

2022/23



THE FRESHWATER
RESEARCH CENTRE



ANNUAL REPORT



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About the FRC

The Freshwater Research Centre (FRC) is a non-profit organisation that undertakes research across a range of disciplines in the field of freshwater science. The centre promotes cross-cutting, collaborative and relevant research and is committed to developing innovative solutions for balancing human needs and ecological requirements for water. Members are specialist river and wetland ecologists, with collective research experience exceeding 150 years.

Freshwater is widely acknowledged to be fundamental to economic and social well-being, and its availability or scarcity is rapidly becoming one of the planet's most pressing environmental concerns. Sustainable use of water resources is essential if human societies are to continue to derive long-term benefits in the face of local development needs and global climate change. Integral to the FRC's philosophy is the conviction that water is not just a resource, but an essential element for the sustenance of life itself, and that maintaining healthy aquatic ecosystems is central to the continued existence of human society.

Despite its fundamental value, this resource is threatened by human activities that continue to degrade its quality and quantity. Water resources are particularly threatened in countries like South Africa where the climate is generally semi-arid and water resources are naturally scarce. To effectively manage water resources, it is imperative that we understand how freshwater ecosystems function and the ecological consequences of water use.

Our goals are to achieve a thorough understanding of how freshwater ecosystems are structured and how they function, to improve our ability to use water resources sustainably, and to predict the effects of climate change and other human-related impacts on the integrity of freshwater ecosystems. Ultimately our research generates knowledge on ecological infrastructure of freshwater ecosystems and its value to society, which informs policy and management.

Our vision is to undertake collaborative research that is relevant, data-driven, scientifically defensible and which promotes the effective management, conservation and rehabilitation of freshwater ecosystems in southern Africa. We are committed to promoting excellence in research, training and education, and through these channels to better understand and cope with global change.

We aim to share this knowledge with society and raise awareness of the value of freshwater ecosystems through traditional and digital media channels, as well as peer-reviewed literature. We strive to develop local capacity in the aquatic sciences through supervising and mentoring students and by providing internship opportunities. Our environmental education and outreach programme – Living Labs – exposes school groups to the wonders and values of healthy ecosystems.



2022–2023 in Review



I am excited to reflect on the past two years, which seem to have passed in a flurry of activity. Perhaps the increased pace is in response to the preceding year of 2021, where our lives were curtailed by the pandemic. FRC celebrated our 10 year anniversary in March 2022 – an amazing milestone – and one which we are all incredibly proud of. We continue to strive to deliver outstanding work in our focal areas of monitoring and management, resource protection and conservation, bioinformatics, climate change, and water and livelihoods.

In fiscal years 2022 and 2023, we:

- Completed the development of decision support tools aimed at assessing the risks of pesticides in freshwater ecosystems. A Pesticide Use Map and three Pesticide Risk Maps are now available for the South African freshwater and agricultural community.
- Built a collaborative relationship with the Greater Cape Town Water Fund to monitor and evaluate the ecological responses to clearing of invasive alien plants (IAP). Our M&E plan focuses on both river and wetland health and biodiversity. The “paired catchments” study provides a unique and valuable opportunity to improve our understanding of IAP impacts on freshwater ecosystems.
- Rescued over 30,000 juvenile sandfish through our Saving Sandfish project in the Biedouw River, Cederberg, and tagged and released 1500 fish – an intervention that has boosted the wild sandfish spawning population in the Biedouw River by 99 fish, representing a 55% increase in the number of migrating sandfish.
- Initiated a river restoration project on the Breekkrans River in the Cederberg, which will mechanically remove alien spotted bass from 8km of the otherwise-pristine Breekkrans River to increase the range of the Critically Endangered Doring fiery redfin. The project is building freshwater conservation capacity and creating an employment opportunity for local community members.
- Began a project led by WWF-Zambia to undertake a systemic conservation planning to identify high priority freshwater conservation areas in the Kavango Zambezi region encompassing the Cubango, Cuito and Cuando River Basins of southeast Angola – the three key basins delivering water to the Okavango Delta.
- Commenced Phase 2 of the Freshwater Biodiversity Information System (FBIS) for tracking change in South Africa's freshwater biodiversity, which includes over 650,000 biodiversity records for anurans, fish, aquatic invertebrates, adult odonates and algae in South African rivers. Our user-base has grown to >550 individuals from over >235 organisations.
- Mobilised > 140,000 biodiversity occurrence records for the lowveld region of South Africa, through our collaboration with the Association for Water and Rural Development.
- Hosted two online seminar series “Freshwater Biodiversity in Africa Seminar Series 2021” and Freshwater Biodiversity in Africa Seminar Series 2022, which provided an exciting space to learn from other freshwater bioinformatics projects, discuss common challenges, and explore future collaboration and synergies amongst projects.
- Completed Odonata Map project, which developed an atlas and phenology of dragonflies and damselflies in South Africa. Over 150,000 citizen science data are now at the fingertips of decision-makers through integration in the FBIS
- Developed the Rwanda Biodiversity Information System (RBIS) and trained data management teams from the Center of Excellence in Biodiversity and Natural Resource Management, University of Rwanda, University of Rwanda.
- Developed the Okavango Repository for Biodiversity data (ORBIS) and trained data management teams from the Okavango Research Institute, University of Botswana.
- Contributed to updating the climate change status quo analysis for water resources and the development of the Climate Change Response Strategy for the Water and Sanitation Sector.

- Forged new collaborations for our work in the water-stressed and biologically significant Koue Bokkeveld. Excitedly, in 2022, the 9607 ha Tweerivieren Nature Reserve was gazetted – a direct result of tireless work by the project team.
- Undertook SASS training again in earnest with a total of 18 staff from the Grootvadersbos Conservancy training, City of Cape Town and independent consultants, trained in SASS5 biomonitoring method.
- Continued our Living Labs education and outreach programme, where we ran several outings and to date FRC have run four miniSASS training courses, 70 school outings, and 4 school camps reaching over 2500 learners.
- Published 12 scientific papers, three technical reports, five chapters in books, 12 popular articles and produced seven short films.
- Supervised five PhD and 2 MSc students.

I am personally enormously grateful and humbled to have been awarded the Southern African Society of South Africa's Gold Medal for my contribution to the aquatic sciences in SA and beyond its borders and the conservation of our ecosystems. My colleague, Dr Jeremy Shelton, received the Mail and Guardian Greening the Future 2022 award in recognition of his contribution to freshwater fish conservation in South Africa.

Our team at FRC remain steadfast in our commitment and passion for our work and welcome the positive outcomes that result from our energy and dedication. We thrive on collaboration and are grateful to the many individuals and organisations with whom we work. As always, I am enormously appreciative of the enthusiasm and dedication of our board members, researchers, students and interns; and indebted to our funders and donors who continue to support us.

Helen Dallas
Executive Director
Freshwater Research Centre



Monitoring & Management

An Integrated Approach to Managing and Mitigating the Risk of Agricultural Nonpoint Source Pesticide Pollution to the Aquatic Environment

South Africa has a well-developed agricultural sector which uses high quantities of numerous different pesticides on an annual basis. We have very little information on the impact that this pesticide use has on our very limited freshwater resources and no reliable resources are available for identifying risks of pesticides to water resources in South Africa. Considering the increasing challenges related to water quality management in South Africa and acknowledging the role of pesticide pollution in the deterioration of water quality, the aim of this Water Research Commission (WRC) funded project was to improve the management of nonpoint source pesticide pollution in South Africa through investigating and developing monitoring, modelling and risk assessment approaches that:

- 1) Identify target areas (or hotspots) where agricultural NPS pollution of pesticides is of greatest concern;
- 2) Identify specific pesticides in hotspot areas which are likely to pose the greatest risk to freshwater resources;
- 3) Identify important transport routes of contamination and reliably predict pesticide concentrations derived from these transport routes;
- 4) Provide guidance on reducing impacts through:
 - a) Improving application, or
 - b) Selecting pesticides which pose less risk to the aquatic environment,
 - c) Reducing the transport of chemicals from source to the aquatic environment.

These objectives were met through a combined field and desktop research approach involving several research organisations including the FRC, University of Pretoria and the Agricultural Research Council. Using Geographical Information System (GIS) software and a variety of environmental fate and transport models (including the SWAT, AgDISP and PWC) which were validated through field- and catchment-scale monitoring studies, several innovative outputs were developed. These outputs include updated national pesticide use maps for South Africa, pesticide risk maps indicating the relative risks of pesticide application per quaternary catchment to aquatic biota (algae, invertebrates and fish) and a simple risk indicator software which prioritises high risk pesticides and identifies the most important route of contamination (i.e. runoff or spray drift). While similar products have been developed throughout the rest of the world, no such products have been developed for South Africa. The outputs of this project therefore help improve our understanding and management of the potential impacts of pesticides on aquatic biota at multiple scales (i.e. field, catchment and national) and directly addresses the Department of Agriculture Draft Pesticide Management Policy (2006) in which the need to minimize hazards and risks to health and the environment was highlighted.

The five-year project was finalised in March 2022 and, with the permission of the WRC, and in an effort to make mapping product more readily accessible, the pesticide use maps and the pesticide risk maps have recently been integrated into the Freshwater Biodiversity Information System (FBIS). Outputs associated with the project are listed in Table 1.

Funders

Water Research Commission

Partners

University of Pretoria, Agricultural Research Council

Project Value

R 4,000,000.00



Resource Protection & Conservation

A Paired Catchment experiment with Greater Cape Town Water Fund (The Nature Conservancy), monitoring the effects of invasive alien clearing

Over the past five years, the Freshwater Research Centre has built a collaborative relationship with The Nature Conservancy (TNC), through the Greater Cape Town Water Fund (GCTWF). The GCTWF has a strong focus on clearing and control of invasive alien plants (IAPs) in order to increase water supply and water security for Cape Town, while ensuring that freshwater biodiversity and ecosystem functioning is maintained or enhanced. The GCTWF has embarked on an ambitious restoration project to clear thirsty invasive plants from seven priority water supply catchments in an effort to increase flow into the City's biggest water supply dams.

In 2020, FRC provided freshwater ecological input to a multi-disciplinary Monitoring and Evaluation (M&E) plan for the targeted removal by the TNC of 54 300 ha of IAPs over six years (2019 – 2025) from these priority catchments. In late summer of both 2021 and 2022, we collected baseline biodiversity and habitat data at sites on six paired catchment tributaries, and one wetland. The field surveys revealed a high diversity of aquatic macroinvertebrates at each site, and good habitat for amphibians such as the Cape Ghost Frog, *Heleophryne purcelli*, and the Cape River Frog, *Amietia fuscigula*, and illustrated spatial variation in both biodiversity and habitat conditions among the six tributary sites. We detected measurable links between biodiversity

and key habitat factors like flow, sedimentation, detritus and soil saturation/inundation. Moreover, certain indicator taxa showed a preference for fast-flowing (in the rivers) or permanently saturated (in the wetland) habitat areas and may stand to benefit most from IAP clearing and associated increase in summer runoff.

Funders

The Nature Conservancy

Partners

CapeNature

Project Value

R 422,350.00





Saving Sandfish

The Clanwilliam sandfish, endemic to South Africa's Olifants-Doring River system which flows through the Cederberg Mountains, is the country's most threatened, migratory freshwater fish. Once widespread throughout the system, its distribution has contracted and fragmented, to the point where it may have disappeared from the Olifants catchment entirely, leading to its Endangered IUCN conservation status.

The Doring River is the last free-flowing river in South Africa's Cape Fold Ecoregion (CFE) Biodiversity Hotspot, and the last outpost for remaining sandfish populations. However, a recent FRC-led survey of the Doring has revealed that the river has been overrun by invasive alien fish, and that native fish populations (including the sandfish) are in sharp decline. The survey also revealed an absence of young sandfish, which indicates widespread recruitment failure, and a species headed rapidly for extinction. With only two known tributaries where sandfish still spawn urgent conservation action is required to prevent the sandfish from going extinct. To this end, the Saving Sandfish project has initiated a programme to increase sandfish survival by employing local community members to rescue and relocate young fish from vulnerable habitats (with invasive fish and excessive water abstraction) in the lower Biedouw River to sandfish sanctuaries created by working with land-owners to remove alien fish from farm dams.

To date, over 30,000 juvenile sandfish have been rescued and relocated to the sanctuary dams, where they are reared to a bass-proof size and then released back into the wild. A PIT-tagging study is being used to monitor the survival of the dam-reared fish, and whether our rescue-rear-release intervention is boosting the wild spawning population of sandfish. To date over 1500 fish have been tagged and released – an intervention that has boosted the wild sandfish spawning population in the Biedouw River by 99 fish, representing a 55% increase in the number of migrating sandfish.

Looking forward, we will be building on these foundations to (1) rescue 10,000 more sandfish, (2) tag and release a further 3500 dam-reared sandfish back into the wild, (3) monitor the survival and movement of these fish using a PIT tag antenna, (4) initiate an alien species removal project in the upper Biedouw River to secure the long-term survival of the sandfish and co-occurring endemic fish species and (5) use visual media to raise awareness and support for local freshwater conservation.

Saving Sandfish is a community conservation project that would not be possible without support from our project partners, supporters and funders.

Funders

National Geographic Society, Mohammed Bin Zayed Species Conservation Fund, IUCN Save Our Species co-funded by the European Union, the Ford Wildlife Foundation, IUCN Species Survival Commission and the Rufford Foundation.

Partners

Fishwater Films, Fynbos Fish Trust, CapeNature, Cederberg Conservancy, the Northern Cape Department of Environment and Nature Conservation, Endangered Wildlife Trust, World Fish Migration Foundation, Enjo Nature Farm, Driehoek Guest Farm, Alpha Excelsior Farm, Mertenhof Farm, Hartbesluit Farm, Jai Yen Yen, Mount Ceder, Bushmans Kloof, Gone Outdoor, Federation of South African Flyfishers (FOSAF), Investec, Caleo Capital, Wemmershoek Diagnostic Laboratory.

Project Value

Since 2019: R 2,527,215.00

2021–2022: R 1 850 000.00





Breekrans River Restoration Project

Freshwater fish are the most threatened species group in South Africa and the Western Cape Province is at the epicenter of South Africa's freshwater fish emergency, with a higher proportion of threatened endemic freshwater fish than anywhere else in the country, and perhaps the continent. Threats include anthropogenic impacts on water quality and water quantity, climate change and invasive species, but predation by non-native fish is recognized as the top threat to the regions' endemic freshwater fishes. Urgent conservation action is needed to restore priority aquatic ecosystems and safe guard threatened species from extinction.

The Breekrans River Restoration Project aims to mechanically remove alien spotted bass from 8km of the otherwise-pristine Breekrans River to increase the range of the Critically Endangered Doring fiery redfin from 2km to 10km.

The project, which involves constructing a barrier weir to prevent bass reinvasion after clearing, and comprehensive monitoring and communication components, will substantially improve the conservation status of the Doring fiery redfin. The project will reclaim habitat for five co-occurring native freshwater fishes, build freshwater conservation capacity and create an employment opportunity for local community members.

The first step of the project is trimming riparian vegetation to open up the river channel and expose all pools in the river to enable effective manual eradication of bass.

Funders

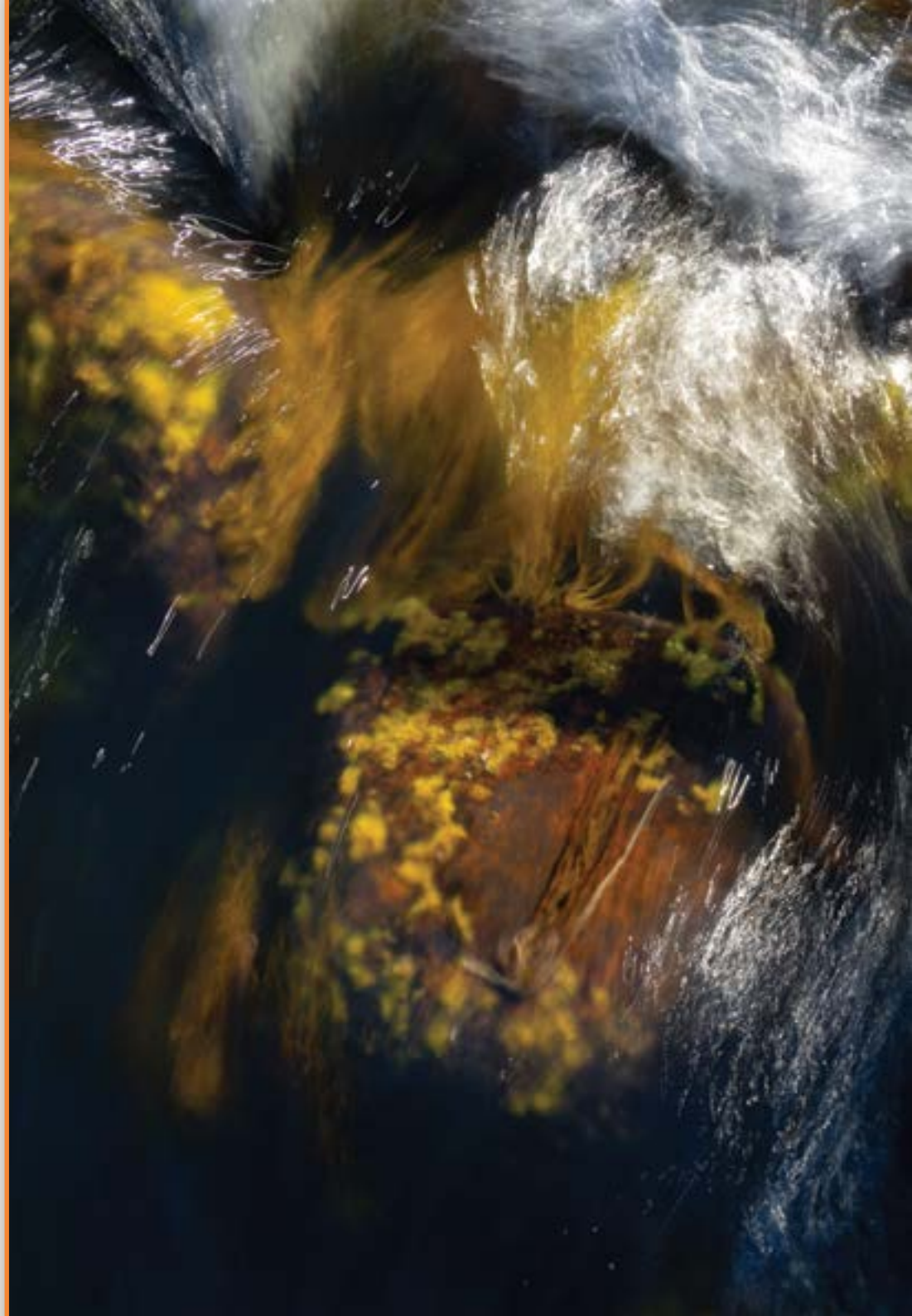
TotalEnergies

Partners

Fynbos Fish Trust, CapeNature, Cederberg Conservancy, Mountain Club South Africa, Breekrans Trust, Fishwater Films

Project Value

R 1,500,000.00





Kavango Zambezi Transfrontier Freshwater Ecosystems Systematic Conservation Planning Study

2022 saw the commencement of a new project led by WWF-Zambia to undertake a systemic conservation planning to identify high priority freshwater conservation areas in the Kavango Zambezi (KAZA) region encompassing the Cubango, Cuito and Cuando River Basins of southeast Angola – the three key basins delivering water to the Okavango Delta.

The government of Angola intends to re-zone national parks, identify community conservation areas, designate a new Ramsar site in the headwaters and delineate a Biosphere Reserve within parts of the Cuito-Cuando basins. Freshwater protected areas will be key to this planning and re-zoning process and essential for delivering ecosystem services to the Okavango.

The project is being implemented through WWF-Zambia, in partnership with The Nature Conservancy, Associação de Conservação do Ambiente e Desenvolvimento Integrado Rural and the Peace Parks Foundation as well as other key Angolan institutions.

Researchers at the FRC will use a GIS-based, systematic conservation planning approach that will integrate identified and predicted freshwater biodiversity hotspots, and corridors within and outside the parks, including community and natural resource use areas, agriculture, fisheries, water sources and sacred and cultural sites.

Progress to date includes the assimilation of all available distribution records relating to freshwater biodiversity features in the basins of interest, including, fish and water-dependant mammals and birds. We have been working with partners in the United States to develop detailed geospatial information relating to the hydrography, vegetation, wetlands, as well as human impacts including indices of human settlement density and existing and future water resource infrastructure.

Experts from the South African Institute for Aquatic Biodiversity were consulted, and datasets were assimilated from the National Geographic Okavango Wilderness Project for the latest information on freshwater species distributions in the basins.

These datasets will be analysed with key Water Source Areas to identify areas, not only of biodiversity value, but areas which deliver critical downstream ecosystem services. Our next task in 2023 will be to assimilate these layers using the conservation planning software Marxan to identify areas of high conservation priority.

Funders

WWF-Zambia

Partners

WWF-Zambia, The Nature Conservancy, Associação de Conservação do Ambiente e Desenvolvimento Integrado Rural, Peace Parks Foundation, Zambezi Watercourse Commission, Gabinete para a Administração da Bacia Hidrográfica do rio Cunene, and OKACOM and the National Water Resources Institute; Instituto Nacional de Recursos Hídricos. National Geographic Okavango Wilderness Project.

Project Value

R 811,324.00



Bioinformatics

Freshwater Biodiversity Information System (FBIS)

In May 2021, FRC, together with our technical partner, Kartoza, and key stakeholder, SANBI, began working on Phase 2 of the FBIS project. This second phase focuses on increasing the diversity of data served, data flow, geographic coverage and strategically embedding FBIS into South Africa's main freshwater decision-making pipelines. During these two years, we have developed two new abiotic modules for serving water temperature time series data and physico-chemical data. The thermal module is based on outputs from the water temperature guidelines for perennial rivers in South Africa, developed by FRC as part of a Water Research Commission-funded project (K5/2537). A physico-chemical module allows these data, which are often collected as companion data to biodiversity data, to be uploaded and visualised independently of biodiversity data. Water temperature time series data and physico-chemical data are now at the fingertips of freshwater decision-makers, conservation planners, research scientists and environmental consultants, and the thermal module will improve our ability to track climate change impacts on South Africa's freshwater ecosystems and manage them accordingly.

From the biodiversity data perspective, FRC have developed anuran (frog) and wetland plant modules. Approximately 41,500 anuran occurrence records for the 134 South African anuran species, and 67,200 plant occurrence records for the 2,500 plant species are served in FBIS. The inclusion of inland wetland data will expand the FBIS community by bringing in many wetland scientists and practitioners, adding greater value to the FBIS through data sharing. Excitingly, a mobile app is currently in testing stage – this will increase data flow into FBIS in the future.

The FBIS community continues to grow with over 553 sign ups from 235 different organizations. A major focus this period has been training, both training of FBIS Administration team and FBIS data providers. For the latter, this has been done as a series of online weekly FBIS training sessions. A total of 300 individuals registered for the training, from > 200 different organizations. All [FBIS Training Sessions \(2022\)](#) and [FBIS Tutorials \(2022\)](#) are available on the FRC YouTube channel.

A significant focus for Phase 2 of FBIS is integrating data from FBIS into key decision-support tools and to date data from FBIS has been used to generate the first freshwater biodiversity sensitivity layers for inclusion in the national Department of Forestry, Fisheries and the Environment (DFFE) Environmental Impact Assessment (EIA) Screening Tool, alongside the development of national freshwater fish sampling protocols. Further data pipelines being focused on include the River Ecosystem Monitoring Programme, National Biodiversity Assessment, Species Red Listing, and National Freshwater Ecosystem Priority Areas.

The FBIS currently serves > 650,000 freshwater biodiversity occurrence records. Here is a link to the FBIS platform: <https://freshwaterbiodiversity.org/>

Funders

JRS Biodiversity Foundation

Partners

Kartoza, South African National Biodiversity Institute, South African Environment and Observation Network, South African Institute for Aquatic Biodiversity, Department of Water and Sanitation, Endangered Wildlife Trust, CapeNature, SANParks, Association for Water and Rural Development, City of Cape Town, Water Research Commission.

Project Value

Since 2017: R 9,500,000

FBIS Phase 2: R 5,000,000

Tracking change in South Africa's Freshwater Biodiversity

LOGIN

SIGN UP

CONTACT

Biodiversity Records



Fish

60,846 Records
15,652 Sites
24,614 Site Visits



Invertebrates

370,909 Records
20,319 Sites
83,376 Site Visits
13,048 SASS



Algae

17,601 Records
611 Sites
12,056 Site Visits



Odonates
(adult)

100,417 Records
13,154 Sites
22,467 Site Visits



Anurans

41,486 Records
16,136 Sites
41,252 Site Visits



Plants

67,273 Records
24,929 Sites
67,273 Site Visits

BioSmart: Biodiversity Systems Management and Analytics for the Restoration of Transboundary Rivers

The FRC collaborated with the Association for Water and Rural Development (AWARD) (<http://award.org.za/index.php/projects/bio-smart/>) on the Biodiversity Systems Management and Analytics for the Restoration of Transboundary Rivers (Bio-SMART) project, an expansion of the Freshwater Biodiversity Information System (FBIS). Data consolidation and mobilisation focused on data received from three key stakeholder, namely the South African Environment Observation Network, South African National Parks, Inkomati-Usuthu Catchment Management Agency, as well as independent external database submissions. A total of 143,077 biodiversity occurrence records mobilised for the lowveld region of South Africa are now available to freshwater practitioners and authorities mandated to manage and conserve freshwater ecosystems and biodiversity.

Funders

Association for Water and Rural Development (AWARD)

Partners

South African Environment Observation Network, South African National Parks, Inkomati-Usuthu Catchment Management Agency

Project Value

R 182,000.00

African freshwater bioinformatics workshop

FRC hosted two online seminar series “Freshwater Biodiversity in Africa Seminar Series 2021” and Freshwater Biodiversity in Africa Seminar Series 2022. This replaced the original in person workshop that had been cancelled due to the COVID pandemic. The seminar series was well attended by over 20 different organisations from seven different African countries (South Africa, Rwanda, Botswana, Malawi, Tanzania, Kenya, Uganda), as well as some relevant European organisations. The seminar series provided an exciting space to learn from other projects, discuss common challenges, and explore future collaboration and synergies amongst projects. Topics explored included: Cultivating productive data-provider relationships, Achieving platform impact, Tracking platform impact, Platform scaling and synergies, Platform sustainability and longevity, Platform outreach and promotion, and Freshwater taxon lists. Both series were recorded and are available as playlists on the FRC YouTube channel ([Freshwater Biodiversity in Africa Seminar Series 2021](#)) and ([Freshwater Biodiversity in Africa Seminar Series 2022](#))

To highlight the value of a data point, a short film “[The Life of a Data Point](#)” has been produced.

Funders

JRS Biodiversity Foundation

Partners

Albertine Rift Conservation Society, Rwanda; Center of Excellence in Biodiversity and Natural Resource Management, University of Rwanda; National Fisheries Resources Research Institute, Uganda; the Association for Water and Rural Development, South Africa; National Museums of Kenya, Kenya; Dar es Salaam Institute of Technology, Tanzania; Sokoine University of Agriculture, Tanzania; Lilongwe University of Agriculture and Natural Resources, Malawi; Groundwater Management Institute, SADC; Okavango Research Institute, Botswana; African Demography Unit, University of Cape Town, South Africa; South African National Biodiversity Institute, South Africa; South African Earth Observation Network, South Africa; South African Institute for Aquatic Biodiversity, South Africa; Kartoza, South Africa; Upande, Kenya; NugSoft, Uganda; AquaHub, Austria.

Project Value

R 800,000.00

The Rwanda Biodiversity Information System (RBIS)

The FRC worked with the Center of Excellence in Biodiversity and Natural Resource Management, University of Rwanda, and our technical partner, Kartoza, to develop a modified version of the FRC's Freshwater Biodiversity Information System (FBIS), tailored to the needs of Rwandan stakeholders. The RBIS includes biodiversity records and collections, a resource site, analytic and mapping capacity, and thematic modules. Substantial focus has been on training the RBIS data management team in the data administration workflows to create master lists for each biodiversity group, uploading occurrence records, and manage all aspects of the RBIS administration.

Funders

Center of Excellence in Biodiversity and Natural Resource Management, University of Rwanda, University of Rwanda

Partners

Kartoza

Project Value

R 600,000

The Okavango Repository for Biodiversity data (ORBIS)

The FRC are working with the Okavango Research Centre (ORI) to develop a modified version of the FRC's Freshwater Biodiversity Information System (FBIS). The ORBIS includes biodiversity records and collections, a resource site, analytic and mapping capacity, and thematic modules. A small ORBIS data management team have been trained in the data administration workflows to create master lists for each biodiversity group, uploading occurrence records, and manage all aspects of the RBIS administration. The FRC and ORI are actively seeking further funding to expand ORBIS, to improve the quality and accessibility of biodiversity-related data and to establish a data repository to store biodiversity-related data collected in Botswana. ORBIS promotes the use of data for evidence-based decision-making and conservation policy development in Botswana.

Funders

The University of Botswana

Project Value

R 100,000

Partners

Kartoza

Developing an Atlas and Phenology of Dragonflies and Damselflies in South Africa

One of the greatest challenges for scientists, including citizen scientists, is getting their data into the 'marketplace' or into a space where they can be used to inform management, conservation or policy. The successful collaboration between the Biodiversity and Development Institute (BDI) and the Freshwater Research Centre (FRC) has enabled the wealth of citizen science data in the Virtual Museum's (VM) OdonataMAP and FrogMAP databases to be accessible via the Freshwater Biodiversity Information System (FBIS). The project promotes citizen science by engaging with the citizen science community and encouraging the collection and submission of data to the VM. In 2021 alone, 18,678 new records were added to OdonataMAP for South Africa, many for Near Threatened, Vulnerable, or Endangered species. Through this project, the BDI has also produced online atlases of dragonflies, damselflies, frogs and toads in South Africa, where each species page includes maps, phenology plots, annotated photographs showing the chief identification features of each species, and photographs of their habitat. The success of OdonataMAP and FrogMAP would not be possible without the tireless efforts of passionate and nature-loving citizen scientists. Their data contributions now have far greater reach through the linking with FBIS, which has successfully mobilised the wealth of citizen science biodiversity data in South Africa.

Funders

JRS Biodiversity Foundation

Partners

African Demography Unit, University of Cape Town, South Africa; Biodiversity and Development Institute

Project Value

R 1,650,000.00

Climate Change

Update of the Climate Change Status Quo Analysis for Water Resources and the Development of a Climate Change Response Strategy for the Water and Sanitation Sector in South Africa

During 2022, the Freshwater Research Centre was commissioned by Emanti (Pty) Ltd in partnership with Zutari (Pty) Ltd and the Climate Systems Analysis Group (CSAG) to review, update and expand the Department of Water and Sanitation (DWS) Climate Change Status Quo Assessment and Climate Change Response Plan. The FRC headed up the status quo assessment of South Africa's aquatic ecosystems – both inland and estuarine – in terms of their current state and anticipated responses to climate change and recommended appropriate adaptation strategies which will enhance their resilience in the context of IWRM and water governance. The review covered the following issues:

- *South Africa's aquatic ecosystems*—the typology and classification of inland and estuarine aquatic ecosystems were described in terms of the country's main ecoregions introducing their vegetational and physiographic characteristics as well as their biogeography and diversity.
- *Threats and current state*—we reviewed and consolidated information on the current status of freshwater ecosystems in terms of existing threats and vulnerability.
- *Climate change effects*—here we reviewed the current state of knowledge relating to climate change effects on inland aquatic and estuarine ecosystems on a global as well as national scale.

- *Regional Analysis by WMA*—we provided a broad overview of the response of specific water management areas, hydro-climatic zones and freshwater ecoregions relating to the effects of climate change
- *Adaptation and Risk Mitigation Strategies*—we proposed adaptation strategies and ways to enhance the resilience of freshwater ecosystems in terms of appropriate policies, methods and tools for mitigation and risk management in the context of IWRM and water governance. The adaptation and risk mitigation strategies focussed on management actions that reduce non-climate threats.
- *Monitoring and Research*—we proposed monitoring and research priorities moving into the future based on predicted climate change responses and likely future needs.

In addition to Water Ecosystems, the review included consideration of the effects of climate change on future streamflow and evaporation, groundwater, sanitation, water quality, water management and infrastructure. We undertook two workshops for training and capacity building on behalf of the DWS.

Funders

Emanti (Pty) Ltd

Partners

Emanti (Pty) Ltd, Zutari (Pty) Ltd and the Climate Systems Analysis Group (CSAG)

Project Value

R 123,420.00



Water & Livelihoods

A multi-stakeholder approach to enhancing sustainable water management and agricultural practices for the benefit of people and the environment in the Koue Bokkeveld

The years 2021 and 2022 were busy and exciting ones for our work in the Koue Bokkeveld, with strong collaborations established with the Institute for Water Research at Rhodes University as well as the National Research Institute for Agriculture, Food and Environment (INRAE) in France. Invaluable partnerships with WWF-SA and Western Cape Department of Agriculture, Landcare Programme continue to bear fruit.

In mid-2021 we commissioned Zutari Engineering to develop a user-friendly Water Balance Tool (WBT) that can be used by WUAs for month-by-month as well as for strategic planning. We will be developing this tool further in Excel using VBA script to automate much of the analysis.

More sophisticated Agent-Based Models are being developed by the IWR (funded by the Water Research Commission of South Africa) and INRAE. All these models will be tested in terms of their suitability for supporting both operational and strategic management and planning of water resources in the Koue Bokkeveld. These models are considered cutting edge approaches to natural resource management.

We intend to use these models to draft a water resources management plan which will be a document outlining monitoring tools and protocols for managing the catchment optimally while also providing flows for downstream ecosystems and species.

At the core of our approach is monitoring and data gathering – in particular rainfall and river flows – which are used to evaluate the state of the system as well as calibrate hydraulic and hydrological models. We now have four rainfall stations and two flow monitoring sites – with a third being set up on the Suurvlei River.

In addition to the work we are doing on the rivers, our catchment coordinator, Stefan Theron has overseen the clearing of 443 ha in 2021 and 95 ha in 2022 of alien invasive plants in the Suurvlei, Twee and Middeldeer Rivers.

Early in 2022, the 9607 ha Tweerivieren Nature Reserve was gazetted. This was a direct result of tireless work by the project team – particularly WWF-SA – to find consensus among landowners and push the process through. This will be managed under the CapeNature Stewardship reporting and management structures.

Funders

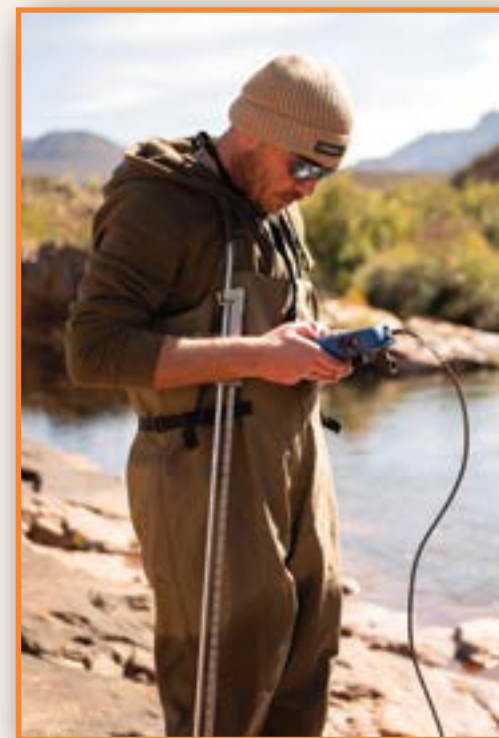
Hans Hoheisen Charitable Trust,
WWF-SA, Department of Agriculture
Western Cape, Water Research
Commission of South Africa (WRC).

Partners

WWF-SA, Department of Agriculture
Western Cape Landcare
Programme, French National
Research Institute for Agriculture,
Food and Environment (INRAE),
Koue Bokkeveld Water Users
Association.

Project Value

R 1,142,460.00



Catchment Coordinator, Stefan Theron



Skills & Training

Biomonitoring Training

The team from the Grootvadersbos Conservancy (GVB) were trained in SASS (South African Scoring System). SASS is the cornerstone of river monitoring and is widely used by river practitioners in South Africa to assess the health of our rivers. The course involves a combination of theoretical and practical training on SASS and the identification of aquatic macroinvertebrates.

The course was given in the GVB Conservancy allowing the GVB team to grow their confidence and practical ability in their home territory. The dedication of the GVB team to practicing the SASS field assessments and in particular identification of macroinvertebrates, following the course, ensured that they all became accredited within 6 months of the training. They now undertake regular SASS assessments as part of their routine monitoring, the results of which are communicated to stakeholders, and add their data to the Freshwater Biodiversity Information System (FBIS).

In February 2022, a team of scientists, interns and trainees from the City of Cape Town, received training in SASS5. Together with two independent consultants, the group enthusiastically sampled a range of rivers, identified aquatic macroinvertebrates, interpreted data and learnt to add SASS data to FBIS. More experienced scientists shared their knowledge with newer trainees, making for an enjoyable and rewarding training course.





Education & Outreach

Living Labs

Founded in 2016, Living Labs is the Freshwater Research Centre's River education and outreach programme. It centres around connecting schools and other community groups to nearby rivers for an immersive nature experience, at the same time collecting meaningful ecological data. Rivers are ideal outdoor classrooms for learning about biodiversity, ecology and conservation, and the activities covered during the Living Labs experience are designed to complement what is learned in Life Sciences at schools. Under the guidance of passionate freshwater biologists, the groups conduct their own 'miniSASS' assessment – a biomonitoring tool to estimate the health of the river.

This hands-on, wet feet, “real science” experience allows learners to relax in nature and connect with their local river environment – often for the very first time. Besides the palpable excitement that an encounter with a larval dragonfly generates, the river health assessment also produces meaningful data about the state of the river ecosystem. The results are uploaded to a national database and thereby made available to scientists and freshwater decision makers.

Living Labs also offers miniSASS training, equipment and ongoing support for school teachers and community leaders, thereby striving to grow a strategic network, each connected to a river which they learn from and help conserve.

Over the period 2022-2023, the focus of the programme was on running training courses, miniSASS river health outings and school camps. To date we have run 4 miniSASS training courses, 70 school outings, and 4 school camps reaching over 2500 learners. In total, 67 educators have received training in both river health assessment protocols, and in running river conservation biology experiences for school groups, and river health sampling kits have been provided to five of these groups.

A highlight over this period has been partnering with NGO Youth 4 Conservation (Y4C) to run Saving Sandfish conservation camps in the Cederberg for high school learners. The learners participated in a sandfish rescue and saved over 1000 juvenile sandfish from predation by invasive fish species.

Funders

The National Geographic Society, Cape Town Environmental Education Trust, Keen Outdoor and The Nature Conservancy has made this work possible.

Partners

Youth4Conservation

Project Value

R 250,000.00



Publications 2021

Scientific Papers

Dallas HF. 2021. Rapid bioassessment protocols using aquatic macroinvertebrates in Africa – considerations for regional adaptation of existing biotic indices. *Frontiers in Water*. DOI: 10.3389/frwa.2021.628227.

Lehner B, Katiyo L, Chivava F, Sichingabula HM, Nyirenda E, Rivers-Moore NA, Paxton BR, Grill G, Nyoni F, Shamboko-Mbale B, et al. 2021. Identifying priority areas for surface water protection in data scarce regions: An integrated spatial analysis for Zambia. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31: 1998–2016.

Olsen T, Shelton JM and Dallas HF. 2021. Does thermal history influence thermal tolerance of the freshwater fish *Galaxias zebratus* in a global biodiversity hotspot? *Journal of Thermal Biology*. DOI: org/10.1016/j.jtherbio.2021.102890.

Ramulifho PA, Foord SH and Rivers-Moore NA. 2021. Structure and diversity of blackfly assemblages in the Luvuvhu River system, South Africa in response to changing environmental gradients. *Hydrobiologia* DOI: 10.1007/s10750-021-04741-4.

Ramulifho PA, Rivers-Moore NA and Foord SH. 2021. Loss of intermediate flow states only evident when considering sub-daily flow metrics in a major tributary of the Limpopo basin. *Ecohydrology* 15(2). DOI: 10.1002/eco.2381.

Rivers-Moore NA and de Moor FC. 2021. Climate-linked freshwater habitat change will have cost implications: Pest blackfly outbreaks in two linked South African rivers. *River Research and Applications* 37: 387–398.

Rivers-Moore NA, Paxton BR, Chivava F, Katiyo L, Phiri H, Katongo C, Thieme ML, Lehner B and Linke S. 2021. Aquatic areas of ecological importance as inputs into surface water resource protection areas in Zambia. *Aquatic Conservation: Marine and Freshwater Ecosystems*.

Reports and Theses

Shelton J, Snaddon K, Paxton B. 2021. Freshwater biodiversity and habitat monitoring at mainstem sites in the Theewaterskloof Catchment, South Africa. *Prepared for The Nature Conservancy by the Freshwater Research Centre*, August 2021. Pp 56.

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Chapters in books

Dallas HF, Rivers-Moore NA and Kaje M. 2021. Climate Change: Abiotic drivers, impact on water resources and ecosystems, mitigation, and management options. Chapter 12. In (Eds. Day JA, Day BA and Reizenberg J) *WRC@50*. Water Research Commission, Pretoria. South Africa.

Machingura J, Coetzee J, Dallas H, Day B, Day J, Hay D, Skelton P, Thirion C and Uys M. 2021. The evolution of ecosystem research – from biodiversity to biosessments. Chapter 07. In (Eds. Day JA, Day BA and Reizenberg J) *WRC@50*. Water Research Commission, Pretoria. South Africa.

Snaddon K, Kotze D, Pretorius L and Fortune F. 2021. The Water Research Commission Wades into Wetland Research. Chapter 9. In (Eds. Day JA, Day BA and Reizenberg J) *WRC@50*. Water Research Commission, Pretoria. South Africa.

Popular articles

South Africa's freshwater fish face extinction (*Mail and Guardian* 2021)

Conserving one of the world's most threatened migratory fish (*The Fisheries Blog* 2021)

Helen Dallas – A career dedicated to the conservation of southern Africa's freshwater systems. (*Water Wheel* Page 24)

Films

Dr Jeremy Shelton Freshwater Scientist and photographer

Waterdak – the roof of the Western Cape

(To view these films and others visit the 'Freshwater Research Centre' and 'Fishwater Films' Youtube channels)

Publications 2022

Scientific Papers

Cerrilla C, Afrika J, Impson D, Jordaan MS, Kotze N, Paxton BR, Reed C, Schumann, van der Walt JA and Shelton JM. 2022. Rapid population decline in one of the last recruiting populations of the endangered Clanwilliam sandfish (*Labeo seeberi*): The roles of climate change and non-native fish. *Aquatic Conservation: Marine and Freshwater Ecosystems* DOI: 10.1002/aqc.3785.

Dallas HF, Shelton JM, Sutton T, Tri Ciputra D, Kajee M and Job N. 2022. The Freshwater Biodiversity Information System (FBIS) – mobilising data for evaluating long-term change in South African rivers. *African Journal of Aquatic Science* 47(3): 291-306, DOI: 10.2989/16085914.2021.1982672.

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Tanner J, Mantel S, Paxton B, Slaughter A and Hughes D. 2022. Impacts of climate change on rivers and biodiversity in a water-scarce semi-arid region of the Western Cape, South Africa. *Frontiers in Water* 4. doi.org/10.3389/frwa.2022.949901.

Reports

Shelton J, Snaddon K, Paxton B. 2022. *Monitoring freshwater biodiversity responses to invasive alien plant removal in catchments surrounding Theewaterskloof Dam*. Prepared for The Nature Conservancy by the Freshwater Research Centre. 53 pp

Chapters in books

Jordaan M, Shelton J, Chakona A, van der Colff D. 2022. Under water and out of sight: the hidden world of the threatened freshwater fishes of the Cape Fold Ecoregion Elephant. In: M.T. Sethusa, D.L. Dalton & C. Pretorius (eds), *South African animals at risk of extinction*. South African National Biodiversity Institute, Pretoria, South Africa.

Rivers-Moore NA and Dallas HF. 2022. Quantifying climate change impacts on river system ecology in South Africa. In: *Climate Change Impacts on Water Resources: Implications and Practical Responses in Selected South African Systems*. (Ed. Petja BM). *Water Research Commission Report no. SP 155/22*, Water Research Commission, Pretoria, South Africa.

Popular articles

Giant Redfin: Conserving South Africa's Native Fish (*The Nature Conservancy's Cool Green Science Blog*, 21 March 2022)

Safe havens: Conserving endangered Clanwilliam sandfish, pool by pool (*UCT News*, 22 April 2022)

Scientists, farmers team up to save one of SA's most threatened fish (*News 24*, 1 April 2022)

Red die onderbekvis (*Landbou Weekblad*, 22 April 2022)

Saving South Africa's most threatened fish (*Getaway*, 2022)

The unprecedented effort to save one of Africa's most threatened fish (*National Geographic*, 2022)

Clear Water Revival (*bioGraphic* 2022)

Saving the Sandfish – a case study in biodiversity (*Investec* 2022)

South Africa's sandfish are on the brink of extinction: how farmers are helping rescue them (*The Conversation* 2022)

Films

Diving In: Students Document River Habitats in South Africa

Protecting the Giant Redfin

Saving sandfish – The quest for spawning

The Ghosts of Table Mountain

The Life of a Data Point

(To view these films and others visit the 'Freshwater Research Centre' and 'Fishwater Films' Youtube channels)

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JRS Biodiversity Foundation
Mohammed Bin Zayed Species Conservation Fund
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Red Meat Research & Development South Africa
Rufford Foundation
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South African National Biodiversity Institute
Southern Waters
Table Mountain Fund
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The University of Botswana
The University of Rwanda
Total Energies
Water Research Commission of SA
World Wide Fund for Nature – South Africa
World Wide Fund for Nature – Zambia

Key Partners

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Department of Agriculture Western Cape, Landcare Programme
Department of Water and Sanitation
Department of Environment and Development Planning
Institute of Natural Resources
Kartoza
South African Institute for Aquatic Biodiversity
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Financials 2022

Statement of Financial Position

Figures in Rand	2023	2022	2021
Assets			
Non-Current Assets			
Property, plant and equipment	42,492	44,322	53,129
Current Assets			
Trade and other receivables	9,718	251,139	104,870
Cash and cash equivalents	4,807,417	3,469,353	2,557,278
	4,817,135	3,720,492	2,662,148
Total Assets	4,859,627	3,764,814	2,715,277
Capital and Liabilities			
Capital			
Retained income	1,045,239	733,740	628,238
Liabilities			
Current Liabilities			
Trade and other payables	3,814,388	3,031,074	2,087,039
Total Equity and Liabilities	4,859,627	3,764,814	2,715,277

Statement of Comprehensive Income

Figures in Rand	2023	2022	2021
Revenue	6,041,256	5,224,571	3,541,193
Other income	436,576	629,091	607,384
Grant funding expenses – Consulting fees	(3,778,358)	(3,488,383)	(3,128,746)
Grant funding expenses – Other	(963,498)	(2,315,746)	(850,818)
Grant prepaid income	(685,602)	–	–
Operating expenses	(860,196)	–	–
Operating profit	190,178	49,533	169,013
Investment revenue	121,321	55,969	58,820
Surplus for the year	311,499	105,502	227,833
Other comprehensive income	–	–	–
Total comprehensive income for the year	311,499	105,502	227,833

Detailed Income Statement

Figures in Rand

	2023	2022	2021
Grant Revenue			
Grant funding income	6,041,256	5,224,571	3,541,192
Grant funding expenses – consulting fees	(3,778,358)	(3,488,383)	(3,128,746)
Grant funding expenses – other	(963,498)	(777,655)	(1,194,207)
Grant prepaid income	(685,602)	(958,533)	781,761
Training and Education			
Living Labs training income	–	33,309	–
Living Labs training expenses	–	(33,309)	–
SASS training income	161,948	45,187	46,800
SASS training expenses	(161,948)	(45,187)	(46,800)
Freshwater Research Centre NPC Income			
Donations	257,440	4,877	12,696
Saving Sandfish donation income	190,300	182,350	–
Saving Sandfish donation expense	(190,300)	–	–
Equipment and vehicle rental income	86,002	122,816	28,599
Gains on disposal of assets	35,999	–	–
Grant administration fees	–	464,386	536,626
Insurance proceeds	–	3,962	–
Office rental income	19,835	17,975	5,400
Profit on sale of asset	–	–	3,913
Salary reimbursements	37,300	15,075	20,150
	436,576	629,091	607,384
Freshwater Research Centre NPC operating expenses	(860,196)	(579,557)	(438,373)
Operating profit	190,178	49,534	169,011
Investment income	121,321	55,969	58,820
Profit for the year	311,499	105,503	227,831

