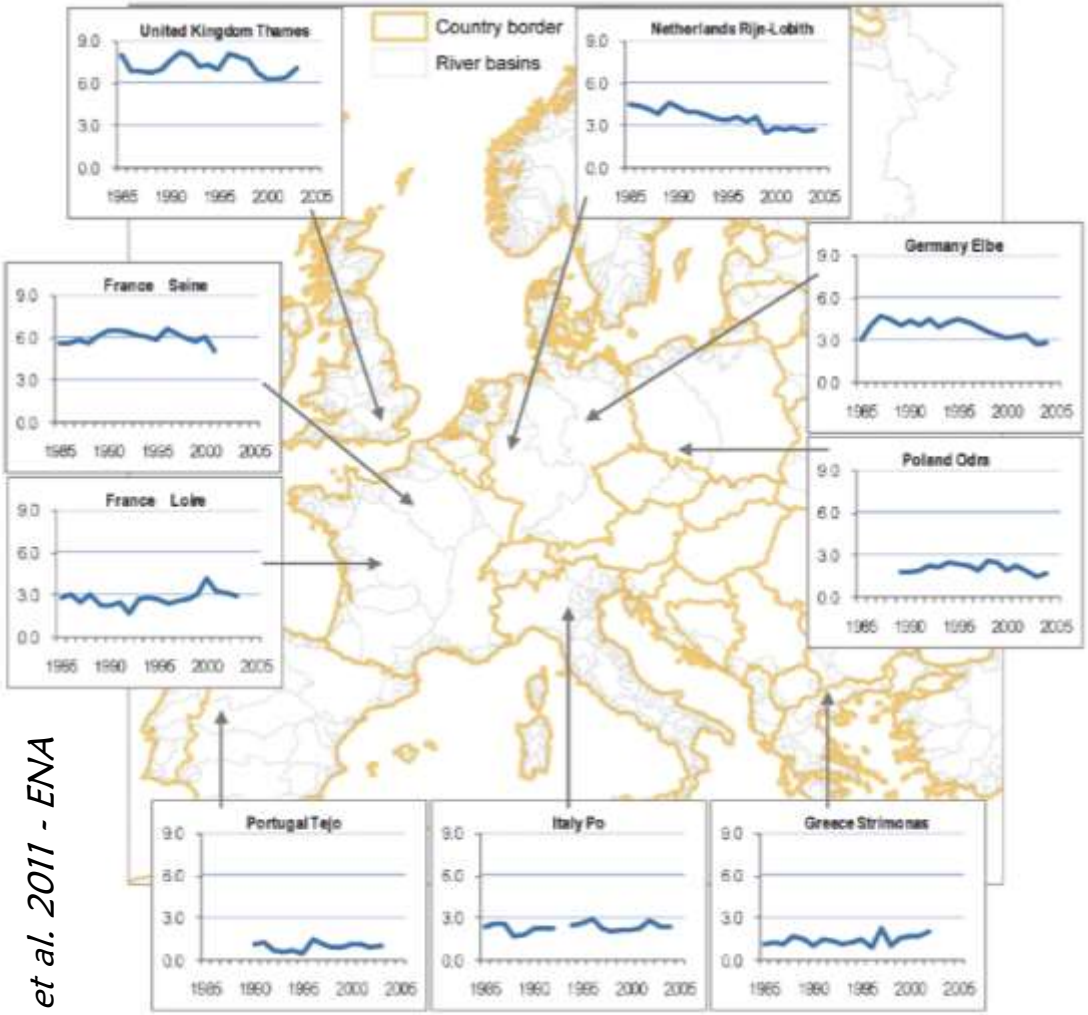
IL SERVIZIO ECOSISTEMICO DELLA VEGETAZIONE ACQUATICA PER LA PREVENZIONE DELL'INQUINAMENTO DA NITRATI: IL CASO DEL BACINO BURANA-PO DI VOLANO

Elisa Soana, Fabio Vincenzi, Elisa Anna Fano, Giuseppe Castaldelli

Dipartimento di Scienze della Vita e Biotecnologie, Università degli Studi di Ferrara

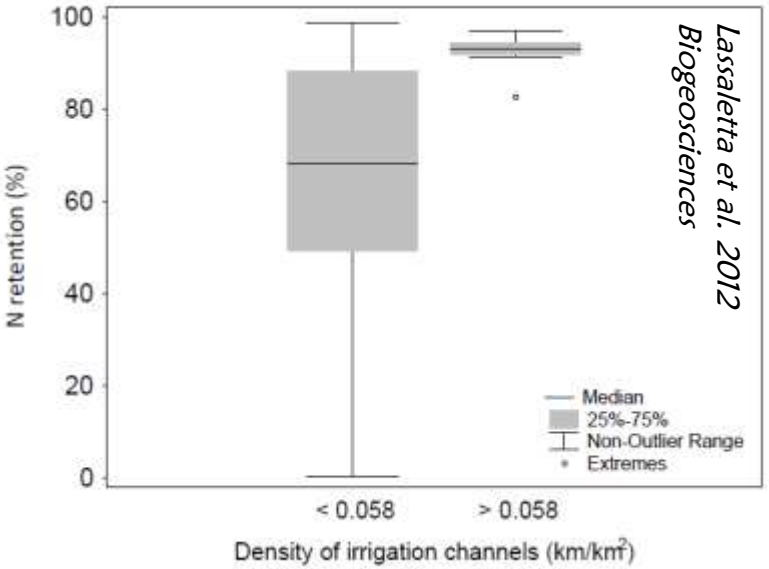
AGRICULTURAL IRRIGATED WATERSHEDS MAY MAINTAIN A BUFFER CAPACITY TOWARDS NO_3^-

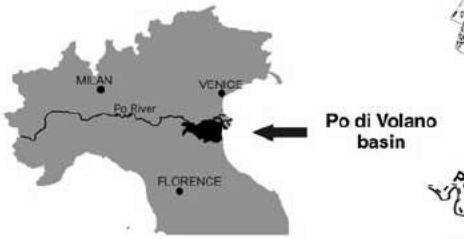


Grizzetti et al. 2011 - ENA

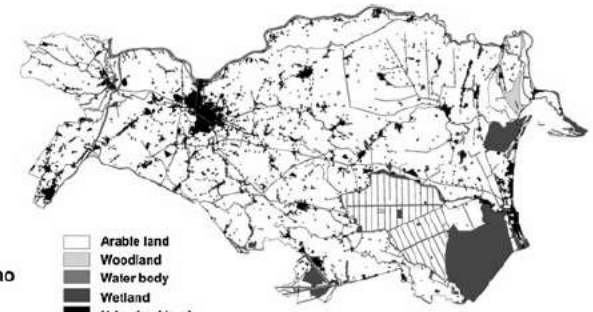
Annual average NO_3^- concentration (mg N l^{-1})
at the closing section
of some major Europen Rivers

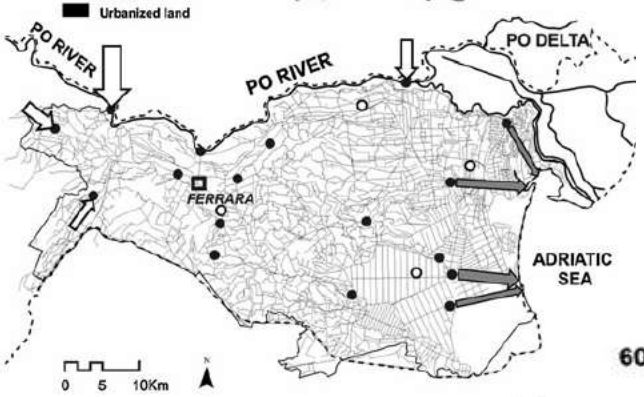
N retention in slightly and highly channelized sub-catchments (Ebro River, Spain)



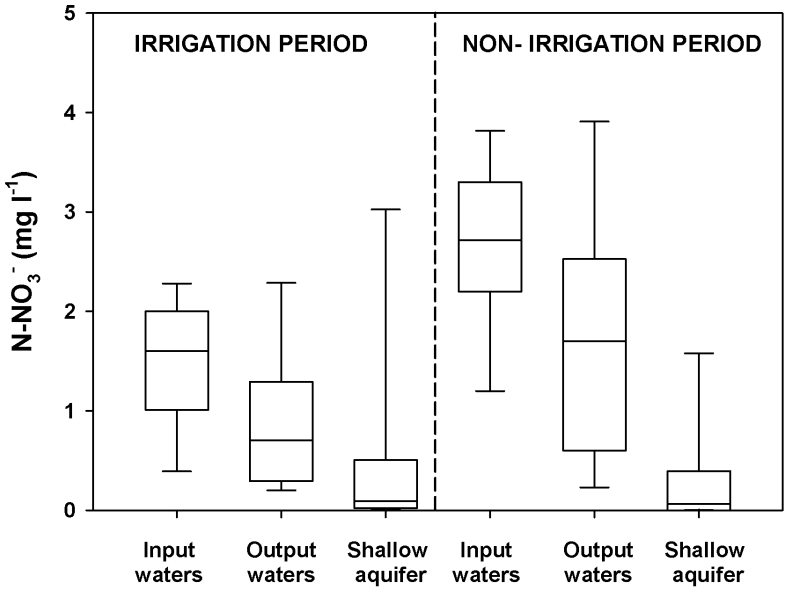


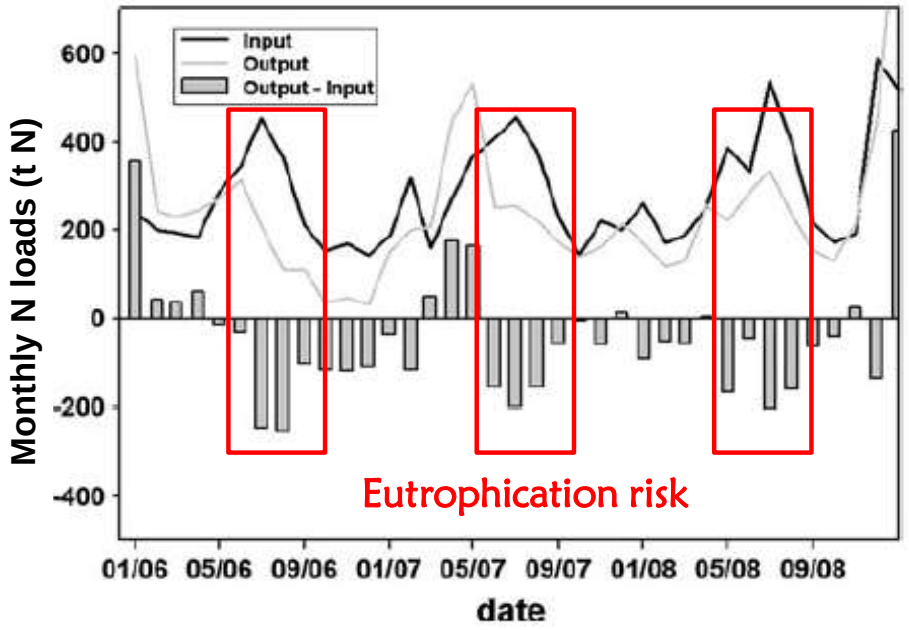
Po di Volano basin





canal network
surface water sampling stations
rainfall sampling stations
water input
water output



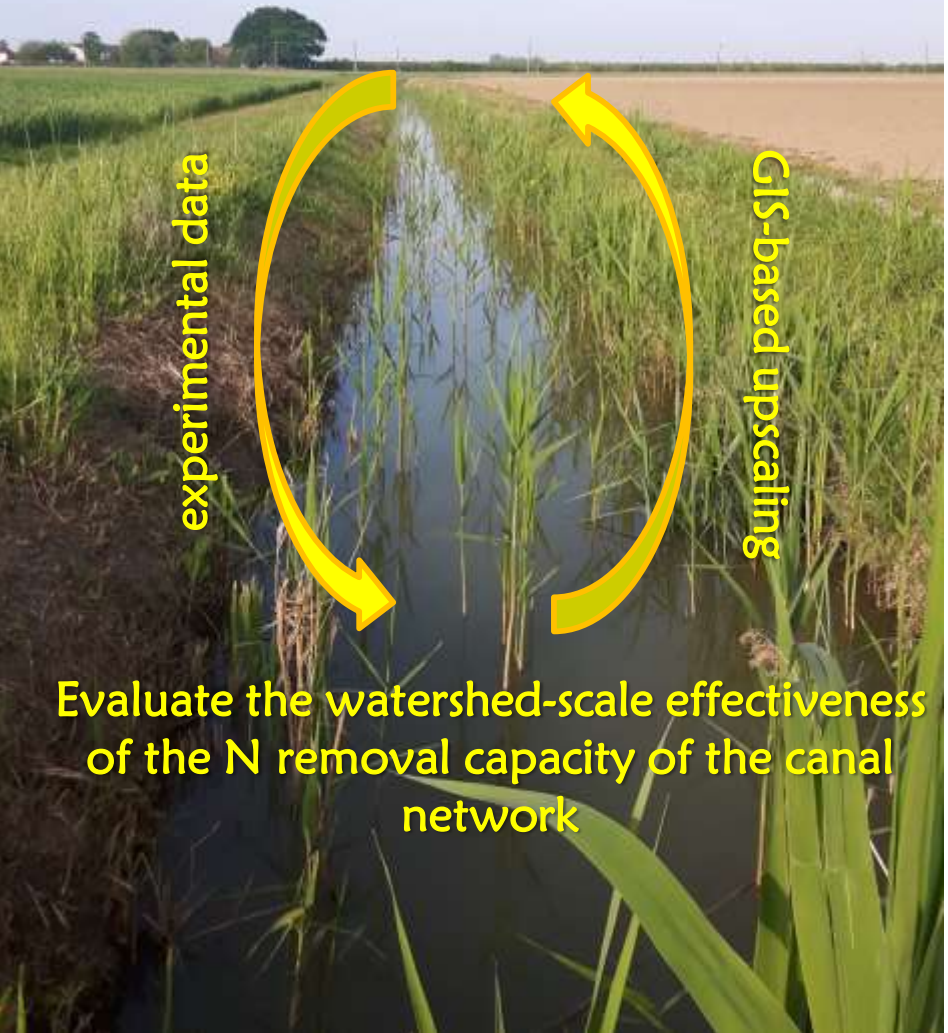


Nitrogen Budget in a Lowland Coastal Area Within the Po River Basin (Northern Italy): Multiple Evidences of Equilibrium Between Sources and Internal Sinks

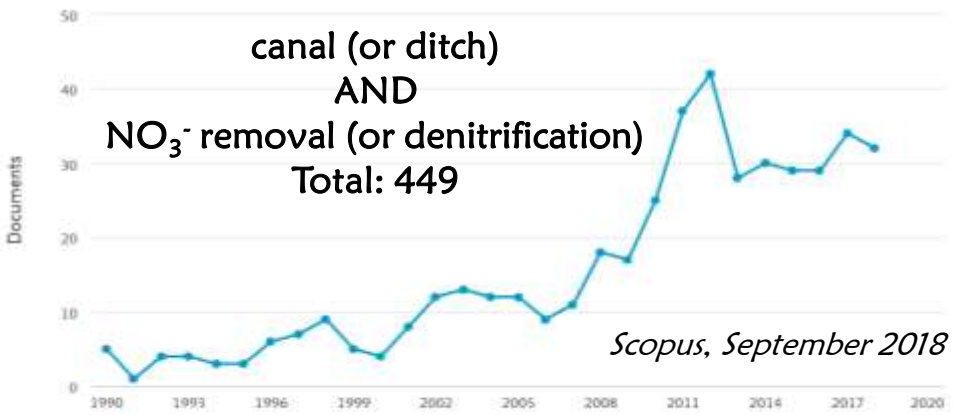
Giuseppe Castaldelli · Elisa Soana · Erica Racchetti · Enrica Pierobon · Micol Mastrocicco · Enrico Tesini · Elisa Anna Fano · Marco Bartoli

Environmental Management (2013) 52:567–580
DOI 10.1007/s00267-013-0052-6

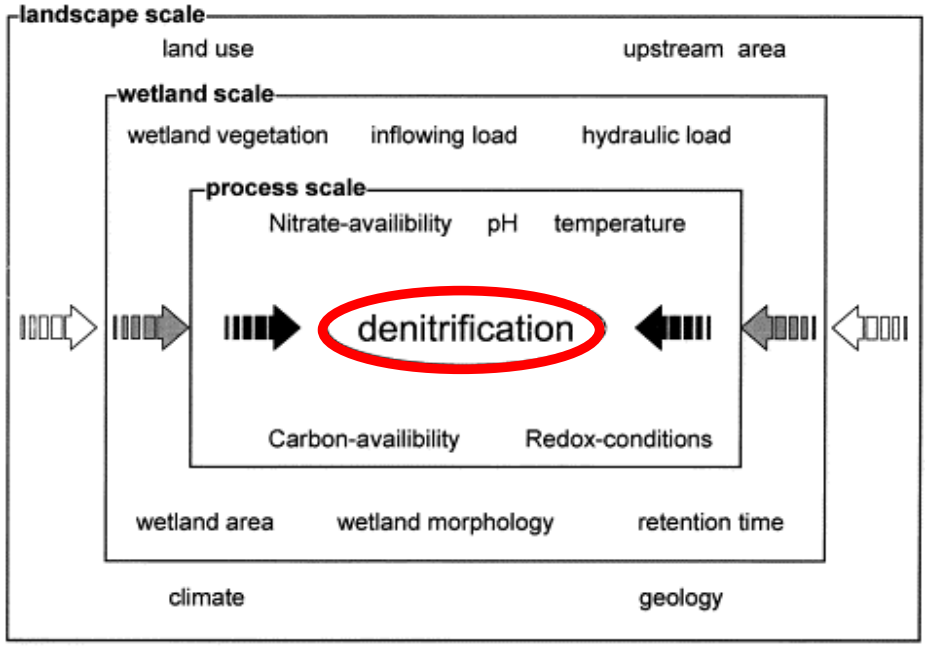
Parameterize N removal in relation to biotic (e.g. presence of emergent vegetation and biofilms) and abiotic drivers (e.g. NO_3^- availability, water velocity, temperature)



Evaluate the watershed-scale effectiveness of the N removal capacity of the canal network



Total records for other freshwater aquatic ecosystems: wetlands 3360, rivers 2662, lakes 1635



Trepel & Palmeri, 2002 – Ecol Eng

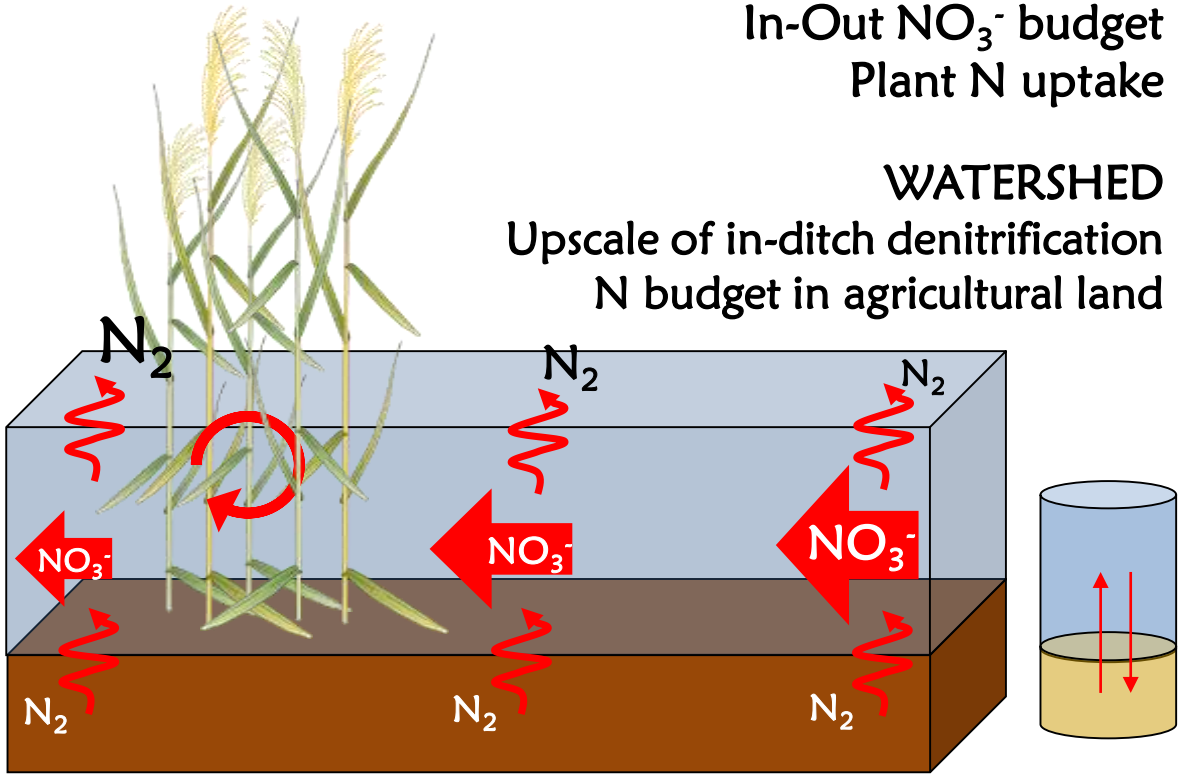
Canal and ditches are "*linear wetlands*"

Multiple spatial scales

MESOCOSM
Laboratory incubations
(benthic fluxes of gases and nutrients, isotope pairing)

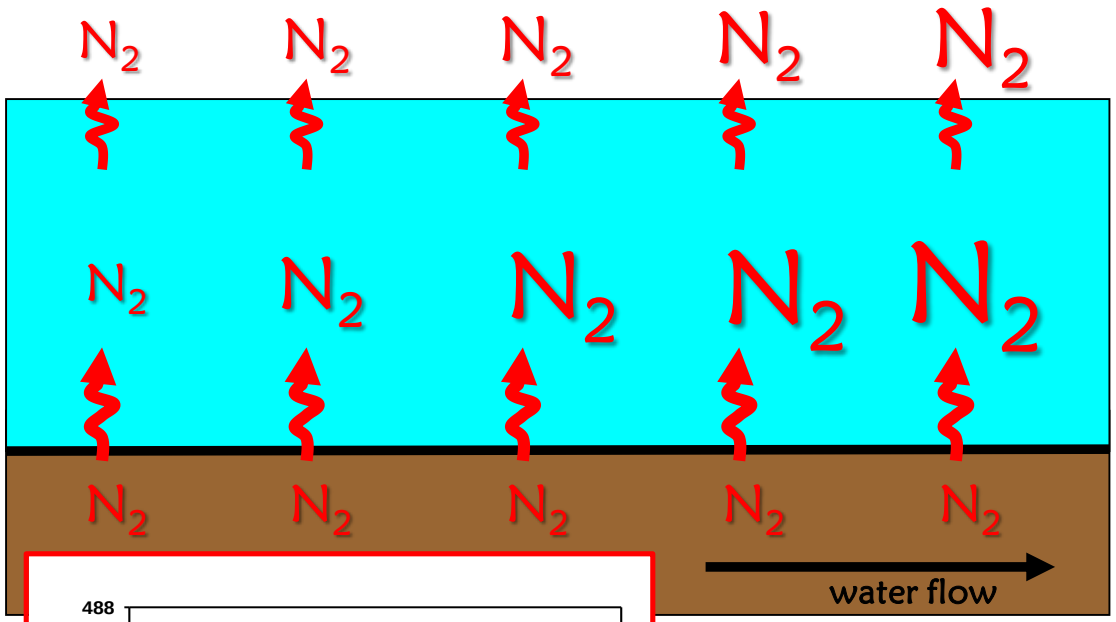
CANAL
Open-channel denitrification
In-Out NO_3^- budget
Plant N uptake

WATERSHED
Upscale of in-ditch denitrification
N budget in agricultural land

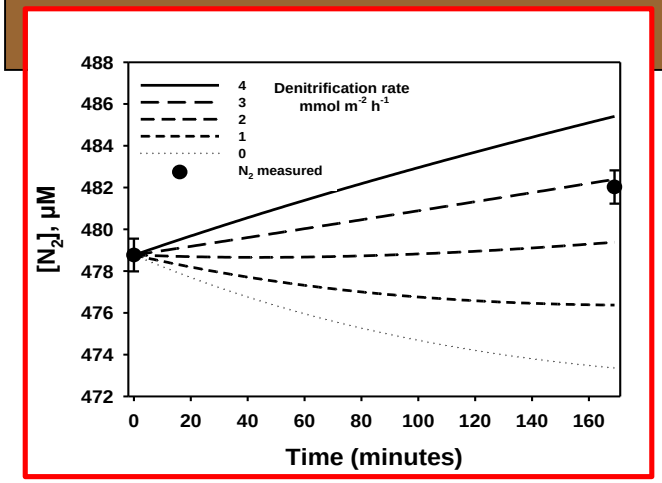


Multiple experimental approaches
Conventional *vs.* innovative methods

OPEN-CHANNEL DENITRIFICATION



- ✓ **Lagrangian sampling**
- ✓ **N_2:Ar** analyses by Membrane Inlet Mass Spectrometry (**MIMS**)
- ✓ A model-based approach is used to solve for denitrification rate based on **changes in N_2 concentration** during riverine transport and channel physical characteristics (width and depth) affecting air-water gas exchanges



Agriculture, Ecosystems and Environment

Contents lists available at ScienceDirect

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Vegetated canals mitigate nitrogen surplus in agricultural watersheds

Giuseppe Castaldelli, Elisa Soana, Erica Racchetti, Fabio Vincenzi, Elisa Anna Fano, Marco Bartoli

Hydrobiologia 485: 67–81, 2002.

Measurement of denitrification in rivers: an integrated, whole reach approach

Andrew E. Laursen[1,2] & Sybil P. Seitzinger[1]

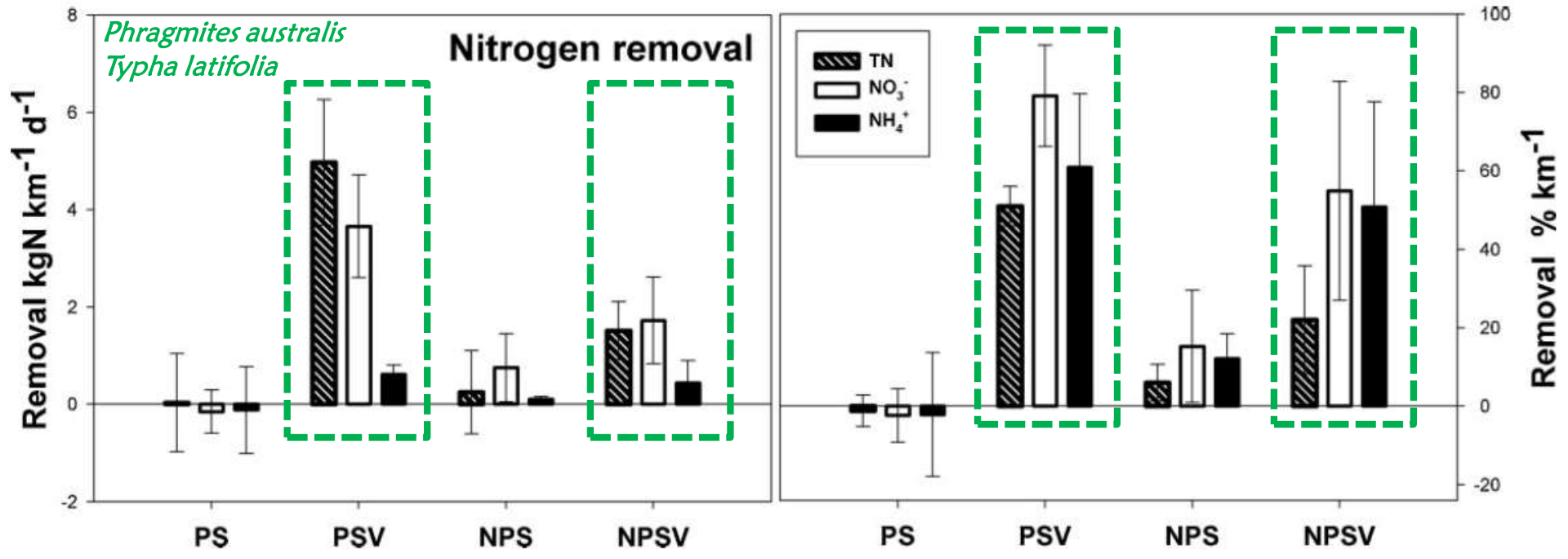
from American rivers to Italian canals

Agriculture, Ecosystems and Environment

Research Paper

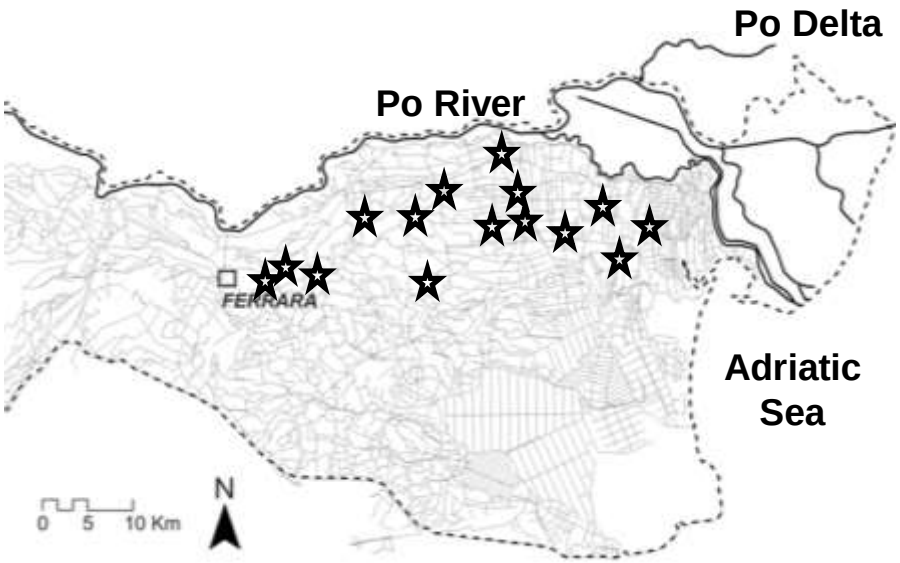
Mitigation of nitrogen pollution in vegetated ditches fed by nitrate-rich spring waters

Elisa Soana, Raffaella Balestrini, Fabio Vincenzi, Marco Bartoli, Giuseppe Castaldelli



PS: point source pollution
NPS: non-point source pollution

24 canal reaches
> 50 sampling events during the vegetative phase



CLEAN
Soil Air Water

24

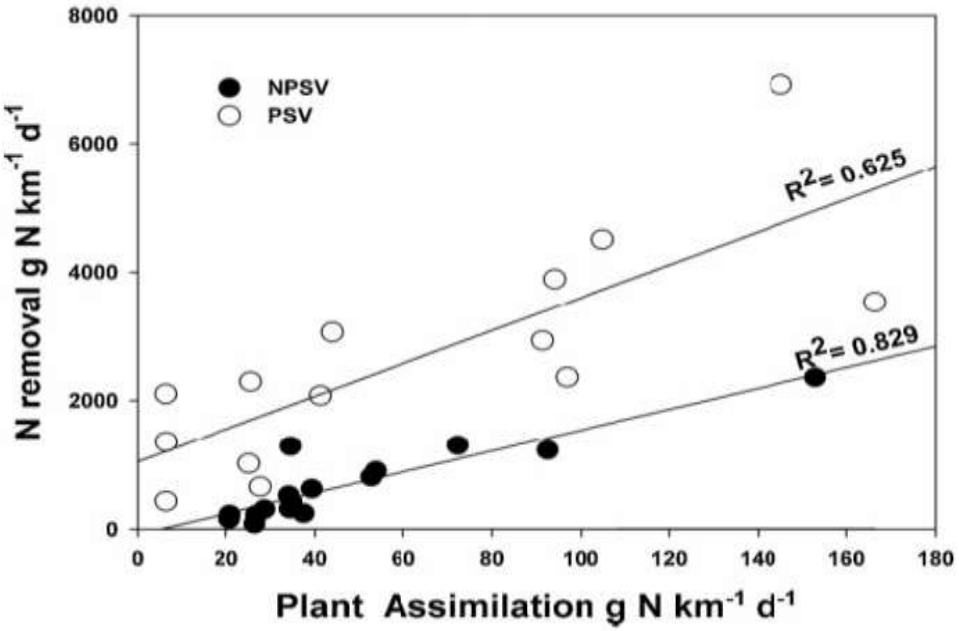
Enrica Pierobon
Giuseppe Castaldelli
Sara Mantovani
Fabio Vincenzi
Luisa Anna Fano

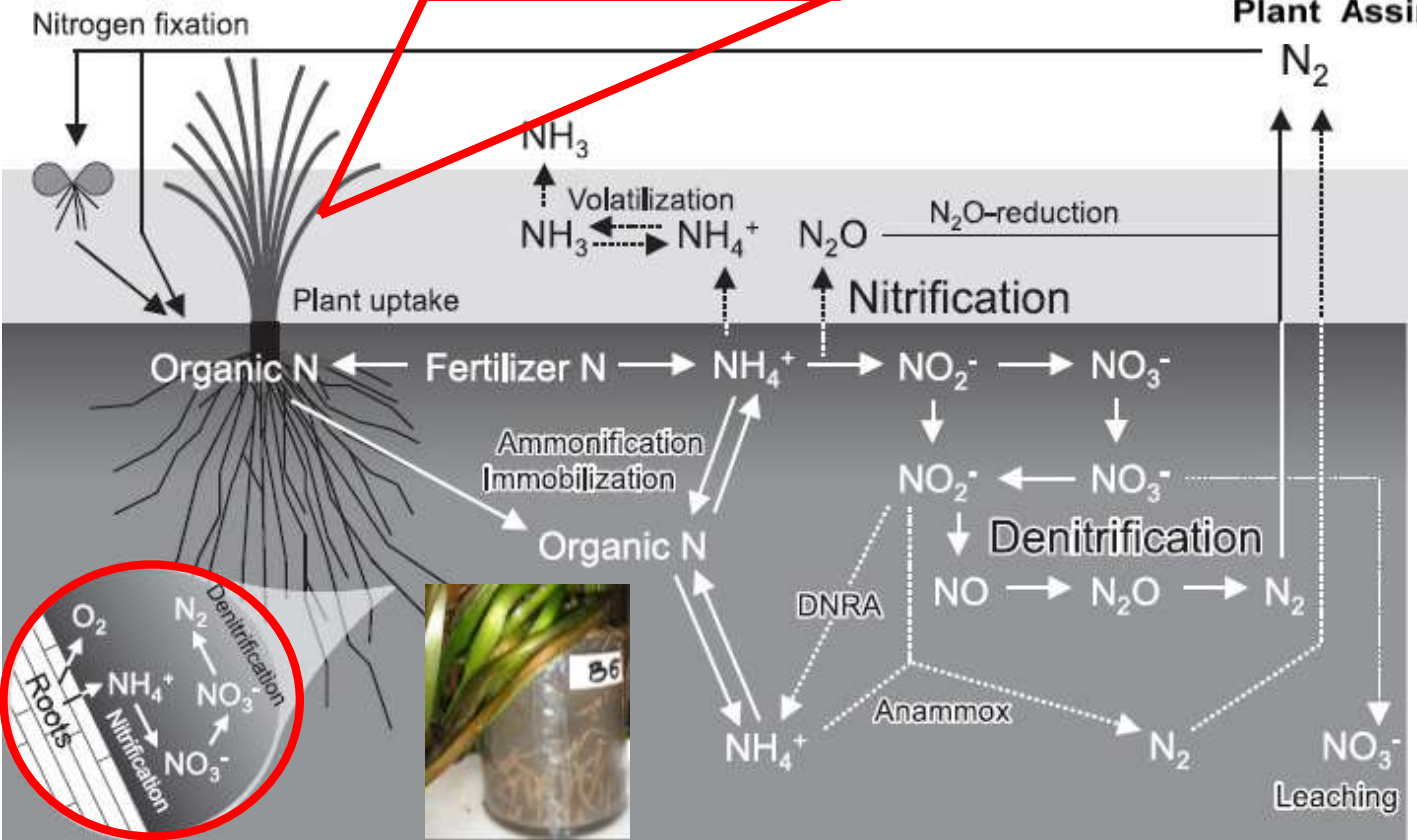
Department of Biology and Evolution, University of Ferrara, Ferrara, Italy

Research Article

Nitrogen Removal in Vegetated and Unvegetated Drainage Ditches Impacted by Diffuse and Point Sources of Pollution

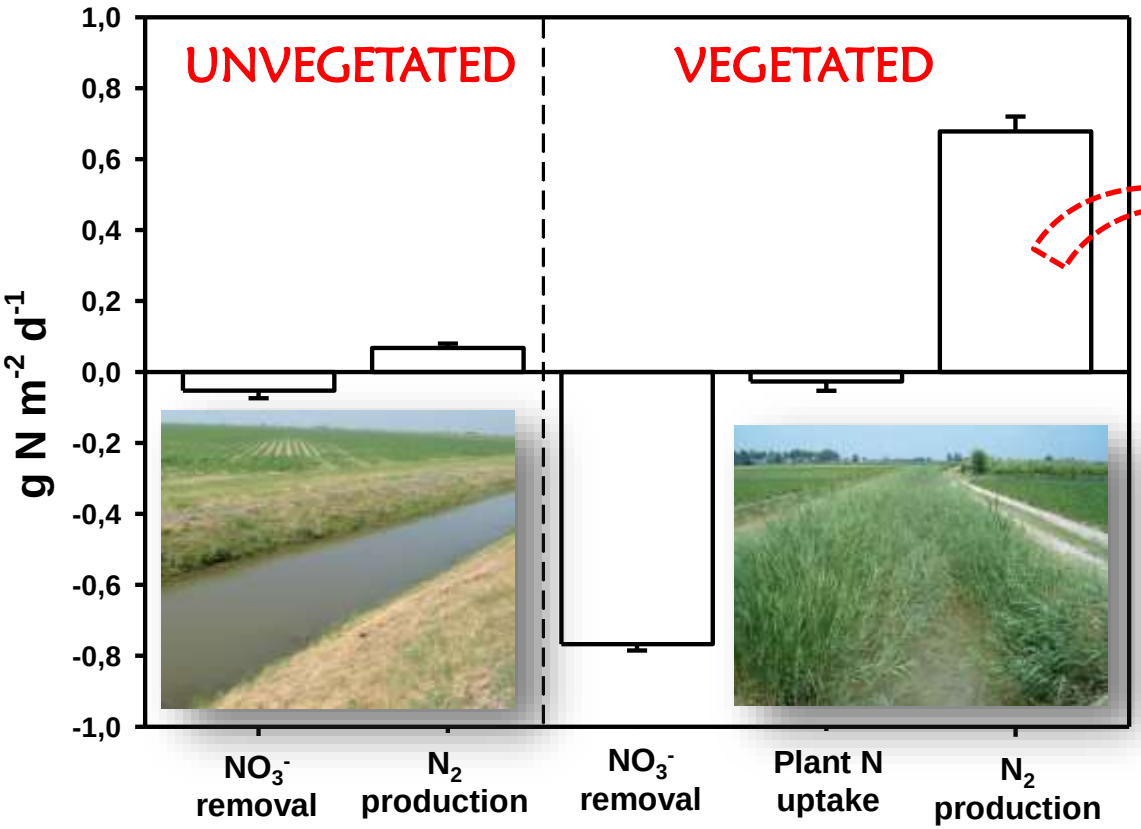
BIOFILM

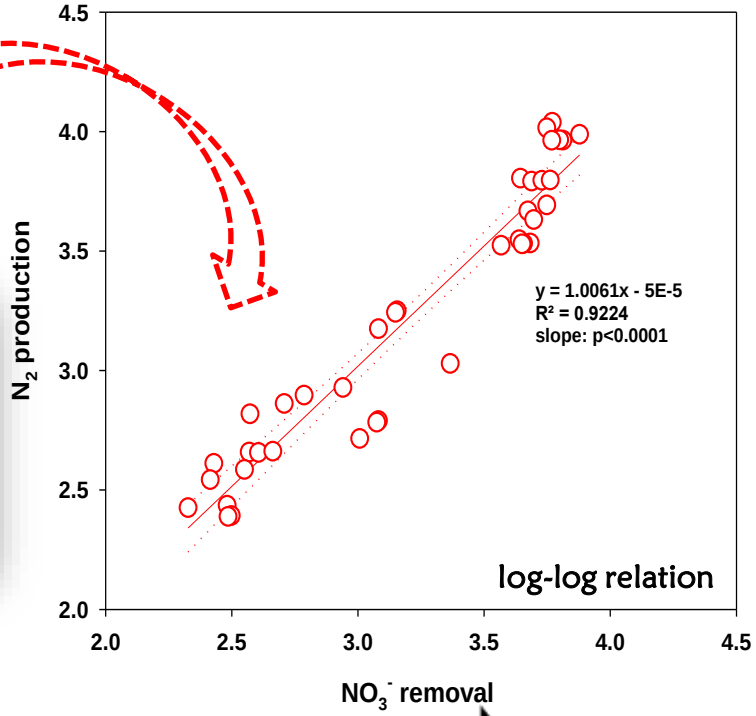




What does what: direct and indirect contribution of aquatic vegetation

Castaldelli, Soana et al. 2015 – Agr Ecosyst Environ
Soana et al. 2019 – Sci Tot Env



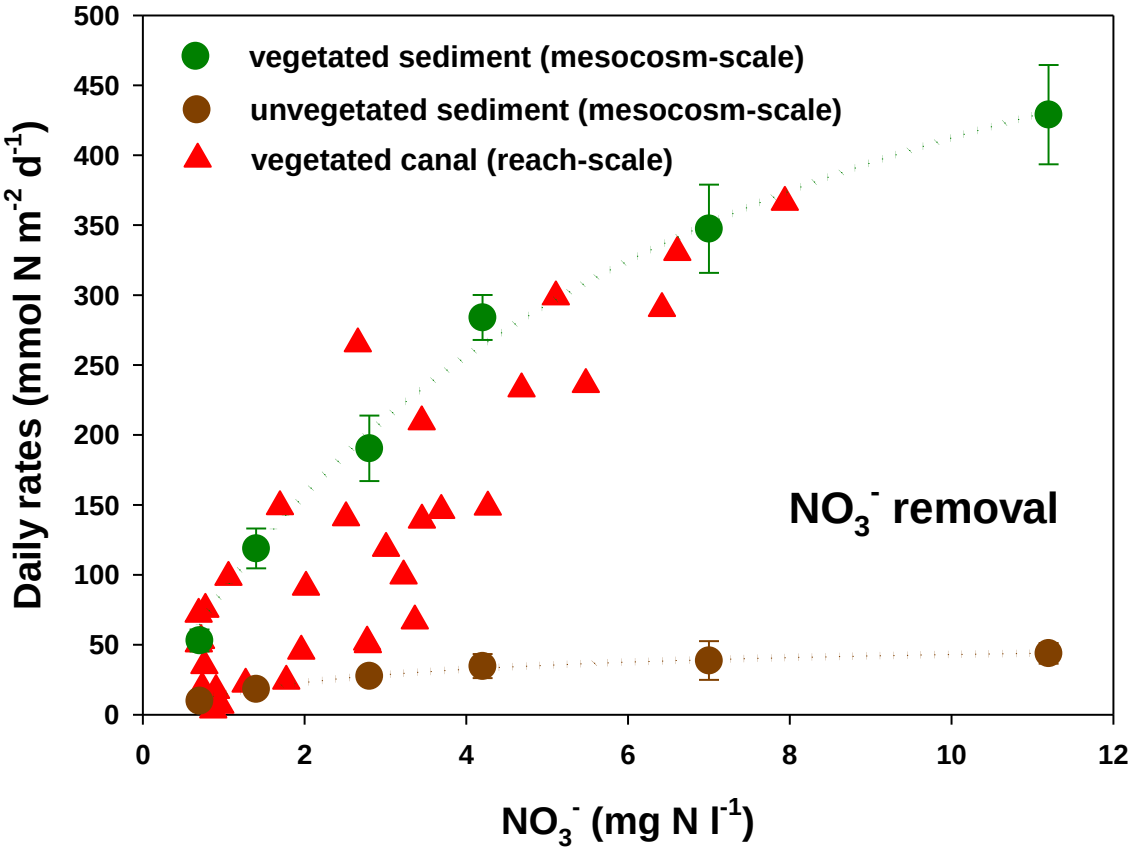


DENITRIFICATION → Ecological process

NO_3^- REMOVAL → Ecosystem function

WATER TREATMENT → Ecosystem service

Reach-scale in-out NO_3^- budgets



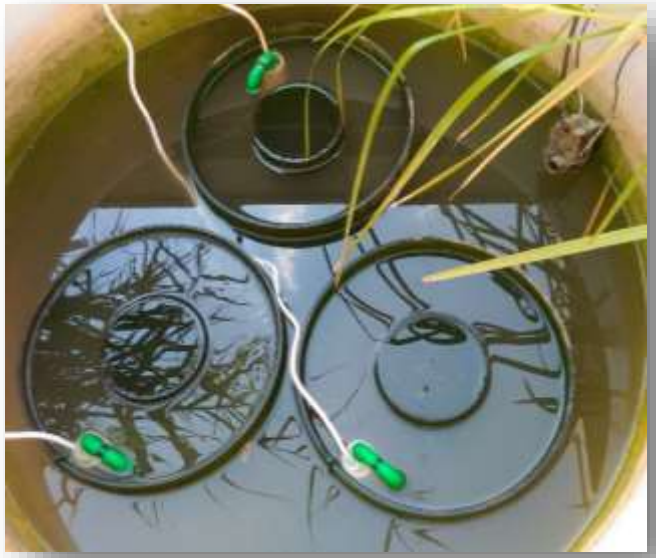
Mesocosms with *P. australis*
Dark and light incubations
Water temperature: 25°C

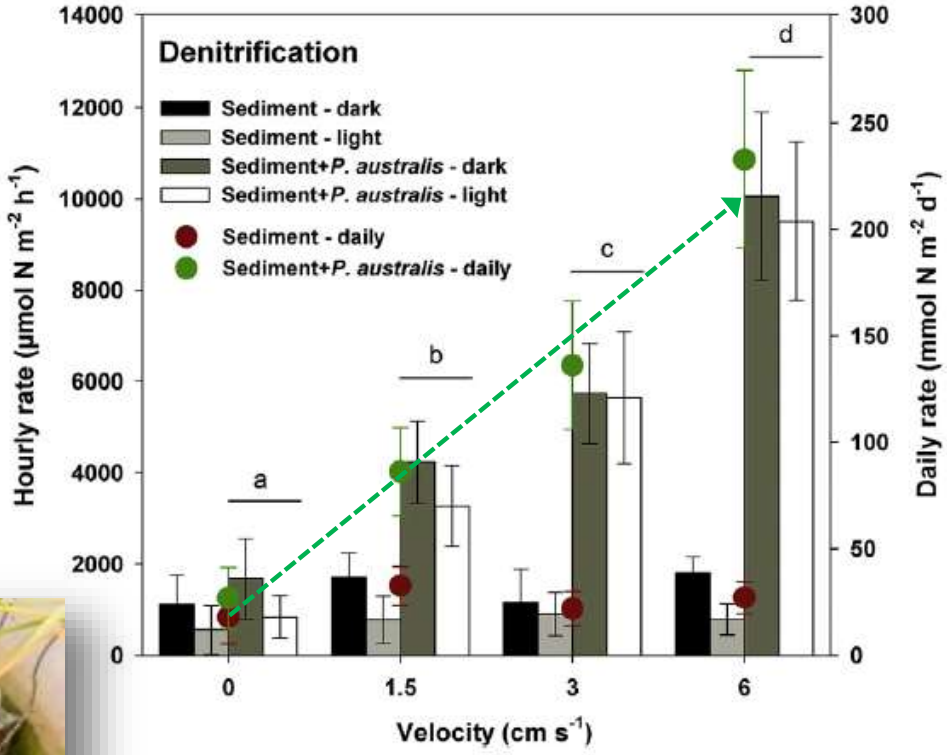
Gradient of water NO_3^-

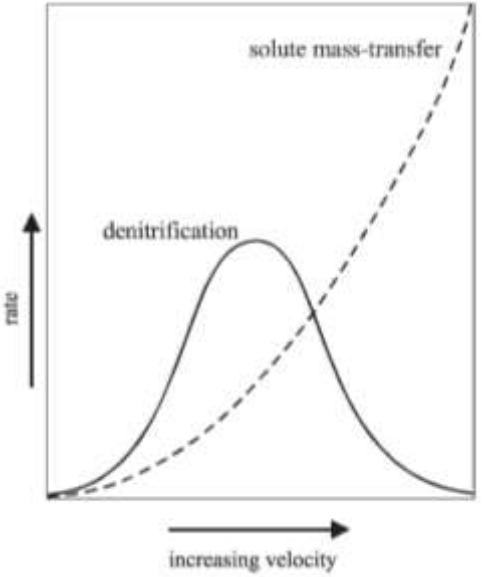
Soana et al. in preparation

Sediment with *P. australis*
Dark and light incubations
Water temperature: 25°C

Gradient of water velocity







Arnon et al. 2007 Limnol Oceanogr

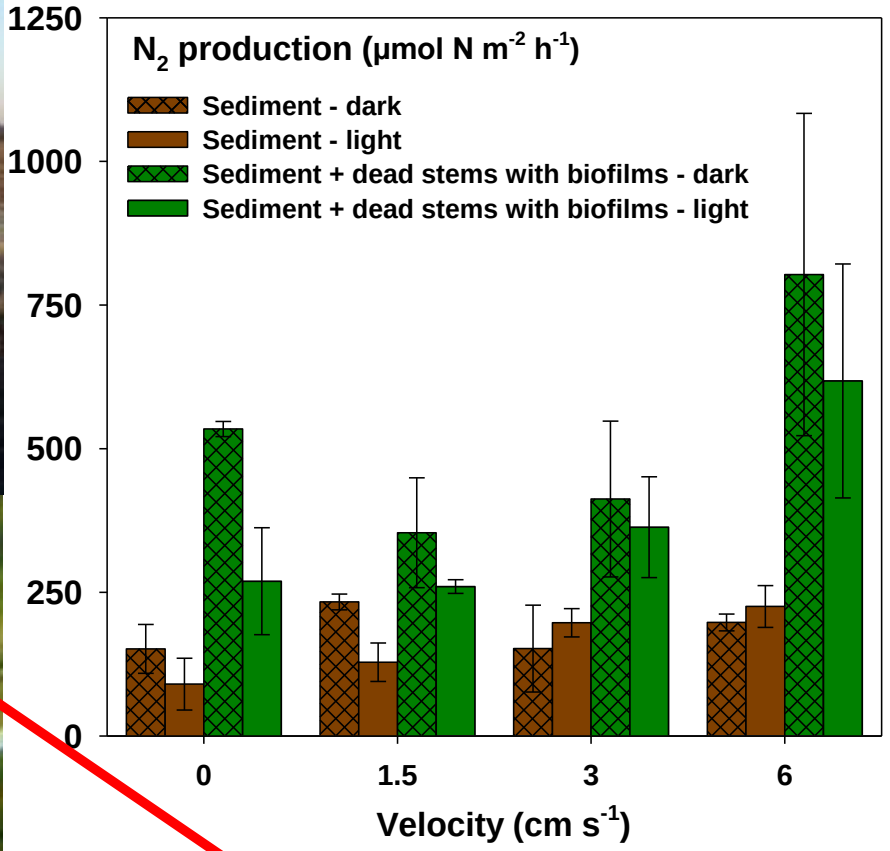
Research article

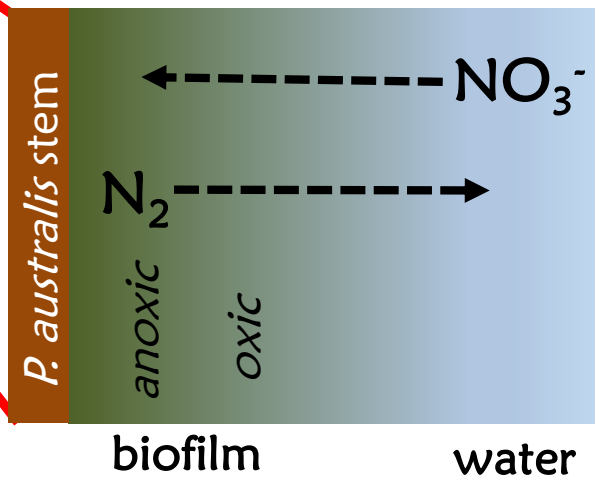
The effect of water velocity on nitrate removal in vegetated waterways

Giuseppe Castaldelli, Vassilis Aschonitis [1], Fabio Vincenzi, Elisa Anna Fano, Elisa Soana*

Department of Life Sciences and Biotechnology, University of Ferrara, Via L. Borsari 46, 44121 Ferrara, Italy

Journal of Environmental Management 215 (2018)





Ecological Engineering 113 (2016) 1–10

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

To mow or not to mow: reed biofilms as denitrification hotspots in drainage canals

Elisa Soana*, Anna Gavioli, Elena Tamburini, Elisa Anna Fano, Giuseppe Castaldelli

Department of Life Sciences and Biotechnology, University of Ferrara, Via L. Borsari 46, 44121 Ferrara, Italy

Upscaling the NO_3^- removal capacity form local hot spots to the ditch network of the Po River lowland

REACH-SCALE

Vegetated condition
predictive relationships between water NO_3^- and reach-scale NO_3^- removal rates (experimental data)

Unvegetated condition
denitrification rates as a function of NO_3^-, O_2 and sedimentary oxygen demand (diffusion-reaction model based on ARPA dataset)

DITCH NETWORK SCALE

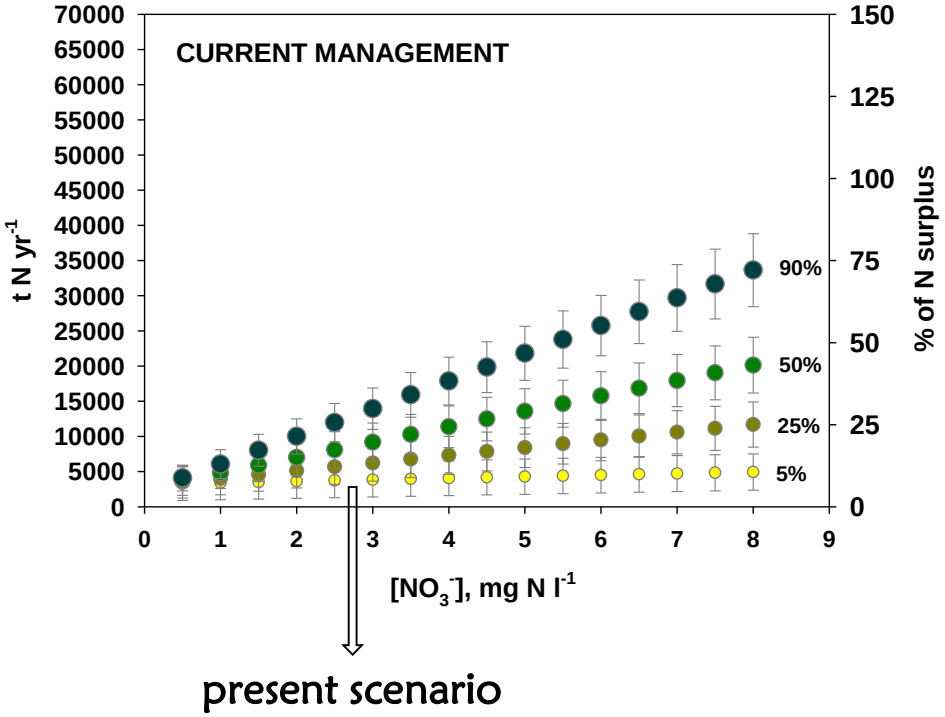
vegetation maintenance
5%, 25%, 50%, 90%
of the network lenght

SCENARIOS

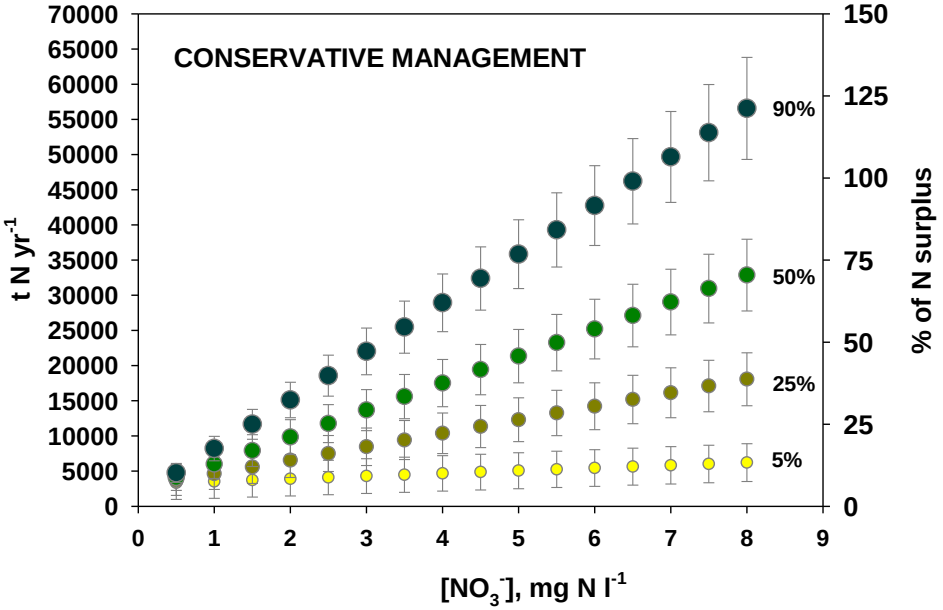
vegetation management
current vs conservative

Area < 50 m a.s.l.
9,100 km² (~90% arable land)
1.8 million inhabitants
~ 18,500 km of canals and ditches

Predicted NO_3^- removal according to different NO_3^- availability
vs
N surplus in arable land



present scenario



Po River export to the Adriatic Sea ~110,000 t N yr^{-1}
(Viaroli, Soana et al. 2018 STOTEN)

Science of the Total Environment 647 (2019) 301–312

Contents lists available at ScienceDirect

Science of the Total Environment

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ELSEVIER

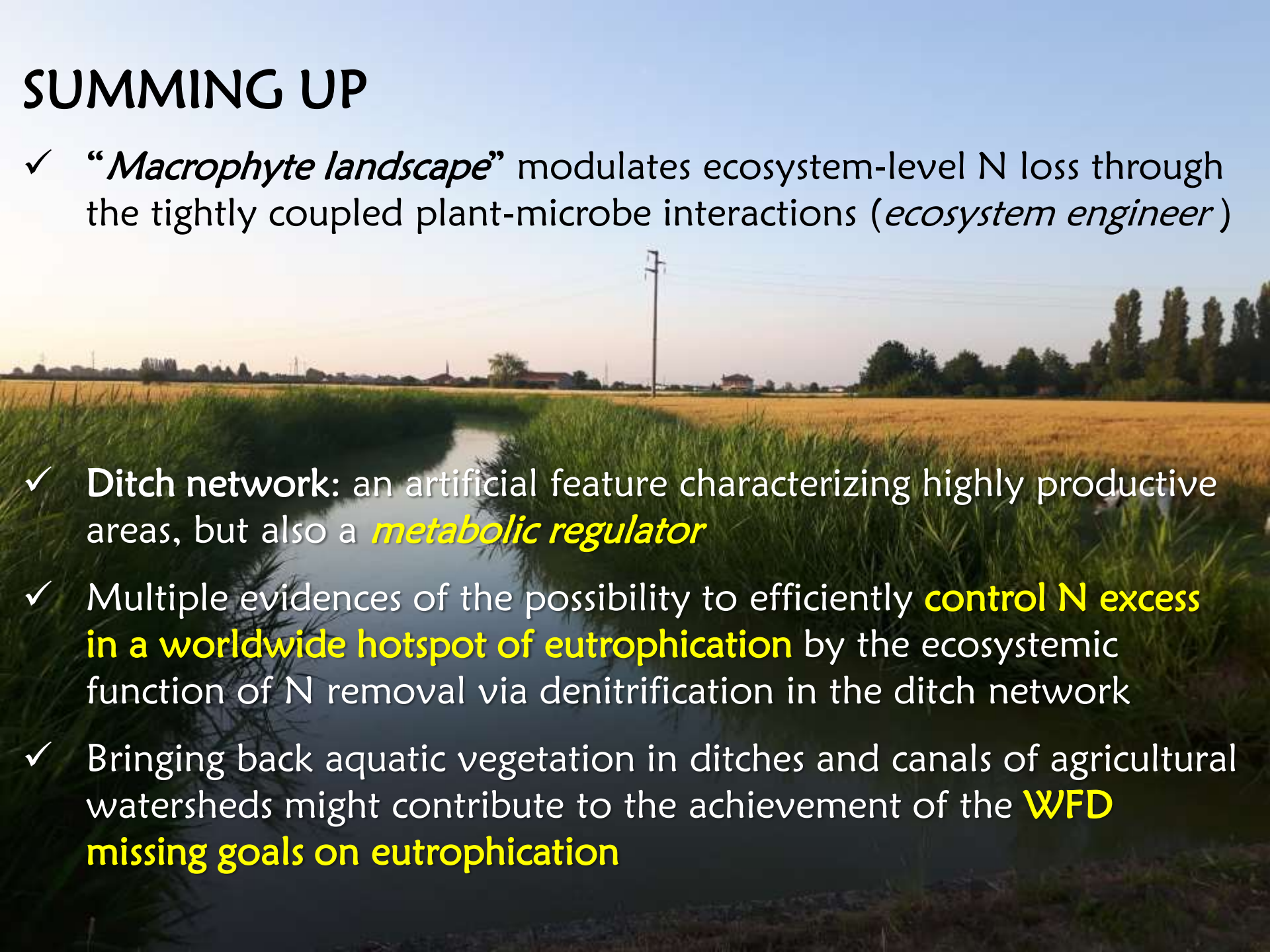
An ounce of prevention is worth a pound of cure: Managing macrophytes for nitrate mitigation in irrigated agricultural watersheds

Elisa Soana [a,*], Marco Bartoli [b], Marco Milardi [a], Elisa Anna Fano [a], Giuseppe Castaldelli [a]

Vegetated ditches:
the "new" wetlands?

SUMMING UP

- ✓ "*Macrophyte landscape*" modulates ecosystem-level N loss through the tightly coupled plant-microbe interactions (*ecosystem engineer*)



- ✓ **Ditch network:** an artificial feature characterizing highly productive areas, but also a ***metabolic regulator***
- ✓ Multiple evidences of the possibility to efficiently **control N excess in a worldwide hotspot of eutrophication** by the ecosystemic function of N removal via denitrification in the ditch network
- ✓ Bringing back aquatic vegetation in ditches and canals of agricultural watersheds might contribute to the achievement of the **WFD missing goals on eutrophication**

Centro Italiano per la
Riqualificazione Fluviale

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GRAZIE!