National Research Foundation | SAIAB South African Institute for Aquatic Biodiversity

The South African Institute for Aquatic Biodiversity

ANNUAL RESEARCH REPORT 2019-2020

NRF-SAIAB

ANNUAL RESEARCH REPORT
2019 - 2020

National Research Foundation | SAIAB South African Institute for Aquatic Biodiversity

NRF-SAIAB Annual Research Reports 2019 and 2020
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Human Capacity Development

NETWORK.

Strategic Engagement and Collaboration

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Strategic Engagement and Collaboration

APPENDICES.

OBITUARY
Professor Olaf Lawrence Fredrick Weyl
(1972-2020)

Photo courtesy of NRF-SAIAB, taken by Robyn Oosthuizen

Professor Olaf Weyl was born in Giesen, Germany, but moved to Africa at an early age as a result of his father's work in international development. He completed his BSc at Rhodes University, South Africa, before embarking on an MSc, rapidly upgraded to a PhD, on The dynamics of a sub-tropical lake fishery in central Mozambique under Professor Tom Hecht at Rhodes. After completing his PhD, Olaf moved to Malawi where he worked as fisheries research and management advisor to the Department of Fisheries (1998-2002). During this period he learned much about interacting with experienced scientists and managers, something he carried through the rest of his career. He returned to South Africa in 2003 first as a Post-Doctoral fellow and then as Senior Lecturer in the Department of Ichthyology and Fisheries Science at Rhodes University (2004-2009). Thereafter, Olaf seized on an opportunity to grow his research career and was employed by the National Research Foundation at the South African Institute for Aquatic Biodiversity (NRF-SAIAB), initially as a Senior Scientist in 2009, then Principal Scientist in 2012, and Chief Scientist in 2017. This calculated move to a National Facility resulted in Olaf using his skills and global network to build multiple collaborations with researchers from across Southern African and globally in the fields of fish ecology, invasion biology and inland fisheries management. He built a strong and dynamic research group in SAIAB that without doubt will miss his leadership and boundless drive. In 2017 Olaf was awarded the South African Research Chair in Inland Fisheries and Freshwater Ecology, which was testimony to his outstanding work in the pursuit of excellence in both inland fisheries and freshwater invasion biology.

Olaf had a profound impact on both the research and applied aspects of fisheries science and ably bridged the gap between these two very different discourses. He was a prolific author with over 220 peer-review papers, with many more to come from the legacy he leaves behind. He served as Assistant Editor for Journal of Fish Biology and Associate Editor for Aquatic Invasions, African Zoology, Biological Invasions, and BioInvasions Records. Sustained research outputs and a high standing resulted in his appointment as a Professor at the University of Toronto Scarborough (Canada), Adjunct Professor at University of Nebraska Lincoln (USA), Honorary Professor at Rhodes University (South Africa) and a Core Team Member at the DST/NRF Centre of Excellence for Invasion Biology (University of Stellenbosch, South Africa). He was also the Regional Chair for Southern Africa in the Freshwater Fish Specialist Group of the IUCN Species Survival Commission (SSC), Scientific Committee member of the Future Earth bioDISCOVERY Core Project,

and lead author for the IPBES assessment report on invasive alien species and an expert for the IPBES nexus assessment scoping report. He contributed to the development of South African policy frameworks including the National Strategy on Alien and Invasive species and the National Environmental Management: Biodiversity Act: Alien and Invasive Species Regulations and Lists.

Olaf was an incredibly gregarious character, which he attributed to his formative days meeting and talking with consultants visiting and working with his father. It was inevitable that Olaf would work in fisheries: he developed a passion for nature as he grew up in Zimbabwe and was an avid and excellent angler. He was never happier than when trying to catch fish in remote areas or showing you his favourite fishing spots. Olaf passed away doing what he loved best, chasing fish in mountain streams.

He had an infectious personality, formidable intellect and wicked humour. He was incredibly forward thinking and was at the forefront of research and policy to promote sustainable development of fish and fisheries and aquatic ecosystems in African inland waters, but he never forgot his roots in aquatic ecology and conservation. He brought a unique blend of fisheries science and management to a wide audience, from academics to managers to fishers to landowners, and was always willing to offer his support and knowledge to identify solutions to wider environmental conflicts. Indeed, just days before he sadly passed away, Olaf submitted the edited proofs of a paper to the *African Journal of Aquatic Sciences* entitled "Ten research questions to support South Africa's Inland Fisheries Policy", which exemplifies his amazing ability to bridge science and policy. This remarkable ability was especially valuable when dealing with what he described as 'wicked problems' in society, as when bridging the deep chasm of mistrust between the anglers and authorities wishing to regulate alien sport fishes in South Africa. As an active party to both communities, he understood where each came from and what was desirable and achievable in seeking a solution. It is credit in no small way to his contributions that, after many years, the National Environmental Management: Biodiversity Act (NEM:BA) regulations including all major freshwater fish alien species in South Africa, were finally approved and signed into law by the Minister earlier this year.

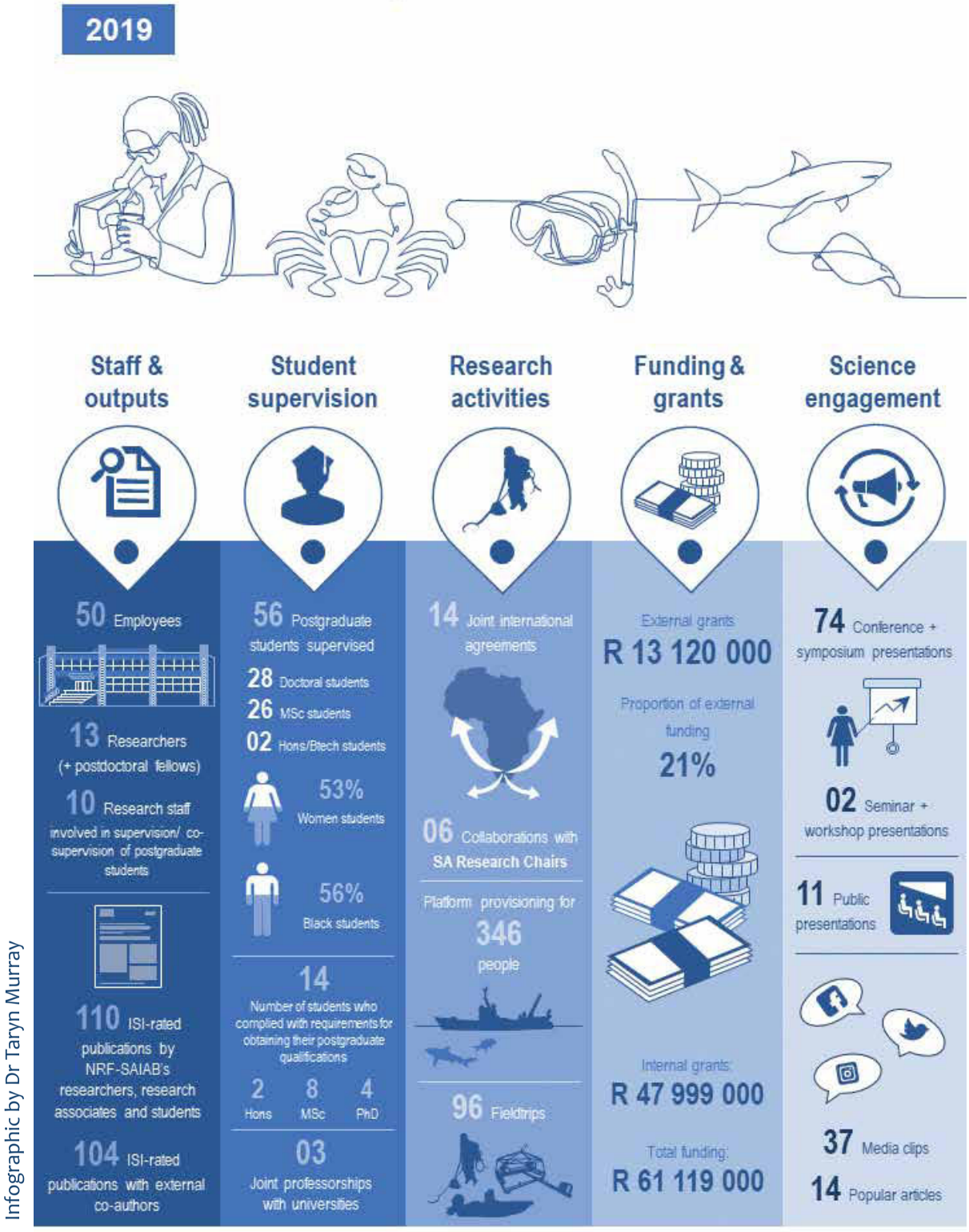
Olaf had a special talent in attracting excellent students from all corners of the subcontinent at a time when there is a desperate need to grow and transform the discipline in Africa. With his teams of postgraduate students and postdocs, he was supportive of numerous fisheries research and management projects across the region. Throughout these projects, Olaf was a constant source of encouragement and guidance, not only to his researchers but also to everyone engaged in fisheries activities in the region. The research results from his numerous projects provided the scientific justification for sound management and legislation, while at the same time supporting research capacity development and leaving in place trained scientists in countries across southern-central Africa. At conferences on fish, fisheries and other aquatic research disciplines throughout Africa, he and his students were invariably prominent contributors and active participants in discussions and future planning.

His personality was such that in one breath he could sweep aside nonsense from any individual and in the next completely nurse the bruised ego that might have resulted from the bluntness of his approach. Through his remarkable academic leadership and outsized personality he was able to coax tremendous loyalty, dedication and productivity from his colleagues, post-docs and students. The personal tributes that have flowed forth from his team following his passing illustrate just how deeply he engaged with every one of them. In all, he leaves a massive institutional gap, and it will be very difficult to fill. In part, the tragedy of his passing at this time is that the educational and mentoring aspect of his life-journey, building a new science generation in Africa, was just hitting full stride.

Dr Angus Paterson of SAIAB and a close friend of Prof Weyl summed up his life so perfectly: "Olaf was in so many ways a giant of man with an intellect that could only be matched by his inordinate ability to love and nurture those around him". He will be sadly missed by his family, friends, colleagues and all those who had the pleasure of knowing and working with him.

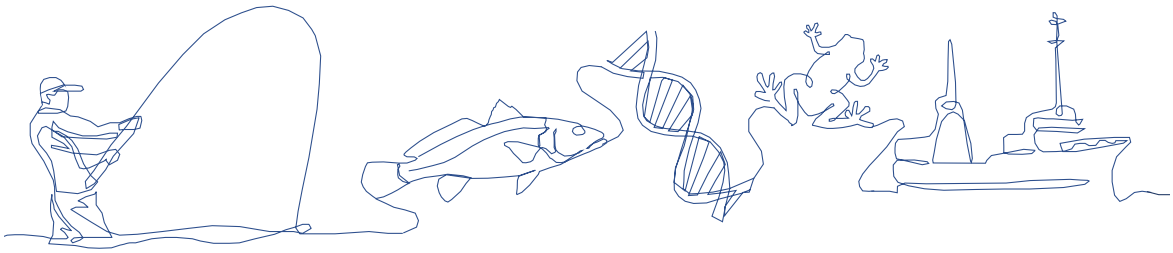
Olaf is survived by his wife Michelle, twin daughters Phillipa and Olivia, parents Ulrich and Gaby, brothers Michael and Phillip, and sisters Julia and Anika. He was highly respected and the impact of his research, mentoring and larger than life personality will continue to resonate in Africa and beyond for a long time.

Ian G. Cowx, University of Hull International Fisheries Institute, UK
Nicholas Mandrak, University of Toronto Scarborough, Canada
Denis Tweddle and Paul Skelton, South Africa Institute of Aquatic Biodiversity, SA



Infographic by Dr Taryn Murray

2020



Staff & outputs

52 Employees

17 Researchers (+ postdoctoral fellows)

10 Research staff involved in supervision/ co-supervision of postgraduate students

143 ISI-rated publications by NRF-SAIAB's researchers, research associates and students

124 ISI-rated publications with external co-authors

Student supervision

61 Postgraduate students supervised

31 Doctoral students

27 MSc students

03 Hons/Btech students

48% Women students

43% Black students

17 Number of students who complied with requirements for obtaining their postgraduate qualifications

4	8	5
Hons	MSc	PhD

03 Joint professorships with universities

Research activities

11 Joint international agreements

06 Collaborations with **SA Research Chairs**

Platform provisioning for **275** people

26 Fieldtrips

Funding & grants

External grants

R 14 114 000

Proportion of external funding

18%

Internal grants:

R 65 839 000

Total funding:

R 79 953 000

Science engagement

20 Conference + symposium presentations

05 Seminar + workshop presentations

08 Public presentations

45 Media clips

16 Popular articles

Infographic by Dr Taryn Murray

For more information, please visit **www.saiab.ac.za/**

2019 Research Overview

The South African Institute for Aquatic Biodiversity (NRF-SAIAB) serves as a hub for national and international scientific research into the country's most precious resource—water—and the diversity of life supported by our marine, coastal and inland freshwater ecosystems. NRF-SAIAB's mandate is to undertake research for the sustainability of Africa's marine and freshwater environments. To this end, NRF-SAIAB provides research platforms and infra-structure which enable a wide range of multi-disciplinary and multi-institution research into inland fisheries and freshwater ecology, constantly changing coastal systems and the movement of marine fisheries species. All the research undertaken at NRF-SAIAB contributes knowledge about how water-based ecosystems function: this includes up-to-date information on the movement of fisheries species along the coast and the impact of societal demands on the coastal, estuarine and freshwater resources of the country. This information is crucial for understanding and managing these essential natural resources for the long-term benefit of South Africa's people.

NRF-SAIAB's unique research platforms are available to the broader research community in the National System of Innovation (NSI). These platforms include the aquatic biodiversity collections, associated specialist laboratories and services which integrate modern molecular and bio-banking systems, a community-driven marine flagship programme (the African Coelacanth Ecosystem Programme—ACEP); and marine platform provision—coastal craft, *in situ* instrumentation, Remotely Operated Vehicle (ROV), Remote Video Systems and the Acoustic Tracking Array Platform (ATAP). In line with its status as a National Facility, all platforms are available to the broader research community.

SAIAB hosts the DSI/NRF Research Chair in Inland Fisheries and Freshwater Ecology and provides a regional research platform for freshwater African aquatic biodiversity research through research and project management with a number of sub-Saharan countries.

NRF-SAIAB interacts with a broad range of universities and local and national governments regarding current environmental issues, which require the integration of science with management, and providing scientific evidence that policy makers can apply in the formulation of national environmental policy. Areas of national concern in which NRF-SAIAB is involved are socio-economic development, water security issues, ecosystem degradation and the influence of climate change on food security.

The NRF-SAIAB fish collection is an internationally acclaimed research resource. In 2019 international visitors to the platform included Dr Dave Ebert from Moss Landing, USA, Dr Irit Zohar (University of Haifa, Mount Carmel, Israel), Dr Peter Psomadakis (FAO, Rome, Italy), Dr Jay Stauffer (Pennsylvania State University, USA) and Dr Franz Uiblein (Institute of Marine Science, Bergen, Norway).

Postdoctoral Fellow, Dr Josie South was awarded a Transnational Access EU2020 AQUACOSM grant to take a South African cohort to study microplastics and pharmaceuticals in The Nether-lands. Collaborators included Postdoctoral Fellow Dr Josephine Pegg and PhD candidates Mr Dumisani Khosa and Mr Lubabalo Mofu.

Dr Ant Bernard was appointed as a member of the Global Oceans Observing System (GOOS) Biology and Ecosystems Panel to further the development of the essential ocean variables for fishes and subsequently attended the GOOS BioEco panel meeting in Santa Barbara, California.

Dr Albert Chakona visited the Royal Museum for Central Africa (MRAC, Belgium), Bavaria State Collections (ZSM, Germany) and Cornell University Museum of Vertebrates (CUMV, USA) to work with collaborators on fish taxonomy and gain expertise in next generation sequences techniques, and analysis of electric organ discharges (EODs) which are integral to the systematics of weakly electric fishes (Mormyridae) endemic to Africa.

Dr Gavin Gouws undertook a research visit to the Western Australian Museum (Perth) to advance several taxonomic projects, and undertook an extended roadshow in Australia, presenting seminars at the Indian Ocean Centre (University of Western Australia), Murdoch University and the University of Queensland to explore collaborative opportunities. Dr Gouws attended the FSBI Advances in eDNA for Fisheries and Management Conference in Hull, UK. He also visited and presented a seminar at the Institute for Biological, Environmental and Rural Sciences, University of Aberystwyth (Penglais Campus), Wales, to develop and continue collaborations.

Prof Paul Cowley travelled to Arendal, Norway to attend the 5th International Conference on Fish Telemetry (ICFT), where he presented on the long-term acoustic monitoring of juvenile bull sharks and gave a talk to introduce the global acoustic telemetry exchange (GATE) programme.

ATAP Instrument Technician, Matt Parkinson, attended the annual Ocean Tracking Network's International Data Management Committee Meeting in Halifax, Canada on behalf of ATAP, maintaining strong ties with the international acoustic telemetry community.

Prof Olaf Weyl hosted a research collaboration workshop in South Africa to develop continued collaboration with Jaimie Dick (Queens University,

Belfast), Tony Ricciardi (McGill University, Montreal, Quebec) and with Hugh MacIsaac (Windsor University, Windsor, Ontario) on future collaboration and approaches in invasion ecology. Prof Weyl gave a presentation at the Idaho Department of Fish and Game Eagle Fish Genetics Laboratory to an audience of research scientists on alien fish research in South Africa and participated at the small scale fisheries advisory roundtable on the development of new assessment tools for small scale fisheries at FAO in Rome.

The productivity of NRF-SAIAB research staff, students, postdocs and Honorary Research Associates continued at a high level during 2019, with 111 ISI rated scientific papers being published. The majority of these papers were by NRF-SAIAB affiliates of Rhodes University. It was also a bumper year in terms of conference and symposium papers, with 74 being delivered at a wide variety of national and international venues. Some research highlights follow.

NRF-SAIAB's Acoustic Tracking Array Platform (ATAP) monitors more than 650 tagged animals (33 species) for more than 30 researchers from 14 institutions around the country. Data collected over 2019 highlighted the remarkable journey of a Zambezi shark that undertook return migration from the Breede Estuary to Mozambique. The platform was highlighted during several presentations at the 5th International Conference on Fish Telemetry held in Norway and the 5th South African Marine Linefish Symposium, where Prof Paul Cowley gave a plenary talk entitled *A century of fish tagging in South Africa: what have we learnt?*

During 2019, Dr Nikki James and her research team focussed on the relative value of different coastal nursery habitats for marine and estuarine fish species as well as the impact of climate change on fish species within these habitats. A highlight for the year was initiating an NRF Marine and Coastal Research Grant programme to further explore the connectivity of coastal and estuarine nursery habitats.

Dr Ant Bernard initiated a research project looking into the potential of environmental DNA (eDNA) to survey photic and mesophotic benthic reef fishes. This project, which is funded through the NRF Marine and Coastal Research Grant, will develop field and laboratory protocols for the collection and analysis of eDNA, validate the technique against other benthic sampling methods, and establish a eDNA laboratory at NRF-SAIAB and Rhodes University.

The 2019 research highlights for the Coastal and Ocean Sciences Team (COST) led by Dr Francesca Porri underlined important outputs that link to maintenance of biodiversity and discoveries. These features include research carried out in African mangroves, with the description of a new of decapod, *Parasesarma capensis* and an analysis of patterns of recruitment of crab larvae in the East African mangroves which has revealed the tight link between fauna and trees in these unique and endangered systems.

Dr Gavin Gouws's research group is expand-ing its research footprint to include behavioural ecology and evolutionary biology as research themes through a focus on reproductive behavior of and sexual selection in clinid fishes.

The focus of Dr Albert Chakona's research group is to advance revisionary taxonomy and systematics of freshwater fishes in southern Africa. A key publication from his research group in 2019 explored the use of molecular data as a novel approach for reconstructing the historical distribution ranges of freshwater taxa fragmented by human-mediated impacts.

Prof Olaf Weyl's research group continues to engage at multiple levels with key research contributions including comment on long-term sustainable fisheries in the African Great Lakes; an evaluation of the current extent and potential spread of black bass invasions in South Africa; thermal tolerances of native freshwater fishes in South Africa's Cape Fold Ecoregion; assessments of predator-prey interactions in a chemically altered aquatic environment; and a global review and metaanalysis of applications of the freshwater Fish Invasiveness Screening Kit.

Professor Olaf Weyl
Chief Scientist: NRF-SAIAB

2020 Research Overview

2020 was an unprecedented year and a year of challenges. Not only did the Covid-19 pandemic change the face of our research, but NRF-SAIAB also lost its Chief Scientist, Prof Olaf Weyl.

Before the lockdown regulations, US collaborators Dr John Hargrove, Dr Mathew Campbell, Dr Amanda Carr (Idaho Dept of Fish and Game, USA), Dr Eric Peatman (Auburn University, USA) and UK Collaborator Dr Robert Britton (Bournemouth University, UK) visited NRF-SAIAB to collaborate in a workshop with the freshwater group on "Genetic bottlenecks and the success of alien fish populations".

In early 2020, visitors to the Collections Platform included Dr Jay Stauffer (Pennsylvania State University, USA), Dr George Turner (Bangor University, UK) and Dr Antonia Ford (University of Roehamton, UK).

Dr Johann Mourier (Institut de Recherche pour le Développement (IRD), France) spent a month at NRF-SAIAB, collaborating with Prof Paul Cowley and the ATAP team. Dr Albert Chakona visited the Royal Museum for Central Africa (MRAC, Belgium), the Bavaria State Collections (ZSM, Germany) and Cornell University Museum of Vertebrates (CUMV, USA) to work with collaborators on fish taxonomy, to gain expertise in next generation sequences techniques and to gain expertise in the analysis of electric organ discharges (EODs), which are integral to the systematics of weakly electric fishes (Mormyridae) endemic to Africa.

Postdoctoral Fellow, Dr Josie South was invited to give talks at the British Ecological Society Invasions Symposium in Northumbria, University of Essex and Queen's University Belfast, while Postdoctoral Fellow, Dr Jessica Glass attended an Adaptation Genomics workshop in Berlin, Germany.

The productivity of NRF-SAIAB research staff, students, postdocs and Honorary Research Associates continued at a high level during 2020, with a record 143 ISI rated scientific papers being published. Some research highlights follow.

During 2020, more than one million detections were recorded on ATAP's nationwide array of receivers, bringing the total number of detections in the database to just shy of 25 million. In addition, two new Vulnerable species (lesser guitarfish and spinner sharks) were equipped with transmitters, bringing the total number of animals tagged and monitored to more than 1 600 from 48 species.

The year started with a return visit to Breede Estuary to tag more bull sharks. The ATAP local team was accompanied by collaborators from the Institute of Research for Development (IRD) in France. Prof Paul Cowley also joined NRF-SAIAB's freshwater group to acoustically tag alien carp in the Groenvlei Lake. Further fieldwork during the year was limited due to Covid-19 travel restrictions. However, ATAP obtained an essential services exemption permit to ensure that all deployed receivers within the national ATAP array could be serviced.

Prof Paul Cowley and the ATAP team continued to assist three ACEP-funded projects in 2020 (which collectively saw the tagging of approximately 60 animals), and ATAP also provided infrastructure and data management support to two newly funded projects managed by the WILDOCEANS programme of the WILDTRUST that aim to tag over 200 new animals with a focus on selected South African threatened endemic sharks and rays, as well as transboundary movements and MPA connectivity by selected species. To date, over 40 animals of seven different species have been tagged, with significant tagging efforts to be undertaken in 2021.

With funding support from an NRF-Marine and Coastal Research Grant, Dr Anthony Bernard and his team commenced their project investigating the potential for environmental DNA (eDNA) to assess diversity and assemblage structure on benthic and demersal fishes found on photic and mesophotic reef habitats in South Africa. They began collaborative research on two new WILDOCEANS projects: Oceans Alive and the Shark and Ray Conservation project, that build on research carried out previously in the iSimangaliso Wetland Park, on eDNA research and on national stereo-BRUVS research. The planned research collaboration with Nekton on the First Descent project in the Seychelles and Maldives was postponed to 2022.

2020 saw the commissioning of MARIP's lightweight deep-sea stereo-camera landers and mid-water drifting baited remote underwater stereo-video systems (stereo-BRUVs), to sample fishes found on the deep mesophotic habitats on South Africa's continental shelf and to investigate the shallow and deep-sea pelagic and demersal fish assemblages. MARIP remained an integral platform within ACEP, by successfully completing the data collection for the Canyon Connections and SALPA projects and being included in all the new ACEP projects approved in 2020. Additional research support was provided for the Blue Action Fund Oceans Alive project, the Shark Conservation Fund Shark and Ray conservation project, the NRF Reef Fish eDNA project.

Under the leadership of Dr Errol Wiles, the Geophysics and Mapping Platform's new inertial navigation system was successfully commissioned on *RV uKwabelana*. The commissioned system was put through its paces conducting nearshore surveys off Durban's Bluff, and uMdloti reef complexes with the benefit of SBG's post-processing software, Qinertia, to deal with motion-induced data artefacts common when working along South Africa's wave-dominated

and energetic coastline. The Geophysics and Mapping Platform is primed to support geo-spatial marine research, providing high resolution and high-accuracy bathymetry and backscatter intensity data to the marine scientific community. The second edition of the International Symposium on Coastal Hazards in Africa, hosted by NRF-SAIAB and chaired by Dr Errol Wiles, took place in October 2020. The symposium provided opportunities to develop relationships between research, industry, and national/local government. A Special Issue in Estuarine, Coastal and Shelf Science will highlight the most relevant research emanating from the symposium and invited additional contributions which grapple with coastal hazards in Africa.

During 2020, Dr Nikki James and her research team continued to focus on the relative value of different coastal nursery habitats for marine and estuarine fish species, as well as the impact of climate change on fish species. This research is collaborative and multi-disciplinary: examining and mapping habitat, autotrophs (seaweed and seagrass), resources (invertebrates and diatoms) as well as fish assemblages. A team of six PhD students were involved in this research in 2020. The students in this team are 67% female and 67% black, helping to address equity and transformation of the science sector in South Africa.

During 2020, the Coastal and Ocean Sciences Team (COST), led by Dr Francesca Porri, saw through several student graduations, successfully signalling the end of several projects. The associated research outputs for the year mostly include novel knowledge on the architectural complexity of mangrove roots used as microhabitats by fish and invertebrate larvae, as well as the on the role of ecological engineering on the associated intertidal biodiversity (World Harbour Project). Much of the research progress during 2020 was achieved thanks to home-relocated laboratories, where several morphometric traits have been measured for the research on resilience of sea urchin populations along the coast of South Africa. Once back in the molecular laboratory, good progress has been made in terms of unravelling the taxonomy of several groups of larvae (including fish and crustaceans), collected from coastal microhabitats, such as jetties and pontoons, within an urban marina.

Dr Albert Chakona's research visits to the Royal Museum for Central Africa (MRAC, Belgium) and the Bavarian State Collection of Zoology (ZSM, Germany) enabled examination of primary type-specimens from various museums in Europe and the USA, training on next generation sequencing techniques, and analysis of electric organ discharges (EODs). This information is integral to the ongoing revisionary taxonomy and systematic research for freshwater fishes of southern Africa. A Special Issue on the biology and ecology of African freshwater fishes, co-edited with Prof Olaf Weyl, was published in the *Journal of Fish Biology*.

Dr Gavin Gouws's research group expanded its research footprint to include behavioural ecology and evolutionary biology as research themes through a focus on reproductive behaviour of and sexual selection in clinid fishes. Dr Gavin Gouws resigned from NRFSAIAB at the end of August of 2020, emigrating to the UK with his family.

Prof Olaf Weyl contributed to high impact papers on global issues such as climate change, and fisheries and invasion impacts. The outputs of a workshop drawing together African and international experts in inland fisheries science and management published in the African Journal of Aquatic Science, reports on aspects of key importance to national policy development. Whilst many conferences were cancelled due to Covid-19 in 2020, the group attended the online American Fisheries Society annual meeting. Prof Olaf Weyl gave an invited talk titled "The importance of respecting culture, practicing inclusivity, and enabling participation when leading diverse teams in southern Africa". The 2020 field season started well; however, it ended abruptly in March due to the COVID-19 lockdown. As a result, several student projects had to be significantly amended or replaced with new projects. Lack of access to both to NRF-SAIAB and analytical facilities made work difficult for some team members. Over the course of the year significant efforts were made to remedy this, within the limits of what could be safely achieved. Sadly, on 14 November 2020, Prof Olaf Weyl passed away while doing what he loved most; he was in the mountains exploring new sites to sample trout genetics. NRF-SAIAB lost a formidable leader, highly respected scientist and a loved colleague and friend. Despite his untimely passing, Olaf's contributions to science will resonate for a long time. After the passing of Prof Olaf Weyl, his research group continued to engage at multiple levels with key research contributions including comment on long-term sustainable fisheries in the African Great Lakes; an evaluation of the current extent and potential spread of black bass invasions in South Africa; thermal tolerances of native freshwater fishes in South Africa's Cape Fold Ecoregion; assessments of predator-prey interactions in a chemically altered aquatic environment; and a global review and meta-analysis of applications of the freshwater Fish Invasiveness Screening Kit.

Professor Paul D Cowley
Acting Chief Scientist: NRF-SAIAB

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Spatial Ecology for Improved Management of Coastal Resources

Prof Paul Cowley, Principal Scientist

Background and objectives

Effective management of marine and estuarine fish resources in southern Africa lags far behind most other parts of the world. With broad multi-institutional collaborations, my research group has been using acoustic telemetry methods to investigate the behavioural ecology of coastal fishes for approximately two decades. The overarching goal of this research is to generate new knowledge for the implementation of improved local and regional conservation measures, and it specifically addresses questions relating to (i) movement patterns (residency vs migratory), (ii) habitat use patterns and changes with ontogeny, (iii) multiple habitat connectivity, (iv) identification of migration corridors and critical habitats, (v) transboundary movements, and (vi) management effectiveness of Marine Protected Areas (MPAs). Answers to these research questions are essential to mitigate the multiple stressors placed on marine and estuarine fishes in the Anthropocene, including over-exploitation, habitat alteration and destruction, pollution, and the increasing threats of climate change.

This research is strongly aligned with the global Sustainable Development Goal (SDG) #14 (Life below Water) to address objectives relating to the management of marine and coastal ecosystems, sustainable use of resources for increased economic benefits, development of research capacity, and scientific knowledge to conserve biodiversity. This research also supports SDGs 1 (No Poverty), 4 (Quality Education), 5 (Gender Equality), 12 (Responsible Consumption and Production) and 17 (Partnerships for the Goals). This research was instrumental in establishing the nationwide Acoustic Tracking Array Platform (ATAP), managed by NRF-SAIAB, thereby supporting South Africa's National Development Plan (NDP) to provide infrastructure and foster innovation.

Research activities

During 2019, I attended several conferences relevant to my research activities. Several colleagues from South Africa and I travelled to Arendal, Norway to attend the 5th International Conference on Fish Telemetry (ICFT). SAIAB hosted the 2nd ICFT in 2013 of which I am a member of the scientific organizing committee. At the event, I gave a presentation on the long-term acoustic monitoring of juvenile bull sharks and gave a speed talk to introduce the global acoustic telemetry exchange (GATE) programme. I was also a co-author on presentations by two ex-PhD students of mine. Later in the year I attended the 5th South African Marine Linefish Symposium and gave a plenary presentation entitled "A century of fish tagging in South Africa: what have we learnt?" Many of my past and current students also gave oral or poster presentations at this event.

During 2019, several field expeditions were undertaken, one of which was a trip to the Breede Estuary to tag more bull sharks, and several trips to service ATAP's acoustic telemetry hardware around the country. My research group also participated in a training Summer School to expose students from several HBUs to acoustic telemetry research.

Training and supervision

My research provided training and capacity development to one PDP postdoctoral candidate, two PhD students, three Masters students, one BSc (Hons) student and one WWF intern. Ms Chantel Elston (PhD) was the only student to graduate in 2019. The postdoc candidate, Dr J.D. Filmalter, expanded our research at the Breede Estuary in order to assess connectivity with the nearby De Hoop no-take marine reserve.

Outcomes

My research outputs in 2019 included seven ISI-rated publications. I participated in a multi-authored international review paper that highlighted the contribution that animal-borne telemetry has made to monitor our ocean's environmental conditions. My colleagues and I described the spawning dynamics of the world's largest aggregation of giant kingfish. Some individual fish travelled as far as 600 km and crossed an international border to participate in the spawning event involving over 3000 fish. This spatially and temporally predictable aggregation is extremely vulnerable to over-exploitation. Other papers stemming from student-based research included a description of the movement patterns of the vulnerable porcupine ray in an important nursery at a remote atoll in the southwestern Indian Ocean.

At the same remote location, we tagged bonefish, which is a highly sought-after recreational angling species and economically important fish within the tourism-based flyfishing industry. This work revealed that catch-and-release angling within this tourism sector is not benign as high post-release mortality

occurs at remote areas with high predator (shark) biomass.

Another paper analysed a large fish tagging dataset collected over 30 years to reveal the intra-population variability in the movement behaviour of wide-ranging and resident coastal fishes. In addition, a detailed assessment of the movement patterns of the endemic black musselcracker revealed extreme residency, particularly in juveniles. Lastly, mark-re-capture methods were used to estimate population size and survival of the endemic pyjama catshark in a coastal embayment. All the above-mentioned research outputs have direct implications for the conservation and management of the studied species, hence appropriate management measures were recommended.

Impact for society

The sustainability of fishery resources worldwide is plagued by conservation inadequacies, including inappropriate management measures, limited law enforcement capacity, and low compliance by resource users. Knowledge of the movements and migrations of exploited, threatened, and vulnerable species is essential to integrate spatial planning initiatives such as protected areas, and to designate no-take areas. My research addresses these management inadequacies by providing empirical long-term data on the movements and habitat use patterns of numerous fish, sharks, and rays. A further concern is that management uptake of such information is often slow, so our research team engage actively with fishery participants (e.g., attend fishing competitions) and give public presentations. We also expose our research on social media (Facebook, Twitter, and Instagram) and through the publication of popular articles.

Future work

My research on coastal fishery species is ongoing. Significant focus will be placed on shared stocks and transboundary movements of selected sharks, rays and fishery species over the next few years.

This work will also address the management effectiveness of several MPAs (e.g., De Hoop marine reserve, Goukou Estuary no-take zone (Stilbaai MPA), Mntentu Estuary (Mkambati MPA) and the iSiMangaliso Wetlands Park MPA.

Funders

Ocean Tracking Network (Infrastructure); Save Our Seas Foundation (Running expenses); SA-Norway Research Co-operation Programme; SAN-COOP and SANOCEAN (Infrastructure and running expenses); WILDTRUST (Infrastructure and running expenses from the Blue Action Fund and the Shark Conservation Fund); NRF (Infrastructure, bursaries and running expenses).

Dr JD Filmalter preparing to tag two juvenile dusky kob with acoustic transmitters in the De Hoop MPA.

2020 Highlights

The year started with a return visit to Breede Estuary to tag more bull sharks; our local team was accompanied by collaborators from the Institute of Research for Development (IRD) in France. I also joined NRF-SAIAB's freshwater group to acoustically tag alien carp in the Groenvlei Lake. Further fieldwork during the year was limited due to Covid-19 travel restrictions. However, we obtained an essential services exemption permit to ensure that all deployed receivers within the national ATAP array could be serviced. During 2020, I co-authored seven manuscripts and devoted considerable time to drafting two chapters for a new book entitled *Fish and Fisheries in Estuaries: A Global Perspective* that will be published in 2021.

Where do rays roam?

Dr Chantel Elston, Postdoctoral Fellow

The year 2020 saw the start of my postdoctoral research project which aims to investigate the distribution and movement patterns of certain rays along South Africa's coastline. Animals had already been tagged with acoustic transmitters prior to the start of my project, and data on the movement of these animals have been passively accumulating for several years. Eighty-nine individuals across four different ray species are being tracked, and this has resulted in a large dataset. Given this, much of 2020 involved preliminarily analysing this data to understand where these rays spend their time. Additional data in the form of citizen sightings have also been accumulated to further understand the distribution patterns of these species. This has required public outreach and education. Finally, a localized Baited Remote Underwater Video Systems (BRUVs) fieldwork component was also planned to determine how rays utilize certain ecosystems. Fieldwork is planned to commence in 2021. Understanding animal movement is essential for conserving and sustainably managing and using marine resources (SDG 14: Life below Water and SDG 12: Responsible Consumption and Production).

Prof Paul Cowley tagging a stingray with an acoustic tag.

Reef ecology and conservation

Dr Anthony Bernard, Instrument Scientist

Background and objectives

Subtidal rocky and coral reef ecosystems extend from the shoreline down into the deep sea. The ecosystems support high biodiversity and essential services that contribute significantly towards the well-being of humans. These essential services include the provision of nutrition and jobs for millions of people from different cultural and economic backgrounds, the protection of coastal communities, and numerous valuable natural products. However, reef ecosystems are exceptionally vulnerable to anthropogenic impacts. Equally, global climate change is causing warming and acidification of the oceans, intensifying storms, and changing ocean currents and upwelling systems; this is having knock-on effects on ecosystem structure and species distributions. Investigating the effects of natural environmental variables on the structure of reef ecosystems provides fundamental knowledge to improve our basic understanding of these systems. This fundamental knowledge is essential to understand the scale, extent and impact of anthropogenic disturbances, and is the foundation for meaningful applied research.

This project aims to contribute towards delivery of ecosystem services by advancing the reef ecological research through method development and by providing knowledge suitable to inform and optimise biodiversity and resource management. Within the scope of this aim, we conduct research under three key objectives:

1) Advance our understanding of how environmental factors influence the structural and spatial ecology of reef ecosystems from the shallow subtidal into the mesophotic zone. Current research: long-term monitoring of warm-temperate reefs; determining reference states for fish assemblages; assessing how environmental variation effects the structure of reef fish assemblages in the Western Indian Ocean (WIO).

2) Determine the impact of pressures and management interventions on the structure and functioning of subtidal reef ecosystems. Current research: measuring the effectiveness of MPAs at conserving biodiversity and fisheries species within South Africa and the broader WIO; assessing the impacts of cumulative pressures on reef ecosystem condition; testing hypotheses for fishing and climate change refugia associated with increased water depth.

3) Advance subtidal research methodology and research capacity in South Africa through development, testing and optimisation of sampling tools. Current research: development of untethered baited remote underwater stereo-video systems for deep-sea benthic research; development of protocols for collecting and processing environmental DNA from photic and mesophotic reefs.

Training and supervision

Research undertaken within this project is supported by the NRF-SAIAB's strong post-graduate programme, and includes students based at NRF-SAIAB or at other local and international institutions. Although from diverse backgrounds, these students have a common interest in life underwater, ecology and the sustainable management of reef ecosystems. Furthermore, our research involves a diverse suite of local and international collaborators from various governmental and non-governmental organisations, and where required, we contribute towards the training of early career scientists.

Impact for society

Capacity development:

In 2019, 10 post-graduate students undertook research within the project. This included four PhD students looking into environmental drivers of reef ecosystem structure, the effects of cumulative pressures on reef ecosystem condition, and the impact of fisheries decisions on reef fishes. Six students carried out research towards MSc degrees, with research ranging from assessments of MPA effectiveness, environmental drivers of fish population structure, and the effect of MPAs on the physiological resilience of reef fishes to climate change.

Management support:

By improving our understanding of the structure and functioning of reef ecosystems in South Africa and the WIO, the research from this project enables us to measure the impacts of fisheries and conservation initiatives and track the effects of climate change. Our findings provide critical information to support marine spatial planning, and sustainable biodiversity and resource management. Knowledge generated through the project fed into the 2018 National Biodiversity Assessment, published in 2019. Furthermore, research conducted in 2019, in collaboration with the Wildlife Conservation Society, identified priority areas for conservation in northwest Madagascar and provided data to advance the conservation of elasmobranchs in the WIO.

Knowledge development:

In 2019 three peer-reviewed papers were published, with a key paper in *Marine Ecology Progress Series*, demonstrating the effectiveness of a suite of MPAs on South Africa's south and east coasts.

Future work

Many of the current research activities, listed above, will continue into 2020. We have new PhD students starting to work on the eDNA project and the regional assessment of fish assemblage structure and status. New research includes a national assessment of the status of endemic elasmobranchs and assessments of pelagic fishes at the Coco de Mer seamounts, Seychelles and Maldives.

Additional information

Our research is supported by: Wildlife Conservation Society (Collaboration and Funding), NRF-Research and Technology (Funding), NRF-Marine and Coastal Research Programme (Funding), NRF-SAIAB (Collaboration and Funding), Wild Oceans (Collaboration and Funding), ACEP (Funding), iSimangaliso Wetland Park (Funding).

The untethered acoustic release stereo-BRUVs prior to deployment (a) and retrieval (b) during a research cruise to the outer Agulhas Bank.

2020 Highlights

With funding support from an NRF-Marine and Coastal Research Grant, we commenced our project investigating the potential for environmental DNA (eDNA) to assess diversity and assemblage structure on benthic and demersal fishes found on photic and mesophotic reef habitats in South Africa. We began collaborative research on two new WILDOCEANS projects: Oceans Alive and the Shark and Ray Conservation project, that build on our research carried out previously in the iSimangaliso Wetland Park, our eDNA research and our national stereo-BRUVS research. Our planned research collaboration with Nekton on the First Descent project in the Seychelles and Maldives has been postponed to 2022. Four papers were published; of these, the highlights were international collaborative papers, one on the best practices for the baited remote underwater stereo-video system (stereo-BRUVs) sampling method and the other, published in *Nature*, on the status and conservation potential of reef sharks around the world. Four students (one PhD, two MSc, one BSc Hons) within the research group graduated during 2020.

Malagasy fishermen returning to shore at the end of the day.

A cloud of small reef fish surround a barred rubberlip (*Plectorhinchus plagiodesmus*) stationed above a patch of coral reef in Nosy Sakatia in the northwest of Madagascar.

Shallow water nursery seascapes

Dr Nicola James, Senior Scientist

Background to the project and objectives

Although it is well understood that estuaries, and particularly seagrass beds in estuaries, serve as important nurseries for marine fish, comparative data on the use of marine habitats, such as seaweed beds, by marine species and the degree of connectivity between nursery habitats is lacking. Habitat degradation and loss of structural complexity are recognised as major threats to marine ecosystems, with impacts associated with climate change placing additional pressure on these ecosystems. Identifying and valuing nursery habitats, as well as quantifying impacts, is critical if these habitats are to be constructively managed and/or conserved. This information is vitally important for adaptation and mitigation planning, particularly in the fisheries sector. This project contributes towards the SDGs on Sustainability (SDG 12), Climate Action (SDG 13) and to Managing and Protecting Marine and Coastal Ecosystems (SDG 14).

Co-investigators and collaborators

Prof. Janine Adams (NMU)
Dr Amber Childs (RU)
Dr Gavin Rishworth (NMU)
Dr Anusha Rajkaran (UWC)
Dr Lucienne Human (NRF-SAEON Elwandle)
Dr Taryn Murray (NRF-SAIAB)
Dr Shirley Parker-Nance (NRF-SAEON Elwandle)
Dr Paul-Pierre Steyn (NMU)
Prof. Warren Potts (RU)
Prof. Sam Dupont (University of Gothenburg)

Research activities

Seasonal sampling of the Swartkops and Sundays estuaries and the nearshore sandy and shallow water reefs in Algoa Bay was undertaken throughout 2019. Monthly monitoring of coastal pH and acidification in Algoa Bay continued in 2019 as part of NRF-SAEON's PELTER Programme.

Training and supervision

Six PhD students: Ms Phakama Nodo, Ms Phumza Ndaleni, Ms Lauren Bailey, Ms Melissa Pollard, Ms Kerry-Ann van der Walt and Ms Carla Edworthy, as well as two MSc students: Mr Thembani Mkhize and Ms Kylen Brown were involved in this NRF-funded research programme. Preliminary research has highlighted important nursery habitats for marine and estuarine species in Algoa Bay.

Outcomes

An overview of this project was presented at a Swartkops Research Symposium. Ms Kerry-Ann van der Walt completed her PhD work on the impact of climate change on coastal and estuarine organisms in 2019.

Impact for society

Determining the nursery function of coastal and estuarine habitats, as well as assessing the impact of climate change on these habitats is particularly relevant, as the first national marine spatial plan in South Africa is currently being developed for Algoa Bay.

2020 Highlights

During 2020, Dr Nikki James and her research team continued to focus on the relative value of different coastal nursery habitats for marine and estuarine fish species, as well as the impact of climate change on fish species. This research is collaborative and multi-disciplinary: examining and mapping habitat, autotrophs (seaweed and seagrass), resources (invertebrates and diatoms) as well as fish assemblages.
A team of six PhD students, Ms Phakama Nodo, Ms Phumza Ndaleni, Ms Melissa Pollard, Ms Carla Edworthy, Ms Lauren Bailey and Mr Cuen Muller, as well as three MSc students: Mr Thembani Mkhize, Mr Mihle Gayiza and Ms Kylen Brown were involved in this research in 2020. The students in this team are 67% female and 67% black, helping to address equity and transformation of the science sector in South Africa.
A highlight for the year was the completion of Ms Carla Edworthy's PhD in December 2020 and the publication of ten research papers from this research team.

Future work

Funding from the NRF Marine and Coastal Research Grants allowed us to expand this programme, with a focus in the future on the connectivity of vegetated habitats in estuaries and Algoa Bay.

Additional information

NRF Marine and Coastal Research Grants (Funding), DST PDP Programme (Funding), NRF-SAIAB (Funding).

MSc students Thembani Mkhize and Mihle Gayiza setting up underwater video systems to record fish in seaweed habitats.

MSc student Kylen Brown, researchers Dr Anusha Rajkaran and Dr Nikki James and MSc student Thembani Mkhize collecting seagrass in the Swartkops Estuary.

Ecology of ecosystems

Dr Francesca Porri, Senior Scientist

Background and objectives

The research carried out by members of the Coastal and Ocean Sciences Team (COST) focuses on the ecology of coastal ecosystems, especially considering the spatio-temporal processes of early transitional forms and connectivity of, mostly, but not only, benthic invertebrates. Several individual projects, commonly pursued by postgraduate fellows, fall under a core of long-term research that aims at filling gaps of knowledge on the population-to-organism patterns and processes of coastal biodiversity in response to environmental and human pressure, often using a range of multidisciplinary applications, taxa and life stages.

The research carried out on larval ecology by the COST addresses several of the 17 sustainable development goals, closely interlocking human capacity efforts (Poverty Alleviation; Gender Equality; Quality Education; Peace, Justice and Strong Institutions) and directed research (Zero Hunger; Industry, Innovation and Infrastructure; Climate Action, and Life Below Water). Some of these goals are covered by the South Africa's National Development Plan, with the overall common objective of sustainably preserving the South African biodiversity and long-term boosting of the blue economy.

Research activities

Research operations in 2019 have focused on the patterns of larval assemblages at natural rocky shores and artificial hard infrastructures such marinas. More fieldwork has been carried out within the frame of the False Bay Project, investigating the role of natural ecosystems in reducing the effects of pollution in coastal areas. This project focuses mainly on False Bay, a highly urbanised coastal area bounded by Cape Town and several other coastal towns. Multiple fieldtrips along the east, south and west coast of South Africa were led by intern Suzanne Redelinghuys for her study on the phylogeography of the sea urchin, *Parechinus angulosus*.

Training/ supervision

Realistic development of human capacity and achievement of transformation goals are aggressively pursued by the COST through an inclusive and personal integration of individuals from under-represented demographic groups, accounting for the individual growth, educational needs and background. The mentoring of one Honours and five MSc students (four South African and one international), three PhD students, three Department of Science and Technology (DST) interns and one international intern has filled 2019, resulting in the successful completion of four MSc and one Honours.

Outcomes

The 2019 research advances by the COST led by Dr Francesca Porri highlight the description of a new pseudo-cryptic species of decapod, *Parasesarma capensis*, from the southeast African mangroves. Furthermore, patterns of recruitment of sesarmid crab larvae in the east African mangroves revealed a close association with vegetation where the adult populations occur, reinforcing the tight link between fauna and trees in these unique and endangered systems. Further research on larval ecology and connectivity of coastal populations has highlighted the active role of depth regulation by invertebrate larvae around coastal fronts and possible enhancement of shoreward advection and nearshore distribution of propagules. Rates of oxygen consumption of the dominant zooplankton from permanently open and temporally open/closed subtropical estuaries has also been determined.

Impact for society

Early-stage processes are drivers of population dynamics; they determine the onset of marine biodiversity and hence provide important functions and services, and they are important indicators of food webs, vulnerability and fitness of ecosystems exposed to

Dr Francesca Porri, Principal Investigator of the Coastal and Ocean Sciences Team (COST), rinsing larval samples while sampling on the rocky shores during fieldwork on the False Bay Project. Photo: Morgan Trimble.

climate, but they can be lost as a result of human pressure, such as the discharge of contaminants and nutrients in the water and the hardening of the natural shorelines.

Involvement in national research programmes with key societal links such as marine spatial planning (community of practice in Algoa Bay) and ecosystem resilience to pollution (False Bay Project), reinforces the importance of the focus on early-stage processes for maintenance of healthy systems and provision of services.

International involvement through participation in scientific meetings (invited presenter at the 6th International Marine Connectivity Conference September 2019, Aveiro, Portugal) also highlights the central role of organism-to-population processes in shaping coastal communities.

Future work

Research prioritised by the COST will further assess the effects of urbanisation on the diversity and functioning of larval assemblages. This topic remains largely overlooked although it is of increasing biological and societal significance, given the continued loss of natural habitats and the fundamental role of the mechanisms of larval transport of important economic and ecological marine resources in maintaining coastal resources.

Funders

NRF-ACEP; NRF-Community of Practice;
Rhodes University.

Seshnee Reddy (MSc candidate), Siphelele Dyantyi, Rebecca Reddy (DST interns) ready to deploy light traps at the natural rocky shores at Bushman's River mouth.

Seshnee Reddy (MSc candidate) and Siphelele Dyantyi (DST intern) showing the inner part of the light traps.

2020 Highlights

During the unprecedented 2020 year, the COST, led by Dr Francesca Porri, has seen through several student graduations, successfully signalling the end of several projects. The associated research outputs for the year mostly include novel knowledge on the architectural complexity of mangrove roots used as microhabitats by fish and invertebrate larvae, as well as the on the role of ecological engineering on the associated intertidal biodiversity (World Harbour Project). Much of the research progress during 2020 has been achieved thanks to home-relocated laboratories, where several morphometric traits have been measured for the research on resilience of sea urchin populations along the coast of South Africa. Larval assemblages associated with natural and artificial habitats have also been targeted.

Once back in the molecular laboratory, good progress has been made in terms of unravelling the taxonomy of several groups of larvae (including fish and crustaceans), collected from coastal microhabitats, such as jetties and pontoons, within an urban marina.

Evaluating resiliency of early life stages of fish and invertebrates in urban coastal systems using green eco-engineering

Dr Kerry-Ann van der Walt, Postdoctoral Fellow

The year 2019 was dedicated to completing my PhD thesis for submission on 12 December 2019. I was awarded an NRF postdoctorate funding scholarship at NRF-SAIAB to commence in 2020, to evaluate the resiliency of early life stages of fish and invertebrates in urban coastal systems using green eco-engineering. Throughout the course of the year, I assisted students where possible with field work at Kenton-on-Sea and Port Alfred. I also attended the 5th South African Line-fish Symposium where I gave an oral presentation on the topic, "Combining the dynamic method, static respirometry and maximum heart-rate experiments to understand the thermal physiology of the common recreational line-fish *Diplodus capensis* (Smith 1844)".

Prof. Jessica Glass, Dr Kerry-Ann van der Walt and Seshnee Reddy at Sydney's Hope Gully, Bushman's River mouth, ready to deploy Seshnee Reddy's light traps with her MSc project.

Seshnee Reddy, Siphelele Dyantyi and Kerry-Ann van der Walt leaving Sydney's Hope Gully, Bushman's River mouth, after a day of fieldwork deploying all Seshnee's light traps for her MSc project.

2020 Highlights

During 2020, I was able to start on my postdoctoral research on evaluating resiliency of early life stages of fish and invertebrates in urban coastal systems using green eco-engineering. This new research focuses on using innovative green eco-engineering structures that can counteract the adverse impacts of coastal armouring in a more sustainable manner and improve the value of coastal habitats in terms of early-stage usage, functioning and diversity. This objective is being achieved by collaborating with a local community, the Keiskamma Trust, to develop innovative complexifying green structures; to test the durability of both the material and structures, and to test the thermal performance of fish and invertebrate larvae exposed to acute increases in temperature. Numerous online discussions and visits were carried out toward the end of 2020 with the Keiskamma Trust. These engagements helped forge a strong partnership to co-create the green complexifying structures. Further, to advance and communicate my knowledge around this project, I participated in numerous online workshops and courses. I also contributed to public communication in the form of two articles and a digital story and submitted one peer-reviewed manuscript. Future work for 2021 will focus on durability testing of the material and green complexifying structures, the physiology of fish and invertebrate larvae and on deploying green complexifying structures to determine larval assemblages.

SHESHA: accelerating the understanding of SHoreline and coastal zone Evolution in South Africa.

Dr Errol Wiles, Instrument Scientist

Background and Objectives

The coastal zone is under ever-increasing pressure from various stakeholders and environmental drivers under a changing global climate (Figure 1), from active stakeholders that purposely modify the coastal zone (e.g., developers, municipal services, etc.), to passive stakeholders that make use of natural and anthropogenic services, but do not intervene directly to implement change (e.g., tourists, local residents, beachgoers, etc.). In order to improve the understanding and management of coastal zones, it is fundamental to understand coastal environmental changes, with the first and most critical aspect of coastal change being the position of the shoreline and its dynamics over various temporal and spatial scales.

Although shoreline position is the fundamental measure of change in the coastal setting, it must be considered within an integrated approach which includes the analysis of coastal zone geomorphology, marine habitat, morpho-sedimentary dynamics and environmental forcing, linking these aspects with the occupation and development of socioeconomic activities in coastal areas. The acquisition of the various datasets required for such a holistic approach to coastal analysis is complex; thus, a coherent and comprehensive methodology is essential for a meaningful analysis. This approach implies that quantifying changes in shoreline position are never the endpoint. Beyond the assessment of changes in shoreline position in relation to erosion or accretion, understanding the natural and anthropogenic drivers, their impact on coastal processes and sediment fluxes over time is critical. Through such understanding, one can develop holistic coastal management strategies based on objective measures of coastal environmental change.

Understanding the interaction between marine and terrestrial systems along the coastal zone is essential in preparing for the sustainable development of cities and communities under variable climatic conditions. SHESHA aims to

1) accelerate the understanding of shoreline evolution and associated coastal zone hazards at focal sites along South Africa's coastline through the acquisition and analysis of physical and remotely sensed data;
2) effectively integrate stakeholder engagement with natural science in order to develop a robust product, and
3) offer meaningful input to coastal management, policy and planning schemes by linking shoreline dynamics to coastal management issues.

Research activities

Local and virtual workshops enabled our research group to exchange ideas and plan the development and growth of small-scale projects with the potential to become large-scale, integrated research programmes.

Training/ supervision

Research under this new research project is carried out by an ever-expanding local and international group from industry, government, and research.

Outcomes

The coastal zone is especially dynamic and challenging to study, particularly when practical and applicable outcomes are desirable. In 2019 the project foundation was laid through the development of a research network. The pilot study area of Mossel Bay has seen meaningful progress in better understanding the interplay between marine processes and coastal evolution using in situ data and field observations. Access to long-term geomorphological data was granted, which will see the project grow significantly in KwaZulu-Natal.

Impact for society

The coastal zone is a focal point for human populations and development, with the greatest potential for future growth. Understanding coastal zone evolution over various operational time scales will better prepare the policy makers and practitioners in their roles, equipping them with the knowledge to develop appropriate tools and policies for sustainable management of the coastal zone with positive outcomes for socioeconomic growth. Thus, this project speaks to SDGs 11 (Sustainable Cities and Communities), 13 (Climate Action), and 14 (Life below Water).

Future work

The pilot project in Mossel Bay highlighted the distinct need for multibeam bathymetry data crucial to defining nearshore geomorphology and assessing marine habitat and wave climate. These types of data are lacking in South African waters, creating a gap that

limits research in the region. Over the coming years, sites around South Africa will be in-corporated in to SHESHA. As the project grows, it will develop student capacity which will feed back into the research as students progress, as well as out into industry and local government through applied research and stakeholder engagement.

Collaborators

Oceanographic Research Institute, South Africa; University of Sterling, United Kingdom; Council for Geoscience, South Africa; Obscape, South Africa; eThekwini Municipality, South Africa; Environmental Affairs and Development Planning, Western Cape Government, South Africa.

South Africa's shoreline stretches nearly 3000 km; it is a zone where the interaction between anthropogenic and natural processes play out;
a) highly developed coastal zone within Mossel Bay (inset: study area),
b) failed coastal seawall structures,
c) overgrown remnant of a parking lot.

2020 Highlights

The second edition of the *International Symposium on Coastal Hazards in Africa*, hosted by NRF-SAIAB and chaired by Errol Wiles, took place in October 2020. Seven sessions over the three days fostered interactions between 69 delegates from 13 countries and over 50 institutes, including one Industry Spotlight and three Keynote sessions. A wide range of topics were covered highlighting the diversity of coastal hazards faced in Africa, and relevant globally. This diversity represents a significant challenge to research and management of the coastal zone, yet equally represents great potential for collaboration between those in the coastal field. The symposium provided opportunities to develop relationships between research, industry, and national/local government. Such relationships are necessary if we are to produce results and outputs beyond research; meaningful products that result in knowledge-based action.

A special issue in *Estuarine, Coastal and Shelf Science* will highlight the most relevant research emanating from the symposium and invited additional contributions which grapple with coastal hazards in Africa.

Biodiscovery in marine and freshwater habitats and taxonomic groups

Dr Gavin Gouws, Senior Scientist

Background and objectives

The description of species new to science, taxonomic revisions and studies into the phylogenetic relationships among taxa, specifically marine and freshwater fishes and crustaceans, is a long-standing and ongoing research programme at NRF-SAIAB. Often this foundational biodiversity research results from continuing and more applied biogeographic, phylogeographic or population genetic research. Beyond being the foundation for all applied research, the accurate description of biodiversity is critical to its conservation and management, its sustainable use, and the maintenance of ecosystem integrity and services. Esoterically, this research speaks directly to the SDG around Life below Water, but has relevance for SDGs around Poverty Alleviation, Food Security, Health and Wellbeing, Economic Growth and Job Creation. With respect to the latter, this aspect addresses the NDP's goals around reducing poverty and inequality.

Research activities

Several studies on various groups were undertaken, completed or submitted for publication in 2019, mostly in collaboration. An assessment of the status of subspecies in the yellowstripe goatfish (*Mulloidichthys flavolineatus*) was completed with Dr Franz Uiblein (Institute of Marine Research, Norway). This collaboration also advanced research into a new species of goatfish (genus *Upeneus*) from the east coast of South Africa. A project with Israeli partners sought to determine which gaper species (genus *Champsodon*) have invaded the Mediterranean. Yonela Sithole (PhD student, Rhodes University) submitted her MSc research, describing a new species of moray eel (formerly Gymnothorax undulatus) from the Western Indian Ocean (WIO), for publication. This research is all due to be published or submitted in early 2020. Research aiming to confirm or refute the validity of a new species of 'geelbek' (*Atractoscion macrolepis*), and to describe a new species of gaper from the WIO continued. A research visit was also undertaken to the Western Australian Museum to advance the descriptions of some Australian freshwater isopods.

Training and supervision

Yonela Sithole, a promising young fish taxonomist and second-year PhD student was selected to undergo taxonomic training for three months at the Royal Museum for Central Africa, Tervuren, Belgium, where she was involved in several research projects.

Outcomes

The description of new species is significant in improving our understanding of our biodiversity heritage, while the collaborative nature of this research enhances the profile and worth of NRF-SAIAB.

Impact for society

This research contributes to our increased understanding of biodiversity, which in turn is necessary for informing conservation and understanding ecosystems and ecosystem services. The barcoding and hermit crab studies were nested in the SeaKeys Programme, which involved citizen science components and aimed to develop resources for the public at large.

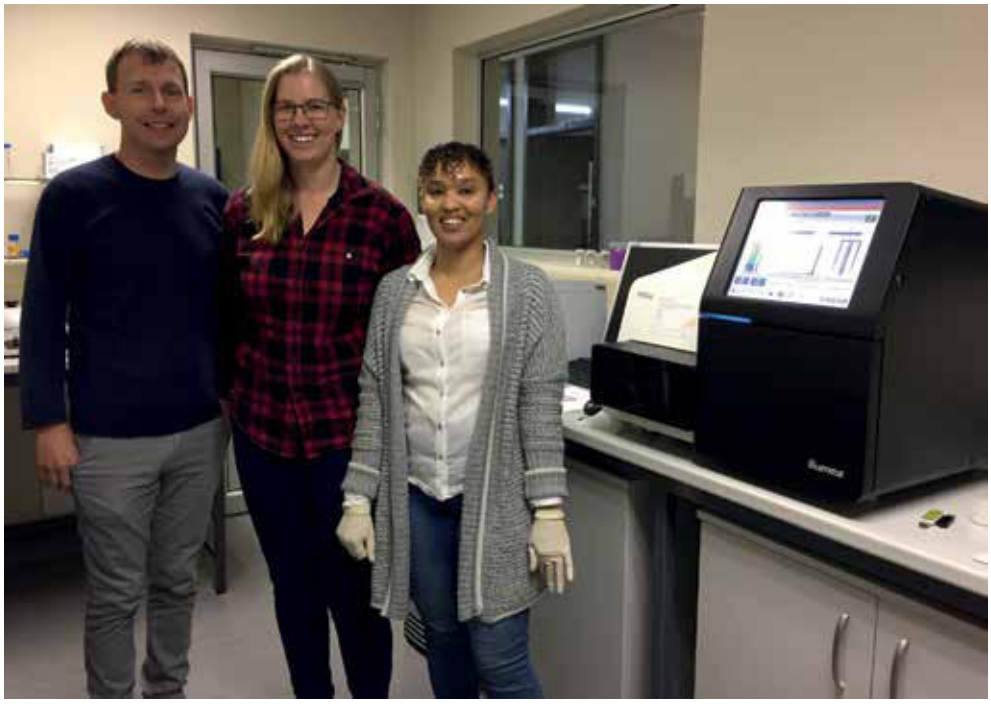
Future work

Through continuous exploration, interaction with other researchers and the public, and past genetic studies, a number of taxonomic problems were highlighted that require attention. These include the investigation of a possible cryptic species in the sharptooth cardinalfish, the resurrection of a species of emperor fish from South Africa, and the description of three species of freshwater crabs, three species of freshwater isopods (from Australia and South Africa) and a new species of gaper.

Additional information

Funding for the research discussed above (NRF, discretionary grants, NRF-SAIAB, SeaKeys-SANBI-NRF Foundational Biodiversity Information Programme); student funding (NRF and NRF-SAIAB through discretionary grants, NRF-SAIAB, and the SeaKeys project of the SANBI-NRF Foundational Biodiversity Information Programme).

Yonela Sithole (PhD student) and other trainees examine specimens at the Royal Museum for Central Africa, Tervuren, Belgium.
Photo: Muriel Van Nuffel (RMCA).



Dr Gavin Gouws, visiting MSc student, Jessica Gilmore and PhD student, Samantha Ockhuis on the first attempt at conducting quaddRAD sequencing on the Illumina Miseq at the Aquatic Genomics Research Platform.

Diversity and systematics of freshwater fishes in southern Africa

Dr Albert Chakona, Senior Scientist

Background and objectives

Emerging evidence from molecular studies shows that a remarkable proportion of the diversity of freshwater fishes in southern Africa remains scientifically undocumented. The underestimation of taxonomic diversity and poor understanding of species distribu-tion patterns has profound conservation implications as freshwater systems within our region are highly threatened by multiple impacts. There is, therefore, an urgent need for an approach that can be used to assign specimens to known species as well as accelerate the pace of species discovery in order to identify priorities for taxonomic research and conservation actions.

The NRF-SAIAB initiated a multiinstitutional research programme including national (e.g., provincial conservation agencies), regional (e.g., University of Zimbabwe, Chinhoyi University of Technology, Zimbabwe Museum of Natural History, WWF Zambia) and international collaborators (e.g., the Royal Museum for Central Africa, Cornell University Museum of Vertebrates and the Bavarian State Collection of Zoology) to undertake comprehensive surveys to collect DNA tissue samples and voucher specimens (specifically targeting type localities) to accelerate comprehensive systematic and biogeographic studies and taxonomic revisions of freshwater fishes in southern Africa. At a systematic and biogeographic level, the relationships between taxa will be interpreted within the framework of the previously suggested biogeographic history of southern African freshwater fauna. At an intraspecific level, genetic diversity could provide information to assist in formulating conservation plans for threatened fish species. Findings of this research will contribute towards addressing the 'taxonomic impediment' identified by the Convention on Biological Diversity (CBD), to assess the conservation status of species through the IUCN criteria, and achieving SDGs linked to Ending Poverty (SDG 1), achieving Food Security (SDG 2), ensuring Healthy Lives (SDG 3), promoting Sustainable Economic Growth (SDG 4) and promoting Sustainable Resource Utilisation (SDG 12) through implementing science-based decisions on natural resources management.

Research activities

Major field surveys were conducted in the Eastern Cape Province of South Africa, the Kabompo River, Upper Zambezi system in Zambia, and the Mzingwane River, Limpopo system in Zimbabwe. Dr Chakona received training on next generation sequencing and data analysis in Dr Ulrich Schliewen's Lab at ZSM (Munich, Germany) and went on a research visit to MRAC to examine key type-specimens that were loaned by Dr Emmanuel Vreven from various museums in Europe and the USA. He also visited Prof. Carl Hopkins and Dr John Sullivan at the Cornell University Museum of Vertebrates (USA) for training on recording electric organ discharges (EODs) of mormyrid fishes. Electric signals are integral to studies that seek to discover and describe the many still scientifically undocumented species of mormyrids. Dr Chakona also attended an IUCN Red List workshop for freshwater fishes of Mozambique and contributed to the mapping of freshwater Key Biodiversity Areas for the country.Training and supervision

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Research activities

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Training and Supervisiion

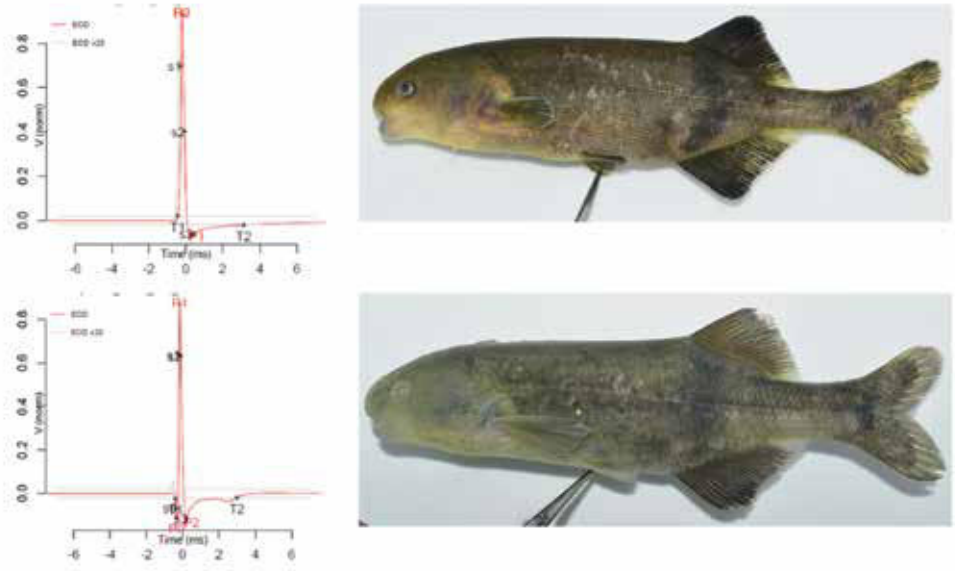
Dr Pedro Bragança joined Dr Chakona's research group as a postdoctoral fellow. Craig Rennie (BSc Hons; Taxonomic revision of *Amatolacypris trevelyani*) obtained his degree, Delsy Sifundza (MSc; Ecology and conservation of *Sandelia bainsii*), Nkosinathi

Mazungula (MSc; Taxonomic revision of *Amphilius natalensis*), Tadiwa Mutizwa (MSc; Evaluation of genetic and taxonomic diversity in the *Hippopotamyrus ansorgii* complex) and Nonjabulo Matomela (MSc; Ecology of streams in the Amatolo-Winterberg freshwater ecoregion) completed their degrees and will graduate in 2020.

Manda Kambikambi (PhD; Systematics and ecology of *Enteromius anoplus*) is on track to complete in 2020. Five postgraduate students were recruited to join the research group commencing in 2020: Tholoana Ntokoane (PhD; Systematics and revision of *Labeobarbus marequensis*); Yonela Sithole (PhD; Taxonomic revision and evolutionary history of *Parauchenoglanis ngamensis*), Tadiwa Mutizwa (PhD; Diversity and biogeography of mormyrid fishes in southern Africa), Nenekazi Mthombeni (MSc; Stream fish ecology) and Thulisile Nkomo (MSc; Stream fish ecology).

Members of the research group presented at several regional and international conferences including the Southern African Society of Aquatic

Riffle habitat in the Upper Kambompo River and some of the weak electric (mormyrid) genera collected during the 2019 survey of the Kabompo River.



Distinct electric organ discharge (EOD) wave forms of two sympatric morphs of the slender stone basher, *Hippopotamyrus ansorgii*, from the Kabompo River.

Scientists (SASAqS; Limpopo, South Africa), Zoological Society of Southern Africa (ZSSA; Kruger National Park, South Africa) and the Willi Hennig Society (UC Berkely, USA).

Outcomes

One of the major highlights for 2019 was the publication of a paper on the use of molecular data as a novel approach for reconstructing the historical distribution ranges of freshwater taxa fragmented by human-mediated impacts. This information is crucial for identifying appropriate conservation strategies such as river rehabilitation and eradication of non-native species, as well as guiding reintroductions and informing assisted gene flow where these are deemed necessary interventions to protect and preserve imperilled species. Research funding was secured from the Belgian government for the MbiSa: Congo II, a multi-institutional collaborative program (led by Dr Vreven, MRAC) aimed at strengthening north-south, south-south collaboration on systematics, taxonomy and conservation of freshwater fishes in central, eastern and southern Africa.

Impact for society

More accurate knowledge of fish distributions, discovery of unique lineages and description of new species has been incorporated in the recently completed IUCN assessments of freshwater fishes of South Africa and Mozambique. Within South Africa, the information has also been used to help define national freshwater fish sanctuaries as part of the National Freshwater Ecosystems Priority Areas (NFEPA) initiative. These sanctuaries will be used to define priority freshwater areas for conservation in South Africa. The NFEPAs are a critical tool for freshwater conservation planning in the country. The data were also used to help define alien fish areas for South Africa's new National Environmental Management: Biodiversity Act. These maps will be used to allow restricted activities to continue in defined areas for certain valuable alien fish species, while at the same time, prohibiting the occurrence of these species in sensitive biodiversity areas. The data are shared with regional conservation agencies to inform conservation planning and prioritization. This has, for example, already led to a more informed permit evaluation process within Cape Nature and other regional conservation agencies.

Future work

There is a growing network of collaboration with research teams working in other regions on the continent, particularly in central, east and west Africa, which will result in data sharing and more coordinated systematic studies that are envisaged to provide better understanding of the diversity and distribution of freshwater fishes in our region. Research effort will continue to focus on filling information gaps in least explored regions in southern Africa.

Additional information

Research funding (Rhodes University Research Council Grant; NRF, under the Foundational Biodiversity Information Programme (FBIP)); the Rufford Small Grants for Nature Conservation (RSG); the International Foundation for Science (IFS); the Mohammed bin Zayed Foundation; the NRF-SAIAB Institutional Support System; RMCA (Belgium).

2020 highlights

Research visits to the Royal Museum for Central Africa (MRAC, Belgium) and the Bavarian State Collection of Zoology (ZSM, Germany) enabled examination of primary type-specimens from various museums in Europe and the USA, training on next generation sequencing techniques, and analysis of electric organ discharges (EODs). This information is integral to the ongoing revisionary taxonomy and systematic research for freshwater fishes of southern Africa. A Special Issue on the biology and ecology of African freshwater fishes, co-edited with Dr Olaf Weyl, was published in the *Journal of Fish Biology*. Six peer-reviewed papers were published, with the focus on biodiscovery, taxonomic revisions, reconstruction of historical ranges of native species with contemporary fragmented distribution ranges and identification of critical conservation gaps for freshwater fishes. Four MSc students obtained their degrees in 2020, and one PhD thesis was submitted for examination.

Discovery and evolution of African freshwater fishes

Dr Pedro de Bragança, Postdoctoral Fellow

Integrative taxonomy, the science field that leads with species description and identification, in which findings have a major importance for conservation, had a central role in the research of postdoctoral fellow, Pedro de Bragança, his supervisor, Albert Chakona, and other NRF-SAIAB freshwater fish experts. As a first step to understanding the biodiversity and diversification patterns in small-sized, freshwater southern Africa fishes, two research lines were developed: one focusing on the little-known southern African lampeye genus *Lacustricola*, and the other in the small darters genus, *Nannocharax*. Through combined analyses of traditional morphological characters and the mitochondrial gene COI, it was possible to identify five new *Lacustricola* species from southern Africa and to prepare the redescriptions of *L. johnstoni*, *L. chobensis* and *L. myaposae*. The last one is a species endemic to the KwaZulu-Natal Province in South Africa. A similar methodology was applied to the study of *Nannocharax*, historically considered to have only three species in southern Africa. To date the dataset consists of more than 35 COI gene sequences from individuals distributed along the main river drainages in southern Africa and in the neighbouring Cuanza and Congo rivers. Preliminary results indicate that previously unnoticed diversity is being reported for the region.

Both projects are a starting point towards more comprehensive phylogenetic and biogeographic studies to be carried out in the future, which could help in understanding southern Africa's landscape evolution.

Lacustricola pygmaeus, a new miniature freshwater species from the Okavango and Zambezi floodplains.

Live colour of *Lacustricola myaposae*, a species endemic to KwaZulu-Natal. A: male, 33.0 mm SL B: female, 35.2 mm SL; both from Nseleni River, KwaZulu-Natal.

2020 Highlights

During 2019–2020, great advances in the taxonomy and systematics of African freshwater fishes were accomplished, especially in understanding the diversity of and relationships between the southern Africa killifishes (Procatopodidae) and darters (Distichodontidae). Through the implementation of integrative taxonomy approaches, including both molecular and morphology data, a hidden diversity was revealed for the genus *Lacustricola* and *Nannocharax*. In both cases the development of a more robust taxonomy knowledge assists in understanding the biogeographical evolution of Africa and the ongoing biodiversity crisis.

Species were redescribed, such as *Lacustricola chobensis*, *L. myaposae*, and *L. johnstoni*; a new species was described, *L. pygmaeus*, from the Okavango and Upper Zambezi swamps and *Hylopanchax multisquamatus* and *H. thysi*, both from the Ogowe in Gabon. The three new species are miniatures, and include one of the smallest fish species in Africa. Collaboration with researchers from US and Europe allowed, for the first time, the identification of new species and the mapping of paleoclimatic and geologic events that affected *Aplocheilichthys spilauchen* evolution.

Inland fisheries and freshwater ecology

Prof Olaf Weyl, SARChI: Inland Fisheries and Freshwater Ecology

Background and objectives

Poverty, hunger, health and education are at the forefront of South Africa's NDP, and at the top of the 2030 Agenda for Sustainable Development. The value of biodiversity and ecosystems as natural assets that provide ecosystem services and cultural benefits is recognised within these policy instruments, and development strategies must include the conservation and rehabilitation of biodiversity assets to maintain ecosystem services. In Africa, where more than 50% of the population live below the poverty line, there is a high dependency on services provided by aquatic ecosystems, particularly fisheries which provide a local, low-input protein supply to people with minimal reliance on infrastructure. These services are important for Poverty Alleviation (SDG 1), Food Security (SDG 2) and the Provision of Essential Micronutrients (SDG 3). Freshwater ecosystems, and the fisheries that they support, are under increasing pressure from overfishing and from the human-induced stressors including habitat loss, pollution, the changing climate, and species invasions (Global Biodiversity Outlook 4, 2014; WWF, 2014). To safeguard fishes and the fisheries that they support will require proactive conservation and management interventions that will need to be guided by knowledge on the link between fisheries and their resilience to these stressors and implemented by well-trained personnel (SDG 4).

To develop regional capacity and research on the biological, ecological and social aspects of inland fisheries to support ecologically, economically and socially sustainable inland fisheries this research programme has three overriding objectives:

- to develop southern African capacity and knowledge for sustainable inland fisheries development;
- to describe African freshwater fish diversity, distributions, ecology and resilience to better understand fisheries dynamics and inform conservation and fisheries management;
- to understand the consequences of human-mediated pressures on freshwater ecosystems.

Research activities

Fisheries research themes include assessing small-fish species as potential providers of micronutrients and food security; developing appropriate harvest methods to enhance food security and livelihood opportunities in rural communities, and developing management strategies for small-scale fisheries in the Orange, Limpopo and Zambezi river basins. To better understand ecological processes, novel techniques are being developed and applied. These include using underwater cameras for better detection of rare endangered species, monitoring invasions, and assessing fish diversity and abundance. Ecosystems of interest are the Cape Fold Ecoregion and the Zambezi system, including Lake Malawi/Niassa. Research on impacts includes work on understanding the impact of invasive black bass, tilapia, trout, catfish and freshwater crayfish in southern Africa, and the future impacts of climate change on freshwater ecosystems. Research areas range from small ephemeral ponds and small streams to the large floodplains on the upper Zambezi River and the African Great Lakes.

Training and supervision

A strong post-doctoral programme provides the backbone to research. Active engagement in the mentorship and supervision of postgraduate students and contributes greatly to the success of the freshwater research team at NRF-SAIAB. South African host institutions include Cape Peninsula University of Technology, North West University, Rhodes University, University of Fort Hare, University of the Free State, University of KwaZulu-Natal, University of Limpopo, University of the Western Cape, and University of Venda. International partner institutions are the University of Toronto Scarborough, Queens University Belfast, Wageningen University, Technical University of Munich, University of Zimbabwe, Botswana International University of Technology, University of Namibia and University of Zambia.

Outcomes

The 2019 research advances by the COST led by Dr Francesca Porri highlight the description of a new pseudo-cryptic species of decapod, *Parasesarma capensis*, from the southeast African mangroves. Furthermore, patterns of recruitment of sesarmid crab larvae in the east African mangroves revealed a close association with vegetation where the adult populations occur, reinforcing the tight link between fauna and trees in these unique and endangered systems. Further research on larval ecology and connectivity of coastal populations has highlighted the active role of depth regulation by invertebrate larvae around coastal fronts and possible enhancement of shoreward advection and nearshore distribution of propagules. Rates of oxygen consumption of the dominant zooplankton from permanently open and

temporally open/closed subtropical estuaries has also been determined.

Impact for society

Capacity development: The Professional Development Programme (PDP) appointed postdoctoral fellows Sean Marr and Sanet Hugo completed their three-year contracts in 2019. Postdoctoral researchers Josie South and Josephine Pegg were joined by Mandla Magoro whose research focus is on the distribution, spread and management of Nile tilapia in South Africa. The postgraduate research team comprised four BSc Honours, five MSc and seven PhD candidates. Rowshyra Castañeda (University of Toronto Scarborough) earned her PhD for her dissertation on "Development of a novel detection technique for rare freshwater fishes".

Policy support

Small-scale fisheries and aquaculture development provide opportunities for food security and economic empowerment in South Africa. To support small-scale fisheries development in inland fisheries, the research group collaborated with Leon Barkhuizen from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA) to implement a one-week workshop on "Decision Making in Small-Scale Fisheries Development" at the Gariep Aquaculture Training Centre of the Free State Department of Agriculture and Rural Development. To support the development of the Inland Capture Fisheries Policy, the results of a workshop on the "Top ten research requirements for inland fisheries in South Africa" were presented at the South African Society for Aquatic Scientists Conference with co-authors from Department of Environment Forestry and Fisheries (DEFF); DESTEA; CapeNature; NRF-SAIAB and the Universities of Fort Hare, Venda, Limpopo, Toronto Scarborough and Hull.

To support aquaculture development while mitigating environmental harm, a project assessing the distribution of Nile tilapia in the Limpopo and Mpumalanga Provinces of South Africa was initiated in collaboration with SANBI and the DEFF. The first surveys on the project were conducted in October 2019 and it is expected to run until year-end 2021.

The results of the WRC-supported project on Rotenone policy support and capacity development concluded with the publication of the final report dealing with the impact and recovery of native biota in one river and two dams, following alien fish removals using Rotenone (Marr et al. WRC Report No. TT 780/1/18).

Internationally, an exciting research project entitled "Upper Zambezi Floodplain Ecology and Fisheries" was initiated in 2019 in partnership with the WWF-Zambia. Through applied research, the project aims to develop a better understanding of the biological, ecological and social aspects of upper Zambezi floodplain fisheries to inform ecologically, socially and economically sustainable fisheries resource utilisation. Key to this is understanding what factors influence fish production and how this critical eco-system service is likely to be affected in the future.

Knowledge development

The research group published two book chapters and 22 papers in 2019. Key research contributions included: a prognosis for long-term sustainable fisheries in the African Great Lakes (*Fish Management and Ecology*); an evaluation of the current extent and potential spread of black bass invasions in South Africa (*Biological Invasions*), and impacts of non-native fishes under a seasonal temperature gradient (*NeoBiota*); thermal tolerances of native freshwater fishes in South Africa's Cape Fold Ecoregion (*Journal of Fish Biology*); assessments of predator-prey interactions in a chemically altered aquatic environment (*Ecotoxicology*); a global review and meta-analysis of applications of the freshwater Fish Invasiveness Screening Kit (*Reviews in Fish Biology and Fisheries*).

Future work

Future work in South Africa will continue to support the implementation of the National Environmental Management: Biodiversity Act and the Inland Fisheries Policy through targeted work in the Cape Fold Region and the Orange and Limpopo river basins. Regionally, research will increasingly focus on the Upper Zambezi floodplains in Zambia.

Additional information

The freshwater research in 2019 was supported by the DSI-NRF South African Research Chairs Initiative, DSI-NRF Professional Development Programme, DSI-NRF Centre of Excellence for Invasion Biology, the Water Research Commission (WRC), the South African National Biodiversity Institute (SANBI) and the World Wide Fund for Nature (WWF).

MSC student, Dinah Mukhari, on board research vessel *Netty*, using acoustic telemetry to track non-native carp on Groenvlei.

PhD student, Nawa Nawa, and intern, Siphamandla Mceleli, carry out electrofishing on the margins of the Orange River.

2020 Highlights

Dr Josephine Pegg, Interim SARChI Chair-holder and Postdoctoral Fellow

From an academic perspective, 2020 was a good year. Twenty-nine papers linked to the Chair, were published; in several cases, the first author was a PhD student, including Rowshyra Castañeda's work on occupancy dynamics of rare cyprinids after invasive fish eradication, plus a methods paper derived from the same project. Takudzwa Madzivanzira and the supervisory team produced a timely review of freshwater crayfish introductions in continental Africa. In addition, Dr Olaf Weyl contributed to high impact papers on global issues such as climate change, and fisheries and invasion impacts. The outputs of a workshop drawing together African and international experts in inland fisheries science and management published in the African Journal of Aquatic Science, reports on aspects of key importance to national policy development.

Whilst many conferences were cancelled due to Covid-19 in 2020, the group attended the online American Fisheries Society annual meeting en masse. Prof Olaf Weyl gave an invited talk titled "The importance of respecting culture, practicing inclusivity, and enabling participation when leading diverse teams in southern Africa". Other presentations included: "The predatory behaviour and removal of redclaw crayfish" (Takudzwa Madzivanzira); "Feeding ecology of fishes in the Sundays River valley irrigation ponds" (Dr Lubabalo Mofu); "The combined risk of drought and invasive species to small stream communities" (Dr Josephine Pegg); "Microhabitat utilisation by small-fish communities in the Kabompo River" (Craig Rennie); "Impacts of fluoxetine and microplastics on invertebrate food webs" (Dr Josie South); "Human dynamics of crayfish invasions" (Dr Josie South). PhD students, Dumisani Khosa and Lubabalo Mofu, successfully completed their degrees in 2020. Both have continued working within the group as PDP Postdoctoral Fellows.

Challenges

The 2020 field season started well; however, it ended abruptly in March owing to COVID-19 lockdown. As a result, several student projects had to be significantly amended or replaced with new projects. Lack of access to both to NRF-SAIAB and analytical facilities made work difficult for some team members. Over the course of the year significant efforts were made to remedy this, within the limits of what could be safely achieved.

In November 2020, Prof Olaf Weyl passed away.

Prof Olaf Weyl with a small tigerfish.

Common Carp (*Cyprinus carpio*) in South Africa, ecology, impacts and management

Dr Josephine Pegg, Postdoctoral Fellow

Background and Objectives

Globally, common carp is one of the most widely translocated species and one of the most harmful aquatic aliens. Carp are a threat to water quality, ecosystem health and native fauna, yet at the same time, they are a valuable sport and food fish. Despite a long presence in South Africa, their distribution, ecology and impacts are poorly understood. In order to enable better decision making by conservation authorities and land managers, the goal of my research is to fill these gaps in the knowledge of this species in South Africa.

Research activities

In 2019 my fieldwork focused on two areas, the Orange River and Groenvlei in the Western Cape. Groenvlei was surveyed over a series of seasonal visits during which biological and stakeholder surveys were undertaken. The Orange River expedition saw data collection from the mountains bordering Lesotho to the brackish waters nearing the Atlantic, sampling in rivers and dams, with a highlight being the survey undertaken within the Richtersveld Transfrontier National Park.

Training and supervision

In addition to the students and intern who have gained practical experience as part of my field teams, in 2019 Njabulo Madlala (Rhodes University) undertook his Honours project, carrying out experimental work at NRF-SAIAB to test the mechanism of field observations on trophic interactions of carp and native species. Munetsi Zvavahera (Fort Hare University) collected samples for his PhD and Valeria Sorgato (Technische Universität München) completed her MSc thesis titled "Analyzing the public perception, knowledge, and attitude of carp invasion in Groenvlei, South Africa".

Outcomes

This work has been presented at the SASAqS and ZSSA conferences and a number of manuscripts are in preparation.

Impact for society

With limited resources available to manage non-native species, targeting these resources effectively is key. This research will advise if, where, and how carp should be managed in South Africa, as well as elsewhere globally.

Future work

In addition to the field data collected, DNA and stable isotope samples have been archived. Once analysed, these will answer questions such as how connected the carp population on the Orange River is, and whether invasion has been achieved by a single stocking event and natural migration or by multiple stockings. Stable isotopes will be used to describe the carp's trophic niche and reveal the nature of their interactions with cohabiting native species.

Additional Information

My postdoctoral fellowship is funded through the DST/NRF Research Chair in Inland Fisheries and Freshwater Ecology.

2020 Highlights

2020 is the second year of the common carp research project and some notable successes have been achieved. At the start of 2020, NRF-SAIAB hosted an international workshop on invasive sport fishes with attendees from the USA, UK and southern Africa. As a result of discussions at this meeting, I have collected and shared genetics samples from carp with our American partners who are looking for sex markers for the species. The year 2020 also saw the completion of the Orange River survey, with the Northern Cape section now complete. Of particular interest were the high numbers of carp in the Ais/Richtersveld National Park cohabiting with native protected largemouth and small-mouth yellowfish. Finally, the tracking programme at Groenvlei, led by MSc student Dinah Mukhari, collected a year's worth of movement data on the resident carp populaton, which has generated a lot of interest from our project partners, Cape Nature, who manage the vlei.

Page 26: Munetsi Zvavahera and Ntombizanele Tshali interview residents of Fairview as part of the Groenvlei stakeholder survey.

Left: Dr Josephine Pegg holding a large, tagged carp, part of the Groenvlei population study.

Below: Dr Mandla Magoro and Dr Josephine Pegg sort stable isotope samples at Gariep Dam on the Orange River.

Predicting impact of anthropogenic disturbances

Dr Josie South, Postdoctoral Fellow

Background and objectives

1. Assessing and predicting the impact of invasive species: this is an on-going project spanning many different species and regions. The project aims to quantify how aquatic invasive species may be affecting native species, ecosystem services and rural livelihoods. It addresses the SDG: Life below Water, as the project focuses not only on both biodiversity and conservation, but also addresses a human aspect in terms of food security; many invasive species can have detrimental impacts on economically important species.
2. Ecosystem effects of contaminants: this project aimed to understand how various aquatic contaminants can affect food webs and trophic interactions. The project was part of a European Union grant awarded to Josie South. This project supports the SDGs Life Below Water and Clean Water and Sanitation, as the myriad effects of urbanisation can have cascading implications for humans and aquatic species.

Research activities

In March 2019, an intensive three-week project was undertaken as part of a European Union-funded transnational AQUACOSM grant to take seven inter-disciplinary researchers from South Africa to the Netherlands Institute of Ecology. The EMERGEINTERACT project used mesocosm and microcosms to understand the effect of multiple contaminants (microplastics and the pharmaceutical fluoxetine) on behaviour and food web structuring in freshwater invertebrates.

Two major field surveys were completed (April 2019 and September 2019) for invasive crayfish, one in the Okavango panhandle in Namibia, and another in the Upper Zambezi catchment in Zambia.

I participated in an aquaculture stakeholder working group meeting in Pretoria, South Africa where I provided evidence of ecological impacts of redclaw crayfish on native biota and ecosystem services as part of an assessment regarding the regulation of banned crayfish species.

Training / supervision

Projects provide opportunities for training students and interns in field and lab methodology. Notably, the EMERGEINTERACT project participants were all Early Career Researchers and PhD candidates. Students and interns are integrated into all research activities which result in publications.

Outcomes

Major international collaboration was developed between South African higher educational institutions and the Netherlands Institute of Ecology, including a blog post for Noldus Information Technology

https://www.noldus.com/blog/microplastics-pharmaceuticals.

The first set of deliverables for the WWF Upper Zambezi landscape project were submitted.

Impact for society

Work on emerging contaminants fills a major research gap in the way that pollutants interact with each other and affect biodiversity. It is currently one of few projects assessing long-term and ecologically relevant concentrations of microplastics on freshwater food webs. The results will provide realistic effects of multiple stressors and will address both biodiversity concerns as well as sanitation and pollution.

Work on invasive species, especially in the Upper Zambezi, contributes to understanding how introduced species can affect fisheries productivity, rural food security, and biodiversity in one of the most under-studied yet biodiverse areas on Earth. Evidence gathered from this project has been used to advocate for the continued limitations on crayfish aquaculture in South Africa. During surveying, time was taken to engage with local schools to deliver information on invasive species.

Future work

Invasive species research is moving from assessing the ecological implications to characterising the interface between species ecology and socio-economic repercussions as some species can represent both costs and benefits to society.

Future research will involve the development of concepts in invasion ecology with a broader relevance to southern hemisphere invasive species management and will improve prediction metrics and methods to be recommended to nature conservation managers.

Additional information

The EMERGEINTERACT project forms part of an AQUACOSM Transnational Access Grant awarded to

Dr Josie South (Grant Agreement Number: 731065). Noldus Information Technology in Wageningen donated a DanioVision chamber for the duration of the project.

The Upper Zambezi project is funded by DOB Ecology and WWF Zambia. Logistical and technical support was given by the Kamutjonga Inland Fisheries Institute in Namibia, and the Department of Fisheries Zambia; Mongu District, Lukulu District, Nalolo District and Senanga District.

Work on crayfish in South Africa was facilitated logistically by Mpumalanga Parks and Tourism Agency (MTPA) and Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FS DESTEA).

Researchers from NRF-SAIAB and the Kamutjonga Inland Fisheries Institute surveying in the Okavango panhandle, Zambezi Region, Namibia.

Fluorescent microscopy of microplastic beads ingested by *Daphnia magna.*

PhD candidate, Takudzwa Madzivanzira, with invasive redclaw crayfish in the Barotse floodplain, Zambia.

2020 Highlights

Invasive species have severe economic and ecological impacts, but they may also have socio-economic benefits by providing food or ecosystem services. These dynamics occasionally make management and legislation of invasive species contentious.

My projects span fisheries, invasive species and socio-economics to build evidence for appropriate legislation to benefit both biodiversity and human wellbeing in a sustainable way. I have been a visiting researcher at the University of Bournemouth to quantify the effect of climate change and invasive fish impacts across their native (UK) and invasive regions (South Africa and Canada). I held an international workshop to determine shared threats and opportunities between South Africa, Argentina and Brazil. I have been part of a team quantifying the economic costs of crayfish invasions and have contributed to a large screening analysis of potential conflict species. Three of my supervised students (one BSc Hons, one MSc and one PhD) completed their degrees, with three manuscripts currently published as a result, and more to come.

An investigation on the biodiversity patterns of freshwater inhabiting organisms

Dr Lubabalo Mofu, Postdoctoral Fellow

My postdoctoral research focuses on understanding the socio-economic contribution of small-scale fisheries, resource utilization patterns, as well as the current state of fishery resources in government-owned impoundments in the Eastern Cape, Free State and Limpopo Provinces. The objective of the project is the understanding of biotic interactions between native and non-native species, an objective that supports the global Sustainable Development Goal (SDG): Life below Water. Invasive species represent a major challenge worldwide, so understanding both the short-and long-term impacts on freshwater ecosystems is pivotal.

During 2020, site selections were carried out, and I assisted MSc students, Nobuhle Mpanza and Dinah Mukari, at Groenvlei. I conducted an otolith preparation workshop and assisted PhD student Phumza Ndaleni with data analyses on one of her data chapters on the effects of environmental factors in the diet of *Gobiidae* sp. I was co-author on a paper in *Aquatic Conservation: Marine and Freshwater Ecosystems* titled, "Ecosystem responses to the eradication of common carp Cyprinus carpio Linnaeus, 1758 from an impoundment in South Africa using rotenone", and was senior author on a paper titled, "Life-history of the river goby *Glossogobius callidus* (Teleostei: Gobiidae)" in the Journal of Fish Biology.

Dr Lubabalo Mofu sampling in the Sundays River Valley irrigation ponds, Eastern Cape, South Africa, to determine fish abundances in novel environments.

Invasion status of Black Bass in South Africa.

Dr Dumisani Khosa, Postdoctoral fellow

I was a co-author of the proposal submitted to the Water Research Commission titled: Inland small-scale fisheries in man-made impoundments as safety nets in South Africa's response to the impact of Covid-19 on the country's economy. Although the proposal was unsuccessful, intentions are to continue with the project as it forms an integral part towards the development and the establishment of the Inland Fisheries Policy in South Africa. I have provided expert input on Alien Species Risk Analysis in South Africa for the South African National Biodiversity Institute (SANBI). I served as a referee for the journal Biological Invasions and reviewed a chapter in the book *Emerging Freshwater Pollutants: Risk, Fate and Regulation* (edited by Dr Tatenda Dalu). I had two papers published, in one I was the lead author. I am co-supervising an Honours student from Sol Plaatje University. I participated in several field trips for the Inland Fisheries and Freshwater Ecology group.

Dr Dumisani Khosa deploying gillnets during a fish biodiversity survey in the Breede River, Western Cape.

The survey of rivers for Nile Tilapia

Nicholas P E James, Project Field Manager

Project background

That Alien Invasive Species (AIS) are a major threat to South Africa's biodiversity is recognised by several legislative instruments, including The National Environmental Management: Biodiversity Act (NEM:BA), and AIS management is now a legislated priority in South Africa. Management is complicated by species that are valuable economically but also cause harm to biodiversity. These species are termed conflict species, as the different value sets associated with them result in considerable conflict between user groups. The most important conflict species is currently Nile tilapia, *Oreochromis niloticus*, because its invasions result in hybridization with native tilapias; however, it is also the only viable species for warm-water aquaculture, a sector which has remained stagnant, despite considerable attempts at development, arguably because it is unable to use Nile tilapia. Nile tilapia have, however invaded considerable sections of the Limpopo River basin and have been reported from several other river systems in the warmer regions of the country. Current knowledge of their distribution is therefore essential. As distribution surveys for Nile tilapia are complicated by the potential for hybrids, and the genetic methods for efficiently detecting hybrids are not well developed, a two-phase strategy was agreed upon between the South African National Biodiversity Institute (SANBI) and the South African Institute for Aquatic Biodiversity (NRF-SAIAB), with morphological and genetic assessments being undertaken in two, clear, and separately funded phases. The current agreement between SANBI and NRF-SAIAB is for the first phase, which is to run over two complete field seasons. The project was initiated on signing the collaboration agreement between SANBI and NRF-SAIAB in April 2019 and a Project Manager for field operations was appointed in July 2019.

Research activities

Initiation of the project in July 2019, actual implementation was delayed because of negotiations with provincial authorities regarding permitting, and the logistics of survey implementation. Subsequently, the first survey of Limpopo was undertaken between 27 October and 4 November 2019, and the second survey from 27 November to 11 December 2019.

Training and supervision

Project fieldwork was carried out by Nicholas James, Project Manager, and Dr Mandla Magoro, Postdoctoral Fellow. A rigorous chain of custody was adopted for the collections made, as deemed essential by the project.

Outcomes

The two Limpopo surveys of 2019 targeted a total of 16 large dams within the province. Fish collected were visually identified to species level using a series of specific morphological characteristics. Most sites (dams) were surveyed at a habitat that seemed to fit the agreed consensus for preferred habitat for *O. mossambicus*. In small dams, this was easy, as gill nets and cast netting could be targeted at different parts of the water body within the time period allocated. Thus, small dams such as Hout, Damani, Chuniespoort, and Spies were extensively sampled. Large dams such as Nandoni, Albasini, Mokolo, and Nzhelele were more difficult to sample owing to the logistics of the large areas to cover, and lack of local knowledge of where to find possible *Oreochromis*. Where zero catches were experienced after two hours, the gill nets were then moved to another selected location.

Impact for society

Analysis of the collections will reveal the presence of Nile tilapia or their hybrids. Morphometric examination will be followed up by genetic analysis in the second phase of the project, to give an accurate prediction as to the invasion by Nile tilapia. This information will then facilitate the permitting process and decision-making for aquaculture development.

Future work

In 2020, focus will turn to the dams of Mpumalanga, and two surveys are planned to cover the eastward-flowing rivers of the Limpopo and Incomati River catchments. A separate survey will target the Lowveld rivers of the Kruger National Park.

Additional information

Mr Khatushelo Nelukalo of DEFF and Mrs Gillian Taylor (fish vet) joined the surveys for several days as observers.

Large specimen of what resembles a Nile tilapia from Middle Letaba Dam.

Postdoctoral Research Fellow, Dr Mandla Magoro, processing catch.

2020 Highlights

During the first quarter of 2020 two field surveys were successfully carried out by Nick James and Dr Mandla Magoro. Both surveys targeted water bodies in Mpumalanga. A wide variety of tilapia of differing sizes and species were collected and preserved for later study. During the balance of the year, Nick James examined preserved specimens, data sheets and accompanying photographs in an attempt to identify the collection to species level. Twenty-five morphological observations and meristic measurements were recorded for each of 373 individual specimens. Clear examples of *Oreochromis mossambicus*, *O. niloticus* and some possible hybrids were noted. A report covering the future survey work and goals required to expand the scope of the project for 2021, was compiled.

Ecological statistics for aquatic science

Dr Sanet Hugo, Postdoctoral Fellow (PDP)

Background and objectives

The year 2019 marked the end of my contract at NRF-SAIAB within the Inland Fisheries and Freshwater Ecology Research Group, whose goal is to develop and apply statistical models to examine South Africa's freshwater ecosystems. In 2019, I contributed to studies and reports finalising the Water Research Commission's Rotenone Policy Support and Capacity Development Project, which had been running for 2017 and 2018 (SDG 4: Quality Education, and 14: Life Below Water), and I contributed to a study on Cape Stumpnose (*Rhabdosargus holubi*) juveniles in the Kariega estuary (SDG 14, published March 2020). Further, I was involved in studying a system of irrigation ponds on the Sundays River, in terms of fish population dynamics and sustainable small fisheries, which supported several student projects (SDG 2: Zero Hunger, 4, and 14). One of my main contributions was developing population dynamic models for the four dominant fish species, namely, estuarine round herring (*Gilchristella aestuaria*), Mozambique tilapia (*Oreochromis mossambicus*), Western mosquito fish (*Gambusia affinis*) and river goby (*Glossogobius callidus*). I also assessed dam-based fisheries at a national scale, using gillnet data from 44 dams and Geographic Information System (GIS) climate and human land-use data associated with 442 dams, to demonstrate methods for overcoming the critical data deficiencies that inhibit the formulation of a South African policy for sustainable use of inland fisheries (SDG 1: No poverty, 2, 14, and the South African National Development Plan (NDP) to reduce poverty).

Research activities

My research was mainly desktop-based using datasets stored at NRF-SAIAB, but original data were also collected during 2019 by the students.

Training and supervision

I co-supervise a PhD student, Munetsi Zvavahera (completing 2020), and supervised an Honours student, Mfundo Kanana (completed 2019), both registered at the University of Fort Hare, with Professors Olaf Weyl and Niall Vine. Munetsi studies many aspects of the fishery potential of *G. aesturia*, ranging from micronutrients to harvest experiments, and therefore required advice on many types of statistical methods, including multivariate analysis and non-linear regression. Munetsi presented on *G. aestuaria* morphometics at SASAqS 2019. Mfundo examined reproductive variation across seasons for *G. affinis* in the Sundays River irrigation ponds, which helps to evaluate population dynamics models. Mfundo won best Honours presentation at the UFH Zoology Department's postgraduate symposium.

Further, I used gillnet data from NRF-SAIAB to present a practical applied statistics course for the Rhodes University Statistical Science Honours students.

Outcomes

Munetsi's depletion harvest experiments in the Sundays River ponds yielded estimates of total population size for the four dominant species that are remarkably similar to estimates from the population dynamics models. This finding suggests that the population models produce realistic results, even though the models were based on very sparse time-series data. Further, the South African dam assessment indicated that we need more intensive dam-specific data to understand the wide variation in fishery resources; however, dams can be classified into groups with shared climate or land-use characteristics to help plan and prioritise preliminary management goals and plan future data collection.

Impact for society

Statistical analyses applied to ecological data can offer predictions of ecological impacts (e.g., harvesting on the irrigation ponds, SDG 14), but can also be used to plan future sampling efforts to channel limited funds where most needed. For example, groups of dams with shared characteristics can be systematically prioritised for intensive research and management, especially those surrounded by subsistence land uses that may play an important role in food and economic security (SDG 1 and 2). This work showcases tools to spur the development of an institutional policy that is so urgently needed for ensuring equitable use and protection of freshwater fishery resources.

Future work

Munetsi's support continues in 2020, and SAIAB hosts datasets that can benefit from other advanced statistical techniques. The population dynamics models may be used to predict undisturbed baseline populations in the Sundays River ponds, against which disturbances such as harvest experiments and the introduction of African sharp tooth catfish (*Clarias gariepinus*) can be tested. The Coastal Hazards in Africa Network has grown rapidly since the inaugural international conference in Morocco, 2018. The 2020 conference was a resounding success and set the tone for 2022, which sees the next African country host this diverse, African-focused event

Fish depletion sampling experiments on the
Sundays River Valley irrigation ponds.

Ntombizanele Tshali, Prudence Mashobane and Munetsi Zvavahera doing depletion sampling experiments of *Gilchristella aestuaria* using seine nets at the
Sundays River Valley irrigation ponds.

Current and potential future status of Schistosomiasis (Bilharzia) in South Africa

Dr Lizaan de Necker, Postdoctoral Fellow

2020 was the first year of my Water Research Commission-funded (WRC) research project regarding the current and potential future status of schistosomiasis (bilharzia) in South Africa. This is a collaborative project with the University of Limpopo.

The last comprehensive snail distribution studies in South Africa took place between the 1950s and 1960s as part of the collections for the National Freshwater Snail Collection (NFSC) of South Africa. Given that temperatures and rainfall have changed in the past 60 years, the distribution of snails may also have changed, particularly in regions that were on the distribution fringes of the schistosomiasis intermediate-host snails. Our study will address the lack of knowledge regarding the present distribution of schistosomiasis in South Africa using a combined field and desktop-based study approach. The overarching aim is to determine whether the ranges of the intermediate-host snails and associated parasites have expanded, how affected communities perceive and experience these changes, and whether changes may further expand and increase the potential prevalence of the disease in humans and animals, given future predicted climate change.

We had three students associated with the project, two Honours students who completed their projects, and one first-year MSc who will continue with his second year in 2021. One field survey was able to take place in August 2020. I published a popular article in the *Water Wheel* introducing the WRC-funded project, and we created a digital version of the *Bilharzia Atlas of South Africa*, which is a first of its kind in South Africa. Future work includes computer modelling of current schistosomiasis distribution in South Africa and then sampling in newly identified locations to test the accuracy of the model. Interviews with local communities will gauge their knowledge regarding schistosomiasis and a community workshop at the end of the project will distribute the research findings.

Additional Information

This project is funded by the Water Research Commission (WRC Project No C2019/2020-00151)

August 2020 fieldwork for North West University Honours projects.

EXPLORE.

Platform Provision and Infrastructure Development

African Coelacanth Ecosystem Programme – ACEP

Ryan Palmer, Marine Platform Manager

Background and objectives

The DSI/NRF ACEP promotes competitive, multi-disciplinary and multi-institutional east coast marine research with an emphasis on capacity building in the marine sciences. The key to ACEP's success has been the ongoing relationship between DSI, NRF-SAIAB, NRF-SAEON, DEFF and RISA.

As a National Research Platform, ACEP is in place to ensure that:

- appropriate research platforms and technol ogies are available for scientists to undertake the required marine research to guide South Africa's decision makers;
- the correct baseline data and understanding of the marine environment are available to decision makers so that decisions are in the best interest of sustainable and inclusive development;
- the next generation of scientists, policy makers, and environmental managers is well trained and is representative of the country as a whole.

Since 2002, ACEP has been effective in responding to the needs of the country, shifting its research priorities appropriately over time. The primary aim of ACEP during the 2019/20 period has been to support research priorities along South Africa's east coast as outlined in South Africa's Marine and Antarctic Research Strategy, as well as Operation Phakisa: towards sustainable development of the Ocean Economy through Marine Spatial Planning and MPA research.

Research activities

Four projects are currently supported through ACEP's Open Call, both with funding and access to infrastructure and technical and logistical support:

- Dr Warren Potts (Rhodes): SALPA Project – Fisheries-induced evolution on fish physiology.
- Prof. Mandy Lombard (Nelson Mandela University):Canyon Connections – The ecological role of submarine canyons on the east coast of South Africa.
- Dr Sean Fennessy (ORI): CAPTOR – Connectivity and dispersal between MPAs.
- Prof. Kerry Sink (SANBI): Deep Forests – Taxonomy, phylogeny, habitat, ecology and benefits of deep coral and seaweed habitats in South Africa.

All these projects are well into their fieldwork components.

Training and supervision

ACEP places a major focus on training students, and a large proportion of its budget goes towards student bursaries and academic support for students. Through the ACEP Phuhlisa Programme, 96 students (100% black) from historically disadvantaged universities (HBUs) were supported through bursaries, project running costs, access to infrastructure, and academic support though courses. The ACEP Open Call had 25 students (75% black) on the four competitively awarded projects, who received bursaries and access to the marine platforms.

Outcomes

Notable outcomes from projects in 2019 include preliminary results from the cutting-edge research undertaken by Dr Warren Potts which demonstrates the importance of MPAs on a fish population's genetic resilience to climate change. The first visual survey work on much of South Africa's deep shelf and shelf edge has been conducted by ACEP. This work has contributed significantly to South Africa's National Marine Ecosystem Map as well as to the National Biodiversity Assessment.

Impact for society

As a result of support of research priorities outlined by Operation Phakisa, several of the projects supported by ACEP over the past few years have been in support of South Africa's National Ecosystem Classification Map and National Biodiversity Assessment. Both works underpin Marine Spatial planning in South Africa which allows for the sustainable growth of the Blue Economy.

In terms of capacity building, a large cohort of post-graduate students is currently being supported. This representative group of students will take this work forward in the future.

Future work

ACEP will continue to support the current projects until the end of 2020, after which a new cohort of projects will be competitively selected for support in 2021–2023. The focus of the projects, steered through the Open Call, will probably be similar; however, engagement with policymakers will ensure that priorities remain relevant to societal needs. Gaps identified in the National Biodiversity Assessment 2019 have been included in the focus areas for future work.

PhD student on ACEP Deep Secrets Project, Zokeka Filander, with a "ski-monkey" benthic camera sled system onboard *RV Algoa*.

2020 Highlights

The primary aim of ACEP during the 2018–2020 period was to support research priorities along South Africa's east coast as outlined in South Africa's Marine and Antarctic Research Strategy, as well as Operation Phakisa: towards sustainable development of the Ocean Economy through Marine Spatial Planning and MPA research. The focus of the 2021–2023 ACEP Open Call also includes alignment with research priorities identified in the National Biodiversity Assessment and the UN Decade of the Ocean. The four projects supported through ACEP's Open Call 2018–2020, both with funding and access to infrastructure and technical and logistical support, have mostly been completed. In terms of training and supervision, the ACEP Open Call had 19 funded students (75% black) on the four competitively awarded projects, all receiving bursaries and access to the marine platforms.

ACEP will continue to support the four new projects for the 2021–2023 period:

- Prof. Kerry Sink (SANBI): Deep Connections
- Dr Natasha Karenyi (UCT): Agulhas Bank Connections
- Dr Warren Potts (Rhodes University): SALPA2 Project
- Prof. Mandy Lombard (NMU): SmartZone MPA

The focus of these projects, steered through the Open Call, are similar to the previous call. However, engagement with policymakers has ensured that priorities remain relevant to societal needs. Gaps identified in the National Biodiversity Assessment 2019 have been included in the focus areas for future work.

The deployment of a robotic sea glider on *RV Phakisa*.

RV Observer, a 15 m custom-built research vessel based in Algoa Bay, forms part of the NRF-SAIAB coastal craft fleet, providing researchers access to the coastal and offshore marine environment.

Marine Remote Imagery Platform – MARIP

Dr Anthony Bernard, Instrument Scientist

Background and objectives

The MARIP provides researchers from South Africa and the Western Indian Ocean (WIO) access to a variety of advanced underwater imaging equipment that can be used to conduct exploratory and quantitative surveys of benthic, demersal and pelagic marine biota from the shallow subtidal down to a depth of 1000 m. The equipment includes a ROV, multi-imaging drop cameras, and a broad variety of stereo-video camera systems, including tethered and untethered stereo-BRUVs, pelagic stereo-BRUVs and a diver-operated stereo-video system.

The MARIP has its own research vessel and tow vehicle to enable access to remote locations within the waters of South Africa and its neighbouring countries. The platform includes a computer laboratory with all the required software for processing the imagery data, a large network-attached storage system for long-term archiving of all imagery samples, and a comprehensive biodiversity data management system linked into the Specify software system used for managing biological specimen collections. The MARIP is the largest of its kind in South Africa and provides our scientists unprecedented access to research opportunities to enable cutting-edge research of underwater ecosystems. The platform directly aligns with the United Nations SDG 4 (Quality Education), SDG 9 (Industry Innovation and Infrastructure) and SDG 14 (Life Underwater). Importantly, the platform works towards South Africa's NDP by improving education, training and innovation, while the research that the MARIP does enables works towards environmental sustainability.

Team

Ryan Palmer (ROV Pilot and Technician), Nick Schmidt (MARIP Field Technician), Roxanne Juby (MARIP Data Technician), Aseeqah Davids (MARIP Intern).

Research activities

During 2019, the MARIP provided various levels of support to 13 projects. This included three of the current projects supported by the ACEP (CAPTOR, Canyon Connections and SALPA) and research conducted in the WIO with the Wildlife Conservation Society (Mozambique and Tanzania), the Marine Megafauna Foundation (Mozambique), the University Lurio (Mozambique), and WILDOCEANS (Comoros and Mozambique).

The platform provided additional support to projects in South Africa, including the long-term monitoring of the Tsitsikamma National Park (NRF-SAIAB/ NRF-SAEON) and the Pondoland MPA (Oceanographic Research Institute), the Knysna Seahorse Project, and the West Coast visual survey on board the *RV* Ellen Khuzwayo (SAEON Egagazini). Lastly, the platform supported research conducted by NRF-SAIAB in freshwater systems, including surveys of the fishes in the streams of the Cedarburg.

Training and supervision

Twenty-six postgraduate students are currently working on projects that use equipment, data and resources provided by the MARIP. The platform pro-vides the students involved in the projects with relevant training in the use of the equipment and the management and processing of the data. In addition, the MARIP co-hosts, with ATAP and Aquatic Genomic Research Platform (AGRP), a Summer School which offers training and field experience for undergraduate students who wish to pursue a career in marine science.

On an annual basis, the MARIP also hosts interns who assist with the management of the platform, and with field-related work activities.

Outcomes

The expedition led by WILDOCEANS, to the Vamizi Islands in northern Mozambique in August 2019, collected stereo-BRUV samples and carried out the first visual survey of the benthic fishes occurring in the mesophotic zone for this area. The data collected will be used to support the future marine spatial planning to ensure the sustainable management of reef ecosystems in the region.

The expedition led by SAEON Egagazini, to the outer Agulhas Bank on board the *RV Ellen Khuzwayo*, carried out successful field trials of the acoustic release stereo-BRUVs down to depths of 360 m. These deep-water baited camera systems will enable future research down to depths of 2000 m.

Impact for society

By providing advanced research infrastructure to scientists in South African and the WIO, the MARIP serves a critical role in advancing marine science in our region. Much of the research supported by the platform is relevant to society and feeds directly into the development of recommendations and strategies

for the sustainable management and utilisation of South Africa's marine biodiversity. The platform supports a diverse group of postgraduate students, ensuring the development of the next generation of scientists. Furthermore, the platform works extensively with other counties in Africa, supporting regional development.

Future work

Research activities planned for 2021 will focus on completing the current ACEP projects and begin the national assessment of benthic endemic elasmobranchs to inform conservation planning.

SCUBA divers on the ACEP SALPA project prepare for a dive off the *RV Hispidus* to retrieve acoustic listening stations that have been recording the movement behaviour of roman, *Chrysoblephus laticeps*.

(From left to right) The crew of the *RV Ellen Khuzwayo* prepare the acoustic release stereo-BRUVs for deployment; species of dogfish (squalidae) and catshark (scyliorhinidae) approach the system while on the seafloor; prior to retrieval, the system floats on the surface signalling its position with radio and satellite beacons and drawing the attention of inquisitive seabirds.

2020 Highlights

2020 saw the commissioning of MARIP's light-weight deep-sea stereo-camera landers and mid-water drifting baited remote underwater stereo-video systems (stereo-BRUVs). The new landers can be deployed off small vessels with a davit arm and can sample down to 1000 m depth, making them the ideal tool to sample fishes found on the deep mesophotic habitats on South Africa's continental shelf. The mid-water drifting stereo-BRUVs can be deployed between 1 and 1000 m depth and will provide scientists with the opportunity to investigate the shallow and deep-sea pelagic and demersal fish assemblages. MARIP remained an integral platform within ACEP, by successfully completing the data collection for the Canyon Connections and SALPA projects and being included in all the new ACEP projects approved in 2020. Additional research support was provided for the Blue Action Fund Oceans Alive project, the Shark Conservation Fund Shark and Ray conservation project, the NRF Reef Fish eDNA project.

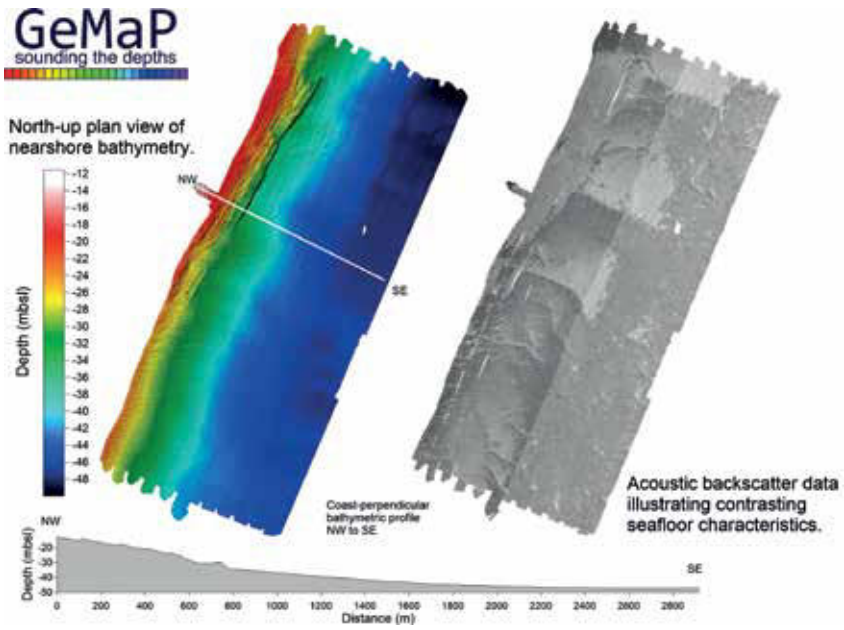
Geophysics and Mapping Platform – GeMaP

Dr Errol Wiles, Instrument Scientist

The Geophysics and Mapping Platform's new inertial navigation system was successfully commissioned on RV *uKwabelana*. The SBG Navsight Apogee will provide high accuracy and precision position and motion corrections to the Reson 7101 multibeam echosounder system on board RV *uKwabelana* negating the need for a Real-Time Kinematic (RTK) positioning base station.

The commissioned system was put through its paces conducting nearshore surveys off Durban's Bluff, and uMdloti reef complexes with the benefit of SBG's post-processing software, Qinertia, to deal with motion-induced data artefacts common when working along South Africa's wave-dominated and energetic coastline.

The Geophysics and Mapping Platform is primed to support geospatial marine research, providing high-resolution and high-accuracy bathymetry and backscatter intensity data to the marine scientific community.



Bathymetry and backscatter intensity data from the uMdloti region, KwaZulu-Natal. The data cover 17 km^2, from 12 to 50 m below mean sea level, highlighting the rugged reef complexes common along South Africa's east coast.

2020 Highlights

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Acoustic Tracking Array Platform – ATAP

Prof Paul Cowley, Principal Scientist and ATAP Manager

Background and objectives

The Acoustic Tracking Array Platform (ATAP) is a marine science infrastructure programme that monitors the movement and migrations of inshore marine animals equipped with acoustic transmitters. Tagged animals are monitored by a network of more than 100 acoustic receivers spanning approximately 2000 km of the South African coastline, from the Berg Estuary in the Western Cape to Ponta do Ouro at the South Africa/Mozambique border. More than 1400 acoustic transmitters have been deployed by ATAP and its partners on over 40 species, including important coastal fishery species (e.g., dusky kob and white steenbras) and threatened apex predators (e.g., white sharks).

An improved understanding of the spatial ecology of species important to fisheries, and/or of conservation concern, is essential for the development of effective management measures. The long-term empirical data of animal movements by the ATAP can be used for conserving and sustainably using marine resources for sustainable development (SDG 14: Life below Water), can improve food security (SDG 2: Zero Hunger), work towards ensuring sustainable consumption patterns (SDG 12: Responsible Consumption and Production) and alleviate poverty (SDG 1: No Poverty). ATAP is well positioned in the international arena and continues to have strong ties with the Canadian-based Ocean Tracking Network (OTN) (SDG 17: Partnerships for the Goals). By working with and providing support to scientists from more than 20 organisations, ATAP also aims to develop human capacity, with emphasis on training students from HBUs and involving female researchers (SDG 4: Quality Education; SDG 5: Gender Equality).

Research activities

In 2019, a total of 142 animals, comprising 20 species, were tagged by the ATAP tagging community. There was a strong focus on elasmobranchs, with 20 smooth hammerhead sharks, 17 diamond stingrays, 14 spotted gully sharks, eight white sharks, six duckbill stingrays and four bull sharks tagged. In addition, 20 red roman were tagged in the Tsitsikamma MPA and off Noordhoek, Port Elizabeth, as part of an ACEP-supported project. Receiver rollovers proceeded as normal, with only a 2% loss rate in 2019. ATAP assisted three ACEP-funded projects in 2019 with acoustic receivers being deployed at (i) deep-water canyon heads off northern and southern KZN, (ii) two MPAs (St Lucia and Pondoland), (iii) in the Tsitsikamma MPA, and (iv) off Noordhoek (near Port Elizabeth). The ATAP also assisted two projects with equipment loans: (i) two receivers were deployed off Rabbit Rocks (near Sodwana Bay) to monitor the movements of potato bass and green jobfish, and (ii) eight receivers were deployed in southern Mozambique to monitor the transboundary movements of sharks and a spawning aggregation of giant kingfish.

Training and supervision

Since its inception, ATAP has provided data to support the work of at least 20 post-graduate students from numerous universities. To expose acoustic telemetry research to a broader audience of students, ATAP staff once again hosted the annual NRF-SAIAB Summer School in 2019, which was attended by ten students from HBUs.

Outcomes

The ATAP is well recognised at the international level as a benefit-sharing marine science programme and has been cited in several manuscripts outlining the opportunities and benefits of large-scale telemetry networks. Several papers published in 2019 made use of data collected by ATAP. These publications included: (i) a study describing the spawning aggregation dynamics of the world's largest aggregation of giant kingfish, and (ii) a mark-recapture study to estimate the population size and survival of pyjama catsharks in Mossel Bay. In total, 41 data reports were requested by ATAP partners in 2019.

Impact for society

Movement information is critical to the development of appropriate management strategies, particularly marine spatial planning interventions, such as MPAs. The data collected by ATAP also contributes towards evaluating the management effectiveness of current no-take MPAs, such as the De Hoop MPA and Addo Elephant National Park MPA. Such evaluation has a direct impact on society as, without protection, fishery resources would be overexploited, leading to collapse of stocks, unsustainable consumption levels, hunger, and ultimately, loss of biodiversity. To bring the public's attention to these issues, ATAP actively participates in science engagement activities, including in SciFest Africa and social media (Facebook, Twitter and Instagram).

Future work

While ATAP continues to monitor the movement and migrations of numerous coastal fishery species, future work will focus on (i) assessing transboundary movements and MPA connectivity of marine fauna, where multiple species will be equipped with long-life (up to 3 650 days) acoustic transmitters, and (ii) understanding the movement behaviour, habitat connectivity, and ecology of multiple estuarine species, including important food fish species, such as mullet.

Additional information

Running expenses (ATAP acknowledges the Save Our Seas Foundation and the ACEP); acoustic telemetry hardware (Ocean Tracking Network, the Shallow Marine and Coastal Research Infrastructure Programme, and the NRF).

The South African coastline hosts the largest marine migration on the planet. The annual sardine run, dubbed as the Greatest Shoal on Earth, is pursued by large numbers of predators, including sharks, whales, dolphins and birds. Here a pack of spinner sharks *Carcharhinus brevipinna* take advantage of a sardine bait ball. Photo: Ryan Daly.

2020 Highlights

During 2020, more than one million detections were recorded on ATAP's nationwide array of receivers, bringing the total number of detections in the database to just shy of 25 million. In addition, two new Vulnerable species (lesser guitarfish and spinner sharks) were tagged, bringing the total number of animals tagged and monitored to more than 1 600 from 48 species. The ATAP continued to assist three ACEP-funded projects in 2020, which collectively saw the tagging of approximately 60 animals, and ATAP also provided infrastructure and data management support to two newly funded projects managed by the WILDOCEANS programme of the WILDTRUST that aims to tag over 200 new animals with a focus on selected South African threatened endemic sharks and rays, as well as transboundary movements and MPA connectivity by selected species. To date, over 40 animals of seven different species have been tagged, with significant tagging efforts to be undertaken in 2021.

Collections and Specialised Laboratories Platform

Roger Bills, Collections Manager

Background and objectives

The Collections Platform comprises a range of specimen collections and specialised laboratories all available to local and international students and researchers. The aim of the platform is to provide access to museum specimens mostly for taxonomic, systematic and biodiversity research. The main collections facilities were built in 2007 and have been operational since then, and the upper collections building was completed in 2018. The facilities consist of a collection management centre, where most collections staff work and where research and sorting of collections is conducted; a collections building which has two large temperature-controlled specimen stores, three wet sorting laboratories, a biobank with -80°C freezers, an x-ray room, a chemical store, a dermestarium, and various plant rooms.

The specimens held in our collections reflect NRF-SAIAB's aquatic research over the past 50 years and thus are particularly important for the southern African continent south of the DRC, the Western Indian Ocean, and Southern Ocean regions. The collections are dominated by the National Fish Collection which comprises over 120 000 lots of samples and over a million specimens. Since 2007, we have been actively developing collections of amphibians, cephalopods and tunicates with the help of donations and honorary curators. The National Diatom Collection is owned by NRF-SAIAB, but is held at the North West University in Potchefstroom.

Team

Staff: Roger Bills, Nkosinathi Mazungula, Amanda Gura, Mzwandile Dwani, Vuyani Hanisi

Interns: Nonkoliso Mgibantaka, Prudence Moshabane

Curators: Fishes: Roger Bills (NRF-SAIAB)
Freshwater: Dr Gavin Gouws (NRF-SAIAB) and Ofer Gon (retired; NRF-SAIAB)
Marine: Dr David Ebert (Moss Landing, USA) - Chondrichthyans;
Amphibia: Dr Michael Cunningham (associate at Melbourne Museum, Australia) and Dr Werner Conradie (Bayworld, Port Elizabeth);
Diatoms: Dr Jonathan Taylor (North West University);
Cephalopods: Dr Marek Lipinski (retired);
Tunicates: Dr Shirley Parker-Nance (Nelson Mandela Metropolitan University);
Aquatic Invertebrates: Dr Helen Barber-James (Albany Museum, Makhanda).

Research activities

We provide support to research projects by helping with field work logistics, providing collections materials, taking part in expeditions, lodging voucher specimens and data into collections, and loaning specimens. The main daily activities of the collections staff are cataloguing, curating and loaning specimens for research projects; this year we have catalogued just over 2000 lots and 32 379 specimens. We enable access to museum specimens through loans which may be examined at NRF-SAIAB or can be posted to foreign institutions. So far this year we have made 62 loans totalling 8549 specimens. We are involved in a number of research projects.

Most recently we have participated in the National Geographic project looking at freshwater fish diversity in the headwaters of the Okavango River system in Angola. We have been on several expeditions to Angola, have assisted with sorting and identifying specimens, and are assisting with some new species descriptions. This work continues. For the last 30 years we have provided the main datasets for the Southern African Red Data Lists for freshwater fishes, and NRF-SAIAB scientists have also coordinated most of the Red List assessments. Currently we are part of an international team, coordinated by SANBI, producing the first Mozambique Red Data Lists. Roger Bills has been to Maputo three times this year to identify all the specimens in the Maputo Museum and to take part in assessment workshops.

Training and supervision

Numerous students have used the NRF-SAIAB collections facilities through the year, from undergraduates using specimens for course work and fish identification courses, through to PhD students working on systematic studies. Usually, these students are not supervised by collections staff. We host varying numbers of interns each year and they gain valuable work experience in museum curation.

The IUCN Red Data list project in Mozambique has involved training Mozambican students and staff. We have run a fish identification course at the Maputo Museum and assisted with Red List assessment training during two workshops.

Impact for society

Natural history collections are a sample of biodiversity from a point in time. Large collections such as those housed at NRF-SAIAB, collected over decades and over a wide geographic range, provide researchers with a unique resource enabling a wide range of projects on taxonomy, systematics and biodiversity. These studies help us to understand species and natural environments better, and ultimately feed into a knowledge base aimed at assisting officers in governments and developers in industry to make informed decisions on how natural resources can be used responsibly.

Future work

The IUCN Red Data project in Mozambique will continue into early 2020 and culminate with the first threatened species lists. We hope this project will evolve into field work that will be aimed at filling knowledge and collections gaps identified by the listings. Part of this work involves training Mozambican scientists in Red List assessment methods, fish identification and field work methods. We expect additional collections from Angola (freshwater) and from *Dr Fridtjof Nansen* cruises (marine) during the next year and to have visitors working on these collections.

2020 Highlights

Collections have had a varied but positive year. Early in the year we had a series of international visitors and in-house SAIAB students. In August we hosted a marine Nekton workshop run by researchers from Oxford University UK. Loans have been active for most of the year. We have been involved with fish identification courses at Ulovane to wildlife students and with IUCN red data assessments in Mozambique. Collections staff took part in varied training courses from bar-coding workshops at the University of Johannesburg through to firefighting, CV writing and in-house training in Specify. Two of our students graduated - Moloko Matlala (PhD, University of Pretoria) and Ryan van Zeeventer (MSc, Rhodes University). All collections staff have been involved with aspects for the National Science Collections Facility (NSCF) programme. This really has impacted much of collections work over the past 2-3 years. A highlight is the production of a South African museum collection procedures manual (nearing completion) which is the product of many national meetings/workshops. This work has also impacted on our assessments of work practices and operations and we have made improvements in many areas from procedures, signage to assessments of infrastructure. In June we completed a biobank assessment which has now lead into an audit of biobank stocks and data and this is currently underway.

IUCN Red Data Workshop held at the Maputo Museum attended by Dr Albert Chakona (left) and Roger Bills (second from left).

Aquatic Genomics Research Platform - AGRP

Taryn Bodill, Molecular Laboratory Manager, and
Dr Gwynneth Matcher, Next-Generation Sequencer Advisor

The Aquatic Genomics Research Platform (AGRP) provides workspace for researchers in the field of aquatic genetics research. It is strongly positioned in terms of its link to the National Fish Collection, the NRF-SAIAB biobank, and to active researchers. The platform provides national genomics infrastructure for aquatic research, thereby contributing to global Sustainable Development Goal 14.

Research undertaken includes both freshwater and marine genetics with the platform utilised research that includes phylogenetic studies to understand aquatic biodiversity, evolution, ecology and genome studies. Climate change studies are also conducted in collaboration with the Aquatic Ecophysiology Research Platform (AERP). The platform is equipped with laboratory equipment for capabilities that extend from DNA extraction through to Sanger sequencing, as well as next-generation sequencing (MiSeq).

A high-performance computer was acquired in 2019 that enables the assembly of genomes from metagenomics data. The platform is operated on a cost-recovery basis, allowing users access to equipment and training that would otherwise be prohibitive. The platform is an invaluable teaching resource. Staff provide technical support to all platform users, allowing those with little or no practical experience to gain the skills needed to obtain their qualifications or to pursue a career in molecular work. There are no other platforms that offer this type of hands-on training.

WWF and DST-NRF interns underwent practical and administrative training by platform staff and scientists in 2019. Laboratory users in 2019 included students and postdoctoral students from the South African Environmental Observation Network (SAEON), Rhodes University (RU), the Institute for Environmental Biotechnology (EBRU), the Albany Museum, Stellenbosch University, University of Fort Hare (UFH), the University of Johannesburg (UJ), the University of Botswana and the South African Association for Marine Biological Research (SAAMBR). The platform played an active role in science engagement by providing practical workshops and lectures for local high schools, RU and UFH. The platform hosted the annual workshop on Next-generation Sequencing Data Analysis in 2019.

2020 Highlights

The AGRP was operational, albeit at reduced capacity due to the pandemic restrictions, for six months in 2020. The platform was utilised by 33 students/researchers during this time and a DSI intern was trained in practical lab techniques. The physical laboratory space was extended to accommodate additional users. The AGRP high-performance computer was upgraded and now boasts 2TB of RAM, facilitating faster analysis of next-generation sequencing generated data. Remote access to this computer was installed and researchers from RU and the Cape Peninsula University of Technology (CPUT) used the computer. Platform users in 2020 included students and postdoctoral fellows from the Albany Museum, RU, EBRU and UJ. An Amplicon Data Analysis Workshop was conducted remotely and was attended by 16 researchers from CPUT, SANBI, UJ and RU.

Mpilo Nyawo (PhD student) preparing an agarose gel in order to evaluate environmental DNA samples for subsequent analysis on the MiSeq.

WWF Intern, Tholoana Ntokoane, using the UVITEC machine to visualise DNA bands.

Aquatic Ecophysiology Research Platform (AERP)

Seshnee Reddy, AERP Co-ordinator

Background

The Aquatic Ecophysiology Research Platform (AERP) was established in 2014, through a formal collaboration between the South African Institute of Aquatic Biodiversity (NRF-SAIAB) and Rhodes University, Department of Ichthyology and Fisheries Science (DIFS). The AERP provides researchers with the tools for determining the effects of global climate change on the relationship between living organisms and their surrounding environment, for determining how these effects are likely to unfold, and what actions might prevent their effects in the future.

Climate change research is receiving increasing attention on a global scale, and it is essential that South Africa maintains a global standard in its research in this field. Climate research in South African marine science is still limited, especially in the field of ocean acidification and the combined effects of temperature and other climate change-related drivers. It is essential to improve our understanding of the effects of these environmental changes across a range of species from various taxa and ecosystems. Climate change is an ongoing phenomenon and understanding the potential effects on our marine resources will be a field that will increase in importance in the upcoming years. The organismal responses at the physiological, metabolic, and behavioural levels are central to research that addresses adaptation and resilience to environmental long-term and extreme changes.

AERP research involves scientists at NRF-SAIAB, DIFS and the Rhodes University Department of Zoology and Entomology, as well as postgraduates at the Honours, MSc, PhD, and postdoctoral levels, from the above-mentioned institutions and external institutions.

Owing to the nature of the research conducted at the AERP, there is a continuous need to update equipment to complement and expand existing experimental design and system set-ups. Along with an increase in demand for the low- and high-volume oxygen-sensing systems at the AERP, there has also been a need for water-quality measuring equipment. Water quality is a major component of these set-ups, as water is used to monitor and control the conditions in which animals are reared and exposed to during experimental procedures. The AERP has now acquired duplicate sets of hand-held water-quality equipment that enables measurements of pH, temperature, conductivity, dissolved oxygen and salinity, all of which aid researchers (most of whom are postgraduate students) in creating appropriate experimental designs for their respective projects. The platform has also taken a step forward and increased its capacity for behavioural studies by purchasing a selection of choice chambers with different designs and size ratios to cater for a wider range of species and experimental set-up.

Thirteen projects ran during 2019, involving varying degrees of fieldwork, equipment and facility usage. Academic achievements and highlights included Michael Skeeles, DIFS, MSc who graduated with distinction, and publication for his Honours project. A former NRF-SAIAB/DIFS postdoctoral fellow, Dr Murray Duncan, also published his PhD work in *Nature*. Both these users made use of AERP facilities and equipment for housing collected fish species and laboratory-based respirometry trials.

The AERP facilities were used to host a practical for DIFS undergraduate students (August/September 2019). The practical involved housing small fish in an existing system set-up for teaching students about the methodology that needs to be followed on ethically approved fish sedation.

Future work

Future projects (as per current projects) will potentially target small-scale and short-term experiments/research focussed on larval, juvenile and adult invertebrates and fish, as current fully operational facilities of the AERP will allow for this type of research.

Potential interest for collaborative work on terrestrial invertebrates can also be considered, as well as continuing projects on biological control agents. Further enhancement of the scientific understanding of climate change and ocean acidification can be achieved by developing protocols and procedures of a global standard. With potential expansion into new fields, bioeconomy, food security, and energy security can be addressed. A paradigm shift in the AERP platform would translate as an advance in international research and innovation, while simultaneously and directly addressing the need for the economic growth of the country. This objective would be attained by bottom-up progress of research capacity in South Africa achieved through training new graduates, as well as by attracting and retaining excellence, hence boosting the research capacity and economic growth. This research uniquely tackles the ecological issues behind climate change in a selection of sensitive systems of ideal and diverse model organisms, including the most vulnerable early life history stages. This approach is unusual and possibly unique for aquatic research in the country.

2020 Highlights

Academic achievements and highlights included PhD completions by Carla Edworthy, with her project on the eco-physiological and behavioural response of a coastal fish species to pH shifts due to future ocean acidification, and Lyle Vorsatz, with a chapter of his thesis focussed on the effects of temperature on the physiology of different developmental stages of mangrove-associated larvae. Both these users made use of the AERP high- and low-volume respirometry equipment, respectively. There were three publications by AERP users, who made use of equipment and/or facilities offered by the platform.

The AERP was afforded the opportunity to participate in National Marine Week and highlighted the projects carried out by its users which make significant contributions to research in the field of climate change. To ensure extended redundancy for current and future platform users, duplicate sets of equipment such as recirculating water baths, water-quality meters and experimental respirometry-based accessories were purchased, along with an updated respirometry software package which is a more user-friendly version and will provide users with a more refined and robust overall analysis of their collected data.

Adult red roman housed in holding tanks at the AERP facility.

Rebecca Reddy (NRF/DST Intern) taking water-quality measurements at Kenton-On-Sea.

Information Platform
Biodiversity Information Unit

Managing and preserving aquatic biodiversity data generated by SAIAB researchers

Dr Willem Coetzer, Biodiversity Information Manager

Background and objectives

The objective of this project is to design a workflow to preserve the structure, integrity and security of biodiversity data using new techniques in research data management. Since 2017, the Institute's changing needs and opportunities within the broader biodiversity community have caused the scope of biodiversity information management at NRF-SAIAB to expand. Areas that now fall within the orbit of biodiversity information management include: 1) observation records made by NRF-SAIAB researchers which have no bearing on physical specimens (e.g., remote underwater imagery), 2) making the process of integrating curation (preserving specimens) and annotation (database work) more efficient, and 3) capacity development among workers in other South African natural science museums, mostly to preserve data about preserved specimens. These three areas of work are briefly discussed below.

Research activities

Data generated from underwater photographs and remote underwater video.

Together with Dr Anthony Bernard and Roxanne Juby, we improved the quality-control mechanism to detect potential errors in video annotations during the data analysis process. We used the lengths of fish, measured from stereo photogrammetry, and the depth values accompanying these, to re-examine or exclude records of species whose lengths and depths fell beyond known ranges. This will help to improve the quality of the data that will be used to make defensible decisions in important areas such as the management of fisheries resources.

In this collaboration, Dr Elodie Heyns-Veale and Dr Anthony Bernard took their biodiversity data a step further than most. The data generated from underwater videos of fish, and underwater photographs of invertebrates on the sea floor were standardised according to international convention, and published on the Data Portal of the Global Biodiversity Information Facility. This will not only preserve the security of the records and make them freely available to anybody but will also allow the context and meaning of the data to be interpreted with greater ease.

Improvement and integration of curation and data management in the Collections Division.

A large number of specimens and samples pass through the Collection Management Centre every month and managing the curation and annotation workflow can be fraught with difficulties (e.g., different batches of material being in different states of sorting and identification, or some batches lacking adequate accompanying information). Work has begun to develop a workflow system that will ensure that each batch of specimens is documented with a minimum amount of information, and that a standard checklist of curation activities is completed at each stage of the process for all batches. This will improve the quality of preserved specimens as well as the quality of data associated with them.

Broader outcomes

Support and capacity development for South African natural science museums.

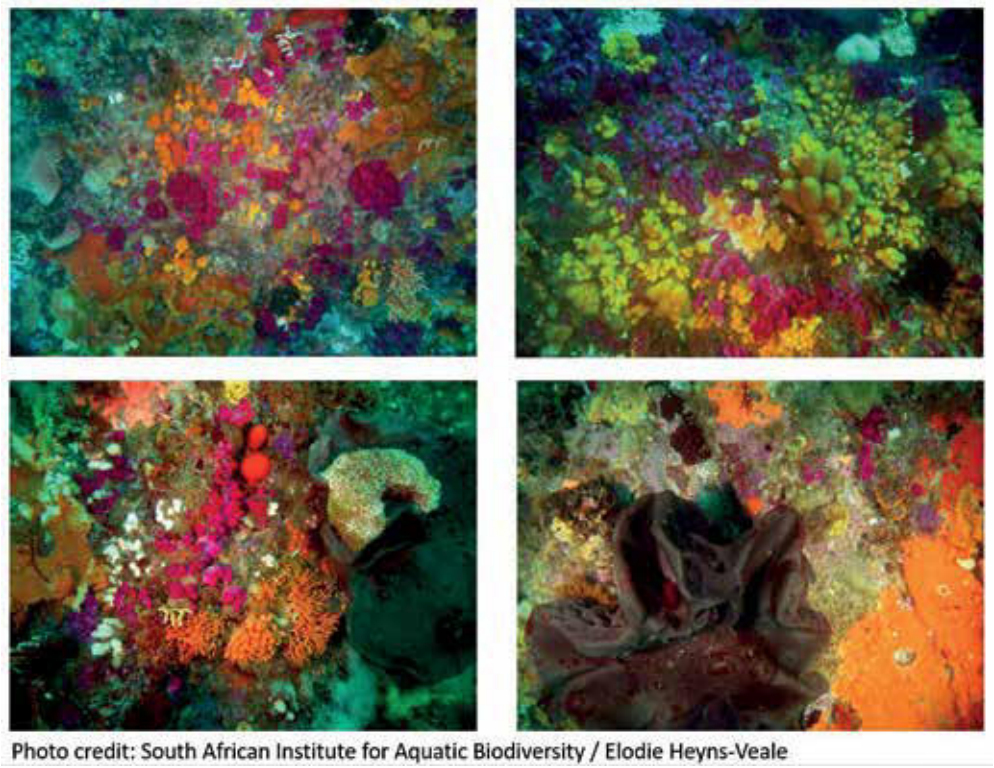
The Natural Science Collections Facility (NSCF) is a virtual facility funded as part of the DST's long-term funding programme, the Research Infrastructure Roadmap (SARIR). Together with the NRF-SAIAB Systems Administrator, who runs the physical IT hardware, we developed the Biodiversity Data Curation Platform for natural science museums, specifically to support the NSCF. The outcome is an online specimen database, hosted by NRF-SAIAB, for each of the eight participating natural science museums. During the reporting period, much work was done to consolidate more biodiversity specimen data in a number of collections and institutes, and to introduce more people in natural science museums to the joys of rigorous biodiversity data management. This is seen as an investment in the future of natural science museums.

Impact for society

The set of biodiversity data is much larger than the set of records representing physical specimens in natural science collections. It follows that people who are skilled in managing biodiversity research data have the potential to make an impact in all areas of biodiversity research.

Future work

We can potentially standardise training and capacity development in biodiversity information management and register an accredited qualification, so attracting skilled technicians to the natural science museum community and improving the retention of skills.



Photographs of invertebrates on the sea floor in Tsitsikamma National Park. A 0.2m2 photo quadrat on each photograph was sampled by identifying the species on which 50 random points fell. The data thus generated may be viewed or downloaded from the GBIF Data Portal.

2020 Highlights

The objective of this project is to design a workflow to preserve the structure, integrity and security of biodiversity data using new techniques in research data management. This includes observation records made by NRF-SAIAB researchers, which have no bearing on physical specimens (e.g., remote underwater imagery). Together with Dr Anthony Bernard and Roxanne Juby, we improved the quality-control mechanism to detect potential errors in video annotations during the data analysis process, as explained above.

Margaret Smith Library

Maditaba Meltaf, Senior Librarian

Background and objectives

The MS Library is a resource shared with the Rhodes University Library. Being part of the Rhodes University community means that SAIAB students have the same level of access to the University E-learning Resources. The MS Library also serves as the primary library for the Rhodes University Department of Ichthyology and Fisheries Science (DIFS). Our literature collection is specialised and focused only on ichthyology, aquaculture and fisheries.

When building our collection, emphasis is on relevance, with material that speaks to the need/demand of our users. This method has resulted in high circulation of books and excellent user satisfaction survey.

The year 2019 marked an historical milestone for the MS Library: for the first time in its history the Library has only one Librarian, Ms Maditaba Meltaf, as Ms Sally Schramm retired in December 2018.

Research activities

The Margaret Smith Library survey was sent out in 2019 to all users and stakeholders. This survey aimed to identify weaknesses and strengths of the Margaret Smith Library with regard to customer service and library infrastructure. The survey highlighted an overwhelming rating of satisfied Library users, and we hope to maintain the status quo.

During the reporting period, the Library submitted claims for 100 ISI-rated publications for 2019, through the NRF Research and Innovation Reward Programme (RIRP), and NRF-SAIAB received an award of R2 591 000 for these publications by our researchers, students and Honorary Research Associates.

Training and supervision

The Margaret Smith Library conducts library user training for NRF-SAIAB interns and students and for Rhodes University DIFS undergraduate and post-graduate students.

In May 2019 Ms Mahlori Salane was appointed as a library intern for the year, but she was with us for only five months before taking up a permanent post as a librarian at Damelin College in Bloemfontein.

Outcomes

The Margaret Smith Library is a member of Biodiversity Heritage Libraries (BHL), a global consortium of university libraries and special libraries in the world, with 520 contributing members. This membership enabled us to digitise the iconic 1949 edition of the book, *The Sea Fishes of Southern Africa* by JLB Smith, through Cornel University. The volume is now available through BHL. The first edition of *Smith's Sea Fishes* by PC Heemstra and MM Smith, was digitised by the Harvard University, Museum of Comparative Zoology, Ernst Mayr Library, and the digital copy is also available through BHL. The Smithiana Monograph No 4 entitled *Fishes of Southern African*

Students making use of the computer room of the Margaret Smith Library

Estuaries: From Species to Systems by AK Whitfield is digitally available from the Rhodes University Library Digital Commons (Repository). This monograph has impressive metrics since digitised – Hits: 514, Visitors: 521, Downloads: 163.

Impact for society

The Margaret Smith Library supports Open Access and the digitisation of *Smith's Sea Fishes* which is still under copyright, is a big win for Open Access. The publication is now fully accessible online and is downloadable fully or in part.

Future work

The Margaret Smith Library plans to digitise the *Ichthyological Bulletins* by JLB Smith and edited by MM Smith (Volume 1: 1-20; Volume 2: 21-32), as well as other reference works, particularly from the African continent.

Additional information

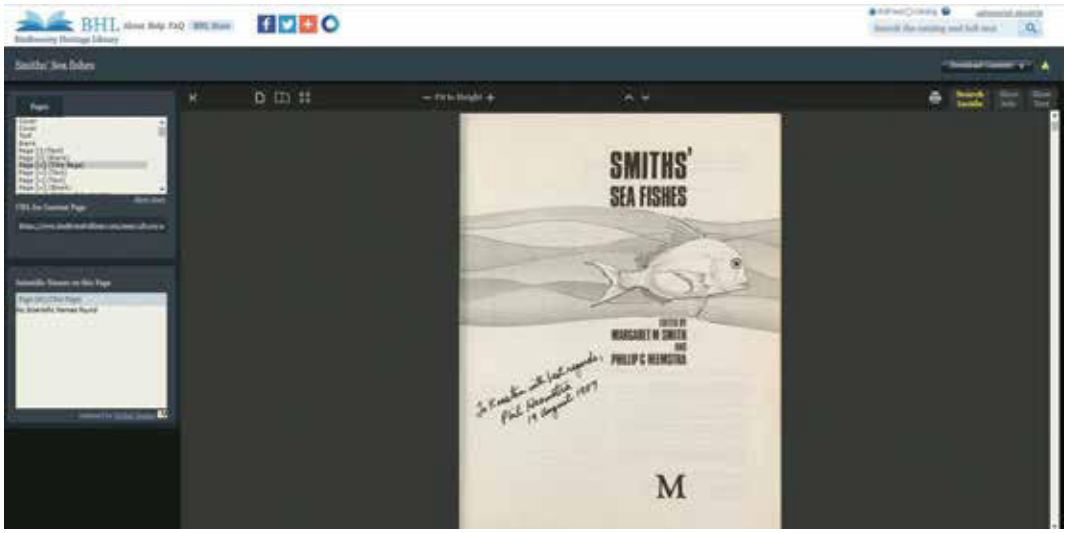
The Librarian, Ms Maditaba Meltaf, is a Sesotho narrator for audiobooks at the South African Library for the Blind.

2020 Highlights

The Margaret Smith Library is a member of IAMSLIC – the International Association of Aquatic and Marine Science Libraries and Information Centres. This membership proved to be very beneficial to the Library during the Covid-19 Pandemic when the Library was closed. Library services remained available to users through the IAMSLIC consortium, enabling libraries to lend each other articles or book chapters when one has no access / subscription.

The Margaret Smith Library was able to harvest 142 ISI-rated publications for 2020 from the Web of Science database. This was a record number of publications by NRF-SAIAB researchers, students and Honorary Research Associates.

During 2020, the Library was able to purchase new books to the amount of R28 536.00.
The pandemic prevented digitising of materials, so this will become part of the 2021 plan and targets.



Digitised version of the Smith's Sea Fishes on the BHL website.

ACEP Phuhlisa Programme.

Human Capacity Development

ACEP Phuhlisa Programme

Garth van Heerden, Human Capital: Development Manager

Background and objectives

The African Coelacanth Ecosystem (ACEP) Phuhlisa Programme, a strategic Department of Science and Innovation (DSI) transformation initiative in partnership with four Historically Black Universities (HBUs), aims to assist in building capacity in Marine Science at the HDIs with the goal of accelerating transformation of the marine science research community. Collaboration between NRF-SAIAB and the four HDI Universities (Universities of Fort Hare, Zululand and the Western Cape and Walter Sisulu University), has resulted in a managed programme through which research support is provided by NRF-SAIAB and NRF-SAEON researchers to enhance supervisory capability at these universities. The NRF-SAIAB Human Capital Development Manager, Mr Garth van Heerden, and his office provide the professional support needed to drive the programme and ensures that high quality research is maintained. This strong strategic initiative ensures that black and female South African postgraduates are trained within the marine sector and that marine science is entrenched more deeply at partner universities. The ACEP Call was designed as a split call to facilitate the initiative. Two thirds of the funding goes to an open call and a third of the funding is ring-fenced to support Marine Science researchers at HBUs. The programme, foremostly, capacitates HBU marine science researchers by providing access to National Facility research equipment and expertise, which would otherwise only be available to scientists at historically white or research intensive universities.

In order to address the articulation gap of students coming from a disadvantaged background the Phuhlisa Programme facilitates custom training courses to help students catch up on writing, presentation and other skills. During 2019, 96 students from HBUs were supported through Phuhlisa bursaries and running costs: 25 BSc Hons, 59 MSc and 12 PhD students.

Critical to the success of the programme is that we follow an HBU researcher centred-approach. We believe that this is where the greatest potential is for capacity building. Nineteen researchers from the HBUs were supported through the Phuhlisa Programme during 2019.

The ACEP Phuhlisa Programme supports the three following Sustainable Development Goals (SDGs):

SDG 4: Quality Education. This goal is aligned with the Phuhlisa Programme in that it aims to ensure inclusive and equitable quality education and that marine science is entrenched more deeply at HDIs.
SDG 5: Gender Equality. The Phuhlisa Programme has been planned and designed around key impediments which limit entrance or participation in marine science, as articulated by HBU researchers and students. The Programme aspires to deliver transformative change that is driven towards enforcing gender equality and empowering female students in marine science.
SDG 14: Life Below Water. The Phuhlisa Programme tries to implement SDG 14 by securing ocean science researchers and students with funding and access to specialised marine equipment and technical expertise to drive projects that aim to conserve and sustainably use the oceans, seas and marine resources for sustainable development.

The ACEP Phuhlisa Programme similarly supports the goals of the National Development Plan through growing an inclusive economy, building capabilities and enhancing the capability of top class black South African graduates from disadvantaged backgrounds.

Challenges

- **Bursary payments by universities**. The NRF has changed bursary payments to paying direct to student accounts instead of to universities to ensure students bursaries are not unduly delayed in the university systems.
- **Limited running expenses**. Besides supervisory capacity, the next most limiting factor is that of running costs, currently paid from the ACEP Open Research Call. We are not able to support all post-graduate research projects to the required level any longer, e.g. in order to fund all projects we have had to reduce the amount of funding to PhD projects from R40k per annum to R25K per annum and for MSc projects from R25K to R15K per annum. Negotiations with DSI need to factor in sufficient support to cover running costs for research projects.
- **Capital equipment**. The University of Fort Hare is located closest to NRF-SAIAB so their students benefit the most from using NRF-SAIAB research platforms, such as the ACEP RV *uKwabelana*, river boats, divers, genetic laboratory, etc. Other universities, however, are further away and cannot make full use of our platforms and thus need to be

assisted in other ways. For example, UniZulu was assisted with the purchase of a digestion microwave for their ecotoxicology work as well as a multi-parameter estuary probe when their probe became unserviceable. They will also be assisted with the purchase of a small riverboat to use for their research in St Lucia as well as the purchase of a PC to run their Atomic Absorption spectrometer.

ACEP Phuhlisa students attend an academic writing workshop at NRF-SAIAB.

2020 Highlights

Since its inception in 2012, the Phuhlisa Programme has grown substantially and in 2020 supported over 100 postgraduate students and 20 supervisors at the four coastal Historically Disadvantaged Institutions (UWC, UNZUL, UFH and WSU).

In 2020, the DSI/NRF initiated the next chapter of this exciting programme by providing support to the ACEP Phuhlisa to assist in the development of four marine laboratories at the participating Historically Disadvantaged Institutions. The programme is known as the DSI/NRF- SAIAB Joint Marine Labs Programme (JMLP). The objective of the JMPLP being the twinning of the expertise of each of the four universities with the expertise of a DSI/NRF National Facility viz. NRF-SAIAB. These laboratories will build on existing research and laboratory activities at the Universities and will ensure access by university staff to ACEP infrastructure e.g., coastal vessels and equipment. The laboratories will be jointly co-ordinated by the university and NRF-SAIAB.

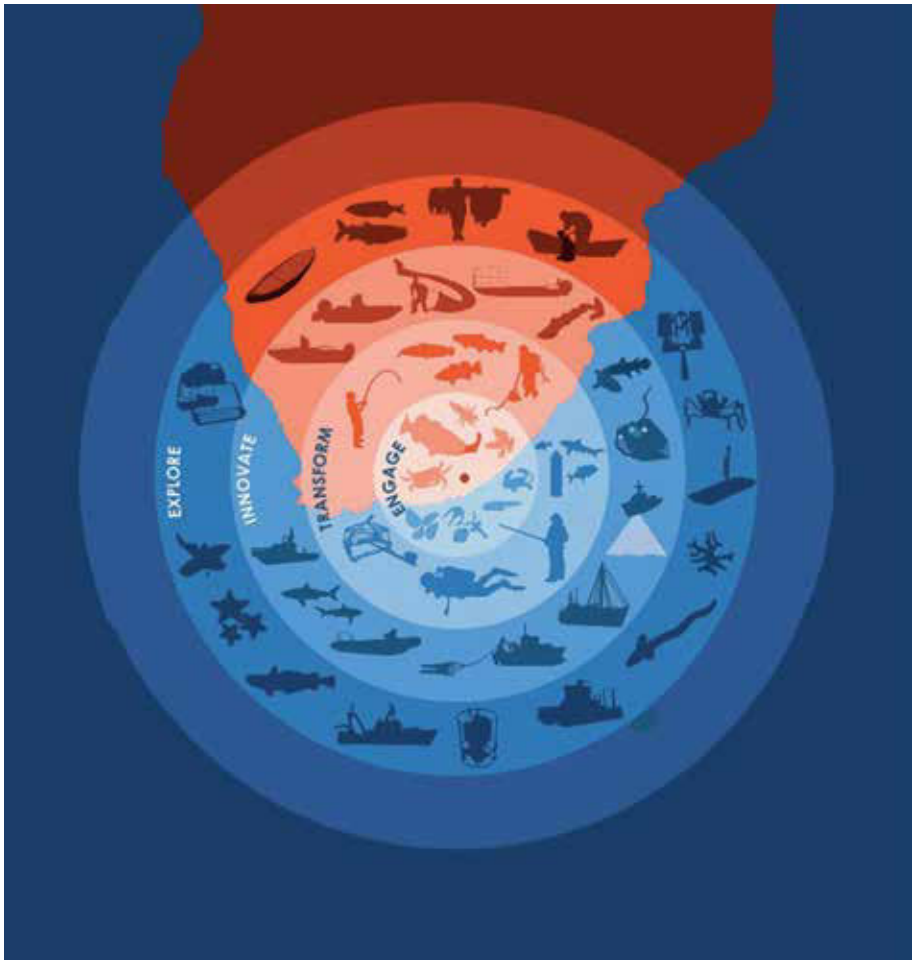
The JMLP will all aim to address key marine social and economic opportunities and challenges facing South Africa. The laboratories are as follows:

- Walter Sisulu University: Rural Livelihoods and Food Security
- University of Western Cape: Marine Micro-plastic Pollution
- University of Zululand: Marine Ecotoxicology
- Fort Hare University: Marine Bio-economy

Critical to the success of the programme is that we follow an HDI researcher-centred approach. We believe that this is where the greatest potential lies for capacity building. Passion and research excellence is imperative but, if South African marine science is to thrive, we must ensure that we have a representative scientific cohort reflecting the demographic characteristics of our society. This requires dedicated and strategic transformation initiatives such as the Phuhlisa Programme.

NETWORK

Strategic Engagement and Collaboration



Infographic by Dr Taryn Murray

Freshwater invertebrates

Dr Helen Barber-James (NRF-SAIAB Honorary Research Associate),
Dr Ferdy de Moor (NRF-SAIAB Honorary Research Associate),
Mr Musa Mlambo and Dr Alex Holland
(all at Albany Museum)

The staff and students at the Albany Museum's Department of Freshwater Invertebrates continued their close relationship with NRF-SAIAB. Dr Helen James, head of the department, oversees the various projects. Her team was again involved with the National Geographic Okavango Wilderness Project, with further fieldwork in November 2019, producing many previously unknown freshwater insect species which need to be barcoded genetically. Mr Musa Mlambo, assistant curator, continues to focus mostly on the invertebrates inhabiting temporary water bodies. Projects making use of the NRF-SAIAB molecular laboratory included:

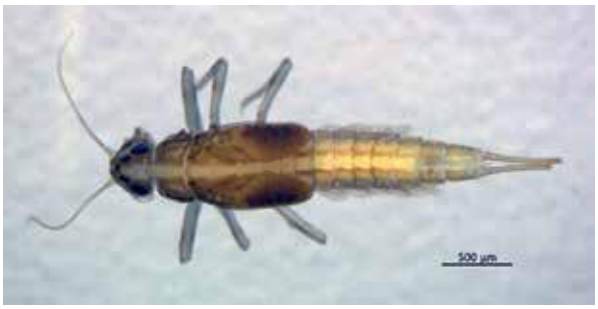
(i) postdoctoral student, Dr Alexandra Holland's revision of the systematics of Leptoceridae caddisflies, and descriptions of multiple new species, under the mentorship of Dr de Moor;

(ii) Ms Ina Ferreira continued PhD research on Leptophlebiidae mayflies; she has discovered several previously unknown species and is unravelling their biogeography to explain their current distributions and ecological preferences;

(iii) an investigation of the relationships of modern-day stoneflies with their fossil ancestors (an MSc project by Mr Ben Kirkaldy, jointly supervised with the museum's Earth Science department);

(iv) Ms Nonkazimulo Mdidimba's MSc research on invasive crayfish and eDNA under the supervision of Mr Mlambo.

Dr Helen James collecting freshwater insects in a tributary of the Cuanavale River in Angola, November 2020.
Photo: Rainer von Brandis.



A new species of Baetidae mayfly from Angola

The museum values the continued support that NRF-SAIAB offers which enables the successful achievement of projects which would otherwise not have been possible.

Highlights

Although the research and collection-based activities of 2020 have been slowed by Covid-19 restrictions, the Albany Museum Department of Freshwater Invertebrates has continued to be productive. Several of our students and our postdoctoral fellow, Dr Alexandra Holland, have continued to use the NRF-SAIAB molecular laboratory for DNA studies. Mr Benjamin Kirkaldy was awarded his Entomology MSc thesis with distinction on the historical phylogeny of stoneflies (Plecoptera) in South Africa, relating to the Permian fossils being discovered in the Sutherland area by Dr Rose Prevec's palaeontology team at the Albany Museum. The genetic work for the fossil-dated molecular phylogeny was done in NRF-SAIAB's molecular laboratory. Ms Ina Ferreira is continuing with her PhD research on the Leptophlebiidae mayflies (Ephemeroptera). Dr Holland has been working on Trichoptera (caddisflies), generating many sequences, with descriptions of some 20 new species underway in collaboration with Emeritus Curator, Dr Ferdy de Moor.
Mr Musa Mlambo, Assistant Curator, is currently completing his PhD. He continues to focus on the invertebrates inhabiting temporary water bodies, with a recent research on cave-dwelling crustaceans with his MSc student, Zizile Mlungu, and eDNA of alien crayfish with his MSc student, Nomkazimulo Mdidimba, both of whom are doing genetic work in the NRF-SAIAB laboratory. Dr Helen James, who is head of the department, oversees the various projects, and continues to be involved with the National Geographic Okavango Wilderness Project, with nine new species of mayflies from Angola soon to be published. The department is also heavily involved preparing data for red-listing selected invertebrate groups, a collaborative project with SANBI.

The Albany Museum continues to be grateful for the support that NRF-SAIAB offers though donating ethanol for the preservation of wet collection specimens, for the occasional use of fieldtrip vehicles, and for support with the SPECIFY database, as the museum has no IT expertise to help with this.

Freshwater fisheries in Namibia

Dr Francois Jacobs, Ministry of Fisheries and Marine Resources, Namibia
(NRF-SAIAB Honorary Research Associate)

In 2019, we described the longest potamodromous movement of any freshwater fish in Africa in an article for the *Journal of Fish Biology* titled "Implications of the movement behaviour of African tigerfish *Hydrocynus vittatus* for the design of freshwater protected areas". This radio telemetry research has directly contributed to the formation of two new freshwater protected areas on the Kavango River system in an effort to sustainably manage Namibia's freshwater fisheries resources. I am co-supervising seven MSc students whose research contributes towards better understanding on the impacts of freshwater fish communities and includes aspects of sustainable utilisation, recreational, conservation and fisheries ecology, especially in the northern perennial rivers of Namibia.

Since it was first collected 98 years ago, the cave catfish, *Clarias cavernicola*, was known from only one cave pool in the Aigamas cave system. In 2019 we discovered two additional cave pools that contained populations of the endemic and critically endangered cave catfish in the Aigamas cave system.

We undertook fieldwork to monitor the presence of Australian redclaw crayfish, *Cherax quadricarinatus*, in the Kavango, Kwando and Zambezi rivers, conducted fisheries stock assessment surveys throughout Namibia and investigated the impact of overfishing on riparian communities that are dependent on healthy fisheries resources. We wrote popular articles for the *Southern African Fly Fishing*, *Tight Lines*, *The Complete Flyfisherman* and *Skiboat* magazines, and participated in numerous public outreach and media engagements.

Professional angler, Johan Burger, with the world's largest radio-tagged tigerfish, *Hydrocynus vittatus*, (6.011 kg) to date.

The rarest fish in southern Africa and listed as critically endangered by the International Union for Conservation of Nature (IUCN), the cave catfish, *Clarias cavernicola*.

Amphibian diversity, conservation and parasites

Prof. Louis du Preez, North West University (NRF-SAIAB Honorary Research Associate)

Background and objectives

The research focus of the African Amphibian Conservation Research Group (AACRG) based at the Potchefstroom campus of the North West University includes:

- Evaluation of the conservation status of threatened amphibians in South Africa;
- Phylogenetic studies on amphibians to identify and describe cryptic species;
- Documenting the parasite diversity of amphibians and freshwater turtles;
- Expanding the NRF-SAIAB amphibian collection by collecting calls, photographs and voucher specimens.

Research activities

During 2019, several local field trips took place and a new species of rain frog was discovered in KwaZulu-Natal. Follow-up visits to the area took place during 2019 and we now have sufficient material to describe this cryptic species. At least two other rain frog species have been identified, based on molecular evidence. We undertook field trips to collect rain frogs from the various type localities to enable us to move forward on this.

A study on the endangered long-toed tree frog was initiated. Automated recorders were set up for the 2019-2020 season to document call activity.

After the 2018 research visit to Florida and North Carolina, we undertook a follow-up visit to Florida during 2019. This trip was successful, and we obtained material that will now enable us to resolve some taxonomic questions regarding polystomatid flatworms.

Training and supervision

During 2019, the AACRG research group consisted of three postdoctoral fellows, two doctoral students, three Masters and three Honours students. Postdoctoral fellows and doctoral students help cosupervise Masters and Honours students.

Outcomes

Nine peer-reviewed papers were published. Eight international conference presentations authored or co-authored, and three national conference presentations authored or co-authored.

Impact on society

Television interviews, radio interviews, several talks presented to school groups.

Future work

- Study frog and turtle parasites in the Vhembe Biosphere Reserve.
- Follow-up field trip to Mozambique to document frog diversity and parasites of lungfish, frogs and turtles: February–March 2021.
- Field trip to Gabon to document frog diversity and parasites of lungfish, frogs and turtles: August 2021.

2020 Highlights

The information currently available about animal-associated diatoms may seem minimal in the face of the immensity of the ocean and the as yet unexplored marine diatom diversity. Yet, skin-associated diatoms make a significant contribution to the epimicrobiome of, for example, glabrous marine megafauna, and it has been shown that these communities include both the exclusively epizoic core species typical of a certain animal group, or even species, and generalist benthic taxa that attach to the already conditioned surface of aquatic animals. This raises the important possibility that shifts in the composition of the animal-associated diatom flora may inform about the suitability of the local environment and/or the condition of the host, with the former also possibly directly influencing the latter. In the course of the ongoing studies on diatom biodiversity and bioindicators, six new epizoic diatom species from South Africa were described. These include the first-ever diatom described from sea snakes. Descriptions of nine other species and one diatom genus have been submitted to phycological journals. Among other outcomes, an efficient, inexpensive and straightforward technique to extract siliceous exoskeletons of diatoms from permanent slides, prepared with commonly used mounting media, was designed, tested and described.

Left: Long-toed tree frog, *Leptopelis xenodactylus*
Below: *Leptopelis xenodactylus* habitat.

Above: Catching river turtles in Florida, USA.
Right: Drawing blood from an angry snake.

Alien invasive fish species

Dr John S. Hargrove, Pacific States Marine Fisheries Commission, Idaho
(NRF-SAIAB Honorary Research Associate)

In 2019, I collaborated with Prof Olaf Weyl on a series of projects that used genetic techniques to characterise alien invasive fish species introduced in South Africa. One of our primary projects involved applying cutting-edge genetic techniques to refine our understanding of where different black bass species have been introduced and how populations have responded in areas where two species have been co-introduced. A manuscript detailing this work titled, "Using species-diagnostic SNPs to detail the distribution and dynamics of hybridized black bass populations in southern Africa", was published in *Biological Invasions*.

In September 2019, I gave a presentation at the American Fisheries Society Conference hosted in Reno, Nevada titled "Genetic Insights on Invasive Black Bass in Southern Africa". This talk provided an overview of a series of collaborative research projects conducted by Olaf Weyl and myself. Following this conference, I hosted Olaf Weyl in Boise, Idaho where he provided an overview of his research programme to an audience of 25 research scientists at the Idaho Department of Fish and Game.

John Hargrove with a Lahontan cutthroat trout from Nevada's Pyramid Lake.

Prof Olaf Weyl presenting a programme overview to research scientists in Idaho.

2020 Highlights

I collaborated with Dr Olaf Weyl on several projects in 2020 that focused on the genetic characteristics of invasive fishes in South Africa and abroad. In January, Dr Weyl hosted a group of international researchers that centred on "Genetic bottlenecks and the success of alien fish populations". My supervisor, Matthew Campbell of the Idaho Department of Fish and Game, and I participated in a four-day workshop at Gariep Dam in which we outlined relevant research needs and priorities moving forward for studies in South Africa. Several collaborative research projects arose from this workshop. The first is focused on the genetic characteristics of non-native rainbow trout in South Africa. The second expands upon ongoing work to analyse the genetic characteristics of invasive largemouth bass, but the new project has been scaled up to address this topic on a global scale. Related to our collaborations on largemouth bass, we published a manuscript titled, "The genetic characteristics of invasive largemouth bass in southern Brazil" in which we used DNA sequence data to detail which invasive species were present in Brazil, identify potential sources of introduction, and assess levels of genetic diversity observed in populations. Dr Weyl's death on 14 November 2020 was both unexpected and deeply saddening. The research projects outlined above continue as planned, and the resulting products will be dedicated to Olaf's memory and his tireless efforts to enhance our understanding of freshwater fisheries and invasive fishes in southern Africa.

Participants at the genetics workshop hosted by Prof Olaf Weyl at Gariep Dam in January 2020.

The Keiskamma Rivers Project

Prof. Martin Villet, Department of Zoology and Entomology, Rhodes University
(NRF-SAIAB Honorary Research Associate)

The Keiskamma Rivers Project partners were deeply shocked and saddened at the passing of their team leader, Prof. Olaf Weyl in 2020. Olaf's leadership was pivotal to the project, and it has been difficult to adjust to his loss under the physical isolation of the team members. The project was largely mature by the time of Olaf's passing and some valuable data sets had been completed. In late 2020 Dr Sanet Hugo, Dr Terence Bellingan and Prof. Martin Villet regrouped to move the publication of outstanding datasets forward and have initiated three manuscripts dealing with the interactions of invasive and indigenous fishes with the insect fauna of the headwater streams, the Cata, Gwiligwili and Mnyameni rivers, in the Eastern Cape Province. Other co-authors have been reached out to as well and progress is steadily being made in finalising and submitting the data as manuscripts as soon as is feasible.

A malachite damselfly from the invaded reach along the Mnyameni River.

South African estuarine fish research reviewed

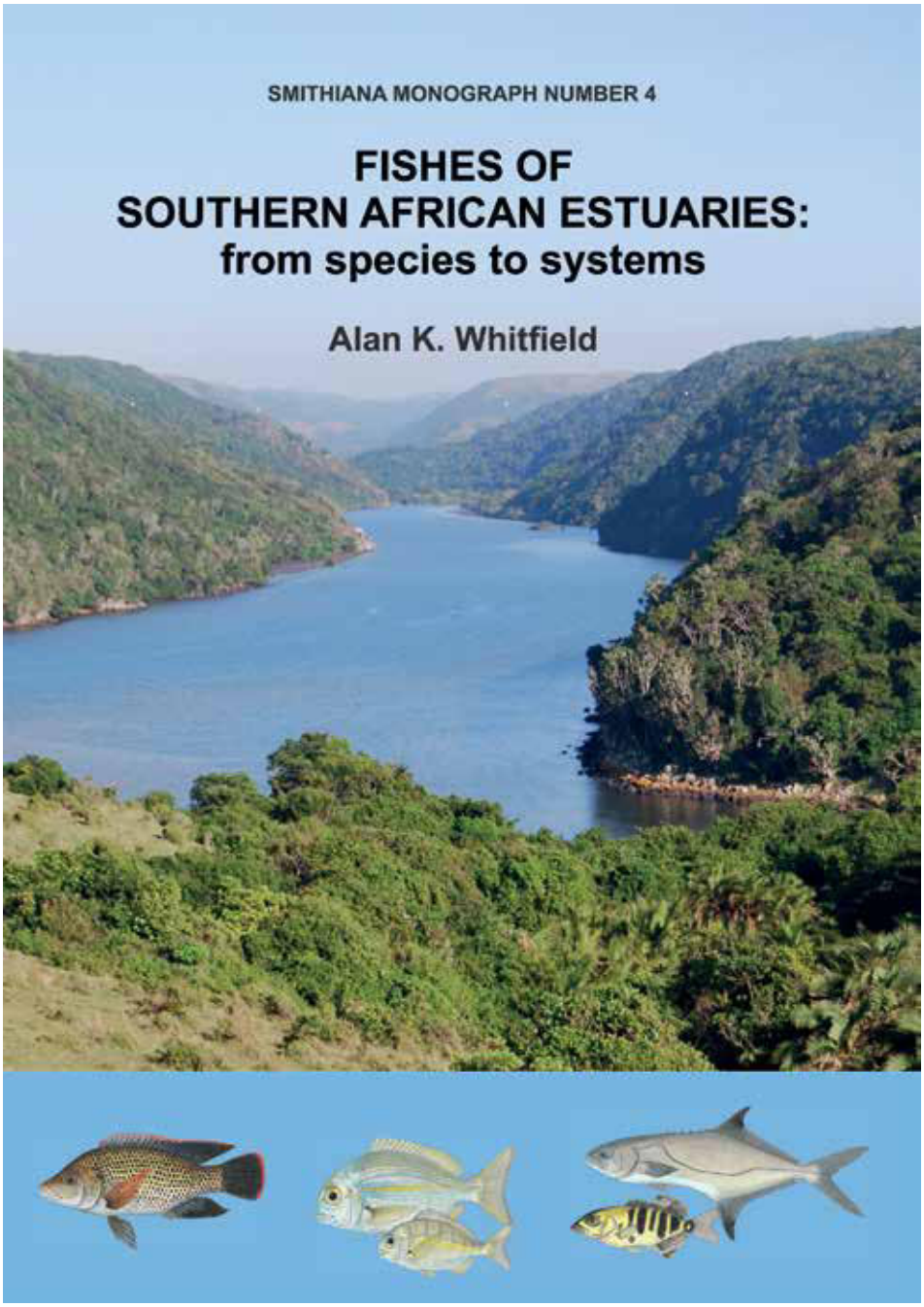
Prof Alan Whitfield
(Chief Scientist Emeritus and NRF-SAIAB Honorary Research Associate)

The highlight of 2019 was the publication of the *Smithiana* Monograph No. 4 entitled "*Fishes of Southern African Estuaries: From Species to Systems*". This book is an update and expansion of the 1998 JLB Smith Institute Monograph entitled the "*Biology and Ecology of Fishes in Southern African Estuaries*". The following extract from the Foreword to the latest monograph by Dr Steve Blaber says it all:

> "This book by Professor Alan Whitfield is the culmination of forty years of dedicated research by the author and more than a century of work by fish scientists in the many and varied estuaries of southern Africa. It is comprehensive in its treatment of the subject and copiously illustrated with beautiful photographs and many original diagrams. Southern Africa is blessed with a high diversity of estuaries, from small blind systems to very large coastal lakes, with a variety of physical attributes and fascinating fish faunas. Hence estuarine fish research in the region has been wide-ranging and detailed—there is little about fishes in estuaries that is not covered in this volume. The contents of the book are therefore of relevance to a worldwide readership, including scientists, fishers, conservationists and environmental planners."

The monograph is available for free electronic download (pdf file) from the SAIAB website.

Prof Alan Whitfield about to release a juvenile leervis, *Lichia amia*, during an East Kleinemonde Estuary fish research project. Photo: Jill Sheppard.



Fishes of Southern African Estuaries: From Species to Systems cover: Smithiana Monograph No. 4, published by Prof Alan Whitfield.

Epizoic diatoms – what do they tell us about their hosts?

Dr Roksana Majewska (NRF-SAIAB Postdoctoral Fellow) and
Prof Jonathan Taylor (NRF-SAIAB Honorary Research Associate), both of North West University

Diatoms, unicellular microalgae enclosed in porous, richly ornamented silica shells, colonise almost all hard-surfaced objects and structures immersed or floating within the photic zone, including aquatic animals. Several studies focused on diatoms growing on marine mammals, reptiles and seabirds, and discoveries made across the last decades suggest that epizoic diatoms constitute a common, ancient, and presumably important, element of these vertebrates' microbiomes. Thus, studying epizoic microbes may complement our knowledge about the host animal biology and evolution, and epizoic diatoms may be used as indicators of, for example, individual animal health, migration routes, or other behavioural patterns.

Museum zoological collections of aquatic animals, both vertebrates and invertebrates, constitute an extremely valuable and largely overlooked source of epizoic diatom samples. These specimens can contribute knowledge about epibiotic and surface-associated diatoms, minimising the cost and environmental footprint of a similarly extensive new study involving fieldwork and fresh material collection.

The Übersee-Museum in Bremen (Germany) hosts unique samples of what is thought to be the skin of the extinct sirenian, Steller's sea cow (*Hydrodamalis gigas*). The specimens are probably the only such samples in the world. During the recent investigation, diatoms were extracted from the Steller's sea cow and several aged turtle samples hosted by the Übersee-Museum (Bremen, Germany), Martin-Luther Universität Halle-Wittenberg (Halle, Germany), and Lutherstadt Wittenberg (Wittenberg, Germany) through sonication. Further, diatom frustules were extracted from three historical specimens of yellow-bellied sea snakes and their associated barnacles and dozens of baleen samples owned by Port Elizabeth Museum (Bayworld, Port Elizabeth, South Africa). The diatom samples will now undergo detailed analysis using both light and scanning electron microscopy.

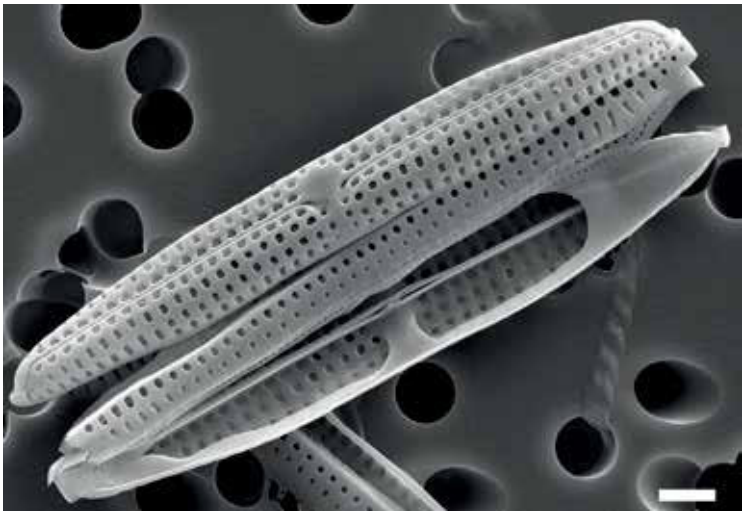
To describe the state and possible changes in diatom flora that could be linked to the overall health and fitness in captive animals, living diatoms were collected from seven sea turtles and ten dolphins residing in uShaka Sea World (Durban, South Africa), from seven sea turtles from Bayworld (Port Elizabeth, South Africa), and from five manatees from the Africarium, Wroclaw Zoo (Wroclaw, Poland). These materials were analysed microscopically, and contributions of various diatom taxa (including new species) were assessed. New diatom strains were isolated and barcoded. These data will be compared with results obtained from wild animal populations and will further contribute to the global effort to resolve the diatom tree of life.

2020 Highlights

The information currently available about animal-associated diatoms may seem minimal in the face of the immensity of the ocean and the as yet unexplored marine diatom diversity. Yet, skin-associated diatoms make a significant contribution to the epimicrobiome of, for example, glabrous marine megafauna, and it has been shown that these communities include both the exclusively epizoic core species typical of a certain animal group, or even species, and generalist benthic taxa that attach to the already conditioned surface of aquatic animals. This raises the important possibility that shifts in the composition of the animal-associated diatom flora may inform about the suitability of the local environment and/or the condition of the host, with the former also possibly directly influencing the latter. In the course of the ongoing studies on diatom biodiversity and bioindicators, six new epizoic diatom species from South Africa were described. These include the first-ever diatom described from sea snakes. Descriptions of nine other species and one diatom genus have been submitted to phycological journals. Among other outcomes, an efficient, inexpensive and straightforward technique to extract siliceous exoskeletons of diatoms from permanent slides, prepared with commonly used mounting media, was designed, tested and described.

Dr Roksana Majewska (North West University) holding a Steller's sea cow skin sample. (photo: Volker Beinhorn, Übersee-Museum).

Collection of the epizoic diatoms from dolphin teeth (uShaka Sea World, Durban, South Africa).



Scanning electron microscopy image of *Tursiocola ziemanii* dominating the skin biofilm of the Wroclaw Zoo manatees. Scale bar = 1 µm

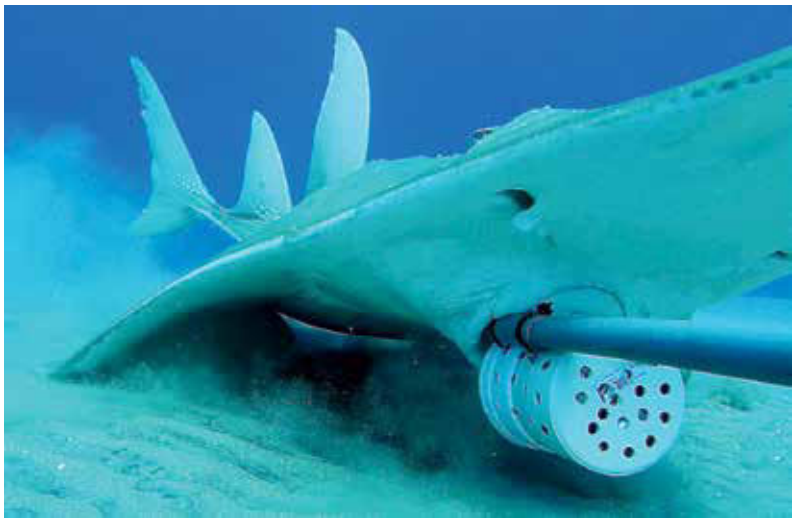
Assessment of elasmobranch populations in the Western Indian Ocean

Dr Rhett Bennett, Wildlife Conservation Society,
Shark and Ray Conservation Programme Manager, Madagascar and Western Indian Ocean
(NRF-SAIAB Honorary Research Associate)

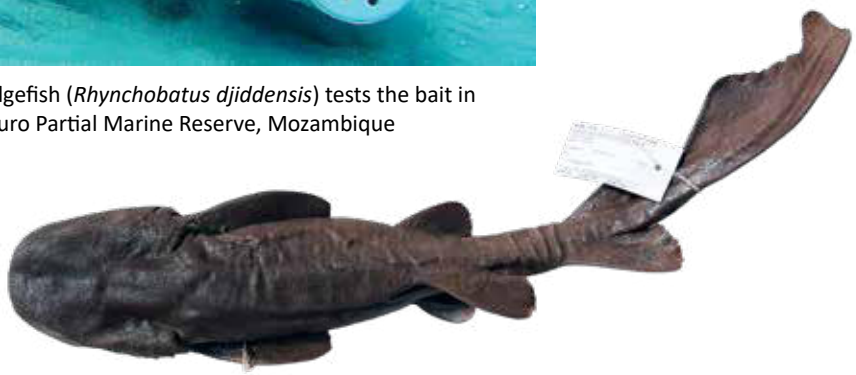
Collaborators and affiliations

Dr Anthony Bernard (NRF-SAIAB); Dr David Ebert (NRF-SAIAB Honorary Research Associate and Honorary Curator: Chondrichthyans); Stela Fernando (Instituto Nacional de Investigação Pesqueira - IIP).

The Western Indian Ocean is a global hotspot for elasmobranch diversity, with over 230 species recorded. Intense fishing pressure threatens at least 25% of these species. The Wildlife Conservation Society (a global NGO) and NRF-SAIAB have partnered to assess the status of elasmobranch populations across Madagascar, Kenya, Tanzania and Mozambique, using baited remote underwater video (BRUV) surveys. Through this collaboration, nearly 600 new sites were surveyed in 2019, bringing our collaborative effort to over 1200 sites in these countries, and revealing valuable new information. Southern Mozambique revealed the greatest elasmobranch species richness and frequency of occurrence, with at least ten species recorded. This area was also identified as a key area for the Critically Endangered whitespotted wedgefish, *Rhynchobatus djiddensis*, and produced the first wild records of the Critically Endangered shorttail nurse shark, *Pseudoginglymostoma brevicaudatum*, in Mozambique. The latter record sparked further investigation, revealing a single previous record of this species in Mozambique, a 1967 specimen, collected by JLB Smith and housed in the NRF-SAIAB collection. This individual was measured and photographed, and these records are detailed in a peer-reviewed paper. Both species were included in a proposed prohibited species list presented to the Mozambique government in July 2020.



A whitespotted wedgefish (*Rhynchobatus djiddensis*) tests the bait in Ponta do Ouro Partial Marine Reserve, Mozambique



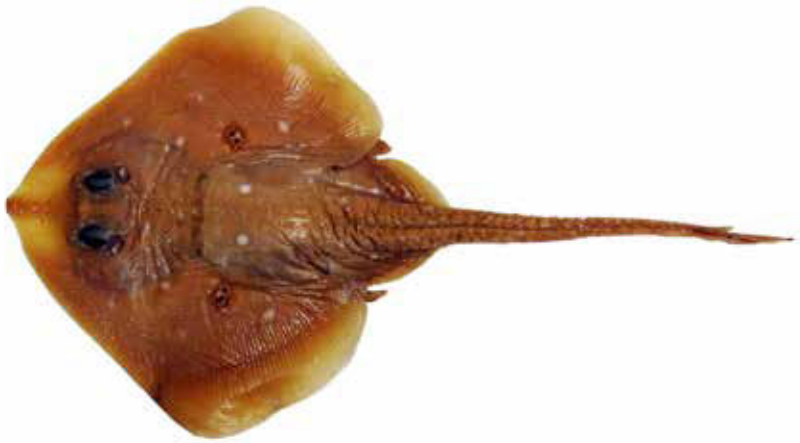
Preserved whole museum specimen of a shorttail nurse shark (*Pseudoginglymostoma brevicaudatum*), SAIAB catalogue number 13152, collected off Xai-Xai, southern Mozambique, in 1967. Photo: Rhett Bennett (WCS).

Search for lost sharks

Dr David Ebert: Moss Landing Marine Laboratories, California
(NRF-SAIAB Honorary Research Associate and Honorary Curator: Chondrichthyans)

David Ebert's search for lost sharks continued with research expeditions to Mozambique and Tanzania. The expeditions were in collaboration with Dr Rhett Bennett (Wildlife Conservation Society, WCS) as part of a Save Our Seas Foundation and NRF-SAIAB supported project entitled "Playing for time: Guitar and Violin Sharks, is this the last dance?" The study aims to clarify the taxonomy and distribution of Western Indian Ocean guitarfish and wedgefish, one of the most conservation-challenged elasmobranch groups today. In addition to surveying fish landing sites and markets, David Ebert conducted identification workshops for local fisheries officers, university researchers, and WCS field scientists in Zanzibar, Dar es Salaam, and Maputo.

He continues his tenure as President of the American Elasmobranch Society (AES), and to serve on the executive committee for the International Union for the Conservation of Nature Shark Specialist Group, which held regional workshops in California, Colombia and Nagasaki, Japan. He gave keynote addresses at two major international conferences, the annual AES and the Peru Sharks and Rays conference.



Leucoraja elaineae, described in 2019 by Dr David Ebert and named after Elaine Heemstra. This skate was collected off Kenya in 1980 by Elaine's late husband, Dr Phil Heemstra, NRF-SAIAB Marine Curator Emeritus.

2020 Highlights

Dr David Ebert spent a month researching the NRF-SAIAB Chondrichthyan collection re-identifying specimens in the collection and examining several new species that are presently in preparation for publication. The major projects undertaken in 2020 were the preparation and publication of a monograph entitled *An annotated checklist of South African Chondrichthyans* (for publication in early 2021) and publication of a book, *A Guide to the Sharks, Rays, and Chimaeras of Europe and the Mediterranean* by Princeton University Press. In addition, he prepared and submitted papers describing three new shark species from southern Africa, including one species near endemic to South Africa. In early 2020, he participated in filming a Discovery Channel Shark Week programme that featured several shark species unique to South Africa. The programme, *Extinct or Alive: Land of the Lost Sharks*, aired in July 2020.

Collaborative research on sharks

Dr Enrico Gennari, Oceans Research Institute
(NRF-SAIAB Honorary Research Associate)

The Oceans Research Institute collaborated with NRF-SAIAB in 2019 on several studies including: collaborative work with colleagues in Australia focused on shark electric and acoustic deterrents; a predator-prey ecology study on white sharks and Cape fur seals; a global fishery-related spatial risk assessment for sharks; South Africa-based studies on the beach-goers' perception of sharks along South Africa's coastline; the first population estimate and survival study of pyjama catsharks in Mossel Bay; a quantification on antibiotic sensitivity of bacterial flora present in the oral cavities of white sharks; a genetic study on the populations of smooth hammerhead sharks along our coastline; an opportunistic study on the first observation of a white shark preying upon a live humpback whale. All the above work culminated in ten peer-reviewed papers, including one in *Nature*.

The Oceans Research Institute continuously con-tributes to long-term datasets for Mossel Bay on the white shark sight-per-unit effort trend, the ATAP's acoustic tracking of fish, ORI's mark-recapture of fish, BRUVs, marine mammal acoustic database run by Stellenbosch University, marine mammal stranding response, as well as the marine mammal spatial database.

Two PhD students (Sussex University and Rhodes University) and two MSc students (University of the Western Cape) were co-supervised by Dr Enrico Gennari, NRF-SAIAB.

All the research projects, mostly self-funded, are intended to support the management and conservation of the rich marine biodiversity of southern Africa via collaborative research.

Above: The Oceans Research Institute Director, Dr Enrico Gennari, about to release a duckbill ray after being tagged with an internal tag.

Right: Members of the Oceans Research Institute team measure a catshark as part of a study on the tropical ecology of these endemic species.

The Largest Aggregation of Giant Trevally

Dr Ryan Daly, Save our Seas Foundation
(NRF-SAIAB Honorary Research Associate)

Highlights in 2019 included a range of research projects, from manta rays in Seychelles, new host records of shark-associated leeches in Mozambique, using “fitbits” on sharks and a collaborative study to investigate the global overlap of industrial fisheries with shark hotspots. On a personal level, the most rewarding research to come out of 2019 was describing the residency and migration patterns of the largest aggregation of giant trevally on record in southern Mozambique. Collaborating with the ATAP network and others at NRF-SAIAB, we used acoustic telemetry to reveal how these fish show repeated and predictable patterns of site fidelity, making them exceptionally vulnerable to over-exploitation. Additionally, we recorded the furthest migrations for the species on record and showed that they undertook consistent transboundary movements. This insight proved that many of the fish found in South African waters depend on Mozambique waters for spawning, thus highlighting the need for improved transboundary conservation cooperation between these neighbouring countries. We hope that continued research on giant trevally and many of the other iconic, charismatic and ecologically important species we are tagging and monitoring across the South African and Mozambican border will provide critical information to improve conservation for these vulnerable species.

Adult giant trevally at the largest aggregation on record in southern Mozambique. Our research revealed predictable and repeated migration patterns to and from an aggregation site that is critical for this population of iconic fish.

A tiger shark with a scar on its lower jaw, probably caused by interaction with fisheries. A collaborative study published in *Nature* showed that there are few places left in the world's oceans where industrial fisheries do not overlap with shark habitats.

2020 Highlights

Research highlights in 2020 included a focus on endangered marine species. Early in the year, we published the first comprehensive study on the endangered humphead wrasse (*Cheilinus undulatus*) in the Western Indian Ocean. The study focussed on this iconic fish species' home range in Seychelles and evaluated the effectiveness of a proposed Marine Protected Area for improving its conservation. Additionally, we used satellite telemetry to conduct novel research on the vulnerable reef manta ray (*Mobula alfredi*) to investigate their regional movements in Seychelles.

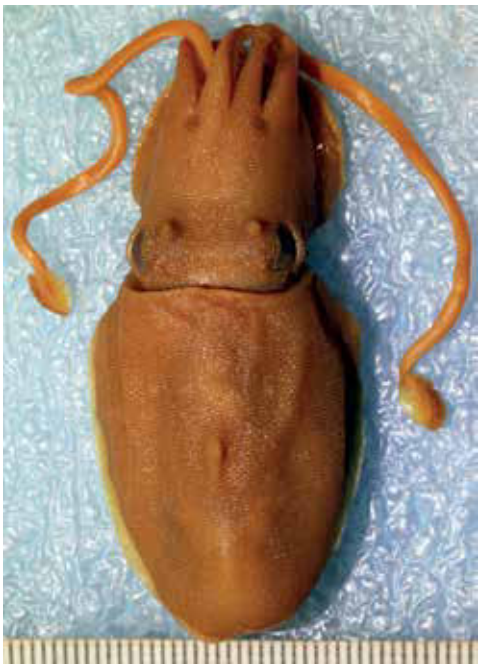
Finally, we analysed long-term catch data for the critically endangered white spotted wedgefish (*Rhynchobatus djiddensis*) in South Africa and found that it has suffered a 65% decline in abundance over the last 40 years, a finding that highlighted the need for improved conservation action for this vulnerable species.

In summary, we had a productive 2020 that will hopefully provide critical information to improve the conservation management for vulnerable and endangered marine species in the Western Indian Ocean.

Cephalopods in NRF-SAIAB collections

Dr Marek R. Lipinski
(NRF-SAIAB Honorary Research Associate)

In 2018 I published a paper based on the NRF-SAIAB cephalopod collections (Lipinski & Leslie, 2018, "A new species of *Sepia* (Cephalopoda: Sepiidae) from South African waters with a re-description of *Sepia dubia* Adam et Rees, 1966", *Folia Malacologica* 26(3): 125–147). This was the first of a planned series of papers about small cuttlefish in southern African waters. During 2019 I started preparations for another two papers, one of which (Lipinski, 2020, "Two new species of *Sepia* Linnaeus, 1758 (Cephalopoda: Sepiidae) from South African waters", *Folia Malacologica* 28(3)) was just published on-line (www.foliamalacologica.com). I attach photographs of these new species (scale bars in mm). A third paper of this project (Lipinski, 2020, "Redescriptions of two species of *Sepia* (Cephalopoda: Sepiidae) from South African waters: *Sepia robsoni* (Massy, 1927) and *S. faurei* Roeleveld, 1972" has been submitted to *Folia Malacologica* and is now under consideration for publication in this journal.



Newly described cuttlefish species: *Sepia roeleveldi*.

Newly described cuttlefish species: *Sepia barosei*.

2020 Highlights

The Covid-19 pandemic and restrictions on travelling, put paid to visits to NRF-SAIAB in 2020 and to work on the cephalopod collections. Instead, work focused on publishing results based upon these collections. Two such papers were published in *Folia Malacologia*: "Two new species of Sepia Linnaeus, 1758 (Cephalopoda: Sepiidae) from South African waters", and "Redescriptions of two species of Sepia (Cephalopoda: Sepiidae) from South African waters: *Sepia robsoni* (Massy, 1927) and *S. faurei* Roeleveld, 1972".

A paper titled, "Age estimates of chokka squid *Loligo reynaudii* off South Africa and their use to test the effectiveness of a closed season for conserving this resource" was published in the *African Journal of Marine Science* (first author's affiliation to NRF-SAIAB mentioned).

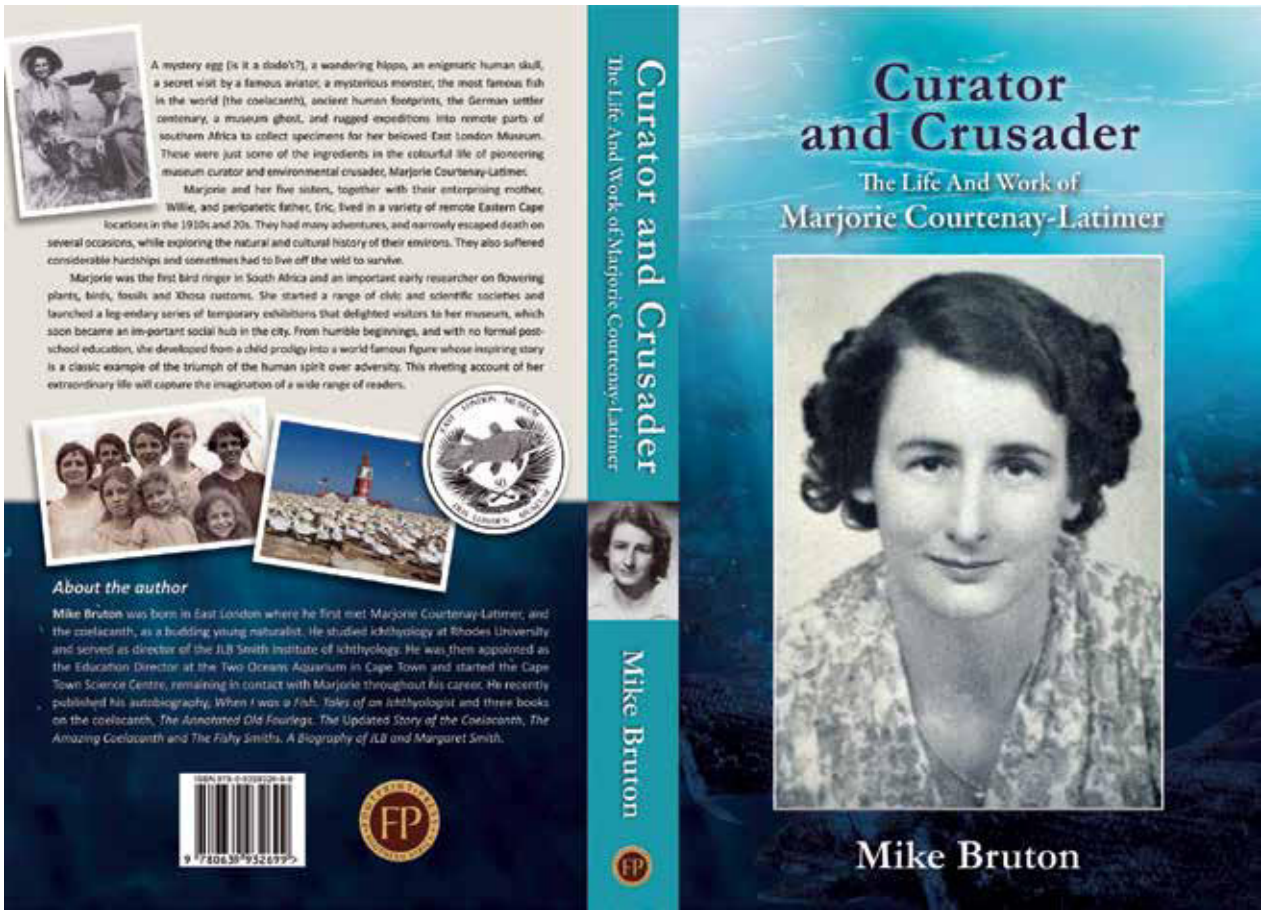
Writing about coelacanths

Dr Mike Bruton, Imagineering
(NRF-SAIAB Honorary Research Associate)

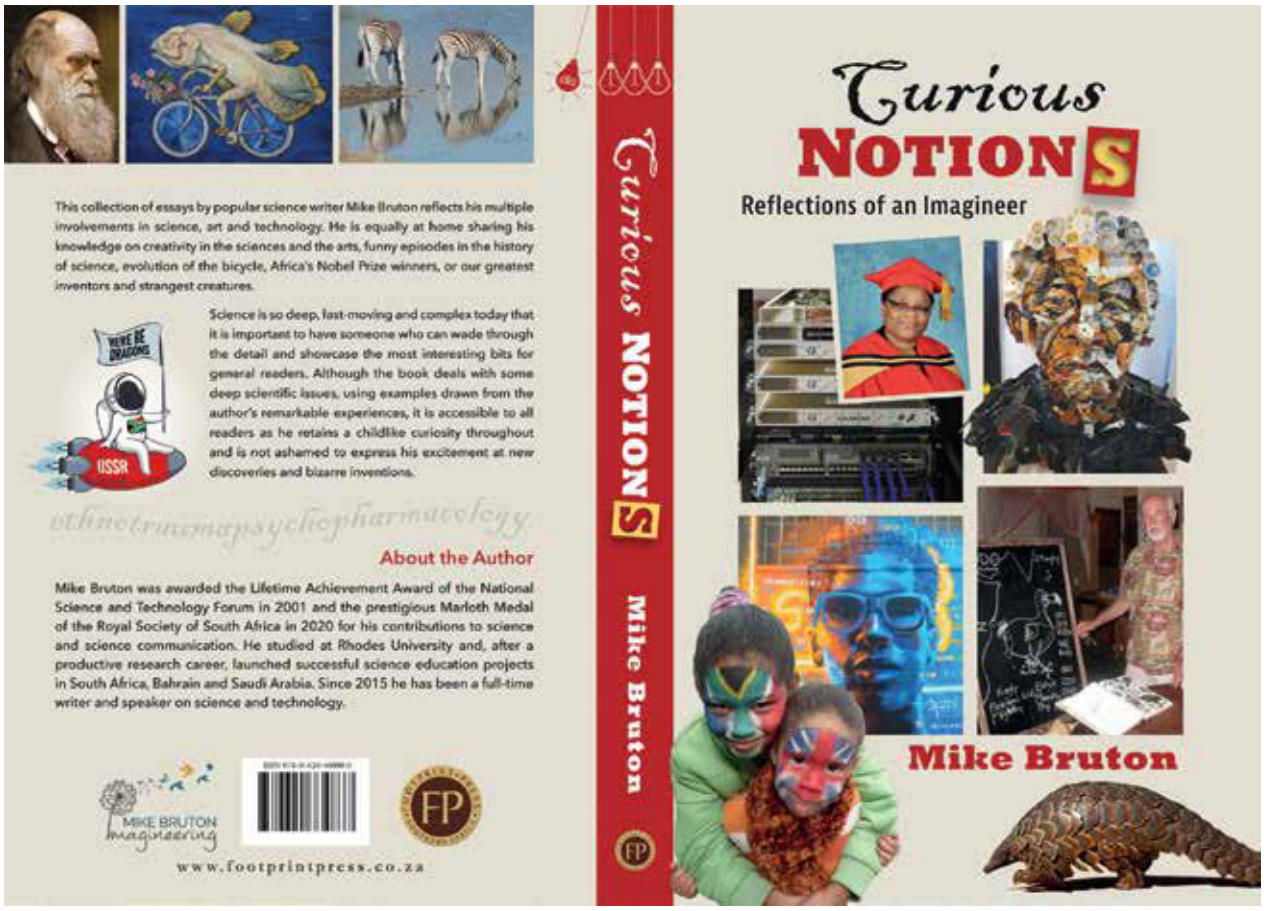
During 2019, I published the first comprehensive biography on the curator of the East London Museum who played a key role in the discovery of the first coelacanth in December 1938 and was also a lifelong friend and scientific collaborator with Professors JLB and Margaret Smith. The book, *Curator and Crusader. The Life and Work of Marjorie Courtenay-Latimer* (Footprint Press, Cape Town, 2019) was launched in research institutes, universities, aquaria, science centres and museums in five provinces and has created a new level of awareness among modern readers on the significance of the coelacanth's discovery.

Marjorie emerged from a poverty-stricken childhood to become one of the most respected museum directors in the world. The genus, family and suborder of living coelacanths are named after her (*Latimeria*, Latimeriidae and Latimeroidei), as well as new species and subspecies of plants, snails and birds. She received many honours and awards, including an honorary doctorate from Rhodes University (1971) and the Freedom of the City of East London (1989).

Following the observation of a living coelacanth off the South Coast of KwaZulu-Natal on 22 November 2019 by a team of mixed-gas divers, I co-authored a paper with the divers on the significance of this discovery, which is the first coelacanth recorded between the isiMangaliso Wetland Park in Zululand and East London.



Curator and Crusader. The Life and Work of Marjorie Courtenay-Latimer cover – a biography on the curator of the East London Museum by Mike Bruton.



2020 Highlights

During 2020, I worked on a paper entitled "Coelacanth discoveries in Madagascar, with recommendations on research and conservation", to be published in the *South African Journal of Science* in early 2021, with two co-authors from Madagascar, Andrew Cooke and Minosoa Ravololoharinjara. The paper provides the first overview of the 34 coelacanth specimens known to have been caught off the ancient island and notes that the main population, as judged by catch returns, appears to live in the Onilahy canyon in southwest Madagascar. We also present evidence for the existence of one or more populations of *L. chalumnae* distributed along about 1000 km of the southern and western coasts of the island and hypothesise that coelacanths are likely to occur around the whole continental margin of Madagascar, making it the epicentre of coelacanth distribution in the Western Indian Ocean and the likely progenitor of the younger Comoros coelacanth population.

During the review period I also completed two books that reflect my wide interests in science, technology and science education. They include *Curious Notions: Reflections of an Imagineer* (Footprint Press), a collection of essays, and *Harambee: The Spirit of Innovation in Africa* (Human Sciences Research Council), a comprehensive overview of innovation on the 'bright continent'.
Both books will be published by October 2021.

Appendix A: NRF-SAIAB Research Outputs 2019

Thomson Reuters Web of Science Index (formerly ISI) Publications by SAIAB Scientists, Honorary Research Associates and Postgraduate Students using SAIAB's address

1. Bates, A.E., Cooke, R.S.C., Duncan, M.I., Edgar, G.J., Bruno, J.F., Benedetti-Cecchi, L., Côté, I.M., Lefcheck, J.S., Costello, M.J., Barrett, N., Bird, T.J., Fenberg, P.B. & Stuart-Smith, R.D. 2019. Climate resilience in marine protected areas and the 'Protection Paradox'. *Biological Conservation* 236, 305–314.
2. Bellingan, T.A., Hugo, S., Woodford, D.J., Gouws, J., Villet, M.H. & Weyl, O.L.F. 2019. Rapid recovery of macroinvertebrates in a South African stream treated with rotenone. *Hydrobiologia* 834(1), 1–11.
3. Bird, M.S., Mlambo, M.C., Wasserman, R.J., Dalu, T., Holland, A.J., Day, J.A., Villet, M.H., Bilton, D.T., Barber-James, H.M. & Bredonck, L. 2019. Deeper knowledge of shallow waters: reviewing the invertebrate fauna of southern African temporary wetlands. *Hydrobiologia* 827(1), 89–121.
4. Bragança, P.H.N., Ramos-Junior, C.C., Guimarães, E.C., Ottonf, F.R. 2019. Identification of the Mexican Molly, *Poecilia mexicana* (Cyprinodontiformes: Poeciliidae), introduced in Brazil through α-taxonomy and DNA barcoding. *Cybium* 43(4), 331–340.
5. Cannicci, S., Mostert, B., Fratini, S., McQuaid, C.D. & Porri, F. 2019. Recruitment limitation and competent settlement of sesarmid crab larvae within East African mangrove forests. *Marine Ecology Progress Series* 626, 123–133.
6. Chaabane, A., Verneau, O., Du Preez, L. 2019. *Indopolystoma* n. gen. (Monogenea, Polystomatidae) with the description of three new species and reassignment of eight known *Polystoma* species from Asian frogs (Anura, Rhacophoridae). *Parasite* 26, art. no 67.
7. Chakona A., Gouws, G., Kadye, W.T., Jordaan, M.S. & Swartz, E. R. 2020. Reconstruction of the historical distribution ranges of imperilled stream fishes from a global endemic hotspot based on molecular data: Implications for conservation of threatened taxa. *Aquatic Conservation: Marine and Freshwater Ecosystems* 30, 144–158.
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2. Bennett, R., Bräutigam, A., Bürgener, M., Clausen, A., Kiszka, J., Razafindrakoto, C., Bladon, A., Leeney, R., Okes, N., Ranaivoson, R., Muthiga, N., Oddenyo, R., Birrel,l C., Bernard, A., Markes, S., Markovina, M., Kasuga, M. & Beuningen, D. 2019. "Improving shark and ray conservation and management in the Western Indian Ocean through a collaborative regional process." 11th Symposium of the Western Indian Ocean Marine Science Association, Mauritius.
3. Bernard, A.T.F., Heyns-Veale, E.R., Parker, D., Mann, B.Q., Maggs, J.Q., Smith, M.K.S. & Götz, A. 2019. "Is depth a natural refuge for reef-associated linefish species occurring along the east and south coast of South Africa?" 5th Southern African Marine Linefish Symposium, Mpekweni.
4. Broom, C.J., Castañeda, R.A. & Weyl, O.L.F. 2019. "Native fish recovery following the eradication of alien smallmouth bass from the Rondegat River." 8th World Conference on Ecological Restoration, Cape Town.
5. Chakona, A., Kadye, W., Bere, T., Mazungula, N. & Vreven, E. 2019. "Evidence of hidden diversity and taxonomic conflicts in five stream fishes from the Eastern Zimbabwe Highlands freshwater ecoregion." SASAqS Congress 2019, Bela Bela.
6. Chakona, A. & Skelton, P. 2019. "A review of the Pseudobarbus afer (Peters, 1864) species complex (Teleostei, Cyprinidae) in the eastern Cape Fold Ecoregion of South Africa." 39th ZSSA Congress, Skukuza, Kruger National Park.
7. Childs, A-R., Potts, W.M., James, N.C., Murray, T.S., Winkler, A.C., Duncan, M.I., Cowley, P.D. & Naesje, T.F. 2019. "Linking physiology to movement behaviour of coastal fishery species to understand adaptation in the Anthropocene." 5th Southern African Marine Linefish Symposium, Mpekweni.
8. Cowley, P.D. 2019. "A century of fish tagging in South Africa: what have we learnt?"
9. Cuthbert, R.N., Dalu, T., Wasserman, R.J., Weyl, O.L.F., Callaghan, A., Froneman, P.W. & Dick, J.T.A. 2019. "Towards improved quantifications of interaction strengths in temporary ponds." 39th ZSSA Congress, Skukuza, Kruger National Park.
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11. Daly, R., Smale, M.J., Singh, S., Anders, D., Shivji, M., Keating Daly, C.A., Lea, J.S.E., Sousa, L.L., Wetherbee, B.M., Fitzpatrick, R., Clarke, C.R., Sheaves, M. & Barnett, A. 2019. "Refuges and risks for tiger sharks (*Galeocerdo cuvier*) in the southwest Indian Ocean." 5th Southern African Marine Linefish Symposium, Mpekweni.
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13. Duncan, M.I., James, N.C., Bates, A.E. & Potts, W.M. 2019. "Considering 'Ocean Weather' will improve our understanding of climate change effects on South Africa's linefish." 5th Southern African Marine Linefish Symposium, Mpekweni.

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16. Edworthy, C., James, N.C., Potts, W.M. & Dupont, S. 2019. "The importance of monitoring local ocean acidification and the eco-physiological and behavioural responses of species in an era of climate change." Species on the Move 2019, Kruger.
17. Filmalter, J.D., Cowley, P.D., Forget, F. & Dagorn, L. 2019. "The associative behaviour of silky sharks, *Carcharhinus falciformis*, with floating objects in the Western Indian Ocean." 5th International Conference on Fish Telemetry, Arendal, Norway.
18. Filmalter, J.D., Cowley, P.D. & Naesje, T.F. 2019. "The demise of an iconic species: Do site fidelity and habitat dependence drive the vulnerability of adult dusky kob *Argyrosomus japonicus* in coastal fisheries?" 5th Southern African Marine Linefish Symposium, Mpekweni.
19. Glass, J.R., Harrington, R.C., Faircloth, B.C. & Near, T.J. 2019. "Using a novel genomic sequencing method (ultra-conserved elements) to address phylogenomic relationships of carangiform fishes." 45th Annual SAAB, AMA & SASSB Joint Conference, University of Johannesburg.
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25. Heckendorn, K., Sauer, W., Aswan,i S., da Silva, I. & Bernard, A. 2019. "Fishers' decisions and willingness to change in three communities around Pemba Bay, Mozambique. 11th Symposium of the Western Indian Ocean Marine Science Association, Mauritius.
26. Hlungwani, H.A., Sara, J.R., Marr, S.M. & Weyl, O.L.F. 2019. "Establishing the fisheries potential of Flag Boshielo Dam based on the combined data collected from Flag Boshielo and Loskop dams." SASAqS Congress 2019, Bela Bela.
27. Hlungwani, H.A., Sara, J.R., Marr, S.M. & Weyl, O.L.F. 2019. "Establishing the fisheries potential of Flag Boshielo dam based on the combined data collected from Flag Boshielo and Loskop dams." 39th ZSSA Congress, Skukuza, Kruger National Park.
28. Hoareau, T.B., Pretorius, P.C., Bloomer, P., Fennessy, S., Gouws, G., Klopper, A.W., Mann, B. & Parker, D. 2019. "DNA barcoding of South African linefishes." 5th Southern African Marine Linefish Symposium, Mpekweni.
29. James, N.C., Cowley, P.D. & Whitfield, A.K. 2019. "The marine fish assemblage of the East Kleinemonde Estuary over 20 years: declining abundance and nursery function?" 5th Southern African Marine Linefish Symposium, Mpekweni.
30. James, N.C., Cowley, P.D. & Whitfield, A.K. 2019. "The marine fish assemblage of the East Kleinemonde Estuary over 20 years: declining abundance and nursery function?" 11th Symposium of the Western Indian Ocean Marine Science Association, Mauritius.
31. Kambikambi, M.J., Kadye, W.T. & Chakona, A. 2019. "Evaluation of the nomenclatural status of the synonyms of *Enteromius anoplus* (Weber, 1987) (Teleostei, Cyprinidae)." 39th ZSSA Congress, Skukuza, Kruger National Park.
32. Kambikambi, M.J., Kadye, W.T. & Chakona, A. 2019. "Evaluation of the nomenclatural status of the synonyms of *Enteromius anoplus* (Weber, 1987) (Teleostei, Cyprinidae)." SASAqS Congress 2019, Bela Bela.

33. Khosa, D., South, J., Wasserman, R.J. & Weyl, O.L.F. 2019. "Does habitat structure mitigate predation impact of *Micropterus salmoides* and *Micropterus floridanus*?" 39th ZSSA Congress, Skukuza, Kruger National Park.
34. Kock, A., Taylor, J., Smit, N.J. & Wepener, V. 2019. "The effect of controlled flood releases from the Pongolapoort Dam on the taxonomic richness of diatoms in the Phongolo River." SASAqS Congress 2019, Bela Bela.
35. Landschoff, J., Gouws, G., Du Plessis, A. & Griffiths, C.L. 2019. "Hermit crabs as an example of species underestimation in the South African bioregion and the potential of microCT scanning and barcoding to uncover crustacean diversity." The Crustacean Society Mid-Year Meeting, The Chinese University of Hong Kong, Hong Kong.
36. Madzivanzira, T.C., Barkhuizen, L.M., South, J. & Weyl, O.L.F. 2019. "Controlling of the Louisiana red swamp crayfish *Procambarus clarkii* (Crustacea, Decapoda) populations in the Free State Province using various eradication methods." 39th ZSSA Congress, Skukuza, Kruger National Park.
37. Madzivanzira, T.C., South, J., Nhiwatiwa, T. & Weyl, O.L.F. 2019. "Standardisation of *Cherax quadricarinatus* sampling gear and abundance data in southern Africa." 39th ZSSA Congress, Skukuza, Kruger National Park.
38. Magoro, M.L., James N.P.E., & Weyl, O.L.F. 2019. "The distribution of non-native Nile Tilapia (*Oreochromis niloticus*) in the Limpopo and Incomati River basins." South African Institute for Aquatic Biodiversity End of Year Student Symposium.
39. Magoro, M., Perissinotto, R., Dalu, T. & Whitfield, A. 2019. "Fishes and tadpoles as indicators of the transition from micro-outlets to micro-estuaries in the Eastern Cape Province South Africa." SASAqS Congress 2019, Bela Bela.
40. Mataboge, B.B., Bernard, A., James, N.C., Potts, W.M. 2019. "Do fish found inside MPAs show enhanced activity levels under stressful physiological conditions?" 5th Southern African Marine Linefish Symposium, Mpekweni.
41. Matam, N. 2019. "Quantifying fisheries resource use from publicly accessible dams in the Makana municipal area, Eastern Cape, South Africa." SASAqS Congress 2019, Bela Bela.
42. Mayekiso, S., Smith, M.K.S., Bernard, A., Baliwe, N., de Vos, L., Arendse, C., Oosthuizen, A., Parker-Nance, S., Lawrence, C. & Kock, A. 2019. "Long-term monitoring of threatened and commercially important linefish and elasmobranchs in South African National Parks." 5th Southern African Marine Linefish Symposium, Mpekweni.
43. Mofu, L., Woodford, D.J., Wasserman, R.J., Dalu, T. & Weyl, O.L.F. 2019. "Gut content and stable isotope analyses to trace the feeding behaviour among four co-occurring fishes in man-made impoundments." 39th ZSSA Congress, Skukuza, Kruger National Park.
44. Motimele, S.S., Sara, J.R., Smit, W.J., Marr, S.M. & Luus-Powell, W.J. 2019. "The human health risk associated with consuming *Oreochromis mossambicus* (Peters, 1852) and *Labeo rosae* Stendachner, 1894 from Flag Boshielo Dam in relation to changing water levels." SASAqS Congress 2019, Bela Bela.
45. Mpopetsi, P.P., Potts, W.M., Childs, A-R. & James, N. 2019. "Towards defining the tipping point of tolerance to CO_2-induced ocean acidification for the growth, development and metabolism of larval dusky kob, *Argyrosomus japonicus* (Pisces: Sciaenidae)." 5th Southern African Marine Linefish Symposium, Mpekweni.
46. Murray, T.S., Cowley, P.D., Mann, B.Q., Maggs, J.Q., Filmalter, J.D., Bennett, R.H., Childs, A-R. & Naesje, T.F. 2019. "New insights into the migrations and vulnerability of leervis, Lichia amia, gained from long-term passive acoustic tracking." 5th Southern African Marine Linefish Symposium, Mpekweni.
47. Mxo, V., Cowley, P.D., Murray, T.S. & Parkinson, M.C. 2019. "Joining the dots: How absence data can influence the interpretation of movement patterns." 5th Southern African Marine Linefish Symposium, Mpekweni.
48. Nodo, P., James, N.C., Childs, A-R. & Pattrick, P. 2019. "Settlement habitat and use of the estuary-ocean ecotone by linefish species in Algoa Bay." 5th Southern African Marine Linefish Symposium, Mpekweni.
49. Ockhuis, S., Gouws, G. & Fennessy, S. 2019." A temporal comparison of genetic diversity in the slinger *Chrysoblephus puniceus* along the east coast of South Africa." 5th Southern African Marine Linefish Symposium, Mpekweni.
50. Padare, G., Cowley, P.D., Murray, T.S., Du Plessis, J. & Lamberth, S.J. 2019. "Can partial estuarine area protection reduce the vulnerability to capture the spotted grunter *Pomadasys commersonnii*?" 5th Southern African Marine Linefish Symposium, Mpekweni.
51. Parkinson, M.C., Potts, W.M., Childs, A-R., Booth, A.J. & Winkler, A.C. 2019. "Spatial dynamics of west coast dusky kob, *Argyrosomus coronus*, in southern Angola". 5th Southern African Marine Linefish Symposium, Mpekweni.

52. Pegg, J., Attwood, C., Baker, N., Impson, D., Lombard, A., Meyer, W., Smith, K. & Weyl, O. 2019. "Controlling invasive carp in a natural lake ecosystem – lessons in management." SASAqS Congress 2019, Bela Bela.
53. Pegg, J., Mabin, C.A., Khosa, D., Barkhuizen, L.M. & Weyl, O.L.F. 2019. "Common carp in South Africa – exploring invasion using formal and informal records." National Symposium on Biological Invasions, Tulbagh.
54. Pegg, J., Mabin, C.A., Khosa, D., Barkhuizen, L.M. & Weyl, O.L.F. 2019. "Common carp in South Africa – exploring invasion using formal and informal records." 39th ZSSA Congress, Skukuza, Kruger National Park.
55. Pollard, M., James, N.C., Childs, A-R., Murray, T.S. & Adams, J.B. 2019. "Shallow-water seascape connectivity: Micro-habitat utilization by an important juvenile linefish species in the estuary-ocean ecotone." 5th Southern African Marine Linefish Symposium, Mpekweni.
56. Porri, F., Dyantyi, S. B., Oliver, J.C., McQuaid, C. D., Teske, P. R. 2019. "Eastern origins, larval wastage and local processes drive the ecology of mussel communities on the south-east coast of South Africa." 5th International Marine Connectivity Conference, Aveiro, Portugal.
57. Potts, W.M., Bova, C.S., Mann, B.Q., Saayman, M., Sauer, W.H.H., Weyl, O.L.F., Raemaekers, S. & Wood, A. 2019. "Striking disconnect between the economics, policy and management of SA's marine recreational fisheries." 5th Southern African Marine Linefish Symposium, Mpekweni.
58. Pretorius, P.C., Bloomer, P., Fennessy, S., Gouws, G., Klopper, A.W., Mann, B., Parker, D. & Hoareau, T.B. 2019. "FishBOL-SA: DNA-barcoding of South African linefishes." 39th ZSSA Congress, Skukuza, Kruger National Park.
59. Rennie, C., Chakona, A. & Kadye, W. 2019. "A taxonomic revision of the border barb, *Amatolacypris trevelyani*: species delimitation, morphological diagnosis and revised geographic distribution." 39th ZSSA Congress, Skukuza, Kruger National Park.
60. Scheepers, M. & Gouws, G. 2019. "Mating system, reproductive success and the opportunity for sexual selection in bluntnose klipfishes (*Clinus cottoides*)." 2019 Congress of the European Society for Evolutionary Biology, Turku, Finland.
61. Skeeles, M.R., Duncan, M.I., Winkler, A.C., Childs, A-R. & Potts, W.M. 2019. "The effects of exploitation and temperature on the energy use of *Chrysoblephus laticeps* using acoustic accelerometer tags." 5th Southern African Marine Linefish Symposium, Mpekweni.
62. Smith, M.K.S., Arendse, C.J., Mokhatla, M.M., Bernard, A.T.F. & Parker-Nance, S. 2019. "Social and ecological research and monitoring associated with community fishing in the Tsitsikamma marine protected area." 5th Southern African Marine Linefish Symposium, Mpekweni.
63. South, J., Botha, T., Wolmarans, N., Wepener, V. & Weyl, O. 2019. "Assessing the effects of DDT on behavioural predator-prey interactions between *Xenopus laevis* and *Culex* sp. larvae." SASAqS Congress 2019, Bela Bela.
64. South, J. & Weyl, O.L.F. 2019. "Does intra-individual behaviour determine invasion success and ecological impact?" SANBI Invasion Symposium 2019, Tulbagh.
65. South, J. & Weyl, O.L.F. 2019. "Does intra-individual behaviour determine invasion success and ecological impact?" 39th ZSSA Congress, Skukuza, Kruger National Park.
66. Van der Walt, K., James, N.C., Potts, W.M. & Porri, F. 2019. "Combining the dynamic method, static respirometry and maximum heart rate experiments to understand the thermal physiology of the common recreational linefish *Diplodus capensis* (1844)." 5th Southern African Marine Linefish Symposium, Mpekweni.
67. Van Wyk, A., Weyl, O.L.F., Bernard, A., Pegado, A., Hugo, S., Ngochera, M., Jonasse, C & Gobo, E. 2019. "The potential of Baited Remote Underwater Video Systems (BRUVS) in Lake Malawi for the monitoring of *Chambo Oreochromis* (Nyasalapia) spp." SASAqS Congress 2019, Bela Bela.
68. Vorsatz, L., Pattrick, P., Porri, F. & Cannicci, S. 2019. "Assemblages and metabolic responses of invertebrate larvae associated to the Ting Kok, Hong Kong mangrove habitats." The 5th International Mangrove, Macrobenthos and Management Meeting, Singapore.
69. Wasserman, R.J., Weston, M., Weyl, O.L.F., Froneman, P.W., Welch, R.J., Vink, T.J.F. & Dalu, T. 2019. "Sacrificial males: the potential role of copulation and predation in contributing to copepod sex-skewed ratios." 39th ZSSA Congress, Skukuza, Kruger National Park.
70. Weyl, O.L.F. 2019. "Understanding anglers is essential for managing alien invasive fishes in South Africa." National Symposium on Biological Invasions, Tulbagh.
71. Weyl, O.L.F. 2019. "Black Bass *Micropterus* spp. invasion status, impacts, fisheries and conflict management in South Africa." 39th ZSSA Congress, Skukuza, Kruger National Park.

72. Weyl, O.L.F., Barkhuizen, L., Christison, K., Cowx, I.G., Dalu, T., Hlungwani, H.A., Impson, D., Mandrak, N., Marr, S.M., Sankar, K., Sara, J.R., Smit, N., Tweddle, D., Vine, N., Wepener, V. & Zvavahera, M. 2019. "Opportunities, threats and research requirements for developing sustainable inland fisheries in South Africa." SASAqS Congress 2019, Bela Bela.
73. Winkler, A.C., Arkert, N., Bernard, A., Butler, E.C., Bova, C., Childs, A-R., Farthing, M., Mannheim, S., Mullins, R. & Potts, W.M. 2019. "Working with, not against, recreational anglers: two case studies changing competitive angling behaviour through engagement, education, rule changes and incentives." 5th Southern African Marine Linefish Symposium, Mpekweni.
74. Zvavahera, M., Weyl, O.L.F., Hugo, S. & Vine, N. 2019. "Investigations into the effect of the environment on the life-history strategies and morphometric traits of the estuarine roundherring, *Gilchristella aestuaria* (Pisces Clupeidae)." SASAqS Congress 2019, Bela Bela.

Seminar and workshop presentations

1. James, N.C. 2019. "Shallow water seascape connectivity." Swartkops Research Workshop. Nelson Mandela University, Port Elizabeth.
2. South, J, Weyl, O.L.F. "Ecological impact of crayfish invasions in South Africa. Assessing the capacity for aquaculture of the redclaw crayfish." Workshop 2019, Pretoria.

Public presentations

1. Dyantyi, S. & Vorsatz, L. 2019. "COST members go coast to coast: Experiences and insights from recently attended international conferences." SAIAB Seminar, Grahamstown, August 2019.
2. Gouws, G. 2019. "The view from the other side: molecular studies and marine biodiversity in the southwest Indian Ocean." Presentation at University of Western Australia, Perth, Australia, February 2019.
3. Gouws, G. 2019. "The National Research Foundation – South African Institute for Aquatic Biodiversity: securing the sustainable use of Africa's aquatic biodiversity." Presentation at Murdoch University, Perth, Australia, February 2019.
4. Gouws, G. 2019. "The view from the other side: molecular studies and marine biodiversity in the southwest West Indian Ocean." Presentation at University of Queensland, Brisbane, Australia, February 2019.
5. Gouws, G. 2019. "Molecular studies and marine biodiversity in the Western Indian Ocean." Presentation at University of Aberystwyth, Wales, July 2019.
6. Haworth, P. 2019. "From here to where? Insights gained from SAIAB's role as a case-study on the four-year EU-funded Horizon 2020 NUCLEUS project which is exploring ways in which institutions involved in science can be more responsive to society's needs and values." SAIAB Seminar, Grahamstown, February 2019.
7. Holleman, W. 2019. "Your culture, my culture…. Whose culture? What is culture anyway?" SAIAB Seminar September 2019.
8. Porri, F. 2019. "Planktonology MMB4301 Larval connectivity in the coastal environments: drivers & mechanisms." Skype presentation to Universiti Malaysia Terengganu, March 2019.
9. South, J. 2019. "EMERGEINTERACT: assessing the combined threat of multiple emerging pollutants." SAIAB Seminar, Grahamstown, May 2019.
10. Stauffer, J. 2019. "Fishes of Pennsylvania: distribution, behaviour, and threats." SAIAB Seminar, Grahamstown, April 2019.
11. Talma, S. 2019. "Seychelles: above and below water (The Aldabra Clean-Up Project & Nekton First Descent Expedition)." SAIAB Seminar, August 2019.

Appendix B: NRF-SAIAB Research Outputs 2020

Thomson Reuters Web of Science Index (formerly ISI) Publications by SAIAB Scientists, Honorary Research Associates and Postgraduate Students using SAIAB's address

1. Adams, J.B., Whitfield, A.K., Van Niekerk, L. 2020. A socio-ecological systems approach towards future research for the restoration, conservation and management of southern African estuaries. *African Journal of Aquatic Science*. *Special Issue*. 45(1–2), 231–241.
2. Arkert, N.K., Childs, A-R., Duncan, M.I., Farthing, M. & Potts, W.M. 2020. Physiological stress response and recovery of an important estuarine fishery species, dusky kob, *Argyrosomus japonicus*, after a simulated catch-and-release event. *African Journal of Marine Science* 42(3), Special Issue, 339–345.
3. Azari, M., Farjad, Y., Ali, N., De Stefano, M., Ehsanpour, M., Dobrestov, S. & Majewska, R. 2020. Diatoms on sea turtles and floating debris in the Persian Gulf (Western Asia). *Phycologia* 59(4), 292–304.
4. Barkhuizen, L.M., Weyl, O.L.F. 2020. Evaluating the suitability of fyke nets for small-scale fisheries in the Free State Province of South Africa. *Water SA* 46(1) 153–157.
5. Bonnin, L., Lett, C., Dagorn, L. & Filmalter, J.D. 2020. Can drifting objects drive the movements of a vulnerable pelagic shark? Aquatic Conservation-Marine and Freshwater Ecosystems. Online early.
6. Bragança, P.H.N., Smith, T.G., Vreven, E.J.W.M.N. & Chakona, A. 2020. Integrative taxonomy reveals hidden diversity in the southern African darters genus *Nannocharax* Gunther 1867 (Characiformes: Distichodontidae). *Journal of Fish Biology* 97(6), 1713–1723.
7. Bragança, P.H.N., van der Zee, J., Sonnenberg, R., Vreven, E. 2020. Description of two new miniature species of *Hylopanchax* Poll & Lambert, 1965 (Cyprinodontiformes: Cyprinodontoidei) from northeastern Gabon, with a redefinition of the genus. *Journal of Fish Biology*. Online early.
8. Bragança, P.H.N., van Zeeventer, R.M., Bills, R., Tweddle, D. & Chakona, A. 2020. Diversity of the southern Africa *Lacustricola* Myers, 1924 and redescription of *Lacustricola johnstoni* (Günther, 1894) and *Lacustricola myaposae* (Boulenger, 1908) (Cyprinodontiformes, Procatopodidae). *ZooKeys* 923, 91–113
9. Bronnmann, J., Smith, M.D., Abbott, J., Hay, C.J. & Naesje, T.F. 2020. Integration of a local fish market in Namibia with the global seafood trade: Implications for fish traders and sustainability. *World Development* 135, art. no. 105048.
10. Buglass, S., Nagy, S., Ebert, D., Sepa, P., Turchik, A., Bell, K.L.C., Rivera, F. & Giddens, J. 2020. First records of the seven-gilled *Notorynchus cepedianus* and six-gilled *Hexanchus griseus* sharks (Chondrichthyes: Hexanchiformes: Hexanchidae) found in the Galapagos Marine Reserve. *Journal of Fish Biology* 97(3), 926–929.
11. Butler, E.C., Childs, A-R., Duncan, M.I. & Potts, W.M. 2020. Understanding the effects of recreational catch-and-release angling on an increasingly important foreign fishing tourism species, the giant African threadfin, *Polydactylus quadrifilis* (Cuvier). *Fisheries Management and Ecology* 27(6), 603–614.
12. Camp, E.V., Kaemingk, M.A., Ahrens, R.N.M., Potts, W.M., Pine, W.E. III, Weyl, O.L.F. & Pope, K.L. 2020. Resilience Management for Conservation of Inland Recreational Fisheries. *Frontiers in Ecology & Evolution 7*, art. no. 498.
13. Castañeda, R.A., Mandrak, N.E., Barrow, S. & Weyl, O.L.F. 2020. Occupancy dynamics of rare cyprinids after invasive fish eradication. *Aquatic Conservation – Marine and Freshwater Ecosystems* 30(7), 1424–1436.
14. Castañeda, R.A., Van Nynatten, A., Crookes, S., Ellender, B.R, Heath, D.D., MacIsaac, H.J., Mandrak, N.E. & Weyl, O.L.F. 2020. Detecting native freshwater fishes using novel non-invasive methods. *Frontiers in Environmental Science* 8, art. no. 29.
15. Castañeda, R.A., Weyl, O.L.F., Mandrak, N.E. 2020. Using occupancy models to assess the effectiveness of underwater cameras to detect rare stream fishes. *Aquatic Conservation - Marine and Freshwater Ecosystems*. 2020 30, 565–576.
16. Chakona, A., Gouws, G., Kadye, W.T., Mpopetsi, P.P. & Skelton, P.H. 2020. Probing hidden diversity to enhance conservation of the endangered narrow-range endemic Eastern Cape rocky, *Sandelia bainsii* (Castelnau 1861). *Koedoe* 62(1), art. no.1627.
17. Cowan, D.A., Hopkins, D.W., Jones, B.E., Maggs-Kölling, G., Majewska, R. & Ramond, J.-B. 2020. Microbiomics of Namib Desert habitats. *Extremophiles* 24(1), 17–29.

18. Crookes, S., Heer, T., Castañeda, R.A., Mandrak, N.E., Heath, D.D., Weyl, O.L.F., MacIsaac, H.J. & Foxcroft, L.C. 2020. Monitoring the silver carp invasion in Africa: a case study using environmental DNA (eDNA) in dangerous watersheds. *NeoBiota* 56, 31–47.

19. Cuthbert, R.N., Dalu, T., Wasserman, R.J., Monaco, C.J., Callaghan, A., Weyl, O.L.F. & Dick, J.T.A. 2020. Assessing multiple predator, diurnal and search area effects on predatory impacts by ephemeral wetland specialist copepods. *Aquatic Ecology* 54(1), 181–191.

20. Cuthbert, R.N., Dalu, T., Wasserman, R.J., Weyl, O.L.F., Froneman, P.W., Callaghan, A. Coughlan, N.E. & Dick, J.T.A. 2019. Alternative prey impedes the efficacy of a natural enemy of mosquitoes. *Biological Control* 141, art. no. 104146.

21. Cuthbert, R.N., Dalu, T., Wasserman, R.J., Weyl, O.L.F., Froneman, P.W., Callaghan, A. & Dick, J.T.A. 2020. Examining intraspecific multiple predator effects across shifting predator sex ratios. *Basic and Applied Ecology* 45, 12–21.

22. Cuthbert, R.N., Dalu, T., Wasserman, R.J., Weyl, O.L.F., Froneman, P.W., Callaghan, A. & Dick, J.T. 2020. Inter-population similarities and differences in predation efficiency of a mosquito natural enemy. *Journal of Medical Entomology* 57(6), 1983–1987.

23. Cuthbert, R.N., Sithagu, R., Weyl, O.L.F., Wasserman, R.J., Dick, J.T.A., Callaghan, A., Froneman, P.W., Foord, S. & Dalu, T. 2020. Water volume differentially modifies copepod predatory strengths on two prey types. *Limnologica* 81, art. no. 125747.

24. Cuthbert, R.N., Wasserman, R.J., Dalu, T. 2020. Arid-adapted paradiaptomid copepods contribute to mosquito regulation. *African Zoology* 55(3), 185–186.

25. Cuthbert, R.N., Wasserman, R., Dalu, T., Kaiser, H., Weyl, O.L.F., Dick, J.T.A., Sentis, A., McCoy, M.W. & Alexander, M.E. 2020. Influence of intra- and interspecific variation in predator-prey body size ratios on trophic interaction strengths. *Ecology and Evolution* 10(12), 5946–5962.

26. Dalton, D.L., Kotzé, A., McEwing, R., De Bruyn, M., Mnisi, C. & Mwale, M. 2020. A tale of the traded cat: development of a rapid real-time PCR diagnostic test to distinguish between lion and tiger bone. *Conservation Genetics Resources* 12(1), 29–31.

27. Dalu, T., Bellingan, T.A., Gouws, J., Impson, N.D., Jordaan, M.S., Khosa, D., Marr, S.M., Mofu, L., Schumann, M., Slabbert, E., van der Walt, J.A., Wasserman, R.J. & Weyl, O.L.F. 2020. Ecosystem responses to the eradication of common carp, *Cyprinus carpio*, using rotenone from a reservoir in South Africa. *Aquatic Conservation-Marine and Freshwater Ecosystems* 30(12), 2284–2297.

28. Dalu T., Cuthbert R.N., Taylor J.C., Magoro M.L., Weyl O.L.F., Froneman P.W. & Wasserman R.J. 2020. Benthic diatom-based indices and isotopic biomonitoring of nitrogen pollution in a warm temperate Austral river system. *Science of the Total Environment* 748, art.no. 142452.

29. Dalu, T., Magoro, M.L., Naidoo, L.S., Wasserman, R.J., Human, L.R., Adams, J.B., Perissinotto, R., Deyzel, S.H., Wooldridge, T. & Whitfield, A.K. 2020. Microphytobenthos diversity and community structure across different micro-estuaries and micro-outlets: Effects of environmental variables on community structure. *Environmental Pollution* 260, art. no. 114097.

30. Daly, R., Keating Daly, C.A., Gray, A.E., Peel, L.R., Gordan, L., Lea, J.S.E., Clarke, C.R. & Weng, K.C. 2020. Investigating the efficacy of a proposed marine protected area for the Endangered humphead wrasse, *Cheilinus undulatus*, at a remote island group in Seychelles. *Endangered Species Research* 42, 7–20.

31. Dames, V., Bernard, A., Floros, C., Mann, B., Speed, C., Maggs, J., Laing, S., Meekan, M. & Olbers, J. 2019. Zonation and reef size significantly influence fish population structure in an established marine protected area, iSimangaliso Wetland Park, South Africa. *Ocean and Coastal Management* 185, art. no. 105040.

32. Daniels, S.R., James, N.C. & Gouws, G. 2020. Phylogeographic structure and continued surveys of a Vulnerable South African freshwater crab (Potamonautidae, *Potamonautes lividus*): Implications for the IUCN Red Listing of the Afrotropical fauna. *Aquatic Conservation: Marine and Freshwater Ecosystems* 30, 2221–2239.

33. De Bragança, P.H.N., Guimaraes, E.C., Brito, P.S. & Ottoni, F.P. 2020. On the natural occurrence of *Poecilia reticulata* Peters, 1859 (Cyprinodontiformes: Poeciliidae). *Cybium* 44(4), 309–316.

34. De Ridder, F., Taylor, J.C. 2020. Diatom types of REM Archibald from Lake Sibaya and Lake Nhlange. South Africa. *Diatom Research* 35(1), 37–54.

35. Dickey, J.W.E., Cuthbert, R.N., South, J., Britton, J.R., Caffrey, J., Chang, X., Crane, K., Coughlan, N.E., Fadae,i E., Farnsworth, K.D., Ismar-Rebitz, S.M.H., Joyce, P.W.S., Julius, M., Laverty, C., Lucy, F.E., MacIsaac, H.J., McCard, M., McGlade, C.L.O., Reid, N., Ricciardi, A., Wasserman, R.J., Weyl, O.L.F. & Dick J.T.A. 2020 On the RIP: using Relative Impact Potential to assess the ecological impacts of invasive alien species. *NeoBiota* 55, 27–60.

36. Du Preez, L.H., Verneau, O. 2020. Eye to eye: classification of conjunctival sac polystomes (Monogenea: Polystomatidae) revisited with the description of three new genera *Apaloneotreman* g., *Aussietreman* g. and *Fornixtreman* g. *Parasitology Research* 119 (12), 4017–4031.

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Other Refereed (Peer Reviewed) Scientific Papers

1. Hollander, J., Linden, O., Gudka, M., Duncan, M.I., Obura, D., James, N., Bhagooli, R., Nyanapah, J., Onjango, C., Duvane, J., Louis, Y., Ngotho, D., Mvungi, E., Mamboya, F., George, R., Hamad, H., Issa Hamisi, M., Adeleke, B., Ngoa, E., Harlay, J., Oduor, N., Fondo, E., Wambiji, N., Raharinaivo, L., Winkler, A., Okemwa, G., Karisa, J., Madi Bamdou, M., Mtaki, K. & Randrianandrasana, J. 2020. Marine organisms' response to climate change effects in the Western Indian Ocean. *Journal of Indian Ocean Rim Studies* (Special Issue on Blue Economy, January to June 2020) 3(1), 33–59.
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3. Viana, S.T.F.L., Lima, D., Viana, K., Felinto, A. & Rosa, R.S. 2020. Cartilaginous fishes (Class Chondrichthyes) from the Ichthyological Collection at the Federal University of Paraíba, Brazil. *Revista Nordestina de Biologia* 27(1), 25–58.

Books, book chapters and book reviews

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2. Weyl, O.L.F., Ellender, B.R., Wassermann, R.J., Truter, M., Dalu, T., Zengeya, T.A. & Smit, N.J.l. 2020. Alien Freshwater Fauna in South Africa. In: van Wilgen, B., Measey, J., Richardson, D., Wilson, J. & Zengeya, T. (eds.) *Biological Invasions in South Africa. Invading Nature – Springer Series in Invasion Ecology*, vol 14. Springer, Cham.
3. Le Roux, J.J., Clusella-Trullas, S., Mokotjomela, T.M., Richardson, D.M., Skein, L., Wilson, J.R., Weyl, O.L.F. & Geerts, S. 2020. Biotic Interactions as Mediators of Biological Invasions: Insights from South Africa. In: van Wilgen, B., Measey, J., Richardson, D., Wilson, J. & Zengeya, T. (eds.) *Biological Invasions in South Africa. Invading Nature – Springer Series in Invasion Ecology*, vol 14. Springer, Cham.
4. Zengeya, T.A., Kumschick, S., Weyl, O.L.F. & van Wilgen, B.W. 2020. An Evaluation of the Impacts of Alien Species on Biodiversity in South Africa Using Different Assessment Methods. In: van Wilgen, B., Measey, J., Richardson, D., Wilson, J. & Zengeya, T. (eds.) *Biological Invasions in South Africa. Invading Nature – Springer Series in Invasion Ecology*, vol 14. Springer, Cham.

Reports and theses

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Popular articles and other publications

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2. Bragança, P.H.N., Henschel, E. 2020. Anmerkungen zu Verbreitung, Ökologie und Verhalten des kleinen Amazonas-Leuchtaugenfisches *Fluviphylax zonatus* (Cyprinodontiformes: Fluviphylacidae). *Deutsche Killifisch Gemeinschaft*, 52 (5–6): 258-264. October 2020.

3. de Necker, L. 2020. Waterborne disease: Bilharzia and its snail vectors under the spotlight in current study. *The Water Wheel* November/December 2020. http://www.wrc.org.za/mdocs-posts/the-water-wheel-november-december-2020/
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7. Dlamini, L. Haworth, P. & Sithole, Y. 2020. Taxonomic revision leads to description of new moray eel species. *National Research Foundation Press Releases*. May 2020, https://www.nrf.ac.za/media-room/news/taxonomic-revision-leads-description-new-moray-eel-species
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9. 9Elston, C. 2020. Sharks as an important conservation tool in South Africa. *ELMO blog*. https://www.elmoafrica.org/post/sharks-as-an-important-conservation-tool-in-south-africa
10. Elston, C. 2020. What makes a shark a shark? *ELMO blog*. https://www.elmoafrica.org/post/what-makes-a-shark-a-shark
11. Madzivanzira, T.C. 2020. A review of freshwater crayfish introductions in Africa. *NRF Science Matters* 3(2), 22–24.
12. Pegg, J. 2020. Carp in South Africa – The good, the bad and the muddy. *SAIAB Feature*. https://www.saiab.ac.za/features/carp-in-south-africa-%E2%80%93-the-good,-the-bad-and-the-muddy.htm
13. Sink, K. & Palmer, R. 2020. Twenty new Marine Protected Areas – a science-to-policy success in South Africa. *A Better World* UK Publication 6, 77–80, 2020, http://digital.tudor-roseco.uk/a-better-world-vol-6/77/#zoom=z
14. South, J. 2020, All the better to eat you with. *CIB Research Nuggets*. https://blogs.sun.ac.za/cib/all-the-better-to-eat-you-with/
15. South, J. 2020. Freshwater pollution and the African Clawed Frog. SAIAB Featured Research. https://www.saiab.ac.za/features/freshwater-pollution-and-the-african-clawed-frog.htm
16. Weyl, O.L.F. & group. Invasions Research News from South Africa from the Weyl-Lab. *Pathways* 23(2), 7–10. (Invasive and Introduced Species Section of the American Fisheries Society Newsletter).

Conference and symposium presentations

1. Bernard, A.T.F., Heyns-Veale, E.R, Parker, D., Mann, B.Q., Maggs, J.Q., Smit, K.P., Smith, M.K.S., Gotz, A. 2020. Is depth a natural refuge for reef fish occurring along the east and south coast of South Africa? *Deep Sea Biology Society Symposium*, August 2020.
2. Bernard, A.T.F., Kerwath, S.E., Wilke, C., van Wyk, A. 2020. Development of a deep-sea baited remote underwater stereo-video system. *Deep Sea Biology Society Symposium*, August 2020.
3. Coetzer, W. 2020. Extending the use of Specify Software in South African natural science museums. Society for the Preservation of Natural History Collections */ ICOM NatHist Joint Virtual Conference*, June 2020.
4. Coetzer, W. 2020. Development of protocols and tools to manage and archive data from aquatic biodiversity surveys. *Biodiversity Information Science and Standards* 4: e59027, October 2020. https://doi.org/10.3897/biss.4.59027
5. Elston, C., Cowley, P.D., von Brandis, R.G. 2020. Understanding nursery use by stingrays to assist conservation efforts. *International Marine Conservation Congress*, August 2020.
6. Elston, C., Cowley, P.D., 2020. Using acoustic telemetry to track stingray movements: from fine- to large-scale insights, November 2020.
7. Glass, J.R., Daly, R. Santos, S.R., Kauwe, J.S.K., Near, T.J., Post, D.M., and Cowley, P.D. 2020. Spatial trophic variability and genetic connectivity of important recreational fishery species, giant trevally and bluefin trevally, across Seychelles. *Seychelles Ocean Science Symposium*. November 2020. Online.
8. Haworth, P.S. Contextualising RRI - Lessons from participation in the EU HORIZON 2020 Project - NUCLEUS. *STARBIOS2 International Conference*, May 2020. Online.

9. Madzivanzira T.C., South J, Nhiwatiwa T., Weyl O.L.F. 2020. Evaluation of two mechanical removal methods for invasive Australian Redclaw Crayfish (*Cherax quadricarinatus*) populations in southern Africa. *American Fisheries Society* 2020, Online.
10. Madzivanzira T.C., South J., Weyl O.L.F. 2020. Invasive crayfish have a predatory advantage over a native African freshwater crab at higher but not lower temperatures. *American Fisheries Society* 2020, Online.
11. Mofu L., Dalu T., Wasserman R.J., Woodford D.J., Weyl O.L.F. 2020. Feeding ecology of co-occurring fishes in the Sundays River valley irrigation ponds, assessed using stable isotope and gut content analyses. *American Fisheries Society* 2020, Online.
12. Nyawo, M., Heyns-Veale, E.R., Bernard, A.T.F., Harris, J. 2020. The effect of ecosystem and depth on the diversity and structure of benthic fish assemblages found in Wright Canyon, South Africa. *Deep Sea Biology Society Symposium*, August 2020.
13. Pegg J., South J., Domingo J., Chake P., Weyl O.L.F. 2020. The combined risk of drought and invasive species to small stream communities in a South African National Park. *American Fisheries Society* 2020, Online.
14. Pegg, J. 2020. Invasive fishes in a protected inland water in South Africa: Conflicts, common ground and challenges for management. *American Fisheries Society Virtual Spring Conference*, April 2020.
15. South J., Botha T.L., Pegg J., Khosa D., Mofu L., Walsh G., Jordaan M., Ranan Nm Teurlincx S., Helmsing N., Wepener V., Weyl O.L.F., Senerpont Domi de L. 2020. A wild combination: fluoxetine and microplastics alter strength of invertebrate foodweb Interactions. *American Fisheries Society* 2020, Online.
16. South J., Madzivanzira T.C.M., Rennie C.L., Ellender B.R., Weyl O.L.F. 2020. Australian aliens in the Zambezi Basin: ecological and human dynamics of crayfish invasions in southern Africa. *American Fisheries Society* 2020, Online.
17. 17.South J., Madzivanzira T.C.M., Rennie C.L., Ellender B.R., Weyl O.L.F. 2020. Australian aliens in the Zambezi Basin: ecological and human dynamics of crayfish invasions in southern Africa. *American Fisheries Society* 2020, Online
18. South, J. 2020. Australian invaders in southern Africa. British Ecological Society Invasions Symposium 2020, University of Northumbria, April 2020 *Cancelled due to COVID19.
19. van der Walt, K. 2020. Thermal tolerance and the vulnerability to climate change of coastal and estuarine marine species from the warm-temperate region of South Africa. *Rhodes University Postgraduate Conference*, Online.
20. Weyl, O.L.F. 2020. The importance of respecting culture, practicing inclusivity, and enabling participation when leading diverse teams in southern Africa. *American Fisheries Society* 2020, Online.

Seminar and workshop presentations

1. Glass, J.R. 2020. Integrating genomic patterns and ecological processes to address fisheries questions: lessons from a marine predator. University of Alaska Fairbanks College of Fisheries and Ocean Sciences. Invited Seminar Speaker, *Department of Fisheries. Fairbanks, Alaska USA*. May 2020. Online.
2. South, J. 2020. Shared threats, opportunities and collaboration avenues in aquatic invasion ecology between South Africa, Argentina and Brazil. *Workshop, Cannon Rocks*, February 2020.
3. Glass, J. R. 2020. Long Live the Kingfish: Integrating Genomic Patterns and Ecological Processes to Address Critical Fisheries Questions for Carangiform Marine Predators. Brigham Young University. Invited Seminar Speaker, *Department of Biological Sciences. Provo, Utah USA*. November 2020. Online.
4. South, J. 2020. The pan-African crayfish hunt: Impact, implications and management of the Upper Zambezi crayfish invasion. *University of Essex, UK*, March, 2020
5. Glass, J.R. 2020. From Zoo to Zooplankton: How Miller Park Zoo led to a Career in Marine Biology. *Miller Park Zoo, Bloomington Illinois, USA*. November 2020.

Appendix C: NRF-SAIAB Research Division 2019 - 2020

RESEARCH AND MANAGEMENT STAFF

Name	Position
Dr A.W. Paterson, PhD (Rhodes University)	Managing Director
Prof. A.K. Whitfield, DSc (Rhodes University)	Chief Scientist
Prof. P.D. Cowley, PhD (Rhodes University)	Principal Scientist
Prof. O.L.F. Weyl, PhD (Rhodes University)	Principal Scientist
Dr A. Chakona, PhD (Rhodes University)	Senior Scientist
Dr G. Gouws, PhD (Stellenbosch University)	Senior Scientist
Dr N.C. James, PhD (Rhodes University)	Senior Scientist
Dr F. Porri, PhD (Rhodes University)	Senior Scientist
Dr A.T.F. Bernard, PhD (Rhodes University)	Instrument Scientist
Dr T.S. Murray PhD (Rhodes University)	ATAP Instrument Scientist
Dr E.A. Wiles, PhD (University of KwaZulu-Natal)	Geophysics Instrument Scientist
Dr W. Coetzer, PhD (University of KwaZulu-Natal)	Biodiversity Information Manager
Ms T. Bodill, MSc (Rhodes University)	Molecular Laboratory Manager
Ms S. Reddy, BSc Hons (Rhodes University)	Ecophysiology Laboratory Co-ordinator
Mr I.R. Bills, MSc (Rhodes University)	Collections Manager
Mr D.N. Mazungula, BSc Hons (Rhodes University)	Senior Curation Officer
Mr R. Palmer, MSc (Rhodes University)	ACEP Technical & Scientific Manager
Mr Thor Eriksen, BSc (UNISA)	ACEP Marine Technician
Mr Siseko Benya, BSc Hons (Walter Sisulu University)	ACEP Marine Technician
Mr Koos Smith	ACEP Marine Technician
Mr M. Parkinson MSc (Rhodes University)	ATAP Instrument Technician
Mr Nick Schmidt, MSc (Rhodes University)	MaRIP Technician
Mr D.N. Mazungula, BSc Hons (Rhodes University)	Senior Curation Officer
Dr A. Wood, PhD (Rhodes University)	Senior Marine Research Assistant to the MD
Mr F. Jacobs	Freshwater Field Assistant
Ms R. Juby, MSc (Rhodes University)	MaRIP Senior Video Analyst
Mrs V.T.J. Rouhani, MSc (Rhodes University)	Research Support Administrator

POSTDOCTORAL SCIENTISTS

Name	Primary study area	Institute collaborator
Dr J. Filmalter (2019)	Fish movement studies	Prof. P. Cowley
Dr J Glass (2019-2020)	Fish movement studies	Prof. P. Cowley
Dr S. Hugo (2019)	Invasions and freshwater ecology	Prof. O. Weyl
Dr M. Magoro (2019 - 2020)	Invasions and freshwater ecology	Prof. O. Weyl
Dr A. Nel (2019)	Larval ecology	Dr F. Porri
Dr J. Pegg (2019 - 2020)	Invasions and freshwater ecology	Prof. O. Weyl
Dr J. South (2019 - 2020)	Invasions and freshwater ecology	Prof. O. Weyl
Dr K-A van der Walt (2019 - 2020)	Larval ecology	Dr F. Porri
Dr P. de Bragança (2020)	Freshwater taxonomy	Dr A. Chakona

Dr L. de Necker (2020)	Freshwater ecology	Prof. O. Weyl
Dr C. Elston (2020)	Fish movement studies	Prof. P. Cowley
Dr D. Khosa (2020)	Invasions and freshwater ecology	Prof. O. Weyl
Dr L. Mofu (2020)	Invasions and freshwater ecology	Prof. O. Weyl

HONORARY RESEARCH ASSOCIATES

Name	Status
Dr E. Anderson, PhD (College of William & Mary)	Curator Emeritus
Dr A. Becker, PhD (Deakin University)	Honorary Research Associate
Dr R. Bennett, PhD (Rhodes University)	Honorary Research Associate
Dr S. Blaber, PhD (Rhodes University)	Honorary Research Associate
Dr A. Bok, PhD (Rhodes University)	Honorary Research Associate
Dr M. Bruton, PhD (Rhodes University)	Honorary Research Associate
Dr R. Chalmers, PhD (Rhodes University)	Honorary Research Associate
Prof A. Channing, PhD (Natal University)	Honorary Research Associate
Mr W. Conradie, MSc (North-West University)	Honorary Research Associate
Dr M. Cunningham, PhD (University of Queensland)	Honorary Research Associate
Dr R. Cuthbert, PhD (Queen's University of Belfast/University of Reading)	Honorary Research Associate
Dr T. Dalu, PhD (Rhodes University)	Honorary Research Associate
Dr R. Daly, PhD (Rhodes University)	Honorary Research Associate
Dr N. Deacon, PhD (Rhodes University)	Honorary Research Associate
Prof. R. Dorrington PhD (University of Cape Town)	Honorary Research Associate
Prof. L. du Preez, PhD (University of the Free State)	Honorary Research Associate
Dr D. Ebert, PhD (Rhodes University)	Honorary Research Associate
Dr B. Ellender, PhD (Rhodes University)	Honorary Research Associate
Prof. M. Elliott, PhD (Stirling University)	Honorary Research Associate
Dr J. Filmalter, PhD (Rhodes University)	Honorary Research Associate
Dr E. Gennari, PhD (Rhodes University)	Honorary Research Associate
Mr O. Gon, MSc (University of Jerusalem)	Curator Emeritus
Dr G. Gouws, PhD (University of Stellenbosch)	Honorary Research Associate
Dr J.S. Hargrove, PhD (University of Florida)	Honorary Research Associate
Dr T. Harrison, PhD (Rhodes University)	Honorary Research Associate
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Mr M. Scheepers	MSc	Rhodes University	Dr G Gouws
Ms J. Trassierra	MSc	Rhodes University	Dr F. Porri
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Appendix D: Acronyms and Abreviations

AACRG	African Amphibian Conservation Research Group
ACEP	African Coelacanth Ecosystem Programme
AERP	Aquatic Ecophysiology Research Platform
AES	American Elasmobranch Society
AGRP	Aquatic Genomics Research Platform
AIS	Alien Invasive Species
ATAP	Acoustic Tracking Array Platform
BHL	Biodiversity Heritage Library
BRUVs	Baited Remote Underwater Video systems
CAPTOR	Connectivity And disPersal beTween prOtected aReas
CBD	Convention on Biological Diversity
CBOL	Canadian Barcode of Life
CFE	Cape Fold Ecoregion
CIB	Centre for Invasion Biology
COST	Coastal and Ocean Sciences Team
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
CT scan	Computed Tomography scan
DEA	Department of Environmental Affairs
DAFF	Department of Agriculture, Forestry and Fisheries
DEFF	Department of Environment, Forestry and Fisheries
DESTEA	Free State Province Department of Economic, Small Business Development, Tourism and Environmental Affairs
DIFS	Department of Ichthyology and Fisheries Sciences (Rhodes University)
DSI	Department of Science and Innovation
DST	Department of Science and Technology
EBRU	Institute for Environmental Biotechnology, Rhodes University
EEZ	Exclusive Economic Zone
EOD	Electric Organ Discharges
ESASTAP	European South African Science and Technology Advancement Programme
EU	European Union
FAO	Food and Agriculture Organisation
FBIP	Foundational Biodiversity Information Programme (NRF-FBIP)
GATE	Global Acoustic Telemetry Exchange
GBIF	Global Biodiversity Information Facility
GeMaP	Geophysics and Mapping Platform
HBUs	Historically Black Universities
IAMSLIC	International Association of Aquatic and Marine Science Libraries and Information Centres
ICFT	International Conference on Fish Telemetry
IFS	International Foundation for Science
IRD	Institute of Research for Development (France)
IUCN	International Union for the Conservation of Nature

KBA	Key Biodiversity Area
KZN	KwaZulu-Natal
LTER	Long-term ecological research
MARIP	Marine Remote Imagery Platform
MPA	Marine Protected Area
MbiSa	MbiSa is from the words for "fish" in the languages Lingala: "mbisi" and Swahili: "samaki"
MRAC	Musée Royale d'Afrique Centrale
NDP	National Development Plan
NEM:BA	The National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystems Priority Areas
NFSC	National Freshwater Snail Collection
NGS	Next-Generation Sequencer
NNF	Namibia Nature Foundation
NRC	Norwegian Research Council
NRF	National Research Foundation
NRF-FBIP	National Research Foundation Foundational Biodiversity Information Programme
NRF-RTF	National Research Foundation Research and Technology Fund
NRF-SAEON	South African Environmental Observation Network
NRF-SAIAB	South African Institute for Aquatic Biodiversity
NSCF	Natural Science Collections Facility
ORI	Oceanographic Research Institute
OTN	Ocean Tracking Network
PDP	Professional Development Programme
PELTER	Pelagic Ecosystem Long-term Ecological Reserve Programme
RISA	Research and Innovation, Support and Advancement
RIRP	Research and Innovation Reward Programme
RMCA	Royal Museum for Central Africa
RSG	Rufford Small Grants for Nature Conservation
RTK	Real-Time Kinematic
ROV	Remotely Operated Vehicle
RU	Rhodes University
RU JRC	Rhodes University Joint Research Council
R/V	Research Vessel
SALPA	South African Linefish Physiology Assessment
SAAMBR	South African Association for Marine Biological Research
SANBI	South African National Biodiversity Institute
SANCOOP	South Africa-Norway Research Co-operation on Climate Change, the Environment and Clean Energy
SANCOR	South African Network for Coastal and Oceanic Research
SANParks	South African National Parks
SARChI	South African Research Chairs Initiative
SARIR	South African Research Infrastructure Roadmap
SASSAqS	Southern African Society of Aquatic Scientists
SASSCAL	Southern Africa Science Service Centre for Climate Change and Adaptive Land Management

SDG	Sustainable Development Goal
SHESHA	Shoreline and coastal zone Evolution in SoutH Africa
SL	Standard Length
SNP	Single-nucleotide polymorphisms
SOSF	Save Our Seas Foundation
SWIO	South West Indian Ocean
SWG	Scientific Working Group
TNP	Tsitsikamma National Park
UFH	University of Fort Hare
UK	United Kingdom
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
USA	United States of America
UWC	University of the Western Cape
WCS	Wildlife Conservation Society
WIO	Western Indian Ocean
WRC	Water Research Commission
WWF	World Wide Fund for Nature
ZSSA	Zoological Society of Southern Africa
ZSM	Bavarian State Collection of Zoology



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