SEA-EU Module description

Module offers for the SEA-EU 'Virtual Modules'

Module/Course Name	**Biodiversity and Biogeography**	
Module/Course Code	Bio5027 @ Nord University	
Field of Education	Generic programmes and qualifications	☐
	Education	☐
	Arts and humanities	☐
	Social sciences, journalism and information	☐
	Business, administration and law	☐
	Natural sciences, mathematics and statistics	☒
	Information and Communication Technologies	☐
	Engineering, manufacturing and construction	☐
	Agriculture, forestry, fisheries and veterinary	☒
	Health and welfare	☐
	Services	☐
Study programme	MSc Bioscience	
Number of ECTS and total student workload	7.5 ECTS and 180 hours total	
Contact hours and Independent study hours	28 lecture hours	
Typology of contact hours	28 hours in class, 10 hours within-course assignments, 50 hours study (reading), 32 hours for data analysis exercise, 60 hours for essay assignment, no written exam	
Academic Year	2026	
Semester / Specific period	1 (spring; Jan-Jun)	
Teaching Language	English	
Delivery mode	In-person and online.	
Responsible Lecturer	Name: Prof. Mark Costello E-Mail: mark.j.costello@nord.no	

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Other lecturers	Name: Prof. Michael Patten E-Mail: michael.a.patten@nord.no
Learning outcomes	*Knowledge*: Students will be familiar with the • diversity of life, especially in marine and freshwater environments, biogeographic theory and concepts, • potential and limitations of biodiversity informatics resources for research and management. *Skills*: • Students will know how to apply understanding of how biodiversity is maintained to nature conservation and invasive species management, • including projections of how climate change will affect biodiversity and biogeography. *Competence*: • Students will be able to explain and apply key theories and concepts in biodiversity and biogeography, and • to analyse online biodiversity databases for research and information management.
Course contents	Biogeography is the science of how the Earth's history and present environment determines speciation, habitat diversity and biodiversity patterns. It provides both a theoretical basis for understanding how biodiversity evolved and has applications in deciding where to have nature reserves, the spread of invasive species, and predicting the effects of climate change. The course moves from an introduction of core concepts in biogeography, to summarising the biodiversity of life in marine and freshwaters, including contrasting how many species exist in marine, freshwater and terrestrial environments; alternative measures of biodiversity, and why confusion on how many species may exist complicates estimates of extinction rates. Key theories, hypotheses, rules and concepts include: Island Biogeography, continental drift, connectivity, dispersal, geneflow, Mid-domain model, Rapport's, Bejernick's (= Bass –Becking), endemicity, realms, biomes, ecosystems, habitats, deep-sea diversity, environmental niche, effects and causes of mass extinctions. How leading biodiversity informatics resources have developed and can be used, including the Global

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	Biodiversity Information Facility, Ocean Biodiversity Information System, FishBase and AquaMaps, will be explained. Practical exercises will involve students using these resources to study selected species they are interested in, e.g., if threatened, charismatic, important food species, pest species, keystone. Use of categorical data analysis methods, such as multi-variate cluster and neural network analyses, will be demonstrated.
Prerequisites and/or recommended academic background	BSc level courses in biology and/or ecology.
Assessment	There are three assessments: (1) students submit summaries of previous lectures to the teaching platform (Canvas) (10%), (2) analyse a species distribution dataset they download to answer a research question they have themselves (30%), (3) an essay demonstrating critical thinking that challenges some theories or ideas in biogeography or macroecology (60%).
Main bibliography	Costello MJ, Chaudhary C. 2017. Marine biodiversity, biogeography, deep-sea gradients, and conservation. *Current Biology* 27, R511–R527. Brown JH, Lomolino MV. 1998. *Biogeography*. Sinauer. xii+ 691 pp. ISBN 0 87893 073 6. **Online resources:** Biogeography Buffon's Law Island biogeography Macroecology Gene flow and speciation Species diversity and richness measures Species-are relationship Competitive Exclusion Principle Gause's Law Latitudinal ranges wider at high latitudes (altitude, depth) Rapoport's rule Latitudinal diversity gradient and mid-domain effect Limb and surface area to body volume ratio with temperature, Allen's rule Body size and temperature Bergman's rule Body size Gigantothermy and Deep-sea gigantism Skin colour Gloger's Rule "Everything is everywhere, the environment selects" Bass Becking (Beijerinck's) hypothesis Species lineages get bigger Cope's Rule Island dwarfism and gigantism Foster's rule Fish have more rays and vertebrae in colder temperature Jordan's Rule Marine benthic invertebrates tend to more planktotrophic larvae at low latitudes (vs lecithotrophic or brooded at high latitudes) Thorson's rule Rescue Effect

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Organisational Information

Maximum number of SEA-EU participants
20
Learning Management System
Canvas
Course schedule (date and time)
Between 10:00-14:00 CEST on 13th, 15th, 17th, 20th, 22nd, 24th, 27th, 29th April
Application deadline
22nd February 2026

See the detailed module schedule on the next page.

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Schedule

All classes are held in hybrid, i.e., in person on the Bodø campus and also online available. There is a short break in the middle of each class. Classes are from 10:15 until 14:00 on Mondays and Wednesday, and until 12:00 on Fridays.

When	Lecture topic	Presenter
Mon 13	Introduction to biogeography and tropical biogeography Some rules in biogeography	Michael Patten Mark Costello
Wed 15	Measuring biodiversity: richness, phylogenetic, evenness, dominance, traits, habitats, biomes, ecosystems Marine species richness gradients, endemicity and biogeography	Mark Costello
Fri 17	Global species richness, marine vs terrestrial	Mark Costello
Mon 20	Endemicity, realms, evolution and islands (including examples from New Zealand and Ireland) Freshwater biogeography Applied Biogeography: - Conservation (protected areas and invasive species) Climate change	Mark Costello
Wed 22	Designing Marine Protected Area networks to be ecologically representative and climate-change resilient Biogeography tools	Mark Costello Michael Patten
Fri 24	Biodiversity informatics with examples: WoRMS, CoL, GBIF, OBIS, FishBase, AquaMaps Data download and analysis.	Mark Costello
Mon 27	Student presentations of their data analysis for feedback	Mark Costello
Wed 29	Students present their draft project reports for feedback	Costello, Patten,

See the different lecture topics on the next pages.

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Lecture topics

Introduction: core laws, rules and concepts in biogeography
Equilibrium Theory of Island Biogeography: effect of area, distance (rescue effect), and time on species richness, fragmentation and relaxation time after area reduced (supersaturation).
Succession vs opportunity, gene flow, genetic drift, genetic bottlenecks, natural selection, competition, character displacement, adaptive radiation, vicariance and continental drift, allopatric and sympatric speciation.
Endemic, cosmopolitan, amphi-tropical, tropical submergence.
Applications**:** Conservation, Climate change, Invasive species.

Measuring biodiversity
The most fundamental ways of measuring biodiversity will be summarised, including measures of relative abundance, richness, dominance and evenness, and how to adjust for sampling variation in estimating richness. Species composition may be compared using rank ordination methods. However, biogeographic (and ecological) data analyses commonly use multivariate cluster data analysis where each species is a variable and the data are "categorical" (i.e., not numerical, as each species is different). Data may be presented in tables, dendrograms and MDS plots. Species traits may be used to reclassify an assemblage regarding its ecological function.

Marine biology – a diversity of lifestyles
Marine biodiversity contrasts with that on land and freshwater in having many endemic phyla and classes, and a diversity of complex life-histories, including planktonic larvae (and eggs) in many species. This lecture introduces the diversity of marine life, how it may have arisen, and how species traits (e.g., body size, dispersal) influence their dispersal and biogeography. The major marine species guilds, including phyto- and zoo-plankton, nekton, sessile and sedentary fauna, sediment infauna, and biogenic habitats (e.g. corals, seagrass, seaweeds, shell-beds) will be introduced as a foundation for the following lectures.

Marine environment and biogeographic barriers
This lecture will first review environmental patterns across the oceans and with depth. It will consider how these present conditions may influence species abundance and evolution, and thus present patterns of species richness and endemicity. Furthermore, how might continental drift, past glaciations and mass extinctions have influenced present day biogeography. Where may be the barriers to species dispersal in the ocean? These concepts will be contrasted with their application on land.

Marine species richness gradients
This lecture maps the present richness of species to global geography, and depth and latitudinal gradients, and compares these with the previously introduced environmental variation. Our recent research has been mapping marine biomes (plant life-forms), and ecosystems (environmentally defined) in three-dimensions. The lecture then considers how Island Biogeographic Theory, Mid-domain model, Rapport's rule, and Bejernick's rule (= Bass –Becking hypothesis) help explain the observed patterns.

Marine species endemicity
Endemicity has two parts; the number of species unique to an area; and the percentage that these species are of all species in an area (= % endemicity). Our research has recently mapped marine species endemicity globally. How this was conducted and its findings will be explained. In contrast to richness, it indicates barriers to species dispersal (i.e. vicariance) due to continental drift, and also the role of

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isolation and salinity in marine biogeography. New Zealand and Antarctica have the higher percent endemicity of any country and continent respectively. Current research to understand how other environmental factor may cause boundaries between these "realms" of endemicity will be outlined.

Freshwater biogeography

The biogeography of the freshwater environment is reviewed. Although it has less species than the land and ocean, it has more per unit area. Despite its importance to humans it is the most threatened of the three environments by human impacts. These impacts include pollution, water extraction, over fishing, and introduced species. Freshwaters thus contain a greater proportion of extinct and threatened species of all three environments. The extraordinary species richness of cichlid fish in the African rift valley lakes and high endemicity of Lake Baikal are remarkable. However, then the contradictions that other more isolated habitats, such as lakes, have less endemic species than rivers are discussed. Recent studies on palaeo- and neo-endemicity illustrate the importance of evolutionary history including continental drift in determining what species occur where today.

Global species richness

One of the most popular topics in the scientific literature has been wondering how many species exist on Earth. In this lecture, past estimates are summarised, and their methods are critically reviewed. The historic rates of discovery of species living on land, in the sea, and amongst parasites, are reviewed. Contrasting marine and terrestrial species richness, and associated biogeography, helps explain what factors led to the evolution of global patterns of species richness. In particular, why are there more species on land, but almost the same number of marine and freshwater fish species? It is argued that global estimates of species richness must account for biogeography to be reasonable.

Marine biogeography and oxygen

The topic in this lecture includes ocean deoxygenation, hypoxia, coastal dead zones, oxygen minimum zone, the vulnerability of marine species to low oxygen, and theories about how oxygen limits life GOLT, and OCCLT. The lecture will first introduce oxygen dynamics in the ocean. Then current status and causes of ocean deoxygenation will be illustrated. Furthermore, how expanding low oxygen waters influence marine species' biological traits and biogeography will be reviewed, and related theories. Finally, we will review how climate change will likely influence marine species due to oxygen constraints, with implications from the past mass extinction in the ancient warm and hypoxic ocean.

Marine ecology and climate

How living organisms interact with their environment includes the interactions among themselves and with their surrounding environmental, or abiotic variables. This implies that the way that individual species and communities adapt to their reality is affected by climate, and is responding to climate change. In this lecture, we will explore the different paths through which climate shape ecological interactions, and how are these expected to respond to climate warming. From changes in phenological behaviour to food webs, we will tackle the basic questions from a theoretical perspective, and then find examples in the material world. We will also review the current state of the art of this field, to understand what we know, what we expect but have not observed, and what we ignore.

Body size, biogeography and climate change

Abiotic conditions will have variable determinant effects on the body size and distribution of different groups of organisms, for example, mammals versus ectothermic species or aquatic versus terrestrial species. Bergmann's rule states that larger organisms of the same species will be found in cooler temperatures. This rule is widely accepted, although the mechanisms behind any "temperature-size response" are still debated. This lecture will discuss these mechanisms, as well, the implications of climate change on the body size, distribution, and life history events (phenology) of wild populations.

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