



Center for International Programs and Sustainability Studies

Course Title: Freshwater Ecology

Course code: ENV 3170

Total contact hours: 60

Prerequisites: Basic concepts in biology preferred

COURSE DESCRIPTION

Water is a vital resource for human beings, but it is a limited resource that has been degraded and the demand for this resource is growing. Freshwater ecology, also known as limnology, is a course to help us understand the physical, chemical and biological properties of inland aquatic environments (wetlands, lakes, rivers, mangroves, and reservoirs). It aims to give emphasis to the problems and conservation efforts for water resources, for that we will learn methods for monitoring aquatic environments with field trips and laboratory work.

COURSE PRE-REQUISITES

For this course it is recommended to have taken general biology, however it is not an essential requirement.

CLOTHING AND FOOTWEAR REQUIREMENTS

Please, take into account the following information:

- o This is an environmental science course.

- Field work may include long walks, long boat rides and snorkeling activities. Although many places in the country have allowed us to find suitable accommodations, many of the volunteer work stations or research areas require rustic accommodations.
- Water shoes, Velcro sandals or tennis shoes that you can wet, are necessary for intertidal zone exploration.
- Personal field notebook is required for the field trips
- Rain jackets are important on field trips.

AUDIENCE

This course is structured for international students attending the Study Abroad Program at an LCI Education university campus. However, courses are not exclusive to foreigners so local degree-seeking students may enroll in this course. Some of the courses are also taught in Spanish as part of our Bachelor's in Sustainability Management or Business Administration programs.

This is a theoretical-practical course and explores/responds to the following inquiry according to the professional/disciplinary profile:

What are the optimal ecological characteristics of different freshwater water bodies?

How humans altered the water characteristics and what techniques are used to monitor the water quality?

How to apply this knowledge in carrying out daily actions and propose future solutions that help with the conservation and improvement of freshwater systems?

In order to respond this question, we will study the following generative topics:

- Chemical, biochemical and physical processes that occur in aquatic environments.
- Characteristics of the main tropical freshwater ecosystems.
- Methods for monitoring aquatic environments.
- Main problems affecting the aquatic environments.

- Main solutions to increase water quality.

Along the course, the following **skills** will be fostered:

- Ability to identify the main physical and chemical characteristics of the tropical freshwater environments and relate them with the organisms that live within.
- Ability to identify the main characteristics of the main tropical freshwater bodies with emphasis in Costa Rica.
- Ability to identify communities and keystone species that live in each of the studied freshwater ecosystems.
- Ability to recognize the main threats freshwater systems confront and adopt daily action to counteract or minimize our impact.
- Ability to recognize the main methods for monitoring the freshwater ecosystems.

Among the **values** and **attitudes** that will be promoted among students are the following:

- Systemic thinking.
- Logical and communicative intelligence.
- Interest in solving problems.
- Interest in learning to learn.
- Connect well with others.
- In-depth listening.

COMPETENCIES, CRITERIA AND EVIDENCE

The competencies for the Veritas University are reflexive and integral actions that respond to the professional profile and to the problems of the context, with suitability and ethical commitment, integrating the know-how, and the knowledge to know in a perspective of improvement.

Below are both the disciplinary and general competencies, linked to their criteria and evidence of performance for this course.

Competencies	Key competences	Learning Assessments
Recognizes the main characteristics of the tropical freshwater ecosystems with emphasis in Costa Rica, considering the factors that affect their quality, learning methods of water monitoring to promote their conservation.	Characterizes freshwater ecosystems according with their biotic and abiotic factors.	Lab 1, 2, 3 Field trips Class discussion Reading analysis Presentation on selected topics and websites Class project
	Identify the main tropical aquatic ecosystems and the methods to analyze the water quality of each ecosystem.	Field trips Class discussion Debate Reading analysis Class project
Integrates knowledge, skills and attitudes to learn continuously and through one's life pursuing an efficient development in the knowledge-based society	Learning to learn.	Presentation on selected topic and website Field trips Reading analysis Debate
Builds the necessary knowledge, skills and attitudes to learn how to communicate orally and in written form in the different disciplines that make up the	Communicate thoughts of the discipline orally, in an iconic way, and in written form.	Presentation on selected topic and website Field trips Restoration project Debate Class discussion

curriculum.		
Integrates the necessary knowledge, skills, and attitudes to learn teamwork and leadership techniques	Execute teamwork and leadership.	Field trips Lab 1, 2 3 Debate
Integrates the necessary knowledge, skills and attitudes to learn interpersonal communication techniques	Relate well to others, manage and solve conflicts, negotiate reliably and empathetically, speak responsibly, Listen attentively	Field trips Lab 1, 2, Class discussion Debate

COURSE CONTENTS

Topic 1. Introduction to the aquatic environment.

- Introduction.
- Definition of limnology.
- Ecosystems included in the course.
- Importance of the aquatic environment.

Topic 2. Physical and chemical water properties.

- The water molecule.
- Water Color.
- Temperature.
- Sedimentation.
- Water density and viscosity.
- Surface tension.
- Heat distribution in temperate lakes vr. Tropical lakes.
- Oxygen and CO₂ in the water.

- pH.
- Methods to measure the physical and chemical water properties.
- Nitrogen and phosphorus cycle.

Topic 3. Water as an ecosystem.

- Photosynthesis.
- Respiration.
- Food webs.
- Nutrients.
- Symbiosis.
- Ecological succession.
- Definitions of the main communities in the aquatic environments.

Topic 4. Rivers.

- River's origin.
- Currents classification.
- Movement.
- Parameter to study rivers
- River's communities.
- Adaptation of organisms to lotic environments.
- Aquatic macroinvertebrates in streams.
- The role of vertebrates.
- Aquaculture and fish trade.

Topic 5. Mangroves

- Classification.
- Salinity.
- Productivity.
- Communities.
- Importance.

Topic 6. Lakes and reservoirs.

- Classification of lakes according with the origin.
- Costa Rican lakes.
- Lakes zones.
- Lake's 'communities.
- Adaptation of organisms to lentic environments.
- Parameter to study lakes.
- Reservoirs characteristics.
- Ecological problems related with reservoirs.
- Reservoir ecology.
- Plankton ecology in lakes.

Topic 7. Water quality

- Water pollution.
- Important parameters to measure water quality.
- Biological indicators of water quality.
- Biological index.
- Macroinvertebrates.

Topic 8. Water conservation

- How to protect the water.
- Global water conservation.
- Regional and local water conservation.
- Restoration of aquatic ecosystems.

METHODOLOGY

The course will be taught through a combination of lecture, discussions, labs sessions and research projects with the intervention of both the students and the teacher. We will use

Limnology textbooks and scientific journals as our main source of knowledge. Movies, online videos and news as complementary sources.

The lab sessions consist in 3 practices where students will apply the information provided in class to develop a report. The first lab is about the physical characteristics of water, where the students will use fish tanks to demonstrate how these conditions change. The second lab is about the chemical characteristics of water and they change according to external factors. The third one is about organisms in freshwater environments, more specifically plankton and benthos.

During the course students will participate in one or two field trips where they will have the opportunity to visualize the information learned in class and report their findings in a written form.

In this course students will be responsible for their own learning, so it is expected that the students bring their own questions, find their own answers and share all the newly built information with the rest of the class. The teacher will be a facilitator of information and techniques.

EDUCATIONAL RESOURCES

In order to guarantee good development of the course, therefore to guarantee learning, the following resources are available: an updated bibliographic database, multimedia equipment that students can use for their individual presentations; whiteboards readings provided by the educator. All of these complement the suggested projects and provide the students with higher possibilities of knowledge on their own ship. Most of the lessons will take place in the classroom. During independent work periods students will be able to attend the institution. A campus library, study rooms, and computer labs are available for the students' independent work time. Free Wi-Fi connection for students, educators, and staff is provided on campus, which gives students the possibility to work not only in the library or computer labs, but also around campus.

For specific lessons and field trips students will have access to specific equipment from the school or rented), like snorkeling equipment, rubber boots, microscope and sensors. Students must be careful with the equipment and be sure to return everything to the professor after use.

LEARNING ASSESSMENT

Evaluation compiles and evaluates evidence by taking into account feedback providing pre-established criteria. The course evaluation must be aligned with the competencies and the teaching methodology. There is a rubric for each evaluation resource, and the details will be provided in **CANVAS LMS**. Even though the rubric grants a grade, it is also a quantitative and qualitative description of the students' performance. The rubrics include the core and discipline key competences.

ASSIGNMENTS	PERCENTAGE VALUE
Presentation on selected topic and website	25%
Class activities 1. Practice 1: Physical characteristics of water 2. Practice 2: Chemical characteristics of water 3. Practice 3: Plankton and Benthos	10% 10% 10%
Projects 1. Class project on Mangroves	15%
Field trip report	30%
Forum: Current news in marine biology.	10%

LEARNING STRATEGIES AND RUBRICS

The following learning strategies will be developed:

1. Presentation on selected topic.

Students will choose a topic from the below list (or propose a new one) in order to present an oral Bibliographic Revision.

This presentation should include new, scientific information about the topic, also studies and data.

1.1 Requirements:

- The topic should be specific
- Students should select the topic on the second day of classes.
- The topic should be explained in general way first, then more specific and later present some study cases
- Students have to do a PowerPoint or a presentation in another format
- Oral presentations should not exceed 20 minutes of exposition plus 5 minutes for questions (30 minutes total).
- Students have to create a game activity related to the topic for the end of the presentation. Where everybody in the class will participate
- At least 5 scientific references should be used and cited (internet sources are not considered scientific references) but they may be included within this list as well
- The recommended order of the presentation is:
 1. Title and participants
 2. Objectives
 3. Introduction
 4. Specific information about the topic
 5. Study cases
 6. Conclusions
 7. References

1.2 Ideas for Class presentation:

- Invasive species in freshwater, specific case studies.
- Water quality and human parasites, specific case studies
- Water pollution and monocultures, specific case studies
- Extinction in freshwater, specific case studies
- Water scarcity and gender
- Water access and diseases
- Natural history of a specific freshwater species
- Camouflage strategies in freshwater ecosystems
- How to survive in intermittent water bodies
- How we are dealing with freshwater scarcity
- Role of freshwater vertebrates, what limnologist don't see

*** You can propose a new one related with our major, your interests, your experience or your curiosity

2. Laboratories:

a. Laboratory 1: For this laboratory session, students will recreate thermoclines and haloclines using fish tanks and petri dishes. Also, students will demonstrate the variation in seasonal temperatures between a tropical lake and a temperate lake. Students will have access to a laboratory manual with detailed instructions about the procedure, the format and information required for the report.

b. Laboratory 2: In this laboratory session students will analyze chemical water parameters: Oxygen level, pH, nitrates, phosphates and conductivity using water from different sources. Students will also learn to use the equipment that will be later used in

field trips. Students will have access to a laboratory manual with detailed instructions about the procedure, the format and information required for the report.

c. Laboratory 3: For this laboratory session we will visit a local lake and collect samples of plankton and benthos. We will bring the samples to the lab and analyze the organisms collected using the microscope. Students will be observed and draw preserved samples of microalgae. Students will also learn to use the equipment that will be later used in field trips. Students will have access to a laboratory manual with detailed instructions about the procedure, the format and information required for the report.

3. Class project

Identification guide: The students will create an identification guide related with aquatic organism. Students will create a digital version, and once that it is checked by the professor will print it in the shape of field plates.

4. Field trips:

Field trips give students the opportunity to observe the ecosystems and organisms studied in class, to question their own observations and have a real picture of the ecological and social reality of marine ecosystems and their surroundings. Field trips are assessed as reports and students can work in groups of 2 or 3 students. Each report should have an introduction, a methodology, results and discussion. It requires bibliography. The location and day of the field trip depends on the weather, ecological and/or budget conditions, in the same way, the specific information that is required in the field trip report can change depending on the location. Specific instructions will be provided before the field trip.

Important:

- Lodging and main meals are covered by the course.
- Participants must be fully enrolled in this course and no guests are allowed.
- Students must be on time for all field trip activities including departure from places and pre-scheduled mealtimes.

ATTENDANCE**Regarding classes:**

1. Students are only allowed a two (2) **non-consecutive (back-to-back) class absences**. A student shall fail the course if more than two absences are registered by the professor. Administration does not control attendance.
2. Three **late arrivals** to class (arrival after the first 15 minutes) are treated as one absence. Attending class 30 minutes late without an official justification will also count as an absence.
3. In the case of an **absence from any assignment evaluated in class** (presentations, evaluations, field trips, etc.) a student will be given a grade of zero unless an official document is presented within **one week** of the absence.
4. If a student presents an official document to excuse the absence, the missed assignment is to be presented on that same day.

Regarding field trips:

5. An unjustified **absence on a field trip** will immediately result in the loss of all points assigned to that specific trip. However, if an official document justifying the absence is presented, 50% of the assignment points may be obtained upon presentation of a complementary research assignment, to be agreed upon with the professor, within

one week of the field trip.

6. An absence on a field trip may be justified should two course field trips coincide. In such a case, and to avoid losing points, students shall be able to opt for carrying out a research assignment.

CODE OF CONDUCT

Professors have the right to expel a student from the classroom should he / she/ they:

1. Be disruptive in the classroom.
2. Behave in a disrespectful way.
3. Be under the influence of alcohol.
4. Be under the influence of any illegal drug.
5. Shows hygiene or odor problems that may disturb other students.

ELECTRONIC DEVICES

The use of cell phones, smartphones, or other mobile communication devices is disruptive and is therefore prohibited during class. **Please turn all devices OFF and put them away** when class begins. Devices may be used only when the professor assigns a specific activity and allows the use of devices for internet search or recording. Those who fail to comply with the rule must leave the classroom for the remainder of the class period. Using devices while the professor or other peers are lecturing, or presenting is perceived as a lack of interest and disrespectful.

STUDY ABROAD PROGRAM POLICIES

The student must comply with the provisions of the Study Abroad Program Policies available on the Canvas/Omnivox platform.

BIBLIOGRAPHY

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Merrit, R., Cummins, K. (1996). An introduction to the Aquatic Insects of North America. Kendall Hunt Publishing. Iowa. 862 p.

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Wetzel, R.G (2001). Limnology. Lake and River Ecosystems. 3 ed. Academic Press. 1006 p

Note: Scientific papers, news and book chapter can be assigned during the course

CHRONOGRAM

Session	Sub competency	Contents	Learning strategies
1	Characterizes freshwater ecosystems according with their biotic and abiotic factors	Topic 1: Introduction to aquatic environments, important definitions in freshwater ecology and understand the importance of freshwater	Professor's exposition Syllabus discussion Brainstorm activity about ocean characteristics
		Topic 2. Physical and chemical water properties: Water color, temperature, sedimentation, water density, surface tension	Reading discussion Professor exposition Video analysis
		Topic 2: Physical and chemical water properties: heat distribution in temperate lakes vs. Tropical lakes	Lab 1: Physical characteristics of water
2		Topic 2: Physical and chemical water properties: heat distribution in temperate lakes vs. Tropical lakes	Lab 1: Physical characteristics of water

		Topic 2. Physical and chemical water properties: Oxygen and CO2 in water, pH Nitrogen and phosphorus	Professor's exposition Video analysis
3		Topic 2. Physical and chemical water properties: Using instrument to analyze water characteristics	Lab 2: Chemical characteristics of water
		Topic 3. Water as an ecosystem: Photosynthesis, respiration, aquatic food webs and symbiotic interactions	Reading discussion Students presentations
4	Identify the main tropical aquatic ecosystems and the methods to analyze the water quality of each ecosystem	Topic 4: Rivers. Origin, classification, movements, parameters to study rivers, communities, adaptations and the role of aquatic insects	Professor's exposition Student presentation: River restoration
		Topic 4: Rivers. The role of vertebrates	Field trip 1 Analysis

		Topic 4 River. Aquaculture and invasive species	Class debate
5		Topic 5. Mangroves. Classification, salinity, productivity, communities and importance	Professor's exposition Student presentation: Mangrove restoration
		Topic 6. Water quality Understand how water quality can be affected and how to quantify the damage	Professor's exposition
6		Topic 6. Water quality The use of macroinvertebrates to analyze water quality	Professor's exposition
		Topic 6. Water quality Analyze water quality	Field tip 2 data analysis
		Topic 6: Water quality Analyze water quality	Field tip 2 data analysis

7		Topic 7: Lakes and reservoirs Classification of lakes. Lakes 'zones, communities, parameters to study lakes, paleolimnology	Professor's exposition Student presentation: Lake restoration
		Topic 7: Lakes and reservoirs: Reservoir characteristics, reservoir ecology, ecological problems related with reservoirs	Professor exposition Student class activities
8		Topic 7: Lakes and reservoirs: Plankton ecology in lakes	Lab 3: Plankton and benthos
	Apply the concepts learned in class to identify how to preserve the aquatic ecosystems	Students presentations	Student presentations
Topic 8: Water conservation: How-to protect water			
Topic 8: Water conservation: How-to protect water			
10		Final conclusions	Grades