

THE EAST AFRICAN
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EAWLS URGES KENYANS TO LOOK BEYOND THE MAU

The East African Wild Life Society (EAWLS), the region's widely respected champion of conservation, urged Kenyans on Thursday to look beyond the controversy over the Mau forest to see a much wider range of real and potent threats facing Kenya's rich natural heritage through inadequate governance, inadequate collaboration and inadequate information.

"We welcome the current public debate over the very serious impact of the destruction of the Mau water tower and the public support for its restoration. But that is just one aspect of a much broader lack of sound and sensible governance of Kenya's natural resources which threatens to undermine its worldwide standing as an environmental treasure trove," EAWLS said in a statement.

The Society's new Executive Director, Nigel Hunter, urged the government, other responsible authorities and the people of Kenya to take urgent action before damage to forests, water resources, wetlands and wild life becomes irreversible.

He said EAWLS, an important voice of conservation in East Africa, wanted the authorities, with the support of Kenyans, to focus on the following areas before they become yet another national crisis. "Extinction is for ever."

- **Agriculture:** the sale and use of Furadan, as one example, in Kenya, a pesticide banned in the United States, is killing wild life but, more dangerously, threatening the pollination of plants and species that have contributed to Kenya's reputation for plant and species richness. But that is not all. Local farmers depend on pollination to get good yields for many crops. Bad use of pesticides therefore threaten farmer livelihoods
- **Forests:** Some forests outside of protected

areas are very vulnerable. The Dakatcha forest near Malindi is an example. This almost unique forest mirrors the Sokoke-Arabuka. These two forests are the only known location for a Kenyan endemic bird – Clarke's Weaver. The birds breeding quarters are unknown, but it is thought that Dakatcha may be crucial in this regard. If Dakatcha were to perish, the bird may perish with it. Dakatcha currently faces being allocated, irrespective of local people's rights, and cut down for a plant called *Jatropha*, which is being claimed, without any supporting evidence, to be a commercial winner for biodiesel production. Why is that important? Kenya's rich and varied biodiversity is a key element in Kenya's tourism industry. Start to destroy that biodiversity and the tourism sector will suffer. Why is it happening? Land use planning and land allocation has no coherence, undergoes no evaluation and lacks any governance.

- The Society has been active in bringing the serious problems related to the Mau and Kenya's other water towers to the fore and we strongly support the restoration initiatives. However there is no coherent forest policy in regard to the growing of trees in both designated plantation areas and farmland. Failure to address this issue will lead to a continuation of expensive timber imports and illegal cutting.
- **Water:** the current drought should focus minds on the steady deterioration of Kenya's key water sources in recent years, of which the drying up of Lake Naivasha is only the most visible and alarming example. Despite being a Ramsar Site, there is no agency with any legal responsibility for coordinating the lakes sustainable and wise use. If there was no abstraction from the lake, it is suggested the water would be 4 metres higher than the current level.

- **Wetlands:** Kenya hosts some of the world's most important and rare wetlands, such as the Tana delta, but these areas, together with the people and biodiversity they host, could quickly become memory unless action is taken to protect and develop them along sound lines. Yet again the threats are coming from unproven biofuel initiatives wanting vast acres with a total disregard for the local communities who live there.

"So much of Kenya's environmental wealth lies outside of protected areas that there is a real danger of our biodiversity being confined to a sort of series of environmental theme parks unless we act now," Hunter said.

EAWLS, he said, was launching an appeal – Beyond Park Gates – for funds to lobby and advocate to protect Kenya's natural wealth outside of enclosed and guarded areas. "We will campaign for sound governance across the whole range of environmental issues before it becomes too late," said Hunter.

MANY OF KENYA'S UNPROTECTED, YET CRITICAL INDIGENOUS FORESTS CONTINUE TO BE CUT AS THE MAU DEBATE CONTINUES

The Mau Complex Forest may be a major issue of concern, but there are other forests, the majority of which are the country's critically important water towers, that continue to be decimated. These also require attention. Continued destruction of Kenya's Water towers is weakening the economy and impoverishing the lives of many Kenya through hunger and drought.

Important coastal Dakatcha woodlands under threat

Covering about 32,000 hectares, Dakatcha Woodland, in Malindi District, is one of the most important biodiversity and water catchment forests at the coast and it is in danger of being depleted. It is home to one of the world's rarest birds: Clarke's Weaver. This species has only been seen here and in Arabuko-Sokoke Forest to the south. Its nest has never been found. Dakatcha Woodland is considered the likely nesting site.

Because of its importance for the conservation of Clarke's Weaver and other threatened birds, Dakatcha Woodland is considered an Important Bird Area (IBA). Dakatcha Woodland is also home to a rich variety of birds and endangered mammals of the East African Coastal Forests.

The dry forests of Dakatcha Woodland form the water catchments for springs, wells and seasonal streams that local communities depend upon. The natural vegetation protects the soil from erosion. In some areas, the soils are extremely fragile, and readily erode. The woodlands and thickets also provide environmental services such as carbon sequestration and climate moderation, and provide local communities with grazing grounds, wild fruits, medicinal plants, firewood and other benefits.

At present, however, Dakatcha Woodland has no protected status, although in 2006 the Kenya Forest Service posted a forest officer at Marafa forest station. Dakatcha Woodland is administered by the County Council of Malindi and the local community. There are many other similar forests in Kenya especially under county councils in private group ranches all the country that are of the same status and currently under clearance. These are the forests that nobody is talking about.

The northwestern part of Malindi District has few sources of permanent water and relatively infertile soils. A major source of income for local communities over the past 20-30 years has been selective logging of trees, sold as timber in nearby coastal towns. Since 2005, large-scale charcoal production started in the area, leading to clear felling of large sections of forest. Today, commercial logging, commercial charcoal production, and local slash and burn clearance of forest for poor quality agricultural fields, pose a grave threat to Dakatcha Woodland.

Commercial growing of *Jatropha* to replace Dakatcha woodlands

In 2009 a new and devastating threat emerged: the proposal to grow plantations of *Jatropha curcas* for the production of bio-diesel. Growing of *Jatropha curcas* for bio-diesel is still largely unproven and untested in Kenya. In some parts of the world, the plant has failed to thrive, while in others it has become an invasive that is now banned. Nevertheless, on 15 May 2009, a locational leaders meeting was held in Marafa, during which the local community were informed of a proposal by Kenya Jatropha Energy Limited to lease the woodland for growing of *Jatropha*. In this era of climate change, replacing the woodlands with *Jatropha* will have a negative net effect of releasing most of the carbon held by the current vegetation to the air. It is therefore not an environmentally friendly thing to consider especially in absence of studies showing that *Jatropha* will do well in the area. In the absence of studies of its viability in the area, it may also turn out to be economic catastrophic. The local community may be enticed to lease the land to the company by the many goodies that come with such offers. They have been for example promised employment, digging of water wells, building of schools and health centres. This will not be sustained if the project fails. However, by then all the woodland will have been cleared and the infertile land left tree less.

The East African Wild Life Society, Nature Kenya and the Kenya Forests Working Group are opposed to the *Jatropha* project for the following reasons:

1. Any further clearance of the natural vegetation will threaten a bird found nowhere else on Earth – Clarke's Weaver – with extinction.

2. Any further cutting of forest, woodland or thicket in Dakatcha will damage the ability of the landscape to be a water catchment and protect the soil from erosion, thus threatening the ability of local people to live in the area.

3. It has not been proved that *Jatropha curcas* will grow in the area; or produce sufficient quantities of bio-diesel, or will not become an invasive species.

4. Local people stand to lose their rights to the land on which they live if the investors are allocated large areas of land on a long lease.

We are proposing a precautionary approach to the planting of *Jatropha* in absence of a biofuel policy and strategy. We recommend an Environmental Impact Assessment (EIA) for any commercial biofuel project, a cost-benefit analysis to determine whether growing a biofuel crop carries an energy cost as well as environmental and social costs, no growing of commercial *Jatropha* in critical water catchment and biodiversity rich areas and in areas where local communities will be deprived of local community rights on land that they live.

Pressure for construction timber poses a threat to indigenous forests

The demand for construction timber does not match the supply. This has contributed to the high prices of timber in the country which in turn has heavily contributed to illegal cutting of indigenous forests. The failure to have sustainable wood supply is to be blamed on the government. Large areas of plantation forest in the country are not well managed. The country does not seem to have a clear coherent policy on timber production. Commercial tree growing is therefore done on ad hoc basis. The East African Wild Life Society urges the government to save the last indigenous tree in Kenya by ensuring that the country has a sustainable wood industry that is affordable to the majority of Kenyans.

LAKE NAVIASHA – FROM A RIFT VALLEY JEWEL TO A “MUDDY POND”

“Nothing more than a muddy fish pond,” is the best description of Lake Naivasha, according to a group of stakeholders, who recently met at Lake Naivasha Sports Club to find solutions to save the vanishing Lake.

The current lake levels are among the lowest recorded and the lake’s ecosystem is probably irreparably damaged. In the last one year alone, the lake has receded over 500 meters along the riparian zone. This can be attributed to excessive use of central pivot irrigation units around the lake, where the groundwater levels have been seriously depleted, resulting in an outflow of water from the lake to refill the groundwater lost. Water abstraction figures show that flower farms are responsible for 50% of the abstractions, vegetable farmers 42%, and all others combined at 8%.

Lake Naivasha is an indicator for all of Kenya’s troubled lakes; if it dries up, so too does an incredible wealth of biodiversity all around it.

The drying up of the rivers Malewa and Gilgil, which lead to the lake, is clearly as a result of the excessive diversion of waters leading to those rivers by small-scale farmers, along with severe deforestation of the upper catchment area, as well as abstraction diverted to Nakuru and Gilgil.

The papyrus fringe that once acted as a kidney to the lake, sieving the impurities, has been cleared to pave way for horticultural farming and settlements. Excessive nutrient enrichment from the flower farms has increased the Ph (alkaline level) of the lake, threatening the habitat of the famous Kingfisher and 500 plus bird species, various fish species, the hippopotamus and crocodiles. Instead of the beautiful scenery that the Lake used to have, dying hippos are now stranded in mud pools up to a kilometer from any water source, while heavy machinery owned by wealthy commercial vegetable and flower farms are digging canals and wells in unsustainable attempts to harness the fast retreating waters

of Lake Naivasha. This unsustainable water use and pollution has driven the locals to a situation where they can no longer enjoy the benefits of the wetland.

The degradation of Lake Naivasha is against the Convention on Wetlands (Ramsar, 1971) to which Kenya became a contracting party, which saw the lake listed as the second Ramsar site in Kenya. According to the intergovernmental treaty, all countries that have ratified it are obliged to embrace sound environmental conservation policies to protect wetlands in their bid to attain sustainable development. However, due to severe degradation, Lake Naivasha has now been listed in the Montreux record of endangered sites.

The task of restoring the lake is simply monumental, as there are so many diverse interests at stake and there is no National Wetlands Policy in place. No one holds any realistic hopes of progress, particularly when there is no co-ordinating legal management authority for the lake and consequently a complete lack of enforcement of any of the regulations that could have helped. The Lake’s Management Plan, which was developed by the local residents in a collaborative process, is still sub-judice, following the court injunction against its implementation. But even if the plan was implementable, the lack of a management authority to coordinate the management, conservation, and protection of the lake would have made implementation very difficult. Therefore, when the other statutory laws like the EMCA, Water Act, Land Act and general agriculture policies are flouted, as usually happens, the lake suffers and in the end the country, its people and the ecosystem degenerates, if not collapses to the detriment of Kenya, its people, its environment and its economy.

Lake Naivasha embodies the way in which much of Kenya’s environment slips between the cracks of the many government Ministries

supposed to regulate what happens to it. There is no one authority to bring coherent and prudent governance to its water, land, wild life, people and natural wealth.

Lake Naivasha has the potential as a Ramsar site for sustainable, small scale agriculture and eco-tourism. This could protect both the lake and the livelihoods of the communities around it, as well as promoting food security for Kenyans and attracting more local and foreign investors who would help the local community, while causing little or no damage to the environment. Even flower farming is acceptable, provided it is limited to the sustainable capacity for the lake to provide water to all the local users. But this will not happen in the absence of any legally appointed management authority. Even then rolling back the free for all that has prevailed will be a miracle

It is for this reason that the East African Wildlife Society, and the Kenya Wetlands Forum recommends that Lake Naivasha be made a protected area, and thus give the lake the first step to restoring its former glory of this once bountiful ecosystem. The danger signs – algal bloom from pollution, disappearing water levels and struggling wild life – are there for all, including tourists, to see. Kenya does not need this sort of image.

PESTICIDES POISONING WILDLIFE IN EAST AFRICA

One especially vicious killer of wildlife, pollution, is mostly invisible: chemical toxins that enter the food chain. Most poisons enter natural habitats inadvertently as a by-product of human activities such as industry and agriculture.

There is a growing trend that is causing alarm among conservationists and scientists in the region. Reports from all across East Africa point to the deliberate use of a chemical pesticide to poison wildlife. The victims of this pesticide are wide, including lions, fish, water birds in irrigation schemes, birds of prey and other scavengers including vultures and untold damage to honeybees and other useful insects.

The main chemical being used to poison wildlife in the region is in a class of toxins known as carbamates. The chemical compound itself is called carbofuran and it is marketed in East Africa as a product called 'Furadan'.

Following a meeting of scientists and stakeholders organized by the conservation organization WildlifeDirect in April 2008, and widespread media coverage of the problem, including a segment on the US news show 'CBS 60 minutes', the American company that manufactures Furadan, FMC, agreed to withdraw it from the market and claim to be buying it back from all outlets.

The fact that carbofuran has been deemed a risk in the EU and US should be enough to ban its use. At the April meeting, Dr Richard Leakey noted: "If Furadan is too dangerous for Americans and Europeans, we have no business using it in Kenya".

In the May the US Environmental Protection Agency (EPA) revoked all tolerances of carbofuran in food products stating:

"EPA has concluded that dietary, worker, and ecological risks are unacceptable for all uses of carbofuran. All products containing carbofuran generally cause unreasonable adverse effects on humans and the environment and do not meet safety standards, and therefore are ineligible for reregistration."

This effectively bans the use of carbofuran in US agriculture from December 2009. Carbofuran remains totally banned in the EU. In light of the US decision, Canada is now considering banning carbofuran. In a Nairobi meeting with the WildlifeDirect Poison Task Force, senior FMC Directors argued that the EPA facts were incorrect and that they would challenge the decision. They also revealed that the patent for Furadan had expired, opening the door for other manufacturers to supply the poison. A quick internet search reveals that carbofuran is already in production at over 20 companies in China, Pakistan and India.

As of August 2009, Furadan was still widely available from stores in some towns such as Eldoret, Rongai, Kiserian, Nakuru and Narok. Reports from Uganda

and Rwanda reveal that no buyback is in place as promised by FMC, and Furadan is widely available there. It is even sold and widely used in the areas right up to and surrounding the mountain gorillas.

Conservationists strongly believe that a total ban is a first and vital step to halting the decline of wildlife from poisoning.

DETAILS ON THE EFFECT OF THE ABUSE OF PESTICIDES: LIONS

All across the region lions are disappearing. And one of the major killers of lions is deliberate poisoning. Laurence Frank and colleagues working in the greater Laikipia ecosystem estimate that over 70 lions have been killed over the past few years using 'Furadan'.

Kenya's lion population is estimated at just over 2000, and recent reports indicate that somewhere between 100-200 lions are being killed annually mainly by poisoning (although deaths from spearing are also important). If this trend continues unabated, lions will vanish from Kenya in less than 20 years, if not sooner! Monitoring of lion deaths by the KWS indicates that around 38 % of lions killed are poisoned with carbofuran. This is a very dire statistic given the central role played by lions in the pride and heritage of Kenyans, their value to the tourism industry and their important role in maintaining ecological dynamics on the savannahs.

VULTURES AND OTHER BIRDS

Birds are being poisoned both deliberately and indirectly by carbofuran in Kenya. In Western Kenya, fieldwork by Martin Odino, has revealed a widespread practice of lacing baits with Furadan. Birds feed on the baits and end up being killed, plucked and sold for food locally. A wide range of species are targeted including ducks, Open-billed storks, doves and pigeons. Indirect poisoning of large flocks of birds, including migratory waterfowl, has been documented from some of the irrigation schemes. On several occasions entire lorry-loads of poisoned birds have been collected. Rice is one of the crops in Kenya where carbofuran is applied, even though in the US this chemical is not approved for use on rice.

One group of birds, the vultures, have suffered very heavily from the use of Furadan to lace carcasses. The vultures are not the intended victims of this practice, but a tragic part of the 'collateral damage' exacted by Furadan being used to poison attributed predators of livestock. Studies by Munir Virani of the Peregrine Fund and Simon Thomsett, have revealed widespread poisoning of vultures across most of the habitats that they frequent.

Some vulture species, such as the Egyptian Vulture, have virtually disappeared and will soon be locally extinct if swift action is not taken. Many vultures wander widely in search of food, and therefore are particularly vulnerable to the effects of poisoning. Even populations that nest or live predominantly within the safer confines of protected areas range

outside these habitats for hundreds of miles and can feed on carcasses that have been laced with poisons.

FISH

One area that is little studied as of yet is the prevalence of pesticide fishing in East Africa. Fishing with poisons is being carried out on Lake Victoria and other water bodies. While only a minority of unscrupulous fishermen engage in this practice, the results of pesticide fishing cause localised die-offs of pretty much all aquatic life: big saleable fish, small indigenous fish such as cichlids and invertebrates such as dragonflies.

A study comparing dragonfly diversity between pesticide-fished and other sites showed that dragonflies are highly susceptible to this practice and all but disappear from areas that are routinely pesticide-fished. Only two species of dragonfly can be found in areas that are pesticide fished. One, the Globe Skimmer, is a tramp species that wanders in, and the other the Banded Groundling, breeds in very shallow sheltered reedy areas that are likely less affected by the poisons. In contrast areas that are not fished using pesticides have a high diversity and abundance of dragonflies. What other long-term effects and the potential for these pesticide-fished fish entering the human food chain remain to be investigated.

BEES

All pesticides are harmful to honeybees to some extent. Honeybees are insects after all, and pesticides are designed to kill insects. Honeybees and other bees, all of them useful and important pollinators, are very susceptible to carbamates, which include carbofuran. Toxicity of pesticides to honeybees have been rated by the FAO. In this rating, each pesticide was determined to have a 'LD50 score', which is a figure that captures the lethality of the pesticide to honeybees. The lower the LD50 score, the more toxic the pesticide is to honeybees. DDT, one of the most potent poisons ever developed in the history of synthetic pesticides, has a score of 5.44. Carbofuran has a score of 0.149. Therefore, carbofuran is more than 36-times more toxic to honeybees than DDT! Ironically, carbofuran has been widely touted, and marketed as, a 'better' alternative to DDT.

In the current global crisis surrounding honeybees scientists have identified one cause of their decline as the widespread use of chemical pesticides. These work twofold against bees as they are both highly toxic as well as making them become disoriented and unable to find their way back to their hives. Another aspect of honeybees' accumulating pesticides is that these can find their way into their honey when they gather nectar and pollen from crops or areas that have been treated. This then puts the consumers of that honey, including both the young bee larvae and humans, in danger.

THE TANA RIVER DELTA WETLAND

The spectre of conflict between conservation and development regularly rears its head in the Tana Delta wetlands. Examples are a declaration by the Tana and Athi Rivers Development Authority (TARDA) to undertake sugarcane growing and sugar production in the Tana Delta. More recently there is a growing demand to use the Delta area for the commercial production of *Jatropha*.

The Tana Delta wetlands within Tana River district of Coast province is arguably Kenya's largest, most ecologically and biologically diverse, socially and economically important wetland. The Tana Delta is formed at the lower Tana River floodplains found largely in the new Tana Delta District (Garsen Constituency). A small portion is located in Witu location of Lamu District. It covers about 130,000ha of which some 69,000ha are regularly inundated. The head of the Delta is below Lakes Giritu and Bilisa to south of the Tana River National Primate Reserve. Below these lakes the flood plain widens and a series of old and new river channels fan out to reach to the coast at Ungwana Bay-Western Indian Ocean Coast. There are extensive permanent swamps and smaller lakes along the channel/floodplain.

In summary, the delta has a very rich and diverse biological resources. 76% of this biodiversity comprises permanent water bodies; swamp or marsh vegetation; seasonally flooded grasslands; mangrove swamps; riverine/floodplain forests; marine sea grass beds; coral gardens and coastal dune habitats. The remaining 24% comprises wooded grassland and bush land association. At the species level, it is worth highlighting that parts of the delta sustain 2 species of monkeys that are considered endemic to Kenya - the Tana River Mangabey and the Tana River Red Colobus and one Kenya endemic bird - the MalindiPipit.

The proposed sugar developments can best be summarized as the TARDA/Mumias Sugar Company project, initially covering 20,000ha (but now covering 40,000 ha) most of it in Tana delta district and a small portion in Witu location in Lamu District, under an irrigation system with water supply from the river. An EIA study was done but was challenged in terms of technical and scientific weakness, omissions, errors, ambiguities as well as procedural flaws. Nevertheless an EIA license was given to MSC/TARDA on 16th June 2008. The other initiative is via MAT International, who have applied for 2 parcels of land - 30,000ha in Tana Delta District between the Tana River Primate Reserve and the TARDA/ MSC proposed site and 60,000ha in Lamu District bordering Tana Delta District to the West and Ijara District to the North. MAT is also seeking to apply for another parcel in Ijara District. For the first 2 parcels, approvals have been done but have been challenged.

To date neither a project document nor an EIA study has been undertaken.

The existing human settlement and land use can be summarized as over 18 villages within the delta in the proposed sugar sites, comprising pastoralist/livestock herders –Orma, Wardei and Somali; farming communities –Pokomo, immigrant Mijikenda; fishing communities –Malakote, Bajuni and immigrant Luos; and gatherers –Wasanya/ Boni. It is estimated that some 25,000 people will be adversely affected.

Such is the immense value of the wetlands that when TARDA declared that it intended to convert a large area of the wetlands for sugarcane growing and sugar production, several varying opinions have been expressed regarding the venture. These sentiments have either been in support of, or contrary to the proposed project. Those in support of the project propagate the argument that the proposed project will act as a factor for development and economic growth, thus leading to alleviation of poverty, which is reported to be high in the area, providing alternative sources of livelihoods, improving quality of life and raising material living standards among the area inhabitants. On the other hand, those with contrary opinion argue that imminent displacement, change of livelihood systems and limited attention to environmental aspects of the delta will have serious immediate and long-term ramifications on the delta, its people and the national interest of Kenyans. They believe that this is not the best use of the resources (both social and ecological). They believe that these ventures are short term and will cost the Kenyan Government and the local people great loss in the long term.

In considering those two viewpoints, the following concerns need to be noted

- No public access to correct information has been provided, only propaganda
- Weak public participation in decision making regarding the project
- Political and administrative decisions have been made thus imposing the projects despite fundamental concerns
- Council betrayal of its responsibilities to local communities in regard to Trust Land custodianship
- Government agencies and public servants including TARDA, NEMA and local administration have avoided generating any debate because of the factional and vested interest pressures.
- The EIA findings and licenses granted are technically scientifically and procedural weak. The EIA has not withstood independent verification.
- The proposed schemes negates adherence to the principles of international law which Kenya is party too. e.g. Ramsar convention, Convention on

Biological Diversity etc

- Impact of reduction in flood volumes from irrigation, thus impacting the traditional flood dependent small scale/subsistence agriculture, has been ignored
- An increase and intensification of land use conflicts between farmers and livestock herders has been ignored.
- The drying up of delta and displacement will have severe adverse impacts on fresh water fisheries
- The proposed schemes and wetland reclamation will cause severe physical destruction of the delta floodplain habitats and associated biodiversity
- Pollution from agricultural inputs and factory effluents will adversely affect the Coastal and Marine biodiversity such as mangroves, coral gardens and sea grass beds and associated biodiversity and livelihood systems
- Hydrological imbalance and reduced river flow will cause intrusion of saline water further upstream, which will impact negatively on flood recession agriculture and other floodplain agricultural system.

With these concerns in mind, two questions surface

1. Are the proposed large scale plantation schemes the best way to develop the very rich and diverse resources of the Tana Delta?
2. Are there alternative approaches to developing these resources in ways that will benefit the local communities and bring sustainable and widespread development to the area?

The Society believes the answer to 1 is that the proposed plantation schemes will monopolise all the rich and diverse resources of the delta for a single agricultural operation, to the detriment of the local population and to local environment, with no proven national benefit to justify 25,000 people or more be disaffected

In response to 2 the Society believes that there are many alternative approaches that put emphasis on multiple land use within the principles of wise use that can result in sustainable development without adverse environmental impact. However until the national interest prevails over individual interest and until proper dialogue occurs in a joined up manner that allows transparent and objective evaluation, the proposed sugar cane projects are a manifestation of poor/bad governance in natural resources management and poverty alleviation.

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**DIFFERENCES IN ODONATA ABUNDANCE AND DIVERSITY
IN PESTICIDE-FISHED, TRADITIONALLY-FISHED AND
PROTECTED AREAS IN LAKE VICTORIA, EASTERN AFRICA
(ANISOPTERA)**

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The growing use of pesticides for fishing is a current practice of concern for biodiversity in Eastern Africa. There is little information available, however, on the extent and effect of this practice on conspicuous indicator groups like dragonflies. Odon., especially during the larval stage, are particularly vulnerable to pesticides. This survey found significant differences in both dragonfly abundance and diversity in bays of Lake Victoria that had been fished using pesticides. Only 1-2 dragonfly spp. can be found in areas routinely pesticide fished in contrast with > 20 spp. in protected areas. This survey highlights the detrimental effect of pesticide fishing on invertebrates.

INTRODUCTION

Odonata have widely been viewed as useful indicators of water quality. They are particularly vulnerable to poor water quality in the larval stage both through direct poisoning, and as the larval stages are obligate predators, through the reduction of their prey which are also susceptible to poisons (CORBET, 1983). High concentrations of inorganic pollutants and pesticides have been shown to affect different life-stages of odonates and application of insecticides is known to produce a direct effect of decrease in odonate numbers from various studies as summarised by CORBET (1999).

As brightly coloured, diurnal and active insects they are also easy to track and identify and therefore a useful proxy for quality of a given aquatic habitat

(CLARK & SAMWAYS, 1996). This makes them a reliable indicator of the health, stability and integrity of a given wetland habitat (CHOVANEK & WARINGER, 2005). While differences in life-history strategies may result in uneven species' distributions, the diversity and abundance of most common species can be tied to the health of the habitat (WATSON et al. 1982).

Lake Victoria is the world's second largest fresh-water lake and an important area for a wide range of biodiversity taxa including cichlid fish and birds (BENNUN & NJOROGI, 1999). The lake has suffered from a number of ecological catastrophes including the introduction of the Nile Perch (PRINGLE, 2005), the

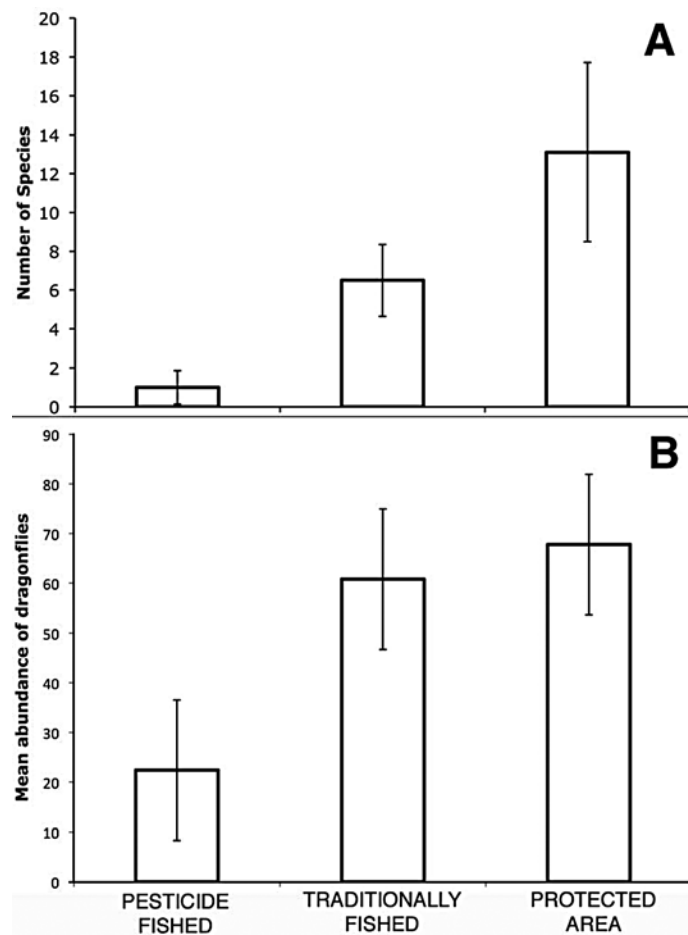


Fig. 1. (A): diversity of dragonflies at three categories of sites in Lake Victoria, N = 20 sites for each category; – (B): mean abundance of dragonflies at the three categories of sites studied in Lake Vic-

water hyacinth and more recently pollution (MARTINS, 2006). Use of pesticides for fishing is one growing area of concern and this study sought to conduct a preliminary investigation of the effect of pesticides on the diversity and abundance of odonates in Lake Victoria.

MATERIAL AND METHODS

All study sites were located in the Mwanza Gulf on Lake Victoria. Three different categories of sites were chosen: (i) areas that were fished using pesticides, (ii) areas that were fished traditionally (no pesticides, but using nets, lines and fish-traps) and (iii) protected areas that were neither fished nor had pesticides directly applied. Pesticide-fished areas were identified through interviews with local fishermen and direct observation of poisoned fish and odonate larvae. Vegetation and habitat structure around all sites was similar consisting of a rocky shore with aquatic grasses, *Sesbania* sp. and small patches of papyrus. Odonate diversity was quantified by identifying the species present at each 20 different sites in each category over ~1 month (July) in 2006 and 2008. This was done through direct observation and occasionally netting and checking with field guides (TARBOTON & TARBOTON, 2002; MILLER & MILLER, 2003). Abundance of odonates was measured by counting the total number of adults flying past a fixed point for 1 hr between 10-11 a.m. in the morning on five separate days at sites for each category. This was the general peak time for insect activity. Only adult dragonflies were identified and counted as they were easier to identify, damselflies were not included in the survey. Data were maintained in spreadsheets using Excel and analysed using STATA.

RESULTS

Significant differences were found at all sites in both dragonfly diversity and abundance (Fig. 1A, B). Only 2 spp. were present in areas that were pesticide-fished in contrast with traditionally-fished (10 spp.) and protected areas (23 spp.) (Tab. I). Odonate diversity differed significantly between all sites (Fig. 1A, ANOVA $F_{2,57} = 86.6$ $p > 0.0001$). There were significant differences in odonate abundance between pesticide-fished and the two other categories of sites (Fig. 1A, ANOVA $F_{2,12} = 12.07$ $p > 0.0013$). Odonate abundance did not differ significantly between traditionally-fished sites and protected areas (Fig. 1B, Bonferroni post-hoc test $p > 1.0$), but diversity did ($p > 0.0001$).

DISCUSSION

The results of this survey show that there are clear differences between areas that are pesticide-fished and areas that are not subject to direct application of pesticides on Lake Victoria. The two species that were observed in the pesticide-fished areas are *Pantala flavescens*, that is widely known to migrate both locally and regionally (TARBOTON & TARBOTON, 2002) and *Brachythemis leucostica*, which we observed to be the most common dragonfly in the region. *B. leucostica* was observed to lay many hundreds of eggs at the base of vegetation surrounding the bays and inlets of the lake. This reproductive strategy may be the reason

Table I
Diversity of dragonfly species observed at the different sites

Species	Pesticide-fished	Traditionally-fished	Protected area
<i>Ictinogomphus ferox</i>			X
<i>Anax ephippiger</i>			X
<i>Anax speratus</i>			X
<i>Anax imperator</i>		X	X
<i>Phyllomacromia picta</i>			X
<i>Brachythemis lacustris</i>			X
<i>Brachythemis leucostica</i>	X	X	X
<i>Palpopleura lucia</i>		X	X
<i>Palpopleura portia</i>		X	X
<i>Rhyothemis semihyalina</i>		X	X
<i>Orthetrum cafferum</i>			X
<i>Orthetrum chrysostigma</i>			X
<i>Acisoma panorpoides</i>		X	X
<i>Pantala flavescens</i>	X	X	X
<i>Philonomon luminans</i>		X	X
<i>Sympetrum fonscolombii</i>			X
<i>Trithemis hecate</i>			X
<i>Trithemis kirbyi</i>			X
<i>Trithemis arteriosa</i>		X	X
<i>Crocothemis erythraea</i>		X	X

utilising micro-habitats that may be more sheltered from the effects of pesticide application.

The use of pesticides in and around Lake Victoria needs to be addressed at a regional level. Pesticides are widely available in lake-side towns, such as Mwanza, and sometimes sold in shops that deal in fishing gear and tackle. It is apparent that it is a few unscrupulous fishermen who use this technique and not the majority. Several different pesticides are used and more work needs to be done on the different kinds of pesticides being used, including through both surveys of indicator groups such as dragonflies on Lake Victoria and more detailed analysis of water and aquatic habitats.

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