CHAPTER 4:
SIZE AND NATURE OF THE HIGHER EDUCATION SUPPLY TO THE BIODIVERSITY SECTOR

INTRODUCTION

In his inaugural budget speech, the newly appointed Minister of Higher Education and Training, Dr Blade Nzimande, placed particular emphasis on the importance of moving from increased access of black students to higher education towards the improvement of "… throughput rates and the quality of higher education experiences" (DoHET, 2009). A related objective included improving the low rate of participation and success of black students in scarce fields, including accounting, natural sciences, engineering, research and postgraduate studies (DoHET, 2009). Specific reference was also made to increasing the system capacity of the HEIs to produce plant and animal health specialists, among others. It is evident that there is an abundant awareness of the challenges facing the HE system, and the need to promote collaborative approaches to address these challenges. It is thus appropriate that a key focus of a future HCD strategy is to define the specific role of the biodiversity sector as an active partner in and contributor to the improvement of access, efficiency, quality and equity within the higher education system.

This chapter provides an analysis of the nature and size of supply of HE graduates and diplomates in study fields relevant to the development of biodiversity professionals and managers. This is followed by an overview of the nature and size of enrolment, graduation and throughput rates of qualifications in the HE sector. Where appropriate, reference is made to interrelationships with employment.

SCOPE, NATURE AND LIMITATIONS OF DATA

The Higher Education Management Information System (HEMIS) database was the key source for trends in data on formal tertiary qualifications offered by academic universities and universities of technology. It is the most comprehensive database of supply-side data in public higher education institutions. The HEMIS data is disaggregated, and analysis was conducted for 2000 to 2007.

The data is captured on an annual basis representing the total supply of graduates for that year. This does not mean that the total supply is currently available. Graduates may have left the country, may have pursued occupations outside their graduating fields of study, or may no longer be economically active. Further, the

analysis provided the average annual growth rate[1] of annual supply of qualifications. Finally, throughput rates were calculated for those qualifications with a clear time period, such as three-year undergraduate degrees. Throughput rates indicate the extent to which students complete their qualifications within the specified time period, and are indications of efficiency in the system and relative success rates among students. Owing to the undefined length of postgraduate degrees, throughput rates were not calculated.

Since the merger of the Higher Education Institution (HEIs), qualifications obtained at either universities of technology (formerly known as technikons) and academic universities were synergised. The key qualifications in this analysis were the following:

- Three-year NDipl (university of technology)
- Three-year undergraduate higher diploma/bachelors degree
- Professional undergraduate degree (four years or more) or BTech degree (4 years)
- Honours/masters degree
- Doctorate

Table 4.1 provides an overview of different fields of study in broad categories. The primary fields of study relate to the core professional occupations that are key to fulfilling the mandate of the biodiversity sector. Secondary fields are important, but supplementary, given new challenges in the field with regard to the direct and indirect effect of atmospheric changes; the chemical content in water; geological processes; anthropological findings; physics; earth and space science; human societies, economic activities and engineering planning on plant and animal life. Generic fields are ancillary and supportive to the efficient functioning of the sector, and demand may change in response to changing legislative and policy demands. For instance, the demand for computer scientists and other social sciences arose from capacity challenges in mapping spatial areas and determining the impact of communities on biodiversity losses and degradation.

Table 4.1: Fields of study in the biodiversity sector

FIELDS OF STUDY: UNIVERSITIES & UNIVERSITIES OF TECHNOLOGY

BIODIVERSITY RELATED FIELDS OF STUDY
0102, Agricultural Extension
0104, Animal Sciences / Zoology
0105, Horticulture
0106, Plant Science / Botany
0107, Soil Sciences
0108, Fisheries
0109, Forestry
0110, Outdoor Recreation
0111, Wildlife
0113, Renewable Natural Resources
0199, Other Ag and Renewable Resources
0908, Veterinary Health Sciences
1503, Biological Sciences
1506, Oceanology
1599, Other Life Sciences and Physical Sc
2203, Geography

SECONDARY FIELDS OF STUDY
1502, Atmospheric Sciences
1504, Chemistry
1505, Geology
1507, Physics
1508, General Earth Space Science
0812, Environmental Engineering and Tech
2201, Anthropology
2202, Economics
2206, Sociology

GENERIC FIELDS OF STUDY
0600, Computer Science and Data Processing
2101, Public Administration
2299, Other Social Sciences and Social Studies

FINDINGS

The Draft Framework for Identifying and Monitoring Scarce Skills (2006) identifies those occupations where there is a perceived or observed scarcity of qualified and experienced people – current and anticipated. Occupations in the SET fields are identified as having scarce skills shortages where employers find it difficult to fill these vacancies. These include engineering, business science, computer science and health science, among others. In line with national policy over the period under analysis, qualifications in business and sciences were also regarded as important for economic growth.

Thus, in order to facilitate increases in overall supply and attain a dramatic shift away from the Humanities, the National Plan for Higher Education (NPHE) (Ministry of Education, 2001) proposed a target ratio of 40:30:30 for enrolments in the Humanities & Social Sciences (HSS): Business Science, Commerce & Management (BCMS); Science, Engineering & Technology (SET). Over the period 1993 to 2006, the ratio of HSS:BCMS:SET changed from 57:24:19 to 42:29:29 (OECD, 2008). Thus, it took 13 years for SET enrolments to increase to levels where the target is within sight. The OECD report (2008:345) argues that the relatively slow progress may be attributed to a range of well-known reasons, including declines in Grade 12 learners with university admission, poor HE retention rates as students drop out as a result of financial and/or academic exclusion, the cost of HE and shifts in the value of HE given the move towards business sciences and the decline of the humanities. Also, poor success rates in Mathematics and Science at Grade 12 are a barrier to entry and success in the SET fields of study.

The rest of the analysis focuses on the extent to which the biodiversity sector shared in the relative improvement in SET supply in terms of qualifications specific to the sector, enrolment, graduation and throughput rates, postgraduate supply and diversity for 2000–2007.

Graduation trends in biodiversity and related fields

Graduation in biodiversity-related fields (5.8% average annual growth) showed substantial growth over the period, especially when compared to considerably

smaller growth in secondary (Sec) fields and also a slightly smaller growth in computer science & data processing (CSDP) and stagnation in generic fields of study. This was clearly a result of the enrolment targets set to improve SET supply, although biodiversity-related field graduations are still slightly lower than those in secondary fields of study. However, even though biodiversity-related fields and CSDP are both in SET, absolute numbers indicate that growth in biodiversity widened the relative gap, especially in the post-2003 period with more focus on environmental and climate change issues. The decline in the CSDP field may be part of the reason for the difficulties in filling IT vacancies in the biodiversity sector. Also, the relatively small absolute number of graduates in the secondary fields implies that the biodiversity sector has to compete for a small pool of fairly specialised skills. The shift away from the humanities is clearly evident in the results, with negligible growth over the period. The nature of work in the biodiversity sector requires more people with a social science background in dealing with communities and social developmental issues. However, the sector may have difficulty in acquiring sufficient skills from the slow growing humanities supply to balance its science orientation.

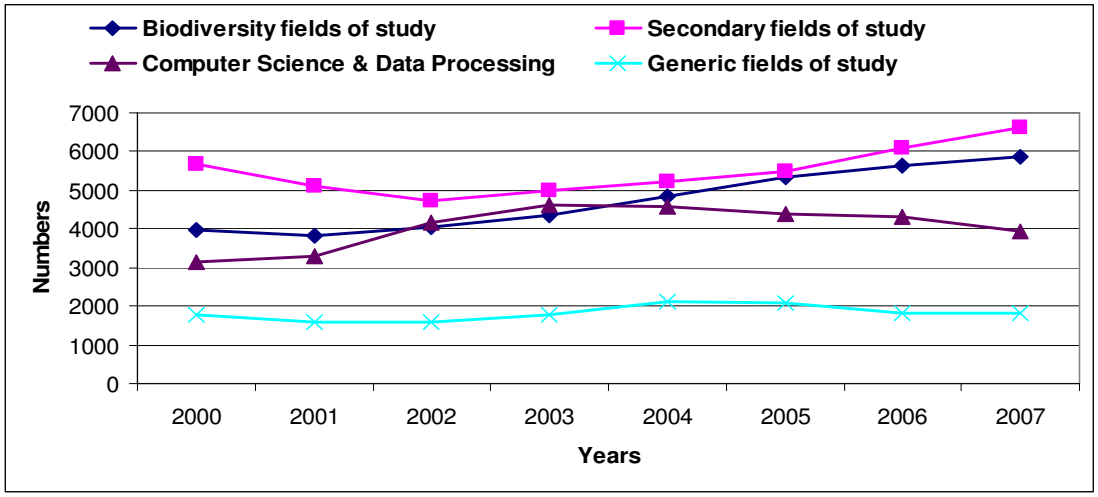


Figure 4.1: Graduation trends in biodiversity-related, secondary and other fields of study (2000–2007)

Source: HEMIS, 2000–2007; own calculations

Table 4.2: Average annual growth in graduations in biodiversity-related, secondary and other fields of study (2000–2007)

Fields of study	2000	2001	2002	2003	2004	2005	2006	2007	Average annual growth
Biodiversity fields of study	3971	3831	4064	4333	4845	5332	5644	5882	5.8
Secondary fields of study	5666	5089	4727	4985	5240	5478	6090	6621	2.3
Computer Science & Data Processing	3142	3280	4151	4626	4596	4379	4306	3941	3.3
Generic fields of study	1786	1579	1597	1790	2106	2093	1820	1833	0.4

Source: HEMIS, 2000 – 2007; own calculations

Also, in comparison to general higher education (2.3% average annual growth) and the broader SET field of study (5.6% average annual growth), biodiversity-related fields of study graduations overall had a higher average annual growth (5.8%) over the 2000 to 2007 period. The biodiversity-related field of study, like other fields of study, is dominated by entry-level undergraduate degrees and higher diplomas (Figure 4.2). One positive indicator is that the proportion of postgraduates (honours, master's and PhD graduations) in biodiversity-related fields of study was higher (28.7%) than the proportion of postgraduates either in SET (18%) or higher education in general (22.7%) in comparison to undergraduates. However, this advantage of postgraduate graduations to SET and higher education in general is changing, as the proportion of biodiversity-related fields of study postgraduates in

relation to undergraduates has been decreasing, while the proportion of postgraduates in SET and higher education in general has been increasing since 2000. This drop in postgraduate proportions in biodiversity-related fields of study was as a result of a decrease in the proportion of honours and master's degree graduations.

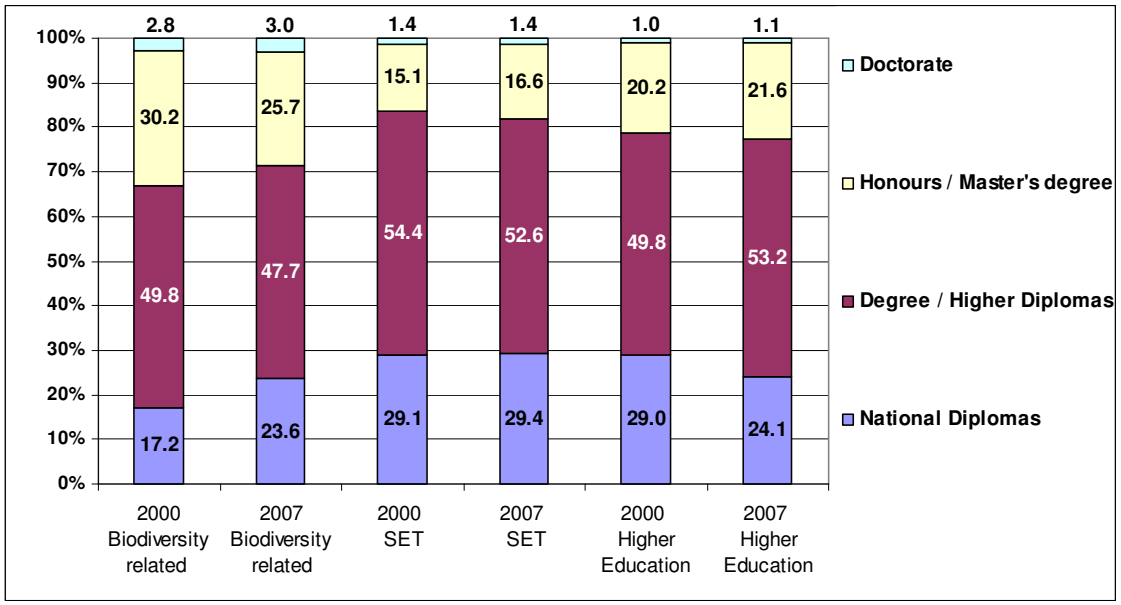
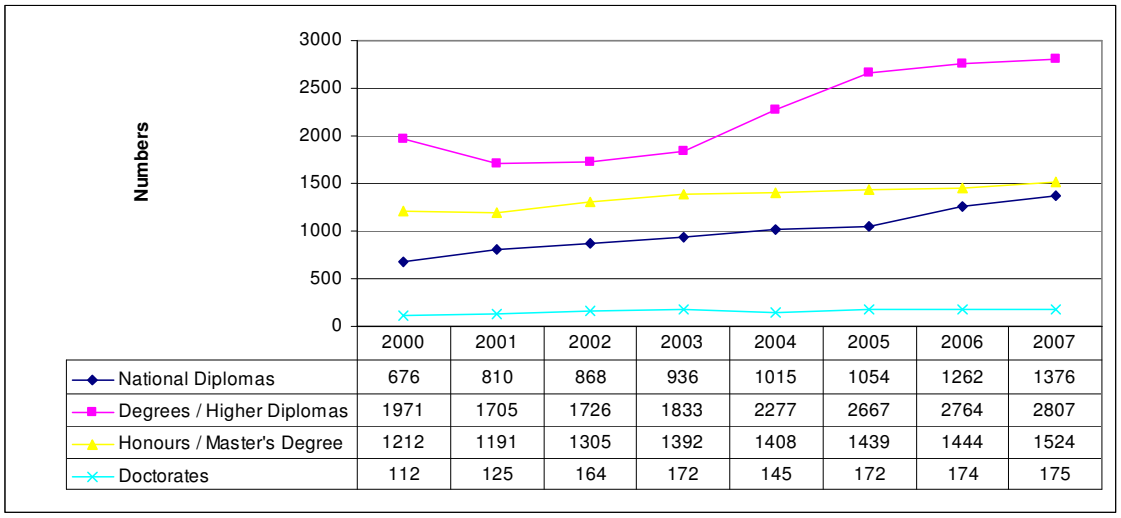


Figure 4.2: Comparison of the proportion of qualifications in biodiversity-related fields of study to SET and higher education (2000–2007)

Source: HEMIS, 2000 – 2007; own calculations

Undergraduate qualifications grew at an annual average rate of 5.2%, just below the field's overall rate of growth (see Figure 4.3). Thus, after a period of static growth, these qualifications recovered in the post-2003 period, levelling off over the last three years (2005–2007). The results suggest that the sector has access to a sizable number of entry-level graduates. Output of NDipl grew the fastest (10.7% p.a.), but from a very low base. The slowest growth was observed in honours/master's, increasing at a rate of 3.3% on average, considerably below the field at 5.8%. Thus, compared to earlier on in the period, fewer students were proceeding to honours/master's on completion of undergraduate degrees. This is further supported by the widening gap between the supply of degrees and honours/masters supply. This confirms concerns in the field that postgraduate supply at this level is in short

supply for the biodiversity sector, as well as constituting a national challenge. While the supply of doctorate qualifications increased by 6.5% on average over the period, the stagnation in the last three years is of concern. The levelling off in supply over the last three years indicates that the ratio between undergraduate degree, honours/master's and doctorate is not likely to change in the near future in the absence of interventions. This challenge has been acknowledged in the draft HRD strategy, which proposes improving the transition from undergraduate into honours and master's degrees (DoE, 2008). Later on in the chapter, we will examine a more disaggregated analysis factor in the role of population group and gender in this transition.



	2000	2001	2002	2003	2004	2005	2006	2007
National Diplomas	676	810	868	936	1015	1054	1262	1376
Degrees / Higher Diplomas	1971	1705	1726	1833	2277	2667	2764	2807
Honours / Master's Degree	1212	1191	1305	1392	1408	1439	1444	1524
Doctorates	112	125	164	172	145	172	174	175

Figure 4.3: Levels of qualifications in biodiversity fields of study (2000–2007)

Source: HEMIS, 2000–2007; own calculations

The next section analyses trends in the demographic profile of enrolments and graduations at all levels of qualification in biodiversity-related fields of study. Figure 4.4 shows that there are always more enrolments than graduations and that graduations have fluctuated less over the years than enrolments. Enrolments had an average annual growth rate of 6.7% over the 2000 to 2007 period, while graduations had a slightly lower growth rate of 5.8% over this period. Enrolments and graduations can, however, not be compared year by year; those who enrolled for NDipls graduate three years later; those who enrolled for undergraduate degrees graduate around three to four years later and the number of years of study for

postgraduates varies to a great extent. In order to compare enrolments and graduations, it is necessary to calculate the throughput rates by calculating only "first-time enrolments" (excluding those that are repeating) which is shown in Figures 4.14 to 4.19.

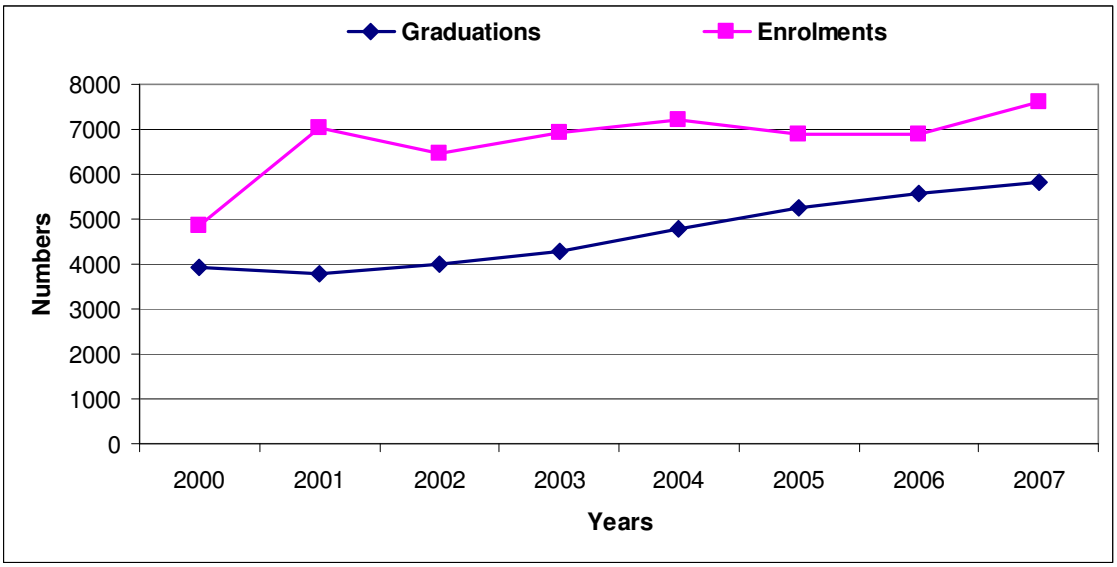


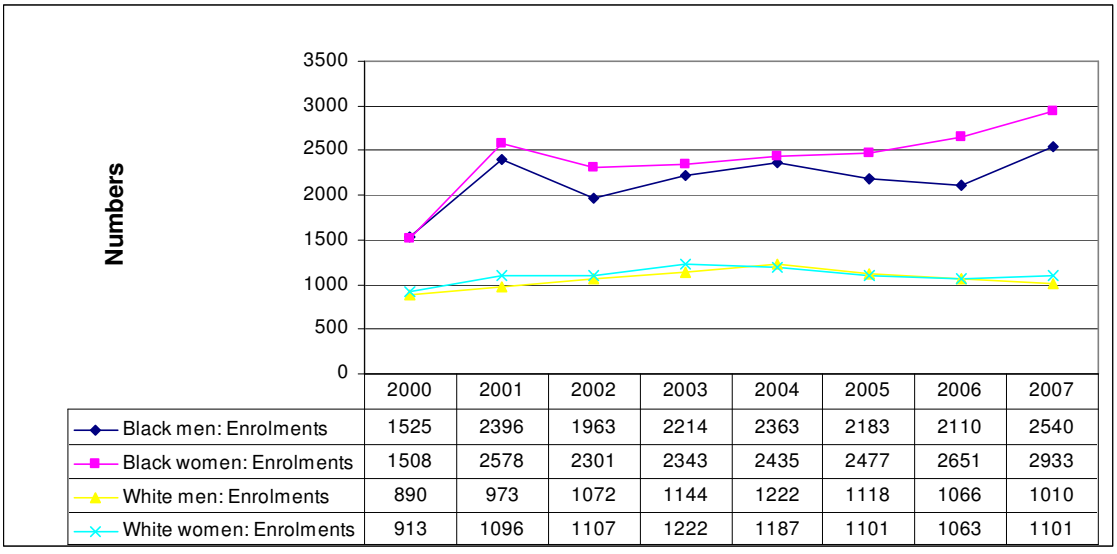
Figure 4.4: Trends in the number of enrolments and graduations across all qualifications in biodiversity fields of study (2000–2007)

Source: HEMIS, 2000–2007; own calculations

Figures 4.5 and 4.6 show that biodiversity-related qualifications were dominated by blacks in terms of enrolments and graduations throughout the period of analysis. Women dominated enrolments throughout the period, doubling in annual enrolment by 2007. This growth was largely due to increased enrolments among black women (10% p.a.), the single largest category. The enrolment rate of black men, the second largest category, increased by an average of 7.6% p.a. Enrolments of white men and women increased by between 1.8% and 2.7% p.a., respectively.

Black women also dominated the annual number of graduates, and their graduations grew the most at 8% on average. This was slightly below their enrolment rate, indicating a small dropout rate. Improvement in the number of black women graduates started in 2003 and the gap between their graduations and that of other

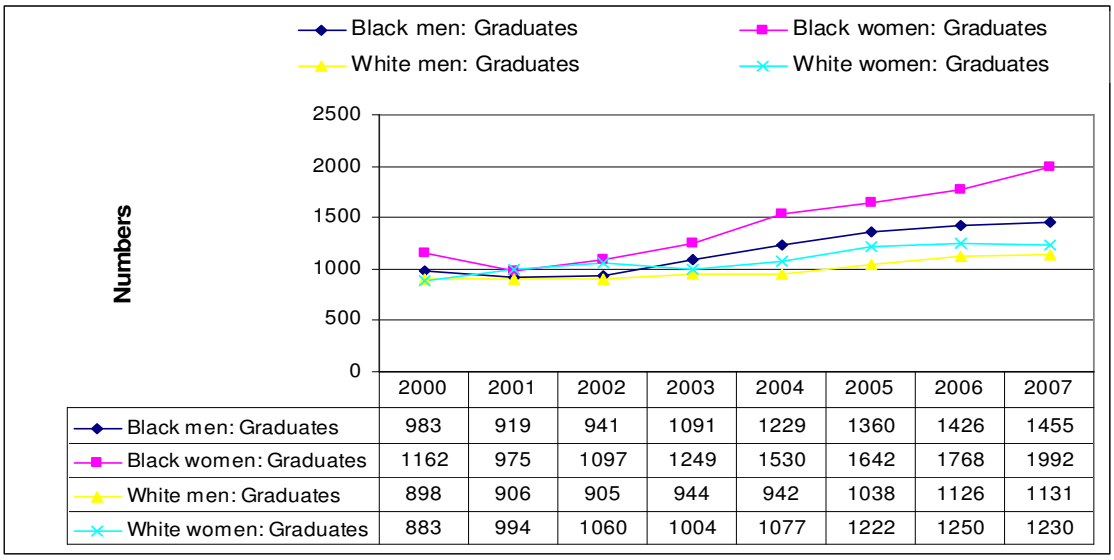
groups gradually widened over the subsequent years. Graduations among black men increased with a 5.8% average annual growth as opposed to only 3.4% among white men. White women graduations also had a slightly stronger growth rate (4.8% average annual growth) than that of white men. The pool of previous disadvantaged groups is thus increasing and bodes well for future transformation processes in the work environment. However, changes in graduation profiles are still predominantly at undergraduate level and to a lesser extent at postgraduate level as shown in Figure 4.8 and Figures 4.9 to 4.11. Concern was expressed in interviews about the generalist qualifications as opposed to specific, specialised qualifications of new graduates that are not applicable in the work environment. For some, specialised qualifications meant an honours or master's degree. Knowledge about "climate change and the real world" for instance is lacking and potential candidates need to go through additional training before they are productive in the working environment. These trends are thus suggesting an increase in enrolments and graduations across demographic profiles and gender.



	2000	2001	2002	2003	2004	2005	2006	2007
Black men: Enrolments	1525	2396	1963	2214	2363	2183	2110	2540
Black women: Enrolments	1508	2578	2301	2343	2435	2477	2651	2933
White men: Enrolments	890	973	1072	1144	1222	1118	1066	1010
White women: Enrolments	913	1096	1107	1222	1187	1101	1063	1101

Figure 4.5: Trends in the number of enrolments across all qualifications in the biodiversity fields of study by population group and gender (2000–2007)

Source: HEMIS, 2000 – 2007; own calculation



	2000	2001	2002	2003	2004	2005	2006	2007
Black men: Graduates	983	919	941	1091	1229	1360	1426	1455
Black women: Graduates	1162	975	1097	1249	1530	1642	1768	1992
White men: Graduates	898	906	905	944	942	1038	1126	1131
White women: Graduates	883	994	1060	1004	1077	1222	1250	1230

Figure 4.6: Trends in number of graduates across all qualifications in the biodiversity fields of study by population group and gender (2000–2007)

Source: HEMIS, 2000–2007; own calculations

Demographic trends within each level of qualification

This section provides a comparative analysis for 2000 and 2007 for qualification trends by population group and gender within each level of qualification. At one level, it assesses progress made in facilitating the entry of more blacks and women into higher level qualifications, and the overall diversity profile of biodiversity-related qualifications. Further, in order to assess the potential labour market value of these qualifications, the qualification criteria used by the South African Council for Natural Scientific Professions (SACNSP) for 2005[2] to register scientists were used as a proxy benchmark[3] in the absence of comprehensive salary data. The SACNSP is a professional council for the registration and accreditation of natural scientists in the country.[4] The council has been heavily criticised in Parliament for its declining membership, challenges of financial management and governance, and apparent lack of representation of black and women scientists (PMG, 2007). Currently there are more black and women graduates than previously and membership, especially among these graduates, needs to be encouraged to promote professionalism and stimulate engagement and growth in the sector. If registration with SACNSP becomes compulsory, more exact data on employment figures may be available to

do future planning. However, in the absence of other criteria, the entry-level qualifications and required vocational experience stipulated for the three categories of registered natural scientists were used as a benchmark. The three categories of natural scientists are professional natural scientists, candidate natural scientists and certificated natural scientists. If registration is encouraged, the three categories could become incentives for advancement and professionalism. Registration could potentially contribute to stimulating upward movement on the career ladder, especially if it is linked to continuous update of knowledge, be it advanced study, short courses, publications and/or conferences.

The NDipl is one of two entry-level qualifications (the other being the three-year bachelor degree), the third largest and the fastest growing in potential HE supply to biodiversity. Figure 4.7 illustrates a large increase in the share of blacks, and black women in particular, in NDipl qualifications. The eligibility criteria to be registered at the second lowest level as a Candidate Natural Scientist are the NDipl and at least one year of appropriate experience. The increased output of those with NDipls clearly contributed to the increasing employment of such staff. However, this is the lowest qualification applicable to those in associate professional jobs. However, Chapter 2 on employment showed that those with a NDipl tended to take on professional jobs instead of associate professional jobs in biodiversity. Thus, the employment of core professionals with a NDipl doubled from about 10 to 21%. Even more worrying was the fact that the percentage of professionals with an NQF 4 and less also increased from 9% to 13%. At the same time the proportion of professionals with a degree or a postgraduate degree declined. This implies that the sector was not able to attract the honours and master's graduates coming out of the system with biodiversity-related qualifications. The sector had to settle for less it appears. This implies that if, professional registration were mandatory, least 13% of the current professional workforce would not have been eligible for even the second lowest level as a candidate scientist on qualifications alone. Worryingly, one third of professionals (34%) in 2007 were taking on responsibilities that should ideally be done by someone with an honours degree or higher. This partly explains why respondents in the fieldwork, the DEAT ESSP research and others have raised question marks about, for instance, the competence of biodiversity conservation

officials at all government levels. The lack of enforcement capacity was often raised as a concern.

The sharp decline in the share of whites, especially white women at the NDipl level, may reflect declines in enrolments of whites at universities of technology, because whites may need higher level qualifications than blacks to get a foot in the labour market as a result of the demand for equity. These trends need to be monitored, lest a shortage of whites at this entry level creates future representative challenges.

Turning to the second entry-level qualification, the three-year bachelor degree (for certified natural scientists), it appears that the black–white share remained the same, and was dominated by black women. Graduations are mostly at the three-year bachelor degree level (refer to Figure 4.3) with an average annual growth rate of 5.2%, which is lower than the average annual growth rate (5.8%) for all level of qualifications combined. Chapter 2 on employment trends showed that the share of associate professionals and core professionals with degrees declined over the period. Thus, the proportion of associate professionals with an NQF 4 level more than doubled, from 11.4% to 26.2%. This confirms the point made earlier that, despite limited improvements in the supply system, especially with regard to blacks with first or postgraduate degrees, they were not going into biodiversity.

The four-year degree (BTech, BSc) graduations had the lowest average annual growth rate (1.6%) of all qualifications among all racial groups (see throughput trends in the next section). However, in terms of professional registration, this is the entry-level requirement for registration as a candidate natural scientist – the next highest level is to become a professional. Interestingly, the council recommends a mentorship programme (it is not a legal requirement for registration) to support those qualifying in this qualification. However, as is widely known in the sector and across the economy, mentorship programmes are often cited as an important professional development intervention, but rarely implemented. If mentoring of new graduates could be made one of the criteria that needs to be met in order to register at a certain level, this may improve active mentoring. In 2000 slightly more blacks (55.5%) than whites attained this qualification, conversely in 2007, 52.2% of the share went to whites.

According to the DEAT's Scarce Skills Audit (KNC & Associates 2006), conservation assessment is a data-driven process that requires specialist skills which include Geographical Information Systems (GIS) and IT skills. In 2007 only about 5% of graduates graduated with majors in both IT and Botany or IT and Geography or IT and Zoology, which is a big gap that needs to be addressed in South Africa (Table 4.3). What was promising, however, was that most of these graduates were black and black women (47.3%).

Table 4.3: Graduations (all levels) with majors in IT and Botany, IT and Zoology or IT and Geography (2007)

	Race and Gender							
	Black women	Black men	White women	White men	Total	Black	White	Total
N	53	35	7	17	112	88	24	112
%	47.3	31.3	6.3	15.2	100	78.6	21.4	100

Source: HEMIS (2007)

In conclusion, the results suggest that, at entry level, blacks and black women specifically dominated the supply of these science qualifications, levelling off at four-year degree level.

Figure 4.7: Trends in undergraduate qualifications in biodiversity by population group and gender (2000–2007)

Source: HEMIS, 2000–2007; own calculations

In the biodiversity sector, the absence of a master's degree is often cited as a barrier to entry or resulting in high vacancy rates, as suitable candidates cannot be found. The results suggest that indeed to require a master's degree at entry level may be unrealistic given that, as Figure 4.8 shows, the share of qualifications remained constant with low levels of growth with the exception of doctorates. The single largest qualification was at honours level, with a slight decline (from 57.2 to 57.1%) over the period. The share of master's qualifications also remained the same at one-third of all postgraduate qualifications. As noted earlier, there was more progress in increasing the number of PhDs. In 2005, Biodiversity-related PhDs constituted about 31% of all SET PhDs. DST (2007) projects a five-fold increase in SET PhDs (3000 p.a.) by 2018 in order to become globally competitive. Thus, it appears that while there was some progress in the number of doctorates, there appears to be an obstacle in the progression from honours into master's level courses. Incentivising higher levels of study is thus required with urgency. But the best target group for

such incentives may be among existing staff who would like to do a postgraduate degree.

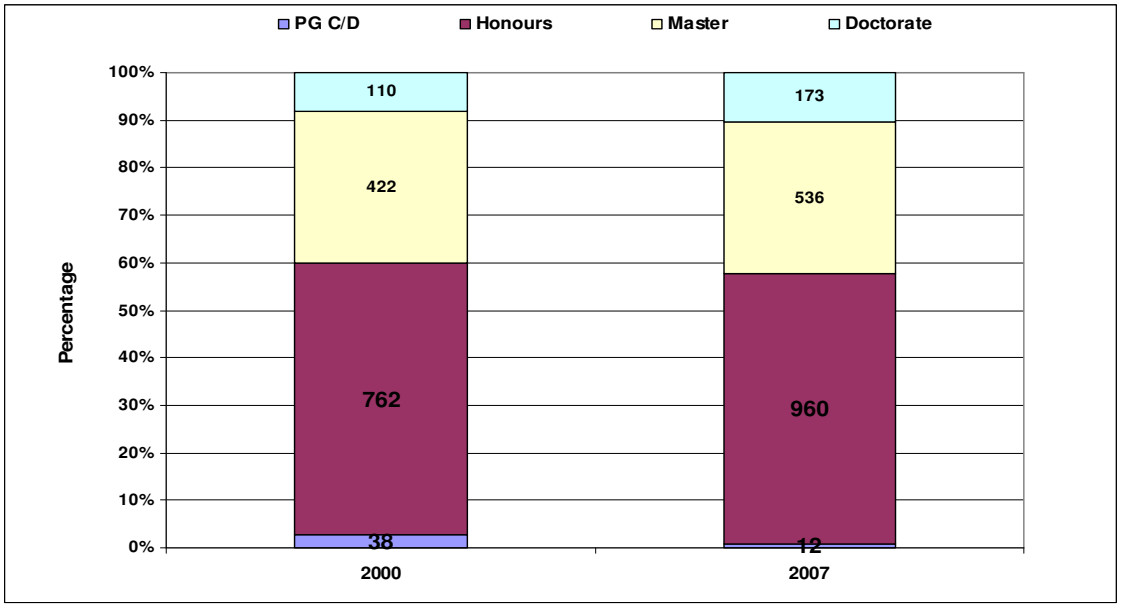


Figure 4.8: Trends in postgraduate qualifications in biodiversity (2000, 2007)

Source: HEMIS, 2000 – 2007; own calculations

A final comment with regard to candidate registration: qualifications (based on the scientist registration criteria) appear to be of less value in progressing from candidate natural scientist to professional natural scientist than the length of appropriate work experience. For instance, to move to the next level as a professional scientist, three years (with 4-year B degree, honours, B Tech), two years (with master's) and one year (with doctorate) work experience is required. Otherwise, these very same qualifications, but without appropriate work experience (and the non-compulsory mentor who may recommend eligibility for registration5), only allows one to become a candidate natural scientist. Thus, the real return on investment in postgraduate qualifications (based on registration) only increases with work experience deemed appropriate. In the absence of mentorships and work experience opportunities, and a small and overburdened professional workforce, the incentive to progress beyond honours appears to be limited. Workplace-based learning towards studentships and higher qualifications is thus crucial. JIPSA (2007) found that employers preferred lower skilled labour or the unemployed for work

experience initiatives, as they are cheaper and the unemployed are subsidised by a SETA grant. The failure of many universities of technology students to find experiential workplace placements often results in their failure to complete qualifications.

The focus should be more on attracting those entrants who have obtained their theoretical background by offering proper experiential workplace opportunities. There are some initiatives in place to provide an opportunity to gain appropriate work experience for graduates, including public sector internships; the DST internship; and the National Youth Service, among others (DoE, 2008) and then also the DEAT internships and university of technology programmes with national parks and nature reserves. These allow for both private and public sector organisations to combine forces (financial and human resources) to provide a development pathway to employment and learning.

Various funding opportunities are available that can be accessed by organisations to provide experiential training opportunities for candidates and absorb these new entrants into the biodiversity sector. Partnerships between government, organisations in the sector and training institutions need to be addressed.

Examples of existing funding opportunities include the Mitsubishi Corporation Fund for Europe and Africa (MCFEA), which supports two students each year from the Southern African Wildlife College, based in the Kruger National Park in South Africa, to participate on the Earthwatch Capacity Building Programme. The Capacity Building Programme offers practical experiential learning and conservation training to individuals across Africa, Asia and Eastern Europe (Mitsubishi Corporation 2009).

Another example is the financial support for work of the African Biodiversity Network (ABN) and many of its partner organisations, which has been secured from mainly European donors, such as, *inter alia*, The Dutch Biodiversity Fund and The European Commission (African Biodiversity Network 2008).

The African Women's Development Fund (AWDF) funds local, national, subregional and regional organisations in Africa working towards women's empowerment. The AWDF is an institutional capacity-building and programme development fund, which aims to help build a culture of learning and partnerships within the African women's

movement. In addition to awarding grants, the AWDF attempts to strengthen the organisational capacities of its grantees. Organisations can be local, national, subregional or regional African women's organisations from any part of Africa (African Women's Development Fund 2009).

Projects are also funded by The Green Trust, an associate trust of WWF-SA, with the aim to conserve South Africa's unique biodiversity (WWF-SA 2009). To receive funding from the Swiss–South African Co-operation Initiative (SSACI), a project must comprise a substantial technical or vocational training component and a post-training support programme aimed at assisting successful trainees either to find jobs or to create their own. Since SSACI seeks to get youths into sustainable long-term employment, it concentrates its projects within sectors of the economy that are growing, and are therefore likely to offer future opportunities for advancement and are creating job opportunities at entry level, but also offer good prospects for further on-the-job training and hence for career advancement (Swiss–South African Co-operation Initiative 2009). Furthermore, by retaining older and more experienced professionals to mentor young candidates, more entrants can be absorbed by the biodiversity labour market.

This argument is further explored in the next section which looks at progress made in the key demographic groups who attained postgraduate qualifications over this period.

The number of postgraduate certificates were very small and declining and only included for illustrative purposes (Figure 4.9). At honours level, the trend of a dominant and constant share of blacks and black women continued over the period. White women improved their share, second only to black women and higher than black men over this period. The general improvement in the share of women is in line with improved HE enrolment and graduation rates among women.

As argued earlier on, the transition to and completion of master's and doctorate-level qualifications are a challenge to the HE system as a whole, and for science-related qualifications especially. It is at this level that there is a decline in the upwards movement of blacks and black women on the HE qualification ladder described earlier on. At the start of the period, more than two-thirds of those with master's

degrees were white. White women were very well represented with at least one-third overall. By 2007, the share of blacks increased by about 11%, resulting in a relatively even alignment among the various groups. Thus, the results suggest that there has been some improvement in facilitating the transition from honours to masters. However, it appears that while there is growing diversity, it is of insufficient scale, and constituted the largest share of master's graduates by 2007.

How does transformation in graduations in biodiversity-related fields of study compare with higher education in general and with SET graduations? Growing racial diversity at honours, master's and doctorate level was slightly better in general higher education, less so in SET fields of study and least so in biodiversity-related fields of study. This confirms views expressed in the field work about the difficulties in the sector to find black candidates with higher level qualifications, especially master's degrees. Also with regard to gender diversity in graduations, the best progress was visible in general higher education, slightly less so in SET graduations and the least in biodiversity fields of study.

At the honours level, the proportion of general higher education graduations of blacks has improved by around 39.3%, SET graduation proportions of blacks by 5.3%, and the proportion of graduations in biodiversity-related fields of study stayed about the same between 2000 and 2007. The proportion of black women graduations improved by 5.7% in both general higher education and SET graduations but by only 2.3% in biodiversity-related fields of study over the 2000 to 2007 period.

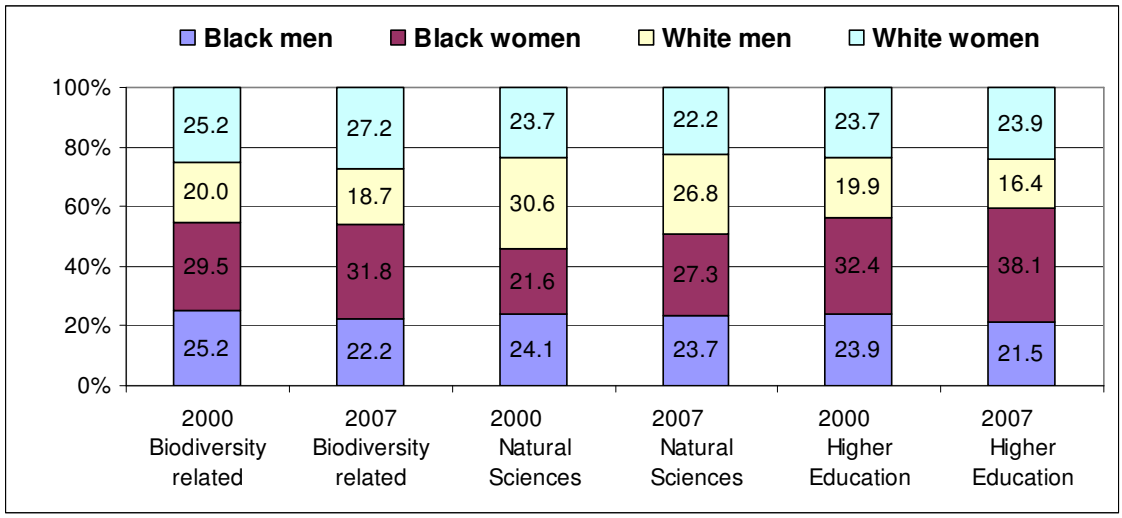


Figure 4.9: Trends in honours level qualifications in biodiversity-related fields of study, general higher education, and SET (2000, 2007)

Source: HEMIS, 2000–2007; own calculations

At master's level, the proportion of general higher education graduations of blacks has improved by about 11.9%, SET graduation proportion of blacks by 12.3%, and the proportion of graduations in biodiversity-related fields of study by 11.3% since 2000. The proportion of black women graduations improved by 6.6% in both general higher education and biodiversity-related fields of study, but by only 4.5% in SET fields of study over the 2000 to 2007 period.

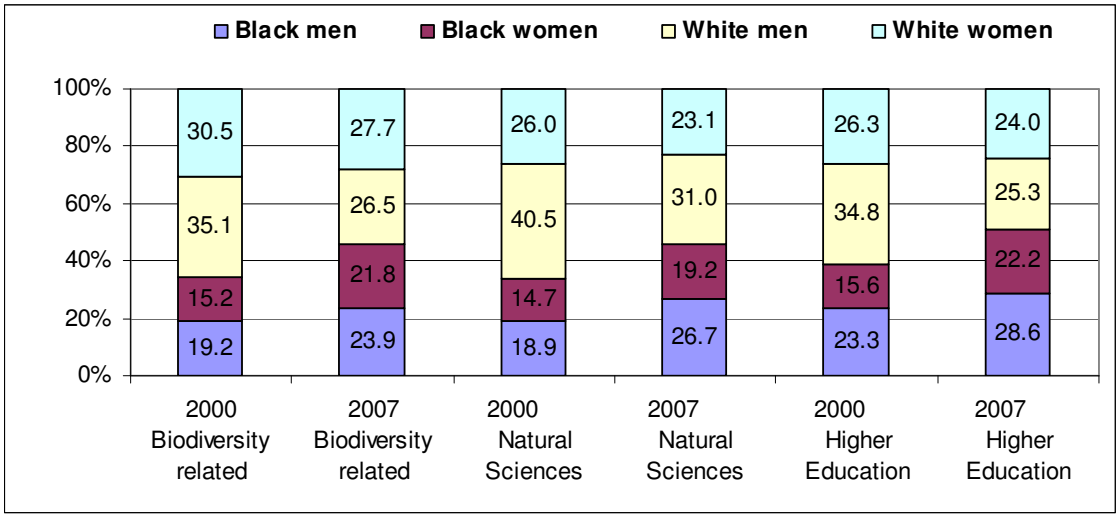


Figure 4.10: Comparison of trends in master's degrees in biodiversity-related fields, general HE and SET (2000, 2007)

Source: HEMIS, 2000–2007; own calculations

At the doctoral level, the proportion of general higher education graduations of blacks has improved by about 14.9%, SET graduation proportions of blacks by 14.1%, and black graduation proportions in biodiversity-related fields of study by 12.9% since 2000. The proportion of black women graduations improved by 6% in general higher education, by 1.5% in SET, and only by 0.4% in biodiversity-related fields of study.

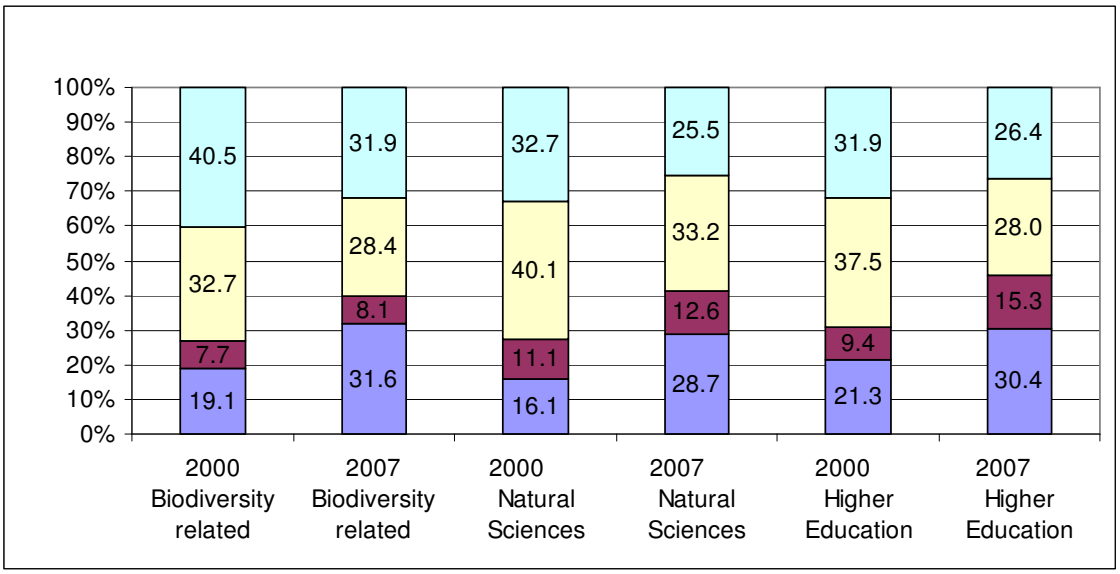


Figure 4.11: Comparison of trends in doctoral degrees in biodiversity-related fields, general HE and SET (2000, 2007)

Source: HEMIS, 2000–2007; own calculations

Whites, however, still obtained two-thirds of biodiversity-related doctoral degrees over the 2000 to 2007 period and blacks one-third, as shown in Figure 4.12. Most (19.2%) doctoral degrees were obtained at the University of Pretoria and about equal proportions (around 13%) at the University of KwaZulu-Natal, the University of the Free State, the University of Cape Town, and the University of Stellenbosch, with less than 10% at the rest of the other universities and universities of technology.

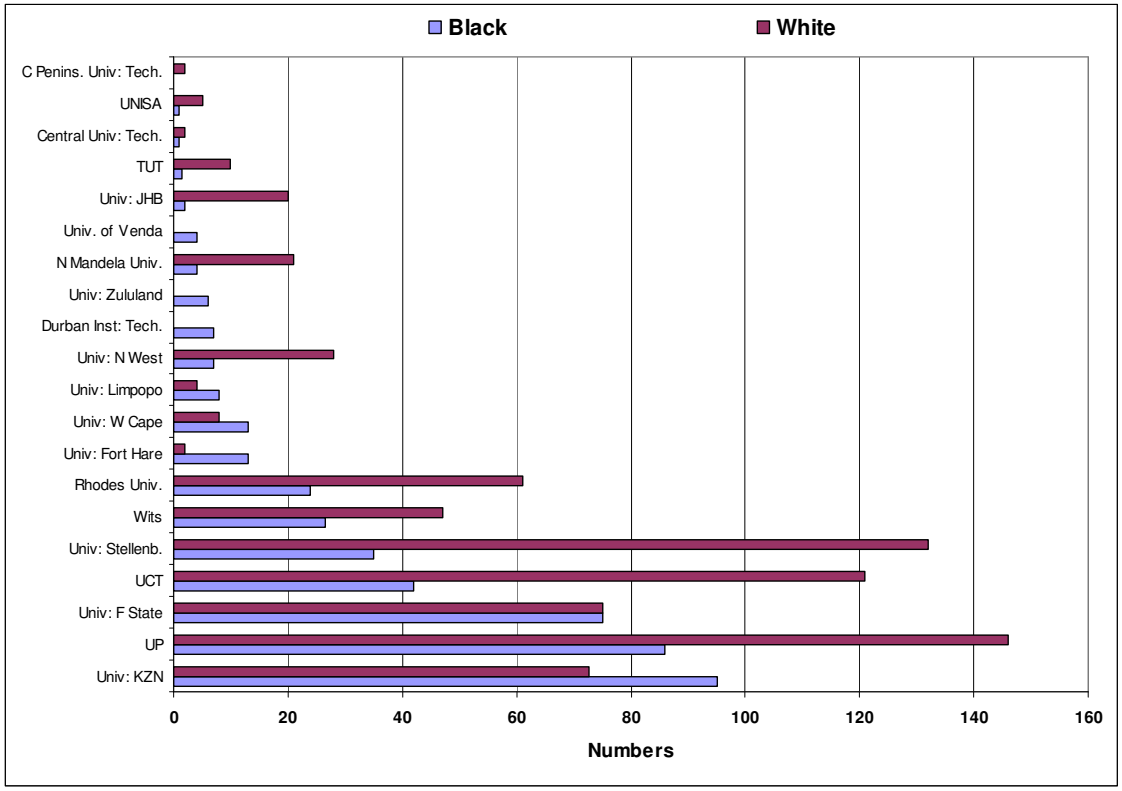


Figure 4.12: Average number of doctoral degrees in biodiversity-related fields of study by tertiary institution and race (2000, 2007)

Source: HEMIS, 2000–2007; own calculations

It is also of concern that, theoretically, the biodiversity sector may have access to these graduates, yet they may not be available. At the current supply rate of 500 master's graduates and under 1 000 honours graduates per annum by 2007, competition from other sectors will be fierce. At a doctoral level, white graduates constituted about two-thirds of supply and white women graduates almost a third in 2007. Over the 2000 to 2007 period, much of the improvement in the black share of doctoral graduates accrued to black men. It appears that the apparent upward trend of black women came to a virtual stop at this level. The differential in the progress of black men to black women from masters into doctoral studies is quite large and warrants further investigation. For instance, the extent to which access to mentoring by black men may be the differentiating factor could be important. Active mentoring may provide access to and support from a network of experienced and connected scientists, all important factors in starting and completing the arduous process of

acquiring a doctoral degree. The burden of family and household responsibilities, and the associated financial burden, may also provide more of a barrier to black women. Alternatively, with black women being sought after in the labour market to address employment equity requirements, they may find work opportunities quite soon and may not be motivated to further their studies. However, other studies suggest that there is a phenomenon called the “pipeline leakage” where women leave higher education for a range of reasons. Other evidence also suggests that while there have been improvements in the number of women achieving higher level degrees they “lag behind men” in doctoral degrees (Fox, 1998 cited in Boshoff, de Beer, Esau, Prozesky & Lorenzen, 2005:14). In South Africa this is partly ascribed to the fact that men still receive more research funding compared to women (Kahn, 2009). The DST runs a programme called SET 4women which is geared to the development of women graduates and investigates the dynamics of “pipeline leakage”.

This analysis confirms that women are well represented and a potential recruitment source at all levels except at doctoral level for black women. Intervention in honours–masters growth path appears to represent the biggest constraint to growth. This is echoed in a number of recommendations cutting across the HRD strategy and the National Innovation Plan for studentships, ranging from four-year graduate programmes to increase the numbers of master’s graduations; a government-funded four-year BSc honours programme; and a four-year government funded PhD programme.

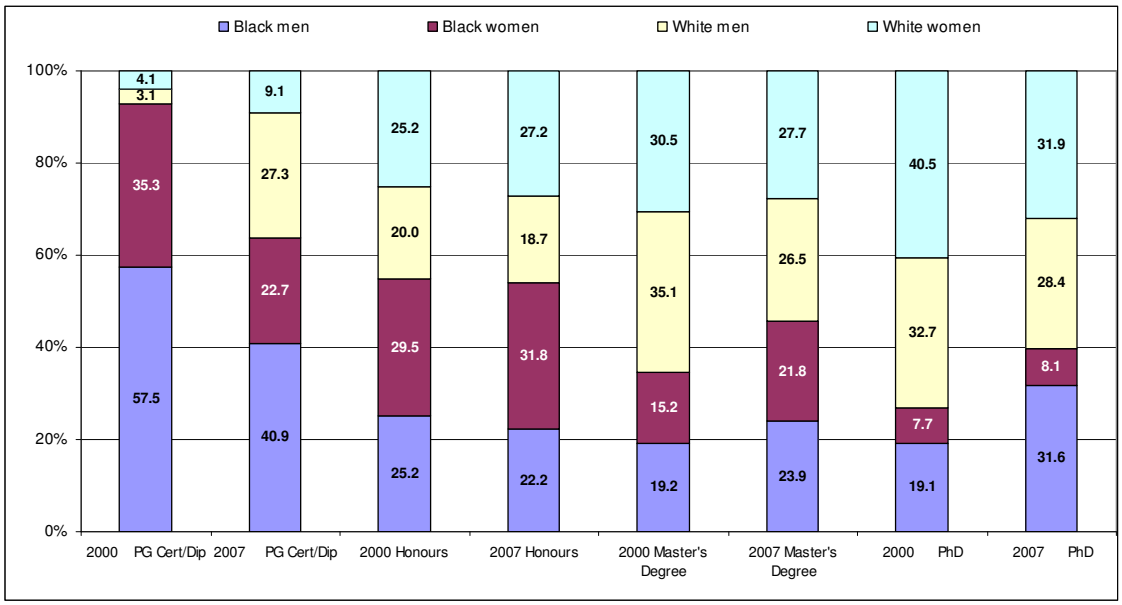


Figure 4.13: Trends in postgraduate qualifications in biodiversity by population group and gender (2000, 2007)

Source: HEMIS, 2000–2007; own calculations

A key national objective in the bid for greater economic growth and competitiveness (see the Human Resource Development Strategy, National Innovation Plan [NIP]) is to increase the aggregate number of scientists, as well as blacks and women enrolling and completing postgraduate SET degrees in the SET field. The NIP cites as a key obstacle the quantity and quality of the human capital "pipeline" from higher grade mathematics and science matriculants, to SET undergraduates, honours graduates, master's graduates and PhD graduates in the SET field (DST, 2007:27). Thus, ideally, efficiency in the system implies interdependent growth all along the pipeline. However, the existing ratios do not lend themselves to extensive growth at the upper end, as there is a gradual decline in the proportions of blacks and especially black women from undergraduate up to doctoral level qualifications. Each level of qualification is a stepping stone towards the next level and this is why any intervention to improve outputs will have to be coordinated at the lower, mid and upper levels. A further illustration of this imbalance may be sought from South Africa's performance on the Human Development Index (HDI) (1992–2005). Thus, in

comparison with the average for all other developing countries, South Africa performed better in terms of the GDP index. However, the Primary gross enrolment ratio and Tertiary gross enrolment ratio (GER) in 2005 were lower than all other developing countries (DoE, 2005:19). Thus, on average, South Africa may be wealthier than comparable countries, but it appears to fail in keeping its children at school or its students at university.

When one compares the potential share of biodiversity-related qualifications to the broader SET field, another imbalance becomes apparent. In 2005, the potential biodiversity share of 15 991 SET undergraduates was 23%; 26% of 3 200 SET honours graduates; 20% of 2 900 SET master's graduates; and 30.7% of 561 SET PhDs. It implies that the HE flow of biodiversity qualifications had no particular logic, with apparent success at the top end and at honours level, while performing poorly at the bottom and intermediate levels. Once again, this ratio confirms that the bottleneck is in moving from honours to master's level. The incentive structure for PhD production "PhD as the driver" (NRF) may have borne some fruit, but also the unintended consequence of de-emphasising other feeder qualifications further down the line. One of the key challenges in terms of HE supply in the HCD strategy is to deliberate on an appropriate target ratio for HE qualifications in this pipeline. Thus, the sector has to agree on what would be the most optimal profile in terms of the proportion of undergraduates, honours, master's and doctoral employees. This may differ from organisation to organisation or even from one division to another. However, a proportional distribution that allows for mentorship will be more optimal compared to one that does not.

Therefore, if biodiversity conservation wishes to employ more master's level graduates, given the complex demands flowing from its mandate, it will have to grow them itself. This is underpinned by the finding in the employment chapter that in fact the qualifications profile in the sector has been dropping over the period. This suggests that there is a systemic problem in getting postgraduates into biodiversity employment, partly because the numbers are insufficient, but also because the sector is clearly not attractive to them. However, there is a pool of employed professionals who have degrees or a postgraduate degree. Although the LFS does not disaggregate postgraduate qualifications, it may be assumed that at least 60%

(of the postgraduates) had an honours, based on the supply-side figures (see Figure 4.6 in this chapter). Therefore, an internal master's development programme may capitalise on existing potential. This programme may be coupled with a programme to develop those with an NDipl (see next section).

Throughput trends in undergraduate degrees

This section analyses enrolment, graduation and throughput rates within each type of undergraduate qualification across the biodiversity study fields by population group and gender. It is an indicator of the extent to which students are successfully completing their undergraduate degrees. In light of the obstacles often faced by black students (given poor schooling in mathematics and science and other barriers to completion), throughput rates provide some insight into specific areas where interventions may be required.

The results show that among blacks with three-year degrees, women were more successful in completing their degrees. Thus, over the period, the gap in the throughput rate more than doubled for women when compared to men. This is despite both groups coming from a similar background with similar constraints.

With regard to whites, both men and women had very high throughput rates. However, despite lower enrolment rates, men had a 100% throughput rate, while women were completing at a declining rate since 2003.

The results suggest that there have been major improvements in the conditions (for completion) of blacks who are graduates in biodiversity-related degrees. Thus, their throughput rates are just slightly below those of whites, and at very high levels.

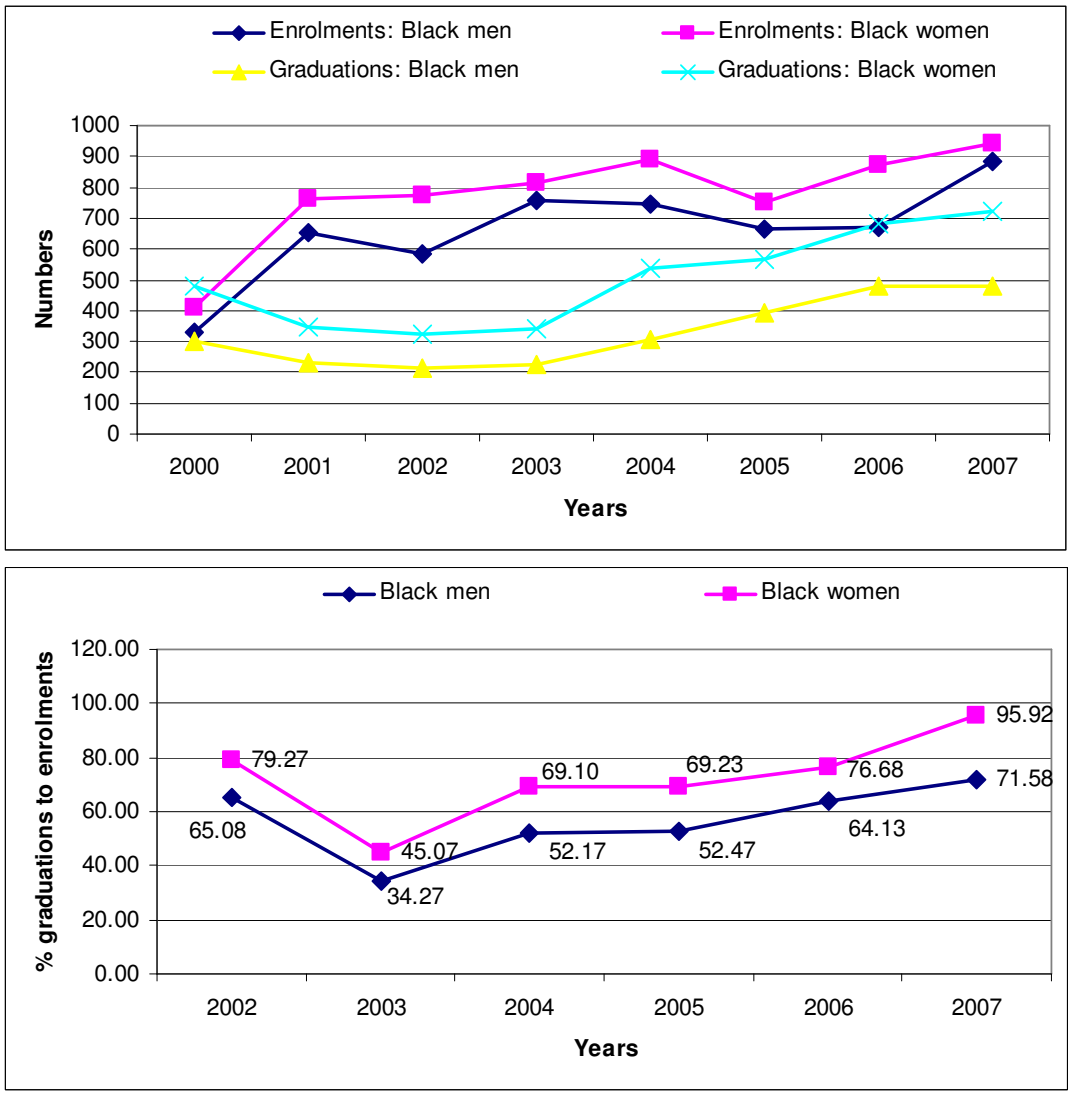


Figure 4.14: Enrolment, graduation and throughput trends in three-year degrees among black men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

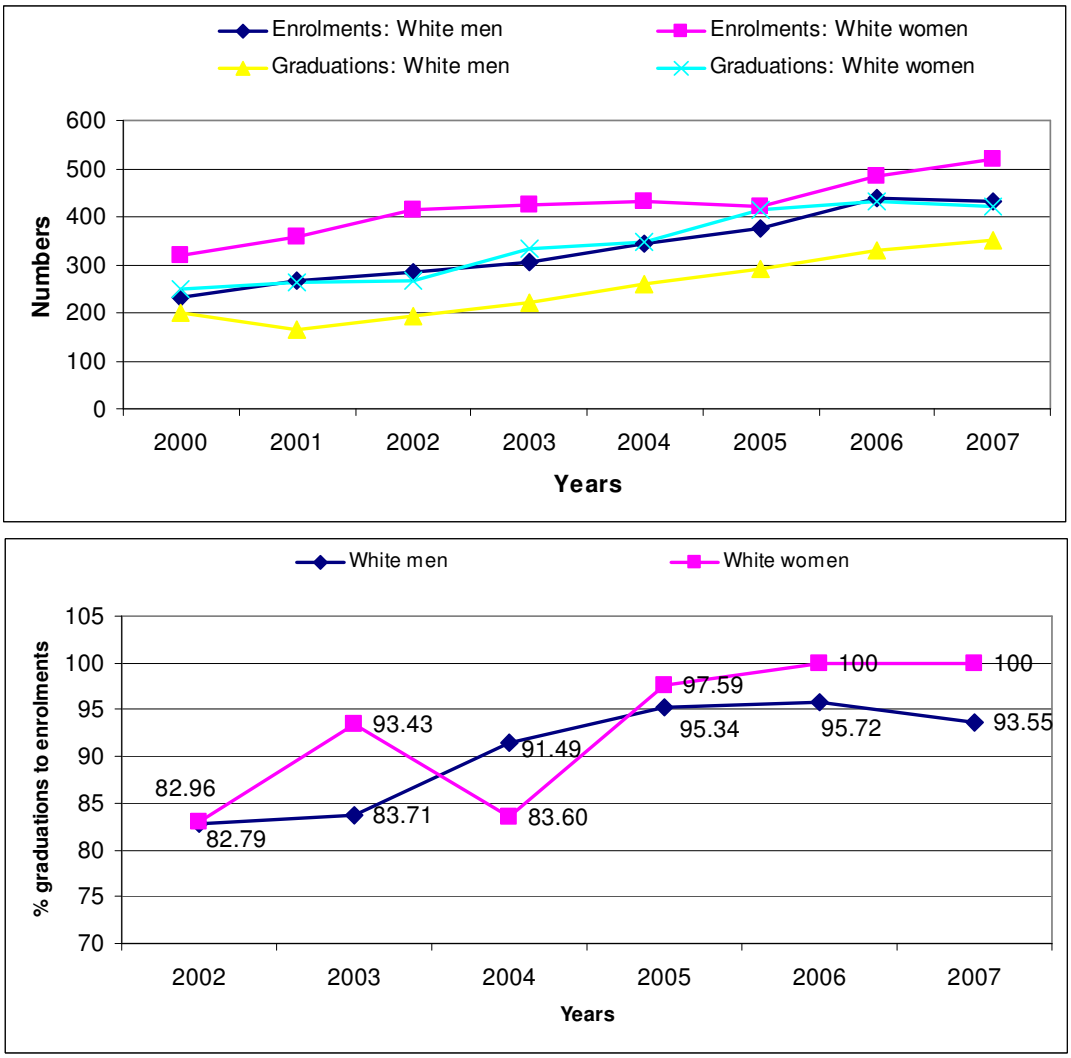


Figure 4.15: Enrolment, graduation and throughput trends in three-year degrees among white men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

The four-year degree programme is usually followed by candidates who did not meet the initial entry requirements, especially with regard to mathematics. An extended programme is like an additional bridging year to help catch up in certain subjects.

Among blacks in the four-year degree programme, the throughput rates varied significantly over the period. Thus, earlier in the period high enrolment rates were

accompanied by very low throughput rates; however, throughput rates improved dramatically to their highest in 2007. There were no major differences between the performance of men and women. Whites also appeared to have had rather mixed fortunes in this degree programme. It was only in 2004 that a very low level of enrolment appeared to have resulted in a 100% throughput rate.

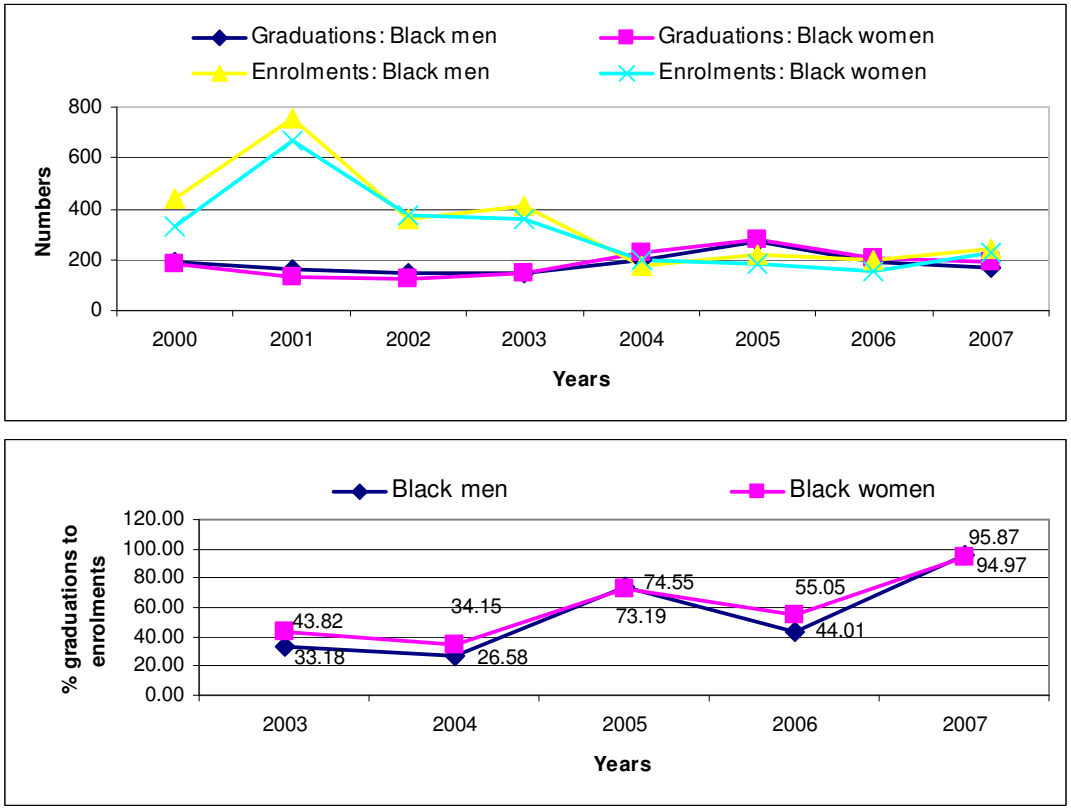


Figure 4.16: Enrolment, graduation and throughput trends in four-year degrees among black men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

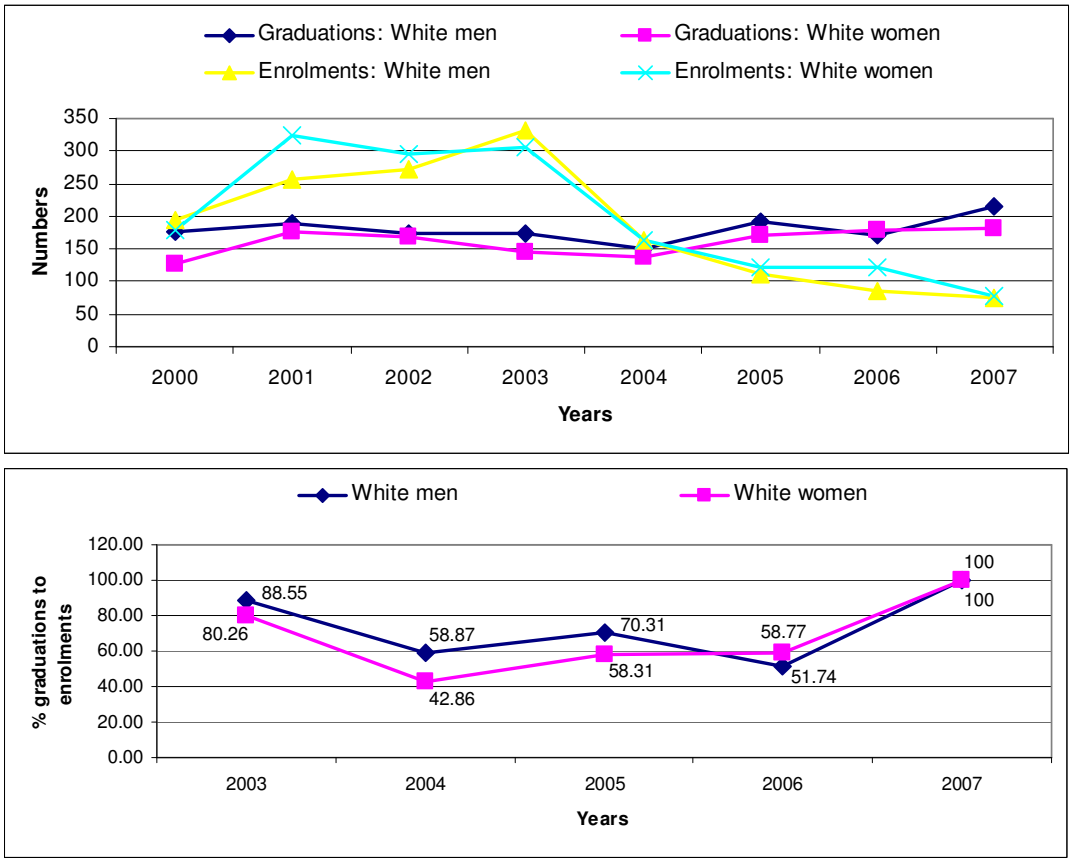


Figure 4.17: Enrolment, graduation and throughput trends in four-year degrees among white men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

In conclusion, the results suggest that those on the three-year programme had a better chance of successful completion, and within the specified time period, when compared to the four-year programme. However, in both programmes, it appears that over time blacks appear to have caught up with whites with a very small gap still in place.

Enrolment, graduation and throughput trends in NDipls

When compared to throughput rates for three-year degree programmes, NDipl programmes were not very successful. Thus, among both blacks and whites, there were extreme fluctuations over the period. Throughput rates of 50% and lower imply high levels of wastage and systemic issues at play. The dropout rate at technikons was 58% from 2000 to 2002 (DoE, 2005:9). The poor performance of both blacks and whites suggests that the problem may not lie in blacks lagging behind in terms of their mathematics and science backgrounds. More deep-seated problems exist in relation to the quality of the university of technology learning experience and the quality of the diplomates it produces. The key challenge for the biodiversity sector is in dealing effectively with the fact that it absorbs a large proportion of these diplomates as core associate professionals (34.3%) and a growing proportion in the core professionals (20.8%) (see Chapter 2). Currently around a quarter of those employed in the biodiversity sector has an NDipl qualification and it is thus important to assure improved quality in this programme.

Intervention at the NDipl level is advisable, since the poor throughput rates imply that the quality of the diplomates is compromised. There was some evidence to this effect in the fieldwork in terms of the low levels of literacy and skill among newly employed diplomates. A skills upgrading programme of diplomates could be conducted instead of a programme focusing on external recruits. One of the structural constraints is that, based on the limited information on past and future employment growth and the downturn in the economy, it does not seem likely that much of the sector will employ in any significant numbers. The overall skills level of the existing workforce needs to be improved, since it is evident that the influx of newly qualified postgraduates is not going to be extensive. Therefore, the feasibility of a skills upgrading programme on two levels needs to be considered, an honours into master's stream and a diplomate upgrading programme. The proposed skill levels and types of skills must be considered based on the needs of the sector. A third leg may be to provide support to an education and training provider in terms of the quality of the programmes. Maybe an additional year to catch up on certain

subjects, such as mathematics and natural science, would support some students in completing the programme more successfully.

As has been indicated, JIPSA (2007) found that employers preferred lower skilled labour or the unemployed for work experience initiatives, as they are cheaper and the unemployed are subsidised by a SETA grant. The failure of many university of technology students to find experiential workplace placements often result in their failure to complete qualifications. Partnerships between training institutions, government and employers need to be formed to address experiential workplace placements, especially to provide opportunities to NDipl learners.

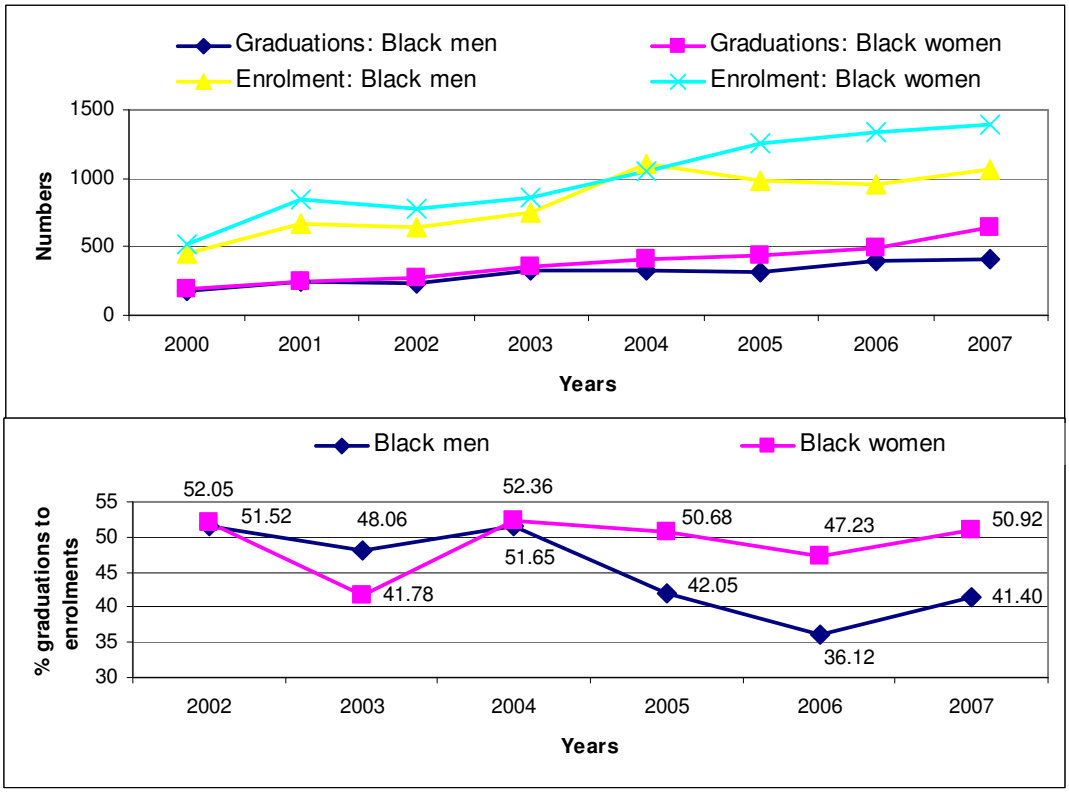


Figure 4.18: Enrolment, graduation and throughput trends in NDipls among black men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

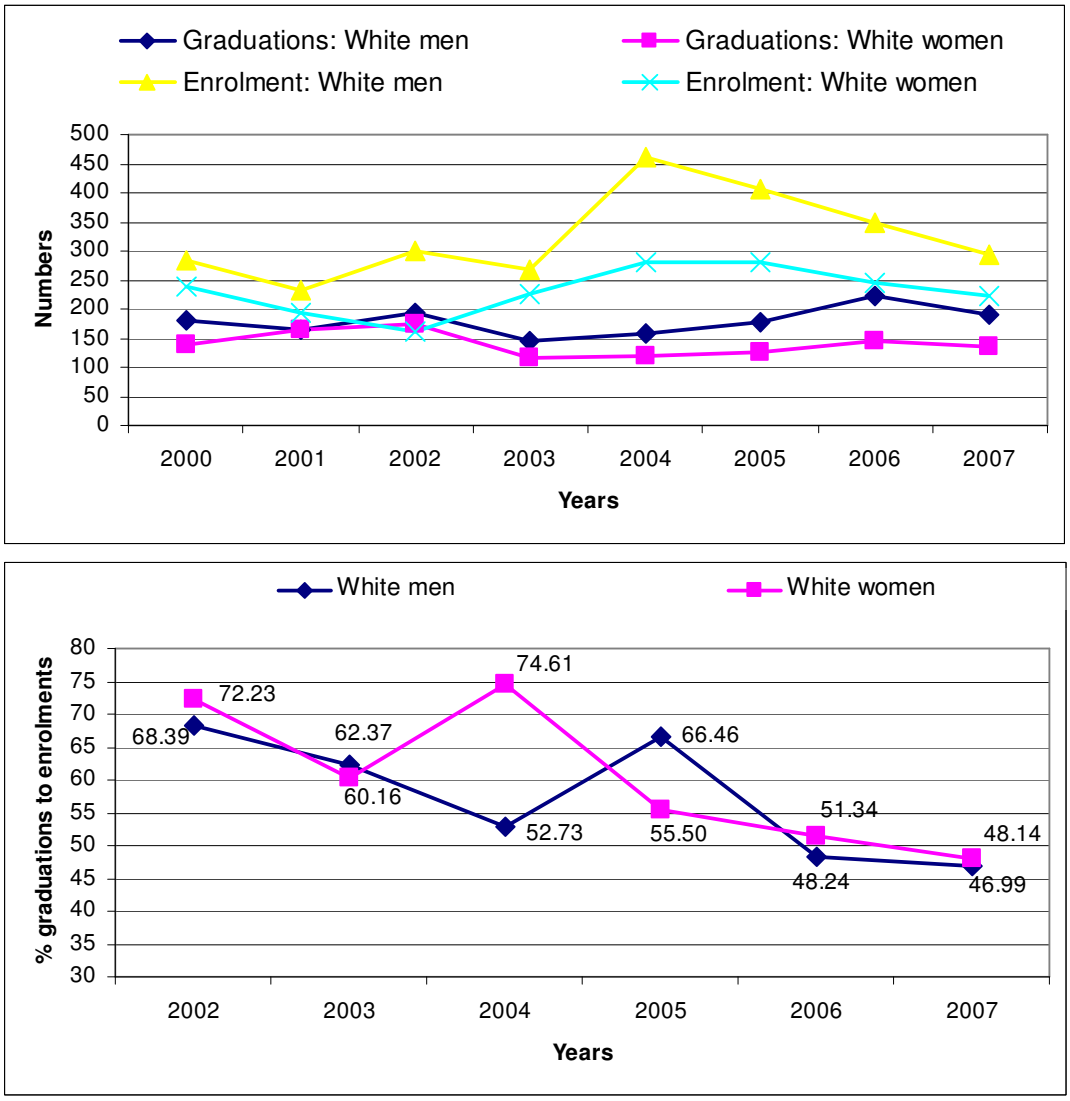


Figure 4.19: Enrolment, graduation and throughput trends in NDipls among white men and women (2000–2007)

Source: HEMIS, 2000–2007; own calculations

Despite the claims of a shortage of SET skills, there are some indications that in some fields there is an oversupply of graduates. For instance, the Development Policy Research Unit (DPRU, 2007) reported that the unemployment rate (2000–2005) among SET graduates increased from 11.3 to 16.5%, despite an apparent national commitment to increase SET uptake in response to economic skill needs. The SET unemployment rate is high, third highest after those in the Humanities

(25%). The severity of the lack of work opportunities prompted the development of a register of unemployed science graduates, while the Department of Labour's Employment Services Directorate also keeps a database of detailed information of those who register as unemployed. The National Youth Service (part of the Youth into Science programme) also keeps a database of young unemployed science graduates organised by the National Science and Technology Forum (NSTF). This project was launched in June 2008 to provide science graduates with skills to make them more employable. Science volunteers are placed at science centres, and they receive a monthly stipend. The training and mentoring programme includes computer skills, driver's licence training, project management, presentation skills, event management, facilitation skills and life skills, and team leader training (the latter organised by Umsobomvu Youth Fund). Many would like to pursue postgraduate studies or find employment and their information has been put on the NSTF website (Niehaus, 2008).

Registrations in biodiversity applicable learnerships

Learnerships can be important feeder programmes to the biodiversity sector, especially given that the NDipl programmes are currently not very successful. However, both programmes are important, as the two programmes are just different routes that learners with various needs can follow to enter the biodiversity sector. Although there are very few (only 1.3%) learnerships at level 5 that are applicable to the biodiversity sector, the proportion of level-5 appropriate learnerships as a proportion of all learnerships has been increasing from 1.4% in 2000 to 4.4% in 2007 (Table 4.4). Three of the four applicable learnerships are, however, secondary and not primary learnerships, as these three learnerships are computer-related programmes, while only one is a conservation learnership programme. Unfortunately there was a decrease in the number of learners on the conservation learnership programme between 2000 and 2007.

Table 4.4: Proportion of learnerships applicable to the biodiversity sector (2000–2007)

SETA	Learnership	Missing	Before 1April 2000	1 Apr 2000 to 31 March 2001	1 Apr 2001 to 31 March 2002	1 Apr 2002 to 31 March 2003	1 Apr 2003 to 31 March 2004	1 Apr 2004 to 31 March 2005	1 Apr 2005 to 31 March 2006	1 Apr 2006 to 31 March 2007	Total
ISETT SETA	Systems Support Engineer Level 5		0				154	105	833	604	1,696
ISETT SETA	Systems Support (Desktop) Level 5		0				181	28	299	6	514
ISETT SETA	Solutions Development /Programming Level 5		0	1			253	1	299	224	778
THETA	National Certificate in Conservation: Terrestrial Resource Management Level 5	4	126		5	12	26	24	28		225
	Total population in biodiversity related learnerships: NQF level 5 by year	**4**	**126**	**1**	**5**	**12**	**614**	**158**	**1459**	**834**	**3213**
	Total population on database by year	5,867	8,697	3,417	7,814	17,670	43,092	83,534	54,617	19,021	243,729
	Sample as percentage of population	0.0	1.4	0.0	0.0	0.1	1.4	0.2	2.7	4.4	1.3

Source: HSRC learnership survey database, September 2007

Most (88%) registrations for the applicable learnerships were by Africans, 5.2% by coloureds, 3.6% by whites, and 2.7% by Indians over the 2000 to 2007 period. Registrations for ISETT SETA learnerships were also predominantly by Africans (89.8%), coloureds (5.5%), Indians (2.8%) and only 1.3% by whites over this period. Two-thirds of the THETA learnership (conservation) registrations were by Africans, one third by whites, 1.3% by Indians and only 0.4% by coloureds over the same period.

More than half of registrations for learnerships were by men and 43.9% by women. Among the men, 95% of registrations were by black men and only 5.4% by white men. Among the black men, most registrations were by African men and the fewest by Indian men. Among the women, 98.6% of registrations were by black women and 1.4% by white women. Almost all (95.3%) the registrations among black women were by African women.

The sector has not really utilised the learnership system effectively. However, while there are fewer learnerships at NQF 5 levels and above, there are successful examples in the FASSET, for example The sector may consider the development of

a learnership at NQF level 6 (progression from the NDipl) that is custom designed to meet some of the complex needs arising from the biodiversity mandate.

CONCLUSION

In comparison to general higher education and the broader SET field of study, graduations in biodiversity-related fields of study overall had a higher average annual growth over the 2000 to 2007 period. However, the proportion of biodiversity postgraduates decreased compared to increasing proportion of postgraduates in SET and higher education in general. This drop in postgraduate proportions in biodiversity-related fields of study was caused by a decrease in the proportion of honours and master's degree graduations. Therefore, the absolute number of honours and master's graduates in biodiversity-related qualifications relative to undergraduates has declined. Black women are also being sought after in the labour market which may contribute to them finding work opportunities quite soon without the need to further their studies beyond masters or honours level. However, other studies suggest that women lag behind men in acquiring PhDs or leave higher education for a range of reasons, including insufficient research funding and other lifecycle reasons including family responsibilities. A commitment to the development of black women with PhDs in the biodiversity sector should include some cooperation with the DST programme called SET 4women which is geared to the development of women graduates and investigates the dynamics of "pipeline leakage".

However, the main blockages were in the transition to doctoral qualifications, mostly for black women, whose participation dropped to 8%. Black men, on the other hand, progressed into doctoral studies much better. The drop-off by black women at doctoral level is not specific to biodiversity only, and is referred to as "pipeline leakage" in the HE and SET fields. That is, there are particular periods in the life cycle of women scientists, and in this case black women scientists, where they leave the system for a range of reasons.

There has been a decline in employment in the biodiversity sector as a whole. This decrease in employment may be related to an insufficient number of candidates available with appropriate qualifications and severe competition from other sectors.

Enrolment and graduation trends are, however, suggesting an increase across demographic profiles and gender. Interviews also revealed an increase in the supply of graduates. Respondents argued that there is a lack of depth in knowledge and that qualifications are too general and not specialised enough to attend to real issues and problems in the working environment.

The real return on investment in postgraduate qualifications only increases with work experience deemed appropriate. In the absence of mentorships and work experience opportunities, and the presence of a small and overburdened professional workforce, the incentive to progress beyond honours and master's degree appears to be limited. Various funding opportunities are available that could be accessed more by organisations to provide experiential training opportunities to candidates and help absorb new entrants into the biodiversity sector.

Currently, around a quarter of those employed in the biodiversity sector has a NDipl qualification and it is thus important to assure improved quality in this programme. Both learnerships and NDipl programmes are required and these need not be in competition, as the two programmes are different routes into the biodiversity sector available to learners with various needs, especially financial.

It is generally accepted that in the post-apartheid period, access to HE by blacks (Africans specifically) and women has increased. At the same time there has been a decline in the enrolment of whites. There has been progress in graduation transformation in the broader SET field, although to a lesser extent than in general higher education. In the biodiversity-related graduations, transformation progress is also visible, albeit to a slightly lesser extent than in the broader SET field. This provides a challenge to the biodiversity labour market which aims to increase its staff complement over the next five years, as was indicated in interviews, especially with a view to addressing employment equity.

More graduations with a combination of majors in IT and Botany or IT and Zoology or IT and Geography would help to address the need for conservation assessment, a data-driven process that requires GIS and IT skills in particular. Very encouraging, however, is the fact that black women, as opposed to other groups, predominantly

obtained qualifications with a combination of majors in IT and Botany or Zoology or Geography in 2007.

Registration with SACNSP or another professional body needs to be considered. Professional registration may encourage professionalism among young graduates and stimulate growth in the sector. The problems with the current professional association need to be addressed, since they are a statutory body and receive funding under an Act of Parliament.

Any learnership or master's programme in the sector should be responsive to the real needs of the sector. This will require coordination and communication between the various government departments, the private sector and higher education in the sector. The new QCTO will quality-assure learnerships based on the input of a Community of Experts in the field.

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[2] The updated criteria were not available at the time of writing.

[3] The proxy labour market value assessment is for illustrative purposes only.

[4] Scientists may be employed without being registered, but may not operate in a private capacity without registration.

[5] While mentorship is not a legal requirement, the guidelines suggest that the individual identifies a mentor (preferably a registered professional scientist him/herself) who will ensure that the appropriate experience is gained. This in itself may be a barrier to entry (for blacks and women) as fulfilling the requirement may depend largely on social and professional networks (that are predominantly white and often male).