GLOW VII

Protecting Great Lakes of the World:

Managing Exploitation with Ecosystem-based Science

AQUATIC ECOSYSTEM
HEALTH & MANAGEMENT SOCIETY

Program & Abstracts

June 17 - 20, 2012
Bujumbura, Republic of Burundi

Conference Organization

Conference Organizing Committee
H. Mwima (conference co-chair, Republic of Burundi)
M. Munawar (conference co-chair, Canada)

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Cover image
S. Marijnissen

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Welcome to GLOW VII!

The Great Lakes of the World (GLOW) Working Group was established by the Aquatic Ecosystem Health & Management Society in 1996 when the first GLOW symposium was organized at Victoria Falls, Zimbabwe. Since then the AEHMS has launched a continuing series of international symposia in order to promote interaction and communication amongst various great lakes/large lakes researchers across the world. The purpose of GLOW is to establish a global platform where ecosystem-based studies of structure, function and performance of large/great lake ecosystems are promoted, organized and synthesized. In addition, GLOW attempts to promote ecosystem, science-based management of these extensive natural resources in an integrated, multi-trophic and multi-disciplinary fashion.

A majority of the great lakes/large lakes researchers, students and managers are aware of the GLOW series of symposia as well as the resulting peer reviewed publications. These publications include special issues of the journal *AEHM* and books of the Ecovision World Monograph Series (see list of publications in tables I and II in the AEHMS Introduction).

GLOW VII in Bujumbura, Burundi is the 5th GLOW in the series organized in Africa to ensure the participation of African scientists and colleagues. The Bujumbura GLOW is turning out to be a unique and interesting experience since a majority of papers are from Africa. The AEHMS is pleased to engage and include African colleagues and plans that their involvement in this international scientific group will bear fruit in publications. The program has been categorized as described below:

1. Lake Tanganyika
2. Lake Victoria
3. Other lakes and ecosystems
4. Panel discussion and synthesis

We greatly appreciate the assistance of Organizing, Scientific and Local Arrangements Committees towards the organization of this meeting, especially committee members Dr. Martin van der Knaap and Dr. Kaitira Katonda for their important contributions. We sincerely thank the members of the Conference secretariat, namely Jennifer Lorimer, Lisa Elder, Susan Blunt and Mark Fitzpatrick for their hard work.

We are sure that the GLOW VII symposium in the beautiful surroundings of Lake Tanganyika will be productive, interesting and generate new energy and momentum for the continued success of the AEHMS-GLOW Working Group and its symposia.

Co-chairs:

H. Mwima
Executive Director:
Lake Tanganyika Authority

M. Munawar
Research Scientist: Fisheries & Oceans Canada
President:
Aquatic Ecosystem Health & Management Society

AQUATIC ECOSYSTEM
HEALTH & MANAGEMENT SOCIETY

Introduction to the AEHMS

The Aquatic Ecosystem Health & Management Society (AEHMS) was established in 1989 to encourage and promote integrated, eco-systemic and holistic initiatives for the protection and conservation of aquatic resources of the world. The Society has four broad objectives centering on health, management, the convening/sponsoring of conferences/symposia, and publications via its international primary journal, monograph series and its website (www.aehms.org). The objectives of the Society are:

- To focus on the structure, function and ecology of freshwater and marine ecosystems.
- Promote the application of integrated approaches for protection, remediation, and restoration.
- Adopt an integrated, multidisciplinary and multitrophic approach.
- Advocate new approaches, techniques, models and novel technology.
- Encourage international and interdisciplinary communication among scientists, managers, universities, governments, industry, and the public sector.

The Society is actively involved in primary and peer-reviewed publications. It publishes an international journal, ***Aquatic Ecosystem Health and Management (AEHM)*** on a quarterly basis (in collaboration with the publisher Taylor and Francis, Philadelphia). From 2007 onwards the AEHM was selected by Thomson Scientific for coverage in the Science Citation Index Expanded (SciSearch®); Journal Citation Reports; Current Contents®/Agriculture, Biology, and Environmental Sciences; Zoological Record; Biological Abstracts; and BIOSIS Previews. It has published over **30** special issues on diverse topics from across the world. Table 1 provides a general picture (also see www.aehms.org).

Table 1. Special issues of the Aquatic Ecosystem Health and Management (AEHMS, 2000-2011), devoted to Great Lakes.

Special issues	**Volume**	**Year**
Large Lakes of the World: Comparative Ecology	3(1)	2000
Ecosystem Health of Lake Baikal, Russia	3(2)	2000
Great Lakes of the World: Food Web, Fisheries, and Management	5(3)	2002
Comparing Great Lakes of the World	6(3)	2003
Coastal Wetlands of the Laurentian Great Lakes: Health, Integrity and Management	7(2)	2004
Emerging Issues in Lake Superior Research	7(4)	2004
Great Lake Victoria Fisheries: Changes, Sustainability, and Building Blocks for Management	10(4)	2007
Changing Great Lakes of the World	11(1)	2008
State of Lake Huron: Ecosystem Change, Habitat, and Management, Part I	11(2)	2008
Checking the Pulse of Lake Ontario	11(4)	2008
The State of Lake Huron: Ecosystem Change, Habitat and Management, Part II	12(1)	2009
Changing Great Lakes of the World and Rift Valley Lakes: Sustainability, Integrity & Management	13(1)	2010
Assessing Large and Great Lakes of the World	13(2)	2010
Ecosystem Health and Recovery of the Bay of Quinte, Lake Ontario	14(1)	2011

In addition, the AEHMS also produces a peer reviewed book series under the banner of the ***Ecovison World Monograph Series***. It has already published over 20 peer reviewed books on a variety of subjects and aquatic environments (see table 2).

Table 2. Books published under Ecovision World Monograph Series from 1995-2010.

Books	**Year**
The Lake Huron Ecosystem: Ecology, Fisheries and the Management	1995
Phytoplankton Dynamics in the North American Great Lakes, Vol. 1: Lakes Ontario, Erie and St. Clair	1996
The State of Lake Erie Ecosystem (SOLE): Past Present and Future	1999
Phytoplankton Dynamics in the North American Great Lakes, Vol. 2.: Lakes Superior, Michigan, North Channel, Georgian Bay and Lake Huron	2000
The Great Lakes of the World (GLOW): Food-web, Health & Integrity	2001
Ecology, culture and conservation of a protected area: Fathom Five National Marine Park, Canada	2001
State of Lake Ontario(SOLO): Past, Present and Future	2003
State of Lake Michigan (SOLM): Ecology, Health and Management	2005
Checking the Pulse of Lake Erie (CPOLE)	2008
State of Lake Superior (SOLS)	2009
Burning Rivers	2010

The Society welcomes individuals for membership belonging to a wide range of disciplines. AEHMS cordially invites to join the Society to support global conservation and education. Membership includes 4 quarterly issues of the journal with on-line access as well as discounts on conference registration fees, purchases of Ecovision books and back issues of our journal. A discounted membership is available for the participants of this conference, students and retired colleagues.

M. Munawar
President:
Aquatic Ecosystem Health & Management Society

AQUATIC ECOSYSTEM
HEALTH & MANAGEMENT SOCIETY

Introduction to the Lake Tanganyika Authority

The four Lake Tanganyika riparian governments of the Republic of Burundi, the Democratic Republic of Congo, the United Republic of Tanzania and the Republic of Zambia signed the **Convention on the Sustainable Management of Lake Tanganyika** on 12th June, 2003. Article 23 of the Convention provides for the establishment of the Lake Tanganyika Authority (LTA), which was formally established during the first meeting of the Conference of Ministers held in April, 2007 in Dar Es Salaam, United Republic of Tanzania. However, the implementation of activities by the LTA started in January, 2009 shortly after an extraordinary meeting of the Conference of Ministers which was hosted by the Government of the Republic of Burundi on 19th December, 2008. On 4th November, 2009, the LTA Secretariat Headquarters Agreement was signed with the host government of the Republic of Burundi.

The LTA has the international legal personality and legal capacity necessary to perform the function of coordinating the implementation of the Convention by the Contracting States. Furthermore, the LTA has the mandate of advancing and representing the common interests of the Contracting States in matters concerning the management of Lake Tanganyika and its catchment basin (see Figure 1 below).

LAKE TANGANYIKA	
Area:	32,600km^2
Volume:	18,900km^3
Shore line:	1,828km
Max Depth:	1,470m
Mean Depth:	570m
Mean Length:	650km
Mean Width:	50km
17% of the global available surface freshwater supply	

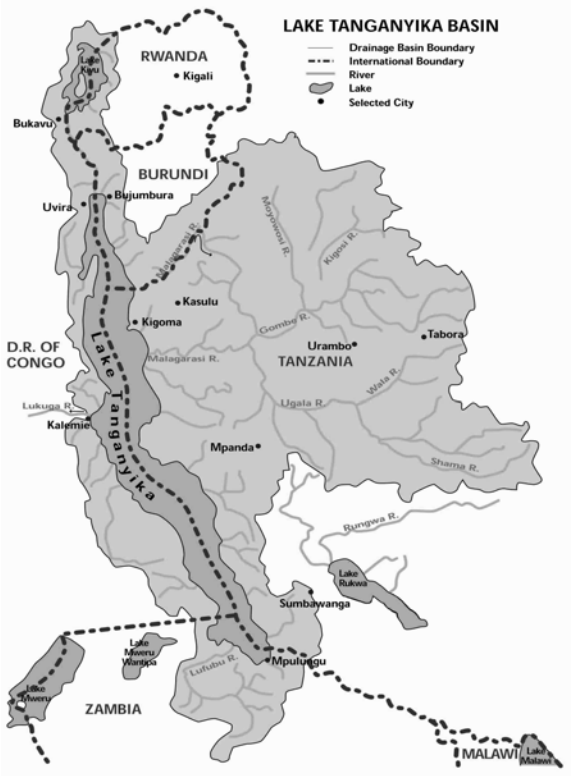

Figure 1. Lake Tanganyika and its catchment basin.

The major function of the LTA is to oversee the implementation of the Lake Tanganyika Regional Integrated Management and Development Programme (LTRIMDP) which was developed to facilitate the implementation of the Convention on the Sustainable Management of Lake Tanganyika, the Framework Fisheries Management Plan (FFMP) and the Strategic Action Plan (SAP). The LTRIMDP has two immediate objectives: 1) To achieve sustainable

management of the natural resources of Lake Tanganyika through implementation of activities prioritized in the SAP and 2) To improve livelihoods through physical and social infrastructure development. The first objective of the LTRIMDP is supported by the UNDP/GEF funding through the Partnership Interventions for the Implementation of the SAP for Lake Tanganyika Project. Both the first and second objectives are supported through the African Development Bank (AfDB) and Nordic Development Fund (NDF) funded Project to Support the Lake Tanganyika Integrated Regional Development Programme (PRODAP). The two projects are complementary in scope and are co-financed by the four Lake Tanganyika riparian governments of the Republic of Burundi, the Democratic Republic of Congo, the United Republic of Tanzania and the Republic of Zambia.

The FFMP, based on the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries (CCRF), was developed under the FAO-executed Lake Tanganyika Research (LTR) Project between 1992 and 2001 and was adopted by the Committee for Inland Fisheries of Africa (CIFA) – Subcommittee for Lake Tanganyika at its eighth session in 1999. The Lake Tanganyika Biodiversity Project (LTBP) which operated from 1995 to 2000 with funding from United Nations Development Programme/Global Environment Facility (UNDP/ GEF) led to formulation of the Trans-boundary Diagnostic Analysis (TDA) and the Strategic Action Programme (SAP).

The SAP document was endorsed by the four Lake Tanganyika riparian governments on 13th July, 2000. The priority trans-boundary concerns are identified in the SAP, as well as sectoral interventions needed to resolve trans-boundary problems. Furthermore, the SAP has identified regional and national institutional mechanisms for implementing strategic components of the SAP. The LTA has the responsibility of overseeing effective implementation of the provisions of the SAP. As provided under Article 13 of Convention, the LTA Secretariat – with support from the UNDP/GEF Partnership Interventions for the Implementation of the SAP Project - has facilitated the process of updating the SAP document. The Conference of Ministers endorsed the updated SAP document on 29th February, 2012 during the fifth ordinary meeting held in Kigoma, United Republic of Tanzania. The updated SAP document has identified six strategic components: i) adaptation to climate change impacts, ii) sustainable fisheries, iii) sustainable land management, iv) protection, restoration and management of critical habitats, v) control and prevention of biological invasions and vi) reduction of pollution and improvement of water quality.

H. Mwima
Executive Director:
Lake Tanganyika Authority

General Information & Publication Plans

Badges
You should consider your personal name badge as a valuable entry ticket. Please wear your badge at all times during the conference.

Coffee and tea breaks
Coffee/tea breaks are included with registration.

Publication Plans
Selected manuscripts will be considered for publication subject to peer review in the ISI rated journal: Aquatic Ecosystem Health and Management (AEHM). AEHM is an ISI rated international primary journal published by Taylor & Francis, Philadelphia.

Presenters are encouraged to submit manuscripts to the AEHM for consideration for publication subject to the AEHMS instructions to authors, and guidelines (www.aehms.org/Journal/ins_authors.htm). Due to the large number of manuscripts expected the AEHMS has set page limit guidelines as follows: 8 printed pages including tables and figures (Text: Times New Roman 11 pt, Margins: 2.5 cm (1”), Paper: letter size 21.6x28 cm (8.5x11”)). For more information please contact Dr. M. Munawar, Chief Editor (mohi.munawar@dfo-mpo.gc.ca).

Presenters who are planning to publish in the special issues are requested to complete the publication questionnaire and return it the Registration Desk or by email to jennifer.lorimer@dfo-mpo.gc.ca, before the end of the conference.

Liability
Neither the conference organization, the Lake Tanganyika Authority, nor the Aquatic Ecosystem Health & Management Society can be held responsible for damage, loss or theft during the conference.

Program at a Glance

Sun, Jun 17	Mon, Jun 18	Tues, Jun 19	Wed, Jun 20	Thurs, Jun 21	Fri, Jun 22
• Arrival • Registration	• Registration • Inaugural Ceremony • Session 1 • Lunch • Session 1 • Posters	• Session 2 • Lunch • Session 2 • Banquet	• Session 3 • Lunch • Session 3 • Panel Discussion • Conclusion & Publication Plans	• Post-conference excursion: Rusizi River and Wetlands trip (Rusizi National Park)	Tentative: Post-conference excursion

Program

Day 1: June 18, 2012

8:30-9:30 AM	**Registration**	
9:00-9:10	**Inauguration**	
9:10-9:20	**AEHMS Welcome**	
9:20-9:30	**LTA Welcome**	
9:30-10:00	**Break**	
SESSION 1: LAKE TANGANYIKA		
10:00-10:20	**S1.01**	**Nkotagu, H.H.** The current health state of Lake Tanganyika and its basin
10:20-10:40	**S1.02**	**Mgana, H.F.**, Herzig, A., Mgaya, Y.D. Zooplankton distribution and abundance in Lake Tanganyika with special reference to *Tropodiaptomus simplex*, Kigoma, Tanzania
10:40-11:00	**S1.03**	**Mulimbwa, N.**, Sarvala, J., Raeymaekers, J.A.M. Seasonal variation in the pelagic catch and reproductive activity of zooplanktivorous clupeid fish in relation to the abundance of their copepod prey in Lake Tanganyika
11:00-11:20	**S1.04**	**Sinyinza, D.** Trophic relations in deepwater fish community in Lake Tanganyika
11:20-11:40	**S1.05**	**Kangwa, P.**, Lupikisha, J., Chintu, R. Baseline survey report at the inception of PRODAP interventions in the Lake Tanganyika basin of Zambia
11:40-12:00	**S1.06**	**Howard, G.W.**, Abonyo, E.A. Development of a biological invasion prevention and management system in Lake Tanganyika
12:00-13:30	**LUNCH**	
13:30-13:50	**S1.07**	**Muzumani R Isasi, D.** *Oreochromis Macrochir* (*Cichlidae Perciformes*, Boulenger 1912), an invasive species in ponds of the Ruzizi River Delta
13:50-14:10	**S1.08**	**Nkotagu, H.H.** Community based organizations in promoting sustainable fisheries management in the Lake Tanganyika riparian states
14:10-14:30	**S1.09**	**Marijnissen, S.A.E.**, Plisnier, P.-D., Chen, S.S., Smith, E., Howard, G.W., Mutelekesha, A., Hakizimana, G. Environmental monitoring for sustainable management: examples from the Lake Tanganyika Basin
14:30-14:50	**S1.10**	**Mbewe, Martin** Agricultural production systems, food security, environmental protection and natural resources conservation in the Lake Tanganyika Basin: a view from Zambia
14:50-15:10	**BREAK**	
15:10-15:50	**S1.11**	**Ntahuga, L., Ndabaneze, P.** Integrated management of invasive alien species management in Burundi
15:50-16:10	**S1.12**	**Bulayi, M.**, Sobo, F., Nkotagu, H. Fisheries frame survey results and implications for fisheries management in the Tanzanian Waters of Lake Tanganyika
16:10-16:30	**S1.13**	**van der Knaap, M.**, Katonda, I.K., De Graaf, G.J. Assessment and management of the data-poor fisheries of Lake Tanganyika
16:30-17:30	**POSTER SESSION**	

Day 2: June 19, 2012

SESSION 2: LAKE VICTORIA

9:00-9:20	**S2.01**	**Agembe, S.**, Ojwang, W.O., Nyamweya, C.S., Ojuok, J.E., Owili, M.A., Olilo, C.O., Omondi, R., Njiru, J.M. The bounties of river mouths in Lake Victoria, Kenya
9:20-9:40	**S2.02**	**Njiru, J.**, Van Der Knaap, M. Increased fishing pressure and increased fish production on Lake Victoria
9:40-10:00	**S2.03**	**Kayanda, R.**, Munyaho, T., Everson, I., Mgaya, Y. Environmental influences on the vertical distribution of Nile perch and other fish species assemblages in Lake Victoria, East Africa
10:00-10:20	**S2.04**	**Nkalubo, W.**, Chapman, L., Muyodi, F. Cascading effects of fishing pressure on the feeding ecology of the Nile perch, *Lates niloticus* in Lake Victoria, Uganda
10:20-10:40	**TEA BREAK**	
10:40-11:00	**S2.05**	**Mkumbo, O.**, Marshall, B. What can we do to manage the Nile perch fishery in Lake Victoria?
11:00-11:20	**S2.06**	**Munyaho, T.A.**, Nyamweya, C., Sitoki, L., Kayanda, R., Eversons, I. Spatial and temporal variation in the distribution and density of pelagic commercial fish species in Lake Victoria
11:20-11:40	**S2.07**	**Ojwang, W.O.**, Ojuok, J.E., Nyamweya, C., Agembe, S., Owili, M., Yongo, E., Wakwabi, E.O. The intriguing dynamics of *Rastrineobola argentea* (OMENA) fishery in the Kenyan waters of Lake Victoria
11:40-12:00	**S2.08**	**Owili, M.A.**, Ojuok, J.E., Agembe, S., Nyamweya, C.S., Ojwang, O., Olilo, C.O. Fish Catch trends in Kenyan waters of Lake Victoria
12:00-12:20	**S2.09**	**Nyamweya, C.S.**, Agembe, S., Ojwang, W.O., Ojuok, J.E., Owili, M.A., Olilo, C.O. Status of Fish distribution and abundance in rivers draining into Lake Victoria, Kenya
12:20-13:50	**LUNCH**	
13:50-14:10	**S2.10**	**Olilo, C.O.**, Ojuok, J.E., Ojwang, W.O., Nyamweya, C.S., Agembe, S., Owili, M.A. Effects of environmental factors on the distribution and abundance of indigenous fish species in the Winam Gulf of Lake Victoria, Kenya
14:10-14:30	**S2.11**	**Mzighani, S.I.**, Nikaido, M., Okada, N. Population genetics as an important tool in demographic parameters for sustainable exploitation and conservation of Lake Victoria Cichlid species
14:30-14:50	**S2.12**	**Sitoki, L.** Occurrence of Microcystins in Nyanza Gulf of Lake Victoria and the potential public health risk
14:50-15:10	**S2.13**	**Obua, J.** Research around Lake Victoria and the basin: challenges and opportunities
15:10-15:30	**S2.14**	**Lawrence, T.** Taking the "co" out of "co-management": the delegitimization of fishing communities on Lake Victoria, E. Africa
15:30-15:50	**TEA BREAK**	
15:50-16:10	**S2.15**	**Odongkara, K.**, Kabali, J.A., Mbilingi, B. Effectiveness of policy directives of the Lake Victoria Fisheries Organisation on Lake Victoria, Uganda

16:10-16:30	**S2.16**	**Lawrence, T.** Examining community-based organizations within the fishery co-management program on Lake Victoria, E. Africa
16:30-16:50	**S2.17**	Gray, E., **Apse, C.**, Tear, T., Kelly, D., Magoti, A., Brown, M. Building freshwater and terrestrial ecosystem resilience to climate change on Lake Tanganyika
19:00	**BANQUET**	

Day 3: June 20, 2012

SESSION 3: OTHER LAKES AND ECOSYSTEMS

9:00-9:20	**S3.01**	**Munawar, M.**, Fitzpatrick, M., Niblock, H., Kling, H. The structure and function of the microbial food web in the deep chlorophyll maxima of the largest lake in the world – Lake Superior, 2011
9:20-9:40	**S3.02**	**Goddard, C**., Dettmers, J., Wingfield, J. The impact of invasive species on the foodweb and fisheries of the Laurentian Great Lakes
9:40-10:00	**S3.03**	Gaden, M., **Mkumbo, O.**, Lawrence, T., Goddard, C. Top-down and bottom-up collaboration in the management of the Laurentian Great Lakes and Lake Victoria fisheries: A comparison of two shared water bodies
10:00-10:20	**S3.04**	**Dobiesz, N.E.**, Hecky, R.E. Different lakes, same problems: common data management challenges of North American and East African great lakes
10:20-10:40	**S3.05**	**Ngowenubusa, C.** Climate change: drought analysis in Burundi
10:40-11:00	**TEA BREAK**	
11:00-11:20	**S3.06**	**Ogutu-Ohwayo, R.**, Odongkara, K.N., Okello, W., Efitre, J., Wandera, S.B., Mbilingi Bwambale, Natugonza, V. Mainstreaming impacts and adaptations to climate variability and change among small-scale fishers and riparian communities of inland fisheries of Africa
11:20-11:40	**S3.07**	**Yongo, E.**, Lwenya, C. Lake Baringo, the community and fishing of declining resources: using local knowledge for sustainability
11:40-12:00	**S3.08**	**Muli, J.R.** Fishing grounds of Lake Baringo
12:00-12:20	**S3.09**	**Ojuok, J.E.**, Malala, J.O., Ojwang, W.O., Owili, M.A., Nyamweya, C. The biology of fishes of economic importance in Lake Turkana, Kenya
12:20-12:40	**S3.10**	**Gebremedhin, S.**, Mingist, M., Getahun, A., Anteneh, W. Spatial and temporal segregation of *Labeobarbus* species migrating to Arno-Garno River
12:40-14:10	**LUNCH**	
14:10-14:30	**S3.11**	**Pasche, N.**, Mugisha, A., Rugema, E., Umutoni, A. Monitoring methane extraction in Lake Kivu
14:30-14:50	**S3.12**	**Mdegela, R.**, Sandvick, M., Skaare, J. Use of biomarkers in *Clarias gariepinus* for monitoring pollution in aquatic environments in Tanzania
14:50-15:10	**S3.13**	**Mbabazi, D.**, Hecky, R.E., Balirwa, J.S., Verburg, P., Muhumuza, E., Chapman, L. Stable isotopes of nitrogen and carbon as indicators of trophic position in fish communities in lakes with and without introduced Nile Perch in the Lake Kyoga basin (Uganda)

15:10-15:30	**S3.14**	**Shoko, A.P.**, Mgaya, Y.D. Evaluation of stocking density for production of *Oreochromis niloticus* (L.) (Nile tilapia) and *Clarias gariepinus* (B.) (African sharptooth catfish) in polyculture ponds
15:30-15:50	**S3.15**	**Sobo, F.A.S.** Community participation in fisheries management
15:50-16:10	**TEA BREAK**	
16:10-16:30	**S3.16**	**Haambiya, L.**, Matiya, G., Msukwa, A., Kapute, F., Sikawa, D. Local institutions in promoting community participation in artisanal fisheries management in Malawi: a case of Mbenji Island fishery
16:30-16:50	**S3.17**	Van Der Knaap, M., **Thiam, D.** Fisheries co-management in west and east Africa, a comparison
16:50-17:10	**S3.18**	**Mbewe, Mbamwai** Stakeholder involvement in data collection: will we get the same desired results?
17:10-17:30	**S3.19**	Dave, G., **Munawar, M.** Ecosystems without borders: treaties, conventions and agreements
SESSION 4: PANEL DISCUSSION & SYNTHESIS		
17:30-18:00		**Panel Discussion**
18:00-18:20		**Conference overview and summary**

DAY 1: June 18, 2012

16:30-17:30 POSTER SESSION

P1 **Mushagalusa, C.D.**, Nshombo, M., Lushombo, M.
Fisheries impact on littoral fishes Cichlidae (Pisces) from the northwestern part of Lake Tanganyika (East Africa)

P2 Munawar, M., Fitzpatrick, M., El-Shaarawi, A., **Lorimer, J.**, Niblock, H., Kling, H., Rozon, R.
Intensive field and laboratory testing of the Fluoroprobe for assessing photosynthetic communities under eutrophic and oligotrophic conditions

P3 **Makasa, L.**, Haambiya, L.
Annual variation of water level in the southern part of Lake Tanganyika from 1960 to 2011

P4 **Msafiri, A.**
Assessment of the effects of plerocecoid larva of *Ligula intestinalis* (Cestoda) in *Engraulicypris sardella* (Cyprnidae) from northern Lake Nyasa/Malawi

P5 **Nkotagu, H.H.**
The multivariate statistical analysis of abiotic parameters of the Lake Tanganyika sub-catchment

P6 Ojwang, W.O., **Nyamweya, C.S.**, Ojuok, J.E., Agembe, S., Owili, M.A., Olilo, C.O.
Identification and mapping of critical fish habitats in Lake Victoria, Kenya

P7 **Tesfaye, M.**, Abebe G.
Diversity and relative abundance of fishes in some temporary and perenial water bodies of the Baro Basin, Gambella, Ethiopia

Abstracts

The abstracts are given in the order of the program, and are marked with their program number.

S1.01

NKOTAGU, H.H.

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The current health state of Lake Tanganyika and its basin

Currently Lake Tanganyika faces numerous threats including excessive sedimentation resulting from unsustainable human activities in its basin. Data show that, to date, about 2-3 tons of sediment per second may be entering the lake through the Malagarasi River in Tanzania alone. Also the Rusizi River in the Democratic Republic of Congo and other smaller rivers discharge considerable quantities of sediment into the lake.

The 2011 fisheries frame survey in Tanzania has shown an increase of about 110% in the number of fishermen and 60% in the number of fishing gears (most of which are of an illegal nature) during the last five years, indicating that over-fishing could be taking place in the lake. Over-fishing threatens to deteriorate the lake's biodiversity health. This is also taking place in other riparian states of the lake.

In addition, recent studies have shown that climate change has resulted in reduced primary productivity which in turn reduces fish yield. This possibly explains trends in the observed decrease in fish catch around the lake, thus supporting the existence of the threat of over-fishing.

Pollution as another threat is seriously impacting the lake's health due to frequent use of agrochemicals, discharge of untreated domestic waste waters and mining activities taking place within the basin. It is estimated that Ntahangwa River alone in Burundi carries about 73% of industrial waste water and 80% of domestic waste water generated from Bujumbura city to Lake Tanganyika. Un - quantified oil spillage due to boat and ship operations within the lake contributes heavily to the overall lake pollution as observed at Kigoma Bay, Mpulungu Port, and the harbors of both Bujumbura and Kalemie.

Data conclude that the current health state of Lake Tanganyika and its basin is at risk of deterioration. It is thus recommended that urgent management measures be taken in order to save the lake from further health deterioration.

S1.02

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Zooplankton distribution and abundance in Lake Tanganyika with special reference to *Tropodiaptomus simplex*, Kigoma, Tanzania

Zooplankton abundance, distribution and the impact of *Stolothrissa tanganicae* on *Tropodiaptomus simplex* were studied in Lake Tanganyika for three months during the wet season (October 2008 – February 2009). Water samples were collected, on a biweekly basis, using a 7.4-litre Limnos water sampler. The collected water samples were filtered through a 40-µm mesh net and the zooplankton composition and abundance estimated. *Stolothrissa tanganicae* stomachs were analysed to quantify the contribution of zooplankton in their diets. The relative contribution of Cyclopidae and calanoid nauplii to the total zooplankton community was very high (69%). Ovigereous and post naupliar-stages of *Tropodiaptomus simplex* exhibited a very clear diel vertical migration. Ovigereous females were negligibly low in the 0-40 m depth during the day while at night they stayed above 30 m. Shrimps also exhibited diel vertical migration while adults and copepodites of Cylopidae, Cylopidae nauplii and *Tropodiaptomus* nauplii did not show any clear diel vertical migration. The contribution of adults, copepodite and nauplii stages to the total numbers of *Tropodiaptomus simplex* was 8.2, 8.6 and 83.2% respectively. The analysis of *S. tanganicae* stomachs revealed a dominance of *Tropodiatomus* females and the electivity indices proved that *T. simplex* females (with or without eggs) were highly selected by *S. tanganicae*, which could probably be explained by size-selective feeding. Analysis of the incubation data indicated that approximately 60% of *T. simplex* nauplii did not develop into copepodites, the loss which could not be explained by the results of the present study. It is hypothesized that predation and mortality due to food scarcity in the lake are responsible for these losses.

S1.03

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Seasonal variation in the pelagic catch and reproductive activity of zooplanktivorous clupeid fish in relation to the abundance of their copepod prey in Lake Tanganyika

Total catches of clupeid fish were recorded twice a week from February 2007 to January 2008 in the northernmost end of Lake Tanganyika, and allocated to species (*Stolothrissa tanganicae* and *Limnothrissa miodon*) according to representative catch samples collected from ten artisanal lift-net fishing units (one kg of fresh fish from each fish box). In each sample, clupeids were measured for length frequency analysis, weighed, and dissected for assessing reproductive status. Monthly values of the gonadosomatic index and the percentage of clupeids with ripe gonads were used to determine spawning periods. Copepod zooplankton was sampled twice a month with a 100-µm closing net from 0-100 m depth. Copepod abundances were converted to biomass by multiplying with individual carbon values. Monthly rainfall data were obtained from the Hydrobiological Research Centre in Uvira. Rainfall peaked in April and November. Peaks of copepod zooplankton were recorded in the rainy season. Clupeids appeared in the catch at the age of three-four months and their longevity was estimated at 18 months for *S. tanganicae* and 36 months for *L. miodon*. Gonadosomatic index of clupeids was significantly influenced by the abundance of copepods. Two peaks of clupeid catches occurred, in July and October, mainly determined by the catch of *S. tanganicae*. The strong *S. tanganicae* cohort of July likely originated in March-May, when the abundance of copepods was high. The two major cohorts that influenced the peak catches of *Limnothrissa* in June and December were then approximately 8 months old, thus likewise originating in the rainy season when food was abundant. For both clupeids, the survival rate of juveniles thus seems to be linked to rainfall and abundance of copepods. Both species were recruited in the catch before the age of maturity, making them vulnerable to over fishing.

S1.04

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Trophic relations in deepwater fish community in Lake Tanganyika

Studies based on stomach contents analyses provide useful information on the food habits of fish in areas where direct observations can not be done. The present study examined stomach contents of deepwater fish in the southern part of Lake Tanganyika. Food items of 43 fish species were identified into 18 categories mainly including shrimps, copepods and fish, but not algae.

These results suggest that the fish community in the deep water of the lake may be supported directly by planktonic primary production in the pelagic zone, whereas fish production in the littoral zone is largely supported by algae. The results also suggest the importance of conservation of diversity in Lake Tanganyika.

S1.05

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Baseline survey report at the inception of PRODAP interventions in the Lake Tanganyika basin of Zambia

The government of the Republic of Zambia, through a loan from the African Development Bank, is implementing a project to support the Lake Tanganyika Integrated Regional Development Programme (PRODAP). PRODAP aims at rationalizing the exploitation of fishery resources sustainably, protecting the lake environment and reducing poverty of Lake Basin communities. Additionally it aims to diversify income sources, improve food security and living conditions of people through proper management of the Lake.

An inception baseline survey was conducted in 2010 to establish: the status quo of the communities and environment; the status of the fishery and evidence of co-management structures in villages; household social economic status and income generating activities; education and health conditions, prevalent diseases and infrastructure needs.

Preliminary consultations were done with stakeholders including literature review. Primary data collected through semi structured interviews using questionnaires. The lake communities were seperated into 4 strata and in each stratum 5 households were randomly selected in each village giving a total of 420 respondents. Thirty enumerators were trained and recruited to collect data. SPSS version 12, Microsoft Excel and Word software were used during data analysis and reporting.

Poverty and food insecurity were evident in households. Environmental hotspots and reduced fish stocks against increased fisher population were noted. Co-management structures were not active in villages. There was no access to health and education services and a lack of infrastructure in the lake basin. Malaria and waterborne infections respectively were major causes of morbidity.

Poverty, food insecurity and environmental threats were evident, thus PRODAP intervention is justified. Increased populations of fishers and use of illegal fishing methods pose a threat to the fishery and environment. Health and infrastructure problems must be addressed.

S1.06

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Development of a biological invasion prevention and management system in Lake Tanganyika

Lake Tanganyika, the second deepest and the longest freshwater lake in the world, is under increasing threat from biological invasions. This stems from increased globalization which has resulted in enhanced travel, trade, tourism and transport and thus faster rates of introduction and spread of alien species. Millions of people depend on the lake for food, water and transport. However, the impacts of the invading species continue to be felt and seen across systems such as the environment, wild ecosystems and habitats, human health, agriculture, livelihoods and species diversity. It is against this background that the Convention on the sustainable management of Lake Tanganyika was agreed and its Authority (LTA) established. The Regional Integrated Management and Development Programme of Lake Tanganyika, working with LTA, includes a component to develop a monitoring system to address this issue so that the invasive species situation can be frequently assessed and urgent action taken where necessary. The initial surveys aimed at the collection of baseline data in and around the lake began in 2010. The output has been a list of species identified as actual and potential threats. These include emergent, submerged and terrestrial plant species, alien fish species and other suspected threats. In response to CBD Aichi biodiversity target 9 (which calls for pathways of invasions to be identified, prioritized and managed), analysis of pathways leading to introduction and spread of alien species in the lake and catchment is underway. This has identified areas of concern that need immediate attention to address this risk of invasion and negative impacts on the Lake Tanganyika ecosystem - if the pristine state of this precious lake is to be restored and ecosystem services maintained.

S1.07

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***Oreochromis Macrochir* (*Cichlidae Perciformes*, Boulenger 1912), an invasive species in ponds of the Rusizi River Delta**

Sampling of fish was conducted during three months from June to August 2011, in the northern part of Lake Tanganyika. The Nyangara and Kyamvubu natural ponds in the flooded zone of the Rusizi River delta were visited. Two Cichlid fish species of the genus *Oreochromis* were collected: *Oreochromis niloticus* (Boulenger 1912), a species native to the Rusizi River flooded areas and, *Oreocromis macrochir* (Boulenger 1912), introduced into the basin by aquacultural activities about sixty years ago. This species has accidentally found its way out of the fish ponds. The sample included 54.1% of the introduced species, versus 45.9 % for the native species. At Kyamvubu, *O. macrochir* represented up to 88 % of the catch and reached up to 28% at Nyangara. This result shows that the introduced species *O. macrochir* gradually invades the ecological niche of *O. niloticus* in the natural ponds of the delta of Rusizi River. Factors which appear to explain the success are: the early size of first sexual maturity which is reached at a size 10 mm smaller than *O. niloticus*, the higher sex ratio of *O. macrochir* compared to *O. niloticus*, the high average rate of relative fecundity, which is even inferior to that of *O. niloticus* and, the diversified diet and competition of *O niloticus*.

S1.08

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Community based organizations in promoting sustainable fisheries management in the Lake Tanganyika riparian states

The primary advantage of co-management is that within the right institutional and legislative framework, it allows the knowledge and understanding of all stake holders to be reflected in decision making. Furthermore their diverse capacities can be harnessed in implementation thus potentially improving sustainability of fisheries resources exploitation.

It involves relationships between resources users and government authorities at both local and central levels. However, the private sector, processors, (net and boat makers, ice manufactures, etc.) and society each having a role to play at different stages.

The initiative to promote co-management through the resource user groups known as Beach Management Units (BMUs) started in Tanzania in 2009 at Lake Tanganyika. But BMUs have yet to take roots towards this end due to various challenges. At the moment 22 BMUS in Tanzania have been established with full fledged leadership.

Riparian states around the Lake Tanganyika have established various forms of co-management units as reflected in their nomenclatures, but all are focused towards fisheries sustainability

Since fish migration has no boundaries across the lake, and given that there are many factors that influence such migration, availability of fish resources in space and time does not influence fisheries activities across the lake.

Therefore it is strongly recommended to harmonize the various co-management approaches in the riparian states of the Lake Tanganyika in order to make the lake a sustainable future.

S1.09

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Environmental monitoring for sustainable management: examples from the Lake Tanganyika Basin

To determine whether environmental management interventions are successful, and to ensure that future management decisions are informed by scientific data, an effective monitoring programme is essential. The Lake Tanganyika Authority is the first African intergovernmental body to pilot implementation of a multi-country lake basin monitoring programme integrating a wide range of environmental parameters at a regional level, with focus on the following topics: climate change; fisheries; biodiversity and invasive species; landuse, and; water quality.

These topics reflect priorities of the Strategic Action Programme on the Protection of Biodiversity and Sustainable Management of Natural Resources in the Lake Tanganyika basin, which is a key document uniting the environmental quality objectives of the Republic of Burundi, Democratic Republic of Congo, United Republic of Tanzania and Zambia.

The four countries agreed on a set of parameters on which to collect environmental data, and identified national as well as international partners to participate in the monitoring programme. While various national institutions exist with a mandate to collect data relevant to the management of the lake and its catchment basin, sampling continues to be affected by capacity and funding challenges. Our programme tackles these challenges by making use of existing structures, and building capacity through partnerships with international institutions.

We present results of successful partnerships for each key monitoring topic, including those obtained through combining participatory research with system-based tools, methods for data integration, and plans for the establishment of an International Consortium to support the Lake Tanganyika Regional Integrated Environmental Monitoring Programme.

S1.10

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Agricultural production systems, food security, environmental protection and natural resources conservation in the Lake Tanganyika Basin: a view from Zambia

The objective of this paper is to present the agricultural production systems that prevail in the Lake Tanganyika basin from the Zambian perspective. It is also to present a generalised view of the state of the environment in the area and then suggest remedial measures towards sustainable approaches to sustainable agriculture within the context of an overall environmental protection and natural resources conservation strategy.

Rapid on-site-visit assessments using non-randomly selected single transects were undertaken to study the agricultural conditions and the general state of the environment in targeted areas on the Zambian side of the Lake Tanganyika basin. Informal discussions were conducted with community members to obtain their insights on the ecology of the areas.

The findings indicated that the Lake Tanganyika basin was endowed with a rich biodiversity which was heavily interdependent, though the ecological balance was continuously disturbed by human actions. Abundant water; fish; fertile soils and trees in wetlands and river valleys; grasses; bees in some areas; and wildlife were found. Inhabitants very much depended on these natural resources for their survival - socially, economically and biologically.

The Lake Tanganyika basin, however, faces enormous ecological challenges: deforestation; over-use of wetlands for agriculture purposes; poor land and soil management practices; over-fishing; absence of common property user rules and regulations; weak institutional and synergistic support from Government and Non-Governmental institutions; lack of innovative funds to support communities to invest in natural resources conservation practices; and limited technologies to add-value to honey, crafts, fruits, fish, and miscellaneous foods.

It is suggested, therefore, that to save the ecological system of the Lake Tanganyika basin, strategic natural resources and management measures are put in place to encompass indigenous and orthodox knowledge systems; multi-stakeholder participation; and capacity building of leaders in organizational skills and operation of the community based natural resources management framework.

S1.11

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Integrated management of invasive alien species management in Burundi

Invasive alien species (IAS) have a significant impact on agriculture and livestock, biodiversity and human health. Burundi regulations govern the import of animal and plant IAS to avoid the import of harmful species and to monitor and control the behavior of imported species in the natural ecosystems. However, regulations have not been respected in some cases. On the other hand, plant and animal species monitoring structures are not efficient to the extent that currently some useful species adopt the characters of IAS. The challenge is therefore how to efficiently and sustainably manage those species. A broad view of the management of IAS is therefore paramount and needs to reflect on the fact that many people consider IAS as natural resources to be harnessed. An integrated and research-based management process of IAS is discussed.

S1.12

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Fisheries frame survey results and implications to fisheries management in the Tanzanian waters of Lake Tanganyika

Under the auspices of the Lake Tanganyika Authority (LTA), Tanzania conducted a full fisheries frame survey on the shores of Lake Tanganyika in March/April 2011for five consecutive days. Fisheries Frame Survey is an activity whereby basic fisheries information for a given fishery of a water body are collected. This paper describes the results of the survey and explains the driving forces in the changes of the fishery from an industrial one to an artisanal fishery.

Furthermore the results are compared with the previous surveys to seek an explanation for the above changes in relation to the abundance of fisheries resources. The 2011 Frame survey data shows that, there is significant increase of fisheries pressure to a magnitude of about 110%. It was as well observed that, the number of fishing crafts, increased by about 60% while their motor mechanization, increased to a tune of 68%. Over the same period, the total number of landing sites increased to 78%. However, landing site facilities and social services in Tanzania were observed to be poor or nonexistence.

Special attention is paid to the transboundary implications for the future exploitation of the lake's fisheries resources, in the light of the LTA's attempt to manage the different fisheries in the regional context. Estimation is made of the possible impact of illegal fishing by Tanzanian nationals.

Recommendations are presented to improve data collection processes and on sharing the results with fishing communities in order to generate awareness about the problems the lake is facing.

S1.13

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Assessment and management of the data-poor fisheries of Lake Tanganyika

Lake Tanganyika represents 17% of the world's surface freshwater and contains a wide variety of fish species, with a high degree of endemism. Fisheries were studied in the 1990s and this revealed that management was required to stop their collapse. From 1999 to 2011, the fisheries remained largely unmonitored and the area saw some humanitarian crises with much displacement of people, both internally and externally. When relative peace returned to the region, refugees returned back to their ancestral grounds where they found their houses destroyed or occupied. One of the last resorts was fishing and well meaning NGOs and UN-organizations donated fishing equipment to those returning and to demobilized soldiers.

Recent stocktaking of the fishery revealed that the total number of fishermen and fishing units had doubled since the first regional frame survey in 1995. Stringent management measures were recommended back in the 1990s and catch rates in one of the four Riparian countries have declined since. The question is whether or not the fisheries can still be restored after the recorded increase in the fishing capacity. Relevant national authorities find it difficult to monitor their fisheries, which are under high pressure, despite the fact that the Convention for the Sustainable Management of Lake Tanganyika stipulates the control of fishing effort and the battle against illegal fishing. The four States established the intergovernmental Lake Tanganyika Authority to implement fisheries conservation and management measures.

Results of the frame survey in 2011 pointed out that the use of illegal fishing gears is rampant and that action needs to be taken in the form of regulating the access to the fishery by the introduction and improvement of licensing systems, while putting ceilings on the numbers of fishermen and fishing units in the different fisheries. Other possible management measures are also discussed in order to restore the valuable Lake Tanganyika fisheries, such as formal monitoring, control and surveillance, as well as community surveillance. The way forward for the lake's fisheries is discussed.

S2.01

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The bounties of river mouths in Lake Victoria, Kenya

River-lake interfaces in the Kenyan portion of Lake Victoria have historically been known to support several components of biota including early life history of potamodromous fish species. However recent anthropogenic activities such as pollution, illegal fishing practices, water diversion have continued to negatively impact the rivers and associated river mouths without due regard to the importance of these systems. In order to protect and conserve the rivers-lake interface acquisition of information on the biota inhabiting these key areas is fundamental.

This study is therefore aimed at determining spatial distribution of fish egg/larvae and composition and abundance of various zooplankton species at rivers-lake interfaces. Twenty stations were sampled in various months in 2011 and 2012. At each station, plankton was collected using a bongo-type sampler equipped with two nets (100 and 500 micron mesh), each having a 61-cm opening. Additionally, one haul was made using mosquito seine net to collect fish juveniles and larvae. *Lates niloticus* dominated larval occurrence (100%), followed by haplochromine (88%), *Oreochromis niloticus* (75%) and *Rastrineobola argentea* (63%) respectively. Highest zooplankton densities were reported in the Yala river mouth (255 individuals l^{-1}) followed by Awach-Asembo (223 individuals l^{-1}). Copepoda dominated zooplankton abundance in all the stations (69.7%-93.1%). The study provides necessary empirical evidence and information on key attributes to enable formulation of appropriate policies and restoration of key habitats in Lake Victoria.

S2.02

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Increased fishing pressure and increased fish production on Lake Victoria

The present paper discusses the estimate of one million tonnes of fish from Lake Victoria when the fishing capacity is greater than ever. The approach by two schools of stock assessment experts is discussed and their methods compared to shed light on the future fisheries management regime to be applied to Lake Victoria's fisheries. The theories behind limiting factors of nutrients of one school and the limiting factor due to overfishing are discussed. Furthermore the standard operating procedures (SOP) for fish production estimation are discussed and compared with the systems that have been replaced by these SOP.

Recommendations for recalculation of the production estimates are presented as no evidence can be found to corroborate the estimate of one million tonnes. Based on the estimates presented and in the light of the updated fish biomass estimates, more realistic fisheries management measures are suggested for the fisheries of Nile perch, tilapia and small pelagics in an attempt to salvage the export industry.

The fishing capacity as it was between 2000 and 2002 was considered close to a sustainable level, provided that the fishing effort would have been controlled to the levels in these years. The economic loss is calculated for the non-implementation of the management measures recommended by the Lake Victoria Fisheries Research Project in 2002, among them the slot size for Nile perch as approved by the Council of Ministers of the Lake Victoria Fisheries Organization on the one hand and the ceiling to the processing capacity on the other.

S2.03

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Environmental influences on the vertical distribution of Nile perch and other fish species assemblages in Lake Victoria, East Africa

A study to investigate the relationship of environmental variables and vertical distribution of fish was carried out on the entire Lake Victoria during the biannual acoustic surveys conducted in August 2007, February 2008, August 2008 and February 2009. The relationship between environmental variable and fish distribution was determined using General Linear Model (GLM) with seasons, quadrants and strata as factors; physico-chemical variables as covariates and Nile perch and other fish species' densities as response variables. The results indicated that Nile perch vertical distribution along the water column is influenced by depth, temperature, dissolved oxygen, quadrant and strata, while that of other species assemblages by temperature, dissolved oxygen and chlorophyll-*a*. Seasonal differences in density of both Nile perch and others are observed mostly in the northern quadrants, while that of southern appeared to be more stable.

S2.04

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Cascading effects of fishing pressure on the feeding ecology of the Nile perch, *Lates niloticus* in Lake Victoria, Uganda

Fishing pressure on Nile perch, *Lates niloticus* (L.) in Lake Victoria, East Africa, has led to a resurgence of haplochromine fishes that were, till the late 1980s, the main diet of Nile perch. Given the preference for haplochromine prey when the Nile perch first established itself in the lake, the diet of Nile perch (8.0 – 121.0 cm total length (TL)) from Lake Victoria was determined from stomach content analysis of specimens collected from experimental catches and fish factory samples between 2006 and 2008, with the aim of establishing the influence of a resurging haplochromine prey base on the Nile perch diet and its reflection in the population traits of the predator. The proportion of haplochromines in the Nile perch diet increased coincident with intense fishing pressure on Nile perch, a decline in Nile perch catches, and haplochromine cichlid recovery. In comparison to historical patterns, the Nile perch exhibited a much smaller size (15 cm versus 30 cm TL) at shift to piscivory. Nile perch that had a high proportion of fish prey (versus invertebrates) in their stomachs, showed a larger size for a given age, and were in a better condition (K=1.24) than those that had primarily invertebrates (K=1.10) in their stomachs. The recovery of haplochromines as a result of declining Nile perch densities illustrates the importance of developing sustainable management options that can define a proper balance between fishing mortality and predation.

S2.05

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What can we do to manage the Nile perch fishery in Lake Victoria?

Lake Victoria supports the world's largest inland fishery with an annual catch of around one million tonnes. The most important species is the introduced Nile perch *Lates niloticus* which although making up only 30% of the catch accounts for 70% of its value. It is a significant export commodity and the Nile perch fishery stimulates the economies around the lake and supports thousands of fishermen and their families. The catches have remained relatively stable since the fishery began over thirty years ago but recent developments are causing concern. Evidence of overfishing is now apparent; this includes the loss of large fish, a reduction in the size of first maturity, decreasing biomass, and falling catches. A collapse in this fishery would have serious consequences and finding a solution to its problems has exercised the minds of fishery managers in the region. Although it has been suggested that the environment is responsible for this situation, no workers in the region doubt that excessive fishing effort is the cause of the fishery's problems and the real problem is how to manage and control it. A Fisheries Management Plan has been drawn up and local fishermen organised into co-management system through Beach Management Units but these have not, as yet, had any impact. Because so many people depend on this fishery, conventional methods of controlling effort such as closed seasons, quotas and gear restrictions are difficult to enforce and could have a major social impact. In a poverty-stricken region lacking social welfare or subsidies the challenge of fisheries management is to maintain catches without causing large-scale human suffering.

S2.06

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Spatial and temporal variation in the distribution and density of pelagic commercial fish species in Lake Victoria

Densities of three pelagic fish taxa (Nile perch, Dagaa, and haplochromine cichlids) in Lake Victoria were estimated through 17 lake-wide acoustic surveys conducted bi-annually (for seasonal effects) between August 1999 and September 2011. Nile perch were estimated through echo-counting (single target detection) while Dagaa and Haplochromines by echo-integration. Mixed generalized linear models indicated up to 30% decline in Nile perch density from about 15 – 25 to 10 – 15 t km^{-2} in the deep and coastal areas and up to 70% reduction in the shallow inshore areas between 1999 and 2011. There was a twofold increase in Dagaa density while the haplochromines show up to 10% increase over the same period. Factors strongly influencing trends in distribution and densities were season, stratum (locality) and year of survey. In addition to fish exhibiting seasonal clustering in the upper layers of the water column, they also spread to shallow inshore waters. Some unique localities like the Nyanza, Speke, and Emin pasha Gulfs demonstrated localised predator (Nile perch)-prey (Dagaa and haplochromine) oscillations. Observed predator-prey abundance, and spatial and temporal variability in densities suggest inclusion of ecological and ecosystem considerations in stochastic models aimed at predicting fish stocks in the lake seem essential.

S2.07

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The intriguing dynamics of *Rastrineobola argentea* (OMENA) fishery in the Kenyan waters of Lake Victoria

The Lake Victoria ecosystem once hosted a diverse fish community dominated by a large species flock of haplochromine cichlids. Today this fish assemblage is highly altered by anthropogenic activities, with at least half of the indigenous species either extinct or very rare. The fishery has been reduced to three fishes of economic importance: introduced Nile perch (*Lates niloticus*) and (*Oreochromis niloticus*), and indigenous minnow, *Rastrineobola argentea*, locally known as Omena. The decline in fish stocks in the lake is still ongoing; however, in order to circumvent and rejuvenate stocks therein, a closed fishing ban was imposed in November, 2001 between 1st April and 31st July of each year through a Kenyan Government gazette notice. The ban was not only intended to protect Omena fishery but was also used to anchor efforts towards protecting and rejuvenating dwindling stocks in the lake. But whether the Kenyan approach has made any gains for the region is still equivocal and it is on this basis that we evaluated existing information on both historical and current stock levels of *R. argentea*, and the fishery implication on the livelihoods of the riparian communities. Our results indicate that Omena biomass has increased considerably from approximately 500,000 MT in 2001 to 911,328 MT in 2011. *Rastrineobola argentea* is now the most important fish stock by mass in Kenyan waters contributing almost 61.5% of the total fish landings (10,339.0 MT), with ex-vessel value of total fisher's earnings of about Kshs. 207 million (approx. US D, 2.5 million). In spite of realized positive impacts from the ban, we recommend friendlier but all inclusive and focused restriction targeting a few critical breeding / spawning areas and nursery grounds to avoid complete alienation of fishers whose livelihood depends almost entirely on the fisheries resources and Omena in particular

S2.08

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Fish catch trends in Kenyan waters of Lake Victoria

The Lake Victoria fishery plays an important role in the economy of the country and the livelihoods of the riparian communities. There is an indication of steady decline in fish stocks, catch per unit effort and rise in the fishing effort, hence the need for continuous monitoring. Consequently, several surveys were conducted between June 2005 and September 2011 to establish the fishing gears, catch per unit effort in different effort groups which are then used together with the relevant frame survey data to obtain estimates of the total catch, and catch composition by species. Catch Assessment data was collected using Standard Operating Procedures. The most important fishing gears in the Nile perch fishery are gillnets and long lines which are predominantly carried by the Sesse boats using paddles, which operate in waters close to the in-shores; and Sesse boats with motor or sail.

Catch rates for Nile perch in sesse paddled boats using long lines was 12.22 ± 2.01 in September 2011. Catch rates for Nile perch the former fluctuated from 22.2 ± 1.3 kg $boat^{-1}$ day^{-1} to 11.43 ± 0.3 kg $boat^{-1}$ day^{-1} in June 2005 and September 2011, respectively. However, catch rates for paddled Sesse boats using gillnet fluctuated between 9.27 kg $boat^{-1}$ day^{-1} and 5.39 ± 0.93 kg $boat^{-1}$ day^{-1} in June 2005 and September 2011 respectively while Sesse motorised carrying long line hooks realized 15.73 ± 0.92 kg $boat^{-1}$ day^{-1} in September 2011. Parachute and paddled Sesse boats are the main craft that operate in the Tilapia fishery of the Kenyan waters of Lake Victoria and are used in combination with gillnets and hand lines which are the main gears. The Tilapia catch rates from Parachute boats using gillnet increased slightly from 3.58 to 3.67 kg $boat^{-1}day^{-1}$ between the March 2010 and September 2011. Dagaa fishery is dominated by paddled Sesse boats using small seines where catch rates decreased from 162.4 ± 11.03 kg $boat^{-1}$ day^{-1} to 111.4 ± 5.27 kg $boat^{-1}$ day^{-1} in August 2006 and September 2011 respectively. There was however significant increase in the catch rates for motorized and sail boats from 185.9± 21.0 in March 2010 increased to 358.6 kg $boat^{-1}$ day^{-1} in September 2011. Given the high rate of fluctuation in catches of Nile perch and tilapia, it is imperative to have regular monitoring of the fishery. Exploitation of dagaa need to target offshore waters where the its stocks is in abundance. The information generated from CAS surveys provides indicators that aid formulation of policy and decision-making in fishery resource management.

S2.09

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Status of fish distribution and abundance in rivers draining into Lake Victoria, Kenya

The study assessed the riverine fishery of Lake Victoria, Kenya from 2003 to 2012. A total of 9 rivers namely Awach, Kibos, Kisian, Lisumu, Mara, Nyando, Nzoia, Sondu-Miriu and Yala located on the Kenyan part of Lake Victora basin were investigated for catch composition, catch per unit effort (CPUE) and index of relative importance (IRI). Fish samples were collected using an electrofisher (600V 8.0Hp) on a river reach 35 times the width of the river per station and identified to species level, counted, weighed and lengths measured. A total of 38 species belonging to 13 familes were recorded. *Barbus altinialis*, *Labeo victorianus* and *Clarias gariepinus* dominated catch with IRI values of 62.4%, 22.8% and 6.6% respectively. The CPUE was 3.0 kg/set for *B. altinialis*, 1.4 kg/set for *C. gariepinus* and 1.3 kg/set for *L. Victorianus*. Cyprinids *B. altinialis* and *L. victorianus* and cichlids *Oreochromis leucostictus* and *Oreochromis variabilis* recorded in the current study once formed healthy stocks in Lake Victoria. However, these species disappeared from the main Lake after the introduction of *Lates niloticus* and *Oreochromis niloticus*. They are now restricted certain sections of these rivers in the catchement. The rivers are therefore important refugia for the indigenous species hence the need for ecosystem based management for the Lake Victoria basin to conserve its biodiversity

S2.10

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Effects of environmental factors on the distribution and abundance of indigenous fish species in the Winam Gulf of Lake Victoria, Kenya.

Historical data show that environmental factors, predation, fish species introductions such as Nile Perch and Nile Tilapia, and invasive species such as Water Hyacinth, have influenced the abundance of indigenous fish species such as *Haplochromine* spp., *Barbus* spp. and *Synodontis* spp. over the years in the Winam Gulf of Lake Victoria. The objective of the study was to investigate the relationships between environmental factors and the dynamics of indigenous fish species abundance with an aim of determining the state before and after the introductions, predations and new invasions, what it is today and the future of the indigenous fish species abundance in the Gulf in relation to the environmental factors.

The studies were undertaken during dry and wet seasons from September 2011 to April 2012, in order to augment the historical data available in the database. Fish samples were obtained by trawl using *R/V Uvumbuzi*. Fish specimens were sorted to species level, weighed and measured. Water samples for nutrients and other environmental parameters were collected and analysed using standard procedures.

Phosphorus, oxygen and turbidity significantly affected the distribution of indigenous species (*Haplochromine* spp, *Barbus* spp and *Ratrineobola argentea*) and introduced fish species abundance (Nile Tilapia and Nile Perch) ($p < 0.05$). On the other hand, biomass of Water Hyacinth influenced oxygen levels significantly ($p < 0.05$), thus affecting the distribution of fish. The watershed had direct impact on the environmental factors which in turn impacted negatively on the dynamics of both indigenous and introduced fish species. The study also showed trends that could influence decisions on watershed and fisheries management.

S2.11

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Population genetics as an important tool in demographic parameters for sustainable exploitation and conservation of Lake Victoria Cichlid species

More than 500 endemic haplochromine cichlid species inhabit Lake Victoria. This striking species diversity is a classical example of recent explosive adaptive radiation, thought to have happened within the last ~15,000 years. In this study, examinations were done on the population structure and historical demography of three pelagic haplochromine cichlid species that have similar morphology and ecological niche. The haplochromine cichlid species investigated belong to Laparogramma group, *Haplochromis (Yssichromis) laparogramma*, *H. (Y.) pyrrhocephalus* and *H. (Y.)* sp. "glaucocephalus". The investigation was on the sequences of the mitochondrial DNA (mtDNA) control region and the insertion patterns of short interspersed elements (SINEs) of 759 individuals. The findings show that sympatric forms are genetically differentiated in four of six cases based on mtDNA, but also apparent weakening of the genetic differentiation in areas with turbid water and evidence of introgressive hybridization were found. Intraspecific comparisons revealed that some but not all populations were significantly differentiated based on mtDNA, in which *H. (Y.) pyrrhocephalus* was more strongly differentiated between localities than the other species. The estimated timings of population expansion and species divergence coincide with the refilling of the lake at the Pleistocene/Holocene boundary. The findings showed that qualitative data (population genetics) are more powerful than quantitative data (catch assessment survey). Therefore, the use of both qualitative and quantitative data is of such importance for drawing management measures for conservation and sustainable development of fisheries resources. The status of the haplochromine cichlid species should be studied for the species-specific management plans in Lake Victoria.

S2.12

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Occurrence of microcystins in Nyanza Gulf of Lake Victoria and the potential public health risk

In recent years, signs of severe eutrophication, including the occurrence of cyanobacterial blooms, have become prominent phenomena in the Nyanza Gulf of Lake Victoria. Cyanobacterial blooms can synthesize toxins harmful to both animal and human health. Few records of cyanobacterial toxins have been documented from the African lakes despite their increasing frequency. Between July 2008 and September 2009 five stations along a transect of about 100 km from inshore to offshore of the Nyanza Gulf, including the opening to the main basin of Lake Victoria, were investigated for cyanobacterial dominance and occurrence of microcystins. Phytoplankton biovolume varied between 1.5 – 40.4 $mm^3 l^{-1}$ (mean = 7.5 $mm^3 l^{-1}$). Chlorophyll-a ranged between 4.0 - 75.0 $\mu g l^{-1}$ (mean = 13.0 $\mu g l^{-1}$). More than 50 % of the phytoplankton samples from the inshore stations were dominated by cyanobacteria whereas diatoms dominated most of the time in the offshore stations. *Microcystis* and *Anabaena* taxa accounted for the largest part (> 60 – 97 %) of cyanobacterial biovolume and alternated in dominance in the inshore areas during the wet season. In contrast during the dry season only *Anabaena* dominated offshore. Field samples and *Microcystis* strains isolated from the Nyanza Gulf were analysed for microcystin production using HPLC-DAD (High Performance Liquid Chromatography coupled with Diode Array Detection). Microcystins were detected in nearly all isolated strains (94 %, n=16) of *Microcystis* and in 52 % (n=80) of field samples. Except in February microcystins were detected throughout the study period inshore and occurred in highest concentrations in the time period between November and March. In contrast, microcystins occurred in two out of 8 samples only in offshore waters. There was a considerable scatter of cellular microcystin content in both field samples and cultivated strains: range 15 - 262 fg $cell^{-1}$, mean 159; and 1 – 233 fg $cell^{-1}$, mean 124, respectively. The frequent occurrence of microcystins in the waters of the Nyanza Gulf, Lake Victoria poses a public health challenge that should be addressed since those toxins may have caused the fish kills that have been recorded in the past and repeatedly in recent years.

S2.13

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Research around Lake Victoria and the basin: challenges and opportunities

Lake Victoria is the second largest fresh water lake in the world covering about 80,000 km^2 while the lake basin covers an area of about 180,000 km^2. More than 30 million people in the East African Community Partner States of Burundi, Kenya, Rwanda, Tanzania and Uganda depend on the lake and the basin, endowed with resources, for their livelihoods. The need to ensure sustainable management and utilization of the resources for the benefit of the local communities and to support regional development cooperation of the Partner States provided the impetus to establish the Lake Victoria Research Initiative (VicRes) as a regional collaborative and multidisciplinary research programme. Since 2002, VicRes has been implemented by the Inter-University Council for East Africa (IUCEA) with financial support from the Government of Sweden through the Swedish International Development Cooperation Agency (Sida). Several challenges related to carrying out research on problems of a transboundary nature using multidisciplinary research teams have been encountered during the implementation of VicRes. At the same time, opportunities for attracting investments and promoting regional development cooperation have arisen through VicRes' Research and Development (R&D) approach. The paper highlights and discusses the challenges, opportunities and stakeholder expectations in light of VicRes activities in Lake Victoria basin and the East Africa region.

S2.14

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Taking the "co" out of "co-management": the delegitimization of fishing communities on Lake Victoria, E. Africa

Effective fishery co-management institutions require a strong relationship between the national-level government and the local-level community. Within these institutions, relationships are strengthened by legitimacy, or fishers' acceptance of the regulations, rules, and authority that governs the fishery. This paper describes two major factors that undermine legitimacy of the community-level organizations—called beach management units (BMUs)—which are the action arm of fishery management within Lake Victoria's co-management program. Research conducted on Lake Victoria during 2009-2010 indicates that a lack of support from higher political authorities, and, a lack of financial returns from the fishery and higher political authorities (tax black hole), undermines authority and reduces the community-level's ability to function, respectively. These weaknesses cause de-legitimization of the local-level management organizations by the local level users (resource harvesters), rendering the organizations ineffective at implementing fishery management duties.

S2.15

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Effectiveness of policy directives of the Lake Victoria Fisheries Organisation on Lake Victoria, Uganda

The Lake Victoria Fisheries Organization (LVFO) is a regional body that coordinates management of the shared fisheries resources of Lake Victoria between Kenya, Tanzania and Uganda. The fisheries, which provide a source of income, employment, food and foreign exchange with estimated catch of 800,000 tonnes annually, valued at US $590 million, is threatened by unsustainable fishing practices.

LVFO is responsible for adopting management and conservation measures and making directives to safeguard the fisheries. However, the effectiveness of these directives is unknown. There is, therefore, need to identify and address any challenges to the directives, in order to realise their benefits.

The objective of the study was to assess the implementation of LVFO directives in Uganda with a view to making them effective. It is based on a case study of the 2009 directives to rejuvenate the Nile perch stocks and catches. The key elements were a rise in the minimum legal mesh size from 5 to 7 inches for Nile perch, restriction on the use of hooks of size 4 to 9, rise from 5 to 10 mm for dagaa, instituting closed areas and a ban on vertical joining of gillnets.

The methodologies used were Key Informant Interviews with fisheries specialists and sample survey involving 315 respondents.

The results revealed that implementation was hindered by the unclear legal status of the directives at the national level, poor dissemination and inadequate resources for enforcement. Fishes were unwilling to accept the directives due to the low catch ability of the minimum meshes recommended.

It is recommended that in order to improve their effectiveness, directives should be ratified by national parliaments, resources provided for implementation and there should be co-ordination in enforcement.

S2.16

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Examining community-based organizations within the fishery co-management program on Lake Victoria, E. Africa

This paper is a comparative study between successful and unsuccessful local-level, community-based fishery management organizations within a larger formal co-management fishery governance institution on Lake Victoria, E. Africa. The community organizations—called beach management units (BMUs)—are the action arm of fishery management on the lake. The intent of this institution is to guide fishing behavior of local-level users toward sustainable practices through community and government oversight. In spite of these efforts, unsustainable practices have continued. The following hypotheses guide this research: 1) the ability of a community to self-organize depends on a suite of complex, multi-level variables, including those of formal institutions, and; 2) local users are unable or unwilling to organize when formal institutional variables and preexisting socio-political variables are in conflict. Using data from research conducted on Lake Victoria in 2009 and 2010, this paper isolates the key variables which influence self-organization within BMUs around Lake Victoria, and explores the relationships between formal institutional fishing rules and the behavior of fishermen amongst the preexisting informal variables on Lake Victoria. Results suggest that external factors, like high human populations and high value of the resource, have limited the local-resource user's ability, but not their will, to effectively *self-organize* in light of institutional assistance to overcome those variables.

S2.17

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Building freshwater and terrestrial ecosystem resilience to climate change on Lake Tanganyika

Climate change is a known threat to the ecological integrity of the Lake Tanganyika basin and a challenge to those that pursue their livelihoods there. In the eastern portion of the basin (western Tanzania), temperatures have been rising steadily at a rate of 0.12°C per decade since the 1950s. Annual temperatures are projected to continue to increase 1-2°C over the next 50 years and up to 4°C by 2100. In addition, changes in the frequency, intensity and predictability of precipitation are expected, leading to wet seasons becoming wetter and dry seasons becoming drier. Despite some seasonal increases in precipitation, western Tanzania will likely become more arid, due to increased evapotranspiration. Higher temperatures are already impacting the primary productivity of Lake Tanganyika. Lake temperatures have been warming since the early 1900s, at a rate not seen for at least 1500 years.

In addition to assessing past and likely future climate trends, The Nature Conservancy convened a local participatory process in the Tanzanian portion of the basin involving the Jane Goodall Institute, the Frankfurt Zoological Society, the Tanzania National Parks (TANAPA), and Kigoma and Mpanda District officials to establish effective climate adaptation strategies and actions. This process was based on the premise that the most effective way to combat climate impacts is to empower local communities to sustainably manage their own natural resources. The group identified a set of climate adaptation strategies which will be presented along with the project methodology. Efforts to implement many of these strategies, and improve their underlying science, will also be presented.

S3.01

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The structure and function of the microbial food web in the deep chlorophyll maxima of the largest lake in the world – Lake Superior, 2011

Lake Superior is a cold stenothermic lake that spans 82 100 km^2 and has a maximum depth of 409 m. The deep chlorophyll maximum (DCM) is a common feature of large, deep-water ecosystems that has attracted the attention of limnologists as well as oceanographers. We used an *in situ* fluorometer to detect the DCM at 27 sites across Lake Superior during late July and early August of 2011. The DCM was observed at depths between 20 and 40 m and had chlorophyll *a* concentrations ranging from 1 – 3 $\mu g\ l^{-1}$. We focused on a detailed structural and functional analysis of the microbial and planktonic communities within the DCM at 3 sites, 1 site in each of the eastern, central and western regions of the lake. The structural assessment included bacteria, autotrophic picoplankton, phytoplankton, heterotrophic nanoflagellates and ciliates. The functional assessment included size fractionated primary productivity and bacterial growth rates.

Within the DCM at these 3 sites, we found that chlorophyll *a* was ≈ 2 $\mu g\ l^{-1}$ and phytoplankton biomass ranged from 100 – 240 $mg\ m^{-3}$, containing a mixture of Chrysophyceae, Chlorophyta and Diatomeae. These samples also contained a number of pico-sized centric diatoms (typically < 4 μm) which are unusual in the Great Lakes. Primary productivity was between 1.0 and 1.5 $mg\ C\ m^{-3}\ h^{-1}$ and dominated by smaller picoplankton and nanoplankton. This paper will examine physiological dynamics of the organic carbon pool within the DCM and assess the relative importance of autotrophs and heterotrophs for energy transfer to higher trophic levels. Such assessments are unique and not widely available in the Great Lakes. Our results provide another ecological dimension to the ongoing research about the characteristics of the deep chlorophyll maximum of large lakes.

S3.02

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The impact of invasive species on the foodweb and fisheries of the Laurentian Great Lakes

Invasive species have had a devastating effect on the ecosystem and fisheries of the Laurentian Great Lakes. The earliest invasive species, Sea Lamprey and Alewife, which became established during the 19th century, exerted a profound impact on the fish community, including the collapse of the commercial, recreational, and tribal fisheries. Successful control of the Sea Lamprey and Alewife resulted in the return of the commercial and tribal fisheries and a thriving recreational fishery based on the judicious stocking of Pacific Salmon. Recent invasive species, including Dreissenid Mussels, Round Goby, and Bythotrephes, however, have fundamentally altered the foodwebs in Lakes Huron and Michigan, such that the nature of the fishery is again changing. The difficult decisions currently faced by fishery managers, in light of the recent assault by invasive species, will be described.

S3.03

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Top-down and bottom-up collaboration in the management of the Laurentian Great Lakes and Lake Victoria fisheries: a comparison of two shared water bodies

The Laurentian Great Lakes and Lake Victoria, two productive freshwater resources, support thriving fisheries that provide millions of people with jobs, food, income, subsistence, and recreational opportunities. The lakes in both regions transcend many political borders: officials from two nations, eight states, the province of Ontario, and U.S. tribes are involved in Great Lakes fishery management and officials from three nations—Kenya, Tanzania, and Uganda—are involved in Lake Victoria's fisheries management. Officials in both regions must coordinate their fisheries management activities amongst themselves, while also understanding and incorporating stakeholder interests and needs into management actions.

This paper, based upon an upcoming chapter in a book about participatory governance, discusses collaborative fishery management in both regions. In the Great Lakes region, top-down coordination occurs through an agreement called A Joint Strategic Plan for Management of Great Lakes Fisheries, while bottom-up coordination remains the responsibility of each of the state, provincial, and tribal management agencies. On Lake Victoria, through decentralized governance, a co-management approach is coordinated by the Lake Victoria Fisheries Organization (LVFO), whereby top-down and bottom-up fisheries management is conducted between the individual countries and through local, beach-level fishing units. This paper concludes by comparing top-down and bottom-up processes of the Great Lakes and Lake Victoria and argues that the established coordination structures were developed deliberately to meet the specific needs and fishery management regimes of the respective regions.

S3.04

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Different lakes, same problems: common data management challenges of North American and East African great lakes

The vast size of the world's great lakes makes them important natural resources for millions of people residing in their basins but also complicates their management. The North American and East African great lakes extend across international boundaries with each lake managed by a number of different resource management entities. Coordinated management approaches have been established through the creation of international cooperative agencies such as North America's International Joint Commission and the Great Lakes Fishery Commission, and East Africa's Lake Victoria Basin Commission, the Lake Victoria Fisheries Organization, and the Lake Tanganyika Authority. While these organizations have recognized that natural resource management must be coordinated, little or no emphasis has been placed on coordinating data management activities. Lack of data integration across the various agencies managing a single lake obscures critical ecosystem inter-relationships and slows the determination of appropriate management actions thus delaying decision making. Difficulties arise because agencies collecting data employ different methods or units of measure, varying spatial/temporal scales, incompatible data management software products, and conflicting data quality control procedures. Even though management objectives differ and regional standards vary, management agencies in North America and East Africa are confronted with similar data management and integration problems. We outline the common challenges and describe solutions needed to address management goals on a great lake.

S3.05

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Climate change: drought analysis in Burundi

Burundi is a small country of 27,834 km^2 and its location is 3°3' under the equator in Central Africa. Its general climate is defined as tropical highland, but differences in altitude from region to region cause temperature variations with an average about 23 °C and an average annual precipitation of 800 mm.There are two main seasons: the dry season (June - September); the wet season (October- May).The water catchments of Burundi fall within two great African watersheds: the Nile basin and the Congo basin. In fact, climate change impact on agriculture, land use, forest, water resources, health, etc. is increasing and Burundi is now being affected by drought.

Unfortunately, in Burundi drought impacts were observed in several sectors. In the economic sector, there are losses in crop production (annual and perennial crop losses, reduced productivity of cropland, insect infestation, plant disease damage), and decline in food production (high livestock mortality rates, unavailability of water, increase in food prices). In the social sector, there are decreased nutritional levels, malnutrition, famine resulting from food shortage, loss of human life(food shortage, heat, etc..) increased poverty, decreased living conditions in rural areas. Furthermore population migration (rural to urban areas, and to neighbouring countries like Tanzania) is also observed. By proactively planning for drought, society will be better prepared and able to deal with its damaging effects. Therefore, using data available and collected from the Geographic Institute of Burundi, namely the precipitation, it was possible to carry out Drought Analysis in Burundi.

The objective of the study is to understand the rainfall variation in space and time in the study area and analyze drought characteristics such as intensity, duration, frequency, and severity. The relationship between rainfall variability and drought events over the country was studied; recommendations about identifying appropriate mitigation actions for future drought events and minimizing its impacts on agriculture, water resources, health, etc. were also highlighted. Therefore, this paper should be a helpful document for decision makers by raising political awareness related to policy in order to reduce drought impacts in Burundi.

S3.06

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Mainstreaming impacts and adaptations to climate variability and change among small-scale fishers and riparian communities of inland fisheries of Africa

Climate variability and change is a developmental challenge affecting resources and livelihoods. In fisheries, it can add to non-climate stressors such as over-exploitation, invasive species, pollutants, changes in land use, nutrient enrichment and population growth to drive vulnerable small scale fishers and riparian communities deeper into poverty. Climate variability and climate change increases temperatures, causes fluctuations in precipitation, floods and drought, intensifies winds and storms and re-configures ecosystems and resources. This displaces communities, damages infrastructure, and affects water, food supply, sanitation, and resource availability. The poor who depend on climate sensitive natural resources such as crops, livestock and fisheries are affected most. About 30% of Africans are poor and food insecure and 70-80% depend on climate sensitive natural resources. Addressing climate change in Africa however has concentrated on crops, livestock and forestry, and less on fisheries despite the high economic and nutritional value of fish. Most available information on fisheries is on marine ecosystems of the developed world. Inland fish production systems are vulnerable and have historically undergone fluctuations in water levels, desiccation and drying due to climate variability and change. This has affected riparian ecosystems, infrastructure, aquatic habitats, aquatic productivity, fishes, fisheries and livelihoods especially in poorer regions of the world such as those in Africa. There is therefore need to mainstream climate issues as climate change intensifies especially to enable the poor and vulnerable to adapt, cope and increase their resilience. This requires: building capacity by creating networks of scientists, policy makers, community service organizations and the general public to address climate issues; generating and providing information on impacts of climate changes on the fish habitat, aquatic productivity, fishes, fisheries, riparian ecosystems and livelihoods; increasing awareness; adjusting policies, regulations and governance systems; and developing, piloting, and up-scaling adaptation and coping strategies.

S3.07

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Lake Baringo, the community and fishing of declining resources: using local knowledge for sustainability

This paper discusses the use dwindling resources against environmental degradation leaving the local communities with limited alternatives for livelihoods. A survey was conducted on the local fishermen on use of fisheries resources, with special emphasis on traditional management approaches and knowledge on the breeding grounds. There are three pastoralist tribes, namely Njemps, Turgens and the Pokots, with very low or no education and are now turning to fishing for their livelihood.

A total of 56 respondents were randomly interviewed using semi-structured questionnaires about their landings. The age distribution of respondents indicated that the fishermen were young with a mean age of 30 years. The marital status of respondents seems to reflect a pattern of early marriages. The concentration of married fishers is around 20 – 30 years of age. Those who are single seem to belong to lower age category, of 12 years at the lower limit, indicating that they should be in school.

The respondents indicated areas fished and how nets were set. The main fishing areas were identified as the Salabani and Meisori areas, particularly the mouths of rivers Pekera, Molo, Loiminange, and Nasuguro. Some fishers indicated that there are some particular habitats occupied by *Barbus* spp. only (the area around Komolion Bay). The fish are abundant during the rainy seasons when the lake level rises after long rains. The fishers have indicated that the nets for *Clarias* are set differently from those of *Protopterus* depending on the prevailing winds. They indicated that small nets set at river mouths are responsible for the decline of the fishery of the lake.

S3.08

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Fishing grounds of Lake Baringo

A one day monthly sampling exercise was carried out from February to June 2011 to identify and map the fishing grounds of Lake Baringo. Overall, 216 fishing gears were recorded, with long lines dominating with 42% of all gear sampled. Gillnet followed closely with 38% and hand line with 20%.

The study revealed that a substantial number (about 34%) of undersize gillnet of mesh size ≤ 3'' are in use in the lake. This explains why high numbers of immature and smaller sized Tilapia were observed at the landing beaches around the lake. Availability of a large proportion of illegal gillnet implied that enforcement is not happening, or is not effective. The use of undersize gillnets should be eradicated completely for the Tilapia fishery to recover to its former glory days when the lake used to produce up to 600 t annually and supported a fish processing factory.

Five major fishing areas were identified in order of decreasing magnitude as: i) southern zone: onshore near area characterized by fringing macrophytes from the mouth of River Ngasotok in the east of lake up to the mouth of River Kapthuran (mororupa) in the west, ii) northern zone: the area which lies between Rongena Island and Komolion, iii) central zone: the area which lays between Kampi ya samaki and west of Samatiany Island, iv) southern zone: the area between Lesukut island and mouth of River Ngasotok. Also, immediately south of Lesukut island v) central zone: the area off Karibari beach, v) southern zone: the area immediately south of Lesukut island. Fishermen set their fishing gear in these major grounds due to: i) availability of target fish species ii) accessibility of the fishing grounds and iii) the safety of their fishing gear.

S3.09

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The biology of fishes of economic importance in Lake Turkana, Kenya

Studies on the distribution, abundance and some aspects of the biology of fishes of economic importance in Lake Turkana were carried out in the months of December, 2008 and May 2009. Fish were sampled in the northern, eastern (areas within Sibiloi National park) and central (including Ferguson's Gulf) sectors using multi-mesh size gill nets, line and hooks, and beach seines. Alestes baremose, Hydrocynus forskalii, *Oreochromis niloticus* occurred in >80% of the sampled stations. *Synodontis* spp. constituted >30%, of the landed fish species while *Oreochromis niloticus* and *Lates niloticus* contributed 20 and 6% to the catches, respectively.

Stomach contents analyses revealed that *Oreochromis niloticus* diets were composed mostly of Cyanophytes (70%); *Alestes baremose* mostly of ostracods and zooplankton (75%); *Hydrocynus forskalii* mostly of fish and *Caridina nilotica* (90%) and *Lates niloticus* mostly of fish and *Caridina nilotica* (over 95%). The fishes were able to change their feeding strategy and exploit available food in various habitats.

Size at first maturity of *O. niloticus* in the Ferguson's Gulf derived at 19 cm was lower than the 2007 estimate of 22 cm, indicative of intensive fishing pressure in the shallow gulf waters. In spite of that, the Relative Condition Factor (RCF) revealed that the species were generally in good condition.

S3.10

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Spatial and temporal segregation of *Labeobarbus* species migrating to Arno-Garno River

The spawning migration of *Labeobarbus* species of Lake Tana to Arno-Garno River was studied from July to December, 2010. Five sampling sites, based on their nature, velocity of the flowing river, human interference and suitability for fish spawning were selected by preliminary survey.

Fish were sampled monthly in the non-peak spawning season (July, November and December) and bimonthly in the peak spawning season (August to October) using 6, 8, 10, 12 and 14 cm stretched mesh size gillnets. A total of 1077 *Labeobarbus* specimens were collected. *Labeobarbus intermedius*, *L. brevicephalus*, *L. nedgia* and *L. tsanensis* were the dominant species, contributing 93.03% of the total catch. The monthly gonad-somatic index indicated that the spawning season for *Labeobarbus* species was from August to October. *Labeobarbus intermedius* and *L. tsanensis* were the first species to aggregate at the river mouth starting from July and *L. brevicephalus* and *L. nedgia* aggregate starting from September. However, *L. intermedius* was the first to migrate to the upstream sites starting from the end of July, followed by *L. tsanensis*. The last migrant species was *L. brevicephalus* starting from the fourth week of August. Pair wise comparison of the *Labeobarbus* spp. showed temporal segregation in all sampling months, except *L. intermedius* and *L. brevicephalus* that did not show temporal segregation with *L. nedgia*.

The best management option to protect these species is a closed season that should be strictly implemented during spawning (from June to October).

S3.11

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Monitoring methane extraction in Lake Kivu

Lake Kivu is a large tropical lake situated in the East African Rift Valley between the Republic of Rwanda and the Democratic Republic of Congo. Largely influenced by two active volcanoes, the Nyiragongo and the Nyamulagira, this unique lake contains an enormous quantity of dissolved methane (~60 km^3) and carbon dioxide (~300 km^3). The sudden potential release of these gases, similar to the limnic eruptions in Lakes Nyos and Monoon in the 1980s, could have catastrophic consequences for the riparian population reaching 2 million inhabitants. To avoid such a risk, the two riparian governments have decided to exploit the methane. Depending on the efficiency of the process, the methane extraction could produce as much as 500 to 800 MWe during 50 years. Then, the exploitation will be reduced to the annual natural recharge of methane in the lake, transforming it into a veritable renewable source of energy. Methane extraction in Lake Kivu is therefore a win-win solution, as it will simultaneously supply energy and reduce the risk of gas eruption.

To ensure a safe and environmentally friendly exploitation, the Lake Kivu Monitoring Program was set up under the Rwandese Ministry of Infrastructure and has now been transferred under the Rwandese Energy and Water Sanitation Authority. The team is monitoring the main risks associated with the methane extraction: the alteration of the lake stability and the deterioration of the lake ecosystem due to an increase in nutrients input. To minimize these risks, international experts established rules and guidelines for the extraction, recommending that the degassed water be re-injected below 260 m. To enforce these prescriptions and to conjointly manage the methane resource, the creation of a bilateral regulation authority has been initiated between Rwanda and Democratic Republic of Congo.

This presentation will focus on the findings from three years of monitoring of the first extracting station. Since October 2008, the KP pilot station has extracted methane generating ~1.5 MWe. This station is pumping gas-rich water from 330 m and releasing the degassed water together with the washing water at 90 m. The main potential disturbances for the lake could come from this re-injected water, which is more dense and richer in nutrients than the lake water at 90 m. Despite its higher density, the plume of re-injected water re-stratified between 93 and 109 m, because the entrainment of local lake water strongly diluted the re-injected water. The re-injected water is therefore not deteriorating the stability of the lake. However, it increased the upward fluxes of nutrients by 1.5%, compared to the current natural sources. The effects of this small-scale pilot plant are currently not damaging the lake but the industrial-scale plants will have to conform to the rules by re-injecting below 260 m.

S3.12

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Use of biomarkers in *Clarias gariepinus* for monitoring pollution in aquatic environments in Tanzania

Clarias gariepinus (African Sharptooth Catfish) is one of the most important tropical freshwater fish, with a wide range of geographical distribution and habitats, and highly tolerant to extreme environmental conditions that other fish species hardly survive. This important fish species has been studied in Tanzania to establish its suitability for monitoring pollution in aquatic environments.

Through experimental exposure studies, accumulation of fluorescent bile compounds (bile FACs), induction of cytochrome P4501A (hepatic and branchial EROD) and inhibition of acetylcholinesterase activities were demonstrated as potential biomarkers of exposure and effects of pollutants in *C. gariepinus.* Following waterborne exposure, the gills were shown to be more sensitive to CYP1A inducers than the liver, but also more affected following exposure to mixtures of polyaromatic hydrocarbons and oestrogenic compounds. The glutathione *S*-transferases (GSTs) activity did not show significant response. Vitellogenin (Vtg), a biomarker for monitoring exposure to estrogenic pollutants, was induced in male *C. gariepinus* at maximum level after one week of exposure to both natural (17alpha-estradiol [E2]) and synthetic ostrogens (17alpha-ethynylestradiol [EE2]. Dual exposure of Benzo(a) Pyrene and EE2, increased rate of biliary excretion of EE2.

Under field conditions, as a result of long term exposure of fish to a mixture of pollutants at low concentrations, the biomarkers that demonstrated significant responses included the Liver somatic index (LSI), Gonadosomatic index (GSI), Haemoglobin concentration, Cytochrome P4501A (hepatic and branchial EROD), UDP-glucuronyl transferases (UGT) and Metallothionein (MT) content. Based on these findings, it was concluded that biomarkers in this fish species were useful in monitoring environmental pollution in aquatic ecosystems in Tanzania and in other tropical regions.

S3.13

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Stable isotopes of nitrogen and carbon as indicators of trophic position in fish communities in lakes with and without introduced Nile Perch in the Lake Kyoga basin (Uganda)

The stocking of multi-species Lake Kyoga fishery with the predatory Nile Perch, *Lates niloticus*, in the 1950s was followed by dramatic changes in the fish assemblage and functioning. Some satellite lakes in the Kyoga basin however, still maintain diverse fish faunas free of Nile Perch and thus provide a comparative framework for exploring the impacts of Nile Perch introduction.

This study used stable carbon (^{13}C) and nitrogen (^{15}N) isotopes to examine trophic relationships and food chain lengths of similar fishes present in two lakes with introduced Nile Perch (Kyoga and Nakuwa), and in two other lakes without Nile Perch (Nawampasa and Bisina) in the Lake Kyoga basin. The fish species from the Nile Perch free lakes had higher trophic positions -TPs (mean TP= 3.9) than similar species from the lakes containing Nile Perch (mean TP=3.2); correspondingly the Nile Perch free lakes had longer food chain lengths (FCLs) (Bisina 4.9 and Nawampasa 4.7) than the lakes with Nile Perch (Nakuwa 3.7 and Kyoga 3.4) (One-way ANOVA $p < 0.01$), but these did not differ within either the Nile Perch free lakes (paired $t = 0.900$, $df = 8$, $P > 0.05$) or the other 2 lakes studied (paired $t = 0.387$, $df = 8$, $P > 0.05$).

This pattern likely reflects the higher species richness in Nile Perch free lakes. The Kyoga small lakes without Nile Perch are therefore important refuges for functional and species diversity that were lost in Lakes Victoria and Kyoga.

S3.14

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Evaluation of stocking density for production of *Oreochromis niloticus* (L.) (Nile tilapia) and *Clarias gariepinus* (B.) (African sharptooth catfish) in polyculture ponds

On-farm fish production experiments were conducted for 240 days to investigate whether polyculture of *Clarias gariepinus* (African sharptooth catfish) and *Oreochromis niloticus* (Nile tilapia) can increase fish growth and yield performance. Experiments were conducted in monoculture and polyculture systems. Low stocking density (LSD) and high stocking density (HSD) of 3 and 6 fish m^{-2} respectively, for both culture systems were tested to determine a better stocking density for polyculture production. Fingerlings of *O. niloticus* and *C. gariepinus* both of mean (± se) initial weight of 5.01 ± 0.01 g were stocked in 12 earthen ponds (150 m^2, mean depth 1.25 m). Each culture system had 6 ponds having 3 replicates per stocking density. Fish were fed on 29.75% crude protein diet made out of cotton seed cake (68.34%) and maize bran (31.66%) at 5% per mean body weight twice a day. Fish sampling was conducted monthly and weight gain measured. At the end of culture period a final mean weight gain of 209.70 ± 2.84 g and 145.72 ± 3.63 g with mean specific growth rates of 2.54 ± 0.01 g d^{-1} and 1.86 ± 0.02 g d^{-1} were attained from *O. niloticus* cultured at LSD and HSD, respectively. Polyculture of *O. niloticus* and *C. gariepinus* attained highest net fish yields (44,184.47 ± 1283.13 kg m^{-2} yr^{-1}) when cultured at LSD than at HSD (15,174.145 ± 671.95 kg m^{-2} yr^{-1}). Results from this study demonstrate that fish farmers can achieve high growth rates and yields through polyculture of *O. niloticus* and *C. gariepinus* reared at a stocking density of 3 fish m^{-2}.

S3.15

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Community participation in fisheries management

The great challenge of fisheries management is to choose the best management strategies to achieve the objectives of managing fishery resources. In Tanzania, the main objective of fisheries management is to ensure that fisheries resources are conserved developed and managed sustainably for economic growth and improved human livelihood. For this purpose, human and financial resources must be obtained in order to manage the aquatic resources in a sustainable manner. In the absence of human resources, fishing communities can be used in fisheries-dependent monitoring because reliable and accurate information is crucial to making well informed decisions in managing the fishery resources.

This paper is an attempt to devise ways to improve the management of fishery resources through community participation in data collection, monitoring control and surveillance in artisanal fisheries of Tanzania. It describes how Beach Management Units were established, and used as data enumerators. They developed their own by-laws and fisheries resources management plans, thereby forming Collaborative Fisheries Management Areas in some districts. The papers will also explain their move to Networking so that they can be represented in the higher level meetings of fisheries managers within and outside the country.

S3.16

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Local institutions in promoting community participation in artisanal fisheries management in Malawi: a case of Mbenji Island fishery

While local fisheries institutions are crucial for fisheries resource management, functional local institutions are hardly ever found in small-scale fisheries in Malawi. Beach Village Committees, formed in response to greater demands placed on scarce government resources, are working with the Department of Fisheries but have not met fishing needs. A study aimed at investigating and describing factors that influence effectiveness of local fisheries institutions in promoting community participation in fisheries management within the small-scale fishery of Mbenji Island, Lake Malawi, was conducted. The objectives were to; determine the local institutions and their roles, assess their effectiveness, and assess factors that promote participation of local communities in fisheries management.

The study was conducted between April and December 2008. It involved semi-structured interviews with 150 fishers, eight village heads and five staff of DoF. Survey data was entered and analyzed in SPSS. Mbenji Island fishery, unlike others, was identified with four institutions that are actively involved in fisheries management: Beach Village Committee, Beach Executive Committee, Mbenji Management Committee and Fisheries Committee. These institutions are dynamic but characterized by well-defined design principles that are a measure of institutional effectiveness in the management of resources. Some socioeconomic and demographic characteristics of sampled fisherfolk were also found to have important bearing on community participation in fisheries management.

In conclusion, local institutions are most effective in areas of low population density, and where internal and external pressures on resources are monitored. Policy should provide for demarcation of great lakes into fishing grounds allocated to specific TAs or otherwise, where fishers of a particular locality will belong. This instils a sense of ownership, responsibility and accountability of resources. The advocacy of integrated involvement of other stakeholders is necessary.

S3.17

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Fisheries co-management in west and east Africa, a comparison

It is difficult to assess whether fisheries co-management regimes are successful or have failed. Senegal's co-management system is often referred to as a success story and this is also the case for the current system on Lake Victoria. However, a closer look at the systems in West and East Africa may show both differences and similarities after an extended period of time. The present paper describes the Artisanal Fisheries Local Councils (ALFC) in Senegal, Community Fishery Centers (CFC) in the Gambia, and the Beach Management Units (BMU) on Lake Victoria and their comparison.

Emphasis has been placed on the governance of the co-management units as well as on their stakeholder compositions. The role of the authorities is highlighted as is their influence exerted at the community level. A question that may be asked is to what extent the fishing communities comply with the objectives of the co-management systems in which they take part.

This paper also suggests improvements in the co-management approach to overcome certain weaknesses experienced over time. The AFLC, CFC and BMU approaches are often considered successful, but may not necessarily be replicated by other fisheries situations, as they seem specific to the situations for which they were put into place. Recommendations are presented for the introduction of co-management systems in other fisheries situations in Africa.

S3.18

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Stakeholder involvement in data collection: will we get the same desired results?

Collection of basic fisheries statistics is costly on the part of government. It involves teams of fisheries staff to cover one or more strata in the collection of data. As an alternative, stakeholder involvement through fisheries co-management arrangement may be cheaper or ideal.

Information related to numbers of fishing villages by status; fishers by gender, status and age; boats by type and ownership; gear distribution and other livelihoods may be collected cheaply using leaders of co-management structures at the Fishing Village Management Committee (FVMC) level. This information is needed in every fishery for establishing a sampling frame for Catch Assessment Survey (CAS), general planning and management of the fisheries resources. Where fisheries co-management exists, such activities may sometimes be assigned to fishery stakeholders and government resources would be allocated to other tasks.

Following activities carried out on Lake Kariba fishery, where Fisheries Co-management was introduced in 1994, this paper compares data sets collected by fishers (FVMCs) and Department of Fisheries (DoF) to determine whether there exists any significant statistical difference in their overall utilisation. The two data sets compared in this analysis were collected during the September 2004 and April 2006 by fishers and the department of fisheries frame surveys respectively.

S3.19

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Ecosystems without borders: treaties, conventions and agreements

Historically international co-operative agreements on aquatic environments have dealt with exploitation of natural resources like fish, oil and minerals, shipping and trade. In contrast, the governments of Canada and the United States in 1972 developed a new model for the Great Lakes which emphasized pollution control and improvements to water quality. The scope of the Great Lakes Water Quality Agreement was expanded to include an ecosystem approach towards resolving environmental stressors and setting restoration objectives. European countries followed suit, setting binding water quality targets in 1980 and eventually creating the Water Framework Directive adopted by the European Union in 2000. The focus of these international agreements is on environmental protection and the concept is being deployed in other aquatic ecosystems that are shared by multiple countries including the Arabian (Persian) Gulf and the Mediterranean Sea, but there remain many more in need of protection. This paper will explore the history behind these agreements with examples of environmental threats and consequences (acidification, eutrophication, exotic invasive species and pollution), and summarize the differences and similarities in the approach and conduct of these agreements. Finally, the paper will highlight the successes of international agreements and provide a broader perspective for future adoption of suitable agreements to protect aquatic resources throughout the world

Poster Abstracts

P1

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Fisheries impact on littoral fishes Cichlidae (Pisces) from the northwestern part of Lake Tanganyika (East Africa)

Lake Tanganyika is well known for its exceptional biodiversity and fish fauna. It has particularly rich and diversified benthic and coastal areas (Nshombo, 2008) with a high number of species of fish including a very high endemism, especially in the family Cichlidae (98%) and non-Cichlidae (46%). The littoral habitat is more complex and rocky, sandy and rocky / sandy shores offer a variety of habitats, dominated by the cichlids that depend on these habitats. However, studies of cichlids from Lake Tanganyika, mainly along the coasts Congolese, remain fragmented. Few of them deal with the state of fish during the current population increase. These fish are caught with nets and gear choices for fishing are less important while the number of fishermen are increasing in parallel with that of local residents. This study is a contribution to the knowledge of the impact of fishing gear on fish Cichlidae shoreline of Lake Tanganyika (East Africa), the fishing industry at the end of Uvira Northwest, from March to July 2010. Cichlidae littoral fishing in Uvira is characterized by three main fishing gear including: beach seine, gillnets and gillnets dormant nets; distributed according to the substrates of the littoral habitat. These devices have generally captured more immature fish (63%) and small sizes are captured due to the small mesh and inappropriate fishing techniques. The beach seine caught more species on the sandy substrate, and gillnets more individuals on various littoral habitats in Uvira.

P2

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Intensive field and laboratory testing of the Fluoroprobe for assessing photosynthetic communities under eutrophic and oligotrophic conditions

The Fluoroprobe is being used globally for the assessment of chlorophyll a and spectral classification of photosynthetic organisms. A critical evaluation of the Fluoroprobe data compared to standard laboratory methods is warranted to assess the suitability of the instrument. Consequently, we compared chlorophyll a measured in situ from the probe with chlorophyll a measured in vitro (cold acetone pigment extraction and spectrophotometric analysis). We also compared the spectral groupings of the photosynthetic community by Fluoroprobe with taxonomic identification and enumeration of phytoplankton by standard Utermöhl microscopic analysis. Intensive spatial and temporal sampling was conducted in Lake Ontario, Bay of Quinte and Hamilton Harbour across habitats ranging from ultra-oligotrophic to hyper-eutrophic. The chlorophyll a data was subjected to statistical analysis including linear regressions and paired sample t tests. In Hamilton Harbour, Fluoroprobe generated spectral classes were compared against species composition. The results suggest that Fluoroprobe data was not compatible with the taxonomic analysis. Consequently, ground truthing of the Fluoroprobe against standard taxonomic analysis is essential before spectral classes could be considered as reliable indicators of community composition for research and monitoring.

P3

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Annual variation of water level in the southern part of Lake Tanganyika from 1960 to 2011

The water level of Lake Tanganyika, East Africa, fluctuates from year to year. In the Southern end of the lake, the water level rose by 3 m between 1960 to 1963. It went down 2.5 m by 1977. It rose 0.80 m by 1981, and then dropped 0.90m by 1987. The water level rose again by 0.80m in 2000 almost reaching the peak again. In this paper we examine changes in some weather parameters, (air temperature and rainfall) as possible causes of the water level variation. The fluctuations of water level have also contributed to the depletion of some species of fish, for instance *Oreochromis tanganyicae* and displacement of some species of fish like *Tropheus* spp.

P4

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Assessment of the effects of plerocecoid larva of *Ligula intestinalis* (Cestoda) in *Engraulicypris sardella* (Cyprnidae) from northern Lake Nyasa/Malawi.

The tapeworm *Ligula intestinalis* (Linnaeus 1758) is thought to be the most important tapeworm that infests cyprinids and can be a major threat to natural and farmed fish populations. *Engraulicypris sardella* (Günter, 1868), locally called "Usipa", is one of the most significant cyprinid species exploited in the pelagic waters of Lake Nyasa/Malawi. It has recently been observed that this pseudophyllidean cestode in its plerocercoid stage infests *E. sardella*.

Although *L. intestinalis* has been the subject of a number of studies where it has been established to inhibit puberty in host cyprinid fish, there is no information on the effects of this parasite on *E. sardella*. The main objective of this study was to assess the prevalence and impact to fecundity of *L. intestinalis* to *E. sardella* at selected landing sites of Mwaya and Kafyofyo in the north of Lake Nyasa/Malawi. Samples of *E. sardella* were collected for a period of ten months (Feb. – Nov. 2007) from artisanal fishery. Two kilograms of *E. sadella* randomly procured from fisher folk were sub-sampled at the laboratory to half a kilogram for the assessment. Data recorded for each individual fish included; total length in millimetres, weight in grams, sex and maturity stage, number of parasites, gonad assessment and egg count. The number, length and total weight of *L. intestinalis* found per fish host were also recorded. The average infestation rate of *L. intestinalis* on *E. sardella* from the two fishing grounds was 32.5%. Kafyofyo had the highest infestation rate of 50% and Mwaya 15% and on average each infested fish had 1.7 parasites. The majority of fish infested carried one parasite (57%) with 23.1% having two parasites, 13.8% three parasites, 1.5% four parasites and 4.6% five parasites. There was significant difference between the weight of fish with parasites and without parasites ($P<0.05$, $r= 0.15$). Mean length and weight of parasites was 73.6 mm and 0.25 gm respectively. There was significant difference between the weight of gonads of infested and non-infested fish ($P<0.05$). The average weight of gonads from infested fish was 0.28gm while that of non-infected fish was 0.32gm. The gonads of all infected fish were atrophied.

Infestations of *L. intestinalis* on 'Usipa' affect fecundity and consequently inhibit the reproductive capacity of this cyprinid fish population. Also acceptance of the fish to consumer was not alluring to the eye calling for urgent innovations in fish processing technologies to remove the parasite before the fish is put on market.

P5

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The multivariate statistical analysis of abiotic parameters of the Lake Tanganyika sub-catchment

Results from multivariate statistical analysis of abiotic parameters conducted during the dry season at 20 accessible sites on 8 rivers, 2 lakes and a dam covering the Lake Tanganyika sub catchments are discussed. Standard methods were used to determine the levels of abiotic parameters from water samples. Physical parameters DO, EC, Eh, turbidity, temperature, pH and secchi transparency were measured in situ while chlorophyll a was determined in the laboratory. Nutrients such as NO3 -, SiO2, PO4 3- and Fe2+ were determined along with HCO3 -.

Factor analysis resulted in four factors including increased primary productivity, redox conditions, dissolution, and reduction processes. Processes including dissolution, diffusion, adsorption, absorption, nitrification, denitrification, mixing and reduction along with the anthropogenic activities, increased photosynthetic activity of algae and the geomorphology of the ecosystems contribute to the variation of the abiotic parameters.

It is recommended that quantification of river flows, sediment load and nutrient budget at various sampling points be determined seasonally for proper evaluation of the hydrologic and limnological functioning of the ecosystem.

P6

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Identification and mapping of critical fish habitats in Lake Victoria, Kenya

Lake Victoria, the largest fresh water lake in the tropics, supports one of the richest fisheries in Africa. Sustainability of the lake's high commercial fish yields is a major concern given the declining fish stocks and loss of diversity, deterioration of water quality and habitat degradation since the 1960s.The study was carried out on the Kenyan part of the lake to determine fish species composition and diversity indices in different localities, identify and map out critical fish habitats. The structure of the fish community was described by examining the number of species per abundance class, species richness and Hill number as well as Shannon index. Results showed that river mouths and associated wetlands, bays and rocky areas/islands were critical fish breeding and nursery grounds. River mouths and sheltered bays exhibited significantly higher species richness compared to other sampled areas ($p<0.05$). Identified key fish habitats are represented using GIS application and recommended are best eco-solution approaches to the protection and conservations of areas broadly considered as the panacea for biodiversity conservation in Lake Victoria.

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Diversity And relative abundance of fishes in some temporary and perenial water bodies of the Baro Basin, Gambella, Ethiopia

The diversity and relative abundance of fish species of seven sites of the Baro basin were studied. Fishes were sampled using seines, dip nets (mesh sizes 0.5 cm and 1 mm), hook and line, fish traps, cast net (local fishermen) and electrofishing in smaller fast running streams. Fish identification was done to species level by using taxonomic keys found in the literatures. Shannon diversity index (H') and Index of Relative Importance (IRI) were computed to evaluate diversity and relative abundance of fish species, respectively. A total of 51 species belonging to 38 genera 20 families and 11 orders were identified. A higher number of species was recorded from Alwero (H'= 2.56) followed by Obela, Baro at Gambella & Gilo (H'= 2.03 each), Itang (H'= 1.91) and Tdha (H'=0.35). Mormyridae was the most dominant family in number of species comprising 8 species followed by Mochokidae (7 species) and Cyprinidae (6 species). *Barbus prince* was found in the six sites; *Oreochromis niloticus* was found in five sites and *Brycinus macrolepidotus*, *Siluradon auritus*, *Clarias gariepinus*, *Barbus stigmatopygus* and *Polypterus senegalus* were found in four sites and were considered the most dominant species. IRI showed that *O. niloticus* (IRI=37.2%) was the most abundant species followed by *S. auritus* (IRI=14.6%), *B. macrolepidotus* (IRI=13.1%), *B. stigmatopygus* (IRI=10.0%), *B. prince* (IRI=9.8%), and *P. senegalus* (IRI=7.4%). Further comprehensive assessment of the fish diversity of the basin and socio-economic aspects for sustainable fish resource utilization is recommended.

Notes

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