La risposta della ricerca CNR alle sfide ambientali

Le attività di ricerca dell'ISE nel contesto nazionale ed internazionale

Marina M. Manca

Roma, 21 Dicembre 2015

National Research Council

Institute of Ecosystem Study

Dynamics, conservation and management of ecosystems

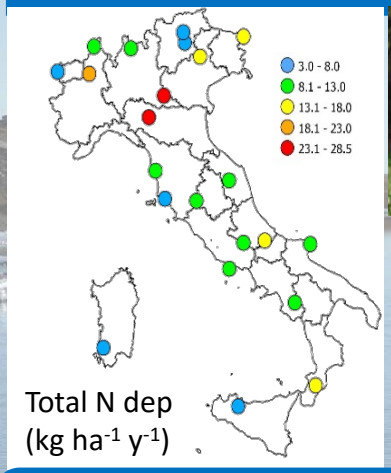
Mission

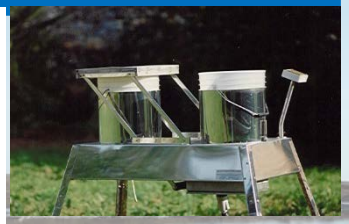
Basic and applied research into the structure and function of freshwater and terrestrial ecosystems, taking account of **anthropogenic pressure** and **climate change**.

Aim: to acquire scientific knowledge for **management actions** being developed by environmental agencies to protect **ecosystems** from new damage and help them **recover** from historical damage.

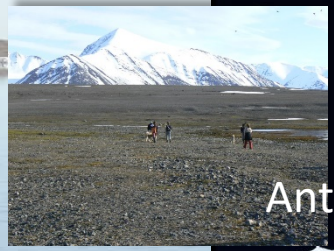
Impacts of Global Change

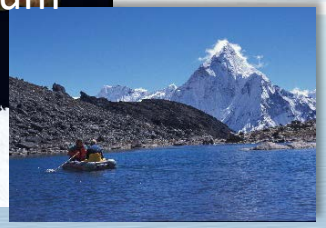
Atmospheric deposition effects on forest, soil and waters



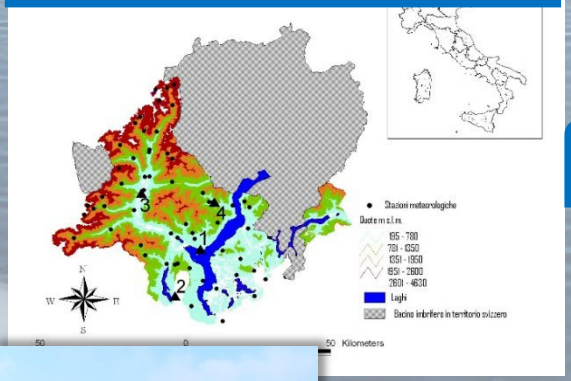


Ecosystems in remote areas

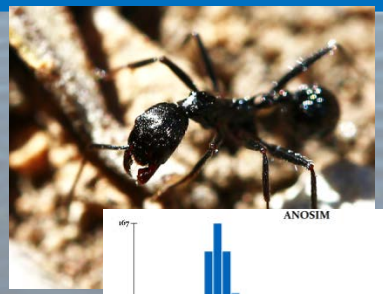


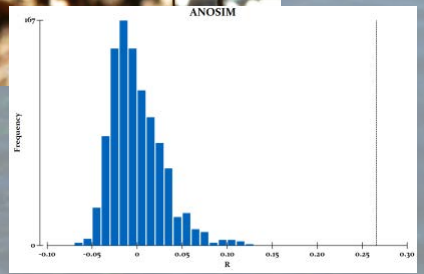


Climatology and hydrology

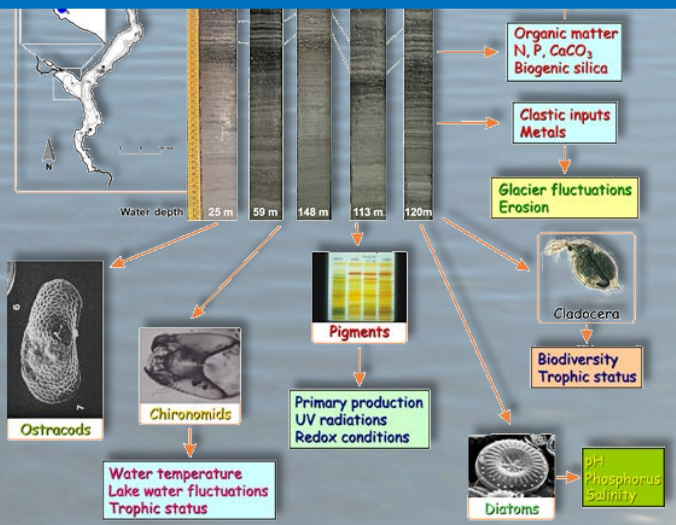


Effects on soil communities





Palaeolimnology – lake archives

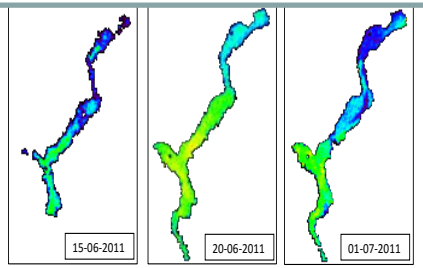


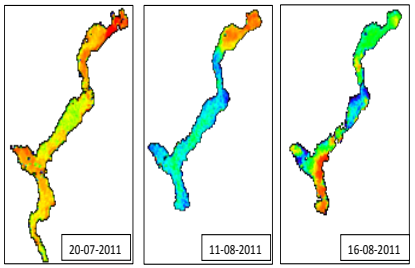
Global changes - Challenges

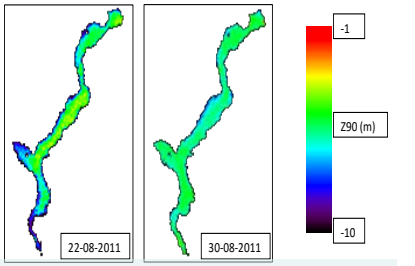
- Quantifying the **distribution in the ecosystems** of compounds deriving from air pollutants (e.g., nitrate, ammonium, volatile organic compounds) and carried by atmospheric deposition;
- Estimating effects at **ecosystem level**, and evaluating the efficacy of current emission control strategy and/or the need of new policies;
- Disentangling the effect of **direct human impact** from **climate-driven effects** in order to identify sound mitigation strategy;
- Assessing the role of the thawing cryosphere (glaciers, permafrost) on soil and water quality and on biodiversity in **remote areas**;
- Using **natural archives** to infer environmental condition during past periods of fast environmental changes;
- Estimating climate-driven variability in the structure and function of pristine ecosystems, and in the restoration targets (i.e. "**reference conditions**") of impacted ecosystems.

Research Project founded by National Programme of Antarctic Research (PRNA) Ministero dell'Istruzione, dell'Università e della Ricerca 2013-2015.
- *Development of a portable Fluorosensor for investigation on microbial communities in terrestrial environments polar* (**SFIDA**).

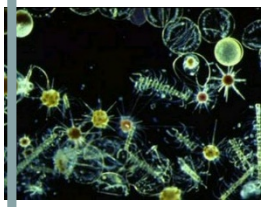
Research Project founded by National Programme of Antarctic Research (PRNA) Ministero dell'Istruzione, dell'Università e della Ricerca 2013-2015
- *Structure, function, development of Biological Soil Crusts (BSC) in the polar regions: contribution to the understanding of the ecological role of the BSC on a planetary scale* (**WHYCRUST**).

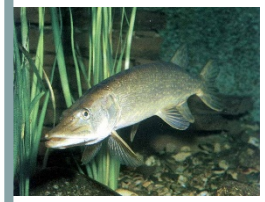


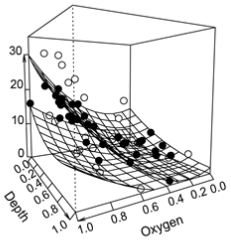




Remote sensing of phytoplankton blooms

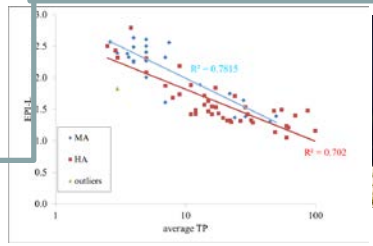


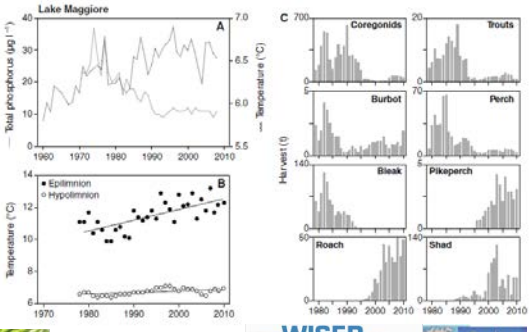


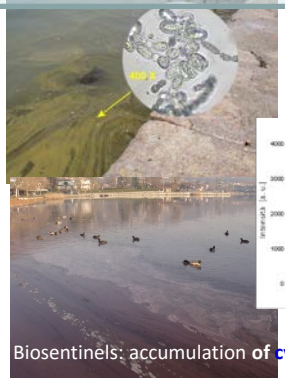


Graphical representation of quantile regression models.

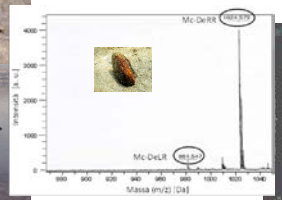
Aquatic Ecosystems

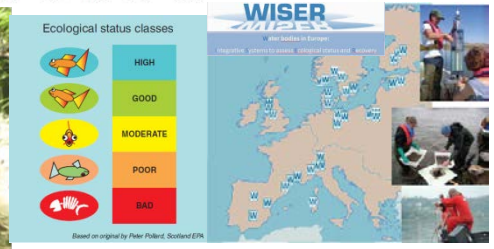






Biosentinels: accumulation of cyanotoxins





Tools and techniques to the implementation of the EU-WFD

European Water Framework Directive 2000/60 EC

States that…

Water is not a commercial product like other goods, but a heritage that must be protected and preserved;

It is necessary to develop a common European Policy for freshwaters;

Water supply is a service of a general social interest;

A good water quality will contribute in providing drinking water supply to most of people.

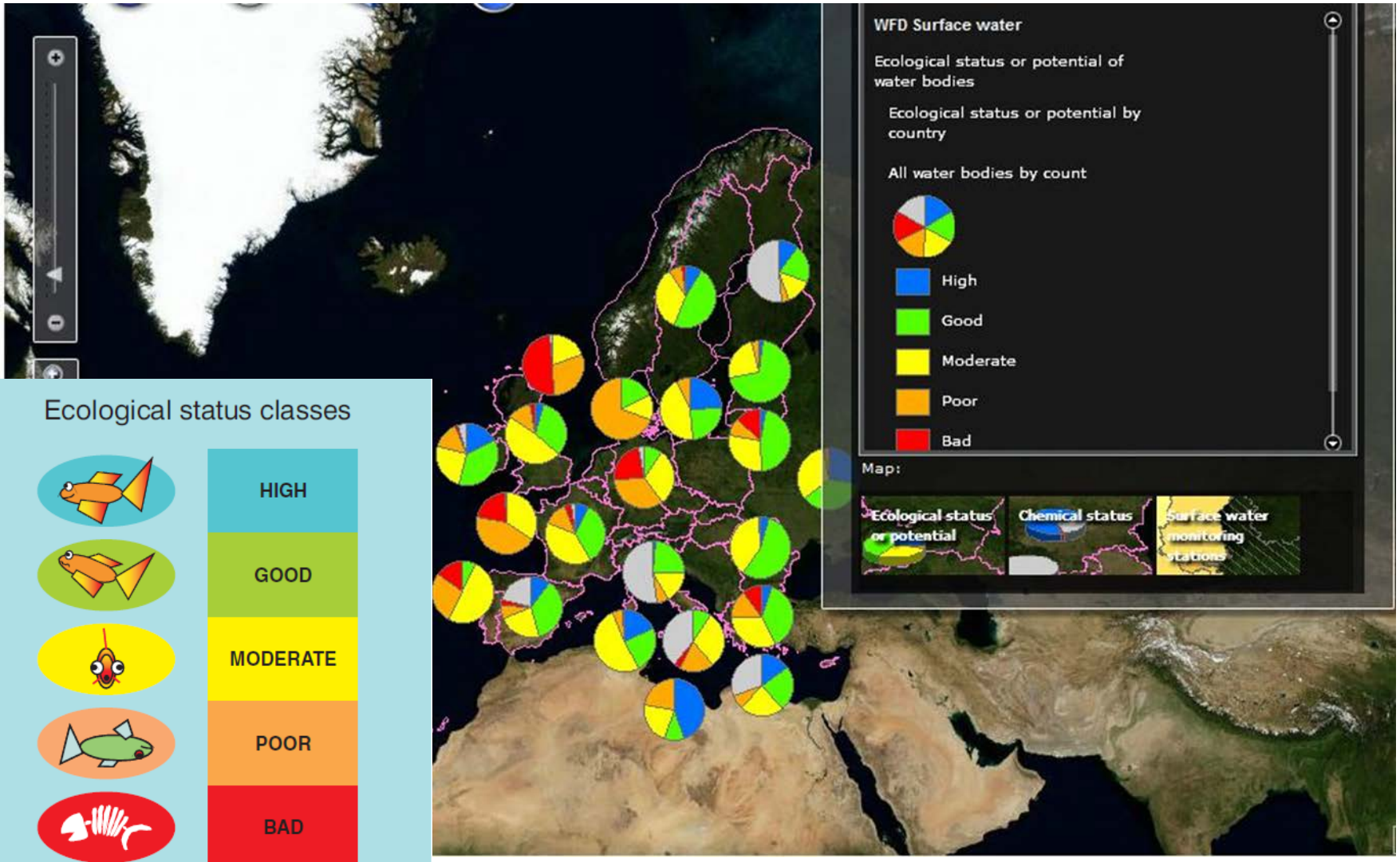
With the aim to…

Avoid further worsening of freshwater ecosystems, protect and improve their status;

Promote a sustainable use of water resources, based on the long-term protection of available water sources and ecosystems.

European Water Framework Directive (WFD 2000/60 EC)
Development of biological indices to assess lake ecological quality

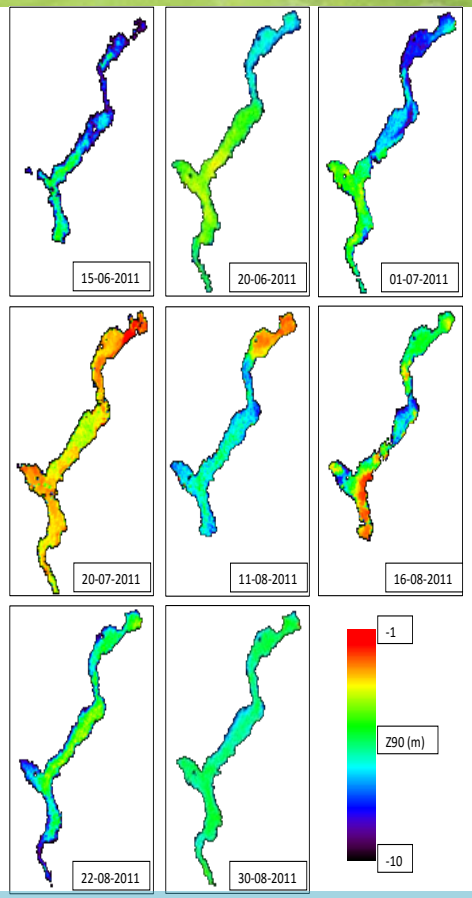
Intercalibration at European level



Aquatic ecology- Challenges

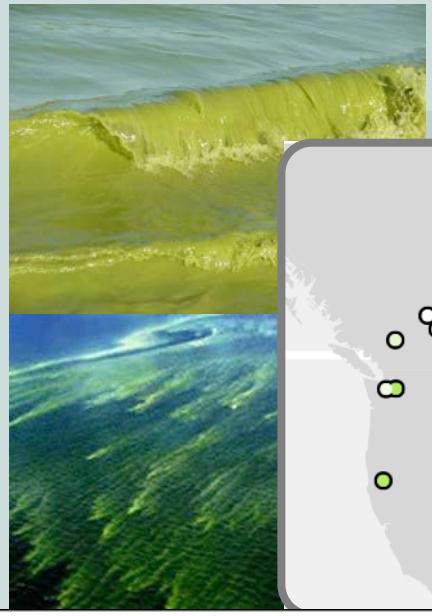
- Metrics, reference values and class boundaries should take account of climate change;
- Pay greater attention to ecosystem functioning and trophic interactions;
- Better metrics for Eastern and Mediterranean regions needed;
- More metrics needed for reservoirs (HMWBs);
- Linking ecological status in lakes to ecosystem services: events like blooms of **toxic cyanobacteria** can seriously impact the use of water for human needs;

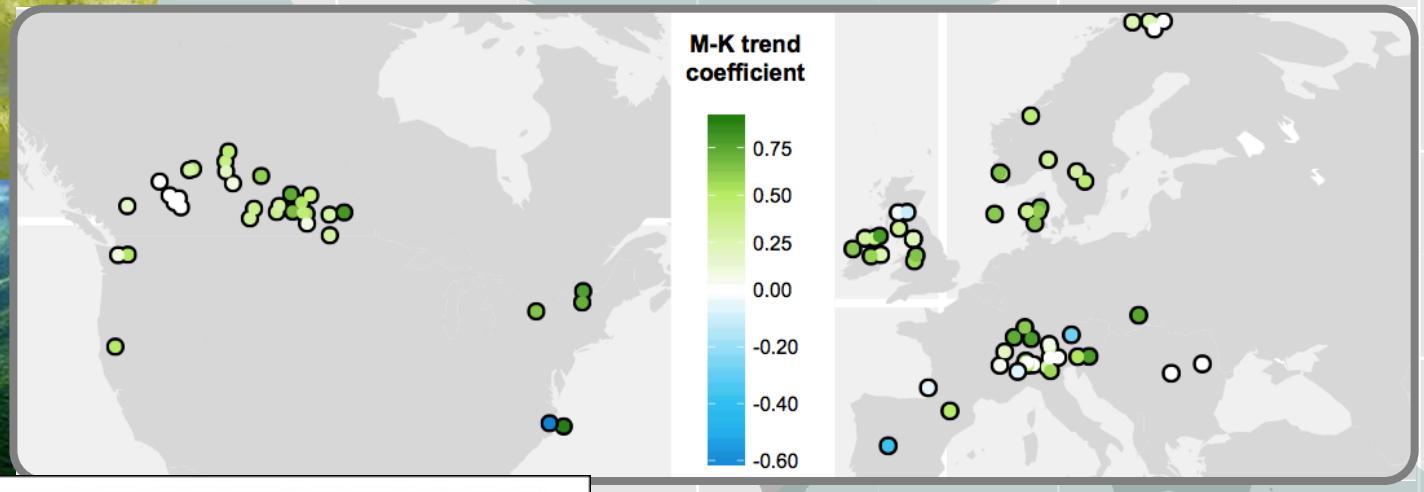
- Reaching good ecological status;
- Including so far neglected ecosystem components e.g. ZOOPLANKTON;
- Redefining criteria for assessing sensitivity in e.g. groundwater species;
- Assessing biodiversity by applying molecular techniques (e.g. barcoding and metabarcoding).



Remote sensing of phytoplankton blooms

Challenge: controlling global expansion of cyanobacteria





ECOLOGY LETTERS

Ecology Letters, (2015) doi: 10.1111/ele.12420

LETTER

Acceleration of cyanobacterial dominance in north temperate-subarctic lakes during the Anthropocene

Zofia E. Taranu,[1,2]* Irene Gregory-Eaves,[1,2] Peter R. Leavitt,[3] Lynda Bunting,[3] Teresa Buchaca,[4] Jordi Catalan,[4,5] Isabelle Domaizon,[6] Piero Guilizzoni,[7] Andrea Lami,[7] Suzanne McGowan,[8,9] Heather Moorhouse,[8] Giuseppe Morabito,[7] Frances R. Pick,[10] Mark A. Stevenson,[8] Patrick L. Thompson[1] and Rolf D.Vinebrooke[11]

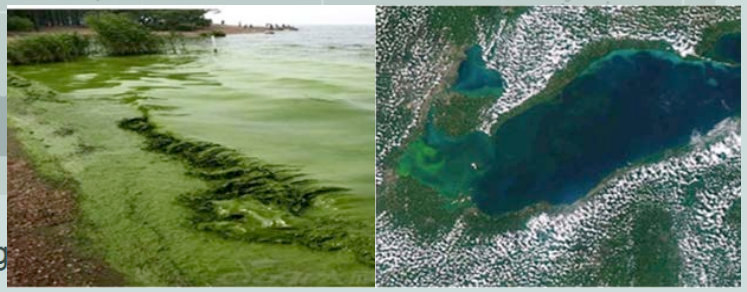
Abstract

Increases in atmospheric temperature and nutrients from land are thought to be promoting the expansion of harmful cyanobacteria in lakes worldwide, yet to date there has been no quantitative synthesis of long-term trends. To test whether cyanobacteria have increased in abundance over the past ~ 200 years and evaluate the relative influence of potential causal mechanisms, we synthesised 108 highly resolved sedimentary time series and 18 decadal-scale monitoring records from north temperate-subarctic lakes. We demonstrate that: (1) cyanobacteria have increased significantly since *c.* 1800 CE, (2) they have increased disproportionately relative to other phytoplankton, and (3) cyanobacteria increased more rapidly post *c.* 1945 CE. Variation among lakes in the rates of increase was explained best by nutrient concentration (phosphorus and nitrogen), and temperature was of secondary importance. Although cyanobacterial biomass has declined in some managed lakes with reduced nutrient influx, the larger spatio-temporal scale of sedimentary records show continued increases in cyanobacteria throughout the north temperate-subarctic regions.

Keywords

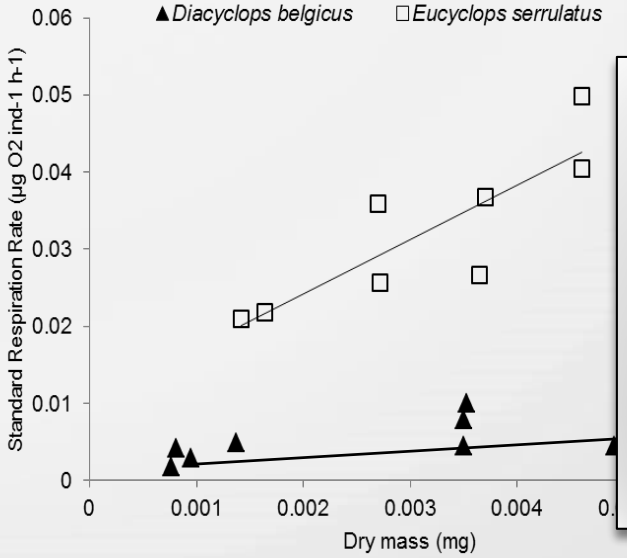
Anthropocene, climate change, cyanobacteria, eutrophication, long-term trends, meta-analysis, paleolimnology, regression tree.

Ecology Letters (2015)

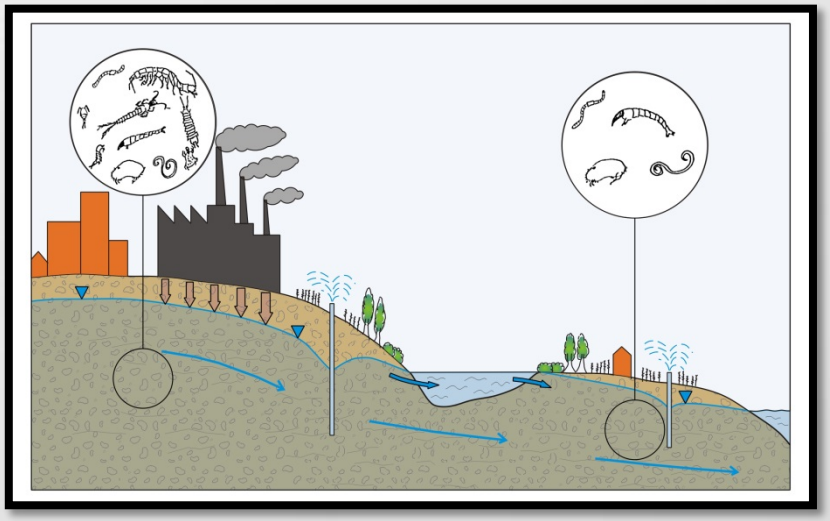


Challenge: improving the EU approach for the ecological risk assessment in groundwater bodies

According to Annex V of the WFD, the base set of taxa that should be used in setting EQSs for freshwater bodies are algae and/or macrophytes, Daphnia and fish. We warn about using surfacewater species to infer the sensitivity of groundwater relatives, due to the relevant difference in the sensitivity.



The respiratory metabolism of groundwater species are 5 times lower than those of their surface water relatives. The lower metabolism delay the onset of defense mechanisms against a toxic and can be advocated as the reason of the high sensitivity of groundwater species.

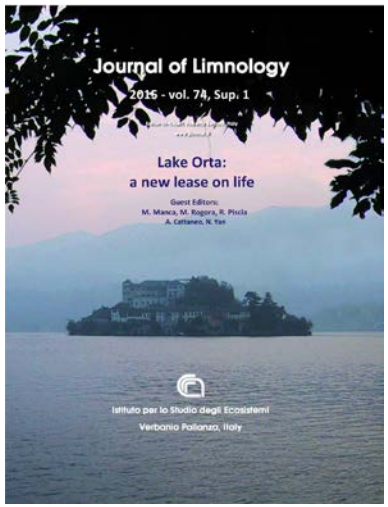


Groundwater copepod species (dominant in groundwater bodies) are 37 times more sensitive to some pollutants, such as ionized ammonia, than their surfacewater relative under 21-day exposure.

Lake Orta: a new challenge for geo-engineering

- Lake Orta is a «living lab»: key questions related to the **biotic recolonization** can be addressed by **integrated studies**;

- Lake Orta still lacks a pelagic fish community (VOLTA, 2015) and **key species** necessary for a **GOOD QUALITY status** according to international standards (e.g. WFD).



PREFACE to Orta special volume:

What have we learned about ecological recovery from liming interventions of acid lakes in Canada and Italy?

Marina MANCA, Norman D. YAN[2]

Challenge: sustainable fishing

CNR Consiglio Nazionale delle Ricerche

ISE Istituto per lo Studio degli Ecosistemi

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

IRSA CNR

Fish fauna monitoring in lakes: mandatory or even useful?

«Research as a tool for freshwater management»

EXPO ACQUAE VENEZIA

September 8th , 2015

Sustainable fishing in Inland Waters

Overfishing - A global disaster

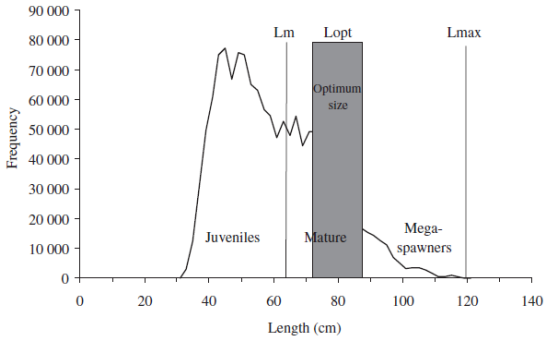
CNR Consiglio Nazionale delle Ricerche — ISE Istituto per lo Studio degli Ecosistemi

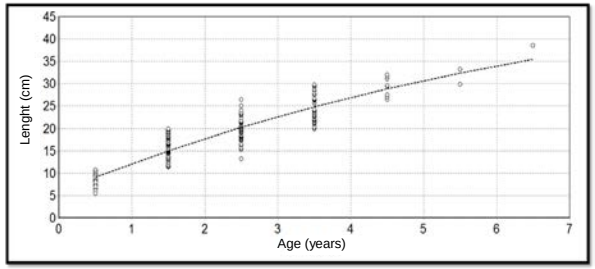
PARCO NAZIONALE ValGrande

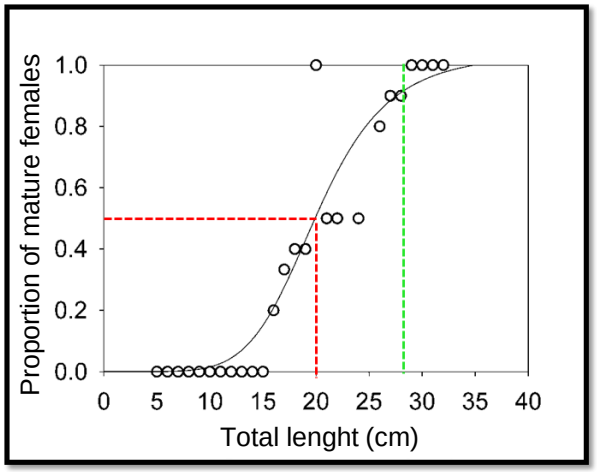
Corpo Forestale dello Stato

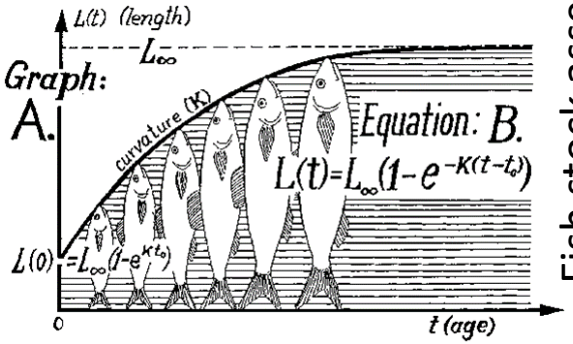
Fish stock assessment in Val Grande National Park

1. Let them spawn! (at least once)
2. Let them growth! (capture at L_{opt})
3. Let megaspawners live! (>20% in number)

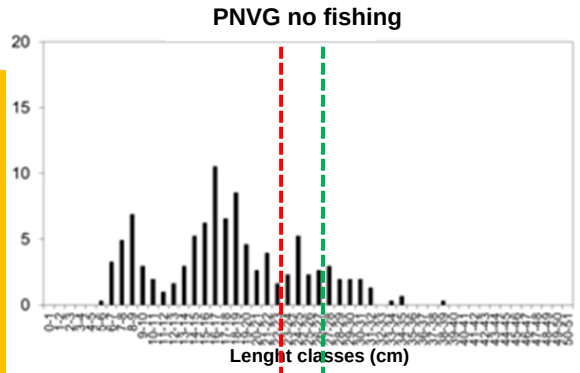


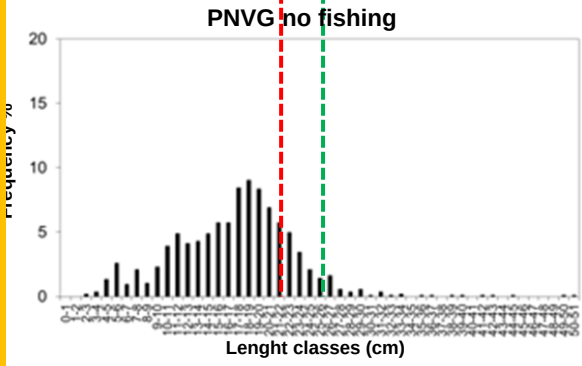






Length at 50% of maturity = L_m = 20 cm
Length at 100% of maturity = 28 cm
Optimum lenght of capture = L_{opt} = 27 cm ± 2.2

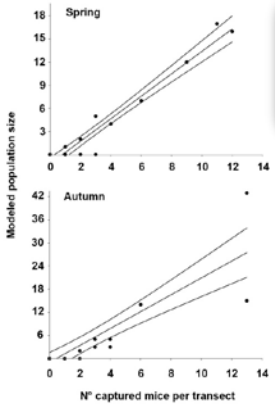




New fish management Plan

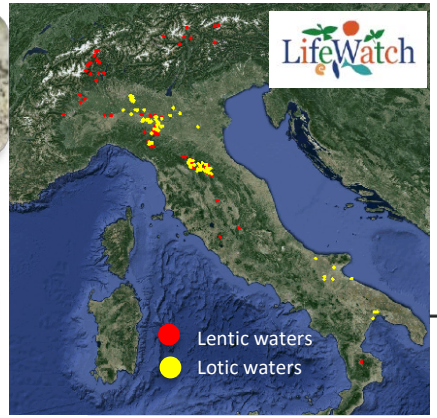
New minimum catchable size
No-kill areas
New fishing areas

Relationship between abundance indices and models of population densities of rodents



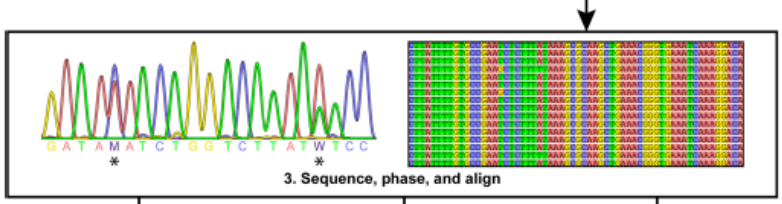
Procambarus clarkii

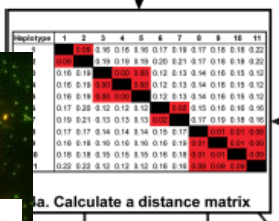
Dreissena polymorpha

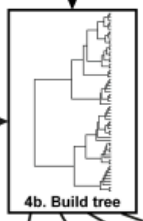


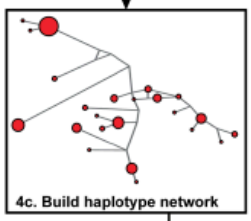
LTER europe

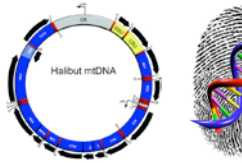
Biodiversity

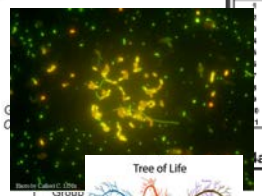


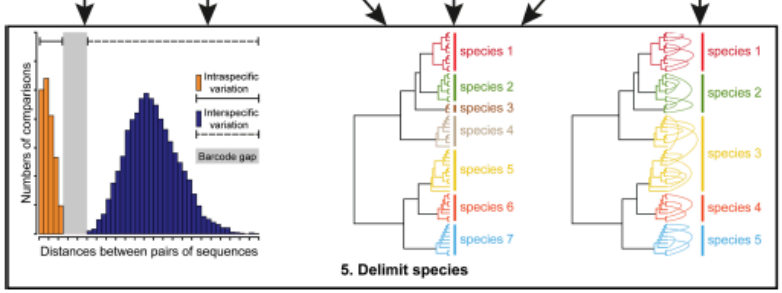








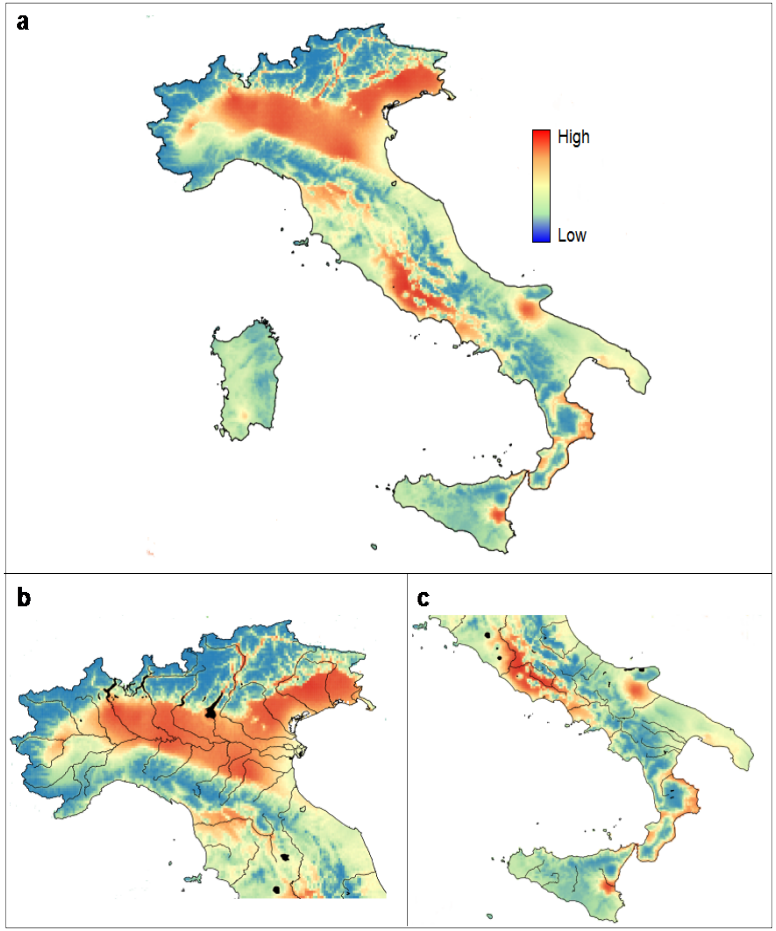




Biodiversity challenges: invasion risk maps

- Invasion biology research often focuses on single alien taxon or group of related species (i.e. genera, families, orders)
- The availability of the large LifeWatch database allows to test generalized invasion patterns through a **macroecological approach**:
  - Multiple taxa
  - Multiple habitat
  - Multiple sites

The model was developed to explain Alien Species occurrence through local **air temperature**, **precipitation amount**, and **site accessibility**. It considers simultaneously different taxa and habitats, giving a picture of **invasion dynamics** not related to a single species.
In practice, the model is useful to create **invasion risk maps** for the entire peninsula.



THE MULTIPLE ASPECTS OF BIODIVERSITY: GENETICS AND ECOLOGY

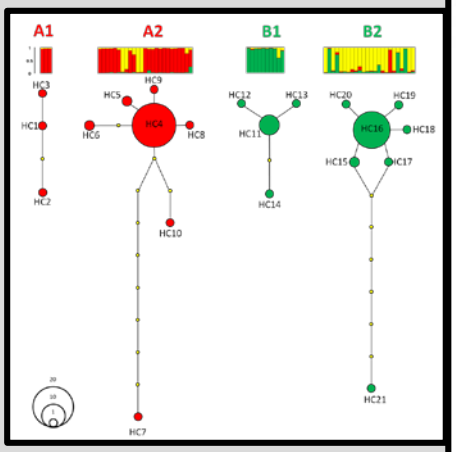
Bivalves in Lake Maggiore:

Taxonomy

Alien species: *Dreissena polymorpha*
Corbicula fluminea
Sinanodonta woodiana

Native species: *Unio elongatulus*
Anodonta spp
(4 lineages)

Genetics



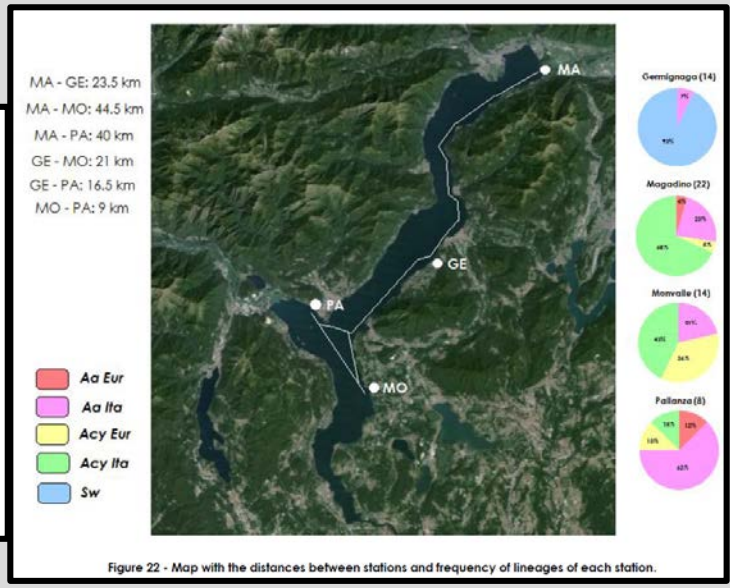
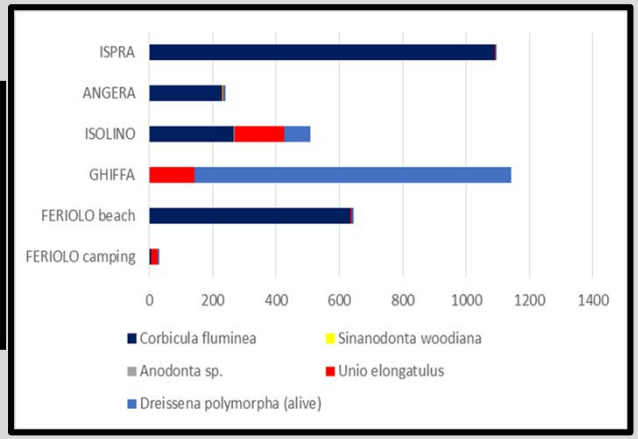


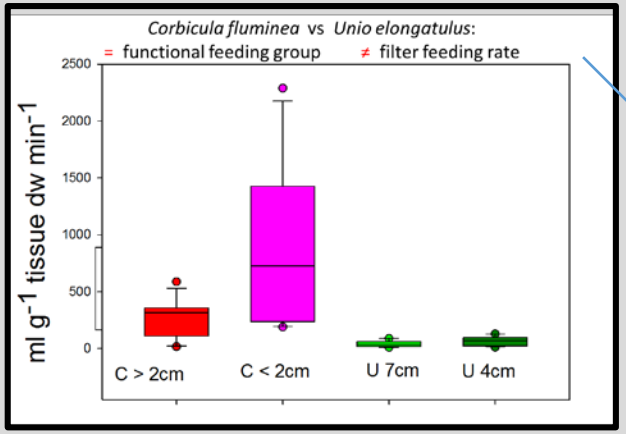
Figure 22 - Map with the distances between stations and frequency of lineages of each station.

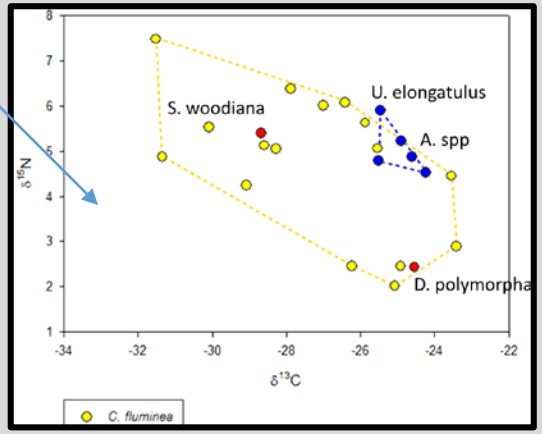
Ecology

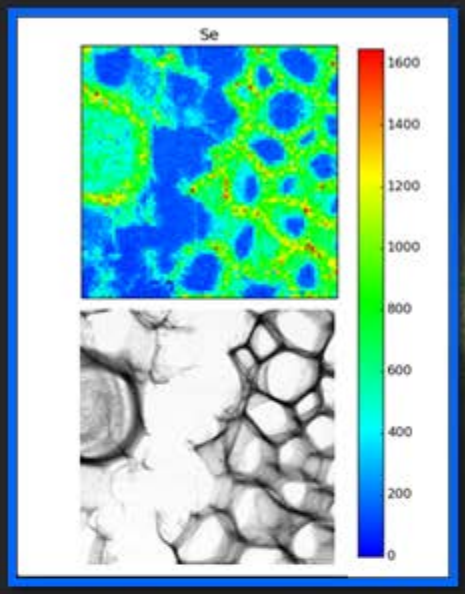
Spatial niche



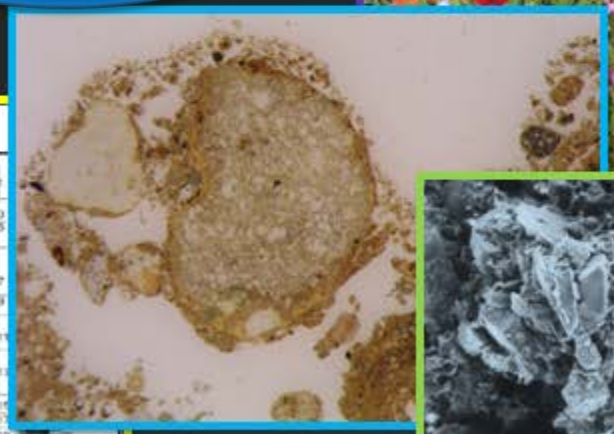
Trophic niche

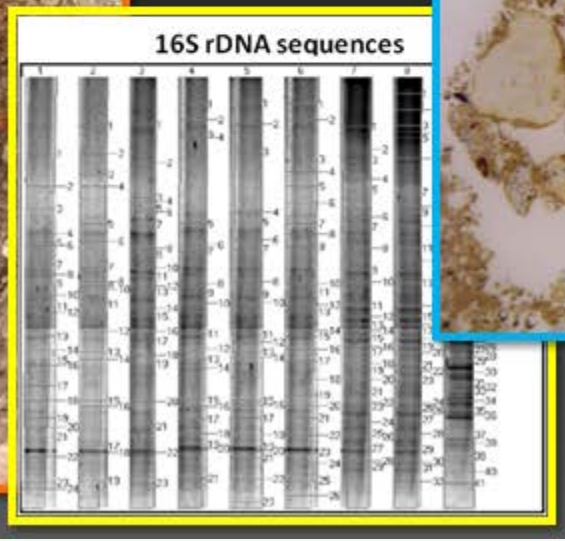


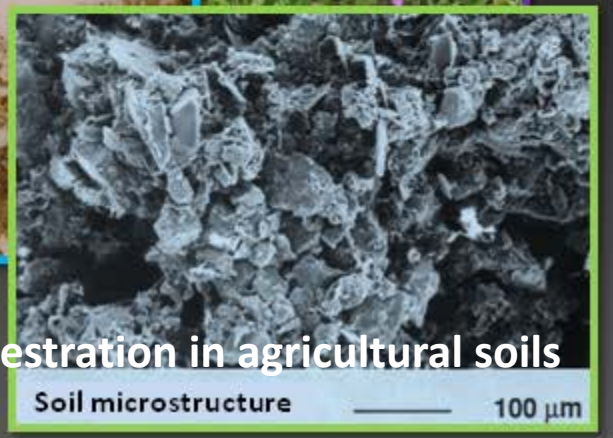




The soil-plant system





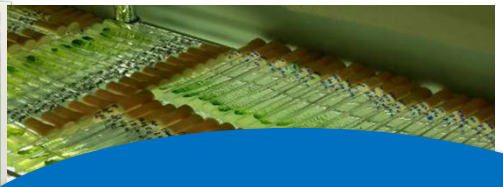


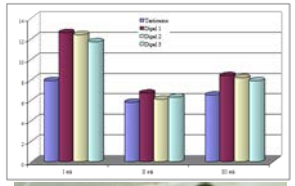
C sequestration in agricultural soils

The soil-plant system - challenges

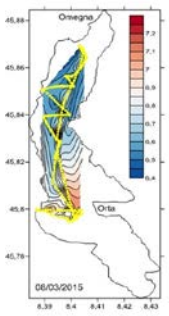
- **Remediation strategy** to recover **degraded soils** based on **stabilized organic matter** and **autochthonous plant species;**
- **Innovative monitoring processes** (**biochemical** and **metaproteomical** soil properties);
- Use of de-contaminated sediment as growth substrate for “food” production;
- The soil-plant system for **food production and human health**, as well as the **mitigation of climate change**;
- Dynamics of **selenium** in the soil-plant system and study of the physiological and metabolic effects caused by the accumulation in the tissues of cultivated plants.

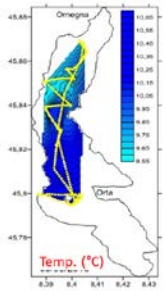
Environmental technologies

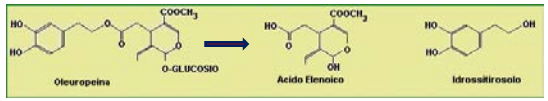




Toxicity of microorganisms and plant extracts on non-target insects





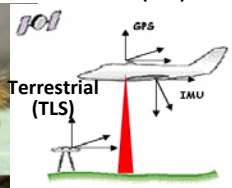


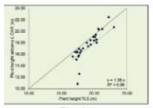
Lymantria dispar

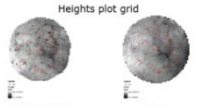
Malacosoma neustrium

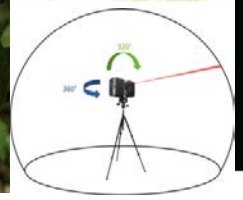
Monitoring of Lepidopteran defoliators in forests of Sardinia by integration of remote sensing techniques

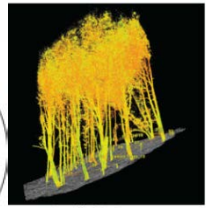
Aerial (ALS)

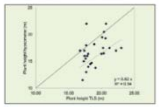


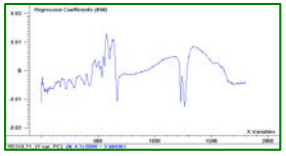


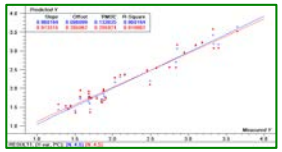




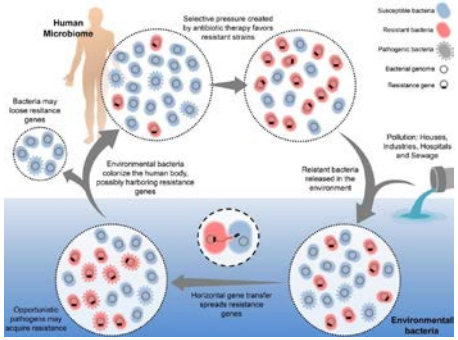


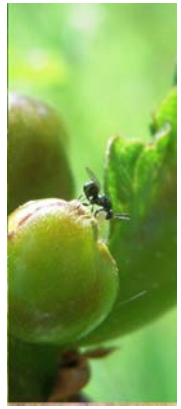






Photoacoustic spectroscopy PAS-PLS multivariate analysis.





Selection of a synergic able to activate and/or strengthen the activity of pathogen bacteria on insects

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Fotobioreactors for biofuel production (hydrogen and biodiesel) from microalgae

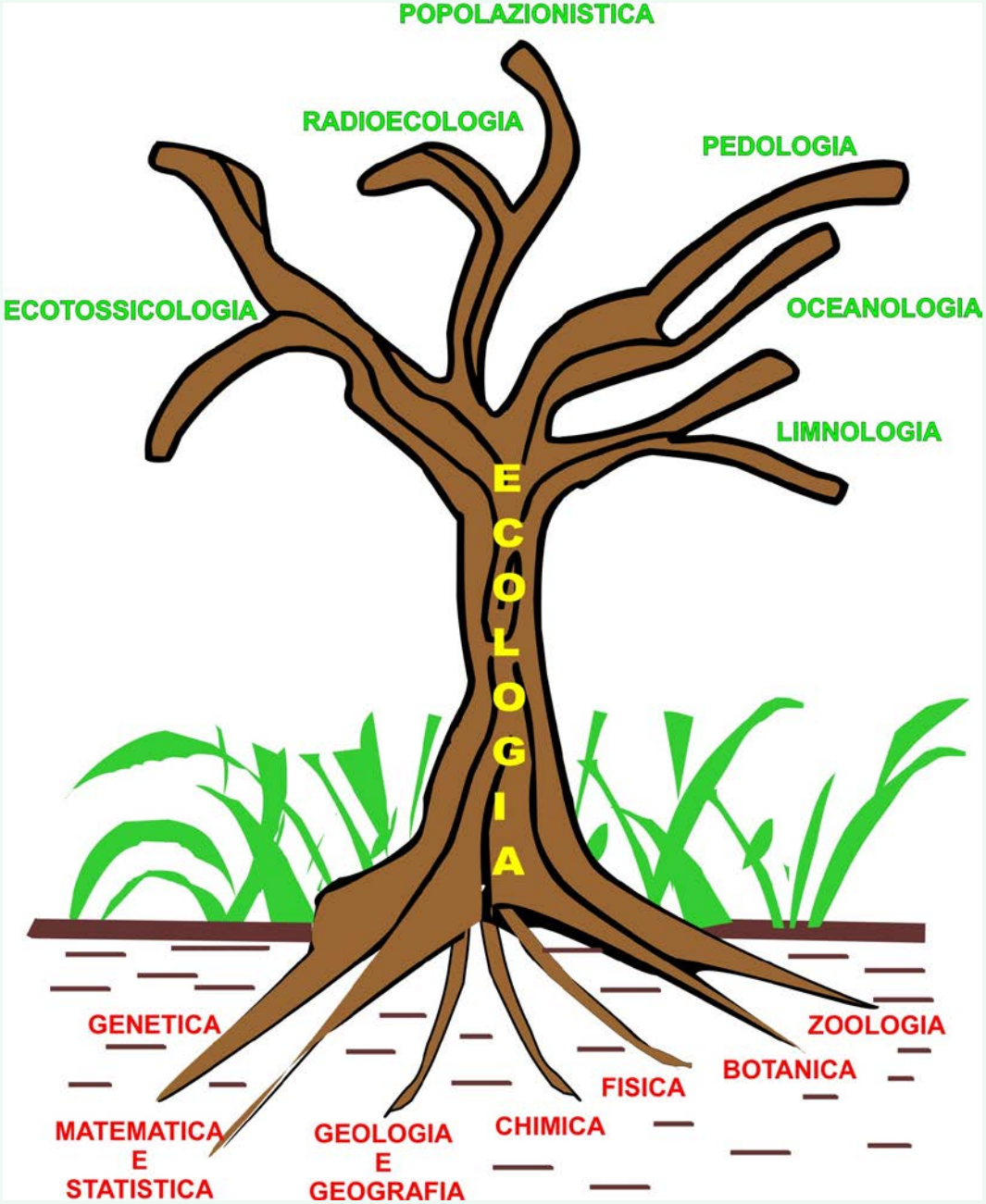
Why hydrogen?

- Excellent energy carrier;
- Direct use in an internal combustion engine.

Why Biodiesel?

- High lipid production (up to 70% by weight);
- High growth rate and no fertilizer requirement;
- Reuse of wastewater;
- All year round;
- CO_2 as carbon source (2 g of CO_2 to synthesize 1 g biomass).

CHALLENGE: enhance EFFICIENCY (MAX 2 %, compared to 10 % of solar energy)



The «Ecology Tree». From the original drawn by late Prof. Oscar Ravera, pioneer of ecological thought and founder of radioecology (www.jlimnol.it).