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The ephemeral pans of Gras-Holpan: Mokala National Park, Northern Cape, South Africa

Authors:
Nkabeng T. Mzileni[1]
Hendrik Sithole[1]
Hugo Bezuidenhout[1,2]
Roxanne Erusan[1]
Rodney Makwakwa[1]

Affiliations:
[1]Conservation Services Division, Scientific Services, South African National Parks (SANParks), Kimberley, South Africa

[2]Department of Environmental Sciences, Applied Behavioural Ecology and Ecosystem Research Unit, University of South Africa, Johannesburg, South Africa

Corresponding author:
Nkabeng Maruping-Mzileni,
nkabeng.mzileni@sanparks.org

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Ephemeral pans are transient natural habitats with harsh conditions found in semi-arid regions. These pans endure high evaporation rates, extreme temperatures and an overflow of water. Pans are characterised by dry land becoming submerged in water temporarily (flood-like) followed by a prolonged period absent of water (drought-like). Ephemeral pans are unique habitats that are essentially transient habitats from a freshwater system to increased salinity and eventually a dry landscape. Biodiversity associated with these pans must adapt to the transient environmental conditions. Unique adaptations of the biota for these habitats allow them to withstand extreme conditions. The objective of this study was to (1) identify changes in the water quality over time in the pans, to (2) identify succession of macro-invertebrates and (3) identify the water quality parameters of pans as drivers of macro-invertebrate assemblages. A total of five pans were measured in the Northern Cape province of South Africa located on the Savanna and Nama-Karoo biomes within a 4500 ha area. The measurements taken included water quality variables (pH, salinity, total dissolved solids [TDS]), taxon diversity and richness of macro-invertebrates and aquatic birdlife. Evaporation rate between the pans varied with time. There was a difference in the macro-invertebrate taxon richness between the pans. Macro-invertebrate taxon succession was observed over time and some macro-invertebrates showed confinement to pans of a particular biome. It was found that pH was significantly the most contributing factor to the taxon richness and diversity of the macro-invertebrates recorded, while the salinity and TDS increased with time as water evaporated.

Conservation implications: The shrimps (fairy, clam and tadpole) were unique to the Nama-Karoo pans. It was found that pH ($p < 0.05$) was the most contributing factor to the taxon richness and diversity of the macro-invertebrates recorded, and salinity and TDS increased with time as water evaporated.

Keywords: ephemeral pans; transient; macro-invertebrate; water quality; salinity; pH.

Introduction

Ephemeral pans are natural habitats that change from terrestrial to aquatic (and vice versa) because of the presence and absence of the transient water body in such habitats. In southern Africa they occur in semi-arid regions such as the Northern Cape province of South Africa (Nhiwatiwa, Brendonk & Dalu 2017), Bushmanland, in north-eastern Namibia (Jamieson et al. 2000), Gonarezhou National Park in Zimbabwe (Gandiwa et al. 2012) and the Makgadikgadi salt-pan in Botswana (McCulloch et al. 2008). Ephemeral pans undergo conditions that range from a flood-like habitat into drought-like conditions and extreme temperatures within a short period of time (Herrmann, Anderson & Seaman 2004; Nhiwatiwa et al. 2017). The inundations in such pans change their physical and chemical characteristics (Meintjes, Seaman & Kok 1994), while the high evaporation rates contribute to extreme changes in water quality of such pans. A pan may start as a freshwater system, and as the dry season progresses, the system can become more saline (Escalera-Vázquez & Zambrano 2010).

The transient environmental conditions of pans require the associated biota to adopt survival strategies in a transient habitat. Ephemeral pans are characterised by frenzied activity shortly after rainfall followed by a series of species succession (Herrmann et al. 2004) until eventually the inhabitants shrivel as the pans dry (Brock et al. 2003; De Necker et al. 2016). These pans have closed drainage and play a critical role in the hydrological cycle (Allan 1987). They are key habitats for biodiversity such as eubranchiopod crustaceans, migratory aquatic birds (McCulloch, Aebischer & Irvine 2003) and lifecycles stages of many invertebrate larvae (Nhiwatiwa et al. 2017). The biota have been documented to adopt one of three strategies; either they reach sexual maturity rapidly or have a dormant phase in the life cycle that can withstand the dry period, or they move to areas with favourable conditions (Williams & Hynes 1976). For the macro-invertebrates, the first two strategies are generally adopted (Williams & Hynes 1976).

In the semi-arid regions of the Northern Cape, South Africa, transient aquatic habitats in the form of ephemeral pans are found in the Gras-Holpan section, which is a nature conservation area (henceforth called Gras-Holpan) of the South African National Parks (SANParks). Gras-Holpan is situated 30 km outside of Kimberley, Northern Cape province, South Africa. The pans at Gras-Holpan are located in a unique interface of the savanna and Nama-Karoo biomes (Bezuidenhout 1995; Mucina & Rutherford 2006). These pans were last filled with water in 2013 and have since been dry and the associated aquatic species dormant, until the late summer rains of 2019 (from February to April) filled them and a rapid surge of life took place.

Macro-invertebrates are commonly used as valuable indicators of the biological condition of water bodies, notably the riverine ecosystems (Dickens & Graham 2002). Freshwater macro-invertebrates are generally visible to the naked eye, can be easily identified and have sedentary habits and a rapid life cycle. Although this group of organisms are highly diverse, they pose a narrow range of ecological requirements, making them useful bio-indicators of the aquatic habitat (Dickens & Graham 2002). Several components were measured and monitored that influence the pans, including water quality and associated aquatic macro-invertebrates. All these define the health of the pan as a functioning ecosystem. This study aimed to (1) identify changes in the water quality over time in the pans, to (2) identify succession of macro-invertebrates and (3) identify the water quality parameters of pans as drivers of macro-invertebrate assemblages.

Study area

The Gras-Holpan is situated at −28°25′ to −28°40′ and 24°12′ to 24°26′ (Bezuidenhout 1995) and is 4576 ha in extent (Figure 1). It is located on a significantly important interface for the biodiversity of the savanna and Nama-Karoo biomes (Bezuidenhout 1995; Mucina & Rutherford 2006). There are pans scattered widely in the Gras-Holpan (Berry 1991). Of the pans studied, Pans 1, 4 and 5 are located in the Nama-Karoo biome, while Pans 2 and 3 are located in the savanna biome (Figure 2). The soils of these pans are clayey, shallow (< 0.3 m to −0.8 m) and poorly drained (Bezuidenhout 1995). All the pans on Gras-Holpan were last filled with water in

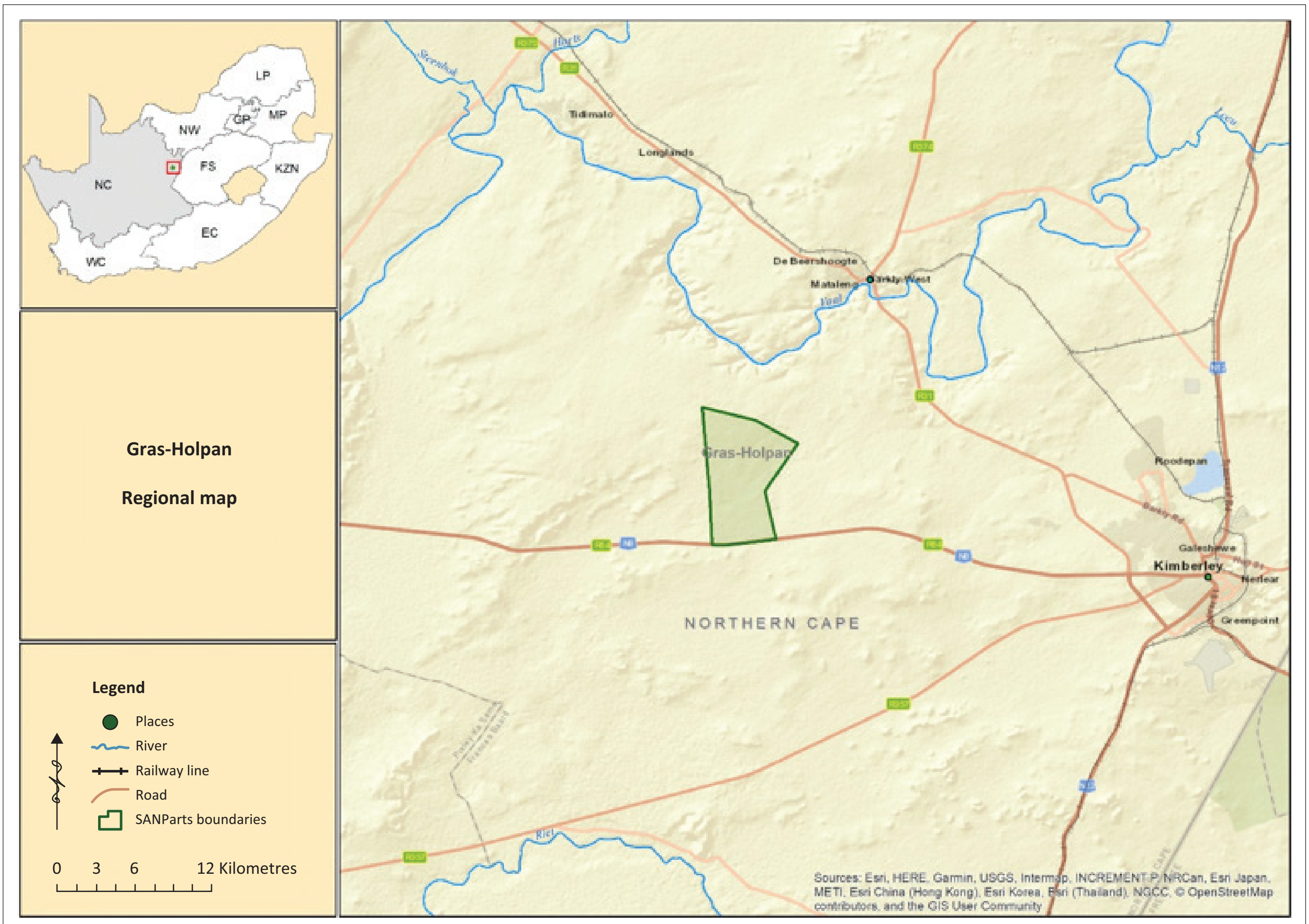

FIGURE 1: Location of Gras-Holpan, Northern Cape, South Africa.

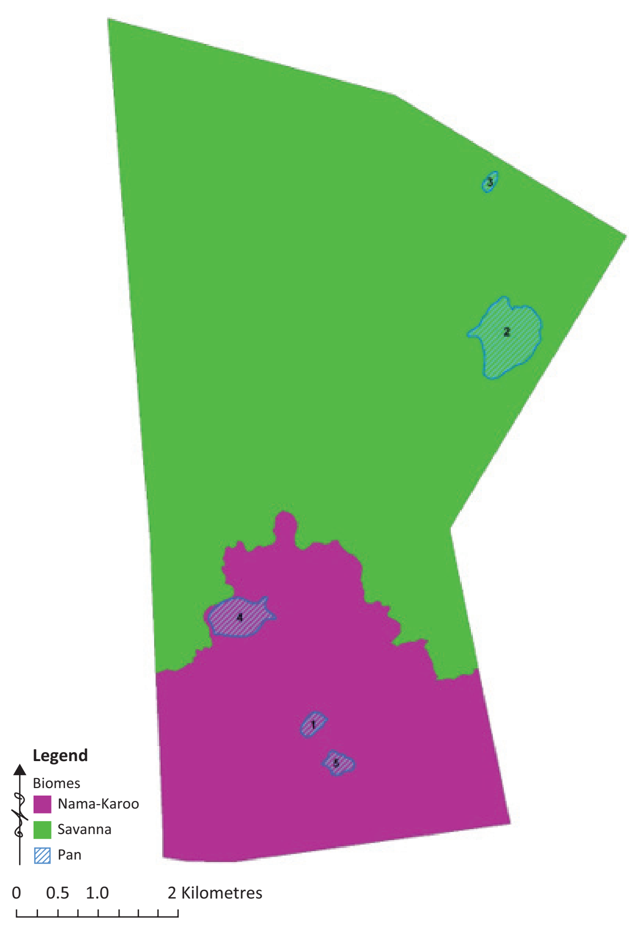

FIGURE 2: Localities of pans in Gras-Holpan, where the north falls in the savanna biome (Pans 2 and 3) and south in the Nama-Karoo biome (Pans 1, 4 and 5).

2013 and have since been dry, and the aquatic species associated with them became dormant. The pans were then filled up by the rains of late summer 2019, but some started to dry up while they were being sampled.

The landscape of the Gras-Holpan varies from flat to gently undulating plains, with altitudes of 1136 to 1160 m. Its topographical features mainly consist of midslopes, bottomlands, pans (Land Type Survey Staff 2012) and patches of rocky outcrops from different rock types (Bezuidenhout 1995). The Gras-Holpan is underlain mainly by three geological systems, viz. the Andesitic to basaltic lava rocky outcrops of the Ventersdorp Supergroup, the tillite of the Dwyka Formation and shale of the Prince Albert Formation, with the red to flesh-coloured aeolian sand and limestones sporadically occurring in the area (Land Type Survey Staff 2012).

The plant communities at Pans 1, 4 and 5 consist mainly of *Sporobolus ioclados*, *Panicum coloratum* and *Aristida adscensionis* variants of the *Chloris virgata – Eragrostis bicolor* tall closed grassland, while the plant community at Pan 2 consists of *Sporobolus coromandelianus – Sporobolus discosporus* low open grassland and at Pan 3 is mainly the *Diplachne fusca* variant of the *Chloris virgata – Eragrostis bicolor* tall closed grassland.

The Gras-Holpan mainly receives summer rainfall and ranges from 300 mm to 700 mm. Temperature ranges from −4°C (June and July) to 44°C (December and January). The pans on Gras-Holpan were filled with water in 2013 and have since been dry and associated aquatic species dormant. When the rains of late summer 2019 came, the pans were filled and eventually dried.

Methods

Field work was conducted once a month from April 2019 until December 2019 and was stopped once a pan had dried up. In each pan, the pH, salinity, conductivity, total dissolved solids (TDS) and the clarity of the water were measured. The depth of each pan and the macro-invertebrates that were present at the time were also measured.

A pocket combo-meter with multimeasurement was used to measure the pH, salinity, conductivity and TDS to determine the natural conditions of these variables in each pan over the sampling period.

Salinity can be simply defined as the amount of dissolved salts in a body of water (which is the pans in this case). A clarity tube was used to measure the clarity of the water in relation to the suspended elements (Kilroy & Biggs 2002), euphotic depth (Kirk 1985) and the predator–prey interactions in each pan (Benfield & Minello 1996; Gutierrez et al. 2021; Lloyd, Koenings & Laperriere 1987). A mean of three readings on the same sample was taken to ensure reliability (Ferreira et al. 2013).

Water depth was measured using a measuring rod to find how rapidly the water level was decreasing and thus the rate of evaporation. Measurements were taken at 10 m intervals on a transect that started from the edge of the water to the 100th metre or the deepest point a human can measure in cases where the pan section became too deep.

Macro-invertebrates were collected from each pan using the adapted sampling method (De Necker et al. 2016) where a 30 cm^2 frame sweep net with 1 mm meshes was used to 'kick-stir-sweep' at each transect. The macro-invertebrates were transferred to a white plastic tray with clear water and identified to the highest possible taxonomic level (mostly family level). All the taxa were counted to give an indication of diversity and richness (Griffiths, Day & Picker 2015). The whole identification process was given a maximum of 15 min, and the macro-invertebrates were then released back into the pan.

Analysis

Dissimilarity of the pans was measured using macro-invertebrates as the response variable and water quality (pH, salinity, clarity and TDS) as the explanatory variables. To measure the differences between the pans based on the macro-invertebrates, the Bray–Curtis dissimilarity was used. The macro-invertebrate taxon richness and diversity were calculated using the Shannon–Weiner diversity index. Two-way ANOVA wass used to measure the variation in water quality parameters between biomes, pans and over time until the water in the pans evaporated. To identify if there was a correlation between the water quality parameters, the data were analysed using Pearson's correlation and Spearman rank. To measure which water quality parameter was the driver of macro-invertebrates, principle component analysis was used. The depth of the pans was measured and recorded but not included in the analysis because pans are uneven and not symmetrical; thus, depth would only provide an indication of evaporation and likely not contribute to the variables being measured. The analysis was conducted in R (version 4.1.2; RStudio PBC, Boston, Massachusetts, United States of America).

Ethical considerations

H.S. is South African Scoring System (SASS) accredited. The macro invertebrates that were sampled were released back into the pans where they were collected. All procedures performed in studies involving animals followed all international, national, and/or institutional guidelines for the care and use of animals.

Results

A total of 20 families were found in the pans. Five families (viz. Branchipodidae species *Brachipodopsis wolfi*, Corixidae, Notonectidae, Chironomidae and Dytiscidae) were sampled in all pans but at different periods. *B. wolfi* and Corixidae were sampled in all the pans in April, Notonectidae in May. Chironomidae were sampled in all pans from July to December, while Dytiscidae were sampled in all pans from October to December. The other 15 families were sampled at different pans and months. They included *Triops granarius* that was only sampled in one of the Nama-Karoo pans and not in the savanna pans.

Figure 3 indicates the depth of the pans in April when all the pans were filled with water.

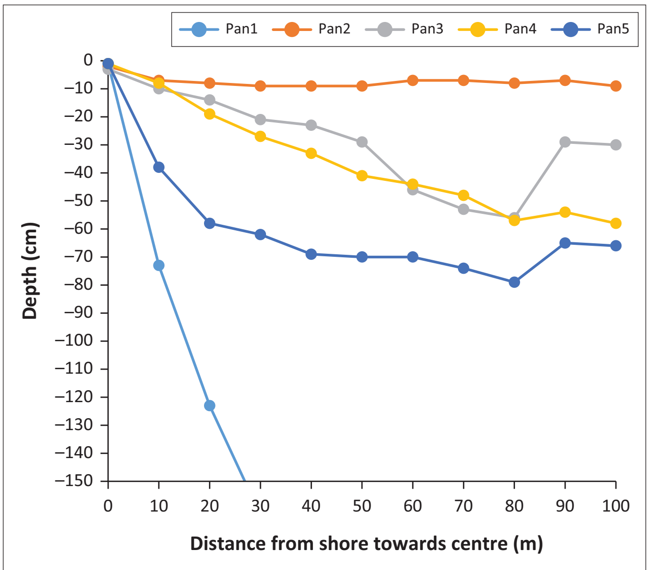

FIGURE 3: Depth in cm from the edge of the pan up to 100 m towards the centre of the pans in April 2019, where Pans 2 and 3 were in the savanna biome and Pans 1, 4 and 5 in the Nama-Karoo biome.

The two-way ANOVA indicated a significant difference in water quality between the pans (F = 12.561, p < 0.05), and there was a significant seasonal difference in water quality over time (F = 2.115, p < 0.05). However, there was no significant difference in the water quality between the savanna and Nama-Karoo (F = 7.708, p > 0.05).

pH (p = 0.023) was the most contributing factor to the macro-invertebrate species diversity and richness (Figure 4). Salinity (p = 0.831), conductivity (p = 0.699), TDS (p = 0.762) and clarity (p = 0.307) were not significant contributing factors to macro-invertebrate species diversity and richness.

For the duration of the study, Pans 1, 4 and 5 consistently had a pH outside of the tolerance range of most organisms (pH > 7). However, by August all other pans (Pans 2, 3 and 5) had either dried or had also reached a pH level outside of the tolerance range of most organisms (Pans 1 and 5 pH > 9; Pan 2 pH = 9; Pans 3 and 4 pH > 8) (Figure 4).

Pans 2 and 3, which were located in the savanna biome, were the first to dry. The water from Pan 2 was the most saline until the pan dried out, while the least saline was Pan 3. Salinity (Figure 5), conductivity (Figure 6) and TDS (Figure 7) increased with time as water evaporated. Of the remaining pans that did not dry up, August and November had the lowest diversity of organisms.

The TDS increased with time in all the pans (Figure 8). The TDS levels were not significantly high (p = 0.762) and did not have known effects on the macro-invertebrates.

Bray–Curtis dissimilarity indicated that the water quality differed between the pans (R = 0.132, p < 0.05). Macro-invertebrate community composition varied (p = 0.042) between the pans, and there were distinct representative families (Figure 8). Of these, Pan 1 (Nama-Karoo, relatively deep [> 3 m] pan and rocky calcrete) was the most dissimilar to all the other pans. Pans 2, 3 and 5 (Pans 2 and 3, savanna,

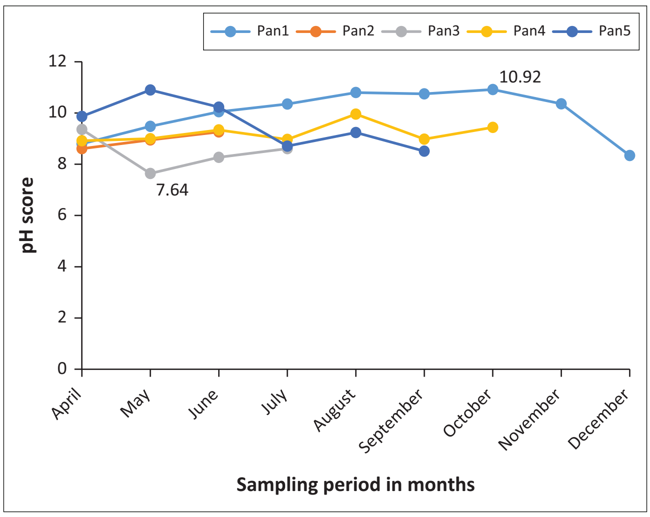

FIGURE 4: Range of pH readings at five pans in Gras-Holpan between April and December 2019, where Pans 2 and 3 were in the savanna biome and Pans 1, 4 and 5 in the Nama-Karoo biome. The dashed lines are the known range of tolerance for macro-invertebrates.

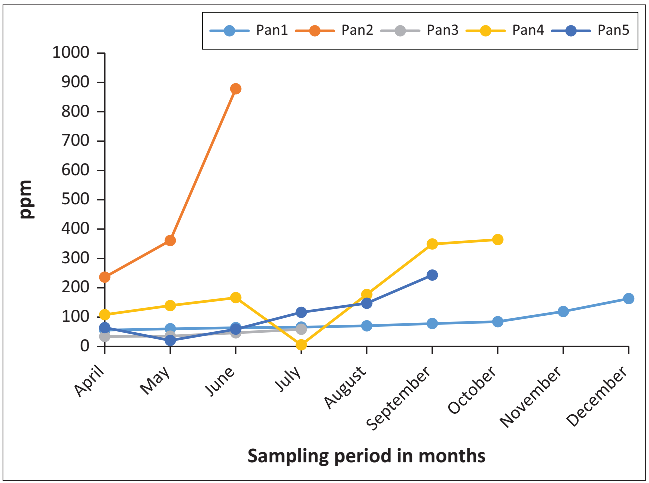

FIGURE 5: Salinity readings parts per million (ppm) at five pans in Gras-Holpan between April and December 2019, where Pans 2 and 3 were in the savanna biome and Pans 1, 4 and 5 in the Nama-Karoo biome.

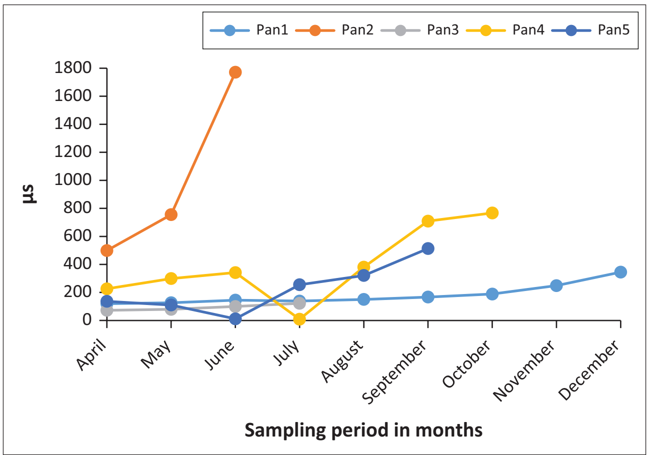

FIGURE 6: The conductivity readings in µS of five pans in Gras-Holpan between April and December 2019, where Pans 2 and 3 were in the savanna biome and Pans 1, 4 and 5 in the Nama-Karoo biome.

shallow [< 0.3 m] pans and Pan 5, Nama-Karoo, shallow pan and clayey soil texture) were the most similar in species composition, and Pan 4 (Nama-Karoo, moderately deep [0.3 m – 0.8 m], clayey pan) was intermediately dissimilar. By mid to late winter (July to August), the Branchipodidae (shrimp) had all but disappeared and replaced by Podonidae (water fleas) which persisted until the pans dried. Although Branchipodidae were found in all pans, the species differed. Families that were seen throughout the study period in all five pans included Notonectidae, Chironomidae, Libellulidae and Corixidae. Appendix 1 refers to the biodiversity recorded in association with the pans for the duration of the study.

Species of interest found around the pans included the giant bullfrog, *Pyxicephalus adspersus*, which is the largest southern African frog (Carruthers 2001).

The aquatic bird life associated with the pans encompassed 23 species, which included African spoonbills (*Platalea alba*), lesser flamingos (*Phoeniconaias minor*) and an abundance of red-billed teals (*Anas erythrorhyncha*) and little grebes (*Tachybaptus ruficollis*). Aquatic birds were only found on the Nama-Karoo pans (Pans 1, 4 and 5) and were surveyed

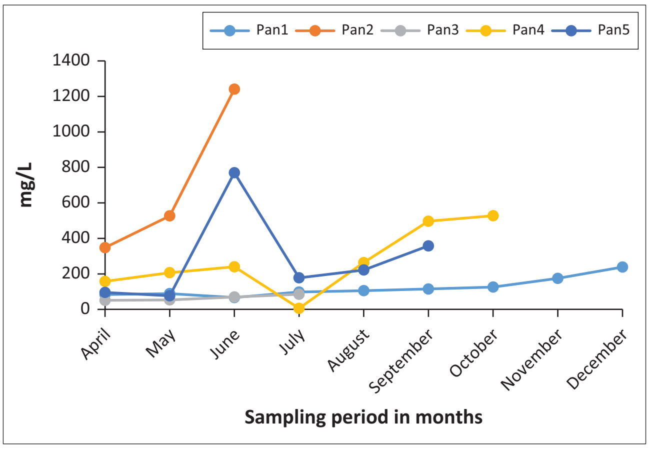

FIGURE 7: Total dissolved solids measurements in mg/L at five pans in Gras-Holpan between April and December 2019, where Pans 2 and 3 were in the savanna biome and Pans 1, 4 and 5 in the Nama-Karoo biome.

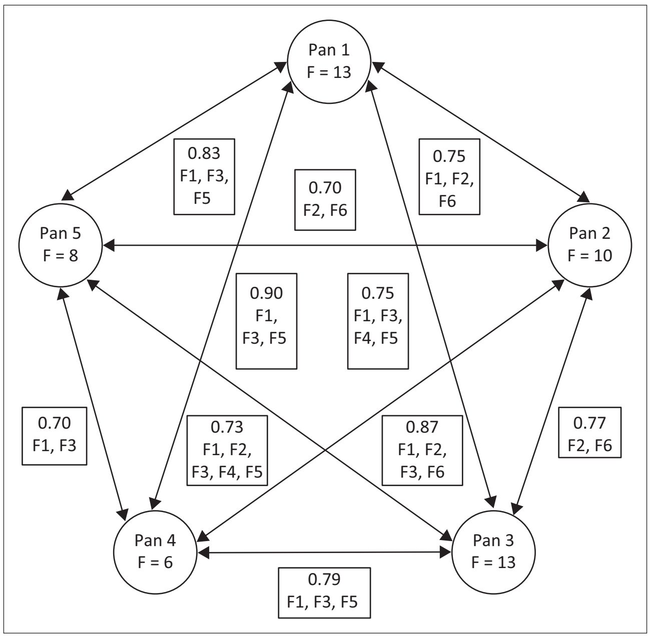

FIGURE 8: Pair distances between the pans indicating dissimilarity based on macro-invertebrate family richness (F), where F1 = Notonoctidae, F2 = Chironomidae, F3 = Podonidae (water flea), F4 = Gerridae, F5 = Branchinectidae (*Brachipodopsis wolfi*) and F6 = Branchinectidae (*Leptestheria rubidgei*).

in July and August. Although monitored, aquatic birds were not observed on Pans 2 and 3 in the savanna.

Discussion

This study aimed to (a) monitor changes in the water quality over time in the pans and to (b) identify succession of macro-invertebrates and (c) identify the water quality parameters of pans as drivers of macro-invertebrate assemblages.

There was a difference in water quality and the associated biodiversity between the savanna and Nama-Karoo biomes. The water evaporated quickly in the savanna biome pans (Pans 2 and 3), which is likely because of the adjacent soil texture and water depth (Brady & Weil 2002). The soil of these pans in terms of depth and texture was not analysed for this study; however, this has been identified as potential driver of water retention. This in turn would have affected the water quality; however, more research is needed to compare the properties of the soil in the different biomes (McCauley, Jones & Jacobsen 2005). Consequently, TDS and salinity concentrations in the environment can change over time, particularly for a closed environment such as a pan without a drainage point. Naturally, all water bodies have dissolved salts that have leached from the surrounding rock and soil (Priyadarshi 2005), and such salts are essential to the organisms in those ecosystems (Kefford et al. 2007). The dissolved salts in water at certain concentrations, or varying at 15% from the natural concentrations, have been reported to be toxic to the aquatic ecosystems, however (Palmer et al. 2004; Weber-Scannell & Duffy 2007). Salinity and pH can influence the tolerance of other properties, compromising the habitat and macro-invertebrates (Dunlop et al. 2007; Horrigan et al. 2005). In this study, it was found that water salinity increased over time. Given the relationship between salinity and conductivity, similarly, the conductivity followed an increasing trend over time. Similar findings were recorded in north-east Australia, where varying salinity concentrations changed over time (Horrigan et al. 2005). The increase in salinity over time is likely because of the hydrologic cycle of the study area and the closed drainage system of the pans (Dunlop et al. 2007; Horrigan et al. 2005). The evaporation decreased the water (solvent) levels in the pans, while the solids constituting the salinity did not change that much, resulting in the increase of salinity concentrations. The closed drainage system of these pans is likely preventing the pans from receiving water from other bodies that would otherwise influence the salinity concentrations in the pans (Roderick & Farquhar 2004).

The pH scales of freshwater ecosystems range from six to eight and are mostly influenced by their surrounding soils and bedrocks (Lenntech 2013). The majority of aquatic organisms prefer waters with pH values ranging between 6.5 and 9.0 (Carr & Neary 2008; Fondriest.com n.d.), with water beyond these ranges often being toxic to the aquatic ecosystems (Ausseil 2013). The range suitable for macro-invertebrates is between 7 and 9 (Fondriest.com n.d.). The nature of both the hydrologic cycle and the drainage system of the pans likely affected the pH, TDS concentrations and the clarity of water of the pans. The pH and TDS concentrations increased in all pans with time (with pH eventually being outside the range of tolerance for all macro-invertebrates), while the clarity of water decreased as density of the suspended sediments in amount of water increased. The TDS levels up to 187 mg/L were similar to the levels sampled from unpolluted river systems (Chatanga et al. 2019) that are associated with sensitive macro-invertebrates of riverine systems (Sithole et al. 2019). Considering that the pans are in a natural lectic system, the TDS levels higher than 187 mg/L could be considered natural conditions of the pans that support organisms that are adapted to these higher levels.

Succession and changes in the community composition of the macro-invertebrates over time suggested that the shrimp found in the Nama-Karoo pans were among the first to reach sexual maturity and reproduce and were the most abundant family upon first sampling. The macro-invertebrate species composition changed from being dominated by shrimp to water fleas in the Nama-Karoo pans. Similar patterns of macroinvertebrate succession were documented in shallow lakes in the arid regions of Spain (Cañedo-Argüelles & Rieradevall 2011) and the Sonoran Desert, United States of America (Grimm, Boulton & Sabo 2010). Both studies found that the communities of macro-invertebrates changed over time, as well as density and species richness. This exemplifies the rapid life cycle and the survival strategy adopted by the macro-invertebrates (Sponseller et al. 2010). Adaptive life strategies of macro-invertebrates associated with ephemeral pans include the length and number of life cycle stages, development, emergence and dispersal (De Necker et al. 2016; Siepel 1994), allowing them to survive in harsh conditions such as pans (Sponseller et al. 2010). Studies have found that the reproductive traits and life cycle of freshwater macro-invertebrates are adopted to allow for survival in harsh ecological conditions (Verberk, Siepel & Esselink 2008). The occurrence of the European net algae is likely due the movement of aquatic birds. The movement of migrating aquatic birds has been documented to be the agent for dispersal of plants, seeds and algae (Atkinson 1972; Kristiansen 1996; Schlichting 1960). The timing of migratory European birds has been documented to lead to the dispersal of plants, seeds and algae (Atkinson 1972). The transient movement and migrations between other pans and localities is the most plausible explanation for the net algae distribution and occurrence. Monitoring of water quality, macro-invertebrates and other associated biodiversity assisted with assessing the functioning of an ecosystem. While many areas of South Africa, including the Northern Cape, experienced the effects of drought, the pans are continuing to be filled, thus necessitating continued monitoring. Pan systems are challenging to monitor, because of the location, unpredictable timing of being filled with water and their transient nature. These pans provided insight into the distribution of species associated with pan ecosystems such as macro-invertebrates, the giant bullfrogs and aquatic birds. Giant bullfrogs are known to breed in the shallows of temporary pans and depressions in grasslands and savannas. Juvenile giant bullfrogs were found at the banks of the pans in the Nama-Karoo and none in the savanna pans. During the study, only juvenile giant bullfrogs were observed. Further monitoring of the *T. granarius* would assist with better understanding the species and the systems in which it occurs.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

All authors contributed towards the investigation. N.T.M. contributed the formal analysis, writing, editing and reviewing

the draft document as well as visualisation. H.S. contributed to conceptualisation, methodology, visualisation, resources and manuscript drafting, editing and review. As an entomologist, H.S. was pivotal for identification of the macro-invertebrates. H.B. contributed through conceptualisation, methodology, resources, visualisation and manuscript drafting, editing and review. R.E. and R.M. contributed to data curatorship.

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Data availability

Figures 4 to 9 have associated raw data. The data that support the findings of this study can by made available by the corresponding author upon reasonable request.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliation agency of the authors.

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APPENDIX 1: Biodiversity monitored and recorded in all pans.

Date of sample	Sampling site	Macro-invertebrate family																					Total Taxon counted
		Branchinectidae Cape clam shrimp	Corixidae	Hydrophilidae	Libellulidae	Tabanidae	Branchinectidae Wolts fairy shrimp	Chironomidae	Notonectidae	Dytiscidae	Hydracarina	Neptidae	Ceratopogonidae	Culicidae	Leptestheriidae	Triopsidae	Bivalve	Lestidae	Gerridae	Aeshnidae	Gyrinidae	Pleidae	Monthly taxon richness
April	Pan1	P	P	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29
	Pan2	-	P	-	P	-	P	P	-	-	-	-	-	P	P	P	-	-	-	-	-	-	
	Pan3	P	P	-	-	-	P	-	p	P	-	-	-	-	-	-	-	P	-	-	-	-	
	Pan4	-	P	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	P	P	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	P	
May	Pan1	-	-	P	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	18
	Pan2	P	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan3	P	-	P	P	-	-	-	P	-	-	-	-	P	-	-	-	-	P	-	-	-	
	Pan4	-	-	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-	
June	Pan1	P	-	-	-	-	-	P	P	-	-	-	-	-	-	-	P	-	-	-	-	-	14
	Pan2	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	-	-	
	Pan3	-	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	P	P	-	-	
	Pan4	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
July	Pan1	-	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	16
	Pan3	-	-	P	P	-	-	P	P	P	-	-	P	-	-	-	-	-	-	-	P	-	
	Pan4	-	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	-	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
August	Pan1	-	-	P	-	-	-	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	9
	Pan4	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
September	Pan1	-	-	-	-	-	-	P	P	P	P	P	-	-	-	-	-	-	-	-	-	-	10
	Pan4	-	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Pan5	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	
October	Pan1	-	-	P	-	-	-	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	8
	Pan4	-	-	-	-	-	-	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-	
November	Pan1	-	-	-	-	-	-	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	4
December	Pan1	-	-	-	P	-	-	P	P	P	-	-	P	P	-	-	-	-	-	-	-	-	6