

BIODIVERSITY OBSERVATIONS  
RESEARCH PAPER (ENVIRONMENTAL EDUCATION)

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# Water, birds, and biodiversity - key elements of education

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*Journal editor:*  
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*Manuscript editor:*  
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Received: February 8, 2018; Accepted: September 5, 2018; Published: September 05, 2018

Citation: **Fincham J, Mbewu S and Hobbs J. 2018. Water, birds, and biodiversity - key elements of education. Biodiversity Observations 9.6:1-18**

Journal: <https://journals.uct.ac.za/index.php/BO/>  
Manuscript: <https://journals.uct.ac.za/index.php/BO/article/view/533>  
PDF: <https://journals.uct.ac.za/index.php/BO/article/view/533/553>  
HTML: <http://thebdi.org/blog/2018/09/05/water-birds-and-biodiversity>



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# Water, birds, and biodiversity - key elements of education

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## Introduction

### *Current and historical Facts*

Given the reality of the water crisis in the Western Cape (WC), especially in the City of Cape Town and the satellite towns, a unique opportunity exists to use the **combination of the Paarl Bird Sanctuary and the Drakenstein Waste Water Treatment Works (PBS/WWTW) for education about water and related facts.** Severe drought is not the only reason for the shortage of fresh water. It is likely that the water requirements of the burgeoning human population of the province, together with the need to use water to irrigate food crops, now exceed the water resources of the WC, despite the storage created in dams. An associated fact is that in the WC a large proportion of employed people work in Agriculture, both directly and indirectly. So any cut in water for irrigation, would increase unemployment and intensify poverty, which are already huge problems. **The overall predicament has country-wide, and even global implications, emphasising the need for water-related education.**

The PBS/WWTW complex is situated on the east bank of the Berg River, about 30 km from the source, which is in the mountains above Franschoek. This riverside location creates the responsibility to constantly ensure good water quality for downstream use by people and agriculture. It also provides an exceptional opportunity for environmental and health education, from schoolchildren to students at universities. For schools in particular, the venue can be an open-air classroom that excites and holds the attention of scholars, thereby increasing the educational impact of the available resources. Opportunities for research projects, tourism and recreation are also substantial. By contrast, the processed water from the Strandfontein WWTW at Cape Town flows directly into the sea without any reuse by people. However, the water crisis in the City is likely to soon compel recycling of the Strandfontein water.

Some of the history of PBS has been described (Schmidt 1996, Cohen, Spottiswoode & Rossouw 2006, Harebottle et al. 2008, Hobbs 2018). The seven existing pans form a substantial artificial wetland covering approximately 50 hectares (Figure 1). In recent years the waste water treatment process has been modernised, and final water quality is monitored in an on-site laboratory. The return of water to the river throughout the year contributes to a sustained flow for human and other uses, in towns and on farms downstream. In the dry summer months the proportion of treated water in the flow volume of the river, increases.

In addition to the exceptional educational potential of the process of treating waste water for reuse, especially by people, the PBS artificial wetland and the adjacent Berg River, create

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**Received:** February 8, 2018; **Accepted:** September 5, 2018; **Published:** September 05, 2018

**Recommended citation:** Fincham J, Mbewu S and Hobbs J. 2018. Water, birds, and biodiversity - key elements of education. *Biodiversity Observations* 9.6:1-18

**Manuscript subject:** Environmental education



Figure 1: Paarl Bird Sanctuary is bordered by the Berg River and vineyards to the west, with industrial and residential areas to the east. Pans A-D form an artificial wetland that attracts prolific birdlife, and from which treated waste water feeds back to the river for reuse downstream.

an important opportunity for learning about biodiversity, especially as regards birds and invasive vegetation on the river banks. Key aspects of these components have not been described previously and are the main focus of this paper.

#### *Bird counts at PBS*

Monthly counts of water-associated birds at PBS are in the 24th year, and no count has been missed. Data for the first 10 years of counts has been analysed and published (Harebottle et al. 2008). It was concluded that PBS was second only to Strandfontein WWTW (now known as the Birding Section of the False Bay Nature Reserve) for conservation of water-associated birds in the Cape Town area. Furthermore, PBS supports 11 universally and regionally important species for monitoring numbers and migrations. A recommendation was that PBS qualifies globally and regionally as an Important Bird Area and a Ramsar Site.

The Grey-headed Gull *Chroicocephalus cirrocephalus* (Figure 2) is a sought-after bird that is numerous and approachable at PBS. The list of species seen regularly is substantial (Cohen, Spottiswoode & Rossouw 2006, Harebottle et al. 2008) Exciting vagrants that are occasionally present include Squacco Heron *Ardeola ralloides*, African Jacana *Actophilornis africanus*, Lesser Flamingo *Phoeniconaias minor* (nomadic), Little Bittern *Ixobrychus minutus*, and Goliath Heron *Ardea goliath*.



Figure 2: A Grey-headed Gull (*Chroicocephalus cirrocephalus*) sitting on nestlings. These gulls are numerous at PBS and allow a close approach, which facilitates photography.

### *Recent problems at PBS*

It is on record that in 2004 thousands of local and international birders visited PBS (Harebottle et al. 2008). By 2017 the number of visitors had dwindled to a few at weekends only, and under security cover, because of robberies, sometimes with violence. The adverse publicity from this criminal activity has been disseminated widely, including online and by social media. Moreover, facilities have been repeatedly vandalised. The Yvonne Weiss bird lookout platform is a concrete and brick structure that provides high-level views over five pans (Figure 3). Below the platform there is an undercover area that can be used for audiovisual aids like videos, slide projection, and poster displays (Figure 4). There are also toilets. It was originally funded jointly by the Drakenstein Municipality and the Rowland & Leta Hill Trust. It has been severely vandalised twice. To try to stop further vandalism, it is now surrounded by high security fencing topped by razor wire; strong locked gates; pepper spray in the toilets (activated automatically at night); 24 hr CCTV camera surveillance; and flood lighting at night. It is currently only open to visitors over weekends because of the threat of vandalism and robberies.



Figure 3: The Yvonne Weiss bird lookout platform is a substantial structure that is a useful part of the outdoor classroom because the upper deck overlooks five pans. Here the waste water treatment process is being explained in Afrikaans, to children from Dalweide Primary School.

“Donated by the Cape Bird Club” was the inscription on a plaque in the Rita Meyer/Sand Island bird hide, which was built by Paarl Boy Scouts (Schmidt 1996). This hide, and three others, have been destroyed by vandals, were rebuilt, and destroyed again. Since 2010 there have been about 10 robberies in PBS, three of which involved minor stabbings, and one couple was threatened with a firearm. These incidents are less serious and not as frequent as in some other areas. To counter crime, PBS is now only open at weekends when security officials are in attendance. Birders are instructed to stay in their cars and use them as hides by parking at cleared vantage points. Since these arrangements came into force visitor numbers have started



Figure 4: Children watching a video showing microscopic, commensal organisms that occur normally in clean water. They are in the undercover part of the Yvonne Weiss bird lookout facility, which is also suitable for other teaching aids, such as projecting slides and showing posters.

to increase slowly.

### *Human population pressure*

There is an ongoing increase in the population in the Mbekweni and Groenheuwel suburbs of Paarl along the eastern side of PBS. The provision of housing has been overwhelmed, so that many people are living in shacks under conditions of poverty, with a high rate of unemployment (Figure 5).



Figure 5: Human population pressure is high along the eastern side of PBS. Many people live in shacks under conditions of poverty, and there is a high rate of unemployment.

## **Methods**

### *Informing communities through schools*

It was proposed that if communities in Paarl, and particularly adjacent to PBS, were informed about the potential of the PBS/WWTW complex for environmental and health education, as well as for tourism, recreation, research and job creation, then they would come to realise these assets needed to be safeguarded and used wisely for their own benefit. The principle that local community support is essential for recreational and wildlife areas, and National Parks, is widely known and accepted.

The Drakenstein Municipality, which is the local government authority for the area, requested a business plan as a condition for authorisation of the project. A document was accordingly prepared, submitted and accepted by the top municipal management. It proposed to work through schools as an effective way to start to convey key information back to the communities they serve. This plan is on file with the first author.

School Principals arranged meetings with all the teachers at schools in order for the project to be described. There is time gap at 14h00 when teachers can attend meetings. Meetings took

place at all the schools serving Mbekweni and Groenheuwel suburbs of Paarl. A total of 205 teachers attended, usually including the Principals. Details of the meetings are summarised in Table 1.

School	Date	Teacher attendance
Langabuya PS	1/3/2016	21
Imboniselo PS	18/4/2016	30
Mbekweni PS	4/5/2016	32
Desmond Tutu HS	5/5/2016	32
Dalweide PS	15/8/2016	25
Groenheuwel PS	6/10/2016	23
Ihlumelo HS	1/3/2016 & 14/9/2017	42
<b>Total</b>		<b>205</b>

Table 1: School meetings, dates and numbers attending (PS = Primary School. HS = High School)

#### *Information presented to teachers at school meetings*

Emphasis was placed on crucial environmental messages conveyed clearly by birds in five ecosystems. In addition, the need to ensure water quality and flow in the Berg River was explained (as specified previously), as well as the problem of invasive, non-indigenous trees along the river banks. Information was presented by means of discussion supported by visual aids. The teachers were advised that practical examples relating to the information presented could be demonstrated at the nearby PBS/WWTW complex, which is an ideal outdoor classroom for environmental and health education.

Examples of messages conveyed by birds, according to ecosystems they utilise, follow.

**Terrestrial birds globally:** long distance bird migrants are warning of devastating habitat destruction along flyways that span the earth (Hockey 2012; BirdLife International 2015; Taylor, Peacock & Wanless 2015). The numbers of some of the migrants that reach PBS, such as the Common Sandpiper *Actitis hypoleucos*, and the White-winged Tern *Chlidonias leucopterus*, have declined drastically since counts started 23 years ago. Human related pressures are damaging the flyways migrants use in several ways. These include urban sprawl; overgrazing by livestock; destruction of forests and woodlands; agricultural monocultures (crops, forestry and livestock); draining of wetlands; flooding of wetlands by dams; and lethal obstacles in flyways (electricity power lines, wind turbines, fences). In India, migrating Amur Falcons *Falco amurensis* (which cross the Indian Ocean to reach Africa) are caught in nets for food (Kumar 2014). In Malta, there is ruthless hunting pressure on migrating birds (Azzopardi 2005), which is also the case in Cyprus and other Mediterranean countries.

**Oceanic seabirds:** pelagic birds that feed exclusively at sea include albatrosses, penguins, gannets, cormorants, and others. They are in serious trouble because industrialised overfishing is depriving them of food and killing them as by-catch; and also because we have introduced predators that are killing their chicks on the islands where some of them breed (Crawford & Makhado 2012; Ryan 2012; Davies, Dilley et al. 2015; FitzPatrick Report 2015; Taylor, Peacock & Wanless 2015; Yeld 2015; Knapton 2016, Crawford et al. 2017; Ryan 2017; Wanless 2018). Ultimately there may be no fish left for birds or people because high-tech, mechanised, industrial fishing, was not part of evolution.

**Birds regionally in southern Africa:** here the avian messengers of disaster are all the vultures, some large eagles (e.g. Martial Eagle *Polematius bellicosus*, Crowned Eagle *Stephanoaetus coronatus*, Bateleur *Terathophus ecaudatus* & Tawny Eagle *Aquila rapax*), and the Secretarybird



*Sagittarius serpentarius*. In 2015 they were classified as vulnerable, endangered or critically endangered (Taylor, Peacock & Wanless 2015; Ogada et al 2016). In South Africa there are many places named Aasvoëlскоп/krans, but the vultures are no longer there. The background to this situation is that the region has been carved into 7 countries and numerous provinces by politicians, with no consideration of environmental impacts. The biomass of ecologically adapted migratory game, that fed vultures and some eagles, may well have exceeded the biomass of current farm animals. Seasonal migration routes have been cut by numerous barriers. Some of these are lethal, such as electricity power lines and the veterinary fences in Botswana and Namibia. Absurdly the fences are a condition for beef importation by the remote European Union. Moreover, there are now extra obstacles in wind turbines, as well as the less intrusive solar energy facilities. The link that follows provides recent information on damage from wind turbines: <https://www.fin24.com/Economy/wind-farms-can-be-deadly-20171217-2>

**Urban birds locally:** crows in towns are easy to see and can be important scavengers, indicating the presence of litter that they help to clean up. However, with litter there are inevitably rats, mice, fleas, lice and numerous microscopic pathogens in excreta from humans and animals. When there is promiscuous human defecation on the ground because there are no toilets, children are often infected by helminths, and other intestinal parasites (Fincham et al. 1998). The illustration of a piece of intestine surgically excised from a 3-year old boy because it was blocked by *Ascaris lumbricoides* worms, emphasises the risk, and elicited shocked gasps from some teachers.

**Rural birds locally:** away from towns crows must hunt for food. When they decimate tortoises it is an indication of an impoverished rural environment with an imbalanced biodiversity (Figure 6). The crows have moved into a niche vacated by vultures, eagles and other raptors (as described regionally), and tortoises can be a vulnerable residual prey species. (Uys 1966, Simmons & Barnard 2011, Fincham & Lambrechts 2014; Fincham et al. 2015; Fincham & Nupen 2016). Some local tortoise species are on the verge of extinction (Branch 2008).

**Water quality & quantity:** natural wetlands are the source of rivers, into which they filter clean water. They are rich in biodiversity, of which birds are a part. Humans take clean water from rivers, emanating from natural wetlands, pollute it seriously (including sewage; other excreta; soaps, detergents and dirt from washing; discharges from hospitals, industry and agriculture), and must then return it to the river because it is needed for use downstream. This situation pertains to the Berg River at Paarl and Wellington. If the water is not cleaned thoroughly, pathogens, toxins and pollutants could be disseminated to communities all the way to Velddrif, at the mouth of the river. A warning of a dangerous situation is when ducks and other water-associated birds die in numbers due to excessive levels of botulism toxin in algae, snails, maggots, mussels & fish that they eat, especially when water is semi-stagnant (Soos & Wobeser 2006). Details of the water treatment process are not the main focus on this paper, but were summarised in introductory talks to teachers and scholars. The need to ensure minimal risk of transmitting water-borne diseases and toxicities downstream was emphasised in the preferred language of each tour group. It was confirmed by Primary and High School teachers that water purification is an important part of the curricula.

**Invasive riverine trees:** the Berg River and its banks are an ecosystem that is used by birds and a wide range of other organisms. The river banks have been invaded by non-indigenous trees, especially *Eucalyptus spp* and Black Wattle *Acacia mearnsii*. These trees need so much water to sustain their prolific growth that the hydrology of the river, as well as the biodiversity of the ecosystem, have both been adversely affected (Marais & Wannenburg 2008). The river flow has been reduced, and erosion has been enhanced because peak flow pressures on the banks and the bed have changed. Moreover, the unnatural tree cover has compromised many of the indigenous plants and animals associated with the river. A programme is underway to eradicate the invasive trees and restore natural biodiversity (Figure 7).



Figure 6: The carapaces of 315 small tortoises killed by a pair of Pied Crows to feed four chicks and themselves, in the karoo. Additional prey must also have been taken. Photo by Nollie Lambrechts.



Figure 7: Clearing of invasive trees from the banks of the Berg River is underway. Indigenous species are being planted to replace the non-indigenous invaders.

*School tours*

Following the descriptive introduction to the teachers, they were keen to have scholars undertake educational tours of the PBS/WWTW complex. Accordingly groups from two High Schools and three Primary Schools toured the complex, as detailed in Table 2.

Date	School	Scholars	Teachers
1/10/2016	Desmond Mpilo Tutu HS	42	1
2/10/2016	Desmond Mpilo Tutu HS	44	1
22/2/2017	Groenheuwel PS	76	1
23/2/2017	Groenheuwel PS	76	2
24/4/2017	Langabuya PS Scouts	64	2
4/9/2017	Dalweide PS	60	2
6/9/2017	Dalweide PS	60	2
12/9/2017	Dalweide PS	66	2
10/10/2017	Ihlumelo HS	45	2
11/10/2017	Ihlumelo HS	47	2
12/10/2017	Ihlumelo HS	47	2
23/10/2017	Ihlumelo HS	52	2
24/10/2017	Ihlumelo HS	21	1
25/10/2017	Dalweide PS	60	1
26/10/2017	Dalweide PS	30	1
<b>Total</b>	<b>5</b>	<b>790</b>	<b>205</b>

Table 2: Details of educational tours by schools to PBS/WWTW (PS = Primary School. HS = High School)

On arrival, each tour group was given a short introductory talk in their preferred language as far as was practical. So they were addressed in Afrikaans by Adam Small and Marshall Diedericks (WWTW); in isiXhosa by Mteteleli Sibaca (WWTW) and Skhumbuzo Mbewu; and in English by Albert van Vuuren (Aquavan consultant) and John Fincham. This helped the children to relax. They were introduced to how we use water, and the necessity for reuse after purification, since available water, sustained by natural wetlands, is limited. A key point was to explain and emphasise biodiversity as being the whole range of interacting, water-dependant life forms (animals and plants) in any ecosystem, including humans.

After this, groups were divided so that half were helped with bird identification by experienced birders, working from the Yvonne Weiss bird outlook platform, using binoculars and spotting scopes. Each child was provided with a laminated sheet (for reuse) with photographs in colour of 24 birds that are always present at PBS, printed on both sides. A score card corresponding to the coloured photos, with thumbnail bird images, gave the bird names in four languages: Afrikaans, English, SeSotho and isiXhosa. Completion of the score card created a competitive task for each individual on the day. The use of spotting scopes and binoculars to facilitate identification of different bird species was an exciting experience for the scholars (Figure 8).

The other half of each group went on a guided nature walk along the berm between pans E2 & E3 (see Figure 1). On the walk a wide variety of birds were identified. Nests of the Southern Masked Weaver *Ploceus velatus* were demonstrated. The intricacy and complexity of nest construction by weavers is an important lesson for everyone, and deserves enormous respect. Nests with eggs of the Black-winged Stilt *Himantopus himantopus* (Figure 9), and the Grey-headed Gull *Chroicocephalus cirrocephalus* (Figure 2) were also shown to the scholars. After about an hour the groups changed around.



Figure 8: Grade 10 scholars using a scope & binoculars as aids for identifying birds, at PBS. These are important tools for use in outdoor classrooms. The girls are on the Yvonne Weiss bird lookout platform, scanning pan A for birds (see Figure 1).



Figure 9: A nest of the Black-winged Stilt *Himantopus himantopus* with eggs, as demonstrated to scholars on the nature walk.

## Results

Details of educational tours made by 790 scholars from five schools, accompanied by 24 teachers, are presented in Table 2.

Scholars from the High Schools in grades 10, 11 & 12 completed questionnaires to evaluate their educational experience from the tour of the PBS/WWTW complex. The analysis in Table 3 shows the percentage responses to specific questions by grade 10 scholars.

Question	Response
<b>Paarl Bird Sanctuary (PBS)</b>	
Would you like to have bird-related school projects?	87% definitely would
Would you like to visit PBS again soon to learn more about birds?	87% definitely would
How much did you enjoy looking at the birds?	74% replied 'A lot.'
<b>Waste Water Treatment Works (WWTW)</b>	
How much did you learn about water purification?	60% replied 'A lot.'
Will what you learned at the WWTW help with your school work?	70% replied 'A lot.'

Table 3: Responses from grade 10 scholars to questionnaire (n = 86 scholars)

Written comments were submitted by 55 High School scholars. A selection of these is presented as the quotations that follow.

"This place is very attractive to tourists because it has things that attract people, such as different kinds of birds, and demonstrating how water is purified."

"This tour helped us to get knowledge about how birds are important and how water is purified."

"I learnt a lot about birds and how water is purified, and I loved it."

"I definitely want to visit again. Outdoors studying is more interesting. I will educate my friends about the wonderful tour we had today. I will tell my peers and family to remove waste from the water because it can seriously damage the WWTW."

"I splendidly enjoyed being here. It gave me more interest in nature. I will always remember what I have been taught about water."

"It was quite a mind-blowing experience and I really enjoyed it. I liked the part where we learnt about birds. There was also useful information on water purification."

"I have learned so much from you guys. You are excellent and I hope to see you again, teaching me about birds and how to purify water. Thank you."

"I really enjoyed this session, especially water treatment because it taught me that I must respect water."

"All I want to say is I enjoyed the day on both sections, water purification and birds. So I just say thank you guys. I have learned a lot."

"The WWTW was great. It helped me a lot about water purification and birds."

"Visiting the WWTW was very exciting and interesting. I would like to visit the place often because it helps you to know what is happening in the community we live in."

"Visiting the WWTW was very exciting and more interesting than being in class to learn what exactly is the purpose and role of natural organisms. I would like to visit this place often."

"I have learned many different things about birds, their behaviour and how they raise their children. It was the most awesome lesson I ever had. I want to learn more about birds."

"I enjoyed each and every moment. I learned many new things about birds and nature. It made me more curious to study about nature."

"I found the place so beautiful and I didn't know there is a place like this in Paarl. It has a lot of exciting activities."

Only one girl in 790 scholars commented that she was not interested in birds or water purification.

**Evaluation by teachers:** eight Primary School teachers stressed the need for security protection of the PBS/WWTW complex, especially to make it safe for education. Two teachers commented on the importance of community involvement, as follows:

"This is such a valuable part of our environment. So, if we can get more schools to visit the sanctuary, people and the community will become aware of it and learn how to appreciate, respect and conserve our environment."

"The residents of the surrounding area should be informed about the value that PBS holds for tourism, and that new job opportunities can be created. Then they must work together with PBS to fight crime."

A comment specific to education was: "Educational tours/excursions like these expand the learners' frame of reference and make the curriculum more 'alive'. It also teaches them to respect and appreciate our environment, as well as to conserve our animal and plant species."

A teacher at Desmond Mpilo Tutu High School wrote as follows: "I would like to thank you for opening up opportunities to our learners at Desmond Mpilo Tutu. They have learned a lot, and the information gathered will be used on science-related projects. We are looking forward to have more of these awareness programmes and we hope that they can improve environmental awareness in our community and promote a healthy lifestyle. This initiative will strengthen our relationship."

## Discussion

The most important result from this project has been the enthusiasm of the teachers and scholars at all the schools serving Mbekweni and Groenheuwel townships in Paarl, for information about water, birds, and biodiversity. This thirst for vital knowledge can be contagious. Based on this, it is recommended this report should be circulated for consideration and action to all administrators of education, curriculum planners, and schools in the Western Cape, and possibly throughout South Africa. Education needs to be adjusted as a matter of urgency, in order to communicate the crucial messages about the unsustainable pressure from humanity on the global and local environments, that are conveyed so clearly by birds. Wherever there are outdoor classrooms similar to the PBS/WWTW complex, these should be used as they are the most appropriate and effective venues for this essential form of environmental and health education.

A grade 10 girl reinforced this recommendation when she wrote in the evaluation questionnaire: "The out of class lesson is much better because you are taught on what you can see and



I would like it to be done every week, just one day a week, so we can understand what we are taught and help us to know how birds are essential in our environment. It gave me an interest to learn more about nature and water.”

A different but equally important reaction was from a boy at a different Senior School. After he had seen the wide range of bird species in PBS he said that before the tour he had thought that doves were the only birds. This emphasises the ignorance of many urban children about nature as a whole, and the urgent need to move education outdoors as the best way to teach holistically about biodiversity and threats imposed by humanity on the survival of their own species.

The current extreme shortage of potable and irrigation water in the Western Cape, and in much of the rest of South Africa, emphasises the reality of the environmental crisis that exists. The water requirements of the human population of the Western Cape now probably exceed the fresh water resources of the province, despite storage in dams. The water crisis defines the urgency of conservation of the natural wetlands from which our water originates, throughout southern Africa.

An overall conclusion and recommendation is that humanity needs to listen to and act on the clear messages from birds and biodiversity. It is imperative that human population pressure on the environment locally in the WC and universally, must be reduced. A key to achieving this is that the reproductive rate of our species needs to slow down, so that the global human population starts to show negative growth.

### **Acknowledgements**

Our thanks go to Senior Engineer Ronald Brown, i/c the Drakenstein WWTW, who has supported this project throughout, together with key WWTW staff members: Adam Small (Access Controller), Marshall Diederichs (Process Manager), Mteteleli Sibaca (Chemist) all of whom gave short talks to the children; Nonkululeko Tyantsi (Chief Chemist) for her encouragement; and Sandra Ontong for organisational support. The Drakenstein Municipality provided administrative and financial support (by paying for buses) through their Environmental Management Division and staff members Ilze Fiellies and Cindy Winter.

The Principals and teachers of all the schools were enthusiastic and gave us great encouragement, and as did the scholars. Mr Chris Bam, the Principal of Dalweide Primary School, was a particularly strong supporter.

Many individuals helped the children to identify birds with binoculars, some using their own spotting scopes. Those who assisted on more than one occasion were: Simon Fogarty, Yolanda Wellem, Pikkie Rousseau, Priscilla Beeton, Thembanani Magazi, Dick Barnes and Patsy Copeland. Antoinette le Roux helped specifically with Groenheuwel and Dalweide Primary Schools based on her fluency in Afrikaans and teaching experience.

Others who came to help with the school visits were Lucia Rodrigues, Ian Rijdsik, Julian Hare, Penny Dichmont, Gillian Barnes, Rose Mills and Dale Wright. Rudolph Röscher and Francis Steyn of the Western Cape Department of Agriculture introduced us to the Junior Land-Care Project. Cedric Morkel introduced us to Dalweide and Groenheuwel Primary Schools. The 20 pairs of binoculars on loan from the Cape Bird Club were essential tools and a strong incentive to the children.

Funding came from the Cape Bird Club, Tygerberg Bird Club, the Western Cape Birding Forum, BirdLife South Africa Western Cape, and the Western Cape Department of Agriculture through their Junior LandCare Project.

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