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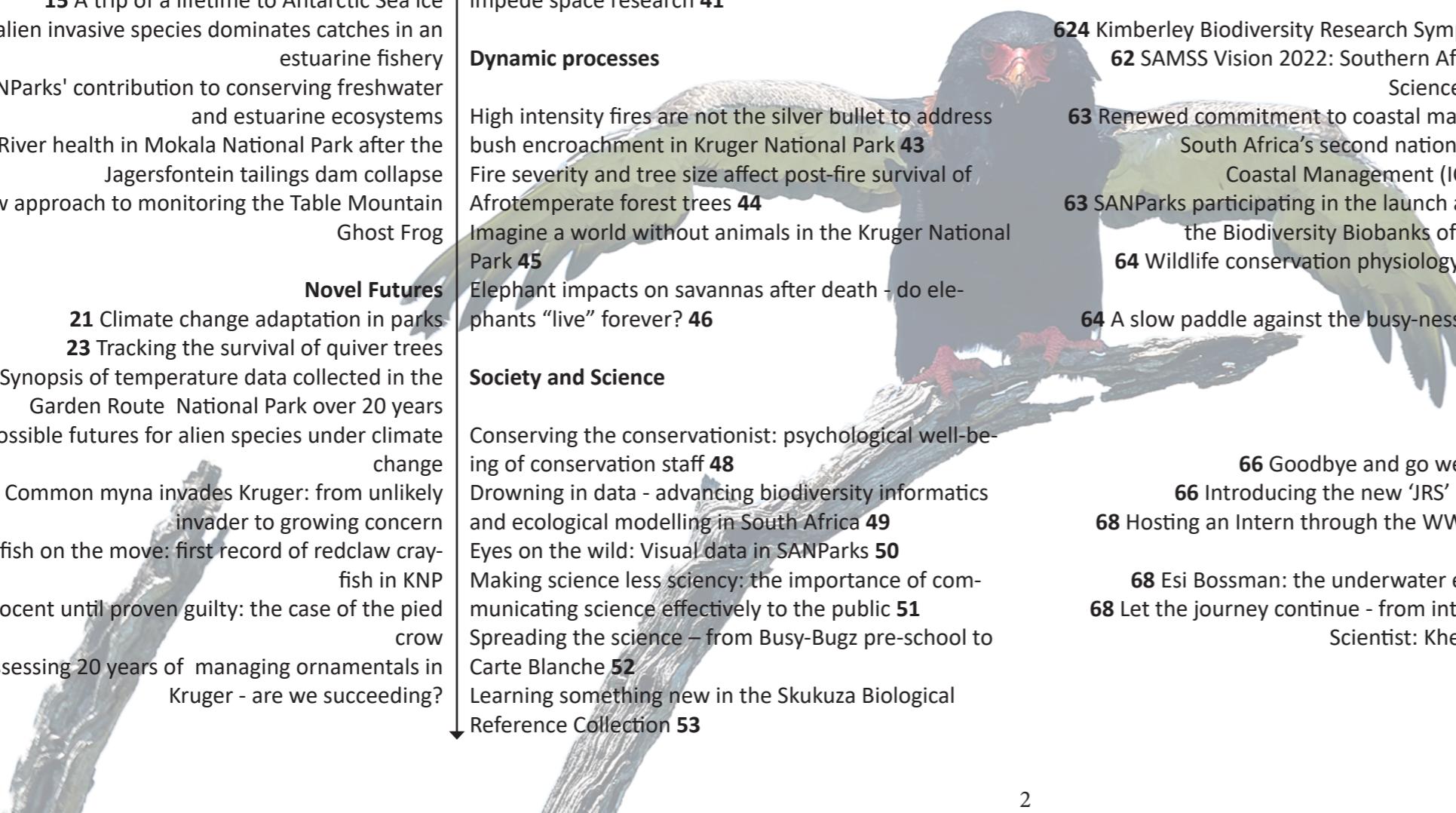
South African
NATIONAL PARKS

Content

<p>Waves of Change</p> <p>4 Marine Protected Areas as complex socio-ecological systems: The importance of people 30</p> <p>6 Waves of change: A holistic Management Plan to shape the future of the Namaqua National Park Marine Protected Area 31</p> <p>7 Unveiling a coastal wonder: Table Mountain National Park Marine Protected Area 32</p> <p>9 Participation in the National Abalone Plan to combat poaching and recover the species 33</p> <p>9 State of the Bay: Langebaan on film 33</p> <p>10 A year down the road: Estuary Management Plans in National Parks 34</p> <p>11 Understanding and managing a highly infectious bird flu outbreak among South African coastal seabirds 35</p> <p>12 Vegetation growth spurt on Bird Island, Addo MPA, seems good for African penguin conservation 37</p> <p>13 Many hands make light work: Increasing capacity for the monitoring of African penguins on Bird Island 39</p> <p>14 Killer whales drive white sharks away: A shifting predator seascape 39</p> <p>15 A trip of a lifetime to Antarctic Sea ice 40</p> <p>16 An alien invasive species dominates catches in an estuarine fishery 41</p> <p>17 SANParks' contribution to conserving freshwater and estuarine ecosystems 42</p> <p>18 Riet River health in Mokala National Park after the Jagersfontein tailings dam collapse 43</p> <p>19 A new approach to monitoring the Table Mountain Ghost Frog 44</p> <p>Novel Futures</p> <p>21 Climate change adaptation in parks 45</p> <p>23 Tracking the survival of quiver trees 46</p> <p>24 Synopsis of temperature data collected in the Garden Route National Park over 20 years 47</p> <p>24 Possible futures for alien species under climate change 48</p> <p>26 Common myna invades Kruger: from unlikely invader to growing concern 49</p> <p>27 Crayfish on the move: first record of redclaw crayfish in KNP 50</p> <p>27 Innocent until proven guilty: the case of the pied crow 51</p> <p>28 Assessing 20 years of managing ornamentals in Kruger - are we succeeding? 52</p>
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<p>Celebrating species</p> <p>Have you seen the golden mole? Improved monitoring of species of special concern within Kruger 30</p> <p>Hungry for more: camera traps reveal martial eagle feeding behaviour 31</p> <p>Spreading their wings: monitoring crowned eagles in the Garden Route 32</p> <p>iNaturalist City Nature Challenge: my Skukuza Edition 33</p> <p>Aerial census of large herbivores in Golden Gate Highlands National Park 33</p> <p>Back to the Wild 34</p> <p>What did you say? A leopard, where? 35</p> <p>Improving the safety of lion immobilisation 35</p> <p>Improving blood oxygenation monitoring in immobilised white rhinoceros 37</p> <p>To reintroduce or not to introduce? Site visit to Kuno National Park, India 38</p> <p>Field report: Visiting Reunion National Park in 2022 39</p> <p>The SANParks Herbarium Digitisation Project 40</p> <p>When the rivalry between honeybees and humans impede space research 41</p> <p>Dynamic processes</p> <p>High intensity fires are not the silver bullet to address bush encroachment in Kruger National Park 43</p> <p>Fire severity and tree size affect post-fire survival of Afrotropical forest trees 44</p> <p>Imagine a world without animals in the Kruger National Park 45</p> <p>Elephant impacts on savannas after death - do elephants "live" forever? 46</p> <p>Society and Science</p> <p>Conserving the conservationist: psychological well-being of conservation staff 48</p> <p>Drowning in data - advancing biodiversity informatics and ecological modelling in South Africa 49</p> <p>Eyes on the wild: Visual data in SANParks 50</p> <p>Making science less scency: the importance of communicating science effectively to the public 51</p> <p>Spreading the science – from Busy-Bugz pre-school to Carte Blanche 52</p> <p>Learning something new in the Skukuza Biological Reference Collection 53</p>

<p>54 Creating an ecological corridor between the Tankwa Karoo and the Cederberg Wilderness Area 54</p> <p>55 Sharing the benefits of elephant dung with traditional healers 55</p> <p>56 It's not just about the animals – monitoring the impacts of SANParks week, Kruger National Park 56</p> <p>57 Cultural heritage research in action 57</p> <p>58 Environmental policy: a duty of care to people and nature 58</p> <p>Sharing the science</p> <p>60 Consolidating lessons from research through peer-reviewed publication 60</p> <p>61 Conferences/Meetings/Workshops hosted, organised or attended 61</p> <p>61 4th Garden Route Interface and Networking (GRIN) Meeting 61</p> <p>67 Savanna Science Networking Meeting - 20 year celebration! 67</p> <p>624 Kimberley Biodiversity Research Symposium 2022 624</p> <p>62 SAMSS Vision 2022: Southern African Marine Science Symposium 62</p> <p>63 Renewed commitment to coastal management at South Africa's second national Integrated Coastal Management (ICM) Lekgotla 63</p> <p>63 SANParks participating in the launch and forum of the Biodiversity Biobanks of South Africa 63</p> <p>64 Wildlife conservation physiology and disease workshop 64</p> <p>64 A slow paddle against the busy-ness of everyday demands 64</p> <p>Staff news</p> <p>66 Goodbye and go well Luthando! 66</p> <p>66 Introducing the new 'JRS' project team 66</p> <p>68 Hosting an Intern through the WWF Internship Programme 68</p> <p>68 Esi Bossman: the underwater entomologist 68</p> <p>68 Let the journey continue - from intern to Junior Scientist: Khensani Nkuna 68</p>



Improving blood oxygenation monitoring in immobilised white rhinoceros

Text by Thembeka Mtetwa, Edward Snelling & Leith Meyer

OUR STUDY HAS SHOWN THAT BLOOD OXYGENATION CAN BE MONITORED RELIABLY IN IMMOBILISED SOUTHERN WHITE RHINOCEROS USING A NONIN PALMSAT 2500A PULSE OXIMETER WITH A 2000T TRANSFLECTANCE PROBE, ATTACHED IN THE SPACE BETWEEN THE THIRD EYELID AND THE SCLERA, FACING THE THIRD EYELID, AND WHEN OXYGEN LEVELS ARE ABOVE 70%

The population decline of black and white rhinoceroses remains a crisis around the globe. Rhinoceros management and conservation efforts, such as dehorning, wound treatment and research, require the use of immobilising drugs, such as etorphine and thiadiazepam. However, these drugs affect the respiration of rhino, causing hypoxaemia which results in low blood oxygen levels. Severe hypoxaemia can be acutely life-threatening, and if it is left untreated, can damage the brain and other tissues, leading to tissue hypoxia, organ failure and ultimately death. It is therefore important to find reliable, affordable, and easy-to-use methods to monitor hypoxaemia and blood oxygenation in field settings.

Devices commonly used to monitor hypoxaemia in white rhinoceros (e.g. pulse oximeters and blood analysers) are mostly designed for humans. These devices estimate blood oxygenation, either as partial pressure of oxygen in arterial blood (PaO_2) or arterial oxygen-haemoglobin saturation (SaO_2) and peripheral arterial oxygen-haemoglobin saturation (SpO_2), using blood characteristics of humans. However, the haemoglobin and oxygen-haemoglobin dissociation curve of white rhinoceros' blood is different to that of humans. Determining the magnitude of this potential error and the repeatability of measurements obtained from human devices helps in identifying reliable methods for measuring or calculating blood oxygenation in

rhinoceros and will have significant indirect benefits for their conservation.

We examined the reliability of five different methods used to assess blood oxygenation, using the AVOXimeter 4000 benchtop co-oximeter as a reference (gold) standard method. The research was conducted in Kruger where boma-habituated white rhino were immobilised with etorphine-based drug combinations. Non-invasive devices (i.e. Nonin PalmSAT 2500A pulse oximeters and Masimo Radical-7 pulse co-oximeters) with their transreflectance and transmission probes were attached at different attachment sites (i.e. third eyelid, cheek, ear, rectum, and/or tail) to monitor the reliability of peripheral arterial oxygen-haemoglobin saturation (SpO_2).

Arterial blood samples were drawn, at different time points, from catheters inserted into the ear pinna and analysed for calculated SaO_2 , partial pressure of oxygen and carbon dioxide (i.e., PaO_2 and PaCO_2) and pH, using an Enterprise Point-of-Care (EPOC) blood analyser. Blood samples were also analysed for oxygen content (CaO_2) and SaO_2 using the benchtop co-oximeter reference method. Arterial oxygen-haemoglobin saturation was calculated from a Siggard-Andersen algorithm, modified for rhinoceros, after correcting for EPOC measured PaO_2 , PaCO_2 and pH.



Immobilisation drugs affect the respiration of rhino, causing hypoxaemia which results in low blood oxygen levels and ultimately can be life-threatening. It is therefore important to find reliable, affordable, and easy-to-use methods to monitor hypoxaemia and blood oxygenation in field settings. Thembeka Mtetwa's (middle top) did her PhD on this topic.

We found that only the traditional pulse oximeter was reliable for the measurement of blood oxygenation in immobilised southern white rhinoceros (*Ceratotherium simum simum*). Peripheral oxygen haemoglobin saturation (SpO_2) measurements from the Nonin 2500A PalmSAT pulse oximeter with a 2000T transreflectance probe attached to the third eyelid were reliable, but only at 70-100% saturation range. The Nonin 2500A PalmSAT pulse oximeter, at the other attachment sites gave unreliable SpO_2 readings across the entire 0-100% saturation range. The Masimo Radical-7 pulse co-oximeter with a LNCS TF-I AH transreflectance probe attached to the third eyelid, and with a LNS YI AH transmission probe attached to the ear pinna gave unreliable readings across the entire 0-100% saturation range. The EPOC's cSaO_2 readings were unreliable across the entire 0-100% saturation range. Furthermore, arterial oxygen-haemoglobin saturation calculated by the oxygen content equation using Tucker-derived CaO_2 was also found to be unreliable

across the entire 0-100% saturation range. Arterial oxygen-haemoglobin saturation (blood oxygen) calculated by the Siggard-Andersen algorithm, modified for rhinoceros, was reliable but only at saturations above 90%.

Our study has shown that blood oxygenation and hypoxaemia can be monitored reliably in immobilised southern white rhinoceros using a Nonin PalmSAT 2500A pulse oximeter with a 2000T transreflectance probe, attached in the space between the third eyelid and the sclera, facing the third eyelid, and when oxygen levels are between 70% and 100%. Below 70%, it is important to use a benchtop co-oximeter to obtain reliable and accurate measurements in these animals. These findings will assist wildlife veterinarians in monitoring blood oxygenation and hypoxaemia more reliably, continuously, and non-invasively. We hope that this will significantly reduce the number of deaths associated with rhinoceros immobilisation.