

# AEHMS 10

Advancing & Nurturing Aquatic Ecosystem Health Sciences for 20 Years  
An International Conference

## The Aquatic Ecosystem Puzzle: Threats, Opportunities and Adaptation



Siena, Italy  
June 13-15, 2011



# PROGRAM & ABSTRACTS



The logo for AEHMS 10, featuring the text "AEHMS 10" in a blue, sans-serif font inside a white oval with a blue border. The background of the entire top banner is a scenic view of a lake or bay with mountains in the distance under a cloudy sky.

AEHMS 10

# The Aquatic Ecosystem Puzzle:

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## Threats, Opportunities & Adaptation

June 13-15, 2011  
Siena, Italy

*Co-Chairs*  
S. Loiseau & M. Munawar

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*Organized by*  
University of Siena, Italy  
Aquatic Ecosystem Health and Management Society





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## Organization

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### *Conference Co-chairs*

Steven Loiselle (Università degli Studi di Siena, Italy, loiselle@unisi.it)

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Claudio Rossi (Italy)

Eric Odada (Kenya)

Victor Langenberg (Netherlands)

Andrew Price (UK)

### *Local Organizing Committee*

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Roberto Bertoni

Arduino Dattilo

Alessandro Donati

Carlo Gaggi

Chiara Mocenni

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Maria Pia Picchi

Antonio Tognazzi

### *Secretariat*

L. Elder

J. Lorimer

S. Blunt

M. Fitzpatrick

N. Jarrett





## *Welcome to AEHMS 10 in Siena!*

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The Aquatic Ecosystem Health and Management Society (AEHMS) is celebrating its tenth biennial conference. With AEHMS 10: “The Aquatic Ecosystem Puzzle: Threats, Opportunities and Adaptation”, the Society enters into its third decade of promoting the understanding of ecosystem health, management, and conservation of both marine and freshwater aquatic resources through its ongoing international series of conferences and publications. Previous biennial conferences were held in Vietnam, China, France, Netherlands, Mexico, Portugal, USA, Germany and Canada.

The Organizing Committee of AEHMS 10<sup>th</sup> extends a warm welcome to all the participants in this beautiful and historic city of Siena, Italy, part of the scenic Tuscan region. This conference has been designed to focus on the current state of the world’s water bodies, the common threats/risks they face and their unique management needs. The meeting plans to explore the application of ecosystem-based science for sustainable management of aquatic resources, hopefully contributing towards solving the complex ecosystem puzzle.

The program has been carefully prepared to present an interesting integration of topics which has been categorized on the following themes:

- ✦ Adapting to climate change in aquatic ecosystems: European & global perspectives
- ✦ Biogeochemical dynamics: Local processes with global implications
- ✦ Health and biodiversity in aquatic ecosystems: Bottom up and top down strategies
- ✦ Integrating ecology, toxicology and management: Can laboratory and field approaches meet?
- ✦ Tools, toys and techniques for the 21st century

Traditionally AEHMS emphasizes publications of papers originating from its activities. Similarly for this meeting the AEHMS plans to publish selected peer-reviewed papers in its official journal *Aquatic Ecosystem Health & Management* (Taylor and Francis, Philadelphia). We invite you to become a member of the AEHMS and receive the four quarterly issues of its journal each year (see [www.aehms.org](http://www.aehms.org) for the membership form).

Once again we are pleased to welcome you to the scenic surrounding of Siena. It is hoped that this conference will bring together experts on various environmental health issues to promote ecosystem-based management. The organizers are expecting that new insights, techniques and approaches may emerge from this conference, which will be useful for the conservation and protection of the precious aquatic resources of Europe and the world.

Mohiuddin Munawar, Co-Chair  
*Fisheries and Oceans Canada*  
AEHMS

Steven Loiselle, Co-chair  
*Dipartimento Farmaco Chimico Tecnologico,*  
*Università degli Studi di Siena*





## *An Introduction to the AEHMS*

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*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](http://www.aehms.org)). The objectives of the Society are outlined below:

- Adoption and promotion of ecosystem health concept.
- Application of integrated management from a multi-disciplinary, multi-trophic and sustainable perspective.
- Focusing on integrated approaches for protection, remediation, and restoration.
- Enhancing understanding of marine and freshwater ecosystems: structure, function, ecology, biodiversity, etc.
- Advocating the development of new approaches, tools, techniques and models.
- Encouraging interdisciplinary communication amongst scientists, managers, universities, governments, industry, and public sector.
- Organizing and co-sponsoring international conferences, symposia, workshops, eco-forums and working groups.
- Publication of an international primary journal, special issues and peer reviewed book series.

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. Currently, plans are under way for publications on: the ecology of Lake Superior; the state of the (Arabian/Persian) Gulf ecosystem; ecosystem health and recovery of the Bay of Quinte; managing ecosystem health of tropical seas and coastal ecosystems; marine environmental changes in the South China Sea; and ecosystem health of River Ganges and other major rivers of India. A full list of the special issues is given at the back of this Program book.

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 the list given at the end of this Program book). One of its books, *Burning Rivers*, has just won the 2011 Green Book Festival Award in the scientific category.

Upcoming Society events include the following conferences and symposia:

- Exploring food web linkages and dynamics in the Upper Great Lakes: Past, Present & Future. At IAGLR 2011, Duluth, MN, USA, May 2011.
- Ecosystem health of River Ganges and Major rivers of India. Kolkata, India, November 2011,
- Ecology of South China Sea, MEC. Guangzhou, China, December 2011



- Ecosystem Health and Integrity of Lake Vänern. Sweden, June 2012
- Great Lakes of the World (GLOW) VII. Bujumbura, Winter of 2012

The Society welcomes individuals for membership belonging to a wide range of disciplines. AEHMS cordially invites you 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





## *General Information & Publication Plans*

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### **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. The locations will be announced at the time of the conference.

### **Registration Desk**

The registration desk will be available at 8:30 am on Monday before the program starts and throughout the conference.

### **Social Events**

AEHMS 10 conference organizers want to ensure participants have the opportunity to explore some of the sights and culture of the surrounding region by including experiences and tours into our full program. The conference will be holding two events:

- Join us Monday evening for a presentation by a local sommelier, followed by a free wine tasting, and help toast the AEHMS as we celebrate over twenty years promoting ecosystem health!
- Join us Tuesday evening when we take a scenic walk through Siena (15 min.) to the Palazzo Pubblico, one of Siena's most noted landmarks. Outside you can enjoy this stunning example of Italian medieval architecture and how it relates to the Piazza del Campo. Here you can catch the best view of the palace's tower which inspired architects the world over. Inside we will have the opportunity to explore the palace's museum and many frescoes which were unusual and unique for the time they were commissioned.

For those of you who would like to infuse even more Italian culture into your conference experience, tickets are available to join us on Tuesday evening for a traditional Tuscan social dinner. A street section will be closed and we will dine outdoors, indulging in great food and great company under the stars. The meal will be preceded by a presentation hosted by the Contrada della Torre where their leaders will explain the centuries of tradition that surround this beautiful city including the annual Palio horse races.

### **Publication Plans**

*Aquatic Ecosystem Health and Management* 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, guidelines and page charges ([www.aehms.org](http://www.aehms.org)). Due to limited space, AEHMS has set page limit guidelines as follows: Keynote: 10; Oral & Poster: 7 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@dfompo.gc.ca](mailto:mohi.munawar@dfompo.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 [lisa.elder@dfompo.gc.ca](mailto:lisa.elder@dfompo.gc.ca) before the end of the conference.

### **Liability**

Neither the University of Siena, Italy, the Santa Maria della Scale Museum Complex, nor the AEHMS can be held responsible for damage, loss or theft during the conference. Please take precautions to ensure the safety of yourself and your valuables.



## Program-at-a-Glance

Monday, June 13		Tuesday, June 14		Wednesday, June 15	
8:30-9:30	Registration	8:30-9:00	Keynote: R. Sommaruga	8:30-9:00	Keynote: J. Brils
9:30-10:00	Welcome & Inauguration	9:00-10:15	Session 3	9:00-10:30	Session 5
10:00-10:30	Break	10:15-10:45	Break	10:30-11:00	Break
10:30-11:00	Keynote: M. Kernan	10:45-12:15	Session 3	11:00-12:15	Session 5
11:00-12:30	Session 1			12:15-1:00	Panel Discussion
12:30-2:00	Lunch	12:15-1:45	Lunch	1:00-2:30	Lunch
2:00-2:30	Keynote: L. Tranvik	1:45-2:15	Keynote: M. Munawar	2:30-3:15	Overview & Summary
2:30-4:15	Session 2	2:15-3:45	Session 4	3:15	Adjournment
4:15-4:45	Break	3:45-4:15	Break		
4:45-5:00	AEHMS celebration	4:15-5:00	Session 4		
5:00-5:30	Honourary talk: A.R.G. Price	5:00-6:00	Visit to Palazzo Pubblico		
5:30-6:00	Honourary talk: F. Krupp				
6:00-6:30	Honourary talk: M. van der Knaap				
6:30-7:15	Wine tasting				
7:15-8:30	Poster session				

**Please note:**

All presentations and posters are the property of the presenter. Audio recordings, copying, videotaping or photography of the presentations is prohibited. Media should obtain the permission of the conference chair for use of any conference material.

We request participants to switch off mobile phones in the conference hall.

Thank you for your cooperation!

## Program

<b>Monday, June 13<sup>th</sup></b>			
8:30-9:30	Registration		
9:30-9:40	Welcome from UNISI & AEHMS: S. Loïselles & M. Munawar		
9:40-9:50	Inauguration by the Regional Minister of the Environment		
9:50-10:00	Welcome by the President of the Province of Siena		
10:00-10:30	Break		
<b>Session 1. Adapting to climate change in aquatic ecosystems: European &amp; global perspectives</b>			
10:30-11:00	S1.01	Keynote: M. Kernan	<i>Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems</i>
11:00-11:15	S1.02	D. Gerdeaux	Impact and adaptation to climate change in Lake Geneva: Changes in the fish community and adaptation of the fishery
11:15-11:30	S1.03	D. Harper	Lake Naivasha, Kenya: Threats, opportunities and adaptation
11:30-11:45	S1.04	A. Ludovisi	Impact of climate change on the hydrology and the sponge population of the shallow Lake Trasimeno (Umbria, Italy): history, forecasting and management
11:45-12:00	S1.05	P. Ghavam Mostafavi	Are symbiotic algae on Iranian corals resilient to climate change?
12:00-12:15	S1.06	S. Uddin	Evidence of acidification in Arabian Gulf
12:15-12:30	S1.07	R. Ma	China's lakes: The present and the past
12:30-2:00	Lunch		
<b>Session 2. Biogeochemical dynamics: Local processes with global implications</b>			
2:00-2:30	S2.01	Keynote: L. Tranvik	<i>Aquatic carbon dynamics: Local processes with global implications</i>
2:30-2:45	S2.02	M. Azzaro	Carbon remineralization in the Mediterranean Sea
2:45-3:00	S2.03	P.C. Pollard	The link between aquatic microbial respiration, forests and atmospheric carbon dioxide — small bugs with a global impact
3:00-3:15	S2.04	L. Bracchini	An alternative way to analyze the shape of CDOM absorption curve
3:15-3:30	S2.05	D. Vione	Modelling the photochemical fate of organic pollutants in surface waters: Transformation kinetics and occurrence of intermediates
3:30-3:45	S2.06	V. Hull	A systems ecology approach model for dissolved oxygen dynamics in coastal lagoons
3:45-4:00	S2.07	C. Santinelli	The role of DOC in C export in the Mediterranean Sea
4:00-4:15	S2.08	L.M. Frohn	Nitrogen deposition to the Baltic Sea – who are the main contributors?

## Monday, June 13<sup>th</sup>

4:15-4:45	Break		
4:45-5:00	AEHMS Celebration		
5:00-5:30	H.01	<i>Honourary talk:</i> A.R.G. Price	Robustness-resilience in marine ecosystems and measures of health assessment
5:30-6:00	H.02	<i>Honourary talk:</i> F. Krupp	Freshwater biodiversity conservation in the Arabian Peninsula
6:00-6:30	H.03	<i>Honourary talk:</i> M. van der Knaap	Biodiversity on the African Great Lakes, may we eat it?
6:30-7:15	Wine tasting and presentation by a local sommelier		
7:15-8:30	Poster session		

Poster Session		
P.30	M.S. Andersen	The impact pathway method for monetary valuation: Application to agricultural nitrogen and water quality
P.01	T. Arruebo	Hydromorphological indicators and water characterization at the Escalar glacier lake (Spanish Pyrenees): A limnological approach
P.02	M. Azzaro	Temporal variability of microbial biomass and respiratory activity in the epi-, meso- and bathypelagic waters of the Tyrrhenian Sea (Mediterranean Sea)
P.03	M. Azzaro	Relationship between microbial parameters and environmental changes in coastal aquatic ecosystem
P.04	N. Bogutskaya	Radioactive contamination of the environment and skeleton development in the common roach <i>Rutilus rutilus</i> (Linnaeus) (Actinopterygii: Cyprinidae)
P.05	F. Borghini	Environmental factors affecting microbial mat photosynthetic pigments in Victoria Land (Antarctica)
P.06	S.B. Brandt	How does hypoxia affect habitat quality of fishes?
P.07	O. Buhvestova	Predictive model for phosphorus in large shallow Lake Peipsi: Approach based on covariance structures
P.08	M. Cantonati	Coping with desiccation and high irradiance in the eulittoral of a large lake: Adaptive biology of the rhodophyte <i>Bangia atropurpurea</i> (ACE-SAP Project, A2.WP2)
P.09	A. Dattilo	The impact of solar UV radiation on <i>Artemia</i> growth stages
P.10	N.T.W. Ellwood	Epilithic phototrophic biofilms of Lake Albano
P.11	L. Encina	Development and evaluation of a multimetric index for measuring the ecological potential of Spanish reservoirs
P.12	R. Francaviglia	Soil, land-use and water quality in a coastal agro-system of Central Italy
P.13	L. Galgani	The C-cycle on ocean's surface: the sea-surface micro-layer, its composition and the production of dissolved and particulate organic matter from phytoplankton under stress conditions

Poster Session		
P.14	J.Á. Gálvez	Timing of the carbon dioxide emission from two monomictic Mediterranean reservoirs
P.15	P. Grillas	Sidi Boughaba Lake (NW Morocco): Preliminary ecological diagnosis and proposals for adaptive management
P.16	J. Haberman	The status of the southernmost part (Lake Pihkva) of large Lake Peipsi: A purification pond and polluter
P.17	M. Falcucci	Climate change impacts on the hydrodynamics of the coastal lake of Fogliano (Central Italy)
P.18	N. Kanavillil	Role of Wetlands in the lake water quality: Studies at Mill Creek and Victoria Point wetlands, Orillia, Ontario, Canada
P.19	G. Kapanen	Temporal distribution of polycyclic aromatic hydrocarbons (PAHs) in Lake Peipsi sediments, Eastern Europe
P.20	S. Kurissery	Phosphorus input into Lake Simcoe: A preliminary study on differentiating human vs. non-human sources using caffeine as a marker
P.21	P. Lombardo	Planarian–gastropods interactions in benthic food webs and implications for littoral biomanipulation in shallow lakes
P.22	M.G. Marin	Long-term effects of sea water acidification on physiological responses of juvenile bivalves <i>Mytilus galloprovincialis</i> and <i>Chamelea gallina</i>
P.31	P.M. Masilya	The recent introduction of <i>Lamprichthys tanganicanus</i> in Lake Kivu (Eastern Africa): a threat for pelagic fishery?
P.23	M. Mjelde	Causes and consequences of <i>Elodea canadensis</i> invasion in Steinsfjord, Norway — implications for macrophyte and lake management
P.24	G. Romanescu	Water resources in Romania and their quality in the main lacustrine basins
P.25	Z. Santolaria	Water chemistry of two high mountain lakes and their catchment's lithology
P.26	Z. Santolaria	Seasonal variability of water chemistry in Astún high mountain lake
P.27	M. Shapoori	Study the heavy metals (Copper, Zinc) in <i>Chironomidae</i> and <i>Gammarus pulex</i> , Namrood River, Province Tehran
P.28	Y. Zhang	Temporal and spatial variability of chlorophyll <i>a</i> and TSM concentration in Taihu Lake using time series MODIS Data
P.29	N. Zorriasatein	Study of Phytoplankton community in Tajan River and their relationship with physicochemical parameters of water

## Tuesday, June 14<sup>th</sup>

<b>Session 3. Health and biodiversity in aquatic ecosystems: Bottom up &amp; top down strategies</b>			
8:30-9:00	S3.01	<i>Keynote:</i> R. Sommaruga	<i>Adaptations and responses of the biota of alpine lakes to different environmental changes</i>
9:00-9:15	S3.02	H. Sarmento	The importance of the microbial food web in tropical lakes: Facts, hypothesis and speculations
9:15-9:30	S3.03	M.-F. Racault	Phenology of phytoplankton growing season in the global ocean
9:30-9:45	S3.04	M. Cantonati	The contribution of benthic cyanobacteria and algae to the definition of spring types as a prerequisite for the development of ecological-integrity and environmental-quality assessment procedures for spring habitats
9:45-10:00	S3.05	A. Al-Azri	Occurrence of Harmful Algal Blooms (HABs) in the coastal water of Oman as a threat to marine resources of the Sultanate of Oman
10:00-10:15	S3.06	B. Williams	Bayesian network model of Anabaena blooms in Grahamstown Lake
10:15-10:45	Break		
<b>Session 3. Health and biodiversity in aquatic ecosystems: Bottom up &amp; top down strategies</b>			
10:45-11:00	S3.07	N.G. Bogutskaya	Fish in a brackish sea: The specific fauna of the Sea of Azov
11:00-11:15	S3.08	J. Moreau	Multispecific Approaches for the management of African fisheries: Similarity and geographic differences the cases of Benin and Rwanda
11:15-11:30	S3.09	H.A. El-Serehy	Brachyuran crabs: Their systematic account and decoration behavior in the Suez Canal-the connecting link between the Red Sea and Mediterranean
11:30-11:45	S3.10	J. Lappalainen	Growth and consumption of pike ( <i>Esox lucius</i> ) stocked in a lake with frequent winter hypoxia
11:45-12:00	S3.11	P.W. Namisi	A comprehensive assessment of Yemen's marine fisheries sector
12:00-12:15	S3.12	M. Milardi	Brown trout introduction and interaction with boreal lake ecosystems
12:15-1:45	Lunch		
<b>Session 4. Integrating ecology, toxicology and management: Can laboratory and field approaches meet?</b>			
1:45-2:15	S4.01	<i>J.R. Vallentyne Lecture</i> <i>Keynote: M. Munawar</i>	<i>Can laboratory and field investigations be integrated? A success story from the North American Great Lakes</i>
2:15-2:30	S4.02	F.J.M. Al-Imarah	Determination of Cyanide by ion selective electrode in waters of Umm Qasr and Khor Al-Zubair ports, Basrah - Iraq

## Tuesday, June 14<sup>th</sup>

2:30-2:45	S4.03	K. Al-Rasheid	Heavy metal concentrations and their distribution along the western coast of Port Said on the Mediterranean Sea, Egypt
2:45-3:00	S4.04	Y. Fakir	Hydrogeological approach for contributing to the conservation action plan of the Ramsar wetland of Oualidia-Sidi Moussa, Atlantic Coast, Morocco
3:00-3:15	S4.05	M. Galar-Martínez	Oxidative stress and genotoxic damage produced by acetaminophen, diclofenac and its mixture on the common carp ( <i>Cyprinus carpio</i> )
3:15-3:30	S4.06	S. Mori	Significant role of offshore petroleum deposits in sustaining marine food chain
3:30-3:45	S4.07	K. Murugan	Mosquitocidal and water purification properties of botanicals for the control of disease vectors, Malaria, Filariasis and Dengue and water reuse technology
3:45-4:15	Break		
4:15-4:30	S4.08	N. Pacini	Dioxin-like compounds in freshwater fish from Campania Region
4:30-4:45	S4.09	G. Pavanello	Biofilm based sensors for environmental and industrial monitoring
4:45-5:00	S4.10	E. Dimitriou	A water quality assessment in a Greek artificial lake. Threats and restoration measures
5:00-6:00	Visit to Palazzo Pubblico		

7:00-8:00 PM      Contrada presentation and Museum tour  
 8:00 PM            Tuscan Dinner

## Wednesday, June 15<sup>th</sup>

### Session 5. Tools, toys and techniques for the 21st century

8:30-9:00	S5.01	Keynote: J. Brils	<i>Tools, toys and techniques for the 21st century</i>
9:00-9:15	S5.02	B. Qin	Freshwater Lakes in China: Exploitation, Restoration and Prospective
9:15-9:30	S5.04	N.T.W. Ellwood	Biomonitoring of upland water nutrient status
9:30-9:45	S5.05	L. Rukhovets	Modeling the response of the Great European Lake Ladoga ecosystem to decreased of phosphorus loading
9:45-10:00	S5.06	M. Fitzpatrick	Comparing <i>in situ</i> and <i>in vitro</i> methods for assessing chlorophyll <i>a</i> and algal communities in the North American Great Lakes
10:00-10:15	S5.07	C. Mocenni	Complex dynamical models and management of ecosystems
10:15-10:45	Break		
10:45-11:00	S5.08	D. Wang	Coastal upwelling in summer 2000 in the northeastern South China Sea observed by hydrographic, tide-gauge, sub-surface mooring and satellite measurement
11:00-11:15	S5.09	S. Corsi	Innovative use of naturalistic engineering techniques, vegetation and seagrass residuals for coastal sand dune protection and reconstruction
11:15-11:30	S5.10	B. Hasler	Integrated modelling of the social value of changes in atmospheric emissions and marine ecosystem goods and services
11:30-11:45	S5.11	R. Dobell	Web-enabled platforms for citizen science and computer-supported collaborative work in integrated coastal and marine spatial planning
11:45-12:00	S5.12	S.H. Mansoureh	Status of marine environment in the Strait of Malacca – A strategic assessment of vessel movements
12:00-12:15	S5.13	I.A. Kimirei	Status of the fisheries and physico-chemical environment of Lake Rukwa, Tanzania
12:15-1:00	Panel Discussion		
1:00-2:30	Lunch		
2:30-3:15	Conference overview & Summary		
3:15	Adjournment		



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*Oral Abstracts*

*In order of presentation*



## **S1.01**

### **KERNAN, M.**

Environmental Change Research Centre, University College London, Pearson Building, Gower Street, London WC1E 6BT, UK.

#### **Adaptive strategies to mitigate the impacts of climate change on European freshwater ecosystems**

Climate modelling studies indicate that even if greenhouse gases were stabilised at present levels, change is inevitable as the climate system adjusts to emissions that have already taken place. With emissions expected to rise until at least the middle of the century, stabilisation is likely to occur, if at all, at significantly higher levels than present. Understanding how freshwater ecosystems will respond to future climate change is essential for the development of policies and implementation strategies needed to protect aquatic and riparian ecosystems. Measures to restore freshwater ecosystems or to sustain priority species need to be designed to adapt to future climate change. There is a pressing need therefore to generate the scientific understanding that will enable such measures to be implemented successfully. Here we describe ongoing work to develop a system that will enable water managers to design cost-effective restoration programmes for freshwater ecosystems at the local and catchment scales, taking into account the expected future impacts of climate change and land-use change. The focus is on three principal climate-related and interacting pressures; i) increasing temperature; ii) changes in water levels and flow regimes; and iii) excess nutrients.

This ongoing work will improve the ability to predict the hydrochemical response of surface waters to land-use/management and climate change and the subsequent changes in aquatic ecological interaction. This will support restoration planning by allowing decision makers and managers to generate forecasts under different scenarios that incorporate alternative adaptive measures and enable optimum choices to be made that also acknowledge uncertainty and risk. The cost-effectiveness of alternative adaptive strategies will also be modelled and evaluated.



## S1.02

### GERDEAUX, D.

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#### **Impact and adaptation to climate change in Lake Geneva: Changes in the fish community and adaptation of the fishery**

Lake Geneva is a large and deep lake (580 km<sup>2</sup>, 309 m). It went through a period of eutrophication (t-P increased from 20 µg l<sup>-1</sup> to 90 µg l<sup>-1</sup>) between 1960 and the mid-70s, after which it has been improving. During the last 30 years, a lot of changes occurred in the lake such as: warming, re-oligotrophication, pollution, and fisheries management with an increase of stocking and sport fishery.

The mean temperature of Lake Geneva has increased by 2 °C during the last decades. The warming has had an impact on Lake Geneva's ecosystem. The phenology of phytoplankton and zooplankton is now one month forward in comparison to 30 years ago. The re-oligotrophication changed the structure of algae communities and the depth of the maximum of production.

Models show that the lake will be warmer at the end of this century with regular overturns re-oxygenating the deep water. The threshold of 7 °C will be exceeded in the second part of the century. Above this temperature, the reproduction of Arctic Char will be jeopardized. The recruitment of Arctic Char is negatively correlated with the temperature in the deep water in the lake.

At the same time, better water quality could contribute to better reproduction of fish such as Whitefish (*Coregonus lavaretus*) and Arctic Char (*Salvelinus alpinus*). The changes in the Whitefish fishery in Lake Geneva are very positive. The yield during the last few years hasn't been attained since over half a century ago. The climate change and the better water quality could contribute to a better recruitment of whitefish due to a better match between the dynamics of zooplankton and hatching time of whitefish. French commercial fishermen on Lake Geneva quickly adapted their fishing habits while the Swiss fishermen were slower to shift from perch to whitefish.



### S1.03

**HARPER, D.<sup>1</sup>, MORRISON, E.<sup>1,2</sup>, FOX, R.<sup>3,4</sup>, MACHARIA, M.<sup>5</sup>, NJOROGE, L.<sup>6</sup>, KYALO, M.<sup>7</sup>, MWINAMI, T.<sup>5</sup>, NDUNG'U, K.<sup>5</sup>, CHEGE, E.<sup>8</sup>, KIMINTA, E.<sup>4,9</sup>, STRANADKO, N.<sup>2</sup>, UPTON, C.<sup>2</sup>**

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#### **Lake Naivasha, Kenya: Threats, opportunities and adaptation**

Lake Naivasha is a globally-unique lake - freshwater in a chain of alkaline-soda lakes running along the floor of the Eastern Rift Valley. It not only supports world-renowned bird and mammal biodiversity, great scenic beauty but is also the source of Kenya's largest foreign exchange earner – the export of horticultural produce.

The ecosystem of the lake is dominated at each main trophic level – primary producer, consumer and primary predator – by alien species. The sum of all water abstractions for human uses is at least 50% greater than the lake can naturally sustain over the longer-term – domestic water for urban populations including Nakuru outside the catchment; geothermal power; upper-catchment agriculture and export horticulture.

The consequence of all these pressures is obviously a threat to the longer-term ecological state of the lake, yet it is also an opportunity. The main abstractors – domestic water, power and horticulture – have high economic value which could be recycled as Payment for Ecosystem Services (PES) schemes. Improvements to the state of the lake as a result of these opportunities will come against the impacts of climate change manifest as hydrological changes. We finally review the adaptations that will be necessary in the future, to ensure that the opportunities are not lost against the increasing threats of climate change.



## S1.04

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### **Impact of climate change on the hydrology and the sponge population of the shallow Lake Trasimeno (Umbria, Italy): History, forecasting and management**

Lake Trasimeno is a shallow lake of a remarkable naturalistic relevance. The strict dependence of the water balance on meteorological conditions has caused dramatic floods and droughts over the centuries, and numerous interventions have been made in order to regulate the lake level since Etruscan or Roman times. The “Lake Trasimeno problem” still remains unsolved, because the regulation works and restriction rules recently adopted seem to be ineffective in the current climate change phase. The present study analyses past and future scenarios of management of the water resource, with the aim of identifying effective strategies limiting the fluctuations of the lake level and maintaining water quality at a suitable condition for the established biological community.

On the basis of long-term data series, a hydrological model was developed, which incorporates the climate forcing and the water regulation policies adopted in past and present times. Future scenarios of water level change were also simulated taking into account possible future interventions, such as those involving water withdrawals from two dams located within the Upper Tiber River basin. Future changes of some water quality variables (temperature, total dissolved and suspended solids) were also predicted on the basis of historical trends and models previously set up for Lake Trasimeno. Finally, on the basis of *transfer functions* previously developed in a paleolimnological study, scenarios of change were delineated for the sponge population of the lake (*Ephydatia flu viatilis*) as a function of the predicted water level changes.

The pilot simulations indicate that, without mitigation, more frequent drought periods and a progressive worsening of the water quality will take place in Lake Trasimeno in the next decades, and recommend that an eco-hydrological management be planned for the conservation of the waterbody.

The research was financially supported by National funds F.I.S.R. within the M.I.C.E.N.A. project



## S1.05

### **GHAVAM MOSTAFAVI, P., SHOKRI, M.**

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#### **Are symbiotic algae on Iranian corals resilient to climate change?**

Zooxanthellae are symbiotic algae essential to the survival of coral reefs. They belong to the genus *Symbiodinium* and provide oxygen and other nutrients to the coral polyps. The polyps give the algae the carbon dioxide they need to survive. There are eight genetics clades of *Symbiodinium* (A to H). *Symbiodinium* and their coral hosts are sensitive to environmental stresses including high and low temperatures; hence climate changes impact coral reefs direct and/or indirectly. Diverse *Symbiodinium* types probably have differing physiology and this may play an important role in the survival of corals. Identifying to what extent different clades of zooxanthellae are susceptible to climate change is so important. For this purpose different coral species were collected from Kish, Larak, Hengam and Farur Islands in the northern part of the Persian Gulf. Partial 28S nuclear ribosomal (nr) DNA of *Symbiodinium* were amplified by Polymerase Chain Reaction (PCR) and then PCR products were analyzed by phylogenetic analyses of the LSU DNA sequences based on PAUP 4.0 and Clustal X software. This study showed that clade D is a dominant clade of *Symbiodinium* in the northern part of the Persian Gulf. The fact that a wide range of coral genera from Kish, Hengam, Farur and Larak Islands possess this clade may provide optimism to the future maintenance of coral diversity in Iranian coral reefs in the face of global warming.



## **S1.06**

**UDDIN, S.<sup>1</sup>, GEVAO, B.<sup>1</sup>, AL-GHADBAN, A.N.<sup>1</sup>, NITHYANANDAN, M.<sup>2</sup>**

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### **Evidence of acidification in Arabian Gulf**

The detrimental effects of increasing atmospheric levels of carbon dioxide (CO<sub>2</sub>) and other green house gases since the industrial revolution has led to a concerted international effort to control their release and abate the environmental and human health impacts. CO<sub>2</sub> is removed from the atmosphere by photosynthesis of plants in the terrestrial environment and by aquatic sequestration. In the Middle East and other arid countries, terrestrial removal is minimal. The most likely removal pathway for CO<sub>2</sub> in arid regions around the world is by aquatic sequestration. In the Middle East the major sink is the Arabian Gulf which leads to acidification of the marine environment. Biweekly pH concentration measurements in surface waters of the northern Arabian Gulf over a four year period in this study suggests that the Arabian Gulf waters are getting acidic with time. Supporting evidence for increased CO<sub>2</sub> sequestration comes from increased marine primary productivity over the past decade. Biological effects, like coral bleaching, observed during this period suggests that urgent action is required to reverse the trend and protect marine life. The data highlights the fact that this semi-enclosed sea is undergoing a rapid degradation that might affect the oceanic chemistry and biogeochemical cycle much earlier than predicted for most oceanic waters.



## **S1.07**

**MA, R.<sup>1</sup>, DUAN, H.<sup>1</sup>, LOISELLE, S.<sup>2</sup>, HU, C.<sup>3</sup>**

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<sup>3</sup>College of Marine Science, University of South Florida, 140 Seventh Avenue South, St. Petersburg, FL 33701, USA.

### **China's lakes: The present and the past**

Lakes constitute an important component of the terrestrial hydrosphere and are sensitive to climate change. Lakes are affected by both climate change and anthropogenic activities, making them significant indicators of global driver and regional response. We used 11004 CBERS CCD and Landsat TM/ETM images mostly acquired in 2005-2006 to extract the spatial distribution of all lakes in China, following pre-established interpretation rules. The corresponding information from digital raster images ((1:100000 and 1:50000)) and digital vector dataset (1:250000) were used to support the interpretation of lake boundaries. The result shows that there are presently 2693 natural lakes in China with an area greater than 1.0 km<sup>2</sup>, excluding reservoirs. These lakes are distributed in 28 provinces, autonomous regions and municipalities and have a total area of 81414.6 km<sup>2</sup>, accounting for ~0.9% of China's total land area. In the past 30 years (1960s-1980s), dramatic changes are found in both lake number and lake size; of these, 243 lakes vanished mainly in the northern provinces (and autonomous regions) and also in some southern provinces while 60 new lakes appeared mainly on the Tibetan Plateau and neighboring provinces. The reasons why there is a large heterogeneous distribution in lake changes are given; however, they are needed to be confirmed further.



## S2.01

### TRANVIK, L.

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#### **Aquatic carbon dynamics: local processes with global implications**

Inland waters receive large amounts of organic carbon (OC) from surrounding terrestrial ecosystems, largely in the form of dissolved organic carbon (DOC). A large fraction of this OC is mineralized in lakes, resulting in methane and carbon dioxide emissions, and the rest is either stored in the sediments over geological timescales, or transported downstream towards the sea. Recently, it has been shown that these processes result in fluxes of importance in the global carbon cycle. It is therefore important to understand what regulates OC cycling in inland waters, and how the inland water carbon cycle may change with climate and anthropogenic influence.

This presentation will give an overview of the constraints on the metabolism of OC in inland waters, and how they may shift in the future; e.g. temperature effects on the mineralization of OC, and the effects of impoundments on the retention of carbon on the continents. In addition, I will present an attempt to upscale from local processes to the global inland water carbon cycle, and discuss the importance of different processes and fluxes.



## S2.02

### **AZZARO, M., LA FERLA, R.**

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#### **Carbon remineralization in the Mediterranean Sea**

The enhancement of the natural Greenhouse Effect has been tempered by oceanic uptake/sequestration of CO<sub>2</sub> in the deep oceanic waters, which accounts for nearly a third of anthropogenic carbon added to the atmosphere. In fact, topical studies have supported the significant role of the oceanic biological pump and continental shelf pump with respect to the atmospheric CO<sub>2</sub> build-up.

In this context, the Eastern Mediterranean Transient (EMT) event resulted as a particular case of a continental shelf pump that has significantly affected deep respiration, firstly in the Ionian Sea, and afterwards in all the Mediterranean Sea.

With the aim of evaluating the effect of EMT spreading throughout the Mediterranean and its impact on the microbial compartment, in October-November 2004 a trans-Mediterranean cruise was performed, spanning longitudinally from the Gibraltar Strait to Creta Island. The study of prokaryotic biomass and respiratory rates (ETS) from surface to bottom depth was carried out and particular emphasis was given to the deeper layers.

Prokaryotic abundances and respiration classically decreased with increasing depth. The longitudinal patterns of the prokaryotic cell abundance along the Mediterranean showed statistically different distribution between Western and Eastern basins at all layers with high values in the Western basin and a decreasing Eastward trend, in accordance with the well-known Mediterranean trophic gradient. On the contrary the cell sizes enhanced Eastward and with depth. Different patterns in respiration were observed in the Western and Eastern basins due to both the circulatory pathway of water masses and the trophic gradients existing on the whole Mediterranean basin.

In this context, both the prokaryotic abundances and respiratory rates seem to be suitable markers to describe the variability in the dark deep waters of the Mediterranean Sea.



## S2.03

### POLLARD, P.C.

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#### **The link between aquatic microbial respiration, forests and atmospheric carbon dioxide — small bugs with a global impact**

In aquatic ecosystems, bacteria are responsible for the bulk of the aerobic respiration. So they generate most of the  $\text{CO}_2$  from these wet environments. I spent 6 months in Central America and in the protected temperate boreal forests of Massachusetts (USA) measuring aquatic microbial respiration in two major freshwater lakes. After making over 300 direct measurements of the rate that freshwater microbes use dissolved oxygen, I was able to compare aquatic microbial respiration with the gross primary forest production in their respective watersheds. Forest production was estimated from tree leaf production and also from Eddy Flux Towers (less plant respiration) that were collected over several years by other researchers. Here I will show aquatic microbial respiration in freshwater can return large amounts of the organic carbon from temperate boreal and tropical forests to the atmosphere as  $\text{CO}_2$ . As global temperatures rise, forest respiration is increasing, but much plant production also appears to be lost to microbial respiration in the nearest water body. The amount of  $\text{CO}_2$  major lakes and rivers returned to the atmosphere equates to that fixed by the oceans.



## S2.04

**BRACCHINI, L., A.M. DATTILO, RICCI, M., TOGNAZZI, A., ROSSI, C., LOISELLE, S.A.**

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### **An alternative way to analyze the shape of CDOM absorption curve**

Chromophoric dissolved organic matter (CDOM) makes up the most important UV (290-400) absorbing compounds in aquatic ecosystems. One of the most useful approaches to examine photochemical and biological changes in the chemical composition of CDOM is the estimation of the exponential slope of the spectral absorbance at different wavelength ranges. However, the underlying assumption behind the spectral slope calculation is that the CDOM absorption curve follows an exponential decay. However, due to the complexity of CDOM composition, the validity of this approximation is often weak. In the present work, we introduce an alternative method to analyse the CDOM absorption curve that does not require the hypothesis of exponential decay. The proposed method is used to analyse the variability of photodegradation rates in coastal ecosystems where CDOM plays an important part in optical conditions. The results provide additional evidence of the spectral variability of slope and indicate the spectral region in which photodegradation of CDOM is most sensitive to change.



## S2.05

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### **Modelling the photochemical fate of organic pollutants in surface waters: Transformation kinetics and occurrence of intermediates**

The phototransformation processes of organic pollutants in surface waters include direct photolysis of sunlight-absorbing molecules and indirect transformation reactions with transient species, such as the radicals  $\bullet\text{OH}$  and  $\text{CO}_3^{\bullet-}$ , singlet oxygen ( $^1\text{O}_2$ ) and the excited triplet states of chromophoric dissolved organic matter,  $^3\text{CDOM}^*$ . These species are produced by photosensitisers such as CDOM, nitrate, nitrite and, often to a lesser extent, Fe(III). The photochemical transformation rates depend on sunlight irradiance, water chemical composition, absorption spectrum and column depth, which together determine the generation rate of the reactive transients, and on the intrinsic reactivity of the pollutants toward each pathway. The intrinsic reactivity is measured by the direct photolysis quantum yield and by the rate constants of the indirect processes. It is possible to foresee the photochemical transformation kinetics of organic pollutants in surface waters by means of models that take into account all the variables cited before.

The direct photolysis quantum yield and the reaction rate constants with  $\bullet\text{OH}$ ,  $\text{CO}_3^{\bullet-}$ ,  $^1\text{O}_2$  and  $^3\text{CDOM}^*$  can be measured by means of dedicated laboratory experiments, which can make use of  $\text{H}_2\text{O}_2$  or nitrate as  $\bullet\text{OH}$  sources,  $\text{NaNO}_3 + \text{NaHCO}_3$  to produce  $\text{CO}_3^{\bullet-}$ , Rose Bengal for  $^1\text{O}_2$  and suitable model molecules as proxies of CDOM. Anthraquinone-2-sulphonate can be a useful CDOM proxy because its UV irradiation induces the formation of a reactive triplet state without yielding  $^1\text{O}_2$  or  $\bullet\text{OH}$ . From the kinetic data obtained in the laboratory it is then possible to foresee the transformation kinetics of a molecule as a function of the environmental variables. It is also possible to foresee the formation rates of the intermediates, provided that their yields of production via the different photochemical reaction pathways are known. Some examples are provided, together with comparisons with the available field data.



## S2.06

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<sup>3</sup>Centro Ricerche per lo Studio delle Relazioni tra Piante e Suolo, Via della Navicella, 2 – 00184 Roma

### **A systems ecology approach model for dissolved oxygen dynamics in coastal lagoons**

Dissolved oxygen is an essential element for aerobic communities living in aquatic natural systems as it is involved in all metabolic processes. However, despite analysis of the evolution of dissolved oxygen in aquatic ecosystems over time and space, we find that many aspects of its' dynamics are still unclear. Experimental measures, on different time scales, show first a seasonal dynamic, peaking in the coldest part of the year and with its lowest values in the warmest; a second diel dynamics with highs during the most irradiated hours of the day and lows shortly before dawn. More recent studies have also found additional sub-daily periodicities. The seasonal and daily patterns are well known in the literature. The sub-daily periodicity has been poorly analyzed, often because periods shorter than one hour are seldom measured in routine ecological studies. In fact, an integrated theory on short-time dissolved oxygen dynamics is lacking. Dissolved oxygen dynamics lead back to an overall process that can be summarized as follows:

- physical processes of aeration and de-aeration at the air-water interface layer, during which further processes of advection and diffusion together with hydrodynamic circulation are active to assure all dissolved gasses are transported along the water column;
- biochemical processes, including photosynthesis production, respiration and organic matter degradation consumption in the water column and in the sediments.

In the last decade, new developments in ecological modelling have contributed significantly to our understanding of dissolved oxygen dynamics, in particular forecasting models which include the indirect impacts of biogeochemical processes. Notwithstanding, the substantial efforts made in formally representing these phenomena, the dynamics of dissolved oxygen in shallow water ecosystems remain difficult to simulate with accuracy. In the present study, we use a systems ecology perspective to develop a dissolved oxygen model for shallow water systems that includes underestimated processes and feedback loops. One such process is physical re-aeration, governed by wind regime. Rather than focusing on chemical equilibrium, we include the possibility of wind induced super-saturation in the upper layers of shallow water bodies. We propose an empirically based quantification of photorespiration in relation to light availability and we include the oxygen requirement of sediments related to organic matter microbial degradation. Field experiments in a shallow coastal lake were used to validate the model and simulations were performed in relation to changing climate conditions.



**S2.07**

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### **The role of DOC in C export in the Mediterranean Sea**

Dissolved organic carbon (DOC) represents the largest, the most complex and the least understood reservoir of organic carbon on the Earth. Seven years (2001-2008) of DOC vertical profiles were studied in order to assess the role of DOC in C cycle in the Mediterranean Sea. In the deep waters (DW), DOC distribution was strongly affected by DW formation, with a significant increase to values of 76  $\mu\text{M}$  in recently ventilated DW and low concentrations, comparable to those observed in the open oceanic waters (34-45  $\mu\text{M}$ ), where the oldest DW occurred. In the intermediate layer, the main path of the Levantine Intermediate Water (LIW) was followed in order to estimate the DOC consumption rate in its core. Multiple regression between DOC, apparent oxygen utilization (AOU) and salinity indicated that 38% of the oxygen consumption was related to DOC mineralization. In DW of the southern Adriatic Sea a DOC decrease of 6  $\mu\text{M}$ , together with an AOU increase of 9  $\mu\text{M}$ , was observed between the end of January 2008 and the end of June 2008. These data indicate a rate of microbial utilization of DOC of about 1.2  $\mu\text{M C month}^{-1}$ , with 92% of the oxygen consumption due to DOC mineralization. These values are surprisingly high for DW and represent a peculiarity of the Mediterranean Sea. Finally in order to quantify the DOC export from the surface below the mixed layer, the DOC data collected in the Southern Adriatic Sea during six cruises in the period 2006-2008 were studied. Surface DOC distribution was strongly affected by the stratification of the water column. The highest DOC values were observed in the late summer/fall period. The DOC that escapes remineralization and accumulates in the mixed layer is exported from the surface the following winter. This export was estimated to be of 3-5  $\text{g C m}^{-2} \text{y}^{-1}$ .



## S2.08

**FROHN, L.M., HANSEN, K.M., HASLER, B., GROSS, A., GEELS, C., CHRISTENSEN, J.H., BRANDT, J., SKJØTH, C.A., HEDEGAARD, G.B., HANSEN, A.B., ZARE, A.**

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### **Nitrogen deposition to the Baltic Sea – who are the main contributors?**

In the Baltic Sea Action Plan (BSAP), the countries around the Baltic Sea have agreed to take action to reduce the input of nitrogen and phosphorus to the Baltic Sea to restore the good ecological status of the Baltic marine environment by 2021. A reduction of 15.25 kt of phosphorus and 135 kt of nitrogen is required to fulfil the BSAP, and the countries have agreed to share the nutrient reduction burden through a country allocation scheme. Only reductions in land based sources were included in the current BSAP. However, a balanced and strategic approach to control both nitrogen and phosphorus from all major sources is recommended. In the Baltic Sea, the atmosphere accounts for approximately 25% of the nitrogen input, and furthermore the retention time of the nitrogen input via the atmosphere is much shorter compared to land based input. Due to this, the atmospheric contribution will be included in the next BSAP. A quantification of the current and future atmospheric nitrogen deposition is therefore important, especially when the main contributing countries and emission sectors need to be identified, since different technical and political measures apply to different emission sectors.

We have calculated the nitrogen deposition to the Baltic Sea based on actual emissions for the year 2007 using the Danish Eulerian Hemispheric Model (DEHM). In a series of model simulations the contribution from each country around the Baltic Sea to the deposition of nitrogen to the Baltic Sea is calculated by applying a tagging method. These results show that Germany, Poland, Denmark and Russia are the top four contributors of nitrogen to the Baltic Sea. Similarly a series of model simulations have been performed to identify the contribution from each emission sector.



## H.01

### Price, A.R.G.

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#### **Robustness-resilience in marine ecosystems and measures of health assessment**

Disturbances to coastal ecosystems are limiting the flow of goods and services that have sustained societies for millennia. Unexpected phase shifts from coral dominated reefs to an alternative stable state of algal overgrowth are one example. Robustness-resilience concepts are a valuable proxy for ecosystem health, and also a desirable feature of assessment metrics. Here we examine some approaches for capturing robustness, and highlight ecosystem assessment methodologies that are robust against disparities in observer skill and/or resolution of information. A probabilistic, spatially explicit metric of robustness recently developed for reefs, using coral cover data, provides information about robustness to disturbance in general, and to specific disturbances (e.g. dredging, sedimentation, climatic events). Its use could be extended to  $\beta$ -diversity, a signature of spatial heterogeneity, which in turn is a cornerstone of resilience and may provide insurance against ecological uncertainty. Additionally, the robustness metric could potentially utilize data on the balance of 'good' to 'bad' colonisers of coral reefs, or other features of functional groups. Potential complementary approaches include use of power laws to graphically portray robustness determined from the relationship between the magnitude of disturbance event(s) and frequency of occurrence. The slope of resulting curves may provide insights into robustness, so that the sensitivity of different coastal systems and regions may be compared and conservation actions prioritized. 'Taxonomic' measures of  $\beta$ -diversity seem more robust to uneven sampling effort than many commonly used 'species' indices. Semi-quantitative information on species/ecosystems and disturbances, derived from 'rapid environment assessment' and questionnaire surveys, can also be a robust and surprisingly effective means of assessing coastal health and environmental change. Ecosystems are degrading at a faster rate than our ability to develop coherent robustness-resilience concepts and to implement what we know.



## H.02

### **KRUPP, F., SCHNEIDER, W., AL-JABER, K.H.**

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#### **Freshwater biodiversity conservation in the Arabian Peninsula**

Lying in the Afro-Asian desert belt, hyperaridity prevails in the Arabian Peninsula, a subcontinent with a landmass of three million square kilometres. Permanent rivers are restricted to mountainous areas in the western and southern parts of the peninsula, while ephemeral water bodies and artesian springs prevail in the rest of the region. During the Miocene, Arabia was inhabited by a diverse Afrotropical freshwater fauna, which impoverished with increasing aridity. Many taxa colonized the area during the recent geological past. About 500 species of freshwater invertebrates have been recorded, but this is only a fraction of the actual species richness. Endemism is high, amounting to more than 50% in Ephemeroptera, Trichoptera, and several families of Diptera. Odonata, the best-known insect taxon, is represented by about 64 species. Arabia is home to 16 endemic species of primary freshwater fishes, two secondary freshwater fish species, two species of marine origin, two anadromous species, and several marine species inhabiting inland waters. Main threats include uncontrolled development associated with water abstraction, pollution, introduction of alien species and habitat fragmentation. There is a lack of awareness and existing laws are inadequately enforced. The present human-induced threats are aggravated by climate change. Conservation measures must focus on ecosystem management and enhancement of resilience, and be based on research, assessment and monitoring. Conservation measures must include the establishment of protected areas designed to conserve freshwater habitats, captive breeding programs, engagement of local communities to raise public awareness, and improving environmental legislation and enforcement. There is an urgent need to establish a regional biodiversity research institute and natural history museum.



## **H.03**

### **VAN DER KNAAP, M.**

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#### **Biodiversity on the African Great Lakes, may we eat it?**

Some of the characteristics of the African Great lakes are the numerous species of fish, crustaceans, mollusks, plankton species, and other phyla, most of them endemic. The usual sources of perturbation when speaking about Great Lakes also have their impacts on the African Great Lakes, like overfishing, dumping of untreated sewage, pebble and sand mining, agricultural run-off, and other threats. Should this biodiversity be protected in times of sheer poverty of the riparian populations? What are the values of these endemic species in economic terms? This paper is reviewing the impacts on biodiversity by man-induced factors like exotic fish introductions and the invasive water hyacinth, but also by indirect factors like climate change. Lake Victoria has a long history of fish introductions and invasive weeds, but on Lake Tanganyika the original species composition of many taxa can still be preserved and protected, at a cost. The Great Lakes' surrounding countries, by means of conventions and regional management bodies, sought to protect the environments and called for international assistance to improve management of the natural resources, both terrestrial and aquatic. The way forward will be to involve local fishing communities in nature conservation and management, but there are many communities and many fishermen. How to reach them in areas where there is no municipal electricity supply, no GSM network, or other means of IT possibilities. In the 21st century, around the African Great Lakes the keyword is survival, not only of biodiversity, but also of the inhabitants of their basins.



### S3.01

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#### **Adaptations and responses of the biota of alpine lakes to environmental changes**

Alpine lakes (i.e., above the treeline) are ecosystems where organisms live under a delicate balance as a consequence of harsh environmental conditions such as low water temperatures, high UV radiation, and low nutrient/food concentrations. Although alpine lakes are not even considered in water protection and management policies, they are excellent sentinels of different global changes. In many alpine lakes, important man-made changes in biodiversity already started ca. 500 years ago, when keystone species such as *Daphnia* disappeared due to the first unintentional biomanipulation. However, the sensitivity of these ecosystems to different global changes has the potential for further alteration in species composition. In this talk, I will first show environmental changes taking place across the altitude gradient which are crucial to understanding adaptation strategies in planktonic organisms, for example, to live in a high UV environment. Then, I will give examples of the response of the microbial community to expected changes in bottom-up variables in these ecosystems, such as DOM composition. Finally, I will discuss important environmental changes expected to alter the species composition in these ecosystem. Among them, the increase in atmospheric deposition rates of nitrogen is an important global change resulting in the replacement of algal species. In addition, we have recently uncovered a connection between this global change and the ability of planktonic organisms to efficiently protect against the damaging effects of UV radiation. Climatic warming is also accelerating changes in water turbidity and in other physicochemical factors of glacier lakes with clear alterations in plankton composition. Finally, another threat is arising from high nickel concentrations in alpine lakes influenced by rock glaciers with values sometimes exceeding the threshold for drinking waters. At present, the consequences for biodiversity and ecosystem function are poorly understood.



### S3.02

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#### **The importance of the microbial food web in tropical lakes: Facts, hypothesis and speculations**

Most breakthroughs in limnology took place in temperate regions. Long-term studies are not common in tropical regions, despite the number of large tropical lakes that aggregate a large proportion of global freshwater resources. Comparative studies have shown that tropical lakes present some unique features. Constant high temperature and radiation have strong consequences in stratification and in biological processes, such as higher primary production on a given nutrient base, or low efficiency in passing primary production to the highest trophic levels, comparing to lakes at higher latitudes.

There are few data available on the microbial processes in tropical lakes. Still, the compilation of these data revealed unexpected features in trophic food web functioning. In tropical lakes, for a given level of chlorophyll *a*, bacterial production and abundance are comparable (and probably lower) to those of temperate lakes. Our observations indicate that the proportion of primary production attributed to picophytoplankton throughout the year is higher in tropical lakes. Additionally, recent studies in Lake Tanganyika showed that herbivory by protists is a major carbon flow. Despite the low number of studies available, it is probable that the microbial food web carries a larger fraction of the carbon flow in tropical lakes than in temperate systems, and these differences would be related to the phototrophic fraction of the picoplankton.



### S3.03

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#### **Phenology of phytoplankton growing season in the global ocean**

In recent years, phytoplankton phenology has been proposed as an indicator to systematically monitor the state of the pelagic ecosystem and to detect changes triggered by perturbation of the environmental conditions. Here we describe the phenology of the phytoplankton growing season for the world ocean using remote-sensing ocean colour data, and analyse its variability between 1998 and 2007. Generally, the tropics and subtropics present long growing season (~15-20 weeks) of low amplitude ( $< 0.5 \text{ mg Chl m}^{-3}$ ), whereas the high latitudes show short growing season ( $< 10$  weeks) of high amplitude (up to  $7 \text{ mg Chl m}^{-3}$ ). Statistical analyses suggest a close coupling between the development of the growing season and the seasonal increase in insolation in the North Atlantic and Southern Ocean. In the tropics and subtropics, variability in light is low, and the growing season is controlled by nutrient supply occurring when mixing increases. Over the decade 1998-2007, the duration of growing season shows positive anomalies following the major 1997-98 El Niño-La Niña events. As the anomalies decrease with succeeding years, negative linear trends in duration ( $- 10\% \text{ yr}^{-1}$  on average) are observed over a large fraction of the ocean. Higher Sea-Surface Temperature (SST) over the duration of the growing season is associated with longer duration at high-latitudes indicating an extension of the growing season over summer months. The opposite is observed in the tropics and subtropics, where the duration is shorter when the SST is higher, indicating increased stratification. Positive phases of North Atlantic Oscillation and Southern Annular Mode and negative phases of Multivariate ENSO Index, associated with enhanced water mixing and nutrients supply, generally sustain longer growing season. On the basis of the results, perspectives are drawn on the utility of phenology as an organising principle for the analysis of pelagic ecosystems.



### S3.04

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#### **The contribution of benthic cyanobacteria and algae to the definition of spring types as a prerequisite for the development of ecological-integrity and environmental-quality assessment procedures for spring habitats**

Springs are special habitats that host a rich biodiversity. However, they are endangered mainly because of tapping to gain drinking water. This impact is likely to increase because of the predicted reduction in precipitations. Epilithic cyanobacteria and algae are probably the most widespread photoautotrophic organisms in mountain springs beside bryophytes and lichens. Cyanobacteria comprise several macroscopic taxa as key elements of the biota which can be evaluated directly in the field. CRENO DAT (2004-2008) is a comprehensive project that was carried out in the south-eastern Alps (Autonomous Province of Trento). 110 springs were sampled, located over a wide range of altitudes and on a variety of lithologies. All main morphological spring types (from helocrenes to rheocrenes) were considered. Results gained during CRENO DAT and several other spring investigations suggested that bioassessment procedures should be habitat-type specific and adapted for the different geographic areas (in the case of springs, this is necessary both because of distributional patterns of some organisms and of the uneven geographical distribution of morphological spring types). In Europe, the Water Framework Directive promotes bioassessment methods in which the actual situation of aquatic environments is compared to reference situations. Therefore, the definition of spring types based on one or several groups of organisms is a fundamental pre-requisite to develop assessment methods. Hence the main goals of this paper are: to provide an outline of the assemblages of diatoms and macroscopic benthic algae (including cyanoprokaryotes) found in the main morphological spring types using fuzzy clustering; to determine the most influential environmental factors using multivariate analyses; to discuss autecological traits; and, to discuss the species richness and diversity of spring habitats. We are convinced that the bioassessment methods that we are developing for spring habitats should address not only quality issues but also ecological integrity and relevance for aquatic biodiversity conservation.



### S3.05

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#### **Occurrence of harmful algal blooms (HABs) in the coastal water of Oman as a threat to marine resources of the Sultanate of Oman**

The extensive coastline of the Sultanate of Oman has shaped the country's culture, economy, history and its people for millennia. Today, even with an oil-driven economy, coastal marine resources are still of great economic importance and continue to influence and sustain the lifestyle of the people of Oman. Marine living resources along the coast of Oman provide abundant food and opportunities for tourism and recreation. Unfortunately, the continuous pressure of development threatens this marine environment primarily via over-fishing, global climate change, habitat modification and destruction and coastal zone pollution. One of the clear indications on the changes happening in the coastal water of Oman is the frequent occurrence of the harmful algal blooms.

The Arabian Sea and Sea of Oman experienced devastating Harmful Algal Blooms (HABs) in 2008 that caused massive kills of marine organisms and had significant economic impacts on desalination plants and tourism. Over the past 10 years these outbreaks have been on the rise and the forces contributing to more frequent blooms are still unclear. One of the limitations has been the lack of a dedicated monitoring program, and a systematic multivariate sampling strategy along the coast and offshore waters at regular time intervals. As a consequence, the region is poorly investigated in terms of seasonal and inter-annual variability of phytoplankton communities, and their related driving forces. We have been collecting data from monitoring sites in the coastal areas that will not only provide us with baseline data necessary for future studies on anthropogenic impacts on this ecosystem but also a better understanding of the seasonal and interannual changes associated with monsoonal forcing. In this paper we address the seasonal monsoonal cycle and its impact on the biology of the coastal waters and use our findings to arrive at conclusions about how variability in phytoplankton and its environment could impact the food chain of this ecosystem.



### S3.06

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#### **Bayesian network model of *Anabaena* blooms in Grahamstown Lake**

Grahamstown Lake is an off-river storage supply for the city of Newcastle, Australia. It has an average depth of 7 m and surface area 28 km<sup>2</sup>. It has a catchment area of 100 km<sup>2</sup> which generates half its water, with the remainder being pumped from the Williams River. The conventional water treatment processes, including powdered activated carbon dosing, does not completely remove Saxitoxins which may be released from *Anabaena* blooms in the lake.

Since the lake has experienced an increase in *Anabaena* blooms over the last 20 years, a number of investigations have been undertaken. Previous modelling of water quality in Grahamstown Lake has used traditional process-based methods. Because there is very little data relative to the complexity of the system, these models could not be rigorously calibrated to generate accurate predictions and have been ineffective for decision-making purposes.

This paper describes the development of a data-driven decision-focused Bayesian network model for Grahamstown Lake. In the first stage of the development, all available data were massaged into a consistently formatted database from which the model could 'learn' probabilistic relationships between model elements such as pumped nutrient load, lake water column nutrient concentrations, *Anabaena* concentrations, etc. This stage produced useful insights into ecosystem relationships and provided a basic model for later stages. The first stage model was static and took no account of the system dynamics. The stage 2 model used the data sequentially and predicted *Anabaena* concentrations a few weeks into the future, following management interventions. The probabilistic nature of the model informs rational consideration of the uncertainty of predictions in this complex system.

The paper describes the Stage 1 model structure and modelling outcomes and preliminary Stage 2 dynamic modelling.

Future development of the model will involve formal expert elicitation of conditional probabilities to strengthen components of the model for which there is little data available at this time.



**S3.07**

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**Fishes in a brackish sea: The fauna of the Sea of Azov**

The Sea of Azov is a unique marine waterbody from many points of view, despite its small size. It may be considered as a peripheral waterbody of the Black Sea and/or the vast brackish estuary (“liman”) of the River Don, i.e., the mixing zone of fluvial and Black Sea waters. Low water salinity is the main reason for relatively low diversity of flora and fauna while shallow water, high summer temperature, large input of organic and minerals with river influx, and some other factors lead to very high biological productivity. Virtually the entire Azov Sea area, with few exceptions, represents an extended feeding ground, both for adult fish species and their juveniles. The deltas of rivers entering the Azov Sea, such as the Don and the Kuban, serve as spawning grounds for anadromous and semi-anadromous fish species. Some 120 species and subspecies from 40 families occur in the Sea of Azov. The most distinctive specific feature of the Sea of Azov fish fauna is its ecological and historical complexity. According to their origin, there are freshwater species, Ponto-Caspian relicts, Atlantic-Mediterranean migrants, and several non-indigenous species introduced in recent time. From a taxonomic point of view, the most diverse are families Cyprinidae and Gobiidae (20.9 and 17.4%, respectively). In relation to water salinity, fish fauna of the Azov Sea includes representatives of all ecological groups: anadromous, semi-anadromous, freshwater, brackish water, and marine species. This presentation overviews the Sea of Azov fisheries, providing some historical and modern statistical data. Some conclusions are made for conservation of the Sea of Azov unique fish fauna and restoration of sustainable use of its resources.



### S3.08

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<sup>4</sup>Laboratoire d'Ecologie Fonctionnelle ENSAT, Toulouse, France.

#### **Multispecific approaches for the management of African fisheries: Similarity and geographic differences the cases of Benin and Rwanda**

Within a comparative research program on the lakes of Rwanda and lagoons on Benin, we tried to identify key issues for the fisheries management of these ecosystems which experience strong human influences outside fisheries. The Ecosim software which is part of the Ecopath package helped to obtain some preliminary answers. Control and limitation of predatory fish populations would be obtained by a fishing system which would specifically target them; whereas, low fish populations of lower trophic levels would be properly taken care of by improving ecological water conditions. This last point is particularly important in all western African lagoons which are close to heavily populated large cities.



### S3.09

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#### **Brachyuran crabs: Their systematic account and decoration behavior in the Suez Canal-the connecting link between the Red Sea and Mediterranean**

Suez Canal is the main connecting link between the Red Sea and the Mediterranean. On its route from the Red Sea in the south to the Mediterranean in the north, it crosses different lakes which represent different habitats and in some cases hinder the migration activity of the faunal community from one sea to the other. Brachyuran crab species were collected from the Suez Canal during the period from June 2005 to July 2007. Regular bimonthly trips were carried out to the best known six landing sites along the Suez Canal. Catches were examined and sorted at each site and the occurrence of the different species was recorded. Ten species of brachyuran crabs belonging to 10 genera and seven families were surveyed. All of all are represented in the Red Sea and/or Mediterranean; though not always by the same species. In contrast with other brachyuran crabs collected from the Suez Canal, the spider crabs of the family Majidae frequently have the integument densely covered with an assortment of plants and animals, both living and dead. This behavior was absent in other brachyuran crabs collected. The diversity, abundance, spatial distribution of epibionts colonizing *Hystanus hilgendorfi* and *Schizophrys aspera* and the important factors that affect the level of decoration in both spider crab species were discussed. The widespread use of less edible materials (macro-epibionts) for masking purposes suggests that these two crab species use their mask primarily for camouflage purposes.



### S3.10

#### **LAPPALAINEN, J., VINNI, M., MALINEN, T.**

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#### **Growth and consumption of pike (*Esox lucius*) stocked in a lake with frequent winter hypoxia**

Lake Savijärvi is a small (40 ha) and shallow lake (max. depth 2.5 m) situated in the southern Finland. It is clay-turbid and highly eutrophicated, with frequent algal blooms during summers and fish kills during winters. Therefore, the fish fauna consisted only of extremely abundant Crucian Carp (*Carassius carassius* L.), and of a few individuals of roach (*Rutilus rutilus* (L.)) and tench (*Tinca tinca* L.). During the spring of 2008, 99 individually marked pike (*Esox lucius* L.) (mean weight 708 g and length 47 cm TL), 11000 newly hatched larvae and 230 juvenile pike were stocked in Lake Savijärvi. Our main aim was to analyse the growth and consumption of pike, while the longer term objective was to reduce the abundance of Crucian Carp, and to improve the water quality of the lake. The fish sampling showed that of 99 marked pike, 20 were caught at least once during the three-year study period. In 2009, sampling also showed that some of the 2008 stocked larvae and juveniles survived. The marked pike also spawned for the first time during the spring 2009, based on the catches of age 0 juveniles in the same autumn. Notably, all caught pike showed exceptionally good growth when compared with other Finnish lakes. During the three-year study period, Crucian Carp catches decreased from 243 kg to 136 kg per hectare, and pike catches increased from 0.1 kg to 5.7 kg per hectare. At the same period, the total consumption of all caught pike (marked and non-marked stocked pike, and those born in the lake) was estimated to be 912 kg, or about 23 kg per hectare.



### **S3.11**

#### **NAMISI, P.W.**

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#### **A comprehensive assessment of Yemen's marine fisheries sector**

The Comprehensive Assessment of the Yemen Fisheries Sector was undertaken from October to November 2010 as part of the process for the development of the National Fisheries Sector Strategy. Yemen has extensive territorial waters and marine resources that stretch across a coastline of 2,520 km<sup>2</sup>. The coastline has a total of 552,669km<sup>2</sup> Exclusive Economic Zone, including significant areas of the region's 41,000 km<sup>2</sup> continental shelf, making this vast marine area home to some of the most productive and rich marine resources. It harbours a variety of important ecosystems such as coral reefs and mangroves that have the potential to produce 840,000 tons of fish each year.

The study objectives focused on fisheries resources production and productivity including aquaculture; and the general fishing industry performance emphasizing the private sector's role, livelihoods issues, and the role of women in the fisheries sector. Using participatory research methods, several issues affecting the fisheries sector were identified and prioritized, including: inadequacies in strategic planning and implementation; uncertainties in fishery status and declining fish stocks; low quality of fisheries products; low productivity of fishers; under utilization of fisher women's potential; limited private sector development; and poorly developed information systems affecting all levels of the fisheries sector. Yemen's fisheries sector, however, remains one of the most promising sectors in terms of the social and economic contributions with 8 kg per capita fish intake, employment/livelihood support of 3.3%, revenue earnings of about US \$ 250 million, and of great importance are the Yemen marine environmental resources, habitat conservation and protection.

Ensuring sustainable, environmentally sound management and development of marine capture fisheries using adaptive management arrangements are some of the recommendations that formed the basis for the national fisheries strategy formulation and fisheries policy for Yemen.



### S3.12

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#### **Brown trout introduction and interaction with boreal lake ecosystems**

Lake Kuutsjärvi is a small subarctic lake in close proximity to Varriö research station (Eastern Lapland). The lake, oligotrophic and with a surface of approximately 0.5 hectares, was originally fishless like most of the lakes in the surrounding area. In the early 1970s Brown Trout were intentionally stocked in the lake by local fishermen. This kind of practice is extremely widespread and long dated in the lapland region and the effects of it are still scarcely investigated.

Our project aims to reconstruct the effects of fish introduction through a multiproxy analysis of lake parameters. On a wide scale, we will try to assess the impact of multiple environmental stressors to assess the relative impact of anthropogenic and non-anthropogenic factors. To do so we will use both recent biology and paleo-limnology methodologies. Investigation of paleo-limnological changes will be conducted with a particular focus on planktonic invertebrate communities and paleo-chemical indicators while water chemistry, fish population and recent plankton communities will be used as indicators of the present state of the lake. Other fishless lakes in the area will be used as control experiments to underline the differences between the assumed natural state and the human affected one.

In 2010 we conducted a survey of the lake's present state and an analysis of fish community, growth and diet as well as an overview on past plankton assemblages. In 2011 we plan to conduct a bio-manipulation experiment of lake restoration and a monitoring of lake recovery after the manipulation attempt. Trout will be removed from the lake using intensive fishing with gillnets and whole food web structure will be sampled. Monitoring will be continued and new control lakes will be added.



## S4.01

### J.R. Vallentyne Lecture:

**MUNAWAR, M.<sup>1</sup>, FITZPATRICK, M.<sup>1</sup>, MUNAWAR, I.F.<sup>2</sup>**

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<sup>2</sup>Plankton Canada, Burlington, Ontario, Canada.

### **Can laboratory and field investigations be integrated? A success story from the North American Great Lakes**

Across the globe, aquatic ecosystems have been adversely affected by multiple anthropogenic stressors including pollution, eutrophication, over-exploitation of fisheries, the establishment of exotic biota and climate change. As a result of rapid globalization and population growth, the impacts of such stressors have been compounded. The proliferating, cumulative challenges to aquatic ecosystems require integrated, adaptive, science-based approaches to management in order to mitigate the impacts. Generally, there is a communication gap and lack of integration between toxicology and ecology. Experiments conducted in the laboratory are not applied to the field and vice versa. An integrated strategy including both laboratory and field based techniques are badly needed to generate data applicable to natural ecosystem conditions. The Great Lakes provide an ideal example of ecosystem based management due to their enormous size (245 000 km<sup>2</sup> containing almost 20% of the global supply of fresh water) which could be applied globally. Our paper will deal with some of the approaches we have adapted in conducting multi-trophic bioassays with natural microbial and planktonic communities as stressed organisms. In addition, laboratory grown cultures were also conducted to complement the field observations. Examples from selected stressed ecosystems in the North American Great Lakes will be presented to highlight the successful integration of field and laboratory assessments for facilitating management decisions.



## S4.02

**MIZHIR, A.A., MUSA, Z.J., EMTAGHI A.H., AL-IMARAH, F.J.M.**

Department of Marine environmental Chemistry, Marine Science Centre, Basrah University, Basrah, Iraq.

### **Determination of cyanide by ion selective electrode in waters of Umm Qasr and Khor Al-Zubair ports, Basrah - Iraq**

Cyanide contamination was investigated in the waters of Umm Qasr port and Khor Al-Zubair lagoon, southern Iraq, over three periods: 28-29 April, 9-10 May and 26-27 May of 2009. Water samples were collected by water sampler from the surface, middle and bottom at four times: 00:00, 06:00, 12:00, and 18:00 hours from each of the areas. Four sites were sampled in Umm Qasr port (1–4), and 8 sites in Khor Al-Zubair lagoon (5–12). The method of detection used was ion selective electrode. The amount of cyanide detected in the water samples from Umm Qasr port ranged from 0.01– 0.460 mg l<sup>-1</sup>. Khor Al-Zubair cyanide levels ranged from ND – 0.635 mg l<sup>-1</sup> in April, to ND – 0.90 and ND – 0.95 mg l<sup>-1</sup> during early May, and ND – 0.500 and ND – 0.915 mg l<sup>-1</sup> during late May. The values of cyanide reported for the three depths of each site were close to each other due to high turbulence from high water current in Khor Al-Zubair and dredging in Umm Qasr Port. Highest values of cyanide were recorded in Umm Qasr port in stations 2 and 3, while the highest levels recorded in Khor Al-Zubair were in stations 5 and 6. In general higher values of cyanide were recorded in Khor Al-Zubair compared to Umm Qasr port due to industrial wastes discharge, especially from an iron and steel casting factory towards Khor Al-Zubair lagoon without any treatment.



#### S4.03

**EL-SEREHY, H.**<sup>1,3</sup>, **ABOULELA, H.**<sup>1</sup>, **KAISER, M.**<sup>2</sup>, **AL-RASHEID, K.**<sup>3</sup>, **EZZ EL-DIN, H.**<sup>1</sup>

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#### **Heavy metal concentrations and their distribution along the western coast of Port Said on the Mediterranean Sea, Egypt**

This study aims to analyze the distribution of several metals in bottom sediment, surface water and soft tissue of the bivalve (*Donax trunculus*) from five sites in El-Gamil beach along the western coast of Port Said on the Mediterranean Sea. El-Gamil is a very important area to the local community, due to its industrial activities, its increasing tourism development and its artisan fishery.

The concentrations of Fe, Mn, Cd, Zn, Cu and Pb in total fractions of sediments, water and the bivalve (*Donax trunculus*) samples collected during December 2005 and August 2006 from the five selected sampling sites were measured. The results showed metal distribution with different decreasing order, in the samples of sediment (Fe> Mn> Zn> Pb> Cu> Cd); water (Fe> Zn> Mn> Pb> Cu> Cd) and bivalve (Fe> Zn> Pb> Mn> Cu> Cd) soft tissues, respectively. Water contamination was found to be higher in the summer than in the winter, while sediment contamination was found to be higher in the winter than in the summer. During the present study, El Manasre (site 4) and El Debba (site 5) sustained the highest values of heavy metal concentrations. Different pollutants detected along the El Manasra and El Debba sites were associated with industrial development, and discharge from natural gas companies and electric power generating stations. The proximity to various anthropogenic sources of pollutants warrants a monitoring program for different pollutants in sediments, water, and biota for an effective coastal management program to protect the ecological integrity of this valuable ecosystem in the eastern Mediterranean and the health of humans associated with it.



#### S4.04

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#### **Hydrogeological approach for contributing to the conservation action plan of the Ramsar wetland of Oualidia-Sidi Moussa, Atlantic coast, Morocco**

The wetland of Oualidia-Sidi Moussa on the Atlantic Sahel ( $32^{\circ}54'N$   $008^{\circ}49'W$ ), is one of the 25 sites in Morocco protected by the Ramsar Convention. Despite this status, these sites, particularly those located in coastal areas, are managed in a fragmented way and face many threats and attacks on their biodiversity related to uncontrolled human development and overexploitation of natural resources. To preserve the wetland of Oualidia-Sidi Moussa, the Moroccan government is implementing a conservation action plan.

The present work aims to contribute to this process. It aims to better understand the hydrology of the ecosystem, to make a diagnosis of the land use and to provide data and technical tools to help land planning and decision-making. The geological and hydrogeological studies helped conceptualizing the aquifer system as a bilayer system with karstic functioning, open to hydraulic exchanges with surface water (ocean and lagoons). In this context a strong link exists between the protection of the wetland and the water resources of the basin. To help managers and public authorities implementing safeguard or management zones of our ecosystem, a vulnerability map was elaborated. This map provides a delineation of different areas of vulnerability based on a holistic vision of the watershed. The obtained zoning is transposed to the land use practices mapped with satellite imagery in order to understand the complexity of implementing a land use regulation and an action plan for the preservation of the wetland. The results indicated that the natural protection of the site is low due to the dominant hydrological and geomorphological conditions. The surface and groundwater pollution risks are high because of the concentration of the human activities in the coastal area. A question then seems quite legitimate: facing all these challenges, is it still possible to preserve the environmental status of the Oualidia-Sidi Moussa Ramsar wetland?



#### S4.05

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#### **Oxidative stress and genotoxic damage produced by acetaminophen, diclofenac and their mixture in the Common Carp (*Cyprinus carpio*)**

In recent decades the presence of pharmaceutical products in several water bodies worldwide has increased significantly, which has raised concern over possible adverse effects of this pollution on aquatic organisms. In Mexico, some drugs are sold without medical prescription, leading to self-medication practices as well as irrational use of pharmaceutical products. Within these there are the anti-inflammatory drugs (NSAIDs) such as diclofenac and acetaminophen. Some studies done in mammals had demonstrated that during biotransformation, these toxic compounds produced reactive metabolites and reactive oxygen species, generating oxidative stress. We assume that similar action mechanisms could be present in fishes such as the Common Carp.

The aim of the present work was to evaluate the toxicity produced by diclofenac, acetaminophen and their mixture on the Common Carp (*Cyprinus carpio*). To this purpose, a sublethal toxicity study was done, exposing the test organisms, during 96 h, to a concentration equivalent to 1/10 LC50 of each toxicant, isolated and in mixture. After the exposure time, organisms were sacrificed, gills, brain and liver were removed and the toxicity was evaluated by oxidative stress biomarkers (lipid peroxidation degree, oxidized protein content and antioxidant enzymes activity (superoxide dismutase, catalase and glutathione peroxidase), and genetic damage biomarkers (comet assay).

The results showed that diclofenac and acetaminophen, isolated and in mixture at sublethal concentrations, produced oxidative stress and genetic damage. Lipid peroxidation degree and oxidized protein content were considerably increased, the antioxidant enzymes activities were modified and the comet assay demonstrated that these pharmaceutical products produced DNA damage. Toxicity was organ-selective, the major toxicity was produced in gills, followed by the liver and finally the brain, and diclofenac was more toxic than acetaminophen and the mixture.



## S4.06

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#### **Significant role of offshore petroleum deposits in sustaining marine food chain**

Offshore petroleum deposits may play significant roles, possibly in marine environmental enrichment as well as marine environmental hazards.

Oil and gas offshore deposits often coincide with abundant fisheries in oceans across the world. Hydrocarbon diffusion out of offshore marine petroleum deposits may play a major role in localized enhancement of marine organism populations, assumed as a model. Conformable superposition of field data for marine microorganism concentrations and distributions and offshore petroleum field distributions in oceans across the world makes this coincidental examination possible using literature sources. Significant conformity is observed between offshore petroleum deposits and marine microorganism concentrations in regions of the world's oceans including the Gulf of Mexico, the Persian Gulf, the North Sea, etc., wherein the microorganism data are provided by *in-situ* plankton concentration and distribution data in the marine environment and also satellite ocean color images by SeaWiFS Project.

On the other hand, most studies in the literature on the consequence of oil spills to marine ecosystems have focused mainly on high concentrations causing hazardous aquatic pollution. However, some of those laboratory experimental data clearly indicate stimulation of plankton population at properly low concentration of dissolved petroleum hydrocarbons. A second model is introduced that an increase of low hydrocarbon concentration leads from its nutrition changing to toxicity upon crossing over a pivotal concentration, a plankton stimulation/inhibition threshold concentration (SITC) of hydrocarbons. The model is examined with laboratory experimental data in literature indicating stimulation and inhibition of various planktons along concentration variation of petroleum hydrocarbons to determine its SITC to various kinds of planktons vs. various petroleum hydrocarbon fractions or crude oils in unique combinations.

Fulfilment of the 1st and 2nd model assumptions suggests that proper level of natural diffusion of petroleum hydrocarbons out of offshore petroleum deposits seems to play a major roll to sustain ocean microorganism and consequently the food chain.



S4.07

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**Mosquitocidal and water purification properties of botanicals for the control of disease vectors, malaria, filariasis and dengue and water reuse technology**

Mosquito-borne diseases are major component of communicable diseases (malaria, filariasis, dengue and Japanese encephalitis) in India and in other Asian countries. Chemical insecticides to control mosquitoes were favored so far. But they are non-selective and harmful to other beneficial organisms. Therefore alternative pest control strategies are thus needed. Laboratory toxicity bioassays were conducted by employing aqueous extracts of botanicals such as *Azadirachta indica*, *Cynodon dactylon*, *Aloe vera*, *Hemidesmus indicus* and *Coleus amboinicus* were tested for their toxicity effect on the 3rd instars of *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* breeds in drinking water, stored and sewage water ecosystem. Among the plant extracts *Azadirachta indica* and *Cynodon dactylon* showed significant toxicity, and lethal concentrations (LC<sub>50</sub> LC<sub>90</sub>) were also worked out. Plant extracts showed the highest larval reduction in the breeding sites in the field. Providing quality water is of paramount importance to the public but due to mosquito breeding the water gets contaminated. The selected plants were shown to exhibit water purification properties. Water quality parameters such as turbidity, pH and water clarity were analyzed in the water samples (Pre-treatment and Post treatment with plant extracts) taken from the different breeding sites of mosquitoes. The allelochemicals present in the botanicals affect the biochemical and physiological processes of mosquito systems and thereby control mosquito breeding, while at the same time vitamin and amino acids in the botanicals nullify the contaminants in the water and make its usable by humans. Hence, plant products can be readily used in the future for the control of mosquitoes in aquatic systems as well as aid water purification in the process.



**S4.08**

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**Dioxin-like compounds in freshwater fish from Campania Region**

Dioxin-like compounds have been repeatedly detected in blood, milk, cheese and in inert environmental compartments in the Campania Region. Freshwater fish were targeted as a critical indicator of environmental contamination. Analysis of fish muscle and liver samples from the Garigliano, Volturno, Sarno and Sele Rivers revealed moderate contamination by PCDD/Fs, and relatively more important concentrations of PCBs. A limited number of samples had concentration levels which were beyond the Action Levels introduced by European norms and therefore further monitoring is recommended. The sum of the concentrations of DL-PCBs and 30 NDL-PCBs in fish muscle was between 263.69 and 41,027.01 ng g<sup>-1</sup> (wet weight); many samples were beyond normative levels concerning total PCBs proposed, as well as already implemented, by authorities in several European states. One Eel (*Anguilla anguilla*) had contamination levels which were beyond the tolerable intake limit recommended by European authorities. The distribution of PCDD/Fs congeners among different species showed significant variation with Chub (*Leuciscus cephalus*) being characterised by a higher proportion of low-chlorinated congeners in relation to Eel. Using a benthic as well as a pelagic species for characterising fish tissue contamination by organic compounds provided a more complete representation of the congeners present in the environment. Although they were within European norms, concentrations detected in most of our Eel samples were beyond protection levels calculated using a Species Sensitivity Distribution approach based on NOER/LOER values derived from different freshwater species. Further research is warranted to better describe organic contamination transport within the riverine trophic chain and to derive sediment/fish muscle bioaccumulation factors.



#### S4.09

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#### **Biofilm based sensors for environmental and industrial monitoring**

The discharge of industrial and municipal wastewaters containing substances potentially harmful to aquatic ecosystems and human health represents one of the major problems connected to water management.

The efforts towards reduction of this threat must go hand in hand with the development of monitoring systems able to provide, on-line and in real time, an early-warning about the presence of pollutants in the water. Starting with these considerations, the electrochemical activity of natural water biofilms, largely studied in the last 20 years, has been exploited to develop two different kinds of biosensors for industrial and environmental applications.

In the first case, since large amounts of disinfectants and other chemical substances are employed in the water lines of industrial plants as a countermeasure against biofilm, aim of this research was to realize a sensor for bacterial growth monitoring, to optimize the above mentioned biofilm cleaning treatments. This optimization, indeed, entails a reduction of both costs and of the environmental impact of biocide treatments. In the second case, considering that the biofilm is a micro-ecosystem, the changes induced in its electrochemical activity by addition in water with toxic substances were studied, to develop a biosensor for water pollution, based on this phenomenon.

Concerning the industrial application, it emerged that adjusting biocide treatments based on the real biofilm growth monitored by this sensor prototype, it was possible to drastically reduce the use of chemicals within industrial water lines. The biosensor for water pollution provided interesting results too; when different toxic substances were added to the water in which the biofilm was growing, the bacterial electrochemical signal was inhibited, and this inhibition was proportional to the concentration of the added toxic substance.



#### **S4.10**

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#### **A water quality assessment in a Greek artificial lake: Threats and restoration measures**

The Water Framework Directive (WFD, 2000/60/EC) sets as a main target the achievement of good ecological status in all the European water bodies by 2015. For artificial water bodies the WFD requires a good ecological potential which implies minor deviations from the undisturbed ecological conditions of a comparable natural water body. Plastira Lake is an artificial water body, located in the region of Thessaly, Greece, and its water is used for domestic consumption, irrigation and hydroelectric power production. The lake has an area of 25.20 km<sup>2</sup> and an average water level elevation of +792 m while the main economic activities in the catchment area include tourism and agriculture. A monitoring effort began in 2009, for a series of environmental parameters including macroinvertebrates, major ions, nutrients and heavy metals. A sampling network covering the entire lake and its catchment was established (10 sites in the lake and 5 in the catchment area) while the sampling frequency was bimonthly for the chemical parameters and seasonal for the others. The results indicated that the ecological status of the lake can be characterized as good but there are indications of a progressive movement towards a moderate status. The concentrations of total phosphorous and iron in both the lake and the adjacent streams were generally low but during the summer period, significant increases were observed. Moreover, limited macroinvertebrate species were found, some of which indicate anoxic conditions. A series of measures have been proposed to restore the water quality status and ensure the long term achievement of good ecological potential, including: 1) the establishment of a 200 m protection buffer zone around the lakeshore to avoid livestock breeding and crop cultivations; 2) the installation of a wastewater treatment plant in the area; and 3) to apply erosion reduction measures through vegetation plantation and soil detention dam construction.



## S5.01

### **BRILS, J., VAN DER MEULEN, S., LANGENBERG, V.**

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#### **Tools, toys and techniques for the 21st century**

A plethora of tools, toys and techniques is already available for further unraveling of the aquatic ecosystem puzzle. In Europe, for instance, the European Commission funded projects MODELKEY and AQUATERRA developed such tools for use ranging from the molecular to the full river basin scale. Furthermore, scientists hardly need stimulation to develop sophisticated new tools, such as those under the exciting new science field of ‘omics’.

The real issue is to get these tools—both state-of-the-art new and ‘old school’ tools—accepted by policy makers and used in the practice of water resources management. Even ‘old school’ tools like bioassays, although ‘mature’ and readily available, with few exceptions, do not yet meet the same level of acceptance by policy makers and management as chemical analysis. It will for instance be hard to find bioassays mentioned in the first generation (2010) of the European Water Framework Directive (WFD) river basin management plans (RBMPs). In our opinion, we need a paradigm shift to get our ‘ecosystem puzzle unravelling tools’ really accepted and used by policy making and management. The achieving of this paradigm shift will be the biggest challenge for the 21st century.

First—and this will be the hardest—we need a shift towards real political willingness to protect and, where needed, improve our aquatic ecosystems. Again, in Europe we now have legally binding RBMPs that aim to achieve a good ecological status in all European waters. However, plans are only words: only the actual implementation of the selected measures will result in achievement of good ecological and chemical status. Thus, actions should speak louder than words. Subsequently a second shift is needed towards a new water resources management approach. As the pressures from both anthropogenic and natural causes on aquatic ecosystems increase, it is no longer effective or efficient to deal with one issue at a time, since solving a singular problem often causes damaging impacts on other environmental compartments or in other places. We must consider the consequences of our actions on all parts of the environment in an integrated way and configure these actions to cope with an uncertain future. These challenges demand a different approach in order to achieve actual improvement of the ecological quality of our aquatic ecosystems, and thus sustain the goods and services they provide for the well-being of society. This new approach, according to the European project RISKBASE ([www.riskbase.info](http://www.riskbase.info)), is risk-based management which involves the integrated application of three key-principles: be well informed, manage adaptively and take a participatory approach.



## **S5.02**

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### **Freshwater lakes in China: Exploitation, restoration and prospective**

China has many freshwater lakes. Most are shallow and located in the middle and lower reaches of Yangtze River. Because of overemphasis on resource exploitation, especially those of fishery resources, a great amount of grass carp was introduced into these shallow and macrophyte dominated lakes, which caused them to shift to be phytoplankton dominated. Eutrophication is the main issue currently confronting these lakes.

During the tenth five-year period of ecological restoration (2001-2005), i.e. macrophyte restoration, the control of eutrophication was emphasized. However, very few lakes were successfully restored. The reason for this failure is the macrophyte restoration was simplified to the macrophyte crop, and alleviation of environmental stressors which influence growth was completely neglected. These stressors include: trophic level, hydrodynamic action, depth, underwater light availability, sediment physico-chemical feature, fish community, etc. During the eleventh five-year restoration period, changes in environmental conditions were emphasized and results were optimistic.



## S5.04

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#### **Biomonitoring of upland water nutrient status**

In upland streams, especially those draining peaty or forested catchments, the nutrient concentration and ratios are extremely variable. Total phosphorus concentrations may vary up to three orders of magnitude and can be mainly composed of organic phosphorus. The increasing body of evidence on photoautotrophic organic nutrition in aquatic environments merits the inclusion of the dissolved organic nutrient fraction in regular sampling programs. Using standard chemical methods, such waters require frequent sampling to give a realistic picture of the water chemistry. If performed in combination with suitable biomonitoring methods, the sampling frequency could be reduced to acceptable levels as long as the biological response integrates the water quality variation.

An effective tool for monitoring upland streams is the phosphatase assay, especially when performed on long-living organisms, such as bryophytes and some colonial algae. For larger organisms, phosphatase activity is an indicator of its phosphorus status. It is relatively easy to perform and can provide rapid information. Ideally, some measurements are made on-site, but more detailed assays on return can provide important further insight. For instance, comparison of assays with organic phosphorus concentrations similar to field conditions and assays under standard saturating conditions can provide valuable insight as to whether the organism can make efficient use of highly variable concentrations in the field. The broadly similar assay methodologies for aquatic and terrestrial bryophytes make them particularly useful in monitoring the phosphorus status of whole upper-catchments.

By ensuring the methodology is as robust as possible, it could be adopted widely within the EU Water Framework Directive. As many upland areas are undergoing change driven by climate change and nutrient pollution deposition, this is where there is the most need for improved monitoring. Specific studies on methodology development, site studies and biomonitoring applications will be discussed.



**S5.05**

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**Modeling the response of the Great European Lake Ladoga ecosystem to decreases in phosphorus loading**

The phosphorus load on the Lake Ladoga ecosystem increased during the period 1962-1983. In this situation, the eutrophication process of the Lake Ladoga ecosystem began. The oligotrophic status of Lake Ladoga transformed to mesotrophic status. During the period 1984-1995 the trophic status of Lake Ladoga ecosystem remained unchanged.

During the period 1996 – 2005, such important indicators as concentration of the total and mineral phosphorus in lake water have decreased and have reached values corresponding to the oligotrophic status of the lake in 1959-1962. However, the state of biota, primarily the phytoplankton, differs from its condition in the oligotrophic period until 1962.

In the given talk, by means of mathematical modeling, an explanation to this phenomenon is given. Computing experiments have shown that the increase in speed of destruction of detritus and dissolved organic matter can lead to an unexpected result: a decrease in phosphorus loading is compensated by an increase in the speed of the phosphorus circulation in a lake ecosystem, and phytoplankton production does not decrease. This result can clarify why a decrease in phosphorus loading leads, for some lakes, to their return to an oligotrophic state, and for other lakes this does not occur.

This work is supported by Russian Fund for Basic Research (RFBR, grant № 10-06-00380 a).



## S5.06

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### **Comparing *in situ* and *in vitro* methods for assessing chlorophyll *a* and algal communities in the North American Great Lakes**

The North American Great Lakes are an enormous freshwater resource with a surface area of 244 000 km<sup>2</sup>, approximately 20% of the global supply. Since the 1970s, research and monitoring efforts in the Great Lakes have depended on *in vitro* measurements of chlorophyll *a* by acetone pigment extraction, from a large number of sites for broad characterizations of algal standing crop, coupled with more comprehensive assessments of the algal communities by microscopic analysis at a smaller subset of stations.

An *in situ* fluorometer (Fluoroprobe; bbe Maldaenke GmbH), with the capability of rapidly detecting both chlorophyll *a* and major algal classes simultaneously, has been deployed in the Great Lakes by our laboratory since 2008. In this paper, we compare a large set of chlorophyll *a* data derived from the Fluoroprobe, against those derived from acetone extractions in a variety of environments ranging from ultra-oligotrophic to hyper- eutrophic. These data were statistically analysed to assess the reproducibility of the association and calculate the range of validity.

While *in situ* and *in vitro* techniques produced significantly different results, we found that these differences could be “corrected” with a logarithmic model that also included total phosphorus and temperature as associated variables. Furthermore, at selected stations we compared the probe’s pigment based algal groupings against taxonomic composition generated by the standard Utermöhl microscopy. Our results indicate that caution should be exercised in deploying and interpreting new technology without testing it against standard methods.



**S5.07**

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**Complex dynamical models and management of ecosystems**

This talk concerns the development and analysis of mathematical models describing the spatio-temporal behaviour of aquatic ecosystems. The models are defined by a set of non-linear reaction-diffusion equations involving ecological and biochemical species, such as plankton, algae, nutrients and dissolved oxygen.

The problem of estimating the parameters of the distributed models obtained by finite element numerical discretizations is investigated. The influence of rough boundaries on the model solutions is studied by using multi-scale analysis and homogenization theorems. Some considerations on the development of suitable methodologies for the management of complex ecosystems, such as lakes and lagoons, are also presented.



**S5.08**

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**Coastal upwelling in summer 2000 in the northeastern South China Sea observed by hydrographic, tide-gauge, sub-surface mooring and satellite measurement**

Hydrographic, tide-gauge, near bottom mooring and satellite observations were used to study coastal upwelling in the northeastern South China Sea (NSCS) off the coast of Fujian and Guangdong Provinces, China, in the summer of 2000. Surface cooling was the most significant near Dongshan-Shantou, though intermittent at times and occurred preferably when surface winds were southwesterly.

Subsurface upwelling phenomenon existed near the bottom boundary of the whole region investigated. The northeastward flow following the bathymetry was accelerated by the drop of coastal sea level and led to onshore transport and subsequent cooling in the bottom boundary layer (BBL). The cross-shelf current did not always penetrate through the stratification and reach the surface.

With the aid of wind-driven surface Ekman flow, cold and salty water rose along the sloping bottom and reached sea surface in the hydrographic transect east of 116°E, with a thermohaline front separating the upwelling region from the open-sea water in the surface layer. To the west, a fresh-water tongue originating from the Pearl River formed a barrier layer, which resulted in local high surface temperature. The observational evidences shown in this study provided important information for further understanding the upwelling dynamics and its ecological effects in the NSCS.



**S5.09**

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**Innovative use of naturalistic engineering techniques, vegetation and seagrass residuals for coastal sand dune protection and reconstruction**

Sand dunes are an important system of coastal area and infrastructures protection against sea storms, sand ingressions, floods and groundwater salinization; moreover they constitute an important system able to promote biodiversity preservation. During the past decades, most of the dune systems have been heavily damaged or depleted, mainly from human activities. Even if dune systems can naturally recreate themselves in the undisturbed areas, this process may require many years and may be interrupted by human fruition also if at a low level.

Dune reconstruction and preservation activities should accelerate the natural process and contrast eventual erosion factors. The solutions commonly used are mainly based on wind erosion reduction and sand accumulation through sand-fencings, windbreaks and similar techniques. In sites with low wind activity and eventual sea erosion, different alternatives must be studied in order to ensure correct dune preservation: this study attempts to illustrate innovative solutions for areas characterized by sandy beaches with reduced width.

Particularly, the present work provides the use of naturalistic engineering techniques for ante-dunes creation and dunes slub, together with residual materials obtained from seagrass removal (*Posidonia oceanica*) and back-dune vegetation management. The main technological innovation is the creation of assembled handiworks, consisting of biodegradable nets filled with sand and residual wood or seagrass, in order to build structures for defence and consolidation.

Various design applications have been developed in four different Italian sites, one in Puglia (southern Italy) and three in Tuscany (central Italy) and their realization is currently in progress.

The study highlights that dune preservation and restoration projects must be carried out only once a specific site dependent analysis has been carried out. Naturalistic engineering can be used in a wide range of situations, also permitting the reuse of residual materials from beach or vegetation management.



## S5.10

**HASLER, B., FROHN, L.M., HANSEN, K.M., SMART, J.C.R., MARTINSEN, L., ZANDERSEN, M., MØLLER, F.**

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### **Integrated modelling of the social value of changes in atmospheric emissions and marine ecosystem goods and services**

Marine ecosystem goods and services, including productive, cultural and aesthetic services such as fisheries and tourism/recreation, are affected by eutrophication. Eutrophication in coastal and open marine water bodies is caused by riverine inputs and atmospheric deposition of nutrients. Atmospheric deposition typically accounts for around 25% of such nitrogen loads annually.

An integrated model system, incorporating economic cost minimisation, atmospheric, catchment and marine components, is under development to help inform policies for managing eutrophication in the Baltic Sea. A pilot study for an expansion of this model system will demonstrate how the EVA (Economic Valuation of Air pollution) modelling approach can be used to quantify the environmental and economic effects of changes in atmospheric nutrient input to the Baltic Sea. The pilot study illustrates EVA's application by modelling how changes in atmospheric nutrient inputs affect marine ecosystem services, the costs of protecting these services and the value of changes in delivery of ecosystem goods and services in coastal and open marine areas. Results will incorporate the latest findings from on-going valuation studies.



## S5.11

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### **Web-enabled platforms for citizen science and computer-supported collaborative work in integrated coastal and marine spatial planning**

Ocean observatories such as NEPTUNE Canada ([www.neptunecanada.ca](http://www.neptunecanada.ca)) are now generating an explosion of observations from the ocean floor. Social media are generating a torrent of text around public policy decisions—for example, in marine spatial planning—that must be informed by evidence drawn from the data flowing from such observatories. But there are not enough scientists or graduate students in the world to extract the relevant information from the accumulating database. Software agents must do most of the initial work. But in some tasks, such as pattern recognition in visual images, humans can still perform better than computers. This paper explores some of the tools and techniques that will be used in a Web2.0 and Web3.0 world to respond to the challenge of making sense of an accelerating accumulation of data and a rising torrent of text for purposes of integrated marine spatial planning to promote marine ecosystem integrity. Specifically, it outlines the deployment of Digital Fishers ([www.digitalfishers.net](http://www.digitalfishers.net)), a web interface to recruit volunteers to tag images from video clips for purposes of enriching the massive DMAS database serving VENUS and NEPTUNE Canada. But also, like comparable initiatives within the Zooniverse platform ([www.zooniverse.org](http://www.zooniverse.org)), Digital Fishers reaches out to engage those outside the research community in scientific undertakings. The conclusion is that deployment of Digital Fishers through Zooniverse as well as within Oceans 2 ([www.neptunecanada.ca/o2](http://www.neptunecanada.ca/o2)) can bring oceans issues and the challenges of managing human activity for reduced degradation of marine ecosystems to a broader public, and can also offer, through supporting tutorial activities, new learning opportunities leading to more informed public involvement in marine spatial planning, particularly in cross-border settings.



## S5.12

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#### **Status of marine environment in the Strait of Malacca – A strategic assessment of vessel movements**

Marine water quality of the Strait of Malacca attained great significance due to the strong dependence of Peninsular Malaysia's west coast population on the Strait for health, sustenance, aquaculture, tourism, and other economic and social activities. The waterway is subject to a wide variety of land-based industrial, agricultural and urbanization pollution, in addition to that caused by shipping and other marine-based industries. The complexity of environmental issues in the Strait of Malacca needs strategic programs to provide a balance between economic development and environmental protection through a Strategic Environmental Assessment (SEA), which aims to provide a comprehensive approach to sustainable development.

The increase in oil and grease levels in the Strait of Malacca waters between 2004 and 2008 pointed to the higher risk of water pollution for this strategic waterway and to the economic lifeline of local communities. It is clear that this increase was the result of cumulative actions originating from different pollution sources, both from the land and the sea into the Straits of Malacca.

A cumulative-approach technique is required to address questions about the effects of pollution, its short and long term consequences, and types of environmental considerations that have to be taken into account to ensure viable economic development and sustainability for the Strait. This study noted that oil and grease levels were consistently related to the number of fishing boat movements and not with ship callings by ports. Oil and grease levels were highest along the west coast of Malaysia in Perak, where the maximum fishing boat movements occur, whereas they were not as high in Selangor, where maximum ship callings by port occurred. Therefore, introducing new fishing harvesting strategies and implementing relevant operational rules and regulations to improve the quality of fishing boat and crew operations would contribute significantly towards developing sustainable fishing activities in the Strait.



S5.13

**KIMIREI, I.A., SEKADENDE, B., NGATUNGA, B.P., GABAGAMBI, P.N., KIHEDU, J., MSHANA, J.J.**

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### **Status of the fisheries and physico-chemical environment of Lake Rukwa, Tanzania**

Lake Rukwa is the largest inland lake in Tanzania which is not shared with other countries. It has a lucrative fishery which is based mainly on *Oreochromis esculentus*. The fish from Lake Rukwa form an important protein and income base for the riparian communities. However, the Lake Rukwa ecosystem is currently threatened by over-exploitation of its fisheries resources, eutrophication and heavy metal pollution.

The status of the fisheries and the physico-chemical environment were assessed in the Mbeya side of Lake Rukwa in 2010. Both fishery and non-fishery based catch data were collected and used to assess the status of the fishery. Water quality parameters (physio-chemical) and some heavy metals (mercury and lead) were measured from sediments, water, and fish tissue using standard methods.

It was observed that although the *Oreochromis esculentus* fishery in Lake Rukwa is flourishing, the level of fishing effort is high. Most *Oreochromis esculentus* measured showed signs of stuntedness, probably caused by poor water quality and or high exploitation pressure. Nutrient levels were very high. Atmospheric fallout due to biomass burning, overgrazing, and agricultural fertilizers application upstream in the Songwe River, and other intermittent rivers, was plausibly the main source of high nutrient levels in Lake Rukwa. Algal blooms were a common observation all over the lake. Chlorophyll *a* concentrations were also high, similar to eutrophic shallow lakes. Mercury and lead concentrations were significantly highest in fish tissue than in water and sediments; they were beyond permissible WHO standards.

Small-scale alluvial gold mining in the catchment is, most probably, the main source of heavy metal pollution. Mining and unsustainable agriculture are causing high sediment loads which threaten proper functioning of the Lake Rukwa ecosystem. The status of this ecosystem may continue to deteriorate if no stern management actions are taken. Both fisheries and lake environmental management options are proposed.



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*Poster Abstracts*

*In order of presentation*



**P.30**

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**The impact pathway method for monetary valuation: Application to agricultural nitrogen and water quality**

The European Union's Water Framework Directive (2000/60/EC) presents a challenge to the management of water resources because it stipulates integrated water management, where quality and quantity aspects of water resources are supposed to be interlinked. The challenge of ensuring effective integrated management of inland and coastal surface waters with groundwater reserves can only be met with an integrated framework for economic assessment of the water resources. A framework that allows for a detailed breakdown of benefits related to the different attributes of the water is required to account for water quality improvements and to explore whether the associated costs are proportional to the benefits.

In this paper of the EXIOPOL project we explore how the impact-pathway methodology, which previously has been applied to establish a framework for valuation of air pollution effects, can be applied to establish a coherent framework for valuation of water pollution effects, which could allow for more integrated and consistent assessment of changes in management practices affecting the different water bodies (rivers, coastal waters, groundwater etc.).

The starting point of the impact-pathway methodology is with the emissions that affect environmental quality, not the water resources per se. Our focus here is on nitrogen, which is known to leach from agricultural activities and which transforms to nitrate that is believed to affect the quality of water as a healthy source for drinking water, and for its ability to cause eutrophication that leads to increased algal growth, which decrease the recreational and aesthetic benefits of water bodies.



**P.01**

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**Hydromorphological indicators and water characterization of the Escalar glacier lake (Spanish Pyrenees): A limnological approach**

High mountain lakes are among the most sensitive aquatic ecosystems. They are a consequence of the intense climate dynamics that shaped the Pyrenees mountain range during the Pleistocene. They harbour unique communities with frequent endemic species. Their sedimentological and recent ecological records show great scientific value as a source of unique data on the Pleistocene and recent climatic changes. Moreover, in recent years Pyrenean high mountain lakes have become a valuable resource for educational and recreational activities. This study describes a limnological approach to the Escalar high mountain lake located in the Spanish Pyrenees (province of Huesca). According to the EU Water Framework Directive, this includes hydromorphological and physicochemical characterizations. Its hydromorphological characterization was based on a bathymetric chart and realized by means of a multibeam echosounder, a GPS device, and a Geographic Information System (GIS) for data processing. Physicochemical characterization was determined through analysis of lake water samples at different depths.

The hydromorphological results showed the lake capacity,  $0.0281 \text{ hm}^3$ , the atmospheric deposition measured,  $1661.6 \text{ mm}$ , the water inlet,  $0.813 \text{ hm}^3 \text{ year}^{-1}$  and the residence time,  $0.0552 \text{ years}$ . On the other hand, physicochemical water analyses showed significant and interesting fluctuations with depth and/or season for some parameters.

Due to the large number of high mountain lakes located in the Pyrenees, this area is ideal for the study of their functionality and natural dynamics. This study is also the first limnological approach to Escalar Lake, including information required by the EU Water Framework Directive for ecological assessment.



**P.02**

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**Temporal variability of microbial biomass and respiratory activity in the epi-, meso- and bathypelagic waters of the Tyrrhenian Sea (Mediterranean Sea)**

In the last few decades, the scientific community has assembled a comprehensive set of data on the fate of phytoplankton production from the euphotic layer to the deepest layers of the ocean, based on measurements with sediment traps. This data, however, underestimates the flow of organic matter, because it does not consider the fraction of dissolved organic carbon. In contrast, the estimates of microbial respiration, especially in the deeper layers of the ocean, have received little attention, but they are excellent indicators of the flow of organic matter in aquatic systems, because they estimate the remineralization of different sources of organic carbon (particulate and dissolved).

This study focuses on abundance/biomass of prokaryotes and microbial respiration in the water column of the Tyrrhenian Sea, in order to gain a better understanding of the factors that modulate the carbon cycle in environments epi-, meso- and bathy-pelagic. The data was produced in the context of several multidisciplinary projects (MedGOOS, FIRB, CIESM, VECTOR, Vetimer 4) in the Tyrrhenian Sea in a fixed pelagic station from 2005 to 2010 (Lat.N=39°30'; Long.E=13°30'), where a interannual time series was gained.

On an annual scale, the parameters examined varied greatly in relation to the trophic status of the epipelagic zone and the trends in the deeper layers basically mirrored the superficial pattern. From the microbial biomass data, a clear seasonal cycle related to the spring bloom period and the signal of "Summer of St. Martin" appeared. Matching the instantaneous rate of oxygen consumption with the cumulative consumption of oxygen (AOU), two major metabolic pathways emerged by microbial oxidation: a) from POC to DOC in the deep waters; b) DOC to CO<sub>2</sub> in the intermediate waters. The biogeochemical implications will be discussed in the light of signal propagation of the "transient" from the Eastern Mediterranean to the study area.



### **P.03**

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#### **Relationship between microbial parameters and environmental changes in coastal aquatic ecosystems**

Coastal aquatic ecosystems are among the most geochemically and biologically active areas of the biosphere playing an important role in global cycles. The aim of this research is to assess whether microbial parameters may be useful indices of environmental changes and may provide functional ecological information to monitor the health status of coastal areas.

The prokaryotic community, both in terms of abundances (prokaryotic abundances, vibrios) and activities (enzymatic hydrolysis of proteins, by leucine aminopeptidase -LAP, polysaccharides by  $\beta$ -glucosidase -GLU and organic phosphates by alkaline phosphatase -AP; heterotrophic prokaryotic production -HPP; respiration -R), has been investigated together with physical and chemical parameters (temperature, salinity, nutrients) and particulate carbon and nitrogen (POC, PON), for a 2 years period (2006-08) in the coastal area of Cape Peloro (Messina). This area is constituted by two brackish basins (Faro and Ganzirri Lakes), comprised between the Tyrrhenian and Ionian Seas.

The obtained results showed that the Cape Peloro area was characterised by high seasonal variability, which was higher than the spatial one.

The abundance of vibrios followed a seasonal trend and was significantly correlated with temperature in both lakes ( $R^2=0.51$  and  $R^2= 0.79$ ,  $P<0.01$  in Ganzirri and Faro, respectively), as well as  $\beta$ -GLU and Respiration, indicating a direct stimulation of the warm season on heterotrophic bacterial metabolism. Moreover, positive correlations were observed between temperature values (from 13.3 to 29.6 °C) and HPP, LAP, AP, POC, PON in Ganzirri Lake.

The highest prokaryotic abundances occurred in summer 2008. The C/N ratio, always lower than 5, suggested the predominance of heterotrophic biomasses in this ecosystem.

We suppose that global warming may affect microbial metabolism, so we suggest the use of microbial indicators (vibrios and microbial activities) as a signal of the trophic status of lagoons, because they are well related to water warming and seasonal trends.



**P.04**

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**Radioactive contamination of the environment and skeleton development in common roach *Rutilus rutilus* (Linnaeus) (Actinopterygii: Cyprinidae)**

The present study (RFBR 10-04-01178) contributes to the knowledge of the osteological abnormalities in fish due to radioactive contamination. It was designed to describe the occurrence of axial skeletal malformations in common roach, *Rutilus rutilus*, from an area of radiation contamination. Control samples were from the Zoological Institute historical collection. Abnormal specimens were collected in waterbodies of the Techa Cascade of Reservoirs (Chelyabinsk Province, Russia), located in the area of the Eastern-Urals Radioactive Trace. A high number of malformations were detected, both in the unpaired fin and the vertebral column including the caudal complex. The abnormalities were extra-numerous elements, fusions, deformities, and displacements of the elements. A large number of individuals, 94.1 and 97.2% in two samples studied, showed at least one anomaly, and the highest occurrence of abnormalities was observed in the caudal region. We identified classes, categories, and types of axial skeleton abnormalities, most of which were considered as minor, such as doubling of arches and spines, and shortening or deformation of the latter. Only a few major abnormalities were found. The causes of malformations were not identified, but the high incidence of anomalies may be attributed to either direct or indirect effects of radiation and/or chemical contamination that affects skeletal development. The results show that the detection of axial skeleton abnormalities in fish can be an indicator of unfavourable environmental conditions in areas impacted by radioactive contamination both historically and recently (e.g. in Japan).



**P.05**

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**Environmental factors affecting microbial mat photosynthetic pigments in Victoria Land (Antarctica)**

The northern Victoria Land represents one of the most interesting and yet understudied limnological regions in East Antarctica. During four Italian Antarctic expeditions (austral summer 2001/02-2005/2006), microbial mats were collected from 55 lakes and ponds in ice-free areas with different lithological features and located at different latitudes (from 72.13°S to 76.91°S) and altitudes (from 1 to 1,000 m a.s.l.). Samples were collected by hand from the ice-free littoral zone and were stored at -20 °C for transport to Italy. With the aim to characterize communities of photoautotrophic organisms and to identify environmental factors affecting their composition and distribution, the mat photosynthetic pigments were analyzed by Liquid Chromatography-Mass Spectrometry, coupled with a Photodiode Array Detector and used as proxy for algal communities.

Benthic primary productivity in Victoria Land lakes varied over two orders of magnitude and the waterbodies showed a different composition and total number of pigments. Cyanophyta, Chlorophyta, Bacillariophyta and purple bacteria were the main identified taxa in agreement with available literature data from microscopy-based studies on Antarctic freshwater phytoplankton. Total pigment concentrations were in the same range of those previously reported for other lakes in East Antarctica, such as in the McMurdo Dry Valleys and the Larsemann Hills. Redundancy Analysis indicated that the water chemistry (especially nutrient concentrations and conductivity) was the main factor affecting the pigment composition in mats from northern Victoria Land. The n-MDS analysis of pigments did not show a clear pattern in relation to different lithological features or latitudinal and altitudinal gradients.

The High-Performance Liquid Chromatography (HPLC) analysis of photosynthetic pigments was a valuable approach to point out the main algal taxa in Antarctic freshwater mats, and the characterization of autotrophic communities throughout northern Victoria Land lakes will be very useful to evaluate possible spatial and temporal responses of these communities to local climatic and environmental changes.



**P.06**

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### **How does hypoxia affect habitat quality of fishes?**

Nutrient abatement programs to reduce the effects of cultural eutrophication are often implemented in an effort to reduce hypoxia and mitigate hypoxic effects on fishes. Yet, it is unclear how hypoxia actually affects habitat quality for fishes, particularly those in midwater. Reduced oxygen availability has the potential to cause mortality or indirect sublethal effects, including reduced feeding and growth rates, changes in behavior and distribution, and increased encounter frequency with predators or prey. Detailed analyses of spatial distributions of environmental factors and fishes in the Great Lakes, Chesapeake Bay and the Northern Gulf of Mexico suggest that spatial distributions and other habitat features, such as water temperature and the timing of hypoxia, have species and ecosystem specific effects. Indeed some fishes may actually benefit from hypoxia. Research needs to focus on these complex interactions, including the degree of overlap between predators and prey habitats, and changes in the habitat quality and growth rate potential of fishes. Comparisons across ecosystems may yield further insights into intra-specific and food-web variability in response to hypoxia and eutrophication.



**P.07**

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**Predictive model for phosphorus in large shallow Lake Peipsi: Approach based on covariance structures**

Long-term datasets of nutrients provide a unique opportunity to study the changes that occur in lake ecosystems subjected to multiple man induced and natural pressures. Unfortunately, the related dataset of thousands of records for Lake Peipsi (Estonia/Russia) is rather fragmentary and a direct use of raw data for drawing scientific conclusions is complicated. To enable better understanding of ecosystem processes in large eutrophic Lake Peipsi, we have turned to special general statistical multifactorial linear models for hydrochemical and hydrobiological water parameters. The modelling of total phosphorus (TP), the most important variable concerning eutrophication, is a central issue of the present paper. We provide a new application of statistical linear mixed models focusing on spatial covariance structures using the advanced technique of repeated measures available in SAS/STAT software (MIXED procedure). Our approach allows estimation of spatial distribution of TP in the lake and the factors involved. The model distinguishes the high-frequency variability of TP related to the natural factors, affecting lake areas within 75 km or an even longer distance, from that associated with the local errors in measurements of single water probes. Both variability components are approximately equal (variance on log<sub>2</sub>-scale 0.12–0.15). Relative to previous modelling tools, the linear mixed model is more precise in prediction of TP concentration. Our developments in phosphorus modelling provide considerable potential for management of large shallow lakes.



**P.08**

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**Coping with desiccation and high irradiance in the eulittoral of a large lake: Adaptive biology of the rhodophyte *Bangia atropurpurea* (ACE-SAP Project, A2.WP2)**

*Bangia atropurpurea* is a filamentous red alga occurring on hard substrata in the eulittoral of lakes, where it experiences extreme conditions (high irradiance-UV exposure and desiccation). The main aim of the ACE-SAP\_A2\_WP2 Project is to elucidate the adaptive traits conferring stress tolerance from the ecological, bioorganic, morphological, and ecogenomic point of view. A field experiment was performed in which patches of *B. atropurpurea* were exposed to a combination of factors (immersion, emersion, UV-filters). A strong effect in terms of abundance and ratio of R-phycoerythrin, R-phyococyanin, chlorophylls, and MAAs between immersed and emerged samples was shown. R-PC and R-PE were more abundant (consistently in time even though decreasing in extent) when filaments were immersed. The ratio between MAAs and chlorophyll a was higher in immersed filaments, but with a weak difference among UV-treatments. Expression studies on genes encoding for the beta subunit of phycoerythrin (*cpeB*) and for the largest subunit of Rubisco (*rbclL*) are ongoing. We are confident that significant advancement on the mechanisms involved in *B. atropurpurea* stress tolerance will be gained from the combination of these different approaches.



**P.09**

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### **The impact of solar UV radiation on *Artemia* growth stages**

In recent decades, the increase of ultraviolet (UV) radiation measured at the earth surface, in relation to the decrease in the concentration of stratospheric ozone, has led to important direct and indirect effects on aquatic organisms. In combination with global warming and lake/ocean acidification, further modifications on the penetration of UV radiation have occurred. Field and laboratory experiments have shown that increased UV radiation can alter the trophic and physical conditions of aquatic ecosystems. In the present study, we examine the effect of changing UV exposure on *Artemia* species, in particular the sensitivity of different life stages (nauplius and adult) to different doses of UV radiation.

The impact of different doses of artificial UV radiation on the growth stages of this marine zooplankton was investigated using laboratory microcosms. Mortality percentages of naupliar and adult samples of *Artemia franciscana* were recorded in relation to single exposures at 75, 150, 300, 600, 1200, 2400, 3900, 7800 J m<sup>-2</sup>, at specific observation times after exposure (24, 48, 72, 96 and 120 h). The relationship between mortality percentage and UV dose showed significant differences in relation to the zooplankton growth stage. The elevated susceptibility of the naupliar samples to UV radiation is quantified using a mortality model based on a logistic equation. The data analysis shows that the slope of mortality versus dose remains the same for the two growth stages, while the lethal dose in the naupliar stage was 3.3 times less than that determined for the adult stage. The slope of the UV mortality rate versus post-incubation time was found to be significantly different ( $P < 0.05$ ) at low UV doses for the two life stages examined, i.e. naupliar and adult. The lower value of LD50 in naupliar stages compared to that for adults confirms that in the early growth stage this marine zooplankton is more susceptible to UV radiation.



**P.10**

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### **Epilithic phototrophic biofilms of Lake Albano**

Lake Albano is a volcanic lake located in central Italy. Over the past 20 years, increased nutrient loading has resulted in recurrent blooms of the toxic cyanobacterium, *Planktothrix rubescens*. In this study, we explored the unknown benthic algal component (epilithic phototrophic biofilms) growing on the rocks of the littoral zone. These natural microbial communities have an important ecological role in food-web and nutrient cycles, and can potentially be used as bio-indicators of climate change, metal contamination, anthropogenic stressors, and organic pollution.

The epilithic community was sampled monthly over one year from benthic natural stone surfaces. The site has minimal human disturbance and is located in the north-east area of the lake. The concentrations of a range of chlorophylls (*a*, *b*, *c1+c2*) were used to evaluate changes of the total phototrophic biomass and the relative proportion of the major algal groups. Analyses of a range of water quality variables were made to determine possible causal factors of algal biomass development. Observations of fresh and fixed samples were conducted by light, fluorescence, confocal and scanning electron microscopy.

Seasonal changes were observed in the phototrophic biofilms composed of diatoms, green algae and cyanobacteria. Total phototrophic biomass was maximum in winter and minimum in summer or species composition. Diatoms and green algae peaked during winter with *Gomphonema*, as dominant taxa, *Stigeoclonium* and *Ulothrix*. Cyanobacteria were present all year round with species of the genera *Leptolyngbya*, *Calothrix*, and *Nostoc*. Total nutrient concentrations indicated that the benthic community is experiencing oligo-mesotrophic conditions and some nitrogen limitation. A seasonal change in temperatures varying by almost 20 °C was also indicated as a potent driver of seasonal changes in community composition.



**P.11**

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**Development and evaluation of a multimetric index for measuring the ecological potential of Spanish reservoirs**

The European Union has taken an ambitious course in water policy towards an ecologically orientated, sustainable management of waterbodies by enacting the Water Framework Directive (WFD). In the case of high modified waters, as reservoirs, the WFD establish that Member States (MS) must work to achieve the best ecological potential. In accordance with these requirements, MS must develop, evaluate and implement fish-based methods to assess the ecological status of their reservoirs in order to classify them within different levels of degradation, enable a distinction between the various types of human pressures and describe reference conditions of good ecological potential.

An index of biotic quality was developed to evaluate the biological potential of reservoirs in Spain. The index has been used to reflect the ability to support and maintain a balanced, integrated fish assemblage close to that of good ecological status. The index combines several metrics classified into four groups (species richness and composition), trophic composition, reproductive guilds and fish biomass. A modified version was used when no standardized methods for fish catches were available. Data were collected from 150 reservoirs, belonging to five hydrographical basins. The index was developed by means of statistical multiple linear regression models. The most serious worry for Spanish reservoirs is eutrophication, but the non-integrity of reproductive areas was also relevant. Though the proposed index needs to be tested and refined for some Spanish regions, and intercalibrated with other metrics from the Mediterranean European Members States, this work represents an important first step in providing a useful tool for evaluating the ecological potential of these relevant aquatic resources.



**P.12**

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### **Soil, land-use and water quality in a coastal agro-system of Central Italy**

This study explores the influence of different land uses (agricultural, animal husbandry, recreational, built-up areas) on the quality of subsurface waters in the area surrounding the coastal Lake of Fogliano (Central Italy). The reciprocal impact of the saline lake waters on the neighbouring soil quality was also examined. A network of 15 piezometers located along 6 transects were set up perpendicular to the lake. Periodic monitoring of water quality and ground water level to a maximum depth of 3 m was performed. Water samples (13) were collected from August 2009 to November 2010 and the temporal and spatial dynamics of the concentrations of N-NH<sub>4</sub>, N-NO<sub>3</sub>, N-NO<sub>2</sub>, P-PO<sub>4</sub>, electric conductivity (EC<sub>w</sub>), total dissolved salts (TDS), chlorides and sodium were determined. Spatial data were interpolated using the ArcGis extension Spatial Analyst and IDW (Inverse Distance Weighted). The results show the clear impact of animal husbandry on phosphate concentrations. Nitrate concentrations (as N-NO<sub>3</sub>) were found to be influenced by proximity to agricultural areas. Ammonium concentrations (N-NH<sub>4</sub>) showed increases both in relation to areas with animal husbandry, as well as to areas with a strong intrusion of saline waters and/or peaty soils. Nutrient concentrations in the sub-surface waters did not show any significant contribution to the concentrations measured at the lake. These results indicated that the present intensity of agricultural and livestock activities is sustainable in this transitional agro-ecosystem. Indicators for saline intrusion (specific conductance, sodium and chloride concentrations) showed a decreasing trend, moving from the saline lake towards the inland areas. A large area of the transect is characterised by mean values of 5000  $\mu\text{S cm}^{-1}$ , 2900 ppm and 3500 ppm, respectively. This indicates that the potential for a growing saline content of agricultural soils, through the use of well water for irrigation, is a management and research priority in these complex coastal ecosystems.



P.13

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**The C-cycle on ocean's surface: the sea-surface micro-layer, its composition and the production of dissolved and particulate organic matter from phytoplankton under stress conditions**

The ocean's surface is a special environment playing a key role in the interactions between the underlying ocean's water and the atmosphere. The sea-surface micro-layer (SML), and the boundary between these two compartments, mediates fluxes of mass and energy and influences the emission of organic particles from the ocean. In the framework of the SOPRAN project (*Surface Ocean Processes in the Anthropocene*), we investigated the composition of the sea-surface micro-layer during a joint experiment on ocean acidification (BIOACID), conducted between September and December, 2010. Three tanks (70L) of 0.2  $\mu\text{m}$  filtered North Sea water were inoculated with diatom cultures (*Thalassiosira weissflogii*) grown under different  $\text{CO}_2$  partial pressures (180, 380 and 780 ppm) and at controlled temperature in chemostat chambers. SML samples were later collected from the three tanks and from a control tank (containing just 0.2  $\mu\text{m}$  filtered North Sea water) with a glass plate sampling device. To examine temporal changes, three samplings were done every 24 hours. Replicates were also performed according to growth conditions of the phytoplankton. Following the hypothesis that main constituents of the micro-layer may derive from cell growth, exudation and death, we examined the enrichment in organic material of the surface film with particular attention to carbohydrates and transparent exopolymer particles (TEP). This enrichment finds evidence in our first results: TOC and total carbohydrates concentrations were higher in the SML when compared to the underlying water, even though individual fractions differ. The presence of more or less labile organic compounds and their uptake, in our experiment, were only related to phytoplankton and bacterial metabolism: therefore, varying  $\text{CO}_2$  scenarios affecting phytoplankton production may result in compositional changes of the sea-surface micro-layer.



**P.14**

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**Timing of the carbon dioxide emission from two monomictic Mediterranean reservoirs**

Inland waters are important components of the global carbon cycle. Most of these aquatic ecosystems are supersaturated in CO<sub>2</sub>, and therefore act as sources to the atmosphere. Reservoirs are particularly important sources of greenhouse gases, emitting about twice the global CO<sub>2</sub> flux of natural lakes to the atmosphere. These flux estimates are usually made from short-term measurements, assuming low temporal variability. Using measurements of pCO<sub>2</sub>, we estimated air-water CO<sub>2</sub> exchange with hourly resolution in two reservoirs with different trophic status in southern Spain. In addition to differences in CO<sub>2</sub> emissions between reservoirs (fourfold higher for the eutrophic impoundment), a marked temporal variability at daily, seasonal and interannual scales was observed in both reservoirs. Daily cycles were mainly driven by plankton metabolism, with maximum amplitude in pCO<sub>2</sub> of about 1000 µatm. Seasonal variability was found to be related to water surface temperature and thermal structure of the water column. A major release of CO<sub>2</sub> occurred with the offset of the seasonal stratified period. Likewise, intermittent deepening of the thermocline, caused by sporadic strong winds events, also resulted in relevant rises of the CO<sub>2</sub> flux to the atmosphere along the stratified period. Inter-annual differences in CO<sub>2</sub> air-water fluxes were mainly related to changes in the water residence time and allochthonous carbon loading. Our results show that CO<sub>2</sub> emissions from freshwater ecosystems in general, and reservoirs in particular, may have a pronounced temporal variability which should be carefully considered in the assessment of the role of this component of the global carbon cycle.



**P.15**

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**Sidi Boughaba Lake (NW Morocco): Preliminary ecological diagnosis and proposals for adaptive management**

Located along the Northern Atlantic coast of Morocco, Sidi Boughaba wetlands (a biological reserve and a Ramsar site) are very important for biodiversity, notably for the presence of bird and plant species that are locally and globally threatened. The wetland provides additional services through leisure activities and environmental education at the national level. In the global context, an adaptive management approach, based on an improved knowledge of ecosystem functioning, is required to conserve ecosystem services and functions. In this framework, we have combined paleoecological studies, a baseline assessment of the present ecological status of the lake, and an identification of present and future anthropogenic pressures to develop options for an adaptive management strategy.

Paleoecological studies show that the site experienced important changes in the last 150 years, notably with an increase of the salinity, of the trophic level and of the sedimentation rate. These changes were associated with impacts of urban and agricultural development, in particular through hydrological and hydraulic functioning of the catchment. At present (2009-2010), the lake appears unstable: ongoing anoxic crises, increasing concentrations of salinity, nutrients and phytoplankton. These changes have caused a reduction in water transparency of the loss of submerged rooted macrophytes.

Integrated and intersectoral planning is needed to reconcile land use (agriculture), urbanization, environmental education and biodiversity conservation. An adaptive management process is being initiated that takes the diverse issues of the catchments (restoration of dune systems, management of wastes, management of groundwater resources) into consideration.



**P.16**

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**The status of the southernmost part of large Lake Peipsi (Lake Pihkva): A purification pond and polluter**

Lake Peipsi (3555 km<sup>2</sup>) consists of three different parts: the northern, which is the largest and deepest one (mean depth 8.1 m), eutrophic Lake Peipsi s.s. (*sensu stricto*), and the southernmost part, hypertrophic Lake Pihkva (mean depth 3.8 m), connected with Lake Peipsi s.s. by the river-like Lake Lämmijärv. The research of Lake Pihkva, belonging almost entirely (98.7%) to Russia, has been possible only during Estonian–Russian joint expeditions (2003–2010) in August. About 30 indices from 15 sampling sites enabled evaluation of the variances in the dynamics of phyto- and zooplankton, and of nutrient content in the different parts. Our study demonstrates statistically significant variances in the data regarding hydrochemistry, as well as in zoo- and phytoplankton between the lake parts.

Several essential parameters, characterizing the lake's ecosystem, were considerably higher for Lake Pihkva than for Lake Peipsi s.s.: TP concentration, 3 times; TN -2 times; Chlorophyll *a* - 3 times; biomass of cyanobacteria, 4 times; *Microcystis* - 4 times; *Aphanizomenon* - 4 times; abundance of *Chydorus sphaericus*, 5 times; *Keratella tecta* - 5.5 times; *Trichocerca* - 5.8 times. However, several values were lower in Lake Pihkva than in Lake Peipsi: water transparency, 3 times; N:P ratio, 1.5 times; ratio between zoo- and phytoplanktonbiomasses, 2.3 times; mean weight of zooplankton, 1.5 times; abundance of *Eudiaptomus gracilis*, 1.5 times; *Kellicottia longispina* - 1.7 times. Different natural conditions (topography, catchment area, relative depth) and different pollution loads of the lake parts have resulted in different resistances of their ecosystems and different responses to human activity. The southern part of the lake acts as a purification pond and, at the same time, as a polluter for the other parts of the lake.



**P.17**

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### **Climate change impacts on the Hydrodynamics of the coastal lake of Fogliano (Central Italy)**

One of the effects of climate change in the Mediterranean is the modification of the duration of the summer season. A longer and warmer summer favours an increased growth of submerged vegetation in coastal lagoons. These changes may affect hydrodynamics, a major factor in the processes of accumulation and/or dispersion of pollutants and nutrients. In order to explore these dynamics, we built a finite element hydrodynamic model for the brackish Lake of Fogliano, located on the Tyrrhenian coast of Central Italy. The hydraulic circulation of the lake was simulated considering tidal dynamics through the Foce del Duca channel, wind regime and the distribution of submerged vegetation. Two different scenarios were simulated:

- winter conditions, where tide and wind are the main forces driving hydrodynamics;
- summer conditions, where wide areas of different vegetation species are present.

The results of the model demonstrated that the tidal regime controls the areas closest to the inlet channel, controlling the velocity field in relation to the distance from the channel. The hydraulic circulation in the extreme areas of the lake is controlled by the wind regime that controls water movement. During the summer, the presence of widely distributed submerged vegetation acts to limit the wind-induced hydraulic circulation and dramatically increases the residence time. This reduced circulation and increased residence time favor the accumulation of nutrients and pollutants in the lake. Most importantly, these factors decrease the diffusion of dissolved oxygen into the deeper layers of the water system, creating anoxic conditions near to and in the sediment.



**P.18**

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**Role of wetlands in the lake water quality: Studies at Mill Creek and Victoria Point wetlands, Orillia, Ontario, Canada**

Lake Simcoe, a large lake in central Ontario, has been the focus of research in recent times due to deterioration of its water quality and cold water fishery. Urbanization and changes in land use patterns have resulted in an increased effluent discharge and have been implicated as the causative factors of the deterioration. As part of the broad restoration strategies, studies have been undertaken in two wetlands in the Lake Simcoe watershed, namely Mill Creek and Victoria Point, in order to understand their roles as sink and export of nutrients into Lake Simcoe. Ten sampling locations were identified based on the direction of water flow from the wetlands towards the lake; five each were located at Mill Creek and Victoria Point wetlands, respectively. Water samples were collected on a monthly interval for 15 months from October, 2009. The samples were analyzed for nutrients and other water quality parameters, including chlorophyll *a*. Among the water quality parameters, phosphorus and chlorophyll *a* showed a reduction in the water that left the wetlands, indicating the buffering role of wetlands. However, the concentrations of these parameters were higher in wetland water as compared to that entering the wetland. This showed nutrient regeneration in wetlands from the degrading biomass.

Therefore, wetlands are acting as nutrient filter and nutrient generation systems. Thus, the study provided baseline data suggesting the possibilities of wetlands acting as both nutrient filter and nutrient export system. This study suggests the need to have a constant wetland monitoring strategy, especially on the nutrient outflow into aquatic ecosystems such as lakes. This study also emphasized the need to protect our wetlands to have a natural buffering system of water quality.



**P.19**

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**Temporal distribution of polycyclic aromatic hydrocarbons (PAHs) in Lake Peipsi sediments, Eastern Europe**

The Lake Peipsi system (3555 km<sup>2</sup>) consists of three distinct basins: Lake Peipsi sensu stricto (s.s.), Lake Lämmijärv and Lake Pskovskoye. 1916 was considered to be the beginning of the Estonian oil shale industry in north-east Estonia. There are large power plants operating on oil shale (from 1949), which is a potential source of the pollution to Lake Peipsi and its catchment. By 2002, fly-ash emissions from the power plants had decreased more than 10-fold, compared with maximum rates during the late 1970s. The distribution of 15 individual polycyclic aromatic hydrocarbons (PAHs) was investigated in a <sup>210</sup>Pb dated sediment core from the southern part of Lake Peipsi – Lake Pskovskoye (708 km<sup>2</sup>, mean depth 3.8 m). Observed levels of ΣPAHs ranged between 75 and 345 ng g<sup>-1</sup>. The most persistent PAHs are benzo(b+k)fluoranthene, pyrene and fluoranthene. The top 10 cm of the sediments is the most important layer that contributes to PAHs fluxes, as the PAHs in deeper layers of the core are relatively inactive and stable. The atmospheric transformation and high persistence of the 5–6 ring group of PAHs in sediments suggested that their elevated appearance in the sediments may be used as a time marker (in Estonia ca the 1920s). The distribution patterns of PAHs in Lake Pskovskoye were indicative of dominant contributions from pyrolytic sources, but contained a mixture of petrogenic and pyrolytic profiles. PAHs with 4–5 rings implied petrogenic activity and ranged from 74 to 87% of ΣPAHs which is higher than in a similar existing profile for Lake Peipsi s.s.



**P.20**

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**Phosphorus input into Lake Simcoe: A preliminary study on differentiating human vs. non-human sources using caffeine as a marker**

The Lake Simcoe watershed covers an area of 3,303 km<sup>2</sup> and includes 23 municipalities. There are approximately 35 tributaries emptying water into Lake Simcoe. Lake Simcoe watershed attracts a large cottage population during summer months and therefore supports an active tourism industry. The recent increase in phosphorus concentration in the lake and the depletion of cold water fishery, have resulted in increased monitoring and remedial activities towards restoration of the health of this water system. The strategies mainly include reduction of phosphorus loading, both from point and non-point sources.

Various researchers use differing markers to test and study the health of aquatic ecosystems. These include parameters such as, presence or absence of signature species, variation of their density, the concentration of different chemicals in water or sediment etc.

The present study has tested the possibility of using caffeine as an anthropogenic marker of human originated phosphorus into Lake Simcoe. Water and sediment samples were collected on monthly intervals starting in spring 2010 from 5 different sampling stations in the north-western part of Lake Simcoe. Samples were analyzed for caffeine and nutrient concentrations, total phosphorus and total dissolved phosphorus. The results showed an increased level of caffeine and phosphorus during summer months compared to spring, coinciding with the increased anthropogenic activities. A correlation between caffeine and total phosphorus in the water would lead to using caffeine as a marker for human originated phosphorus in this ecosystem. Once established, caffeine monitoring may be used as an evaluation strategy to pinpoint human-originated phosphorus into aquatic ecosystems.



P.21

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**Planarian–gastropods interactions in benthic food webs and implications for littoral biomanipulation in shallow lakes**

Following the alternate stable state theory for nutrient-rich shallow lakes, control of phytoplankton biomass can be attained by enhancing macrophytes through the biomanipulation of littoral benthic food webs. Focus is often on gastropod grazers, which remove the periphyton that limits macrophyte access to light and nutrients, and their predators.

We have run a series of laboratory experiments targeting poorly known aspects of planarian–gastropod interactions. *Dugesiid planarias* include snails in their diets. Predation on intact snail egg clutches remained low in the presence of the common dugesiid *Dugesia* (= *Schmidtea*) *polychroa*. Of the eight snail species tested, only *Planorbis planorbis* suffered nonnegligible predation, with ~40% of its pre-hatching eggs lost to *D. polychroa*.

*D. polychroa* predation on snails at different stages of their life cycles remained similarly low in separate multiple-choice trials, with a total of 132 attacks, of which only 10 out of the possible 1200 were successful,. However, *Physa acuta* bore the brunt of planarian predation with 5 losses, all newborns and juveniles. *D. polychroa* and *P. acuta* also exhibited the highest overlap in diel activity among the species tested in independent experiments.

A high-replicate laboratory experiment was run with *D. polychroa* and size-structured *P. acuta* populations. *D. polychroa* immediately reduced the density of newborns, and then decreased oviposition and eventually attacked larger, reproductive-age snails. All *P. acuta* populations in planarian-present aquaria went extinct within six weeks.

Our results support the view that dugesiid planarias act more as scavengers than predators on snails, with limited effects at population scale. However, active predation by *D. polychroa* may effectively prevent the (re)establishment of small *P. acuta* populations in hard-substratum habitats. The available information suggests that most snails may exert their beneficial effects on macrophytes in soft-bottom, productive shallow lakes regardless of dugesiid presence or absence.



P.22

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**Long-term effects of sea water acidification on physiological responses of juvenile bivalves *Mytilus galloprovincialis* and *Chamelea gallina***

Human activities are responsible for the increment in CO<sub>2</sub> atmospheric concentration, resulting in global warming and increasing acidification of oceans. In order to compare effects of acidification on physiological responses of juveniles of two bivalves species, *Mytilus galloprovincialis* and *Chamelea gallina*, an experimental outdoor flow-through plant was set up, fed with sea water from the lagoon of Venice. Six tanks (3 for control and 3 for treatment conditions) were used. 400 mussel and 600 clam juveniles per tank were exposed to two pH levels (lagoon water pH as control, and 7.4 pH as treatment) from October 2009 to April 2010. Environmental parameters were monitored daily, while bivalve growth (length and weight) and mortality were evaluated monthly.

At the end of the experiment, physiological parameters (respiration, clearance and excretion rates) and condition index were measured. In mussels, byssal thread formation was also evaluated. In both species, mortality was very low during winter periods, but significantly increased during the last month of the experiment. Length, weight and condition index significantly decreased in *C. gallina*, whereas no difference between treated and control mussels was highlighted. The results show that physiological responses were affected by low pH. In particular, clearance rate decreased significantly in both species, whereas excretion rate increased, although significantly in *C. gallina* only. Respiration rate did not show any significant variation. The mean number of byssal threads also decreased significantly in treated mussels. Our results suggest that *C. gallina* is less tolerant than *M. galloprovincialis* to the stress conditions considered, and its populations may be more threatened in future climate change scenarios.



P.31

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**The recent introduction of *Lamprichthys tanganicanus* in Lake Kivu (Eastern Africa): a threat for pelagic fishery?**

The introduction of *Limnothrissa miodon*, the “Tanganyika sardine”, in 1959 allowed the development of a pelagic fishery in Lake Kivu, with an annual yield of ca. 10000 tons. Until recently, the sardine was the only fish species in the pelagic zone, but this has changed since *Lamprichthys tanganicanus*, another endemic fish to Lake Tanganyika, has been found in the fishermen’s catches. In order to assess possible interspecific competition, experimental catches were conducted in the littoral and the pelagic zone of the lake. The utilisation of the lake resources by both species was studied using gut content analyses and stable isotopes signatures. The results show that *Lamprichthys* has colonized the littoral and the pelagic zone, and that it fed mainly on mesozoplankton offshore, resulting in substantial diet overlap with *Limnothrissa*. Diet overlap was somewhat reduced inshore. According to stable isotopes studies, *Limnothrissa* and *Lamprichthys* occupy a similar trophic position, but differences in  $\delta^{13}\text{C}$  signature show that *Lamprichthys* partly relies on littoral resources (benthic algae and invertebrates), whereas *Limnothrissa* essentially consumes pelagic resources. However, the expansion of the invader in the pelagic zone, where it uses the same planktonic resource as the sardine, raises concern about the future of the fishery.



P.23

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### **Causes and consequences of *Elodea canadensis* invasion in Steinsfjord, Norway — implications for macrophyte and lake management**

The macrophyte community of (Lake) Steinsfjord, a large, clear-water, oligo-mesotrophic lake in southeastern Norway, has been studied in detail since the 1970s, when the now red-list species *Najas flexilis* was one of the most common species of a low-density, equitable assemblage.

The North-American native macrophyte *Elodea canadensis* has dominated the macrophyte community of Steinsfjord since its inception in 1978 and biomass peak in 1984. *E. canadensis* significantly increased its depth range since 1978-80, but the cover-weighted mean depth has remained unchanged through 2004 (the year of the last large-scale quantitative survey), suggesting that 3–4 m is its optimal depth in Steinsfjord.

Species richness (total number of taxa) and maximum colonization depth have not changed much since before the *E. canadensis* invasion, though total vegetation density has dramatically increased since. Quadrat-based richness had decreased in shallow (<2 m) and intermediately deep waters (2–4 m) and increased in deep waters (4–6 m) by 2004.

*E. canadensis* colonization and establishment were apparently favored by space availability at intermediate depths and hampered by water level fluctuations and waterfowl grazing in shallow waters, where the unpalatable *Myriophyllum alterniflorum* has continued to thrive.

*Potamogeton pusillus* was common in 1976-80, when its spatial distribution overlapped significantly with that of *E. canadensis* at mid-depth. The mean depths of most common taxa in 1976-80 overlapped with *E. canadensis*'s. The taxa that "moved away" from *E. canadensis* have maintained or increased their presence in Steinsfjord (*Chara globularis*, *Potamogeton berchtoldii*, *P. crispus*, *P. perfoliatus*); those apparently unable to shift their mean depth have become rare (*N. flexilis*, *Callitriche hermaphroditica*) or locally extinct (*P. pusillus*).

Most of the changes in the Steinsfjord macrophyte community since colonization by *E. canadensis* were dramatic and rapid, stressing the importance for large-scale management of prevention of aggressive invasive plants such as *E. canadensis*.



**P.24**

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**Water resources in Romania and their quality in the main lacustrine basins**

For each region, river basin and aquatic surface, the quality of the lacustrine waters have been studied, in order to use them in different fields of activity, as well as a life support for the biologic component. The seasonal campaign for 10 years had the complex characterization of lacustrine waters quality as a main purpose, by interpreting the results of the field measurements with reference to their classification in quality classes.

Lakes in Romania are relatively evenly distributed in most physical-geographical regions. A low density is specific to the West, where powerful drainage works (Banato Field-Crisana) have been undertaken. The highest lacustrine density is typical of the Northeast, with numerous ponds (in the Moldavian Plain), recorded from the fourteenth and fifteenth centuries onwards. One hundred and thirty-six lakes have been analyzed, sufficient to cover the entire surface of Romania and portray the actual state of lake water quality. Most lakes in Romania, especially those analyzed in this study, are naturally anthropogenic. Those of large dimensions are located in the mountains or along the Danube. Most natural lakes are small and have no environmental or economic importance (except along the coastal plain and the Danube). The lakes analyzed, although situated in different physical and geographical conditions, fall, in the majority of cases, into the category of good water in terms of quality (class I) and eutrophic, hypertrophic or mesotrophic, in terms of trophicity. Due to the fact that most are man-made, it is clear that they are artificially maintained at this point. Most mountain lakes, or the volcanic units, are ultra-oligotrophic or oligotrophic and most lakes which supply water are heavily used in the main settlements and agriculture.



P.25

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### **Water Chemistry of two High Mountain Lakes and their catchments' lithology**

During the last glacial pulses, the height and hardness of huge ice sheets on mountain locations broke the soil during their movement creating hollows. Some of those hollows were refilled with melted water during the glacier retreat becoming High Mountain Lakes. Thus topography, configuration and the nature of bottom materials vary considerably from lake to lake. Lakes meet with both the atmosphere and the underlying material of their terrestrial basins and interact with each. Lake water physicochemical properties are of high importance to most lake processes.

The primary focus of this work was to study the physicochemical water properties of lakes and to establish relations with their catchments' lithology. Two high mountain lakes located in the Spanish Pyrenees were selected for this study Sabocos and Baños. Both are very similar in location, height, and size but their catchments have very different lithology. Water sampling was conducted seasonally during an annual cycle and samples analysed were formed by integrating lake water taken at different heights in a water column at the deepest part of the lake. Local geological information was compiled from available bibliography.

Results showed that local lithology greatly determined the chemical composition of water in high mountain lakes. Main elements found in lake waters matched the main constituents of their basins, probably transported to the lake by rivers and streams from the local drainage basin. This determines lake water physicochemical properties, which is of high importance to most lake processes. Thus, local basin composition was found to be one of the main determinants of lake water physicochemical properties.



**P.26**

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### **Seasonal variability of water chemistry in Astún's High Mountain Lake**

Seasonal changes cool or warm the surface water of lakes. As water density depends on temperature, it causes water density variations and thus water movement until stability is achieved. This is termed overturn of lake waters. When stable conditions are set, lakes often stratify in terms of light penetration, temperature range, and oxygen concentration. Such gradations from top to bottom profoundly affect the life of lakes in terms of distribution and adaptation. In temperate regions that cool below 4 °C in winter, lakes used to experience spring and fall overturns of water and summer and winter stratification.

The primary focus of this study is to report the variability of water chemistry related to seasonal changes in the physical conditions in Astún's high mountain lake. The lake was sampled at different depths and water physicochemical properties were analysed seasonally in order to determine the processes occurring.

In agreement with results obtained, it can be confirmed that Astún Lake is a dimictic lake and experiences water overturn twice a year. It stratifies during the winter period due to ice and snow cover based on a negative thermocline. Meanwhile, in the summer a gentle positive thermocline is established, but no epilimnion and hypolimnion are formed because Astún Lake is very shallow. Thus, anoxic conditions are never reached.



**P.27**

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**Study of heavy metals (copper, zinc) in *Chironomidae* and *Gammarus plux*, Namrood River, Province Tehran**

In this study, the Namrood River, located in Firoozkooh, Tehran, was assessed regarding the existence of heavy metals. Since the Namrood River is situated on the route of Firoozkooh Road and influenced by pollutants such as tourist and recreational centers, gas stations, sewage from the villages in the vicinity, agricultural wastewater and fish culture workshops, its water is extremely contaminated in some parts and possibly contains heavy metals. After carrying out the study, two stations located upriver and downriver were determined from which to sample the sediment,s as well as *Chironomidae* and *Gammarus plux* in both cold and hot seasons of the year (middle of March and middle of August). Each stage of sampling contained 3 repetitions.

The measured heavy metals were copper and zinc. The results showed that copper concentrations in the samples ranged from 0.170 ppm to 0.966 ppm, while zinc concentrations ranged from 0.1872 ppm to 3.8467 ppm.

Such results also indicated that upriver station sediments had the most copper concentration among the samples in both seasons of the year. The largest concentration of zinc in the sediments of the upriver station was in the cold season of the year. Analysis of the data was performed using EXCEL and SPSS, One-way Anova Variance Analysis as well as DUNCAN and LSD complementary tests with the significant quotient of  $P < 0.05$ .



P.28

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**Temporal and spatial variability of chlorophyll *a* and TSM concentration in Taihu Lake using time series MODIS Data**

Based on *in situ* water sampling and reflectance measurements, the universal algorithms to derive synoptic maps of water constituents (chlorophyll *a* and TSM) of Taihu Lake (located in eastern China) from concurrent time series MODIS data have been developed. The results indicate that time series MODIS data could effectively be used to determine the temporal and spatial distribution of chlorophyll *a* and TSM concentration for Case 2 inland water, and the accuracy and stability of our models demonstrate the potential of an empirical model used to derive synoptic maps of water constituents over a long period of time.

In our study, there was a significant relationship ( $r^2=0.907$ ) between measured chlorophyll *a* concentrations and time series band 2 MODIS data. Consequently, a common empirical algorithm was developed to retrieve distribution of chlorophyll *a*. The seasonal and inter-annual variability of chlorophyll *a* concentration was then examined using Empirical Orthogonal Function (EOF) analysis. The results revealed the significance of the first four modes, explaining 54.0% of the total chlorophyll *a* variance, and indicated the frequency of algal blooms in northern bays during the summer. The duration of algal blooms was from April to December of 2007, which was different from that in 2006 and 2008.

Furthermore, we found a good relationship ( $r=0.8736$ ) between measured TSM concentrations and MODIS band 3 and band 1, which is consistent with the conclusions of previous studies. The model performance indicated that this empirical model could map TSM concentrations successfully, except when TSM concentration is higher than  $200 \text{ mg l}^{-1}$ . Synoptic maps of model-estimated TSM of 2007 showed that TSM in the central lake and southern lakeshore were consistently higher than in other regions, while TSM in east Taihu was generally the lowest among the regions throughout the year. Moreover, a wide range of TSM concentrations appeared from winter to summer.



**P.29**

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**Study of phytoplankton community in Tajan River and its relationship with physicochemical parameters of water**

The region of study consists of Tajan estuarine region as one of the sub-basins of the Caspian Sea which covers a surface of 2 km<sup>2</sup>. In this assessment, 6 riverine, estuarine and marine stations were chosen in which non-biotic parameters such as temperature; salinity, dissolved oxygen, pH and nutrients, and biotic parameters such as variation, density, and plankton were sampled and measured monthly. The most important and dominant planktonic groups in this region included Bacillariophyta. Assessing the annual variation in these three riverine, estuarine and marine regions, phytoplankton with 3.1 showed the most density in the estuarine region. Assessing the annual density, phytoplankton (6,118,967 no. in m<sup>3</sup>) showed the most density in the marine region. The statistical tests determined that the estuarine and riverine regions had a significant difference in planktonic density ( $p < 0.005$ ) compared with the marine region. Toon test and one-way variance analysis showed that in assessing the planktonic groups ( $p < 0.005$ ) there was a significant difference in variation index between river and estuary, and estuary with the sea.

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# AQUATIC ECOSYSTEM HEALTH & MANAGEMENT

*The official Journal of the Aquatic Ecosystem Health & Management Society*

**A peer reviewed international journal published quarterly which is devoted to understanding ecosystem performance, function and management from integrated, multi-disciplinary and sustainable perspectives.**

## Objectives:

The major objective of the Journal is to promote an understanding of the structure, function and performance of healthy and damaged ecosystems (freshwater, marine, estuarine) from integrated, multi-disciplinary and sustainable perspectives. The Journal focuses on the development and application of management practices that will protect, maintain or restore the health of ecosystems.

The AEHMS recognizes the need to explore the complex interactions between human society, ecology, economy/development, politics and the environment. It also encourages a watershed approach, acknowledging that aquatic ecosystems are influenced by atmospheric and terrestrial processes, both natural and anthropogenic.

The Journal provides a forum for the assessment and discussion of ecosystemic, integrated approaches to aquatic ecosystem research and management. This includes concepts and approaches that address health, integrity, performance, efficiency, remediation, restoration recovery, conservation, sustainable human use and development. This Journal seeks to foster international and cross-sectorial exchange of information among scientists, academicians, managers, engineers, doctors, lawyers, citizens, business, industry, politicians and governments on the health and sustainability of global aquatic resources.

## Scope:

Aquatic Ecosystem Health & Management (AEHM) will publish:

- peer-reviewed original papers
- state of the art reviews and critiques on current issues
- invited perspective essays
- short, communications dealing with concepts, techniques and ideas warranting rapid publication
- special issues devoted to selected themes, approaches, ecosystem types and ecotechnologies



## Representative Topics:

- Integrated and ecosystemic approaches to management
- Assessment of the effects of the onset and cessation of anthropogenic perturbations on the health and integrity of food webs
- Bioassessment/biomonitoring techniques, protocols and other diagnostic tools that enhance the understanding of the ecosystem performance, resilience, response and recovery processes
- Development and modification of early warning indicators and diagnostic methods for a better understanding of ecosystem health, resilience, functioning and evaluation of management practices
- Development of environmental and habitat guidelines, aquatic quality guidelines, remedial actions, innovative management strategies, and monitoring protocols for the restoration of impacted ecosystems and the maintenance of healthy systems
- Evaluation of the cumulative effects of large scale perturbations and activities such as damming, dredging, river diversions and water transport
- Technologies for the reclamation of highly-damaged or poorly-utilized areas including war-affected regions
- Application and integration of various disciplines such as ecology, toxicology, limnology, fisheries, statistics, modeling and environmental risk assessment towards the assessment of ecosystem health.

*“The Instructions for the Preparation of the Manuscript” can be found at [www.aehms.org](http://www.aehms.org).  
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***Dr. M. Munawar, Chief Editor***

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*Dr. M. Munawar, Series Editor*

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