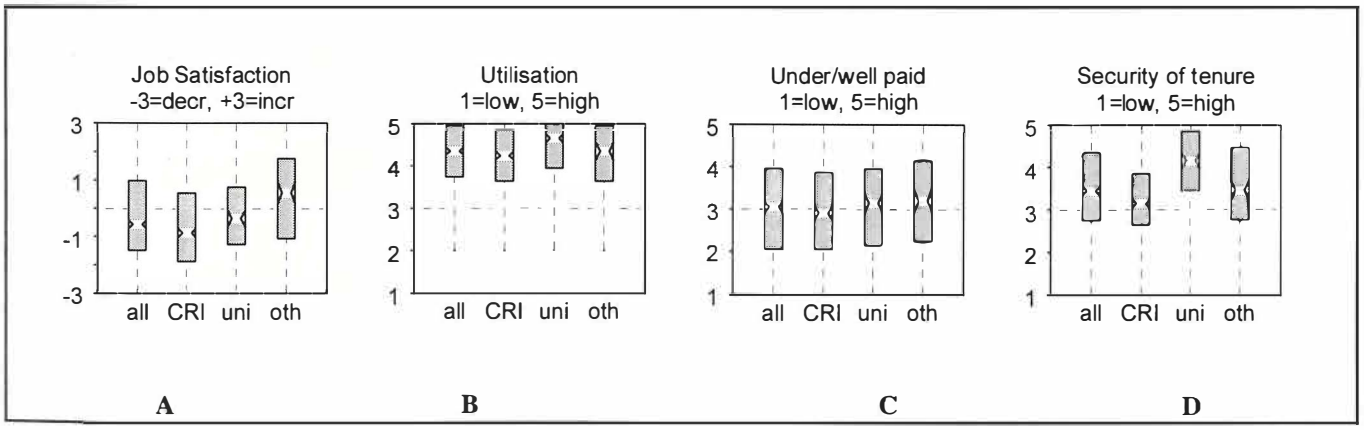


Figure 3A Job satisfaction. Changes in job satisfaction were scored on a 7 point scale from greatly decreased (-3) to greatly increased (+3).

Figure 3B Skill utilisation. The extent to which current work utilises qualifications and experience was scored on a 5 point scale from not at all (1) to full (5).

Figure 3C Pay. Respondents were asked to consider their qualifications, experience and the work they were doing in relation to pay on a 5 point scale from underpaid (1) to well paid (5).

Figure 3D Job security. Security of tenure over the next 5 years was scored on a 5 point scale from certain to disappear (1) to very secure (5).

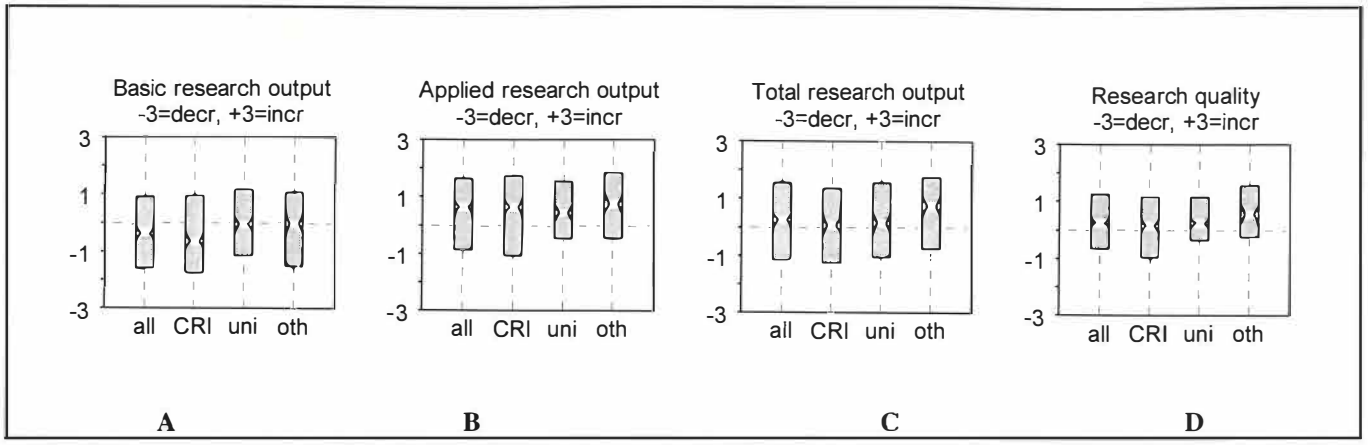


Figure 4 Personal research output and quality. Changes in basic (A), applied (B) and total (C) research output and quality (D) were scored on a 7 point scale from greatly decreased (-3) to greatly increased (+3).

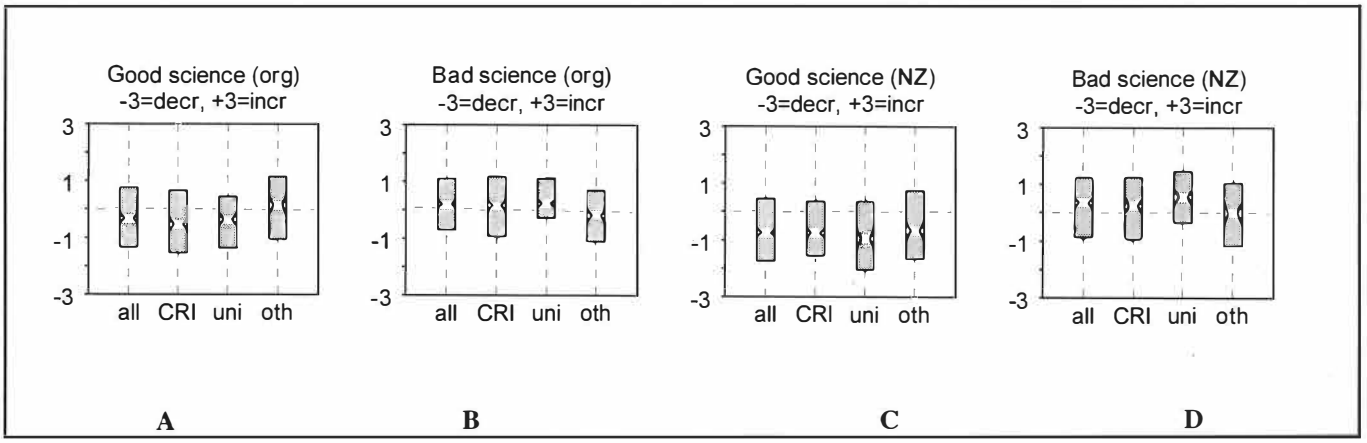


Figure 5 Effects of changes on the quality of science within institutions and in New Zealand. The effects of changes in the organisation of science in New Zealand over the last five years within an individual; organisation (A,B) and in New Zealand overall (C,D) were scored on a 7 point scale from greatly decreased (-3) to greatly increased (+3) 'good' science (A,C) and 'bad' science (B,D).

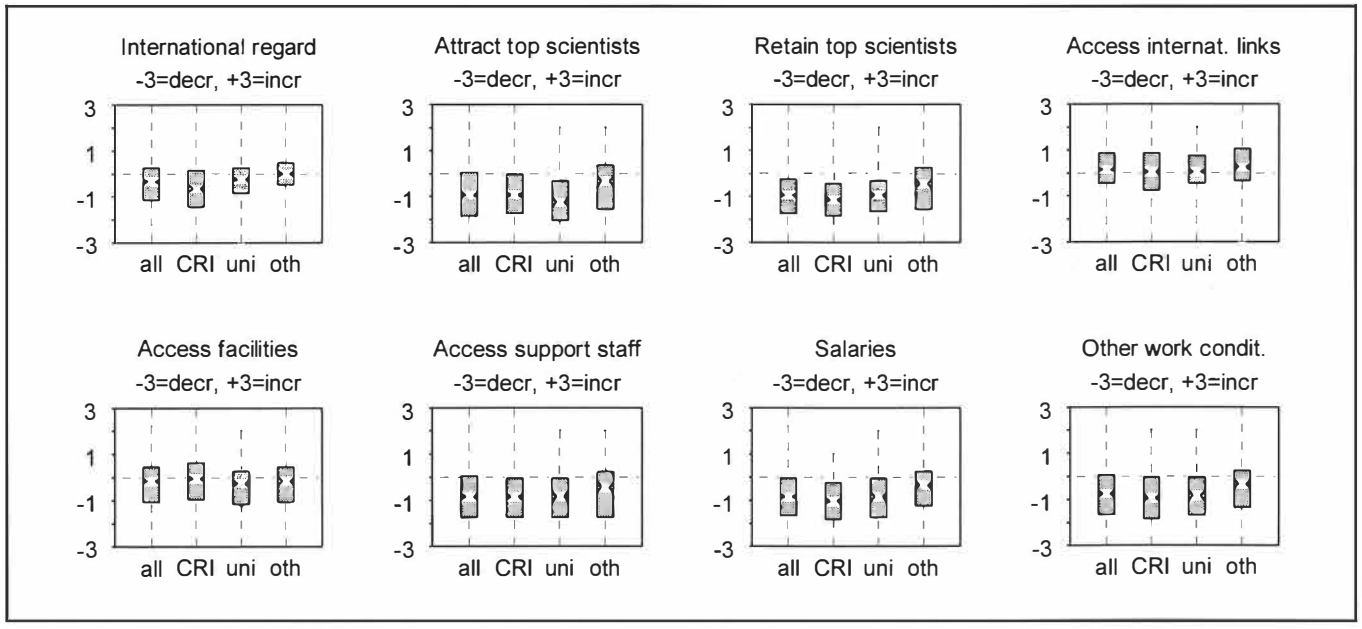


Figure 6 Effects of restructuring on science and the provision of science. The effects of the restructuring of New Zealand science over the last five years on various aspects of science and its provision were scored on a 7 point scale from greatly decreased (-3) to greatly increased (+3).

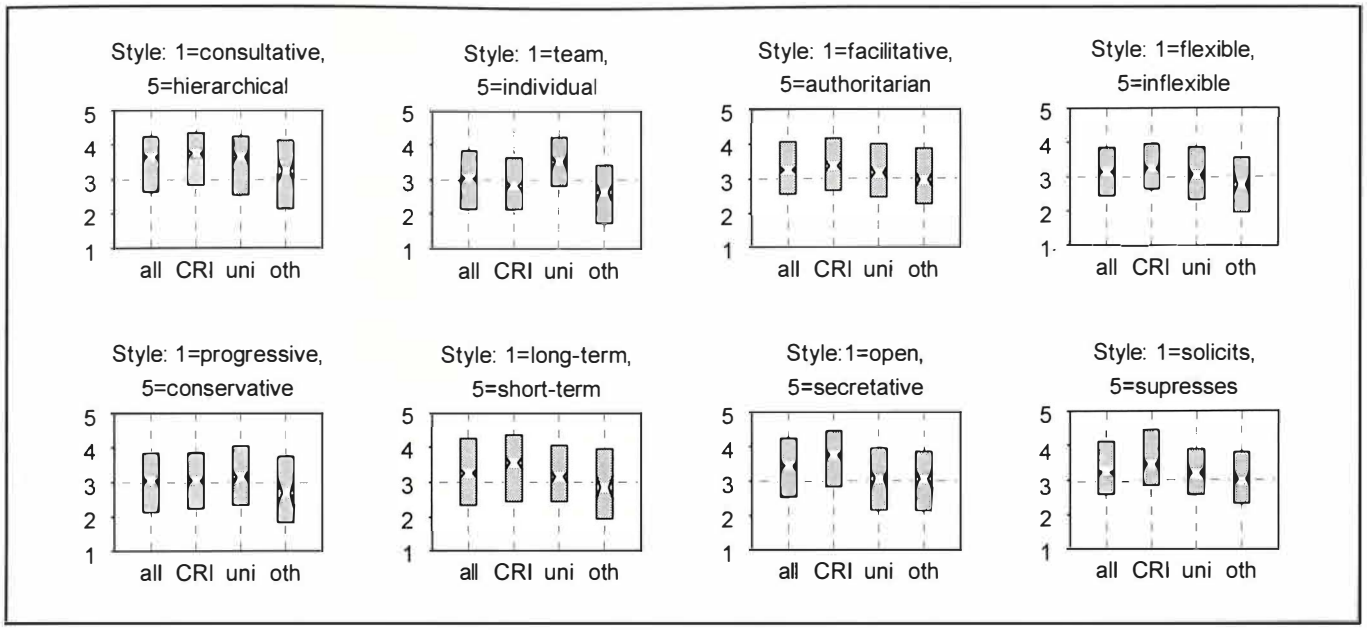


Figure 7 Management style within an organisation. Management styles were scored on a 5 point scale representing the extremes of each style (see Table 14 for exact descriptors).

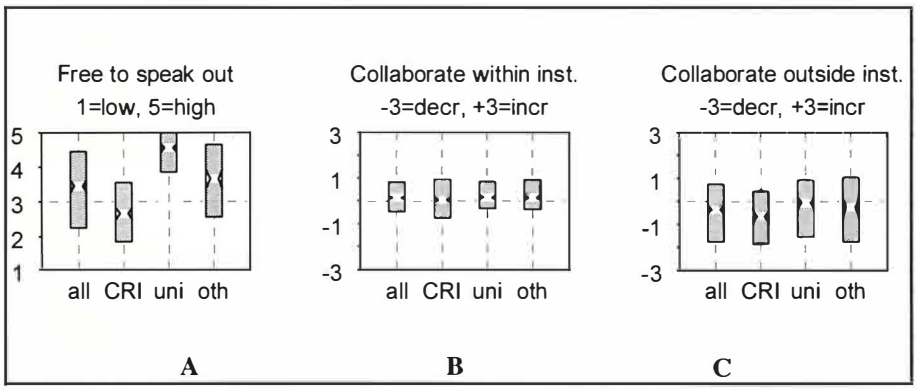


Figure 8 A. Freedom of expression. Freedom of scientists within the context of their organisation to speak out on a public policy issue on which they had particular expertise was scored on a 5 point scale from not at all (1) to freely (5).

Figure 8 B, C. Freedom to collaborate. Changes in the ability of scientists to collaborate with other scientists within their institution (B) and outside their institution (C) were scored on a 7 point scale from greatly decreased (-3) to greatly increased (+3).