End of season report for project 59.05.08

Using *Caiman crocodylus yacare* as a sentinel species to monitor the environmental degradation of the Pantanal wetlands

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Summary

The primary aim of this second project phase was to trial methodology– established in phase 1− upon caiman inhabiting environmentally degraded areas within the Pantanal wetlands. This goal was achieved, and over 110 caiman of various sizes were sampled from a known polluted river system in the Pantanal. The caiman inhabiting these areas were found to contain higher levels of trace metals compared to caiman from unpolluted habitat. The increased toxicant load was observed in caiman captured up to 70 km from the contaminate point source. Caiman captured from these polluted sites had a low body mass index, and higher levels of corticosterone, illustrating that they were in a poor physiological state. The study concluded that caiman are an ideal sentinel species to monitor environmental degradation within the Pantanal, because they persist throughout the degradation gradient and show physiological effects which correlate with pollutant load.

Results and discussion

This study examined *Caiman yacare* populations along a polluted river (Rio Miranda) to quantify the extent to which toxins were being transported from urban development into the wetlands food web. Three separate field trips were undertaken and ~40 *C. yacare* were sampled during each trip. It was the original aim to sample greater number of animals, but we found that caiman populations were substantially reduced in environmentally degraded areas.

C. yacare were captured at night, weighed, length and sex determined. A permanent coded ID T-bar tag was inserted into the right side of the neck, and positional coordinates of the capture site determined by GPS. A 3ml blood sample will be extracted from the cranial sinus, prepared and stored. A fat biopsy was also extracted, and this was prepared and stored, samples were later analysed by atomic absorption spectrophotometry at the Environmental Biochemical Laboratory at The Federal University of Sao Carlos, Sao Paulo. As requested by RSG, we did not gut-flush the caiman to inform us of the dietary habits of the caiman. As an alternative we relied upon data collected from a Masters thesis stored at the University of Sao Paulo state, SP, Brazil.

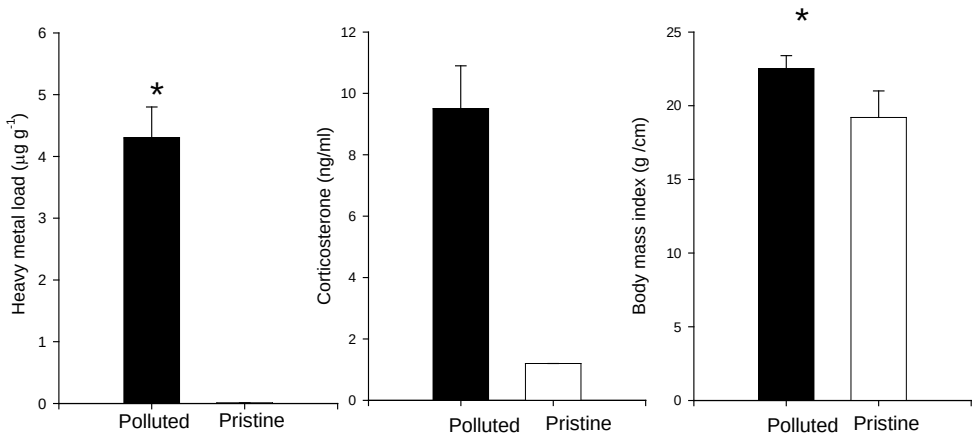

Figure 1. The level of heavy metals, corticosterone, and body mass index from caiman captured downstream from a large urban development (+ 30 000 inhabitants) compared with caiman captured from a river with no upstream urban development. In total 108 caiman were sampled from the polluted river and 146 were sampled from the unpolluted river. * indicates that there was a significant difference between the means of the two groups, as tested by one-way ANOVA.

As hypothesised the study results found that caiman inhabiting rivers downstream from urban areas had higher levels of the heavy metals, copper, zinc, mercury, and cadmium stored within their fat, compared with caiman inhabiting unpolluted environments (Fig. 1). The high toxic load was probably acquired from ingested prey or carrion (Alho & Vieira, 1997). Although the heavy metals had been sequestered by the caiman in stored fats, during periods of drought this fat with the heavy metal load would become mobilised. This may explain the large number of dead caiman found along polluted river systems towards the end of the dry season.

Caiman from polluted river systems also had higher levels of corticosterone in the blood compared with caiman captured from non-polluted areas, suggesting that these animals were in a state of increased physiological stress. This may be directly related to the heavy metal load, but could also be due to other biological stressors such as pesticides, detergents and organic compounds. These were not measured during this study, but present an interesting avenue for future research.

Caiman from polluted river systems also had a lower body mass index compared to caiman from non-polluted sites, supporting a theory of reduced physiological health. This may also be related to a poorer quality of food supply, as it would be expected that fish biomass would be significantly reduced in polluted areas of river.

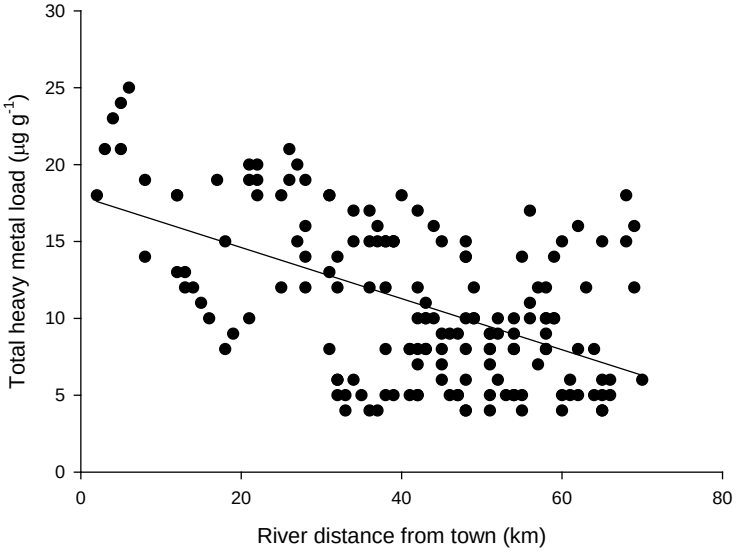

Figure 2. The total heavy metal load (cadmium, copper, zinc and mercury) recorded within the fat tissue of caiman, plotted against capture location – expressed as km downstream from an urban development of 30 000 people.

This graph (Fig. 2) shows that a negative correlation existed between caiman heavy metal and the distance they were captured downriver from the town. Those animals captured within 10 km downstream had a 5-fold greater heavy metal load compared with caiman captured 60 km to 70 km downstream. Caiman 70 km downriver from the town did however, still show levels of heavy metals within their fat, which was higher than animals from unpolluted rivers. This result is important as shows that the run-off from urban development has the potential to cause detrimental effects on wildlife up to 80 km from the point source.

How is this project benefiting the conservation status of the Pantanal wetlands?

The study is promoting conservation status within the Pantanal wetlands at four independent levels. These are:

1/ The development of low cost field methodology to assess the health and physiological condition of wild animal populations. These cheap and simple techniques can be applied quickly and repeatedly upon numerous animals inhabiting remote areas, and are vital for helping third world countries to assess their ongoing environmental degradation.

2/ The study results have identified physiological correlates that can now be used to examine caiman along river systems, identifying the extent by which environmental degradation is spreading from the point source.

3/ The results from this study have been submitted to the relative environmental and water authorities within Brazil (EMBRAPA). It is hoped that this information will stimulate authorities to act and create water treatment facilities for the urban development used in this

study. The local and national interest that this study has generated is highlighting the need for water treatment facilities in urban development throughout the Pantanal.

4/ The environmental degradation problem within the Pantanal wetlands has been revealed to the scientific and conservation biology community through talks at international conferences (Society for Experimental Biology, Conservation Physiology, Glasgow, U.K. 2009) and peer reviewed publications related to this project.

Future Directions

I propose three main areas of project development. These are:

1/ Identification of anthropogenic organic compounds which may be impacting on caiman health. A 2003 biochemical analysis of sediment samples along rivers within the Pantanal recorded the following anthropogenic pesticides and herbicides; alachlor, sulphate endosulfan ß-endosulfan, trifluralin, metolachlor, metoxichlor, metribuzine, simazine,chlorpyrifos, p,p'DDE, p,p'DDT, ametryn, terbutilazine (Cunha, 2003). The use of these compounds is banned within Brazil, but the lack of stringent regulation has allowed their continued use. By identifying the extent by which these compounds have bio-accumulated within the Pantanal food web – including human food sources- it is anticipated that greater control will be observed at the national level.

2/ Development of cheaper, more rapid, and simpler methodology and techniques for identifying the physiological status of individual animals and the overall health of discrete animal populations. These will enable non-scientists, including NGO volunteers to evaluate the health of local animal populations on very limited budgets.

3/ Engaging people at the local and national level to understand the problems of anthropogenic water contamination and the necessity of grey water treatment.

Publications arising from this study

Campbell, H.A. (2009) A cheap and simple method for assessing the physical condition of a reptile population at remote field locations. Comparative Biochemistry and Physiology, A **153**, 60.

Franklin, C.E., Read, M.A., Kraft, P.G., Liebsch, N., Irwin, S.R. & Campbell, H.A. (2009) Remote monitoring of crocodilians: implantation, attachment and release methods for transmitters and data-loggers. *Marine and Freshwater Research* **60**, 284-292.

Campbell, H.A., Micheli, M.A. & Abe, A. (2008) A seasonally dependent change in the distribution and physiological condition of *Caiman crocodilus yacare* in the Paraguay River Basin. *Wildlife Research* **35**, 150-157

Other References

Alho, C.J. R.Cleber & VieiRa, L.M. (1997) Fish and wildlife resources in the Pantanal wetlands of Brazil and potential disturbances from the release of environmental Contaminants. Environmental, Toxicology and Chemistry, Vol 16, 71-74.

Cunha, M.L.F. (2003) Determinação de resíduos de pesticidas em sedimentos dos principais rios do pantanal mato-grossense por cg/em. Univeridade Federal de Mato Grosso, Masters Thesis.

Detailed breakdown of how the RSG was spent.

Travel

3 x Return flights for applicant from Sao Paulo to Rio Grande**,…..£ 686**

Return bus to get to location of field site**…….£150**

Subsistence

6 persons for 60 days ….**£ 2400**

Hire of local guides

Hire of 4 local Pantaneros for 60 days ….**£ 1460**

Equipment

300 T-bar ID tags printed with name and phone number (FLOY U.S.A.) **…..£ 210**

Small transportable field centrifuge **……£ 380**

Hire of liquid nitrogen dewier with liquid Nitrogen for cold storage**…….. £110**

Hired analysis

Heavy metal analysis ……..£**590**