UM5MRM28	MANAGEMENT AND CONSERVATION OF MARINE ECOSYSTEMS	
6 ECTS	*Keywords*	biotic indicators, eutrophication, harmful algae, marine urbanization, marine-protected areas
M2	*Managers*	Pascal RIERA, Éric THIÉBAUT (AD2M, Roscoff)
Roscoff	*Professors*	Jean-Charles LECLERC, Nathalie SIMON, Christophe SIX (AD2M, Roscoff), Philippe KOUBBI (BOREA, Paris).
	Tracks	Biodiversity and conservation of marine ecosystems

Description

Format

Teaching

This course is open to students from Sorbonne University, but also to students from the International Marine Biological Research on the Sea (IMBRSea), therefore all teaching will be given in English.

- Lectures: 24h dispatched in 3 topics: (1) Biotic indicators and indices (2) Marine pollution and urbanization, (3) Marine Protected Areas (MPA)
- Practical work: 36h, from fieldwork-sampling at low tide to the assessment of coastal pollution levels through taxonomy and biotic indices calculations (AMBI, CCO, …), harmful phytoplankton assessment
- Seminars by non-academic professionals: 2 or 3 according to their schedule availabilities, on topics concerning: the implementation of the Water framework Directive, or on the Marine Strategy Framework Directive, or on Daily work in a Marine Protected Area…

Evaluation

Type	% Quotation	Modality	Nature
Oral	40%	Work in groups of 3-5 students	Analysis on a given data set or literature review (about biotic indices, marine urbanization, harmful blooms, marine protected areas….) presented as a ppt file for the class. Each student from each group presents a part of the ppt orally.
Written exam	60%	Individual work	On 2 out of 3 topics proposed about the lectures and the practical work done during the course.

Summary

This course on management and conservation of marine ecosystems aims to (1) give an overview on biotic indicators developed in the context of European Directives to assess the Environmental Status of marine ecosystems to human disturbances, in particular the pollutions and eutrophication along the land-sea interface, (2) to address the effects of "marine urbanization" on marine ecosystems (e.g. modified food webs) and assess the existing solutions to manage the development of infrastructures (e.g. ports, marine renewable energy) at sea, and (3) to identify the efficiency and the way to design Marine Protected Areas (MPA), both in coastal and open seas.

Lectures are given on these topics, and a large time of the course is devoted to fieldwork and practicals: (1) the determination and calculation of biotic indices (based upon the identification of benthic macrofauna and macroalgae) and (2) the assessment of eutrophication, and harmful algal bloom along anthropogenic gradients. Seminars by non-academic professionals constitute an opportunity for the students to get in touch with people, who daily work with the implementation of the European framework directives and/or manage biological resources in the French MPA of the Marine Iroise Natural Parc. Students will also be

trained to use scientific literature to argument pro- & contra- Large Scale MPA, as done by international commissions e.g. for Antarctica.

Learning objectives

At the end of the GECOMAR course, the student will be able to:

1. Assess the Good Ecological Status or the Good Environmental Status of marine ecosystems using biological indicators developed from the Water Framework Directive, and the Marine Strategy Framework Directive
2. Cite, compare and relate existing pollutions at sea, their life cycle, known (often interacting) impacts on marine ecosystems
3. Assess a pollution level of a coastal ecosystem (e.g., harbor) from eutrophication and phytoplankton bloom
4. Scientifically argue the relationship between eutrophication and harmful algal bloom
5. Design a Marine Protected Area with respect to scientific knowledge, and assess its efficiency
6. Scientifically argue about the relevance of MPAs

Prerequisites

To follow this course, the students must master the bases in oceanography and biological ecosystems, i.e. have followed a course on oceanography and on marine ecology during their first master degree. Although not a prerequisite, student ability to identify common species of macrofauna and macroflora from the shore (taxonomy) will be much appreciated.

Bibliography

(1) Sea pollutions

Monaco A & Prouzet P. (2014) Mer et Océans : Vulnérabilité du système océanique. Editions ISTE, 373 pages (in French!) https://www.eea.europa.eu/publications/zero-pollution/ecosystems/marine-pollution

(2) Marine urbanization

Hawkins, S. J., L. B. Firth, and A. J. Evans. 2020. Structures spread across our seas. Nature Sustainability:1–2.

Todd, P. A., E. C. Heery, L. H. L. Loke, R. H. Thurstan, D. J. Kotze, and C. Swan. 2019. Towards an urban marine ecology: characterizing the drivers, patterns and processes of marine ecosystems in coastal cities. Oikos 128:1215–1242.

Airoldi, L., M. W. Beck, L. B. Firth, A. B. Bugnot, P. D. Steinberg, and K. A. Dafforn. 2021. Emerging solutions to return nature to the urban ocean. Annual Review of Marine Science 13:445–477.

(3) Biotic indices:

Rombouts I, Beaugrand G, Artigas L F et al., (2013) Evaluating Marine Ecosystem Health: Case studies of indicators using direct observations and modelling methods. Review. Ecological Indicators 24: 353-365.

Guerra-García, J. M., C. Navarro-Barranco, M. Ros, F. Sedano, R. Espinar, A. Fernández-Romero, G. Martínez-Laiz, J. A. Cuesta, I. Giráldez, E. Morales, M. Florido, and J. Moreira. 2021. Ecological quality assessment of marinas: An integrative approach combining biological and environmental data. Journal of Environmental Management 286:112237.

Van Denderen P.D., Plaza-Morlote M., Vaz S., Wijnhoven S., Borja A., Fernandez-Arcaya U., Gonzalez-Irusta J.M. et al. (2024) Complementarity and sensitivity of benthic state indicators to bottom-trawl fishing disturbance. Ecological Applications, 34, e3050. doi.org/10.1002/eap.3050

(4) Marine Protected areas:

Balbar AC, Metaxas A, (2019) The current application of ecological connectivity in the design of marine protected areas. Global Ecology & Conservation 17, e00569.

Grorud-Colvert K., Sullivan-Stack J., Roberts C., Constant V. et al. (2021) The MPA guide: a framework to achieve global goals for the ocean. Science, 373, eabf0861, doi: 10.1126/science.abf0861

Humphreys J., Clark R.W.E. (2019) Marine Protected Areas. Science, policy and management. Elsevier.

(5) Dedicated Websites:

www.ospar.org for annuals reports on protecting and conserving the North-East Atlantic and its Resources.

www.ccamlr.org for publication on the Commission for the Conservation of Antarctic Marine Living

Resources.
https://environment.ec.europa.eu/topics/marine-environment_en
https://www.protectedplanet.net/en/thematic-areas/marine-protected-area

Organisation details

The course on Management & Conservation of Marine Ecosystems (GECOMAR) presents lecture overviews, practical works, from the field to the final assessments, and seminars by non-academic professionals to fulfil four main goals:
(1) Provide a critical overview of existing pollutions at sea and their known effects on marine systems.
(2) Assess the effects of marine urbanization and evaluate the inputs of marine urban ecology, especially in the management of artificial structures.
(3) Assess local environmental status using various biotic indicators (benthic organisms, plankton)
(4) Learn how to design Marine Protected Areas and how to assess their efficiency.

The pollutions and anthropisation overview (1) will address how diverse heavy metals, radionuclides, persistent organic pollutants (PAH, PCB, PFAS…), plastics etc… Where do these pollutions originate? What is their fate in the environment (sea water, sediments, biota, food webs)? What are the existing tools to monitor and manage them?

The practical works (2) consist in the assessment of water quality (including eutrophication) through a series of using official protocols, as those provided by the monitoring authorities, based upon macrofauna, macroflora and phytoplankton (comprising harmful taxa).

The conservation part (3) deals with an efficient design of Marine Protected Areas both in coastal areas and at high seas, and how this can be assessed. Moreover, one of the teachers (Pr. P Koubbi) has a direct and yearly updated experience in the processes required to implement a Large Marine Protected Area in Antarctica.
As training, the students will have both individual practical work for assessing pollution levels, as well as work in small groups, when analyzing timeseries on biotic indexes, but also a kind of autonomous team management, e.g. when searching scientific arguments for and against MPA implementation. Finally, the seminars by non-academic professionals give them an opportunity to discuss and get a further insight in work with management and conservation of marine ecosystems.

The teachers and the Biological Marine Station of Roscoff provides to the students:
- Lectures and practical works are given with duplicated lecture notes containing illustrations to annotate, or with pdf on Moodle, sometimes with text/pictures/videos for further information.
- A dedicated classroom, to which students have free access 24h/24h, with microscopes et stereomicroscopes for the practical work (1 set per student) and internet connection.

Note: This document is for informational purposes. The details of the content and format of the courses and evaluations may change from year to year.