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COMMUNICATION

Water loss at twenty natural waterholes in Guanacaste National Park, Costa Rica: implications for wildlife

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The importance of waterholes for wildlife and plant species has been studied in semiarid and dry forest environments. For instance, Ayeni (1975), Child et al (1971), Knight et al (1988), and Weir (1971) coincide that in Africa, seasonality of rainfall and water availability influences seasonal movements (wet season dispersal and dry season concentration) of water-dependent species. In addition, Ayeni (1975) found big-game attained a degree of time-spaced ecological separation at waterholes. Western (1975) suggested that permanent water distribution creates a "physiological barrier" for a wildlife species´ numbers and distribution. Mandujano and Gallina (1995) found water availability for white-tailed deer influenced by intensity and monthly distribution of rainfall. However there is virtually no published literature on dry season water sources in neotropical environments.

Because of its 1.5 m average annual precipitation, freshwater seems abundant for wildlife species in Guanacaste Conservation Area (ACG) throughout most of the year. However, during the dry season, temporal waterholes form: a) when rivers and streams dry up and leave intermittent waterholes, b) from underwater springs reaching the surface, c) when rainfall is deposited in rocks or crevices and/or d) due to a combination of the above. Most waterholes in ACG dry during the early part of the dry season.

To manage ACG waterholes, it is important to understand their physical and temporal nature. The objective of this study was to measure water loss in 20 waterholes in ACG by measuring changes in water depth and waterhole permanency on a monthly basis.

Research was conducted in ACG, an area of 70,000 ha, located 30 km south of the Nicaraguan border and 30 km north of Liberia, the Guanacaste provincial capital (Fig. 1).

The primary vegetation type in ACG is Pacific Mesoamerican tropical dry forest, the most endangered tropical ecosystem (Janzen 1988) because of its conversion to pastureland. Pacific Mesoamerican dry forests receive almost 100% of annual rainfall (900 to 2,400 mm) between May and November (Janzen 1988), and virtually no precipitation from December and April. ACG has an average 1,473 mm of precipitation and between May and November 1994, received 1,120 mm of rainfall (Janzen pers.com.). During the dry season, many wildlife species in ACG live near water sources or travel daily to drink water. Most waterholes surveyed in this study were found in the Playa Naranjo Valley, and along the Calera, Nisperal, Poza Salada and Carbonal rivers (Fig. 1). This area has fertile alluvial soil due to runoff from the upper plateau; therefore a much taller forest canopy exists (30+ m) with more evergreen patches then above (Hartshorn, 1983). Other waterholes were found in the Nancite, Tule, Duende, Guapote and Cuajiniquil river basins (Fig. 1).

Data were collected between December 1994 and April 1995. Twelve days in December and five days in January were spent locating waterholes by asking park rangers and researchers in ACG their location and then hiking up river beds to find them. Twenty water-

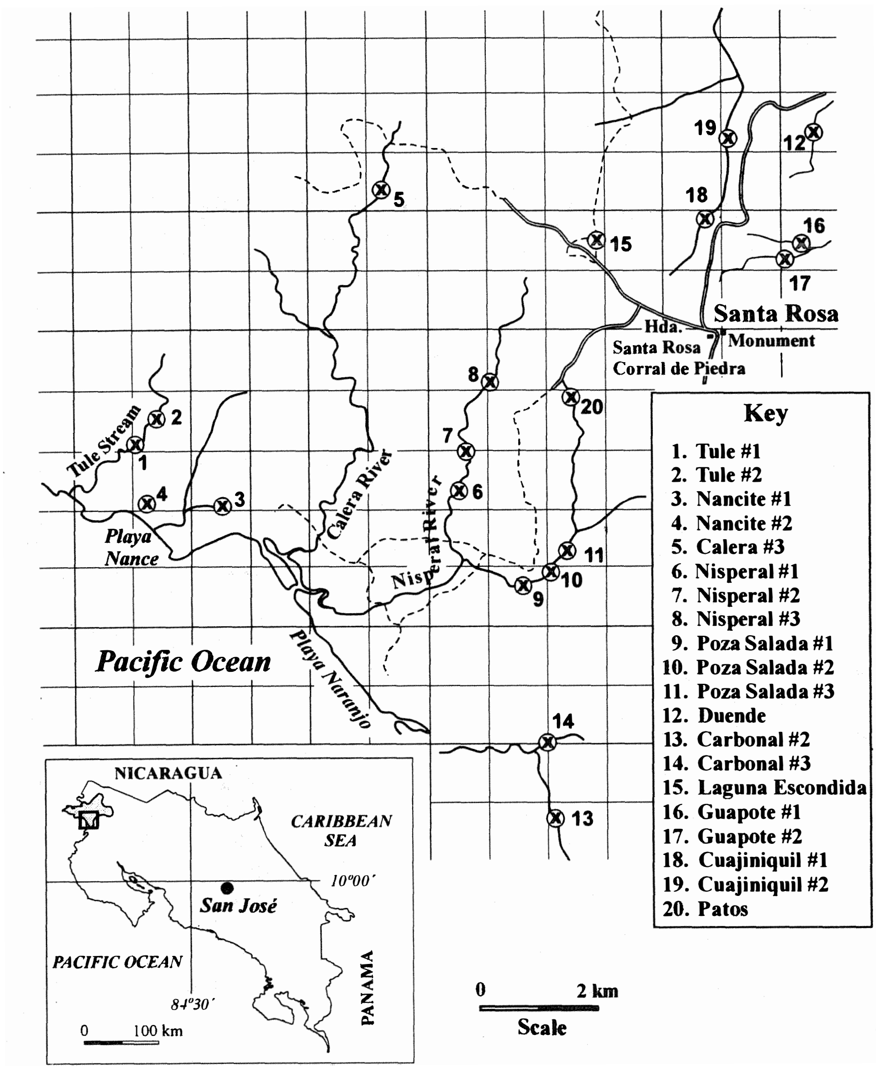

Fig. 1. Waterhole location in Guanacaste Conservation Area, Costa Rica.

holes were selected for study, because they were thought to be permanent

water sources. The deepest part of each waterhole was measured monthly with a tape measurer. A two-way analysis of variance compared water depth at each waterhole and water depth between waterholes in standing water and those with water entering from known sources on a monthly basis. Our results were as follows:

Waterhole number change over time- During December and January, literally hundreds of waterholes were observed along the river courses in the study area. Of the 20 waterholes selected at random, only 9 remained by April 19th when the first rains occurred (Table 1). The greatest monthly decrease in waterhole number (from 20 to 12) occurred between January and February. Waterholes remaining at the end of the dry season in 1995

TABLE 1

Waterholes in Guanacaste Conservation Area, Costa Rica. January-April 1995.

Waterhole	Water entering	Veget.	Water Depth (cm)			
			Jan.	Feb.	March	April
Tule 1		Deciduous	28	0	0	0
Tule 2		Semi Decid.	214	207	190	180
Nancite 1	X	Semi Decid.	112	108	118	104
Nancite 2	X	Evergreen	8	4	3	2
Calera 3	X	Decid.	280	280	260	246
Nisperal 1		Evergreen	4	0	0	0
Nisperal 2	X	Decid.	116	97	63	48
Nisperal 3	X	Semi Decid.	182	178	163	170
Poza Salada 1	X	Evergreen	18	0	0	0
Poza Salada 2	X	Evergreen	140	138	140	140
Poza Salada 3	X	Evergreen	2	2	2	2
Duende		Decid.	38	0	0	0
Carbonal 2		Evergreen	72	25	0	0
Carbonal 3	X	Evergreen	2	2	2	2
Laguna Escondida		Semi Decid.	100	60	0	0
Guapote 1		Decid.	21	0	0	0
Guapote 2		Decid.	25	0	0	0
Cuajiniquil 1		Decid.	19	0	0	0
Cuajiniquil 2		Decid.	24	0	0	0
Patos		Semi Decid.	150	75	48	0
Total depth (cm)			1 555	1 176	989	894

are not necessarily permanent. A severe drought during the 1995 rainy season and/or a longer dry season would probably have dried up waterholes Nancite 2, Carbonal 3 and Pozo Salado 3, which had only 2 cm of water in middle April. On the contrary, such waterholes as Tule 2, Nancite 1, Calera 3, Nisperal 3 and Poza Salada 2 averaged 168 cm in April and would have persisted. All waterholes, except Tule 2 had water sources entering them in January.

Longevity and location of a waterhole could affect local concentrations of wildlife, and resulting interactions with other species (predation, browsing, seed dispersal, etc). For instance, in Tsavo National Park, Kenya, Ayeni (1975) noted that animal species dependent on a regular supply of drinking water, concentrated near waterholes during the dry season. They exhibited a time spaced ecological separation, with smaller species using waterholes during the daytime and larger species at night.

Water depth-Combined water depth for all 20 waterholes decreased during the study from 1,555 cm to 894 cm. Waterholes varied greatly in water depth, changes in depth and total water volume. Comparing each waterhole individually over time, there was a significant change in water levels between January and April ($F = 3.690$; $df = 3, 54$; $P = 0.022$). Waterholes studied were of two types: a) standing water with no known water source ($n = 11$), and b) running waterholes with water entering from a stream, river or spring ($n = 9$) (Table 1). There was an obvious difference in water depth during the study period between standing ($x = 33.64$ cm) and running water ($x = 87.066$ cm). However water loss throughout the dry season was not significantly different between standing and running water ($F = 2.424$, $df = 1, 18$; $P = 0.137$), although eight waterholes with running water persisted until the end of the dry season.

Waterhole numbers and water availability change seasonally in the neotropical forest environment in northwest Costa Rica.. The next stage will be to establish changing resource´s impact on wildlife species and resulting changes on the environments, as Ayeni (1975), Child et al (1971), Knight et al (1988), and Weir (1971) found in Africa.

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REFERENCES

Ayeni, J. S. 1975. Utilization of waterholes in Tsavo National Park (East). E. Afr. Wildl. J. 13: 305-323.

Childs, G., R. Parris & E. Le Riche. 1971. Use of mineralized water by Kalahari wildlife and its effects on habitats. E. Afr. Wildl. J. 9: 125-142.

Janzen, D.H. 1988. Tropical dry forests: the most endangered tropical ecosystem, p. 130- 137. In E. O. Wilson (ed.). Biodiversity. National Academy of Sciences. Washington, D.C.

Knight, M. H., A.K. Knight-Eloff & J.J. Bornman. 1988. The importance of borehole water and lick sites to Kalahari ungulates. J. Arid Environ. 15: 269-281

Mandujano, S. & S. Gallina. 1995. Disponibilidad de agua para el venado cola blanca en el bosque tropical caducifolio de México. Vida Silv. Neo. 4:107-118.

Weir, J. S. 1971. The effect of creating additional water supplies in a Central African National Park, p. 371-385. In E. Duffy and A.S. Watt (eds.). The Scientific Management of Animal and Plant Communities for Conservation. Blackwell Scientific, Oxford.

Western, D. 1975. Water availability and its influence on the structure and dynamics of a savannah large mammal community. E. Afr. Wildl. J. 13: 265-286

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