THE WILDERNESS PROJECT

EXPEDITION OVERVIEW

MIDDLE ZAMBEZI RIVER

ZIMBABWE

THE WILDERNESS PROJECT

ABOUT THE WILDERNESS PROJECT

By 2035, in partnership with local communities, governments, researchers and NGOs, The Wilderness Project aims to explore, study and better protect 1.2 million square kilometres of irreplaceable African wilderness. Central to this effort is to establish detailed hydrological and ecological baselines of the largely undocumented sources and watersheds of Africa's greatest river basins — Zambezi, Congo, Nile, Chad and Niger.

ACKNOWLEDGEMENTS

Our research transects would be impossible without the collaboration of our partners, who provide access to the river, permissions to camp, and invaluable local perspectives. For their continued support and collaboration, we thank the Zimbabwe Parks and Wildlife Management Authority, the Great Plains Foundation, Natural Capital, Wilderness Safaris, and Wildlife Conservation Action.

FOUNDATION GREAT PLAINS
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INTRODUCTION

The Middle Zambezi Valley is situated in a cluster of world-renowned national parks and wildlife concessions that form the greater Mana Pools UNESCO World Heritage Site. At the heart of these, Mana Pools National Park is a 22,000 km^2 landscape of mahogany, wild fig, acacia and baobab trees in an open savanna. Together with surrounding safari areas — Charara, Hurungwe, Sapi, Chewore, Dande and the Lower Zambezi National Park in Zambia — Mana Pools supports some of the highest densities of large game anywhere along the Zambezi River.

The Middle Zambezi Valley has been a significant site of natural and cultural importance since at least 10,000 BC, as indicated by evidence of a stone age "tool factory" in Mana Pools. The name "Mana" comes from the Shona word for "four," referring to the four large permanent pools — Main, Chine, Long, and Chisambuk — formed by old river channels. In the 1800s, elephant population in the region was nearly extirpated, leading to the establishment of the Mana Pools Game reserve. This later became a National Park in 1975.

The natural integrity of the Middle Zambezi Valley is ensured by the hard work of local communities, conservation organisations, and the Zimbabwean and Zambian governments. The landscape is defined by large hippo pods, family groups of ground hornbills, and iconic mahogany trees that together serve as a testament to the continued efforts of these stakeholders. Our research transect aimed to contribute to this work by highlighting the important role of the Zambezi River as a corridor of life within the valley.

The Middle Zambezi has one of the highest hippo densities in Africa. The total population is estimated at over 6,000

Upstream of the Middle Zambezi Valley lies Lake Kariba — the world's largest artificial lake by volume. Completed in 1959, the Kariba Dam controls the flow of the Middle Zambezi River, releasing water that generates hydroelectric power for communities in Zimbabwe and Zambia. Along its course, the Middle Zambezi also receives water from the Kafue and Luangwa tributaries — two of the largest on the Zambezi — before emptying into Cahora Bassa in Mozambique, on its eastward journey to the Indian Ocean.

The construction of Lake Kariba is widely recognized as a transformative event for the Middle Zambezi River. The dam significantly reduced river flow, flood volume, and sediment load[1,2,3]. These changes had far-reaching impacts on erosion dynamics, wildlife migrations, and the composition of both terrestrial and aquatic vegetation[4,5]. However, ecological monitoring in the valley has focused largely on charismatic wildlife, leaving critical aspects such as water quality, hydrology, and human activity under-researched.

TOP: The confluence of the Kafue and Zambezi Rivers. BOTTOM: The banks of Lake Kariba amidst a severe drought in 2024.

THE EXPEDITION

267 km

The total distance travelled from Kariba Dam to Luangwa Town

12 people

From four African countries

31

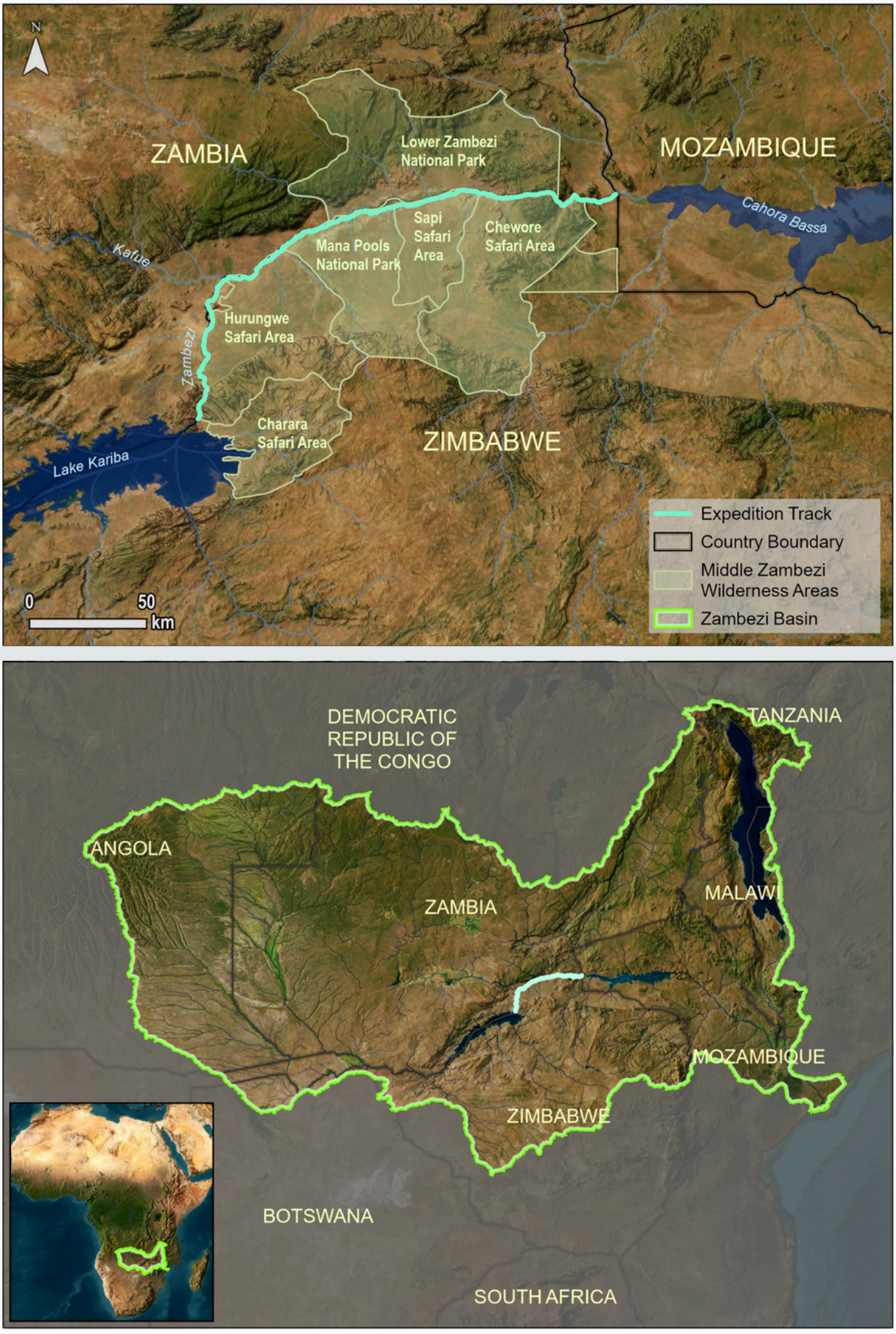
Fixed survey sites established

9 days

06 August - 14 August 2024

In August 2024, The Wilderness Project (TWP) undertook a research transect along the Middle Zambezi River from downstream of the Kariba Dam to Luangwa Town. This transect was conducted as part of a broader effort to document the Zambezi River from its source to its mouth at the Indian Ocean. The aim was to collect baseline data on hydrology, water quality, biodiversity, and human activity along the river. The study also identified key conservation information, including ongoing threats to the river.

These data will be used to inform future monitoring and support sustainable river management. We hope that this report will become a valuable resource for river managers, conservation authorities, government agencies, and anyone invested in the future of the Middle Zambezi River.



The Middle Zambezi River is situated between Lake Kariba and Cahora Bassa, surrounded by iconic wilderness areas.

RECOMMENDATIONS

INVASIVE SPECIES MANAGEMENT

- Ongoing monitoring of the spread and impacts of invasive species, including redclaw crayfish (*Cherax quadricarinatus*), water hyacinth (*Eichhornia crassipes*), and spongeplant (*Limnobium spongia*).
- Targeted interventions to reduce the spread and impact of invasive species, where possible — for example, mechanical removal of giant milkweed from the Sapi Safari Area.

WATER QUALITY

- Sustainable management of the Middle Zambezi River should include consistent monitoring of physiochemical parameters, nutrients and sediment loads to develop a robust water quality baseline.

BIODIVERSITY MONITORING

- In alignment with the IUCN World Heritage Outlook[19], a new wildlife survey is needed in the valley. This survey should expand monitoring efforts to include not only large wildlife but also underrepresented taxa.
- Investigate opportunities to incorporate community-driven data collection and utilize advanced tools such as eDNA to enhance biodiversity assessments.

MINING IMPACTS

- Monitor the impacts of mining on sensitive ecosystems, particularly around the Mana Pools UNESCO World Heritage Site. This includes early detection of toxic spills, heavy metal pollution and ongoing monitoring of water abstraction from the river.

METHODS

CONTINUOUS MONITORING

Observational survey data and 360° imagery were collected continuously along the transect. Sightings were limited to within 100 m of the river edge and recorded in Survey123 (ESRI) using a smartphone.

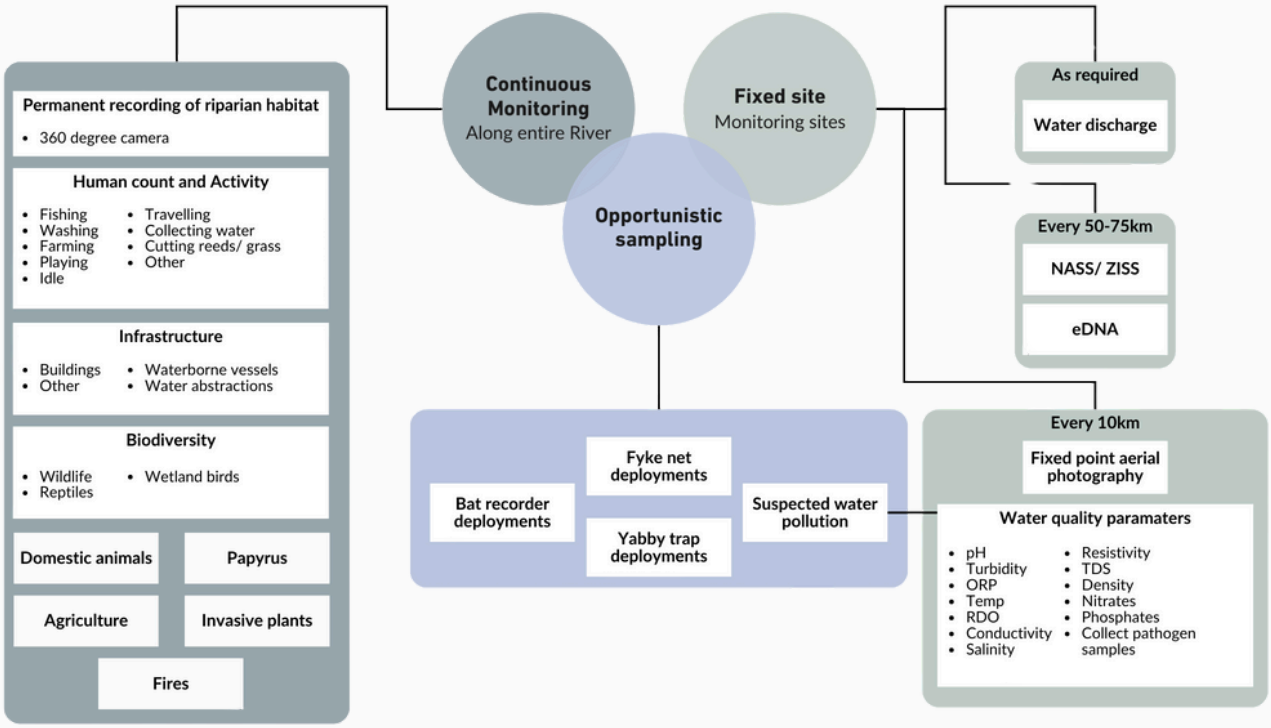
FIXED SURVEY SITES

Fixed research sites were established at regular intervals along the transect. These included drone flights, eDNA assessments, macroinvertebrate surveys, and water quality testing for a comprehensive analysis of river health.

OPPORTUNISTIC SITES

Specific sites along the transect were chosen for river flow measurements, crustacean trapping, fish sampling, and bat-call recording. These data offered a deeper understanding of the biodiversity and hydrology of the river.

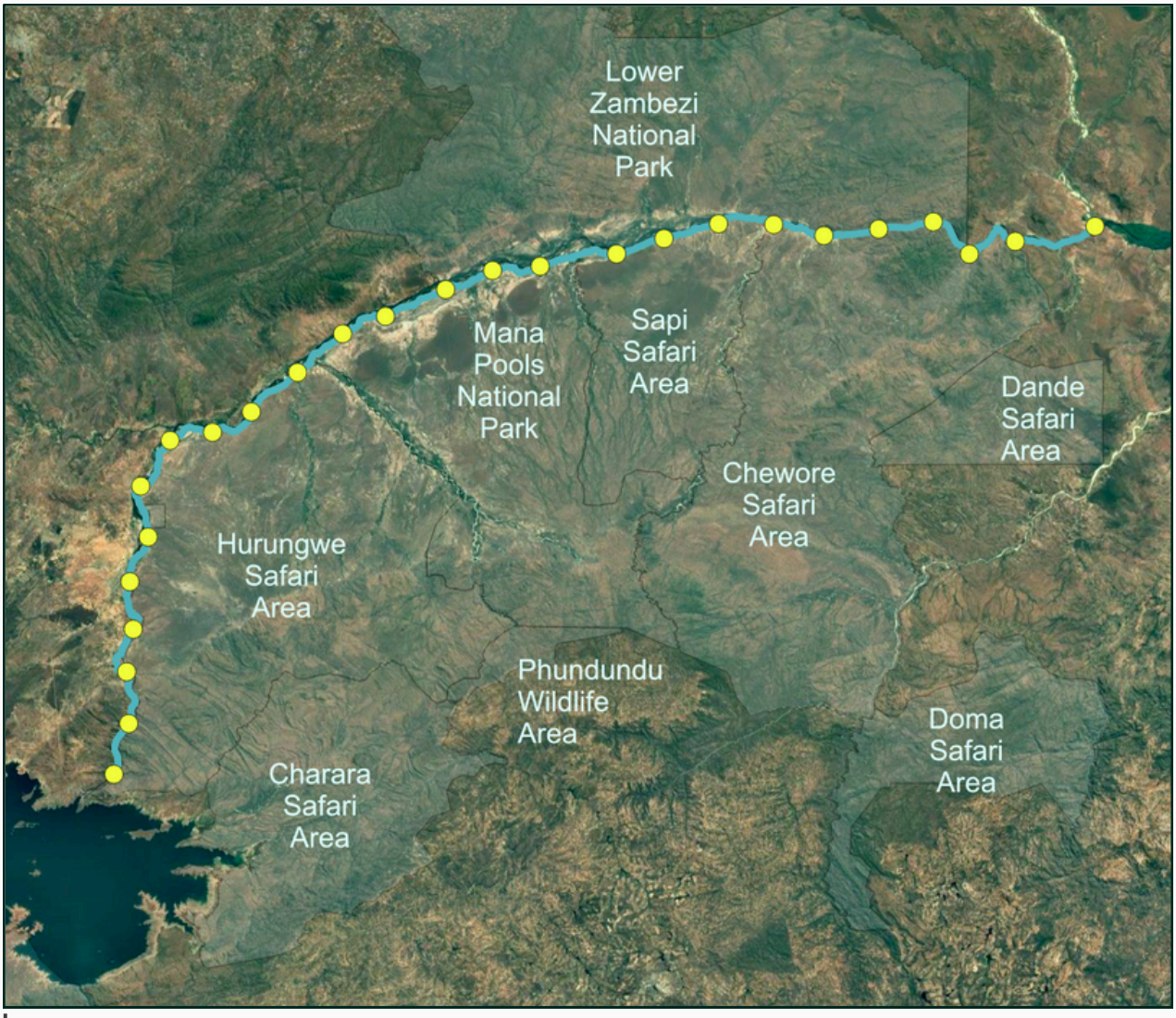
A SUMMARY OF THE DATA COLLECTED ALONG THE TRANSECT



RESEARCH SITES

31 research sites

26	4,060	23
water quality measurements	hippos counted	aerial drone surveys conducted



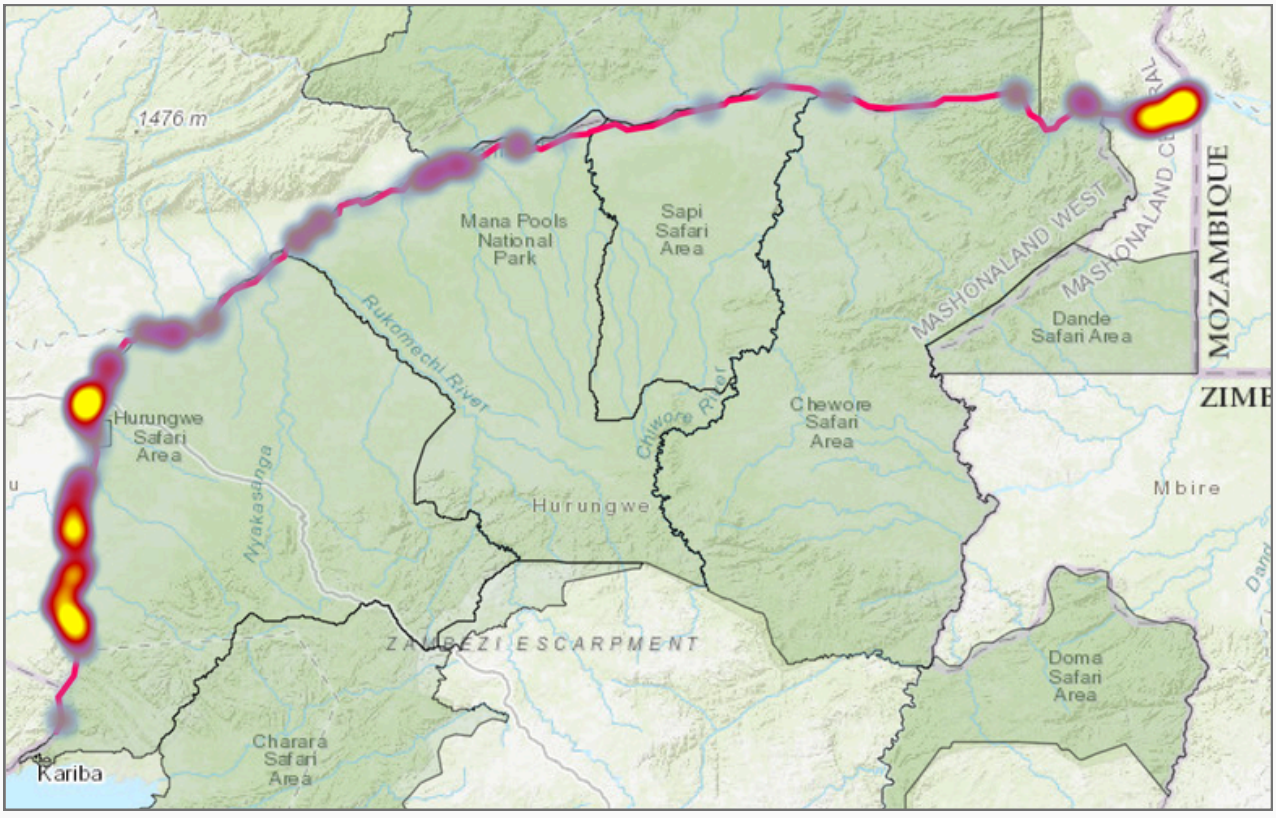
The distribution of research sites along the river

ABOVE: Olivia Marimira from Great Plains assists with deploying the Acoustic Doppler Current Profiler (ADCP). BELOW: This instrument uses sound waves to detect the depth and flow of the river.

HUMAN FOOTPRINT

The Zambezi River supports a mosaic of rural and urban communities. The livelihoods of these communities are directly tied to the health of the river, which provides water, food and transport, thereby facilitating the local economy. As a result, understanding patterns of human presence along the Zambezi River is crucial, highlighting areas where targeted interventions can support both local livelihoods and nature.

Indicators of Human Activity						
	People/ km	**Fishers/ km**	**Fishing Gear/km**	**Vessels/ km**	**Livestock/k m**	**Riparian Cropland (% of transect)**
Middle Zambezi	2.3	0.3	0.4	1.4	3.7	1.7%
Zambezi Average	6.5	0.5	3.4	3.7	5.2	4.6%



People were predominantly distributed along the border of the Hurungwe Safari Area, and near Luangwa Town. Most people were on the Zambian bank of the river.

BIODIVERSITY

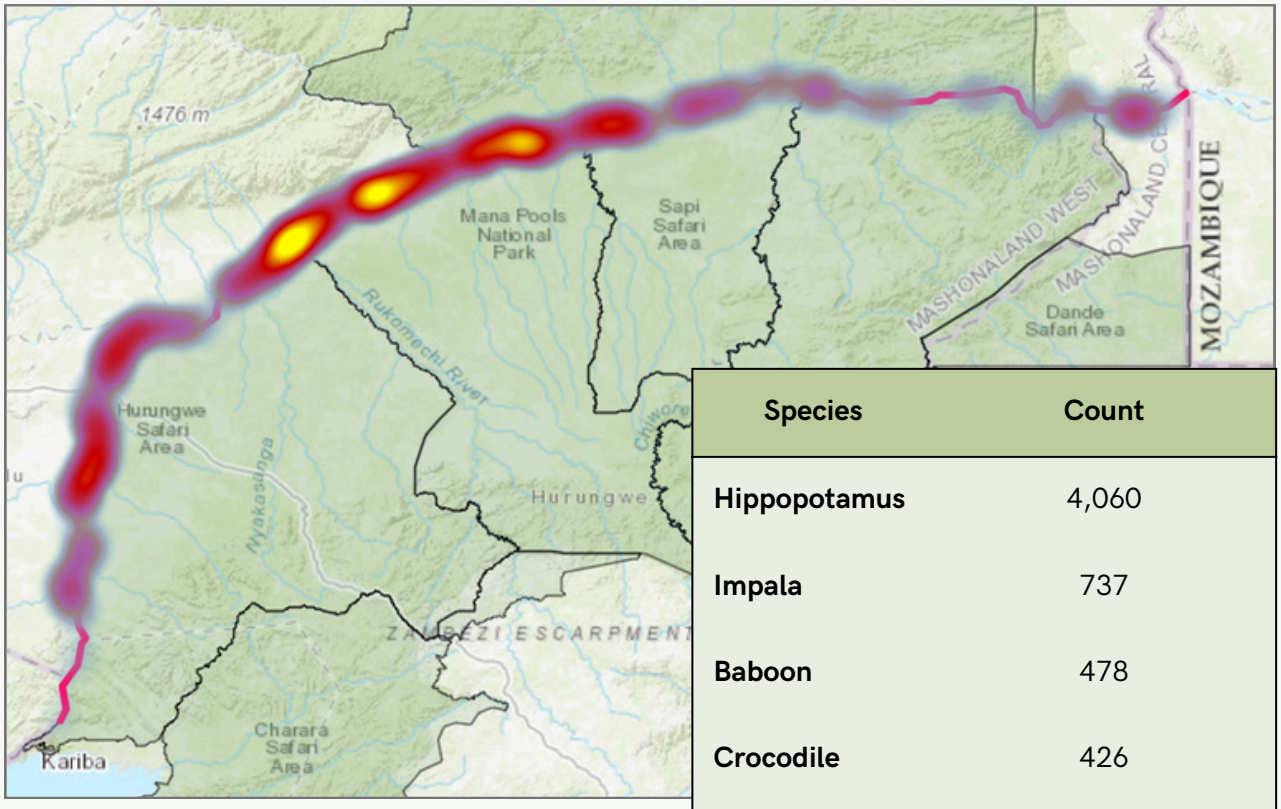
The successful management of conservation areas along the Middle Zambezi protects a remarkably high density of wildlife. During the dry season, large mammals concentrate on the alluvial floodplain — their numbers increasing as the season progresses[6,7]. These herbivores are drawn to the Zambezi River and the remaining pools in the floodplain, as well as the grasses and *Faidherbia* trees that provide essential food and water.

Notable large mammals include elephants, buffalo, hippos, and eland, along with a variety of antelope species such as zebra, waterbuck, nyala, impala, bushbuck and grey duiker. The area also supports a wide array of predators, including lions, leopards, cheetahs, wild dogs, and both spotted and brown hyenas. Black rhinos once occurred, but were locally extinct due to heavy poaching between 1989 and 1991[8].

6,388 large animals were documented along the 2024 transect. This represents one of the highest densities of large animals on any stretch of the Zambezi River surveyed to date by TWP. Approximately 64% of the large animals counted along the transect were hippos, with an average density of 15 hippos/km.

Importantly, this transect was unable to survey the full Zambian bank because of braided sections and islands. As a result, we believe that the hippo population may be as high as 6,500 — a density of over 24 hippos/km. If true, this would suggest that the population may be stable compared to 1996, 1998 and 2002, when aerial surveys reported densities of 24.74-26.61 hippos/km[9].

Other common large wildlife included impala (N=737), baboons (N=478), crocodiles (N=426), waterbuck (N=263) and elephant (N=148). These were mostly distributed on the Zimbabwean side of the river, particularly within Mana Pools National Park.

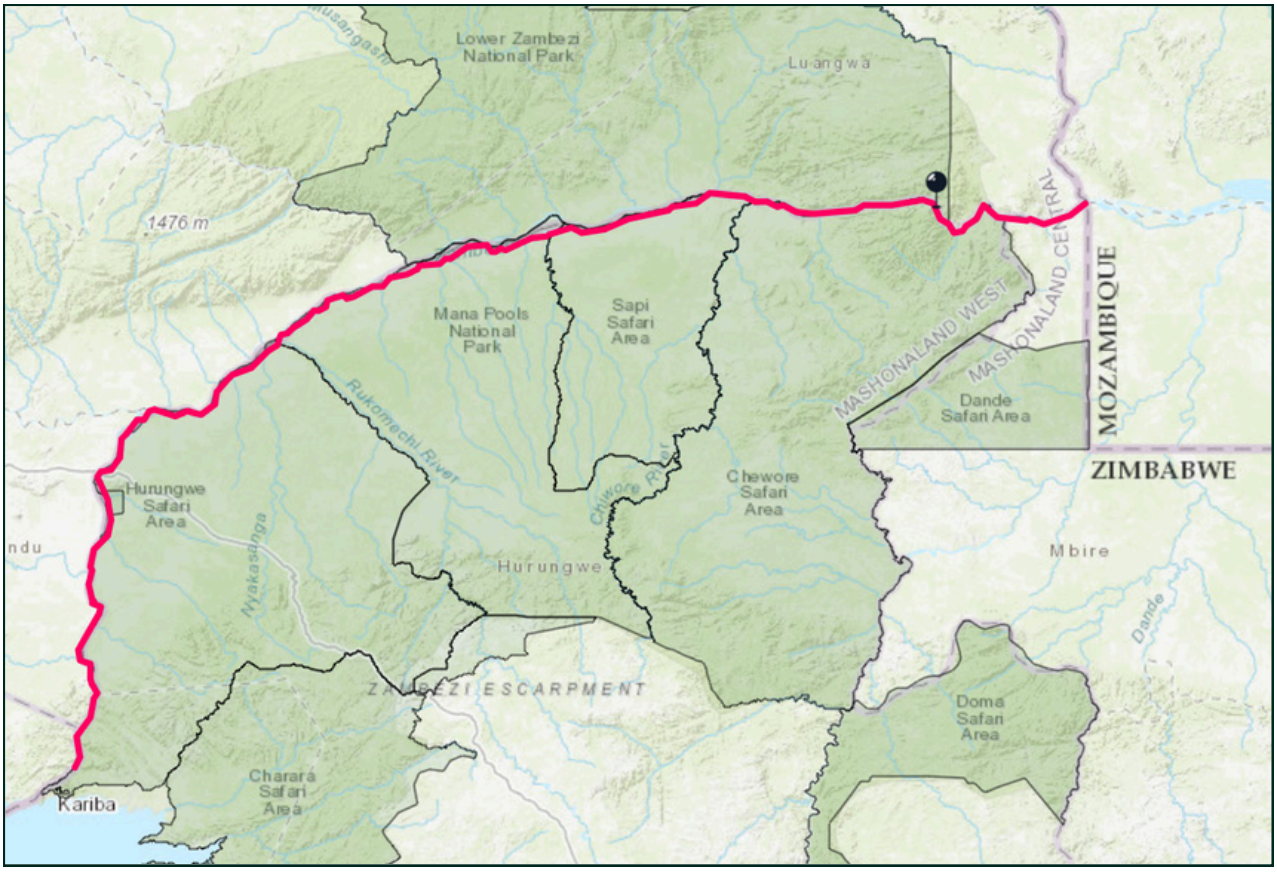


Species	Count
Hippopotamus	4,060
Impala	737
Baboon	478
Crocodile	426
Waterbuck	263
Elephant	148

TOP: distribution of large wildlife along the Middle Zambezi transect. ASIDE: The six most common large animals along the Middle Zambezi transect.

A sighting of four gentle monkeys, believed to be the local subspecies *Cercopithecus mitis moloneyi*, was recorded within a rocky gorge of the Cherowe Safari Area. Moloney's Monkey is mainly distributed west of the Luangwa River in northwestern Zambia, northern Malawi, and the Southern Highlands and Lake Rukwa region of southwestern Tanzania[10]. This is a rare sighting of the subspecies on the south bank of the river, providing justification for ongoing monitoring of wildlife in the Middle Zambezi Valley.

Moloney's Monkey occupies a variety of habitats, including lowland and mid-altitude montane forests, woodlands, gallery forests, and riverine forests. Although listed as Least Concern, *C. m. moloneyi* is threatened by habitat loss and fragmentation driven by population growth, deforestation and land conversion for agriculture and settlements.



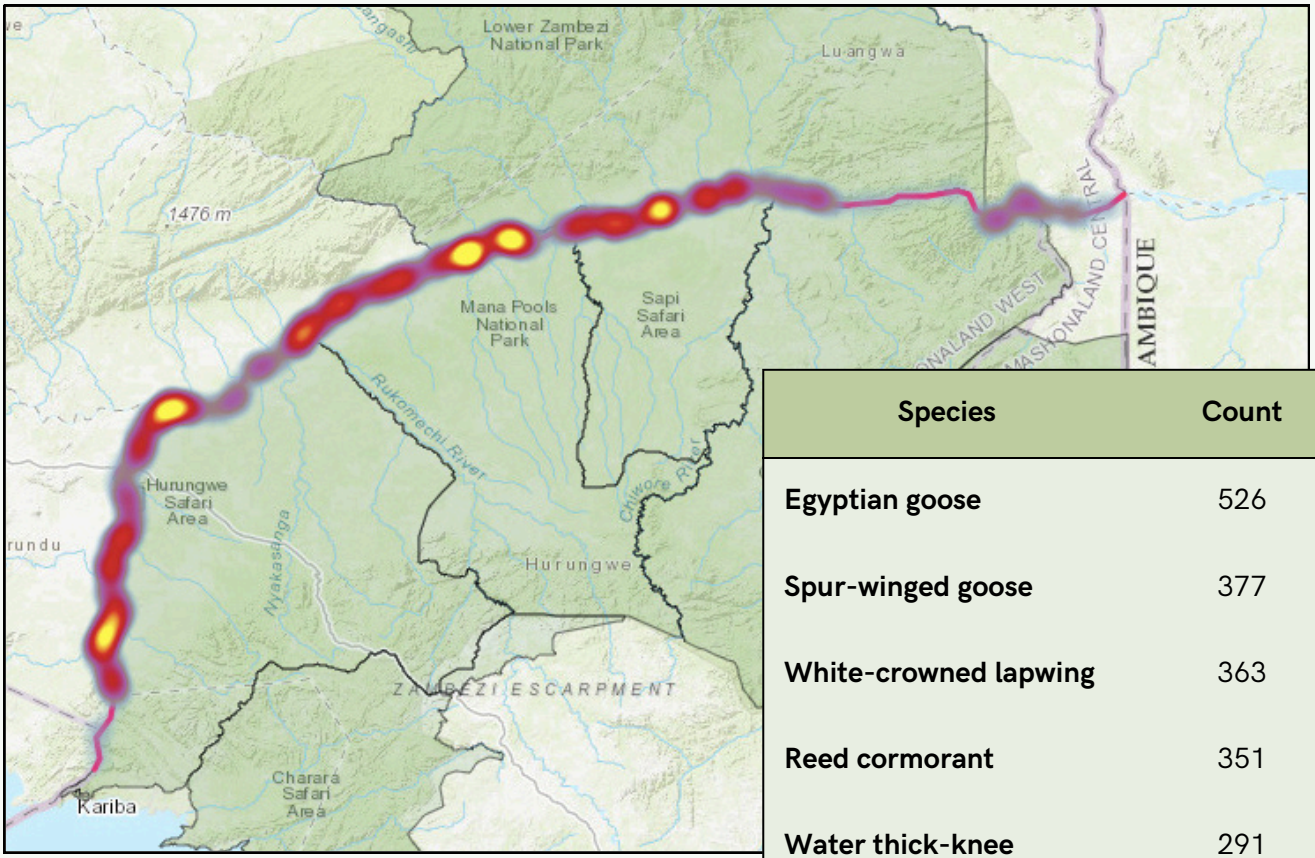
The location of the C.m. moloneyi sighting a rocky gorge of the Cherowe Safari Area. illustration of C.m. moloneyi by Stephen Nash and used with permission of Thomas M. Butynski and Yvonne A. de Jong, Wildsolutions.nl[11].

WETLAND BIRDS AND RAPTORS

The Middle Zambezi Valley is an Important Bird Area (IBA) for endangered birds, as recognised by the IUCN. The valley is home to over 400 bird species, including several large species that are uncommon outside of parks and protected areas. These include 6 vulture species, 12 eagle species, and the southern ground-hornbill *Bucorvus leadbeateri*, which occurs at very high densities in the area.

Wetland birds are powerful indicators of environmental change, especially in river systems where their presence often reflects the availability of wetland habitat. By regularly monitoring bird populations, we can detect early ecological shifts and identify emerging conservation priorities.

A total of 3,456 wetland-associated birds, comprising 58 species, were recorded along the transect. These were mainly distributed in Mana Pools National Park and Sapi and Hurungwe Safari Areas. The most common birds included the Egyptian goose (N=526), spur-winged goose (N=377), white-crowned lapwing (N=363), reed cormorant (N=351) and water thick-knee (N=291). The African fish eagle was the most common raptor, with a density of 1 bird/4.6 km.



Species	Count
Egyptian goose	526
Spur-winged goose	377
White-crowned lapwing	363
Reed cormorant	351
Water thick-knee	291

TOP: distribution of wetland-associated birds and raptors along the Middle Zambezi transect. ASIDE: The five most common birds along the Middle Zambezi transect.

RIVER FLOW

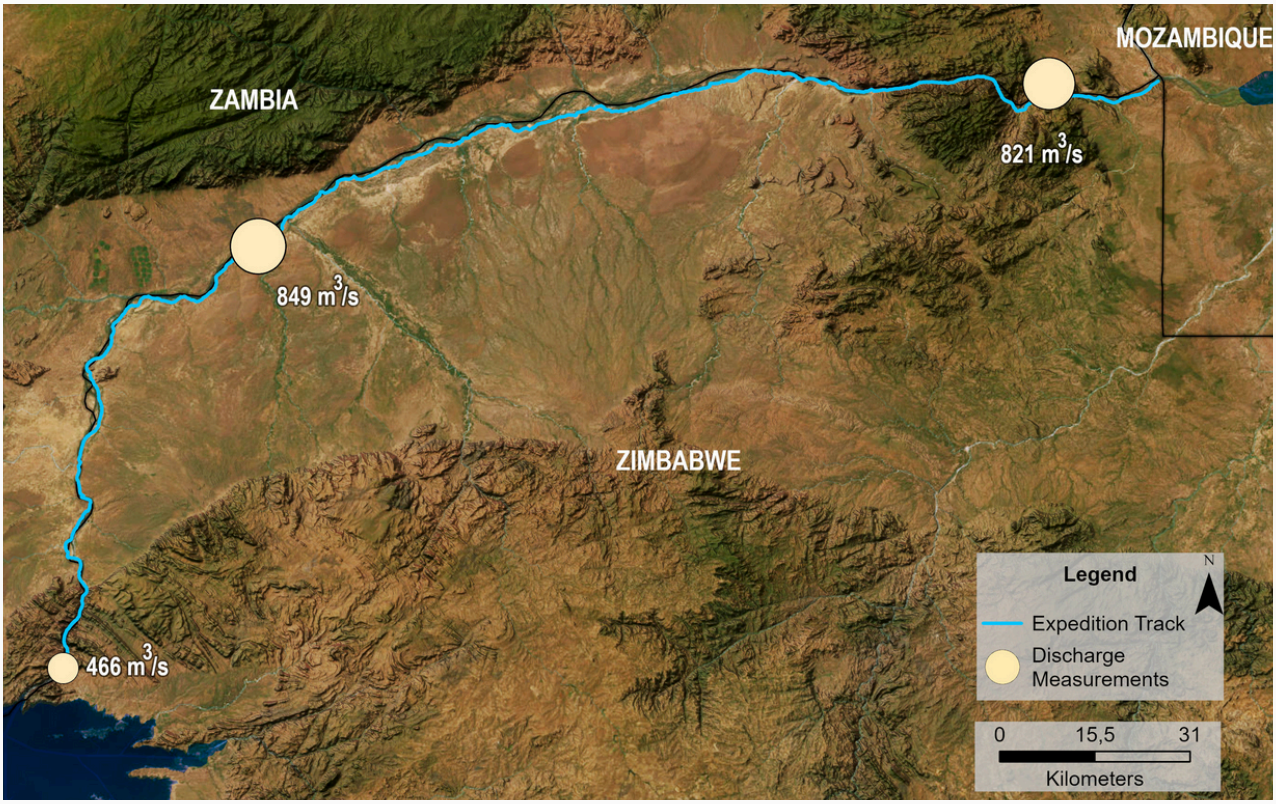
In the dry season, the flow of the Middle Zambezi River is primarily determined by the controlled release of water from the Kariba Dam. In addition, the Kafue River — which joins the Middle Zambezi ~70 km downstream of Lake Kariba — has several hydroelectric dams along its course. As a result, the hydrology of the Middle Zambezi is significantly influenced by upstream dam development.

To sample the flow of the river at the time of the transect, river discharge was measured at three sites. These sites were:

1. Directly below Kariba Dam;
2. At the Nyakasanga Fishing Camp, downstream of the Kafue confluence; and
3. At a narrow gorge in the Chewore Safari Area.

The flow of the Middle Zambezi River below Lake Kariba was 466 m^3/s, linked to extreme drought conditions at the time of the survey. The Kafue River added a further ~380 m^3/s of water to the flow of the Middle Zambezi, as indicated by a discharge measurement of 849 m^3/s directly downstream of the confluence. This highlights the important role of the Kafue River as a source of dry-season flow in the Middle Zambezi River.

Interestingly, the flow of the Zambezi River declined in the 160 km between Sites 2 and 3, probably because of controlled water releases from the Kariba Dam Rehabilitation Project, which was underway at the time of the expedition. Alternatively, it is possible that reduced flow was a result of the net loss of water from evaporation in the shallow, braided river.



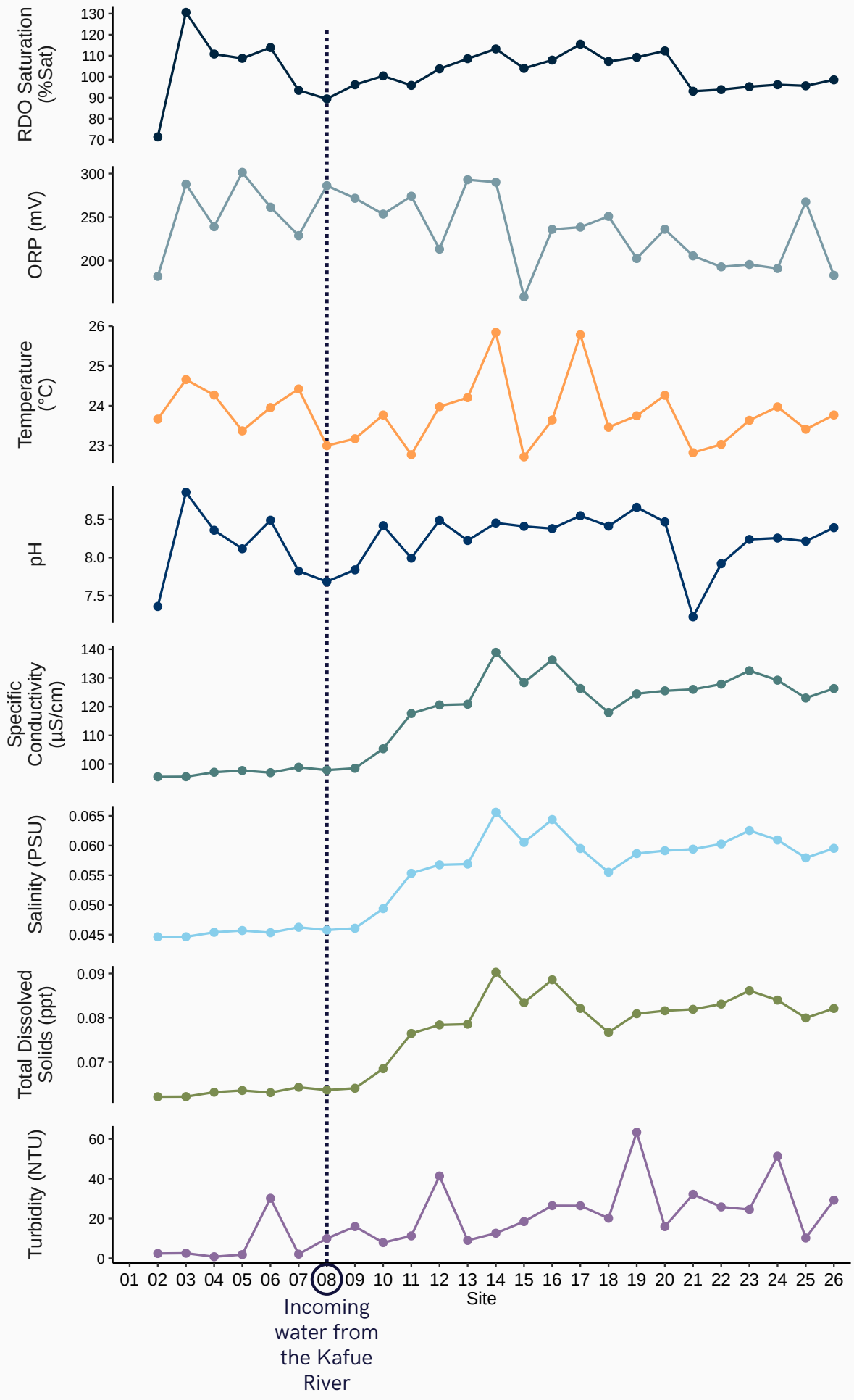
River discharge measurements along the Middle Zambezi transect.

WATER QUALITY

Monitoring water quality in the Middle Zambezi River is essential for assessing ecosystem integrity and guiding conservation efforts. Similarly to river flow, water quality is heavily influenced by upstream anthropogenic activity. River levels can fluctuate rapidly with dam releases, contributing to bank erosion and increased suspended sediment load. These hydrological alterations have implications for aquatic biodiversity, erosion dynamics, and the long-term health of the ecosystem.

At the time of the survey, water quality was generally within established guidelines for the Zambezi River[12,13], suggesting acceptable river water quality. However, turbidity spiked several times. This was associated with unseasonal and rapid releases of water from the Kariba Dam, causing erosion of sediments from the riverbanks. In addition, pH was higher than expected, with further study needed to determine the drivers of pH-balance in the river.

The Kafue River likely has a substantial influence over the water quality of the Middle Zambezi, as indicated by a gradual rise in specific conductivity below the confluence. Specific conductivity reflects the ability of water to conduct electrical current — a property directly influenced by the concentration of dissolved ions, such as salts, minerals, and other inorganic substances. Along the Middle Zambezi, ions originate from natural weathering of rocks, soil leaching, and biological processes, but can also be influenced by anthropogenic sources such as agricultural runoff, sewage discharge, and industrial effluents.

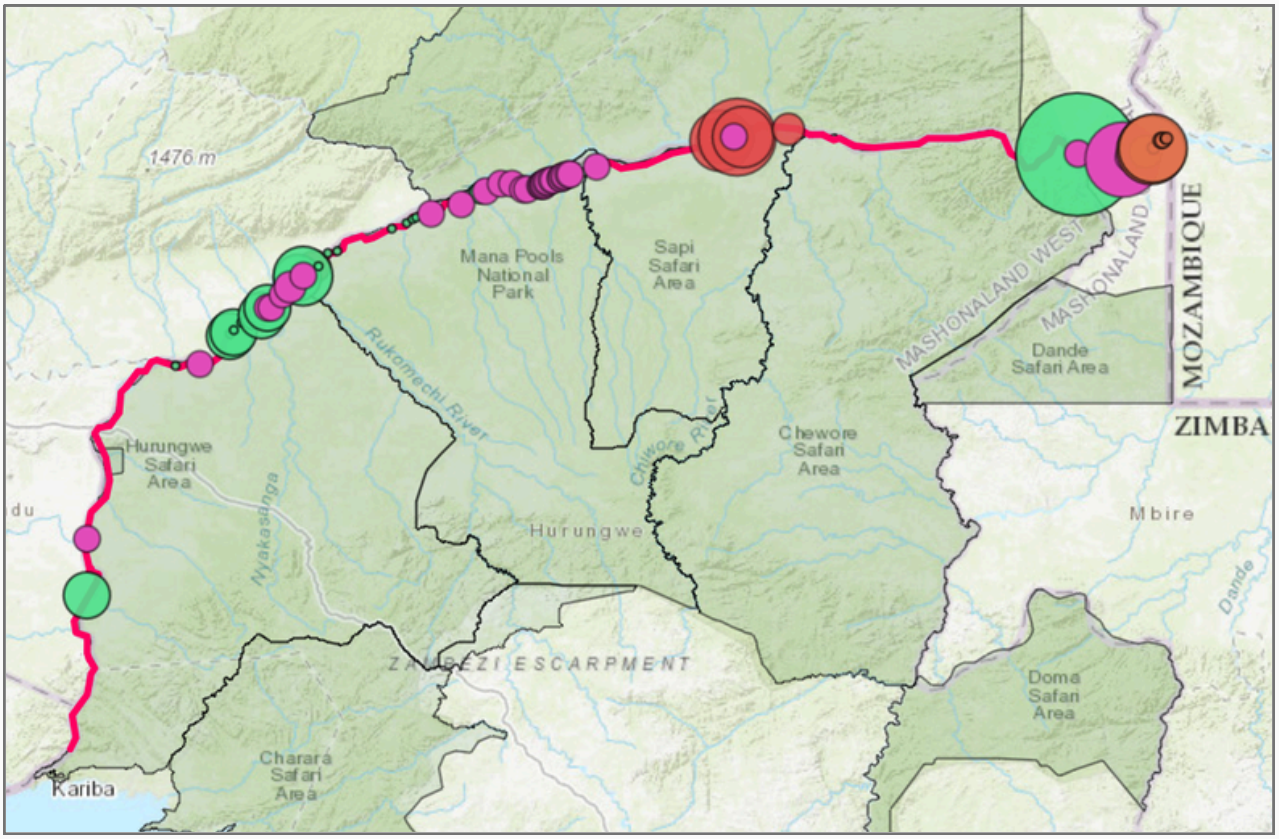

RDO Saturation (%Sat)
130
120
110
100
90
80
70
ORP (mV)
300
250
200
Temperature (°C)
26
25
24
23
pH
8.5
8.0
7.5
Specific Conductivity (µS/cm)
140
130
120
110
100
Salinity (PSU)
0.065
0.060
0.055
0.050
0.045
Total Dissolved Solids (ppt)
0.09
0.08
0.07
Turbidity (NTU)
60
40
20
0
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Site
Incoming water from the Kafue River

INVASIVE PLANTS

Alien invasive plants (AIPs) are known to have several impacts on river systems in Africa. These include the displacement of natural vegetation and changes in nutrient cycling, which have detrimental impacts on native biodiversity[14]. In addition, AIPs reduce water quality by increasing evaporation rates and reducing stream flow and dilution capacity[15]. The continuous monitoring of AIPs allows for early detection of threats to riverine ecosystems — particularly along major watercourses like the Zambezi River — where early intervention is critical for maintaining ecological integrity.

Invasive plants were common along the river, likely because of introduction and proliferation in upstream waterbodies, including Lake Kariba and along the Kafue River. The most widespread species was the water hyacinth (*Eichhornia crassipes*), followed by the spongeplant (*Limnobium laevigatum*).

Giant milkweed (*Calotropis procera*) was identified within Sapi Safari Area. This plant contains a noxious milky sap that is toxic to people and wildlife. As a result, herbivores are unlikely to eat the plant, and mechanical removal should be considered — particularly if the population is still establishing itself.



Four invasive plants are present in high densities along the river. These are water hyacinth (Eichhornia crassipes) (pink), spongeplant (Limnobium laevigatum) (green), giant sensitive plant (Mimosa pigra) (orange) and giant milkweed (Calotropis procera) (red).

INVASIVE CRAYFISH

Invasive crayfish (*Cherax* species, particularly the redclaw crayfish, *Cherax quadricarinatus*), are widespread in the Zambezi Basin (for more information on their distribution, see the World of Crayfish Map)[16]. Invasive crayfish can drive biodiversity loss and habitat degradation in rivers. In addition, they impact fisheries by scavenging fish from static gillnets. For example, in Lake Kariba, *C. quadricarinatus* causes post-harvest losses estimated at 212 tonnes per year — equivalent to approximately US$500,000[17].

During the transect, *C. quadricarinatus* was detected at two sites along the Middle Zambezi River. The species is already known from Lake Kariba, the Kafue River, and downstream sections of the Zambezi toward Cahora Bassa[18]. However, both detection sites were upstream of the Kafue River confluence, suggesting that the species has either spread upstream from the Kafue River or, more likely, downstream from Lake Kariba. These detections add to mounting evidence that *C. quadricarinatus* is ubiquitous in the Middle Zambezi River between Lake Kariba and Cahora Bassa.

Joshua Huchu from Zimbabwe Parks and Wildlife holds two large redclaw crayfish.

REFERENCES

[**1**] Shela, O., 2000. Management of shared river basins: the case of the Zambezi River. Water Policy, 2, 65-81.
[2] Mikhailov, V.N., Kravtsova, V.I., and Isupova, M.V., 2015. Impact of reservoirs on the hydrological regime and morphology of the lower reaches and Delta of the Zambezi River (Mozambique). Water Resources, 42, 170-185.
[3] Ronco, P., Fasolato, G., Nones, M., and Di Silvio, G., 2010. Morphological effects of damming on lower Zambezi River. Geomorphology, 115, 43-55.
[4] Magadza, C.H.D., 2010. Environmental state of Lake Kariba and Zambezi River Valley: lessons learned and not learned. Lakes & Reservoirs: Research and Management, 15, 167-192.
[5] Attwell, R.I.G., 1970. Some of the effects of Lake Kariba on the ecology of a floodplain of the Mid-Zambezi Valley of Rhodesia. Biological Conservation, 2, 189-196.
[6] Jarman, P.J., 1972. Seasonal distribution of large mammal populations in the unflooded Middle Zambezi Valley. Journal of Applied Ecology, 9, 200-212.
[7] Dunham, K.M., 1994. The effect of drought on the large mammal populations of Zambezi riverine woodlands. Journal of Zoology, 234, 489-526.
[8] Cumming, D.H.M., Lynam, T.J.P. (Eds.), 1997. Land Use Changes, Wildlife Conservation and Utilisation, and the Sustainability of Agro-ecosystems in the Zambezi Valley. Final Technical Report. WWF, Harare, Zimbabwe.
[9] Chakuya J. et al. 2024. Zambia–Zimbabwe 2022 hippopotamus (Hippopotamus amphibius) and other species population distribution along Zambezi River, International Journal of Environmental Studies.
[10] Butynski et al. 2020. Taxonomy and Biogeography of the Gentle Monkey Cercopithecus mitis Wolf, 1822 (Primates: Cercopithecidae) in Kenya and Tanzania, and Designation of a New Subspecies Endemic to Tanzania. Primate Conservation. 34. 71-127.
[11] ibid.
[12] K. Nachiyunde and C. Namakando, "Evaluation of seasonal patterns of water quality in the Zambezi River Basin, using Zambezi River Authority (ZRA) data of 2011," Journal of International Development and Cooperation, vol. 19, no. 3, pp. 31–48, 2013.
[13] Zambia Bureau of Standards, "Ambient Water Quality – Specifications (ZS 1182: 2021)", ZABS, Lusaka, Zambia, 2021.
[14] Vilà, M., 2011. Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. Ecology Letters, 14, 702–708.
[15] Chamier, J., 2012. Impacts of invasive alien plants on water quality, with particular emphasis on South Africa. Water SA, 38, 345-356.
[16] World of Crayfish Map, available at: https://map.crayfish.ro/en/map/crayfish/
[17] Chakandinakira AT et al. 2023. Socioeconomic impacts of Australian redclaw crayfish *Cherax quadricarinatus* in Lake Kariba. Biol. Invasions 25, 2801–2812.
[18] Rice MA et al. 2023. Population Ecology and Current Distribution Assessment of the Introduced Invasive Crayfish in the Kafue Floodplain and Lake Kariba, Zambia: Summary of Results.
[19] IUCN World Heritage Outlook. Mana Pools National Park, Sapi and Chewore Safari Areas. Available at: https://worldheritageoutlook.iucn.org/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