



ES/GE320 MEDITERRANEAN OCEANOGRAPHY
IES Abroad Barcelona

DESCRIPTION:

This course provides an overview of the main oceanographic and biological characteristics of the Mediterranean Sea, from the bathymetry, geology and chemistry of a semi-enclosed sea, to the environmental characteristics and ecological processes of different marine habitats and the current human-induced threats of climate change and invasive species. Through a broad range of topics, the course covers: (i) the particular oceanographic characteristics of the Mediterranean, with its unique chemical and hydrographic features resulting from a complex geological history and geographical position; (2) the factors affecting primary production in the Mediterranean and its consequences for fisheries and trophic chains across different ecosystems; (3) the main characteristics and ecological dynamics of the most emblematic Mediterranean ecosystems and; (4) the key challenges faced by the Mediterranean in the face of climate change, over-exploitation, pollution and invasive species.

The course features a mandatory full-day excursion to the Delta del Ebro that will take place on a Friday.

CREDITS: 3 credits

CONTACT HOURS: 45 hours

LANGUAGE OF INSTRUCTION: English

INSTRUCTOR:

PREREQUISITES: None

ADDITIONAL COST: None

METHOD OF PRESENTATION:

- **Readings:** Readings will introduce the basic concepts for each session, introducing students to the main physical, hydrological, geological and chemical processes, as well as the characteristics and dynamics of key Mediterranean ecosystems.
- **Reading Quizzes:** These are designed to evaluate students on the readings and help them focus on the key concepts from each article.
- **Lectures:** Lectures accompany the students through the core topics and concepts for each session, illustrate how these apply in the Mediterranean marine biome, and provide a platform to discuss the content from the readings. Lectures for particular ecosystems will introduce the key concept first and then focus on the differences for Mediterranean habitats and ecosystems. The course features a mixed methods approach to lectures to support the learning process, using class-discussions, videos, group activities and participation to build the scaffolding of each class.
- **Lab classes:** students will be trained in mollusc anatomy, taxonomy and identification, in support of the survey activities during the field excursion.
- **Course related excursion:** The course includes one mandatory field element: a full-day trip to the Delta del Ebro, **which will be on a Friday**. This is designed to illustrate some of the material reviewed during the lectures and presented in the readings, to provide students with a learning methodology that is closer to academic research, and contribute to help the student to gain a deeper insight into some of the topics covered by the course.
- **Research project:** Working in teams, students will design a professional funding proposal for a global biodiversity conservation initiative by integrating ecological research with strategic project management tools. This project utilizes AI-assisted information synthesis and a structured quality assurance process to address real-world environmental challenges, culminating in a formal group presentation.

REQUIRED WORK AND FORM OF ASSESSMENT:

- Reading seminars and quizzes - 15%
- Course related excursion and lab class - 15%
- Midterm exam - 20%



- Final exam - 20%
- Research project & presentations - 30%

Reading seminars and quizzes

Students will prepare and take part in short seminar sessions and quizzes in class based on the set readings.

Course related excursion

Midterm exam and Final exam

Research project & presentation

LEARNING OUTCOMES:

By the end of the course, students will be able to:

- Recognize the major components of Mediterranean marine ecosystems
- Describe the dynamics of Mediterranean marine ecosystems
- Analyze the impact of human activities on Mediterranean marine ecosystems
- Value marine biodiversity and the need for sustainable development.

ATTENDANCE POLICY:

As a member of our class community, you are expected to be present and on time every day. Attending class has an impact on your learning and academic success. For this reason, attendance is required for all IES Barcelona classes, including course-related excursions. If a student misses more than three classes in any course without justification, 3 percentage points will be deducted from the final grade for every additional absence. Seven unjustified absences in any course will result in a failing grade. Absences will only be justified, and assessed work, including exams, tests and presentations rescheduled, in cases of documented medical or family emergencies.

CONTENT:

SESSION	Content	Assignments
Session 1	• Course introduction (objectives, contents and assessment). • An overview of the major Mediterranean marine ecosystems and species.	
Session 2	The rocky shores and the subtidal rocks	• Sala et al. (2012). The structure of Mediterranean rocky reef ecosystems across environmental and human gradients, and conservation implications. PLoS ONE 7: e32742. • Gili, J.M. et al (2014). Zoobenthos. In S. Goffredo and Z. Dubinsky (eds.) The Mediterranean Sea. Its history and present challenges. Heidelberg: Springer. (213-235).

Session 3	Beaches and soft bottom ecosystems	• Little, C. (2000). The biology of soft shores and estuaries. Oxford: Oxford University Press. (pp 35-56). • Peters, W. S. (2022). Underwater-sailing locomotion in intertidal gastropods: a comparison of Neotropical species. Archiv für Molluskenkunde International Journal of Malacology, 93-105.
Session 4	Seagrass meadows	• Pérez-Lloréns, J. et al. (2014). Authochthonous seagrasses. In S. Goffredo and Z. Dubinsky (eds.) The Mediterranean Sea. Its history and present challenges. Heidelberg: Springer. (137-158). • Gobert et al (2006). Biology of Posidonia. In: Seagrasses: Biology, ecology and conservation, 387-408.
Session 5	Estuaries and coastal marshes	• Blondel, J. (2010). The Mediterranean region: biological diversity in space and time. Oxford University Press. (pp. 1-5, 128-131) • Franco, A., Elliott, M., Franzoi, P., & Torricelli, P. (2008). Life strategies of fishes in European estuaries: the functional guild approach. Marine Ecology Progress Series, 354, 219-228.
Session 6	Mollusc taxonomy and identification lab 1 Training	
	Course related trip: Ebro Delta (on Friday)	
Session 7	Mollusc taxonomy and identification lab 2 Processing collected material	
Session 8	Living in the water column: environmental constraints and adaptations	• Herring, P. (2002). The biology of the deep ocean. Oxford: Oxford University Press. (pp 1-7). • Mann, K.N. (1991). Organisms and ecosystems, In R.S.K. Barnes and K.H. Mann (eds.). Fundamentals of aquatic ecology. London: Blackwell. (pp 8-11).

Session 9	Living in the water column: the blue Mediterranean	• Stambler, N. (2014). The Mediterranean Sea- Primary productivity. In S. Goffredo and Z. Dubinsky (eds.) The Mediterranean Sea. Its history and present challenges. Heidelberg: Springer. (113-121). • Longhurst, A. (2006). Ecological geography of the sea. Now York: Academic Press. (pp 177-183). • Di Cicco, A., Sammartino, M., Marullo, S., & Santoleri, R. (2017). Regional empirical algorithms for an improved identification of phytoplankton functional types and size classes in the Mediterranean Sea using satellite data. Frontiers in Marine Science, 4, 126.
Session 10	Bathymetry, hydrography and chemistry of a semi-enclosed sea	• Longhurst, A. (2006). Ecological geography of the sea. Now York: Academic Press. (pp 173-177). • Skliris, N. (2014). Past, present and future patterns of the thermohaline circulation and characteristic water masses of the Mediterranean Sea. In S. Goffredo and Z. Dubinsky (eds.) The Mediterranean Sea. Its history and present challenges. Heidelberg: Springer. (29-48). • Pinardi, N., Cessi, P., Borile, F., & Wolfe, C. L. (2019). The Mediterranean sea overturning circulation. Journal of Physical Oceanography, 49(7), 1699-1721.
Session 11	From Tethys to the Mediterranean, a convulsive geological history	• Stow, D. (2010) Vanished ocean. Oxford: Oxford University Press. (pp 188-214 and 227-241).
Session 12	Research project workshop	
Session 13	Midterm exam	
Session 14	Mediterranean Marine Biodiversity and Invasive Species	• Coll, M., et al. (2010). The biodiversity of the Mediterranean Sea: estimates, patterns and threats. PLoS One 5, e11842. • Walls, R. H., & Dulvy, N. K. (2021). Tracking the rising extinction risk of sharks and rays in the Northeast Atlantic Ocean and Mediterranean Sea. Scientific Reports, 11(1), 1-15.

Session 15	Pollution	● Cózar, A., Sanz-Martín, M., Martí, E., González-Gordillo, J.I., Ubeda, B., Gálvez, J.Á., Irigoien, X., Duarte, C.M (2015) Plastic accumulation in the Mediterranean Sea. <i>PLoS ONE</i> 10(4): e0121762. ● Ludwig, W., et al. (2009). River discharges of water and nutrients to the Mediterranean and Black Sea: major drivers for ecosystem changes during past and future decades? <i>Progress in Oceanography</i> 80: 199-217. ● De Sales-Ribeiro, C., Brito-Casillas, Y., Fernandez, A., & Caballero, M. J. (2020). An end to the controversy over the microscopic detection and effects of pristine microplastics in fish organs. <i>Scientific Reports</i>, 10(1), 12434.
Session 16	Climate change	● Lejeusne, C., Chevaldonne, P., Pergent-Martini, C., Boudouresque, C.F., Pérez, T. (2009). Climate change effects on a miniature ocean: the highly diverse, highly impacted Mediterranean Sea. <i>TREE</i> 1204: 1-11.
Session 17	Overfishing. Film viewing. "Empty oceans, empty nets"	
Session 18	Fisheries management	● FAO (2022). The state of world Fisheries and Aquaculture 2022 (SOFIA). ● Cánovas-Molina, A., García-Charton, J. A., & García-Frapolli, E. (2021). Assessing the contribution to overfishing of small-and large-scale fisheries in two marine regions as determined by the weight of evidence approach. <i>Ocean & Coastal Management</i>, 213, 105911.
Session 19	Research project presentations I	
Session 20	Research project presentations II	
Session 21	Marine Protected Areas	● Bazairi, H., El Asmi, S., Limam, A., Espinosa, F., Warr, S., Muirhead-Davies, N., ... & Fa, D. (2023). Marine area-based conservation in the context of global change: Advances, challenges, and opportunities, with a focus on the Mediterranean. <i>Coastal Habitat Conservation</i>, 17-40. ● Guidetti, P. and Sala, E. (2007). Community-wide effects of marine reserves in the Mediterranean sea. <i>Marine Ecology Progress Series</i> 335: 43-56.

Session 22	The Messinian Salinity Crisis 1	• Agiadi, K., Hohmann, N., Gliozzi, E., Thivaoui, D., Bosellini, F. R., Taviani, M., ... & García-Castellanos, D. (2024). The marine biodiversity impact of the Late Miocene Mediterranean salinity crisis. <i>Science</i>, 385(6712), 986-991. • Ryan, W. B. (2023). 50th anniversary review of the Mediterranean desiccation hypothesis. <i>La Rivista del Nuovo Cimento</i>, 46(4), 163-179, 252-254, 262-265.
Session 23	The Messinian Salinity Crisis 2	• García-Castellanos, D., Micallef, A., Estrada, F., Camerlenghi, A., Ercilla, G., Periañez, R., & Abril, J. M. (2020). The Zanclean megaflood of the Mediterranean—Searching for independent evidence. <i>Earth-Science Reviews</i>, 201, 103061.
Session 24	Tourism and the management of the coastline.	• Mejjad, N., Rossi, A., & Pavel, A. B. (2022). The coastal tourism industry in the Mediterranean: A critical review of the socio-economic and environmental pressures & impacts. <i>Tourism Management Perspectives</i>, 44, 101007. • Plan Bleu (2022). State of Play of Tourism in the Mediterranean: A Roadmap for a Greener, Inclusive & Resilient Tourism in the Mediterranean. UNEP/MAP Interreg Mediterranean Sustainable Tourism Community project. (Chapters 1, 2 & 4).
	Final exam	

COURSE-RELATED TRIP:

- Ebro Delta (on Friday)

REQUIRED READINGS:

- Agiadi, K., Hohmann, N., Gliozzi, E., Thivaoui, D., Bosellini, F. R., Taviani, M., ... & García-Castellanos, D. (2024). The marine biodiversity impact of the Late Miocene Mediterranean salinity crisis. *Science*, 385(6712), 986-991.
- Bazairi, H., El Asmi, S., Limam, A., Espinosa, F., Warr, S., Muirhead-Davies, N., ... & Fa, D. (2023). Marine area-based conservation in the context of global change: Advances, challenges, and opportunities, with a focus on the Mediterranean. *Coastal Habitat Conservation*, 17-40.
- Blondel, J. (2010). The Mediterranean region: biological diversity in space and time. Oxford University Press. (pp. 1-5, 128-131).
- Cánovas-Molina, A., García-Charton, J. A., & García-Frapolli, E. (2021). Assessing the contribution to overfishing of small-and large-scale fisheries in two marine regions as determined by the weight of evidence approach. *Ocean & Coastal Management*, 213, 105911.
- Coll, M., et al. (2010). The biodiversity of the Mediterranean Sea: estimates, patterns and threats. *PLoS One* 5, e11842.
- Cózar, A., Sanz-Martín, M., Martí, E., González-Gordillo, J.I., Ubeda, B., Gálvez, J.A., Irigoien, X., Duarte, C.M (2015) Plastic accumulation in the Mediterranean Sea. *PLoS ONE* 10(4): e0121762.
- De Sales-Ribeiro, C., Brito-Casillas, Y., Fernandez, A., & Caballero, M. J. (2020). An end to the controversy over the microscopic detection and effects of pristine microplastics in fish organs. *Scientific Reports*, 10(1), 12434.

- Di Cicco, A., Sammartino, M., Marullo, S., & Santoleri, R. (2017). Regional empirical algorithms for an improved identification of phytoplankton functional types and size classes in the Mediterranean Sea using satellite data. *Frontiers in Marine Science*, 4, 126.
- FAO (2022). The state of world Fisheries and Aquaculture 2022 (SOFIA).
- Franco, A., Elliott, M., Franzoi, P., & Torricelli, P. (2008). Life strategies of fishes in European estuaries: the functional guild approach. *Marine Ecology Progress Series*, 354, 219-228.
- Garcia-Castellanos, D., Micallef, A., Estrada, F., Camerlenghi, A., Ercilla, G., Periañez, R., & Abril, J. M. (2020). The Zanclean megaflood of the Mediterranean—Searching for independent evidence. *Earth-Science Reviews*, 201, 103061.
- Gili, J.M. et al (2014). Zoobenthos. In S. Goffredo and Z. Dubinsky (eds.) *The Mediterranean Sea. Its history and present challenges*. Heidelberg: Springer. (213-235).
- Gobert et al (2006). Biology of Posidonia. In: *Seagrasses: Biology, ecology and conservation*, 387-408.
- Guidetti, P. and Sala, E. (2007). Community-wide effects of marine reserves in the Mediterranean sea. *Marine Ecology Progress Series* 335: 43-56.
- Herring, P. (2002). *The biology of the deep ocean*. Oxford: Oxford University Press. (pp 1-7).
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- Little, C. (2000). *The biology of soft shores and estuaries*. Oxford: Oxford University Press. (pp 35-56).
- Longhurst, A. (2006). *Ecological geography of the sea*. Now York: Academic Press. (pp 173-177, 177-183).
- Ludwig, W., Dumont, E., Meybeck, M., Heussner, S. (2009). River discharges of water and nutrients to the Mediterranean and Black Sea: major drivers for ecosystem changes during past and future decades? *Progress in Oceanography* 80: 199-217.
- Mann, K.N. (1991). Organisms and ecosystems, In R.S.K. Barnes and K.H. Mann (eds.). *Fundamentals of aquatic ecology*. London: Blackwell. (pp 8-11).
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- Pérez-Lloréns, J. et al. (2014). Authochthonous seagrasses. In S. Goffredo and Z. Dubinsky (eds.) *The Mediterranean Sea. Its history and present challenges*. Heidelberg: Springer. (137-158).
- Peters, W. S. (2022). Underwater-sailing locomotion in intertidal gastropods: a comparison of Neotropical species. *Archiv für Molluskenkunde International Journal of Malacology*, 93-105.
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- Ryan, W. B. (2023). 50th anniversary review of the Mediterranean desiccation hypothesis. *La Rivista del Nuovo Cimento*, 46(4), 163-179, 252-254, 262-265.
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