The Eye of the Crocodile

William (Bill) E. Magnusson



Open Science

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This book contains names and photographs of deceased aboriginal persons.

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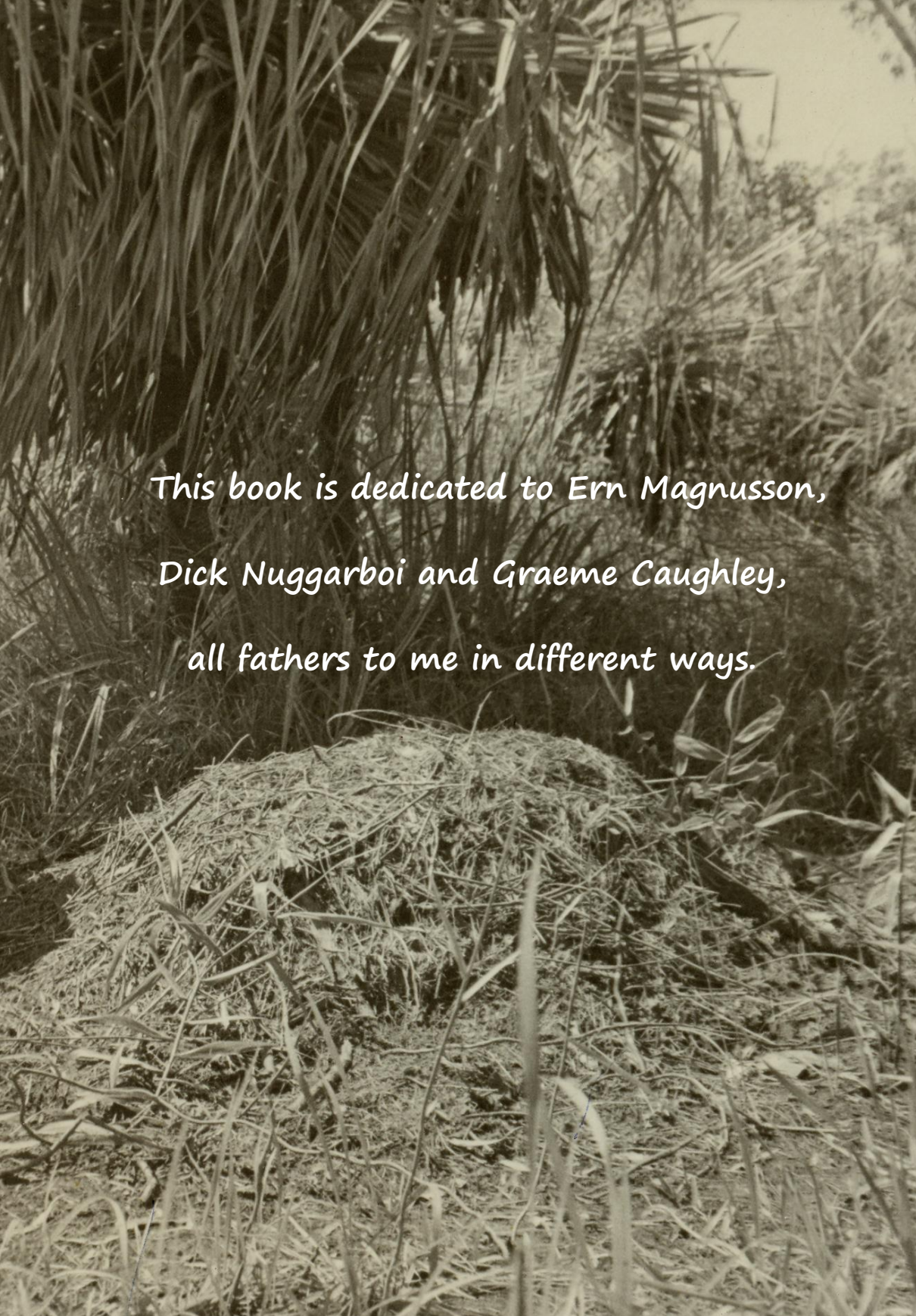
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This book is dedicated to Ern Magnusson,

Dick Nuggarboi and Graeme Caughley,

all fathers to me in different ways.

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Preface

I have been first author or co-author on many scientific papers on crocodiles and caimans[1-86], but those papers will not give insights into the real reason that I was involved in the studies. As Sir Peter Medawar stated honestly in a BBC Broadcast in 1964[87], the scientific paper is a fraud. It presents a logical argument for why you should have done the research, not the real reason, or even the true sequence of events that led to the results.

Tony Pooley wrote a wonderful book about his journey to becoming one of the foremost experts on crocodilian behavior[88], and Tony encouraged me to write an honest account of what makes a crocodile biologist tick. That was a long a time ago, and Tony has passed on to that great river in the sky where presumably all great crocodilian biologists go. However, his words continue to excite the imaginations of young naturalists, and his book is an example of honest story telling that no scientific paper can match. Charles Darwin's ideas on evolution were forged during an around-the-world adventure[89]. Eric Pianka's fame as a community ecologist is rooted in love of deserts and desert lizards[90]. Without adventure, there is no science.

Many people helped me on my journey, and I hope I can do justice to most, but memory is fallible[91], and I will certainly have omitted influential persons and forgotten important facts. Occasionally I will have gotten the chronology wrong. Nevertheless, I hope I have portrayed accurately the emotions that motivated me to study crocodiles and their relatives. Science is about emotions and human interactions, and that is what this book is about.

Acknowledgements

I cannot adequately acknowledge a lifetime of contributors to my studies, but those listed below read and contributed to part or all of the manuscript. All checked my facts, most corrected my spelling, and some even rewrote whole sections. Most of them were also involved in the research. This book is as much theirs as mine, even though the remaining errors are all mine. Thank you ever so much Lyn Branch, Zilca Campos, Renato Cintra, Ronis Da Silveira, Ruth Elsey, Arthur Georges, Gordon Grigg, Jim Kushlan, Alejandro Larriera, Marco Lazcano, Albertina Lima, Dorothy Magnusson, Frank Mazzotti, Maria Tereza Queiroz Melo, Harry Messel, George Monbiot, Chris Moran, Dennis Puffet, Tania Sanaiotti, Laurence Taplin, Janet Taylor, Kent Vliet, Richard Vogt, Tomas Waller, Grahame Webb, Graeme Wells, and Woody Woodward.

Many people have given me photographs over the years, and the authors of those used in the book are acknowledged in the photo legends. The beautiful photos of caiman studies in Mamirauá are from the arquives of Luiz Cláudio Marigo, who contributed so much to photography of Brazilian wildlife before his untimely death in 2014. The photos were chosen because they reflect people or events rather than the quality of the photo. In many cases the photo quality reflects much more the conditions of storage in a hot humid environment in the middle of the Amazon than the ability of the original photographer. Sometimes the photographer is unknown because I or one of the people who donated photos asked a bystander to take a picture with one of our cameras. All of them contributed enormously by capturing details I could never describe in words, and I am most grateful.

Foreword

Professors and students live in different worlds, especially at the postgraduate level. The student, by this time, has usually absorbed enough knowledge to believe he knows more than the professor. If only this was so! Complete success in the knowledge game? Game over. But, occasionally it does happen with excellent results. Bill Magnusson started his career on crocodilians in Northern Australia, slowly, carefully, in one of the largest wildlife research programs in the world at the time. It wasn't easy, but it was exciting and new results came rolling in, day after day. Soon, Bill was to become the expert. He is to be congratulated for assembling some of the exciting episodes from a student's point of view of the early (and some later) history of crocodilian research, especially in Northern Australia, for those were truly pioneering days in this field. Our culture and society have so changed that such a research project could never be repeated. It was also a pioneer in the new era of large research projects where scientists from different fields join and collaborate on complex projects, which today is the norm. It was tough and it was fun - with great results that Bill was part of. Enjoy the often hilarious but true ride.

Emeritus Professor Harry Messel AC CBE.



Professor Harry Messel, 2014.

1

The Beginning



Left to right, Bill Green, Harry Messel and Grahame Webb in a Hercules survey boat in the early 1970s. Photo by Graeme Wells.

The swamp water was tepid. Gases from the mud bubbled up through the brown liquid and popped around my chest. The bank was several body lengths away when the crocodile's head broke the surface beside me. She was big. Her head was longer than my torso was wide, and her yellow eye was the only clue to the complex intelligence honed by millions of years of instinct that was housed in the armored body. I had made a mistake, and believed that I was about to pay for it with my life.

How did I get into that situation? Lives are made of billions of decisions that end up getting you to a particular place at a particular time, but we humans always try to identify especially important turning points. For me, the change in direction that led me into the swamp happened in a seminar room at Sydney University when I was an undergraduate.

I had been interested in reptiles and amphibians for many years, and collected snakes and lizards, but I had never even touched a crocodile. The department had weekly seminars for professors and post-graduate students that few undergraduates attended. The long brown hair of the woman giving the talk hung to her waist, wispy, uncontrolled, and elegant. She was slim and very pretty but she didn't smile at the audience. Every word and gesture was carefully chosen so that she conveyed her message to the listeners and nothing more. Only those who knew her very well would have suspected her extreme nervousness.

I did not know her well. I was 21 years old and in the last year of my bachelors degree at Sydney University. Jane was several years older and just starting research on her doctoral dissertation. Thin and a little gangly, my over long hair and scraggly beard were worn as proud badges of youth and inexperience. I had not learned to hide my nervousness behind a hard wall of apparent disdain.

The Wednesday afternoon seminars were open to everyone, but in practice only Professors and postgraduate students usually attended the seminars back in 1973. The small group of undergraduates and I were breaking new ground in an activity that future generations of undergraduate students would take for granted.

I had read most of the books on Australian reptiles but I had never read anything on the subject of the talk – live bearing in the water skink. Jane referred to papers written back in the 1930s and I was intrigued. After the talk, the professors and postgraduate students inundated her with technical questions. When the stream of enquiries petered out, I raised my hand and she nodded that she would accept a question. I only wanted to know the reference to a paper, but my girlfriend shifted nervously in the seat beside me. She was embarrassed because she never dreamed that an undergraduate, especially one sitting next to her, would have the audacity to ask a question.

None of the Professors seemed to think the question out of place and, as we quietly filed out of the room, Dr. Gordon Grigg approached me and said “It looks like you’ve a keen interest in reptiles”. Dr Grigg studied physiology, but was field oriented, spouted a beard and wore the clothes of a field biologist, including the Swiss-army knife in a leather pouch that was the badge of ecologists at the time. I would get to know Gordon well over the following years and would be an assistant in one of his courses. When one of the gullible undergraduates asked me what was in the pouch, I told her it was where he kept his condoms, a story that quickly swept through the class. However, at the time of the seminar, I was overawed that the tall commanding Lecturer wanted to talk to me.

“We are looking for students to go to Arnhem Land to help in our crocodile studies these coming summer holidays. Would you like to go?” he asked. I was dumbfounded. I had been trying unsuccessfully to work with practicing

scientists during my holidays for the last 3 years and here, out of the blue, was an offer to work in one of the remotest most inaccesible places in Australia with a team of experienced biologists.



Photo 1.1 *Sydney University was founded in 1850 and the buildings were built in Gothic style in the tradition of Oxford and Cambridge universities in the UK. Photo by Bill Magnusson.*

My reply was something profound like "Uhh, great, uhh, thanks." That question in the seminar would have far reaching effects, changing my plans for a Ph.D. topic, and leading me to live most of my life on the other side of the world, but I had no way of knowing it at the time, and I just looked forward to a six week adventure and holiday.

The Sydney University Science Foundation for Physics would pay for the trip, allowing me to do things, such as flying in an airplane and staying in a hotel,

that I, a working-class student, had never done before. I knew nothing about the Science Foundation, and very little about crocodiles, so I asked around and read a few books. Crocodiles, alligators and their kin, collectively known as crocodilians, were called the last of the ruling reptiles by Wilfred T. Neill[92]. He called them ruling reptiles because they belong to an ancient group called Archosaurs, which included dinosaurs and their relatives. Archosaur can be translated as "ruling reptile". However, Neill exaggerated when he said that they were the last Archosaurs. One group of dinosaurs, the birds, did not go extinct and they are still with us today; much more plentiful than crocodilians. However, for reasons that have nothing to do with logic or genetic relationships, most people do not consider birds reptiles.

The link between crocodiles and birds is important because crocodile behavior, especially complex maternal care, is much more like that of birds than it is like that of the other groups generally called reptiles, such as lizards and snakes. The ancestors of crocodilians were basically terrestrial carnivores, something that you are unlikely to realize unless you see a crocodile gallop[93]. Their hearts are also more complex than those of fish and lizards[94], partly a heritage from their Archosaur ancestors, and partly an adaptation to an amphibious life style. Crocodilians have ruled the interface between water and land in tropical climates for over 100 million years, and their ancestors fed on dinosaurs when the largest mammals were still smaller than a rat. They are also one of the few groups of large vertebrates that have withstood the onslaught of modern humans with no extinctions. You should never underestimate one.

The Science Foundation for Physics was founded by Professor Harry Messel[95], a Canadian physicist. Although he was contracted to revitalize the Sydney University Physics Department, which he did, he also had great interest in wildlife and outdoor adventure, and had studied polar bears in the Arctic. The

logical reason, some might call it an excuse, for physicists to study crocodiles was that radio telemetry is vital to understand the ecology of a wide-ranging carnivore. They called the project "Crocodilus", a misspelling of the genus name of crocodiles (*Crocodylus*) that embarrassed the biologists associated with the project. The Science Foundation would revolutionize the teaching of physics at Sydney University, and be responsible for some of Australia's most important infrastructure for the study of the stars[95].

The Foundation generated revenue by patenting important advances in solar heating and radio reception. The School of Physics under Professor Messel collaborated with the Australian Customs, ASIO and the CIA to develop radio receptors that could not be detected by conventional means. Basically, the spies wanted to be able to put a radio transmitter in a suspect's car that could not be detected by a receiver beside the car. To do that, they had to have a radio signal that was below background level of radio interference, but that could be recovered by sophisticated software designed to distinguish it from random noise. It all seemed very esoteric, but it was the type of research that would one day allow me to use a mobile phone to talk to someone on the other side of the world and have my signal sorted from among the millions of other people calling at the same time. The important thing for me and my fellow researchers studying crocodiles at the time was that we would have levels of funding unimaginable by most biologists.



Jet travel between Sydney and Darwin was well established in 1974, even though the airports still did not have boarding ramps, and working-class people rarely thought of flying. Meals were provided on each leg of the flight, an uncommon luxury today. It took 5 hours in the DC 10 jet from Sydney to Darwin

via Adelaide, and we stayed overnight in Darwin so that we could take the flight to Maningrida the next day. Routine for other members of the party who were more world wise than I, but I had never flown in a plane, never stayed at a hotel, and had eaten at a restaurant less than half a dozen times in my life before.

Maningrida is on the coast in the middle of the Arnhem Land Aboriginal Reserve. You needed special permission from the indigenous land owners to visit the area, but the Crocodilus project had all permits in hand. Arnhem Land covers an enormous area, and most of it is under the control of indigenous communities. Government townships and former mission settlements link communities in the interior, known as outstations, to the large commercial centers, such as Darwin. Although Maningrida is on the traditional land of the Kunibídji people, the township is used by people from surrounding tribes.

Maningrida is said to be an Anglicised version of the Kunibídji name Manayingkarírra, which comes from the phrase 'Mane djang karirra', meaning 'the place where the dreaming changed shape'[96]. This is perhaps appropriate, because Maningrida is a symbol of the interaction between modern-Australian and traditional-indigenous culture. It is near the mouth of the Liverpool River and overlooks an estuary of great beauty, with pandanus-lined beaches and wide stretches of water where the river meets the Arafura Sea. Access is via commercial barges that transport goods, and by airplanes that transport mainly people. In 1974, the township was served by Connair. The name derived from Connellan Airways, but it made the company vulnerable to puns, some of which possibly were deserved.

Connair ran DC3s, propeller-driven aircraft that were becoming obsolete, but that had a reputation for reliability and safety. The planes looked to be all metal, but when you got close you could see that the airfoils were made of painted cloth. The pilots were generally young and trying to get up enough hours on

commercial flights to graduate to jets. Maningrida airport was not sealed and the landing strip often developed puddles in the wet season. Because the pilots were trying to accumulate flight time, they did not want the airport to be closed and they would lift the wheels one side at a time to pass over the puddles when landing or taking off, making the plane look like a dancing pelican.

The DC3s also had strict weight restrictions, and passengers and their hand luggage were weighed before boarding. Once, based on the premise that some passengers would be under the weight limits, the Crocodilus team decided that it would not hurt if some of the passengers were overweight. Therefore, we sidled up to the counter with the lead weights used to sink nets disguised as small presents. They were put on the floor or the counter carefully to avoid making a clunking sound, and were not weighed with the passengers. It all seemed sensible until we were on the tarmac.

The DC3 hurtled past the control tower, but the pilot slammed on the breaks half way down the runway and brought the plane to a quivering halt. He announced “Sorry folks, we couldn’t get up enough power for takeoff, we’ll try again.” The plane sped down the runway, and we waited with trepidation, but the pilot aborted again. The third time, the plane got off the ground. Maybe it had burned enough fuel to reduce the load – who knows? In any case, we learned that Connair always worked close to the load limit, and we never tried to get around the weight restrictions again.

Gordon Grigg had accompanied us from Darwin, and was there to assist in setting up the project and to represent the Zoology Department of Sydney University. Gordon and his students would eventually revolutionize thinking about salt regulation in crocodiles, but these were early days and he was almost as green as the rest of us. Grahame Webb[101], a Professional Officer with the Physics Department, the biologist in charge of the project, met us at the airport.

A recent Ph.D. graduate from the University of New England in Armidale, he had done his doctoral thesis on temperature relations in reptiles. Grahame was short and, though muscly, he had a tendency to chubbiness which combined with his short blond hair, snub nose and round features gave him an almost cherubic air. This appearance, however, belied an intense and competitive nature that would one day lead him to be considered Australia's foremost authority on crocodiles.

We loaded into the back of a Toyota utility truck and drove through the township. The sun was hot and burnt into our exposed arms and faces. As we bounced down the dusty track between the rickety shacks, the Toyota rattled, and banged and threw up clouds of dust, but the thin black people who sat in the dust in front of the wooden hovels ignored the truck. There was a concentration of wooden buildings around the store and the school, but most of the houses were just one-room boxes on stilts scattered among the eucalypts and shoulder-high spear grass.

The sense of adventure was increasing. The wind in my face, the discomfort of bouncing around in the back of the truck, and being surrounded for the first time by people of a culture very different from that in which I had been raised, made me feel vibrantly alive. There were sounds and smells that I had never experienced before. I had had good times as a child in Sydney, and I loved the sound of waves beating on sandstone cliffs, but this was different. It was not part of a place that had raised me. What I saw was not colored by the experience of my friends and family; it was uniquely mine.

The truck pulled into the compound. A 2m fence surrounded the abandoned fish factory that had been given to the crocodile project by the Northern Territory government. The factory was the size of a suburban house and contained a storage room, a processing room with stainless steel sinks, 3 walk-

in freezers and a large machine room where the compressors for the freezers had been when the factory functioned. Like most projects in the Northern Territory, and like almost all economic projects in which the government had tried to interest the aboriginal people, it had failed.

The project also had the use of a small office complex with three rooms and a house trailer. The only other buildings on the peninsula at the edge of town were a dormitory/dining complex and a two-apartment living complex that had been part of a failed forestry project, and which were occupied now by a couple who were soon to go to other lodgings.

There were a few houses constructed for aboriginal families around the base of the peninsula, but the research base was essentially isolated from the rest of the town. The calm waters of the Liverpool Estuary stretched from the muddy shores of the peninsula to the thin line of green on the far shore, over a dozen kilometers away.

We spent the remainder of the first day sweeping out the factory and the office, where we would sleep. Grahame introduced us to Elizabeth, his girlfriend who was serving as cook for the expedition. Liz, a Torres Strait Islander, was stout with thick curly hair. Her generous nature soon captivated the hearts of the students, and she became our surrogate mother. She had arrived only a few days before us, but already had a pet pigmy tree goanna. The ten-inch lizard nestled in her fuzzy hair when it wasn’t being fondled or offered little chunks of meat.



Photo 1.2 *The abandoned fish processing factory used as laboratory space by the Crocodilus team. Photo by Graeme Wells.*

Bill Green, the project photographer, had freckles and red hair, and was as thin as Grahame was chubby. The fourth member of the team was Dennis Puffett. Dennis was a big man, not tall, but as thick as a barrel. He had been seconded to the croc program by the Northern Territory government. An Englishman, he had first worked with ropes and taught others as a boy in the Stroud Sea Cadets where he was a Leading Seaman. For a time in the Second World War he was an Escort Leader in the Battle of the Atlantic and was put in charge of the small boats. Afterwards, he joined the SOE, an elite Special Force, in which he spent a great deal of time in small boats. After taking discharge in Australia, he became the Skipper of Caprella, the first Victorian Fisheries Research Vessel. Afterwards, he took responsibility for a fishing district where he often sat with fishermen helping to make and mend nets, and learning the skills that would be so valuable to the Crocodilus team. He was also the first

Superintendent of Wildlife Management in Papua New Guinea and helped launch the crocodile raising industry there. Dennis gives details of these exploits in his book "With a Bit of Luck."[97] When I met him, Dennis was in his early fifties, rotund, grey haired, and with that air of jovial competence that comes from long experience in the field.

The project had brought along three other students, John Boland, a young biology major, Chris Moran, a genetics student who is now a Professor of Veterinary Science at Sydney University, and Arthur Georges, a zoology student from Brisbane who is now Professor of Applied Ecology at the University of Canberra, and one of Australia's foremost specialists on freshwater turtles. Chris, like me, was lightly built and bearded; John and Arthur were clean shaven and stouter. I was hump backed and thin, but had inherited the strong chest muscles and endurance of my father, so I could carry heavy loads and run long distances. That did not make me good at sports though. I always depended on my conscious mind to work out what to do, and the conscience is mind is slow in comparison to the part of the brain that works subliminally[98]. By the time I had worked out what to do with the ball in a football match, it was past me and someone else had made a goal.

The salaried members of the team included Pearce Dougherty, general helper and rousabout. A dedicated surfer in heart and soul he had trucked his surfboard 2000 miles from Sydney to the remote settlement of Maningrida. His long blond hair, surf board and boardshorts gave him almost all the elements he needed to bring the surfie culture to the north. Unfortunately, the quiet tepid waters of the Northern Territory gave barely enough waves to cover his ankles, and the surfboard had to be shipped back to Sydney.



The sun was just peaking over the horizon and dispersing the early morning chill when Grahame's portable tape player blasted us with his favorite accordian polka. Six a.m. starts were not our usual fare back in Sydney and we grumpily stowed our gear and fronted for the hearty breakfast Liz had ready for the table.

We had imagined lots of driving through the bush in Toyotas and roping crocodiles, but we had a lot of work to do before we could start on the biology. There was a 10 m trench that had to be dug so that we could unclog the water system to the factory.The sweat was dripping off us and the sun already high when Chris and I shovelled out the last clods of sand and had the pipe exposed. We would normally consider it more than a full day's work for both of us, but it was barely 10 in the morning when Grahame rolled up in the Toyota and yelled "Come on we've got to get the fuel drums from the barge landing before the tide comes in".

The barge crew had unloaded the 20 drums of gasoline and ten drums of diesel oil by the time we got there. The steel drums were an ungainly load for one man when empty. The 200 litres of fuel in each pushed their weight to well over 200 kg. Grahame showed us how tip the drum into the linked arms of two people. The third could then lift the free end of the drum and the three of them could roll it into the truck. Tired arms from shovelling all morning complained at lifting 200 litre fuel drums, but none of these young bucks were about to voice the state of their aching muscles.

We could only fit 5 drums in the Toyota, so we had to run the half mile back to the base, slide the drums off the truck, roll them into the compound, stand them up, and then drive back for another load. It took six trips and several hours to stow our supply of fuel.

We were leaning up against the fence, content with our day's work, when Grahame said "C'mom we've got to get these empties down to the barge before it leaves". The dozen empty drums were a lot easier to load than the full ones, but by now the sun was beating down with a vengeance. The dry brown grass, blue-grey leaves and shiny white trunks of the eucalypts gave no relief to our tired eyes.

When we got back, we were too tired too complain when Grahame suggested that we load the rubbish from the general clean up into the Toyota and truck it down to the dump. Dumping rubbish proved to be a much more dangerous pastime than we had imagined. On the way back, the truck was rattling along the dirt track at good speed when there was a bang that left our ears ringing, lifted the truck off the ground, and dumped it half a car width to the left. I clung to the wheel, the landcruiser fishtailing in the soft sand of the rough track. Neither of us could figure out what happened, but the truck continued on with no obvious mechanical problems. The next day, we saw the tree that had been hit by lightning, blackened and blown apart, beside the road where yesterday's tire tracks started to fishtail. Thank God for rubber tires!

As we piled out of the truck, Grahame looked up and grinned "I've already put the two-stroke oil in a dozen outboard tanks. All you have to do is pump in the petrol". The hand pump creaked and the gasoline sloshed, mixing with our dripping sweat. We took it in returns to pump and hold the nozzle into the cans. No one shirked, but each was glad when his turn to pump came to an end.

We stacked the outboard tanks in the factory and filed across to Liz's excellent lunch, to which we were far too tired to do justice. The pace did not let up after lunch. We were learning that field work calls for a lot more hard physical effort than the laboratory classes and sitting around posturing during university breaks had prepared us for. I had worked on construction sites with

my father's work mates, but this was no comparison. Each day, Grahame would wake us by playing polka music at maximum volume in the office where we slept.

The buildings had been ceded to the project by the Northern Territory Administration, but they came "as is". We spent days sweeping them out and organizing things. The processing plant had three walk-in freezers that no longer worked. It would be possible to replace the motors and get one working again, but first we had to take down the existing system of pipes that ran around the top of the building. The problem was that the pipes still had ammonia gas that had been used for cooling. Pulling down the pipes meant breathing in the acrid gas. I avoided the gas by getting a job cementing the holes in the floor where equipment had been taken out, but I found that I wasn't as good at concreting as I thought, and had to wake early to fix errors I had made before anybody noticed them. It was all new and adventurous, but there wasn't any biology.

Chris and I had moved to a caravan that was parked near a 3-room living complex at the end of the peninsula. The house and caravan were surrounded by tall *Gmelina* trees that had been planted by the defunct forestry project. Land with a view like that over the bay would have cost a million dollars in Sydney, but we took it for granted. Grahame couldn't reach us with his infernal polka but he continued to wake us at 6 am by bashing on the door. I was waiting for him early one morning, hidden behind the caravan with a bucket of water. He got a drenching as he bashed on the door but I'm not sure that it was much of a victory. I had to get up half an hour earlier to show my displeasure at early rising.





Photo 1.3 *View of the Liverpool estuary from the research base. Photo by Graeme Wells.*

Grahame didn't seem to mind the prank and took us down to a group of humpies midway between the base and the main part of the township. David Milaybuma sat in the shade of some sheets of corrugated iron and drew fine lines on a sheet of stringy bark. We had had little contact with aboriginal people and we stood around self consciously as Grahame conversed with David. Destined to become a famous artist, with paintings hanging in the national art gallery, he was still willing to sell a day or two's hard work for $10 or $20. I was intrigued by the control he had over his hands. He dipped the fine stringy-bark brush in white pipe clay and laid the two inches of drooping fibre, no thicker than a grass stem, onto the brown bark. Without a tremble, he drew a perfectly straight fine line, exactly parallel to, and only a few millimeters from the line he had already drawn.

The eastern Arnhem Land style of bark painting is better known. The whole bark is filled in with complex stories. The central Arnhem Land style that David used is different; colour is less important. A background of red and brown ochre is painted over the bark and the outline of the objects in the scene is drawn in black or brown. The internal details are “painted in” with the incredibly fine parallel lines that have the precision of computer graphics.

David promised to paint us some barks, but we left the conversation to Grahame. My family had never been very social and I had great difficulty communicating with other families in my hometown. I had not learned the few simple conventions that facilitate conversation in my own culture. When faced with a different culture, and a different language, I was dumbfounded. However, David was obviously very fond of Grahame and he instantly accepted the clumsy, gawky students from the project.



Grahame and Gordon had decided that we might be able to estimate the size of the crocodile population from the number of tracks they left on the mudbanks. Also, we might be able to learn something of croc biology by measuring the air, water and mud temperatures at the times that the crocs were using the banks. They therefore organized a trip to the Tomkinson River.

Grahame decided to take two boats, one 4m long with a 40 hp motor, and the other 3m long with a 10 hp motor, and asked if any of the students had experience with boats. I explained to him that I had used my father’s outboard, so he told me to take the 10 hp boat. He wasn’t fazed when I told him that my father’s boat was plywood, with a 1.5 hp motor. Even though it was small, the boat I was about to use was six times more powerful than any that I had piloted before.

We put the motors on at low tide and waited for the water to rise enough to push off. We worried about stone fish, which carry agonizing poison on their dorsal spines, as we pushed the boats through the shallow water. However, no one was ever stung by one, and we found out later that they only occurred around rocks, about 70 m from where we moored the boats. The larger boat pulled away quickly and headed upstream with Grahame and most of the students aboard. Chris and I followed in the 10 hp boat.

The Tomkinson River runs into the Liverpool River about 10 km from the estuary. It has a small catchment above the floodplain, and most of its dynamics is linked to the tides. The water in the Liverpool River was choppy, but once into the Tomkinson, things got better. The boat planed, and the mangroves rushing past on each side gave the illusion of faster travel. The murky water of the Tomkinson River formed little eddies where the current pushed up against the cutaway banks. We caught up with the larger boat, and motored upstream for about two hours, looking for crocodiles or crocodile tracks on the broad mudflats exposed by the falling tide.

The crocodile was completely covered in mud under the edge of the mangroves as the boat ran past. We only saw it because it lost its nerve at the last moment and splattered its way over the mud, almost crashing into the boat as it skidded down on its belly. It was small, less than an arm span long, but we were thrilled to see our study animal up close. Arthur steered the boat around and nosed it into the soft mud. The depression where the croc had lain was clear and it had left a snaking trail bordered by footprints as it tobogganed to the water.



Photo 1.4 *Crocodile running off a mud bank at the approach of a boat. Photo by Graeme Wells.*

It had been hot and a little boring in the boat as we were travelling upstream. I grabbed the thermometer and ruler in one hand and jumped out of the boat onto shore. I might as well have jumped into the water. The black goo gave way and I sank up to my crotch. The stubby shorts, which were my only clothing, gave little protection and I thought of sharp shells, spiny fish and mangrove stakes as the warm slimy goo enveloped my most sensitive parts. A little struggling and I was up to my waist. I had no choice but to hand back the instruments and pull myself out of the mud using the side of the boat. I dragged myself along the boat until I was hanging in free water, and kicked around until I had removed most of the mud.

Returning to the bow of the boat, I surveyed the scene. Little, red-clawed fiddler crabs and pop-eyed mudskipper fish were running around on the surface

of the mud, making a mockery of my clumsy efforts. I lowered myself over the bow and bent my knees forward so that I was almost in kneeling position, spreading the weight of my body along the full length of my lower legs. Still I sank to my knees. I swung one leg around into a semi-kneeling position without sinking any deeper, then swung the other around with all the grace of a man in a full-length plaster cast. I fell forward and impaled my right arm up to the elbow in mud. I could not risk ramming the delicate thermometer into the mud, so I held it above my head and slowly dragged myself up the mudbank in a three-legged crawl.

My lower back began to burn, then my stomach, upper arms and face. I was covered by a fine black coating of biting sandflies. I squirmed and swatted but there was no way that I could escape them save covering myself in the gooey mud; a sensible solution I was not yet ready to take. Trying to ignore the itching, I kept crawling forward to get to the depression left by the croc. Air temperature, mud temperature, the width of the track - three little measurements that seemed to take forever. I turned, crawled, squirmed and ended up planing down the mudbank on my belly and almost knocking myself out on the side of the boat.

Passing the equipment to John, I dragged myself along the side of the boat and rolled in the river water, scraping off mud and sandflies that seemed to be equally thick. When I was free of most of the mud, I started thinking about the crocodiles and sharks that might be attracted by my thrashing around in the water, and hauled myself back into the boat with heart thumping. Arthur was carefully noting data on a card, unmindful of the sandflies that were so scarce over the water but so thick near the mangroves. I was sure that the clouds of sandflies had followed me to the boat, though it was probably just the still-itching bites that tormented me. “Go, go, go!” I badgered Arthur into starting the motor and heading into mainstream.

We tried long-sleeve shirts, but mud and heat made them unpleasant. Repellent washed off and seemed a too-toxic long-term solution. In the end we just adapted. Sandflies were never pleasant, but with time the nerves in the skin accomodate and agony becomes a dull ache, nice to avoid but soon forgotten.



Photo 1.5 *Bill Magnusson measuring croc tracks. Photo by Graeme Wells.*

As the effects of the biting insects wore off and I achieved a deeper tan, I came to appreciate the feel of the sun, wind, rain and even mud on my naked skin. Thousands of nerve endings all over our bodies telling us we are alive and of our surroundings, which we leave unused and unappreciated in our rugged-up urban existence. I came to be envious of the aborigines with their dark skins, impervious to sunburn and skin cancer, and apparently insensitive to the cold night air. Still, I don't remember when I changed from tormented student to fresh-air connoisseur.

The first trip back from the Tomkinson was not as easy as the upstream leg. Grahame took all the other students back in the larger boat, and left me alone in the 10 hp dinghy so that it would run faster. That worked on the flat expanses of the Tomkinson, but there is a large forested mudflat called Bat Island just upstream of where the Liverpool River enters the main estuary. The island channels the water along the eastern bank, creating turbulence. When the tide runs in, the water banks up in the estuary and then rushes up against the out-coming river water in front of Bat Island. The combination of tide, current, and sometimes wind, makes the Bat Island stretch bumpy, uncomfortable, and sometimes dangerous.

Without the extra weight of another person in the front, the little boat would only plane at full throttle. Before I reached the mouth of the Tomkinson, a gale had sprung up. When I reduced speed because of the waves, the boat stopped planing and the rear settled low in the water with the prow high into the wind. The waves thumped the side of the boat, and the wind drove the warm salty water into my eyes. That made it hard to control direction and I had to run at an angle across the waves or they would flip the boat over. I was quickly finding out what I didn't know about boating. Fortunately, I was used to going slow in my father's 1.5 hp boat, and it took me nearly an hour to pass Bat Island, a stretch that had taken the larger boat only 10 minutes.



Almost a week of clean up and measuring croc tracks had passed when Grahame announced that we would set some traps for crocodiles the next day. All we had to do was lay some nets to catch sharks for bait. Grahame had never fished in the area, but one of the locals suggested that the mouth of a creek on the far side of the estuary would be a good place to catch sharks. Pearce, the

other students and I drove down to the beach below the peninsula, two outboard tanks and a 40 hp outboard motor bouncing around in the back of the landcruiser.

We had to transfer the fuel tanks and the outboard motor from the truck to the Hercules aluminium boat which lay 40 m from the firm sand of the beach. Unfortunately, the boat wasn't floating in water, it was lying in soft gooey mud. The mud started at the firm sand of the beach and disappeared into the water 20 yards past the boat. We sloshed out through the mud, the outboard tanks, nets and the motor weighing us down, and forcing our bare feet into the shells deep in the slime. Everyone had warned us of stonefish but we hardly took note of where we put our feet as we tottered from one knee-deep footstep in the mud to the next. We had suffered no casualties when we dumped our muddy cargos into the bottom of the boat, but we were faced with another problem. The boat had worked its way down into the mud so far that our rocking and pushing had almost no effect against the gummy suction.

This was a minor problem as it was still early afternoon, and the incoming tide had already shortened the distance between the water and the boat by several meters. Another half hour and it would be floating. Pearce and I took the Toyota back up to the base.

As we gathered up the last odds and ends to carry down to the boat, a short figure with bandy legs, bushy red hair and fiery beard strode up. His ragged clothes and strange speech added to his wild appearance. He identified himself as the manager of the aboriginal fishing cooperative. They had received word that a cyclone might hit the area and one of the fishermen was stranded in a boat with a broken motor in Gudgerama Creek, exactly on the opposite side of the estuary from where we planned to set the net.

Grahame and Gordon were nowhere to be found, so we didn't hesitate in offering our services; five heroes setting off to save a life in the wild north. We pushed and heaved the boat into the water and then dragged it a further 30 m to where it was deep enough to lower the motor. The 40 hp roared into life, but the 17 ft Hercules just slogged through the waves, never getting up to planing speed. We weren't particularly worried. The fresh breeze on our faces and the sound of the waves slapping on the aluminium hull kept our spirits high. The old fisherman pointed out landmarks, showed us how to avoid shoals, and generally improved our knowledge of the local conditions. The settlement was long out of sight as we negotiated the mud flats at the mouth of the creek and came up to the sturdy fibreglass fishing boat with its inoperative inboard diesel. A tall aboriginal man with grey hair and stately bearing gave us a wave and a welcoming smile, but exchanged only a few words, which we did not understand, with the old fisherman.

We started the slow run back, towing the heavy fibreglass boat. The 40 hp motor was still slugging away, but the Hercules seemed to be riding lower in the water and rolling more with the waves, which were being whipped up by the wind. The old fisherman and the aborigine sat silently watching the water pass with the infinite patience born of age and the sea.

The cool air was becoming less comfortable and the quiet of our companions was not conducive to any boyish tomfoolery. We sat and watched and tried to adapt to the rhythm of the boat which doggedly pushed into each wave, lost ground as the fiberglass boat tugged back on the rope, then surged forward again as the waves, the wind and the following boat combined to permit a little forward motion.

The trip, which had taken less than an hour on the outward leg, took 3 hours on the way back. It was almost dark when we turned loose the fishing boat with

the two old men in front of the landing at Maningrida and gunned the motor for home. We had expected the Hercules to plane well with no extra weight, but it continued to roll and slog into every wave. We were cold and tired, but also content with a job well done. It's not every day that you participate in a successful mission of mercy.The tide was high and the waves were splashing high on the beach as we ran the Hercules onto the sand. Grahame sloshed into the water to secure the boat, obviously concerned at our delayed return. His welcoming smile turned into a dark scowl when he saw the fishing nets still piled in the bottom of the boat.

"Why didn't you set the nets?" was his immediate question.

"Well, we went to save a stranded fisherman" was our proud reply.

"So why didn't you set the nets?" he asked again.

"Well it's dark and windy and choppy and we thought we'd set them tomorrow" was our crestfallen and somewhat shameful reply.

"We need those sharks for bait tomorrow, come back when you've set the nets," and he turned and strode up the beach.

A wave caught the boat, turned it side on and thumped it onto the beach. We had no time for argument. We hauled the boat around and pushed off into the waves and wind, which was getting near gale force. The motor caught on the first pull and the boat slugged its way out from the beach. It was dark and the wind and the waves raced past us, but the lights of the settlement showed that we were making almost no headway. The boat would not plane and the waves were slapping over the sides. We were obviously overladen, but we had less people and fuel than when we had set out that afternoon.

The creek lay over 10 km of open water, and the boat could be swamped at any moment by the rising waves. It responded only sluggishly to the helm. Pearce was driving and, as the only salaried member of the team, he was nominally in charge. I had the irrational confidence in my ability to survive a swamping that is the product of inexperience. However, I doubted the ability of all five of us to get to shore if swamped in the middle of the estuary. Some of the others had even less experience than I in open boats and the sea.

Pearce was younger than us by several years and had the disadvantage that his livelihood depended on his job, so I decided that a bad decision on my part would have less serious consequences than one by Pearce. I said “Pearce, turn up river, we’ll set the nets off the beach”. Obviously relieved, he turned the helm and we started to run up river. The waves were now running across our direction of travel but they were not high enough to roll the boat.



Photo 1.6 *Storm over the Liverpool River. Photo by Graeme Wells.*

We dropped an anchor, a buoy, and started to play out the net. I had thought it would be more difficult, but the net slipped over the side with barely a hitch. Whenever the mesh caught on an exposed rivet, someone ran forward to pry it off, and the boat kept creeping forward. We layed the second net 50 metres from the first, then we chugged around and headed for the beach.

The wind was roaring and the motor obviously didn't have the power to safely manoeuvre in shallow water. Also, we would need the boat on the low tide the next day, so we had to anchor it a hundred meters off shore. The anchor dropped in 4 m of water and the wind jerked the boat around to face into the storm.

We slipped over the side into the boiling water, our imaginations entangled with sharks, killer box jelly fish and the agonizing punctures of stone fish. Although we had swum to and from the boats many times during the past few days when we were doing routine maintenance, everything was different in the dark, the cold, and the shame of having done wrong. The sand finally came up under our feet and we dejectedly filed up to the base in the gloom, wind and rain.

"How come you're back so fast? Haven't you set the net?" Grahame was glowering.

"It's my fault, I thought it was too dangerous to cross the estuary at night. We set the nets off the beach". I said with much more confidence than I felt.

Grahame was not impressed. "Sharks, there where we swim every day. Nobody fishes sharks there. Those nets had better have sharks in them tomorrow!" The comment carried all sorts of threats of further shame if the

project had to be held up a further day by our incompetence, but there was nothing to be done but wait for morning.

The cyclone did not materialize. The next day dawned sunny and calm with no evidence of our previous night's traumas. As he gunned the boat forward, Grahame said "Bill, pull out the bungs". What bungs? He saw that I didn't understand and asked "Don't you know that these boats have flotation tanks under the floor you have to drain or the boat won't plane?" There was the explanation of our wallowing boat the night before. Grahame unscrewed the plugs in the stern of the boat and, as the water drained, the boat came up to planing speed. It was obvious why Grahame had not understood our fear of crossing the estuary in the Hercules the night before. He never imagined that we would try to cross carrying half a ton of water in the flotation tanks.

Feeling pretty stupid, I was not at all confident when we came up on the net, but many of the floats were down and when Arthur pulled on the float line an answering tug came from deep in the water. We heaved on the net and little bits of sea wasp tentacle burned our hands but we didn't care. Up came 3 ft slimy sharks, 1.5 m whaler sharks, banjo rays and sandbar sharks with heads so wide that they didn't get caught in the mesh, but were just held in the folds of the net. As we pulled the net up, it straightened out and the head of a 3 m whaler shark with eyes more than a foot apart rose up towards the boat and then fell back into the murk.

The nets off the beach ended up catching almost every imaginable sort of shark. We continued to swim in from the boats, but never with the supreme confidence born of ignorance of those first few days. Sharks were so thick in that estuary that they must have actively turned to avoid bumping into us as we splashed around. We didn't care though. On that day, we were happy to have our home beach infested with sharks.



There was no GPS at that time and Grahame set Chris Moran to work tracing the river maps and numbering the bends on transparent paper. Bill Green would later produce maps that we used to navigate all the rivers. At first, positions were recorded in relation to the number of bends from the mouth of the river. Later river maps had kilometers from the mouth marked. Gordon Grigg arrived about this time and it was decided to have a big push on searching for nests, with the objective of mapping them onto the newly drawn maps.

Gordon, Chris and I went up river in a boat to an area where there might be nests. The plan was to walk upstream along the riverbank looking for nests until we reached a point where the river ran close to a road and we could rendezvous with the truck. Only Gordon had any experience in the north, but he developed a migraine headache and had to sit down soon after we started walking. By that time, the boat had returned to base. There was nothing that we could do for him, and we would have to get to the truck to summon help, so we left him under the shade of a tree and continued along the river.

The land along the river was not very hospitable for inexperienced hikers. The sun beat down with a vengeance, and there was little shade. We had foolishly set out without water, forgetting that there was no fresh drinking water on the lower reaches of the river. The distance between the drop off and the truck had not seemed very far on the aerial fotos, but we walked for hours, becoming overheated and dehydrated. Walking through mangroves with aerial roots is very different from walking along a paved road. You have to lift your leg high at every step, as though you are walking up steps. A comfortable distance along a footpath is not a comfortable distance when walking along the bank.

I was becoming worried. If we didn't find the truck, we would be lost in unknown territory without water, and we would not be able to summon help for Gordon. When you are lost and very thirsty, the distances seem to get larger and time seems to pass more slowly. I had no idea where we were, but fortunately Chris had been keeping close track of our position on the bend map.

The thirst was becoming unbearable and, when we saw the truck, Chris ran to it and gulped water straight from the tank it carried on the side. He says that he has never been so thirsty before or since. We were all grateful for the warm water, and the headache I had been developing receded.

It was about 20 km by road back to Maningrida, and then we had to navigate back upstream by boat to try to find Gordon. It was only when we were motoring upstream that I realized how foolish we had been to leave Gordon alone. To our immense relief, he was exactly where Chris had estimated his position on the bend map, and was by this stage beginning to recover from the migraine.

We found no nests, and the dangers we had faced were perhaps not all that great. Nevertheless, the adventure showed the folly of inexperienced biologists venturing far into the bush alone. It was obvious that any work we did would be safer and much more productive if we were accompanied by the indigenous land owners.

Jockey Oondabund came to visit Grahame on several nights. We called him Bunda Bunda, but I will call him Oondabund as that is how he has been called by most writers. The tall stately aboriginal man we had rescued at Gudgerama Creek was one of the most famous men in the Territory. He had accompanied Syd Kyle-Little on his explorations of the Maningrida area and had been involved in the development of the settlement. He was a central character in

Kyle-Little's book, "Whispering Winds", and appeared in Enid Drysdale's book, "The End of Dreaming". Grahame even used him as the model for a central character in his fictional story "Numunwarri." One of the oldest and most revered members of the Kunibídji tribe, his advice was greatly valued on all matters. Grahame asked him about crocodiles, the history of the area and the local folklore. Unfortunately, I was too shy and unsure of myself to take advantage of his knowledge.

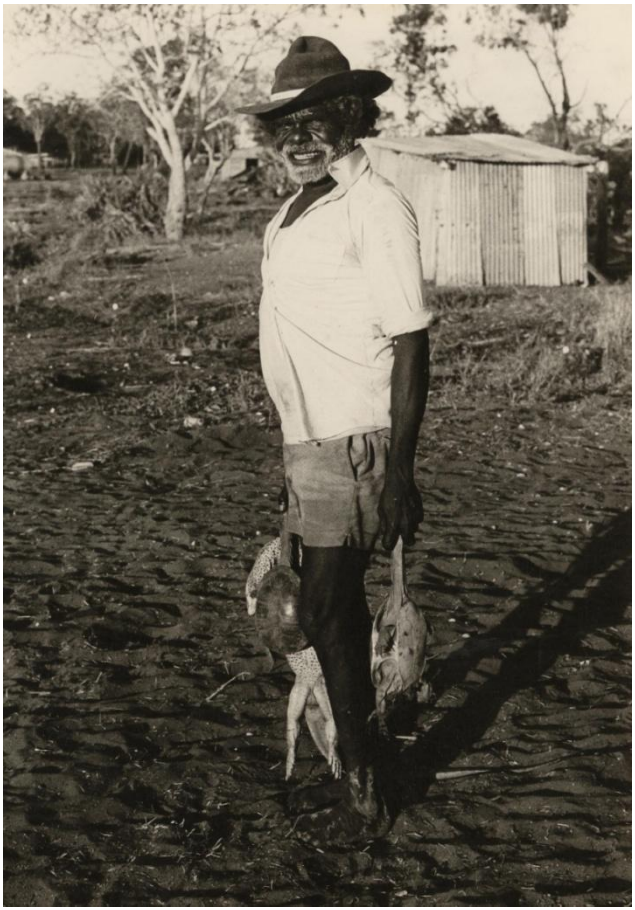


Photo 1.7 *Jockey Oondabund (also known as Bunda Bunda) about 1974. Photo by Grahame Webb.*

I was forced into closer contact with the aboriginal community when Grahame turned up with a man called Silas from a camp on the upper Liverpool River. Silas was thin, middle aged, and continually nodded his head and smiled as Grahame questioned him. He said that he knew of a crocodile nest on the upper part of the river and was willing to take us at 4 pm that day. Pearce and I were selected to look for the nest and I was content to have the chance to see the river and to have been chosen for the important job.

Four pm turned up, but Silas didn't. When it got dark, we left the fuel in the boat and settled down to tasks around the base. Silas appeared at 9 am the next day. He was smiling and didn't seem to realise that he was 17 hours late. We were equiped with wet-weather coats and fish crates of auxiliary gear, but Silas was carrying only a couple of dirty cotton sacks and a dilapidated shotgun.

There was no 40 h.p. motor available for the Hercules, so we bolted on two 10 hp motors. One was fixed in position but the other swivelled to give direction. The two little motors could not make the boat plane, so we puttered up the river at a sedate speed. Silas sat quietly, apparently content just to be travelling. Pearce took charge of the motors, and I sat watching the river.

The Liverpool estuary is 12 km wide at its mouth, narrowing to 3 km wide just upstream of the base. It is there that you feel the current as the river water meets the incoming tide, causing rough travel as the boat slogs into the turbulence. The warm salty smell of mangroves and mudflats wafted across from the banks, but from the middle of the river we could see little of the east bank or of Bat Island, the several square kilometers of mangroves and mudflats that lie near the estuary. The only animals that were large enough to be seen were Brahminy Kites that sat regally on high snags, their pure white breasts and chestnut-brown wings contrasting with the blue sky.

The turbulence decreased as we passed the mouth of the Tomkinson River and the Liverpool narrowed down to 400 m between the banks. The tide was running against us, slowing travel and washing down mangrove seedlings and other flotsam on the opaque brown water. Pipits, Wimbrels and other wading birds were foraging on the exposed mud banks but the wall of mangroves seemed to stretch on forever.

I was starting to get sleepy as the midday sun heated the metal on the boat above a comfortable temperature, and the glare from the river and the exposed mud flats made surveying the banks difficult. The chugging of the motors was hypnotic and I had passed many miles in a semidoze when grass on the banks caught my attention. The current had forced the boat close to the cutaway bank, and grass rather than mangroves stood silhouetted against the sky. In some places, the bank had given way and chunks of earth, 3 m across, were slowly breaking up in the river and dragging their grass haircuts down with them. The low tide, however, did not allow us to see over the bank.

We had been travelling for over three hours when the river narrowed down to 30 m wide and the mangroves became covered by vines and other “dry land” plants. The river was running only a few feet below the bank and eucalypts could be seen dotted over the grassy floodplain behind the mangroves. No animals stirred in the heat of the day. Silas directed us to where 4 men stood on a rough track that appeared suddenly out of the shoulder high spear grass.

Our guide hopped out of the boat and started an animated conversation that we didn’t understand. He sifted through a dirty cloth bag, handed across two handfulls of red plastic, then stepped into the boat and sat down. “Is this where the crocodile nest is?” we asked.

“No”. He held up a red shotgun shell, said “I give my father”, then turned around and looked upstream in a manner that left no doubt that we were to continue upstream.

The river narrowed and the vines covering the trees trailed down into the water. We were less than a mile above the track where we had delivered the shotgun shells when Silas pointed excitedly at the bank. As the boat nudged into the shore three men emerged from the sparse forest and stood silently watching the boat. Silas jumped onto the bank and I grabbed the bowline to secure the boat.

“Is this where the nest is?” we inquired.

“No, I hunt. Nest close there.” and he pointed up river.

“Aren’t you going to show us the nest?” we asked.

“No, I hunt, you go there” and Silas marched off into the bush with his three companions.

It didn’t take us long to realise that we had been duped. We had spent all day and 2 tanks of outboard fuel just to give Silas a lift upriver. We started the slow trip back. On the way up, the use of two slow engines seemed to show initiative and persistence. On the way back, the slow whining of the overstressed motors just emphasized our gullability. Maybe there were interesting things to be seen on the way back, but I don’t remember any. We were stiff from sitting in the boat all day and sore from bumping through the waves near Bat Island when we finally anchored the boat and tramped through the mud back to the base. We had expected admonition from Grahame, but he just nodded and continued preparing the base for the arrival of Professor Harry Messel, the head of the project and the man who had put the program together.



Photo 1.8 *Upper reaches of the Liverpool River. Photo by Bill Magnusson.*

Grahame and I had gotten into an argument over the Professor the night before. I knew nothing of the man, but I had heard that he was a near millionaire. I said with all the confidence that my inexperience and working-class background could muster "Anyone that rich must be a crook."

I knew that Grahame had very conservative political leanings, he having almost gotten into a fist fight with Arthur the day before because of Arthur's involvement in anti-Vietnam-war demonstrations. I had expected him to go into a long political argument, but he just looked me in the eye and said "If you turn out to be like Harry Messel it would be the best thing that could happen to you". He then turned and stalked off.

I am not sure what I had been expecting, perhaps a tall, imperious father figure who was so aloof that he would never bother to talk to students. I certainly hadn't expected the short, chunky, garrulous man with the 1950s college cut who sat at the head of the dining table that night. Professor Messel smiled, chewed on the butt of an unlit cigar and asked us what we had been up to in a loud voice with a grating North American accent. Far from being aloof with students, he ended the evening in a very enjoyable argument with us over the status of kangaroos in the pastoral zone.

I would work with Harry Messel for years, but during that time I always saw him as a dilettante physicist who liked to play crocodile biologist. After reading the book "The Messel Era"[95] published in 1987, I would come to appreciate the depth of his contribution to Australian science, which even extended to the text books that I had used in high school. However, it was only decades later, after I had tried to install the research infrastructure necessary for studies of biodiversity in the Amazon, that I would appreciate that the vision of those who lay the bureaucratic and logistical groundwork is as important as the contribution of those who actually collect the data.

The Professor checked over the arrangements we had made for the storage and maintenance of equipment, conferred with Grahame about various subjects to which we were not privvy, and flew out the next day. We stayed on, ready at last to start some real croc work.



Grahame and the team had set traps for crocodiles before we arrived. A gill net was suspended from a rope across a small inlet in the bank of the river. The mesh was bunched up and tied to the rope by loops of a cord so that the croc

could pass over or under the rope without getting entangled by the net. The free end of the cord ran onto the bank, through a pulley, and was attached to bait, which was usually a big fish. The idea was to entice the croc to move between the net and the bank. When it pulled on the bait, the cord would release the net, which would drop into the water and hang suspended by the rope. Hopefully, the net would entangle the croc when it tried to move back out into the main river. There were a lot of things to go wrong, and pulling the bait triggered a radio alarm that would sound at the base so that the team could get to the croc before it drowned.



Photo 1.9 *A net being rigged as a drop trap to catch crocodiles. Photo by Graeme Wells.*

There was great excitement when the alarm at bend #8 on the Tomkinson sounded. We bundled into the Toyota and sped along the outstation road, Grahame jerking the steering wheel to compensate for the truck's fishtailing in the soft sand of the forestry road. The river was hundreds of meters from the

road, and we trudged through the waist high grass towards the mangroves. Grahame was not wearing a shirt and I was surprised that he didn't notice the engorged mosquitoes that were hanging off his back. An open mudflat led to the thin band of sedges lining the tiny inlet. There was no sign of the croc, but the net had been pulled under water and only the ends of the rope, which had been stretched tight, were visible.

We could not see the croc through the muddy water, but we knew he was big from the marks on the bank. Pulling on the rope was to no avail, and we assumed that the net had caught on a submerged log. The croc may have been under water for an hour already. Although crocs can spend a long time under water when they want to, they die quickly if struggling in a net. Either someone had to dive and free the net or the croc would die.

Diving around nets is always dangerous, even in clear water. If the net billows out when you are ready to come up, and short of air, it is easy to become entangled. The more you struggle, the more tangled you become, and it is impossible to avoid panic when there is no oxygen left in your lungs. Add an enormous frightened croc that does not know you are trying to help it, and a river full of sharks that have probably been attracted by the struggles of the fish and the croc in the net, and you have a recipe for disaster.

Grahame did not hesitate. He slid into the water and disappeared into the depths for what seemed an eternity. When he surfaced, much of the tension had come off the ropes and we rushed forward to pull him out of the river. We were now wet, muddy, and surrounded by a cloud of mosquitoes, but nobody noticed. Adrenalin, testosterone, and all the other things that drive young men were at full flow.

Even without the snag, it was not easy to drag the net in. A wet net is heavy even without a half-ton croc entangled in it, and bank was now wet and slippery. The croc lay still in the net as it came to the surface, but to our relief it thrashed around a little as it came out onto the bank. I had never seen a big croc before and had no idea what to do, but Grahame quickly tied its jaws shut and its legs up over its back.

More than four meters long with part of its tail missing, the croc was impressive, but it didn't do much; just lay in the mud letting us do what we wanted. The only difficulty we had was in moving its great weight around. Grahame marked it by cutting out some of the raised tail scales and took all the standard measurements. We were careful around the huge head, which was heavy enough to break bones even with the mouth shut, and crocodiles have two teeth that stick out near the snout when the mouth is closed. However, familiarity soon breeds contempt, and we stood beside, sat on, and otherwise denigrated our opponent, which was named "Puffett" in honour of Dennis Puffett.

The biggest difficulty was to weigh the croc. It was too big to suspend manually, but the project had a huge tripod made of steel pipes more than 10 cm in diameter. Each leg was about 3 m long, and a massive spring balance was suspended from the apex. I suppose that it could have weighed anything up to about a ton.

The croc just lay there and let us do anything we wanted. We assumed that it had exhausted itself. Mammals and birds generally use aerobic metabolism and have a constantly high metabolic rate, which means they have to continually feed their internal fires or they will die. Most other animals make greater use of anaerobic metabolism to allow them to make fast and powerful movements without having to feed all the time. Anaerobic metabolism at times of stress,

and low levels of aerobic metabolism at other times, needs less fuel, and is therefore more energy efficient, but this type of metabolism builds up lactic acid, which can be toxic. Lactic acid is largely responsible for the tightness in our muscles when we have done heavy exercise at a rate faster than our lungs can supply oxygen to our legs. A crocodile that just lies there after a struggle may be paying off its oxygen debt, but then again it might not.

Our combined weight was as great as the crocodile's, but it was hard to lift the crocodile and hang it from the balance. Ropes ran from the neck to the hind legs, and more were used to keep the tail suspended. Crocodiles don't have any convenient handles, and the smooth skin was covered in mud. The ropes were also muddy and slippery. The croc was dead weight, and it did not struggle or flex against us as we dragged it around. It was extremely hard work and exciting, but it would have been the same if we had been lumberjacks dragging a log around.

Once off the ground and suspended, the croc's weight would work against it and keep it helpless, or so we thought. We used a winch with a steel lever to lift the croc off the ground. At first it only flexed its torso, then it started to wave its tail. The movements gained momentum and we ran back as it started to cartwheel like a giant propeller, scattering mud as its tail and then its head crashed against the ground and the rig. When Grahame tried to release the lever on the winch that was keeping the croc suspended it almost broke his arm. We were helpless and just stood there until the croc stopped.

That was the first time I really saw a crocodile as it was. Before, they had just been sluggish lizards that lay in aquariums or in the mud at the side of the river. This was a massive power capable of leaping into the air and smashing puny humans as though they were insects. I don't remember much more about Puffett. In fact, all my memories of that occasion are dominated by the sight of the giant

crocodile cartwheeling in the air and us standing there physically helpless to stop it. Never again would crocodiles be study objects to me. They became powerful enigmatic beings. Studying them would give me glimpses into a world as foreign to humans as life on another planet.

Drop nets were obviously too dangerous for crocs and, after Puffett, the team focussed on large sock-like traps of barramundi netting that could be mounted on land and that would hopefully prevent the croc from getting to water.



Photo 1.10 *Graeme Wells in front of a crocodile trap made of rope. Earlier versions were made of gill net. Photographer unknown.*

We were covered in mud, sweat and mosquitoes when we stood back to survey our work. In the dark gloom of the mangroves, a bag of mud hung from a branch, slowly turning and twisting the two ropes passing from it, over the branch and down towards the muddy ground. One rope was slack and formed a noose around the mouth of a mesh sock that lay among the mangrove trunks.

Made from thick barramundi netting, the sock was the length of a suburban sitting room, waist high and just as wide. At the end of the mesh tunnel lay the stinking carcass of a shark that only the day before had glided majestically in the waters off the beach at Maningrida. The shark was attached by a stout rope to an iron ring which was limply suspended from a steel spike driven into the base of a mangrove tree. In front of that steel ring, another was dragged upwards by the taut rope which held the bag of mud suspended in the still mangrove air.

Grahame reached through the mesh and tugged on the shark. Both rings snapped off the spike and the bag of mud crashed to the ground, dragging the noose closed and lifting the mouth of the trap high off the ground.

It took 3 of us to haul the bag back into its deadfall position. Grahame adjusted the trigger and the noose, and we slid down the muddy bank, content with trap number two. We roared up the river to find another trap site, trying to imagine what a big croc might like.

“There’s a great spot” I said to Grahame.

“No, he’ll go up that gully and break into the trap from the side” he replied.

“We can run a fence across the gully and use it to lead him into the trap”. He considered my answer a few seconds, then swung the boat around and ran it up to the narrow gully between the mangrove trees.

“O.K., where’ll we put the trap?” I was startled by his response because I had not expected him to take my advice. Quickly I pointed out possible bag and trigger trees, and looked around for saplings that we could cut to make the fence across the gully. The *Bruguiera* mangrove I had selected for the trigger was too hard for the steel spike and sledge hammer, but a slight repositioning of the trap

fixed that, and everything else went like clock work for the now experienced trap-construction team. The row of meter-high stakes we drove into the mud in the shallow gully could not restrain even a small croc, but they appeared to form an effective psychological barrier for any big croc slowly nudging his way into the mangroves on the high tide.

As the boat pulled away from the bank, everyone else was content that a hard day's work was over, but I looked back into the gully with a special satisfaction and I hoped that it would be *my* trap that would catch the first big croc.

Grahame said "I planned to send all the students up river to look for croc nests, but I think I'll keep you back to work with the croc-catching team - what do you think?"

What did I think? Of course I wanted to see if *my* trap would catch a croc. "OK by me" I said nonchalantly.

That night, I revised and revised the setting of the trap. Had the tension on the trigger been right. Had we used enough stakes in the fence across the gully? Would the croc come around the back?

Why was it so important to me? I don't know, but I was ready to head out and check traps, catch sharks and change bait early the next day when Grahame came up to me. "There's been a change of plans" he said. "There is a chance for some of the students to return and the others have said that it is important for them to go back early. Can you stay on and go upstream to help Bill Green look for nests?"

"Of course" I said, my dreams of the night before crumbling around me, but pride forbidding that I show disappointment. I found Bill and we arranged the things that we'd need to explore the upper reaches of the Tomkinson River.

The rainy season had started, but we were blessed with relatively dry days. It was sunny and warm as we passed the trap, sitting in the stillness of the mangroves at the end of its rustic picket fence, and I turned my thoughts to the upper reaches of the Tomkinson. Unlike the Liverpool River, the Tomkinson has little freshwater input during the dry season and it peters out into a grassy floodplain without rapids or eucalypt forests to grace its upper reaches.

The river had narrowed to 10 or 15 m when we saw the eagle flapping ineffectively in the mat of vines covering the mangroves. It tried to fly away from the boat but its feeble attempts just brought it closer to the water. Bill rammed the boat over the vines and we came alongside the wedgetail.

Largest and most majestic of the Australian eagles, wedgetails can have over 3 m wing spans and stand thigh high when on the ground. The great bird looked at us with hatred and disdain, but it was too weak to fly any further. I grabbed it by its golden brown wing and Bill slipped an oar under its feet with their dangerous claws. The bird had no strength to fight and we bundled it into the boat.

No time to take it 60 km back to base, so it would have to go with us. My camp was a canvas tent, long enough to stretch out in lengthwise or side wise. The floor was made of wooden pallets in case the tide came over the bank. It had no shade and stood alone on the empty grass plain, 10 m from the river. Mangrove forests lined the river upstream and downstream, but we couldn’t put the tent there because of flooding and mosquitoes.

Bill helped me unload the supplies and the eagle, then headed upstream, disappearing round the bend in the river with a cheery wave. He would set up camp 5 km upstream and search that area for nests. As the sound of the motor faded, a feeling of desolation settled over me. I would not be participating in the

croc catching and I was all alone on an isolated stretch of river, charged with finding croc nests, none of which I'd ever seen.



Photo 1.11 *The floodplain of the Tomkinson River. Photo by Bill Magnusson.*

The eagle brought me out of my reverie. It was dejectedly trying to flap along. I found a log and positioned it between the tent and the river. The eagle perched on the log and proceeded to ignore me and the cord around its leg which prevented escape.

It was midday, so I opened a can of sardines, sat in the mouth of the tent, ate, and tried to get enthused about slogging along the banks looking for nests. The tent faced the cutaway bank of the river, the grassy floodplain running right up to the swirling brown water. The other bank was covered by mangrove forests, and the meanders of the river meant that I could not see far up or downstream. A boring scene that did nothing to relieve the solitude. I packed the gear into the tent and started to explore downstream.

The knee-high grass dropped to flat lawn directly behind the mangroves. I pushed through the low shrubs and passed from the burning heat of the floodplain into the shady gloom of the mangroves. Ankle-high woody spikes stuck up from the mangrove roots making the ground look like a peg board. No grass for a crocodile to make a nest and the mosquitoes appeared from nowhere. I swiped my right hand down my left arm, leaving hundreds of crushed bloody bodies in its wake, but hundreds more landed on their dead companions. They landed on my face, sucking from my nose and eyelids. I backed out of the mangroves and wiped off the last of the swollen little bodies that where impaled in my skin. The clouds of bloodthirsty little insects did not follow me out into the hot sun and I continued downstream behind the mangroves.

I doubted that crocodiles could make nests on the muddy floors of the mangrove forests but the low sedges of the flood plains did not appear very promising either. The river meandered over the floodplain in half-mile loops. I walked downstream for 40 minutes only to find that the river had doubled around and I was only a stone's throw from where I had started. The second loop of the river looked more promising. The grass was higher and a few scraggly shrubs were scattered behind the mangroves. I started to lose my sense of direction. Inside the loops all I could see was mangroves on the horizon through 360 degrees. I couldn't see the river, and had to assume that it was on the other side of the mangroves. I ventured into the mangroves to check the position of the river twice, but the mosquitoes continued to make life unbearable for a human clad only in stubby shorts. I walked along the lawn between the mangroves and the higher grasses of the floodplain. A patch of grass was doubled over and I moved closer to check it out. The grass next to me exploded and something shot directly for my legs. I jerked high in the air doubling my body backwards and flinging my legs out of harms way. I came down hard, bruising my arm and wrenching my back. My racing heart showed

how tense the nest search had made me. The goanna I had disturbed disappeared into the mangroves. The big monitor lizard was problably as surprised as I was.

Brushing off bits of sticks and flexing my arm, I admonished myself for not being more controlled and not getting a better look at the animal. I continued on, but I was hot, tired and stressed. The nest search seemed a waste of time and I began to think that I might not be able to get back to camp before nightfall. At the end of the next bend I started back, cutting across the loops and walking into camp at 4:30 in the afternoon. The eagle stood on its log, mute witness to my loneliness and incompetence.

I had too much time on my hands to make it enjoyable to sit around camp, and I did not have enough time to make it worthwhile to head back downstream. The eagle's eyes followed me everywhere I went, so I decided I'd catch him a fish.

Sorting through the gear I'd brought, I found a 40 lb breaking strain fishing line with steel trace and 4 hooks. The piece of fish I'd brought as bait was starting to smell, but it looked alright. I sat on the bank and threw the line into the swirling brown water. Fishing is a barbaric sport that never fails to relax an overstrained mind. The tide had risen almost to the lip of the cutaway bank. I watched the crabs and enjoyed the feel of the sun on my back as it gradually sank lower.

Six inch archer fish swam along the surface of the water, their eyes always turned upwards looking for insects they can knock off the foliage with a jet of water. I was keen to see them spitting, but it seemed that they were watching me and never made any attempts at catching insects. Smaller toadfish, smooth and round, with broad yellow and black bands, poked around the edge. I was used to

seeing the deadly poisonous little fish in the sea and they seemed out of place in this stretch of river, which is fresh for much of the year.

The line unravelled and then stretched taut, first running downstream, then cutting the water as the fish swung out from the bank and started upstream. I kept the pressure on and, after two hard runs against the 40 lb line, the fish tired and I dragged it up to my feet. As long as my arm, and weighing at least 15 lb, the fork-tailed catfish lay gasping against the bank.

I slipped my hand under its head and grabbed the union of the two gill chambers beneath the throat. The fish struggled, almost throwing me off balance, but I dragged it away from the water and killed it by driving a knife through the plate-like skull that extended for a fifth of its length.

A filet from one side of its body was more than I'd be able to eat for dinner and breakfast. The rest of the carcass I dragged over to the eagle.

The fish fried quickly on the gas stove and I soon had a mug of hot tea to follow. I sat at the front of the tent, watching the eagle, which was perched on the catfish, delicately snipping off tiny pieces of flesh with the tip of its beak. Engrossed with its fastidious meal, it did not see the enormous crocodile that appeared floating down the river. Its body was inflated with air and its back was a handspan above the water. The head was as long as my lower leg and its eyes stared directly at me. I could see every detail of the head and great body. The triangular scales on its tail were held high above the water, but it made no swimming movements and just floated downstream on the ebbing tide.

The crocodile took less than a half minute to pass in front of the camp, but the image of that great animal with the eagle perched on the giant catfish is

burned into my brain. The tea cooled in my hand and I sat watching long after it was too dark to see.

I took care to move the fish away from the eagle once that it had eaten its fill, and I took much more care when I went to the bank to collect water, but the sight of the crocodile had changed much more than that. The campsite no longer seemed desolate and boring. I was glad that no one else was around to spoil the experience the land was giving me. I searched in vain for crocodile nests for the next two days, but each day I felt and saw a thousand new things. The eagle grew strong and we enjoyed a wary friendship. When the crocodile passed the next day, going upstream on the flood tide, I imagined that he had descended purely to pass a special message to me – I imagine it to this day.

Bill Green pulled into camp and we collected the gear to head downstream. The eagle sat warily but majestically in the boat and I felt strongly my changed perception of the river. It was neither important that I leave nor important that I stay, but I knew that I would have to return.

The DC 3 roared down the runway, spraying up water and vibrating like an old-fashioned washing machine. I was sweating and drowsy from the heat in the stuffy cabin, but I pressed my face against the little window. From being my whole world in the last 6 weeks, Maningrida fell back into being a tiny collection of dilapidated buildings, lost in the immensity of where the grey-green bush meets the green-brown sea. I could make out the tiny cluster of buildings on the peninsula that had become the home of the crocodile project, but I was too high to detect any activity. The other students had the good fortune to have participated in tagging a big croc that had been caught in “my” trap, but that was all over by the time I got back. I had time only to organise the few things I had accumulated and then head back to Sydney to start my Honours year.

2

Back to the North



A hatchling crocodile. The aboriginal hunters measured the size of crocodiles by their width, not their length. Photo by Bill Magnusson.

The white-walled room in the University of Sydney was largely empty except for a large desk. On top of the desk there were 2 piles of books and a dissarray of manuscriptis. Behind it sat Dr Graeme Caughley. Thin, wiry, and not very academic looking, he was so intent with his work that he did not look up as I paused at the door to his office. I did not know much about his work, but rumour had it that he was one of the world's best population ecologists. The question in my mind was whether he would accept me as a Ph.D. student. I was in a good position to start a Ph.D. thesis on fire ecology of rats, or one on fish migrations. I had spent several years laying the ground work for both projects, but something was urging me to take a chance and try something totally different.

That something different was to study the nesting ecology of saltwater crocodiles in Maningrida. Unfortunately, none of the professors at Australian Universities had any first-hand experience with crocodile population ecology. Would I be able to convince Graeme Caughley to take time off from his kangaroo studies to supervise my crocodile work?

During my brief previous contacts with him, he had been very friendly. An ex-deer-hunter[102] and, he said, an ex-South Island of New Zealand boxing champion, he was always anxious to show his non-academic heritage by being friendly to everyone. I knocked on the door jam and he looked up distractedly from his work.

"Dr. Caughley, I am putting together a thesis project on the nesting ecology of saltwater crocodiles and I was wondering if you'd look it over for me?" He mulled over what I had said, and looked back at his work, as though assuring himself that he would be able to pick up the thread of his reasoning later on.

He pushed aside his papers and our talk lasted only about half an hour. His experienced mind quickly picked out the good bits, discarded the bad, and suggested ways to prop up the weak aspects of my thesis outline. I knew that he would have spent much more time on it if I had been his student and he had an emotional as well as academic interest in the research, but he never asked who my supervisor was.

At the end of of our discussion, I asked "So, you think this is a good thesis project?" He paused, as though he had been so engrossed in each technical detail that he had not until then thought about the project as a whole.

He nodded, thought for a bit longer, and said sincerely "Yes, it's a good project".

"Thanks", I said and, as I walked out, he turned back to his scattered papers. I turned at the door and said "So you're willing to supervise my project?"

He looked up distractedly and without thinking said "Oh! – yes." One step took me around the door and into the corridor. I knew that I had caught him unawares and that his next thought would be "Wait on - what?" I didn't give him a chance. I sprinted down the corridor and ducked into the office of the Head of Department, much to his secretary's surprise.

When Graeme's hurried steps passed the door, I slipped out and went the other way. After a hasty "yes", I wasn't about to give him a chance for a hasty "no". According to Gordon Grigg, Graeme walked into his office and said something like "Who is that Magnusson character? I think he has just suckered me."

Whether or not it was an appropriate way to get a supervisor, the next day Graeme said "All right, I'll supervise your project, but only if Gordon is a co-supervisor." That was great with me. With one of the World's best population

biologists and one of the World's best physiologists supervising my work, it could only go wrong if I wasn't up to the task.



Photo 2.1 *Left to right, Tânia Sanaiotti, Bill Magnusson, Graeme Caughley and Albertina Lima when Graeme visited Manaus in 1992. Photographer unknown.*

The DC3 vibrated until our teeth chattered and the roaring engines drove all other sound from the cabin. The pilot released the brake and the plane heaved off down the Darwin runway. When the rear wheel started to lift off the tarmac and we relaxed back into our seats, the pilot powered off and jammed on the brakes; throwing us forward, and just in time to swing the plane around before the end of the runway. "Sorry ladies and gentlemen. We're a bit overloaded, so we'll take off some cargo". The second time around he let the screaming engines reach an even higher pitch and Connair was again on its way to Maningrida.

The stewardess came around with two sweet biscuits and a small cup of sugary cordial. Perhaps they thought that all that sugar would calm our nerves. I was mulling over my plans for the coming months. Grahame Webb hadn't wanted me to work on the nesting biology of the crocs. He had suggested it the year before, but in the meantime he had collected data on the same topic himself and was keen to continue. However, his alternative suggestion, working on the physiology of temperature regulation, did not appeal to me. My Honours year had given me enough physiology to satiate my apetite for a long time. He finally agreed to let me do the nesting study, and I was grateful.

The touchdown was as smooth as our take off had been clumsy. I looked out at the red dust, the half dozen toyotas that had come to meet the plane, and the tiny shed that was Maningrida airport. It seemed I had never left.

Grahame had come to meet the plane and I felt a subtle change in our relationship. He talked of the problems with the project we had to resolve, and for the first time I felt a colleague rather than a student. It was still dry season and the crocs hadn't started to nest. Grahame would need help with the croc catching as they hadn't caught a big croc since the one when I had been up the Tomkinson River.

The new students were a motley bunch and regarded me as a teacher rather than a colleague. I set about teaching them the few things that I had learned the previous season and they were impressed. A one-eyed man is a king in the land of the blind! There was still a lot of maintenance to be done, but they got involved in the biology much faster than the previous interns.



The slab of saw shark was about as much as one man could drag up the muddy bank and into the mangrove forest. I dropped the slimy mass and leaned up against a tree trunk as I waited for my eyes to adjust to the gloom. The 4 m mesh sock was anchored among the mangrove roots poking out of the mud. In the closed end of the sock I could make out the meter-long shark that we had left as bait 2 days before, but my eyes seemed to be playing tricks on me. Instead of gunmetal grey, the shark appeared to be a dirty white colour. My ears were also registering something strange – a rustling, ripping sound, like a thousand cockroaches nibbling on newspaper. The shark appeared to be pulsating rhythmically.

Shaking my head to clear my senses I stepped forward, but the sound and movement were not illusions. The shark had been transformed into a writhing mass of maggots. Its shape was all that it had left; the colour, sound and movement were all due to the maggots.

Someone had to crawl down the mesh sock to drag out the old bait. The maggots were thickest on the shark but they were also all over the mesh, so nobody wanted to crawl along that muddy tunnel and be turned into a living mass of maggots. I quickly made myself look busy doing assorted meaningless tasks until someone else voluntered to pull out the shark. Relieved, I stepped back and brushed up against the ropes suspending the bag of mud in the canopy. Down came a shower of maggots into my hair and onto my face as I looked up to see what was happening. The maggots were all over the sack as well. They must have climbed up the ropes when the high tide had covered the trap and, in their blind wanderings, still not found their way down. In any case, I was covered by maggots and didn’t even have the approval of my peers that I would have gained by volunteering to change the bait - just desserts for laziness.



The alarm went off at 1:50 am; the insistent beeping of the radio indicating that something had set off the trap, 15 km away on the Tomkinson River. We dragged the capture gear into the truck, each beep of the radio pushing our adrenalin to higher levels. Grahame threw the Toyota at maximum speed down the rough forestry track, occasionally losing control in the soft sand and tossing us from one side of the tray to the other. We hardly noticed. We parked the truck on the road nearest the river and ran through the woodland to the mangroves. All was quiet. The big croc had torn a hole through the barramundi netting and taken the bait with him as a reward.

Grahame decided to make the traps stronger. He and Dennis Puffett[97] had been working on the trap all day. I stood back and looked at the new trap. It was the same sock design, but it now consisted of three layers. Four-ton breaking strain cod-end net used by prawn trawlers was lined inside and out by barramundi netting. Dennis eyed the trap and uttered the prophetic statement: "An elephant couldn't break out of that." He was right. No elephants did break out of those traps, probably because there are no wild elephants in the Northern Territory. However, the crocs just went through them like a hot knife through butter. The biggest croc we caught was less than 2.5 m long.

The day after a big croc had provided the ultimate insult to the "elephant trap," I found Grahame in the driveway to the fish factory, which we now called "the lab". The croc had not even bothered to walk into the mouth of the trap, it had broken in through one side and out through the other. It was almost dark, and Grahame was in the mood to talk about ways of improving the croc trap. After a

few dead ends, he said “What we need is one of those cargo nets they use on the docks. A croc would never be able to break through one”.

“Great idea,” I said, “How long will it take to get one sent up?”

“It’ll take weeks or months, but why do we have to have one sent up? We’ve got thousands of feet of rope here, we can make one ourselves”.

“Those nets are spliced together, you have to make the net as you are making the rope” I said.

“No, we can splice the joins with venetian blind cord. If we put enough turns around every join it’ll be stronger than the rope” he replied.

It sounded like a hell of a lot of work to me, but I just nodded, figuring that he’d start on it the next day. “C’mon”, he said, “we can put one together right now”. I hadn’t planned on splicing ropes together all night, but his enthusiasm was infectious. We dragged out the kilometers of rope that Professor Messel had bought and put in the store room, and which I had thought we would never have use for. Cutting and setting out the rope in a grid was easy, but at every join we had to lever open the strands of rope, push the cord through, bind the join in two directions, and tie it off with a knot that would not work its way free. Finally, we had to melt the ends of the cord so that it wouldn’t fray.

It doesn’t sound too hard until you remember that a net large enough to make a sock will have over 600 joins. Even if we could do a join every 2 minutes, it would still take more than 20 man hours, or both of us working flat out for 10 hours, to complete the job.

That’s about what it took. It was almost light by the time we felt that we had enough done to leave it to finish the next day. We had lost a night’s sleep, but the

project had gained several months. It was a valuable lesson to me, though I didn't appreciate it as I dropped into bed and let the badly needed sleep overtake me.

Another cyclone warning was issued but it didn't eventuate. I had been spending long hours driving up and down the rivers looking for crocodile nests, and I wrote a one line letter to my mother – "Nothing much to tell, just mud, maggots and heat". Grahame had arranged for two aboriginal assistants, Jacky Agaral and Maurice Djabaleebee, to help me look for nests. They showed me nests from the previous season but even their sharp eyes couldn't find any fresh nests. It seemed that the crocs would be very late nesting that year. Jacky was short, muscular and cheeky. In his early thirties, he was old enough to know well the hunting skills and the traditions of his people, but he also had a good understanding of the white peoples' ways. Maurice was more retiring, and I think he thought the research games more incomprehensible than Jacky did. We had a good time, but I realized that it was Grahame's earnestness and sense of purpose that made them feel that they were really contributing something useful to an activity that had no direct counterpart in their culture.

Four other things happened that month that were to have a lasting effect on my way of looking at the world, and three of them were people. The project hired Fred Duncan, Dan Grace and Graeme Wells as research assistants. Fred was a botanist who had done his undergraduate studies with me at Sydney University. At the time, he was planning to do his Ph.D. with the project, studying the plants of the floodplains. Short, woolly haired and dedicated just about summed up Fred.

Dan Grace was an ex-US air-force mechanic who had worked in the Antarctic and became interested in biology. He had gingery hair and beard, and a little of the air of the lost 60s generation. The project was really starting to build up a mix of personalities.

The third assistant was Graeme Wells. One too many names pronounced "Graham" for any project. From that time on, Graeme Caughley became "Caughley", Grahame Webb became "Webby" and Graeme Wells became "Wellsy". Wellsy is one of the great characters of the north, or, for that matter, anywhere. His adventures, none of which ever made him quite as rich as he planned, would fill several books. Unfortunately, unless they knew him personally, nobody would believe the stories. He now lives with his wife and son in a million dollar home he built himself and spends his spare time on his farm in the Hunter Valley in NSW.

Wellsy was of average height, but a little chubby from the vast quantities of lime cordial and sugar he ate, and he had rather short legs, giving him a characteristic, impatient-looking trot. Graeme would be an asset to the program because he had worked with CSIRO Fisheries and Oceanography on the Northern Prawns Project at Karumba in North Queensland and then for the Northern Territory Fisheries at Darwin. At that time, he knew more about the mangroves of northern Australia than any other person. Quite a feat for someone who was about the same age as I was. Graeme later wrote a children's book[100] with a crocodile as the main character, and illustrated it with many beautiful photographs taken by Bill Green.

The fourth significant occurrence that month was the arrival of the plane. A high-winged blue and white Cessna with the call sign "Papa Quebec Juliet". I had never flown in a small plane before and the stuffy little cabin seemed flimsy even while we were on the airstrip. Once airborne, the stuffiness, incessant droning of the motor and the general impression of fragility of the little machine sealed my permanent dislike of travel in light aicraft. However, we surveyed the floodplains of the Liverpool and Tomkinson Rivers for croc nests in less than two hours. It would have taken me a week or more by foot and boat.



Photo 2.2 *Left to right, Dan Grace, Grahame Wells and Fred Duncan horsing around and making it difficult for the unknown photographer.*

The rivers were laid out like loops of brown string on a green table. There were no hills, and if it wasn't for the strips of mangroves along the rivers the scene would have been totally 2 dimensional. I thought I saw a nest on the inside curve of the river and I asked Dave Hendry, the ex-airforce pilot to go back and have a closer look. He pulled the plane into a steep bank. The effect was the same as increasing the force of gravity several fold. I was forced back into the seat and my lungs compressed so that I couldn't breathe. My eyeballs were squashed flat and I couldn't see. As we came out of the dive, my eyes popped back into focus and I could see the grass rushing past at wing-tip height. The "nest" was just a bunch of dead grass caught up against a bush - I think. Before I could be sure, I was jerked back as we climbed to clear the mangroves. Someone in the back seat was throwing, up but I couldn't look around. Another strip of river was flashing by and I had to concentrate so as not to miss any

suspicious looking objects on which Dave could practice Kamikaze dives. I learned quickly just how indispensable aerial survey is and, God, how I hated it.

Mainly because of Papa-Quebec-Juliet, Gordon Grigg got his pilot's licence and developed an almost fanatical love of flying. I much preferred him to the ex-airforce pilot, because he flew at speeds above the level that set off the stall warning, and did not squash my eyeballs with sharp turns and kamikaze dives. Gordon planned a series of aerial surveys, and we surveyed most of the river systems between Cobourg Peninsula and the tip of Cape York[77,84].

The surveys gave me a better picture of the distribution of suitable crocodile nesting habitat across much of the north, but surveying was stressful and tiring, especially because Janet Taylor, the navigator, was often air sick, and I would have to navigate and survey at the same time. We received great hospitality wherever we landed, and I began to get an idea of the variety of cultures living in the towns along the northern fringe of Australia, most of which are very different from Maningrida and Darwin. Janet, the only female member of the crew, and now a Professor of Mathematics in Queensland, was unimpressed when a woman missionary greeted her with the statement "As Jesus is the head of the Church, so man is the head of the family." Nhulunbuy on the Gove Peninsula was a remote mining town, and dominated by private industry. Normanton looked like any town in the western cattle country of Queensland.

Robbie Bredl put us up at the Edwards River Crocodile Farm. He was living with the town nurse at the time and let us stay in his house. Generously, he said "There's icecream in the freezer. Help yourself and don't worry about the baby." Then he left us to ourselves. We didn't understand what babies had to do with icecream and made ourselves comfortable. After dinner, someone said "What about that icecream", but when we opened the freezer and found a human baby frozen in a life-like position beside the icecream everyone lost appetite. Even in

the remote north, it is illegal to dispose of a body, so it makes sense to store a dead baby in your freezer until someone can issue a death certificate if your girlfriend is the local nurse and has nowhere else to put it. Nevertheless, I did not sleep comfortably that night.



Photo 2.3 *Janet Taylor and the Cessna we used for surveying on Cobourg Peninsula in 1977. Photo by Bill Magnusson.*

Fortunately, the only aircraft accident we experienced happened when we were still on the ground. The propeller broke on the runway of the airport on Cobourg Peninsula, and Dave Lindner put us up at the ranger station. I published an account of that stay in the Bulletin of the Chicago Herpetological Society in 1990[54], because they were offering cash prizes for the best stories, and I was at an economic lowpoint. It is reproduced with permission below, exactly as it was published 24 years ago.

The lawn ran onto white sands which bordered the sea. The needles of the casuarina trees swayed in the breeze. From the small Cessna as we skimmed along at barely 300 feet it looked every bank clerk's dream of a tropical paradise, but there were no palm thatched huts, no deck chairs and no attentive waiters in penguin suits. This was Cobourg Peninsula, one of the remotest and most sparsely inhabited places on the continent of Australia.

The lawn was the work of nature. Salt spray and infertile dune sand had produced an effect the most talented green-keeper could only dream of. No beer cans or broken bottles disgraced the beaches and the only mark of man was the small cluster of buildings that marked the Smith Point ranger station.

Cobourg Peninsula encloses the estuary of Port Essington. It was there that the second attempt at the foundation of a township in Australia was made. Malaria ended the endeavor and now only the lower sections of a few of the original walls remain. It was perhaps lucky that the malaria, which is not endemic and must have just been a passing legacy of the Macassan fishermen, wiped out the settlement. A terrible price in terms of human suffering, but perhaps it would have been worse if the settlement had succeeded and the beautiful Port Essington had been irrevocably jolted out of its pristine state to meet the "needs" of rapacious humans. Cobourg Peninsula must be one of few places in the world where big crocodiles can be seen surfing on sandy sea beaches.

We had been surveying possible crocodile nesting sites along the coast of the Arnhem Land aboriginal reserve. The pilot was Gordon Grigg, the tall bearded professor of zoology from Sydney University who had initiated the aerial surveys, as much I suspect to satisfy his love of flying as to generate scientific data. The navigator was Janet Taylor, a graduate student studying the food habits of salt-water crocodiles. Her airsickness had not stopped her from

participating in thousands of miles of hot, uncomfortable low-level flying. Gordon Grigg referred to the third crew member as his "calibrated crocodile-habitat-evaluation machine." A 24-year-old graduate from the University of Sydney who was studying the nesting habits of the salt-water crocodiles, he was thin with a scraggly beard, and hair a little too long to be well kept. He also happened to be me.



Photo 2.4 *Ruins of the settlement at Port Essington. Photo by Graeme Wells.*

As we taxied to the end of the grassy landing strip, Dave Lindner drove up in a Conservation Commission Toyota Landcruiser. Dave was big, with more muscles in one leg than most men have in their whole bodies; he must have weighed at least 100kg. I had heard of Dave before, but never met him. An expert bushman and a dedicated ranger with a great love of wildlife, he was often at odds with his political bosses, who considered the wildlife laws political necessities, but who had no interest in seeing them enforced. Dave's mischievous schoolboy grin was awesome in combination with all that physical power.

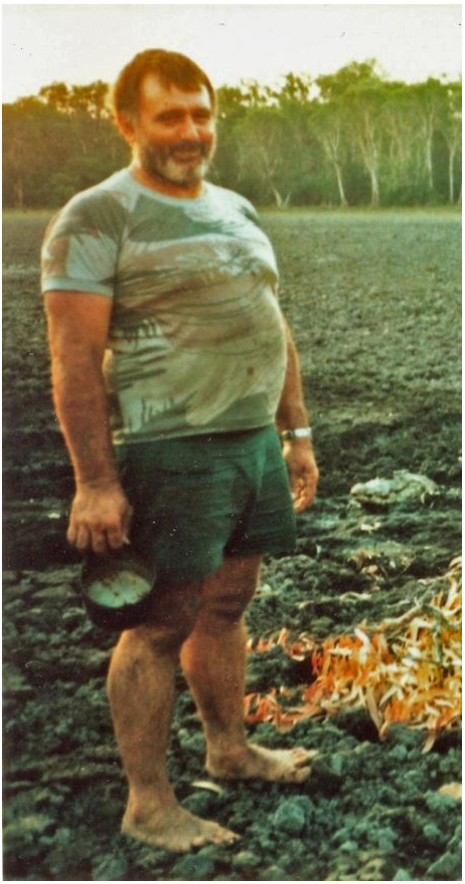


Photo 2.5 *Dave Lindner in the early 1980s. Photographer unknown.*

Dave was obviously very glad to have a chance to talk about crocodiles and quickly invited us to stay on an extra day so that we could help him catch and mark a big croc which had taken up residence in one of the lagoons near the ranger station.

Dave showed us crocodile nesting areas in the freshwater swamps that drain into Port Essington, but crocs cannot breed in the salty lagoons around the seaward shore of the peninsula. Only large crocs use the lagoons and they travel

through the sea between the lagoons, Dave's plan was to catch a big croc, mark him by surgically removing one of his toenails, and release him where he was caught. Dave would then be able to tell when and which lagoon the croc was using from the distinctive tracks it would leave as it passed over the dunes from the sea. It didn't take much to convince us to stay on. We were eager to see a firsthand example of Dave's bushcraft.

Dinner for Dave consisted of slices of slices of banteng cow meat and half a dozen hot peppers, any one of which would have been enough to put my taste buds out of action for a week, stuffed between thick slices of bread. This was washed down with half a bottle of rum. The collection of empty bottles in the corner indicated that the rum had not been brought out especially on our account. We ate the same, minus the hot pepper and rum.

I had never eaten banteng meat before. The fat accumulates on your lips and feels disconcertingly like lipstick. Cobourg Peninsula had one of the largest wild populations of banteng cattle in the world, descendants of a few individuals left behind when Port Essington was abandoned.

Though banteng are endangered in their natural habitat and potentially of great genetic value for cattle breeders, the feral animals on Cobourg were an anathema for Dave and others charged with preserving the fragile natural ecosystem of the peninsula. The banteng had already eaten out much of the understory of the monsoon forest which borders the dune grasslands, and with time would undoubtedly change the whole structure of the vegetation. It would be a shame to lose the monsoon forests with their spectacular fruit pigeons and fearless wallabies that hopped out onto the grasslands to feed at dusk.

In the morning, before we could start catching crocodiles, Dave wanted to catch a banteng calf for one of his projects. We headed out in the Toyota pickup

with Dave, Janet and Gordon in the cabin. Jimmy, a 15-year-old aboriginal youth staying with Dave, and I were standing behind on the bed of the tray.

The Toyota sped across the open grasslands behind the beach dunes and in the distance I could see the herd of banteng break cover near the dune. They looked more like antelope than cattle as they stretched for the forest, their white forelocks flashing in the sun. Dave raced the Toyota across the turf and, dodging between the occasional bush, separated a three-quarter-grown calf from the herd.

The chase soon became a trilling high. The wind rushing into my face, the animal galloping full pelt beside the car, the dips and bumps that threatened to throw me off the truck. All the emotion of civilized man throwing a hundred-horsepower machine against a lone animal. I would probably never have known how the animal felt, pitting its flesh and blood in this unequal contest, had not Dave shoved his head out the racing Toyota and yelled, “Righto Bill, jump on it.”

The man was mad! Me jump off a speeding Toyota onto a galloping cow! Confusion mixed with incredulity. The calf dodged off and Dave did some expert driving to bring us alongside again. “Jump!” He had to be mad! I tried to imagine how it could be done but every imaginary scenario ended with me having my face buried into the earth at 30 kph, with or without a banteng cow on top.

I was saved from my confusion by Jimmy swinging around my useless form and throwing himself off the Toyota onto the rump of the now very tired calf. As he bounced off he gripped the tail and kept running so that, as the calf turned, Jimmy was able to throw it over using its own momentum. He was hardly puffing.

As Dave tied up the calf, no one threw a reproachful glance, but I was determined that I would not put up such a disgraceful show a second time. Thankfully, Dave needed only one calf and we could get back to the business of croc catching.

The lagoon of murky black water was covered by a sparse forest of paperbark trees. It snaked across the plain for half a mile before turning into a shallow marshy trace where it hit the dunes. Dave had shot a feral pig and staked it out on the bank. We could see the bloated carcass in the middle of the lagoon where the croc had dragged it. “We’ve got him!” Dave exclaimed.

To stop the croc from charging off out of the lagoon and into the sea Dave had brought along a piece of tattered gill net about 10 m long. This he stretched across the mouth of the lagoon in the shallow part that had virtually no water. The net only closed about a third of the area through which the croc might go, so Dave stationed Janet and a Jimmy on either side of the net to “direct the croc into it.” I could see that Jimmy was a little apprehensive but his dark skin gave no sign. Janet went decidedly white. I could not see how a lightly built youth or a small woman could direct a charging half-ton croc anywhere, but Dave exuded confidence.

Dave, Frank (a ranger from the Alligator Rivers), Gordon and I returned to the truck to get the capture equipment which consisted of three aboriginal “fish wires,” thee-meter spears with barbless prongs made of stiff fencing wire on the business ends. The nine-inch prongs spread apart as they enter a fish and it is held firmly. To use this instrument on a crocodile you have to depend on the croc’s habit of rolling to free himself from the grip of a predator. A cord is tied to the head of the spear, around the base of the prongs. When the spear is thrust into the tail of the croc, it rolls over and over to release the spear. This breaks off the shaft of the spear just above the prongs and the croc rolls the cord around

its own tail. The tension from the cord acts tangentially to the surface of the tail so the prongs do not pull out and you have your croc. Although Dave had caught some crocs this way, it was yet to be shown that it would work for all crocs. There were only three fish wires, so Dave gave me a broom handle to prod with and instructions to call one of the others if I found the croc. We would start at the top of the lagoon and drive the croc down into the net.

We entered the water in a spirit of camaraderie and high adventure, but it was obvious from our lack of concern that neither I nor Gordon really believed we would find the croc. The water was warm and little bubbles came up from the bottom as we stepped on the accumulated litter from the paperbark trees. We were spread across the lagoon and each engrossed in poking around the cavities and recesses formed by the roots of fallen trees and the occasional patch of reeds. The brown water lapping around our knees and sometimes up to our thighs gave the illusion of being transparent but I soon noticed that I couldn't see my feet on the bottom. The chances of seeing an olive-green croc lying on the bottom were remote, but the four-foot broom handle investigated the bottom before every step I took.

After ten or fifteen minutes of unproductive prodding I found my mind wandering. I was still prodding and my bare feet continued to register changes in the bottom that would direct my broomstick but my mind was far off, constructing traps and laying nets in formations that would surely give better results than the ineffectual playing at blind man with cane. The sun was high, making flecks of light through the paperbark leaves and bringing that inexplicable and lonely quiet of the middle part of the day in tropical climates when almost all animal life takes a siesta. I no longer registered the presence of the others as they poked quietly around on the far side of the lagoon. It was as

though this was just another paperbark swamp to be crossed alone as I might have done on any day during my studies of crocodile nests.

Fifteen meters to my right I saw the telltale string of bubbles that signifies “crocodile” and my feet moved towards it. However, there was nothing in the hot stillness of the day to bring my conscious mind out of its exercises with nets and baits and ropes. I walked straight towards the bubbles trapped under the scum on the surface.

There was nothing under my feet. I fell forward, only just managing to regain my balance as the water rushed up to my chest. As I hit the bottom of the hole my attention snapped back into the real world, like a sleepwalker who takes a sudden fall. I thought, “What if there had been a croc in that hole”?

“Right, Bill, let’s get on with the job.” I looked forward to see whether I could step up out of the hole in front or if it got deeper. Although the water in front was only about knee deep, the reflection from the surface made it difficult to see what was on the bottom. I screwed up my eyes and could make out the rows of huge scales. I was less than an arm’s length from tail of the croc and I was up to my chest in the water. Is tail was thicker than my body!

Pure unadulterated fear flooded into my head. I turned slowly and called to Dave; very quietly so as not stimulate the enormous head that lay somewhere in the murky water into slashing around and reducing me to pulp in a single bite. Dave of course was too far off to hear the squeaky sound I was forcing out of my constricted throat. Courage, fortitude and “Dave!” He heard me and the croc continued to lie still in the murky water.

Dave came churning through the water like a bull water buffalo in full charge. By the time he got to the spot, I had backed out of the hole and with Dave’s

massive presence beside me my courage strengthened – at least temporarily. With just a quick smile and a "We've got him," Dave took control of the situation.

"Here, hold this," and Dave handed me the end of the cord attached to his fish wire. A quick calculation told me that, if all went well and it coiled the cord several times around its tail, I was about to be attached to a very angry 4 m croc by 2 to 3 m of cord. As the courage ebbed back out of me, Dave stood back and hurled the spear into the enormous tail with all his mighty strength.

Time stood still. So did the croc. No rolling, no thrashing. I looked at Dave. He looked at me and we looked back at the croc. The mighty tail with the spear embedded in it started to rise and the broad grey-green back came up into sight. The great head rose slowly to the surface and turned so that golden-green, fearless eye was directly on us. There were a few meters of water between us and the killing jaws, and there was no tree within 5 m of us. It seemed that my only chance for survival was to climb up on the back of Dave, my protector. This idea had to be dropped as I could see that he was looking at me with the same idea. Being climbed on by Dave was probably as dangerous as trying to outrun the croc. Fear again had free rein and the fact that the mighty Dave was just as scared as I was gave no comfort at all.

When it came we had no time to react. The great tail lifted high above the water and in one flick threw the spear over our heads. The croc took off up the lagoon in the direction of Gordon.

As soon as the croc was moving away from us, our courage came tumbling back out the trees and bushes where it had taken temporary refuge and in unison we called out, "Stop him. Gordon."

Gordon first saw the croc as it came planing over the water, spray churning off its jaws and sculling tail. His jaw dropped and the spear in his hand hung limp. To stop that croc with a fish wire would have been like trying to stop a locomotive by putting chewing gum on the rails. Gordon saw that discretion was the better part of valor and turned and started to run up the lagoon. For a few seconds it looked like a scene from a cartoon, with the coyote running in front of the train. Gordon really appeared to be running on the surface of the water but the croc was just eating up the distance between them. At the last minute, by good fortune or by design, Gordon turned off towards the bank of the lagoon and the croc just kept heading upstream, never to be seen again[103].

Common sense says we should have quit while ahead, but common sense wasn't any part of Dave's plan. The next day he decided that there was no point in trying to drive a croc towards shallow water and suggested that we shift the operation to another lagoon which had deep water near the dune end. We had all been shaken up enough by the encounter with the first croc to make us fairly confident that we would not let ourselves get into a situation we couldn't handle, so why not?

The second lagoon was fringed with pandanus trees near the mouth and a deep shady channel, 5 m wide, offered a perfect refuge for a harried croc. Further up, the brown water spread out amongst the paperbarks but the warm shallows no longer induced tranquility. Something ominous lurked there.

Dave had seen croc tracks coming across the dunes a few days before and was fairly confident that the croc was still in the lagoon. The first shock came when he said, "Well, we have to string the net across this part of the lagoon. Bill, you swim across and tie it off against those pandanus roots."

Two days before I would have done it with no qualms but having faced off the great croc the day before, the thought of swimming out over 3 or 4 m deep murky water just about released my bowels. Dave must have seen my apprehension and said “Come on, we’ll set it together.” Having someone else in the water reduces your fear by much more than the 50% that it reduces your chances of being the one who is taken, and we had the net set across the deep pool at the mouth of the lagoon in a few minutes. We then set off up the lagoon armed with wire fish wires and broomsticks to drive the croc into the net.

No daydreaming this time. I checked the depth of the water and the possibility of coming of up on a croc before each step. Everybody was nervous, having absorbed the reality that we could dig up a big croc. Even with care, unseen logs brushed against my legs and every one of them felt like it had rows of scales. It took a long time to walk down that lagoon and it was with considerable relief that we came up against the impenetrable wall of bushes that separated the upper lagoon from the pool near the dunes. Either the croc wasn’t there or he had been driven before us. As we couldn’t pass the bushes which covered the entire surface of the lagoon we started out the margin. No such luck! Dave asked, “How do you think that croc gets through to the pool? There are underwater tunnels through those bushes to the main pool.”

“So what, Dave”, was our unanimous reply.

“Come on, we just have to dive down there and swim through the tunnels, poking the broomstick to drive the croc in front of us as we go.”

After some discussion it was decides that only Dave and I were stupid enough to do it. Perhaps I acceded in part because of the shame of the banteng episode. Who knows? We each grabbed a broomstick and dived down into the murky water to try to find the tunnel by feel. The stems of the bushes were

interlaced like contorted prison bars, slippery and unyielding. I wriggled into an opening, groping in front for something to pull myself along with and praying that it wouldn't be the croc. There were only about 5 m of bushes but fear saps the oxygen out your lungs soon after the water takes away your vision. In theory, you can keep prodding in front with the broomstick but, it practice, when you are the middle of the bushes, running out of air and not even sure if you are heading down an exit tunnel or entering an airless labyrinth, it is difficult even to drag the broomstick along behind. I stopped worrying about the croc and kicked and groped, fighting the instinct to try to reach air through the tangle of bushes above me.

Suddenly there was nothing but water around me. Gasping, I surface in the pool and found that Dave had made it through before me. No, there was no croc in the lagoon, or at least, if there was, he did not deign to be driven around by mere humans. I had learnt a valuable lesson though. No matter how well prepared I was, Dave Lindner was capable of getting me into a situation that was well beyond my ability to resolve. We flew out of Smith Point the next day without having laid hands on a croc.

That was all back in 1977. I now know enough about crocodile capture techniques to take those crocodiles safely and relatively surely. However, I am glad that there are still mighty crocodiles on Cobourg Peninsula that have never been subjugated to technology. I hope that there are still men like Dave Lindner around who are willing to pit flesh and courage against flesh and cunning. Others may well take advantage of high technology to weigh, measure and analyze many more of the great animals. But perhaps they will never really know them.



With the advent of the research assistants, there was even a day a week programmed for relaxation; something that I am sure that Webby never would have countenanced on his own. We went fishing on the offshore reefs for rainbow-coloured coral cod, mangrove jacks and Spanish flags. Wellsy took me up river and showed me how to fish for barramundi with a troll line and a silver spoon as a lure. I threw out the lure, using a 40 lb breaking strain line and hand caster. The first and only barramundi I caught on a line that year weighed 15 lb. It grabbed the lure and almost tore the line out of my hands. Without gloves, the line burned my fingers but I had to stop each run before the fish tangled in the mangroves. Wellsy was amazed at the size of the fish and it was the largest that anyone caught that day. In fact it was the largest barramundi that anyone in the project would catch for some time - but that's another story.

What better way to spend the day before Christmas than swimming in a Northern Territory billabong? The day was hot and clear, and the crystal-clear water of the billabong reflected the masses of red-flowering gums along its banks. We dived into the transparent water, scattering the hordes of tiny fish to hide under the mauve and yellow water lillies that lay like a floral rug over each end of the pool. We had been told that saltwater crocs never went that far into fresh water. Many people have since paid with their lives for the same foolish assumption, but we were ignorant, and ignorance is bliss. We drove back to a Christmas dinner of buffalo meat, mud crabs and barramundi. Our first Christmas together, and we had plans that just had work.

Wellsy, Webby and Anna went spotlighting crocodiles that night, but a storm developed. They were drenched by rain by the time they got back and very cold, but that didn't dampen their spirits too much. Anna told Wellsy that Graham Webb proposed to her later that night.

The rain continued the next day, making work on the river uncomfortable, but nobody except Graham Wells, who was very sensitive about cyclones, was particularly worried. Webby had heard on a BBC broadcast that a cyclone had hit Darwin, but we were relatively unconcerned until we went to a Christmas party about 3 pm. It was only when the police officer said "One in three policemen in Darwin has lost their home" that we realized the seriousness of the situation. There seemed to be something wrong with the world. Disaster and death were things that happened to strangers in other lands, weren't they?

We were worried because Dennis Puffet was on holidays and should have been in Darwin when Cyclone Tracy struck. Unbeknownst to us, there had been a last-minute cancellation and Dennis and his family were able to fly out to attend his neice's wedding on the eve of the cyclone. At that time, the cyclone was on a different track, but it turned and destroyed much of Darwin soon after. Dennis' house was completely destroyed, and it is likely that he and his family would have been killed if they had stayed. The only thing that was salvageable was the expensive Canadian lead line that had been imported to use on our nets and was waiting to be shipped to Maninagrida. It survived the storm under the wreckage.

We spent the day working around the base and listening to the radio for news of Darwin. The barges that served Maningrida were inoperative and nobody knew if the Connair planes still existed, much less when they might fly again. The local police officer asked whether we could help supply food for the 600 people in the township during the crisis, and Grahame Webb offered our services to catch and stock barramundi in our walk-in freezer.

We had caught other fish occasionally while netting for sharks, but Graeme Wells and Dennis Puffett were the only members of the team with first hand

experience of commercial fishing. Dennis was down south and we had no idea whether he would return.

We set out for Mungadobolo Creek, which enters the Liverpool River just south of the the Tomkinson River, the boat laden with gill nets and fish crates. Wellsy nosed the boat into a channel that drained an exposed mudflat. The channel was not much wider than the boat, and it was hard to believe edible-sized barramundi would swim up that murky trickle. However, we followed Wellsy's orders and strung the net across the mouth of the channel.

The first fish made the buoys on the net bob, the second pulled them underwater for a few seconds. The rest of the school dragged the net down and we lost sight of the buoys. Many of the barramundi were near a meter long and well over 10 kgs. They jammed their heads through the mesh and the cord tightened into their gill slits. The sharp spines on their fins caught in the net and spiked our hands. We had to lever the net off with a screw driver while straining to stop the fish in the water from dragging back the one we were working on. By the time we had removed the fish by sliding the boat along the net in one direction, the net had filled again.

In an hour, we had filled the fish crates and we pulled the net in with tired and bloody hands. There were still many barramundi tangled in the net, which we just rolled up and laid on top of the fish crates. As we ran back to the base, I let my hands trail over the side so that the cool water would clean the black mud and fish slime out of my many wounds. I was content with our success and ready to relax, but my joy was premature; we still had to clean hundreds of kgs of fish.

The fish crates were stacked in a long line beside the stainless-steel basins of the fish factory. Wellsy showed us how to slice off a fillet, flip it over and

separate the skin from the flesh. He cleaned a fish in less than a minute, but we took ten. The fish slime burned our cuts, and the hundreds of fish took many hours to be reduced to packets of frozen fillets. Wellsy measured the fish and noted their reproductive state so that he could send the data to the Northern Territory Fisheries Department for their records. It was only much later that we learned that, as a result of this, he had been listed as a probable barramundi poacher.



Photo 2.6 *Grahame Webb and Anna Wilkinson with student volunteers on the beach in front of the Maningrida base in December 1974. Photo by Graeme Wells.*

The after effects of the cyclone were causing torrential rain and we were tired from working crocs all day and barramundi at night. However, Dennis and his family were safe, the barge appeared a few weeks later, and the crisis passed, leaving us with 1000 lb of barramundi in the freezer, much of which we donated the Maningrida Progress Association store.



The Cessna buzzed the base and Grahame drove out to the airport to collect the latest arrivals from Sydney. I cancelled my excursion upriver for that day and packed away the equipment. The plane meant new faces to brighten the breakfast table and news and presents from home. I knew that very little that happened in Sydney would be of interest in comparison to the most mundane adventure in Maningrida, but the ties to home were still strong.

I was making coffee for the new arrivals when Gordon Grigg walked in. “Bill, there’s a package for you in the back of the Toyota” he said. Gordon had been assiduously trying to overcome my fear of machines since I had started my Ph.D. and I figured that he had found some new gismo to make my life easier and more profitable.

There was nothing in the back of the Toyota. Perplexed, I walked around the tray and my girlfriend, Janet Taylor, sprang up from behind the wheel and wrapped her arms around my neck. I was overwhelmed by the strangest, most contradictory feelings. I had been missing her and dreaming of having her in my arms, but she also represented home, and home shouldn’t come to Maningrida. I tried to react spontaneously, but I am not sure that I was convincing. I hadn’t realized how important Manigrida had become to me as a place in which I could develop unencumbered by the traces and prejudices of home. I wrapped my arms around her and waited for the feeling of an icewater douche to pass.

Bill Green moved across to the caravan I had been using so that we could have the beach flats on the point of the peninsula. Isolated from the rest of the base, with a spectacular view of the Liverpool estuary, we had been given what many couples work a lifetime to achieve. However, the spectre of the thesis I

had to write, and the expectations of so many people that I had to live up to, meant that I could not appreciate what I had. Nevertheless, I think that Janet could feel the potential of all she had in her hands. It was a shame that she did not have a more mature man to share it with. Maybe it would have been better if I had understood what I was feeling and been able to explain it to her, but I had been trained since birth to always leave the most important things unsaid. I guess I was just like everyone else.



Photo 2.7 *Bill Magnusson and Janet Taylor around 1978. Photographer unknown.*

I found out later that Gordon had been keen to have Janet in the project because he thought that I was so involved with the aboriginal community that I might end up marrying an aboriginal girl and not finishing my project. In fact, I never had an aboriginal girlfriend, and Janet ended up spending even less time with me because her project involved surveying rivers on the project's ship in

the dry season, which was the time of year I would have spent with her if she had remained in Sydney.

It was good to have Janet along on the nest surveys. She drove the boat and I stood in the bow with Agaral or Djabaleebee, trying to train my eyes to locate nests as well as they did. It was a futile exercise. Agaral would be talking to me, apparently paying no attention to the scenery. Then his arm would shoot out perpendicular to his apparent angle of vision and he'd say "nest". I paid close attention to their eyes, which did not flicker from one side to the other as mine did when I was trying to cover both banks at the some time. They maintained a continual, apparently unfocussed, stare. As a speed reader absorbs all that is on a page in an instant, their eyes registered all that was in the arc of their vision. I tried to focus sequentially on every detail in the scene as I would read the words in a sentence, and most of the world passed by before I had time to register it. The optics of my eyes were at least as good as theirs, but my training in school as a child had robbed me of the connections in my brain that would have let me make use of all the images that impinged on my retina.

It was the third nest that we had found that day. It looked perfect, a mound of grass and mud half a meter high which could serve as an incubator for the eggs, which needed fairly constant temperatures for three months if they were to hatch. We tied the boat to a small bush and approached the nest slowly, cautious of the pool of muddy water at the side of the nest where the mother could be lying; waiting to defend her brood. Agaral poked a stick gingerly into the wallow. His delicate probing revealed no crocodile and he and Djabaleebee burst in broad grins, laughing to relieve the tension of an activity that they realized so much better than us could be a matter of life and death.

With one eye on the river, where the mother could be watching, I slipped my hand into the soft warm grass of the mound. When my elbow started to

dissappear into the leaves, my fingers touched the hard porous shell of the eggs. They scraped against each other as I slipped one out. I did not have to open it. The smell seeping through the shell told me that the perfect mound had already been flooded and the eggs killed. We could weigh and measure the eggs but I began to despair of ever finding a successful nest. It seemed impossible to believe that all the eggs could be killed by flooding. I returned to the base with the irrational feeling that I was somehow responsible for the deaths of all the eggs; it hadn't been in my thesis plan.

The next day, the base was humming with activity as part of the group prepared to return to Sydney. Professor Charles Phipps of the Geology Department, and four student volunteers would return to Sydney in the Cessna, which was due to arrive that day. Anna, who was soon to become Grahame Webb's wife; Grahame Wells; Fred Duncan; Janet Taylor, Professor Phipp's son, and I would stay on.

Grahame Webb had taken me aside the night before and explained his preocupations with the project. As we walked along the sandy track between the gums he stared at the ground and his tone lacked its usual assurrance. He said that he had serious concerns about the project. He was starting to lose confidence in Professor Messel's ability to run the project and he thought that Gordon Grigg and the Physicists were trying to exclude him from the decision making. He said that he would return to Sydney and try to define who would be first author on the papers that would come out of the project, but he did not feel confident of success.

I listened silently, unsure of what I could say. As a student I had imagined that there existed a gulf between Professors and students. Now I was seeing a gulf widening between the Professors that was far wider than any that I had imagined between teacher and student.



Photo 2.8 *Janet Taylor keeps a watchful eye out for crocodiles as she crosses a shallow lagoon while searching for nests. Photo by Bill Magnusson.*

Grahame stopped and looked up, his lost confidence returning suddenly. "Don't worry Bill, maybe I've been up here too long – I'll work it out. The main thing is that I am leaving you in charge. You not only have to look after your own work, you'll have to keep the base running".

I nodded, but I was far from happy. I had serious doubts about my ability to carry out my own project. Now I was to be responsible for the field operations of a multi-million dollar project that involved dozens of people. Grahame was obviously relieved to have gotten his feelings off his chest and his step was lighter and more determined on the return. Somehow, much of the weight seemed to have shifted across onto my shoulders and I did not look forward to the responsibility.

Maningrida airstrip had been closed because of the heavy rain and the Cessna had to divert Millingimbi, to the east. I left alone to survey nests on the Tomkinson River, expecting everyone to be there when I returned. The day was overcast, but the conditions were not unusual for that time of year. By four in the afternoon I was hot and tired from walking the banks looking for nests, and I returned to the boat. The first drops of rain started to fall as I brought the outboard up to full power. I had forgotten to bring wet-weather gear and the rain hurt as it slammed into my bare skin. I tilted my head forward and half closed my eyes to reduce the number of drops that smashed into my eyeballs, but I was only partially successful. The river was narrow and the boat slammed up against the vegetation, which was difficult to distinguish from the grey sheets of rain. Rain squalls usually pass quickly, but after an hour I was still pushing into an almost solid sheet of water. My fingers were white and I was shivering uncontrollably. The boat bucked as I ploughed into the turbulence near Bat Island, but the salty splashes were much warmer than the rain. It was still early, but the world had been transformed into chilly shades of grey. The thumping of the boat against the waves jarred my spine and I had to stand, exposing more of my body to the driving chill.

It was already dark and the bay was full of white caps as I anchored the boat and slipped over the side into the warm water. The wind had whipped up breakers, and I surfed the last five meters onto the beach.

I dried off on a towel and wrapped my fingers around a mug of creamy coffee. The atmosphere in the mess room was cosy, but I was surprised to learn that Webby, Professor Phipps and the students had set off for Millingimbi in two open boats late that afternoon. Professor Phipps was in a hurry to return to Sydney because of a conference he wanted to attend, and had suggested that they could reach Millingimbi by boat, passing through the open sea at the

mouth of the Liverpool estuary and crossing Boucaut Bay. Graeme Wells had a lot of experience in the north, and knew that it would be a long and dangerous trip under the best of conditions. However, when he confronted Professor Phipps with the folly of the adventure, the Professor replied “It’s as calm as a millpond out there”.

Everyone was worried when we went to bed that night, but there was nothing we could do until first light. Wellsy radioed Millingimbi the next morning, but they had no news of the two boats. We contacted the police and they verified that the boats had not made Millingimbi during the night.

The sea was still choppy, and it would have been folly to to try to follow the same route, but I decided to load a boat onto the Toyota and take it out to a landing on the headwaters of the Cadell River. I would be able to follow the Cadell down to its junction with the Blyth and then pass into Boucaut Bay. The Blyth was the only safe harbour between Maningrida and Millingimbi, and I was hoping that they had made camp on the lower reaches.

Prof. Phipp’s son was worried about his father and Anna was just as concerned about Grahame. They came to the truck to see me off as the police sergeant drove up. “Good news Bill, a mission plane has spotted both boats on a beach in Boucaut Bay. They saw 5 people on the beach”. Anna and Phipp’s son stood paralyzed. One person was missing, and I was sure that each was praying that it would not be his or her loved one.

“I’ll take the 3 wheel ATV and try to reach them by running along the beach from Judda Point” I said.

“That’s good, do you have a trolley that you can drag along behind?” He asked.

"We do, but it will slow me down and I can take supplies for them in a haversack". I said.

"Yes, but the body has probably washed up on the beach and you can pick it up and save me a trip out there." he said matter of factly.

I looked at Anna and Phipp's son. They were talking to each other and hadn't heard. I dragged the policeman off to the side. "Please, let's worry about the ones that are alive. If there's a body we'll get it back for you later on" I said with confidence and authority I didn't have. Inside I was saying "Why me, can't somebody else be responsible for this?" To be responsible for people's lives meant that I had to be responsible for their deaths as well. I hadn't even been in charge when it happened, but somehow it didn't matter anymore. I got the gear together and tried to think of all the things I should do but my mind kept alternating between "It can't be true, I must be dreaming" and "If only I had ...." I was frightened, but couldn't let the people who depended on me know how I felt.

I pushed the ATV out of the compound as Webby walked in. The sixth person was accounted for and suddenly there was no urgency. The Millingimbi Mission radioed that one of their fishing boats had picked up the group on the beach. We crowded around Grahame to hear what happened.

They had left for Millingimbi in two boats. The sea conditions were rough, but all went well until they entered Boucaut Bay. Webby was driving the 17 foot Hercules with the fuel and students, but he shifted the students to the 14 foot boat with Professsor Phipps as the Hercules was water logged and had the 200 litre barrel of fuel. It was then about two thirty in the afternoon and they were out of sight of land. The wind was so strong that Grahame had to cut off

the canvas canopy. Then the boat careered up a huge wave so that the motor came out of the water. As it crashed down the other side, the engine stopped.

The other boat came back, and the students climbed into the Hercules to help. The drum had moved and cut the fuel line. Grahame got the motor going, but the 14 foot boat was swamped by a wave. They tried to use the Hercules to drag it out to sea with a rope, which broke, and Webby had to keep going forward to try to drain the boat. The broken rope wrapped around the propellor of the Hercules, which capsized. There was a handrail around the Hercules, to which they tied ropes to help secure people because about every sixth wave washed over the boat. The fuel drum had not come completely loose and it continued to leak fuel into the water, burning their genitals. The thinnest of the students soon became paralyzed by the cold and could not maintain his hold on the boat. Grahame held him between himself and the boat. There seemed little hope of survival as it got dark and the battering and cold sucked out their strength, but about 9:30 pm they felt sand under their feet and the boat was washed onto the beach.

They huddled together on the beach until first light. Professor Phipps had also been washed up onto the beach, had already dragged the 14 foot boat above the surge line, and had done what he could to drain the water out of the engine.

The sun brought only temporary relief. The beach was at the leading edge of many kilometers of dunes and mangrove swamps. There was no freshwater and precious little shade. The thin student became delirious and they had to restrain him from running into the dunes and becoming lost.

While Prof. Phipps organized the students to drag the Hercules up onto the dry part of the beach, Webby set out to find help. He thought they were on an island rather than the mainland, and walking along the sandy beaches he came

across a few Aboriginal skulls and skeletons sticking out of the sand. When he came to the Eastern side of the Blyth, he thought it was a channel between islands and the mainland, and got worried about following the back of the mangroves up into the hinterland. Therefore, he started walking south, but each few hundred metres he walked through the mangroves until he could see the water, which he thought was a channel between islands.

Finally, in the distance, he saw an Aboriginal man, and he says he had never been happier. The man recognized Webby from at least a kilometre, but Grahame didn't really know him. He walked Grahame back to his community camp, rested a little, then took him across the Blyth in a dugout canoe. This brought them to the settlement of Kapanga on the west side of the mouth of the Blythe. The head man, named Big Barney, was huge and had lost half his nose to Leprousy. He fed Grahame damper cakes, and assigned a man called David to guide him back to Maningrida.

Along the route around the coast, they came to a creek and David said that they must wait for the tide to go down. They ate native red apples and had to bury themselves in the sand to get away from the mosquitoes. About 2 am, when David decided that the tide was low enough, they waded across the creek and continued walking in the direction of Maningrida. When they stopped, their muscles started to bind up, so they just kept walking the whole 40 km, and arrived at the base just in time to stop me heading out on a fruitless search with the ATV. Once they stopped, it was three days before either of them could walk normally again.



Somebody had to retrieve the boats from Boucaut Bay, so Janet and I set off overland to the Cadell landing, planning to survey for crocodile nests as we travelled down the Cadell and Blyth Rivers in the direction of Boucaut Bay. David, the man who had guided Grahame back from Kapanga, went with us as a guide.

We set up camp at the Cadell landing and slipped the boat into the water. The upper reaches of the Cadell disappear into an impenetrable swamp covered by sedges and climbing ferns. However, the lower reaches have wide floodplains like those of the Tomkinson River. Below its junction with the Cadell, the Blyth River loops slowly across a broad floodplain. The tide had started to fall and green mangroves drooped over grey mudflats. It was much like the lower reaches of the Liverpool River, but something was out of place. It took me a while to realize that it was the mudskippers. On the Liverpool system, the little bug eyed fish were only about the size of a little finger, and you had to be close to see one. I could see the mudskippers from mid channel on the Blyth. They were the size of cucumbers, but flipped around on the soft mud in the same unfishlike manner as their smaller brethren.

Boucaut Bay was as smooth as glazed tiles as we left the Blyth. It was hard to believe that it had almost taken the lives of 6 people a few days before. David guided us through the muddy channels into open water.

We could see the boats on the open beach even though they were still many kilometers away. I would have made straight for them, but David took us out into the bay away from the shelving beaches that make Boucaut Bay so dangerous during a storm. When we reached the boats, we lifted the outboard motor and ran straight up onto the beach through the knee-deep water.

It was easy to drag the 14 foot boat down to the water, but the 17 ft Hercules wouldn't budge. The three of us heaved and pulled, but our feet just dug deeper into the sand. It seemed inconceivable that Prof. Phipps and the three exhausted students had been able to drag it up the beach. We tied anchor ropes from all of the boats together and made a tow line that reached far enough out from the beach to operate the 40 hp motor. The tide was dropping quickly and it seemed that we would soon have all three boats stranded. Janet drove the outboard and David and I rocked the Hercules to release it from the sand. At first the 40 hp motor made no headway and just crabbed sideways, churning up clouds of sand in the shallow water. David and I pulled desperately and the Hercules inched slowly down the beach to the water.

It took an hour to reach the mouth of the Blyth, towing the two boats and their heavy motors. It seemed that we would have to run all night to reach the landing and I wasn't sure that we had enough fuel. However, once in the calm water of the river, I started to tinker with the motor that Professor Phipps had so carefully dried out. It worked on one cylinder and we were able to bring all three boats up to close to planing speed.

The adventure was over, the boats and motors had been recovered and could be fixed, and nobody had died. We continued the routine work, but I had lost the invincible confidence of ignorance. Death had come close and I had learned that he might never be far away.



The Boucaut Bay escapade was not the last of our rescue operations. I was nominally in charge of the base, but I didn't realize the bureaucratic implications of that position. The Police sergeant said that two men from Elcho Island

who had been adrift in a small boat for a week had been spotted at sea off the mouth of the Liverpool River and asked if we had a boat that could rescue them. We did not generally venture far from sight of land, but Wellsy said that he would have no trouble in taking one of our boats out to find them.

Wellsy and Fred were guided by a mission plane and found the castaways in debilitated condition more than 20 km off shore. Their prompt action probably saved the lives of the drifting men, and surely cut short their suffering.

It seemed a job well done, but a few days later the Police sergeant appeared again and asked who had been responsible for authorizing the rescue operation in the small boat. When I said that I had authorized the operation, he looked at me seriously and said that I might be prosecuted for authorizing a rescue without permission.

Apparently, the rescue operation had been passed to the federal authorities, who had sent a destroyer at great expense to rescue the castaways. Once in federal hands it was illegal to conduct a rescue operation without their consent. It reminded me of a story my father had told me about a friend of his during the Second World War. The soldiers were instructed not to fire into rubber plantations, because the rubber was essential for the war effort, but a Japanese sniper was shooting the Allied soldiers from a position high in a rubber tree. My father's friend shot the sniper, which resulted in him receiving disciplinary action for "firing on the King's enemy without the King's permission."

As it turned out, I heard nothing more about the rescue, but I had been alerted to the complexities of running a large research project. When I coordinated major projects more than 30 years later I discovered that details associated with labour laws and safety regulations could make or break a project, and I sometimes had to justify my decisions before a judge who had no interest in

science and no experience of working in remote areas where rules could cost lives.



I was irritated because one of the geology students working with the project wanted to shoot the crows that perched around the base. He was adamant that someone told him that crows can kill lambs, and this gave him the right to shoot them. The fact that there are no lambs in Arnhem Land did not make any difference.

As Webby had gone south, I was in charge, but I had no more years or experience than the geologist. Many people who stayed at the base for more than about 6 weeks started to become irrational and develop persecution complexes, either about their coworkers, imagined enemies down south or, in this case, crows. I couldn't understand the behavior; much less did I know how to counteract it. People develop deep emotional problems if they feel socially isolated, even when surrounded by many strangers in a large city. Isolating people in small groups away from their friends and family seems to stress an even greater proportion of people. The term for isolation depression in Australia is "bush happy" or "gone troppo", and in the USA it's called "cabin fever".

I could use my authority as the person ostensibly in charge of the base to stop the student shooting the crows because, although we had permits to take game for subsistence when in the field, we did not have permits to shoot around town, or to kill animals that we did not need to eat, and which could have religious significance for the local people. However, the same student stopped working and spent long hours in his room, a situation critical for the other geology student who depended on him for help in collecting data for their joint project. I

had always shirked leadership, and my socialist upbringing made it seem wrong for one person to dominate another. It would take me another 30 years to fully understand the importance of leadership to the wellbeing of people, but I had no choice. I went to his room each day, woke him, and otherwise made sure that he and his research partner got their work done. To someone like me, with few social skills and a deep feeling of inferiority, none of that was very easy.

I am no longer so sure that I am as socially inferior to others as I felt back then. However, I noted a strange change in attitude towards me by people who were undoubtedly my superiors in anything relating to crocodilians. The aboriginal guides, and even elders began to treat me differently. They had always treated me politely, but now they seemed to be treating me deferentially. As I was in charge of the base, I had to be consulted about administrative matters, but people seemed much more anxious to talk to me about crocodiles than could be justified by my limited experience and negligible command of pidgin or any of the indigenous languages. It was some time before I came understand why they considered me extremely brave and knowledgable about crocodiles.

I had been spending quite a bit of time in the field looking for crocodile nests with different guides, but mainly Agaral and Djabaleebee. They could go all day, walking quickly and carrying only a knife. For nourishment, they would eat palm heart from the ubiquitous small palms in the area, and supplement with white kaolin clay from termite mounds, which fills your stomach and leaves you satisfied when you have nothing very nutritious to eat. It probably also neutralizes toxins from almost inedible fruits. I could eat the palm heart, but couldn’t swallow the white clay.



Photo 2.9 *Jacky Ajaral on right, 1979. Photo by Grahame Webb.*

On these expeditions, we would often come across flooded areas that were less than a meter deep, but sometimes blocked our path for 100 m or more. The first time we came to one of these, Agaral touched my shoulder, pointed to the other side and said "crocodile." I couldn't see anything and, after about a minute of him trying to explain where it was, I asked him how big it was. He held his hands about a hand-span apart, which would be smaller than the length of a hatchling. This was good news to me, because it indicated that there might have been a nest nearby, and I headed into the backwater making towards the spot where I thought the crocodile was. However, I could not see the croc, even when close to where it should have been, and we continued on looking for nests.

The same sequence of events, a guide pointing out a small crocodile, but I not being able to find it, occurred many times, and each time the hunter's attitudes towards me seem to change subtly. Instead of being an almost irrelevant white

burden they had to look after, it was as though I was one of them, and they looked forward to going bush with me. Much later, I found out that they measured the size of a crocodile by its width. Obviously you can't show the total length of a big crocodile by the distance between your hands, but the silly white kid hadn't thought of that. My assistants were overawed by the fact that they would show me an enormous potentially man-eating crocodile, and I would bravely lead them right past it as though it were just a little hatchling. After I found out my mistake, I never again led the group near a big crocodile, and would let them decide the route to take. However, my reputation was made and it gave me an undeserved ticket into the world of hunters and crocodile worship.



Most of the team was down south, and Janet, Wellsy and I were looking after the base when we got word that the physics team had a radio transmitter ready to be tested on a big crocodile. The only big crocodile that had been captured since the croc in "my" trap had been captured in a remote billabong and had died during the filming of a sequence for the US television show Wild Kingdom, which I thankfully did not take part in. We had a radio that could reach Sydney from Maningrida; the only one that powerful in Australia outside the armed forces. I always hated talking on the radio and I carefully pronounced all the words slowly, thinking that I was aiding communication. It made me sound so ridiculous that members of the team taped it and played it back to me. On this occasion, I didn't have to say much because Webby just said "We've got our radio transmitters just about ready. You should start setting croc traps as soon as possible. When you get a big one, call us and we'll come up."

Catching crocodiles wasn't my job, but it would have been churlish not to give it a go considering the amount of time and money that everyone had invested in my project. We set a trap near the mouth of the Liverpool where we would pass each day. I was eager to test my intuition as to a good site to catch a big crocodile. Wellsy, Janet and I set up the trap in mangroves along a high bank. The croc would only have access at peak tide, but there was nowhere else much better. The floor of the forest was covered by the aerial roots of the mangroves, making it look like a bed of blunt nails. We put the trap well back from the water so that the croc couldn't roll off the bank and drown, tangled in the net.



Photo 2.10 *Crocodile in the trap near the mouth of the Liverpool River. Photo by Graeme Wells.*

The water was glassy as Janet nosed the boat up against the bank and I jumped out among the spiky mangrove roots. The croc had forced its way through the mesh and the venetion-blind cord holding the joins had given way.

The net was still holding the body, but the croc's head was completely free, and he only needed to snap one more join to be able to run for the river.

We had not expected to find a croc in the trap and had not brought equipment to deal with it. Although it was lying still, we knew that, if it decided to react, the flimsy cord would snap at the first move. The safest course seemed to be to tie its jaws closed and then for me to sit in front of it as a psychological barrier, or at least something to keep its attention, while Janet returned to the base for help.

I edged forward, careful not to slip on the mangrove roots. The croc watched me, its eye holding me in a stare that seemed to bore into my soul. There was indifference, or perhaps even a bit of curiosity in that eye, but no hint of fear. The upper jaw came up to my waist and the lower drooped to the level of my knee. Each tooth was as long as my thumb, but I kept watching the eye.

I let the rope dangle beside the jaw and slipped my hand under the other side to bring it up and form a loop. Very slowly, I brought the ends of the rope together over its snout to form a knot. My feet sunk deeper between the roots and I felt imprisoned, betting my life that the croc was too exhausted to react, or that it would not deign to bite such an insignificant creature as myself as it hurtled for the water. I pulled on the two ends of the rope and the knot tightened, slowly forcing the jaws closed. When the teeth interlocked, I closed the knot and started to breathe again, but the croc just continued to stare into my soul. I had locked the jaws, but I felt that the victory was his. It seemed beneath his dignity to acknowledge my presence by physical force.

With the jaws safely wrapped, Janet could head back to the base. I sat alone in the gloom of the mangroves and watched the croc as the sound of the motor subsided in the distance. At more than 3 m long, the croc was large enough to

swallow all of me and his belly would hardly bulge. He was as much a part of the estuary as the mud and the mangroves. I was a visitor to his world, but I thought that I had won the physical battle. As if to show how wrong I was, the croc shook its head from side to side, hardly putting strain on the net, but the rope slipped off its snout and plonked into the mud beside me.

The first thing that Webby had taught me about crocs was to always slip a turn of the rope between the jaws so that it will catch on the teeth and not slip off. Fear and haste had clouded my memory and now I sat with my back to the water, watching the golden eye above the open jaws. I had won nothing, and the croc had moved only enough to prove it to me. We were alone and sitting in his world.

I stood slowly, watching the eye and wondering what he expected me to do. I picked up the rope and walked over to my adversary, or was he my teacher? I looped the rope around the upper jaw behind the two longest teeth, tied a knot, slid the rope under the lower jaw and, ever so slowly, lifted it up until the teeth in both jaws meshed together. I was alone and more vulnerable than the first time, but I felt that he would let me do it.

I had been scanning the croc's body and thinking of ways of containment while Janet was there, but when I was alone, crouched in front of the crocodile, the only thing that held my attention was his eye. It was as though I was being drawn into it, to a world much bigger and mysterious than the one I was sitting in. I should have been afraid, but I wasn't. The croc seemed to be communicating with me and I felt strangely calm, but at the same time exhilarated. I was crouching awkwardly, mosquitoes were buzzing around me and the mangrove mud exuded warm sweetish vapours. However, I did not feel out of place – it felt like home!

It must have taken Janet less than hour to get back with Wellsy and some hefty assistants, but by that time it seemed as if I had travelled an infinite distance with the croc. I felt as though I was floating, and felt nothing of the mud and roots and sandflies.

I came out of my reverie when the boat thumped into the bank, and my thoughts returned to securing the croc so that it couldn't escape with its mouth tied. The five of us manhandled it into the boat, and it put up little fight. Back on the beach, Wellsy arranged for the town's front-end loader to carry the croc up to the laboratory where we could weigh and measure it, and keep it until the physicists arrived.

They didn't come. I radioed Grahame and he said "I didn't think you'd be able to get a croc that fast. We're not ready – you'll have to release it." I must admit, I was a little annoyed. I had taken off time from my studies, but it wasn't just that. I had risked the life of a magnificent creature. I went over to the lab to tell the croc. It was tied up tight and I took the blindfold off so that I could look into its eyes. They were open and I could get very close, but there was nothing there. I could not regain the feelings I had that morning. In the wild it was a magnificent creature but, without the mangroves, mud and the river, we had robbed it of its power. I have never since been able to look at a captive crocodile without a severe sense of loss.



I received a surprise visit from Graeme Caughley. As far as I know, Graeme only ever supervised 3 Ph.D students, and I was the last. At that time, he had two students. One had taken the university medal, received first-class honours, and was generally regarded as a rising star. The other was me. I had received

second-class honours and was not regarded as exceptional. In fact, I had been in Maningrida when the results of the honours selection had been announced in early 1974 and my mother called the university to see whether I had been accepted. Professor Charles Birch, one of the world's most famous ecologists, answered the phone and said "I'll check, but I doubt it. He's not very good you know." An honest appraisal, but not something you say to somebody's mother!



Photo 2.11 *We borrowed the Council front-end loader to transport the crocodile from the beach to the laboratory. Photo by Graeme Wells.*

The student with the university medal had great difficulty completing his post-graduate studies. Although he was good in the class room, when his study animals were accidentally poisoned by farmers he did not show any great initiative to get the study running again. Graeme had to work hard to get him through the university system. His only other Ph.D student was universally acknowledged as the weakest Ph.D. candidate in the department, so Graeme decided that he had better find out what I was doing, and got a lift in the Cessna when Gordon Grigg came up for aerial survey.

I had had little correspondence with Graeme Caughley since I had started the thesis project. He sent me copies of the letters he received from the university wanting to know why I wasn't on campus. Although the overall thesis plan and analysis had been decided with Graeme Caughley, it was Grahame Webb and Gordon Grigg who had helped me with all the practical aspects. At the time, it was university policy that students should not be off campus for more than 3 months a year. I had to spend 8 months a year in Maningrida, and Graeme had to stall the bureaucrats, defending a student he hardly knew. This wasn't as hard for Graeme as it sounds. He had a deep dislike of bureaucrats, and I suspect that he would have defended anyone from them, right or wrong.

The crocodiles hadn't started nesting, but I could show Graeme nest sites from the last year and the equipment that I was setting up. I was, and still am, technologically backward. Gordon Grigg had ordered a waterproof time-lapse camera and arranged for the physics department workshop to make a 4 m high support for it. He also purchased electrocardiograms, oxygen meters, and other sophisticated equipment that I never would have gotten on my own. I could use them, but without Gordon I never would have done so. At the time, I didn't even have a camera!

The only piece of equipment that I had made was a flood-height gauge that I installed near nests. It consisted of a 2 m wooden stake, a thin copper tube used as a lever arm that swiveled on a nail near the top of the stake, and a reel of thread covered in grease. A float on the end of the lever lifted it when the area flooded, and cotton attached to the other end of the lever unraveled as the lever-arm was suspended. I could determine how high the water had been by lifting the float until the lever pulled the cotton taught against the reel. It was not very sophisticated, but it worked well, except when the female crocs, which didn't like the orange floats, chewed them off. Graeme was impressed by my ingenuity.

It wasn't really very ingenious, but I was favored by the comparison with his other student, who had all the technological advantages, but was doing little.

Graeme liked being in the field and, despite being a very competent theoretician and statistical modeler, he showed greater enthusiasm for adventure than for academic posturing. He sat in the front of the 14 ft boat and I gunned the 40 hp motor so that we sped along the edge of the mangroves lining the Liverpool River. In an open boat, the water is close enough to touch, you can safely brush past the leaves on the overhanging trees and, if you're lucky, the wind may even blow droplets of water onto your face so that you can taste the warm salt. I could see that Graeme enjoyed it as much as I did.

I knew where a croc had nested behind the mangroves the year before, and I maneuvered the boat through the narrow gap between the flooded trees. The path through the mangroves wasn't very wide, and the leaves brushed against us, but the soft leaves posed no threat. What I didn't know was that wasps had built a nest in the leaves overhanging the track in the time since I had last been there. I threw the motor into reverse when I saw it, but I was too late. The boat stopped just after Graeme's head hit the wasp nest.

I reversed out quickly, followed by the swarm of angry wasps. Graeme had lots of stings all over his face and arms, but said nothing when I apologized. I didn't get a single sting. He must have been in a lot of pain, but took it stoically as befits a deer hunter. I found another way in to the nest, and we spent the rest of the day unsuccessfully, but happily, looking for new nests. The only clue that Graeme did not think the wasp incident was an accident came when I talked to someone who met him on his return. They asked how he had gotten on with me in the field, and he replied "Oh, we got on fine, but I don't think much of his sense of humor."

I did some aerial surveys of kangaroos in the pastoral zone with Graeme, but that was the only time we went into the field together in the north. Graeme was a hands-off supervisor, and basically let me choose my own directions. However, he taught me a lot about critical thinking and to worry more about the result than the method. When a group of scientists from the state agriculture department consulted him about the experimental design for their kangaroo studies he didn't have the time to give to them and said "Bill will look after you." I was taken aback, but couldn't graciously do anything but spend the rest of the day with them. When I said that they had wanted his opinion, and pointed out that we always approached problems from very different directions, he replied "That's true Bill, but haven't you ever noticed that we always come up with same answer?"

Graeme left Academia soon after I graduated and spent the rest of his life doing applied work in the Commonwealth Scientific and Industrial Research Organization. His disdain for Academia was reflected in a comment he made to Janet Taylor soon after he returned from visiting me in the north. Janet asked how I was doing and he replied "I'm impressed with Bill ś initiative in making that tide guage. It looks like he's a good researcher."

Janet was my girlfriend at the time and, probably blinded by love, she said "Of course he's good."

His reply was "If he's a good researcher, how did he get through the university system?"

I think he had a point. Not that there aren't people doing interesting and useful things in universities. It's just that there are lots of other important and exciting worlds outside the ivory towers. Graeme Caughley died of cancer at 56 years of age, when he was just reaching the peak of his productive years; a great

loss to conservation biology. I will always be honored to have had the privilege of having him as my supervisor.



Not being very social, I spent little time with the white people in Maningrida. From our point of view, they were divided in two camps, which Webby called the black hats and the white hats. Those branded as black hats were politically conservative, had paternalistic views of the aboriginal people, and generally worked in administrative positions, such as the store manager, Connair representative and the school headmaster. The white hats tended to be younger, left wing, and worked as nurses, school teachers, or in the arts and crafts shop. I had good relationships with both groups because I did not become involved in the local politics.

As I was the only white person at the base much of the time, people would take pity on me, and invite me over on festive occasions, such as Christmas. The store manager was a devout catholic and had seven children, but his pregnant wife had no trouble providing Christmas dinner for all of them and a stray student from Crocodilus. When I asked him if any of his children were planning to go to university, he said that he would discourage them from doing so because he preferred that they do something productive with their lives.

The Connair agent and the local police officer regularly came to the base to play snooker with me on our ¾ size pool table, which was a present to the project from former high-court judge Lionel Murphy. It was sometimes unnerving because the policeman's blue heeler dog would lie under the table and growl every time I approached for a shot. Both my opponents consumed large quantities of beer, but this did not badly affect their snooker playing. In

fact, I generally won most of the games at the beginning of the night, but after they had downed the contents of half a dozen cans of beer they were unbeatable.

The white teachers were about my age, and their pranks, such as putting tampons into the filter for the headmaster's swimming pool, were not much appreciated by the black hats. The boys at Crocodilus were not much of a pick, but the young women teachers didn't have much choice. The only other white men of their age in Maningrida were rough construction workers, and most of them were married. Therefore, we were regularly invited to the teacher's parties.

I ended up having a series of competitions with Judy, the prettiest of the teachers. She had been a champion runner before becoming dedicated to teaching, and her ready smile was captivating. We never dated, however. One night after a party she had pressed up against me, looked into my eyes with her beguiling smile, and said "I suppose you are in love with Janet and wouldn't be interested in me."

I lied, and said "No I'm not available." Not because of Janet, who had another boyfriend down south, which did nothing for my self esteem. However, Judy had been going out with my friend, the policeman with whom I played snooker, and you don't go out with your friend's girlfriend. What I didn't know, was that she had split with the policeman because he was married, and therefore she was available. By the time I found out, she was involved with a coworker, and I had started dating another teacher, Dianne, who had been a ballerina. Nevertheless, Judy and I always had a strong connection.

Judy often went to outstations on her motor bike. Once out of sight of the township, she would take off her shirt and push it into carrier bars on the back of the bike. It was late one night when one of the teachers came around and said that Judy hadn't come back from the outstation, and asked if I could take the

truck to find her. The reason she hadn't returned was because the track was flooded about 30 km from town, and by the time she realized how deep the water was, the bike was totally underwater. Judy was able to pull the bike out, but it wouldn't start, and she had lost her shirt. When we found her, she was walking briskly down the road in the direction of Maningrida, clad only in a pair of shorts. The lights of the truck reflected off the cloud of mosquitoes around her, giving the impression that she was suspended in a giant bubble. Needless to say, she was cold, tired, embarrassed and badly mosquito bitten, but that wasn't enough to wipe the smile off her face.

Judy commented that the boys from Crocodilus were posers, because they always stood when driving boats to show that they were macho. This was in fact not true. The teachers only saw us when we were on the choppy lower reaches of the river. Dennis Puffett had told us not to sit because he said old fishermen always have kidney problems as a result of the jarring they experienced when sitting on hard seats in choppy seas. In any case, the waves jarred our spines, making standing the most comfortable alternative. We stood because we were wimps, not because we were macho, but the teachers didn't believe it.

Seeing it as a game, Judy figured it would be fun to show me up at sports. As she had been a champion sprinter, the logical thing would have been to challenge me to a running race, but she didn't. She challenged me to a series of snooker matches. That didn't work out as she planned, because I knew all the faults of our little table, and that knowledge was more important than skill. I beat her soundly.

Judy then challenged me to a motor bike race. She figured she couldn't lose because she had a 250 cc dirt bike and I only had the project's 90 cc sand bike. The course was around the dirt track near the end of the peninsula. I participated only out of friendship. It was obvious that the project's little bike with its tiny

fat tires couldn't match the dirt bike, so Judy's boyfriend lent me his 150 cc scrambler. I was still outpowered, and in any case I was not about to risk any dangerous manoeuvers with a bike that wasn't mine. Judy disappeared in a cloud of dust and I toddled along at a sedate pace behind. When I came to the last bend, Judy was on her back with the bike on top, the wheels still spinning. I was extremely worried when I pulled the bike off her, but she just looked up and said "You win."

Her last challenge was to play a game of tennis. My mother had wanted me to learn to play tennis, because my uncles had played with some of Australia's most famous tennis players. However, she gave up when my coach said "Look Mrs Magnusson, he's no good and he's never going to improve because he's not interested. We lost an important match because he saw a lizard on the fence and went over to look at it when he should have been receiving a serve."

Judy had a sure thing, but her boyfriend, who was very athletic, said "Why not a game of doubles? Bill can play with Dianne." We accepted, and I was content that Judy would finally be able to win. What I didn't know, was that Dianne, as well as having been a ballerina, was an accomplished tennis player. I hardly moved on the court and hit very few balls. Dianne sped all over, and essentially beat our rivals single handled. That was Judy's last try to beat me at sports.

Spending money on crocodile research did not make sense to most white people in Maningrida, and a rumour passed around that we were CIA and that there was an American submarine in the bay. That was bad news for most white hats, but probably made many of the black hats happy. Another version of the rumour was that we were CIA and looking for a Russian submarine in the bay. That may have been more appealing to some of the white hats. These wacky ideas were only further reinforced when the project's ship, called the Harry

Messel, showed up. The professor had found retired navy commanders to captain it, which fitted with the conspiracy theories. Most of the ship's work was undertaken in the dry season, but I had use of it on several occasions, and it was sometimes moored in the Tomkinson River with only the engineer on board. Being responsible for a ship was just another responsibility that I was not prepared for.



The monsoons brought flooding that affected all of the animals and people that used the floodplains. I had expensive cameras and electronic temperature recorders installed beside nests that would be destroyed by even a brief period underwater. After any intense storm, I would race upriver to check my equipment, but often the rain would fall on the headwaters and by the time I knew that the river was flooding there would be meters of water above the banks.

I had installed the temperature recorders 2 m above ground and used long leads to connect to the sensors in the nest, but that wasn't always enough. Although it had rained the night before, the sun was shining when Janet and I started up river. The water in the estuary was muddy brown, and the tide appeared to be exceptionally high as we passed Bat Island. Mangrove seedlings and other flotsam covered the river, but we were not prepared for what we saw when we reached the point where the river normally started to narrow and form meanders. We were higher than of most of the mangroves, and in the middle of a sea of fresh water 10 km wide.

Water pythons, brown tree snakes, and black whip snakes, as well as many other terrestrial animals were perched in the branches. I could cut across the

floodplains instead of following the bends of the rivers, which shortened the time it took to get to the upper reaches, but to no avail. I found the top of the tree next to the nest, but there was no sign of the temperature recorder. The boat was buffeted by eddies, and the branches I tied it to were almost ripped off when Janet turned off the motor. I wrapped my legs around the trunk and slid into the muddy water. As I pulled myself under, I ran into more branches and had to release my legs, which were immediately stretched out behind me like a flag in the raging water. I could barely hold on to the tree and I was quickly running out of breath. At any moment I could be ripped off and rammed into the trees downstream. Maybe it was exhaustion, and maybe it was just fear, but I soon gave up and left the temperature recorder, which couldn't have been more than a few meters below me. It didn't matter much, because the expensive equipment would have been damaged beyond repair seconds after it went under water.



Photo 2.12 *The Harry Messel in the Tomkinson River. Photo by Bill Magnusson.*

I was able to retrieve a second temperature recorder from under the water, but it never worked again. I had only one time-lapse camera, and I couldn't afford to lose it. The camera perched on its 4 m pole had been giving me invaluable information on nest predators. It had recorded adult crocodiles guarding nests, and monitor lizards digging into the nest when there was no adult present. It even recorded a family of people taking eggs from a nest. They didn't realize the box contained a camera, and vehemently denied that they had raided the nest until I showed them the pictures.

The camera was on a nest higher up river, where I hoped that the flood height would be lower. When we got to the nest, the water was just starting to lick the bottom of the aluminum box containing the camera. The 4 m support with its stabilizing guy wires that Gordon and the physics team designed had resisted hundreds of kilos of water pressure. I carefully removed the camera from its support, trying not to knock off the dozens of small creatures that had used it as a last resort. I was soon covered in brilliantly colored jumping spiders and other small animals that would have drowned if I had arrived 10 minutes later.

Floods also affected people, and soon after I had been put in charge of the base we received a request for help to rescue a sick woman from a camp on the upper reaches of the Liverpool River that had been isolated by flood waters. I did not know the men who made the request, and understood nothing of their language, but they were able to communicate in broken English and gestures. Fred and I set off with our guides on another mission of mercy.

The camp was on the upper reaches, well above the main floods, and we expected to see the woman when we nosed the boat into the track that ran through the 2 m spear grass, but there was no-one there. When we asked where she was, they said "She there. We go." We had not expected to have to walk, but there didn't appear to be any alternative. Fred and I tagged along behind the

two men as they strode along the track. However, there was only about 200 m of dry ground, and the trail disappeared into an expanse of water, 100 m wide and dotted with paper-bark trees. The rain had converted a small stream into a river.

We would have to cross, but there was a strong current. We went back to the boat and got the anchor rope. Crossing in pairs was much safer than just slogging into the current. Tied together by 10 m of rope, one person swam to a tree while the other held on to another in case the current was too strong and their partner was swept downstream. The roles were then reversed, and the person at the front held on while the other swam to catch up. The current was not as strong as it seemed, and we probably didn't need the rope, but I was thinking about the crocodiles that were likely to be hunting hapless animals washed down by the flood.

It was a few km to the camp and by the time we arrived it was nearly dark. When we asked where the woman was, the man with the greatest command of English said "She go hunt, you take tomorrow." I had been duped again. The men just wanted a lift up river and knew how to convince gullible white men. However, we did not want to cross the stream in the dark and didn't have much choice but to stay the night.

The camp was just an area cleared of spear grass with small stringy-bark humpies scattered around. We were shown the young-boy's humpy, which was a stringy-bark dome, about 2 m across and 1.3 m high, with an open door that you could crawl through. The number of boys and dogs that could fit in that dwelling was impressive, and we would have to sleep curled up in a tangle of arms, legs and fuzzy hair.

We had brought no food, but generosity is expected in aboriginal societies. In fact, to be selfish is considered a sin that traditionally could be punished by death. A man with a wide smile on his face ambled over and offered a large chunk of kangaroo meat that was cooked on one side, but raw and dripping blood on the other. He suffered from leprosy, and only had three fingers to hold the meat. A bandaid on one of his finger stubs had come loose and draped across the meat.

I was in a delicate social situation. It was obvious that we had no food, and I probably didn't have enough language skills to talk my way out of the situation in English, much less in any of the local languages. Not wanting to offend, I took the meat, peeled off the bandaid, and munched on the raw meat. Smiling and nodding my head, I said in English he didn't understand "Boy, that was the best raw kangaroo I've eaten all day!"

We were still pretty tired the next day when we extracted ourselves from the tangled mass of young boys and dogs, but there were no clouds in the sky and we set off early without waiting for the desperately sick woman to come back and be saved. The stream had dropped overnight and we didn't have to swim to get to the boat.

I never did master Kunibídji or any of the Aboriginal languages. The little kids would make fun of me because they could speak seven languages and I could only speak one, but Humans are very good at extracting meaning from context[104] and I eventually came to understand a little pidgin. A few years later, I camped beside the river with Agaral, and a few other hunters who had been helping me look for crocodile nests. There was still some meat left over the fire from the meal the night before, and I ate that for breakfast. The hunters mixed equal proportions of flour and sugar with water to make a thick sweet paste, and the burnt stick they used to stir turned it a muddy grey color. I looked at the

dirty mess and said “That’s disgusting. How can you eat it.” Agaral was the only one who understood English, but they all got the idea. Agaral said “Everyone remember first time you go our camp. You eat meat not cooked!” and they all laughed. By that time I had learned that when someone offers you meat roasted over the fire you cut off the cooked part and put the rest back to cook more, but the people just remembered my revolting penchant for raw kangaroo meat!



With the reestablishment of the barge service after the Darwin cyclone, the township had no need for most of the barramundi fillets in our freezer. Apart from game taken by our guides when we were in the field, we had been living on a staple diet of barramundi for two months and it was becoming boring. Barramundi is much sought after because it is a sport fish and it can be frozen for long periods without losing flavor. We preferred catfish because it was tastier, but soon started craving red meat.

Just how it came about has faded into the morass of conversations that memory cannot retrieve, but Janet, Wellsy and I decided to stock the freezer with buffalo meat from the Goomadeer River. We were sure we didn’t need a guide and, as the rest of the team was down south, there was no one to dissuade us from our folly.

We stacked the Hercules with fuel tanks and headed into a slight sea with a cool morning breeze. Within half an hour, we had passed out of the Liverpool estuary and turned west along the coast. The Hercules planed smoothly, occasionally slipping off the crest of the swell, which was running across our course, and dropping into the trough between the waves. There was no danger

of rolling the boat, however, because the swell was low and the crests widely spaced.

I was enjoying the feel of the wind and salt spray on my face. The rhythm of the boat was in harmony with the sea and I was daydreaming when Janet screamed “Look out for the coral!”

Rocks and coral were only a few feet below the keel. I brought the boat up onto the crest of the swell and began to surf with the wave. I didn’t know if I was heading onto or away from the reef, but the adrenalin was charging me up to do something and I didn’t know what else to do. Once we were off the reef I could see the difference between the shallow reef water and the open sea.

Wellsy’s “We’ve got to remember that reef on the way back” seemed an understatement. Conditions remained calm for the next hour, but by the time we turned into Junction Bay I was exhausted by constant and probably unnecessary vigilance. It took a further hour to cross the bay and navigate through the mudflats at the mouth of the Goomadeer River. I ran the boat at half throttle, partly to look for buffalos and partly to detune my nerves from the state produced by the shallow water and jagged coral. Dry mudflats and low mangroves on each side looked and smelled much like the small tributaries on the lower reaches of the Liverpool River, familiar and soothing.

Buffalos and feral cattle were spreading east and we often came across them around the Liverpool system. However, the Goomadeer marked the last high densities. The country was starting to degrade as these living bulldozers with no natural enemies stripped the vegetation and drained the floodplains by cutting tracks between the salty river and the freshwater marshes. At that time, few people worried about the buffalo. The aboriginal people recognized the damage, but buffalo meat could substitute for the native fauna that was disappearing

from their diet. For the majority of white people in the Northern Territory, loss of their natural heritage was a non issue. It was only when it was recognized that the buffalo were potential reservoirs of cattle diseases that any attempt was made to control their numbers. Today it is also recognized that tourism brings as much money into the Territory as cattle ranching. Native fauna has economic value and buffalo damage is no longer considered unimportant.

We saw the damage and felt that reducing buffalo numbers was justifiable in terms of conservation. However, our primary aim was to obtain meat. Having had previous experience of carrying game over long distances, I said to Wellsy "See if you can drop the buffalo near the bank."

He gave me a look that said "Of course, why do you have to mention it?"

The cow, calf and yearling buffalo were less than 20 m from the bank, but they ran off when I nosed the boat into the mud. Wellsy leapt off the boat and ran after them.

Janet and I prepared the fish crates and knives, but were expecting Wellsy to give up when, 10 minutes later, we heard a shot. It sounded far away, but that could have been because the mangroves had muffled the sound. We trudged through the hot black mud and heard the second shot as we came to the dead cow. That shot was definitely a long way off. The third was just a low thud, and we knew that Wellsy must have been running fast to put that much distance between himself and the boat in so little time.

We followed the tracks and found the calf at the same time that Wellsy arrived from the other direction. There was no point in taking meat from the tough old cow, so I suggested that we drag the calf back to the boat and then go

butcher the yearling. Wellsy grabbed the front legs and I pulled on the back ones. The mud oozed up between our toes, but the calf barely moved.

"Righto, we'll just separate the fore and hind quarters and drag them back separately" I said.

The knives were blunt and it took an hour to saw through the tough hide, separate the guts and head, and break the spine. It would have been easier to skin the calf first, but we had to leave the skin on until we returned to base to avoid contaminating the meat with mud.

My back muscles tightened as I straightened up. The midday sun was sucking the water out of the floodplain and out of me. The air over the mud shimmered in heat haze and drops of sweat ran into my eyes. I couldn't wipe them out because my hands and most of my body were covered in mud and blood. Mud and mangrove shrubs stretched to the horizon in every direction, offering no shade or freshwater.

Wellsy and I could drag the hindquarters, but they didn't slide as easily as we had imagined, and we stopped every 50 m for a breather. It would have been easier if it wasn't so hot and if the mud-blood-sweat mix did not make our skin itch. Janet dragged the forequarters that we had separated in two.

The meat from the calf was stowed in the boat by two in the afternoon, but we still had to butcher the yearling, which lay almost 1 km from the boat. It was full grown, and even one hindquarter would have been too heavy for one person. The knives, which had been blunted by the calf skin, were even less effective on the half-centimeter thick hide of the yearling. I sawed along the midline of the belly, and the hot guts spilled out over my feet. The gas from the ruptured

intestines reeked of fermented grass and we were worried that it would contaminate the meat.

The plan was to transfer the meat from the carcass into the fish crates, but most of the time we just seemed to be transferring mud from the floodplain onto the meat, and blood and guts from the carcass onto ourselves. I pushed the hindleg upwards with all my strength, and Wellsy slashed the hot flesh with his knife, but the great muscles and tendons that a few hours before had been a buffalo did not give up easily. We had to cut around the cartilage to separate the joints because there was no way that we could saw through the long bones.

The sparse hair on the buffalo hide spiked our skin. Flies were crawling over my eyes and up my shorts to tickle my genitals. I bent over to close the gap between my shorts and my testicles and the flies started jostling each other for access to my anus. Attempts to remove them just spread more blood and encouraged the little devils. Underpants are hot and uncomfortable in the north, but I decided that the next time I butchered a buffalo I would go better protected.

I slipped in the bloody mud and fell against the buffalo. There was no point in going on. We had taken less than half of the meat, but the sun was getting low and the boat was already overloaded. The dingoes and crows could have the rest.

The warm river water washed off the mud, blood and heat. Our hands were aching and chafed from the sharp handles on the fish crates, but our spirits were high. The exhaustion after a hard day’s work well done is welcome, and we looked forward to the run home in the early evening light.

Janet sat in the bow, Wellsy made himself comfortable on the mound of buffalo meat, and I took the wheel. The sinking sun accentuated the soft browns

in the river water and mangrove trunks. A Brahminy Kite took flight and flapped slowly over the river. It seemed that the world was again rolling along its inexorable course and the plight of a family of buffalo and the exertions of three inexperienced meat gatherers had been lost in the great pool of time.

Sunlight gave way to twilight as we cleared the mouth of the Goomadeer River. Junction Bay was calm and I pushed the throttle fully open. The engine responded, but instead of lifting the boat into a smooth plane, the propeller ground into soft mud and sand. I throttled off and used the electronic tilt to lift the propeller off the bottom. Backing off gained free water, but each time I motored forward I ended up on a mud bank. The tide was still falling and we would soon be stranded in the mud, so I backed into the channel and turned upstream. We would tie off on the lower reaches of the Goomadeer and wait for the tide to rise. Fortunately, and inexplicably, there were few mosquitoes. It was comfortable lying up against the soft meat and sleep came rolling down with the soft breeze.

Something woke me. Everything was calm and dark and perhaps Janet had just rolled in her sleep. My watch showed that it was almost midnight, so I woke the others, and we cast off and headed downstream. Sleep was still clinging to my eyes and, when Janet had trouble connecting the spotlight, both Wellsy and I went forward to help. It was only when we ploughed into the mangroves and were thrown up against the bulkhead that I remembered that I was supposed to be driving. In any case, we weren't badly hurt and the knocking about served to wake us up.

Lightning was dancing on the horizon as we cleared the mouth of the river. Moonlight broke through the spaces between the clouds, and we could make out the shore stretching around the bay. I gunned the boat straight over the mudflats that the tide had covered with 2 m of water. Janet unscrewed the plugs to drain

the flotation tanks and the boat planed well, even though we were overladen with meat.

Gusts of wind started to buff the boat and blow spray into my eyes. We were somewhere near the center of the bay, but I couldn't be sure because the gaps between the clouds closed and I could not see more than a few meters from the boat. The waves were now higher than the boat and close together. I could not make the boat plane without burying its nose into the next wave. I reckoned that the wind and the waves were coming from the north and I needed a course north-east to clear the bay.

It's not easy to maintain course in a rough sea, even when you can see where you're going. As each wave passed, I ran the boat at an angle down the back of the wave so that it ran along the trough and did not plough into the following wave. At the bottom, I had to swing the boat around to ride straight up the next wave or it would have rolled us over. Swinging the boat at the bottom of every trough and the top of every wave was a bit tricky, but I fell into a rhythm, and lost track of time – a bad mistake.

Because it was dark all around I didn't know where the shore was. I reckoned that we had cleared the bay and were in the open sea where there would be nothing between us and Papua New Guinea. The wind was coming from the north east, so all I had to do was cut across the waves to keep away from shore.

I turned to run across the direction of the waves on a course that I calculated would take us parallel to the coast. Only when the waves started to break around the boat did I realize that we had not cleared the bay and I was running into the shore. The storm had produced breakers on the normally protected waters of the bay. I swung the boat out again until I was sure that I had cleared the bay. My reckoning was wrong, and I had to repeat the exercise half a dozen times before

we hit the open sea. When we did, I had no doubt. The waves were higher than the boat was long, and there wasn't much more than a boat length between them.

We were still about 40 km from Maningrida and our lives now depended on the motor. If I could not turn on each trough and crest we would be swamped. As we ran up a wave, the boat was almost vertical. I needed full power to swing it around on the crest, but the motor spluttered as we ran up every wave because water in the carburetor was being sucked into the engine when we angled up. Wellsy grabbed the rubber bulb on the fuel line that could be used to manually pump fuel into the carburettor. The bulb was on a short lead, and Wellsy had to hold onto the motor to avoid being rolled over the back of the boat. Even so, he frequently got a dunking as the motor ploughed deep into the swell.

Five minutes would have been enough time to drain the water out of the carburettor if we could stop the boat, but we didn't have those five minutes. For the next four hours, Wellsy pumped the rubber bulb to keep the gasoline flowing over the water in the carburettor when the boat was almost vertical. Often his feet were over his head, which occasionally disappeared under water.

It was cold, but I didn't have time to be tired. I just clutched the helm and the throttle and swung them in synchrony to keep the boat zigzagging up and down the waves. Cold rain and warm salt water filled my eyes, but it was too dark to see anyway. The angle of the boat told my feet where we were on the wave. I think that Janet suffered most because there was nothing left for her to do. She crouched in the bottom of the boat among rolling carcasses and sliding fish crates, and prayed.

The boat was becoming hard to steer. There was water in the flotation tanks, and I couldn't maintain enough speed to drain them. All I could see were the white caps on the split second that we crested each wave. The boat raced down

one wave and almost ploughed into the next one. I heaved the wheel and we crested the wave, only to drop half a boat length into the next trough. The thump shook me, but I had seen light on my right.

Surely too soon to have covered the 40 km between the Goomadeer and Maningrida, but I brought the boat around, and we surfed into the Liverpool estuary. As we approached the lights, the dawn broke and I saw familiar shapes on the horizon. I had learned that you can't estimate time in an emergency. The first 10 minutes seemed like hours, but the last hours passed as though minutes. I made a mental rule. Next time, calculate time with your watch, not with your guts – it might save your life.

We dumped the meat in the cooler and dragged our weary bodies off to sleep. We would butcher the meat later that morning when our energy and willpower drained back in. That night, we barbecued the calf's ribs and stuffed ourselves. The rest of the meat was cut into succulent steaks and stored in the freezer, but we ended up eating little of it.

A week later, Professor Messel arrived at the Connair office in Darwin only to be informed that the flight had already left. In fact, it hadn't, and the attendant didn't know where the plane was. The Professor had missed the plane, but fury took him to the manager. I wasn't privy to the conversation, but from Professor Messel's recounting it went something like the following:

"Yes Professor Messel, we realize our mistake and we'll charter you a plane right away."

"You're goddam right you'll rent me a [expletive] plane, but you'll have it [expletive] ready for me tomorrow morning after I've had time to do some goddam [expletive] shopping."

The result was that Professor Messel arrived with a plane loaded with cartons of T-bone steaks. They were paper thin and had been partially defrosted on the plane ride, so they couldn't hold a candle to our personalized cuts of prime buffalo meat.

I had been up river when the Professor arrived. He was beaming as I walked into the lab, and proudly exclaimed "Well Bill, you won't have to eat any more of that crappy buffalo meat. We took it down to the camp and threw it off the back of the truck for the abos to eat. The freezer is stocked with prime T bones. What do you think?" Fortunately, he went straight off into a tirade about the air-conditioner in his room that wasn't working, and I didn't have to tell him what I thought.



Agaral appeared one day with a man who supposedly knew where crocs nested in nearby swamps. I was no longer considered an outsider, and the few times that someone tried to trick me into giving them a ride up river, I recognized that they were not being honest, and fronted them immediately. In fact, it was so easy to determine when people were not telling the whole truth that I was surprised by my previous gullibility. This man did not seem to be lying, but appeared to be a half wit. He was short, and the top of his head barely reached my shoulder. When he spoke, his face split into a wide grin, and his words were so mixed with spittle that I couldn't understand anything he said. He was bandy legged, but his most prominent feature was his crotch. It looked as though he had a football stuffed down his shorts.

I suspected that Agaral had put him up to it to con a ride some place, and normally would have felt sorry for the ridiculous little creature. However, he

insisted on calling me “Boss”, as though he thought that I would appreciate being treated like a South African plantation owner. Fortunately, I know that I think slowly, and I still do not voice my opinion until I am pretty sure, which takes days, even for simple things. In any case, if Agaral wanted a ride, he probably deserved it.

Agaral translated and said that we would go to the swamp tomorrow. I agreed only because I had learned that “tomorrow” did not have its everyday English sense for the aboriginal people I worked with. “Yesterday” meant any time in the past, even tens of thousands of years ago. “Today” meant the foreseeable future, or something fairly certain to occur. “Tomorrow” meant the distant future or something with a very low probability of occurring. In any case, it was worth saying anything to the dwarf so that I could get back to useful work. He backed off smiling, nodding and slobbering, and saying “Yes Boss, yes Boss.”

I was getting my gear ready to run up the Tomkinson when Agaral and the old man turned up the next day. “Tomorrow” had meant “tomorrow,” and I could see that I had no way of avoiding taking them anywhere they wanted to go. “Come on then” I said, and prepared for a fruitless day.

The old man directed me to the mangroves on the other side of the estuary. There was no track, so we tied off the boat and climbed over the stilt roots of the mangroves. The low shrubs and mangroves soon gave way to a marsh filled with head-high reeds. The old man said something to Agaral and trotted into the swamp. I tried to keep up, but Agaral put his hand on my arm and said “He go fast. Me you go slow. I follow tracks.” He then proceeded to follow the old man’s tracks at a pace I could hardly keep up with.

I marvelled at the speed of the little man in the swamp. With his funny wobbling gait he had opened up a track for us through the tall cutgrass sedges.

My feet and arms were bloody from the sedges, which wrapped onto you like fly paper and then cut with razor sharp edges as they were pulled off. After two hours of pushing through knee-deep water and cutting sedges I was exhausted and expected to find the old man spent and cut to ribbons. However, when he reappeared out of the solid wall of rushes, he was smiling and didn't have a cut on him. He showed us a nest and stood by smiling as I recorded data in my notebook.

When I packed my gear I thought we'd head back, but Agaral said "He find more nests." The old man splashed across to a paper-bark tree that was as thick as my thigh and 10 m tall. He wrapped his broad palms around it and jumped up, gripping the tree with the soles of his feet like a tree frog, then looped up the tree as though he had suckers on his hands and feet. Seven meters up, he stopped on the vertical trunk, supported only by one hand and the soles of his feet, and surveyed the swamp.

The trunk had no branches, and I knew that it was impossible to climb paper barks because the powdery sheets of bark come off like the skin of a rotten tomato. I marveled that he had been able to find a tree with firm bark, so I grabbed the trunk, and the bark came off like a mix of flour and cigarette paper. The little man was still perched up the tree as though his feet were nailed to the trunk.

The grin never left his face as he dropped down to the ground and trampled off into the swamp. We found two more nests that day; important nests because they were among the few that would not flood that year. On the return, I was too exhausted to watch my step, even among the cutting sedges that sliced between my toes, and I stumbled along behind Agaral and the old man. When the rushes gave way to mangroves and black mud, the old man trotted across to a hole among the mangrove roots. He crouched and inspected it for a while, then

slipped his leg in to mid thigh. Balanced on the other leg, which was bent like that of a Russian dancer, he slowly withdrew from the hole, and out came a mud crab sitting on his foot. Its open claws were the size of my fists, and only inches from his calf. The gnarled old hands shot down and snapped off the claws before the crab could react. The legs were snapped off just as fast and all was stowed in a string bag. Capturing the delicious dangerous crab had taken him less that two minutes and he continued in the direction of the boat.

The cutting sedges made me look and feel as though I had received forty lashes, and the salt water burned the cuts, but I was content as we headed back to Maningrida. I watched the old man sitting in the bow. He had done physical feats that day that I would have thought impossible, but my eyes had opened to much more. His grin was not of ignorance and innocence. He glowed with the love he felt for his country, and it had given him much pleasure to share his love for it with me that day.

I was determined to find out more about him. Up till then, I had not even bothered to learn his name. The other aborigines, including the 80 year old Oondaboond, called him “the old man,” and the whites called him Dick, but his real name was Nuggarboi. Not a Kunibídji, his land was on the other side of the estuary. The staff at the hospital said that his enormous scrotum was the result of a hernia, but no one with a hernia would be able to climb trees as he did. Much later, I found that he had been to Queensland, and a parasitologist said that he had probably contracted elephantiasis from the Kanakas there. Dick did not speak fluent English, but he did speak pidgin, and would throw in some English sentences that he had picked up listening to Agaral and the younger hunters. The major impediment to our communication had not been Nuggarboi’s speech, but the barrier that my mind had put up because I didn’t think he had anything useful to say.



When Nuggarboi reappeared two weeks later, he brought his son, Nalawade. Leprosy had taken most of Nalawade's fingers and toes, making him roll almost as much as his father. Nuggarboi asked "We go Morngarja, my son go?"

Now that I no longer considered him a half wit, I could understand a little of Nuggarboi's pidgin English. I saw no reason that Nalawade should not go to this Morngarja place, and I said "Yes, we can go." It was a decision that would mark all of our lives.

Morngarja is a small freshwater lake in the middle of a paperbark swamp, and to reach it we had to cross a mudflat half a km wide. The black mud was so hot that it burned my feet, but there were fish swimming in the film of water that covered it. A band of monsoon forest abutted the mudflats, and behind this we crossed into a eucalypt woodland covered by head-high spear grass. The aboriginal hunters had no trouble navigating, even though there was no apparent track. They ran forward, jostling each other to pick up the rose-red fruits of a tree that were lying on the ground. I didn't understand their excitement until they passed me one. The crisp white flesh was delicious, and we spent time gathering and eating the fruits.

Ten minutes later, they ran off again, this time in different directions, and I waited to see what they had found. Ten meters away, Nalawade stopped behind a paperbark and looked at me with a bemused smile. "Buffalo!" he cried, and I looked forward. The black shape in the grass that I had taken for a burned tree trunk turned its head toward me. I shot for the nearest tree, cursing buffalos and aborigines with their warped sense of humor, but the buffalo galloped off in the other direction. I kept my eyes open from then on, realizing that my companions

expected me to look after myself. They were not guides; just friends ever ready to laugh at my clumsiness. The extreme divisions, where one person becomes totally dependent on another, did not exist in their society.

The paperbark swamp did not appear to have many obstacles. The ground between the white trunks was covered by fallen leaves. The aborigines zigzagged apparently needlessly, so I kept a straight line. When I dropped into the marshy ground up to my waist, they just laughed. "How?" I asked after they dragged me out. They laughed and pointed at sticks poking out of the ground. The whole swamp was covered with sticks that had fallen from the canopy and impaled into the ground. At first I thought they were having me on, but I eventually saw the difference. They had marked the trail with sticks poked into the ground. The difference was that the stubs of the branchlets faced downwards, not upwards as would happen if the branch had fallen from the canopy. To their eyes, the sticks were like red and white flags telling you where to watch your step.

When we reached the lagoon, they pointed to a platform formed by paperbark roots at the edge of the water. I couldn't see buffalo or inverted sticks, and I turned with incomprehension on my face. Nuggarboi said "Dreaming place." I would normally have avoided their holy places, but they seemed to be indicating that I should go there alone and look. When I reached the platform, I scanned the bank, but could see nothing special. I glanced at my companions, and they were pointing out into the lagoon. There, less than 5 m from me, I could see the head of a crocodile that must have been at least 3 m long.

The crocodiles in the Northern Territory had been persecuted for decades, and they were still not accustomed to protection. They never let you get that close, especially during the day. The crocodile watched us for ten minutes, then sank silently into the lake. Nalawade said "We go nest that one" and continued along the edge of the lagoon. I was nervous walking close to the water where

there was a big crocodile that didn't fear man, but my companions showed none of their usual caution.

Nuggarboi said "That one Dreaming, that one belong Nalawade." The fact that Nalawade believed that he had a spiritual link to the crocodile didn't make me feel any less nervous. The nest was high and jammed between two paperbarks. The female had made a track through the rushes to the water's edge, but was nowhere to be seen. I weighed and measured the eggs, then packed them back into the nest in their original positions.

Nuggarboi had only that nest to show me, and we headed back along the route we had used to come in. It was only one more nest, but Nuggarboi and Nalawade obviously thought that they had shown me something special. I had the same feeling, and the strange sensation that part of me stayed behind when we left the swamp.



Photo 2.13 *Oscar Nalawade in the early 1970s. Photo by Grahame Webb.*

I tried to tell the people back at the base what had happened, but they recorded only the facts, and I realized that only Nuggarboi and Nalawade knew what I had felt. I was being drawn closer to the old man. We had little common language, but conversed silently.

The swamp nests that Nuggarboi showed me were important because they were perched above the level of the main river near the estuary, where there was little flooding. In some years, almost all the nests on the upper reaches of the Liverpool and Tomkinson Rivers were lost to floods, but eggs from the swamp nests almost always hatched. The hatchlings would come out in the middle of the swamp, however, and I was curious about how they got to the river. I asked Nuggarboi, and he said that the female picked them up in her mouth and carried them to the river. Such behavior was unheard of in reptiles and I was intrigued. However, I also asked Nuggarboi if the same female nested in the same place every year. His reply was that they did, and I asked him how he knew it was the same crocodile. He said that he had hunted crocs in the swamp with his father and that they had often caught and eaten the crocodile at the nest. When they returned to the nest the next year, they killed and ate her again. This did not fit into my world view, and I rejected this tale, and the one about the crocs carrying their young in their mouths, as superstitious nonsense.

One of the swamp nests gave me critical results about the mechanism that kept the eggs warm. Crocodile nests are giant incubators, and the temperature has to be kept at about 32 ℃. Less than about 28 ℃, or more than about 34 ℃, and the embryos will die. Temperature also determines the sex of the babies. At about 31.5 ℃, both males and females will be produced. Lower or higher temperatures produce all females.

Rotting vegetation produces heat that could maintain nest temperature, but other sources, such as air temperature and the warming rays of the sun might be

necessary. Although, it is virtually impossible to manipulate temperatures around a croc nest to see what would happen if the rotting vegetation had to raise the temperature by itself, a cyclone performed that experiment for me[82].

The cyclone hit Rolling Bay, just to the west of the Liverpool. We were lucky that it didn't hit Maningrida, because it caused massive destruction, leaving an area of dozens of square km with almost all the trees knocked to the ground. In the Liverpool catchment, the only effect was heavy rain.

The cyclone dumped an enormous quantity of water above Morngarri swamp, where I had a nest with a temperature recorder. The flood gauge indicated that the cold water was about 1 m deep and completely covered the nest. Flooding did not last long, however, and the eggs were not killed. Over the next few days, probes recorded the temperature of the bottom, middle and top of the nest. All temperatures were reduced to below 25 ℃ at first, but then the nest began to heat up from the middle to the surface, proving conclusively that the major source of heat was internal, probably mainly from decomposing vegetation, but possibly with a tiny input from the developing eggs.

I owed the scientific results I was getting to my Aboriginal collaborators. Professor Messel had made a rule that the aboriginal community was not to have free access to the house. I understood the reason for the rule. Research would stop if hundreds of people per day tramped through, curious about the strange culture and wanting to handle the delicate equipment. Most of the researchers interpreted the rule as "No aborigines in the house." However, Nuggarboi and his friends were partners in research, and there are no closed doors to partners. One day, he turned up with his 10 year old grandson and an old man from a camp on the upper Liverpool River called Anka, and I invited them to stay for lunch.



Photo 2.14 *Nest with temperature recorder in Morngarri swamp before a cyclone covered it with a meter of water. Photo by Graeme Wells.*

Anka was a revered holy man, and his advice about spiritual matters was sought by people from many tribes. Nuggarboi showed him great deference, and Anka seemed to have great respect for Nuggarboi, but I knew too little about the kinship system to be able to work out the deference hierarchy in the conglomeration of many tribes that used Maningrida.

I was willing to take responsibility for the way I ran the base, but when Professor Messel, his wife, and some visitors from the south turned up unexpectedly, I was worried that he would not like to see the house full of people and create a scene in front of my friends. Nuggarboi and Anka were on their best behavior, but in trying to interpret and imitate the ways of the whites they were about as clumsy as I was when I ate the raw kangaroo meat.

Nuggarboi was experimenting with a fork, mashed potatoes and peas, causing a glump of food to sail over his shoulder and land on the floor near Professor Messel's foot. Without breaking his stride, or the machine-gun rattle of his conversation, Professor Messel scooped up the mess in a napkin and threw it into the bin. He seemed pleased to have someone to listen to his conversation, even though at least two of those present couldn't understand a word he said.

Later, Anka showed his wish to conform to white cultural norms while in the house. Mrs Messel was staring at the ten year old boy, and Anka deduced, possibly correctly, that she was looking at the green gloop of snot that was dangling out of the youngster's nose. Trying to appear nonchalant, the old man sidled across and pinched off the offending lump of slime. That was when he reached an impasse. In the bush, he would have thrown it on the ground or wiped it on a tree, but he figured that the floor and the table cloth were not usually used as receptacles for such things.

Perplexed, he looked around the house for somewhere to wipe his fingers. He did not find one, and his hand waved in exploratory arcs. All eyes were on him, and he knew it. Finally, he broke into a broad grin, lifted his hand and mixed the green mucous into his grey curly hair. I had been holding my breath since I saw the cultural collision begin, but Mrs Messel kept smiling and talking, and I was sure that Anka would remember the right behavior if ever confronted with a

similar situation. After they left, Professor Messel said nothing, and I was relieved that he was willing to let me use my own judgement.

Anka's prophecies would have a profound effect on my and Nuggarboi's lives, but, at the time, I considered him just a nice old man who was curious about the white man's ways.



Photo 2.15 *Anka in the early 1970s. Photo by Grahame Webb.*

Professor Messel arranged for the 3rd Working Meeting of the International Union for the Conservation of Nature Crocodile Specialist Group to be held in Maningrida in 1976. We were excited, because it would be a chance to meet many of the legendary crocodile biologists we had read about. There were 21 participants, and 11 were from overseas. I would meet Hugh Cott, who had done the first detailed studies on Nile crocs in Africa, Ted Joanen, who had accompanied the recovery of alligators in the USA, and Federico Medem, an

expert on South American crocodilians who would one day provide valuable advice when I went to Brazil.

Robert Chabreck, who worked with Ted Joanen, gave me a little book on the population dynamics of alligators written by James Nichols. Bob had brought the book for Hugh Cott, but Hugh no longer worked on crocodiles, and was more interested in wildlife photography. Using population models to manage crocodilians appealed to me, and I asked Bob how they used the information to estimate quotas. Bob smiled and said that they didn't. When they wanted to know how many alligators they could take, they just asked Ted Joanen. The mathematical model in the book was too simplistic, and they did not have good data to calibrate it. I would not meet James Nichols for another 30 years, but by that time he had become one of the World's foremost population modelers, and I used many of the statistical algorithms he and his colleagues developed.

One of the most important personalities I met at the meeting was Tony Pooley. He worked on crocodiles in South Africa, and had a keen interest in the popularization of science. In fact, he had a large influence on my deciding to write this book. However, it was one of his discoveries that taught me that you have to be very careful before discarding information from people who may have a different religion, and hence world view. Tony was world famous because he had reported that crocodiles open their nests and carry their babies to water in their mouths, and he showed us a film of crocs doing just that. Nuggarboi had been right, and I had not listened.

Professor Messel had said that Janet and I would have the opportunity to publish some of the results of our studies in the proceedings of that meeting, but they were never printed. There was another chance for fame, however. One of the participants was Rick Gore, a journalist for National Geographic. I was happy to take him into the field. Here was my chance to become famous. Well,

at least at that stage of my career, I thought that appearing in National Geographic would make you famous, and I could imagine proudly showing the article to my friends and family. It almost worked. Rick wrote that I had taken him out to see crocodile nests, and that my legs were scarred by the tropical ulcers you get from working in the area. So far so good, but then he followed it with the statement that Professor Messel said that working in Maningrida rots the mind as well as the legs. Needless to say, I didn't go out of my way to show that article to anybody!

I had gotten the tropical ulcers from walking through mud in the estuary. Anaerobic bacteria live in the mud, doing no harm until someone is silly enough to push juicy human flesh down to them. They cause tropical ulcers that eat a hole several cm across into your leg. It is not just the superficial wound that is troubling. You start to run a fever that peaks after about three days, and only after the peak in temperature do you start to feel better and the wound to heal. At least those are the symptoms that I and many of the local people experienced.

Professor Messel was also involved in a second fiasco involving tropical ulcers. He kept telling me that my legs were more scarred than other people's because I had little resistance to tropical ulcers and didn't treat them correctly. I told him that it was because I walked through mud more than the others, which was true. I had to cross mud flats to get to nests, while most of the rest of the crew worked from boats. I told him that if he went with me he would also get them. He didn't believe me, and to prove it he went with me one day. That was enough; he got an enormous tropical ulcer. Worse still, he did not listen to me and took penicillin when he started to have a fever. Penicillin does reduce the fever, but it does not cure the ulcer and the Professor suffered a long time before the ulcer went away. Worst of all, he blamed me.

Some people suffered even worse, especially if they habitually wore boots. Their entire lower legs turned into a mass of ulcers. We now know which antibiotics cure the ulcers, and penicillin is not among them. The scars on my legs eventually disappeared – I wonder if the mind has recovered as well!



Researchers in South Africa, India and the USA were discovering much about the social behavior of crocodilians by watching them in the wild, often from very short distances, and many of the Crocodile Specialist Group were interested in how their observations on nesting compared with those on saltwater crocodiles. Tony Pooley asked how close I could get to nesting females without disturbing them, and I said "If you go down to the beach and start the outboard motor, every croc on the river will go down." It was obviously a gross exaggeration, but reflected the difficulty of observing adult saltwater crocodiles in the wild at that time.

The species had been heavily hunted during the 1950s and 1960s, and effective protection only came in the early 1970s. Therefore, all the adult crocodiles I was studying were survivors that knew how to avoid humans. Any that was willing to allow humans to watch them from close up had received a bullet as a reward for their tameness. This had its advantages. I could spend time close to the bank, and would even swim through the mangroves at high tide to get to nests, behavior that would have got me killed if I had tried it in the 1940s. However, it meant that I had no chance of observing the crocodiles' behavior the way it was being done in other countries.

Apart from occasional records by the time-lapse camera, or a fleeting glimpse from the plane, I had not seen crocodiles guarding their nests, but I knew that

they did so because of their tracks, and because nests would often be repaired after attacks by monitor lizards and other predators. As the crocs were so wary of boats, I decided to try to approach a nest from overland. One female nested on the lower reaches of the Liverpool River, where it snakes across the floodplain in giant loops. There was a place that I could moor the boat a km from the nest by water, which was only about 200 m from the nest by cutting across the floodplain where the bends in the river came closest together.

It was low tide, so we had to scramble up the cutaway bank. Agaral led, crawling on his belly even though we were still hundreds of meters from the nest. The grass on the floodplain was less than a meter high, and we were careful never to rise above it. It was hot, and the hard ground and spicules from the grass made progress painful for someone who had not practiced crawling since he was 1 year old. Nevertheless, Agaral went very slowly, careful not to make the grass sway any more than necessary, and slow enough that any birds would just hop off to the side instead of bursting into a ball of beating wings that could warn the crocodile.

It took about an hour to cover the 200 m, and I never would have had the patience if I hadn't had Agaral to guide me. He inched up behind a log that had washed up onto the floodplain, turned excruciatingly slowly, and signaled me to crawl up beside him. I pushed forward on bleeding knees and elbows, keeping my belly flat on the ground. I was so close now that I wasn't about to risk scaring the crocodile with any fast movements. Agaral moved to one side and I pressed up against him so that I would not disturb any more grass, the musky smell of our hot unwashed bodies combining to emphasize our little cocoon world behind the log and out of sight of the crocodile.

When my head bumped the log, Agaral was lying with his head on the ground and he signaled with his finger to look over the log. I slowly lifted my

head until my eyes were just peeking over the log. There was the crocodile, almost 3 m long, lying beside her nest with her eyes closed about 20 m away. I was ecstatic. The only big crocs I had seen before were males, and here was a female, one of the phantoms that had kept the species in existence through the years of persecution by greedy hunters who cared nothing for the dozens of little lives developing in a nest.

My joy lasted about 3 seconds. I am sure that I had made no sound, and the wind would have taken our scent away from her, but she sensed something, her eye flipped open, and she swung around and slid over the bank into the river. That was the only behavior that I ever recorded close up of a female crocodile in attendance at a nest. My thesis would have no information on behavior except that which I could extract from the images taken by a time-lapse camera. Nonetheless, I had looked into the eye of a ghost, and she became real to me. Agaral turned his head and smiled at me. We had failed in our scientific quest, but we had shared something very special.



When I returned to Maningrida the next wet season, I was met with tragic news. Nalawade had died. I knew that this would be terrible for Nuggarboi because they were so close. To make things worse, they had summoned Anka to determine the cause of death. Anka did not believe that Nalawade had died of complications from leprosy. He pulled a string from Nalawade's head and said that it had been put there by his dreaming crocodile as punishment for taking me to a sacred place. Anka said that he could not protect Nuggarboi in Maningrida, and that he would have to live the rest of his life at Anka's camp on the upper reaches of the Liverpool River, or the crocodile would kill him too. Although

Nuggarboi spent most of his time in Maningrida, it must have been a terrible blow to have to live so far from his land.

It is difficult to explain the importance of the land to the aboriginal people. A group of elders once asked me if I could explain something strange about white people. I said that, being a white person, I probably couldn't give them a useful answer, but they said that I was different because I didn't use shoes when I went walking with them in their country. They asked, perplexed, how someone could put something between himself and his land. It was like a Christian asking how someone could defecate in a church. I had no answer, because it would have been incomprehensible to them that a person could exist without a connection to the land.

Nuggarboi was upstream at Anka's camp, and I had to collect data for my thesis. I could have gone anywhere, but decided I would look for nests in Morngarja. Maybe I had a good scientific reason, and maybe I just wanted to assure myself that science and superstition don't mix. I went alone, however, because I didn't want to be seen as responsible for anyone else's death.

I had been to Morngarja many times the previous season, and I knew the direction to take from the mangroves across the mudflat to find the track through the monsoon forest. However, all the distances seemed much larger now that I was alone, and everything seemed to remind me of Nalawade. The spear grass had not burned during the dry season, and I had to use the sun to navigate to the paperbark swamp. Some of the inverted sticks were still there, but I knew the trees, and had no more trouble navigating the swamp than I would have had walking down the suburban street where I was raised.

I was apprehensive when I came up to the lagoon. I walked out onto the sacred platform, but no crocodile surfaced to greet me. It made me feel lonely,

as though the crocodile had died with Nalawade. I walked along the edge of the lagoon, nervous every time that I had to go close to open water where a crocodile might be lying.

The nest from the year before was as we had left it, and there was no sign that the crocodile had been back. I checked very carefully because, for some reason, I desperately wanted evidence that the crocodile was still there. Crocodiles don't usually nest in exactly the same place, so I figured that she might have made a nest further around the lagoon, in places that Nuggarboi and Nalawade hadn't taken me.

The floor of the swamp was treacherous, because the paperbark trees were growing suspended over what had once been open water. The interlaced roots held them all together, but there were weak spots where I could fall through and end up suspended to my chest. I kept my feet close to the trees, and swung around the climbing ferns that adorned the paperbarks. A small stream entered at the end of the lagoon. It was only about 4 m across, and tall sedges occupied both edges. I could skirt the stream, but it would take a long time, and I figured that the croc had probably made its nest near the lagoon, as it had done last time.

I couldn't see through the black water, but it would only take a minute to cross the stream and I calculated that the probability of a croc being at that point at exactly the same time that I was crossing to be small enough to take the risk. I held my pack over my head, parted the reads and slid into the open water.

The swamp water was tepid. Gases from the mud bubbled up through the brown liquid and popped around my chest. The bank was several body lengths away when the crocodile's head broke the surface beside me. She was big. Her head was longer than my torso was wide, and her yellow eye was the only clue to the complex intelligence honed by millions of years of instinct that was

housed in the armored body. I had made a mistake, and believed that I was about to pay for it with my life.

I don't know how long I looked into that eye, but it seemed to draw me into it, to a world where time had another meaning, and there was no distinction between man and crocodile. When her head sank below the surface, I was sure that she was gliding towards me underwater to give that killing bite and the body roll that would tear me apart. I waited frozen for a while, but the attack did not come, and I backed out of the water and stood shivering with fear a few meters from the bank.

Forget science, I just wanted to live, and I decided that I was not in condition to look for nests that day. I would return when I had recovered my composure. I did not take any silly risks on the way back. In fact, I stayed much further from open water than I needed to. The tide was high when I got to the boat, and I had to climb over the mangrove roots to get to it. I reasoned that the probability of a croc being there just as I was getting into the boat was very low, but just the same, I was shaking with fear when I jumped into the boat.



A few days later, I went to the upper reaches of the Liverpool River in search of nests. Again I was alone, because I didn't want to involve anyone else if I ventured onto Dreaming-Time land. Nuggarboi must have heard the motor from the camp, because he was at the landing when I passed, and I drove across to talk to him. He said "You know that one who finished," not using Nalawade's name to avoid summoning his spirit from the grave. I told Nuggarboi that I knew what had happened and how sorry I was. He told me I should leave Maningrida, but in any case not to go anywhere near Morngarja. I explained

that he didn't have to worry because I was a white man, the Dream-Time laws didn't apply to me, and that I would have to return to Morngarja. However, I didn't tell him that I had already been there.

It was late afternoon when I passed the landing on my way back, and Nuggarboi and his wife were waiting on the landing. He explained again that I shouldn't go to Morngarja, and I told him not to worry, and that I was going the next day. Nuggarboi threw his sack into the boat and he and his wife hopped in. I asked him if he wanted a lift somewhere, and he explained that he was going to Maningrida with me. I ask him if the crocodile would kill him and he said "That one finished. You my son now. I go Morngarja."

I could not dissuade him, and we headed down river. Nuggarboi's wife, who was thin and much taller than he, stood up when we got to the lower reaches, where the Liverpool marks the boundary of Nuggarboi's land. Her wailing carried over the river and must have reached the farthest corners of the territory that Nalawade had called his. We were united in death, and what united us was the land.

We went to Morngarja the next day, did not find any nests, and Nuggarboi did not die. Anka explained that the Dreaming crocodile was now mine and would not kill me, but just the same Nuggarboi would have to stay with him at his camp. As far as I know, that is where Nuggarboi lived out the rest of his life.



My time at Maningrida had come to a close. I had been raised in white society, but my aboriginal friends had shown me another world. The two cultures seemed to work in very different ways, and my send off reflected that. The Crocodilus team and the younger white school teachers had engaged in a

long series of pranks that helped reduce the monotony of life in an isolated town, and the pranks were sort of a statement to the more conservative right-wing elements in Maningrida. I suspected nothing when Judy and two other pretty school teachers offered to give me a massage as a going-away present the night before departure. I was flattered, and of course accepted. What I didn't know, was that the massage was just a ruse so that they could measure the diameter of my ankle.

When I turned up at the plane, they hugged me simultaneously so that I wouldn't notice one of the other teachers locking a ball and chain around my leg. I now had to carry the steel ball, which weighed several kilos, onto the plane. The chain was short and I had to stoop to walk. It was not easy to find a workshop in Darwin to cut the chain before I had to get on the jet for Sydney. Even the lax security laws of that time would not have allowed someone with a ball and chain to get onto a commercial jet. Judy had finally won!

Nuggarboi had come to Maningrida to see me off, and stood back as the school teachers ribbed me about the chain. When it was time to board, I walked over and hugged the old man who was crying. I said to him "Don't worry. I'll come back."

He gave me a confused look, as though it was incomprehensible that I did not know, and said "No, you not come back."

As usual, he was right, and I was wrong. I have never been back, but Maningrida changed me for ever. By the time I finished my Ph.D., the Crocodilus project was falling apart. The project was transferred to Ray Fryer's Uparunga Station at the junction of the Roper and Wilton Rivers, and ship and helicopter surveys continued the work in the north. However, internal tensions resulted in the police being sent to raid one person's house in Sydney. Professor Messel

was prosecuted on a wildlife charge, and was found innocent only after years of litigation and a split vote by the High Court of Australia, which redirected the case to the Federal Supreme Court. All costs were awarded against the Northern Territory Government. However, for me, the excitement and vibrant potential of the early years were gone, and it was time to move on.

3

To the Other Side of the World



The Amazon River in front of the city of Coari, which is more than 1500 km from the sea. Photo by Bill Magnusson.

I was offered a job in Manaus, which was in the middle of the Amazon forest, and I took it. Professor Birch, who had such a low opinion of my academic potential when I entered honours, was now much more supportive, and he recalled the adventures he had while he was there. He also translated the name of the institute I would work for. I knew no language except English, and some of the staff at Sydney University even had difficulty understanding my low-class slang. I also knew virtually nothing of South America. I had a hard time finding Brazil on a map because I thought it would be a little country near the Guianas. It came as a shock to find that it occupied half of South America and was much larger than Australia.

I had to stay overnight in Los Angeles, and thought that would be easy because I assumed that people in the USA would be just like Australians. However, even there, I felt out of place. I had booked into a cheap hotel far from the airport and planned to catch a bus. There were buses to major centers, but nobody knew how to catch a bus to where I was going – they all had cars! I was also not used to buses on which you couldn't get change, and ended up having to pay extra. The driver, was very friendly, however, and told me to catch a cab to the hotel, which was 2 km from the nearest bus stop. He carefully explained the shortest route so I would know if the cab driver tried to overcharge me by going the long way.

When I checked into the hotel, a man grabbed my bags and ran into the elevator. I had planned to carry them myself, but that appeared to be his job, and I let him carry them to my room. He stuck out his hand and I went to shake it, but he pulled it away. "The tip?" he said. I had no change, and when I said so, he just stayed there with his hand out. I paid five dollars to get rid of him, and later asked the attendant at the front desk to teach me when and how much I should tip. It all seemed strange though. My father had a work ethic, and not

being proud enough to always do a good job would have been inconceivable for him. When I left the next day, the concierge offered to call a taxi and I accepted. As the cab started to move off, he ran in front of it and banged on the hood, screaming “Where’s my commission?” I didn’t know whether it was me or the taxi driver who was meant to give the money. To have to pay extra to get good service seemed wrong, and meant that rich people would be better attended than poor people. I reasoned that it was just a different way of doing things, but having to keep watch to make sure that someone would not do something for me and demand payment after made me nervous. I seemed to be in a nation of beggars.

The service on the Varig flight to Manaus was very good, and I said yes when the attendant asked if I wanted coffee. I was feeling low on caffeine because the American coffee at breakfast was weaker than tea. The coffee the flight attendant gave me came in a tiny cup, was stronger than I ever imagined coffee could be, and so sweet that I winced. “Don’t you have any in a larger cup with milk?” I asked.

“No sir, that is Brazilian coffee, and we only have milk in it at breakfast” replied the hostess. Feeling stupid that I didn’t even know how Brazilians drank coffee, I drank as much of it as I could, and dozed off. It was daytime over South America, but it was the middle of the night in Australia, and my internal clock still hadn’t adjusted.

I stayed for a few weeks at the house of the project leader, but he was Canadian, and that didn’t help my Portuguese, so I moved into living quarters on the Institute grounds. That was the loneliest year I have experienced. I had spent time in remote places by myself before, but this was different. I was surrounded by people, but couldn’t communicate with them. Even as my Portuguese improved to the point that I could hold a slow conversation with one

person, I could not follow normal talk at a bar, or even at the dinner table. I would see something interesting, turn excitedly to the person next me and try to formulate the sentence. When the words wouldn't come, I'd give up and say "Forget it." Most people communicate a lot non-verbally, but I wasn't good at that either.

I also wasn't being paid. I had been in Manaus three months, but the Institute Administrator kept inventing bureaucracy that needed to be dealt with. Each time I went to his office, he gave me a different list of documents to get. He assigned me an assistant to help with the paper work, but that didn't help much. Finally, I went into his office and he gave me another list. "OK" I said, and just sat there. He said in Portuguese "No Bill, you must not understand my Portuguese – you can go."

"That's all right." I said. "If I'm going to starve to death, it will be more comfortable here than on the street." An hour later, the paper work was sorted out.

Manaus had 400,000 people when I arrived. It was an old city that originated from a Portuguese fort built in 1669. However, there was an indigenous township there long before that. It became one of the richest cities in South America during the rubber boom in the late 1800's and early 1900's, but declined in economic activity after that until it was declared a tax-free zone in 1960 and became a center for light industry. When I arrived in 1979, the free zone was just starting to launch Manaus on a population explosion that would result in it having about two million inhabitants today.

Manaus has virtually no farmland around it, and almost everything the city needs is flown in or is brought by boat. Although it is in the middle of the continent, and about 1,000 km from the sea, ocean going vessels can navigate to Manaus via the Amazon River. The Rio Negro flows into the Amazon in front

of the city. Although it is only a tributary, and its waters get backed up by the Amazon, more water flows down the Rio Negro than all the rivers of Australia put together.

Being a modern industrial center and a thriving regional port produces many contrasts. Giant cargo ships are moored near small wooden fishing boats and wooden canoes. The person you meet at a bar might be a top executive for a multinational company or a peasant farmer who has come to Manaus to buy supplies.

Driving in Manaus can still be a nerve-wracking experience, but in 1979 traffic was chaotic. When I first arrived, I frequently had dysentery as my intestines adapted to the new flora. Not feeling well enough to catch the bus, I took a taxi back from the city center. The old volkswagon beetle was rusty red in color, but seemed reasonably intact when it pulled up. Dozens of crosses and other baubles hung from the ceiling. Small pictures of Jesus of Nazareth and other religious figures were plastered everywhere, and a miniature hammock swung in the rear window. When I sat beside the driver, he gave me a rope that I kept tensioned so the door wouldn't fly open on the curves. I had to keep my feet apart because there was a hole where the floor should have been, and I could see the road flashing by as the driver showed his driving skills, mostly on the wrong side of the road.

Buses generally went more slowly, but the town council had a rule that all bus routes had to be serviced until midnight. The bus drivers would line up at the central bus station waiting for the last run. It was a sport to take one of those buses. The motors revved and the windows vibrated as the hands on the town clock inched toward the vertical. On the stroke of midnight, all the drivers released their brakes and started a race through the back streets of Manaus, which were barely wide enough for the big Mercedes buses. Fortunately, at that time,

there was virtually no-one else on the roads after midnight, and the drivers would take blind curves with the wheels on one side of the bus clear of the ground. Not as fast as Formula One, but more exciting because you were in the vehicle.

By almost any standard of urban planning, Manaus was a mess. There were open drains, dogs and vultures would rip apart the bags of rubbish put out for collection, and power failures were daily. Nonetheless, the people vibrated with freshness and hope, a stark contrast to the safe conservative life styles in Australia and the US that were quickly becoming dominated by old people with old ideas. Infrastructure and technology were advancing quickly in those countries, but it seemed that, as those aspects advanced, the people shrunk. Although I was even less socially competent in Brazil than I had been in Australia, that didn't seem to matter as much. Born of a mix of European, African and Indigenous cultures, the people seemed to have less expectation of what you should be like, and accepted you wholeheartedly however you were. I had seen cultures working side by side with some degree of mutual respect and intellectual acceptance, but this was the first time I understood what emotional integration was.



I was paid to work on aquatic mammals, and I spent a lot of time learning about them and trying to help the project. Much of the work was based on captive animals, however, and I now felt strongly that you can't preserve animals in captivity. Their bodies stay, but their essence is gone when you excise them from the land that formed them. Nonetheless, when the I found that the fish-culture department had some captive caimans they wanted to get rid of, I asked if I could have them. There are only two species of crocodiles in Australia, and they generally don't occur together. I had read that there were

four species of caimans in the Amazon, and it seemed from the reports that they could be found in the same places. Keeping them in captivity would help me learn to distinguish the species, and maybe learn something about their biology.

Living crocodilians belong to one of three families. Although they look superficially similar, they have been evolving separately for over 70 million years, which is longer than the separation of most families of mammals. Crocodylids, or true crocodiles, occur in all tropical regions of the world, and the few species of Gavialids, crocodilians with extremely thin snouts, are now found only in India and South East Asia. Alligatorids include the true alligators, genus *Alligator*, with one species in North America and one in China. South American alligatorids are called caimans.

All of the caimans were small, and I kept them in fibrous-cement water tanks that are usually installed in the ceilings of houses in Manaus to keep taps working when there is no pressure in the pipes connected to the town water supply, which is frequent. Some of the animals were pitifully thin, and I had to force feed one of them until it had the strength to take food itself.

The largest animals were two black caimans, about 1.2 m long. The species goes by the scientific name of *Melanosuchus niger*, which loosely translated means the black crocodile that is black. The black caimans weren't all black, however. They had irregular thin white lines over most of their bodies, and their heads were rich brown, only broken by black blotches on the jaws. Hatchling crocodilians are often much more intensely colored than adults, and baby American alligators have color so similar to that of the black caiman that Brazil's foremost herpetologist once identified a photograph of a baby alligator I showed him as a black caiman. However, black caimans retain their spectacular color into old age. With time, their heads become grey rather than

brown, and the fine white lines disappear, but the ebony scales, which look like shiny black plastic, are distinctive into old age.

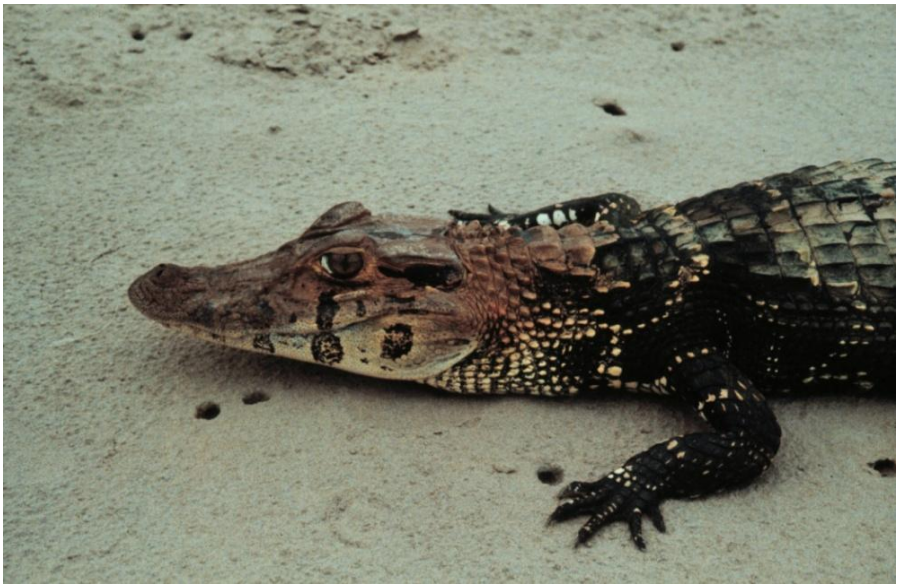


Photo 3.1 *A black caiman,* Melanosuchus niger. *Photo by Bill Magnusson.*

The black caimans had broad heads, giving them an overall shape much like that of an American Alligator, but they had two rows of raised scales along the midline of the body that made it look as though their backbones were protruding. If it wasn't for their fat bellies, I would have thought that they were emaciated. Although they were the biggest of the caimans I had, they were also the slowest and weakest, and I had no trouble handing them.

The next biggest was a Spectactled Caiman. The scientific name for the species is *Caiman crocodilus*, which seemed appropriate because the general shape of the caiman I had was very similar to that of a young saltwater crocodile. It was a dull yellow brown with irregular darker markings, also much like many small crocodiles. The common name stems from the bony ridge that runs between the eyes and looks like the bridge over the nose in spectacle

frames. Scales forming a small spike above the eyes also give the impression of the ornamented glasses that were popular in the 1950s. The bony ridge between the eyes is not unique to the spectacled caiman, however. Other species in the genus *Caiman*, and the black caiman, also have them.

The temperament of the spectacled caiman was different from those of the black caimans. It was a bit stronger and struggled more, but the main difference was that it was always ready to give a quick bite and I had to be careful to keep my hands out of striking distance.



Photo 3.2 *A spectacled caiman,* Caiman crocodilus. *Photo by Bill Magnusson.*

The smallest individual I was given was a Cuvier's Dwarf Caiman, which is sometimes given the ridiculous "common" name Cuvier's Smooth-Fronted Dwarf Caiman. The made-up common name comes from the fact that species in the genus *Paleosuchus* lack the bony ridge between the eyes found in all other species of caimans. The species full scientific name is *Paleosuchus palpebrosus*,

which means ancient crocodile with hard eyelids, a reference to the flat bony plates above the eyes.

The little caiman was not like any other crocodilian I had seen. Its snout was short and it sat with its head raised off the ground so that it looked more like a sitting dog than a reptile. It watched me with large brown eyes that, even in captivity, seemed to show more intelligence than the yellow eyes of the other caimans. It was not only its eyelids that were bony. All crocodilians have bony plates in their dorsal scales, but the rest of the body is usually covered by soft leather that makes them the targets of handbag and shoe manufacturers. The dwarf caiman had bony plates in almost all its scales that made it feel more like a turtle than a crocodile. It was almost much stronger than any of the larger caimans I had received, and its bony neck scutes hurt my hands when it struggled.



Photo 3.3 *A Cuvier ś dwarf caiman*, Paleosuchus palpebrosus.
Photo by Bill Magnusson.

There are other crocodilians that are small, have heavily armoured skins and brown eyes. They are species of *Osteolaemus* from West Africa, crocodylids that independently evolved the same characteristics, apparently as adaptations to living in small streams in and around rainforest. However, there was even less literature about *Osteolaemus* than *Paleosuchus*. I was intrigued, and decided that I would try to find out why *Paleosuchus* was so different from the other caimans.



Photo 3.4 *A Schneider ś dwarf caiman,* Paleosuchus trigonatus.
Photo by Bill Magnusson.

It was some time later that someone brought me a Schneider's Dwarf Caiman, *Paleosuchus trigonatus*. The scientific name means ancient crocodile with three points, reference to its triangular scales. It looked much like Cuvier's Dwarf Caiman, but the large scutes on its tail pointed horizontally rather than vertically, and its snout was long and pointed, more like that of a Spectacled Caiman than

the other species of *Paleosuchus*. Its skin was just as bony as that of Cuvier's dwarf caiman, and it held its head up in the same way. I now had more crocodilians living together than anywhere else in the world except Venezuela and Colombia, where there are also four species, but the Orinoco Crocodile substitutes the Black Caiman as the largest species. It was getting very interesting.

I appreciated any chance to get into the field, which in this case meant onto the rivers. You can't appreciate the size of the Amazon and Negro Rivers unless you have seen them. You can see across the Rio Negro from most points on its bank because it is only five to seven kilometers across at its widest points, but it may be 90 m deep, with fish living in its depths that are found nowhere else. You cannot see the the far bank of the Amazon River at most places due to intervening islands, even 1000 km from the sea, and at high water, when the river floods the forest, it may be 50 km from dry land on one side to dry land on the other.

A storm sprang up on my first trip across the Rio Negro and the waves smashed into the 7m aluminium canoe as they would have done in the Liverpool estuary. I commented in my diary that the rivers looked liked the wide bays in northern Australia, but something was missing. Wind, waves and cold spray on my face were what I was used to, but the sensation that something was wrong stayed with me for many trips onto the rivers. It was only after several months of thinking that I must sick that I worked out what was lacking. The freshwater rivers lack the smell of the sea, which I had grown up with and took for granted. Once I realized the difference, I no longer felt sick, but I had learned that a sense of place entails all of our senses. I have lived in the middle of the largest freshwater ecosystem in the world for over 30 years, but I still crave the scent and taste of the sea. When I visit the coast, the first things I do are to take a deep breath and taste a mouthful of salt water.

The Crocodilus project in Australia had used special harpoons to capture crocodiles, which were too wary to be caught by other means. The harpoon head consisted of the points of two large fish hooks that had been embedded in the end of a few centimeters of water pipe. The barbs of the hooks faced each other and were only a few millimeters apart. When thrust at the neck of the crocodile, the barbs would penetrate the skin, but the flat base of the pipe would stop them from going deep and damaging the animal severely. The skin caught between the barbs was enough to hold the croc while it was played in open water and could be brought alongside the boat when it had exhausted itself.

Live-capture harpoons are only necessary for very wary animals, and they only work in relatively open water, such as the tidal mudflats of the lower reaches of Australian estuaries. They are not necessary to capture most species of crocodilians, and are not efficient in places, such as the Amazon, where there is a lot of submerged vegetation to tangle the line. Nevertheless, they were what I was used to, and I asked a local workshop to make the heads. There were plenty of harpoon shafts available, which the local people used to catch manatees.

The institute had several large wooden boats, each over 15m long, which could accommodate up to 20 people sleeping in hammocks. We took one 500 km upstream of Manaus to the region of Tefé to explore Lake Amanã. The trip upstream took three days, and there was not a lot to see. The captain kept close to the bank, where the current was less, and often navigated through the narrow channels between the islands, but the banks were mainly cloaked in tall grass or regrowth forest, with only occasional tall trees to show how the original forest might have looked.

The first European explorers, such as Henry Bates, described tall imposing forest along the banks of the Amazon in the 1800s, but even then much of the

flooded forest had been cleared by indigenous communities. The European and African settlers, like the Indians, realized the agricultural potential of the rich soil deposited by the Amazon floods. They cleared the tallest forest, which was on the higher areas that were flooded for the shortest periods, and the forest that was left lacks the grandeur of that described by the early explorers.

Tefé is on a blackwater lake formed where the Rio Tefé, which is a tiny river by Amazonian standards, runs into the Amazon River. Fishing has always been an important industry for the town, but the black water of Lake Tefé is not very productive. Most of the fish come from the immense flooded areas around the confluence of the Amazon and the Japurá Rivers, both of which carry sediment-rich white water. In the Amazon, white water does not refer to the white caps of the waves in turbulent rapids so prized by kayakers; it comes from the grayish white color of the turbid rivers that drain the Andean highlands.

A small stream runs into the Amazon just downstream of the meeting of the Amazon and Japurá Rivers. Although it has comparatively little current, it affects the drainage sufficiently to form levee banks and canals that back up the water to form Lake Amanã. At low water, the lake has black water, but the Amazon invades it at high water, and the water turns milky white. It sounds disastrous to have the land alternately dry, then covered by up to 10m of flood waters, and bathed by water that varies from neutral to more acid than coca cola. However, it produced an ecosystem that is incredibly rich in species. Many people live around rivers, but the area has now been included in a corridor of sustainable-use and strict-conservation areas that run along the Japurá River, across Lake Amanã and down the Jaú River to the Rio Negro, 600 km to the east. These reserves cover an area larger than many European countries combined.



Photo 3.5 *Caiman skins bought from poachers being transported in a fishing boat. Photo by Bill Magnusson.*

In 1979, none of these reserves had been created, and the local people, descendents of Indians and the original European and African settlers known as caboclos, lived in scattered communities much as they had done for centuries. We left Tefé in aluminum canoes before the wooden boat, and slept in caboclo houses until the boat arrived several days later. The little wooden houses had shutters on the windows that had to be kept closed after nightfall because the

mosquitoes outside were unbearable. I foolishly accepted the coffee the lady of the house offered towards nightfall, and woke towards midnight with the urge to urinate. However, I had to hold on until dawn. The little house was criss crossed with a dozen other hammocks, and I would have had to wake everyone else to get to the door, which, if opened, would have let in clouds of mosquitoes. None of the books on social etiquette have a section on how to look after your bladder when a guest in a caboclo house!

When our larger boat arrived, we found it moored beside a small wooden boat, about 6 m long and roofed over to form a cabin that I could just stand up in if I retracted my shoulders and kept my head down. The inside of the boat was mainly filled by about 2 tonnes of dried Arapaima fillets. At the time it was legal to catch the giant fish that may grow to over 3 m long. There were also 10 skins of large black caimans, and about 40 skins of spectacled caimans. Caiman hunting was illegal, and I didn't want to attract attention by carefully counting the skins. However, the boat's crew did not seem concerned that they were involved in contraband, and we were in a boat covered by stickers of a federal agency. They allowed me to take photographs, and said that the skins had been bought from caboclos living around the lake.

The work on aquatic mammals was undertaken during the day, and I could study caimans at night. It was nice to get away from the crowd on the boat. Just me and the boat driver in the aluminum canoe with outboard motor. I stood in the bow with the spotlight and communicated to my assistant with gestures since he could not hear what I was saying over the sound of the outboard, and in any case would not have understood my rudimentary Portuguese. It felt much like the northern Australian rivers as we sped along beside the shore. The white spray of the boat reflected the light of the spotlight, and snags of dead trees stood like sentinels above the floating grass mats. The wind was a little cold,

but invigorating, and I realized how much I had missed open water and night air while working in Manaus.

A big difference between Australia and the Amazon became apparent when I saw reflections from a caiman's eyes and signaled the driver to slow down. As the air stopped rushing past, insects started flying into the light and crawling over my bare arms and face. They didn't worry me until I realized that the white and yellow balls rushing at me were not moths, they were 2cm long wasps. The locals call them *caba da noite*, which means night wasps. In fact, they usually fly during the day, and sit quietly on their heart-shaped nests at night unless someone shines a light on them.



Photo 3.6 *Night wasps often make spotlight surveying around the Amazon painful. Photo by Bill Magnusson.*

I just ignored them at first, but one crawled into my shirt and gave me a painful sting to the chest. When I swung my arm to brush it off, I crushed others that were in my shirt and they drove in the poisonous barbs on their tails. I tried

to flick one off my face and it stung me in the corner of my eye. I turned off the light the driver was using to navigate and we crashed into an island of floating grass. I had six stings, including the one near my eye, and they were painful. When I regained my composure, I signaled to the driver to head into midwater. The caiman had long since disappeared and I did not want to risk getting any more stings from the wasps, which I assumed had a nest nearby.

I was wrong about where the wasps were. They were not concentrated near that caiman, but were everywhere. Whenever we slowed down, they would come slamming into the light. By the end of the night, I discovered that it wasn't possible to avoid them. However, by taking off my shirt, and tucking up the edges of my shorts, I was able to avoid getting stung. The yellow hornets only stung if they were crushed up against you by your arms or your shirt. By keeping my arms free of my body, not wearing a shirt, and not trying to brush them off, we entered into a mutual truce. They would wander over me for a while until they got bored and then fly off. Well and good, because they have one of the most painful stings I have experienced from any insect.

The lake was wide where we surveying, I only saw spectacled caimans, and most were too far into the floating-grass mats to capture. Nevertheless, I recorded the type of vegetation, distance from the bank and depth of the water for each individual, as well as an estimate of its size. Most of the caimans that I was able to approach were small, and I captured them by hand. We had paddled the canoe into a small channel through the grass to catch a small spectacled caiman, and I looked over the side of the boat after tying it up. Slowly out of the depths rose a much bigger caiman, perhaps 1.5 m long. It apparently didn't realize that we were there and it had a large catfish that must have weighed at least half as much as itself in its mouth. The fish was still struggling, its brilliant white belly flashing in the spotlight as it shook the caimans head from side to

side. So much for the story that caiman's can't catch fish underwater! The caiman was concentrating on the fish, but sensed our presence as soon as it reached the surface, and disappeared with its catch into the depths, not to be seen again. It wasn't a very productive night in terms of data collected, but it was a good introduction to surveying caimans around large Amazonian rivers and lakes.

The next day, the researchers studying aquatic mammals and fish told me that they had gone out the night before to catch caimans for fun, and had put the three animals they captured in an empty fuel drum. There was a certain rivalry, and I got the impression that they were trying to show how easy it is to study caimans. In fact, most people think it is easy to study crocodilians because they are easy to locate in open water at night from their brilliant eye shines when illuminated by a spotlight, and because it is easy to catch small individuals, which are often very abundant. Finding out something interesting about the species is not so easy, however. You can quickly discover where the juveniles are and collect their stomach contents without hurting them by methods developed by Grahame Webb and Janet Taylor. Capturing, tracking and learning about adults is another matter, and usually takes many years of dedicated study. Most biologists I know who have really advanced our knowledge of crocodilians have studied them for over a decade, and many for more than 20 years.

I had no data on where the caimans in the oil drum had been caught or anything else that might help me understand their habits, but I thought that I could at least mark and release them. Unfortunately, there was a thin film of diesel oil in the bottom of the fuel drum, and all the caimans were dead or dying when I opened it. Useful for me because I learned a lot about anatomy when dissecting them, and had specimens to put in the museum. Nonetheless, I was

sad. Research is a game, but it is a serious game. If you play it superficially, you waste resources that could be better used in social pursuits, such as building hospitals and schools. If you are a biologist, research often means killing animals or plants. It is a tragedy if their deaths do not contribute to knowledge that will help conserve the species, or at least provide benefits to society. Many people want to be scientists, but few want to do science. Ninety nine percent of the data collected by scientists is never used or made available to other scientists, and the researchers take the information with them to the grave. Society pays them to play games, and they never grow up. I could see that studying four species of caimans in the immensity of the Amazon was not going to be easy or quick.

In any case, the diesel oil did not affect the quality of the caiman meat, and I passed it to the cook to prepare for lunch. The meat was white, but tasty and succulent, and much better than the meat of the monkey that one of the mammalogists had shot, which we also ate for lunch. I rated it as good as the meat of the monitor lizards that I had often eaten in northern Australia.

The next night, I headed further up the lake, where the local people said I would find black caimans. They said that black caimans used to be common everywhere, but poachers had taken most of those that were easily accessible. The species still held on in a flooded area called chavascal that is covered by arum lilies on 3m stems. The flooded areas around the white-water rivers, locally called várzea, support different vegetation, depending on the height above the lowest water levels. Chavascal occurs on the lowest-lying areas, and is flooded for much of the year. Even when not flooded, the dense palisades of arum stems and the soft mud of the chavascal make it difficult to penetrate.

We found a black caiman about 2m long near the chavascal, but in fairly open water covered by a thin layer of floating grasses, water lilies, and other

small plants that we could push the boat through. It was different from any other crocodilian I had seen in the wild. Its bulging neck was much wider than its head, and reflected in the spotlight like a gray balloon. I stood in the bow and drove the harpoon into the soft skin behind the wide skull. The harpoon just bounced off and the caiman dived. Experience with saltwater crocodiles had taught me that crocodilians don't give you a second chance, so I gestured for the driver to back out and prepared to look for another caiman. However, the caiman surfaced again in exactly the same place. The second time, the harpoon penetrated, but it came loose as the caiman dived through the tangled grass.

I pulled in the cord, retrieved the harpoon head, and fixed it to the shaft again before turning on the light. The caiman was back where it had been before. This time I was not going to risk hitting it with too little force. As the boat slid alongside it, I positioned the harpoon vertically onto its neck, grabbed the shaft with both hands, and stepped out the boat, driving the caiman straight down into the water with all of my weight. Still the harpoon did not take, and I secured the shaft with one hand and held onto the side of the boat with the other. Hanging in the water with water lilies draped around my neck, I must have looked pretty silly.

I slid the harpoon into the boat, pulled myself up so that my chest was resting on the side of the boat, and told the driver in painful Portuguese that he could back out because the caiman would never let us get close to it again. He shook his head and pointed behind me. I twisted around, and there was the caiman's head, less than a meter from where I was hanging in the water, and apparently unconcerned that it had just been jumped on by a clumsy human. It had gone by the time I clambered into the canoe, but I concluded that the black caiman is the dummest crocodilian in the world. I would discover that not all black caimans are as insensitive as that one, and American alligators also vie for the distinction as the stupidest crocodilian, at least as far as being captured by humans goes,

but black caimans are still among the least wary crocodilians, and I could see why it had been so easy for hunters to extirpate them from so many places.



It was difficult to get close to caimans when the river was high and there were wide mats of floating grass that they could hide in, but we returned to Lake Amanã a few months later when the water was close to its lowest level, and caiman surveying became easier. Seeing caimans was now much less work and I counted more than 70 in a small stretch of canal on the first night. Most were spectacled caimans, which were lying in shallow water or in the floating grass mats. The few black caimans and Cuvier's dwarf caimans were in the deeper areas near cutaway banks with little grass. This was my first inkling as to how the species divided up the habitat.

One of the students was helping me catch caimans, and he held a spectacled caiman that was a little over a meter long while I measured it. He was not securing it firmly, and when I got too close to its jaws it snapped them shut on my hand. Its teeth were needle sharp, but the bite was weak and the caiman didn't hold on. Although blood was dripping everywhere, my hand was not badly damaged and we got on with the work. However, the bite had unexpected consequences.

The shafts for the harpoons I was using had been designed for capturing manatees, and they had a small nail to loop the cord around at about two thirds of their length. The nail stuck out only about 2 mm and I left it there, even though I didn't need it to catch caimans. I had discovered why the harpoons didn't work on the first expedition, and I had separated the prongs a little to

allow the skin to slide through, but I still needed to use a lot of force when I struck a caiman.

The next caiman was big and I drove the harpoon down with as much force as I could, but my right hand was bloody from the caiman bite and it slid down the smooth shaft of the harpoon. The tiny nail slashed through my palm, exposing muscle and leaving a scar that I have to this day. There was no way that I could continue harpooning, and asked the boat driver to switch roles with me. We came up on a Cuvier's Dwarf Caiman that was about 1.2 m long and the driver drove in the harpoon. However, instead of going for the soft skin on the side of the neck, he hit in the middle of its back where the bony scutes in the skin form an almost continuos plate. The harpoon held, but the shaft had smashed a hole in the animals back and I could see its lungs, so I was sure that it would die.

The following night, I decided to avoid using the harpoon because most of the caimans could be caught with a noose on a pole. My hand was in bad shape from the bite and the nail, so I let one of the students do the catching. He noosed a 1.5 m spectacled caiman and brought it alongside the boat, where it spun in the water and beat its head on the metal. I told the student to grab the caiman around the neck and lift it up so that I could tie its mouth shut, but he just made a few tentative movements and pulled back. Exasperated, I pushed him aside and grabbed the caiman, remembering too late that my right hand was badly damaged. The caiman thrashed and, as I lost hold, it turned and latched onto my wrist. Now I was in trouble. It was thrashing and spinning, and I had to spin my hand with it so that it wouldn't be ripped off. I pulled the cord with my left hand to jam the caimans head up against the canoe and yelled for the student to do something.

The student did nothing, but with its neck tight against the side of the canoe, the caiman could only move its head if it let go of my wrist, which it did. My arm was not badly hurt. The teeth had missed all the major veins and the caiman's spinning had not been enough to tear any cartilage. In fact, at that moment, the pain was greater in my shoulder and back from my contortions to prevent the caiman rolling, and the bruise on my ribs where I had fallen against the boat. It was a valuable lesson, however. I could have lost my hand. Most of the serious caiman bites in the Amazon are not from black caimans, which are big and occasionally deliberately attack humans. The most frequent bites are from spectacled caimans, which get caught in fishing nets. They lie still when first pulled from the water, and the fishermen think they are dead until they have clamped onto a limb, and are doing the famous crocodilian "death roll".

That was the most serious bite I have taken from a crocodilian. In fact, the only crocodilian biologist that I have heard of who has been badly bitten by one of his study animals is M. L. Modha, who, according to Tony Pooley, lost a large chunk of one buttock while watching Nile crocodiles from in the water. I remembered that when I first started working on crocodiles Grahame Webb said "If you students think you're brave, read this," and he gave us a copy of a book written by rhinoceros researchers. Rhinos chase after you on dry land, and several would-be researchers have lost their lives studying them. Crocs are only a threat if you go too close to their element, or do something silly while trying to catch them. The man-eating crocodiles of Africa and the Pacific kill many people each year, but none of those victims are crocodile researchers.

4

Crocodilians in the USA



Left to right: Karlheinz Fuchs, Jim Kushlan and Terri Jacobsen in the Everglades in 1980. Photo by Bill Magnusson.

The 1980 meeting of the Crocodile Specialist Group, called by members by its acronym CSG, was held in Gainesville, Florida, and I was keen to attend because it was in the heart of Alligator country and, at that time, more was known about Alligators than any other crocodilian. The most intensive alligator studies had been undertaken in Louisiana, and Ted Joanen, who I had met at the Maningrida meeting, was the lead biologist. Subsequently, research had started up in the everglades in southern Florida, and around Gainesville in central Florida, where the CSG meeting was to be held.

Dave Dietz had done his Ph.D. on alligator behavior, and he offered to take me to his study site on Paynes Prairie near Gainesville. Research always involves some difficulties, but I soon saw that the challenges of studying alligators in the USA were very different from studying caimans in the Amazon. We drove through flat meadows of marsh grasses that were occasionally broken by stands of bald cypress around small ponds and streams. There were stands of oaks on the islands of higher ground that are called hammocks in Florida. Where there was forest, Spanish moss hung from the trees, and gave the landscape a primeval aspect.

Dave stopped the car on a sealed road and we walked a short distance to where an alligator was lying beside her nest. She moved a few meters to put herself between us and the nest, but otherwise did not seem particularly concerned about our presence. I had not seen alligators close up before, and this one allowed us to get within a couple of meters. Her broad head looked very heavy, and I wondered how she could catch prey with such an ungainly weapon. In fact her bright eye seemed lost in the mass of bone. The huge head made her body, and especially her legs, look spindly. She was dull grey all over, and looked like a badly made garden sculpture dropped into the grass.

All marsh dwelling crocodilians tend to have heavy heads. Although no living species has a snout as broad as that of the American alligator, some fossil crocodilians had heads that were so wide that a person could sit on the snout with ease. Although they look ungainly, alligators are capable of dealing sledge-hammer blows with their heads, and smash through the tough marsh sedges as though they were popsicle sticks. The fine snouts of the river crocodiles would tangle in the vegetation, and if they tried to live in the marsh they would starve to death surrounded by juicy snails and rats just a handspan away in the thick grass.

Dave waved me forward, and we approached the nest from the side, the alligator always watching, but immobile. The nest was a pile of grass and mud scraped up to form a mound about a meter high. It looked much like the nests of saltwater crocodiles on the floodplains of the Liverpool River. There was a water-filled channel near the nest where the alligator could have made its escape, but her intense stare left no doubt that she would not abandon her nest. Dave said that most of the alligators he had studied defended the nest that way, apparently as a defense against egg predators, such as raccoons and black bears, which were common in the area.

I could now see why there had been so many good studies of behavior of nesting alligators, and even wondered why there hadn't been more. Alligators are common in suburban settings in the southeast of the USA, and I suspect that people who live in alligator country have become so accustomed to them that they no longer see them as mythical creatures from an ancient lineage. Alligators for most people in the US are just impediments that get in the way when they are backing the car out of the garage, or that eat fluffy dogs when they are swimming in the lake in the middle of the condominium.



Photo 4.1 *An American alligator,* Alligator mississippiensis, *guarding its nest on Paynes Prairie. Photo by Bill Magnusson.*

Dave was enthusiastic about his studies and had obviously developed a strong attachment to alligators during his Ph.D. However, he said that his wife was not enthusiastic about being married to a biologist, which meant living on low wages and little security. He said that he would do a medical degree, but might go back to biology one day. To my knowledge, he never did. I had been heartbroken when Janet had left me, but now I was starting to see the silver lining on the dark cloud. She had been looking for a more mature man to look after her, and had two children soon after she found one. I could now see that if I had such responsibilities soon after finishing my Ph.D. I almost certainly would not have left Australia, and I would not have had the time that is demanded of a field biologist. Good logic, but it didn't relieve the ache I felt when I remembered losing her.

It may look as though it is easy to study alligators, but I repeat my admonition to never underestimate a crocodilian. Tommy Hines and Dave took

me in a boat to see the Orange Lake, a 5 km^2 area of marsh in northern Florida. It had more open water, but the marshy areas around the lake were much like Paynes Prairie. Getting around on the open water was easy, but when I looked into the dense masses of reeds I shuddered at the thought of trying to catch, or even see, an alligator at night. However, Tommy and his colleagues had been able to accurately count nests, because there was very little forest cover, and they had access to helicopters.

Tommy Hines and Allan "Woody" Woodward, carried out an experimental alligator harvest in Orange Lake between 1981 and 1990, with the aim of determining how alligators responded to harvesting. Over the first four years, they killed 25% more adult female alligators than the number of nests that had ever been recorded in a single year. They also harvested more alligators >3m long, presumably males, than they counted during night spotlight surveys. The overall investment in the initial studies and the experimental harvests, including infrastructure and salaries, must have been of the order of millions of dollars on today's values, but nesting continued to increase throughout the 10-year harvest experiment. Despite the continued harvest of a substantial proportion of the adult female population, the number of large alligators taken each year remained relatively unchanged, so the original counts must have underestimated the true density by at least a half. Even the sluggish alligators do not give up their secrets easily.



I drove south from Gainesville through the Big Cypress swamp with Dave and Bob Godschalk, a researcher who would later undertake research on caimans in Bolívia. The Big Cypress does have many more cypress hammocks than Paynes Prairie or Orange Lake, but it would still be dominated by

grasslands if it were not for the introduced Australian *Melaleuca*, which is resistant to both fire and flooding, and will probably end up turning most of the marsh into a forest.

The car broke down on the way and we had to spend several hours on an isolated stretch of road. We got suspicious stares from some of the locals, who Dave said were alligator poachers. It seemed strange to have poachers in a first-world country in an area with easy access by wildlife officials. If poaching could not be controlled here, I decided that trying to enforce wildlife laws in remote areas of the Amazon would be impossible.

I was eager to see the Everglades, which is the marshland that covers the southern part of Florida, where it projects into the Gulf of Mexico. Most of southern Florida was once a coral reef, and water flowing over the flat limestone in the wet season spreads out to form a shallow, but enormously wide, river that flows through the marsh sedges. During the dry season, most of the area is dry, and fires rage through the open prairies. I had seen many television programs dedicated to the Everglades, and even the name conjured up visions of dark, dank swamps.

We went to the headquarters of the Everglades National Park to meet Jim Kushlan, who directed research on the Everglades ecosystem. As we pulled into the parking lot, a truck passed releasing clouds of acrid insecticide over us and the surrounding terrain. I was told that the mosquitoes were so bad that the tourists were badly inconvenienced on the short walk from the car park to park headquarters, which were tightly screened. Nonetheless, it still seemed strange to be pumping so much poison into a national park.

Jim was young, not much older than me, and had long blond hair that hung over his colorful cotton shirt. He was short, thin, and looked more like a surfer

than an academic, but he had a long list of publications about alligators, birds, and other denizens of the Everglades. Although many biologists worked in the park, it was Jim who generally put it all together. Most of Jim's concerns about the alligators and birds were related to water. The Everglades were essentially the end of a long shallow river that started in Lake Okeechobee in northern Florida. The state is at the southern limit of the USA, and one of the few parts of the country that does not become bitterly cold in winter.

The moderate climate by US standards has attracted millions of retiries, and Mediterranean-style agriculture into the state, to say nothing of Cuban refugees. The roads, orange groves, and water impoundments thrown onto an extremely fragile ecosystem have had drastic consequences for the Everglades. The water, instead of arriving in a broad sheet, now comes through a few gaps in the levees. The amount is carefully controlled, and the wild abundance of former times is now siphoned off to meet the needs of the growing human population. Wildlife management in its traditional sense was largely irrelevant for the fauna of the everglades, and most of Jim's discourse was about ecosystem management in the upstream regions outside the park.

Jim's many responsibilities would not allow him to spend much time with us in the field, but he introduced us to Terri Jacobsen, who was responsible for most of the alligator research. Terri was tall, blond, and looked to me as though she would be more at home on a fashionable street in Stockholm than chasing alligators in Cajun country. However, this probably just reflected my sexist bias. If the CSG has an excess of anything, it is probably testosterone. Most crocodilian researchers are male and have macho attitudes, and this reflects in how they relate to each other. I have even had to come between researchers who were taking swings at each other during a meeting of crocodile specialists. It would be many years before I realized that the amount and quality of the data collected

by the few female crocodile specialists were far greater than those collected by most of the men. I am not sure that this relates to innate capacity to do research, the women just seem to have more time to devote to science because they spend less time posturing at meetings.

At that time, most of the alligator research was done from airboats, which are just flat-bottomed punts fitted with an aircraft engine and a propeller that faces backwards. They can travel quickly over thick reeds as long as there is at least a thin film of water and they were thought to be less harmful to the ecosystem than wheeled vehicles. However, if used repeatedly, they form channels through the vegetation, and destroy the nests of birds and other creatures that live in the grasslands, so their use is now much more restricted.

Jim took us to see nests in the marsh, and most of the other crocodile specialists were as eager to see alligators as I was. Although some worked in the field, most were associated with zoos, crocodile farms, or tanneries, and had little experience of crocodilians in the wild. I was amazed that the female alligators would remain near the nest after the noisy airboat with its load of gawking humans stopped beside them.

The Everglades were not what I had expected. My recollections of the television programs about the Everglades consisted of scenes of deep forest, with mist swirling around the contorted cypress trees and their grey beards of Spanish moss. Such scenes do occur in the Everglades, but they are restricted to the tiny areas of woody hammocks scattered across the sea of grasses and sedges. A glade is an open space in a forest, but there was very little forest in the Everglades.

It was interesting to see the Everglades in the company of so many crocodile specialists, but the number of people took away any of the aura that the wild

places might have had, and I was anxious to see the marshes at night. Therefore, I was pleased when Terri invited me stay at her house after the meeting so that I could accompany some real research. Marco Lazcano also stayed on. Marco was a Mexican biologist who would later be instrumental in setting up many conservation programs in his home country. Dark haired, a little chubby, and with a ready smile, he was good company. We arranged to pick up Marco near the highway and drive out to a tower in the middle of the park where we could stay the night.

Marco was not at the pick-up point, and we assumed that he had decided not to go, forgetting that Latin-American time is different from Anglo-Saxon time. Many hours later, we found him walking along the access road to the tower. He had gotten a lift along the highway and walked kilometers along the access road. It was the sort of curiosity and determination that would make him one of Mexico's premier conservationists. Marco also has another distinction. He had dual citizenship because he was born in the US while his father was doing a Masters degree in Orthopaedics at the Mayo Clinic in Minnessota. However, when he applied for his Passport with the Mexican government, he was advised that he could not have it if he had foreign citizenship. Therefore, he had to ask to resign his US citizenship. He said that the US officials had much trouble in doing so because they had never had a case of a Mexican who did not want to be a US citizen and they did not know how to go about canceling his citizenship! Fortunately, the laws were changed with the North America Free Trade Agreement and he now has dual US and Mexican Citizenship.

There were alligators nesting all along the road, and again I was astounded at how easy it was to collect behavioral observations on alligators in the wild. Terri said that we would take an airboat to Shark Slough, a wide channel that receives water from various parts of the Everglades before depositing it in the

Gulf. That would give us an opportunity to see most of the different types of vegetation in the Everglades, which varied from dense rushes in higher areas, sparser reeds in the slough, with hammocks of cypress pine and subtropical rainforest dotted around, all of which give way to mangroves near the west coast.

The motor in an airboat is set very high so that there is space for the propeller. The driver sits on a seat at the level of the motor and has a great view of the marsh, which is necessary as the airboat has no keel or anchor. Sharp turns are impossible and maneuvers have to be planned dozens of meters before they are made. We did not see any alligators in the marshes, but we did see some among the mangroves, showing that alligators can spend some time in salt water.

I enjoyed the feel of the wind in my face and the sedges rushing by as we sped down the open space between the reeds caused by the previous runs of the airboat. It was not as pleasant as driving an outboard boat though, because the airplane motor was very noisy, and the flat bottom did not generate any of the soothing rocking motion typical of boat travel. After we motored back out of the mangroves, Terri asked “Do you want to drive back.” Part of me said yes, but part of me was thinking that this looked dangerous.

I climbed into driver’s seat and grabbed the joystick. Terri showed me how to swing the boat around by turning the rudders behind the propeller, and pointed down the track of crushed reeds that marked the track we had come on. I accelerated forward, gingerly at first, but soon the airboat started to skim down the track and I found that it only took a slight turn on the rudder to realign the boat when the trail changed direction. We seemed to be going much faster when I was seated high in the driver’s seat, and we were too fast for me to take in the scenery. I concentrated on enjoying the exhilaration of racing over the water and maneuvering almost out of control, as though in a car on an oily road.

By the time we got near the landing by the tower, I was really into it and we were racing along near full throttle when the track took a sharp veer to the left. I swung the boat around and we slid sideways down the track. Even though I powered off, we were going too fast to be able to make the turn and I knew that the boat would flip over if we went sideways into the reeds. I turned the boat back to face along the track and we went straight into the rushes where the track did its 90 degree turn. They slowed us down and we came to a stop about 20 m into the prairie.

My heart was racing and I was cursing myself for having gotten carried away at playing in a very dangerous machine. Terri was smiling and I said "Why didn't you tell me the turn was coming up? We could have been killed if I tried to follow the track!"

She just said "Oh, I knew you'd know what to do." I don't like it when people have more confidence in me than I have in my self, but my macho instincts forbade me from saying that to a smiling girl.

It was night when we set out to catch Sora, the female alligator that had carried a radio collar for the longest time in the study, and Terri suspected that she was guarding hatchlings from her clutch of that season. Terri waved the antenna in semicircles with one hand, while driving with the other and listening to the radio signals through headphones. I used the spotlight to light the way. The marsh looked different at night. Terri was driving more slowly and the light penetrated only a short distance into the reeds on either side. It felt like we were in a glade. We had seen few animals during the day, but now there were frogs and fish everywhere that the light went, and myriad insects came to crawl over the lens.

I thought that it would be hard to get close to Sora in the thick rushes, but she was in a patch of water lilies that were growing in slightly deeper water. I saw her eyeshine about 10 m away and signaled to Terri, who stopped the boat about a meter away from her. There was a two-meter aluminum pole with a metal noose on the end in the bottom of the boat, and Terri indicated that I should use it to catch Sora. I gingerly positioned the noose in front of her snout and tried to slide it through the waterlillies without spooking her. Each time it caught on some plants I would try to position it again, my experience with Saltwater crocodiles telling me that, if I touched the sensitive pressure detectors on the side of her snout, she would go down, never to be seen again.

Terri was yelling at me to catch the alligator, but I was sure that if I went too fast she would startle. Slowly she sank out of sight and I turned to Terri and I said "sorry," sure that we would never see the alligator again. Terri was pointing behind me and I turned to see Sora at the surface again about 5 m away. Terri started the motor again and swung the boat around, causing waves and waterlillies to wash over Sora's head, but the alligator did not dive when Terri put the boat right beside her. Again, I gingerly tried to edge the noose over Sora's head without disturbing any of the floating vegetation and again she went down.

After my third failed attempt, Sora surfaced about 5 m away, and Terri, exasperated, switched off the motor, grabbed the pole out of my hand, and jumped into the waist-deep water. She slogged over to the alligator, which just lay in the water looking at her, and she dragged the noose over its head with no concern about waterlillies or sensitive crocodilian touch receptors. When she pulled the noose tight, Sora began to thrash, but Terri just turned around, put the pole over her shoulder and dragged the struggling alligator back to the boat

without a backward look. She climbed into the boat, dragged Sora in after her, and handed me the pole.

Terri was obviously pissed off that she had to get wet doing what should have been easy fare for any experienced crocodilian biologist, such as myself. I was obviously pretty embarrassed, and didn't have the courage to look her in the eye. Soon, however, she was busy checking Sora for the damage that the thick radio collar had done to her neck, and by the time we had finished weighing and measuring the alligator, Terri's exasperation and my shame had passed somewhat. We spent most of the rest of the night spotlighting, and I saw and photographed lots of fish and frogs. By the time we got back to the landing, the sense of camaraderie had returned.

A few days later, Terri, Marco and I went to check on Sora. The radio signal was coming from a clump of dense rushes, and Terri brought the boat slowly up to the edge. There were several hatchlings among the reeds, and they gave little grunts as the wake washed them up and down. I leaned over the front of the boat to take a picture, but quickly fell back when Sora came rushing out the sedges, her head up and her tail thrashing. We did not want to scare her away from the group, and left her to look after her tiny offspring.



That night, Terri, Marco and I stayed at the tower and went catching alligators that did not have radios and still weren't marked. This time, I did not worry about scaring the alligators and just slammed the noose over their heads the way I had seen Terri do it. Within a few hours, we had captured, measured and weighed one 2 m and one 3 m alligator. It would have taken much longer to capture and process such big animals if it had been any other species of

crocodilian, but the alligators seemed resigned to the indignities we were about to inflict. It is the type of attitude that only a species that rarely meets a bigger predator can have. I passed my hand over the head of the biggest individual, feeling the massive bone structure that gave it a head like a hammer. The alligator's indifference reinforced the feeling that it belonged to a different world with a different sense of values. It was not, however, the world I had seen in the eyes of the saltwater crocodiles. I decided that crocodilians must have many different worlds, and that we humans could only have feeble glimpses into any one of them.



Photo 4.2 *A baby American alligator. Photo by Terri Jacobsen.*

Some years later, Jim Kushlan attended a meeting on the Conservation of the Wetlands of the Grijalva Usumacinta Rivers Delta in Southern Mexico and Marco Lazcano picked him up at the airport. Marco didn't recognize him at first because he had short hair and was wearing a suit and a tie. When he asked what

had happened to the long hair, wrecked jeans and sandals, Jim replied "Marco, we all have to act our own age." In fact, Jim had previously managed 15 years without a coat or tie, but the bureaucracy caught up with him when he left the Park Service. He was then a university professor in Texas and Mississippi before becoming the Director of Patuxent Wildlife Research Center in Maryland, which is the US Government's primary wildlife laboratory. He spent a couple years at the Smithsonian Institution, principly to catch up on writing, and retired in his mid fifty's to spend most of his time back in Miami. Jim has produced over 200 publications, mainly on birds. He has not stopped work after retirement, and has three books set to come out in 2014. I will always be grateful to him for the chance to grab some alligators and learn that the real Everglades system is much different from, and just as interesting as, that which was presented on television shows in the 1960s.



Alligators are not the only crocodilians in south Florida. The American crocodile, *Crocodylus acutus*, lives in the tidal areas around the coast and on the Florida Keys. Paul Moler has studied them for many years, and my wife has been into the field with him. Although he has only one arm, she said that he catches crocodiles by hand as large as most people could catch with two hands. I stayed in Paul's house when I returned to the USA for reasons unrelated to crocodiles, but, unfortunately, never got to catch crocs with Paul. When I met him in Gainesville, he told me that I should go into the field with Frank Mazzotti, another of Jim Kushlan's assistants who lived in Miami, and had recently received his Ph.D. for studies on nesting by American crocodiles.

The group that studied American crocodiles was very different from that which studied alligators, though they collaborated extensively. Much of the

alligator research was directed towards commercial pursuits or hunting, whereas the strictly protected American crocodile was only studied for academic or conservation reasons. The species is at the northern limit of its range in Florida, and the low densities do not allow for any offtake. Terri introduced me to Frank, who was thin, prematurely balding, and looked his Italian heritage despite his strong US accent. He offered to take me to the Florida Keys to see crocodile habitat the next day.

The Florida Keys are a series of sandy islands, the largest of which are linked to the mainland by long road bridges. There is not much to see on the larger Keys during the day, except the usual tourist traps associated with coastal towns. However, Frank took us out to the smaller Keys at the south of the peninsula in an outboard boat.

There are mazes of channels meandering through mangrove-covered islets near the shore. Mangroves in Australia are often more than 10 m high, but the little mangroves in the Keys rarely passed 4 m, and most were much shorter. Further out, the small Keys are sandy, have beaches on most fronts, and only small shrubs on the higher areas. Frank nosed the boat onto the sand and we alighted on what looked like any other beach. However, Frank walked to where the sand was about a meter higher than the rest of the beach and crouched down in a wide cavity, about two meters across. Scattered in the sand were fragments of egg shells. This was an American crocodile nest, and very different from any other crocodile nest that I had seen. The mound of sand that the crocodile had scraped up must have been 5 m in diameter and over a meter high. I could not tell exactly how high because the crocodile had scraped out the center to release the babies when they hatched.

I knew that the vegetation in saltwater-crocodile nests generates heat that can warm the eggs independent of any warmth from sun. I assumed that the same

processes functioned in alligator nests, which are also mounds of mud and vegetation. However, the American crocodile nests had no internal sources of heat, except for the tiny amount that might be generated by the embryos themselves. The crocodile therefore has to bury the eggs just the right distance underground so that the rays of the sun, which produce killing temperatures near the surface, will maintain the moderate and relatively constant temperatures necessary for the embryos' survival and generation of both sexes. If the eggs are placed to low, the embryos will die of cold. Several species of Crocodylids and Gavialids can make solar incubators out of beach sand, but no Alligatorid is known to.

We were on a beach in the middle of a bay at midday and there was a fairly strong breeze blowing. Nonetheless, mosquitoes were landing on me and looking for nice places to sink their beaks. Frank said that we would return at night to see if we could find the babies, which he thought probably still had not dispersed far from the nest. If the mosquitoes were that bad during the day, I didn't like to think about what they would be like at night, but I was interested. Baby saltwater crocodiles usually hatch into areas with relatively fresh water, and I assumed that they could not survive in saltwater, but these little American crocodiles must have been drinking saltwater from the day they hatched.

The next day, the park service had organized a plane to give us a better view of the region. I still did not like small planes, and entered the Cessna with trepidation. However, I soon forgot my fears when we started to fly over Florida Bay. The land was laid out like a map and the transparent water allowed me to see fish and manatees swimming in the depths. As we passed over the freshwater marshes, I saw many alligators, which were concentrated around small ponds. In one pond, I counted 40 alligators, which was much more than

the total number of crocodiles I had seen while in aerial surveys of rivers along thousands of km of Australian coast.



Photo 4.3 *Frank Mazzotti on an American crocodile ś nest in Florida Bay in 1980. Photo by Bill Magnusson.*

When we flew over the outer bay, the tiny islands bathed in crystal-clear water looked idyllic, and I could forget that they have no freshwater, little shade, and many mosquitoes. Alongside two of the islands were big American crocodiles. The pilot circled and I could see the long snout, and even the distinctive rows of scutes along the neck. The crocodiles did not seen to be bothered by the plane and stayed where they were, in very shallow water. I realized that Frank and I had probably been very close to those animals the day before. We were only about 100 m above them, but we could have seen them even if we had been flying at 300 m. From water level, however, you would not be able to see them from more than a few meters away. Although big crocs do not have any aerial predators, little ones do, and I assumed that the hatchlings

must have been hiding in the few patches of mangroves scattered around the islands.

The next night, Terri, Frank, Bob and I went out to look for hatchlings around the islands, and Frank was trying to detect the signal from a radio collar on one of the larger animals. Frank could work out about where the big crocodile was, but we couldn't see it. We did find hatchlings, however. Well, they weren't exactly hatchlings and must have been many months old, but we were able to catch them. I was surprised at how unwary they were, and they lay slackly in our hands while we measured them. They certainly didn't have any of the muscle tone of a dwarf caiman of that size. I tasted the water, and it must have been as salty as the open sea. Laurence Taplin still had not published his findings about salt glands in crocodiles, so I speculated that they must have a source of freshwater nearby. Now we know that all the species in the family Crocodylidae, the true crocodiles, are good at maintaining salt balance.



Florida had been fascinating, but I was eager to see Lousiana where serious studies of alligators had started. Ted Joanen met me at the airport. Ted is a big man, with a strong southern drawl. He is a man of few words, but those words count. Lengthy discussions often broke out in CSG meetings because someone disagreed with the evidence that someone else had presented. However, if Ted thought it worthwhile to voice an opinion, everybody would listen because they would assume that he was right. Ted was always up to date on the latest scientific studies from around the world, but he was only interested in them in so far as they were relevant to his world, which is in the marshes of southern Louisiana. Ted has now retired, and I assume that he devotes most of his time to what he likes best, poling his skiff through the marshes in the early morning to

get to where he can shoot the ducks that are attracted to the marshes by the management practices he helped to implement.



Photo 4.4 *An American crocodile seen from the air in Florida Bay. Photo by Bill Magnusson.*

This was before Hurricane Rita. When we arrived, Ted showed me the huge sheds that housed the project's airboats, one for each member of the team, and offered to rent a helicopter to show me what the marshes looked like from the air. I had often thought of using a helicopter, but its cost was far beyond what I could afford for even one overflight. To be able to rent one for a visiting researcher seemed unbelievable, and I asked Ted where he got finance for the studies on Rockefeller refuge. He said that the ready funding was due to the foresight of Edward Avery McIlhenny of the family famous for Tabasco source.



Photo 4.5 *View of Rockefeller Refuge from a helicopter in 1980. Photo by Bill Magnusson.*

McIlhenny loved the marshes and was a brilliant amateur naturalist. He wrote a book called *The Alligator's Life History* in 1935[105], which was for a long time considered to contain just quaint unsubstantiated stories. However, the revolution in interest in crocodile biology that started in the second half of the 20th century, largely as a result of Ted Joanen's studies, showed all of his observations to be correct. McIlhenny bought over 400 km^2 of marshland in 1913 to be managed for conservation and gave the land to the Rockefeller Foundation. When the Foundation passed the land to the State Government, it put on a covenant that revenue from the reserve should be used for its maintenance. If not, the reserve would revert to the Federal Government. It was expected that most money would come from exploiting salt that could be evaporated out of the shallow waters of the Gulf. Urban legend has it that the McIlhenny's were also interested in maintaining the marshes because illegal

liquor was offloaded in the Gulf and brought into the country across the marshes by McIlhenny employees during prohibition.

Salt was never a source of revenue for the reserve, though at times revenues from the sale of muskrat skins were important. The money started rolling in when oil was discovered in the Gulf, and the conservation programs started to receive much more money than they could spend. Ted not only had a great project, he had funding that made even Harry Messel's Crocodilus project look poor in comparison.



Photo 4.6 *Helicopter hired to show me Rockefeller Refuge in 1980. Photo by Bill Magnusson.*

The helicopter pilot took me across the refuge, which stretched from the highway in the north to the waters of the Gulf in the south. The whole area was covered in dikes, making the northern part of the reserve look like a giant paddy field. Gates on the dikes allowed freshwater to be maintained well out into the marshes, and the water in each paddock could be drawn down when necessary

to promote growth of plants that are palatable to ducks. The aim was to make the reserve a staging ground for migratory waterfowl, and at the same time provide an attractive site for hunters.

Managing the reserve for ducks probably also made it better habitat for alligators, but that was not the only McIlhenny legacy. The entrepreneur also played a large part in the introduction of the giant South American rat called nutria or coypu (*Myocastor coypus*), which has become a pest in the USA, as well as one of the most important furbearers for the skin trade. Nutrias can strip vegetation and cause coastal erosion, and they damage levees that hold back the saline water. For adult alligators, however, nutrias are a superabundant source of high-quality protein.

I was grateful for the overflight, because, without it, I would never have realized the extent to which the marshes had been turned into what amounts to a giant farm. Ted gave me lodgings in the housing complex that had been constructed for visiting students, many of whom spent internships at Rockefeller. Food was provided, but the students suggested that we go shrimping and make our own dinner. We walked along the levees to get to the outermost dyke, where the freshwater paddocks drained into the saline water of the gulf.

The gulf shrimp normally migrated up into the brackish areas of the marsh to feed, but the levees meant that there were no large expanses of brackish water, and shrimp would accumulate in large numbers around the outlet gates on the outer levee. The students had a cast net, and three throws were sufficient to fill our buckets with shrimp. It was getting late and the mosquitoes were becoming unbearable, so we hurried back to the accommodation building, which was completely sealed by mosquito-proof netting.

The students cooked the shrimp cajun style, which was much the way I would have cooked them; lightly boiled in dilute sea water. The cajun element was hot chile pepper, which fortunately was not sufficient to cover the taste of fresh cooked shrimp. I had been craving seafood while in Manaus, and we sat talking biology and eating shrimp until late into the night.

The next day, Ted took me onto the marshes. His airboat looked like the ones they used in Florida, but there was a big difference. The Florida airboats would get stuck if the rushes were too thick, or if the ground got too dry. The Louisiana boats were much more powerful. Ted tipped up the trailer, and when he drove forward the airboat slid onto the paved road. He then parked the car beside the road and told me to get into the boat. This didn't seem to make sense, because we were on dry land and a levee with steep walls separated us from the marsh. However, as Ted was already sliding into the driver's seat on the airboat I would look foolish if I didn't follow what he said. The engine kicked over and the boat slid smoothly around on the paved road and across the verge towards the levee. I braced myself as Ted roared the engine and the boat kicked almost vertically upwards and balanced on the top of the 2-m high levee, which was not as wide as the length of the boat. Ted scanned the marsh nonchalantly, as though jumping an airboat onto the top of a levee was the most natural part of a day's work and pointed to something out on the marsh. I couldn't hear what he said because of the sound of the engine, but I assumed that it had something to do with alligators.

Ted dropped the boat off the levee with a short blast from the propeller, and we sped towards the unidentified object in the middle of the marsh, which turned out to be an alligator nest. There were eggs in the nest and Ted checked around for the female, but it wasn't guarding the nest. There were many nests on the marsh, and Ted said that the refuge personnel used airboats and

sometimes helicopters to collect eggs to distribute to alligator ranchers. Giving free eggs seemed to be a very generous subsidy to the industry.

Our next stop was at a row of what looked like giant white domestic freezers. Each was several meters long and about 1.3 m high. They were tightly packed under a roof with open walls, and stretched for about 100 m along the road. Some of the giant coolers were incubators, and Ted lifted lids to show the eggs inside. Others were used to house the growing alligators, which were crammed into the boxes like industrial chickens. Ted said that he could bring the alligators to harvestable size in less than two years by providing ad libitum food, and keeping the temperature up in winter time. The Louisiana marshes can get very cold, and Ted gave me slides of alligators that survived a cold snap by keeping their snouts above water until they were frozen in position. The captive animals did not have to worry about such things. They were kept warm, in total darkness most of the time, and were denied food only one day a week to prevent gout. Optimal conditions for production, but the sight of them depressed me. They were no longer wondrous creatures, they were just products.

There were also rows of pens, each about 10 m by 10 m, which had different numbers of pools and combinations of females with males. Alligators are very territorial, and Ted hoped to be able to grow females together in small spaces to try to overide their natural aggressiveness when they reached reproductive size. Growing out juveniles from eggs collected in the wild, which crocodilian biologists call ranching, has negative aspects. Collecting the eggs can be expensive, you have no control over the genetics of your stock, and many factors could prevent you from having access to natural areas. If breed stock could be kept at high density, and lots of eggs produced, closed cycle production, known as farming by crocodilian biologists, could make the wild stocks irrelevant, and the alligator industry could become as scientific and carefully

controlled as beef of chicken production. All very laudible, but I had no emotional connection to masses of animals stacked in dark boxes or the fat businessmen who would make money off them. Of course I did not say that to Ted, who was so proud of Louisianas achievements.



Photo 4.7 *Ted Joanen inspecting some of his breeding stock. Photo by Bill Magnusson.*

That night, Ted invited me to have a Cajun dinner that his wife had prepared. When she said that it would be rice and beans, I had to hide my disappointment. I had been eating rice and beans every day in Brazil for over a year, and I was a bit tired of them. However, the rice and beans she served were very different. Spiced with Cajun herbs, they were nothing like what I had been eating. The meal and the company were delightful, and Ted asked me what I planned to do with caimans in Brazil. I told him that I was concerned about over hunting in some areas and hoped to be able to promote some reserves where hunting would not be allowed. Ted looked at me seriously and said “Well Bill, we have lots of

reserves in Louisiana and we hunt on all of them. You have to hunt game species, otherwise they become over abundant and sickly."

My father had been a professional hunter before he got married, and I was brought up with a hunting ethic. He bought me an air gun when I was 10 years old. Not because he wanted me to shoot anything in particular, but because, in his world, a man knew how to carry a gun, and could use it when he had to. I had nothing against hunting, and I believe that local people have the right to use natural resources if they can do it sustainably. Nevertheless, I did not abide by the North American ethic that animals need us to hunt them, and I knew that Ted would not understand my strange fixation with the eyes of wild crocodiles. I just nodded, and shifted the conversation to subjects in the middle ground.

When I was leaving, Ted presented me with two boxes of steel snares used to capture fur-bearing animals in the USA. I had never used steel snares before because catching animals in set snares is illegal in Australia and Brazil. However, locking snares are ideal for catching crocodilians. They can be tied to the tip of a pole and the springy steel keeps the noose open to slip it over the animals head. The other end of the snare is tied to a cord, and a quick tug tightens the noose and locks it around the neck. During decades, I, my students, and other Brazilian crocodilian biologists would use the snares that Ted Joanen gave me on that trip.



On the way back through Miami, I was invited to give a talk to a group of Latin-American biologists who were doing a course in crocodilian management promoted by the US Fish and Wildlife Service. I didn't have much to report about caimans, but just described my preliminary results obtained by travelling

in small boats or on foot. After the talk, a Mexican researcher approached me and started to tell me how wonderful my talk had been. I don't like exaggeration, even if it's meant to make me feel better, and I told him so. He said "No, you don't understand. I am sincere. I came to here to learn about what I can do in Mexico, and the only thing I learned is that you have to have airboats and helicopters to study crocodilians. You showed me that I can learn something about caimans with the resources we have in Mexico."

I realized that he was right. I had probably also been very cavalier about the use of high-tech equipment after my experience in northern Australia. I made a point to remember to always ask a person about the resources at their disposal before making suggestions about what they should do. The Australian and US realities are very different from those of most people who are fighting to save crocodilians throughout the world.

The conversations at the CSG had all been about sustainable use, and there was a growing conviction that crocodilians could only be saved if they had immediate economic value. The USA was presented as a prime example of the effectiveness of economic use saving a species, but I didn't see it that way. Ted Joanen had brought alligators back from economic extinction by initially proposing that they be totally protected. They came back so fast that it can only be assumed that they must have been much further from biological extinction than people had presumed – the sort of underestimation of density that had been exposed by the Orange Lake experiment. Protection had also brought alligators in northern Florida back long before they were exploited, and the abundant alligators in the Everglades have never been legally hunted.

The greatest economic returns came from alligators in Louisiana, followed by those in northern Florida, and the least from Everglades alligators. Nevertheless, my subjective feeling is that conservation is best served in the Everglades, next

best in northern Florida, and that maybe the marshes of Louisiana would have been better off if they had not been turned into production systems, even if the density of alligators had remained lower. Perhaps it is a good thing that the three systems exist side by side and, rather than seek a magic bullet, we should be striving to keep all our options open, while giving people freedom to experiment. Only time will tell.

My time in the US was very productive. I saw that other crocodilian species do things very differently from the saltwater crocodiles that I was used to. I also found that people have many different attitudes to crocodilians, from wonder, to utilitarian appreciation, to outright disgust. If crocodilians are to live beside people, we must take into account all of these attitudes, none of which is necessarily more correct than another. I could not have found these things out in such a short period of time without the generous support of the many southern biologists I have mentioned, and a few others who I had to leave out because there were too many names for a short narrative. All of them have my sincere admiration and gratitude.

5

Manaus, Albertina and the Motor Bike



Bill Magnusson and the aquatic-mammal team in 1979. From left to right Astro, Ulisses, Zé, Wallace, Raul, Raimundo and Sr Eduardo. Photographer unknown.

I was becoming exasperated at my inability to learn Portuguese. Languages come naturally to some people, but not to me. My hearing is not the best, and snorkeling in cold water when I was a teenager probably didn't help. I could not detect subtle differences in pronunciation, and even if I heard the sound clearly, my vocal cords would not reproduce it correctly. I was in my late twenties; more than a score of years past the optimum age for picking up languages. It is an age where you should be starting to consolidate your social position, and not feel like an incompetent child.

One incident stands out clearly in my memory, and I still wince when I think of it. Some of the workers in the aquatic-mammal project invited me to a party in the nearby suburb of Coroado. The area had been owned by the university, but squatters had claimed the land and turned it into a shanty town, called a *favela* in Portuguese. The party was in a tiny house, whose largest room was not much more than an armspan wide and two armspans long. The music came from loudspeakers suspended near the ceiling, and the whole house vibrated with the music, including the baby that lay apparently unconcerned in the next room. There were dozens of people and the party spilled out into the front yard and the adjacent dusty street.

My Portuguese was minimal, but with the blaring music it became nonexistent. One of the assistants, whose nickname was *Parafuso*, which means "screw" in English, introduced me to everyone and explained who they were in unintelligible Portuguese. I just nodded and smiled. Everyone was talking and I stood in a corner trying not to look too out of it.

A young girl of undetermined age, but I guess somewhere between 13 and 15 came up to me and asked me something. I asked Parafuso what she had said in English, and he said "She want to dance".

I asked “How do I say that I’d be pleased to dance with her?” and he said a short sentence that seemed longer than necessary, but I asked him to repeat it several times until I could remember it, and I turned and to the little girl and repeated it. She beamed, grabbed my hand, led me to the middle of the room and started to dance. The movements I made would not be considered dancing by any self respecting Brazilian, but I thought that I was at least showing that I was trying to imitate the other dancers around me.

My partner was pressing up against me and making movements that a child should not understand and she was looking up into my eyes in a way that was anything but innocent. I turned to Parafuso and said “What did I say to her?” He pushed his hands forward as though grabbing an imaginary partner and made rhythmic movements with his hips that left no doubt that I had asked her for far more than a dance. I didn’t know what to do. I was a paedophile trapped in the middle of a room with an underage girl, and surrounded by powerful little men who were likely to be her father, uncles or brothers.

I pointed to the back door, said *xixi*, which means pee, and headed out as though I were going to the bathroom. Once in the backyard, I jumped the fence and started walking down the road towards the institute. I had not gone far when I heard the little girl’s voice calling, and I turned to see her running after me. I set off running down the road, a grown man in mortal terror of a child that was running after him. I don’t know how many people saw the scene, but it was some time before I could walk through Coroado again without going red with embarrassment.



My relationship with the head of the Aquatic Mammal Division was not good. We disagreed on just about everything, and one day when I returned from an excursion I found a note saying that I should report to the head of the Fisheries Department. The Head of Department told me that he had heard that I was not happy and would like to transfer to the Ecology Department. I had never even thought of the transferring to the Ecology Department, but he said that he would not stand in my way and I took the opportunity. I was now my own boss, and could spend more time studying caimans.



Photo 5.1 *Parafuso and friend during Carnaval 1980. Photo by Bill Magnusson.*

With freedom came even less financial resources. The Fisheries Department had many boats of all sizes at its disposal. The Ecology Department was new and had almost no equipment. I borrowed the Institute's aging Kombi van to visit small streams on the edge of Manaus, but I could only use it at night when nobody else was working. As I didn't have enough money to buy a car, I decided to buy a motor bike. The only one I could afford was a Yamaha 100 cc

dirt bike, which cost the equivalent of a year's salary. It was imported, I was worried that there might not be parts for it, and I asked the salesman if the store had spare parts. He said that he did, but I sensed he might be trying to trick me, and I asked him to show them to me. He took me to the store room and showed me spare chains, pistons, and just about everthing else that might break. I bought the bike.

A week later something broke, and I returned to the store to buy the part. The saleman said that he didn't have spare parts for that brand of bike. When I reminded him that he had shown me spare parts the week before, he said in Portuguese "Ah, but I didn't say they were for your bike!" If I had been in Australia I probably would have thrown him through the window, but fortunately I was in a different culture and solved the problem in other ways. Violence is never the best solution.

Albertina Lima had come to Manaus from Santarém to work with me. We have now been married for over 20 years, but at the time each of us had other partners. One night after work she suggested we go to see a Brazilian film that was passing in a movie theatre in Cachoeirinha, a relatively new suburb beside a favela. I was worried that someone might steal the bike, but she said that I could park between a car and a wall and lock the steering column. It seemed a good suggestion, but when we came out of the film, the bike was gone. I did not know that you could break the column lock with a swift twist of the handle bars.

We went to the robbery division, which was near the center of town, to report the theft. The detective laboriously typed out my statement with two fingers on an aging typewriter, but showed no interest, and it was obvious that he would do nothing about it. The following Monday, I distributed leaflets describing the yellow Yamaha 100 to the local police, the transport department, gas station

attendents, and to all the employees of my institute. I also started watching the local bikie hangouts to see if anyone turned up on a yellow bike.

On the Tuesday, I got a call from a student in the Medical Department. Her brother knew who took the bike. We went to his house, but he wasn't there, and I talked to his mother. She said that she had heard that the character who had stolen the bike was a bit of a desperado, and that I shouldn't go to his house alone. She suggested that I go to the local police. I wasn't sure about that, because they might have been in on the heist. In fact, they were not interested and said that I should go to talk to Delegado Ignácio, chief of the robbery division in town, who was the uncle of one of the officers. This was the correct way to approach the police. Civic duty was not high on their priorities, but Latin culture puts a lot of weight on family relationships. By presenting myself as a friend of a family member, Ignácio could use his authority to make his subordinates do something about the bike. However, the crime division's office was a long bus ride from where I was, and I returned to see if the brother had come back.

He was there, but his information was limited. He said that many people had seen the bike being stolen by a huge man dressed in blue who was known as Hulk. A known car thief, Hulk had removed the serial numbers, painted the bike brown, and increased its cylinder capacity. The first two actions seemed plausible, but I was pretty sure that he would not have tampered with the motor. Spare parts were too hard to come by!

The kid said that he didn't know where Hulk lived, but I think he was just too scared to say. He invented a story that Hulk lived with various women, never stopped in the street for more than 5 minutes, and always left the motor running. Hulk wanted to sell the bike for exactly 10% of what I had paid for it. I didn't

have an address, but I had an area, and it would be easy to spot the bike because brown was not a stock color; it would be the only brown Yamaha em Manaus.

I received further word that Hulk had been seen the night before at a Bingo Hall in Cachoeirinha, close to where he stole the bike. In Australia, bingo was a game played only by aging church goers, but everybody, including hoods, played it in Manaus in the early 1980s. Having something to work on, the plan changed from broadcast to concentrated. I couldn't go to the Bingo Hall, however, because I would stand out like a sore thumb. I was obviously a gringo, and I was pretty sure that Hulk must have memorized my appearance when I left the bike and went into the cinema. He had the advantage because he knew what I looked like, and I had only a vague description. However, nobody remembers a woman, at least not in Manaus when they were said to outnumber men 3 to 1. Albertina could go into the Bingo Hall without anyone associating her with the bike.

Thus began a long series of nights. Albertina went to play bingo and I waited hidden in the shadows on the other side of the road. I tried to be inconspicuous, but I wasn't very successful. Cachoeirinha was an area where everyone knew everyone else. All the students from the school, who finished classes at 11 pm, stopped to stare at me. I tried sitting hunched over like a drunk and a policeman came up and asked if I was sleeping.

Albertina wasn't having much better luck at being inconspicuous. She was 23, but looked 14, and had all the young bloods around her like flies. She decided that it would be best to pick one that looked most harmless and let him monopolize her attention so that the others would lose interest. The strategy worked, and the second night her admirer decided to teach her how to play bingo. For her first outlay of Cr$ 100, she won Cr$ 1000 and was the center of attention again. Nonetheless, Hulk did not show, except for one night when I

saw him streak past at 10 pm. Abertina saw the bike with three people on it once in the city from the bus, but it disappeared into the traffic.

While the vigil wasn't paying off, the information about the thief's identity was. Parafuso's brother in law had seen the brown motorcycle at a bikie gathering. However, he was more or less a friend of Hulk and did not want to rat on him. He especially didn't want Hulk to find out who had given him away. Through Parafuso, I promised not to involve the police if he gave Hulk's address. He told me that Hulk's real name was Luis, was usually called by its diminutive, Luizinho, and that he sometimes worked in the plaza driving other people's taxis. Nevertheless, Parafuso's brother in law would not go as far as giving me Hulk's address.

I was urged by many people to go to the police, because they were sure that Hulk must have a record. I was dubious, but I was worried that Hulk would sell the bike to someone who would change the color again or, worse still, sell it to a shop to be broken up for spare parts. Therefore, I went to Delegado Ignácio. After I said that I had been referred to him by his nephew, he was very attentive, but he had never heard of Hulk or Luizinho. This was before the information age, and police records were kept in inaccessible mounds of paper, or in the police officers' heads. He said that the robbery division's only car was in the workshop, but if I found out Hulk's address he would call the chief of one of the precincts who would lend a car and an officer so that I could collect my bike. It was obvious that I was not going to get my bike back through police action.

I had decided that I was too conspicuous standing in the street, and perhaps that was why Hulk was not frequenting his favorite bingo hall. Therefore, I started sitting in a little outdoor bar down the street while Albertina went into the bingo club. A more disreputable establishment is hard to imagine, and the music was horrible and loud. The first night a fight almost broke out between

two of the biggest, most heavily muscled, men I have seen. Fortunately, the object of their envy, a huge woman, who to my eyes was almost as ugly as they were, picked up a table and hurled it and its accompanying bottles and glasses against the wall. The two owners of the bar, thin, grotty, dangerous looking men, did nothing except direct a kid to clean up the mess. All the while, cars and bikes were pulling up, the drivers casting furtive glances over the patrons and driving off. I spent my time talking to various drunks and keeping an eye on the road in case Hulk passed by. After a few days, I began to think that Hulk had got word of our stake out and was avoiding the area.

More than a week had passed since the bike had been stolen and I was despairing of finding Hulk in Cachoeirinha. Why would he break his normal pattern of activity if he wasn't on to us? Albertina and I decided to take a break and we went to see a film in town with Uli, a tall, blond, German girl who I was dating. The film, one of the Trinity series with Terence Hill and Ernest Borgnine, was fun and we left in a good mood. Uli, who could down beer like an archetypical German, wanted to go somewhere for a drink. Both Albertina and I were teetotalers, but I said "Great, I know this nice little bar in Cachoeirinha." Albertina went to the bingo club, and Uli and I went to the bar to buy a beer.

I was a little apprehensive. I had not felt particularly vulnerable when alone, because everone else was drunk and I could run fast. However, I didn't know if Uli would have the sense to run if something started. For that matter, I didn't even know if she could run. She was wearing wooden sandals that looked like slabs of 4" by 2" lumber strapped to her feet. They made her even taller, and she stood out like a swan in a chicken coop. I was sure that I could not count on the bar owners if anything happened, but it was Wednesday night and the customers were well behaved.

After about half an hour, a school kid ran up and asked if I was a gringo. When I nodded, he said that a girl had asked him to tell me that she was heading into the favela. This bothered me. I imagined that Albertina might have given Hulk a line and ridden off on the back of his bike. I paid hurriedly and started to drag Uli down the street, but one of the bar owners grabbed my arm and asked if I knew the kid I had just talked to. He thought that the kid might be spinning me a line and was worried that I might get robbed. Once again my prejudices about someone had been wrong, but I didn't have time to explain the situation to him. I disentangled myself, and hurried off. When we reached the bingo club, I left Uli on the main street and ran into the favela.

I couldn't see Albertina anywhere, and I asked a bystander if he had seen a girl of Albertina's description. He said that he had, and that she was heading into the tiny alleyways of the favela. The alleys were dangerous places for strangers, especially women, even during the day. I ran along the route he indicated, past packing-crate houses along a swamp with no lights that passed for a road. As I rounded a corner, I saw Albertina in the middle of a circle of men. I ducked into the shadows, and Albertina passed me as she went back up the road. She just said that she had been following Hulk, but had lost him in the alleys.

It turned out that she had been playing bingo and asked the person next to her if he had seen Hulk lately. Her informant replied in Portuguese "Yes, he's sitting across the table from you." Fortunately, Hulk didn't hear her and, when he left, she sent the kid to tell me, and followed the bike thief into the alley ways. She couldn't get close to him because a group of his friends were walking slowly behind him. It was those friends that she had come up on when I first saw her, and they had told her that she shouldn't walk in the alleys at night because it was dangerous.

I did not know these details as I lurked in the shadows, and I waited for Albertina to get a head start before venturing out. A window opened above me and a man stared down. I could not use my rudimentary Portuguese to explain why I standing in his garden, so I urinated on his front wall. Apparently convinced that I was not doing anything I shouldn't, he retracted his head and closed the window.

I did not want to be seen with Albertina. Nevertheless, I walked a little faster than she did, and was almost level with her, but on the other side of the street, when she met up with Uli. I turned the corner into the main street without acknowledging them, and headed for the bus stop. I was disturbed because I was sure that my running through the favela must have drawn attention, and that word would filter down to Hulk. Albertina saw Hulk pass by me on the bike, but I didn't see the bike until I noticed it parked in front of a milk bar beside the cinema, just 30 m from where it had been stolen.

I was in a quandary. Everyone had warned me not to confront Hulk in the street because he would make a fight of it and the other hoods would side with him. They had told me to carry a gun or a knife and other ridiculous suggestions. I explained to people that you only carry such weapons if you want to kill someone, and a motorbike is not worth anyone's life. On my previous vigils, I been armed with a bag of pepper, but I hadn't taken it to the cinema. If Hulk made a fight of it, his mates could shoot off on the bike, leaving me with no evidence. The only thing in my favor was that I had shown Albertina how to disable a bike, and I hoped that she could do it before anyone knew what was happening.

I ran straight across the street and mounted the bike to disable it, but I found that Hulk had short circuited the ignition, and started and stopped the bike with the emergency fall switch. He was talking to his mates in the milk bar, and he

started out when he saw someone stealing his bike. However, he must have recognized me and stopped a little behind and to one side. I watched him out of the corner of my eye, and as soon as I saw that he was backing off, I kicked the motor over and took off down the street.

Luizinho wasn't exactly a Hulk. He was only about my height and maybe 25% heavier, but I was trembling and very pleased not to have to fight.

Albertina and Uli caught a taxi back to the institute. Hulk had changed the color, lowered the handle bars, and taken off the mirrors to disguise the bike, but he hadn't done any maintenance. He had not oiled the chain, had been running the motor without two-stroke oil, and had overinflated the tires, which were designed for dirt tracks, not bitumen. In all, he had done about 10,000 km of wear in 1,000 km. Still, the bike could be repaired, and it was better than spending a year's salary on a new one. From that time on, no matter how quiet the streets, or how late the cinema session, the little bike only left the house to go directly onto forest tracks.

I remembered how cavalierly I had used the bikes, trucks, plane and ship that Professer Messel had provided me with when I did my Ph.D. As the saying goes, comes easy, goes easy. When you have a lot of resources, one piece of equipment more or less doesn't make a lot of difference. When you have no other equipment, one piece makes a lot of difference. Modern science funding tends to concentrate a lot of resources into a few hands, the idea being that a few brilliant individuals will do all the research we need. There is only a small element of truth in that. I now spend much of my time coordinating projects that are designed to get critical equipment into the hands of biologists in remote areas so that they can get the results that no superstar researcher in a state capital with all the latest computers could ever dream of.



Photo 5.2 *Albertina and the motorbike in the early 1980s. Photo by Bill Magnusson.*

Open Science

6

Africa



Nile crocodiles in the Spencer Creek Crocodile farm. Photo by Bill Magnusson.

The 1982 CSG meeting was held partly at Victoria Falls in Zimbabwe, and partly in St Lucia in South Africa. At that time, Nelson Mandela was still in jail and South Africa was under Apartheid. Zimbabwe was recently liberated from white dominance and looked set to be a shining example for the rest of Africa. Both situations would change drastically in the following years. Looking back now, I think we should have boycotted the meeting in South Africa, but Apartheid was an abstract concept for me, and by going there we would be supporting Tony Pooley, who was strongly against segregation.

I had now been in Brazil for over two years, and I had been spending much of what I earned to do research. Inflation sometimes reached 1000% a year, and at one stage I was earning the equivalent of US$ 100 a week. Also, I had no clothes sense, and was wearing shirts covered in rips and stains. My girlfriend bought me some shirts to take to Africa and found a leather belt. Walter Hödl, an Austrian researcher, had left a pair of leather shoes at the office, and I found that they fitted. The Brazilian National Research Foundation (CNPq) would pay for my airfare and lodging.

George Rebêlo also decided to go. George was a Brazilian researcher who had worked with me on a project to estimate the size structure of hunted caimans based on skins that had been confiscated by IBDF. He was living in the national capital, Brasília, and I sent him my passport to take to the South African Embassy to get a visa. He presented both our passports, and apparently had no difficulty with the visas. George is dark skinned with black curly hair that attests to his recent African ancestry.

We had arranged to meet in the transit lounge in Rio de Janeiro, but George was not there when I arrived. Fortunately, there was something wrong with my documentation, and the airline representative took me out of the transit area to

pass through immigration control. George had been waiting for me outside. CNPq had given him the plane fare, but had not deposited his living allowance. I counted the dollars I had, and we calculated that we could both live on that much money if we were careful. George boarded for Africa with me.

There were no direct flights to Zimbabwe, and we had to stay overnight in Johannesburg. There was a pamphlet for an art museum in the room at the Holiday Inn that we rented for US$ 52, somewhat more than we had hoped to have to pay. Jo'burg was much like Sydney, and it felt homey and boring. We went to the museum, and then to a gallery of "primitive art," which turned out to be just a promotion for an antique shop. We had to wait quite a while to catch a bus for "whites", and George joked that he would take the "non-white bus" and get back to the hotel before me. I could see no reason to ever want to go back to South Africa's largest city.

On route to Zimbabwe, the plane flew low over the dry desert of Botswana, and from the height of the plane the brown earth and wide salt pans made it look much like the central desert of Australia. However, the forest around Victoria Falls is deciduous, and the bare branches stretching to the horizon were like nothing I had ever seen before.

Dave Blake was with the Zimbabwe Department of National Parks and Wildlife Management, and he met us at the airport. Dave was short and sturdy, and his khaki shorts, long socks and shiny shoes, gave him the appearance of an archetypical colonial administrative officer. The National Parks Department worked closely with the Zimbabwe crocodile farmers to develop a ranching program for the country.

The meeting was being held in the Makasa Sun Hotel, a very sophisticated hotel and casino complex beside the Victoria Falls. The five-star hotel was

certainly not the sort of accommodation that George and I were used to. Use of sandals, t-shirts, or running shoes was not permitted after 7 pm, and I was greatful for Walter Hödl's leather shoes. The order was for smart-casual dress, and George was almost thrown out after the third night in a row that he turned up at the dining room with his shirt not tucked in. The hotel was far beyond our budget, but Dave arranged for the Wildlife Department to pay for us.



Photo 6.1 *Marco Lazcano (left) and George Rebelo, Victoria Falls, Zimbabwe in 1982. Photo by Bill Magnusson.*

It was good to catch up with Paul Moler, Marco Lazcano and other friends from Gainesville, but I was embarrassed about the amount of money that the Wildlife Department had spent on our food and lodgings. I was pretty sure that what they would learn from our presentations at the meeing would not compensate for the expense. The local people have been extremely generous at all of the CSG meetings I have attended, and it would be almost 30 years before

I could repay some of the hospitality when the CSG meeting was held in Manaus.

A very friendly man dressed in much the same way as Dave seemed to know me and introduced me to his wife as though we were long aquaintances. I couldn't remember him and I had to ask around to find out his name. It turned out that he was a veterinarian who was studying diseases in captive crocs. I have a terrible memory for names, and often recognize people at meetings but can't remember who they are or where I met them. This is a pathological defect, and one that I am most ashamed of, but something I don't seem to be able to overcome. In fact, if you ask me the name of someone I work with every day, I may only be able to reply after an embarrassing pause. I am sure that I would have remembered the veterinarian's name, however. It was Everard Cock, and I cannot imagine how his parents could have been so cruel to give such a name to a child who would have to spend many of his formative years with malicious school mates.

The scientific meetings were interesting, but there were far less participants than there had been at the Gainesville meeting. A greater proportion of researchers were from Africa, but it was obvious that the continent had few dedicated crocodilian researchers considering its size and the number of species of crocodilians. Most were concentrated in countries near the southern tip, and most studied Nile crocodiles, the most economically important species, and in terms of crocodile attacks. The American Alligator Farmer's Association representative turned up at the talks with a high-calibre rifle that seemed big enough to knock down an elephant, but which he intended to use to include a species of antelope on his life list of kills. Nobody said anything, but it was obvious that he was not sensitive to other people's life view. Taking a gun into

a conservation meeting is a bit like taking a girlie magazine into a bible class; it makes some people uncomfortable.

One of the participants at the meeting was Karlheinz Fuchs, a representative of a company that provided chemicals to tan crocodile skins. There had been much talk at the meeting about alligators and crocodiles with “classic” skins, but I knew that there was an enormous trade in caiman skins, which have much lower quality, but were potentially traded in much greater quantity. There were no field surveys of caimans in most of the places the skins were being taken from, and no official figures because the trade was illegal. I asked Karlheinz if he could estimate the number of caiman skins being traded annually based on the amount of chemicals he was selling to tanneries. He replied “About a million.” I made much of that number in the discussions that followed, and it became a sort of urban legend, gaining validity by the number of times it was repeated. I sure hope that Karlheinz was right!

We went to Spencer Creek Crocodile Ranch. This was a ranch in the conventional sense and what would be called a farm by crocodile specialists. The brood stock lived in large open-air pens, with 20 females and one male per enclosure. The crocs were nesting and producing many hatchlings, which were grown out in completely closed sheds where water, and to some extent air, temperatures could be controlled. Food was not a problem. Elephants frequently had to be culled so that they would not become too dense in reserves and move into surrounding agricultural land. Behind the pens were bits and pieces of elephant, such as the feet, that were too tough for the crocs. Huge storks stood around hoping to pick up scraps.

Dave Blake gave a demonstration of crocodile immobilization using Flaxedil, which is an immobilizing agent that is very effective for crocodiles. Crocodilians, even up to the size of alligators, are fairly easy to handle, as long

as you don't have to do it too frequently. However, Nile crocodiles routinely grow larger than most other crocodilians, and they are man eaters in the sense that they habitually hunt and kill medium-sized mammals, such as humans.

Dave approached a male crocodile that must have been over 3m long. He slipped a pole with a hypodermic syringe on the end through the wire and jabbed the crocodile. The needle must not have hurt the crocodile much because it just shuddered and then layed still. After a short while, the crocodile no longer responded to being poked through the wire and its head started to tilt backwards while the lower jaw remained resting on the ground. Dave went in and sat beside the crocodile, showing that it was completely comatose. We approached and could touch the crocodile, which was completely paralyzed. It is interesting that the huge jaw muscles open the mouth when relaxed, indicating that they are mainly used for clamping it shut, and this explains why it is comparatively easy to hold a crocodile's jaws closed, but very difficult and sometimes dangerous to try to pry them open after they have shut on something, such as your hand.

Both Nile and saltwater crocodiles have moderately sized heads, and the eyes of adults appear to be small and sunk into the bony skull. I ran my hand along the croc's skull and down onto the soft skin around the neck. There is a sort of continuity between the head of a caiman and its stiff skin filled with plates of bone. However, the soft skin of the crocodile, so prized by handbag manufacturers, contrasted with the rock hard sculptures on its head.

This farm was very different from the alligator-raising facilities I had seen in the USA. The large outdoor pens had a semblance of naturalness, and the raising sheds gave the young crocodiles slightly more room to move around than the densely packed alligator-production units in the USA. Nevertheless, I was not much interested in the captive animals. Most of the crocodile specialists

were associated with commercial production or ex-situ captive raising for conservation purposes. Almost all the other participants were bubbling with excitement, eager to see the latest technology for producing more crocodiles in the shortest time in the smallest possible area. I felt out of place and stood back, trying to keep a polite smile on my face as my hosts bubbled on about the poor little crocodiles they had stacked in the raising pens.



Photo 6.2 *Dave Blake demonstrating the use of the immobilizing drug Flaxedil in Zimbawe in 1982. Photo by Bill Magnusson.*

The second part of the meeting was to be held in St Lucia in South Africa, where Tony Pooley worked. George and I ended up in different lines going through immigration when we got back to Johannesburg airport. I was waiting for him in the baggage collection area when one of the alligator farmers came through and said "Your friend seems to be having trouble. Maybe you should go back through immigration and see if you can help him."

I went back and found George pressed up against a wall by two hefty Afrikaaners, who were looking at him menacingly. When I asked what was wrong, they said that he was trying to enter the country illegally and would be deported. I said that he had a visa and had been through Johannesburg on the way to Zimbabwe. They said that was the problem, he only had a single-entry visa, and had used it. There followed a long conversation, in which I explained that we were both scientists, and that George had presented our visa requests at the consulate together. I had been given a double-entry visa, but George, presumably because of his photo, had been given only a single-entry visa. The Afrikaaners were much less aggressive with me than they had been with George, and gave him a seven-day entry permit to allow him to go to Durban to obtain another visa.

We overnighted in Jo'burg, then flew to Richards Bay via Durban. The flight up the coast from Durban was along beautiful beaches, but the land behind was covered by sugar cane, bananas and eucalypts. It looked much like the east coast of Australia. From Richards Bay, we drove to St Lucia, a holiday town at the mouth of the St Lucia estuary. We stayed in little rondavels at the Lake View Hotel, which cost R$28 per day, with 3 meals included. Each meal, including breakfast, had five courses, the only drawback being that they waited for everybody to finish before bringing the next course. There was a waiter for every three customers, and the service was exemplary. We remembered, however, that the cheap prices could only be maintained because wages for nonwhites were ridiculously low.

Tony had arranged for a military helicopter to take us on a tour of the lake. All the meeting participants filed into the giant helicopter and sat on benches with their backs to the walls. I had only seen similar helicopters in films about the Vietnam war. We had to twist around to see out the windows, but the view

from the low-flying helicopter was fantastic. There weren't many crocodiles in the mid to upper sections of the lake where the water was hypersaline, but big crocs lay along the rivers that flowed into the lake, and many were scattered around the nesting beaches. The crocs were a dominant part of the landscape and I noted how much easier it would be study crocodile behavior here than it had been in northern Australia.

Around the lower reaches, near to the St Lucia township, the crocodiles formed a line as they faced up the channel, each was parallel to, and equidistant from the other, as if working in collaboration. Tony said that they captured mullet and other fish that migrated into and out of the lake. With so many crocodiles so near so many holiday makers, I could see how lucky I had been to grow up in Australia, where you can enjoy water sports in most places without having to worry about any large predators, except sharks. Even touching the water in Africa could be dangerous because of the bilharzia parasites that burrowed into your skin. South Africans used rubber gloves when watering their gardens, and Tony had suffered much from the disease at a time when it was harder to cure than today.

Tony's crocodiles were in very large enclosures with natural vegetation, which made them much more attractive to me than the crocs I had seen imprisoned on crocodile farms. Nonetheless, it also meant that they were much further from the fence, and therefore much harder to photograph, especially because this was in the time before digital photography and cheap cameras with powerful zoom lenses. When we went to see the crocodiles, there was a crowd of tourists pressed up against the fence in the only place that you could get a clear look at the crocodiles lying around the pool about 15 m away. We walked up behind them and Tony said "Get your cameras ready, I'll get rid of the tourists."



Photo 6.3 *Military helicopter used to show the CSG members Lake St Lucia from the air in 1982. Photo by Bill Magnusson.*

Tony whistled, and the dozen or so crocodiles that had being lying around the water like fallen logs came running towards the fence so fast that it looked as though they would crash through it. The tourists scattered in all directions, and the crocodiles plonked down in a line about a meter from the fence. Smiling, Tony said "You can take your pictures now."

We crowded around the fence with our cameras, but Tony had taught me a valuable lesson that had nothing to do with photography. Crocodiles have complex social behavior, much of which you can only discover if you spend time very close to them and you really believe you can communicate with them in ways they understand. Production-line farming is demeaning for the great animals, but studies of captive animals in naturalistic settings can give us insights into their lives that would be impossible in the wild. Many showmen have become famous by doing reckless and sometimes stupid things with

crocodilians to show their bravado in front of television cameras. None of them, however, deserve the name of Crocodile Man that so befit Tony Pooley.

After the meeting was over, Tony arranged accommodation for us at Cobie Bride's farm. Coby was very generous to us and personified the many adventurous white people who lived in Africa. Before she had arrived on the continent, she had been temporarily paralyzed by a fall while playing polo, had been a jockey in Singapore, and carried scars from the tropical ulcers she developed while in a prisoner-of-war camp. In Africa, two of her children had been shot dead by border guards, her husband was killed in a car crash, and she drove alone through the Sahara. She established in South Africa to put her remaining children through university. My most vidid memory of the farm is of Coby mounted on a large frisky horse setting out to make sure that all was going well on her land. She could have passed for 40 years old, but must have been very much older.

Tony had captive slender-snouted crocodiles, *Mecistops cataphractus*, and dwarf crocodiles, *Osteoleamus tetraspis*, which are not found around St Lucia, but live in the rainforest regions of West Africa. Laurence Taplin and Gordon Grigg were eager to look for salt glands in these species. Vertebrates that live in the sea have to excrete concentrated salts, especially sodium chloride, to keep the fine osmotic balance in the blood necessary for survival. Marine birds have salt glands in their nostrils, marine turtles have salt glands in the corners of their eyes, and the salt glands of sea snakes are in the mouth under the tongue. Laurence had discovered that salt water crocodiles had salt glands on their tongues, and that these glands could be induced to excrete salt, even if the crocodile was not in sea water, if you inject methacholine chloride.

It is usually easy to jack open a crocodile's mouth and look for salt secretions on the tongue, but Tony's slender-snouted crocodile was much larger than the

dwarf crocodiles, and very much stronger than most other species of crocodilians of similar size. Three of us sat on the crocodile while Laurence crouched over the head and tried to put a steel ring in the mouth to keep it open. The crocodile exploded and threw everybody off. Laurence lept to his feet, which were placed either side of the crocodiles head. Its legs were tied, but it could swing its head, which crashed into Laurence's right leg. He jumped onto the other leg, but the croc's head was in perfect synchrony, smashing into Laurences's calf each time he moved his weight from one leg to the other so that he appeared to dancing a jig at the whim of the crocodile.

It would have been comical, but Laurence's yelps left no doubt that he was suffering. When the croc finally stopped thrashing, Laurence bent over clutching his bruised legs. His study would show that all of the true crocodiles possess functional salt glands, an adaptation that possibly explains how they have managed to colonize all the tropical regions of the world. However, I was more interested in the differences among them. The Nile, slender-snouted and dwarf crocodiles looked, felt and acted totally differently. Nile crocodiles kill many people each year, but individuals of that species are much weaker and easier to handle than animals of similar size of either of the other species. Some of the larger crocodilians, such as the Nile crocodile and the saltwater crocodile, are inveterate man eaters, yet other large species, such as American alligators and black caimans, live in large numbers beside high densities of people and cause comparatively few human deaths. Crocodilians differ not only in their strength and morphology, but also in what turns them on.



Tony took George and Marco to the station to catch a train to Durban to renew their visas. Marco also had only one entry visa. Tony was worried that

George would be put in the “blacks only” wagon, in which he said people were often jammed like cattle. He managed to get him onto a “coloureds” van which apparently was somewhat better. If they got their visas, they would rent a car to visit Kruger National Park.



Photo 6.4 *Laurence Taplin offering refreshments to the African slender-snouted crocodile that made him dance a jig.*

Gordon Grigg, Peter Brazaitis, a reptile keeper at the Bronx Zoo, and Zoe, a conservationist friend of Gordon, were planning a trip to Kruger National Park, and invited me along. Piet, a large, jovial crocodile farmer with an ample waist line and light complexion of his Dutch ancestry, invited us to stay at his farm near the park. Gordon and company planned to travel through Swaziland, and I did not realize that the South African government considered Swaziland a separate country. I was informed at the border that if I entered I would not be able to leave again because I had used my two entry visas into South Africa. It

was obviously a ruse to stop miscegenation with the people of Swaziland, but if they wanted to see Swaziland, the others would have to go on without me.

My companions graciously decided to forego Swaziland, we stayed overnight in Badplaas, which literally means bad place, and drove around the country within a country the next day. Crocodile farming was obviously just a hobby for Piet. He grew sugar cane and bananas, and the workforce on the farm varied seasonally from about 300 to 1000 workers. Keeping that many people under control was not always easy, and he said that he had his own secret police force. A hydroelectric dam on the property provided half the farm's electricity, halving its power bill to R$ 11,000. Just the upkeep of the cane trucks cost R$30,000 per month. All that must have provided a lot of profit, because Piet's farm had an entertainment center that could hold 200 people, and the many different flags on the flag poles indicated that guests came from all over the world. His brothers and sisters had large ranch-style houses scattered across the property, and managed the four acres devoted to floriculture.

Piet's wife, Koeks, was also tall, blond and well padded. It was a bit concerting sitting in the living room conversing with her because Piet had commissioned a 5 m long mural of her lying naked and smiling down on us from the wall behind. Koeks had a servant called Anna who she said she had had since the black girl was three years old. Apparently, Anna had graduated from being an animated doll to being a servant once she was old enough for domestic service. Piet explained that there was no problem in Anna working in the sun because they (meaning black people) don't feel the heat.

We left for Kruger National Park at 4.30 am in Piet's Sunday van, which he had outfitted with a V8 motor. On the other days of the week, he used Mercedes sedans, a different one for each day of the week. When we reached the Kruger National Park early in the morning, the ranger at the entrance asked how many

people were in the car, and Piet replied “Six.” Koeks cleared her throat and jabbed him in the ribs. The black park ranger looked into the car and asked again how many people were in the car. Piet initially replied “Six,” but when Koeks jabbed him the ribs again, he looked pointedly at Anna and said “Oh yes, they count them as people here don’t they – seven.”

We saw lots of wildlife, and one of the highlights was a big group of crocs feeding on the bloated corpse of a hippopotamus. They seemed to be having trouble getting through the thick hide, but there was no fighting. They had a strict hierarchy, and despite the fierce rivalry that almost certainly existed between them, they acted like educated Englishmen around a dinner buffet. These were real Nile crocs doing what they had done for millions of years. Even Tony Pooley’s crocs in their enormous enclosure paled in comparison.

That night we stayed in the fenced enclosure around the accommodation buildings in the park. It was strictly forbidden for whites to leave the compound at night because of the risk of attack by lions and other dangerous wildlife. However, Anna had to leave the compound at nightfall and look for somewhere to sleep because it was forbidden for black people to remain with the whites after nightfall, presumably for fear of miscegenation. That night, we had a barbecue, but Piet could not help because he didn’t even know how to cook sausages. I wonder whether the whites realized how much they lost when they were busy taking the rights away from others. Piet would have been out of place in a democratic South Africa, but he never had that indignity. A few years later I heard that his secret police had failed and he had been shot to death.





Photo 6.5 *The hydroelectric plant that provided power to Piet ́s farm. Photo by Bill Magnusson.*

Back in St Lucia, Tony arranged for Ricky Taylor to take me onto Lake St Lucia in a park-service jet boat. The water in much of the lake was too shallow for propeller driven craft. I was very happy to be out and in real contact with the

natural world. In general, I had too little local knowledge to risk being out in the bush in Africa, and in any case most of the people responsible for me would not have allowed it. On the hypersaline upper reaches of Lake St Lucia I could even touch the water without fear of bilharzia.

It was cloudy, which reduced glare, but it did not rain and we ran along the shallow shores of the lake. Most of the lake was bordered by broad mudflats with salt grass. Even mangroves could not take the salinity. Some sea life can take salt concentrations up to about twice that of sea water. Strangely, the only species of fish that could survive in the parts of the lake with concentrations over four times that of seawater was *Tilapia mossambica*, a freshwater species. Being at water level was not good for seeing crocodiles, however, and we saw none, even though I knew that we were close to where we had seen them from the helicopter.

It was good to be in a boat speeding along with the wind in my face and tasting the salt spray. During the previous weeks I had little time to relax. Either I was in crowded meetings, or I was in natural areas that threatened me in all sorts of unknown ways. I preferred the natural threats, but I longed for relaxation, and the boat trip was giving it to me. I could stop worrying about dangerous predators and just feel.

I was curious that the hippos could survive in such concentrated seawater. They surfaced and wiggled their ears as we passed. They were interesting, but not much more exciting than cows in a paddock. I knew that hippos were one of the species most responsible for human deaths in Africa, but that was because the big grey animals are almost invisible at night, and many a camper had bumped into one after rising for a midnight pee. Hippo teeth are bigger than the canines of any of the big cats, and their jaws can break a human in half.

The hippos ignored us as much as I did them as we roared along, but the tide had fallen when we were returning and the jet boat ran into shallow water. As we slowed, the hippos turned and starting swimming toward us. The motor started to sputter as we were running out of water and mud started to clog the intakes. We were perched on the mud bank, hardly moving, and the hippos were surging towards us with bounds that sent waves running in all directions. I started to rock the boat to break the suction and make it go faster, probably totally ineffectually. When we hit a bit of deeper water the boat would go to walking speed, but then we would run into more mud and the hippos would gain ground. I could do nothing as Ricky looked for deeper water, and I could see that he was as worried as I was. The closest hippo was less than 10 m away when we broke off the mud bank and the boat shot up to full speed. So much for the relaxing boat ride! I would leave others to face the challenges of Africa.



Photo 6.6 *Hippos in Lake St Lucia. Photo by Bill Magnusson.*

7

The Tapajos River



The Tapajós River in front of the Tapajós National Park. The river is now being dammed at this point and will lose its rapids. Photo by Bill Magnusson.

In Manaus, I met Lyn Branch, a lanky red-headed Mississippean. Lyn was in the Peace Corp and she was doing a faunal survey of the Amazon National Park for the Brazilian Institute for Forest Development (IBDF). The name of the reserve has since been changed to Tapajós National Park, but at the time it was the only National Park in the Brazilian Amazon. The survey had been financed by an international donation, and Lyn was looking for people to be responsible for different biological groups. She asked if I could survey the crocodilians.

This was a great opportunity, because the Tapajós River has clear water with rapids and many rocky islands – very different from the flat white- and black-water rivers that I had been travelling on. It was also difficult to get permission to work in national parks at the time, and having an invitation from IBDF would greatly reduce the bureaucracy involved.



Photo 7.1 *Lyn Branch in Manaus 1980. Photo by Bill Magnusson.*

The Tapajos is about 600 km east of Manaus, halfway to the mouth of the Amazon. The flight in a twin propeller Bandeirante had four stops before reaching Itaituba on the mid reaches of the Tapajós River. The plane held about 30 people and their luggage, and was modern in comparison to the DC3s that plied the Maningrida route. The stop in Oriximiná was scheduled to last only about 30 minutes, but, as we taxied for take off on the unpaved runway, the plane shuddered to a halt and the left wing dropped until it was almost touching the ground.

We filed out of the plane and gathered around the pilot, who was looking concerned. He said in Portuguese that I had a hard time understanding "Sorry ladies and gentlemen, we have fallen into an armadillo hole. Can you help lift the plane out?" We dug, pushed and pulled for about an hour until the wheel, which had completely disappeared into the hole where the armadillo burrow had collapsed, came free and we could push it to solid ground. The pilot inspected the damage and evidently decided that it was not too great. He asked us to wait while he took off and returned for an experimental landing. Satisfied, he said that we could board, and we continued on the journey in the plane that had now become very hot from being on the runway in the glaring sun. I was sweating profusely. At each take off and landing I braced myself in case the wheel broke off, or fell into another armadillo hole, but we arrived in Itaituba without further incident.

My harpoon pole was not among the baggage the tractor brought in from the plane, and the agent said that it must have been left in Manaus, but Lyn was not convinced and she walked onto the runway to inspect the plane before it took off. She found the shaft under the passenger seats, where it had been slid because it was too long for the baggage compartment. I was very conservative and never would have thought of questioning authority. Lyn was showing me

that you could not depend on what any supposedly responsible person said, and that doing research in Brazil essentially meant that you had to take care of all the logistical details as well as the science.

We had lunch in a small restaurant with shaky wooden tables and chairs. Food was passed from the kitchen through a small oval window and I watched the cooks, who were sweating profusely, passing to and fro behind the window while we waited for the meal to be prepared. I started to get to my feet when a mass of flames and smoke spurted out of the window, but nobody else seemed to take any notice, and when the smoke cleared the cooks were still about their usual business, as though nothing unusual had occurred. I settled back onto the chair and watched as the cook placed one of the dishes meant for us on the ledge in front of the window. She must have thought that the arrangement of the food was not aesthetically pleasing, because she used her bare hands to scoop the rice into a mound and pat its surface so that it looked as though it had been upended from a bowl. Rule number one when eating at a restaurant in a little town – do not look at how the food is prepared!

The IBDF agent in charge of the park, dressed in cotton trousers, a tee shirt and white sandals, was swinging in a hammock on the varander of the office, and did not bother to get up when we arrived. All the IBDF personnel were extremely unhelpful. They did not like being bothered by researchers, and had little interest in the park, which was about 40 km out of town. They had received considerable funding to construct headquarters in the park, but they were afraid of the forest and had used most of the money to construct a base in Itaituba. The IBDF personnel would not take us to the park until the next day, and we had no money to stay in town, so we camped on the floor of a little room in the IBDF offices. The treatment by the IBDF staff did not improve with time. On a subsequent trip, Lyn contracted malaria and returned to Itaituba

debilitated and unable to take care of herself. The IBDF rangers put her in a small room behind the administration building, called an assistant from the local farmacy to put a saline-solution drip in her arm, and did not look in to bring her food or see if she was still alive during the several days it took for the crisis to pass.



The land around the road before we got to the park had been cleared, and logs were still burning logs in the rough pasture in many places. One of the tires on the four-wheel drive truck went flat halfway to the park, and the jack sunk into the soft mud that passed for a road, so we took many hours to change it and reach the park. The IBDF base in the park could not have been in a more beautiful spot. It overlooked one of the principle rapids of the Tapajos River, which narrows to a little less than 3 km at that point. The wooden buildings were new, but they stood in an ugly scar where the forest had been cleared for the buildings and an airstrip. We went down to the river to swim in the clear water and feed the fish on the barely edible canned meat we had brought for lunch. It was nice in the water, but any exposed body parts were immediately set upon by swarms of black flies, which left little dots of coagulated blood under the skin where they had dined.

In front of the base, there was a look out where we could watch the sun rise over the Tapajós, and often there would be electrical storms that would illuminate the far bank with zig-zag bolts of lightning in the evening. The water surged around the the rocky outcrops in the river, contrasting with the calmness of the rainforest on the steep banks. I did not realize how privileged I was to see the untamed Tapajós. By the time you read this, those rapids will have disap-

peared under a hydro-electric dam; one of a series that will turn the mighty Tapajós into a series of lakes.

The pilot could not take me out on the river for a few days because his wife had just given birth. Lyn introduced me to Sr Joachim and his family. Although people shouldn't live in a national park, many people had been there before the park was declared, and IBDF didn't have funds to compensate them. Sr Joaquim's house had only a few rooms and was built of rough hewn wood, but it was sturdy and reflected the work of a skilled carpenter. Everything was organized around an open palm-thatch hut used to house the equipment used for making farinha, the dry manioc meal that is the staple diet of most people in the Amazon outside the major cities. Chickens, guinea fowl and emaciated dogs mingled with Sr Joachim's relatives and their many children.

Sr Joaquim was about 50 years old, with dark curly hair and average build. His skin was tanned and leathery from the hot sun. He wore dirty, tattered khaki trousers and a scruffy cotton shirt that had few buttons and appeared to be several sizes too small for him. A scrunched up leather hat secured by a strap under his chin seemed too small to serve any practical prurpose. He used home-made leather sandals because his boots had worn out and he had no money to buy more. A tattered belt supported a long well-worked machete in a home-made leather scabbard, and a 45 calibre pistol in a leather holster.

Apparently, the pistol was not just for show. A few years earlier, two brothers, trying to even a score over the death of a son who had been killed accidentally, murdered a man near Itaituba and set off down the highway to get Sr Joachim. He heard they were coming, strapped on his 45, set out to capture them, and marched them to the lock up in Itaituba. This was the story that his family told, but I suspect that not all his uses of the gun were so legal. Lyn had suffered some embarassment when she first visited Sr Joachim's house and her

Portuguese was not very good. At dinner, she tried to say that she would like to go hunting with him the next day. Unfortunately, the Portuguese word for hunt, *caçar*, is pronounced almost the same as *casar*, the word for marriage. The family thought it very forward of this young red-headed girl to ask Sr Joachim to marry her in front of his wife. What Sr Joachim thought of the idea is not recorded.

Juan, another Caboclo who lived near a small tributary of the Tapajos offered to take me out in his canoe. The stream was only about 10 m wide, and consisted of long runs of rapids separated by occasional pools. The heavy wooden canoe was carved from a log, had little freeboard, and was not much wider than the seat of my pants. I put the heavy 12 volt battery for my spotlight and my capture gear in the front of the boat and Juan paddled where he could, but in many places we had to get out and push the canoe around the rocks, which made me nervous because I had seen electric eels in the stream during the day.

My headlight was not working and I had to use the spotlight to to look for caimans, which meant I had only one free hand. The first eyeshines I saw were on the bank and they dipped rthymically before turning to look at me. When I got close, I saw that it was a paca and not a caiman. Pacas are South American rodents, about the size of small dog, that live around streams and are agile swimmers. The fat little animal had white spots like those on a new-born deer. When we got close, it slipped into the water and disappeared.

The next eyes were of a Schneider's dwarf caiman, about 1.5 m long. It was hard to throw the harpoon with one hand while sitting in an unstable canoe, but the technique worked surprisingly well. The caiman dove under the canoe and cord pulled the canoe around, almost swamping us. I let the caiman tire itself out and dragged it across to the shore where I could tie it up and slip it into the

canoe. I caught almost all the caimans I saw, which were all the same species and about the same size.



Photo 7.2 *Sr Joachim and one of his grand children. Photo by Lyn Branch.*

When I had five caimans in the canoe, I signaled to Juan that we could go back. We exchanged positions, he started paddling from the front, put the canoe into the middle of the stream and started to run the rapids. I was worried about my equipment, especially when we struck a rock, and water started spurting into the canoe. I took off my shirt and stuffed it into the hole. Another rock opened a hole further down the canoe, and I had to rip my shirt to plug it. Three holes later, I had no more shirt and I plugged the last hole with my shorts. I was stark naked when we got back to the bridge where the car was waiting, but I had not lost my equipment, which seemed to be something of a miracle. I decided that I had better practice my Portuguese to say "Let's take it slow and stay near the bank."

The Schneider's dwarf caimans I caught were all males, which seemed strange. It would be a while before I realized that the species does not usually breed around large streams, and that most individuals that researchers caught were large males or dispersing juveniles. I also found that you must be very careful when taking stomach contents from the species. When I released the individuals the next day, they were alive, but did not make for the water when I untied them. They just lay in coma, waiting for death to overtake them. I was very careful with the next animals whose stomachs I pumped. Other species of crocodilians close the entrance to the windpipe if you pour water down their throats. Schnieder's dwarf caimans often don't, and even a tiny amount of freshwater in the lungs is enough to dilute the blood going to the heart and brain and kill them. It is easy to avoid, but only if you know what to expect. I was starting to learn some of the many ways that dwarf caimans are different from other crocodilians.



I tried surveying the small streams on foot alone, which made me nervous, because I knew nothing of the Amazon forest, and everyone regailed me with stories of jaguars, anacondas and electric eels. One night I headed off a track in the direction of a small stream and found myself in a stand of babaçu palms, most of which had no trunks and just thrust their huge leaves vertically toward the canopy. The undergrowth started to move all around, and although my headlight was blocked by palms, the warning clacks of their huge teeth left me in no doubt that I was in the middle of a band of white-lipped peccaries. I looked around, but there was nothing to climb, and the palm fronds would offer no defense against enraged peccaries. The pigs were everywhere, so I had nowhere to run. I looked for an open area where I might be able to out manouvre the peccaries, but I found none. I stood still for what seemed an eternity while the unseen peccaries moved on, occasionally clacking their teeth to let me know that they were not happy about my presence.

When I got to the creek, I waded into midstream. Although the channel was only a few meters wide, I was nervous because I remembered that Lyn had told me she had seen an anaconda with a foot-long head in a similar stream the year before. I started walking down the stream, which was less than knee deep in many parts, but occasionally forming chest-deep pools where rocks dammed its flow. Long fish scooted away from my feet in the rapids, but I couldn't see what they were.

I walked into a shallow pool, about 3m wide, 6 m long and 30 cm deep. When I got to the middle, I saw an electric eel, well over a meter long, swimming towards me. I froze as it passed to one side of me, and looked behind to see if I could step onto the opposite bank. There was another eel of almost exactly the same size moving downstream on the other side. I tried not to do anything to startle them. Frightening two electric eels, each of which could

generate over 400 volts, could be the last thing I did. I thought they'd continue along the stream, but they remained in the pool and started circling me. They went around me three times before one continued downstream and I had the courage to step onto the bank.

I was cold and pretty spooked by the time I came on a larger pool, about 8 m long with chest deep water. I hesitated to enter the pool, but at the other end was an enormous Scneider's dwarf caiman sitting on a rock above the stream. I calculated that it was at least 2.5 m long, much larger that any that had been recorded in the literature. I walked into the pool, holding the battery case for my light and my back pack above my head. The water was up to my arm pits and I couldn't see the bottom, where there might be deeper holes or electric eels. I went slowly so as not fall into to the water and ruin my equipment, and so that I wouldn't scare the caiman. It let me get within of a meter, and I noted marks in the rock near the tip of its snout and the end of its tail. When I was looking up from water level it appeared even bigger, and I was startled and almost fell over when it jumped into the water, dousing me as it went down.

It turned out that the caiman was not as big as I had imagined. Frayed nerves tend to magnify things at night, and dwarf caimans, which have relatively short tails, are much thicker than other caimans of similar length. Nevertheless, the marks on the rocks showed it to be about 2 m long, much bigger than any other dwarf caiman I have seen. I did not catch any, but I saw many Scneider's dwarf caimans of all sizes, and no spectacled or black caimans. I was starting to discover that the forest streams belonged to the dwarf caimans.



Surveying the crocodilians around the Tapajós was not easy. The river is treacherous, and only experienced pilots venture into turbulent waters during the day. Many fewer are willing to go at night. Fortunately, it did not take long to discover that there were few caimans along the shores of the main river, or its tributary on the far bank, the Jamanxim River, and most were spectacled caimans, with only a few small dwarf caimans near rocky areas. Sr Joachim said that there were black caimans in the region, but only in the isolated lakes back from the main river.

Lyn, Raimundo, a man who knew the river well, and I set out to survey some small lakes upstream of the base. We arrived in the late evening and tied off to a small tree on the bank. The lakes had no connection to the river at that time of year, and we would have to drag the boat across the levee bank to get into them. However, the sky grew dark and the wind whipped up white caps on the river. The rain came in sheets and Lyn and Sr Raimundo were of the opinion that it would not stop that day.

We unpacked the boat and pulled it into a lake running parallel to the river, and then along a water-filled depression into a second lake. By then, the rain had eased to a drizzle, and we crouched under a tarpaulin and tried to heat some chocolate drink over a kerosene lamp made of a dried-milk tin with a wick. None of us were very comfortable, and Lyn said that the rain would last at least six days, but we could stay if I wanted to. I had a bad cold and blocked sinuses, and she seemed very surprised when I said that we should stay.

To cut short a long, cold story, by 7 pm the rain had eased off enough to survey. The tepid chocolate and dinner of crackers and sardines put us in a better mood, and half an hour later the rain stopped completely. We found 29 black caimans in those two small lakes. The smallest was 60 cm long and the largest about 3m. The largest we caught was about 2m. This was the only place

in the park that we found high densities of black caimans that were obviously breeding.



Photo 7.3 *Bill Magnusson with a black caiman on the Tapajós River in 1980. Photo by Lyn Branch.*

We continued to survey after that, but the pattern was pretty clear. Dwarf caimans mainly in the forest, black caimans in only a few isolated lakes, and

spectacled caimans scattered around elsewhere. Lyn wanted to try her had at harpooning, and I decide to let her have a go because I already had many more spectacled caimans than I needed. She was pretty hopeless at it, and at one point she lost her grip on the harpoon and it sank towards deep water. Fortunately, the head was still attached and I was able to pull up the shaft using the cord.

It was fortunate that I did not abuse Lyn for nearly losing the harpoon pole. A short time later, I tried to harpoon a dwarf caiman that was hidden behind submerged bushes. I tripped and the harpoon shaft disappeared into 3 m of dark water, without the head attached. My sinuses were completely blocked, and having blown blood vessels when spearfishing with blocked sinuses when I was a teenager, I was not about to dive to retrieve the harpoon. However, Lyn was, and she dropped over the side of the boat. When she came up a minute later with the harpoon in her hand she was grinning and I assumed that she had felt my unspoken admonition when she had almost lost the shaft a short time before. The incident reinforced two rules, whose value I only fully understood many years later – don't gloat, and don't criticize anybody but yourself.

8

Venezuela



John Thorbjarnarson and Tomas Blohm, who worked together to conserve Venezuelan crocodilians, at their last meeting in Hato Masaguaral 2007. Tomas died in 2008 and John in 2010. Photo by Luis Sigler.

The next CSG meeting was held in Venezuela in 1984. I was particularly interested in attending this meeting because Venezuela was acknowledged as having the best program of crocodilian research and management in Latin America, led by dedicated researchers, such as Andrés Seijas and Alvaro Velasco. The country also shared with Colombia and Brazil the honour of having the largest number of crocodilian species in the world. Brazil has only alligatorids, but Colombia and Venezuela have both crocodylids and alligatorids. The American crocodiles, which I had seen in Florida, reached their southernmost distribution in the mangroves around the coasts of Venezuela and Colombia. The Orinoco crocodile, *Crocodylus intermedius*, is similar to the American crocodile, but is a bit sturdier, and has a reputation as a man eater where it occurs in the freshwater stretches of the Orinoco River. Both species of dwarf caimans and the spectacled caiman are found in a variety of freshwater wetlands throughout the country.

There was a tendency for the CSG to support only farming and ranching, because most members felt that direct hunting in the wild had been the reason for the reduction in crocodilian numbers in many regions of the world, so legal hunting, which was difficult to control, would only excacerbate the declines. It was also a time that population viability analyses became fashionable. Unfortunately, the most popular computer program for viability analysis had a defect, with the result that biologists throughout the world decided that the only way they could save their species was by captive propagation. Captive breeding undoubtedly saved a few species, but siphoning off resources to vets and zoo keepers and away from field biologists meant that many species lost critical habitat in the last decades of the twentieth century.

Bianca D'Andria had produced an undergraduate thesis that indicated that caimans could only be sustainably exploited by captive raising, but that seemed

to go against the evidence from Venezuela's hunting program and I thought there might be problems with the data that were being being fed into the models. Most people believed that predators, mainly older crocodilians, took about 90% of the hatchlings in the first year, but researchers who had attempted to measure mortality had found it to be only about 50% in the first year. In the paper I presented at the meeting, I proposed that cannibalism on hatchlings had been overestimated, and that the real bottleneck came when young adults challenged territorial adults for a place among the breeders.

Subsequent research would show that I had underestimated cannibalism on hatchlings in very dense concentrations of alligators, but the interactions between subadults and adults were near the mark. This had implications for which species would be most vulnerable to hunting. Young adults of species that lived in linear systems, such as along the shores of large rivers and lakes, would have nowhere to go to avoid adults, and hunters would have easy access to all. In contrast, juveniles could more easily get away from adults and hunters in dense marshlands, swamps and flooded savannas. This was not very palatable to those who sought to save all crocodilians by intense management, because I was essentially saying that, if you give them enough living space, crocodilians can look after themselves.

If I was right, then riverine species should be much more endangered than swamp and marshland species, and I presented a table showing just that. There are of course other confounding factors, such as loss of critical habitat, control over illegal hunters, and the value of the skins, but, even so, the pattern was strong. The only swamp or marshland species that had not lost habitat, but appeared to be badly overhunted, was Morelet's crocodile, *Crocodylus moreleti*, from central America. Even among closely related species, the generalization seemed to hold up. The Orinoco crocodile was critically endangered, but the

American crocodile, which was so similar that most people couldn't tell the two species apart, was holding on much better in the swampy mangrove forests of the coast.

I proposed that the crocodilians have an unusual pattern of demography. Most long-lived, slow-growing animals produce a small number of large offspring. Small, short-lived species usually produce a lot of very small babies. Crocodilians are large and long-lived, but produce many very small progeny. I thought that might be why they were so resistant to hunting. However, most of the delegates were not very interested in what I had to say. They were interested in trade and there were heated discussions about the relative merits of hunting and ranching, and whether Australian saltwater crocodiles should be moved from appendix I to appendix II of the Convention on International Trade in Endangered Species (CITES). Grahame Webb and Harry Messel were only just getting to the point where they would remain in the same room with each other after the acrimonius Crocodilus breakup. In later years, each would be the chairman of the CSG, and they would work harmoniously with each other, but at that time I was the only person involved who had not taken a side. It was good to catch up with everyone, but after what appeared to be an enjoyable conversation with Harry Messel, one of his colleagues came up to me and said "The Professor's worried that you might be a spy for the Webby camp." I had found that human relations could not only ruin scientific study; they could chase you right across the world!



There was a field trip to the Llanos scheduled after the meeting and we piled into a bus the Venezuelan Wildlife Department had leased. The Llanos is the huge floodplain of the Orinoco River, which occupies a third or more of

Venezuela. Most of it is flooded in the wet season, but the water retreats into the river and scattered ponds and lakes in the dry season. The Amazon region of Venezuela has some of the most spectacular mountain scenery in the world, and the World's tallest waterfall, but the Llanos is almost perfectly flat, and the trip would have been uneventful if not for the frequent police check points. Harry Butler, a famous Australian naturalist and television personality had attended the meeting and, when we stopped at a police checkpoint, he surreptitiously put his camera on a ledge near the door of the bus and started taking pictures, an activity that was strictly forbidden. I looked down at the nervous looking police officers with submachine guns and hoped that they would not notice and take offense. Although I doubted that they would shoot anyone, they could demand that everyone get off the bus, hold us up for hours, scatter our luggage along the road in the hot sun, and demand bribes to let us go. These were things that would happen to me on future trips to Venezuela, but the guard didn't notice the clandestine photography, and let us on our way.

A lot of research had been undertaken on the Llanos fauna in Tomas Blohm's estate, Hato Masaguaral, and we would visit other cattle ranches where the Llanos ecosystem was largely protected, such as Hato El Frio. Although it is the primary economic activity there, the Llanos has limitations for cattle ranching. The cattle have their feet in water much of the year, and the native grasses are only seasonally lush, so only hardy breeds can be raised there. Ranches have to have some high areas where the cattle can congregate at high water, or they have to be driven or trucked to temporary pasture in the surrounding dry savanna areas. Because of alternating drought and flooding, many ranchers have installed extensive systems of dykes to regulate the water, so few areas have water regimes similar to those when the Spanish first colonized the area. Nevertheless, most of the fauna has adapted to the new conditions, and wildlife is easy to see and approach.

Tomas Blohm had been captive breeding Orinoco crocodiles on his ranch for many years, and the young crocodiles produced were the basis of an ambitious reintroduction program for the species. We walked around the large naturalistic pens and viewed the crocodiles. Tomas was excited about the program, and very proud of his crocodiles. Nevertheless, I remember little of them. I have seen so many captive crocodiles over the years that they all seem to blend into the same image of log-like objects lying in murky water. I could rationalize about their value to science or conservation, but they did not strike any emotional chords - they were just study objects.

I remember more of walking around the Llanos at the back of the ranch house. The rough grass, with areas of bare ground from overgrazing, surrounded patches of low forest with figs and a few palms. It was hot and dusty, and the howler monkeys peered at us as we walked by. This was a high part of the Llanos, and the dry savanna was more affected by fire than flooding. It reminded me of parts of northern Australia, and, unlike the crocodiles lying in their cages, I could feel the grass, smell the leaves as I pushed into the forest, and sense the ground through my bare feet. I imagine that Tomas and the other Venezuelans also felt the Llanos, rather than just lived in it. I was sure that they felt it differently than I did because my contact with it was filtered through experiences in a distant land. Nevertheless, I was also sure that what they felt was not transmitted in the scientific papers and lists of numbers that had been presented at the CSG meeting.

Most of the other areas were less wild than Hato Masaguaral. The lower parts of the Llanos had been dyked so that the ranchers could control the amount of water, and hence productivity in the dry season. There were few trees on the lower lying areas, and the areas between the levees looked like paddy fields with occasional patches of deeper water where there were water lilies. Even

where there were no dykes, the roads on raised levees had the same effect, altering the natural sheet flow much as they did in southern Florida. The roadside borrow pits and flooded paddocks supported a varied aquatic and semiquatic fauna, and we soon tired of taking photographs of capybaras and storks. Spectacled caimans were everywhere, and I suspected that there might even have been more than were there before humans started increasing the amount of water in the dry season for the cattle.

Venezuelans had a strong hunting culture, similar to that in the USA. Caimans and capybaras were hunted commercially on many ranches, and this led to a conflict in water management. When they were allowed to hunt commercially, the ranchers maintained the dykes full, which was good for the caimans and capybaras, but bad for cattle. When the government imposed restrictions on hunting to protect the wildlife, the ranchers drained the dykes, and caiman and capybara numbers were reduced. There had been a lot of discussion of closed-cycle captive breeding of caimans for skin production at the meetings, and most of the participants seemed to think that would be good, or at least neutral, for caiman conservation. I was unsure. The Llanos was far from a natural system, but humans were an important part of that system. It seemed that conservation would be best served when the interests of both humans and the wildlife were closely tied.



Our Venezuelan hosts told us that we would visit a house where a woman had kept an Orinoco crocodile as a pet for 50 years. I prepared myself to make appreciative comments about some log-like crocodile lying in another pool of dirty water. I could not have been more wrong. The bus pulled up on a street in the middle of a little town called San Fernando de Apure. The houses were

stuck together, and most had no windows, so the street was lined by a continuous wall broken only by the occasional door. It looked like the tenement housing in the inner suburbs of Sydney.



Photo. 8.1 *Tenement housing was habitat for a crocodile kept in captivity for over 50 years by Sr José Faoro and his family. Photo by Gordon Grigg.*

We knocked on a door and it opened to reveal a Spanish style courtyard surrounded by rooms with open doors and windows. The courtyard was only about 8 m wide and the same length. The whole area was paved, but it was filled with potted plants and garden ornaments, so we had to wind our way through narrow pathways. Built up against a wall on one side was a square cement pond, about 2 m long, 1 m wide and waist high. We were ushered across to it and had to press up against the pool so as not to knock over the rows of potted plants. I was nervous at being so close to the pool because in it was a very large Orinoco crocodile. I don't know how long it was because it was completely doubled up to fit into the pool, but its head was as long as my

forearm. It had obviously been living in the pool a long time, because its snout was distorted to one side from lying in the cramped quarters.

There were small children and a cat playing in the courtyard and there seemed to be no protection from the crocodile. I was nervous because I was pressed up against the side of the pool, a few centimeters from the crocodile's head, and there was no cover over the pool. However, I was large and possibly would be considered difficult prey for a crocodile of that size. The children and cat seemed to be perfect prey size, and I asked the lady of the house why she wasn't worried about the children's safety. She said in Spanish "Oh no, he only eats chickens!"

Hoping my head wouldn't look like a chicken, I crouched down and looked closely at the crocodile. The distorted skull had the intricate sculpturing of an adult, but that was not what held my attention. When I looked into its eye, I was momentarily drawn into a deep and ancient world. I felt myself floating, and forgot the mass of crocodile specialists in the quaint little house. I only broke eye contact because someone pushed up to see the crocodile and nearly knocked me over. I stood back and marveled at the animal with its distorted head in the little cement pond – it was not a captive crocodile!

There was no space or time to get near the crocodile again, but I asked the lady why she wasn't worried that the crocodile would escape from the pool and knock over the pot plants. She said that the crocodile could get out of the pond, and that every night it would leave the water, walk carefully among the pot plants, sit beside the family in the living room on the other side of the courtyard, and watch television with them. I do not doubt that what she said was true, and I again marveled at the bonds that could form between humans and crocodiles when both sides were given enough time.



Photo. 8.2 *An Orinoco crocodile that was kept for over 50 years by the Faoro family. Photo by Gordon Grigg.*

9

Anavilhanas



View of Anavilhanas in the distance from the west bank of the Rio Negro. Photo by Bill Magnusson.

I was starting to tire of crocodilian studies; not physically but intellectually. We were a long way from understanding how and why numbers of any species of crocodilian fluctuated over the years, and we had only a vague idea of why they were so resistant to hunting. To understand these things, however, would take dedicated study over many decades, and be expensive due to the costs of manpower, fuel, boats and radio-telemetry equipment. It was popular to count crocodilians around large lakes and rivers from boats, to study the number of eggs and temperature in nests, and to take stomach contents from crocodilians to describe their diet. It was relatively quick and easy to do those studies, and I had done them on a number of species, but the cream had been skimmed off. We just seemed to be consolidating ideas, not coming up with new ones. We knew that the number of crocodilians seen in open water from boats was related to water level and hunting pressure. We knew that all species of crocodilians eat most animal food they can catch, progressing from invertebrates when small to fish or other small vertebrates at intermediate sizes, and eating mammals if they got very big. We also knew that the number of eggs in nests was proportional to female size, and that the temperature of egg incubation determined the sex of the hatchlings. There were details to be worked out for each species, but they were just that – details.

I was interested in other organisms besides crocodilians, many of which had not been the subject of even basic natural-history studies, and I saw that many of them were much more endangered than the wily crocodilians. Therefore, I was not willing to invest the time and resources necessary to maintain a long-term study of caimans around the major rivers in the Amazon. However, there were few crocodilian biologists in Brazil, and the lack of competition made me the Amazon's foremost expert on caimans. Therefore, I received many requests

to supervise post-graduate students, and I tried to turn them down as politely as I could.

One long-haired student was particularly persistent. I told him that I did not have the resources or time to study crocodilians, but he told me that he would find funding, and would not take much of my time. His name was Ronis Da Silveira and, to get rid of him, I told him that I would only supervise his Masters thesis if he came within the top three in the selection exam. He passed in first place, and I had no option but to be his major professor.

The islands in the Rio Negro form the largest freshwater archipelagos in the world, and the archipelago closest to Manaus was an Ecological Reserve maintained by IBDF, which by this time had incorporated the federal Fisheries Department and changed its name to IBAMA. The Anavilhanas Archipelago was formed by the meeting of the black waters of the Rio Negro with the turbid waters of the Rio Branco, 270 km north of Manaus. The acidic water of the Rio Negro causes the sediment from the Rio Branco to floculate and fall out of suspension, creating the hundreds of islands of the archipelago.

The ecological reserve had been created specifically for scientific studies, but few had been carried out to that time, and the IBAMA personnel responsible for the reserve were eager for researchers to use the area. Virtually nothing was known about the caimans in the reserve, so we made a grant request to the Boticaria Foundation, a funding agency associated with a major pharmaceutical company. The foundation made small grants, usually for a year, and exceptionally up to 3 years, but they ended up funding us for 9 years, which was, as far as I know, the most sustained funding of any of their projects to date.

Ronis was from the state of São Paulo and had virtually no experience in Amazônia. His long hair was good for attracting girls in city bars, but did not

seem appropriate for someone who would have to spend long periods in remote areas. He had become enthralled with the idea of working in the field from the hunting and fishing stories that his father told him, but I knew from experience that the adventurous stories your father told you did not prepare you for dealing with similar situations in real life. By the time he had finished his courses in the classroom, I was regretting having taken on the responsibility of supervising his field work.

IBAMA had a base in the middle of the archipelago and offered to let us use it for the caiman study. Similar to the floating houses used by caboclos, it was basically a wooden shed built over floating logs. There was nowhere in the archipelago to construct a conventional house because the water level fluctuated over seven meters, and all of the islands went under water to the level of the tree tops at high water.

The lower reaches of the Rio Negro near Manaus have no islands and are subject to strong winds that sometimes flip over the large wooden passenger boats that ply the river. The wind and the chop made the first 60 km in the outboard aluminum canoe uncomfortable, but once we got among the islands the surface of the river became glassy smooth and we could make good time. You need an experienced pilot in the Anavilhanas. Some of the islands are over 30 km long, even though they are rarely a kilometer, and usually less than 200 m, wide. Worse still, many of them are U shaped, so you can travel dozens of kilometers upstream only to find that you are in a cul-de-sac and have return the same distance downstream to be able to pass around the island. In principle, you can always find your way out of the maze of islands by heading downstream, but you may have to travel 100 km to find your way out, and a few errors of that sort will quickly drain all the fuel and time you have for research.

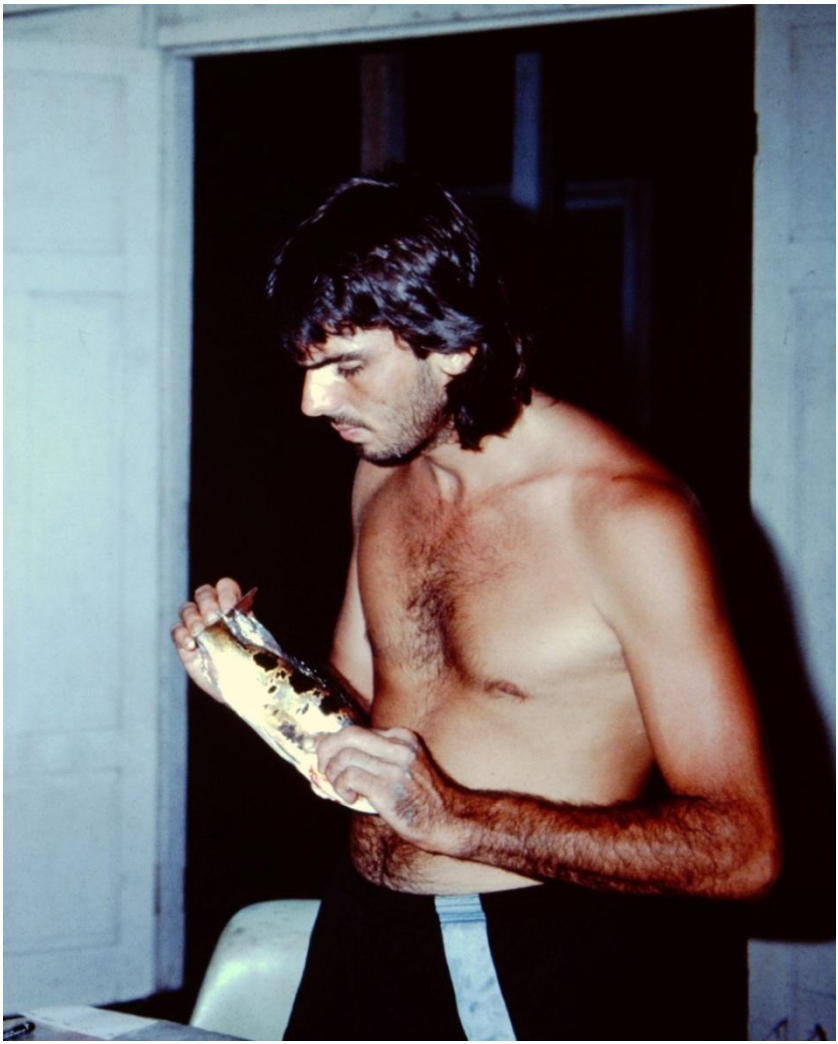


Photo 9.1 *Ronis Da Silveira inspecting a fish captured to estimate food availability for caimans in the Anavilhanas. Photo by Bill Magnusson.*

We set out at night to find caimans. This was before the advent of tiny LED lights, and I had bought miners lights with 6-volt lead-acid batteries that were secured around the waist by belts. They served for work around the boat and as spotlights for finding caiman eyes. Ronis was keen to catch a caiman, and we

were still using the harpoons, even though they usually aren't necessary for the caimans, which are smaller and less wary than saltwater crocodiles.

Ronis stood in the bow with the harpoon, and I sat behind giving instructions. The first caiman was under bushes and Ronis strained forward to place the harpoon, but the pilot put the motor into reverse to stop plowing into the bushes, and Ronis lurched forward and disappeared over the front of the boat. I lept forward and could see Ronis being dragged down into the black water by the weight of the battery and the harpoon. The light was sweeping from side to side as though Ronis was still looking for the caiman even though his head was half a meter under water and still going down. I threw myself onto the bow, grabbed the harpoon and reached down to grasp Ronis by the collar.

When I dragged him to the surface, he grabbed onto the side of the boat and asked if he got the caiman, which he hadn't. The light still worked and Ronis wasn't hurt, but I was now even more worried than before. I did not have time to accompany him on all his excursions, and I had a first-hand demonstration of how an inexperienced student might drown or lose expensive equipment. However, by the end of the night, Ronis had it all together, or at least he didn't fall out of the boat any more, and being thoroughly soaked did not dimish his enthusiasm for standing in the cold wind on the prow of the canoe surveying for caimans.

We only found spectacled caimans around the floating base, which was on the western side of the archipelago, but we found a few black caimans on the banks of the islands closest to the eastern margin. The water from the Rio Branco flowed down the eastern bank and, even though most of the sediment had flocculated out, it was still less acid than the water that came from the upper reaches of the Rio Negro. There were spectacled caimans in that region as well,

but it seemed that the two species responded differently to water quality, and that would be a focus of some of Ronis' studies.

Ronis would also study the diet of the caimans in the Anavilhanas, not because I thought that it would reveal anything especially interesting in terms of science, but I thought it would show that the caimans ate few species that were important to the commercial or sport fisheries in the region. This turned out to be the case, and it is rare for crocodilians to compete with humans for edible fish, though they often damage nets and otherwise make life more difficult for fishermen.

Caimans in general, and especially black caimans, were far less abundant in the Rio Negro than in the white-water rivers. This had drawbacks and advantages for long-term studies. In some places in the Amazon, mark-recapture studies are not viable simply because you can't see through the murky water to verify whether the caiman has been marked by scale clipping, and there are so many caimans that the probability of you randomly catching a caiman that has been marked before is vanishingly small. Ronis started a long-term study of caimans in the Anavilhanas by concentrating on marking a large proportion of the hatchlings each year. Recently hatched crocodilians are easy to catch, and they don't seem to learn to avoid subsequent recapture if you catch them young enough. Sub-adult and adult crocodilians learn to avoid capture by the same method, and the probability of recatching an animal marked as a subadult is tiny. Ronis only marked babies during the hatching season for many years, and captured few larger animals. In the last year, he did not attempt to recapture animals that had not been marked, and spent the time to try to noose the caiman only if it he could see that it had been marked by cutting the prominent tail scutes. In that way, he collected data on movement and growth that would have been impossible in conventional studies where the researcher

continually attempts to catch, and scare, all the caimans he can find. The data on known-age animals marked as hatchlings was especially important for validating growth models based on the recaptures of larger animals.

A major finding of Ronis'study would be that the black caimans grew faster in the Anavilhanas than they did in the much more productive white-water rivers[10]. Apparently, the effect of the density of large caimans is more important in inhibiting growth than the abundance of food is in promoting it. To understand crocodilians, you have to appreciate that they are not just robots mechanically scooping up food. They are highly social creatures, and trying to understand their population dynamics without understanding this complex social milieu would be about as useful as trying to understand how human communities work without taking into account their complex social interactions.

We were lucky to have Peter Bayliss visit us for a few years while he was carrying out research on cane toads for his Ph.D. thesis. Peter was lightly built, with an unlikely combination of freckles and round Japanese features. He was interested in demographic modeling, and had an intense look that befitted a mathematician. We were interesting in estimating densities of crocodilians, and Peter had carried out one of the most interesting studies of density estimation when he was in northern Australia. He had captured large crocodiles at night using conventional methods and marked them to estimate densities by capture-recapture methods. The reason that other researchers had not had much success with capture-recapture was that crocodilians learn to avoid capture quickly, and the statistical methods assume that capture does not affect the probability of recapture in relation to unmarked animals. Peter came up with a novel method to get around the problem. He marked the crocodiles with numbered plastic tags that could be seen during the day from a distance. Although the marked crocodiles were very wary of approaching boats during the night, they did not

seem to associate the boats passing by during the day with the bad experience at night, and Peter was able to get the first realistic estimates of numbers using capture-recapture, even though he only recaptured them visually.

Peter discussed Ronis' study and was keen to go into the field, so we took him to the Anavilhanas. There were many spectacled caimans around and Ronis soon captured several, but Peter was eager to see a big black caiman. This turned out to be harder than we had imagined. The water was low, and the larger caimans were in shallow places that we could not approach in the boat. We could see eyes shines reflecting in our spotlight from among the thickets of small trees and bushes that grow in the lower lying areas around lakes, and we tried to approach them from land.

The dry banks covered in wild rice were easy to traverse because the exposed mud had baked hard during the day. However, it was not as easy to push through the bushes with tough stems covered in spicules from the freshwater sponges, which caused severe itching when they accumulated between necks and shirt collars. Peter spotted a black caiman about 2.5 m long in a clearing among the bushes, and it just sat there calmly as we crept up on it.

I approached from one side and Peter came from the other with the noose. I thought that the caiman would run for water as we could not keep the light on its eyes when we had to bob and duck to get through the bushes. Nonetheless, in typical black caiman style, it just sat looking at us stupidly. Peter slipped the noose over its head and gave a tug. The caiman ran for water and almost pulled the cord from Peter's hands. We were using cord made for operating venetian blinds, which is strong, but thin and difficult to hold because it cuts into your hands. This isn't a problem in a boat, because the caiman only has water for leverage, but it makes it difficult to restrain a caiman running on firm ground.

The caiman ran into the bushes and tangled the line around a fallen log as Peter braced and slowed the cord that was zipping through his hands. It was the turns around the log that stopped the caiman, and it sat still with its head up like a dog as Peter approached it from behind. Peter was hunched over as he closed on the caiman and a little off balance from stepping around the mats of grass and logs on the ground. He was unprepared when the caiman launched itself at him in a complete back flip, mouth wide open.

I had not seen a crocodilian catapult itself into the air like that since Puffett had done it on the banks of the Tomkinson River. I was only a few meters away, but could do nothing as the jaws filled the space around Peter's head. If they had closed at that instant, Peter would have been dead, but the elastic cord was stretched to its limit and pulled the jaws backwards as they closed, snapping the air a centimeter from Peter's nose. Ronis described it as the scariest thing he had seen in his life up to that moment, and my heart was pounding. I can still see those teeth suspended in the torch light around Peter's head. I had again underestimated a crocodilian, and Peter had almost paid for it with his life.

I had become disrespectful of black caimans because I had fallen into the fallacy of believing that what a crocodilian normally does is all that it can do. I remember the advice my father had given in relation to fist fights. He had said "Remember, it's not what you know that's important, it's what you know that he doesn't know you know." Crocodilians have withstood sustained persecution due to human greed and hatred for hundreds of years. No other taxon of large vertebrates restricted to small areas of suitable habitat has been able to resist such attacks without loss of any species. There must be a lot of things they know that we don't know they know!



Photo 9.2 *Left to right, Peter Bayliss, Albertina Lima, Marli Monteiro and Ronis Da Silveira resting at Novo Airão after returning from the Anavilhanas. Photo by Bill Magnusson.*

Open Science

10

Ecuador



Transport to Limoncocha off the Napo River was by a large wooden canoe. Photo by Bill Magnusson.

In 1986, I received a letter from a researcher I didn't know called Phil Hall. The letter exuded excitement about working in Papua New Guinea, and Phil included a photo of himself lying on the floor draped across the teeth of a gigantic crocodile skull. This boyish display contrasted with the reserved, arrogant demeaner of most crocodilian researchers, who took almost any opportunity to promote themselves, but always in low-key macho ways. The patrons who donate the most money to the CSG go by the manly title Big Bull Crocs, but most members would never consider sending a photograph of themselves fooling around to a complete stranger. Phil said that he was looking forward to meeting me at the CSG meeting in Ecuador that year.



Photo 10.1 *Phil Hall in the skull of a large saltwater crocodile. Photographer unknown.*

I had turned down a job in Papua New Guinea to go to Brasil, so I was interested in what crocodilian studies were going on there. After I and a biologist from the US had declined work there, Phil filled the gap. He would show the presence of a third species of crocodile in New Guinea, he would summarize the commercial and monitoring programs in the country, and his work on the biology of the crocs provided the basis for all subsequent work.

Renato Cintra also wanted to go to the meetings. Renato worked on birds in the same institute as I did, but he had previously studied caimans while working for IBAMA in the Pantanal wetlands of southern Brazil. Shorter than I was, and almost painfully thin, Renato was a ball of energy and worked long hours, whether studying birds, caimans or plants. When not doing science he was an inveterate ladies' man, and had more girlfriends every year than I have had in my entire life. We planned to go to the Galapagos Islands after the meeting and and carefully counted our dollars.

There was a stopover in Colombia on the way to Ecuador, and the travel agent told us that I didn't need a visa for Colombia, because Australians could stay up to 12 hours without one, and we didn't have to pay airport tax if we stayed less than one day. However, when I arrived at the airport, the VARIG airline agent said that I could not board without a valid Colombian visa, even though I was going to Ecuador. I explained the rules that were published by the Colombian government, but she was adamant that I could not board. She said that it was just a ruse to get money, I would be detained in Colombia, and the airline company would be fined and obliged to take me back to Brasil on the next flight.

It looked like I was not going to Ecuador, but just as I was giving up, the attendant pointed to short balding man who was assisting a pregnant woman at the departure desk. She said "That's the Colombian Consulate. We can take you

if he'll give you a visa." The Consulate didn't have any official visa stamps, but kindly wrote by hand the rules relating to Australians in my passport, and signed it. The attendant photocopied the page from my passport and said that they would risk it.

When I arrived at the immigration booth in the airport in Colombia, the officer called over two guards with submachine guns who stood beside me as she said that I was in the country illegally, and I would be arrested and sent back to Brazil. The VARIG agent had been right. However, I made a fuss, explained how badly the country would appear when it came out that they had detained an important scientist on a mission to a neighbouring country with the signature of the Colombian Consulate in his passport. It took about an hour, but they finally agreed to let me stay in the transit lounge. We were told, however, that we would have to pay the airport tax. We told them that people in transit did not have to pay airport tax if they stayed less than one day, but they explained that one day was not 24 hrs. Our plane would leave after midnight, so that technically we were leaving the next day. The tax only came to US$ 30, but it cut into our meager funds.

We had a 10 hour stopover, and the transit lounge was cold and uncomfortable. We tried sleeping on the floor, but a security guard woke us and told us that it was illegal to sleep on the floor. He finally took pity on us and showed us a closed cafeteria where we could sleep on the benches. They were a reasonable size for Renato, but were too short for me and not wide enough to curl up on. I wished that I had a visa and been able to leave the airport. Ever since, I have been very careful to get the rules right when visiting another country.

The plane trip from Bogotá to Quito would have been uneventful, but Renato pointed to a tall blond woman who looked like a movie star sitting forward of us, and said in Portuguese "I'm going to date that girl." Renato would have only

come up to her eyebrows, and was very thin, so I doubted she would even let him carry her bags, much less date him. In any case, Renato did not get to talk to her on the plane because there was turbulence and the fasten-seat-belts sign remained on. As she passed through immigration well before us, I commented to him facetiously that he had lost his date.

I had arranged to call Eduardo Asanza to pick us up at the airport. Eduardo was Ecuador's leading crocodilian biologist and I had met him at previous CSG meetings. A bit shorter than Renato, thin, with wavy black hair, he was always eager to talk about caimans and other Ecuadorian wildlife. It only took about 5 minutes to make the call, but when I turned around, there was Renato accompanied by the tall blond woman. He said "This is Sarah. She's going to stay with us." Despite Renato's obviously unselfish wish to give lodgings to the young traveler, I was not about to impose on Eduardo, who had offered to put us up in his flat. I suggested to Eduardo that we drop her off at the bus station, which he did.

Eduardo introduced us to his wife, Ana Cristina, who studied birds. Ana had helped Eduardo organize the CSG meeting, which would be held in a forest lodge in the wilds of Amazonian Ecuador. That involved enormous logistical difficulties, and I was amazed that they had gone to so much trouble. Ana Cristina's father owned the largest brewery in Ecuador, and their flat occupied a floor of a three-story apartment building. My whole house would have fit into it easily, and I was greatful for the accommodation, which was better than a five-star hotel, and allowed us to economize our small reserve of dollars.

Renato and I were anxious to visit a famous tourist location, but we had little money. When we went to a party organized for the CSG members by Eduardo, someone pointed to a woman on the other side of the room and said that we should talk to her because she was the head of the biological station where we wanted to go and might be able to give us some tips about cheap accommoda-

tion. I went looking for Renato, who had left the main room. When I found him about ten minutes later, I said “We should talk to that woman. She is the head of the biological station.”



Photo 10.2 *Eduardo and Ana Cristina Asanza in Ecuador, 1986. Photo by Bill Magnusson.*

Renato said matter of factly “I know, I have already talked to her and we will be staying in her house.” We stayed in her home, and one day we returned to the house mid afternoon after an excursion. It was hot and we were relaxing in the living room when a man appeared in the door way. Always attentive, Renato jumped to his feet, said “Come in, make yourself at home,” and started to show the man around.

The man said “I am home, this is my house!” Our host’s husband had come back from a trip unexpectedly; an embrassing situation for all concerned, but Renato adapted quickly and soon had our visitor on friendly terms. I suspect

that husbands turning up unexpectedly created a situation that Renato had faced many times before.



Ecuador's caimans are in the eastern part of the country, in the Amazonian lowlands far from Quito, which is perched in the Andean highlands. The small plane took about one and half hours to get to a dinghy little town of hovels called Juan Carlos. As in most places with difficult acess in the Amazon, the people had a frontier attitude, and the emphasis was on survival rather than comfort. From there, we caught a bus to the Napo River, whose murky brown waters were about 400 m wide. We walked around in a three-story boat that served as a floating hotel while we waited for the second plane load of delegates to arrive. The river ran fast at that point as it came off the mountains into the Amazonian lowlands, and many logs and other flotsam floated past. The banks, as in most areas around sediment-rich rivers, were heavily cultivated and most was covered in young regrowth forest.

The floating hotel took us down river about 5 km. We then continued along the Napo in canoes with outboard motors, to the mouth of a small river. Each dug-out canoe was made from a single log, and took about 30 people. The heavy canoes had a hard time going up the river, and we had to get out and push when the canoe stuck on a sand bar. The river finally ran into a narrow oxbow lake, about 100m wide and 800 m long, called Limoncocha. A village by the same name was on a small rise near the entrance to the lake. Most of the rest of the lake was surrounded by floating grass mats or flooded forest. Buildings that had originally been erected by the Summer Institute of Linguistics had been converted to tourist lodges run by the local indigenous community. It was one

of the few places where tourists could get access to Amazonian Ecuador in reasonable comfort.

We had an excellent dinner and set out to look for caimans at about nine p.m. There was only one boat available to go caiman spotting. It was about 8 m long and 3 m wide, with a 35 hp outboard motor and a cover over the back half. There were at least 30 people sitting around the edge of the boat, and it was unstable. It was taking water and heaved to one side whenever anyone moved, and threatened to roll over when everyone rushed to one side to take photographs of something interesting.

Eduardo and I went to the front of the boat as we lurched off in search of black caimans. When we were only about 30 m out, Eduardo spotted two sets of eyes and he said that one was a black caiman about 2.5 m long. He was good at estimating sizes, because, when we measured it later, it turned out to be 2.7 m from tip of snout to end of tail. We turned towards it, and it started to swim away with its head and body arched high. Eduardo attracted it by imitating caiman calls and it swam in circles and occasionally approached the boat. Flashes were going off continually, and we were often in danger of swamping as people scrambled to take pictures. Eduardo said “Let’s catch it.”

I said “With what?” We hadn’t brought any capture equipment, but Eduardo pointed to the mooring rope in the bow. I made a lasso and we chased the caiman until I was close enough to throw it. I tried three times, but the caiman was flush with the water, and the light rope floated and just slid over its head. I turned to Eduardo and said “The only way we could catch it is if it opens its mouth.” As though it had heard me, the caiman slowed and lifted its upper jaw. I threw the lasso, the rope slid into the caiman’s mouth, and I pulled the noose closed around its teeth.

The rope was strong and the caiman could not tow the big boat around for long. It soon tired and I pulled it up beside the boat, its upper jaw jammed against the side of the boat, and the lower jaw gaping wide. I was cautious because I had learned that even black caimans can be unpredictable, and I was fumbling around trying to get a shoe lace around the caiman's lower jaw to be able to pull it shut. Kent Vliet, an alligator researcher from Florida, came forward and said "Here, let me give you a hand."

Kent had studied the behavior of alligators for his Ph.D., and was famous for having swum among large groups of alligators when they were mating. Without any protection, he would try to get as close as possible to courting pairs to see how they were communicating with each other. Kent was big and sturdily built, but it was the sort of risk that I would not recommend to anyone. He must have known what he was doing, however, because he is still around to talk about it. Frustrated with my fumbling, Kent nudged me out of the way, closed the caiman's jaws, lifted it up by the tip of its snout, and suspended it high above the water with one hand. Grinning, he turned to me and said "OK, now you can tape up its jaws."

The caiman didn't put up a fight once her jaws were taped, and we dragged her into the middle of the boat between the feet of the crocodile specialists. Back at the jetty there were many hands to help weigh and measure her, and I thought that it was nice to have such a cooperative animal to put on a show for the scientific tourists. We released her and retired for the night.





Photo 10.3 *Renato Cintra and Ginette Hemley at Limoncocha in 1986. Photo by Bill Magnusson.*

We found only spectacled and black caimans in the lake, and I was interested in finding Schneider's dwarf caimans because I had been studying the species in streams around Manaus. Eduardo said that there was a stream at the end of the lake similar to those in which I had found dwarf caimans, and we set off up the lake in two small canoes. We left the canoes at a landing, hiked through Indian gardens, and then into old secondary growth. After about an hour, we came to a stream about 8 m wide that blocked the track. Most of the group, including Eduardo went back, but I and about 8 others decided to go on.

The stream had been backed up by water from the lake and wasn't flowing very fast, but most of the group had camera equipment, and Phil Hall, the researcher who had sent me his photograph in the jaws of a crocodile, couldn't swim. Phil had just about everything going against him to study crocodilians. Of slight build, he suffered from acute diabetes, which limited what he could eat,

and what he could do physically. However, what he lacked in physical ability he made up for in determination and courage. If he couldn't manage it alone, he just asked someone to help him and got on with the job. In this case, he asked me to ferry him across, and I swam on my back, supporting his head with one hand. Richard Luxmoore, a specialist in wildlife trade from the United Kingdom was not as lucky. As he swam across with his camera suspended in one hand, a branch snagged him and he pushed the expensive camera underwater. I was starting to think it foolhardy to have pushed on.

Eduardo had said that there was only one track and one stream further on, but we found a maze of tracks and several streams, none of which, based on my experience up till then, seemed likely habitat for Scneider's dwarf caimans. We encountered two hunters from the military base at Limoncocha. One was carrying a shotgun and a monkey, and the other had a high-powered assault rifle. I couldn't imagine what he intended to hunt with such a rifle, but it would have to be big. Anything small would probably be rendered inedible by the shock wave from a bullet from that gun. They said that there were no streams further on that were different from those we had encountered, so we turned back.

I was amazed at how Eduardo and Ana Cristina had organized so many people under complicated logistics and made the meeting a resounding success. Nevertheless, when we were heading back, one of the canoes was delayed in reaching the floating hotel. The Chairman of the CSG was irate because he had planned a closing meeting on the boat and was worried that there would not be enough time after the canoe arrived. The told Eduardo and Ana Cristina that they were incompetent and had probably prejudiced the success of the meeting. Eduardo said nothing, but I was deeply disturbed. I called the chairman to one side and explained that what he had done was ungrateful and unfair. He looked

at me and said “You are probably right Bill; I guess it’s just because I’m an alpha male.”



Photo 10.4 *CSG members crossing a stream in the Ecuadorian rainforest. Phil Hall is second from the front. Photo by Bill Magnusson.*

I looked at his thin bespectacled face and wondered what qualifies you to be an alpha male. If it was success with the opposite sex, Renato had him beaten hands down. I have been at a meeting where the same man suggested that Phil Hall should not have been allowed to work on crocodiles because of the limitations his diabetes imposed, but time has shown that Phil’s contribution to crocodilian science before he finally succumbed to his illness far outweighs anything that the chairman ever produced. If you measure alpha males by their capacity to influence other people, the chaiman had nothing on Eduardo. The tension between the egos and the workers took something away from science, and I would never again look forward to a CSG meeting with the same excitement I had felt in earlier years.

11

The Caiman Lands on the Cold Southern Coast



Releasing a caiman in the Lago dos Patos, Rio Grande do Sul . Photo by Bill Magnusson.

My invitation to work in Brazil had come from Warwick Kerr, who was Director of the Institute at that time. Dr Kerr is renowned for his work in genetics and one of Brazil's most respected scientists. He is deeply religious, but has a politically incorrect sense of humor that makes it fun to share conversations with him. Everybody who has ever worked with him, including me, loves him. Unfortunately, by the time I arrived in Brazil, he was ending his first term as Director, and my only time with him in the early years was a lunch-time conversation on the day he left Manaus.

Dr Kerr was also famous as the person who had introduced African bees into the Americas. As an agricultural geneticist, he hoped to augment the vigour of the European honeybees raised in Brazil to increase their honey production by selectively adding genes from their African sisters. He was careful to place barriers constricting entrances to the hives so that the large queens could not leave and found new colonies. Unfortunately, one of his assistants, noting that the entrances were abnormally narrow, corrected what he thought was a mistake, and the aggressive bees spread across the continent and eventually into North America. When I lunched with Dr Kerr, I was unaware of the bee episode, and did not expect to be involved in controversies about introduced species.

In 1980, I received an invitation to visit Rio Grande do Sul, Brazil's southernmost state, from Francisco (Chico) Widholzer, the Director of the Porto Alegre Zoo. Brazil is an enormous country, much bigger than Australia and most other nations in the World, só I was eager to see what other parts looked like. It was drizzling and the temperature only 9℃ when the plane landed in Porto Alegre 2 hours early. It was the only time that I have been in a plane that landed more than 10 minutes early, and I didn't want to sit around the cold airport for two hours, so I called Chico. He said that he would come immediately, but when I put the phone down I realized that we did not know

what the other looked like. The only chairs were a long way from the exit gate, and I wondered how I would recognize him in the crowded airport.

I stood out like a sore thumb in the Amazon because I was taller and much lighter skinned that most people. However, most of the Porto Alegrians were descendents of Germans or northern Italians, and my pasty complexion was not out of place in the airport. About half an hour later, a rotund well dressed man entered the airport, looked around and made directly for me. “You must be Bill Magnusson” he said. When I asked him how he had recognized me, he said that, even though he was expecting someone older, I was the only person in the airport huddled over shivering, and he assumed that I must have just arrived from the Amazon.

Chico took me to a five-star hotel, and I was surprised at how like Sydney the city was. The houses had red-tiled roofs, and the street trees were eucalypts and grevilleas. Even the European trees were the same species as those planted in Sydney, such as privet and plane trees. The drizzle and cold of the Austral winter reinforced the resemblance, reminding me of why I had been so glad to leave Sydney. This was the first time I had stayed in a five-star hotel, and things that I take for granted now, such as a well-stocked mini fridge, large television and dimming lights at the head of the bed, were sufficiently different for me to note them in my diary.

The next day, Chico took me to the zoo, 18 km from town, and introduced me to his student trainees. Betina was tall, blond, rambunctious and mainly interested in caimans. Terezina was shorter, quiet, whispy haired and loved birds. They showed me around the zoo, which was set in 400 hectares of what Chico called “natural” forest. I had looked forward to seeing native forests in Rio Grande do Sul, and was disappointed when the forest in the zoo turned out to consist mainly of gum trees, with the occasional casuarina, grevillea or hoop

pine. The forest was called natural because it regenerated by itself, and supported a saw mill that provided timber for the zoo. The zoo had a large collection of kangaroos, reinforcing the impression that I was back in Australia.

I also did the obrigatory tour of the Zoological Foundation's administration. I must have shaken fifty hands, and drunk 50 cafezinhos, the small concentrated coffee served in tiny tumblers, before we finally got to see caimans. The broad-snouted caimans were kept in ponds dug into a small stream that was walled off by 60 cm high fences. I assumed that the caimans were happy there because the fences would not have been an obstacle if they decided to leave. One pair was breeding in the enclosure.

The scientific name for the broad-snouted caiman is *Caiman latirostris*, which has the same meaning as the English common name. It is a strange looking crocodilian adapted to living in swamps and marshs. Its head is wide like an alligator's, but deep like that of a dwarf caiman. The broad-snouted caiman is the only species of crocodilian that occurs naturally on the coastal plains between the Serra do Mar coastal range and the sea in southern Brazil. The same species occurs in a few areas to the west of the divide, and it extends well south into Paraguay and Argentina. Its range covers some of the most densely urbanized and intensively farmed agricultural areas in South America.

The animals were active, even though the water temperature couldn't have been more than 10 ℃. Terezina called the caiman by imitating the grunting roar of an adult, and one of the females swam sinuously towards us, thrashing the water, with virtually the whole body exposed. Betina wanted to study the caimans for her undergraduate thesis, but course commitments did not leave much time for field work. Chico had slides of caimans carrying their babies from the nest to water, so I suggested that Betina study behavior of the caimans in the zoo for her thesis.

We spent the rest of the day at the zoo, which I did not find very exciting. The enclosures were clean and the inmates fat and healthy, but captive animals always depress me. The cold drizzle did not let up and Chico was busy with zoo problems. The wall of the elephant enclosure had collapsed, and the administration was sensitive about animal breakouts because a hippopotamus had escaped into the river a week before. I was amazed at how people underestimated the capacity of animals to escape, especially when they could have the help of natural disasters. This would have a strong bearing on my future attitudes towards farming of introduced species.

The next day we went to a site where Betina and Terezina had been studying caimans in the wild. It was only about a half-hour drive from the centre of Porto Alegre. The landscape was agricultural, with close-cropped pastures broken only by copses of eucalypts and Australian acacias. If you transported a blindfolded Australian there, they would not suspect that they had left their home country. We walked to a turkey dam about 60 m from a farm house. The tiny lake was less than 100 m in its longest dimension and less than 30 m wide. Betina and Terezina pointed to a caiman nest on a raft of floating grass in the middle of the dam. I was astounded that caimans bred in such an artificial landscape.

There were five dams close to the farm house and we walked over the hill to another that was about the same size as the first. Betina played a tape of a caiman roar, and a big animal responded from the far end of the dam. It came thrashing towards us, giving the same display as the caiman at the zoo had done the day before. For me, crocodilian study had mainly been a nocturnal activity, and I was amazed at what you could learn about broad-snouted caimans while sitting on a lawn in the middle of the day.

Chico lagged behind as we walked back up the hill, and was puffing from the exertion. I mentioned to the girls that he did not seem to be accustomed to field work, and they said that it was the first time he had been into the field with them. By the time we got back to the car, the driver had made a churrasco, which is the Brazilian term for a barbeque, using the ubiquitous acacias for firewood. People from Rio Grande do Sul, who like to be called Gauchos (South American cowboys), are very proud of their churrascos, and we ate far more than I was accustomed to. I had been craving red meat because I had been raised on beef and lamb, but fish had been my basic diet in the Amazon.



Photo 11.1 *Betina, Terezina and Chico showed me broad-snouted caiman in the most unlikely agricultural land dominated by pasture and introduced Australian trees. Photo by Bill Magnusson.*

After the long lunch, Terezina, Betina and I took a small boat out on a reed-filled lake in the lowlands between the farms. It was shallow and you could walk across it in most places. The floating vegetation made rowing difficult

except in the open areas in the middle. The girls had chest high waders and walked around in the reeds looking for caimans. Trying to find caimans by walking around during the day in the cold water did not seem to be very efficient, and I asked if they ever went out at night, but they said that they hadn't thought of it.

We saw no caimans, but the reeds supported large snails, as well as their bright pink egg masses, which reflected off the water and looked like the adornments around a Japanese ornamental pool. The girls said that they had taken similar snails from the stomachs of caimans they found as road kills, and I was surprised that snails would be a major item in the diet of a caiman. I had imagined crocodilians as steathly hunters of fast-moving prey, but I would later learn that snails are common food for marsh-dwelling species.

Betina and Terezina took me to dinner at a very nice Gaucho restaurant that night. The atmosphere was cosy and there was a quiet background of traditional music. I had been eating far more than I was accustomed to in the Amazon, and I thought that I would not be able to do justice to the meal. However, I had forgotten how the cold eats into you and makes you crave for high calory food to keep your temperature up. Just being in a warm place away form the cold and drizzle was a reward in itself.

The next day, Chico and the girls arrived at 07:30, which was soon after sunrise in the Austral mid winter. They wanted to show me the islands in the river in front of Porto Alegre where they said caimans still nested. The boat with a powerful outboard motor only took about 15 minutes to get to the first island, which was low lying and fringed by rushes, with their bight pink baubles of snail eggs. Chico related stories about the presence of caimans on the islands that he had heard from local fishermen. With a backdrop of the modern city of Porto Alegre, I was surprised at the caiman's ability to live in close proximity to

dense populations of humans. I asked Chico why he didn't look for the caimans at night with a spotlight. He looked at me as though I was mad and said in Portuguese "No Bill, it's dangerous to go out in boats at night!" I didn't press the point, but I was starting to see why some species of swamp-dwelling crocodilians were thought to be endangered, even though they were easily found if you went looking for them. The caiman experts in those areas simply weren't used to field work.



Photo 11.2 *Betina and Terezinha looking for caimans in farm dams in Rio Grande do Sul. Photo by Bill Magnusson.*

Chico had given me a cheque to cover my expenses in Porto Alegre, but the Foundation had paid for the hotel and most of my meals. I had the equivalent of several hundred dollars over and it did not seem right to keep it because my institution had been covering my salary. I gave the money to Chico and said that he could use it for the project, but he was perplexed, and said that nobody refused the opportunity to make a bit more money over that of their salary. I

said that he could use the money to finance Betina's and Terezina's studies, which he agreed to do, but I could see he was not happy. It was as though I had refused a present, and I was sorry that I hadn't given the money surreptiously to the girls. I would learn later that many Brazilian biologists became rich by accumulating per diems that they did not need.



Betina and Terezina never published their studies, and neither did Chico, though he became a consultant for many caiman farmers in later years. My next contact with Gauchos and broad-snouted caimans came about because Renato Cintra introduced me to Maria Tereza Queiroz Melo, better known as Tereca, at a zoology congress in Cuiabá, near the Brazilian Pantanal. Renato invited both of us to his study site in the Pantanal, and later Tereca asked me to co-supervise her Master's thesis on broad-snouted caimans.

Tereca studied caimans in the extensive coastal lagoons of southern Rio Grande do Sul. The largest of these, the Lagoa dos Patos, is saline at its southern end and turns into freshwater marshes to the north and west. The coastal dunes support pine plantations, and many of the freshwater areas have been converted to rice fields. However, there are still large areas of freshwater marshes that support a wide range of wildlife species, and are important staging areas for migratory wildfowl.

I had taught Tereca how to mark caimans and take stomach contents when we were at Renato's field site, but I had not spent time with her in the field in Rio Grande do Sul, so she arranged for her university to pay for me to give a statistics course at the field station beside the Lagoa dos Patos. The course was

useful to the few students who participated, but it was obviously mainly an excuse to be able to go into the field at night after the lessons.



Photo 11.3 *Tereca taking stomach contents from broad-snouted caimans in Rio Grande do Sul. Photo by Bill Magnusson.*

The marshes were largely impenetrable for humans, and we were limited to the few channels of relatively open water through the rushes. The use of airboats in nature reserves was now restricted because of the damage that they could do to the vegetation and the fauna dependent on it. In any case, the airboats in the reserve did not have aircraft engines, they were powered by Volkswagen Beetle air-cooled car motors, which were heavy and not powerful

enough to push the boat across anything but the sparsest vegetation. The course was given in winter, so I was again surveying for caimans in doleful weather, and this time at night. My fingers were white, my teeth chattered, and I was embarrassed by my feebleness in comparison to the Gauchos, who did not seem to realize how miserable their climate was.

We noosed some animals that were over 2 m long, which is large for broad-snouted caimans. I was surprised at how strong they were for their size. They were much stronger than spectacled and black caimans, and possibly stronger than any other crocodilian I had handled, except the slender-snouted crocodile that had played hopscotch with Laurence Taplin's legs in South Africa. I was cautious because Tereca had a large scar on her thigh where a large caiman had driven the largest of its teeth. Despite the deepness of the wound, and the long recovery period due to infection, Tereca had not been psychologically wounded and handled the caimans we caught expertly.

Despite the cold, the caimans were too heavy and feisty to upend by hand to take their stomach contents. Therefore, we strung them upside down from the wall of the research base and pumped out their stomachs with a garden hose. We didn't get a lot of stomach contents, but I was surprised that the caimans were eating anything at the chilling midwinter temperatures. Out came fish, shrimp and lots of the bony opercula that snails use to close the entrance to the shell when they are attacked or dormant. The opercula may have been in the stomachs for some time, because crocodilians often retain hard objects, called gastroliths, in their stomachs for long periods.



We had a chance to study broad-snouted caimans further north because Tim Moulton, an expatriate Australian, invited us to participate in Earth-Watch expeditions to Cardoso Island in São Paulo State. The island is close to the largest tract of Atlântic forest that still remains, and many parts of its rugged hills are covered by relatively pristine rainforest. The caimans occur around the small streams that flow into the mangroves around the island. The short fast-flowing creeks are generally too small for boat travel, so we had to look for caimans on foot.

The caimans do occur in sea water in the mangroves, and I suggested to Gordon Grigg that he study their salt balance. Tim, Gordon and their teams showed that, like other alligatorids, the broad-snouted caimans have very little physiological ability to regulate salt balance in seawater. However, because of their size, they can spend extended periods in the mangroves before they have to return to the freshwater streams to drink. Most of the caimans Tim, Tereca and I caught were in fresh water, and we marked individuals of all sizes. Most of the largest animals were too wary to catch using nooses and we only managed to mark them because they went into mesh funnel traps that we had set for turtles.

The world of the caimans living on Cardoso Island was nothing like that the species occupied in Rio Grande do Sul. Instead of broad frigid marshes, the caimans were surrounded by lush rainforest in streams that gushed over mountain rocks into short meanders through coastal plains formed from ancient sand dunes. The Atlantic forest was different for me, though some of the forest on the steepest slopes looked like the rainforest on the escarpments in northern NSW that I had hiked through during university breaks in Australia. It would have been a paradise if not for the swarms of sandflies that made any work outside at night agonizing at some phases of the moon.



Photo 11.4 *Gordon Grigg and Lyn Beard taking a sample from a broad-snouted caiman on Cardoso Island in 1992. Photo by Tim Moulton.*

I was trying to find a way through the forest to set a turtle trap one day and I was marking the route by chopping off small patches of bark on trees near the track I was forging. When the machete hit a hard bit of wood it resonated and a

bee dove down and impaled my arm with its sting. It hurt a lot, and I waited about 10 minutes after pulling out the sting for the pain to subside. I then continued on, but when I hit a tree with the machete, another bee stung me on the arm. It was only after the third tree and a sting on my face that I realized what was happening. There was a nest of Africanized bees nearby. Their ancestors had evolved in an environment where chopping or scratching a tree meant an attack by a human or a honey badger. The sound was enough to initiate an attack.

I carefully left the area without chopping any more trees. I could count myself lucky that the bees were safely ensconced in a tree hollow. When they are swarming, and the queen is vulnerable, they do not attack one at a time. Crushing a bee or dragging out its sting releases a pheromone that makes most of the swarm attack, and many people die each year in Brazil because they get too close to a swarm and receive hundreds or thousands of stings. I thought of Dr Kerr, a wonderful man full of the best intentions, and wished that there had been some legal mechanism that would have stopped him from undertaking the ill conceived experiment that led to the introduction of the African bees. With no general legal system to prevent unnecessary imports, every wouldbe introducer of exotic fauna or flora has to discover for himself just how damaging playing God with species distributions can be.

The forest along the lower reaches of the streams was low, and the ground was covered to waist height by bromelias with hooked spines that made walking off paths difficult. Therefore, we generally allocated a lot of time for checking turtle traps. Nonetheless, one night a gale hit unexpectedly and I was worried that a caiman might be trapped underwater in a turtle trap by the rising water. Without waiting for help, I ran upriver, pulling out the traps and leaving them on the bank. It was near midnight when I reached the last trap, and I was cold from the lashing rain, my legs were bleeding from the bromeliad hooks, and I

was nervous from being alone in the dark. The trap was totally underwater, I could not reach it with my foot when hanging from a tree on the bank, and I couldn't see it through the murky water.

There was a danger of being swept into a tangle of logs downstream if I dived to get to the trap, but I know I would have tried if I had someone with me to give me courage. However, I was cold, nervous, and convinced myself that there was little probability of there being a caiman in the trap lying in the dark water. I left it there and went back to the comfort of the research center. The water had receded by the next day and I could retrieve the trap. There was no caiman, but a turtle had drowned in it because I was too frightened to dive at night. I was beginning to realize that you should never work close to the limit of your physical ability or your courage. You should always have a safety margin. If you don't, even if you don't pay the price, your study animals are likely to.



Photo 11.5 *An Argentinian long-necked turtle,* Hydromedusa tectifera, *from Cardoso Island. Photo by Bill Magnusson.*

Tereca would publish on the diet of broad-snouted caimans and Tim would lead a paper on their growth, but I ended up being involved more with another species of crocodilian in Rio Grande do Sul. African researchers were having a lot of success in captive propagation of Nile crocodiles, and they had developed recipes for doing so. Techniques for the captive propagation of caimans lagged far behind, and the lower value of their skins reduced potential profits. Tereca informed me that a farmer in Rio Grande do Sul had imported Nile crocodiles for captive propagation and sale of their skins.

I was worried. I knew that most of the species imported to Brazil in recent years, such as North American bullfrogs and African catfish, had not returned profits to most would be farmers, and the abandonment of raising facilities had led to their escape into the wild and associated environmental problems. In fact, the largest profits associated with any introduction for captive raising usually go to the first importer. The importer advertises that easy money can be made with the species, and earns a lot of money by selling brood stock or equipment to new farmers. There is of course no such thing as easy money, and most of these operations quickly go out of business. I imagined crocodile farms being abandoned all over Brazil, and what it would mean to have man-eating crocodiles inhabiting the major river systems of South America.

I mobilized the CSG, and we got more than 400 letters sent to IBAMA, including one from the President of Paraguay, asking for the cancelation of the import permits. However, as far as I am aware, no reply was received by anybody. I discovered that the President of IBAMA would be at a meeting at the Tropical Hotel in Manaus and went to find him. He was not attending the talks, but someone said that he had a room at the hotel. I knocked on his door and he apparently thought it was just room service, because he opened it

wearing only his underpants. I couldn't miss the opportunity, however, and asked for a minute of his time.

It took more than a minute for me to explain to him the seriousness of the situation, I sitting on one bed listing all the dangers, and he sitting in his underwear on the other nodding agreement. The meeting was hurried, but he seemed to get most of it right. The only thing I regretted was that I said that there could be a lot corruption associated with crocodile farming, and he later told others that I had said that the IBAMA agent who authorized the importation was corrupt, which I didn't. That agent was reprimanded, removed from his post, and has had a very cold relationship with me ever since.

The hotel-room meeting, combined with the letters, did not get the crocodiles sent back to Africa, but resulted in the Nile crocodiles being confined to the original farm. The owners were not allowed to extend the facilities or sell stock to other farms. They got around the first restriction by creating a zoo on the property. Zoos do not have strict restrictions on exotic fauna, but in any case the crocodiles could not legally be taken to other places in Brasil.

I started to advocate stronger restrictions on importation of exotic species to Brazil, and gave talks on the subject in any congresses that I could attend. When I left one presentation, I found Dr Kerr sitting outside and I was worried that he might have been offended because I had used the African bees as an example of unrestricted importations. However, he was his usual generous self, said that he agreed with everything I had said, and that I should continue on my crusade.

One of the congresses was in Porto Alegre, and Tereca looked after me while I was there. We visited the crocodile farm and the owners allowed us to see everything without restriction. The adults were in large outdoor pens with double fences, and the young animals were grown out in completely-enclosed

temperature-controlled sheds. I agreed with the owners that their security arrangements were very good, but could see that a major natural catastrophe, such as a subtropical cyclone or a flood could allow the animals to escape. Losing adults would probably not be an incurable problem because they could be hunted down. However, I knew that no-one was systematically surveying the waterways of Rio Grande do Sul at night, and hatchlings were difficult for untrained people to distinguish from caimans in the field. If a large number of hatchlings got away, there would be no way to find them all, and they would probably be forgotten until they were large enough to start breeding and eating people.



Photo 11.6 *Bill and Tereca at the Zoology Conference in Porto Alegre in 1996. Photographer unknown.*

I thought that I had reasonably good relations with the owners of the crocodile farm, considering the circumstances. However, hysteria was building about the crocodiles in Rio Grande do Sul. There were stories that the crocodiles had been used to smuggle in diamonds that were hidden in their

stomachs, and other equally improbable tales. I obviously used the local example in my talk, but I did not feel particularly aggressive, especially because the farm had been able to retain its operating permit. However, when Tereca took me to the airport after the meeting, she drove through back streets, and ended up taking twice as long to get to there as I had expected. When I asked why, she said that a price had been put on my head and it was best not to take any chances by using a predictable route while I was in the state. I didn't believe that I had a price on my head, but I was grateful for her concern over my safety.

The Nile crocodile farm was a success in terms of growing out the animals, but without being able to make profits by selling stock to other would be owners, it eventually failed economically. All the crocodiles were killed and their skins sold. Soon, nobody will remember the Nile crocodiles of Rio Grande do Sul, and the work done by Tereca, me and other dedicated conservationists in Rio Grande do Sul with the help of the CSG. Nevertheless, I suspect that our contribution to conservation of Brazilian crocodilians through the restriction on the importation of *Crocodylus niloticus* will far outweigh those resulting from any of our scientific publications.

12

Mexico



Marco Lazcano measuring a Morelet´s crocodile, Sian Ka´an Biological Reserve, Mexico in 1987. Photo by Bill Magnusson.

The annual meeting of the Society for the Study of Amphibians and Reptiles was held in Vera Cruz, Mexico in 1987. There are many reasons to visit Mexico, including its history, cultural diversity and a mix of biomes that lets you travel between coral reefs, deserts, temperate mountain forests and tropical jungle within a few days. Albertina Lima, Renato Cintra and I planned to visit many such areas, but I was also interested in seeing Morelet's crocodile, *Crocodilus moreleti*. The ancestors of the American crocodile, an estuarine species, had apparently evolved into a number of freshwater species, including the Orinoco crocodile in Venezuela, the Cuban crocodile, *Crocodylus rhombifer*, in Cuba, and Morelet's crocodile in Mexico.

Morelet's and Cuban crocodiles live mainly in swamps, and I had said in my 1984 talk in Venezuela that such species should be resistant to hunting. Marco Lazcano and Clarence Abercrombie decided to see whether I was right that Morelet's crocodile should be more common than implied by its endangered status in the IUCN classification. They found it just about everywhere, including drainage ditches near towns. It suffered from local pressures, such as pollution and persecution from fishermen, but they showed that it was not in imminent danger of extinction in most parts of the country.

After the meeting, Marco took us south to visit the Sian Ka'an Biosfere Reserve on the Yucatan Peninsula. At one time, the Yucatan Peninsula was a huge coral reef, and there are now shallow soils over a base of limestone rock. The formation is geologically very similar to that under the everglades, but the Yucatan is a little bit higher above sea level and, rather than freshwater marshes, it is covered in the most part by dry forest. The limestone forms large sink holes that were used for human sacrifices by the Mayan preists, but most of the free water is underground, making much of the area inhospitable for crocodiles. Along the coast, however, the underground rivers pour into coastal lagoons,

forming a unique ecosystem with clear or bluish alkaline freshwater bordered on the coastal side by seawater and low mangroves. The Sian Ka'an Biosfere Reserve had been established a year earlier by presidential decree and preserves over 500,000 hectares of such habitat on the eastern edge of the Yucatan Peninsula.

Marco introduced us to several other Mexican biologists studying the wildlife of Sian Ka'an, including Arturo Lopez-Ornat an ornithologist Director of the Friends of Sian Ka'an and Manuel Carrera who was about to initiate experimental captive breeding programs with white tail deer and crocodiles. The reserve has an outstanding variety of birds and coral-reef fish, and is an important area for the conservation of Caribbean turtles. During the day, we toured one of the lagoons in a large tourist boat with comfortable seats and a tarpaulin cover to protect us from the hot sun that shone from a cloudless sky. The boat moved through shallow channels in the limestone rock that were lined by short mangroves. Crabs hung from the mangrove roots, and we could watch the colorful fish close up in the crystal-clear water. It was a perfect place for tourists to get an idea of the complex web of life that underlies all mangrove swamps, without having to get covered in mud and bitten by swarms of mosquitoes.

Marco also said that we would go out at night to look for crocodiles. It did not look like good crocodile country because the water was shallow, crystal clear, and there were no grass mats or other dense vegetation where a crocodile could hide from hunters. However, I had seen American crocodiles in clear open water in the Florida Keys, so I knew that they could live in such places when not heavily persecuted.

The boat held a lot of people, and we were a little crowded on the hard metal seats. I was a little stressed, because I am not very social and the intense

interactions during the conference, and the strain of having to communicate in Spanish, a language over which I had little command, were starting to take their toll. It was nice to be out on the lagoon with the sea air and the wind in my face, and at first I followed the the beam of the spotlight as it swept the mangroves. Everywhere I looked, however, there were people around me in the boat, and I craved the solitude of being in the mangroves alone at night.



Photo 12.1 *Renato Cintra photographing birds in Sian Ka ́an Biological Reserve. Photo by Bill Magnusson.*

With us in the boat were Albertina, Renato Cintra, Manuel Carrera and America Cuff, a Mexican student doing her PhD on crocodile reproduction in Australia who had also attended the Veracruz meeting. The boat operator was Victor Dzul a Mayan fly fishing guide who had teamed with Marco to study Morelet's crocodiles in the area.

I sat down and looked up at the stars in the cloudless sky. They circled slowly as the boat turned and I could appreciate the sea air and forget the people

around me. It was relaxing, so I lay down and stretched out across the bottom of the boat. My head was on the gunnel, so I could feel the water lapping on the hull. It was as though I was alone, and the tension left me. I didn't realize I had fallen asleep until Albertina shook me and I heard Marco calling "Bill, Bill, a crocodile."

Rather embarrassed, I leapt to my feet and made my way forward to where Marco was standing in the prow. By the time I reached him, I had most of my wits about me again and was switching from relaxed-tourist to crocodile-hunter mode, though my tired mind was still craving the former. I had expected the crocodile to be in the mangroves, but we were in the middle of the lagoon. The crocodile was close to the boat, and I could see that it was big for the species; about 3 m long. It dived before we could noose it, and that would have meant the end of the chase almost anywhere else. I knew that black caimans and alligators would often allow multiple attempts at capture, but most crocodiles are much more wary.

I needn't have worried. In the crystal-clear lagoon, the crocodile had no where to go to escape us. It swam along the bottom in two meters of water, but Marco just kept the spotlight on it and signaled the driver to follow it everywhere it went. It took over half an hour, but eventually the crocodile, which must have been completely disoriented by the drumming of the motor and the blinding spotlight, surfaced beside the boat where we could noose it. The croc was powerful, and dragged the boat around for some time, but it couldn't hold its breath and swim indefinitely, and I finally pulled it alongside the boat. Taping its jaws was easy, but getting it into the boat wasn't. The croc weighed over a hundred kilos, and when I pulled it up, the boat almost capsized because the curious observers all moved to that side simultaneously. Marco organized the others to one side to form a counterweight, and we pulled it in.

The catch pleased Marco and the crocodile researchers, because it may have been the largest male in the reserve, and the chase had served to wake me up. Concentrating on the croc had also made me forget the boat load of colleagues, who were extremely nice, but subliminally stressing me.

We took the croc to shore and everybody helped measure and mark it. I was surprised at how much it looked like a saltwater crocodile. It had what I had come to regard as the standard crocodilian form. Species that live in swamps and marshes tend to have broad heavy heads. Species that live in open rivers or the open sea tend to have long thin heads. Forest crocodilians tend to be short and heavily armoured. However, crocodilians that live in a variety of habitats, such as spectacled caimans and saltwater crocodiles, have lightly armoured bodies and snouts that are neither very thin nor very heavy. *Crocodylus moreleti* is such a crocodile, able to live in the crystal-clear coastal lagoons, or in dense freshwater swamps, as the situation demanded.

I soon lost interest in the crocodile after it was tied up, something that seems to happen to me in relation to all captive crocodilians, but I was glad for the opportunity to have seen the species in one of its natural habitats. Crocodiles were surviving in Mexico, a relatively poor country with a dense human population. In the future they will depend more and more on the habitat preserved by dedicated conservationists, such as Marco Lazcano and the friends of Sian Ka'an. Nevertheless, I was relieved that the wily crocodiles were doing their part, and surviving wherever humans left them a patch of wetlands.

I didn't see American crocodiles while I was there, but 27 years later I watched the film "Touch of the Blue Crocodile" about the species in Mexico. One of the best films I seen about crocodiles, it showed the wide range of emotions that Mexicans have in relation to crocodiles, which varied from fear and hatred to respect and reverence. Stories ranged from those about the man

who had lost his leg and remained beside the security of his car as he talked, to scenes of an old man who had befriended an enormous crocodile in the mangroves, and sat beside it as he fed it offal and stroked its head with his hand. It is obvious that American crocodiles are not man-eaters in the sense that saltwater and Nile crocodiles are. Nevertheless, they are large, potentially deadly, wild animals that have only a limited range of options for communicating with us. Perhaps one day there will be portable tomography machines that will allow us to scan their brains and determine whether it is the part of their brains registering “prey” or “friend” that lights up as they look at us.

13

Alter do Chão



The Tapajos River seen from the village of Alter do Chão. Photo by Bill Magnusson.

The Tapajós River flows into the Amazon River near the city of Santarém, and the Amazon's water backs up the Tapajos into a mouth lake or ria, 14 km wide. Santarém is the largest town between Manaus and Belém, but the township that existed before European and African colonization may have been even larger. A dry belt crosses the Amazon basin in the region of Santarém, and many areas are covered by open savanna rather than rainforest.

About 30 km upstream by road from Santarém, near the mouth of a small lake, is the Village of Alter do Chão. Originally inhabited by Tapajós Indians, it was colonized by the Portuguese in 1661. Many people still live by subsistence agriculture, but the village's main economic activity is tourism. The area around Alter do Chão is called the Caribbean of the Amazon because of its sandy beaches and sunny skies for much of the year. From a hill near the village you can see the patchwork of savanna and forest around the village. You can also see the shore of the Tapajós directly opposite the village, but you cannot see land on the horizon when looking upstream along the ria lake.

Tânia Sanaiotti studied birds in the savannas near Alter do Chão for her Masters thesis. Slightly built and very pretty, Tânia turned the heads of all the boys. Of Italian decent, Tânia had the habit of talking with her hands. When I was giving lectures, the other students would bet on the precise moment at which Tânia would interrupt the class by knocking all her books onto the floor. Even today, people clear drinking glasses and other breakables out of the way while Tânia is talking. Despite leaving a trail of broken ornaments in her wake, she is very competent in the field, and has studied many different types of organisms at Alter do Chão, including plants, frogs and caimans in her spare time.

Not being very socially competent, I was never comfortable in Alter do Chão, despite the fact that the local people were extremely friendly and hospitable. It

also took a long time to cross the bay in front of the township and walk into the savanna. Therefore, I camped behind a beach about 2km from the village, close to our principle study site for plants and birds. I was worried that someone might steal my equipment when I was in the savanna, so I hid the camp in the forest, where it couldn't be seen from the beach.

The first time Tânia went to Alter do Chão, she walked into the savanna in search of the rusty-backed antwrens she was studying. The savannas are not continuous, and the forest patches form a maze that is disorienting when you first try to cross it. Tânia got lost, walked two kilometers across the peninsula, and ended up 5km downstream of the camp in terms of distance along the shoreline. When she came onto the beach, she found a fisherman's hut and asked for directions to my camp. The fisherman, who I had never met, replied in Portuguese "Bill hides his camp in the forest behind the beach," and proceeded to give precise directions as to how to get there. So much for my trying to esconce my activities from the locals!

In the early days, I borrowed a boat to ferry gear to the camp. In most places in the Amazon, people get around in dugout canoes propelled by a single paddle. This allows a considerable degree of maneuverability, and the narrow canoes are good for travelling through flooded forest. However, they are unstable, and it is difficult for an inexperienced person to sit in one, much less paddle it around. Local children are often given their own canoe, only a meter long, when they are a few years old, so they do not lack experience or competence, but large, clumsy outsiders, such as myself, do not do well in dugout canoes.

Alter do Chão is the only place in the Amazon that I know of where the people use conventional rowboats, made of calked planks, and row facing backwards with two oars. This was good for me, because my father had spent much time trying to make me a competent oarsman, and the boats at Alter do Chão were

wide and could carry heavy loads. I enjoyed rowing across the wide expanses of the Tapajós, and would often spend several hours rowing even when a motor boat was available that could have gotten me to my destination in 10 minutes.

The people at Alter do Chão said that black caimans had lived in the lake in front of the village at one time, but they had been hunted out, and now I was unlikely to encounter anything but spectacled caimans. This made sense, because black caimans did not seem to reach high densities away from the sediment-laden white-water rivers, and large expanses of beaches would not provide refuges for hunted caimans. I was not particulary sad about the local extinction of the black caimans, because the sandy beaches were a paradise for tourists, and hundreds of children splashing around in the shallows with big caimans would not be a good combination.

I spent many nights walking the beaches between Alter do Chão and my camp or rowing close to shore, and never saw a caiman. However, close to the camp, the low dunes at the shoreward side of the beach enclosed an oval lake about 100 m long and 50 m wide. During the high-water season, the river water flowed over the dunes and filled the lake with water, fish and other aquatic fauna. At low water, the beach was over 100 wide, and the lake dried completely in some years. The local people took advantage of the fish concentrated in the lake as the water level fell, and would pass seine nets to rake out everything they could.

I didn't imagine that any large vertebrates could survive in the lake. However, one day, when the lake water was high, I was walking through the forest that bordered the landward edge and came upon a pile of dead leaves. It looked like the piles of leaves that jaguars use to hide their kills, but when I dug into it I found eggs. The spectacled caimans not only survived around the lake, they bred there. That night, Tânia and I rowed the boat along the beach to the lowest

point on the dunes, and dragged it into the lake. This wasn't easy, because the boat was made of planks of resistant tropical hardwood, which are very heavy. We inched the boat upwards with coordinated heaves that served mainly to drive our feet into the soft sand. Even going down the lakeward side of the dune wasn't easy, because the heavy boat dug into the sand.

Once into the lake, we could see about a dozen pairs of eyes reflecting in our headlights. All except one pair disappeared under the water soon after I started rowing, and I turned towards the red coals with Tânia leaning over the prow ready to catch the caiman. When we were almost on it, the caiman turned into a nightjar and flew away. It would have been easier to catch a bird than to catch the caimans in the lake by hand. I tried sneaking up on the caimans from land, but I only caught a few small individuals that settled into the leaves in very shallow water. Their vulnerability in the shallow lake had made the caimans very wary.



Photo 13.1 *Tânia Sanaiotti and Bill Magnusson at Alter do Chão. Photo by Xavier Desmier.*

One night, I walked across the dunes and saw the reflections from a dozen pairs of eyes close together in the shallows. I had to wade through deep water to get around dense bushes along the shore, and then slosh through shallow water with leaves and other debris to get to the caimans. By the time I was standing where they had been, they had disappeared, but there was a strong odor of rotting flesh. As I walked onto the bank I came across the bloated carcass of a dead rat, which had obviously been what had attracted the caimans, and that gave me an idea for a trap, similar to the one that Grahame Webb had used to catch the saltwater crocodile Puffett many years before.

Late in the afternoon, Tânia and I set a gill net in a semicircle enclosing an embayment in a shallow part of the lake. We staked the lead line onto the bottom, and the floats kept the net suspended in water about 70 cm deep. Low shrubs and small trees lined the bank, and we left a pile of rotting fish under them to serve as bait. About an hour after sunset, we approached the net from different directions, crouched over to move through the bushes, we kept our lights on the ground so as not to alert the caimans. The freshwater sponges that grow on the bushes during high water left spicules of silica that brushed down our backs and caused chafing and itching, but we concentrated on the ground directly in front as we crawled along.

When we were about 10 m from the bait, I looked up and saw a dozen eye shines near the fish. The caimans had swum over the net and were between it and the shore. Together, we ran yelling towards the caimans. The eyes disappeared, but the floats went down and we had six animals thrashing in the net, together with quite a few fish. None of the caimans were very big, and we measured, marked and released them all within a few hours, so happy with our catch that we were oblivious to the mosquitoes that feasted on us as we sat in the sand.

I thought that the method might not work after the caimans had been caught once, but it seemed that they had learned that they could be caught without being killed, and the bait was a powerful attractant. Nevertheless, their behavior changed. The next time we ran up to startle them, they dove, but the floats remained on the surface and the there were no tugs on the net. It appeared that there were no caimans in the trap, but I could not see how they could have escaped. I walked up to the net and focused the headlight into the brown transparent water. A caiman swam past on the bottom, carefully pushing its snout into the net to see if it was loose, then backing off when it wasn't to try another part. It was followed by another doing the same thing. They had learned to probe the net with their toothy snouts without getting meshed.



Photo 13.2 *Bill Magnusson setting a net for caimans in a small lake off the Tapajós River. Photo by Xavier Desmier.*

I watched them try to lift the lead line for about 10 minutes, and I had to grab one by hand when it found a place where the net wasn't staked well and started

to slip under it. However, when they realized that there was a complete wall of net, the rest of the caimans just layed on the bottom beside the net and tried to remain inconspicuous. That didn't work, because we had powerful headlights and were determined to catch caimans. We just grabbed them by hand. However, I could see that the strategy would work with fishermen, who had no interest in caimans if they were not entangled in their nets, and whose kerosene lanterns would not let them see far into the murky water. Nylon fishing nets had been used intensively in the region for only a few generations, but already there had been selection for caimans that knew how to deal with them.

The data on the caimans at Alter do Chão would change my ideas about growth in crocodilians. Most researchers had used simple methods based on the relationship between growth rate and size to estimate ages of crocodilians. The mathematical models differed, but they were all variations on a generic model called the Richards' curve. Growth of the spectacled caimans at Alter do Chão did not conform to the Richards' model, and data collected by Zilca Campos would later show that those models were also not appropriate for several other species of caimans. Perhaps more important though, was that the caimans taught me just how adaptable crocodilians can be in places that are heavily used by humans if they just have a few natural or seminatural areas where they can take refuge.

14

Papua New Guinea



Motif on the front of Papua New Guinea´s Parlament House, showing the nation´s close relationship with the rivers and wildlife. Photo by Bill Magnusson.

I had applied for a job studying crocodiles in Papua New Guinea when I finished my Ph.D., but my experience was with field work and they wanted someone more directly related to captive production. They hired a researcher from the USA who had been associated with the development of dried pelleted food for alligators, which greatly facilitated storage and distribution of feed. He left the USA, but for some reason only got to Papua New Guinea a decade later. Eventually, local people filled the void, aided later by Phil Hall.

The 1988 CSG meeting was held in Papua New Guinea, and I made a point of going. Partly I wanted to go because of my failed attempt to work there, but also because it was an almost mythical place near Australia that I had never visited. Mainland Holdings ran the World's largest crocodile ranching program, and I was eager to see if lessons might be learned to support Brazil's fledgling ranching enterprises. Zilca Campos, who worked on Pantanal caimans and Marc Hero, who had helped me with dwarf-caiman studies, were also going, so we planned some post-meeting field trips. Peter Bayliss would present a paper on the demography of saltwater crocodiles in Australia.

We were not in Lae long before I was glad that I had not taken the job in Papua New Guinea. The government had offered much higher wages than I earned in Brazil, and provided free housing. However, there were strong social tensions that would have restricted enjoyment of the local culture. People in Papua New Guinae had traditionally lived in dense agricultural villages that were often separated by rugged mountain ridges, and warfare and payback killing was commonplace. After European colonization, other forms of economic development were concentrated around the major coastal cities, which attracted people from the interior to live in agricultural settlements and shanty towns.

Poverty and lack of employment in the new townships led to the formation of gangs of unoccupied youths, locally called Rascols, who terrorized their own people and the expatriate whites who ran most of the larger industries. Similar social pressures had led to the formation of drug gangs in the favelas of Rio de Janeiro in Brazil and the inner city suburbs of New York in the USA. We were told that half the white women in Papua New Guinea at that time had been sexually assaulted. This worried me, because Marc and I planned to travel around the country on public transport with Zilca, and I was unsure if we would be able to protect her.

Humans seem to have an automatic sense of "us" and "them." If you are one of us, you are respected, or at least tolerated. If you are one of them, you are the enemy and deserve no respect. I felt one of "them", ensconced in a fancy hotel, and unable to go out at night because the government had imposed a curfew in an attempt to control the Rascols, who often operated at night. We were treated very well by both the government representatives and the expatriate whites during the meeting, and there were no unpleasant incidents, but you could feel the tension generated by the difficult social situation, and the government representatives put high priority on generating employment for local people.

Mainland Holdings was technologically advanced in growing out crocodiles and processing them industrially when they reached marketable sizes. The industry was based on ranching. People in remote areas would collect eggs or capture juvenile crocodiles, which were transported to Lae in trucks or by air. I was impressed that the company even had cardboard boxes made specially for transporting juvenile crocodiles. It was a complex logistical task to bring the eggs and small crocodiles across some of the most rugged and inhospitable terrain in the world, and something that only a technologically advanced industry could achieve.

Even though it involved many people, most of the industry, and most of the profits, remained in Lae with the expatriate owners. The government was eager to increase the participation of local people, and for many years tried to encourage the development of village farms so that the local people could grow out the crocodiles and increase their profits from the industry. However, raising crocodiles is like any other livestock industry; it takes high technology and dedication to make it profitable. People in remote areas did not have access to technology and could only devote time to the crocodiles when not tending their gardens, which were the basis of their livelihoods. The village crocodile farms failed.

The owners of Mainland Holdings were always looking for ways to increase local participation, but the mechanics of the industry and logistical difficulties did not give them a lot of options. They were also concerned about conservation of the resource. When the industry started, the government had undertaken regular helicopter surveys of nesting areas to ensure that the ranching activities were not impacting the crocodiles. However, when the surveys showed neglible effects, the government invested the money in more badly needed social activities, and stopped the annual surveys. Mainland Holdings, recognizing the importance of monitoring to maintain the international credibility of the industry, stepped in and continued the monitoring in areas from which they were taking eggs.

Crocodilian farming and ranching operations tend to depress me. The animals are crowded, banalized and prevented from exercising the hunting abilities of a large intelligent predator. However, Mainland Holding's raising facilities were better than most. The crocodiles being raised for slaughter were kept in large, open pens covered by shade cloth. The floor was totally cemented for ease of cleaning and there was a long shallow pool on one side covered at intervals by

wooden boardwalks. Raised wooden platforms offered places for the crocodiles to sun or find shade underneath. The pens were totally artificial, but provided for most of the croc's needs. They gave the impression of five-star hotels for city loving crocodiles. The animals were at high densities, but not higher than many species of crocodiles and caimans reach at the height of the dry season in the wild. The difference between these facilities and the intensive alligator raising I had seen was a bit like the difference between chickens raised individually in production batteries, where they can hardly move, and so-called "free range" chickens raised together at high densities in large pens.



Photo 14.1 *Mainland Holdings´crocodile farm at Lae, Papua New Guinea. Photo by Bill Magnusson.*

There were also experimental pens for keeping breeding pairs, though closed-cycle farming had little support from the government because it would totally isolate the industry from the people in the interior. The pens were very large, each with a lake and drier areas covered in reeds. As we looked at a large

female through the two meter-high wire-mesh fence I commented to Zilca that the crocodile must be stressed by not being able to get out and wander over a larger area. She was submerged except for the top of her head in typical crocodilian fashion, but her eye was on us and I wondered if she would have attacked if we had been on the other side of the fence.

I could not have been more wrong about her being detained involuntarily. I did not see it, but other participants told me later that Ted Joanen visited the pen with a number of other delegates and decided to see whether the female would respond to his imitations of the distress calls of a baby alligator. She did, and she did not stop when she got to the fence. She went straight over it and lay on the path facing the group. Presumably, Ted stopped making the distress calls at that point. Once again, a crocodilian had shown that, when we think we are making limits for them, very often they are only responding to their own self-imposed boundaries.

I did not go into the field to see crocodiles in Papua New Guinae because I had seen a lot of saltwater crocodiles in the wild, and Zilca, Marc and I planned to see other aspects of the country's biodiversity by travelling around in the small minibuses that were the standard mode of transportation for those who could not afford to go by plane. I was still worried about Zilca, but I needn't have. The Rascols only operated around the major towns. Once we were out in the country, there were no curfews and everybody was friendly. In fact, Zilca turned out to be a major benefit. Her open and innocent delight in other people opened the doors to local culture. While Marc and I were still held back by limits of culture and language, Zilca would be sitting in the middle of a group of women painting faces and having her face painted with betel-nut juice. She turned us from "them" to "we" very quickly and greatly enhanced our experience of Papua New Guinea.



Photo 14.2 *Zilca Campos having her face painted with betel-nut juice in Papua New Guinea. Photo by Bill Magnusson.*

I was beginning to see the "us-them" dichotomy as the basis of many of the debates in the CSG. People tended to be divided in groups labeled by names, such as conservationists, hunters, ranchers, farmers, industry, tanners, government, and locals. In fact, the same dichotomy seemed to be behind many scientific debates. Real progress only came when you were able to substitute "us" and "them" with "we". However, I had classical scientific training, with no classes on empathy or conflict resolution. We all want to belong, and I do not like the feeling of being excluded from a group. Nevertheless, I was starting to be less worried that I was a bit strange and didn't fit into any of the categories. Maybe I would be able to see a bit more clearly if I were in everyone else's category of "them."

15

The Pantanal



Zilca Campos measuring skulls in a poachers camp. Photo by Bill Magnusson.

In 1987, I was invited by EMBRAPA researchers to visit the Nhumirim experimental ranch in the Brazilian Pantanal. EMBRAPA is a federal government agricultural research organization with centers throughout the country. Most of the regional centers study applied questions directly related to the production of crops or livestock. However, the Brazilian Pantanal is a huge flooded savanna where wildlife tourism and fisheries contribute significantly to the economy. There, the EMBRAPA center has active programs for wildlife management, fisheries and conservation-related activities.

The Brazilian Pantanal covers about 100,000 km^2, with few sealed roads. Access is mainly from Cuiabá in the north and Campo Grande in the east. Corumbá, 350 km south-east of Campo Grande, is a small town near the Bolivian border on the north bank of the Paraguay River. It is on the last high ground before descending into the massive flood plains of the river, and conveniently placed for the EMBRAPA Pantanal wildlife division, but in 1987 it did not have a daily air service.

EMBRAPA personnel had arranged to take me on an excursion and I booked a flight to arrive in Corumbá the day before. However, there was bad weather over Corumbá and I was taken off the plane in Cuiabá. I explained to the airline staff that I had to get to Corumbá that day, but they said there was nothing to be done and sent me to a hotel. I was brooding in the hotel room and wondering what I could do to make my time in Cuiabá productive when the phone rang and I was summoned to the reception. The desk clerk said that I should return to the airport in transport that the airline company had sent. There were two young women in the van. One was quiet and reserved, but the other was bubbly and talkative and she chattered away on the way to the airport. They were from the small town of Sinop and were also on their way to Corumbá

The airline attendant said that there was a plane going to São Paulo and that it would make an unscheduled stop in Corumbá to let me off. I had never imagined a jet airliner making an unscheduled stop just for me, and felt pretty important. Apparently, my remonstrating about the importance of my scientific presence in Corumbá had touched the airline staff's conscience. My imagined self importance was shattered when I boarded the plane. The two girls from the van boarded with me and sat beside me in the near empty plane. They explained that they were call girls and one had a special relationship with a state governor. It was for them that the plane was diverted to Corumbá!

There was a note at the hotel to call EMBRAPA, and I arranged to meet the center's wildlife researchers for lunch. Guilherme Mourão was a little taller than me, with unkempt curly hair, a slight lisp, and a habit of cocking his head slightly to the side and looking quizzically when someone was talking to him. Zilca Campos came up to my shoulder, was slightly built and had an eager sincere expression that made me careful about what I said because I was sure that she was storing it away for future use. They were very different from wildlife managers I had met in the USA and Australia and I wondered how long they would maintain their enthusiasm for the Pantanal. Once again, my preconceptions were totally wrong. I would eventually supervise the post-graduate studies of both of them, and they would teach me and the world much about the Pantanal and its wildlife over the next two and a half decades.

The trip to Nhumirim Ranch took most of the morning. At first it was along the low areas around the Paraguay River with extensive areas of flooded rushes and water lilies similar to the lagoons in Rio Grande do Sul. The road was raised above the surrounding marshes and lined by shallow borrow pits dug to provide earth for the levee banks along which the road ran. After a few hours, we turned north onto slightly higher grasslands with scattered islands of trees. It

reminded me of the Venezuelan Llanos, but the vegetation was lusher. Almost all the land in the Pantanal is covered by privately owned ranches, and we stoped regularly to open gates between paddocks. The cattle were mainly white hump-backed Zebu.



Photo 15.1 *Guilherme Mourão and Zilca Campos in the Pantanal in 1987. Photo by Bill Magnusson.*

It was the dry season, and water was confined to the borrow pits and small crystal-clear streams that flowed under small wooden bridges. Capybaras, Jabiru storks and other wildlife abounded wherever there was water. Flocks of giant blue macaws foraged on the ground for palm seeds that were hard to crack with a hammer, but which they could snip in half with their massive bills. In the pools under the bridges, piranhas, pacus, oscars and other aquarium fish circled in a kaleidoscope of colors.

The Nhecolandia region of the Pantanal, and the Nhumirim Ranch in particular, is famous for small isolated lakes, and there are over a hundred on

Nhumirim alone. Some are saline and have little vegetation. Others have floating grass mats and a variety of floating and emergent water plants. All tend to be circular, with a border of grassland flanked by low forest. Local rainfall and overflow from the Paraguay River fill the lakes during the wet season, but many dry out or are reduced to shallow pools in the dry season. In extreme years, all the lakes dry and the caimans suffer.

Standing in the tray of the Toyota pickup and bumping across the sandy tracks, it felt much like parts of northern Australia. There was easy access to the lakes in the dry season, but in the wet season, when the waters of the Paraguay River spread out to cover thousands of square kilometers, the lakes are joined together and are only accessible on a tractor that can push through water over a meter deep. The area seemed ideal for an airboat, especially a powerful one like the ones Ted Joanen had, which would be able to travel across even dry ground. However, the cost of acquiring and maintenance for an airboat was beyond EMBRAPA's budget.

We had lunch of beef and manioc meal, washed down with tea that was so sweet it ran out of the cup like treacle. The meal was not accompanied by salad or other greenery, which the Pantanal cowboys did not seem to consider edible. As we would stay out till late at night we took a meal of salt meat mixed with manioc meal. I would never get used to Zilca's work schedule. I once got so tired that I told her I couldn't go on and we returned to the ranch to sleep at 4 a.m. It seemed that I had hardly closed my eyes when she banged on the door to wake me for breakfast two hours later. The only time I saw her break the work schedule was on a subsequent trip when we were bumping across a dirt track on a cold night in the dry season. It was nominally 15℃, but the wind on the moving truck made it seem much colder. Guilherme told the driver to stop and everybody got out of the truck. Zilca passed out hot coffee as we stood around

the truck in the middle of nowhere. When I asked why we had stopped, Guilherme said in Portuguese “It’s just after midnight, it’s your birthday - we’re celebrating.” After my 10 minute birthday party, we got back to work.

The Pantanal caiman *Caiman crocodilus yacare* differs from the spectacled caimans in most of the Amazon in having a slightly stouter head and dark blotches on the sides of the lower jaw. In other respects, it is very similar to its northern cousins. International pressure and changes in the major drug trafficking routes, had led to a reduction in hunting of Amazonian caimans, and concentration of poaching on Pantanal caimans in the 1970s and early 1980s, resulting in the Pantanal caimans being responsible for most skins on the illegal market. The poachers were mainly poor cowboys who lived essentially as indentured serfs on the major cattle ranches. They would herd cattle during the day and hunt caimans at night to supplement their meager wages. The skins would be sold to intermediaries who flew them to Paraguay or Colombia, often bringing back drugs on the return trip.

I taught Zilca and Guilherme how to operate on hatchling caimans to determine their sex by direct observation of the gonads and how to mark babies by carefully cutting out raised tail scutes. You need patience and a steady hand to mark tiny crocodilians. You do not want to cut too far into the tail and hurt the animal, but you have to take out every vestige of the scute. If you leave even a tiny piece, it will partially regenerate and may not be distinguishable from the scars left by predators when the animal grows. It is hard to maintain patience because you know that the chance of any of the babies reaching adulthood is remote, and the chance of you being able to recapture them less likely still. Zilca’s dedication and patience would pay off twenty five years later when she and Guilherme published one of the most detailed long-term studies of growth in any crocodilian.

Zilca and Guilherme noosed caimans from a boat at night as did most crocodilian biologists. However, the small shallow lakes allowed other capture techniques in the dry season. The caimans would become concentrated in the muddy pools with fish and other aquatic fauna. A strong seine net pulled through the lake would often catch a dozen caimans at a time, some of which were very big. Pulling the net required several strong men on each end, and it was quite an adventure to rope the caimans as they were pulled from the water. My mother, who was then in her early sixties and the same size as Zilca, went with me to Nhumirim on one of those caiman netting expeditions. We had two large caimans roped and several more in the net to pull out. The two caimans with the nooses around their necks were heading in opposite directions, so I gave the ends of the ropes to my mother and told her to hold on. I was busy trying to subdue a caiman thrashing in the net when I heard “Bill, Bill, they won’t stop” and turned around to see my mother with both feet planted on the ground being dragged away from the lake by the two caimans, which had decided to go in the same direction. Each of them was bigger than she was, and they were both up in a high-walk position with their bellies well off the ground. After that, we gave her smaller caimans to hold.

I was surprised that the caimans did not always head for water. They learned quickly, and if they had been in a lake that had been seined, or that had been hunted intensively by poachers, they did not wait to be caught in the net or shot at in a confined space. When the truck pulled up at one end of the lake, the caimans would leave the other end and walk single file in the direction of the nearest forest. Usually it was one of the biggest caimans that led. Once in the forest they would scatter and hide under leaf litter or the abundant bromelias with hooked spines that were the major understory plants in most of the forest patches.

At first we thought that they only walked single file in groups as a result of disturbance, but Zilca and Guilherme found many groups travelling overland in single file, without any indication that they had been driven out of a lake or river. We knew that caimans would often abandon a lake or a pool in mass because it was common to see many caimans in a pool in which there had been none the day before. Presumably they leave when the food runs out in a pool, there is a build up of toxic waste from dead fish, or something else that makes the pool unsuitable. However, we have no idea how they communicate with each other, and how they decide who will be leader. I was reminded of the tracks of dinosaurs walking in a line that archeologists used to infer that they moved in herds. If the caimans passed a muddy patch they would leave the same sort of tracks. I wonder if we should stop thinking of crocodilians as solitary hunters and begin to consider them as pack animals.

Besides cutting some of the tail scutes, Zilca and Guilherme put colored cattle tags in tail scutes or numbered aluminum tags in the membranes between their toes. The plastic tags allow individuals to be identified from a distance, and the toe tags are useful to confirm the reliability of identification by scute cutting. However, they turned out to be useful for another reason. Poachers would camp in the forest near a lake with a concentration of caimans, shoot as many of them as they could during the night, and drag the carcasses up to a convenient spot in the forest to skin them. They took only the skin on the flanks because the back, belly and tail skin is full of bony osteoderms that make it virtually worthless for tanning. Along with most of the body, the poachers left the tags that were in the tail and foot webbing. By searching abandoned poachers camps, Zilca and Guilherme got valuable data on caiman movement, and an idea of the magnitude of mortality due to hunting.

We walked from the scorching heat of the grassland into the cool shade of the forest. Scattered over a dozen square meters were pieces of skull, bleached osteoderms from the dorsal skin, and dried feet, contorted into strange shapes. It was an old camp, and the hundreds of kilos of caiman meat and entrails had long since rotted into the ground. Nevertheless, the stale odor of death still permeated everything. Sorting through the piles of bones was a sad job for Zilca, who had a strong emotional attachment to the caimans she worked on. It could also be dangerous. People regularly died in shootouts between poachers and the forest police, and there was always the chance that the uneducated poachers might not distinguish between government in the form of police bent on capturing or killing them, and government in the form of researchers trying to do their best for both caimans and humans. Zilca and Guilherme would eventually visit hundreds of poacher camps before changes in fashion and international regulations made poaching in the Pantanal uneconomic.

The caimans nested at the beginning of the wet season, either in the forest or on grass mats floating over the lakes. Zilca searched for forest nests on foot or horseback, and found most that were put down each year on Nhumirim and the neighbouring property of Campo Dora. The dense understory of spiny ground bromeliads made nest searching in the forest difficult, but it was even harder in the floating grass mats, which were too fragile to walk over, but too thick to push a boat through. Zilca would climb a nearby tree and try to spot the nests, or use an ultralight aircraft to map them. Guilherme took me for a flight over Nhumirim in the ultralight, and I was impressed by the view it gave of the lakes and forests that were laid out like paisley tapestry. Nevertheless it confirmed my dislike of flying in light aircraft, especially because Zilca and Guilherme had crashed the ultralight several times.



Photo 15.2 *Bill with a Pantanal caiman. Photo by Zilca Campos.*

Zilca was studying sex determination in nests laid down in the forest and on the floating grass nests, and wanted to measure temperatures in as many of each as possible. The temperature of the nest depended on where it was made, so the floating-grass nests on average had higher temperatures. As the sex of

crocodilians is determined by the temperature at which they are incubated, the sex ratios of the hatchlings differed between the forest and floating-grass nests.

Zilca took me to a nest near a tree in the middle of a grass mat. We couldn't get a boat in, so we used boards for support and dragged ourselves along the trail made through the grass by the female. Zilca was in front and I could just see her head bobbing above water. A big female might weigh nearly as much as Zilca, so I was nervous that there might be one in attendance. However, Zilca pulled herself up on the tree and started digging through the nest. She held up an egg and gave a cheery grin of victory, but these eggs would not produce young. The grass mat had subsided and the eggs had drowned. In contrast to the forest nests, few grass-mat nests were raided by predators, such as coatimundis and tegu lizards, but they had to contend with this other source of mortality.

We could get the boat up to the next nest, and I leaned forward as we approached it, hoping to get a glimpse of an attending female. A round leather ball rose to the surface beside the nest, and rolled revealing dark rings on a yellow background. I could almost touch it, and soon realized that it was not a ball, but a loop of the body of a yellow anaconda. I had seen some big yellow anacondas sunning beside lakes in the dry season, and they must have been over 4 m long. This one was at least five times their diameter though, and I imagined a snake at least twice that length, so I wasn't game to grab it. This did not make sense. Yellow anacondas are big snakes, but nowhere near as big as the Amazonian anaconda, so I lent over to look closer and I saw that the snake's skin was stretched almost to bursting. By the time I realized my mistake, the ball was dragged down to be followed quickly by a body that was only a handspan wide. I made a quick grab, but the snake was long gone.

The snake had recently captured large prey, perhaps just as we were paddling toward the nest, and that was why part of it was so bloated. It may have been a

capybara, but there was a good chance that the snake had eaten the caiman that had been guarding the nest, and I had lost the chance of making the first record of a snake eating a caiman in attendance at a nest. Caimans attending nests in the forest are susceptible to jaguars, but we had not imagined that there were any predators that could take an adult caiman on a floating-grass mat. Whether it was a female caiman in the snake's belly I'll never know, but my admiration of Zilca's courage in swimming into nests was heightened. She not only risked the wrath of the caiman, she risked becoming prey to a yellow anaconda.



Photo 15.3 *Zilca Campos marks the position of a flooded nest while an assistant watches for the mother caiman. Photo by Bill Magnusson.*

The Pantanal caiman was listed by the US government as an endangered species, which removed one of the largest and most lucrative markets for hides of that species. US alligator farmers were worried about competition from cheap caiman hides, but I believed that concern was misplaced. Alligators have hides that receive the industry rating of "classic," and they compete mainly with hides

from other classic species, such as the saltwater and Nile crocodiles. Caiman hides are more difficult to tan, and do not have the same glossy sheen of classic hides, so they have much lower price and fill a different consumer niche.

There were no good estimates of the number of caimans in the Pantanal, and the number in trade was still based on Karlheinz Fuchs' guess of a million a year. Therefore, Guilherme got funding for aerial surveys of caimans throughout the Pantanal. It turned out that many other wildlife species were more appropriate for Guilherme's aerial surveys than caimans. However, the data were sufficient to show that the Pantanal caiman was one of the most abundant crocodilians in the world, and not in need of any special embargos by the USA.

Many different groups were interested in harvesting caimans from closed-cycle farming, ranching or controlled hunting, so we applied to an international conservation organization for funds to hold a meeting in Brazil to discuss possibilities for conservation and sustained use of the Pantanal caiman. We put together an extensive justification for the meeting and worked out a budget. We intended to have a scientific meeting to discuss what was known about caiman in the Pantanal, followed by an open meeting with Brazilian government officials to decide on the best strategy for management of the resource.

We had no particular agenda, but I had previously pointed out the economic limitations on caiman farming and ranching because of the low value of nonclassic hides. Therefore, preservationists branded us as anticonservationists, and potential caiman ranchers branded us as anti-use preservationists. Our proposal to the conservation organization was rejected, mainly because of a report by a reviewer from a US zoo. I was accustomed to having applications turned down and was not particularly concerned until I received an invitation to a meeting on Pantanal caiman conservation funded by the same agency. I obtained a copy of the application and I was astounded. The reviewer who did

not like our application had made one of his own. However, he did not change much. In fact, he had only photocopied our application, torn off the first two pages, and substituted them with two of his own. It was exactly our application except for the proposer and the program.

There was still the scientific program, but the meeting afterwards would be restricted to the proposer and representatives of the conservation organization funding the proposal. They would decide what should be done and convey their decision to the Brazilians on the last day. Once I had calmed down, I realized that the US conservationist was sincere and doing what he felt was the right thing for the species. I called the representative of the conservation organization and explained to him how paternalistic the program would seem to Brazilians, and that there were severe ethical considerations associated with the pirating of a proposal by a reviewer. The funding agency changed its mind and funded our proposal, which could not have been as dangerous as the reviewer considered because the Brazilian government officials were extremely conservative and not about to authorize any liberalization of the wildlife laws.

Direct hunting of caimans in the Pantanal was not permitted. Attempts at farming were economic failures. Many ranching schemes also did not work, and it was sad to visit some of the early enterprises and see dead and dying young caimans in the rustic enclosures. A few ranching enterprises are still functioning, and they use high-tech methods adapted from the Argentinian broad-snouted caiman ranching operations. They have difficulty raising caimans to sizes optimal for tanning, but get much of their profits from selling meat to tourist restaurants around the Pantanal. They probably also allow some less legal activities to flourish. I have eaten big caiman steaks in a restaurant that proudly displayed IBAMA permits, but I know that the caiman from which that meat was taken was much bigger than anything raised economically in ranching

facilities. These industries don't seem to have affected the caiman densities in the Pantanal very much. The multiyear cycles of drought affect the Pantanal caimans much more than legal or illegal exploitation. In the drought year that I write this, Zilca tells me that all the lakes of Nhumirim ranch have dried up and many of the caimans have left. Those that haven't are dead or dying. Dams around the Pantanal, and river diversion for irrigation, probably have much greater effects on the number of caimans than any of the humans that think they are actively managing them.



Photo 15.4 *Dead hatchlings in a raising facility in the Pantanal. Photo by Bill Magnusson.*

16

Argentina



Caiman crocodilus yacare **in the Brazilian Pantanal. Photo by Bill Magnusson.**

Ranching and farming became the kingpins of crocodilian conservation in the 1980s and 1990s, and government management agencies embraced them because they thought that putting an economic value on the resource was the only justification for conservation, and it would pass responsibility from themselves to the private sector. I published a paper warning about the economic and conservation limitations of caiman ranching in 1984[65]. Nevertheless, caiman ranching enterprises sprang up all over the place. In 1993, I was invited by Luciano Verdade to give a talk on wildlife management in São Paulo, and there I met Alejandro Larriera, an Argentinian researcher developing conservation programs in Argentina for the broad-snouted caiman, *Caiman latirostris*.

Alejandro, who practiced long-distance swimming in the cold Argentinian waters, had the strong physique of an athlete and the serious demeanor of most Argentinian researchers. I had possibly met Alejandro before at the CSG meetings in Gainesville, but neither of us remembered. Neither my Spanish nor Alejandro's Portuguese were very fluent, so we probably wouldn't have communicated well in the academic setting of the meetings. However, Luciano took us to dinner overlooking the Piricicaba River, and read excerpts from his book of poems that revealed his love of the region. It was a great night, and good for me to see the poet and the sportsman behind the men I knew only as scientists.

Alejandro was concerned about the push for farming in Argentina, and invited me to Santa Fê to give a talk on wildlife management in relation to caimans. I had never visited Argentina and I was very pleased to take up his invitation. My salary was too low to pay for international plane trips, but Alejandro found the funds to pay for my trip, and I flew to Argentina the following year.

The eastern part of Argentina is extremely flat and there is a gradient in rainfall from the northern border with Paraguay to the arid semidesert of Patagonia. This produces conditions that are ideal for a variety of livestock and much of Argentina's economy is based on beef or mutton production. Where conditions are too wet or too dry for intensive livestock production, wildlife is prolific, and Argentina has the most intensive programs for wildlife hunting of any country in the Americas, with the exception of the USA.

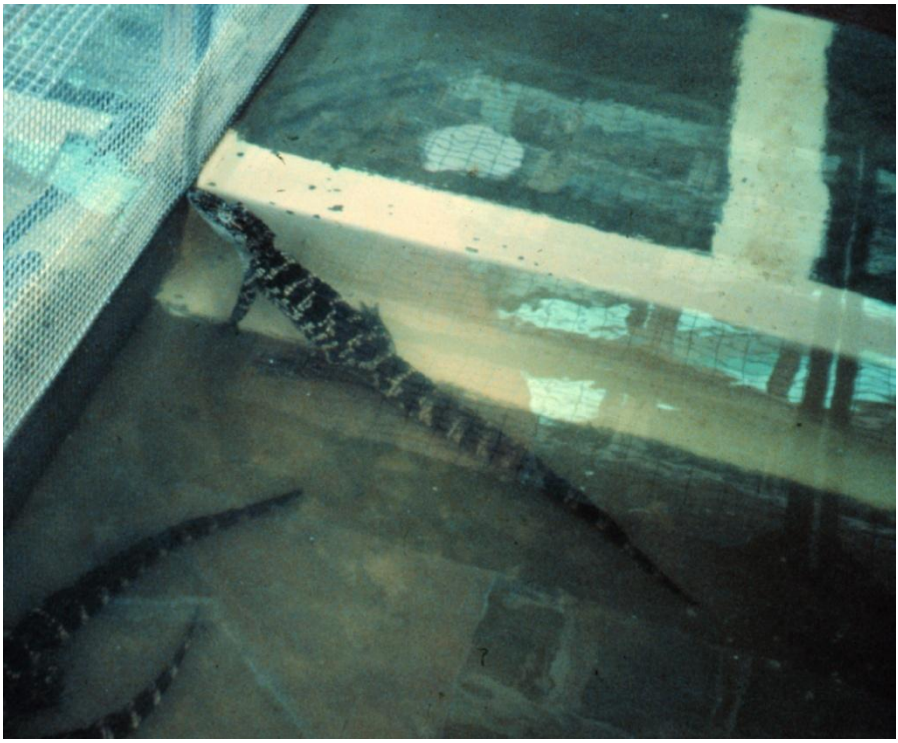


Photo 16.1 *Captive broad-snouted caimans in Argentina. Photo by Bill Magnusson.*

Santa Fé is on the lower reaches of the Paraguay River, with intensive ranchlands to the west, and much less concentrated cattle production to the east on the humid floodplains. As in the Venezuelan Llanos, the ranchers used weirs to control water levels in pastures, and Alejandro had developed the caiman-

ranching program to give them incentive to maintain water levels to the benefit of caimans and other water-dependent wildlife. I was surprised at how like the floodplains were to parts of the Llanos and Pantanal, but the dominant crocodilian in these cold southern latitudes was the broad-snouted caiman, rather than the more tropical spectacled caiman.

Alejandro showed me the ranching facilities with rows of cement tanks housed in temperature-controlled sheds. As usual, the sight of crocodilians packed into small enclosures depressed me, but Alejandro assured me that direct hunting of caimans was not a viable alternative in the area, and egg collection for the ranching operation gave the cattle ranchers incentive to maintain the wetlands. Once again, I was finding out that there is no one best recipe for crocodilian conservation and the strategies have to be adapted to the local socio-economic conditions.

I had not expected to return to Argentina for some time, but the 1996 CSG meeting was to be held in Santa Fê I did not have the financial resources for a second trip, but ended up going with the help of Suheil Neves, a young entrepreneur who had invested in a raising facility on the road to Manacapuru, only a few dozen kilometers from Manaus. Suheil's family owned a highway-construction company and one of Manaus' first shopping centers, so financial resources were not limiting and the growing-out facilities were as intensive and high technology as any I had seen in the USA for alligators.

I was not directly involved with Suheil's ranch, but I was on a commission that advised IBAMA about systems of egg harvesting, and some of my former students were either IBAMA agents or acted as biological consultants for Suheil. I visited the raising facilities, but I was skeptical about the economic viability of raising caimans, because it took a long time to get them to a size where the carcass would produce much meat, and their skins had low market value.

Obviously, Suheil thought otherwise, and I bet him a year of my earnings against a year of his that he would not be able to recoup his financial outlay within five years. It seemed like a good bet at the time, because he obviously earned hundreds of times what I did. However, it had a fatal flaw. He would only be willing to pay if I was wrong and he made money. If he failed, he would lose interest in crocodilians and would not be interested in paying a bet to a crocodilian biologist. Predictably, I won, but received nothing.

Despite our divergent opinions about caiman ranching, Suheil appreciated my efforts to legalize and control egg harvesting from the wild. Therefore, when I didn't have money to go to the CSG meeting in Santa Fé in 1996, he offered to pay the airfare. I was grateful, and I was eager to participate because the program run by Alejandro had become the most promising ranching enterprise in South America.

I gave a talk on adaptive management at the meeting. First-World biologists like to give talks on adaptive management because it seems so logical. They imply that it is the method of choice in developed countries, and that wildlife management in third-World countries would miraculously become effective if only the incompetent local biologists would adopt it. However, my talk was about the limitations of the method.

The name adaptive management was coined for the process of applying some management technique, monitoring the result, and adapting the management if the resource shows unacceptable changes. The problem is that monitoring wildlife populations, and regularly changing government programs, are costly actions. If the resource is extremely abundant and resistant to exploitation, it may generate enough excess cash to support these initiatives, but that usually means that the species can look after itself, and adaptive management is not essential. In fact, a close look at most first-World wildlife programs shows that

management agencies are generally more interested in monitoring public opinion than monitoring the resource. Agencies adapt to what is politically most expedient.

If the species is rare or subject to large natural variations in density, monitoring becomes extremely costly, it is hard to interpret the effects of human interventions, and the profit margin of the industry does not allow financing wide-scale monitoring or intensive management experiments. That is, it is often not economically viable to apply adaptive management to the species that most need it.

Adaptive management, as it is described in the text books, also requires that the management agency define specific acceptable limits to the parameters being measured. This means that the program has to have a limited number of specific outcomes that the agency is trying to optimize. I asked "Do you want to maintain the species within its present distribution, re-establish it in its former range, maintain population densities above some pre-determined level, increase the population size structure, sustainably remove a segment of the population for economic use, maintain the species' 'role' in the ecosystem, avoid human/crocodilian conflicts, or something else? If your answer is 'all of the above,' go back and do some basic reading. Many or most of these objectives are mutually exclusive and ….. very often based on value rather than technical judgements."[40]

Saying something like that to a room full of wildlife managers, many of whom had been trained in the US "use it or lose it" tradition, went over like the proverbial lead balloon. I was sad because I had offended a lot people whose friendship I valued greatly. It was a feeling I had experienced before when I said something that was politically incorrect, but which it seemed to me needed

to be said. The conflict between the need to seek the truth and the need to be accepted by my peers, both of which I feel very strongly, troubles me still.

The Santa Fé meeting also started a series of events that would put me in conflict with a lot of people over the taxonomic status of the Pantanal Caiman. It had been described as a separate species, *Caiman yacare*, but was considered by many just to represent a subspecies of *Caiman crocodilus*. It is often difficult to decide whether geographical variants deserve the status of full species, but the resulting academic squabbling usually doesn't have much practical importance for most people. When the species is of economic or conservation importance, the difference can be important, however.

The US government listed the Pantanal caiman not only as a full species, but also as an endangered species, meaning that it could not legally be imported into the USA for commercial purposes; a difficult situation seing that it was probably the most intensely traded crocodilian in the world at the time. The status of the species would later have implications for caiman ranching in Brazil, because the law restricted ranching or farming of species outside the hydrographic basin in which they occurred naturally.

At the Santa Fé meeting, I met Stephen Busack, a tall imposing researcher in the Division of Law Enforcement of the US Fish and Wildlife Service, and Sima Prandya, a student at Michigan State Univeristy who liked to play rugby in her spare time. They were studying the systematics of the subspecies of the *Caiman crocodilus* species complex and presented their preliminary results on morphological studies, which were basically that none of the purported subspecies, including *Caiman crocodilus yacare*, deserved subspecies, much less specific status.

I agreed with them in their general conclusions, but not in how they had conducted the analyses. Caimans generally move along river systems, so their distributions are generally coincident with major drainage basins. Steve and Sima had separated their samples based on straight lines along degrees of latitude, which mixed caimans from different drainage basins. I suggested that they redo the analysis using drainage basins to delimit geographic distributions. They followed my advice, and in their paper published in 2001[106] they changed their conclusions about the Pantanal caiman, which they then considered as warranting status as a full species, *Caiman yacare*.

This did not make sense to me, because Peter Brazaitis, George Rebêdo and Carlos Yamashita had shown that the Pantanal and Amazonian spectacled caimans show continuous variation in morphology, or at least the blotches on the jaws, from the headwaters of the Madeira River to its mouth in the middle of the Amazon. I reread their paper carefully, and noted that Steve and Sima had few samples from the Madeira River, which runs northeast from the Guaporé River in the western Pantanal over 1000 km into the heart of the Amazon. Stranger still, they said that they had excluded the six specimens they had from the upper Madeira River because "we felt that our search for a clear definition of species or subspecies status would be confounded by inclusion of specimens which might possibly be intergrades or hybrids." That is, they exluded the data that showed that the two taxa were not distinct.

That paper made them the last reviewers and, therefore, the accepted authorities on *Caiman* nomenclature. This was not just an academic argument. Potentially, two tanners could import skins into the USA from caimans that had hatched from the same nest that were taken from the Madeira River. If the skin of one of the caiman was like that of the Pantanal caiman, the importer could be jailed under the endangered species act, while the other importer with a skin

more like that typical of Amazonian caimans would not be considered a criminal. I wrote a paper for the CSG newsletter alerting researchers to the complications of considering Pantanal and Amazonian spectacled caimans to be different species. I received severe criticism from Alligator farmers, who seemed to think that Pantanal caimans might compete with their skins, and researchers from the Pantanal, who thought that specific status for the Pantanal caiman would give more justification for protection. There also seemed to be an element of patriotism involved for researchers from countries within the range of the Pantanal caiman.

A researcher writing a report on Pantanal caimans for an international conservation organization asked me to comment on the two "species". Tongue-in-cheek, I suggested that someone needed to do a survey of over 1000 km along the Madeira River searching for the place with the lowest density of caimans, and put a stake in the ground to define the border between the distributions of *Caiman yacare* and *Caiman crocodilus*. The reason to seek the place with the lowest density of caimans was because fewer individuals would change species as they swam past the stake. I regretted being facetious when he sent me the proof of the article to read and I found that he had taken me seriously and quoted me in the article. I had to tell him that I had been joking and that he would have to modify the article that was already in press; a process that can be expensive.

The controversy about the specific status of the Pantanal caiman continues to this day. William Vasconcelos, George Rebêlo, Zilca Campos and Tomas Hrbek have collected samples for genetic analyses and shown that the two "species" grade into each over more than 1000 km of the Madeira River drainage. The successor to IBAMA, the Chico Mendes Institute for Biodiversity (ICMBIO), recently produced papers on the conservation of Brazilian caimans

and provided maps of distributions. For both *Caiman yacare*[6] and *Caiman crocodilus*[9], they had to include hatched areas on the maps to indicate the region where you cannot tell the two "species" apart. That area covers about 1500 km of rivers, and the area drawn is larger than the total distributions of many species of crocodilians, such as *Alligator mississipiensis* and *Crocodylus siamensis*. I wonder whether it would not have been better if I had held my tongue and let Steve and Sima publish a paper that was perhaps methodologically incorrect, but that had a much more logical conclusion - that you cannot reliably distinguish Pantanal caimans from Amazonian spectacled caimans.



Santa Fé is near the southern limit of crocodilians in Argentina, and most of the caiman habitat lies further to the north. Tomas Waller, an Argentinian herpetologist and conservation expert, said that I should go north to see the Corrientes Province, where I could see *Caiman crocodilus yacare* and *Caiman latirostris*. Tomas also told me about the spectacular wildlife to the south in Patagonia, but I would not see that until several decades later. I had only a few days in Argentina after the meeting and couldn't see how I could get to Corrientes, but Tomas offered to drive me, and told me that I could come back by bus.

Tomas drove with few breaks for 12 hours, and we passed some of Argentina's most productive cattle country. Humans apparently evolved in savannas, and we like to either live in savannas, or modify the landscape so it looks like a savanna. The country north of Santa Fé was highly modified, but much of the wildlife had adapted, and the landscape reminded me of the grasslands of Venezuela and southern Brazil. Tomas was at that time finishing a CITES funded survey of caimans in the region. When we crossed the southeas-

tern tip of the Wet Chaco, we had long talks about whether caimans could be ever extirpated by a harvest in such intricate habitats. We stayed over night on a ranch, Estancia San Juan Poriahú, which means "Saint John the Poor" in Guaraní language, near Loreto, a village in the Northwestern tip of the Iberá Marshes Natural Reserve. This huge wetland encompasses 13,000 km^2 of almost pristine marshes harboring the largest protected populations of caimans, marsh deer, river otters, yellow anacondas, and other marshland species in Argentina. The ranch owner, Marcos García Rams, was very proud of his efforts to maintain wildlife while running a lucrative trade in cattle. Flooded areas that were too deep for cattle were perfect for aquatic fauna, such as caimans. Argentina is not very wide, but stretches over an enormous range of latitudes, so it has a range of biomes, and wildlife, much greater than other country in South America.

I was again seeing wildlife living together with intense human activity around the floodplains of large rivers, whether they are in the Venezuelan Llanos, the Pantanal of Brazil, or the wetlands of the lower Paraguay-Paraná River drainage. The Iberá marshes look open, but the wildlife finds places to hide, often under heavy hunting. In retrospect, it is perhaps obvious why flooded wetland faunas are so resilient. Marshes and swamps are geologically ephemeral, rarely lasting more than a few tens of thousands of years, a period too short to generate many new species. Therefore, wetlands generally have few endemic species, but have many species that are extremely adapatable and that can disperse to new areas when the old marshes dry up. This gives them an advantage over species from other biomes when dealing with changes brought about by humans. I was reminded of a conversation I had with Guilherme Mourão about the role of fire in the Pantanal. Guilherme had isolated some paddocks from fire and was following the changes in vegetation after several years without fire. I commented that it would be interesting to see what the Pantanal looked like

before it was invaded by man. He said in Portuguese “Bill, the Pantanal formed about 10.000 years ago, which was about the time that humans colonized South America. The Pantanal has always had humans and their fire.” Realizing that he was right, I started to re-evaluate my concept of “pristine.”

I was grateful for the opportunity to see this part of Argentina, but I had to return to Buenos Aires because my return flight could not be changed. Tomas dropped me off in Posadas to catch a bus back to Buenos Aires. It was a typical dusty disorganized frontier town of Latin America, but the bus was new and comfortable. An attendant brought around watered down fruit juice soon after I was seated on the bus and I gulped it down because I hungry and thirsty. I probably wouldn’t have drunk anything but bottled water if I had been on the street, but I foolishly didn’t think that the water in the juice must have been the same quality as that being offered in the squalid stalls around the bus station.

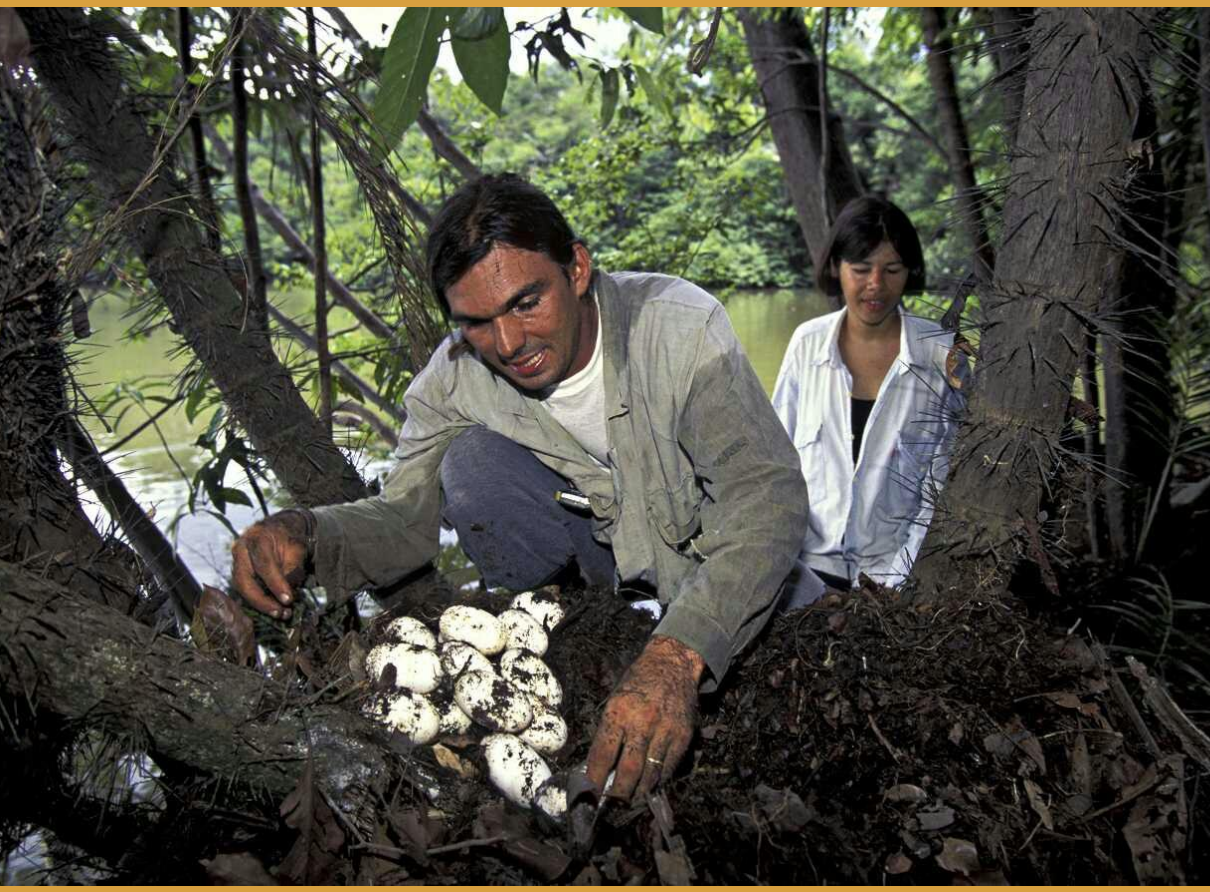
If you live a place for long enough, your intestine adjusts to the new flora present in the local water and you can drink as much as you like. However, the variety of organisms is different in each place. Even the ubiquitous *Escherischia coli*, which lives in all our intestines, has different strains in different regions, and these can make you feel very sick until you adjust to them. Whatever was in that juice was not good for my intestine, and the dysentery hit me hard. I can tell you very little about the landscape on the way back because I spent most of the 16 hour trip doubled over in agony in the stinking toilet, trying not to be thrown against the door when the bus hit a pot hole or the driver braked suddenly. I hope that nobody else on the bus had a great need to use the toilet, because I didn’t give them much opportunity.

It was not a very good send off, but most of my memories of Argentina were extremely positive. It was not only one of the most diverse countries in terms of landscapes and wildlife, it also had a much higher number of people dedicated to

conservation and wildlife management than I had found in any other South American country. Many of the people lived in close contact with wildlife, and their experience would shape many of my conclusions about the supposed fragility of wildlife and the evils of hunting. Give most species enough good quality habitat and they can look after themselves. That means that you can spend more time and resources on those species and landscapes that really need it.

17

Mamirauá



Ronis and Barbara Da Silveira inspect a black caiman nest in Mamirauá reserve. Photo by Luiz Cláudio Marigo.

During my first year in Manaus I sometimes shared accommodation with Márcio Ayres, who was two years younger than me. We engaged in urban adventures typical of young males, but Márcio was much more politically mature than I was. Brazil's foremost herpetologist at the time, Paulo Vanzolini, tended to have a one-word, or short phrase, description of those he worked with. His word for Márcio was "dangerous," not disparaging or indicating that Márcio was violent, but indicating that beneath his easy going exterior, Márcio held a unique combination of determination and political savvy.

Márcio later studied white uakari monkeys in the flooded forests between the Amazon and Japurá Rivers near Tefé for his Ph.D. The area had already been described as meriting conservation status by Márcio and other prominent conservationists, but during and shortly after his Ph.D. Márcio set about making it a reality. He convinced the Amazonas State government to create a new category of conservation unit, a Sustainable Development Reserve (RDS), where fauna and flora could be conserved without removing the local people. He also convinced the Federal government to create a Sustainable Development Institute to support the reserve scientifically, and obtained financial support from the Wildlife Conservation Society (WCS), an international body based in New York. Locally, he enlisted the support of other professionals, notably his first wife, Deborah Lima, an anthropologist whose work with the local people led to a reduction of 50% in infant mortality in the reserve in the first five years. The reserve was called Mamirauá, which is purportedly a local name for a baby manatee, and the name of the largest lake in the southern sector of the reserve. Márcio gained international acclaim for his work, including the Duke of Edinburgh Conservation Medal, but unfortunately died of cancer at 49 years old, just when his intellectual and political capabilities were at a peak.

Márcio was a role model for Ronis Da Silveira, and, after defending his Masters thesis, Ronis obtained funding from WCS to study caimans in the RDS Mamirauá. Ronis was an imposing figure, with long hair tied back in a pony tail that came almost to his waist. His looks were carefully tended to appeal to the opposite sex, and everyone assumed that he would remain a carefree bachelor for a long time. When he said that he would marry a young urban girl just out of high school and take her to live on a floating house in the middle of one of the most isolated reserves in the world, the other students laid bets as to how long she would last in the primitive conditions. They, and I for that matter, were very wrong, and Barbara loved the life on Lago Mamirauá. They remain happily married to this day.

By this time, Ronis was one of Brazil's most experienced caiman biologists, and he had no need for me to teach him about field techniques, but I was supervising his thesis and I went to see his field site soon after he started research in Mamirauá. The Institute was extremely well funded. Márcio had told me that, to be effective, a reserve needed financing equivalent to at least one US dollar per hectare per year. For a reserve the size of Mamirauá, that meant over a million dollars per year, an amount that few biologists except Márcio could dream of raising. We travelled from Tefé to the floating house at the far end of Lago Mamirauá in an aluminum canoe with a powerful outboard motor. It is over 20 km along the Amazon to the mouth of the lake, which has the form of a long thin canal and is itself over 20 km long. We stopped to talk to Mamirauá staff on the floating bases, and the trip took several hours. The Amazon has strong currents and the wind makes the surface choppy, so that part of the trip was not very comfortable, but once on the lake, which is less than 200 m wide, we skimmed over the glassy surface. Lago Mamirauá now has a floating tourist lodge, but at the time only local fishermen ventured into it.

At high water, the river floods the forest with water up to 10 m deep from the dry land on the south bank of the Amazon to that on the north bank of the Japurá River, a distance of over 50 km. However, this was the low-water season and Mamirauá Lake was one of the largest channels cutting through the forest and fields of the várzea. In this season, all the aquatic fauna was concentrated in an area less than 1% of that available at high water. Fish jumped as we sped along the channel, and I often had to duck to avoid being hit in the face by fish weighing over a kilogram.

The wooden rooms built over floating logs that constituted Ronis' and Barbara's home were anchored a few dozen meters from shore. It was an idyllic setting. The logs that supported the house were over a meter in diameter, and nestled into the placid water with only a handspan of their gnarled wood above the surface. Only an occasional splash of a rising fish broke the surface of the lake, and squirrel monkeys played in the trees on the bank. I sat on the planks supporting the house and looked into the dark transparent water. The Amazon and Japurá rivers are muddy and largely impermeable to light, but the sediment decants in the lakes during the dry season, allowing visibility to about a meter in depth. Angel fish and other aquarium oddities swam around the logs and I wished I had an underwater camera to record them.

Ronis said that a large caiman sometimes appeared near the floating house, but there was none to be seen on that day. I sat and worked on a book I was writing while Ronis and Barbara prepared lunch. It was an atmosphere conducive to contemplative work, and I could think of no better place for an extended honeymoon by the young couple. Occasionally there would be a plonking sound as an air-breathing Arapaima fish over two meters long gulped a breath and disappeared back into the dark water.

After lunch, Ronis took me to see the shallow end of the lake where he said the black caiman were concentrated. He was already master of this watery world. I sat in the bow of the aluminum canoe and looked back at Ronis piloting the canoe, his wind blown face framed by the floating house and Barbara waving goodbye, and thought of how far he had come since that time in Anavilhanas when I had fished him out of the water after he fell in trying to catch a caiman.

The lower reaches of the lake have relatively steep banks, populated mainly by small black and spectacled caimans. The densities of caimans there would have been considered high in the Anavilhanas, but the caimans in Lago Mamirau á apparently preferred the shallow inlets further from the large rivers. Although the lake is still wide in the upper reaches during high water, during the dry season the water recedes to the central channel, leaving wide plains of mud flats with sparse cover of grasses and sedges. I had seen high densities of caimans in the Pantanal in the dry season, but never anything like those on the upper reaches of Lago Mamirau á Ronis had estimated densities of over 1000 caimans per km, or one caiman for each meter of bank, in the lake in the dry season, but even this does not give a good idea of the abundance of caimans because it was an average over the whole lake. In many areas, there were tens of meters between each caiman. In the shallow inlets, the caimans were lined up parallel to the bank, and there were often dozens of caimans per meter of shore.

Ronis brought the boat into the shallows beside the apparently unconcerned caimans. All were black caimans more than two meters long, and some were well over three meters from nose to tail tip. The raised dorsal crests on their black backs gave the caimans a sinister look, like the partially decomposed cadavers in horror movies, and the powerful muscles under the grey necks made even the broad heads look small. If they didn’t move, it would litterally have

been possible to walk on their backs the dozen or so meters between the boat and the bank. However, I was not about to put that to the test.



Photo. 17.1 *Ronis and Bárbara capturing a large black caiman. Photo by Luiz Cláudio Marigo.*

The black caiman had been considered endangered, and the species contributed only about 10% of the skins confiscated by IBDF in a study by George Rebêlo and I only a few decades before. It was obvious that the species had not been on the brink of extinction even when it was difficult for hunters to find them, and that many large animals, especially breeding females, had persisted in the myriad inaccessible lakes of the varzea forests.

At night, the reflections of the caimans' eyes in the spotlight made the inlets look like little cities seen from an airplane. Ronis and several other former students of mine would study the caimans of RDS Mamirauá and discover many interesting things about their biology. Large black caimans in the várzea generally don't eat a lot of mammals, simply because there are not many species of mammals that can survive in an area that goes 10 m underwater every year. One species that can survive under such conditions, the jaguar, is a major predator on caiman eggs. That must make life dangerous for females defending nests. Taking on a tegu lizard or a coatimundi stealing eggs in the Pantanal would be much different from defending a nest from jaguars, which often kill and eat even adult caimans.

I spent little time in Mamirauá, and my former students received much more financial and technical support from John Thorbjarnarson, a crocodilian specialist with the Wildlife Conservation Society. I was very greatful for the collaboration with John, because crocodilian research requires a lot of dedication and, although I am fascinated by the animals, I have never really been a crocodilian specialist. John helped people throughout the world, and the caiman research in the Amazon would have been much poorer without John's contribution. Unfortunately, his work was cut short unexpectedly.

Malaria is common in many parts of the Amazon, but it is not usually life threatening to people with access to treatment. In fact, the local doctors

recommend that you do not take prophylactic medicines because they have undesirable side effects, and may mask the symptons and delay a definitive cure. I have never had malaria, and the only researcher from my institute who died from malaria was taking prophylaxis, so he did not know he had the vivax strain until he contracted the falciparum variety, and he suffered from near terminal cirhosus of the liver in any case. The situation is very different in Africa, where malaria is much more dangerous. One of our students completed her masters in the Amazon and then went to Africa to start her Ph.D. She was dead within a month from malaria, despite hospital treatment. Zilca introduced me to a French researcher who was still suffering the side effects of African malaria 10 months after being cured. He arrived in Brazil with it and the doctor saved his life by putting him into an induced coma. One of his colleagues was given exactly the same treatment, but did not survive. John Thorbjarnarson contracted cerebral malaria after only a short visit to Africa, but he did not know it until he went to India and was admitted to hospital with severe symptons. They could not save him. I admire the courage of the biologists who work to save the wildlife of the African continent, but I am glad that I have generally worked in Australia and South America, places where the dangers are often more apparent than real.

Despite the rather benign environment, and black caimans being the pussy cats of the big crocodilians, you should always respect a big carnivore, and never underestimate a crocodilian. In December 2009, Deise Nishimura, a 25 year old student studying Amazonian river dolphins was living in the same floating house that had been used by Ronis and Barbara. She reported that her routine had been to wake at 5:30 am and spend five hours observing the dolphins. She would then have lunch and spend the rest of the day working up the data on her computer. A four meter caiman called Dorotéa (Dorothy in English) lived under the floating house. Black caimans often hang around humans when they are not persecuted. I have a photograph of a black caiman

given to me by Louise Emmons, a researcher who studied mammals in Cocha Cachu in Peru during several years. She said that the 2 m caiman would swim with them when they were having a bath, and they had to be careful not to leave the soap on a log because the caiman would eat it.



Photo 17.2 *A large black caiman under the kitchen of a floating guest house near where Deise was attacked. Photo by Bill Magnusson.*

Deise was cleaning a fish for lunch when Dorotéa lept a meter out of the water, grabbed her leg and dragged her into the lake. The caiman spun and Deise said that she stuck her fingers into two holes in its head, which might have been its eyes or its nostrils, and it let go. However, it is very unlikely that Deise's fingers had any effect. In fact, the caiman did not let go – it had spun off her leg.

The floating house was four meters away, but Deise managed to swim that distance, drag herself up the boat ramp and radioed for help. By luck, one of the Mamirauá support boats was nearby, and she was in hospital in Tefé within an hour, where there was a doctor specialized in amputations. Many improbable circumstances combined to save Deise's life. The most unlikely was probably that the caiman's "death roll" that had torn off her leg had also knotted the skin, blocking the femoral artery. If that had not happened, she probably would have bled to death before being able to get out of the water.

We will never know why Dorotéa grabbed Deise's leg. Perhaps she regarded Deise as prey, but in that case it seems unlikely that she would have taken only the leg of a small woman, which would not be much of a meal for a big caiman. Perhaps Dorotéa thought she was grabbing the fish and had no intention of harming Deise. I suspect that researchers who had been living on the floating base before Deise had been feeding her. In any case, the local fishermen killed Dorotéa the next day and retrieved Deise's leg. Deise said that she was sad that they had killed the caiman, and the last I heard she was waiting for an artificial leg to be fitted so that she could return to her dolphin studies.

The local people in the Amazon often complain about the densities of black caimans because the say that their lives are threatened and they want hunting to be liberated so that they can control the caimans. In fact, this is a bit of a distortion. As Deise's story illustrates, black caiman can be a threat. However, most serious injuries from caiman "attacks" seem to result from bites of spectacled caimans that have become entangled in nets and appear to be dead. The apparently dead caimans often bite when the unsuspecting fishermen try to take them out of the net, causing serious injury, often accompanied by life-threatening infections. Even if they don't bite, the caimans destroy the nets on which the fishermen depend for subsistence. Fishermen regularly killed caimans

and river dolphins because they damage nets, so the argument that the law needed to be changed to allow them to do so was obviously false. What the fishermen were asking for was the right to benefit economically from the caimans they killed.

Local people have always hunted caimans. When there was a market, they hunted them for their skins. When the skin market dried up, caimans were hunted for meat, which was dried, salted and sold mainly in the State of Pará as caiman, or in Colombia as Arapaima. Because the markets are illegal, transporters face the greatest risks, and the highest profits. Local people receive very little. Often it is more economical for the fishermen to use caimans or river dolphins only as bait in traps for mota catfish, which can be sold legally. I would not be happy about creating a new market for a wildlife species, and do not believe the US doctrine that wildlife has to be hunted to be healthy. However, a controlled harvest of a species already hunted extensively could reduce the number of caimans taken, and greatly increase the profits going to local people. After decades of discussion, the federal wildlife officials finally permitted caiman hunting in sustainable-use reserves under the new conservation-reserve legislation.

Mamirauá was the logical place to initiate controlled harvest because Ronis and John had shown that there was already intense illegal use, and that there were high densities of caimans in most of the reserve. Subsequent studies by another former student of mine, Robinson Botero, confirmed these results, and Mamirauá already had legal fishing for Arapaima, a large carnivorous air-breathing fish found in the same lakes as the caimans. The fact that caiman meat could be treated like fish, and was often sold as fish, indicated that the meat might be a product as important, or more important, than the skins.

There was apparently little impediment to the inclusion of caiman hunting in the economic activities of the local people, and there was every indication that this would be positive for them economically, and for their attitudes towards caimans. However, I was again to find that crocodilian management often has little to do with logic and science, and much to do with self interest and emotions. The federal agriculture department licenses processing facilities and certifies meat products. The problem is that they require the same conditions for the slaughter of caimans as they do for cows. This is probably understandable, because the technicians are mainly veterinarians, and have never had contact with caimans. However, it goes against the best practice developed in every other country in the world where crocodilians are harvested, and against the wisdom of the local people, who have been hunting and eating caimans for centuries.

In the USA, alligators are treated as "seafood." That is they can be killed and processed like other cold-blooded animals, such as fish. In contrast, cattle have to be trucked to an abatoire, knocked unconscious, bled and processed under controlled hygienic conditions. Trucking a domestic animal is one thing, transporting a wild animal is another. Careful studies in Mamirauá showed that the worst thing you could do was tie up a caiman, transport it to an abatoire and process it. As soon as you tie it up, stress levels lead it to turn off its immune system and pathogenic bacteria start to proliferate in its flesh, making it inedible after a few days. It is possible to construct floating abatoires, and the Amazonas State Government, mainly under the guidance of a young biologist Sônia Canto, invested a lot of time and money to get one started in the RDS Mamirauá, but even that did not satisfy the veterinarians.

Even if it were possible to construct abatoires in a few locations in Amazônia, the high technology necessary would restrict them to a few locations, and most

of the profits would go to a few business men, again sidelining the local people. I contacted the CSG members in Australia and the USA, and they invited state government representatives to inspect crocodilian production facilities. The state government representatives came back convinced that crocodilians could be treated like fish. They had photographs of alligators that had been killed the day before being processed under primitive conditions with a minimum of care to hygiene. They even took photographs of the dirty fingernails of the people handling the grey chunks of meat, which were left in chemicals overnight to bleach before being packaged for sale. They were sure that they could design processing facilities that would be much more hygienic than those used in the USA.

Despite all the evidence that they were advocating bad practice, and inviabilizing an industry important to the local people, the federal government agriculture officials would not budge. There are vested interests. The caiman ranching facilities in the Pantanal do not want competition from wild meat that does not have to be launded through their operations. An abatoire requires the presence of a veterinarian, and the veterinarians do not want to lose that market for their services. Nevertheless, there are well-meaning conservationists and veterinarians who support the restrictive legislation. It is not because they have bad intentions. It is just that their air-conditioned offices are so removed from the reality of the Amazonian people who live with, and who are responsible for the conservation of caimans, that they simply can’t understand.

18

Thailand



Thai culture emphasizes dragons, elephants and the Budha, but not crocodiles. Photo by Bill Magnusson.

The CSG held a regional meeting in Thailand in 2011. Albertina and I had been married 18 years by this time and she was keen to visit Thailand because she loves Thai food. I was also interested because crocodile management in Thailand had been talked about since the first meetings of the CSG. Utai Youngprapakom had been farming crocodiles in Thailand since the 1950s, and the propaganda for the crocodile farm and the reports at the CSG meetings indicated that the industry was largely responsible for the continued survival of *Crocodylus siamensis*, one of the most endangered crocodiles in the world. Thailand has a high population density, and I wanted to see a place where people were so dense that even a swamp crocodilian could not survive.

Youngprapakom is such a Thai sounding name that I was surprised to learn that Utai Youngprapakom came from a family of Chinese immigrants, and that the name had been adopted to avoid prejudice against Chinese by traditional Thais. Thailand had the largest crocodile farming industry in the world, but it was not the outgrowth of traditional knowledge about crocodiles and their ways, but an intensive business that had been created by recent immigrants who knew almost nothing about wild crocodiles.

The terminal in Bangkok was the largest and most modern airport I had seen, and it was decorated with an outstanding variety of orchids. There were literally tens of thousands of them in intricate displays. There were also giant statues of the Budha and images of Hindu Gods. The delicate aesthetic balance between high technology, floral arrangements, and spiritual worship was like nothing I had experienced before. We would travel into areas of Thailand where the people were very poor, and the technology was more at the level of bicycles than airplanes. Nonetheless, everywhere we went, people devoted much time to make their homes aesthetically pleasing, often with floral arrangements, and the air of spiritual devotion permeated everything.

There seems to be a temple on every street corner in Thailand. I am sure that if you had a motorcycle and a good map you could see a thousand in a day. Albertina and I went to some of the oldest and most famous, but temple visiting soon becomes tedious because we didn't remember whether that outstanding dragon statue was the one we saw yesterday or the day before, or the day before that or …. You don't have to travel far in Thailand to conclude that the Thais have fixations for the Budha, for dragons, and for elephants. Their statues are everywhere, and where there is no statue there will be a painting, a tapestry, or a floral arrangement depicting one of them.

Dragons may have elements of crocodiles in them. They appear to be hybrids between snakes and large four-footed reptiles, such as crocodiles. However, we saw few explicit crocodile effigies. Topiary, or the art of clipping trees and shrubs to make living statues, is very popular in Thailand, and some were so complex that they represented flying birds and rearing elephants. However, we saw only one living statue of a crocodile, and that was in the dividing strip of a busy road in the middle of Bangkok. Among the thousands of statues and carved reliefs in the walls of temples, we encountered only one crocodile. It was about 1.5 m long and carved into the wall beside one of the landings on a staircase that led to a temple. Although impressive, it was dwarfed by the glossy jade-colored ceramic scales of the dragon that accompanied the stairs for over 100 m. Crocodiles had obviously not been dominant features in Thai traditional culture.

There was a strange contrast between the open and friendly Thais, who made you feel instantly welcome, and the millennial culture that would obviously take many decades to start to understand. We spent many hours strolling through the food markets trying to imagine how the thousands of types of fruits, vegetables and animals could be combined into the delicious Thai food. We even spent half

a day in a cooking class, but that only got us into the most basic cuisine. The variety in the markets was astounding. Every stall appeared to have a different combination of colors, shapes and fragrances. I took hundreds of photographs because every display was a work of art. I am sure that the people who ran the stalls did not earn very much money by our standards, but that did not stop them from devoting time to make their little patch of the market spotlessly clean and aesthetically pleasing.



Photo 18.1 *A crocodile motif beside a stairway to a temple in Thailand. Photo by Bill Magnusson.*

We travelled to the most famous tourist spots, and spent time in Chiang Mai during Songkran, the Thai equivalent of New Year's Eve. Originally, the Bhudist monks had sprinkled water on the faithful in a staid ceremony, but modern Thais now drive through the streets in pickup trucks with 200 litre drums of water spraying everybody in sight. Tourists run around with water

guns, and the major hotels have an attendant at the door with towels so that you can dry off before entering the hotel after venturing onto the streets to see the parades. It was a lot of fun.

We also went to an elephant park, where we could ride on the elephants, watch them loading logs in an arena, and even see them painting quite complex scenes with their trunks. It was easy to see why elephants were so revered in Thailand. Before the industrial age, they had been the principle heavy machinery for Thai society, which until comparatively recently was far in advance of anything in Europe. However, we saw no wild elephants. To see those, or any other truly wild animals we would have had to travel into the forest near the border with Myanmar, which would have taken too much time, as well as being dangerous due to military tensions between the two countries.

The beautiful temples, organized markets, and tourist parks are obviously not the only elements of Thai society. We were warned not to walk around some areas of Bangkok, and some aspects of the law seemed repressive. You could be jailed for criticizing the king or a member of the royal family. Once, when we were travelling around a temple complex in a horse-drawn surrey, the guide made an unexpected stop and took us into the garden of a suburban house. Half a dozen young men were standing around table on which stood an impressive cockerel. The ancestors of domestic chickens were native to Thailand and other regions close by, and this cock showed his wild ancestry by his glistening feathers and defiant stare.

The men were interested in the bird because it was a prize fighter that they said was worth about US$ 10,000. I was pretty sure that cock fighting was illegal, and that those men did not gain their earnings by any legal means. They did not seem at all concerned, however, and invited me to stand among them beside the cockerel while the guide took a photo. I still have the photo, but I

would not post it on the web because I could imagine being taken aside the next time I pass through US immigration and an agent asking "What is your relationship with these men?" How do you explain that you were befriended by a group of cocking fighting mobsters on a temple tour?

Although I was fascinated by the Thai culture, and how they incorporated animals and plants into their lives both physically and spiritually, I wanted to see more natural landscapes. I was also getting a little stressed out by continually being surrounded by hordes of people. Therefore, one day when Albertina decided to investigate one more market and have one more Thai massage, I took a hiking tour through the forest to visit a village of one of the hill tribes.

I did the walking tour with two young American tourists. One of them chattered continually about her life in suburban USA and her college course. The other did not talk as much, but she only looked away from her feet when the guide stopped and pointed something out. It seemed strange to me to go into the wilds of Thailand and spend all your time talking about the USA, but I remembered the aboriginal hunters I had worked with who could stand chatting in the boat without missing anything that passed by on the bank. I wondered if these tourists had that ability and I was just judging them by my limited capabilities. In any case, the continual nattering got on my nerves and I walked well back or well forward of my companions, which meant that I missed a lot of the things that the guide said.

I was disappointed by the tour. The "forest" turned out to be mainly bamboo regrowth and degraded farm land. The hill tribes were not the original inhabitants of the area that I had expected, but recent immigrants from China who had colonized the forest on the steep slopes about 80 years before because the best arable land was already occupied by the Thais. I walked down the steep

roads and looked at the fields of pineapples and bamboo, interspersed occasionally by low regrowth forest or isolated giant forest trees draped in orchids and other epiphytes that no longer formed part of a viable ecosystem, and were just waiting their turn for the axe. Trucks laden with cabbages rumbled past, carrying the life of the hills away to the bustling cities. Not only did I not see any old-growth forest, I did not meet anyone from a traditional culture who had seen it.



The CSG conference was held at Mahidol University in Bangkok. Like everywhere else in Thailand, the university was well organized and aesthetically pleasing. The lakes and canals throughout the campus were populated by many species of waterbirds, and giant monitor lizards stalked across the lawns. I was surprised at the number of people concerned with crocodile conservation, not only in Thailand, but in the neighbouring countries, such as Laos, Cambodia and Vietnam. In most areas, poverty, lack of educational opportunities, and previous attempts at domination by colonial powers had led to terrible wars, and made conservation difficult, and not usually a priority for politicians. Nevertheless, these people continued to spend their time, and often to risk their lives, to save crocodiles. Most of the conservation activities were associated with economic exploitation of crocodiles, because the local people generally had to be concerned with the survival of their own children, and only after that was assured could they devote time to crocodile conservation.

I learned a lot at the meeting, and enjoyed catching up with CSG members, some of whom I had seen at the CSG meeting in Manaus in 2010, but many of which I had not encountered in over a decade. I felt a little out of place, however, because this was a regional meeting and I didn’t have much to

contribute that would be useful to local crocodilian biologists. Nevertheless, I made some suggestions as to how the CSG web site could be made more user friendly, and they were adopted, so maybe I did contribute something, even if only indirectly.

It was the field trip after the meeting that I most wanted to participate in. I had seen that the Thai lowlands were mainly devoted to rice paddys, and there was little free water for crocodiles. Even the canals that irrigated the fields were fenced off in sections for fish culture. There are far too many people in Thailand to support with conventional livestock, and most of the protein consumed comes from fish or crustaceans raised in association with irrigation canals.

We were taken to an impressive crocodile-conservation breeding facility, and strolled along steel walkways over large naturalistic ponds in which Siamese crocodiles bred. Their nests looked like those of saltwater crocodiles. In fact, I could see nothing to distinguish the Siamese from the saltwater crocodiles, except perhaps their size; the Siamese crocodiles were slightly smaller. The Thais said that Siamese crocodiles are docile and never attack people. In fact, most of the crocodiles on the farms are hybrids between saltwater crocodiles and Siamese crocodiles, because the farmers wanted the high value of the hide of saltwater crocodiles mixed with the docility of the Siamese species. Although the Thais said that there would be no danger in reintroducing Siamese crocodiles into areas with people, I was less sure. My experience with black caimans made me wary of mixing even docile species of large crocodilians with high densities of people. I asked Grahame Webb what he thought, and he replied “You wouldn’t get me in the water with those crocodiles.”

The fact that the Thai farmers had hybridized the two species of crocodiles, and then passed breed stock to other countries, such as Cambodia, worried me. If the conservation were to be based on captive breeding, it should be based on

pure lines of each species. Hybrids could look like either parental species, so expensive genetic analyses were necessary to determine whether farm raised animals could be released without endangering the genetic integrity of any Siamese crocodiles that might still occur in the wild. However, the Thais said that was not a problem, because there were no wild crocodiles left in Thailand.



Photo 18.2 *A captive Siamese crocodile. Photo by Bill Magnusson.*

After the breeding facility, we went to a huge lake where the researchers associated with the university intended to release Siamese crocodiles, once they had the results of the genetic analyses to determine which captive-bred animals were genetically pure. Having pure stock was not only a question of conservation concern. Saltwater crocodiles are man eaters, and having just one child eaten could undo years of conservation education.

The lake in fact was a huge dam that provided an aquatic landscape that stretched to the horizon. The research station had an aquarium with live examples of the fish from the lake. There were more than fifty species just in that one lake, a diversity that was not more impressive than that in Amazonian lakes, but which made the Australian freshwater fish community look miniscule. As I walked around the aquarium, I marveled that the fish survived intensive fishing, but the crocodiles had been wiped out.

We travelled onto the lake in two large flat-bottomed boats, each of which took a dozen people. The boat was powered by an air cooled motor with a propeller on a long shaft that stuck straight out behind the boat. Motors with a similar design are often used in the Amazon to power canoes because the motor can be light, placed slightly forward of stern, and the shaft can be lifted if the water becomes too shallow, or choked by aquatic vegetation. In fact, the water does not have to be deeper than the diameter of the propeller. The Thai boats, however, had automobile motors powering the drive shafts. The system was noisy and looked ungainly, but the boats moved along at a good speed, despite the large burden of crocodile biologists.

The banks of the lake were lined by floating grass mats, with occasional stands of trees that served as roosts for herons, cormorants, and other fish-eating birds. In the middle of the lake, huge areas covered by lotuses and other lilies were dotted by the pointed ends of rustic fish traps. Bright pink eggs of snails, similar to those I had seen in Brazil, hung from the plants and the traps. This was a different world from the closely tended rice paddys around Bangkok. I could not imagine the effort that would be needed to exterminate a marsh crocodile from the hundreds, or perhaps thousands, of square kilometers of aquatic vegetation.

One of the Thai speaking participants asked the fisherman who drove the boat if he had ever seen a crocodile on the lake. He replied that you could see 10 or 20 crocodiles within a few hours if you went out at night. It seemed incredible that the researchers planning to release captive bred crocodiles did not know that there were still crocodiles there. Releasing captive bred crocodiles in that situation could be a disaster. They could transmit diseases to the wild crocodiles, and if they were hybrids they could dilute the genetic pool. Worse still, if someone were attacked by a crocodile in the future, the local people would not consider it an act of the Gods; they would blame the scientists.



Photo 18.3 *A field trip to see crocodile habitat in Thailand with CSG members. Photo by Bill Magnusson.*

I appreciate the good intentions of the researchers, mainly veterinarians, who want to save the Siamese crocodiles based on farm raised animals. Nevertheless, I think that experienced field biologists should survey the waterways of Thailand

before any releases are permitted. The animals that the fishermen see may even be hybrids that escaped from a crocodile farm. I did not visit a commercial crocodile farm while I was in Thailand, though most have tourist outlets. I get depressed at seeing captive crocodilians when most other people are quite unmoved, but, when I checked the TripAdvisor rating for Thailand's most famous crocodile farm in 2014, I found that only 25% rated it as excellent, and 36% rated it as horrible. I suspect that I would have been depressed. Heavy rainfall at the end of 2011 led to flooding of many crocodile farms around Bangkok, and the escape of many crocodiles, most of which were probably hybrids. Newspapers reported that a man was attacked by one of those crocodiles, but I don't know whether it was an unprovoked attack or the man was trying to catch it.

I came away from Thailand less convinced that farming crocodiles is an important conservation tool. It may be in theory, but if the Thais, who have been successfully farming crocodiles for over 50 years are unable to show that it has positive conservation effects, and have documented negative effects, such as genetic degradation of an endangered species, perhaps it should be approached with much more caution. Maybe, if the Chinese immigrants hadn't started farming crocodiles in the 1950s, some Thai field biologist would have invested in the conservation of the species in the wild, as happened in so many other countries during the same half century, and the Siamese crocodile would be much better conserved, or at least we would know its true conservation status. I hope that the Siamese crocodile is looking after itself as well as most other swamp crocodilians, and that one day we will find out that it didn't really need the well-meaning veterinarians.

19

The Caiman that is Everywhere and Nowhere



Cuvier´s Dwarf Caimans have high dog-like heads. Photo by Xavier Desmier.

Specimens of Cuvier's Dwarf caiman, *Paleosuchus palpebrosus*, and Schneider's dwarf caiman, *Paleosuchus trigonatus*, were among the first caimans I was given when I arrived in Manaus. Nevertheless, I encountered few of them when I surveyed the major rivers. The literature on them was also confused, and I sometimes had a hard time telling them apart. I was particularly intrigued by the Cuvier's dwarf caimans, because they had high dog-like skulls, very different from other crocodilians I had seen. A researcher in Venezuela once suggested that they have a unique skull structure because they are specialized on feeding on the young of other crocodilians, but I have never seen any evidence that they eat other caimans.

Andy Ross of the Smithsonian Institution wrote to me and asked if I could write accounts for the genus and two species of *Paleosuchus* for the Catalogue of American Amphibians and Reptiles. Federico Medem had given me his monographs on South American and Colombian crocodilians, written in Spanish, which included detailed revisions of the taxonomy of all species, so I imagined that it would be easy to translate the relevant sections and update the literature. There was also an old Brazilian monograph on the species by Antenor Carvalho, written in Portuguese, which had a key to the species[107].

I soon found that the taxonomic status of the species was much more complicated than I could have imagined. The original specimen of *Paleosuchus trigonatus* described by Schneider had been lost, but his figure suggested that it had in fact been a specimen of *Crocodylus niloticus* from Africa. The priority rules in the International Code on Zoological Nomenclature meant that the well established names for African and South American crocodilians would have to be exchanged, with implications even for the Family names. I therefore had to obtain the original publications, written in Latin, and study the nomenclatural rules to see if that could be avoided. This was in the days before the internet,

and every time I received a publication it would point to others that I would have to request by post, and wait weeks or months for the material to arrive in Manaus.

Even the descriptions of the species were vague, and the type specimen of *Paleosuchus palpebrosus* had been lost during the bombing of Berlin during the Second World War. I had to rely on the opinions of specialists who had seen the specimen while visiting the museum for other reasons. Fred Medem described the species, but also showed photographs of individuals that he considered hybrids between the two species. He had also documented locality records for the species during his travels through Brazil that seemed erroneous. I had to ask a colleague to revisit a museum he had been to and check the locality records with the curator, and this took much more time than I expected.

Most of the descriptions of the species were based on neck scales, but I wanted characteristics that might be more related to functional aspects of the species' lifestyles. A Japanese researcher, Professor Aoki, put me onto scale patterns on the sides of the tail that seemed more interesting. *P. trigonatus* has a flattened tail, and the prominent scutes on the dorsal surface face laterally, rather than vertically as in *P. palpebrosus* and other crocodilians. Both species of *Paleosuchus* have bony scutes, which reduces the flexibility of the tail, but the flat, fat, tail of *P. trigonatus* would be even more rigid, and there is a line of small, lightly ossified scales along the side of the tail that preserves some flexibility.

After several years, Jeff Lang replaced Andy Ross as editor of the accounts, and he required a different style of presentation. I had originally planned to use only figures copied from the literature to illustrate the accounts, but these did not show all the characteristics I thought important, and I had to draw my own figures, which took a long time because of my limited artistic abilities. To cut a

long story short, the accounts that I thought would occupy at most a few weeks of my time, took nine years from the time Andy first contacted me to when they were finally published. I gained new respect for the researchers who devote their lives to disentangling the morass associated with the names we call species.

I had little difficulty distinguishing the species in the field, and have encountered few individuals with intermediate characteristics that might be hybrids. I have even been able to identify individuals confiscated by the federal police from photographs. Nevertheless, I initially had difficulty determining how the habitat preferences of the two species of *Paleosuchus* differed from each other, and from those of other species of caimans.

The few Schneider's dwarf caimans I found around the larger rivers and lakes were adult males or dispersing juveniles. I found no adult sized females. I found a few pairs of male and female Cuvier's dwarf caimans together in the flooded forest when I was surveying Amanã Lake, but they were far outnumbered by the spectacled and black caimans that occupied the surrounding areas. I tried surveying the flooded forests near Alter do Chão, but it was hard to row the boat through the flooded forest. A few times, I was able to pull the boat through the trees to where the caiman had submerged, and I could see the distinctive brown head of a Cuvier's dwarf caiman resting on the bottom, but most escaped before I could grab them.

In the upper Rio Aracá, near the Venezuelan border, I surveyed for mammals along hunting tracks of the local people armed with a six-guage shotgun because our food had run out and we were living off the land. One night, after heavy rain, I found the track covered by knee deep water for several kilometers. In the distance, I could see a crocodilian eyeshine and, knowing that there were no specimens of caimans from that area in museums, I shot high above its eyeshine in the hope that a few pellets would hit and kill it without destroying

the skull. Either because it is difficult to estimate distance or just because I took a lousy shot, the blast took the top off the caimans head. Even so, I could see that it was a Cuvier's dwarf caiman.

I also saw, but couldn't catch, Cuvier's dwarf caimans in palm forests that wind through the savannas of Alter do Chão in the central Amazon and Roraima in the North. The distribution of the species extended from Venezuela in the North to Paraguay in the south, making it one of the most widespread caimans, but nowhere was it recorded as being common or the dominant crocodilian. I developed a theory that the species was adapted to the smaller, more open and more ephemeral waterbodies in the landscape, occupying the spaces that the other species avoided, perhaps because it was much smaller than its potential competitors.

A pair of Cuvier's dwarf caimans that I had in captivity made a nest and guarded it until the eggs hatched. However, they and the Schneider's dwarf caimans I kept in the open pools became covered in filamentous green algae. It didn't seem to bother them, but the spectacled and black caimans, which have much smoother, plastic-like, skin did not become covered in algae under the same conditions. It was obvious that the dwarf caimans must either not spend much time exposed to sunlight in the wild, or they must have some means of killing the algae, because I never found caimans covered in green turf in the wild.

The dwarf caimans were very strong, and it was much harder to hold them than black or spectacled caimans of the same size. Nevertheless, they were retiring and I never saw them act aggressively towards caimans of other species. In contrast, the spectacled caimans could not be kept with smaller individuals of other species, and the black caimans were the epitomy of cowardly bullies. They were submissive as long as they were the same size or smaller than other

caimans, whether the same species or not. However, as soon as they outgrew their rivals, they would attempt to kill them. I could see why Suheil Neves had not been successful at rearing them at high densities in captivity.

I had a research assistant called Sr Eduardo, who had passed through many laboratories and ended up in mine because no-one else wanted him. He had a reputation for laziness and inattention, but I found that assistants tend to reflect the attitudes of the researchers they work with. If the researcher does not work to a tight schedule, and leaves the assistant to resolve complex questions for which he was not trained, then the assistant will not have pride in his work. I gave Sr Eduardo a desk in the laboratory near mine, and I asked him to identify caiman stomach contents that I had collected. As he had a lot of experience with entomology, he took great pride in his work, and we published several papers together. He also took pride in being part of the laboratory and offered to look after the caimans in captivity. He was not very outdoors oriented, but would put on knee-high rubber boots and walk among the caimans, some of which were 2 m long. If a black or spectacled caiman threatened him, he would put his boot on its neck until it stopped thrashing and then grab it from behind, much to the astonishment of bystanders. He was very proud of his ability to subdue the big caimans, and I laughed when the male Cuvier's dwarf caiman, which was only a little over a meter long, not only shook off his boot, but chased him around the pen until he jumped over the fence.

My haphazard observations were obviously not advancing knowledge of Cuvier's dwarf caiman biology very much, though I was sure that I had enough data to make generalizations about diet and the maximum size of the species. I suggested to Robinson Botero that he study dwarf caimans along the BR 319 highway that stretches through 600 km of rainforest between Manaus and Porto Velho. Robin only collected data in a few sites within 100 km of Manaus for his

masters thesis, but the data were enough to convince me that I was right about the species being very small, not usually found in the larger rivers and lakes or in perennial streams in rainforest, but occupying intermittent streams in the forest or areas on the edge of large water bodies that don't have much aquatic vegetation. I confidently predicted that it would be the dominant caiman in all the intermittent streams between Manaus and Porto Velho. Francisco (Pancho) Villamarin has since surveyed streams along the length of the BR 319 and shown that I was completely wrong. Cuvier's dwarf caimans occur only along the start of the highway, not far from the big rivers. The intermittent rivers in the closed-canopy rainforest have only Schnieder's dwarf caimans.

We would probably still know very little about Cuvier's dwarf caimans, and I would still be considered an expert on the species, if Zilca Campos had not decided to study caimans in the small streams that flow into the Pantanal. Some of the streams were very small. Zilca took me to a cattle ranch on the slightly higher ground a few dozen kilometers from the Pantanal that was owned by a business man who lived in the city, but who supported conservation activities. The ranch looked like others in the area; dry and dusty and apparently inhospitable for caimans, but Zilca had captured Cuvier's dwarf caimans in an intermittent stream and fitted them with radio transmitters.

The insistent beeping of the radio receiver indicated that the caiman was nearby, but the antenna pointed into a patch of grasses and sedges a little bit higher than the surrounding pasture, but not very different from other areas of the ranch. Zilca said that the caiman was in a small pool under the grass that might be dry, but we did not disturb it. Its refuge looked more like that which a lizard might use rather than that of a caiman. The stream nearby wound through low dry forest, and was almost dry, with even the deepest pools being less than ankle deep. Zilca pointed out cavities under the banks where she sometimes

found caimans, but it was difficult to believe that crocodilians could live where there was so little water. We surveyed a slightly larger, permanent stream nearby, but found no caimans. Christine Strüssmann had told me that there were Cuvier's dwarf caimans in the streams draining into the Pantanal before, and we had even spent a night surveying for them in one of the crystal clear streams flowing off the Chapada de Guimarães, a sandstone escarpment similar to those around Sydney, where I grew up. I had been in the field catching Pantanal caimans with Zilca for several days before and I was exhausted, so, after walking through debilitatingly cold water up to my chest for several hours without finding any caimans, I swallowed my pride and said that we should call it a night at 2 am. I never saw the caimans near the Chapada de Guimarães, and Zilca's later studies showed that we should have been looking for the caimans in much smaller streams. In any case, I made a mental note to avoid going into the field on consecutive field trips with female herpetologists, because they don't seem to realize that the human body needs regular sleep!

Zilca and Clarence Abercrombie surveyed for caimans in the streams draining the Serra do Amolar, and later Zilca also found them in streams flowing off Serra do Urucum. These streams were larger, but still very seasonal in flow, and subject to large fluctuations in temperature. In the Austral summer they could be 26 ℃, but in winter the cold winds from the south could drop the water temperature to under 13 ℃ and the air temperature to less than 8 ℃. Zilca's studies using radio telemetry showed the caimans to be mainly active in the rainy season, and surprisingly social, with several animals sharing dry season refuges in burrows and cavities under the bank.



Photo 19.2 *Zilca Campos surveys habitat of Cuvier ś dwarf caiman on the edge of the Pantanal. Photo by Bill Magnusson.*

No other crocodilians occurred in the cold streams studied by Zilca, and I remembered that Fred Medem had written that Cuvier's dwarf caimans could be found at higher altitudes and in colder water than other species. The data Zilca collected showed that the streams around the Pantanal were historically a stronghold for the species. Nonetheless, those areas are threatened by uncontrolled development. The owner of the ranch where Zilca had taken me to see the dwarf caimans leased it to a less conservation-minded rancher. He cut the forest, which caused the streams to dry up. It is unlikely that the small amount of pasture gained increased the profitability of ranch very much, and it destroyed critical habitat. Worse still, a biologist visiting the ranch now would probably never know that it had supported dwarf caimans. The dry grass-filled gullies do not look as though they have ever been streams. This is an example of what Ian McHarg called the shifiting base line[108]. Each generation of

biologists sees less biological diversity, but thinks that what he sees represents pristine conditions. Even the larger streams on the rocky hills that are not suitable for cattle raising are not safe. Almost all the streams running into the Pantanal have been dammed for hydro-electric reservoirs. I hope that the resourceful dwarf caimans can find a space in the human-dominated landscapes, but they will never again be the dominant vertebrates in the foothill streams.

The most surprising thing to come out of Zilca's studies was that Cuvier's dwarf caimans were not as small as everyone, including me, had imagined[20]. Most large individuals Zilca captured had lost their tail tips, but if they hadn't they would have been over 2 m long. The species did not have a large body size for a crocodilian, but it was not much smaller than spectacled caiman, and certainly not smaller than Schneider's dwarf caiman.

I would have been happy to affirm that the species grew to larger sizes near the southern limit of its distribution than in the Amazon where I had studied it. However, Tânia Sanaiotti, after finishing her Masters dissertation on savanna birds and her doctoral thesis on savanna plants, started to study Harpy eagles. One of her study areas was in the flooded forest near the Amazon River and she invited Zilca to accompany her into the field to study the caimans there. Just as I and other researchers had found, Zilca encountered Cuvier's dwarf caimans in the flooded forest behind the major lakes. What was different was that Zilca found big dwarf caimans. The average size of the Cuvier's dwarf caimans she caught was just as big as that of the caimans around the Pantanal. Why is it that Zilca can capture large caimans where I and other crocodilian biologists have looked and only found small individuals? I don't know the answer. I looked at her holding the Castilho Prize for Crocodile Conservation, a silver goblet that is the CSG's most prestigious award, at the 2010 CSG meeting in Manaus, and speculated that perhaps it is because she is the World's smallest crocodilian biologist!

20

Reserva Ducke



Sunshine on the black water of Igarapé Acará makes the bubbles formed by the small waterfalls sparkle. Photo by Bill Magnusson.

If you look at a satellite image of Manaus, you will see a large, almost square block of forest on its northern border. That is Reserva Ducke, named after the botanist Adolpho Ducke. In 1979, the block of forest was about three times larger, and ran into almost continuous forest on its northern and eastern borders. Now, the straight borders of the reserve separate it from housing developments and deforested areas, except for some larger patches of forest to the east that are marked for development. Each of the straight edges of the reserve is 10 km long, so the reserve covers about 100 km^2.

When declared in 1952, the reserve was positioned to be as far away from Manaus as possible without crossing the state highway to the north, presumably because it was thought that the area was so remote that it would never have much economic value. As it was planned to use the area for forestry plantations, little thought was given to ecology. Only a few stands of native trees were planted near the main entrance before it was realized that plantation forestry in the Amazon is expensive and unproductive, and the purpose of the reserve was changed to that of studying ecological processes. Fortuitously, the foresters had located it over a ridge that divides the reserve into western and eastern catchments, so the headwaters of almost all the streams in the reserve are at its center, and polluted water flows into the reserve only in a small area near its south-western corner.

Access to Reserva Ducke was along a dirt road running from the highway to the north. The foresters had made some trails in search of rose-wood trees, and there was an abandoned road running 4 km towards the center of the reserve that had been used by petroleum surveyors. However, few people ventured far from the reserve headquarters where there were large wooden buildings for accommodation and dining, and that was where almost all research had been concentrated.

George Rebêlo had recently arrived in Manaus, and I decided to take him and a few other students to camp on a stream that the reserve workers said was at the end of the petroleum-exploration road. The problem was that I knew nothing of the Amazon forest, and local experts only talked about the dangers of jaguars and tropical diseases transmitted by insects. We loaded supplies into backpacks and hiked the four kilometers along the trail, which was not as easy as it sounds, because exploration roads tend not to follow the terrain contours, but run directly up and down hills. The compacted clay soil becomes as slippery as ice after rain, and the heavy packs were unwieldy.

The tiny remnants of rainforest I was used to in Australia survived on the edges of steep escarpments where grazing and agriculture were unprofitable. A few forest giants, meters in diameter were scattered along the trails, but most of the trees were less than 20 m high. Because the hillsides were so steep, you could look out into the canopies of trees rooted dozens of meters below and appreciate the abundance of orchids and ferns growing on the branches in the misty valleys. Reserva Ducke was different. A few of the larger trees on the sandy soil near the streams were thick, less than 30 m high, festooned in epiphytes, and looked like the trees I had seen in Australian rainforest. However, most of the reserve was covered by tall forest, with the canopy over 40 m above us. The straight trunks with no lower branches rose straight up in palisades, making it difficult to appreciate the grandeur of the forest. The understory was dominated by the fronds of trunkless palms. I was starting to realize that the forests that had once covered large areas of eastern Australia, and the Atlantic forests of coastal Brazil, had probably been very different from the remnants clinging to the sides of steep mountains that we see today.

We covered ourselves in a particularly strong insect repellent. Initially we also used boots, long pants and long-sleeved shirts, though it soon became

apparent they were hot and unnecessary. George carried extra supplies of repellent in his pack, as well as enough bread for the three nights we intended to stay in the forest. After the exertion of tramping up and down slippery clay hills, and pushing through the vegetation that had overgrown the narrow track in many places, the sandy soil around the stream was a welcome relief and we dumped our loads and jumped into the water.

The stream was called Igarapé Acará. Igarapé is the Amazonian word for stream, but it is not very descriptive of the size of the water course. Many of the Amazonian igarapés are larger than any of the freshwater rivers in Australia, even though they are tiny in relation to the larger tributaries of the Amazon. Igarapé Acará was only three to four meters wide, and varied from about 30 cm to 1.5 m deep in most places, except where rocky outcrops formed larger pools. The water was transparent, and looked clear in the shallows, but was stained brown by organic acids and the deeper sections were very dark. The road ended at a sandy clearing beside rocky outcrops that formed large pools and small waterfalls less than a meter high. The forest was not very high or dense near the stream, but provided shade from the hot sun. It was a paradise for tired hikers.

The campsite on Igarapé Acará was special. Most of the reserve was covered by deep clayey or sandy sedimentary soils, and the rocky substrate comes to the surface in few places to make deep pools and waterfalls. The indigenous people who lived in the area before Manaus was founded apparently also appreciated the site, because there were deep grooves in the rocks where they had sharpened their axes.

We used the round poles from an abandoned camp to support the plastic tarpaulin we had brought and made a fire. I drank tea and the others had coffee. After the swim, we covered ourselves in repellent to avoid the swarms of biting insects that everyone had said are found throughout the forest. We made

sandwiches to fill our empty bellies. What we didn't know was that the repellent in George's pack had leaked into the bread. As everything smelt of repellent, we didn't realize that the bread was polluted, and we vomited our lunch. That was the greatest danger I have experienced from insects at Igarapé Acará. Fear of them got us poisoned by repellent!

I would learn that most tropical diseases, such as malaria, are associated with humans, and there is little danger of contracting them if you are just 4 km into the forest. Even forest-associated diseases, such as Leishmaniasis, which causes sores that don't heal, are usually associated with forest disturbance, and you are much more likely to catch them on the edge of the forest than deep into it. Even the insects were not as dense as people alleged. The black water was not good for mosquitoes. Although there were some times of the year that they bothered us during the day, they disappeared at night, and we could sleep without nets.

During almost two decades, Albertina Lima and I would hike to Igarapé Acará most Friday nights after work, camp there until Monday morning, and then hike out to go to work. Most of the time, we got around with bare feet, shorts, and sleeveless shirts, and the insects were much less of a nuisance than in most places I have been in Australia and the USA. It was paradise compared to regrowth forest, the mosquito ridden banks of the sediment laden Andean rivers, or the hot townships. Most of the terror stories were urban legends told by biologists who never ventured far into the forest. In the decades we camped on Iagarpé Acará, only two of the several hundred researchers at our institute hiked out there, we never contracted a serious disease, and we were never molested by the jaguars, which are still common in the reserve.



Photo 20.1 *The camp on Igarapé Acará. Photo by Sandy McMath.*

On a subsequent excursion, Albertina and I decided to explore a small creek that ran into Acará just downstream of our camp. We crossed Igarapé Acará where a ledge of rock spread the water to ankle depth before it cascaded over a small waterfall to make brilliant sparkles in the transparent reddish water of the pool below. We clambered along the far bank until we came to the small stream and turned up it. We had not gone 10 m when I saw a small caiman sitting on the bank, but it slid into the water with a splash before we reached it. The stream was less than 50 cm deep in most places, and had a rocky bottom, but we could not find the caiman. Later we saw another caiman about the same size that did the same disappearing act. I was pleased. If the caimans sat on the bank during the day it was going to be easy to survey them. However, first impressions can be deceptive. During the next 30 years I never saw another caiman sitting in an exposed position on the bank during the day.

At night, we saw the eye shines of caimans in Igarapé Acará, but they were wary and I could not get close enough to noose them before they sank into the dark water. I decided that the only way to capture them would be to dive and noose them on the bottom, so I took along my mask and snorkel. At first, I didn't have a diving light, but the acid water was so deficient in electrolytes that I could use an ordinary flashlight underwater. Albertina and I walked up the small stream during the day until we came to a deeper pool near where I had seen the caiman disappear. I dived about a meter to the bottom and shone the light towards the shore. There was a gap of about 20 cm between the rocky bottom and the silty overhanging bank.

By forcing my cheek onto the bottom I could see into the crevice that sloped up under the bank. About a meter in, I could see the head of a caiman I estimated to be about 80 cm long that was up against the far wall. I made a noose from venetian blind cord and fixed it to a forked stick to keep it open underwater, dived to the bottom, and pushed up under the bank. The water was initially clear, but I kept floating up and knocking sediment off the ceiling of the cave. Within seconds, the water became so turbid that I couldn't see anything. It would have been easy with a weight belt, but I didn't have one, so I asked Albertina to stand on my back when I reached the bottom and push down so that I wouldn't have to swim while my head and shoulders were in the cave.

The trick worked and I pulled myself slowly into the cave without stirring the loose sediment from the overhanging roots. The caiman just lay there looking at me, and I carefully slid the noose over its head and around its neck. I had to do everything very slowly so as not to dirty the water or scare the caiman, so I was completely out of breath when I jerked the noose tight and the caiman started to struggle. The caiman stirred up the sediment, and so did I as I attempted to push back out of the cave.

I had no idea how the caiman would react to being noosed, and a bite from even a small caiman on my face could do a lot of damage, especially if combined with broken glass from the face mask. Fear and lack of air made me desperate to get out of the cave, but Albertina, thinking that I was having trouble staying down gripped the overhanging roots and pushed down with all her might to keep me in the cave. I had nothing to push against, and the cord tangled around my arms and pulled off my face mask. I could see nothing, didn't know where the caiman was, and was damaging myself on the rocky floor of the cave and the larger roots hanging from the ceiling. I was exhausted when I finally managed to push past Albertina's feet, and I lay up against the bank as I gasped air back into my lungs. However, the noose was firm, and I knew from the tension on the cord that I still had the caiman.

Diving into caves under the bank would become routine for us, and we captured and marked many Schneider's dwarf caimans, the only species in the reserve, over the ensuing years. Nevertheless, that first caiman, when Albertina almost drowned me, is the one that I remember in most detail. It thrashed as I pulled it out of the cave, and I felt the hard neck scutes bighting into my cold hands when I grabbed it around the neck. Even though it was small, it was much stronger than the spectacled and black caimans that I had captured. It was my first inkling that this was a very different crocodilian from any that I worked on before.



The sun had disappeared behind the crowns of the trees and the cool stillness of dusk was settling in as I walked to the edge of the stream near the camp. I often sat on the bank and watched the light fade away in the evening. It was a time of peace when I could relax and not feel guilty about not collecting data,

because it was too dark to walk without risk of treading on spines or snakes, but not dark enough to make a flashlight effective. I often sat on the rocky banks in front of the camp, but this time I walked the few meters through the forest at the back of the camp and watched the water striders making streaks across the wide pool that stretched upstream for 10 m.



Photo 20.2 *Albertina Lima searching for caimans in Igarapé Acará. Photo by Bill Magnusson.*

In the dark water about 2 m deep I could see a rock moving on the bottom, and I watched it for a few fractions of a second until it struck me that rocks don't move in still pools. I edged to the bank and I could see the vague outline

of a freshwater turtle on the bottom about 3 m away. I had captured freshwater turtles in Australia that could outswim me by running down the bank and using the momentum of the dive to overtake them. However, I was unsure whether I could get up enough speed from a standing start and, without a face mask, I would be able to see less than 50 cm through the dark water.

I decided that it was not worth the risk of going back to camp to get the mask and I threw my legs as high as I could and dove down into the dark water. The turtle could easily have outswum me, but the splash startled it and it pulled its head and legs into the shell for a second, which was long enough for me to slice through the water and grab it with both hands. It tried to swim, and scratched my hands with its sharp claws, but I had it firmly by both sides of the shell as I doubled for the surface.

The turtle was little more than a handspan long, but I got a shock as I pushed it out of the water and held it with its legs flaying in the air above my head. In the dark reddish water it had appeared to be dull gray, but in the air I could see that its head and legs were bright pink. It was the most beautiful freshwater turtle that I had ever seen. I frogged kicked across to the bank and lay up against the roots looking at the spectacular creature in my hands[109-111].

Back in Manaus, I looked it up in Peter Pritchard's Encyclopedia of Turtles. He wrote that *Phrynops rufipes*, now known as *Rhinemys rufipes*, was one of the rarest of all turtles. It had only been reported previously from Colombia and a few scattered localities in the Brazilian Amazon. I kept the turtle for a time with the Schnieder's dwarf caimans I had in captivity, and it thrived with its dangerous companions. They seemed to know that it was too big to swallow and too hard to break up, but it occasionally had teeth marks on the shell to show that they had tried.



Photo 20.3 *An Amazonian pink turtle. Photo by Bill Magnusson.*

Although diving revealed a few more turtles, the easiest way to catch them was by setting turtle traps baited with chicken. The traps were made of hoops of steel about half a meter in diameter that were wrapped in nylon mesh. They concertinered together for carrying and could be extended to form a mesh cylinder about a meter long, with funnels on each end through which the turtles could enter, but not leave. Sometimes we would go a month without captures, but then we would catch three or four turtles together in the same trap. I assumed that the turtles had just come together because of the bait or because the males were following a female, and I never imagined that they might have more complex social behavior because I believed that all turtles are essentially solitary, and too dum to think of doing things together. Three decades later, Dick Vogt and his students would show that the giant Amazonian freshwater turtles call to each other underwater, and use the vocalizations to keep together when migrating underwater. The females even gather near the nesting beaches

when the babies are hatching so that they can call to them and lead them on journeys of hundreds of kilometers, the tiny babies being lead by mothers thousands of times bigger than themselves. However, we knew nothing of this in the early eighties, and never dreamed of studying turtle social behavior.



I now had another reason to spend time around Igarapé Acará. The caimans often went into the turtle traps as well, and I could study one of the World's least known crocodilians and one of the rarest of all turtles at the same time. I imagined that both the turtles and the caimans would be concentrated in the main stream, which was deep and provided many underwater retreats, but I also surveyed the small streams, only a meter or so wide, and generally less than a finger length deep. Even the deepest pools in these streams were less than half a meter deep, providing little security for a turtle or caiman.

I had a wonderful system for studying the dynamics and behavior of caimans and turtles. The streams and the animals were miniature replicates of the big rivers and giant crocodilians and turtles that lived outside the forest. The cool water, the constant shade, and the lack of plant productivity in the streams would probably result in a system where the physiology of the animals, and hence their demographic turnover, would be slower and easier to follow. However, to understand their dynamics, I had to be able to map the activity of the animals. In Australia, I used the maps derived from aerial photographs by the Crocodilus team to navigate around the northern rivers, but aerial photographs of the rainforest only showed the tree canopies and did not allow mapping of the small streams around their roots. Today I could use a GPS to accurately map the streams under the thick canopy, but the idea of such a

magical device, although already in the minds of a few aerospace engineers, was unimaginable for a field biologist in 1980.



Photo 20.4 *Bill Magnusson mapping a stream in 1989. Photo by Alan Brenner.*

I took a 50 m measuring tape and a compass and started to map the streams within about 2 km of the camp. We would stretch the tape along the middle of the stream from the middle of one bend to another and take a compass reading, then repeat the process along the next stretch. We reduced the smooth bends of the streams to straight-line segments, but you couldn't see the steps, which were

generally much less than ten meters long, when looking at a map covering several kilometers[52]. Each ten meters along the stream, we nailed an aluminum tag to a tree so that we would know where we were when we captured an animal. It was a long process that was not only boring, but debilitating because we spent long hours up to our waist in cold water. Many people volunteered their time to help, but I only remember the contribution of Alan Brenner, because I have a photo of him standing in the stream with the measuring tape. I did not record the people who helped because I did not appreciate just how critical their contribution would be to understanding the system.

Producing the map after recording all the distances and angles was just as hard as walking the streams. Today I could use a GIS program, or even a simple graphics application to produce the map in little more than the time it would take to type in the data. However, the state of the art in personal computers in the early 1980s was an XP computer, the model that controlled the first manned landing on the moon. It had no hard drive and operated by sequentially inserting the program on a floppy disk that could hold only 720 kb of information into the only drive on the computer, then another floppy disk with the data. Today people talk in giga- or terabytes, but then, the dream of having a disk that could hold one megabyte was still just around the corner.

I used a meter-wide roll of transparent paper to draw the segments of stream oriented with a transparent protracter of the sort used by school children. A meter in the field became 2 mm on my map. In the end, it was still about a meter long, so I cut it into pieces, reduced the sections in a photocopy machine, which was then the height of modern technology, pasted the reduced sections together again, and drew over them with transparent paper. My map took months to produce, but I could now record where the animals were when I recaptured them.



The first big caiman we found was lying close to the bank of a small pool downstream of camp at night, and it dived to the bottom of the pool when our headlights got close. I dived into the dark water and found the caiman sitting among the rocks on the bottom. It wasn't hard to slip the noose over its head and swim back to the bank, but all hell broke loose when I yanked the noose tight. When it finally tired, I dragged it to a sandy bank and pulled its head out of the water. It just lay there staring at me, so I asked Albertina to hold the cord taut and I walked up to the caiman from within the stream so that it was facing away from me, and I jumped on it from behind, grasped it around the neck and pressed down with all my weight.

I was not prepared for the sharp neck scutes, or the strength of the caiman, which was only 1.4 m long. It thrashed its tail and its attempts to walk off with me on its back probably would have worked if its feet hadn't lost grip in the soft sand. Its struggling lasted only a few seconds before it apparently became resigned to its fate. That pattern would repeat in other captures of the species. Once dominated, they would stop using their great strength and, unlike spectacled caimans, did not snap at you if you carelessly let your fingers stray too close to their jaws. We marked the caimans by excising some of the projecting tail scutes, and named them by the order in which they were caught. That caiman was #4, and he ruled the stream for several hundred meters above our camp to just below it.

We caught another caiman by diving after we had seen its eyeshine upstream of the camp. It was about the same size as #4, and got the name #5. Because he would eventually take over the territory of #4 in front of the camp, we learned more about #5 than any of the other caimans in the system. We dived into his

caves so often that he ended up being nonchalant about our presence. Schneider's dwarf caimans sit with their necks almost vertical and their heads above the substrate whether they are on land or in the water, so they give the impression of a dog or some other carnivorous mammal, rather than a crocodilian. If something startles them, they generally flatten against the bottom of the stream, but not #5, which made him the ideal star of several films and photo documentaries.

It became routine for us to snorkel along the stream, letting the current propel us along, and diving in the deeper sections to look for caves. It was fun swooping over the sandbanks and logs, but also very cold. Although the water in the streams was never less than 24 ℃, it was also never more than 26 ℃, and few of us could spend more than an hour in the water before becoming hypothermic. Normally, one person would snorkel looking for caimans, and another would walk along the bank carrying the equipment to capture and measure any that were found.

I was watching the beam of Albertina's flashlight swing from side to side in the dark water as she looked for underwater caves when she came into a deeper pool. She stood in the waist deep water for a minute to get her breath and then dived into the dark water and disappeared under the bank. She was underwater for less than a minute, but was shivering and out of breath when she came up. She looked at me and said in Portuguese "You catch it."

Albertina is only 1.6 m tall, and she was not nervous because that was the length of the cave. She had pulled herself along the bottom, focusing the light straight ahead, and did not find a caiman until she came up against the far wall of the cave. When she swung the beam to the side, she looked straight into the eye of the largest caiman we ever found in Reserva Ducke. It was 1.6 m from tip of snout to end of tail, which had been broken off. Albertina's eye was a

handspan away from the caiman's head, and her feet were kicking the tip of its tail. The wall of the cave that she had been following was in fact the caiman's body. She was stretched out in a blind tunnel beside a caiman that was as big as she was. I could see why she preferred that I noose it. The caiman got the name #9, and he commanded a stretch of the main stream that started about half a kilometer below the camp and included the mouth of a small stream that ran into Igarapé Acará 1.3 km downstream of the camp.

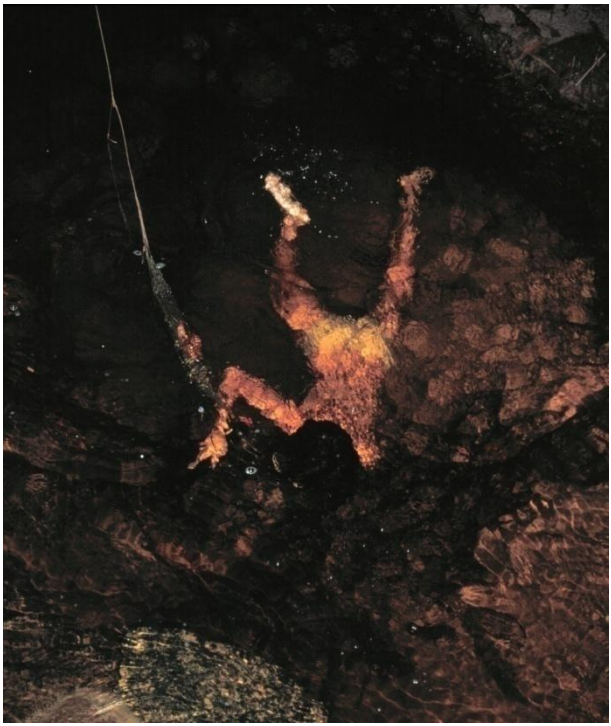


Photo 20.5 *Albertina Lima diving in Iagarpé Acará. The cold water in the stream only permitted about one hour of diving at a time. Photo by Bill Magnusson.*

Sandwiched between the territories of #9 and #4 was #12. He was about the same size as #4, and much smaller than #9. His territory was much smaller than the other resident males, and we suspect that he was not very good at defending it. He lacked one foot and the end of his tail, and one side of his skull had been

caved in, blinding him in one eye. These were exactly the sorts of injuries that one would expect from a confrontation between a caiman the size of #12 and the enormous #9. It seemed a fruitless endeavour to carve out a territory there, but he persisted for many years, crippled and blind in one eye. In the end, his undoing had nothing to do with rival males.

Another big male owned the small tributary that ran in just below camp, but we never found him in Igarapé Acará, and only #4 ventured into his territory occasionally. His territory covered at least twice the length of stream covered by the territories of the males in Igarapé Acará

Male #4, who dominated the stretch of stream in front of our camp, disappeared in 1986. We don't know what happened to him, but we were sure we would have located him if he had been in the area because we had located him 22 times in the preceeding 5 years, and knew a lot about his habits. Possible causes of mortality include jaguars and other males. We found the carcass of an adult caiman that had been eaten, and probably killed, by a jaguar near a tributary 1.3 km downstream, but that was probably not #4. His habit of invading the small stream near our camp that was the territory of another large male could also have resulted in his death. In any case, his removal from the system allowed #5 and #12 to expand their territories to a contact zone 50 m downstream of our camp.

There were few adults in the area, and they remained in limited areas so long that we got to know them individually, but juveniles never stayed long. We captured over a hundred, but they were always gone from our study area within a few days or weeks at most, and we assume that the larger caimans sent them on their way. This made it difficult for us to test our growth models, because we had no known-age animals whose length we could compare to the model predictions. A series of tragic events changed that.

We continued our studies of the pink turtles, and our data indicated that, if they occurred in the same densities as in our study site throughout the area between Reserva Ducke and the parts of Colombia where they had been registered, rather than being one of the World's rarest turtles, they were probably one of the World's most abundant turtles. It was just that nobody studied the small streams under the rainforest canopy. Caimans were often caught in the turtle traps, and this added to our recapture data. However, the caimans often tangled their toothy snouts in the mesh, and we had to be careful to check the traps regularly. Also, heavy rains could cause spates that completely covered the traps, risking drowning of both turtles and caimans. I was sensitive to this, having drowned the turtle on Cardoso Island, and any unusual rainfall sent me desperately pulling out the traps, independent of the hour of the night or day, and independent of any other work I was doing.

I instilled the same urgency into my students, but Dick Vogt sent his students out to study reproduction of the turtles in the same area. Those students were interested in the turtles, which can survive trapped underwater much longer than caimans, and regarded caimans in traps as nuisances, rather than magnificent animals that were much older than they were. Dick assured me that the students would take as much care as I did, but in April of 1989 they brought me #12's dead body. The cripple with the crushed skull and blind in one eye who had fought the forest's biggest male and survived to claim his territory had been drowned by a careless student. The student was offended by what I called him, but I was not only cursing him, I was cursing myself. I felt that I had not only lost an old friend, I was responsible for his death because I had let the students work in the area.

The month before, we had caught #37 in a turtle trap, the thirty seventh male caught in the area, in the middle of #12's territory. He was less than a meter

long and would normally have moved on after a few days or weeks in the area, probably as soon as #12 discovered that he was there. In this case, #12's misfortune was his big break, and he claimed the territory as his own. This probably reflected the dynamics of territory ownership that happens naturally. The small caimans keep travelling through the forest for decades, their only chance of survival and reproduction being if they happen to be in a large caiman's territory when it is killed by a predator. Juveniles probably cover many hundreds or thousands of kilometers before they luck onto an empty territory or are themselves killed by a predator.

He remained in the area over the next seven years, by which time he reached adult size. He was the only caiman for which we could measure growth during late adolescence, because the chance of naturally being present when an adult is replaced by a juvenile is remote. He also had the potential to allow us to determine how long a caiman could live in the wild. All our other adult caimans had already stopped growing when we first caught them. We can be sure that they were over 15 years of age, but as they had stopped growing, they may have been 20, 50 or even a hundred years old for all we knew. We will never know, because the students studying turtles drowned #37 in 1996. My patience was exhausted, and they were banned from the area from then on, but the damage had already been done. Two animals that I had lived alongside for years were dead, and I had come to regard them as companions.



Many people came to visit Igarapé Acará, and I developed what we came to call the tourist trail. The idea was to give them a glimpse of the complexity of the rainforest in the course of a single day and night. This usually included observations of ant-plant interactions, frog spotting, and lizard watching. I

would also take them diving during the day to see the naked-back knifefishes in caves. These little fish, relatives of electric eels, use electric fields to get around and find food. During the day, they usually hole up under overhanging banks, or bury into the sand. However, in the darkness of rocky caves, they come out and forage during the day. You can watch them with a flashlight, and imagine that you are emersed in a giant aquarium.

My mother, who was then in her early sixties came to visit, and I took her to see the knifefish in a sandy cave in about a meter of water. She could not dive by herself, so I dove into the cave to see where the fish were, and then pushed her down and in the direction of the fish with my foot. After about 30 seconds, she signaled that she was ready to come up and I pulled her out. When I asked her if she had seen the fish, she said "Yes, they're just beside the caiman."

I had just been into the small cave and was sure that there was no caiman there, but I put on the mask and dived again. Sure enough, there was a caiman lying up against the wall of the cave, less than 30 cm from the fish. There is a famous experiment[99] where people are told to concentrate on what actors are doing on a stage. In the middle of the performance, a person in a gorilla suit walks among the actors, but most people don't see the gorilla, because they are concentrating on the actors. I often wonder how much we miss when we wander through the forest intent on our academic studies.

My experience with visiting tourists made me sure that there were many scenes to be filmed in the transparent streams that would be of interest to the general public, and one day the Director of the Institute asked me to talk to the producer of a series of films being made by Jacques Cousteau about the Amazon. The film crew was anxious to be able to put the Institute's name in the acknowlegements to give the film scientific credibility. I explained to the film director about the caimans and the clear water in Igarapé Acará. When he asked

about access, I said that there was a road, but many trees had fallen across it recently and the film crew might have to carry their cameras in on foot. He was unimpressed, and asked if the clearing at the camp was large enough to land a helicopter. I said that I doubted it, but I was unsure, so he said we should survey the area with a helicopter first.

Cousteau's ship, the Calypso, was moored at the Manaus docks, so we went to visit. I was thrilled, because the Cousteau film The Silent World had been one of the highlights of my childhood. Jacques Cousteau was not there. In fact he was already over 70 years old, and only flew into the Amazon to record cameo scenes as the Calypso moved down the Amazon. However, his wife Madame Simone Cousteau participated in the whole expedition, living on the Calypso with the small fluffy dog that was her constant companion. We had dinner on the Calypso with Madame Cousteau, and I agreed to guide the helicopter pilot on an overflight of Reserva Ducke the next day.

The helicopter was parked on a special platform on the back of the ship. The Calypso was not very big, and covered in rigging, so I couldn't see how the rotors would have space to swing. Nonetheless, the pilot expertly lifted off, flying backwards, and soon we were zooming over Manaus a few meters above the tallest buildings. When I suggested to the pilot that we should fly higher, he replied "I can't. We don't have permission to fly here and I have to keep below the radar from Manaus airport."

That made me nervous, but I became even more so when I saw the pilot looking anxiously around on both sides of the helicopter. When I asked what he was looking for, he said "There's a local airport around here somewhere, and we mustn't fly over the approach." I started looking around for airplanes, but I knew that it would be impossible to take evasive action if we were in the flight path. I was getting desperate when he said "There it is," and we flew directly

over the middle of the landing strip, which was the safest place, because the planes were near the ground landing or taking off.

I was very nervous by the time we got to the reserve, and we could not fly high enough for a good view without being detected by the airport radar. I couldn't see the blue tarpaulin of our camp under the green canopy, but the overflight was enough to convince the pilot that we wouldn't be able fly into the Acará clearing. The flight back was even more nerve racking because I knew the dangers we were facing.

The plan to fly in having been abandoned, the film director, a North American, said that they would try to get to Acará by car the next day. I knew that there were a lot of trees across the track into Acará, so I went to the reserve early and set out along the track with a machete. I was just clearing the last treefall off the road when the car caught up to me. The film director was irate. He said that one of the main things that movie goers wanted to see was the Cousteau team cutting their way through the impenetrable jungle. I had ruined their scenes by cutting the logs.

When we got to the stream, the film crew was ecstatic. They filmed #5 underwater, and filmed and photographed many other plants and animals. I had warned the divers that we would get cold after about an hour, and they laughed at me and said that they had dived in the Antarctic. An hour and a half later, they were hunched around the fire shivering, with steaming cups of tea in their hands, but I didn't ask them how they had found warmer water in the Antarctic. The film director sipped his tea and said "We have to come back here and film again." When I asked why, he replied "We didn't really believe that the water would be clear enough to film. We only came so that it would appear that we were collaborating with your Institute and we didn't bring any sound gear." I was unimpressed, but agreed to return a few weeks later.

There was another film director on the next trip. Although the expedition was run by the Cousteau team, all the film direction was done by hired professionals that were flown in for six-week stints. The film went back to New York, where editors, who had never been into the field, put it together to make a movie. This time, they had sound gear, and everything seemed to go as planned. However, a few weeks later, the film director showed up at my office and asked me to go out again. He said that the New York office had said that the caiman didn't move enough.



Photo 20.6 *Albertina with the Cousteau team photographing a caiman in a small stream. Photo by Bill Magnusson.*

When we arrived at Acará, one of the cameramen took me aside and said that the problem wasn't that the caiman hadn't moved enough. The problem was that I had appeared in the takes. I said that although I was not pretty, I didn't think I was ugly enough to ruin the shot. He said that my face wasn't the problem. When they filmed, the Cousteau divers used wet suits to maintain

continuity between scenes, and having me diving beside them in just a pair of shorts made them look overdressed. Could I put them into position and then get out of the scene. I did as they asked, and I made sure that I didn't appear in any of the underwater scenes.

Several weeks later, the cameraman came to my office and asked if I could go out again because the New York office had said that the caiman didn't move enough. I told him that I was sure that I hadn't appeared in any of the scenes, but he said that wasn't the problem. This time they really were saying that the caiman hadn't moved enough. This should have been the last straw, but I had become friends with the cameraman, who was teaching me a lot about filming and photography, so I agreed, just to have an opportunity to spend more time with my friend. In the end, it wasn't necessary, because he came back after the Cousteau expedition, and we spent several weeks together filming and photographing.

There was a new film director for the last trip out to Igarapé Acará. When we got there, he started explaining the shots he wanted, but I knew that most of them had already been done before. Each director did not know what the last one had filmed! I was learning a lot about modern films, and how editors put together random shots into what appears to be a coherent story. I said "Look I don't have time to come out here again. I'll give you scenes that the other directors have not done." I then set about directing the scenes. Fortunately, #4 was nearby and I caught him and put him in the middle of a large pool. Schneider's dwarf caimans are too heavily armoured to swim easily and they often just walk along the bottom. Doing his part, #4 walked past the cameras, and he became immortalized in one of Cousteau's Amazon films.



Soon after we started our long-term studies in Reserva Ducke, a researcher invited Albertina and me to visit her hobby farm on the outskirts of Manaus. Most of the land was covered in forest, and we walked along a tiny stream looking for orchids. Albertina saw what looked like white orchid petals on a mound beneath a tree, and she called me over. The petals turned out to be the leathery inner shells of caiman eggs. The mound was our first Schneider's dwarf caiman nest, but the site appeared much more suited to orchids than caimans. The stream was only a few handspans wide, and a few centimeters deep. Few pools in the stream were deep enough to cover an adult caiman's back. It was our first inkling that adult female Schneider's dwarf caimans lived and nested around tiny first- and second-order streams.

We started surveying the small streams around Igarapé Acará more intensively in the hope of finding females, because we had found only males in the main stream. This was much more difficult than surveying caimans from a boat. The best head lights available at the time were powered by two AA batteries held in a plastic box attached to your belt. The batteries could not be immersed, and you had to hold the battery pack over your head when crossing larger streams. The plastic boxes also often opened spontaneously, dropped the batteries in the water, and left you in total darkness. Battery quality was poor, so the light from the headlights was reduced to a weak glimmer within a few hours. By midnight, we would be several kilometers from camp and the batteries would be running out. If we put in expensive new batteries to walk back, they would have little power for the hike the next night. Therefore, we often walked back in the middle of the stream in total darkness to avoid having to use new batteries. Walking in the middle of the stream led us back to camp and avoided the many lance-head vipers that lay curled up on the banks. However, it made walking hard, and we would be very cold when we got back to camp. In later years, we would buy miner's lights, which lasted 12 hours between charges, and

resisted a short dunking in the stream. However, the battery pack weighed over two kilos. The tiny LED lights available today give as much light as the miner's lights, and are powered by a couple of AAA batteries, but they became available long after the main study was completed.

We also dove in the small streams during the day, but most of the caves under the banks were too small for a human to enter. Some of the cavities were high enough to shove my head and shoulders into, but they stretched back too far under the roots of the trees, and I couldn't hold my breath long enough to get to the end of the crevice, which was several meters from the edge of the pool.

There were tracks made by a caiman's tail in one small pool, and I noticed that the bank was relatively flat for several meters back into the forest. I took a breath, sqeezed into the crevice under the bank, and noted the direction that the cave took. I then backed out and looked for a soft spot among the roots on the bank above where I assumed the tunnel passed. Digging down revealed the roof of the tunnel, only a handspan below the surface. The tunnel was completely submerged, but I shoved my snorkel into the hole. If I could push in to the snorkel, I would be able to renew my air and continue into the tunnel.

There were many stiff roots hanging down from the roof of the crevice, but they swung forward as I pushed in. The tunnel the caiman had made was much smaller than the passage I needed, but I could force roots apart and drag myself along. Progress was slow and hard, and I was desperate for breath when I got to the snorkel, which fortunately worked as I had hoped, and I spent several minutes gasping and renewing my oxygen supplies. Once my blood was aerated again, I pushed forward for another half meter, and the crevice opened into a cave under the roots about a meter in diameter and 40 cm high. The floor of the tunnel sloped up at that point, so there was a pocket of air, about 30 cm thick,

above the water. Although I didn't realize it at the time, that air pocket probably saved my life.



Photo 20.7 *Bill Magnusson returning from a night survey of the small streams in Reserva Ducke. Photo by Xavier Desmier.*

I pushed my head into the airpocket and gasped to neutralize the lactic acid I had accumulated while holding my breath. The cave was a magical retreat for the caiman. She was sitting on a ledge at the far end of the cave, just above the water line. The red roots of palm trees hung from the ceiling and the beam of my flashlight reflected their images on the surface of the water. It was fairy land.

I don't know how long I stayed admiring the scene, but I was stiff and cold by the time I started to push the noose over the caiman's head. This wasn't easy, because the tunnel was narrow and my arms were extended straight in front of me.

Getting out was very different from getting in. I had used powerful leg muscles to force my way past the roots. Now those roots were bent against my direction of travel, forming barbs that impeded my return. I had to push back using only my arms, which I couldn't flex because the tunnel was no wider than my shoulders. By the time I got back to the snorkel hole I was exhausted, but the snorkel wasn't there. I had knocked it out of the way as I forced my way in. I was desperate. The lack of oxygen was maddening me, but I couldn't lose control. I had to wriggle a little to one side, use my hands to push a few centimeters back, wriggle to the other side, press a few more centimeters, and then repeat the process. I had my eyes closed, I started to lose focus, and I had to force myself not to give into the desire to just stop struggling.

When I finally got out and pushed my head onto the bank I had gone past the point of even gasping. I breathed normally and unconsciousness seemed to be overtaking me, but the new oxygen took effect, and after ten seconds or so I started coughing and gasping. I had found that the caimans in the small streams have an underground world that keeps them safe, but I abandoned any further attempts to live in it with them. We put snares in front of tunnels when we saw tracks going in, but the snares sometimes remained in place for up to 10 days before the caimans came out again and were trapped.

The females turned out to be much more numerous than the males. They lived in the small streams, their home ranges overlapped, they often used cavities under the bank within a few tens of meters of each other, and on one occasion we even found two females together in the same cave. Igarapé Acará is

a small stream by most people's standards, but it is too big for most female Schneider's dwarf caimans. It is a refuge for many males, but the few adult males with access to many females live along the tiny first- and second-order streams.

Over the years, we recorded the same caimans in the same areas repeatedly, but surveying the small streams at night revealed few caimans, and sometimes none at all. We implanted radio transmitters in the caimans so that we could follow them and determine where they were when we couldn't find them in the streams. They were often in cavities under the bank, like the one I just described. However, on more than 40% of occasions females were in terrestrial retreats more than 5 m from the stream. We found them in hollow logs, debris cavities under fallen trees, and in burrows 9 m to 90 m from the streams. They returned to the same terrestrial retreats repeatedly, which must have been part of their home range, and not just chance occurrences.



We surveyed the banks of all the streams in the area for nests, and occasionally found nests on Igarapé Acará, usually near its confluence with a small tributary, but 80% of the nests were along the small streams where the females had their home ranges. Based on the number of nests and number of females known to be in the area, females only nested once every two or three years. The rainforest is full of mounds of leaves that looked like caiman nests, and the vegetation around streams is often dense, so it tooks weeks of searching for every nest found.

We were particularly interested in egg temperatures. The sex of crocodilians is determined by the temperature in early incubation, so females have to

construct precise incubators. Heat from the sun, decomposition of vegetation in the nest, metabolic heat produced by embryos, and insulation by the nest material had all been indicated as important in maintaining the temperature of crocodilian nests. Therefore, I bought electronic thermometers with leads between the sensor and the dial, so that we could monitor temperatures in nests.

The nests of Scnieder's dwarf caimans are mounds of vegetation, much like those of other mound-building crocodilians. However, as they are constructed deep in the rainforest, very little light, and hence heat, from the sun reaches them directly. About half of the nests we located were up against or built over termite mounds, and this led us to suspect that the caimans might be taking advantage of the metabolic heat of the termites to warm their eggs.



Photo 20.8 *A Schneider ś dwarf caiman nest built against a termite mound. Photo by Bill Magnusson.*

Recording egg temperatures was as tiring as searching for nests. Today, automatic data loggers are cheap and effective, but we did not have funds for

such luxuries in the early 1980s. Albertina and I would set up a tent near a nest, insert the probes, and manually record temperatures each hour. It wasn't too hard during the day. One of us would record temperatures while the other searched for nests. At night it was much harder. We took it in shifts, and whoever was on the graveyard shift from midnight to six a.m., usually me, had to keep awake between the hourly recordings. An hour is long enough to make you sleepy, but not long enough to take an effective nap. At first I looked for nocturnal animals around the tent or in the stream, but my eyes would lose focus because I had no sleep during the day and, in the end, I just sat semidozing waiting for the alarm to remind me it was time for the next reading.

At first we concluded that the caimans needed the termite mounds to maintain temperatures high enough to produce males, but that proved wrong. They could also attain adequate temperatures by building the nest on top of a nest from a previous year, which insulated the decomposing vegetation and the eggs from the cold ground. We were also able to show that the developing embryos were able to generate enough heat to modify nest temperature late in incubation, the first time that it had been shown unambiguously for any crocodilian.

The big question was whether the nest temperatures were high enough to produce a 50:50 sex ratio. If the temperatures that had been shown to be necessary to produce males in American Alligators were also necessary for dwarf caimans, none of the nests we investigated would have produced males. Researchers in the USA and Australia had incubated eggs at set temperatures and checked the sexes of the resulting offspring. Unfortunately it is not possible to reliably determine the sex of newly hatched crocodilians based on the difference between the size of the penis or clitoris. As the experiments were often associated with production facilities, the researchers usually killed all the hatchlings for dissection, or the young alligators were raised in captivity until their sex could be

determined by genital examination. We could not raise all the baby dwarf caimans, and balked at killing all of the hatchlings produced in the study area.

We did kill all the hatchlings from one nest so that we could determine their sex by histological examination. We had no experience with histology, but a researcher from the medical division of our institute lent us a microtome and taught us how to produce histological slides. We took advantage of the 13 dead hatchlings to practice surgery so that we could determine the sex of other hatchlings without killing them, and found that we could easily distinguish the convoluted Mullerian ducts of females from the degenerating ducts of the males. However, surgery on live animals was much more complicated.

There was no safe anaesthetic for crocodilians, which breathe voluntarily. If you knock them out completely, they forget to breathe and die. There were some immobilizing agents, such as Flaxedil or cold, but these did not anaesthetize the animal, and it would continue to feel pain. We ended up using local anaesthetic injected into the region where the principal nerves pass for anaesthesis, and cold for immobilization. At first, the veterinarians criticized us and said that we should have killed all the hatchlings. However, years later, after trying many other alternatives, they came to the conclusion that we had done the right thing, and the technique was approved by veterinarians in other regions.

We operated on all the hatchlings from seven nests, and were able to show that the critical temperature for sex determination for the species is between 31 ℃ and 32 ℃, similar to that of saltwater and Johnston's crocodiles in Australia. Even with a critical temperature lower than that of American Alligators, less than 20% of the nests we studied would have produced males. The great geneticist and statistician Ronald Fisher showed that evolution should always select for an equal investment of parents in male and female offspring. That this has not happened in

Schneider's dwarf caiman indicates that there may be a physiological threshold for sex determination that the caimans cannot get around, or perhaps the species can attain higher nest temperatures in other regions.

Besides our concern not to cause the hatchlings any suffering, we were worried about the ecological effects of our interventions, something that does not seem to be a preoccupation of veterinarians. After determining their sex, we sutured the hatchlings, kept them in captivity for a few days to make sure that they were recovering well, and released them back at the nest site. We recaptured them over the following months until they had migrated out of the study area. Their mortality rates were similar to those of hatchlings that had not been operated on, and they grew even faster, something that we attribute to chance rather than a beneficial effect of surgery. We thought that our technique would result in an explosion of studies of sex determination that avoided removing all the hatchlings, but almost all studies of sex determination in crocodilians still involve killing all the hatchlings or removing them to captivity. Perhaps it is just easier.



The mark-recapture and radio-telemetry studies allowed us to estimate the biomass, or total weight of caimans, in the area. Based on our estimates, the biomass of Schneider's dwarf caimans in the Amazon rainforest is greater than the biomass of all the species of mammalian carnivores put together[52]. Those carnivores include several species that attain sizes much greater than dwarf caimans, such as jaguars and pumas, so the higher biomass results from the caimans being able to support many more individuals, and not larger body sizes.

Being able to function normally in the cool temperatures typical of the streams probably contributes to their ability to maintain high biomass. Mammals use most of the energy they consume just to produce heat. The more efficient physiology of the caimans allows them to use the energy saved to produce more caimans, and hence more biomass. Nevertheless, the small shaded streams have low primary productivity, and hence low biomass of fish, the staple diet of adults of most species of crocodilians. To maintain their high biomass, we assumed that Scneider's dwarf caimans must have diets different from those of the majority of crocodilians.

Raquel was a young student volunteer with the Institute. This was still during Brazil's military dictatorship and her mother had close friendships with several military officers, who recommended her to the Director of the Institute. The Director accepted her as a student volunteer, with only one condition: that she did not go into the field with Bill. Raquel often came by my laboratory, but didn't mention going into the field for several weeks. I was unprepared when she said in Portuguese "I'm going to Reserva Ducke with you this weekend." Having an assistant could have been useful because Albertina couldn't go that weekend, but I remembered the Director's prohibition, and reminded Raquel of it. She replied in Portuguese "Oh, that's no problem. He had a heart attack and is interned in the hospital. He won't be back for weeks."

I showed Raquel how to dive for caimans, and she found a big male near camp. I noosed it and we decided to see what it had been eating. Removing the stomach contents using the techniques developed by Janet Taylor and Grahame Webb involved tying a section of plastic pipe in its mouth and pouring water down its throat. The bank was steep where we caught the caiman, and I carried it up onto flat ground. As usual with the species, the caiman remained still after

the initial struggling. I tied the pipe into its mouth while Raquel sat on its back and pressed down on its neck with her hands.

We had brought along a large aluminum pot, and I told Raquel to sit quietly on the caiman while I went to the stream to fill it with water. I was nearly to the stream when I tripped on a vine and fell head first into the stream, smashing the pot into the water with a resounding bang. The startled caiman began to struggle and Raquel desperately tried to hold it down, but the pipe came out of its mouth and it threw Raquel to one side. I was just getting to my feet when it hurtled over my head into the stream.

I scrambled up the bank to where Raquel was hunched over holding her bloody hands clasped together. I imagined that the caiman had bitten her, but when she relinquished her clutch she still had 10 fingers. If it had been a spectacled caiman, it might have been a different story, but dwarf caimans are not snappy. The blood was just from scratches made by the sharp neck scutes as the caiman spun in her hands. She had been in no real danger, but I still thought about how I would have explained to the Director and the officers of the military dictatorship if I had taken her back to Manaus with less than ten fingers!

Many other people helped collect stomach contents from the caimans, and we developed a good idea of what they ate. The smallest ones ate insects, spiders and shrimp, but soon moved onto snakes and frogs. At a size that other species of crocodilians were just starting to eat vertebrates, the dwarf caimans were eating many mammals, including monkeys and other arboreal species that I never imagined would venture near the water. Those prey were very big in relation to the size of the caimans. It was equivalent to an African crocodile taking down a buffalo.



Photo 20.9 *Bill Magnusson and Marc Hero taking stomach contents from a Schneider ́s dwarf caiman. Photo by Xavier Desmier.*

We knew some of the hunting tricks of the caimans from watching #5 near our camp. When there were minor floods, he would sit on the bank with his head pointing straight out into the water. He kept his lower jaw just below water level and the upper jaw suspended above the water, ready to clamp down on any animal that swam up or was washed down. There were also large tree frogs that called in the trees overhead and laid their eggs in the shallows on the sides of the stream. Often, when a male was calling, #5 would be found sitting below, presumably waiting for the frog to win a mate and lead her down into his jaws. However, neither of these techniques would be much use for catching mammals.

The caimans must be terrible predators for the rainforest mammals. I was once walking up the small stream near the camp when the water running towards me became turbid and the leg of a young paca, a South American rodent the size of a small dog, floated past. I hurried on to find what had taken

the paca, but when I rounded the next bend I found only the scratch marks of a struggle and the tracks of a caiman that disappeared under the bank. Either the caiman had eaten the rest of the paca, or it had dragged the carcass into the cave.

The caimans also often had strange structures that looked like flowers in their skin. About 4 mm across the petals, they formed a tube that penetrated up to a centimeter through the dermis. At first I thought that they parasites, but I couldn't find any evidence that they had a life of their own and I concluded that they must have been formed as an inflammatory reaction to something. For a long time, I couldn't imagine what could regularly penetrate caiman skin, but then I found a possible agent: porcupine quills.

I was walking near one of #5's favorite caves under the bank when I noticed that the sandy beach lining the pool in front of the cave showed signs of a struggle. There were drag marks, blood and porcupine quills all over the beach. I checked the bank and the bottom of the pool, but I couldn't see any sign of the porcupine, so I returned to camp to get a diving light and face mask.

I had not dived for a while and I appreciated the tranquility that flowed over me as I slipped into the cool water. I knew exactly where #5 liked to sit in the cave, so I took a deep breath and swam down to a sunken log that I could hold onto as I looked up into the cave. There was #5, apparently unworried by my presence, sitting in his dog-like stance. His belly was swollen and porcupine quills were sticking out of his jaws. I didn't want to catch him because I was sure that any strong pressure would puncture his vital organs with the sharp quills. In fact, I can't imagine how he had swallowed the porcupine without impaling himself fatally.



Photo 20.10 *Caiman number five in an underwater cave. Photo by Xavier Desmier.*

I pulled myself forward, looked into the caiman's fearless brown eye, and felt myself being pulled into an ancient and unfathomable world that held secrets that mere humans could never appreciate. It was the same world I had glimpsed in the eye of the saltwater crocodile decades before. I stared into his eye only half a minute or so in our time, but it was much longer in some other dimension. When I came back to the surface I hungered to get to know that world better, but I knew that I could never find it by catching and measuring crocodilians, no matter how sophisticated the technology. I guess that no-one reading my papers will ever guess what I saw in the eye of a crocodile.



Photo 20.11 *Eye of a Schneider ś dwarf caiman. Photo by Bill Magnusson.*

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[103] Gordon says that he did not run in front of the croc and after he wrote me I almost took this passage out of the account. However, a few days later, I received a letter from Dave Lindner saying that the most striking memory he had of the incident was Gordon running in front of the croc. Therefore I left it in.

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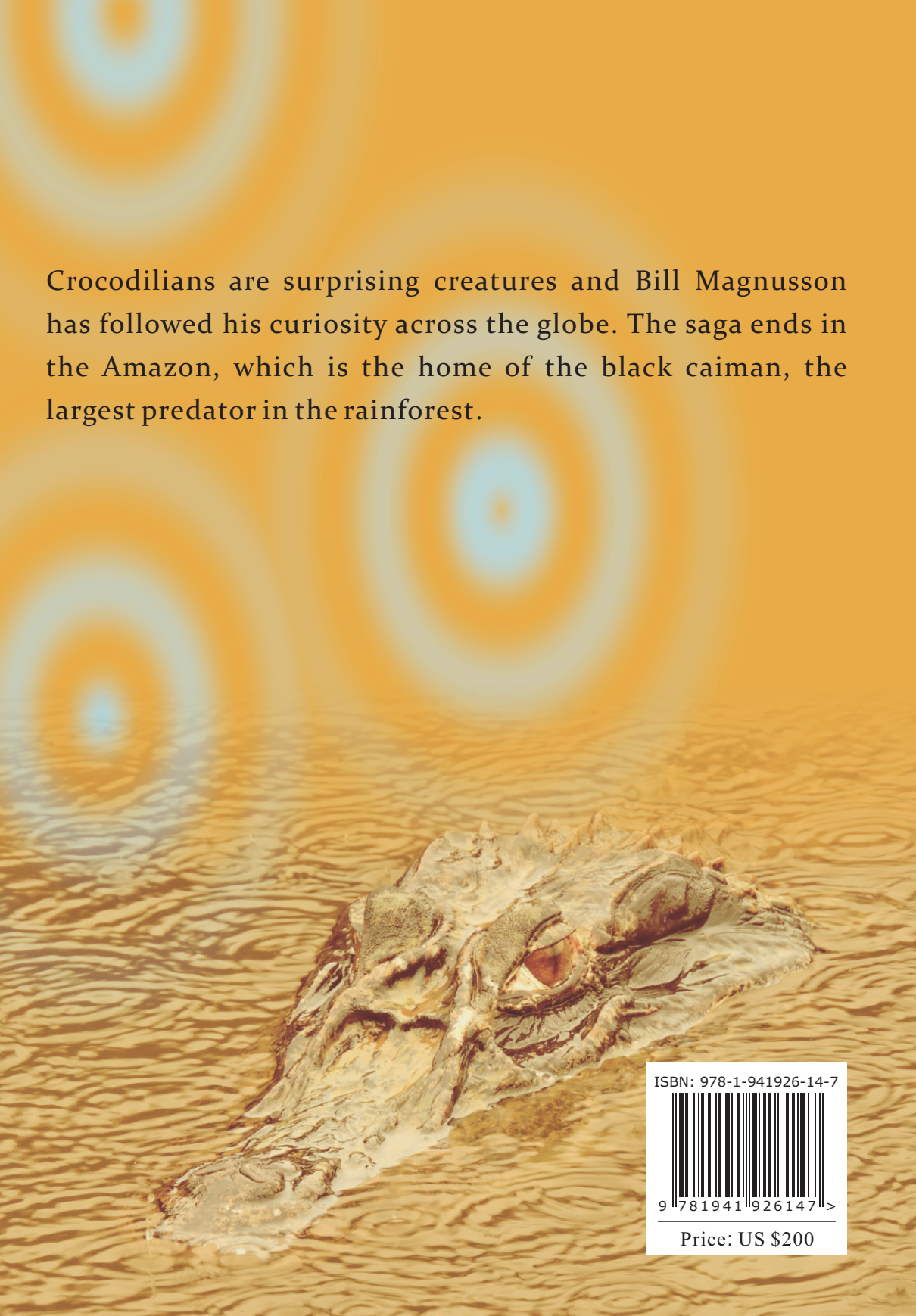
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Crocodilians are surprising creatures and Bill Magnusson has followed his curiosity across the globe. The saga ends in the Amazon, which is the home of the black caiman, the largest predator in the rainforest.



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