Malagarasi Aquatic Ecosystems:

Biodiversity & limnological functioning of the

Malagarasi-Moyovosi wetlands, western Tanzania

P.I.s Ellinor Michel, Hudson Nkotagu, John Friel

Research report prepared by E. Michel

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Abstract:

The Malagarasi drainage in western Tanzania is among the world's most important wetland regions. The area contains biodiversity of regional and international significance but until this expedition its biological and physical characteristics had received almost no scientific attention. Our primary aims were to survey each of the primary biotopes of the Malagarasi Basin to provide baseline quantitative data on 1) aquatic biodiversity and 2) limnological functioning. The scientific data we generated is an important first contribution to understanding this imperiled ecosystem. Contacts with regional policy makers, some established during the expedition, will also help facilitate dissemination and utilization of our survey results for informing on conservation priorities in the region. Accomplishments: We sampled approximately 40 sites along the main flow of the Malagarasi River proper, and additionally associated shallow Lakes Sagara & Nyamagoma, small stream and delta inflows into Lake Tanganyika, other Malagarasi tributary rivers such as the Lugufu, Ruchugi, Ugalla, Makere and Igombe. Biodiversity collections focused on fish, herps (amphibians & reptiles) and molluscs, with additional collections of aquatic insects, crustaceans and diatoms – new species were found among most groups. Limnological sampling included physical parameters, water chemistry and productivity analyses indicating anthropogenic impacts throughout the region. Our aquatic surveys of the remote Igamba Falls area are apparently the first of their kind and revealed a number of new fish and mollusc species, making this site not only of special interest, but also of special concern as it is under discussion for hydropower installation. Our aerial photographic survey was the first for the river drainage and provides detailed information on habitat use in the areas surveyed.

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Introduction to the project:

Geographical setting: The Malagarasi basin is situated in western Tanzania and extends across some 9.2 million hectares, encompassing five substantial rivers and extensive riparian wetlands. It is the largest drainage system into Lake Tanganyika, a recognized center of world biodiversity. Due to the exceptional size and importance of the ecosystem, the core of the basin has been designated a site of international significance under the Ramsar Convention on Wetlands (http://www.ramsar.org). This Ramsar location is second only to the Okavango in geographic scale.

The Malagarasi drainage encompasses a wide array of biotopes including fast flowing streams, slow rivers, open lakes, ponds choked with macrophytes and vast papyrus swamps. During the dry season wetlands cover some 450,000 hectares, but the annual rains expand the flooded area significantly. Before the opening of the East African Rift during the Miocene, the lower part of the Malagarasi was the headwater of the Congo River. This is effectively still true, although regional tectonics have modified the geography of area substantially since that time. Now Lake Tanganyika, the largest of the East African rift lakes, acts as a holding basin for Malagarasi waters before they are discharged into the lake's outflow, the Lukuga River. These waters then move through the Congo, and finally reach the Atlantic (Beadle 1974). The upper reaches of the Malagarasi have a remarkable geological history. The upper northern regions of the basin were formerly within the Nile drainage and flowed northward toward the modern Lake Victoria drainage until tectonic uplift reversed the direction of flow. It has been suggested, based on similarities between the fish species in the two regions, that this reversal brought the Nilotic fauna in contact with that of the Congo (de Vos et al. 2001).

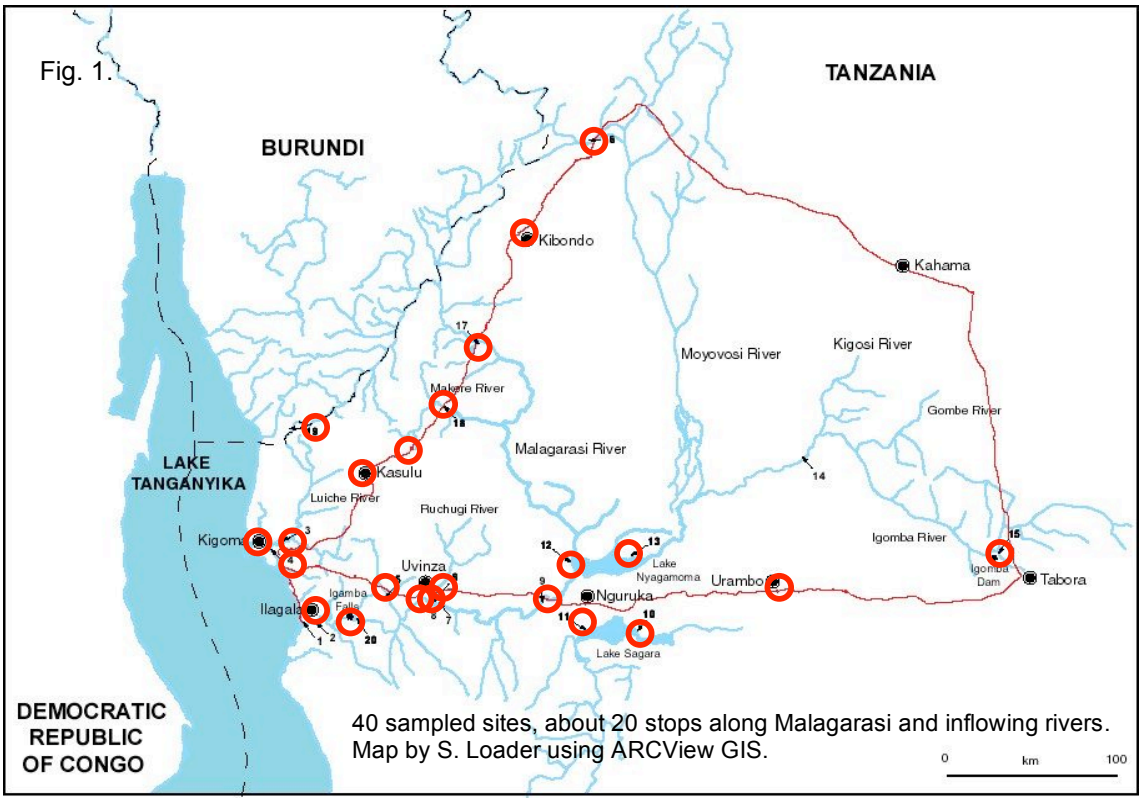
Past research in the region: There is a paucity of information on the region in the scientific literature. For instance, a Web of Science search using the term 'Malagarasi' returns no recent published papers, (whereas 'Okavango' returns 212 and Everglade* 1,118!). Though numerous birds, mammals and large reptiles are recorded from the area, little is known of the freshwater fauna. The few studies of the region that have focused on aquatic organisms have concentrated on fish, although even this comparatively well-studied group yields unexpected surprises. For example, a recent study reported the remarkable finding of an endemic species flock of fluvial 'goby' cichlid fishes, an endemic clariid, and at least three undescribed other catfish species (de Vos & Seegars 1998, De Vos et al. 2001). A recent publication (Nkotagu & Ndaro, 2005) addresses limnological aspects of the large shallow lakes, Nyamagoma & Sagara, but not the larger river area.

Biodiversity and Biogeography: There are a number of controversies regarding the evolutionary origins of the region's fish and mollusks that we are now in a position to address with our recent collections from the Malagarasi. For example, *Potadomoides pelseneeri,* a taxon last collected alive over 50 years ago (West & Michel, 2000; Brown, 1994) has been suggested as the key to the origins of the spectacular gastropod radiation found with Lake Tanganyika. We now have fresh specimens and molecular data to address this evolutionary puzzle. Similarly, our collection of specimens with several new species under description from this region may

help to provide insight into the origins of Lake Tanganyika's cichlid fish species flocks, and also possibly provide a link with the haplochromine radiation in Lake Victoria.

Sampling Strategies & Methods

We sampled approximately 40 sites at 20 stops along the main flow of the Malagarasi River proper, and additionally associated shallow Lakes Sagara & Nyamagoma, small stream and delta inflows into Lake Tanganyika (Kakombe, Rutanga, Mitumba in Gombe Stream Nat. Park, Luiche River), other Malagarasi tributary rivers such as the Lugufu, Ruchugi, Ugalla, Igombe, Moyovosi, and Makere. Our collections were GIS based and are linked with quantitative limnological profiling as well as qualitative habitat descriptions. Table 1 details the site locations and collections made, Fig. 1 shows the map of stops, and the 'logistics overview' at the end of this document gives a temporal overview and list of team members. At each stop we attempted to survey all available aquatic habitats, thus a single stop might have included several habitat-defined sites. Biodiversity collections focused on the taxa of speciality for our team: fish, herps (amphibians & reptiles), molluscs, and phytoplankton (as part of limno sampling), with additional collections of aquatic insects, crustaceans and benthic diatoms which have been distributed to experts on return (listed below). Biodiversity sampling included netting (seine, dip, kick, drift, plankton) and focused hand collecting (e.g. under rocks, plants, night collections, snorkeling, discussions with local people). For all taxa collected we preserved tissue samples in ethanol as a priority and in formalin as vouchers if dictated by the volume of tissue. In this way we were able to make duel use collections with reasonable morphological sample sizes and representative large individuals. Only photos were taken in the National Park.



Limnological sampling included physical parameters measured *in situ* such as dissolved oxygen (DO), electrical conductivity (EC), redox potential (Eh), turbidity, temperature, pH and secchi transparency. Nutrients such as

NO_3^-, SiO_2, PO_4^{3-} and Fe^{2+} were determined along with HCO_3^- using Hach reagents in the laboratory on return to TAFIRI-Kigoma. Biological parameters of primary productivity were assayed using a flourometer (Turner Designs) to assess chlorophyll a and light-dark incubations with Winkler titrations in a mobile field lab. Biodiversity and limnological sampling occurred at the same sites, to the greatest extent possible. As the limnological work required setting up a sampling station (especially for productivity analyses which take several hours), and the biodiversity work included ranging over all available local habitats, the site sample numbers are slightly different.

Fig. 2. Limnological sampling, clockwise from upper left, a) sampling physical paramenters at midpoint of headwater stream, b) Igombe river sampling with expedition zodiac, c) field titrations of Winkler reactions (productivity analyses), d) limno team uses dugout pirogue to find midpoint in swampy waterway Igombe river headwaters at Lake Nyamagoma, e) limno sampling with plankboat & armed guard in Lake Sagara, f), midpont water sampling and incubations in Luiche River, Ujiji, g) water chemisty in field lab, Igamba Falls, h) (center) spectrophotometric work in TAFIRI-Kigoma lab.

We had an opportunity to do a GPS-linked photographic aerial survey of the lower Malagarasi river with an experienced local pilot and professional photographer. We spent 2.5 hours flying over this region in August 2005 to document habitat heterogeneity and land use changes.

Results and Discussion

Biodiversity surveys

The herpetology surveys, lead by S. Loader, were the first systematic geographic sampling with a focus on frogs in western Tanzania. Previous data was limited with only eight recorded frog species (Loveridge, 1942) – this

survey brings the total to 21 species. The real diversity is certainly higher, as our sampling was done during the dry season, which is sub-optimal for amphibians. Moreover, complete herpetological sampling requires year-round monitoring and stationary sampling methods such as pit traps. Nevertheless, as a result of our surveys there are some species range extensions and potentially some new species. Detailed morphological and genetic work will be carried out to investigate this further. The overall pattern is that the Malagarasi amphibian fauna shows similarities to the widespread East African lowland assemblages, rather than the Highlands of East Africa, where no single species is shared (Poynton et al. submitted). We recorded other herps (crocodile, python) and attempted to collect caecilian amphibians (none were found, which may indicate a range limit) and did collect typhlopid (blind) snakes during the expedition. The collections made during this expedition will provide a basis for an authoritative guide to amphibians of Western TZ (Loader, et al. in prep.).

Fig. 3. Animals were photographed live and preserved for morphological and genetic taxonomic work. Photo S. Loader

Night hunting for frogs

The ichthyology sampling, lead by J. Friel, was extremely successful and recovered an estimated 75 fish species (60 of which are identified to date) which is approximately 3/4 of the recorded fish fauna in the whole basin. This is an impressive recovery rate for one collection trip and indicates that the fish diversity is likely to increase significantly with further taxonomic work and further collections. Currently we know that we collected minimum of three new species, but it is highly likely that more will be recovered as work proceeds on the collections. Two new species (one catfish and one cichlid) were found only in the Igamba Falls area and are currently being described. One of the newly discovered catfish may turn out to be a new basal genus that is the sister group to all other *Chiloglanis*, thus significantly improving our understanding of evolution in this important clade.

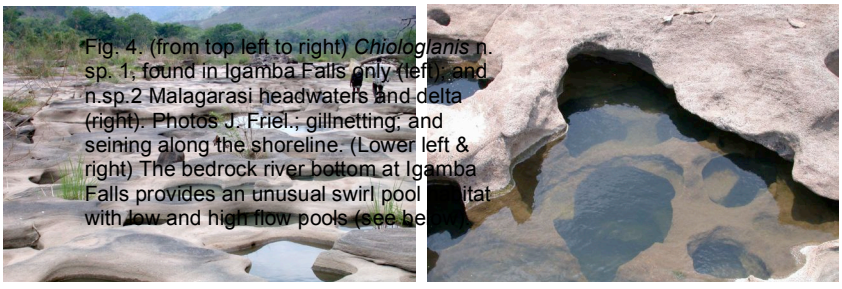


Fig. 4. (from top left to right) *Chiloglanis* n. sp. 1, found in Igamba Falls only (left); and n.sp.2 Malagarasi headwaters and delta (right). Photos J. Friel.; gillnetting; and seining along the shoreline. (Lower left & right) The bedrock river bottom at Igamba Falls provides an unusual swirl pool habitat with low and high flow pools (see be

Fig. 5. Left to right: *Potadomoides pelseneeri,* LT relative; cementing unionid bivalves (freshwater'oysters'); snorkel sampling at Igamba Falls

The malacology sampling, lead by E. Michel, was similarly extremely successful with discovery of several new species and collection of the potential Tanganyika 'outgroup' *Potadomoides pelseneeri* (previously thought to be endangered or extinct, but we found it in very large numbers). Among the gastropods we found as many as five probable new species, some with apparent Congolese affinity. One new species, unique to the Igamba Falls area, is highly unusual and will certainly be the focus of taxonomic and conservation interest. Taxonomic work is proceeding on these species and descriptions are planned for publication in the next year. We were able to provide the first samples of the medically important snails *Bulinus* and *Biomphalaria* from this region for a study of genetics of schistosome (bilharzia) vectors and similarly the first tissue samples of the land snail *Trochonanina* that will allow testing a major hypothesis on faunal origins (Naggs & Raheem, 2005). We also made the first large-scale collection of bivalves in the area.

Although effective taxonomic collections are best done with a focus on particular taxa, by experts, we were able to make preliminary collections of crustaceans, insects and diatoms. These are currently being examined by specialists for identification (listed below in the logistics section) and may also be used for expanded systematic coverage in evolutionary studies. Among crustaceans we collected shrimp that are the first from the region, are potential local endemics, and complement a larger study of elevated endemism in freshwater shrimp in eastern Tanzania. Our collections of crabs did not reveal any novel taxa, but the common, widely distributed scavenger we found were of unusually large sizes. Our entomology collections include several new species of mayflies and the first western Tanzania addition to phylogenetic and distribution studies of African mayflies and dragonflies.

Fig. 6. collecting fish and invertebrates with dipnets at Ugalla River; water scorpion; large *Potamonautes lirrengensis* on machete for scale.

Collections are in the process of being accessed, with type specimens to be deposited in the Natural History Museum, London (molluscs, herps, insects), and Cornell University (fish) and paratypes in the National Museums of Tanzania and TAFIRI-Kigoma with accurate labelling after the taxonomic work is completed.

We were highly alert to the presence of the exotic, destructive South American water hyacinth (*Eichhornia crassipes*), which has been recently introduced into Lake Tanganyika (K. West, pers. comm.). We did not find evidence that it has colonized the areas of the Malagarasi wetlands we visited, however we observed a small clump of water lettuce (*Pistia stratiotes*) at one place in Lake Sagara.

Our aquatic surveys of the remote Igamba Falls area are apparently the first of their kind and revealed a number of new fish and mollusk species, making this site not only of special interest, but also of special concern as it is under discussion for hydropower installation. Although this site has been discussed for hydropower for 10 years or so and is not the highest rated among possibilities in the region (www.ssea.snclavalin.com/pdf/SSEA_Bulletin_no3.pdf) we are aware it is still currently under active consideration as a WB fact-finding team visited the site in August 2005. Our aquatic sampling there was of very limited duration and we strongly advocate detailed biodiversity work be continued in the region.

Limnological surveys

The limnology team had two subcomponents – a physical/nutrient/hydrogeology focus lead by H. Nkotagu and a biological focus coordinated by S. Mwaitega. Both of these have produced completed analyses that have been presented at professional meetings and are in manuscript form ready for submission for publication.

Significant differences among physico-chemical and river geomorphologic parameters were observed across the 20 sampled sites. Similarly, nutrient levels differed with depth throughout the river systems. The mean variation of NO_3^-, SiO_2 and PO_4^{3-} concentrations with depth ranged from 0.4 to 1.75 mg l^{-1}, 7.6 to 24.4 mg l^{-1} and from 0.01 to 0.08 mg l^{-1} respectively for the entire river system. The mean concentrations of Fe^{2+} and PO_4^{3-} were noted to increase with depth at some sites. These changes were attributed to processes including dissolution, diffusion, adsorption, absorption, decomposition of organic litters and reduction along with anthropogenic activities. The geomorphology of the sampled rivers and lakes is influenced by both the native geology of the area and anthropogenic activities. Water depth ranges from 0.5 to 20 m with the shallowest areas most affected by anthropogenic sedimentation. The deepest depth was the plunge pool of the Igamba Falls. Similarly, nutrient data indicate that the limnological functioning of the river system is strongly influenced by anthropogenic activities. We recommend that quantification of river flow, sediment load and nutrient budget at various points of the river be determined for proper evaluation of the hydrologic and limnological functioning of the river system.

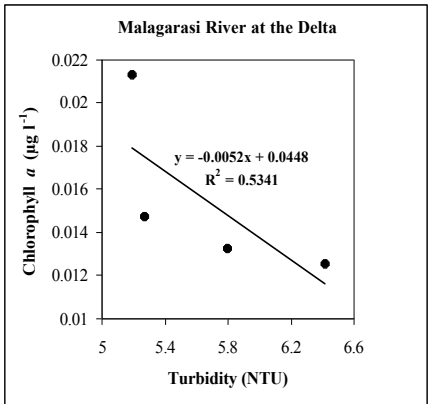


Fig. 7. Inverse relationship of chlorophyll *a* (µg l^{-1}) with turbidity (NTU) at the Malagarasi Delta suggesting that turbidity at this site is mainly a function of suspended sediments, not productivity blooms. Increased agricultural activities are just upstream and close to the banks of the river thus contributing significant suspended sediments to the river at this point. This observation is typical of many of our sampling sites.

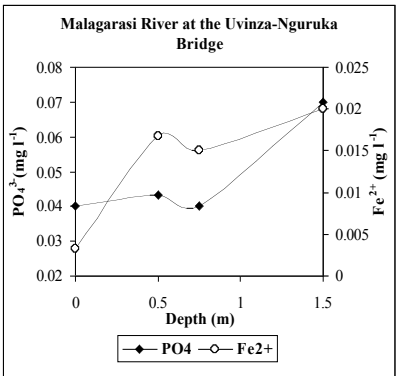
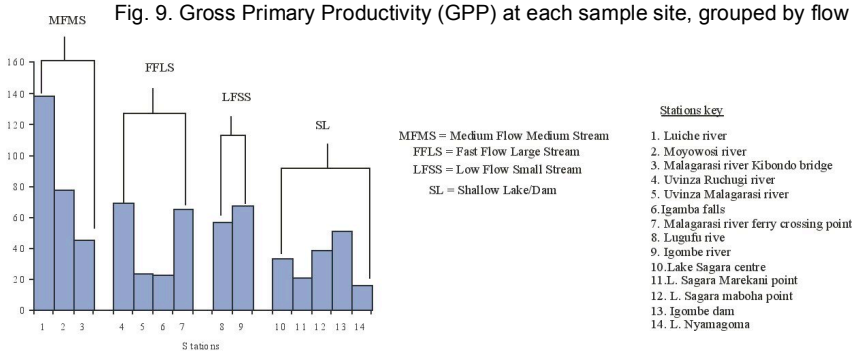


Fig. 8. Mean variation of PO_4^{3-}(mg l^{-1}) and Fe^{2+} (mg l^{-1}) with depth (m) in the Malagarasi River at the Uvinza-Ngaruka bridge. High values of phosphate may be due to increased anthropogenic activities within the catchment. At most sites the mean concentration of phosphate decreased with depth. This is attributed to adsorption of phosphate on to sediments enriched with ferric oxides and or ferrous hydroxide depending on the field stability conditions prevailing there. However, the mean concentrations of ferrous (Fe^{2+}) iron and phosphate were noted to increase with depth at some sites in the catchment as shown at the Uvinza-Nguruka Bridge and Igombe Dam in Tabora

Primary productivity was low compared with other tropical freshwater ecosystems, which might be attributed to light limitation or an ecosystem shift from light limitation to nutrient limitation. The phytoplankton species composition was dominated by species adapted to light-limited environments such as blue green algae, colony-forming small green algae, short forms and centric diatoms such as the *Cyclotella* and floating species such as *Botrycoccus.* We attempted to classify phytoplankton function groups according to habitat type and species composition and found that most of the groups were adapted to nutrient-rich, turbid environments, a sign of eutrophication.

Fig. 9. Gross Primary Productivity (GPP) at each sample site, grouped by flow regime.



Aerial survey

Our aerial photographic survey was the first for the river drainage. We took 4.4 GB of GPS linked photographs (approx. 2000 images), with essentially complete coverage of the river from the delta to Lake Sagara and the inflow of the Ugalla river. The resolution was great enough to identify vegetation and large animals from the photos, and complements satellite information (L. Pintea, pers. comm.). This information will be invaluable for determining habitat heterogeneity and land use along the shoreline. We are planning to incorporate this into an M.Sc. project based at the Univ. Dar es Salaam in hydrogeology and are already using the images for conservation work in the region (D. Erickson, J. MacLachlan, pers. comm.).

Fig. 10. Examples from aerial survey, left to right, top to bottom: a) Malagarasi delta; b) lower Malagarasi near Ilagala, note intensive agriculture, muddy bottom substrate; c) rocky substrate upstream, note cultivation on banks, uncultivated on island; c) braided flow over rocky area; d) hillsides often retain native miombo woodland vegetation, this has been suggested as chimp habitat in some regions; e) Igamba Falls, upper falls area; f) gorge with wooded slopes; h) southern end of Lake Sagara with significant macrophytes; I) Ugalla River flows underground at the base of Lake Sagara. Photos J. MacLachlan.

Local scientific, educational and development context:

This expedition provided essential support for our team of Tanzanian professional limnologists to execute research in one of their most important freshwater wetland systems, as well as establishing lasting collaborations with European and American scientists. The resulting publications will provide a foundation for future biological and limnological research in the western Tanzania region. With the added experience from our expedition, the junior scientists of our team have recently secured competitive grants for higher education (S.M. – Ph.D. in Chemical Oceanography, C.A. – M.Sc. in Hydrogeology & Water Chemistry) and have participated in further scientific research in the region (C.A. – local scientific and logistics coordinator for Univ. Newcastle expedition on schistosome prevalence). E.M. and H.N. have submitted additional grant proposals to expand Malagarasi research opportunities for African scientists (Pan-African START prgm). Our new species discovery has elicited the interest of major conservation organizations such as IUCN and we are becoming increasingly involved in regional assessments. Our local level outreach efforts continue with plans for a permanent exhibition and presentations at the Jane Goodall Institute's TACARE Education Centre in Kigoma. Our aquatic sciences technician (G.K.) will train as a presenter of aquatic conservation issues to local school children and adults, enhancing efforts to educate the community about the practical and scientific importance of their region. For local development programs such as SIMMORS (Sustainable and Integrated Management of the Malagarasi-Muyovozi Ramsar Site), UNHCR, and the World Bank hydropower scheme, we will provide our results as baseline scientific data. This will promote informed decisions on development plans for the Malagarasi region and may help avoid serious, unforeseen impacts on these important wetlands aquatic ecosystems.

Achievements and conclusions

- New species discovery in all focal groups, with taxa of special note among the fish,and molluscs
- First recorded distributions from western Tanzania and first tissue samples for many taxa.
- First aquatic survey of Gombe Stream National Park (preliminary)
- Highly unusual new species found in area under discussion for damming (Igamba Falls)
- First limnological profiling of drainage from source to mouth, documenting anthropogenic impacts
- First fluvial productivity data in most parts of the river
- Coordinated sampling links basic physical and biological patterns
- Evolutionary results in the works for molluscs (major changes in our view of Tanganyikan endemics), fish (critical taxa for understanding diversification of cichlids and catfish), insects, crustaceans, frogs
- Aerial survey providing data on habitat heterogeneity and land use changes along the river

Outputs:

Loader, S.P., & J.C. Poynton, The amphibian fauna of Western Tanzania. In preparation.

Michel, E. 2005. Malagarasi Aquatic Ecosystems: Biodiversity & limnological functioning of the Malagarasi-Moyovosi wetlands, western Tanzania – *or* finding out what's living and flowing in Tanzania's second largest river system. Invited presentation at Roy. Geog. Soc. Grants workshop, April 2005

Mwaitega, S. & E. Michel. Primary productivity and phytoplankton species composition in the Malagarasi and allied rivers and wetlands in western Tanzania. 18 MS pages, 2 figs, 2 tables, ready for submission to Hydrobiologia.

Nkotagu, H.H. & C.B. Athuman. The Malagarasi riverine limnology. MS in advanced stages of preparation

Nkotagu, H.H. & C.B. Athuman. The limnology of the Lake Tanganyika catchment. MS in advanced stages of preparation. *plus* talks on the same topics presented at Intl. Com. Earth Sciences in Africa (ICESA) Intl. Conf. E. Af. Rift Syst.-EAR05 Geodynamics, Environment, Resources, & Sustainable Development, Mbeya, TZ Aug 16-18, 2005.

Planned outputs: synthesis paper (lead by Michel & Nkotagu, co-authored by all participants) coordinating limnological and biodiversity results, further systematic descriptions of new fish, herp and mollusk taxa, evolutionary analyses including specimens from this expedition, analysis of aerial survey results.

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Poynton, J.C., Loader, S.P., Sherrat, E., & Clarke, B.T. (submitted) Amphibian diversity in eastern Tanzania: altitudinal and latitudinal patterns. Biodiversity and Conservation.

Quinn, C.H., Ndangalasi, H.J., Gerstle, J., Lovett, J.C. (2005, in press). Effect of the Lower Kihansi Hydropower Project and post-project mitigation measures on wetland vegetation in Kihansi Gorge, Tanzania. Biodiversity and Conservation 14: 297-308.

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Logistical Outline

Time Schedule: Our field sampling period was the end of the dry season (Sept 1- Oct. 15), as the contracted water bodies concentrate aquatic organisms and road transport is at its most feasible.

Travel: We used a Land Rover and Land Cruiser as our primary transport, equipment storage and mobile labs. We carried an inflatable boat and outboard with us and used it at a majority of sites, and rented local boats as needed. Often two boats were needed as biodiversity and limnological sampling strategies differed and the team was too large to work from a single small boat. Occasionally we used the inflatable for long distance transport (e.g. Kigoma to Malagarasi Delta). We found road access to be possible (though road conditions were not always good) to most of the sites we had pre-selected, and were able to adjust site sampling according to access.

Overview of sampling schedule:

Preparation weeks: Expedition leaders E. Michel & H. Nkotagu spent several weeks ensuring appropriate paperwork was filed and equipment orders were underway. Permits from Univ. Dar es Salaam, Wildlife Dept., letters to regional and district officers, etc.

Week 1: Arrival of Friel & Loader in Dar es Salaam, purchase supplies and travel to Kigoma. Collect and prepare equipment in Tanzanian Fisheries Research Station (TAFIRI) Kigoma. Check-in with local authorities. Prepare vehicles. Trial sampling expedition to Ilagala, local sampling at Kigoma/Ujiji and Gombe Stream National Park (by invitation of GS Research Center).

Week 2: Detailed sampling of Malagarasi Delta region.

Week 3: Initiated lower Malagarasi sampling (Luiche, Lugufu, Ruchugi Rivers, (Uvinza area), first fast visit to Igamba Falls (lower falls only), Urambo base.

Week 4: Ngaruka base, sampled Lakes Sagara & Nyamagoma, Ugalla River mouth, Igombe River, main Malagarasi River

Weeks 5-6: around Tabora, Igombe Dam, traveled past Kahama (no flowing waters) to headwaters region to sample upper Malagarasi, Moyovosi, Makere, Kibondo, to main spring headwaters of Malagarasi (beyond Burundi-TZ border, with military escort)

Week 6: Travels to northern sites (Kasulu, Kibondo, Kahama). Time after this for specimen prep, lab analysis.
August 2005: Aerial photographic survey of lower Malagarasi

Team members:

The team comprised nine people for the full expedition, which resulted in an ideal sized group. With two vehicles this leaves one extra seat to include a rotating participant from the local community. We often included a local fisheries officer, game warden, researcher, etc. and benefited greatly from the added resident expertise. The composition of the expedition team changed from earlier proposal drafts because several of the proposed participants found they had alternative obligations, however we preserved the professional profile of the participants with half the team focused on biodiversity sampling, half on limnology.

Dr. Ellinor Michel (Dept. of Zoology, Nat. History Museum London & Nyanza Project) – expedition leader, aquatic ecologist & evolutionary biologist, mollusks, email: e.michel@nhm.ac.uk

Dr. Hudson Nkotagu (Dept. of Geology Univ. Dar es Salaam) - expedition co-organizer, geologist & hydrologist, hudson@udsm.ac.tz

Dr. John Friel (Museum of Vertebrates/Dept. of Ecology and Evolutionary Biology Cornell Univ.)– ichthyologist, Dr. Simon Loader (Dept. of Zoology, Nat. History Museum London) – herpetologist, s.loader@nhm.ac.uk

Mr. Charles Athuman (Dept. of Geology Univ. Dar es Salaam) – limnologist, water chemistry and physics, buteta@yahoo.co.uk

Ms. Sihaba Mwaitega (TAFIRI-Kigoma) – limnologist, productivity and phytoplankton diversity, sihaba@yahoo.com

Mr. George Kazumbe – aquatic sciences field technician, fish parataxonomist, kazumbe@hotmail.com

Mr. Mbata, driver & local liaison

Mr. Hamisi, driver

Mr. Issa Petit – technical support in Kigoma (equipment repair, electronics fundi)

Specialists who are currently working on collections from the MAE expedtion:

Crustaceans - Paul Clark (NHM London) shrimp, Saskia Marijnissen (Univ. Amsterdam NL) crabs

Molluscs – Dan Graf (Acad. Nat. Sci. Philadelphia) bivalves; D. Kane, D. Robinson, F. Naggs (NHM London), pulmontate gastropods (schistosome vectors & landsnail biodiversity)

Insects - Micheal Monaghan (NHM London) ephemeroptera (mayflies); KD Dijkstra (Naturalis, Leiden, NL) odenates (dragonflies)

Diatoms – Geraldine Reid & David Williams (NHM London)

Fish – M. Stiassney & R. Schelly (Amer. Mus. Nat. Hist. NY) cichlids, D. Twiddle from the (S. Af. Inst. for Aquatic Biodiversity) *Zaireichthys* catfishes, M. Retzer (Illinois Nat. Hist, Survey) *Auchenoglanis* catfishes, molecular work: J. Day (NHM London), J. Sullivan (Acad. Nat. Sci. Philadelphia).

Other logistical details:

For safety coverage we carried a satellite telephone/email so were able to contact medical support in Kigoma if needed and we notified evacuation support of our itinerary before traveling. Our team remained remarkably healthy throughout the trip, however, with only one brief incidence of malaria (readily diagnosed and treated) and a few fleeting digestive and dermatological issues.

We had several major vehicle problems, with a cracked head gasket requiring a return to Kigoma after initial departure, and a destroyed muffler from bushwhacking to Igamba Falls along bicycle trails (there are no roads there). Each of these problems required several days for repair, though we were able to keep the team working by finding alternative transport or tasks.

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Photographs credit E. Michel unless otherwise specified.