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Address the State of Geography Education

*Carlos A. Morales-Ramirez*

## Searching for Biogeography in the Classroom: A Proposed Curriculum to Address the State of Geography Education

**Carlos A. Morales-Ramirez**  
*West Chester University*  
*Rowan University*

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### Abstract

Biogeography is a discipline in charge of studying patterns and spatial distribution of Earth's flora and fauna. In geography, researchers have agreed that the discipline still needs a stronger representation. Considering the minimal focus on physical geography in many educational systems, the inclusion of biogeography in curriculum as a unique subdiscipline is lacking. Prior research on schools in Puerto Rico demonstrate this lack as biogeography is not taught in high school geography classes. The lack of geography standards in the island also adds to the discipline's invisibility. This study explored the status of biogeography in education, specifically at the K–12 level, in Puerto Rico. Evaluating educational standards and course offerings at various schools revealed that biogeography was missing. This study provides recommendations on incorporating biogeography in education through various topics/lessons in island biogeography and suggests a curriculum that can easily be adapted to various standards to meet specific educational aims and goals.

**Keywords:** biogeography curriculum, biogeography education, educational standards, K–12 education, Puerto Rico

### Introduction

Biogeography focuses on studying the distribution patterns of organisms and ecosystems through space and time and is an eclectic discipline that draws techniques from biology and geography (Kafanov, 2009). The practices of biogeography date back to the 18th century with the work of Linnaeus and Buffon (Whittaker, 1998). Buffon observed that different regions with different geographic climates housed unique biotas. Other important studies in biogeography were conducted by Johann Reinhold Forster, Alexander von Humboldt, Phillip Lutley Sclater, and Charles Darwin. Charles Darwin's theory

on natural selection is still discussed in biogeography and biogeography textbooks today.

Alfred Russel Wallace is considered the founder of modern biogeography and remains a key figure in the discipline (Cox et al., 2016). In 1876, Wallace published *The Geographic Distribution of Animals*, which details the zoological characteristics of various regions across the globe. Due to the importance of this work, he is credited as the originator of zoogeography—the past and present distribution of animal species (Cox et al., 2016). In 1967, Edward O. Wilson and Robert MacArthur changed the way biogeographers evaluated species with the publication of their book *The Theory of Island Biogeography* (Whittaker, 1998). The book introduced the subfield of island biogeography, which has facilitated the exploration of numerous evolutionary mechanisms in biodiversity studies. Today, biogeography is divided into two main subfields: historical and ecological biogeography. These subfields both incorporate zoogeography and phytogeography, the past and present distribution of animal and plant species respectively (Cox et al., 2016).

Historical biogeography focuses on evolution and evolutionary time scales (Posadas & Donato, 2007). Most current research in historical biogeography stems from the early work of Buffon (1707–1778), one of the first scientists to conduct biogeographical studies:

“In his *Histoire Naturelle*, Buffon postulated that different areas were inhabited by different species and by comparing mammal faunas of America and the Old World concluded that under similar ecological conditions each area had its own particular fauna” (Posadas et al., 2006, p. 391).

Ecological biogeography studies the current spatial distribution of plants and animals. Research in this subdiscipline focuses on the current distribution and anticipated future expansions as well as the number and densities of species in an ecosystem. Both abiotic and biotic factors are considered (Monge-Nájera, 2008).

Wilhelm (1968) detailed the role of biogeography in education and argued that biogeography is the least practiced geography subdiscipline owing to its overspecialization. Despite authors such as Watts (1978) and Edwards (1964) showing the importance of the discipline and the immense possibilities for teaching, the educational focus on biogeography remains insufficient (Erkens, 2018). The increased importance of biogeography research is also not reflected by the general public’s interest in the field or its inclusion in public education (Ladle, 2008). Ladle (2008) concluded that biogeography has a low public profile in the Anglophone world, while Millington et al. (2011) also noted a lack of focus in biogeography education in Latin American countries, where the subdiscipline is poorly represented in academia. Although biogeography is a core subdiscipline within physical geography and other fields such as biology, the availability of

courses and training resources is still lacking (Erkens, 2013; Lomolino, 2018). Such factors may compound the subdiscipline's perceived "specialization."

Although it may be considered an unusual subdiscipline by biologists due its complexity and diversified approaches (Crisci et al., 2000), biogeography characterizes an intersection of numerous biology subdisciplines. Specifically, it is within ecology—the study of organisms and their interactions with their environments—that biogeographical concepts and methods are prevalent, with some researchers highlighting the importance of integrating both disciplines when researching species distribution (Warren et al., 2014). In landscape ecology—the study of the relationships between ecological processes and ecosystems—biogeography also plays a pivotal role. Due to the spatial nature of some landscape ecology theories, there is a clear overlap with biogeographical methods that fulfill an important niche in important areas such as conservation (Kupfer, 1995). Despite the presence of biogeography in various sciences and its importance in education (Wilhelm, 1968), biogeography has had a low public profile, especially in public schools (Ladle, 2008). This study explored the status of biogeography in the Puerto Rican education system with an emphasis on K–12 education and teaching standards and a brief look at university course offerings. Considering the findings, recommendations to incorporate biogeography in the K–12 education system in Puerto Rico are presented.

### ***Geography in K-12 education in Puerto Rico***

Since 2008, a one-semester geography class, Geography for Life, has been part of the Social Studies curriculum in Puerto Rico. However, the course is optional, and school administration can decide to offer it at the high school (secondary) level. Because it is not mandatory, it faces challenges such as minimal student interest/enrollment, lack of appropriate teaching resources, and lack of teacher preparation. However, no study has investigated the lack of implementation of this course in a comprehensive manner to confirm these assumptions. In 2009, an undergraduate study analyzed the status of geography in public high schools (grades 10–12) in Puerto Rico. The end goal was to catalogue the schools offering geography classes to understand academic achievement relating to the subdiscipline. During the teacher survey, results showed a focus only in physical geography (Morales & Cruz-Torres, 2010). None of the schools that participated incorporated human geography concepts in the class. Although physical geography was the focus of the classes, biogeography was absent from the themes/topics taught. All classes used the suggested textbook, "*Vive La Geografía de Puerto Rico*" (*Live the Geography of Our Puerto Rico*) by Cruz-Baez, Guilbe and Lopez. In the book, only three pages are devoted to ecosystems and diversity, found in Chapter 2 (Cruz-Baez et al., 2002). This lack of comprehensive teaching material may explain the absence of the topic in the class;

however, teacher preparation can contribute to this issue as biogeography is often discussed at the graduate level in universities (Erkens, 2013).

### **Biogeography in Education**

#### ***Biogeography in science standards***

The relationship between concepts addressed in biogeography and the natural sciences is demonstrated in the current national science standards. The Next Generation Science Standards (NGSS) address biodiversity under the disciplinary core idea - life sciences. The life sciences sub-topics that address biogeography are Interdependent Relationships in Ecosystems and National Selection and Evolution (Lead States, 2013). Although the Department of Physics at the University of Puerto Rico is cited as a standard “represented organization,” their role is not clear. It is also not known if these standards are included in the science curricula in Puerto Rico because the island has their own science standards. In Puerto Rico’s science standards, which include terrestrial sciences, environmental sciences, biology, chemistry, physics, and environmental science, biogeography is not mentioned (DE, 2022a).

The concepts of biodiversity and ecosystems are included in the standards of various grade levels (K–12), but they are not incorporated in a biogeographic context. For example, the concept of ecosystems is included in biology standards from second to sixth grade and high school, and the curricula emphasize an understanding of how ecosystems work and how to preserve them from anthropogenic and climate threats. Ecosystems are also part of environmental and terrestrial science standards. An example can be found in the terrestrial science standards of fourth grade, for which students must establish relationships between the different types of landscapes in Puerto Rico and its ecosystems (DE, 2022a). The concept of biodiversity is less prominent than that of ecosystems and is only mentioned in the first, second, fifth, and sixth grades as well as high school. According to sixth grade biology standards, students must define biodiversity and recognize its importance; however, no other standard makes a clear correlation of this concept to biogeography approaches (DE, 2022a).

#### ***Biogeography in geography standards***

The National Geography Standards and/or the National Council for the Social Studies (NCSS) C3—College, Career, and Civic Life—framework can be incorporated in geography classes. In *Geography for Life: National Geography Standards*, biogeography is represented in Standard #8: “The characteristics and spatial distribution of ecosystems and biomes on Earth’s surface” (Heffron & Downs, 2012). The C3 framework addresses high school–level skills used in geography. The council in charge of this framework comprises representatives from various education agencies and individual disciplines who collaborated to

create a framework with guidance for social standards (NCSS, 2017). This framework works to develop knowledge in real-life decision making (NCSS, 2017). It requires students to use “spatial and environmental perspectives, skills in asking and answering questions, and being able to apply geographic representations including maps, imagery, and geospatial technologies.” (NCSS, 2017, p. 40).

“Geographic reasoning rests on deep knowledge of Earth’s physical and human features, including the locations of places and regions, the distribution of landforms and water bodies, and historic changes in political boundaries, economic activities, and cultures.” (NCSS, 2017, p. 40)

[...] An environmental perspective views people as living in interdependent relationships within diverse environments. Thinking geographically requires knowing that the world is a set of complex ecosystems interacting at multiple scales that structure the spatial patterns and processes that influence our daily lives.” (NCSS, 2017, p. 40). Dimension 2 of the framework provides a set of tools and disciplinary concepts that prepare students to develop a dynamic and comprehensive perspective from which they can understand specific core state standards (NCSS, 2017).

Teachers are also encouraged to incorporate the five themes of geography (Gersmehl, 2014). These five themes were created in 1984 by a group of geographers to provide a description of the core ideas underlying the geography discipline. The themes were published in the *Guidelines for Geographic Education: Elementary and Secondary Schools* as follows: (1) location; (2) place; (3) human–environment interactions; (4) movement; and (5) regions (Gersmehl, 2014; Natoli, 1984). The theme of “location” focuses on absolute and relative location, “place” deals with how physical and human characteristics distinguish and define a place, “human–environment interactions” deal with the relationships between various anthropogenic and environmental elements, “movement” deals with how things move around different locations, and “regions” deals with an area and its unifying characteristics. Within all of these themes, biogeography concepts can be introduced, particularly in the themes of location, place, movement, and regions (Gersmehl, 2014). Although a prior study showed that teachers in Puerto Rico employ some of these concepts (Morales & Cruz-Torres, 2010), there are no geography standards on the island.

### ***Biogeography and social sciences***

The K–12 social studies curriculum prepares students for future college and careers (NCSS, 2017). Therefore, this framework focuses on a set of ideas regarding how students learn concepts relating to the subject. The C3 Framework provides inquiry skills and key concepts to guide curricular content required to support a thorough social studies program for geography alongside history,

economics, and civics. The concept of ecosystems is introduced in this framework (NCSS, 2017), but it is not introduced in a biogeographic context. Biogeography is absent in all areas of the C3 framework. There is insufficient evidence to determine whether schools throughout Puerto Rico employ the C3 framework; however, given its status as a territory of the United States, it may not be uncommon to find schools that use the framework.

In K–12 education in Puerto Rico, geography is introduced in social science standards at various levels. Although concepts from both human and physical geography are included in these standards, biogeography is not explicitly mentioned. However, some standards focus on biodiversity. For example, fifth grade students must describe and compare the biodiversity of the countries in North and South America, and sixth grade students are expected to do the same at a global scale (DE, 2022b). Concepts such as ecosystem and biodiversity are mentioned in the social science standard to a lesser extent than in the science standards. For example, the ecosystem is only part of one standard wherein students must demonstrate, with evidence, the relationship of Puerto Rico with other countries based on concepts such as conflict, cooperation and interdependence, privatization, globalization, dependency, and ecosystem dynamics (DE, 2022b).

### ***Is biogeographer being taught in K-12 education?***

Conducting a search online for references about biogeography education in Puerto Rico did not yield any results. Two online search engines were used: ScienceDirect and Web of Science. The keywords used included: “biogeography” + “Puerto Rico”, “biogeography education”, “biogeography AND education IN Puerto Rico”, among other variations. To obtain a better understanding of the current state of biogeography education on the island, a list of all public and private high schools was compiled. A total of 403 schools were identified between the years 2019–2020. Multiple efforts were made to contact the Social Sciences Department at the Department of Education of Puerto Rico to validate the list during this period without success. Telephone numbers were only available for 50 schools, and all were called to obtain more information. Only 14 had a correct or working number; of these, all confirmed that a geography class was not offered in the school. For the remaining 389 schools, an email or fax was sent to obtain data (Table 1). Only three schools confirmed that they offered a geography class, with all confirming that their current curriculum does not include a specific section about biogeography. All three schools reported that the absence of biogeography in the curriculum is due to time limitations: “it is too much material to cover for such a broad discipline in one school semester”, as noted by one geography teacher.

**Table 1.** Outreach to schools and outcomes.

<b>Available/attempted contact methods</b>	<b>Number of schools</b>	<b>Responses</b>	<b>Geography class(es) offered</b>
Telephone call	14	0	
Successful fax	128	8	
Successful fax followed by email	8	2	2
Unsuccessful fax	184	0	
Unsuccessful fax followed by email	12	0	
No fax available	31	0	
No fax available; email sent	11	0	1
No information available; no outreach	15	0	
<b>Total</b>	<b>403</b>	<b>10</b>	<b>3</b>

### ***Biogeography in higher education***

Of the top higher education universities, the University of Puerto Rico and Interamerican University offer biogeography classes. As of the writing of this paper, the main University of Puerto Rico campus in Río Piedras offers an introductory undergraduate class in biogeography while other campuses, such as that in Mayagüez, have four advanced graduate-level classes: graduate-level biogeography, phytogeography, zoogeography, and marine zoogeography. The Interamerican University offers two graduate-level classes: biogeography and island biogeography. Other major institutions offer classes that may incorporate biogeographic concepts (Appendix A).

The information discussed herein was obtained using the class description and/or syllabus, if available online. Hence, our data should not be considered a definitive list of all classes that teach biogeographic concepts at universities in Puerto Rico. As Millington et al. (2011) concluded, most of the work in biogeography comes from biology departments and research centers. This is evident in Puerto Rico with the distribution of classes offered at the major universities.

### **Recommendations**

Although biogeography continues to gain interest, there remains scope for increasing emphasis on the field in Puerto Rico. In K–12 education, there is a clear gap indicated by the lack of a mandatory geography class. In addition to not having a required or guaranteed available geography class, there are no geography educational standards. If high schools continue to teach or further implement



“Geography for Life” courses, clear standards are required for teachers to establish useful and effective expectations with students with clear course objectives. Education standards must focus on various aspects of geography beyond maps. Geography includes a wide variety of topics, including biogeography. Therefore, it is important to establish standards that capture most, if not all, of its various subdisciplines.

Implementing the standards set in the United States is a good start; however, Puerto Rican schools require standards that fit the unique needs of the island’s education system. Some of the standards detailed previously were created based on the needs of students in the United States, which may differ from the needs of those in Puerto Rico. An assessment of Puerto Rican students’ geography knowledge is expected to be useful for developing a baseline from which geography standards can be developed.

### ***Proposed island biogeography curriculum***

It is recommended that a set of six lessons divided into four major topics are created to incorporate biogeography concepts into classrooms. Considering best practices and techniques used in field studies and applying existing standards for biogeography, the following curriculum is advised to address four topics in biogeography: (1) introduction to biogeography and island biogeography; (2) island theory and conservation; (3) island issues and human impacts; and (4) applications and techniques in biogeography.

Each topic was carefully selected to provide a sound foundation of major aspects of biogeography applied to island environments because Puerto Rico is a small archipelago. Classroom activities should culminate in a field experience. If the field experience is not feasible, the teacher should devise an alternate project. The proposed curriculum is based on the United States’ National Standards for Geography (Table 2).

**Table 2.** National Geography Standards covered in each topic of the proposed curriculum.

Topic	Geography Standard				
	1 <sup>1</sup>	8 <sup>2</sup>	14 <sup>3</sup>	16 <sup>4</sup>	18 <sup>5</sup>
1. Introduction to Biogeography and Island Biogeography	X	X			X
2. Island Theory and Conservation	X	X		X	X
3. Island Issues and Human Impacts	X	X	X		
4. Applications and Techniques in Biogeography	X	X			X

A detailed description of the proposed curriculum is divided into the following topics:

TOPIC 1 - Introduction to Biogeography and Island Biogeography. This topic addresses the history of the discipline and introduces biogeography and island biogeography subtopics. In this lesson, students are presented with biogeography subfields and are challenged to identify with scenarios in which they could be applied. For example, if the class is discussing island biogeography, students can investigate why Hawaii has a greater variety of habitat heterogeneity for the *coquí* (small native frog) than Puerto Rico. As another example, because biogeography studies distribution patterns of biodiversity, the class can engage with this topic by analyzing why marsupials are only found in Australia or why orange tree species are more abundant in tropical rainforest than in continental environments.

The second lesson in Topic 1 provides basic concepts in biogeography, such as the Theory of Natural Selection, and introduces student to essential vocabulary, such as “ecosystem,” “community,” “biome,” and “biodiversity.” Students use the Map of Life (MOL) an online mapping and visualization resource (<https://mol.org/>) to analyze the distribution of a specific species.

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<sup>1</sup> Geography Standard 1: How to use maps and other geographic representations, geospatial thinking to understand and communicate information.

<sup>2</sup> Geography Standard 8: Characteristics and spatial distribution of ecosystems and biomes on Earth’s surface.

<sup>3</sup> Geography Standard 14: How human actions modify the physical environment.

<sup>4</sup> Geography Standard 16: Changes that occur in the meaning, use, distribution, and importance of resources.

<sup>5</sup> Geography Standard 18: How to apply geography to interpret the present and plan for the future.

TOPIC 2 – Island Theory and Conservation. The Island Theory is introduced, and conservation biogeography is described. Students perform two activities to better understand these concepts (lessons three and four). In lesson three, students are paired and play a simulation game to introduce new species to an island. The game leads them to understanding the balance of migration and extension. In lesson four, students are asked to identify conservation needs for specific marine environments.

TOPIC 3 –Island Issues and Human Impacts. Students explore the impact of human activities on island biogeography. In lesson five, the students analyze real-world case studies of human interactions with ecosystems, identify how humans affect ecosystems, and predict future impacts due to these interactions.

TOPIC 4 – Applications and Techniques in Biogeography. In lesson six, the class focuses on techniques and application in biogeography. Considering that one of the most common research methods is the phylogenetic method, students are introduced to related techniques by which researchers obtain data on a species' evolution to correlate changes in two or more of its genetic traits. Other methods for collecting data are discussed, including geospatial tools such as remote sensing and geographic information systems, which allow biogeographers to gather live data for modeling and analysis. Field work is introduced as a fundamental part of geographic research to provide more accurate data. Field work methods, such as animal tagging by biogeographers to track them or plant measurement to obtain flora data, are introduced. These techniques are discussed in relation to addressing conservation issues including the development of species recovery plans, which describes protocols needed to protect a specific endangered species population.

Capstone Project - After completing the unit, students are expected to be prepared to participate in a citizen science project in which they can apply the knowledge and skills addressed to a local environmental need. A citizen science project is recommended as the concluding project. However, if such project is not available or cannot be created, an alternative could be to create a species recovery plan for an endangered or endemic species of the island or develop a species distribution model using open-source tools.

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### **References**

Cox, C. B., P. D. Moore, & R. J. Ladle. (2016). *Biogeography: An ecological and evolutionary approach, 9th ed.* Wiley-Blackwell.

- Crisci, J. V., L. Katinas, & P. Posadas. (2000). *Introducción a la Teoría y Práctica de la Biogeografía Histórica*. Sociedad Argentina de Botánica.
- Cruz-Baez, A. D., C. J. Guilbe, & A. R. Lopez. (2002). *Vive la Geografía de Nuestro Puerto Rico*. San Juan: Editorial cordillera.
- Department of Education of Puerto Rico (DE) (2022a) *Science Program*. <https://de.pr.gov/ciencias/>.
- Department of Education of Puerto Rico (DE) (2022b) *Social Studies Program*. <https://de.pr.gov/estudios-sociales/>.
- Edwards, K. G. (1964). The importance of biogeography. *Geography*, 49, 85–97.
- Erkens, R. (2013). On why we should teach biogeography and the need for a biogeography compendium. *Frontiers of Biogeography*, 5, 84–7. doi:[10.21425/F5FBG18580](https://doi.org/10.21425/F5FBG18580).
- Erkens, R. (2018). Sharing good practices for teaching biogeography. *Frontiers of Biogeography*, 10, e37652. doi:[10.21425/F5101-237652](https://doi.org/10.21425/F5101-237652).
- Gersmehl, P. (2014). *Teaching geography*. The Guilford Press.
- Kafanov, A. I. (2009). Biogeography: Geography or biology? *Zhurnal Obshchei Biologii*, 70, 56–65.
- Heffron, S. and R. Downs. 2012. *Geography for life: National geography standards, second edition*. Washington, DC: National Geographic Society.
- Kupfer, J. A. (1995). Landscape ecology and biogeography. *Progress in Physical Geography: Earth and Environment*, 19, 18–34. doi:[10.1177/030913339501900102](https://doi.org/10.1177/030913339501900102).
- Ladle, R. J. (2008). Catching fairies and the public representation of biogeography. *Journal of Biogeography*, 35, 388–391. doi:[10.1111/j.1365-2699.2007.01877.x](https://doi.org/10.1111/j.1365-2699.2007.01877.x).
- Lead States, N.G.S.S. (2013). *Next generation science standards: For states, by states*. The National Academies Press.
- Lomolino, M. V. (2018). On Teaching “...That grand subject,...”. *Frontiers of Biogeography*, 10, 1–3. doi:[10.21425/F5FBG37812](https://doi.org/10.21425/F5FBG37812).
- Millington, A. C., M. A. Blumler, & U. Schickhoff. (2011). Situating contemporary biogeography. In A. C. Millington, M. A. Blumler, & U. Schickhoff (Eds.), *The SAGE handbook of biogeography* (pp. 1–18). SAGE Publications Ltd.
- Monge-Nájera, J. (2008). Ecological biogeography: A review with emphasis on conservation and the neutral model. *Gayana*, 72, 102–112, 148.
- Morales, C. A., & Y. Cruz-Torres. 2010. Geography education in Puerto Rico: Academic achievement of the five themes of geography based on student gender and teaching effectiveness of high school geography educators, 17 April. Vol. 17, *Annual Meeting of the Association of American Geographers*. Washington, D.C.

National Council for the Social Studies (NCSS). (2017). *The college, career, and Civic life (C3) framework for social studies state standards: Guidance for enhancing the rigor of K-12 civics, economics, geography, and history*. <https://www.socialstudies.org/user/login?destination=/sites/default/files/c3/>.

Natoli, S. 1984. *Guidelines for geographic education*. Joint Committee on Geographic Education. Indiana, PA and Washington, DC: National Council for Geographic Education and the Association of American Geographers.

Posadas, P., J. V. Crisci, & L. Katinas. (2006). Historical biogeography: A review of its basic concepts and critical issues. *Journal of Arid Environments*, 66, 389–403. doi:[10.1016/j.jaridenv.2006.01.004](https://doi.org/10.1016/j.jaridenv.2006.01.004).

Posadas, P., & M. Donato. (2007). Everything you always wanted to know about historical biogeography but were afraid to ask: A preliminary overview based on papers published in journal of biogeography 2005–2006. *Biogeografia*, 2, 26–31.

Warren, D. L., M. Cardillo, D. F. Rosauer, & D. I. Bolnick. (2014). Mistaking geography for biology: Inferring processes from species distributions. *Trends in Ecology and Evolution*, 29, 572–80. doi:[10.1016/j.tree.2014.08.003](https://doi.org/10.1016/j.tree.2014.08.003).

Watts, D. (1978). The new biogeography and its niche in physical geography. *Geography*, 63, 324–37.

Whittaker, R. J. (1998). *Island biogeography: Ecology, evolution, and conservation*. Oxford.

Wilhelm Jr., E. J. (1968). The role of biogeography in education. *Journal of Geography*, 67, 526–9. doi:[10.1080/00221346808981003](https://doi.org/10.1080/00221346808981003).

**Appendix A. List of classes in higher education institutions in Puerto Rico.**

Examples of biogeography classes and classes with some biogeographic concepts offered in higher education institutions in Puerto Rico. Classes on biogeographic concepts were selected based on online course descriptions, syllabi, or class websites. For this analysis, we only evaluated the top higher education institutions in Puerto Rico.

Class name	Institution	Department	Concept(s) covered
Tropical Ecosystems	Ana G. Méndez University	Environmental Planning	Geographical distribution
Island Biogeography	Interamerican University	Biology	Biogeography
Evolution			Biogeography
Biogeography			Biogeography

<b>Class name</b>	<b>Institution</b>	<b>Department</b>	<b>Concept(s) covered</b>	
Introduction to Oceanic Sciences		Geography	Marine biology	
The Arctic and Circumpolar Lands			Circumpolar biodiversity	
Marine Biology			Marine biodiversity and distribution	
Biodiversity and Conservation	Turabo University (Ana G. Méndez University System)	Biology	Island biogeography, conservation biogeography	
Biology of Birds			Biogeography	
Biogeography			Biogeography	
Phytogeography			Biogeography	
Zoogeography			Biogeography	
Terrestrial and Fluvial Invertebrates of Puerto Rico			Biogeography	
Introduction to Ecology			Biology	Species populations, ecosystems, communities, island biogeography
Marine Biology	University of Puerto Rico	Biodiversity distribution and ecology		
Tropical Ecology		Distribution of tropical ecosystems		
Large-scale Ecology		Geography of ecosystems		
Marine Ecosystems of Puerto Rico		Marine ecosystems		
Marine Ecology		Biology / Marine Sciences		Marine species and ecosystems

Class name	Institution	Department	Concept(s) covered
Land and Water Resources of Puerto Rico, their Management and Maintenance		Environmental Sciences	Aquatic ecosystems
Ecology and Sustainable Urbanism		General Education	Landscape ecology, ecosystems, biodiversity
Ecosystems and Biodiversity			Species richness, ecosystems, biodiversity
Introduction to Biogeography		Geography	Biogeography
Marine Geography			Coastal ecosystems
Ecology and Zoogeography of Coral Reefs		Marine Sciences	Geographical distribution
Marine Biogeography			Biogeography
Environmental Science	University of the East (Ana G. Méndez University System)	Biology	Ecosystems and biodiversity
Ecology	University of the Sacred Heart	Geography	Ecosystems, biogeography

**Dr. Carlos A. Morales-Ramírez** ([cmorales-ramirez@wcupa.edu](mailto:cmorales-ramirez@wcupa.edu)) has taught in-person and online courses in World Geography, Human Geography, Sustainable Living, Mapping and Remote Sensing, Geospatial Technologies and Analytics, Geographic Information Systems, and Social Sciences, in Spanish and English, at various universities. His research interests is in geography education, with a focus on biogeography curriculum. Dr. Morales-Ramírez is currently a doctoral student of Education Policy, Planning, and Administration at West Chester University.