OMICS GROUP

OMICS Group International through its Open Access Initiative is committed to make genuine and reliable contributions to the scientific community. OMICS Group hosts over **400** leading-edge peer reviewed Open Access Journals and organizes over **300** International Conferences annually all over the world. OMICS Publishing Group journals have over **3 million** readers and the fame and success of the same can be attributed to the strong editorial board which contains over **30000** eminent personalities that ensure a rapid, quality and quick review process. OMICS Group signed an agreement with more than **1000** International Societies to make healthcare information Open Access.

OMICS Journals are welcoming Submissions

OMICS Group welcomes submissions that are original and technically so as to serve both the developing world and developed countries in the best possible way.

OMICS Journals are poised in excellence by publishing high quality research. OMICS Group follows an Editorial Manager® System peer review process and boasts of a strong and active editorial board.

Editors and reviewers are experts in their field and provide anonymous, unbiased and detailed reviews of all submissions.

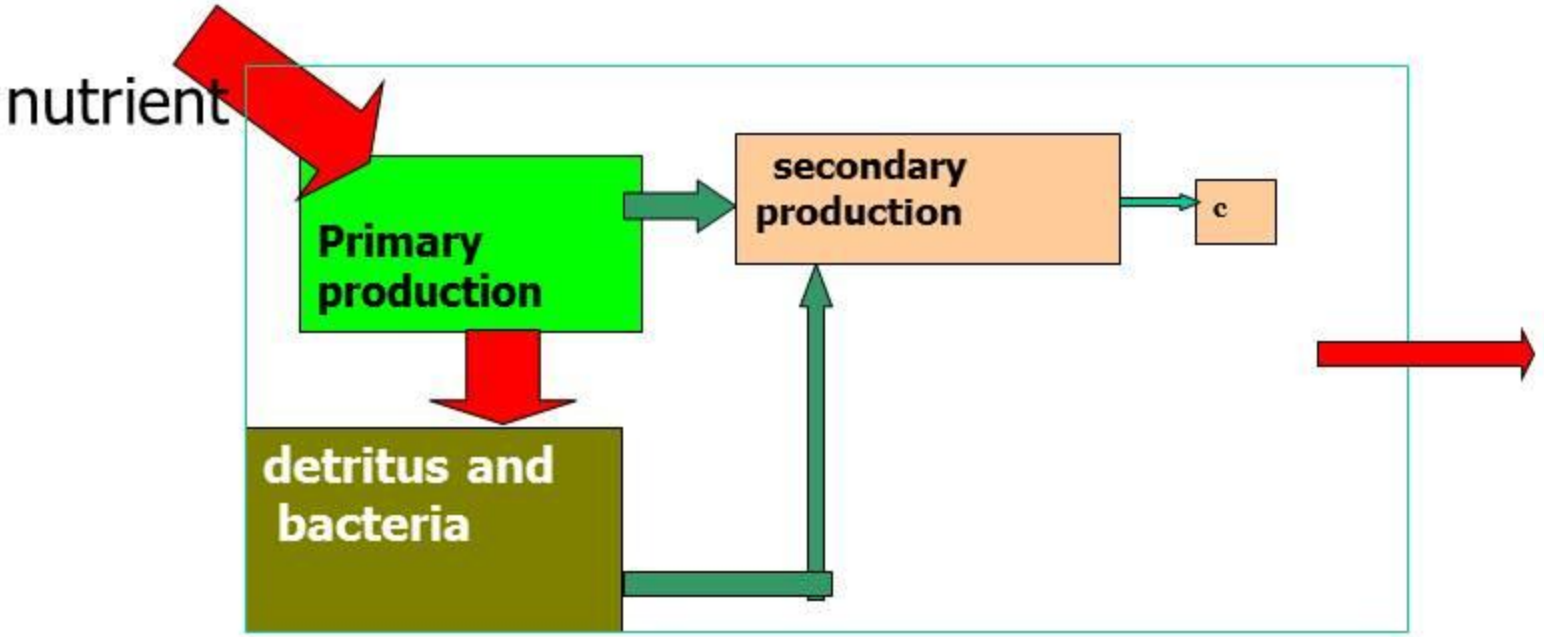
The journal gives the options of multiple language translations for all the articles and all archived articles are available in HTML, XML, PDF and audio formats. Also, all the published articles are archived in repositories and indexing services like DOAJ, CAS, Google Scholar, Scientific Commons, Index Copernicus, EBSCO, HINARI and GALE.

For more details please visit our website:

http://omicsonline.org/Submitmanuscript.php

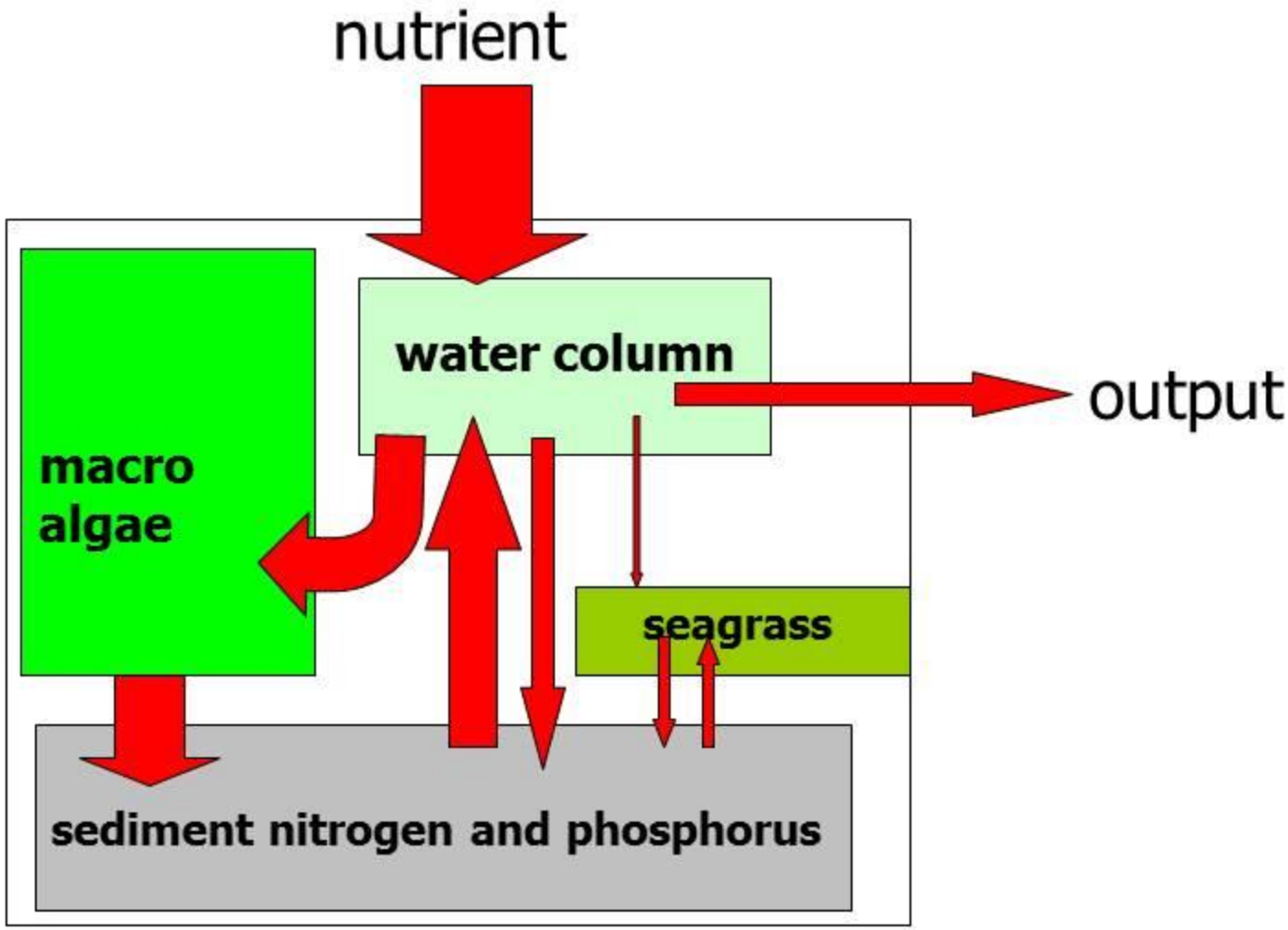
For an effective and sustainable management of eutrophic lagoons

M. Lenzi
Lagoon Ecology and Aquaculture Laboratory
LEALab, OPL c.
Via G. Leopardi 9, 58015 Orbetello (GR), Italy
lealab1@gmail.com



Shallow, eutrophic, low water renewal lagoons are «nutrient traps» : they tend to a natural eutrophication

Lagoon ecosystem



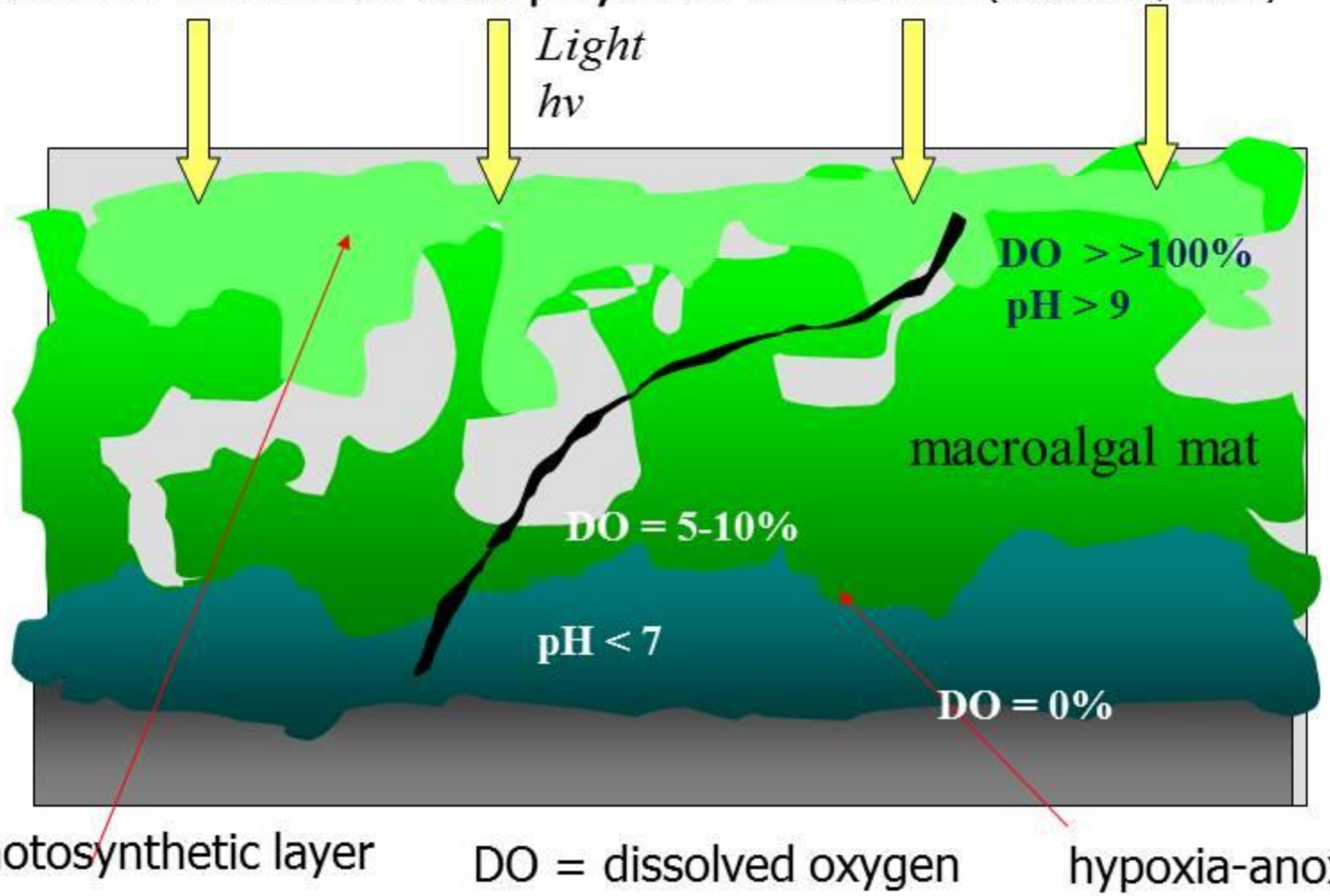
Natural eutrophication and eutrophication induced by high human pressure lead to the dominance of opportunistic macroalgae and reduction of seagrass meadows

Lagoon ecosystem

macroalgal bloom can be very extended,
with high-density mat


the macroalgal mats can reach the surface
of the water columns of 1-1.5 m depth

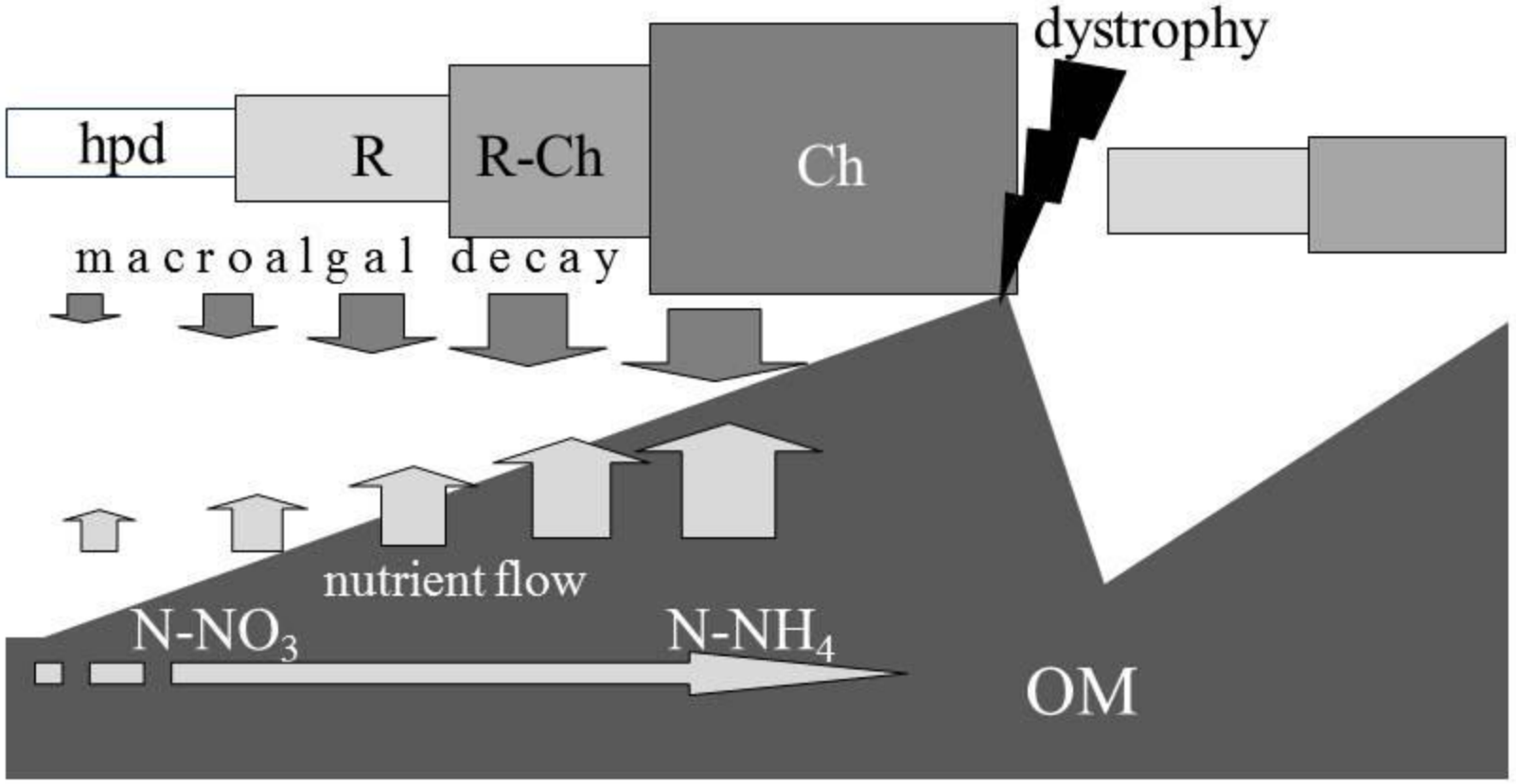
high density algal mats can determine stratification of the values of chemical and physical variables (Lenzi et al., 2013a)



At high density, the light penetrates a few centimeters, and the sub-layer algal mat dies

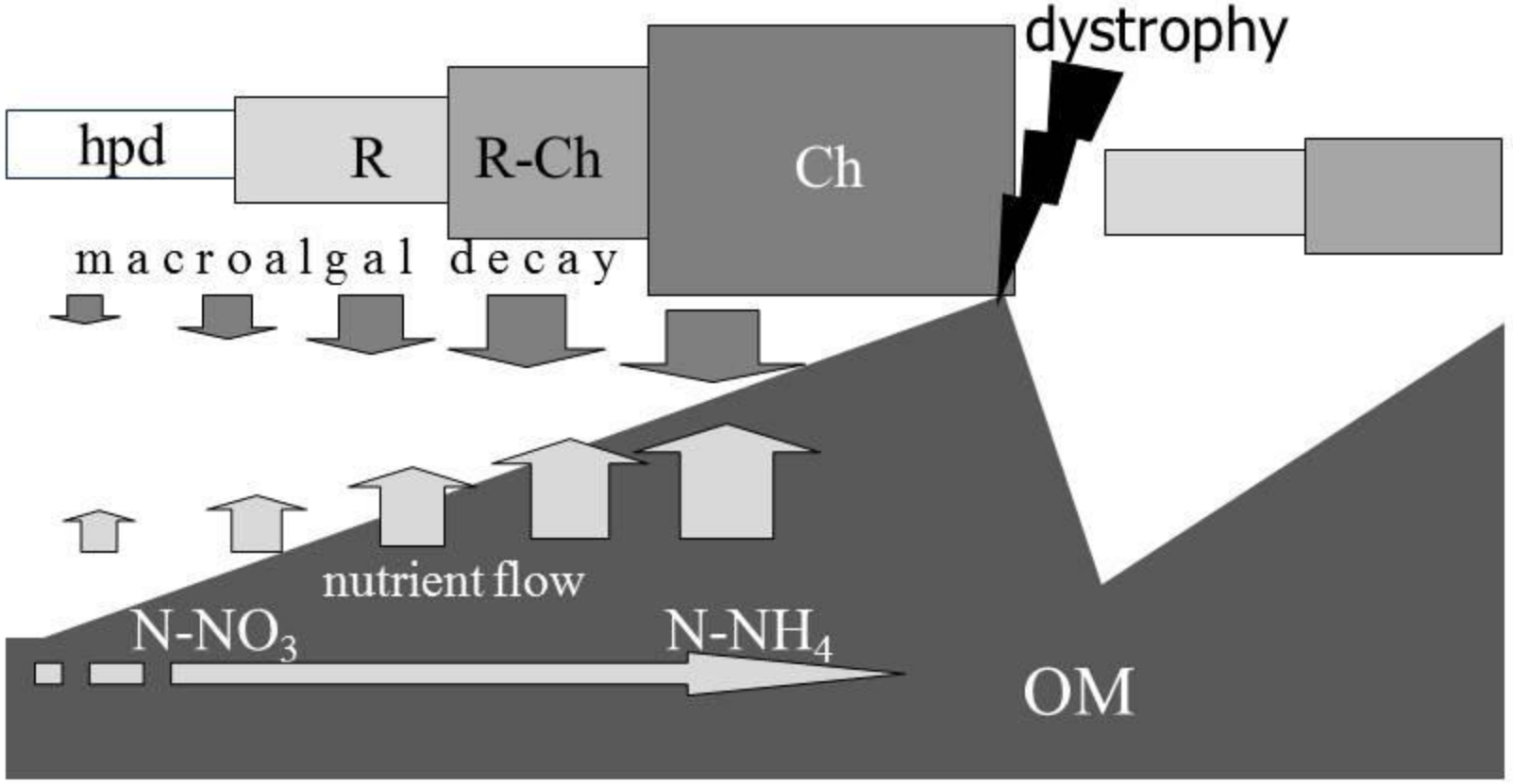
The decay of the algal masses triggers the environmental crisis, causing hydrogen sulfide releases. It can be turned out in the fishes die-off.

Quality and quantity of the vegetation as a function of the accumulation of organic matter in sediments (Lenzi et al., 2011)

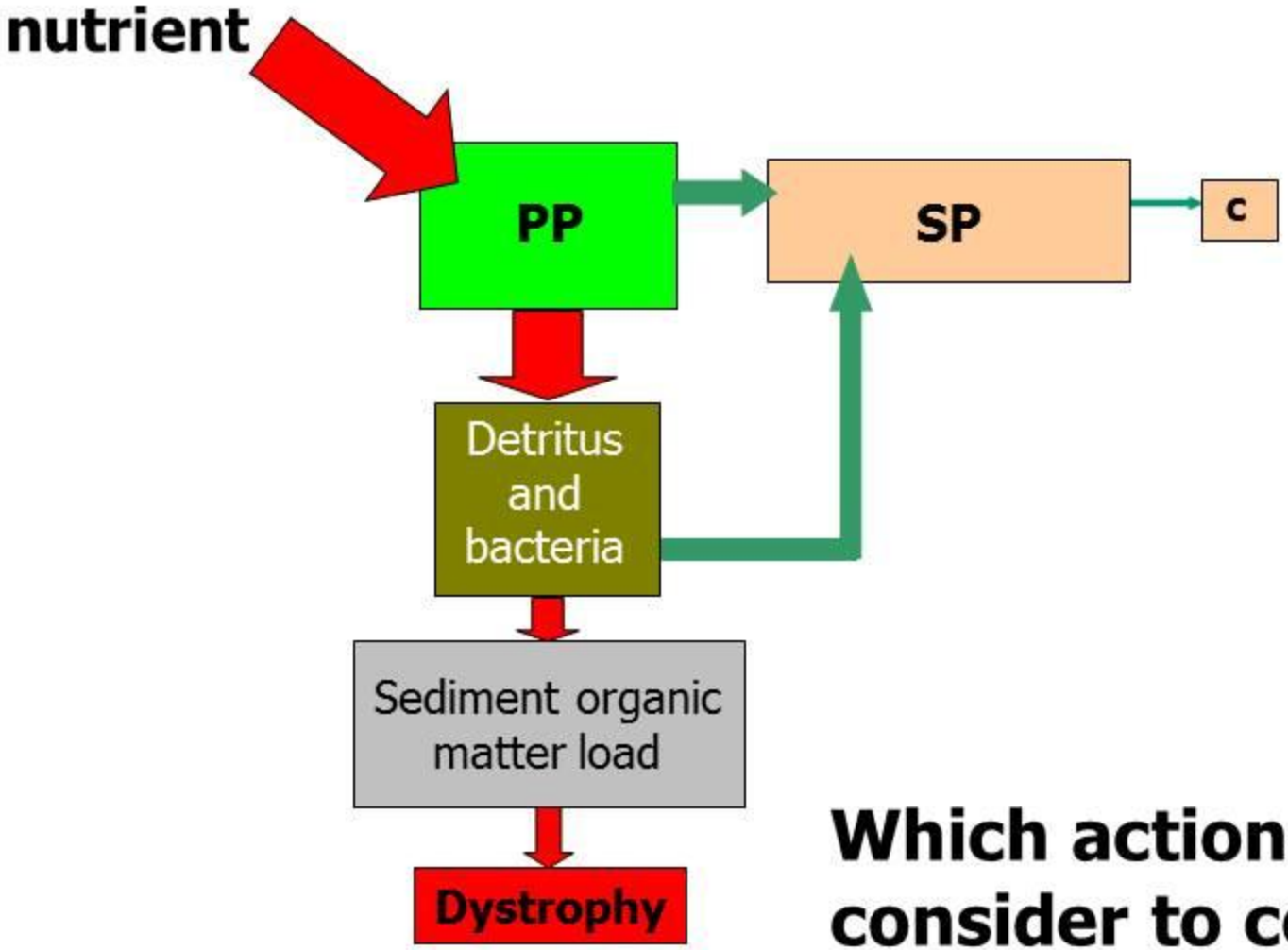


hpd = high phytobenthonic diversity;
R = red algae; **Ch** = green algae;
N-NO_3 = nitric nitrogen; **N-NH_4** = ammonium nitrogen;
OM = sediment organic matter

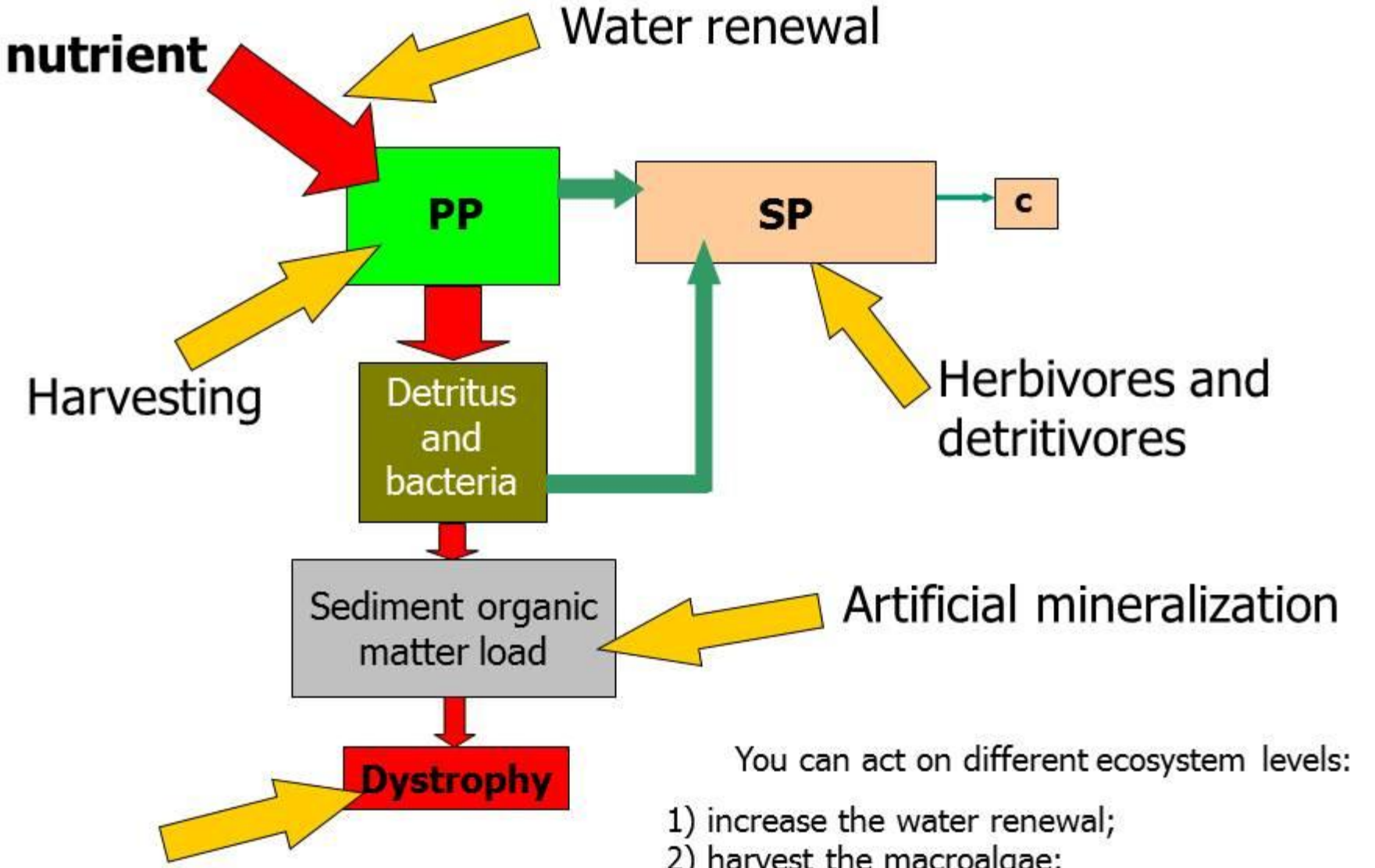
Quality and quantity of the vegetation as a function of the accumulation of organic matter in sediments (Lenzi et al., 2011)



As the organic matter accumulates, the nutrient releases increase and change in chemical species, increasing the ammonium ion with respect to nitrate nitrogen. Dystrophy is a dissipative process whereby the sediment organic load is lowered

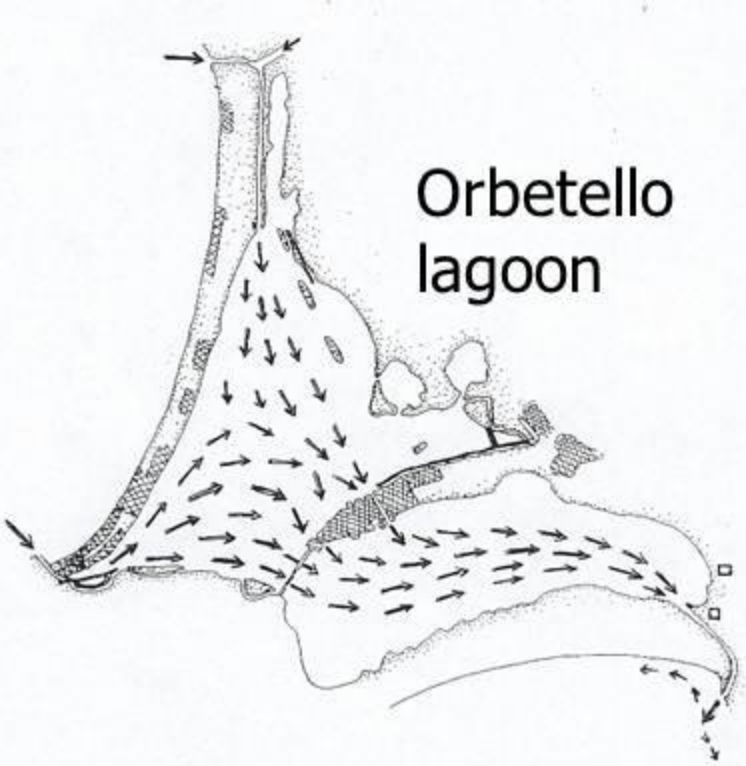


Which actions can we consider to counteract the effects of eutrophication of the lagoon ecosystems ?



You can act on different ecosystem levels:

1) increase the water renewal;
2) harvest the macroalgae;
3) increase the primary consumers;
4) reduce the nutrient inputs;
5) actions on the organic load of the sediments;
6) actions to inhibit the activity of sulphate reducing bacteria (SRB)



Specifically, the main solutions are :
1) the pumping of sea water (Lenzi, 1992),
2) harvesting of macroalgae (Lenzi, 1992; King and Hodgson, 1995; Runca et al., 1996; Lavery et al., 1999; De Leo et al., 2002), and/or
3) heavy engineering interventions aimed to change radically the hydrodynamics and morphology of the lagoon basin (SCE, 2005; Vandenbroeck and Ben Carrada, 2001)


The intake of sea water mitigates the environmental conditions, but, at the same time, supports the growth and maintenance of the algal mats

To achieve the expected results, the effort of macroalgal harvesting should be increased a lot, with a strong increase in spending

But this effort is not supported by the use of the masses: no industrial use is possible for the algal masses at the moment.

Agar – when the opportunistic rodophyiceae are present, the quality of agar is not always good, and the amount is not even industrially sufficient.
Soil amendment – little carbon (96% water)
Compost - little nitrogen and phosphorus; macroalgal masses can be disposed not over the maximum of 15-20%
Cellulose - too many impurities
Animal feed - – poor nutritional value
Biogas – unsuitable: under anaerobic conditions develops hydrogen sulfide (Migliore et al., 2012)
Biodiesel – poor presence of lipids (Bastianoni et al., 2008)
Fuel pellets – too much water, low calorific value and development of sulfur dioxide in combustion

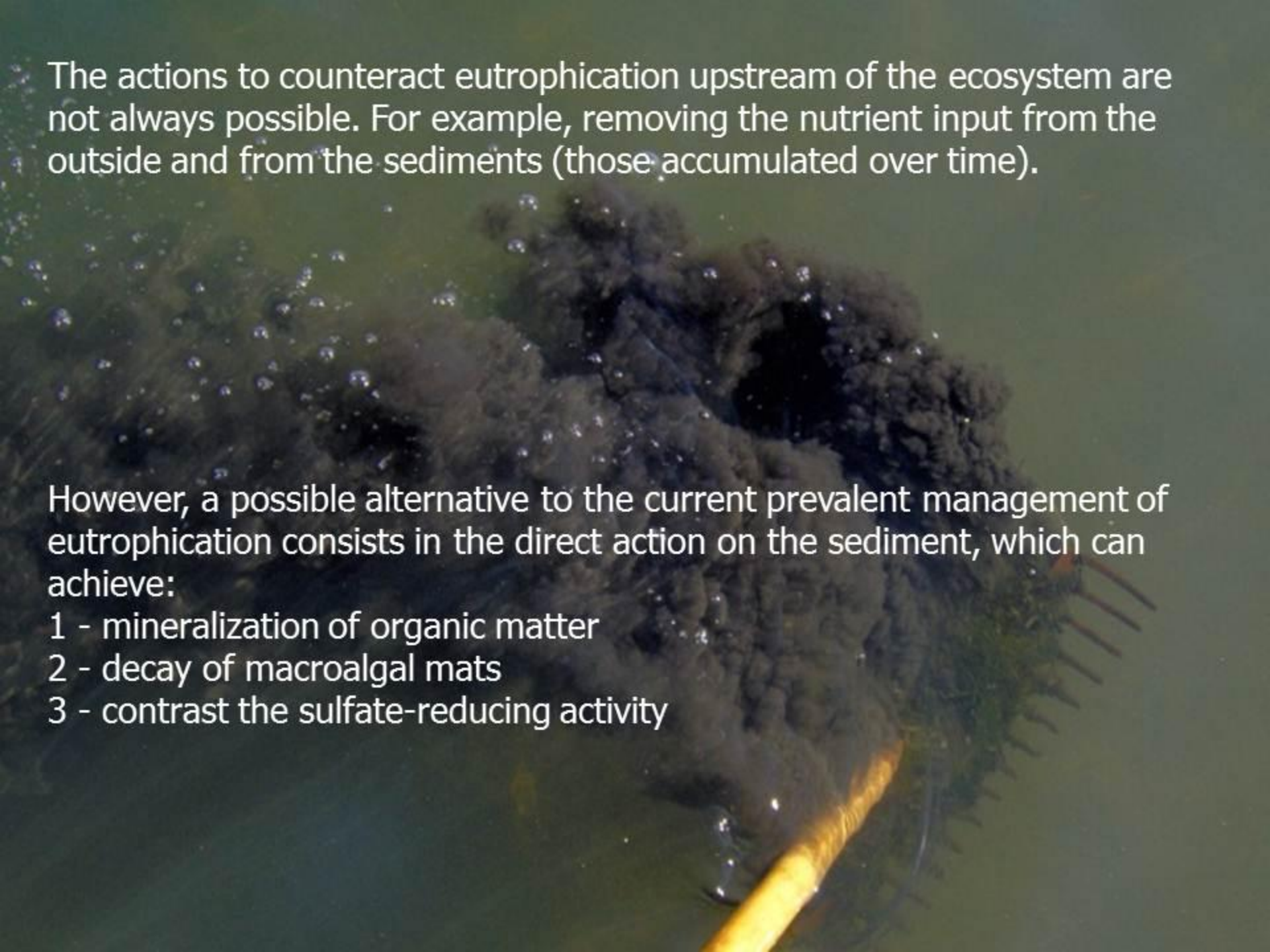
What to do?

Working upstream, ensuring that you have an overgrowth of algae

..

OR

Continue downstream, collecting algal mass completely unusable, which result in high operating costs?



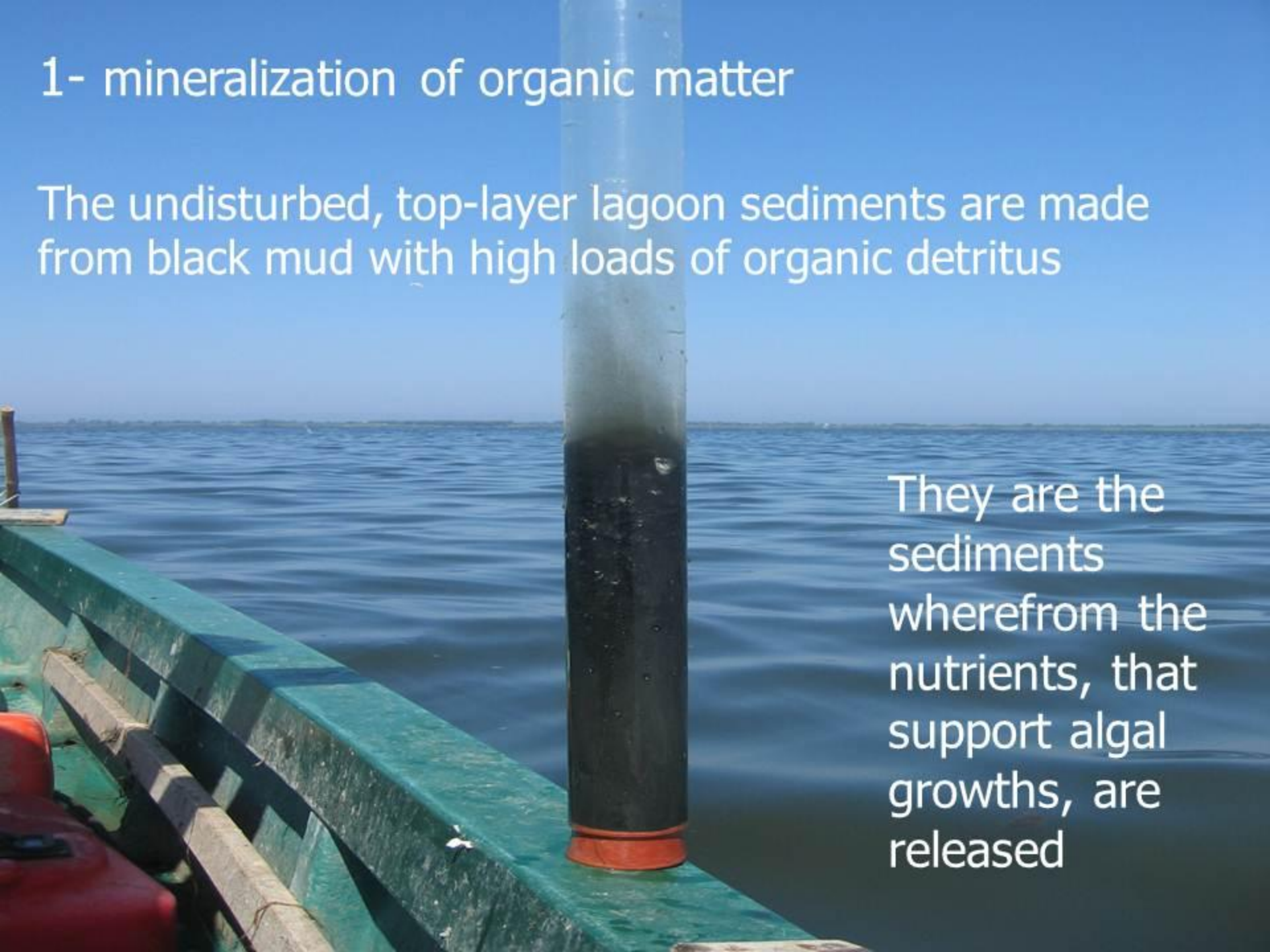
The actions to counteract eutrophication upstream of the ecosystem are not always possible. For example, removing the nutrient input from the outside and from the sediments (those accumulated over time).

However, a possible alternative to the current prevalent management of eutrophication consists in the direct action on the sediment, which can achieve:

1 - mineralization of organic matter
2 - decay of macroalgal mats
3 - contrast the sulfate-reducing activity

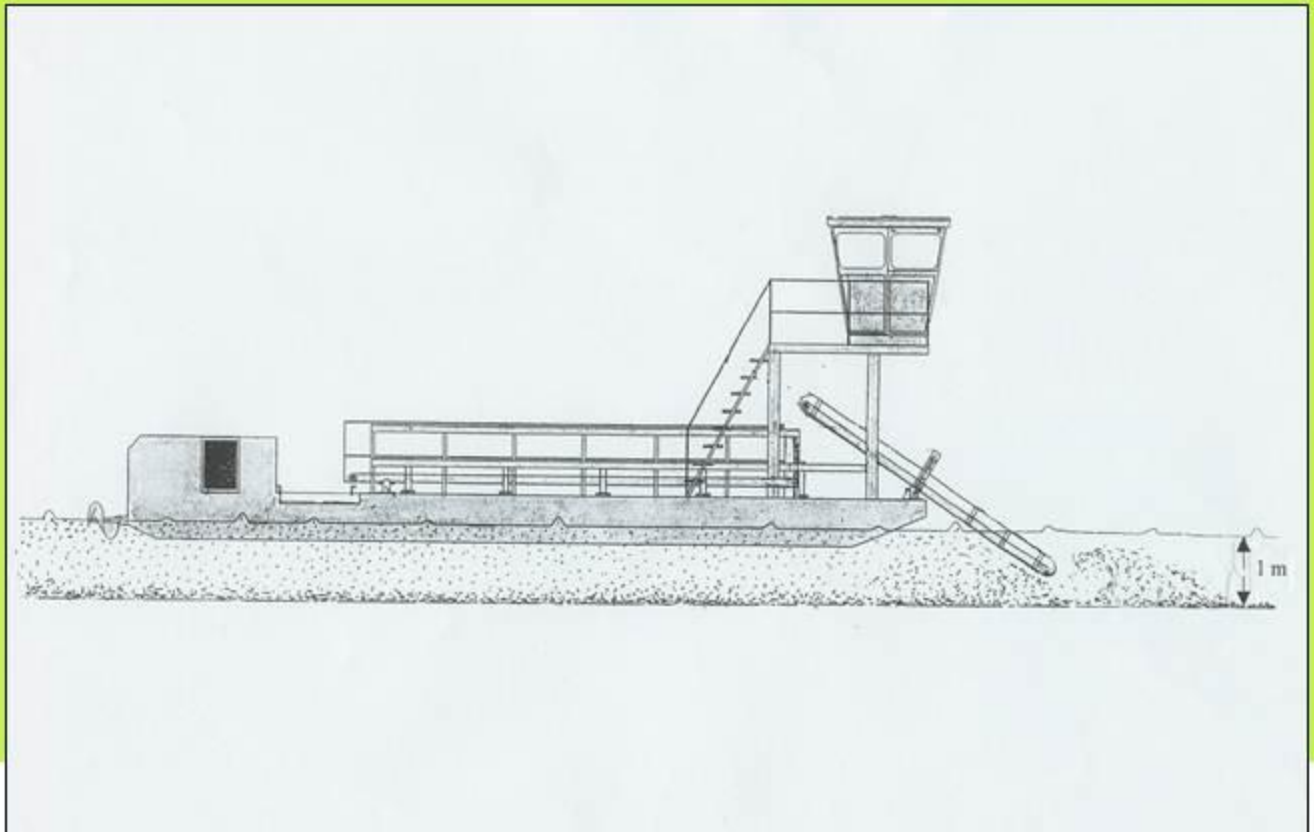
1- mineralization of organic matter

The undisturbed, top-layer lagoon sediments are made from black mud with high loads of organic detritus



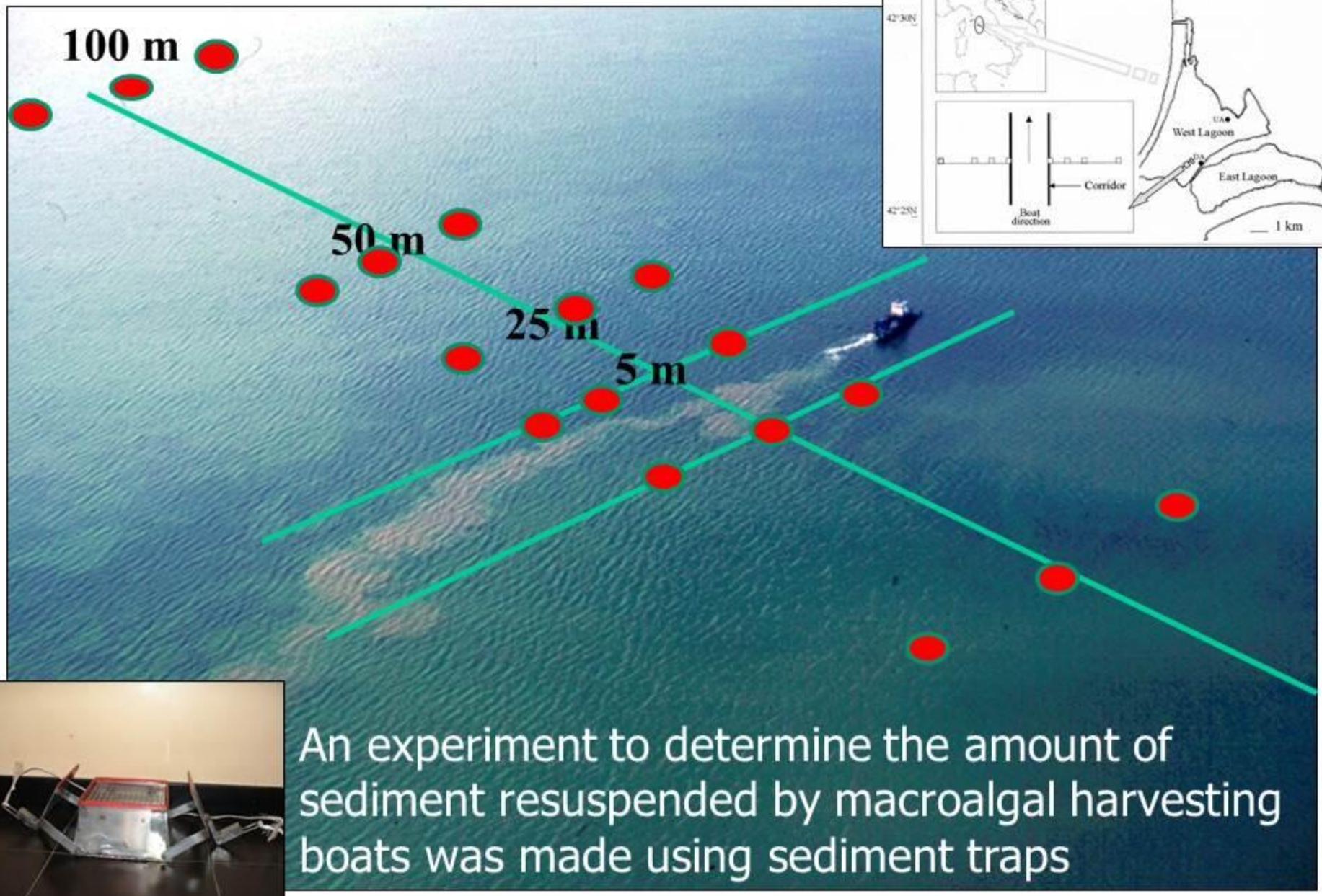
They are the sediments wherefrom the nutrients, that support algal growths, are released

In the case of Orbetello lagoon (1-1.5m depth), the macroalgal harvesting boats mix the soft surface sediment (3-5 cm) while they are working. This has a direct effect, the resuspending sediment in the water column, and an indirect effect, the resuspended sediment fall out to the surrounding bottom.

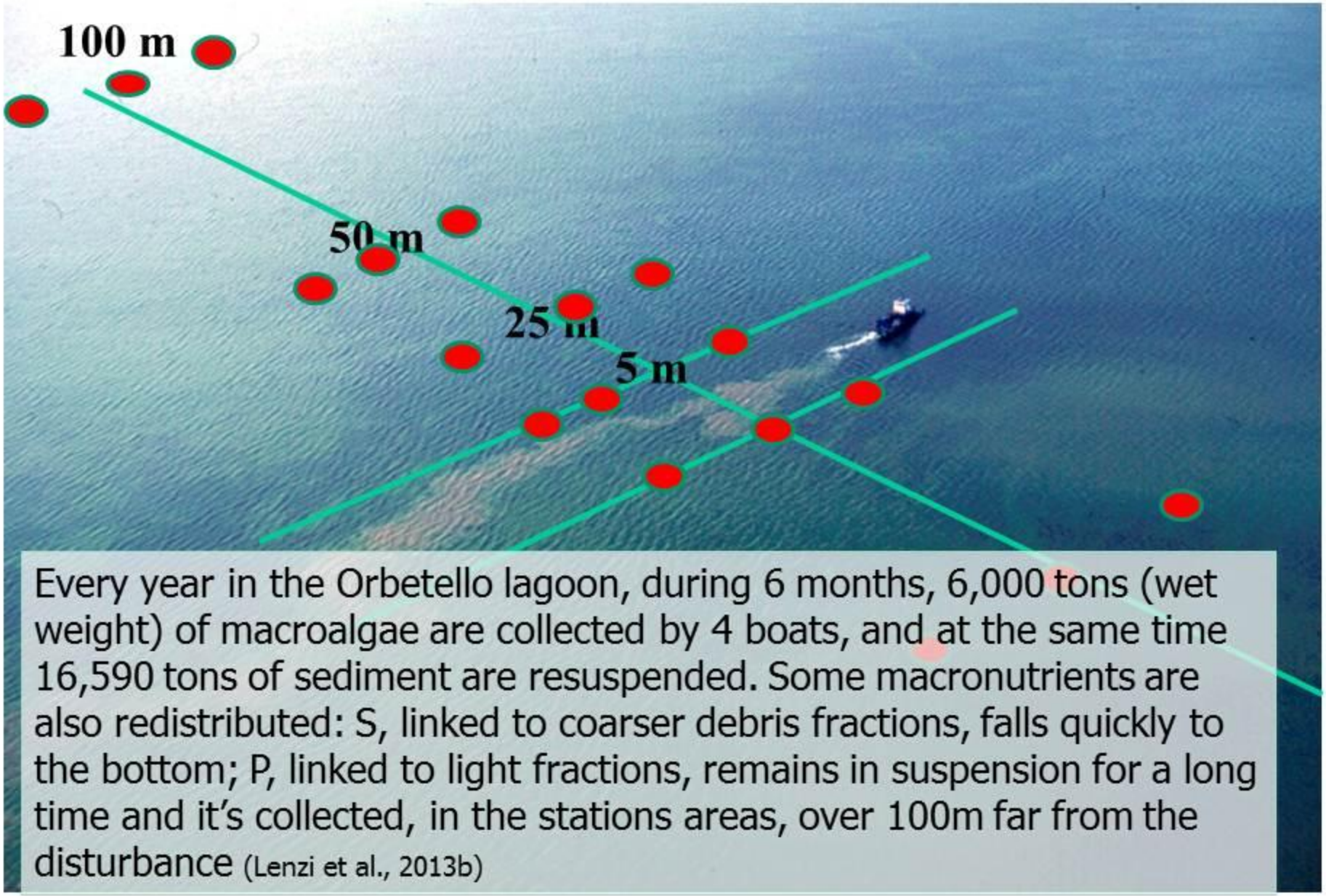


The resuspended sediment is initially anoxic and black (ferrous sulfide)

Due to repeated sediment resuspensions in the water column, the sediment is oxidized and the sludge turns gray by pyrite formation



An experiment to determine the amount of sediment resuspended by macroalgal harvesting boats was made using sediment traps



Every year in the Orbetello lagoon, during 6 months, 6,000 tons (wet weight) of macroalgae are collected by 4 boats, and at the same time 16,590 tons of sediment are resuspended. Some macronutrients are also redistributed: S, linked to coarser debris fractions, falls quickly to the bottom; P, linked to light fractions, remains in suspension for a long time and it's collected, in the stations areas, over 100m far from the disturbance (Lenzi et al., 2013b)

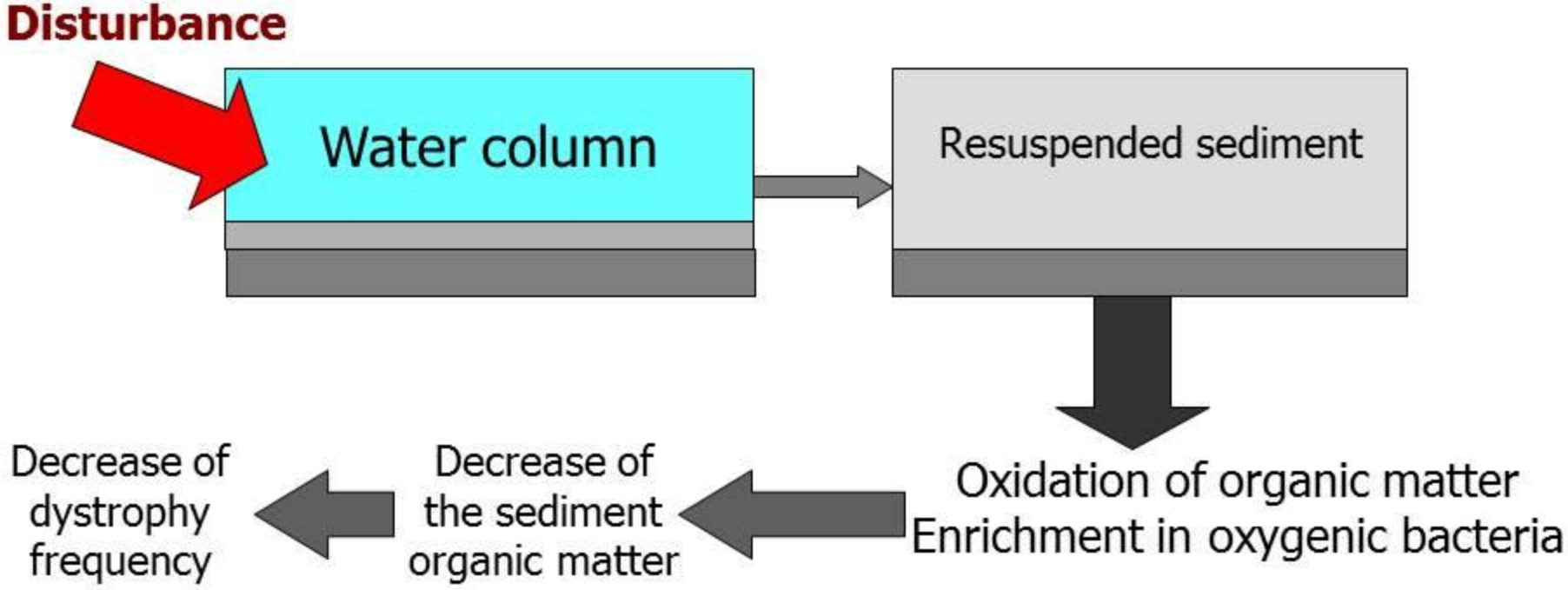
What is the most important role of the boats?

6,000 tonnes of macroalgae havested

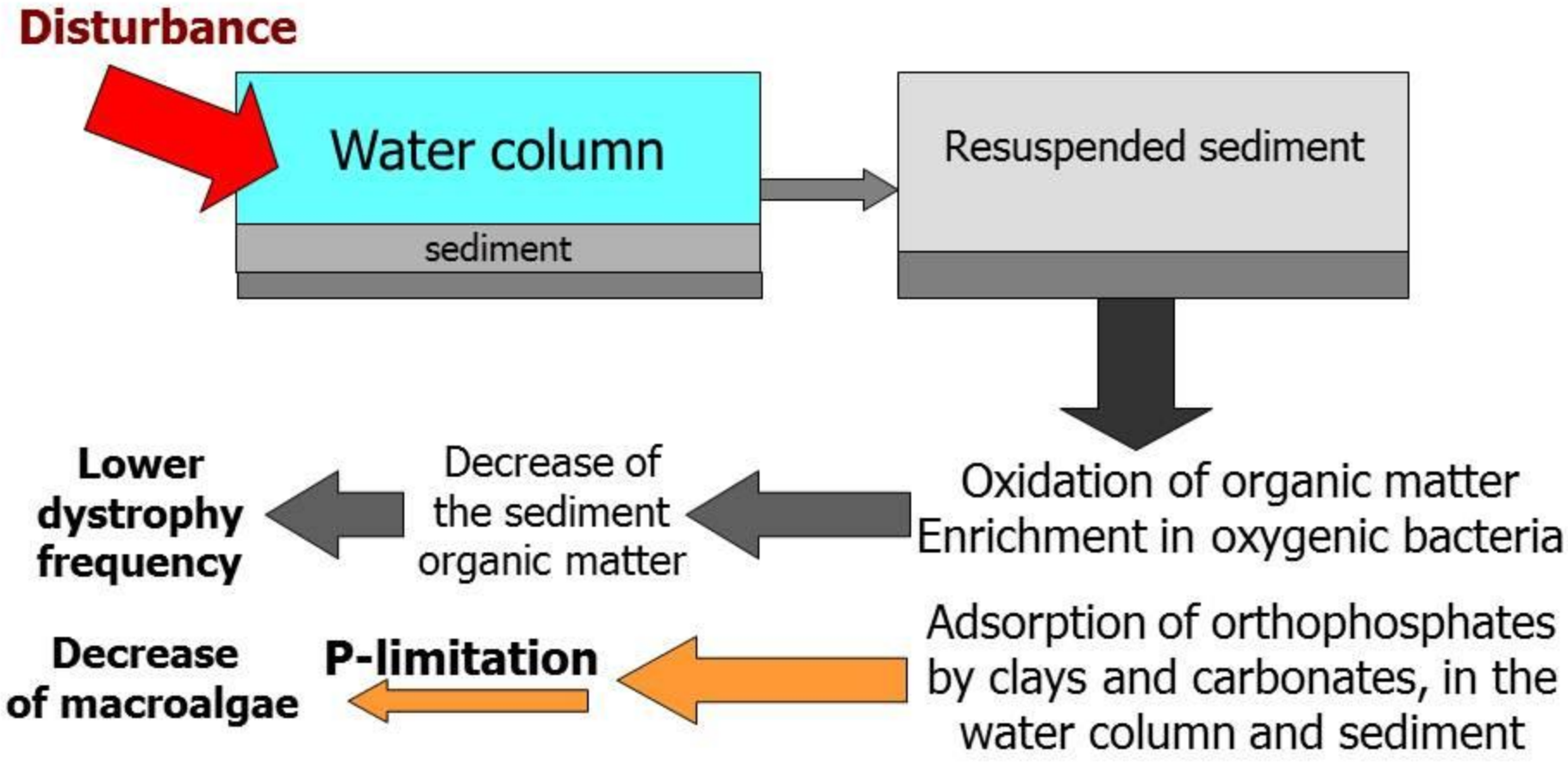
or

16,590 tonnes of resuspended sediment

But what happens as a result of resuspension of the sediments?

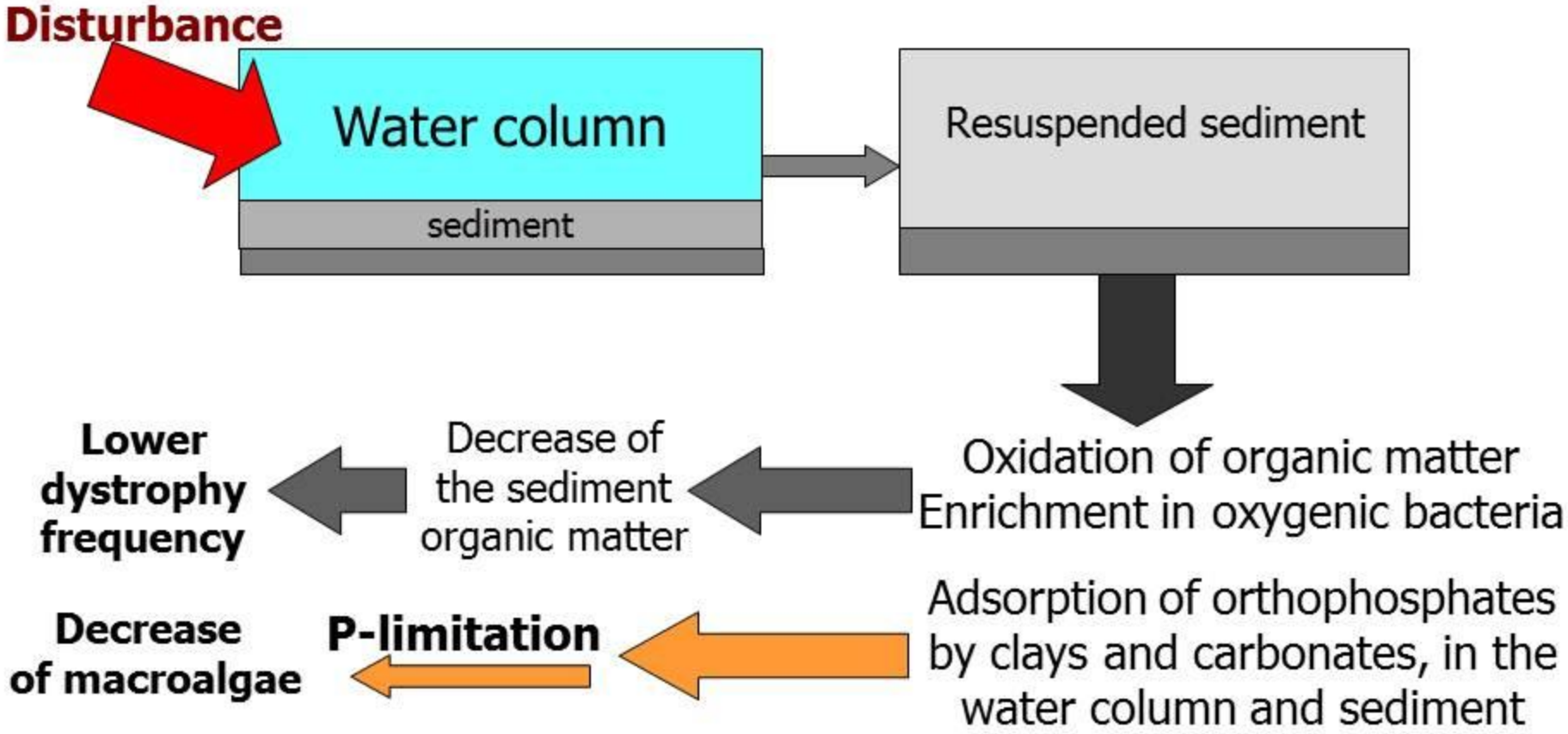


Stahlberg et al. (2006) demonstrated in laboratory that a frequent resuspension of the sediment increased the mineralization rate of organic matter, by a factor of 2-5, compared to not disturbed sediment. Lenzi et al. (2005, 2010) studied this phenomenon in field, while Lenzi and Renzi (2011) settled *in situ* the frequency range of the sediment disturbance necessary to obtain a reduction of labile organic matter of 30-40%.



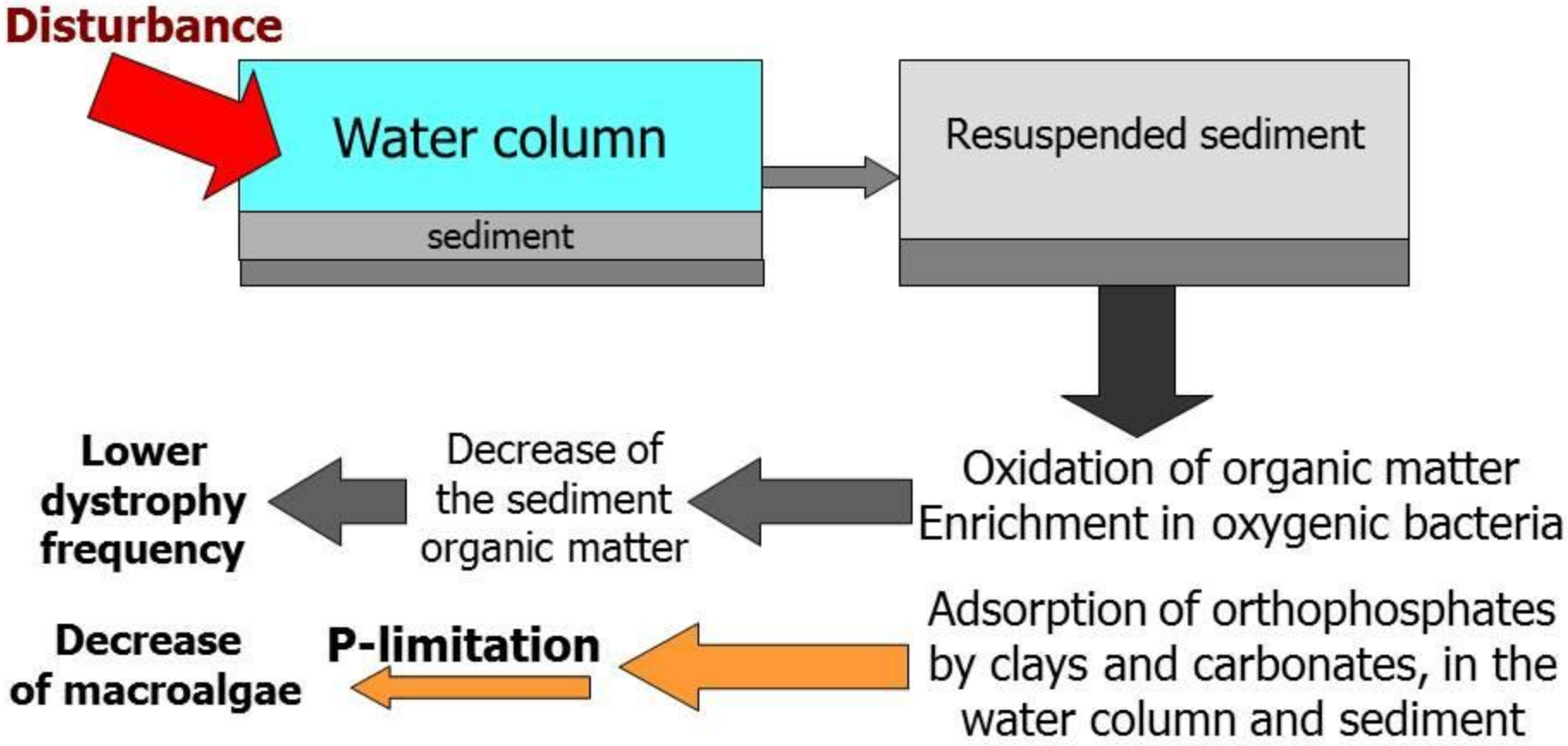
Under the good oxidation of sediments, orthophosphates are linked to ferric oxy-hydroxides (Golterman, 2001), and to carbonates and clays (De Jonge & Villerius, 1989; Dodge et al.,1984), therefore, poorly released into the water column, and, ultimately, unavailable to the algal vegetation.

Sediment oxidation accelerates the process of nitrification and implies the dominance of nitrate against ammonium (Revsbech et al., 1980). Nitrate increase and also produces an increase in the denitrification process (Herbert and Nedwell, 1990).

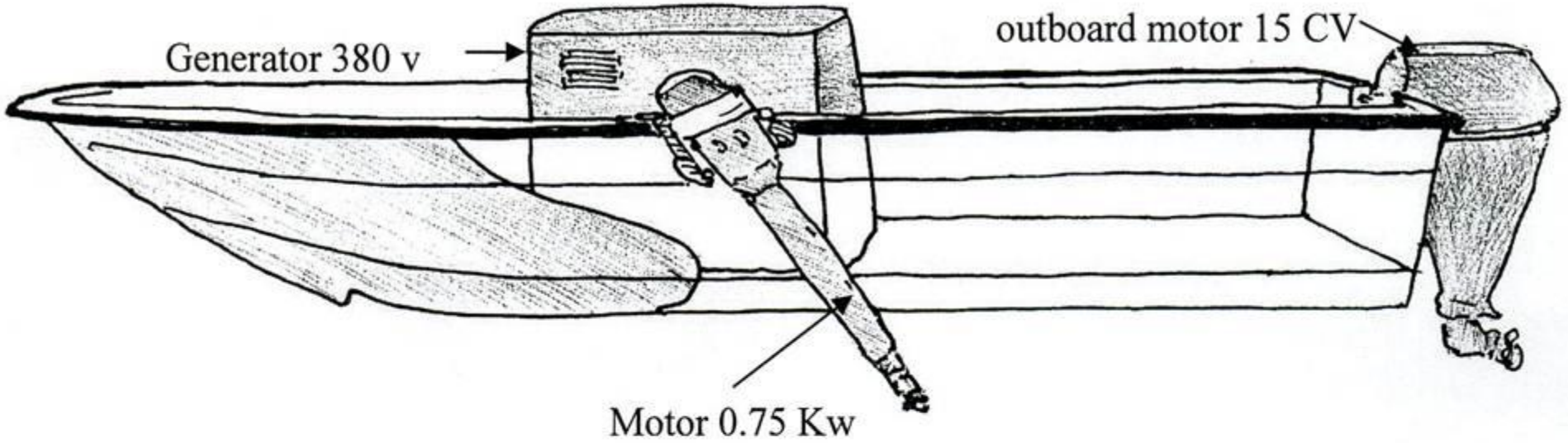


The result is a part of the sediment nitrogen is removed from the system as N_2 or N_2O, and eutrophication decreases (Novicki et al., 1997)

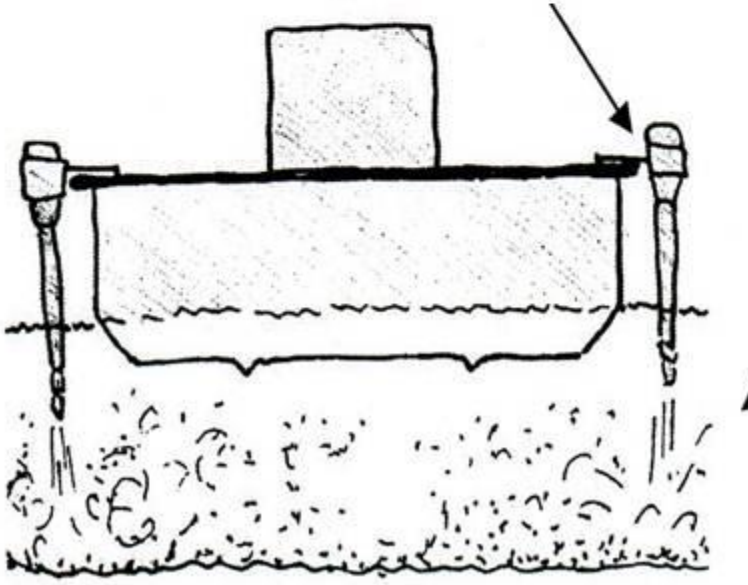
Sediment resuspension can produce variations in the trophic system of the lagoon environments, and consequently a vegetational rearrangement

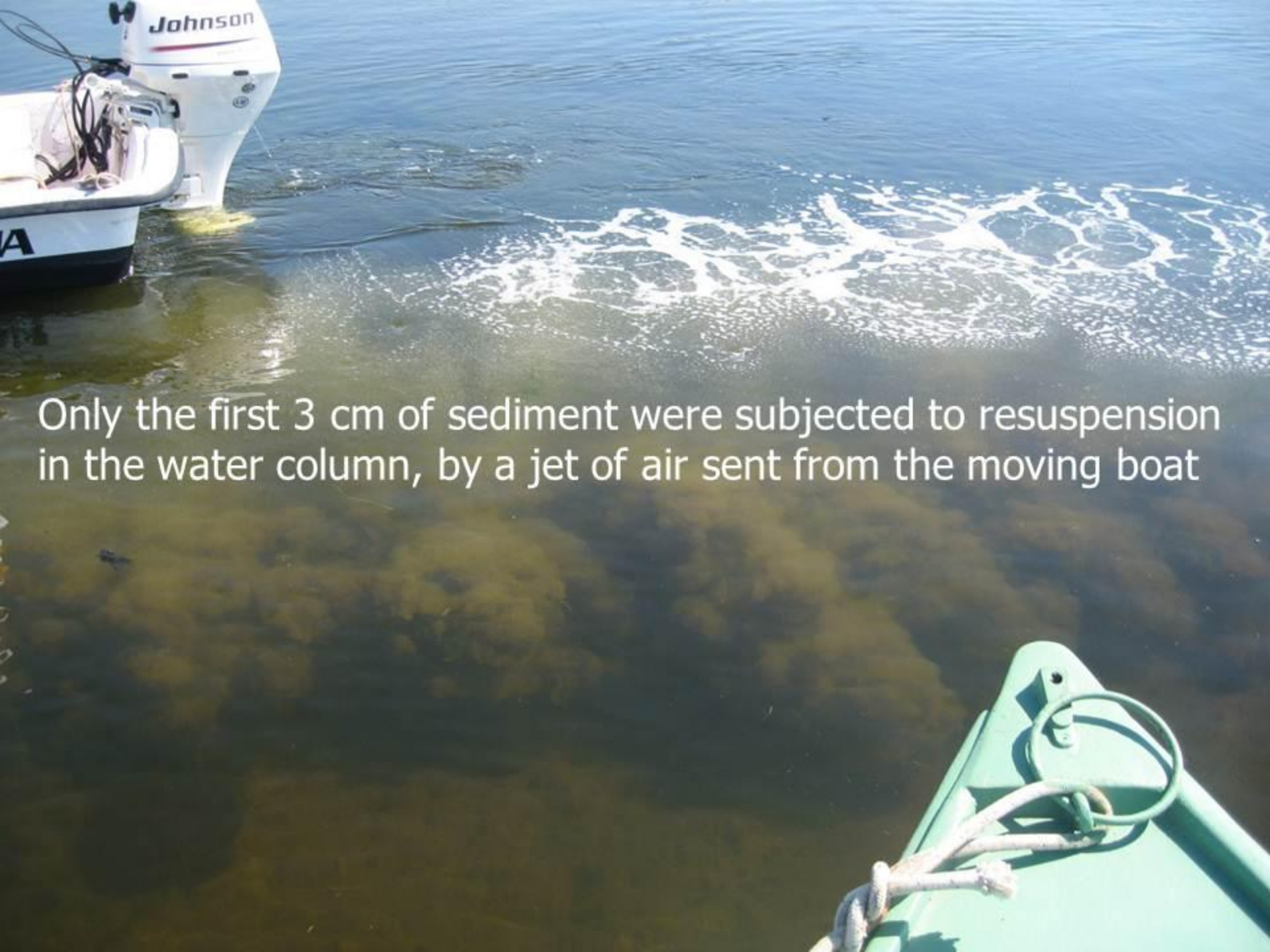


Decrease of macroalgae and a lower dystrophy frequency allow the return and expansion of the seagrass (Lenzi et al., 2010).

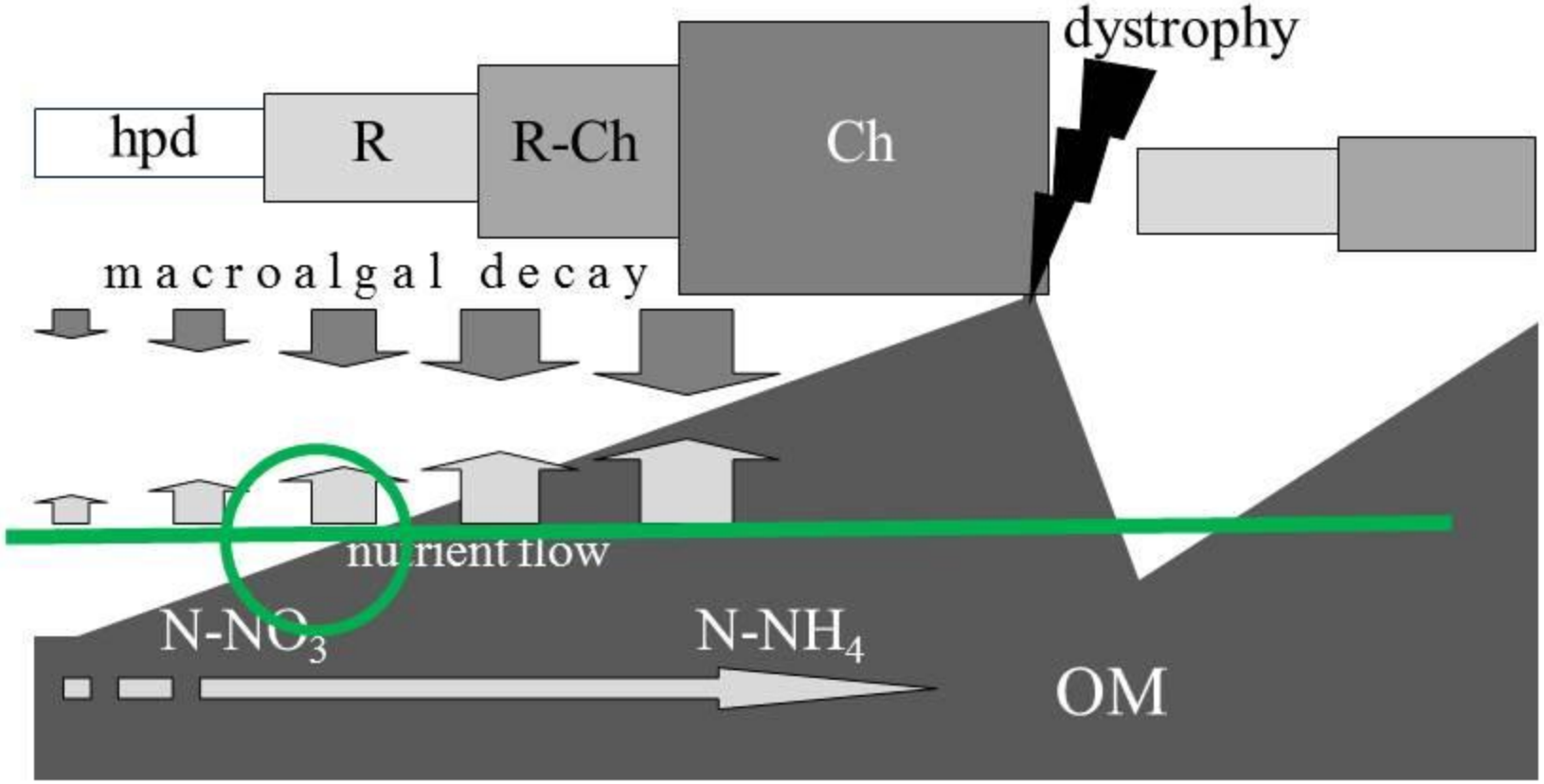


The three-years experience conducted in the Burano Lake (Lenzi et al., 2010), with a boat specially designed for the sediment disturbance, highlighted the drastic reduction of macroalgae and the return of seagrass meadows

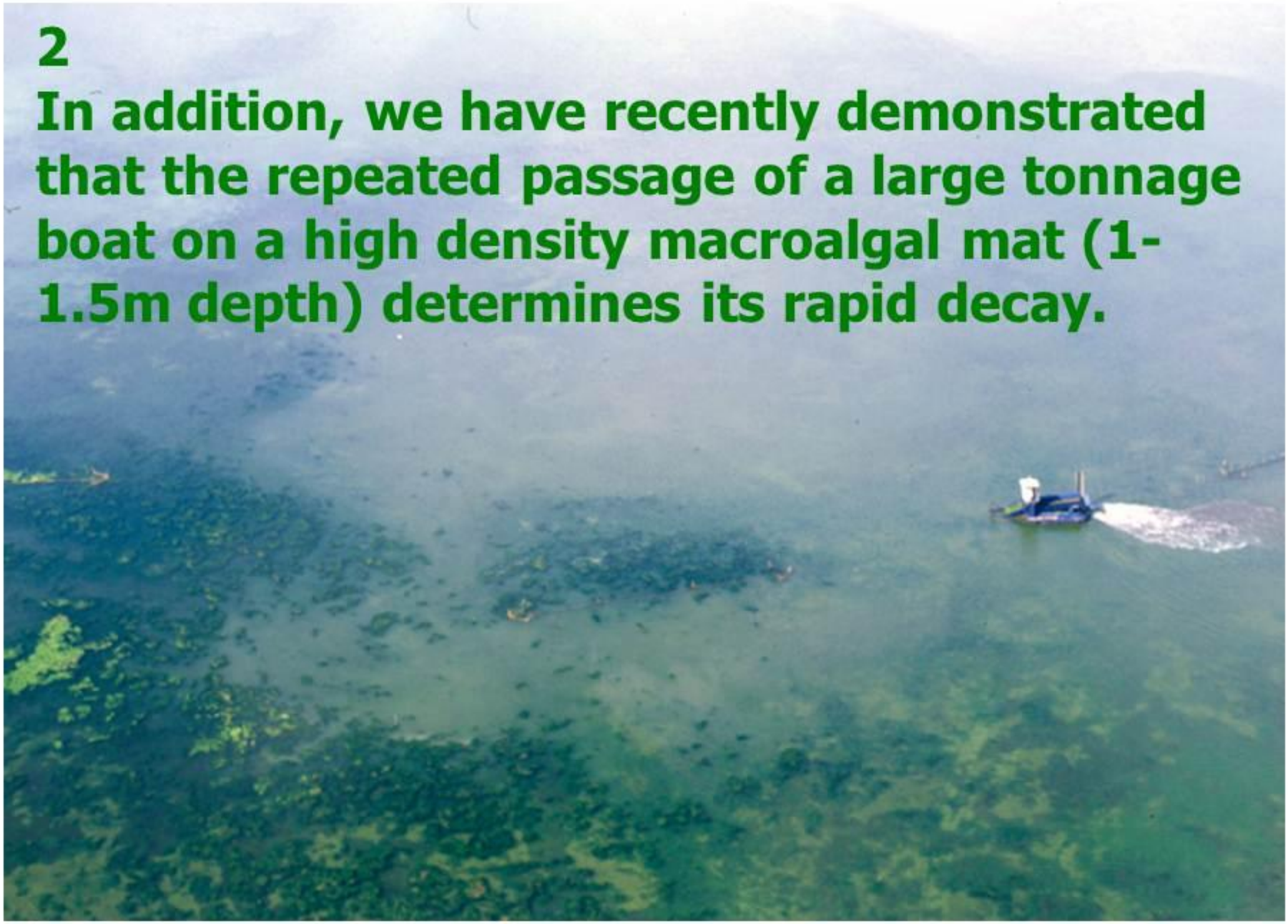


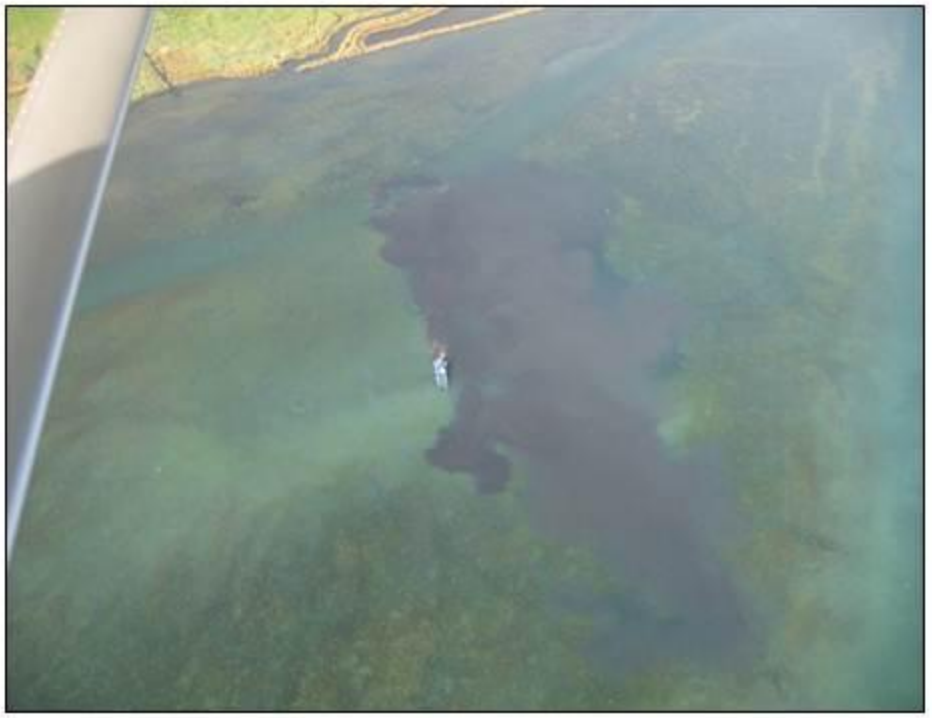


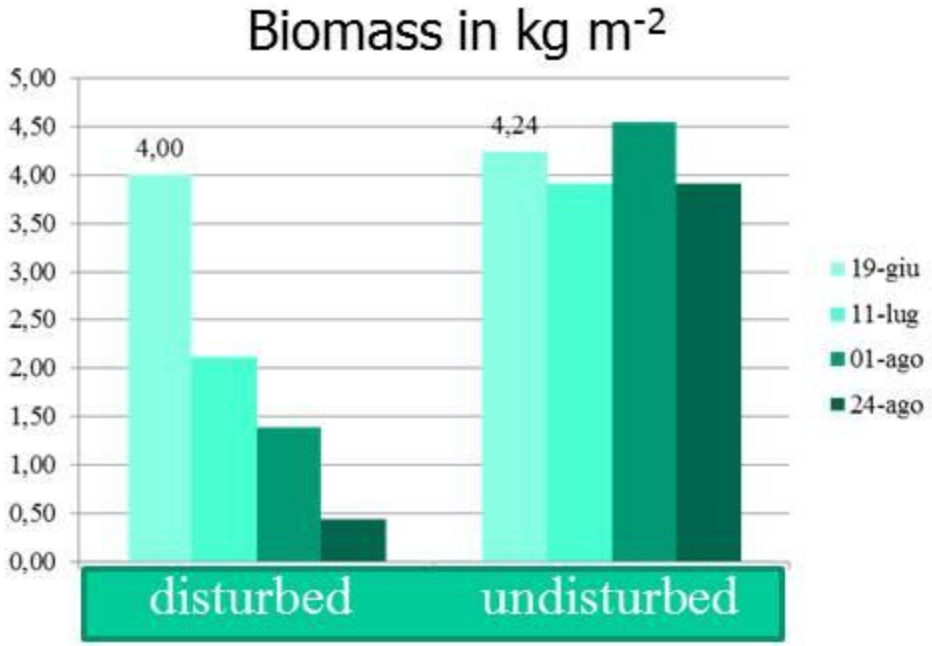
Only the first 3 cm of sediment were subjected to resuspension in the water column, by a jet of air sent from the moving boat



The lagoon eutrophication management must reduce the sediment organic load to value such release of nutrients produced acceptable qualitative and quantitative development of the algal vegetation.


2
In addition, we have recently demonstrated that the repeated passage of a large tonnage boat on a high density macroalgal mat (1-1.5m depth) determines its rapid decay.





In a recent experiment, the biomass of a high density mat remained stable in the undisturbed part of the mat, with a decrease of about 7%, while the decline was the 89% in the mat part subjected to disturbance.

3

The sediment disturbance can be used in the pre-critical and critical phases of the lagoon environmental conditions, to counteract the sulfate-reducing bacterial activity.
Sediment disturbance inhibits the activity of the anoxigenic bacteria (Lenzi et al., 2010).

A new strategy for the environmental management of eutrophic, low water renewal, shallow lagoon

- Direct action of disturbance on the mats without macroalgal harvesting facilitates mat decay

- Summer disturbance on dystrophic areas oxidizes the sediment and blocks the bacterial sulfate-reducing activity

- Autumn-winter resuspension of high organic load sediment increases oxygenic mineralization and decreases macroalgal growth

References

-Bastianoni S., Coppola F., Tiezzi E., Colacevich A., Borghini F., Focardi F., 2008. Biofuel potential production from the Orbetello lagoon macroalgae: A comparison with sunflower feed stock. Biomass and Bioenergy 32, 619-628

-De Jonge, V.N., Villerius, L.A. 1989. Possible role of carbonate dissolution in estuarine phosphate dynamics. Limnol. Oceanogr. 34, 332-340

-De Leo G.A., Bartoli M., Naldi M., Viaroli P., 2002. A first generation stochastic bioeconomic analysis of algal bloom control in a coastal lagoon (Sacca di Goro, Po River Delta). Marine Ecology 23(1), 92-100.

-Dodge, R.E., Jickells, T.D., Knap, A.H., Boyd, S., Bak, R.P.M., 1984. Reef-building coral skeletons as chemical pollution (phosphorus) indicators. Marine Pollution Bulletin 15, 178–187

-Golterman, H.L., 2001. Phosphate release from anoxic sediments or "what did Mortimer really write?". Hydrobiologia. 450, 99-106

-Herbert RA, Nedwell DB (1990). Role of environmental factors in regulating nitrate respiration in intertidal sediments. In: Denitrification in Soil and Sediment (Revsbech, N.P. and Sorensen, J., Eds.), pp. 77- 90. Plenum Press. New York.

-King R.J., Hodgson B.R., 1995. Tuggerah Lakes System, New South Wales, Australia. In McComb, A.J. (Ed.), Eutrophic Shallow Estuary and Lagoons. CRC Press, Boca Raton, Florida, 19-29.

-Lavery P., Bootle S., Vanderklift M., 1999. Ecological effects of macroalgal harvesting on beaches in the Peel-Harvey estuary, Western Australia. Estuarine, Coastal and Shelf Science 49, 295-309.

-Lenzi, M., 1992. Experiences for management of Orbetello Lagoon : eutrophication and fishing. Science of the Total Environment (3 suppl.), 1189-1198.

-Lenzi M., Birardi F., Calzolai R., Finoia M.G., Marcone F., Nocciolini S., Roffilli R., Sgroi S., Solari D., 2010. Hypertrophic lagoon management by sediment disturbance. Marine Pollution Bulletin 61, 189-197

-Lenzi, M., Finoia, M.G., Gennaro, P., Mercatali, I., Persia, E., Solari, J., Porrello, S., 2013b. Assessment of resuspended matter and redistribution of macronutrient elements produced by boat disturbance in a eutrophic lagoon. Journal of Environmental Management 123, 8-13.

-Lenzi, M., Finoia, M.G., Persia, E., Comandi, S., Gargiulo, V., Solari, D., Gennaro, P., Porrello, S., 2005. Biogeochemical effects of disturbance in shallow water sediment by macroalgae harvesting boats. Marine Pollution Bulletin 50 (5), 512-519

-Lenzi M., Gennaro P., Mercatali I., Persia E., Solari J., Porrello S. 2013a. Physico-chemical and nutrient variable stratifications in the water 4 column and in macroalgal thalli as a result of high biomass mats 5 in a non-tidal shallow-water lagoon. *Marine Pollution Bulletin* 75: 98-104 http://dx.doi.org/10.1016/j.marpolbul.2013.07.057
-Lenzi, M., Renzi, M., 2011. Effects of artificial disturbance on quantity and biochemical composition of organic matter in sediments of a coastal lagoon. Knowledge and Management of Aquatic Ecosystems, 402, 08. DOI: 10.1051/kmae/2011058
-Lenzi M., Renzi M., Nesti U., Gennaro P., Persia E., Porrello S., 2011. Vegetation cyclic shift in eutrophic lagoon. Assessment of dystrophic risk indices based on standing crop evaluation. Estuarine, Coastal and Shelf Science, doi:10.1016/j.ecss.2011.10.006
-Migliore G., Alisi C., Sprocati A.R., Massi E., Ciccoli R., **Lenzi M.**, Wang A., Cresimini C. 2012. Anaerobic digestion of macroalgal biomass and sediments sources from the Orbetello lagoon, Italy. Biomass and Bioenergy 42, 69-77.
-Novicki BL, Requintina E, Van KD, Kelly JR (1997). Nitrogen losses through sediment denitrification in Boston Harbour and Massachusetts Bay. Estuaries, 20: 626-639
-Revsbech NP, Sorensen J, Blackburn TH, Lomholt JP (1980). Distribution of oxygen in marine sediments measured with microelectrodes. Limnol. Oceanogr., 25: 403-411.
-Runca E., Bernstein A., Postma L., Di Silvio G., 1996. Control of macroalgae blooms in the Lagoon of Venice. Ocean and Coastal Management 30, 135-143.
-SCE, 2005. San Dieguito Wetlands Restoration Project. Final Restoration Plan. Southern California Edison Company 260 pp. www.sdlagoon.com
-Stahlberg, C., Bastviken, D., Svensson, B.H., Rahm, L., 2006. Mineralisation of organic matter in coastal sediment at different frequency and duration of resuspension. Estuarine, Coastal and Shelf Science 70, 317–325
- Vandenbroeck J., Ben Carrada R., 2001. Restoration and development Project of South Lake of Tunis and its shores. Terra et Aqua 85, 11-20

Aquaculture Research & Development Related Journals

- Fisheries and Aquaculture Journal
- Marine Science: Research & Development
- Fisheries & Livestock Production
- Oceanography-Open Access
- Poultry, Fisheries and Wildlife Sciences

OMICS Group **Open Access Membership**

OMICS publishing Group Open Access Membership enables academic and research institutions, funders and corporations to actively encourage open access in scholarly communication and the dissemination of research published by their authors.

For more details and benefits, click on the link below:

http://omicsonline.org/membership.php