LINK TO EHU MER WEBSITE

Universidad del País Vasco — Euskal Herriko Unibertsitatea

SEMESTERS 2

COURSE	ECTS	TYPE
Research in Marine Environment and Resources	6	C
Advanced Instrumental Analysis	4	OPT
Cellular and Molecular Biomarkers	4	OPT
Comparative Endocrinology and Endocrine Disruption	4	OPT
Degradation and Rehabilitation of Estuarine Ecosystems	4	OPT
Ecological Quality Assessment in Coastal Ecosystems	4	OPT
Ecosystem-based Fisheries Management	4	OPT
Environment and Fisheries/Aquaculture Interactions	4	OPT
Environmental Analytical Chemistry	4	OPT
Environmental Chemometrics - Formerly Environmental Data Analysis	4	OPT
Environmental (Toxico)Genomics	4	OPT
Environmental Monitoring and Risk Assessment in Aquatic Systems	4	OPT
Eutrophication and Harmful Algae	4	OPT
Histology and Histopathology of Aquatic Animals	4	OPT
Instrumentation and Measurements in Operational Oceanography	4	OPT
Marine Enterpreneurship	4	OPT
Marine Microbial Ecology	4	OPT
Marine Resources Genomics	4	OPT
Multicultural integration in EU	4	OPT
Ocean Global Change Biology	4	OPT
Physiological Energetics of Marine Organisms	4	OPT
Satellite Oceanography and Meteorology	4	OPT
Socio-Economic Aspects of Climate Change	4	OPT

C: Compulsory

OPT: Optional at EHU in Semester 2

Course/Unit	Research in Marine Environment and Resources
MER Code	MER EHU 501315
ECTS	6
Level	Compulsory
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigómez, Jon Saenz & A Uriarte (AZTI) (Coord.); guest lecturers
Synopsis	Annually, a general workshop is held in the facilities of the Aquarium in San Sebastian (OFG) for 1 week and at the PiE-UPV/EHU for a second week at the PiE-UPV/EHU. Teaching staff from all the institutions in the MER Consortium and world-wide renowned marine scientists participate as guest lecturers.
Aims	• to provide an updated point of view of the main problems in applied marine research; • to provide a cross-section viewpoint of hot spots in RiMER; and • to facilitate contacting with renowned scientists/research groups.
Objectives At the end of the Unit, the student should:	1. understand the current topics in marine environment and resources research; 2. identify the most active research groups in marine research; and 3. know the main problems that concern applied marine research
Key Skills Acquired At the end of the Unit, the student should be able to:	1. be familiar with science communication skills; 2. develop a critical way of thinking; and 3. acquire a transversal, multidisciplinary perspective of RiMER

Programme/Syllabus	1. Lectures on developments and hot spots in RiMER; 2. Round Table: developments in research in marine environment and resources 3. Lectures on coastal management 4. Round Table: sustainable coastal management 5. Lectures on marine ecosystem health 6. Round Table: threats to marine ecosystem health 7. Round Table: prospects in marine ecosystem health 8. Lectures on global climate crisis 9. Round Table: fossil records of climate change 10. Round Table: challenges of global climate change to marine life and biological resources 11. Lectures on marine resources and fisheries 12. Round Table: future of fisheries in European regions 13. Lectures on challenges for biodiversity conservation 14. Round Table: challenges for biodiversity conservation 15. Practical workshop: an approach to modelling in system biology 16. Round Table: towards regional strategies for marine science 17. Open workshop (cinema): marine environment and resources revisited
Learning & Teaching	• Lectures: 44 hr • Workshops: 16 hr • Personal work: 90 hr (In situ teaching activities might be replaced -at least partially- by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	• Attendance is compulsory. All absences must be justified documentally. Active participation in the activities of the course is required; particular attention will be paid to the participation in open discussions in lectures, seminars and practicals. • Written reports (4): (1) list of 2 questions per lecture; (2) one 5-page or miniclip journalistic summary of the RiMER Course; (3) one 5-page summary or miniclip of the student's choice Round Table; and one report (10-page or MOOC or simlar) on one topic selected among the ones treated during the course (100%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Master Thesis
MER Code	MER EHU 501000
ECTS	30
Level	Compulsory
Semester	4
Timetable slot	To be advised
Teaching Staff	M Soto & I Marigómez (Coord.); M Poulicek, J Schafer, D Purdie
Synopsis	The Unit is designed for graduates in any science discipline, embarking on postgraduate studies in Ocean and Earth Science.
Aims	• To provide an introduction to the chemistry of sea-water through qualitative and quantitative approaches and presentation of the chemical interactions between the lithosphere, the biosphere, the atmosphere and the ocean.
Objectives At the end of the Unit, the student should:	1. Demonstrate sufficiency for research in order to undertake the realisation of the PhD Thesis work, or a professional activity as researcher.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. be integrated in the research group where the MSc Thesis has been carried out. 2. demonstrate basic skilfulness achieved regarding the methods employed in the MSc Thesis 3. design and plan and carry out a research work, under the consideration that the MSc Thesismust be undertaken during a period of 6 months 4. show quality in written scientific reporting 5. show quality in oral presentation and ability to discuss and defend each postulates concerning theMSc Thesis.

Programme/Syllabus	1. 5-6 month research under the supervision of a PhD holder. 2. Written report in English, French, Spanish or Basque language (+ 2nd language summary), according to the standard structure/extension of a scientific paper. 3. Dissertation will consist of a 20 min oral presentation plus a questions/discussion session for an additional 15 min. 4. Oral presentation will be made in English and a simultaneous translation service will not be available. • A list of available MSc Research projects is available every September • The MER JPB may also accept a proposal made individually by a student, provided the proposed supervisor and host institution accept and always in compliance with the academic requirements of the Joint MER MSC programme.
Learning & Teaching	• MER MSc students can follow their MSc research programme in any Partner institution or in Associated Partners or other collaborating institutions, which will host a student considering the field of his/her MSc Thesis, according the subject a student chooses. The MER Secretariat provides administrative support to formalize the required agreements with host institutions when the supervisors are from institutions other than the MER Consortium.
Bibliography	Previous MSc Theses available for consultation at the MER archives (MER Secretariat)
Assessment	• A complete pdf file (including signatures) of the written MSc Thesis report must be sent by email to MER Secretariat before the published deadline. • A public dissertation will consist of a 20 min oral presentation, plus a questions/discussion session for an additional 15 min. Oral presentation will be made in English and simultaneous translation service will not be available. • A Graduation ceremony takes place after the vivas, with participation of students of at least two consecutive cohorts (detailed and updated regulations available on the MER Consortium website)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Advanced Instrumental Analysis
MER Code	MER EHU 501323
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	O Zuloaga (Coord.) G Arana
Synopsis	The most outstanding instrumental methods for trace analysis in environmental samples will be provided. Essentially, the basics and the applications of mass spectrometry to the elemental and molecular analysis and liquid chromatography and gas chromatography will be covered, together with the suitable sample preparation procedures.
Aims	To provide exposure to the most outstanding instrumental methods for trace analysis in environmental samples.
Objectives At the end of the Unit, the student should:	1. Understand the basics of mass spectrometry 2. Be able to design the steps and the requirements of an instrumental method of analysis to fulfill the quality requirements 3. Understand the basics of advanced chromatographic methods
Key Skills Acquired At the end of the Unit, the student should be able to:	1. undersatnd the key points of an instrumental trace analysis method 2. be skill in good analytical practices

Programme/Syllabus	• Sample preparation methods for trace analysis • Basics on mass spectrometry • ICP-MS methods for elemental trace analysis. Isotopic dilution method. • Analysis of micro-organic contaminants by liquid or gas chromatography
Learning & Teaching	• Lectures: 20 hr • Seminars (for case studies and applications): 10 hr • Laboratory work: 10 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• E. Hoffmann. 2008. Mass spectrometry: principles and applications, John Wiley & Sons, Chichester, UK. • V.R. Meyer. 2010. Practical high-performance liquid chromatography. John Wiley & Sons, Chichester, UK. • D. Rood. 2007. The troubleshooting and maintenance guide for gas chromatographers. Wiley-VCH, Weinheim, Germany • S. Mitra (Ed.). 2003. Sample preparation techniques in analytical chemistry. Wiley-Interscience, Hoboken, New Jersey
Assessment	• Written theory examination (40%) • Case studies and exercises in seminars (60 %)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Cellular and Molecular Biomarkers
MER Code	MER EHU 501316
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	MP Cajaraville, A Orbea (Coord.)
Synopsis	Specialization in environmental toxicology with focus on cell/molecular biology. Global/updated view of environmental problems and the use of cell/molecular responses as early warning signals (biomarkers) of ecosystem health in pollution assessment.
Aims	• To provide a global/updated view of environmental toxicology and the use of cell/molecular responses as early warning signals (biomarkers) of ecosystem health in pollution assessment.
Objectives At the end of the Unit, the student should:	1. Understand the mechanisms of cation incorporation into cells, as well as the cellular strategies to detoxify and/or sequester physiological metals at toxic concentrations and xenobiotic metals, depending on the characteristics and speciation of metals. 2. Understand the cellular and molecular responses to pollution by organic xenobiotics, including their biotransformation, involvement in oxyradical generation, and mechanisms and strategies of cellular and molecular adaptation. 3. Understand the cellular and molecular pathways that lead to toxicant-caused genotoxic and non-genotoxic DNA and chromosomal damage, including repair mechanisms, and further development of preneoplastic and neoplastic diseases. 4. Understand the importance of pollutant effects on cell signalling and homeostasis of the endocrine system, with emphasis in ecologically-relevant effects on reproduction. 5. Understand the implications of the changes at cellular and molecular level, in the general health condition of the individuals and the natural populations, with the aim of achieving a reasonable and sustainable exploitation of natural resources. 6. Understand the rationale for the use of cellular and molecular responses to pollutants in environmental monitoring and in environmental risk assessment, including the limitations and challenges of the approach. Role of emerging toxico-genomics and proteomics in new biomarker discovery.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. understand the effects that metal and organic pollutants as well as other environmental stressors cause at cell and molecular levels. 2. understand the advantages and limitations of the biomarker-based approach to assess ecosystem health status.

Programme/Syllabus	1.- Introduction to cellular and molecular biomarkers of pollution: examples and applications in monitoring programmes. 2.- Techniques to measure cell and molecular biomarkers. 3.- Biomarkers and bioassays for endocrine disrupting environmental pollutants. 4.- Toxicity of metallic pollutants in relation with cellular accumulation and storage processes. 5.- In vitro alternative methods in biomarker development. 6.- Generation of oxyradicals and oxidative stress in marine organisms. 7.- Mechanisms of pollutant-induced peroxisome proliferation and rationale for use as biomarker in environmental pollution assessment. 8.- Biotransformation of organic xenobiotics. 9.- Lysosomal perturbations as indicators for toxically induced cell damage. 10.- Biomarkers for assessment of toxicant-caused DNA damage. 11.- Challenges for use of biomarkers in environmental monitoring and risk assessment. LAB PRACTICALS: 1.- Measurement of catalase activity. 2.- Lysosomal biomarkers. 3.- Genotoxicity assessment. 4.- Microscopical observation on cytochemical biomarkers. SEMINARS: 1.- Application of biomarkers to case studies.
Learning & Teaching	• Lectures: 23,5 hr • Seminars: 4,5 hr • Lab practicals: 12 hr • Personal work: 60 hr *(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)*
Bibliography	• Braunbeck T, Hinton DE, Streit D (Eds.) (1998) Fish ecotoxicology. Birkhäuser Verlag, Basel. • Cajaraville, M.P. (ed.) (1995) Cell Biology in Environmental Toxicology. UBCPress Service, Bilbo. • ICES (2004) Biological monitoring: General guidelines for quality assurance. In: Rees H (Ed.). ICES TMES, No. 32. 44 pp. • ICES (2005) Report of the Working Group on Biological Effects of Contaminants (WGBEC), 18-22 April 2005, Reykjavik, Iceland. ICES CM 2005/E: 08. 94 pp. • Lawrence AJ, Hemingway KL (2003) Effects of pollution on fish. Blacwell Science Ltd., Oxford. • Stanley L (2014) Molecular and Cellular Toxicology: An Introduction. John Wiley & Sons, Inc. • UNEP/RAMOGE (1999) Manual on the biomarkers recommended for the MED POL biomonitoring programme. UNEP, Athens. 39 pp. Additional more specialised bibliography delivered during the course
Assessment	• Attendance is compulsory. All absences must be justified documentally. Active participation in the activities of the course is required; particular attention will be paid to the participation in open discussions in lectures, seminars and practicals. (15%) • Written questionaire about basic concepts (30%) • Personal report: Based on one research article, presenting a case study on biomarker use. It will be presented in a seminar by each student (15 min) (30%) • Practical tasks (notebook of practicals) (25%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Comparative Endocrinology and Endocrine Disruption - Formerly Fish and Shellfish Reproduction and Endocrinology
MER Code	MER EHU 501327
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Ortiz-Zarragoitia (Coord.), U Izagirre,
Synopsis	Fish reproduction, sex determination and differentiation. Endocrinology of marine fish and invertebrates. Endocrine and reproductive effects of pollutants. Applications to fisheries, aquaculture and environmental pollution assessment.
Aims	• To introduce the students to the wide diversity and variability existing in fish reproduction and sexual determination and differentiation processes. • To offer to the students basic knowledge on endocrinology of marine fish and invertebrates. • To show the students the effects of environmental pollutants on endocrine system and reproduction of fish and marine invertebrates • To develop skills to estimate reproductive stages in fish and marine invertebrates and understand modern tools on aquaculture of marine fish and invertebrates species.
Objectives At the end of the Unit, the student should:	1. Understand reproduction strategies in fish 2. Identify reproduction strategies and reproductive gonad stages in fish and marine invertebrates 3. Have gained a knowledge of impact of environmental pollutants on fish and marine invertebrates reproduction and endocrine system, as well as of hormonal regulation in aquaculture.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify sex and gonad development in fish and marine invertebrates 2. Identify effects of pollutants in reproductive and endocrine system in fish and marine invertebrates

Programme/Syllabus	1. Reproduction in the marine environment: Fish and invertebrates 2. Reproduction strategies and cycles in fish 3. Sex determination and differentiation in fish 4. Endocrinology of fish 5. Hormones and their function in fish 6. Impact of environmental pollutants on fish reproduction and endocrine system 7. Aquaculture strategies in fish: tools to improve fish reproduction 8. Endocrinology of main marine invertebrate groups (crustaceans, molluscs and echinoderms) 9. Hormones in marine invertebrates: participation on reproduction 10. Endocrine disruption on marine invertebrates 11. Shellfish aquaculture: modern tools and techniques
Learning & Teaching	• Lectures: 20 hr • Seminars: 6 hr • Practical sessions (lab): 10 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Textbook of Fish Endocrinology. Papoutsoglou SE. Nova Science Publishers Inc. 2012. • Fish Endocrinology Vol 1 and 2. Reinecke M, Zaccone G,Kapoor BG. CRC Press. • Advances in Marine and Brackishwater Aquaculture. Perumal S, Thirunavukkarasu AR, Perumal P. Springer. 2015. • Offshore Marine Aquaculture (Fish, Fishing and Fisheries). Nolan JT. Nova Science Publishers, Inc. 2012. • Additional information delivered during the course
Assessment	o Written examination (40%) o Seminar presentation and report 60%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Degradation and Rehabilitation of Estuarine Ecosystems
MER Code	MER EHU 501319
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	F Villate (Coord.), A Iriarte, I Uriarte
Synopsis	The course offers basic knowledge on estuarine ecosystems, such as the main physicochemical and biological characteristics, the resources and services they offer, the human uses and impacts, the estuarine health assessment, and scientifically-based management.
Aims	To know the structure and function of estuaries: main patterns of environmental variability, life variety and physical and biological processes interacting in such systems. To introduce the student in the historic and current problems of the use of estuaries by man, the human impact on them and the causes of estuarine ecosystems degradation. To adquire basic knowledge about estuarine management for the conservation of biodiversity and ecosystem services, and the improvement of estuarine health, including estuarine rehabilitation and clean-up methods.
Objectives At the end of the Unit, the student should:	• Know the peculiarities of estuarine environments and organisms, and those of the main biotic and abiotic processes they are involved in. • Be able to identify the main estuarine habitats and communities, and associated subsystems. • Understand the function of estuarine ecosystems. • Be aware of estuarine ecosystem services, mainly in relation to the living resources • Be able to identify and assess main environmental problems in estuarine systems, as well as the causes. • Have gained knowledge on the measures that should be implemented to prevent, correct or minimize the impacts.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Access scientific and institutional information (paper and online literature) 2. Discuss results, write reports and perform oral presentations 3. Obtain environmental data in water and sediments 4. Apply data treatment methods

Programme/Syllabus	Theoretical programme (Lectures): 1. The estuarine ecosystem.-Definition. Limits. Geomorphologic types. Classifications based on salinity, tides and energy. Functional components. Circulation of materials. 2. Ecological values. Productivity and biodiversity. Pelagic habitats and plankton communities. Benthic habitats and communities. Associated subsystems. Nekton. Birds. Other vertebrates. 3. Socioeconomic values and anthropogenic uses: Natural resources. Urbanization, industry and commerce. Tourism and recreation. Other activities. 4. Human impact.Physical changes and habitat loss. Pollution: enrichment, unhealthiness and toxins. Overharvest and overfishing. Introduction of exotic species. 5. Estuarine management: basic knowledge. Definition and goals. Status assessment. Conservation. Recovery: cleaning, restoration and rehabilitation. Monitoring. Practical programme: 1. Boat survey to obtain environmental data in order to identify environmental problems in a humanised system: the estuary of Bilbao. 2. Field trip for visual assessment of the status of conservation and the human impact of a protected system: the estuary of Urdaibai. 3. Computer session.Treatment of the data obtained during the environmental survey of the estuary of Bilbao. 4. Seminar 1 to share information, discuss results and draw conclusions from the field works in groups. 5. Seminar 2 for the oral presentation of the report on environmental and biological characteristics, main resources and uses, major problems and possible solutions of a estuary chosen by students. The work is the result of a literature rewiew performed in groups.
Learning & Teaching	• Formal Lectures: 9 hr • Field works: 16 hr (Boat survey: 8 hr; Field trip: 8 hr) • Computer session (field data treatment): 4 hr • Seminar sessions: 9 hr (Seminar 1: 4 hr; Seminar 2: 5 hr) • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	1. Attendance to lectures and practical activities (25%) To pass the practicals it is compulsory to attend field and seminar sessions. 2. Oral presentation of the report on the selected estuary and answering to questions about the work presented (25%). 3. Written report on the environmental study of the estuary of Bilbao (25%). 4. Written report on the visual assessment of the estuary of Urdaibai (25%).
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ecosystem-based Fisheries Management
MER Code	MER SOES 6007
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I del Valle (Coord.) & L Motos (AZTI)
Synopsis	EBFM provides the students the key biological and socioeconomic concepts in the framework of the triple bottom line of sustainable fisheries. In particular, students will know a) how the scientific advice is generated, from data collection to data integration and stock assessment, in order to make diagnostics of the stock and ecosystem status and to give scientific advice on exploitation and conservation of ecosystem resources and services; b) the main determinants of the behaviour of fishermen, institutions and stakeholders; and the pros and con of alternative governance options and frameworks. It is not required a profound mathematical background.
Aims	• To know the scientific basis for a sustainable use of living resources (fleet and fishery technology; population dynamics; assessment methods; sustainable fishing and management tools; and management institutions). • To understand the problems concerning the management of fish populations, pelagic and demersal. • To provide an introduction to the basic research techniques in fisheries socio-economy: data gathering and interpretation.
Objectives At the end of the Unit, the student should:	1. Be acquainted with the scientific basis for a sustainable use of living resources, including population dynamics; assessment methods; sustainable fishing and management tools; and management institutions and procedures. 2. Understand the problems concerning the management of fish populations as exploited by European fleets 3. Become familiar with the basic research techniques in socio-economy, data gathering and interpretation. 4. Understand the fundamentals of socioeconomic analysis and develop critical analysis in socio-economy.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Be familiar with sampling, experimental design, computer skills and research writing. 2. Learn and link interdisciplinary subjects. 3. Written and oral communication.

Programme/Syllabus	1. Marine ecosystem services, components and interactions. 2. EBFM1: Ecosystem-based Fisheries Management: the Socio-economic Perspective 2.1. From economics to fisheries socioeconomics: The basic bio-economic models and tools. 2.2. On alternative fisheries governance options. 2.3. Right-based governance systems: theoretical and empirical approaches. 2.4. The complex social-ecological ecosystems (SES) and the multilevel nested framework. Practical issues: Exploring economics with Mathematica; Estimating production elasticities with R. EBFM and portfolio theory; Socioeconomic data collection; Top journals in the field (WoK). 3. EBFM2: Ecosystem-based Fisheries Management: the Biological Perspective 3.1. From single stock assessment and management to ecosystem-based management. 3.2. The basics of Fisheries Science. 3.3. Single stock assessment and management. 3.4. Towards ecosystem-based management. Practical issues: Role games on fisheries managemen; visit to a Fisheries Assessment and Management Lab. Students will meet and learn from Fisheries Research Professionals.
Learning & Teaching	• Lectures: 12 hr (PART 1); 12 (PART 2) • Practicum: 4 hr (PART 1); 8 h (PART 2) • Seminars: 4 hr (PART 1); 4 h (PART 2) • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	EBFM 1: Written (take home) exam (50%) + Individual report. Students have two options: (a) Socioeconomic report of a marine framework; or (b) State of the art of a specific topic related to fisheries socio-economics. Format: Video (40%). Participation: 10% EBFM 2: Mixed system of continuous and final assessment: Written examination (50%) + Oral presentation of Coursework (40%). Participation(10%) Final mark: 50% EBFM1 + 50% EBFM2
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ecological Quality Assessment in Coastal Ecosystems
MER Code	MER EHU 501318
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Bustamante, I Saiz & J Franco (AZTI) (Coords.) JM Gorostiasga, E Quintano, A Martinez de Murgia (OFG), A Borja (AZTI), I Zorita (AZTI)
Synopsis	Coastal ecosystems are globally threatened by anthropogenic impacts (pollution, physical alterations, climate change). In order to protect those environments, several directives (e.g. EU Water Framework Directive) have been developed. The main objective of this unit is to acquire knowledge on the different tools to evaluate the ecological status and the impacts on coastal ecosystems, as well as the criteria for an appropriate management.
Aims	• To be aware that marine diversity is a precious treasure to preserve in conservation programmes and a key component to assess environmental quality in coastal ecosystems. • To introduce the basic concepts used in marine ecological quality assessment. • To provide the methods for the integrative ecological assessment of marine quality. • To present some practical cases dealing with the integrative ecological assessment of marine quality. • To provide a basic knowledge on the Water Framework Directive and other legislative references and their implications for the marine quality assessment. • To provide the main concepts and approaches regarding the management of human activities in the marine environment according to ecological criteria.
Objectives At the end of the Unit, the student should:	1. Recognize characteristic taxa of algae, invertebrates and fishes from coastal ecosystems 2. Assess environmental quality, by using different diversity measures from different biological communities and physico-chemical components 3. Design and analyse monitoring programmes for algae and animals 4. Design monitoring programmes for the assessment of the quality of the marine environment 5. Interpret the data from monitoring programmes 6. Have a good knowledge of the main legislative references in relation to the assessment of the quality of the marine environment, especially the Water Framework Directive
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform report writing, scientific writing, working in teams, oral presentations, library information retrieval and critical analysis of literature, and presentation and manipulation of data (e.g. water quality data interpretation biological data interpretation) 2. complete an integrative interpretation of data

Programme/Syllabus	PART 1. BIODIVERSITY ASSESSMENT & MONITORING 1. Richness of diversity based on algae, invertebrates and fishes from coastal ecosystems. 2. How to sample, undertake surveys and perform floristic and faunistic analyses to: (a) measure diversity; (b) select appropriate bioindicators of environmental state; and (c) assess environmental quality in many endangered habitats. 3. Temporal dimension in the design and analysis of efficient monitoring programmes, to evaluate ecological recovery, once correction measures have been implemented by environmental managers. 4. Role of Aquaria in education programmes and conservation of target species. Field trip 1. Floristic and faunistic survey PART 2. INTEGRATIVE ASSESMENT OF MARINE ENVIRONMENTAL QUALITY 1. Theoretical and practical basis for an integrative assessment of the marine quality. 2. Basic conceptual issues on the marine quality assessment and its relationship with the general features and some peculiarities of the marine environment will be presented. 3. The Water Framework Directive (WFD) and its implications for the marine quality assessment in EU will be presented. Framework for Community action in the field of water policy. Concepts, objectives, requirements and implementation phases of the WFD. Other important legislative references e.g., European Marine Strategy Directive. 4. Relevant aspects of general marine monitoring programs: ongoing projects and case studies. Practical: Marine environmental quality indices and monitoring programmes in the Basque coastal environments. Field trip: Visit to AZTI, Pasaia
Learning & Teaching	• Formal & Audiovisual Lectures: 18 hr; 6 (Part 1) & 12 (Part 2) • Computer practicals: 7 hr • Part 1 Fild trip (½ day): 4 hr • Part 2 Fild trip (1 day): 8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	• Written report (70%) • Lecture attendance (15%) • Field trips assessment (15%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental Analytical Chemistry
MER Code	MER EHU 501321
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	N Etxebarria (Coord.), A Vallejo
Synopsis	Integrative view of the analytical methodologies in environmental issues. We will emphasize the sampling strategies, both active and passive methodologies, the development of target and nontarget analysis workflows, and the interpretation of analytical data. The concepts of bioaccumulation and bioavailability will be introduced.
Aims	• To provide an integrative view of the analytical methodologies in environmental issues. • To offer the criteria to design a suitable analytical procedure • To give the clues to understand analytical procedures and results
Objectives At the end of the Unit, the student should:	1. Understand the basic processes of an analytical method and procedure. 2. Be able to design efficiently a sampling and analysis procedures 3. Understand the differences between targeted and nontargeted requirements 4. Understand the bioaccumulation and bioavailability of contaminants in dynamic scenarios
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Apply the analytical approach to environmental issues 2. Perform good analytical practices

Programme/Syllabus	Topics covered include: • Basics on environmental analytical chemistry • The analytical procedure • Active and Passive Sampling techniques • Bioaccumulation and bioavailability • Targeted and non-targeted analytical methods
Learning & Teaching	• Lectures: 20 hr • Seminars (for case studies) : 12 hr • Tutorials (exercises and presentations):8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• C. Zhang. 2007. Fundamentals of environmental sampling and analysis, John Wiley & Sons, New Jersey, USA. • M. Radojevic, V. N. Bashkin. 2006. Practical environmental analysis. RSC Publ. Cambridge, UK • J.R. Dean. 2007. Bioavailability, bioaccessibility and mobility of environmental contaminants, John Wiley & Sons, Chichester, UK. • Roger Reeve, 2002. Introduction to Environmental Analysis, John Wiley & Sons Ltd. • Miroslav Radojevic, 2006. Practical Environmental Analysis: Edition 2, Vladimir Bashkin, The Royal Society of Chemistry. • AR Conklin,2004. Field Sampling, Principles and Practices in Environmental Analysis, ,Marcel Dekker. • D. Harvery, Analytical Chemistry 2.1 (http://dpuadweb.depauw.edu/harvey_web/eTextProject/version_2.1.html http://www.epa.gov/nerlesd1/chemistry/anal-env-chem.htm
Assessment	• Written theory examination (25%) • Practical activities (35%) • Case studies and reports (40%) By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental Chemometrics - Formerly Environmental Data Analysis
MER Code	MER SOES 6001
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A De Diego (Coord.), M Olivares, JM Madariaga
Synopsis	This course is an introduction to the application of statistic and chemometric tools to the analysis of data obtained mainly, but not only, after chemical analysis of a large variety of environmental samples. Descriptive and inference statistics are briefly reviewed, and the most important multivariate techniques for pattern recognition, classification and regression are also deeply investigated. Rather than on the mathematical detail, the course focuses on understanding the basic concepts behind each technique, and on selecting the most appropriate tool in each specific situation. The theoretical basis of the techniques considered will be illustrated by the resolution of exercises and case studies.
Aims	• To understand and apply multivariate approach to interpret the environmental data
Objectives At the end of the Unit, the student should:	1. Use and apply multivariate data analysis methods; and 2. Interpret the environmental outcomes from large data sets
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Apply a multivariate approach to interpret the environmental data

Programme/Syllabus	1.- Introduction: statistics, chemometrics, environmental analysis, multivariate data analysis 2.- Basic statistics: descriptive and inference statistics 3.- Exploratory analysis 4.- Pattern recognition 5.- Classification 6.- Calibration and regression
Learning & Teaching	• Lectures: 20 hr • Computer work: 15 hr • Seminars and tutorials: 5 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	1.- M. Otto, Chemometrics, Statistics and Computer Application in Analytical Chemistry, Wiley, Weinheim, 1999 2.- D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 8th edition, Thomson Brooks-Cole, Belmont, 2004 3.- J. N. Miller, J. C. Miller, Estatistics and Chemometrics for Analytical Chemistry, 4th edition, Pearson Education, Essex, 2000 4.- G. Ramis, M. C. García, Quimiometría, Síntesis, Madrid, 2001 5.- K. H. Esbensen, Multivariate Data Analysis – in Practice, 5th edition, CAMO Process AS, 2004 6.- B. Kendall, C. Costello, Data Analysis for Environmental Science and Management, (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.115.4159&rep=rep1&type=pdf) 7.- G. Hanrahan, Environmental Chemometrics: Principles and Modern Applications, CRC Press, Boca Ratón, 2009 8.- J. W. Einax, H. W. Zwanziger, S. Geiss, Chemometrics in Environmental Analysis, VCH, Hamburg, 1997
Assessment	The evaluation of this course will be of a mixed type. The final score will be obtained as the weighted average of the following sections: i) Lecture attendance (10%), bibliographic survey (20%), iii) practical tasks (30%) and iv) written examination (40%). A minimum score of 5.0 in each section will be required to pass the course. If the student waives the call, she/he will be graded as not presented.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environment and Fisheries/Aquaculture Interactions
MER Code	MER EHU 501349
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Martínez (Coord.)
Synopsis	The students will get a general overview on the interactions between environmental and breeding conditions on the safety/quality of seafood, both in fisheries and in aquaculture
Aims	• To provide a general view of the impact of environmental conditions, pollutants, climate change and breeding conditions on the safety, quality and biochemical composition of seafood • To provide knowledge suitable to be applied to farming practices and to seafood safety. • To provide a general view of the impact of fisheries and aquaculture on environmental quality status and ecosystem health.
Objectives At the end of the Unit, the student should:	1. Know the foundations of seafood safety and authenticity. 2. Understand how diverse factors affect fish wellbeing and seafood safety/quality. 3. Know procedures to ensure seafood safety/quality and human health. 4. Be familiar with analytical methods to identify fraud and the relationship between fraud and seafood safety
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Find relevant information including updates in laws and regulations and Rapid Alert System for Food and Feed (RASFF); 2. Actively participate in seminars and discussions; 3. Become familiar with the production system and the introduction, control and elimination of undesirable substances from the production chain. 4. Understand the relationship between environmental conditions and seafood safety

Programme/Syllabus	1. The environment and seafood safety: introductory remarks 2. Seafood safety hazards:anthropogenic contaminants, toxins, virus, bacteria, allergen, parasites 3. Emerging risks and climate change 4. Ensuring seafood safety: Hazard analysis and critical control points (HACCP) 5. Seafood quality: fish nutrition, harvesting methods, post-mortem changes 6. Seafood authenticity and how to fight fraud on species identification, geographic origin, production and processing. 7. Environmental impact of fisheries and aquaculture 8. Intelligenty aquaculture systems
Learning & Teaching	• Lectures and Seminars: 40 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	The students will have to find and use relevant published material complementing the one provided during the classes
Assessment	• Attendance is compulsory. Proactive participation in the activities, practical and oral sessions, will be considered. • Written examination (50%) • Oral presentation of a subject to be selected (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental (Toxico)Genomics
MER Code	MER EHU 501347
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Cancio (Coord.), E Bilbao
Synopsis	Environmental genomics, with emphasis on transcriptomic studies in environmentally-relevant non-model organisms. Application of genomic technology to environmental resources management or ecosystem health assessment.
Aims	• To provide basic notions, with the use of practical examples, that will explain the principal techniques used in environmental genomics, in ecotoxicogenomics and in clinic toxicogenomics..
Objectives At the end of the Unit, the student should:	1. Detect/interpret molecularly and mechanistically the adaptation events that living organisms trigger to obtain homeostasis in disease; reproduction; toxicity, feeding regimes and in a changing environment. 2. Determine the action mechanisms of different chemical compounds, on different cell functional pathways and structures. 3. Understand the usefulness of using transcriptional profiles, metagenomics and environmental DNA, in the evaluation of the quality of the environment and its application in pollution biomonitoring programs. 4. Learn the diagnostic usefulness of the ecotoxicogenomic approach in the determination of the ethiology of diverse pathologies and toxicopathies, in animals.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Master the technology, tools and information required for the planning, development and interpretation of high-throughput genomic and transcriptomic studies. 2. know how to design a research project based upon the study of gene transcription profiles for diagnosing exposure to and/or effect of chemical compounds in laboratory and field conditions: selection of sentinel species, sequence information retrieval; traditional and massively parallel sequencing techniques; gene expression analysis techniques; and analysis of gene pathways.

Programme/Syllabus	1. Environmental genomics and gene sources in the seas, soils, rivers, inside metazoa 2. Environmental metagenomics and gene discovery 3. Environmental DNA (eDNA) and biodiversity analysis. 4. Genomic services for aquaculture, fisheries research, study of fish stock dynamics, agriculture, food supply, comparative physiology... 5. Genomics and environmental model organisms. 6. Marine genomics and patents. 7. Basic concepts in toxicogenomics: ecotoxicogenomics, functional genomics, transcriptomics, proteomics, metabolomics, analysis of gene expression, and gene ontology. 8. Molecular mechanisms in cell toxicity: effects on gene transcription levels. Gene families with predictive capacity in toxicology: inflammation; peroxisome proliferation; mutagenesis; carcinogenesis; teratogenesis; agonists of AhR and other nuclear receptors; metal scavengers; detoxification metabolism; cytotoxicity; apoptosis; and immunosuppression… 9. How to address the lack of basic gene sequence information about the species of interest. Cloning, "expressed sequence tags" (ESTs). "Suppression subtractive hybridisation-PCR". Gene sequencing, Genome vs transcriptome sequencing. Massively parallel sequencing techniques. Sequence/Gene annotation (Gene ontology). 10. Basic techniques for the qualitative and quantitative study of differential gene expression (effects of chemical compounds). Toxicological fingerprinting. RT-PCR, Q-RT-PCR. Northern-blot, dot-blot, in situ hybridisation. Differential display PCR. Suppression subtractive hybridisation-PCR. Microarrays (microchips), RNA-Seq and transcriptomics 11. Toxicogenomics vs proteomics vs metabolomics. Systems biology. 12. Knock-down and transgenic technology and the gene dissection of relevant molecular pathways. 13. Practicals: Navigating through the web in search of gene/genome/metagenome data bases. Gene sequence repositories, Genome sequence repositories (NCBI, ENSEMBL, GOLD). Gene expression repositories (GEO, Arrayexpress). Pathway analysis based on Gene ontology (GoFact, KEGG pathways). Microarray
Learning & Teaching	• Lectures: 24 hr • Lab Practicals: 2 hr • Computer Practicals: 8 hr • Tutorials: 4 hr • Personal work: 60 hr (including 12 specific on the seminars) (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Relevant papers delivered during the course • Web resources delivered during the course
Assessment	• Attendance is compulsory. Proactive participation in the activities, practical and oral sessions, will be considered. • Students will prepare in couples a very short ppt presentation (10 min) to explain one gene, group of genes or genome of environmental interest (in the framework of pollution monitoring, climate change, disease outbreaks, resistance to environmental changes, predation, symbiosis…) in front of all the class. From the discussion, we shall agree on two questions that may remain without answer and the students will have 2 weeks to find answer to such questions and present them in a written report to be sent to kecturers and all classmates. Assessment criteria: ppt, presentation in public, capacity to answer in public, written report quality.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Environmental Monitoring and Risk Assessment in Aquatic Systems
MER Code	MER EHU 501317B
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigomez (Coord.), U Izagirre
Synopsis	Regulatory policies for the protection of the aquatic environment. Environmental Risk Assessment (ERA). Ecotoxicological bioassays in ERA. Marine pollution biomonitoring. Biological effects assessment through biomarkers and biomarker indices. Environmental Specimen Banks.
Aims	• To develop the abilities that enable suitable study design for environmental risk assessment • To provide the criteria useful for analysing and interpretation of toxicity and bioaccumulation data • To develop the abilities that enable suitable study design for pollution biominotirng programmes • To provide the criteria useful for analysing and interpreting ecologically relevant environmental levels of pollutants and their biological effects
Objectives At the end of the Unit, the student should:	1. Identify the main questions that can be addressed by the use of bioassays and biomarkers 2. Know the advanced methods for the determination of ecotoxicity of contaminated water and sediments 3. Understand the role of toxicity testing in aquatic risk assessment 4. Know the advanced methods for biomonitoring pollution and its biological effects 5. Understand the role of biological endpoints in the integrative assessment of aquatic pollution, its biological effects and their ecological consequences
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Face problem analysis in an aquatic environment related to risk assessment 2. Face problem analysis in an aquatic environment related to pollution biomonitoring 3. Achieve clear expression (oral or written) of conclusions from results derived from bioassays

Programme/Syllabus	1. Introduction: scope and basic concepts * 2. Ecotoxicity bioassays in aquatic systems * 3. Environmental Risk Approaches (ERA): EDS, TIE and WoE * 4. Chemical biomonitoring: baselines, Long-Term Trends * 5. Mussel Watch and other chemical biomonitoring programmes * 6. Pollution indices in the aquatic environment * 7. Biological effects assessment: biological endpoints * 8. Marine ecosystem health indices * 9. Integrative biomonitoring programmes: design and case studies * 10. Environmental specimen banks (ESBs) * 11. Ecotoxicity bioassays and ERA I: standard BE assays; TIE; Toxicity profiling 12. Ecotoxicity bioassays and ERA II: non-standard assays; WoE Case studies Practical sessions: P1. Coastal biomonitoring: design and sampling * P2. Pollution Indices and Ecosystem Health Indices * P3. Acute toxicity testing & ERA calculations (PNEC, WoE) * P4. Team work mini-projects on toxicity assays or biomonitoring P5. Poster corner workshop on mini-projects ** Priority will be given to remote learning combined with individual/small group tutorials*
Learning & Teaching	Lectures:18 hr Computer practicals (3x3): 9 hr Lab/Field practical work: 9 hr Workshop: 4 hr Personal work: 60 hr *(In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)*
Bibliography	• European Commision. 2014. Technical report on aquatic effect-based monitoring tools. EC Technical Report - 2014 - 077. EU Luxemburng, ISBN 978-92-79-35787-9, 242 pp. • Potters G. 2013. Marine Pollution, Bookboon, ISBN-13: 9788740305401, 231 pp. • Goh, B.P.L., Lai, C.H., Tan, L.T., Yap, N.W.L. & Dissanayake, A. (2014) Handbook of Marine Ecotoxicology Techniques. National Institute of Education, Nanyang Technological University. National Parks Board, Singapore, 110 pp. • OSPAR. 2013. Background document and technical annexes for biological effects monitoring, Update 2013. Monitoring and Assessment Series. 239 pp.
Assessment	• Attendance (compulsory) • Written examination (definitions): 20-30% • Report on computer practicals: 30-40% • Mini-project Workshop (poster and poster corner): 30-40%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Eutrophication and Harmful Algae
MER Code	MER EHU 501320
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	S Seoane (Coord.), A Laza-Martinez
Synopsis	Overview of the effects of harmful algae on marine ecosystems and human health. Factors contributing to harmful algal blooms development. Eutrophication and its control.
Aims	• To provide an introduction to the biology of harmful algae, the methods for their detection and identification and to their relevance for environmental and human health.
Objectives At the end of the Unit, the student should:	1. Understand the biology of harmful algae. 2. Be familiar with methods to detect and identify marine phytoplankton. 3. Understand the foundations of eutrophication and its consequences for environment and human health. 4. Be aware of the factors enhancing eutrophication
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify the main groups of harmful algae 2. Apply methods to detect and identify harmful algae 3. Be conversant on eutrophication and harmful algae

Programme/Syllabus	1. Presentation of the different types of harmful microalgae 2. Methods of detection and identification of harmful algae 3. Impact of harmful algal blooms (HABs) on humans, wild fauna and aquaculture 4. Factors triggering harmful algal blooms 5. Eutrophication of estuaries and coastal waters 6. Factors enhancing eutrophication 7. Restoration of eutrophized habitats: case studies
Learning & Teaching	• Lectures: 12 hr • Seminars (oral presentations): 5 hr • Practical sessions: 14 hr • Field trip (1 day): 6 hr • Tutorials (on writing reports): 3 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Grant, Pitcher & Pillar. 2010. Harmful Algal Blooms in Upwelling Systems. Progress in Oceanography. 85: 1-136. • Glibert, Burkholder, Graneli & Anderson. 2008. HABs and Eutrophication. Harmful Algae. 8: 1-188. • Karlson, Cusack & Bresnan. 2010. Microscopic and Molecular Methods for Quantitative Phytoplankton Analysis. IOC (Intergovernmental Oceanographic Commission of UNESCO). Paris, 110pp. • Suthers & Rissik. 2009. Plankton. A guide to their Ecology and Monitoring for Water Quality.
Assessment	• Written report on a case study of eutrophication control (20%) • Oral presentation of the ecology and toxic effects of a toxic algae (60%) • Written theory examination: a written examination paper based on the lectures (20%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Histology and Histopathology of Aquatic Animals
MER Code	ER EHU 501324
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Soto (Coord.), U Izagirre, B Zaldibar, S Feist, A Villalba
Synopsis	Topics covered will include the description of the normal and pathological histology of marine invertebrates and fish, with special emphasis on the effects of chemical pollutants and other sources of environmental stress.
Aims	• To describe the normal and pathological histology of marine animal species: mainly fishes, molluscs and crustaceans. • To Identify histopathological alterations of viral, bacterial, parasitic and toxic (due to pollutant exposure) ethiology • To characterise the cellular and molecular mechanisms involved in pathological damage and organismal defence.
Objectives At the end of the Unit, the student should:	1. Be familiar with the form and function of organs and tissues in aquatic animals (comparative histology) 2. Understand the normal histological organisation of target tissues in molluscs (integument, kidney, blood, digestive gland) 3. Understand the normal histological organisation of target tissues in marine fishes (integument, kidney, spleen, blood, liver) 4. Recognise major parasites and pathological lesions in molluscs and fish 5. Know the value of histopathology in ecosystem health monitoring and marine pollution assessment
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Conduct histological processing of marine animal tissues 2. Identify normal tissues and cell types at the light microscope in marine molluscs and fish 3. Identify major parasites and histopathological lesions in marine molluscs and fish 4. Search in the web and literature the relevant information concerning molluscs and fish disease, with emphasis in environmentally relevant syndromes

Programme/Syllabus	1. Lectures: Comparative histology of marine invertebrates. Normal histology of molluscs. Normal histology of fishes. Basic principles in biopathology, histopathology and parasitology. Molluscs: general histopathology, toxicopathology, neoplastic lesions, natural variability and temporal trends in histopathological lesions. Fish: general histopathology, mechanisms of chemical carcinogenesis, carcinogenic lesions. Histopathology in ecosystem health assessment: quantitative histopathology, quality assurance, monitoring programmess 2. Practicals: Histotechnology preparation of samples. Microscopical examination of molluscan tisúes. Microscopical examination of fish tissues. Histopathological examination of marine molluscs. Histopathological examination in fishes. Navigating trough the web in search of data bases and images of aquatic animal histopathology 3. Report: Review of cutting edge themes on toxicological pathology in aquatic animals
Learning & Teaching	• Lectures: 20 hr • Practical sessions (laboratory): 8 hr • Practical sessions (microscopy): 10 hr • Practical sessions (questionaire on line) 2 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary
Bibliography	• Pathobiology of marine and estuarine organisms. Couch, JA; Fournie, JW. CRC Press, Boca Raton, Florida, USA, 1993. • Fish and shellfish pathology. Ellis, AE. Academic Press. London, UK, 1985. • Sistemic fish pathology. Ferguson, HW. Iowa State Univ. Press, 1989. • Fish diseases and disorders. Vol 2. Non-infectious disorders. Leatherland, JF; Woo PTK. CABI Publ., Oxon, UK, 1995. • Fish as sentinels of environmental health. Murchelano, RA. NOAA, US Dept, Commerce, Woods Hole MA, USA,1988. • Histopathology atlas of the registry of marine pathology. Murchelano, RA; MacLean, SA. NOAA, US Dept. Commerce, Osford MD, USA, 1990. • Fish Pathology. Roberts, RJ. WB Saunders, London, 2001. • Fish disease and marine pollution. Vethaak, AD. National Institute for Coastal and Marine Management/RIZK, Amsterdam, 1993. • Fish deseases and disorders. Vol 1. Protozoan and metazoan infections. Woo, PTK. CABI Publ., Oxon, UK, 1995.
Assessment	• Attendance is compulsory. Proactive participation in activities, practical and on-line questionaire (follow up of objective fulfilling). • Written report (review) at the end of the module (70%) • Practical examination (daily fulfilling and feedback) (30%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Instrumentation and Measurements in Operational Oceanography
MER Code	MER EHU AZTI-501330
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A Uriarte (AZTI) (Coord.), M González (AZTI)
Synopsis	A practical introduction to the wide range of sampling techniques and procedures applicable to operational oceanographic studies.
Aims	• To introduce the students to the wide range of sampling techniques applicable to operational oceanography
Objectives At the end of the Unit, the student should:	1. Have gained knowledge in the different sampling techniques and data analysis
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform individual assessment of data quality, presentation of written reports, library information retrieval and critical analysis of literature. 2. Perform boatwork and practical laboratory work in operational oceanography

Programme/Syllabus	The following issues are addressed: • Oceanographic instrumentation and sampling techniques (CTD, Sediment grabs and cores, etc.) • State of the art instrumentation in fish biology surveys (acoustic surveys, plankton samplers, etc.) • Physical instrumentation and data analysis (currents, tides and waves) • Geophysical sampling tools and data analysis (multibeam, side scan sonar, etc.)
Learning & Teaching	• Lectures and Seminars: 14 hr • Laboratory practicals: 8 hr • Computer practicals: 8 hr • Field trip: 6 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	Practicals notebook will be marked
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Enterpreneurship
MER Code	MER EHU 20180001
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Del Valle (Coord.) & Torger Edvardsen (consultant)
Synopsis	The course is addressed to marine science students who may consider the option to developing a marine career as entrepreneur. Topics include introduction to business management and entrepreneurship, as well as an integrated overview of ocean economy and some practical cases of ocean economy
Aims	• To awake vocations and prepare students to work with or to become entrepreneurs in the maritime and marine sectors or leaders of marine organizations.
Objectives At the end of the Unit, the student should:	1. Understand the basic principles of bussiness management 2. Know the basic processes and the prospects and hurdles relative to the world of innovation and entrepreneurship 3. Identify the main drivers of ocean economy and the needs and opportunities associated to entrepreneur's endeavours in the marine and maritime sectors
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Increase his/her entrepreneurship skills 2. Improve confidence and increase international business ambition 3. Understand and get insights to practical tools and approaches in business management 4. Know how to support to accelerate the growth of business organizations

Programme/Syllabus	PART 1. Entrepreneurship and business management 1. Introduction to business management: accounting, microeconomics, marketing, small business management, human resources management, operations management 2. Introduction to entrepreneurship: financing and fund raising, markets and sales strategies, new product development, sustainable entrepreneurship, circular economy, entrepreneurial leadership, SMEs, social relations and communication. PART 2. Ocean economy 3. Overview of the ocean economy: the marine and maritime sector, global trends and macro-factors influencing the ocean economy; science, technology and innovation in tomorrow's ocean economy; international maritime regulation and emerging ocean-based industries; perspectives on and projections of the future of the ocean economy; integrated ocean management 4. Workshops on exemplary practical cases:
Learning & Teaching	• Lectures and Seminars: 24 hr • Computer or In place practicals: 8 hr • Field trips: 8 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en • More references delivered during the course
Assessment	Mixed system of continuous and final assessment, where class attendance is compulsory. • Written examination (50%) • Oral presentation of Coursework (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Microbial Ecology
MER Code	MER EHU 20180002
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	B Ayo (Coord:), JM Arrieta (IEO)
Synopsis	Marine microbes are the most abundant organisms in the ocean, and they mediate many essential biogeochemical processes. In this course, we will convey the basic information on marine microbes by addressing their biodiversity and functioning, together with the analysis of currently topical research questions.
Aims	• To provide the students a global view of the abundance, physiology and biodiversity of marine microbes. • To offer to the students a microbial perspective of the functioning of the ocean system. • To develop skills to estimate microbial standing stocks and microbial activities.
Objectives At the end of the Unit, the student should:	1. Recognise the main groups of microbes living in the ocean. 2. Understand the basic processes and activities carried out by the microbial communities in the ocean. 3. Identify the main microbial drivers in the global cycles of carbon, nitrogen and phosphorous.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Identify the main microbial processes taking place in the ocean. 2. Obtain quantitative results about microbial standing stocks. 3. Critically analyse scientific research on marine microbial ecology.

Programme/Syllabus	1. Overview of diversity of marine prokaryotes, eukaryotes and viruses. 2. Ecophysiology of marine microbes: adaptations to oligotrophic conditions, response to different regimes of temperature, hydrostatic pressure, oxygen concentrations. 3. Microbial primary production and phototrophy by eukaryotic and prokaryotic microbes. 4. Degradation of organic material. Bacterial growth efficiency in marine systems. 5. Heterotrophic marine eukaryotic microbes. Overview of protists and grazing activities. 6. Diversity of marine viruses. Impact in microbial processes. 7. Influence of the microbial activities on ocean processes. Cycles of elements. 8. Microbial community structures in the ocean. Genomics and metagenomics of marine microbes. 9. Symbiotic associations. Practicals/Case studies: 1. Estimation of microbial densities in seawater. 2. Estimation of microbial activity rates in seawater.
Learning & Teaching	• Lectures: 20 h • Seminars: 5 h • Lab practicals/Case studies: 15 h • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Kirchman, D.L. (2008) Microbial ecology of the oceans, 2nd Ed. Wiley-Blackwell. • Kirchman, D.L. (2012) Processes in microbial ecology. Oxford University Press, New York. • Munn, C. (2011) Marine microbiology. Ecology and applications, 2nd Ed. Garland Science, Taylor & Francis Group. New York. Specific bibliography: Relevant papers delivered during the course
Assessment	• Attendance is compulsory. All absences must be justified. Active participation in the activities of the course will be considered. • Written report and oral presentation: based on the analysis of research articles about a selected topic on microbial ecology.
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Marine Resources Genomics - Formerly Molecular Population Genetics of Fish and Shellfish
MER Code	MER EHU 501351
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	A Estonba (Coord.), I Zarraonaindia, A. Fullaondo, T.Pérez
Synopsis	Molecular population genetics for fisheries and aquaculture species, and metagenomics for the study of whole biological communities. Conservation management and ecosystem health protection.
Aims	• To initiate students into genomic research in the marine world by exploring current research cases, understanding of cutting-edge lab technologies, building bioinformatics/computational skills, and shaping knowledge base
Objectives At the end of the Unit, the student should:	1. Know the foundations of population genomics and metagenomics 2. Understand principles of bioinformatics and statistics methods to make use of DNA sequence data. 3. Be aware of the potential application of molecular population genetics in the field of marine environment and resources
Key Skills Acquired At the end of the Unit, the student should be able to:	• Apply population genomic approaches to survey patterns of variation within and among marine fish and shellfish populations. • Apply metagenomic/metabarcoding approaches to study of complete communities directly in their natural environments.

Programme/Syllabus	A. ESSENTIALS OF GENOMICS B. METAGENOMICS -Microbial ecology: metagenomics -Metagenomics applications -Quiz test metagenomics -Linux tutorial -Analysis pipeline -Computer practice: tutorial using QIIME C. MARINE POPULATION GENOMICS -Basic principles of fish population genetics -Molecular markers and application in fisheries and aquaculture -Computer practice: tutorial
Learning & Teaching	• Lectures: 16 hr • Computer based exercises: 18 hr • Computer practices report tutorials: 8 hr (following completion of the practices, each student will do an independent report. For computer practices raw sequence data coming from an experiment designed to meet a specific goal will be provided) • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	-Attendance is compulsory. Proactive participation in the activities and practical sessions, will be considered. -Each student should write a lab report following completion of the two computer practices of population genomics and metagenomics: •The two reports should explain what you did in your computer practices what you learned, and what the results meant. •Argument, research problem statement, methodology, and presentation and expression will be evaluated. "The assessment method included in this guide may be subject to change if health authority guidelines so state. The modifications to be adopted would be announced in a timely manner, with the necessary strategies and tools to guarantee the right of students to be evaluated with equity and justice".
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Multicultural integration in EU
MER Code	MER EHU 501351
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	M Soto (Coord.), N Etxebarria
Synopsis	Academic recognition of certified activities in learning languages, participating in cultural/sport/social or science dissemination activities, cooperation with NGO's, etc.
Aims	• To promote and enhance multicultural integration among students or in the host institutions/countries or at EU level
Objectives At the end of the Unit, the student should:	1. Improve the level of language or cultural/social integration at either local scale in the host institution, or an European scale
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Gain knowledge of any MER MSc Consortium or host country official language, other than mother's language 2. Gain integration as regards different cultural, sport, social or organizational aspects of the host institution/country 3. Perceive intercultural, organizational or cooperation (e.g. with NGO's) links among different European countries in the fields of marine and environmental science and technology or in the areas of education, environmental awareness or research career

Programme/Syllabus	N/A
Learning & Teaching	• Personal work: 100 hr (4 ECTS correspond to approximately 100 hr personal work, provided the activity or activities have been previously recognized by the MER UAB in UPV/EHU and approved by the MER JPB, as stated in the MER Student Agreement, and provided it has been successfully achieved and so certified) • Tutorials
Bibliography	N/A
Assessment	A certificate of achievement is needed • Written report: 60% • Questionnaire: 40%
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Ocean Global Change Biology
MER Code	MER EHU 20180003
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	I Marigómez & J Saenz (Coord.); guest lecturers
Synopsis	Global change is conceived as any consistent environmental change and trend (past, present or projected) that affects a substantial part of the global environment and can be caused by a diversity of processes including those guided by biological drivers. The main topics include basic techniques used in the generation of high quality datasets for the stydu of climate change, how marine organisms and ecosystems respond to change drivers and vice versa, and how the biota acclimate and adapt to the major environmental stressors driven by global change and its environmental and evolutionary consequences.
Aims	• To integrate diverse approaches to understand how marine organisms respond to complex, multiple stressors in the global ocean, in past, present and tentative future scenarios.
Objectives At the end of the Unit, the student should:	1. Know which are the different drivers of global change and the possible interactions between them and with marine biota and ecosystems 2. Acquire a basic understanding of how marine organisms respond to changes in environmental factors environment, from alterations in gene expression patterns, through metabolic, cellular and physiological level to ecophysiological adaptation and alterations in phenology; 3. Understand the mechanisms by which marine organisms cope with specific stressors in their environments, including e.g. extreme temperatures and acidification;
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Analyse the causal chain leading from human activities to global change processes and their impact on ecosystems, based on discussions of case studies. 2. Demonstrate a critical, analytical approach to scientific research and have developed skills in literatuire reading and in writing scientific reports.

Programme/Syllabus	1. Introduction: ocean global environmental trends, threats and challenges PART 1. GLOBAL OBSERVATORIES 2. Global meteorology and climate 3. High-quality datasets for monitoring global change and oceanic processes 4. Atmospheric data reanalysis 5. Ocean data assimilation and modelling PART 2. BIOLOGICAL IMPACT OF GLOBAL OCEANIC TRENDS 6. Ocean acidification I: trends and effects on marine life 7. Ocean acidification II: mitigation of CO_2 8. Thermal stress in marine ectotherms I: biological responses to gradual warming 9. Thermal stress in marine ectotherms II: biological responses to heat waves 10. Global long-term trends in chemical pollution 11. Global plastic threat 12. The One Ocean - One Health approach PART 3. GLOBAL MARINE BIODIVERSITY TRENDS 13. Introduction: the 5 w's of global marine biodiversity 14. Climate change and the decline of coral reefs 15. Global shipping and allien species 16. Global marine diversity and MAPs 17. Biosphere's life history: a recapitulation ROUND TABLES (team work and open discussion) & WORKSHOP 1. Round Table on Global Observatories 2. Round Table on Adaptations, Trends and Evolution 3. Workwhop (Poster corner style) on Ocean Global Change Biology
Learning & Teaching	• Lectures: 24 hr • Workshops: 16 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• IPCC 2019 Special Report on the Ocean and Cryosphere in a Changing Climate: https://www.ipcc.ch/srocc/ • Other bibliography to be delivered during the course
Assessment	• Attendance is compulsory. All absences must be justified documentally. • Active participation; questions in roundtables + question list report (30-50%) • Poster Corner Workshop (50-70%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Physiological Energetics of Marine Organisms
MER Code	MER EHU 501322
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	E Navarro (Coord.), MB Urrutia, I Ibarrola
Synopsis	Physiological basis of energetic exchanges between marine animals and environment are analysed.
Aims	• To present the tools that Physiological Energetics provides to understand the basis of energy exchanges and constrains to attain high rates of growth. • To present the tools that Physiological Energetics provides to evaluate sublethal effects of pollutants on individual growth and reproductive potential.
Objectives At the end of the Unit, the student should:	1. Handle information Scope For Growth provides as regards to understanding actual growth and factors that may potentially affect growth rate. 2. Design simple experiments to measure the scope for growth in marine animals
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Perform critical Analysis of literature data on Scope For Growth. 2. Express (write and analyse) experimental results obtained in the laboratory. 3. Design experiments.

Programme/Syllabus	1. The course is organized into two sections: discussion of general principles of physiological energetics; and two independent and complementary modules developing concepts and methods within the framework of production and toxic effects of pollutant agents. 2. Lectures and laboratory experiments deal with the physiological parameters of the energy balance, such as: rates of food ingestion and absorption; absorption efficiency; metabolic rate; excretion rate; and the resulting scope for growth. 3. Modules on production and pollution follow the pattern of a case study where experimental results are thoroughly discussed.
Learning & Teaching	• Lectures: 16hr • Seminars: 12 hr • Practical sessions (laboratory): 8 hr • Tutorials: 4 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	• Galloway, T.S., Sanger, R.C., Smith, K.L., Fillmann, G., Readman, J.W., Ford, T.E., Depledge, M.H. Rapid assessment of marine pollution using multiple biomarkers and chemical immunoassays ,(2002) Environmental Science and Technology, 36 10, 2219-2226. • Widdows, J., Donkin, P., Staff, F.J., Matthiessen, P., Law, R.J., Allen, Y.T., Thain, J.E., (...), Jones, B.R. Measurement of stress effects (scope for growth) and contaminant levels in mussels (Mytilus edulis) collected from the Irish Sea ,(2002) Marine Environmental Research, 53 4, 327-356. • Webb, N.A., Shaw, J.R., Morgan, J., Hogstrand, C., Wood, C.M. Acute and chronic physiological effects of silver exposure in three marine teleosts ,(2001) Aquatic Toxicology, 54 3-4, 161-178. • Niemi, Gerald J., Bradbury, Steven P., McKim, James M. Use of fish physiology literature for predicting fish acute toxicity syndromes ,(1991) ASTM Special Technical Publication, 1124, 245-260. • Willmer P, Johnston I, (2000) Environmental Physiology of Animals. Blackwell Publishing.
Assessment	• Written examination of theoretical and practical issues (40%) • Continuous evaluation of assigned tasks (30%) . Written/oral presentation of selected case studies (30%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Satellite Oceanography and Meteorology
MER Code	MER EHU 501346
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	J Sáenz & C García-Soto (IEO) (Coord.); G Ibarra-Berastegi, G Esnaola
Synopsis	Satellite oceanography: sea surface temperature, altimetry , imaging radars. Meteorology: radiation propagation through the atmosphere, atmosphere-ocean coupling, satellite data analysis applied to oceanography, meteorology and climate
Aims	• To understand the present developments in the fields of Satellite Oceanography and Meteorology
Objectives At the end of the Unit, the student should:	1. Analyze data from satellite oceanography and meteorology for different applications with emphasis on oceanography and climate
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Critical analysis and interpretation 2. Use of numerical tools (R and other languages) for data analysis 3. Use of web resources 4. Working in groups 5. Presentation of written and oral scientific reports

Programme/Syllabus	PART 1 SATELLITE OCEANOGRAPHY 1. Sea Surface Temperature: Application to global warming, ENSO and SST variability. Reconstructions of missing satellite data. 2. Altimetry: Sea level rise, currents and eddies. 3. Other applications: Chlorophyll, waves, wind.. PART 2 METEOROLOGY 1. Introduction to satellites and satellite based data 2. Propagation of radiation through the atmosphere for satellite applications 3. Atmosphere-ocean coupling 4. Satellite meteorology and climate (variability and change)
Learning & Teaching	• Lectures: 16 hr • Exercises: 8 hr • Computer sessions: 16 hr • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	Delivered during the course
Assessment	• Completion of practicals (50 %) • Oral presentation of coursework (50%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.

Course/Unit	Socio-Economic Aspects of Climate Change
MER Code	MER EHU 20180004
ECTS	4
Level	Optional
Semester	2
Timetable slot	To be advised
Teaching Staff	IGalarraga & E Sainz de Murieta (BC3) (Coord.), A Ansuategi, M Escapa (UPV-EHU), Itziar Ruiz de Gauna (Metroeconomica)
Synopsis	This course will illustrate, from a socio-economic standpoint, the dimension of this problem, its causes, its impacts and the potential solutions which are being planned in order to confront the problem on a world scale. It will summarize existing knowledge regarding the potential impacts over all systems, the difficulties to manage the topic, the costs associated to the problem and the magnitude of effort required to confront the situation. It will explain why climate change can be considered as a market failure and what this means in terms of the importance of public policies to correct the problem and its impact on international trade and negotiations. The course will also cover the advances in the United Nations conferences, the Kyoto Protocol and the Paris Agreement that entered into force on the 4th November 2016.
Aims	• To offer a good understanding of the ongoing trends in Climate Change research in the field of economics and policy. • To cover the main challenges to accelerate the transition towards a low carbon economy. • To fully comprehend the impacts, policies and instruments that can be applied in mitigation and adaptation to climate change.
Objectives At the end of the Unit, the student should:	1. Be able to comprehend the complexities and uncertainties surrounding climate change impacts. 2. Understand the enormous effort needed in terms of emissions reduction. 3. Have a good knowledge of what mitigation policies are like in different sectors: industry, energy, transport, housing and others. 4. Be familiar with adaptation policies and policies to enhance resilience. 5. Have an updated comprehension of the international climate policy and the difficulties to reach agreements.
Key Skills Acquired At the end of the Unit, the student should be able to:	1. Have good written and oral communicating abilities in the field. 2. Understand the basic concepts of a mitigation policy. 3. Understand the basic concepts of an adaptation policy. 4. Understand, follow and assess the climate summits. 5. Identify the main sources of policy and research literature.

Programme/Syllabus	1. Introduction to Climate Change 2. Basic socio-economic concepts. 3. Mitigation policies: a transition to a low carbon economy. 4. Adaptation policies: building resilience to climate impacts. 5. International climate policy: Kyoto Protocol, Paris Agreement and the United
Learning & Teaching	• Lectures: 26 hr • Seminars: 6 hr • Role playing games: 8 hr (i) UN Climate Summit, (ii) Designing adaptation plans. • Personal work: 60 hr (In situ teaching activities might be replaced by remote teaching in case of need for sanitary or other reasons)
Bibliography	☐ Fankhauser, S., 2017. Adaptation to Climate Change. Annual Review of Resource Economics 9, 209 -230. https://doi.org/10.1146/annurev-resource-100516-033554 ☐ IPCC, 2019. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. In press. ☐ Roman De Lara, M.V. and Galarraga, I. 2016. The Paris Summit: The Beginning of the End of the Carbon Economy. Dyna Energía y Sostenibilidad. 5. (1) 41-44. DOI (10.6036/ES7954). ☐ Roman De Lara, M.V. and Galarraga, I. 2016. The summit in Paris, a historic result? DYNA Ingeniería e Industria. 91. (2) 131. DOI (10.6036/7958). ☐ Stern, N. (2006): The Stern Review: the Economics of Climate Change, HM treasury, UK Government.
Assessment	• Written assignments (50%) • Oral presentation of coursework (30%) • Participation in role playing games (20%)
Course Evaluation	By completion of University Unit Evaluation Questionnaire by students, annual assessment by Unit Co-ordinator.