SCIENCE TEACHER LEARNING FOR IMAGINATION AND SUSTAINABILITY

EPI·STEM-HEA CPD RESOURCE INITIATIVE

ECOLOGY- A STUDY OF THE RELATIONSHIP BETWEEN ORGANISMS AND THEIR ENVIRONMENT

GERALDINE MOONEY SIMMIE, MARTHA COSGRAVE & TARA E. RYAN

EPI•STEM research-led design team includes Geraldine Mooney Simmie, Niamh O'Meara, Merrilyn Goos, Stephen Comiskey, Ciara Lane, Tracey O'Connell, Vo Van De, Tara E. Ryan, Martina Scully, Jack Nealon, Daniel Casey, Martina Ryan, Keith Kennedy, Annette Forster, Céren O'Connell, Martha Cosgrave, Veronica Ryan and Gemma Henstock

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Contact: Helen Fitzgerald, Senior Executive Administrator:
helen.fitzgerald@ul.ie

UNIVERSITY OF LIMERICK OLLSCOIL LUIMNIGH
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FOREWORD

We designed this series of online Continuing Professional Development (CPD) resources for science teachers, taking a learner centred approach to active pedagogies, beginning with the need for a sound educational rationale for teaching science content knowledge to young people. Our aim is to support science teacher learning by releasing imagination and paying attention to a growing critical awareness, what Maxine Greene called 'wide-awakeness', supporting and interrogating sustainability for the future of humanity, the environment, and the planet.

The process undertaken included paying attention to several key aspects mentioned in the constantly evolving knowledge base about teaching and teacher learning in the research literature, including paying attention to prior learning, the upskilling of teachers in scientific concepts and content knowledge and teachers' adoption of a reflective practice. As a dedicated research-led team in EPI·STEM National Centre for STEM Education at the School of Education in the University of Limerick, we drew from an existing reservoir of mathematics CPD resources for the *Professional Diploma in Mathematics for Teaching* (PDMT), and related research in science education in order to provide teachers with suggestions and new SMART (ICT-enhanced) approaches for deep learning, inspiring curiosity, motivating collaborative inquiry and supporting students' capacities for affirmative and ethical critique of *Contemporary Social, Scientific and Technological* issues.

The online CPD resources will provide science teachers with a wealth of up-to-date ideas, suggestions and links to additional resources for preparation of classroom materials for a wide number of active pedagogies concerned with engagement with many of the big ideas and concepts in science topics in the Science Curriculum in Ireland, from Junior Cycle, to Transition Year, to Senior Cycle, such as electricity, physics of light, sound and waves, mechanics, photosynthesis, ecology, viruses, chemistry of the atom, electrochemistry, earth and space and laboratory management. Many of the topics in this series of on-line podcasts and booklets were requested by secondary school science teachers in a national survey. Science topics that are increasingly important for improving science literacy across the curriculum for all in a rapidly globalising, diversifying and highly complex scientific and technology world.

The pod-casts that accompany this Ecology resource were designed and narrated by Martha Cosgrave in consultation with the EPI•STEM research and design team. Martha acted as a research and development officer on the project while undertaking her final year UL science education studies at the School of Education.

The podcasts and booklets are designed with your professional development in mind, and to provide you with examples of useful materials and links so that you can inspire your students in using an inquiry-based approach in learning science. You will need to adapt the slides, if you intend to use them in class, bearing in mind your own curriculum guidance in this regard from national policy requirements. We take sole responsibility for any errors or omissions that may have occurred in this publication.

We want to take this opportunity to thank Professor Merrilyn Goos for securing this HEA funded project for EPI•STEM, and to thank the HEA performance fund team for allowing additional

time for the project to be completed due to the Covid-19 pandemic. The EPI·STEM team are responsible for the design, development, and evaluation of these on-line CPD resources for science and mathematics teachers. We trust you will find the resources re-invigorating and we will in contact with you shortly for feedback.

Dr. Geraldine Mooney Simmie
Director EPI•STEM National Centre for STEM Education
School of Education University of Limerick

Limerick: University of Limerick. ISBN: 9781911620501

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INTRODUCTION TO SCIENCE TEACHERS' CPD

In this EPI·STEM-HEA funded project, we focus on scaffolding the upskilling and development of science teachers' content knowledge, for teaching young people science for understanding, and for providing teachers with a rich variety of pedagogical approaches. Science teachers can select from the podcasts whatever they find useful and can continue to inform us how we might develop the pod-casts in ways that better support teachers' efforts at continuing professional development (Mooney Simmie, 2021). In this way, science teachers are invited to select practices what work well, and that support their pedagogical wellbeing, for a reflective practice for deep learning and deep democracy, for engaging students in a reflective journey of critical thinking for themselves, for learning competences associated with co-inquiry and, for developing transferable skills for problem-solving capacities in unfamiliar contexts. We included mention of cross-curricular links that can improve scientific literacies across the curriculum and provide a stimulus for teachers to work with students in ways that open new spaces for critical debates between science and ethics [social, cultural and political], that call on students' capabilities to critically (re)imagine new solutions to contemporary science related issues in their own local environments [e.g. school, home, village] and in the wider society and planet (Mooney Simmie, 2022).

The EPI·STEM-HEA initiative, with its overarching aim to design, develop and evaluate suitable on-line CPD resources for science and mathematics teachers in secondary schools in Ireland arose from the existence of an already rich repository of on-line CPD resources in EPI·STEM arising from Version 1 of the *Professional Diploma in Mathematics for Teaching* [PDMT] programme [2012-2019]. The focus of the PDMT is on upskilling teachers in mathematics content knowledge for teaching, including competence with subject knowledge and with the selection and justification of active mathematics pedagogies necessary to teach the mathematics content knowledge for understanding to a diversity of young people.

This attention to content knowledge and context, teaching to a diversity of young people in engaging and imaginative ways, aligns well with the requirements and mandates found in Irish government policies, in science, and in science teacher professional learning. Policies that can be found in the national STEM policy for Ireland and in the Teaching Council's Policy for Teacher Learning, Cosán the Irish for pathway, with its focus on the teacher as a lifelong learner and reflective practitioner within a framework of teacher led CPD [DES, 2017; Teaching Council, 2016].

The theorisation of models of CPD in the literature, alongside the findings from empirical research studies reveal the contested nature of the CPD construct especially within an understanding of teaching as 'outrageously complex' (Shulman, 1989) and for those for whom education is understood as an aspiration to nurture an inner (soul) life as well as living well with others, and taking responsibility for co-constructing with others the social and material world (Biesta, 2002; Edling & Mooney Simmie, 2020; Goos & Beswick, 2021). This theorisation of models of CPD, and the multifaceted nature of this dynamic construct, is revealed in the leading top-ranking journal in the academy dedicated to the interrogation of CPD from multiple directions, the *Journal of Professional Development*. Papers in the journal interrogate the development of teachers as professionals, as extended learners and as boundary crossers in a variety of cultural contexts and in the highly complex world of today. Recent papers have started a call for a new humanising emphasis for understanding teachers' professional development and learning, for eliciting improvement in practice through pedagogies of vulnerability that foreground the relational and interdependent aspects of learning and teaching.

This call for change in the focus of teacher learning aligns with a recent UNESCO call for a new social contract in relation to education and teaching (UNESCO, 2021). The canon of existing knowledge in relation to learning, and learning theories, continues to develop. New findings from neuroscience reveal the embodied nature of cognition and go on to refute former dualistic notions of the head, hand and heart found in earlier learning theories as they underscore the importance of creating interactive sensory learning environments for young people to learn science (Macrine & Fugate, 2022).

The literature provides an understanding of the dynamic and multifaceted nature of CPD and the requirement for supporting teachers' continuing learning from a variety of directions, for example, formal and informal, within schools and outside of school, and all the time encompassing the personal, professional and ethical political dimensions of teacher learning and development [Desimone, 2009; Mockler, 2022]. There is a discernible new emphasis in the multiple purposes of education today, for living well with self, and with others in a highly complex, scientific and technological world, a world facing a perfect storm of existential crises in relation to climate change, sustainability, inequality and our proven susceptibility to pandemics.

ECOLOGY- A STUDY OF THE RELATIONSHIP BETWEEN ORGANISMS AND THEIR ENVIRONMENT

We designed ten online CPD ecology resources to assist science teachers in their planning and development in relation to teaching young people the topic of ecology for understanding. We want science teachers to take time when teaching to give recognition to the diversity of learners in classrooms and schools so that teachers can work to support deep learning and deep democracy. We want science teachers to develop students' competence in relation to weighing up arguments and including evidence in relation to a growing number of environmental issues that require collective, ethical and political solutions in the public sphere, in local, national and in the wider global world.

Four of the ecology online CPD resources offer support for teachers' professional development in relation to the teaching of learning outcomes connected to the Junior Cycle Ecology Curriculum [1-4], and five of the ecology on-line CPD resources offer support for teaching learning outcomes connected to the Senior Cycle Ecology Curriculum [6-10]. We added one additional CPD resource to provide some new ideas for co-inquiry with students in the Transition Year Science Curriculum [5].

The ecology topics are connected to the Nature of Science learning outcomes for understanding how scientists work, and the important role of ecology in the wider society, for scientific findings that support ethical and political decision-making for the common good of humanity and the planet. Scientists develop hypothesis and test them, they seek to identify patterns and relationships, know how to conduct a reliable study, ensure that the study is ethical and causes no harm. Their research designs always include a detailed plan for the collection and analysis of data, for drawing conclusions from findings and for developing critical thinking and finely tuned observation skills. The high value attached to school-based inquiry and investigations today is based on a desire for young people to learn a transferable set of inquiry-based skills that they can call on, and apply, in unfamiliar contexts.

When learning about ecology, students need to know about the dynamic nature of ecosystems and the way they achieve a harmonious balance between energy and matter for sustainability. The students will need to explain how energy and matter flow through ecosystems, how they can conduct a habitat study and observe at first hand themselves the relationship between adaptations, competition, and interdependence, in and between species, human and non-human, in the physical environment. Inquiry based studies come in different shapes and level of depth. For example, there are confirmatory studies, structured inquiry studies, guided inquiry studies and open inquiry studies.

WHAT IS ECOLOGY ABOUT?

Ecology is a branch of biology that it is concerned with studying the relationships between all living organisms, including humans, and the physical environment. It is concerned with interplays between adaptations, competition, and interdependencies. Ecologists are scientists who do their work in a variety of settings, and in a number of different career pathways [e.g., forestry, marine, agriculture, conservation institutes (e.g. Greenpeace)]. Ecologists bring to their scientific work keen observation and investigative skills, capacities to study in depth all aspects of the webs, food chains and energy flows taking place in natural habitats, within an understanding of the necessary balance between the life and death cycles that take place within ecosystems. This is because energy and matter always flow in an ecosystem in ways that support the law of conservation of energy (i.e. energy in a closed and isolated system is neither created nor destroyed – it can only be converted from one form to another). Ecologists normally experience a sense of accomplishment that comes from working with nature and, at the same time, working in ways where science can often make a difference to conservation of the environment and public interest values.

The study of ecology, as a branch of biology, examines how the different parts of an ecosystem interact with each of the other parts, to form one cohesive functioning habitat. It also can show what goes wrong when some additional factor comes to disturb that ecological balance, through for example the introduction of a new species or the damage caused through human-made pollution and/or climate change. Ecologists exhibit advanced laboratory skills and provide new understandings about how we can all work to protect that delicate balance in the ecosystem. This can improve the students' science literacy on a topic that is increasingly topical in today's world and crucial for sustainability of the planet.

Ecologists work with plants, animals and microbes (e.g. fungi, bacteria) across several levels, the individual, population, community, ecosystem and biosphere and use multiple lenses in their analysis of habitats e.g. interrogating behaviours across large areas, searching for patterns in populations and examining the landscape for spatial distribution. Where ecology studies can make a difference to the world is when they bring new information to many crucial societal debates, issues that can only be resolved through negotiation and involve other aspects of humanity, such as ethics, politics, geography, and culture. Care of the environment, the question of green sources of energy and the need for sustainability across the planet as one giant ecosystem is an ecological topic that is decidedly on the minds of most everyone in the world today. However, none of this is as easy as it sounds, renewable energy sources can themselves have a number of intended, and unintended, negative effects on ecosystems.

The study of ecology started sometime in the 19th century, but grew as a branch of biology from the 1960s onwards, when scientific studies began to reveal the extent of damage done by human intervention in the physical world, through industrialisation and new patterns of urban growth and living as constant consumers, such as, the burning of fossil fuels, the cutting down of rainforests, the introduction of new species across the world and the problems found when there is depletion of certain species from rapidly changing landscapes. What we learn from a study of ecology is the importance of interrelationships and interdependencies between ourselves as humans, and with our increasing need to live well with all organisms in a physical world whose ecological balance and harmony is badly damaged and in urgent need of serious repair. As teachers we can provide our students with the safe spaces, they need to critically debate the current issues as we search together for new imagination and new solutions in the co-construction of a just global world. In the CPD pod casts, we have listed a number of educationally sound reasons for the study of ecology.

PLANNING AND REFLECTING ON TEACHING

Experienced science teachers, have to plan for their teaching and learning, deliver the lessons and organise student experimental work and make space for a reflective practice. How experienced teachers do this advanced professional work of planning, delivery and reflective practice may be different, in certain respects, from the approaches taken by pre-service teachers, and newly qualified teachers but the cycle of preparation, action and reflection still needs to be done, if science teachers are to remain close to the needs of learners, align with national policies and take the necessary steps to reinvigorate, to elicit feedback and stay up-to-speed with the touchstone of research.

What follows therefore in the headings below, are signposts for good teaching rather than hard-and-fast rules and protocols. They mirror many of the suggestions, ideas and resources given to science teachers in the podcasts. It is up to each science teacher to draw from their preferred approach for adapting these resources and for using them in ways that make a difference in the secondary school science classroom. There can be a considerable, and often an invisible, push from students, parents and guardians, school leaders and policymakers for teachers to become delivers of right answers and providers of solutions rather than acting as educators, who invite young people into the world of learning and scholarship and who support and challenge young people to grow and learn in equal measure. This 'agent provocateur' role for the science teacher often slips out-of-sight in a world when measurement and management come more to the fore.

LEARNING OUTCOMES IN THE JUNIOR CYCLE

The first four podcasts are centred on exploring the learning outcomes in relation to Junior Cycle Ecology. Here the teacher is introducing young people to a fascinating and increasingly relevant study of the relationships between organisms, including humans and the environment. Teaching for understanding will require students to learn to know how, through processes of energy flow [e.g. living, decaying and dying] there is a very special balance maintained in a healthy ecosystem. Students will learn about that energy flow, about the interplay between competition and interdependency and what goes wrong when there is a disruption introduced. A disruption that can result in an increase or decrease in the population of species, often due to harmful human-made activities. Our aim here is to introduce students to the realities of the human footprint we are leaving on this planet from a scientific point of view.

Philosophical perspectives

We begin each topic asking ourselves what is our philosophical rationale for teaching this topic. We need a sound philosophical rationale for all of our science teaching, we need to constantly ask ourselves: what is the sound educational rationale for teaching this topic? Once this crucial question becomes second nature, we can try this questioning as an approach with our students. What do Junior Cycle students understand as the sound educational rationale for learning about ecology? It's a question worth asking.

Recognition of Prior-Learning

From the teachings of John Dewey in the 1930s, the importance of student-centred pedagogies took hold (Dewey, 1938). This involves a way of working with students that takes full account of their prior-learning - that recognises and honours that prior learning and uses it as a starting place for new learning. This encourages the students to reflect on their learning, thereby increasing student motivation. Beginning from the lived experience of students' life world supports a humanistic view of teaching that foregrounds the relational nature of learning and the interplay in teaching as a dialogue between the teacher and student for knowledge acquisition [rather than what Freire (1970/2018) called a banking model in the direction of transmission and domestication]. This student centred dialogue Freire called a praxis, to indicate it as a rich interplay between the teacher and student, between theory and practice, between the big ideas and concepts found in the study of science and ecology and the everyday common sense knowledge and lived experiences that students already have and bring to the study.

How might we pay attention to inclusion of students' prior-knowledge in their introduction to the study of ecology? In the pod-cast, we suggest one way you might do this is to invite your students to provide some buzzwords and ideas for a mind-map at the start. Later you can bring this mind-map back into view in order to compare the earlier buzzwords and ideas with what the students have learned. We provide you with a link to interactive software if you'd like to complete this mind-map using an ICT-enhanced learning tool. You can ask questions, such as, what do you already know about the topic of ecology, what have you heard about it, where would you find reliable information about the topic and why do you think ecology has taken on a new importance in the world today?

Active Pedagogies

In this section, we are inviting you to probe with us how to invite interest, motivation, curiosity and passion for ecology, among young people in Junior Cycle, through the use of active and engaged pedagogies that invite students to participate and to learn to reflect, review and critically think for themselves (Mooney Simmie, 2007). In addition to the requirement for clear instruction and teacher talk, there is a need to make space and resources available in the learning environment for opportunities for desk based inquiry, for active student investigations in the science laboratory, for science teacher demonstrations, for the use of technology-enhanced learning tools, such as animations and simulations, and for bringing students on field-trips in the outdoors e.g. for a study of a well-defined habitat as an ecosystem.

Science teachers select the most appropriate combinations of pedagogical approaches for their classroom teaching asking themselves how to spark interest in the big ideas and concepts, definitions, theories, contemporary issues and ways of knowing that students require at this JC level of engagement with the topic of ecology.

A field trip in the outdoors will require a considered amount of preparation beforehand, for the health, safety and wellbeing of all and for collection of samples [in plastic bags and containers] and the use of different tried and tested approaches to investigation (qualitative, quantitative) during the habitat study. This will require preparation of a health and safety checklist in addition to the building of a suitable ecological investigation toolkit [e,g, home-made pooter, soil PhD meter, outdoor thermometer]. Besides learning the skillset normally associated with the scientific method students are learning to observe the interplay between organisms and the environment and the importance of recycling and reusing for sustainability. Through a more hands-on approach to science student engagement and motivation is given a much-needed boost. This can provide the students with a positive learning experience. In the four on-line CPD podcasts for JC ecology, we have given guidance and some resource links to a number of active pedagogies in this regard [see table below}.

Pedagogical approaches	**How?**	**Evaluation**
Prior learning	Use of mind map	Using electronic mind-map with a before and after function allows students chart their learning in greater depth [e.g. see coggle website]
Visual displays	Lists of photos	Design questions that go with the visual plays and find ways for students to state or record their answers
Use of Freyer Method	A 2×2 matrix is used for students to begin to learn definitions as a process: list their definition, the characteristics, give examples and sketch some drawings	This can be assessment in multiple ways and perceives learning of definitions as a process rather than a transmission procedure
Teach for understanding	Requires students active engagement; requires the teacher to be upskilled in the relevant content knowledge and to work with others to develop multiple ways to explicate the topic	Can be assessed using a combination of peer and teacher assessments; make it a topic for a teacher collaborative dialogue, sharing ideas on how to teach aspects of ecology for depth of understanding
Use a field trip to a designated habitat	Pay attention to a checklist of health and safety guidelines Plan the field trip Bring measuring tools for heat, light, Ph scale, and plastic sample bottles	Assess the impact of the field trip from a number of perspectives, including the joy of motivating engaged learning through an investigation in the outdoors, eliciting the curiosity of students, as well as measuring the use of a sound scientific approach to the study e.g. use of scientific reasoning, drawing conclusions from evidence, making hypotheses, taking sources of error into account
Cross-curricular links	You can link a field study of a habitat with maths, geography, ethics and politics. Do the findings from ecology studies result in collective agreements for the greater good of humanity and the planet?	e.g. Mathematics, Geography, Civics, Social and Personal, Politics

Stop and Jot	An approach for student to stop and think first when encountering new words and to give the teacher feedback	This approach can be used by both the teacher in their learning, and in practices with students to develop a reflective habitus in relation to their learning
Student experiment(s)	students grow their own ecosystem in a bottle	e.g. students write a case note telling how they built the ecosystem in the bottle. They take three recordings of their observations at three different timelines. What have they learned from this investigation and how does their case note support what they have learned

Formative assessment

We teach because we want results even if there is not some kind of straightforward relationship between input and output, because we are teaching human beings and not robots (Biesta, 2016). As we foreground the relationship of learning, in the topic of ecology for Junior Cycle students, and give due recognition to the processes of student learning, we want to give students time and space to think for themselves. At the same time, we are called on to report on the impact of our pedagogical approaches, to support our learning practices and to report to colleagues and policymakers.

Throughout the podcasts, we have recommended active pedagogical approaches that lend themselves to a number of formative assessment approaches. Formative approaches help the learner to review and refine their strengths and talents, and to discern their strengths and areas for improvement, through using reflective practices that constantly elicit feedback from others, from peers, teachers, students, and the touchstone of research. This process can lead to an honest and wise self-appraisal.

For example, one approach we suggest for assessing ecology keywords and definitions uses a Keyword Bingo game. The student is given 24 keywords. They need to select 9 keywords from this group and place then into a table to match the nine definitions given [EcologyBingo2.pdf]. It is important to remember that in Ireland, we work in a cultural system that traditionally places high value on student achievement of product and measurable results. Therefore, it is important to persevere when starting to teach using formative assessment approaches and to begin this from the outset with students entering first year. It can be rewarding for teachers, and students, to work collaboratively using a caring and trusting approach of self-improvement that asserts that a big part of learning to succeed at anything is connected to coping with recoveries from experiences of failure and that failing itself can be one useful key to any improvement model. There is no such thing as elusive perfection. Moreover, science teacher learning involves an invitation to interrogate our talents, and to connect with areas that need improving so that our teaching talents can be offered as a valuable contribution in the classroom and to the wider society. Maxine Greene reminds that as teachers our aim is to seek to release the imagination of each individual child and young person and to support affordances for transformative possibility (Greene, 2017).

LEARNING OUTCOMES IN TRANSITION YEAR

In pod-cast number 5, Martha Cosgrave provides science teachers with suggestions for student research and debates that are suitable for a study of ecology in transition year, or for interested students who might like to study any one of these examples for entry to the Young Scientist or similar competition. All four examples show the disturbance caused to an ecosystem when something new is introduced, such as the addition of a new species, the removal of a predator, or the effects of human-made problems, such as overfishing or climate change.

In all cases we are looking at the triangular relation between adaptations, competition and the interruption of former interdependent relations. Each example, provides just enough information for science teachers to start framing an investigation as a scientific inquiry that leads to a debate and/or class discussion that supports students in their efforts to argue with evidence. It gives students an opportunity to combine their values and ethical concerns together with their sound scientific reasoning in the drawing of conclusions and being able to propose new solutions, to show how scientific knowledge coming from ecology, can be used to make a difference to the quality of life for all.

If students are to engage with any one of these topics can we recommend that transition year students spend a number of weeks [rather than days] doing and collecting the research data before they take part in the debate, that they present their findings in a number of different ways [agreed in advance], using diagrams and other visual representations and, they consider making a poster of their findings that can be framed for future use. The debate can take place in front of the same class group, or it can be staged as a debate in front of an audience of first year students or some other class group. The ethical rules for conducting the debate, the speaking times and times for questions, will need to be worked out in advance as a negotiation and with the participants. The use of classroom discussion and debate in relation to contemporary social and technological issues in ecology can support teachers' efforts to improve scientific literacies, across the curriculum, and build students' confidence in making an argument with evidence and with values for a more sustainable world.

The Case of the Leisler Bat and Green Energy

The Leisler Bat is a high flying bat that is a distinctive species in Ireland and is now coming under threat as a population from the increasing number of wind farms. We need wind farms as a source of sustainable energy for Ireland. Wind is a highly attractive source of green sustainable energy for Ireland based on geographical location and weather systems. Students will research and study each side of the argument in depth, the value to Ireland of the Leisler Bat and the value to Ireland of Wind Energy. Taking their understanding of competition, adaptations and interdependencies in each case into account, can the debating teams see beyond an either/or solution, is there any other more pragmatic and workable solution to this problem? And what might the intended and unintended consequences be for Ireland if the Bat population is severely reduced? What predator will increase and what effect might that have?

The Hairy Wood Ant and Sustainability of the Woodland

The hairy wood ant has a very special place in the ecosystem of the woodland in Ireland and its population is declining rapidly. This little insect is considered a keystone species and is important from a number of perspectives, it aerates the soil, disperses seeds and helps in different ways with maintaining the energy balance between life and decay and death in the woodland habitat. Those who are tasked with conservation are deeply concerned with the rapid decline in population from the 1970s to 2002, going from 200 nests to 50 nests. It appears that there have been no new studies completed in the last twenty years. So why haven't we heard much about this insect, what are the intended and unintended consequences of its rapidly declining population in the Irish woodland? What can be done to halt this decline? And what happened in the woodlands of Ireland, since the 1970s that has led to this rapid decrease on such a valuable native species? How can we combat such complex situations in real world settings? Opening students' eyes to such complexity enables us to encourage the younger population towards the need for solutions to complex scientific and ethical issues.

Introducing Biodiversity to the School Garden

A diversity of species in a habitat helps to keep the sweet balance point necessary between the rate of life and death in the habitat to be deemed healthy and functioning. There are a number of ways students can study biodiversity for understanding. You and your school management may have an interest in helping them to use a section of the school grounds for a study of biodiversity. You will need to work out in advance how you need to do this, how students will get involved and care for the plants and what might be the intended and unintended consequences e.g., introducing planters and/or bug hotels.

Increasing Population of Jellyfish in Irish Waters

There are consequences for Ireland in the summer months if the seas around the coast continue to get warmer due to climate change and the waters have less fish due to overfishing. Any rapid expansion of the current number of stinging jellyfish does not sound attractive for our beaches and tourist industry in the summer months. We can encourage students to think about the other industries effected by the climate crisis. Here the predator, the fish is being removed through over-fishing. In addition, the jellyfish has shown enormous capacities for adaptations in a vastly long lifetime of survival and is in a position that it can survive, and possibly thrive, if climate change renders the seas around the coast warmer in the summer months.

Given the six different types of jellyfish mentioned, the description of jellyfish and the types of stings they give, this can become an interesting research investigation for transition year and one to raise the consciousness of young people to the urgent need to find new solutions, not only to overfishing but also for climate change. With the fish as predator noticeably reduced in number (competition is reduced), the jellyfish is getting a rare opportunity to vastly increase in population given that it can adapt well to the warner oceans and seas around the coast caused by climate change.

How might an ecology study of jellyfish in Ireland help map this problem in a way that increases students' science literacy and capacity for arguing with evidence and values? What kinds of solutions might there be to this problem of a story of change in a habitat?

LEARNING OUTCOMES FOR ECOLOGY IN SENIOR CYCLE

The sub-topics, definitions, examples, depth of treatment and connectivity to contemporary issues in *Science, Society and Technology* begin by reconnecting the topic of ecology in senior cycle with the introductory ideas and concepts introduced at Junior Cycle, only this time they focus on key principles and examine in greater depth the relationships between competition, adaptation and inter-dependency in an ecosystem from multiple perspectives such as, the sub-units of ecosystem, biosphere and habit and their environmental factors, depending on whether these factors are terrestrial or aquatic, how energy flows through an ecosystem, how nutrients, such as Carbon and Nitrogen are recycled in a healthy ecosystem, waste management and conservation, role of microorganisms and finally, the lens of ecological populations.

Five podcasts [6-10], consider upskilling science teachers with suitable content in each of these sections that helps support teaching ecology to young people in senior cycle for understanding, as well as providing some relevant resources and hyperlinks for active pedagogies and formative assessment e.g. simulations, visuals, games etc. The use of mind-maps, the Freyer method and flash cards can all help students in recapping the introductory terms and definitions from junior cycle ecology and learning to grasp a sophisticated vocabulary and scientific language for an in-depth study of ecology

Ecosystems, habitats, and environmental factors [podcast #6]

Ecosystems are composed of food chains. The term food web captures the full totality of all the food chains in the system. A typical ecosystem can be described as a rainforest [in Brazil], a temperate forest [in Europe], a desert, a freshwater or marine system. The environmental factors that play out in these ecosystems depend on whether or not the system is terrestrial or aquatic. In the case of a terrestrial ecosystem, such as a forest, the environmental factors are categorised depending on whether they are living factors [biotic e.g., predators]; non-living factors [abiotic e.g., altitude]; weather factors [climate e.g., temperature]; and/or soil factors [edaphic e.g., soil pH]. If we were examining aquatic environmental factors, we would start to examine factors such as waves, light, oxygen concentration, current and salt content. We suggest the use of Venn-diagrams and other visual approaches for students to grasp the various definitions, meanings of terms and their related examples. When student get involved in drawing and using numerous other sensory-motor ways of interactive learning they are developing embodied cognition and improving their understanding and retention of the big ideas and concepts in their learning of science topics and sub-units. Recent research findings from neuroscience point in the direction of the importance of embodied cognition for learning (Macrine & Fugate, 2022).

How energy flows through an ecosystem

In podcast #7, the science teacher is upskilled in key ideas and concepts in relation to the energy flow through an ecosystem. The sun is the primary source of energy for planet Earth and feeding chains can act as a pathway for energy to flow. In this case we examine two systems of flow, the first a straightforward food chain that has a beginning and a definite end point [beyond which the energy expenditure would be too expensive] and the food web, which is made of interlinked combinations of different food chains that join at different nodal points and collectively work in harmony to maintain the balance of energy in the ecosystem.

Energy flows from producers to primary consumers, secondary consumers, tertiary consumers and finally falls toward the decomposers where decay and death bring the cycle around again to the starting position. The sun-plant-grasshopper-rat-snake is an example of a food chain. It ends with the tertiary consumer the snake. Hunting the snake to continue this cycle would require too much energy beyond the 10% flow that is happening in the Food Chain. Good exercises here involve young people being given time to research, to draw and to build models of food chains. A food chain game is provided. Similar exercises can be used to show examples and to invite student to build Food Webs. Pyramids can be used to show the status of the organism in each of the hierarchical layers of a food chain, the size of the organism increasing toward the top and the population number decreasing accordingly. When the diagram seeks to actually represent this population number graphically, we call it a pyramid of numbers (link here to ratio and proportion in mathematics). Although we later see that there are limitations to these schematics for different organisms and their food chains. This can be linked back to models used by students during the junior cycle, we can encourage the students to think about some of the limitations of models used in science. The functional role an organism plays in a community is known as its ecological niche.

Nutrient Recycling

The notion of energy flow in an ecosystem can be seen in podcast #8 by way of the example of the Carbon cycle and the Nitrogen cycle. When studying this section, there is an opportunity to make the cross-curriculum link to aspects of chemistry [elements and compounds], and to the biochemistry involved in proteins and DNA etc. The key point made here by the ecologist is that in a healthy ecosystem, the balance of Carbon and Nitrogen is in a constant state of flow and is not thrown out of balance.

Waste management and conservation

In podcast #9, we examine the question of human impact on ecosystems, with definitions and examples of pollution, conservation and waste management and disposal. Since the industrial revolution in the mid-1980s, growing urbanisation and industrial scale deforestation etc. there are discernible human-made disturbances to the energy flows and balance points in energy flows and nutrient recycling systems across the planet. Scientists provide the data, from the NASA ozone watch etc. to show the depletion of the ozone layer and the effects of climate change that have rendered the sustainability of the planet under serious threat. New solutions are urgently needed and joined up thinking between ethics, science, economy, and politics to bring any agreed solution to fruition and will require the support of all (scientifically literate) citizens.

There are wise conservation practices that can be found across the planet in relation to numerous approaches to keeping the energy flows and the balance points working in harmony in ecosystems and habitats. Waste can be reconverted and made into useful products. One good example of this can be seen in the reconversion of fish waste in a plant in Killybegs, Co. Donegal for the manufacture of chicken and pig feed.

Role of microorganisms

When we speak of organisms, including humans in the study of ecology we are including plants and animals as well as microorganisms, such as bacteria and fungi that can only be seen with the aid of a microscope. Therefore, given that ecology is the study of the relationships between organisms and the physical environment, in podcast #9 we examine the role of microorganisms and how they play substantial and different roles in maintaining energy flows in an ecosystem and can be beneficial as well as harmful.

While the first stage in the treatment of sewage, involves the physical removal of objects through filtering and mechanical screening, the second stage involves a biological process where microorganisms, such as bacteria set about breaking down the organic matter and rendering it less harmful. Other stages remove minerals, and quality assurance checks are done on a consistent basis so that the water that emits from the sewage plant is sufficiently pure to cause no harm. We have included a link to a National Geographic video here to let you see what happens in this process. There is a considerable amount of research and development happening now in large scale sewage plants, for example, seeking to find, and successfully finding some cures for diseases, and working to find new ways of making electricity from human waste. The current buzzwords of reduce, reuse and recycle include a clarion call for us all to work on needing fewer consumable goods in our lives, and recycling and sharing more for the common good of humanity and for restoring the sustainability of the planet.

Drawing from the Lens of Populations

In podcast #10, we draw from the lens of populations to study ecological features and how to teach for better understanding of how ecologists work, and the valuable impact of this work on our lifestyle, community, and the planet. We examine the lens of populations under three headings: some limitations found in the pyramid of numbers, the factors that control populations and the unpredictable variables in relation to population dynamics.

Some limitations to using the schematic drawing of a pyramid of numbers can be seen in certain examples of food chains that defy the usual linear patterns previously seen. We see examples of inverted pyramids of numbers and pyramids of numbers that cannot be drawn to scale because of the vast differentials in number between the species.

We briefly examine four factors that work to control the numerical size of a population – the more usual effects of predation [predatory-prey relation], competition for resources between species, and within species, that eliminate or reduce the availability of resources. In addition, we have the influence of parasitism, where a parasite lives on a host and weakens the organism, rather than killing it as it would in predation. Finally, we see mutuality in a relation of symbiosis, where there are two interlinked species living together and they both gain from the relation. The example of lichen is a good example of a symbiotic relation between an algae and a fungus in the plant world, the fungus gets food and the algae is provided with protein and minerals. The role of gut bacteria in the large intestine of humans is another example of symbiosis, the bacteria get food and shelter, and the human gets access to proper absorption from the gut that supports a healthy alimentary system.

Finally, we briefly discuss the many natural and human-made disruptions that play their part in population dynamics and often result in unexpected and exponential changes. In relation to the sum total of the human population, more than 7 billion people on the planet and rising since 2010, there are a number of predictable, and unpredictable variables that work to reduce and/or to increase this population number. Natural disasters, such as hurricanes and earthquakes work in an unpredictable manner to reduce the size of the population. Many socially constructed and human-made disasters, such as wars, genocides, famines and diseases all result in serious loss of life and reduction in the size of the population. Human interventions, such as contraception work in a different way to reduce the size of the population. The exponential rate of growth of the human population happened in the last two centuries with marked public improvements in nutrition, health and education brought about by a combination of scientifically informed, ethical and political decision making. The question of the size of the human population continues in ecology and in ethics to remain an open question for sustainability of the planet and for ensuring ethical care for the future of humanity.

Appendices

We designed templates based on your needs as experienced science teachers for guidance in relation to planning for teaching and for your continuing professional development work as a learner and reflective practitioner (see Appendix I and II). You can adjust them and let us know how we might make these more teacher-friendly and suited to your personal and professional journey of continuing learning.

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APPENDIX I – CPD TEMPLATE FOR PLANNING FOR TEACHING & TEACHER LEARNING

Class Group:..

Subject Content: ....

Date: ....

Criteria and Aspects of Teaching and Teacher Learning to consider (circle any that apply here)

Criteria	**Appropriate Pedagogies**	**Formative Assessment**	**Comment**
Philosophical Rationale	What, and why is the educationally sound rationale for teaching this topic/unit/	How can I inspire the students to reflect?	
Prior-Learning	How will I find out what they know in advance?	Can initial pair work help here?	
Ethics (Values)	What values do I want to develop?	How might we model these?	
Context & Culture	How can I give recognition to each student? Equity	How to include all student voices?	
Subject Content Knowledge	What big ideas, concepts do I want to teach here?	Do I need additional upskilling in content?	
Related Skills	What related skills do I want to teach here?	e.g. inquiry skills, student investigations, crafting conclusions, problem-solving	

Depth of Treatment	How deep here – definition, understanding, analysis, synthesis, justify, interpret?	Using multiple modes: pair work, peer work, oral presentation	
ICT-enhanced learning	ICT- approaches help with different aspects of learning	How will this support student motivation and engagement	
Structuring of Content	Pacing, individuals, class groups and entire class	Inquiry approach, experiments, written reports,	
Contemporary Issues	What are the real world related examples?	Social, Scientific & Technology Issues?	
Cross-Curriculum Links	How might the topic be connected to other aspects of the curriculum?	How science topics link to ethics, RE, CSPE, Geography and Politics	
Pluralism and Democracy [public interest values]	Learning deliberative skills of negotiating and arguing; safe space to debate issues from contrarian perspectives, new thinkers, sustainable planet	Building capacities to make agreements and negotiate with those who are likeminded and with those who are not likeminded	

What am I learning here about me as a learning and about my teaching? What do I need to continue to do the same? What do I need to do differently?

APPENDIX II – CPD TEMPLATE FOR TEACHER LEARNING AS A REFLECTIVE PRACTITIONER

Class Group:...

Subject Content: ....

Date: ....

Criteria and Aspects of Teaching and Teacher Learning to review and reflect upon

What are my strengths as a teacher and as a learner? How do I know this? How might I get clearer feedback on my strengths as a teacher?
Do I ask for feedback from students? From peers? What insights have I gained?

What are my favoured pedagogical and assessment approaches? [Use the list below as an aid]. Can I justify this selection of approaches?

How open am I to trying new pedagogical approaches? To working on an improvement model of learning where perfection is considered to be elusive and not something to aspire toward. Where can I assess support for a new approach?

What are my areas for development? What additional supports will I need?

What new insights have I gained from the touchstone of theory and research?

APPENDIX III
CONTACTS IN RELATION TO PLACES IN IRELAND THAT PROVIDE ECOLOGY FIELDTRIPS

**The prices indicated are merely indicative prices noted at the time of publication.*

Lullymore Heritage and Discovery Park
Lullymore, Rathangan Co. Kildare.
Website: https://www.lullymoreheritagepark.com/field-trips/ Contact: 045 870238
Field trips are directed to senior cycle students. Woodland ecosystem study within a native tree forest. The park provides workbooks for all students. Junior cycle students to partake in a field trip with outcomes for science and geography. Price: €12-€15.

Tralee Bay Wetlands Eco and Activity Park.
Ballyard, Tralee, Co. Kerry.
Website: https://traleebaywetlands.org/education/secondary/ecology-field-trips
Contact: info@traleebaywetlands.org
Field trip for junior cycle and senior cycle biology students. Tour times: 3hrs & 3.5hrs.
Price €13 per student. Caters to groups of 30-35 students.

Castlecomer Discovery Park.
The Estate Yard, Drumgoole, Castlecomer, Co. Kilkenny, R95 HY7X
Website: https://www.discoverypark.ie/schools/secondary-schools/#1510663914598-700445cc-5c30 Contact: info@discoverypark.ie
Field trip caters for junior cycle and senior cycle biology students. This field trip is a woodland ecosystem study. Tour time 1.5hr – 2hrs.
Booklet provided to all students. Price €15 per students. Group sizes 20+

Freedom Surf School Tramore
The Beach House, The Gap, Riverstown, Tramore, Co Waterford.
Contact: info@freedomesurfschool.com
Website: https://www.freedomsurfschool.com/activities/ecology_field_trips
Field trip for junior cycle and senior cycle. The focus is a rocky seashore. Price €20pp.
Alternative: Ecology & Surf Day. Field Trip with Surfing Duration: 5 hrs. Cost: €40pp

Kippure Estate:
Manor Kilbride, Blessington, Co. Wicklow
Website: https://kippure.com/ Contact: eco@kippure.com
Focus on woodland ecology. Group no larger than15 students per instructor.
Full day schedule with lunch break. Price €35 per student.

Tayto Park
Kilbrew, Ashbourne, Co. Meath A84 EA02.
Website: https://taytopark.ie/schools-groups/grassland-ecology
Contact: https://taytopark.ie/contact
Available to junior and senior cycle students. Focus of the study is grassland ecology. The study lasts 2.5 hours. Group sizes of 30-120 students. Price €13 per student.

Tanagh Outdoor Education and Training Centre.
Dartrey, Vie Cootehill, Co. Monaghan H16 HC83.
Website: https://www.tanaghoutdooreducation.com/field-studies
Contact: info@tanaghoutdooreducation.com
Field trip for junior cycle and senior cycle biology students. The focus on woodland or freshwater ecology. Full day schedule. Price: Dependent on group size.

Dublin Zoo
Phoenix Park, Dublin.
Website: https://www.dublinzoo.ie/education/school-visits/secondary-school-courses/
Field trip for junior cycle and senior cycle ecology. Focus on a grassland habitat.
Duration: 2 hours & 3 hours. Prices: €14 per student and €17 per student.

Fota Island Fota Wildlife Park
Carrigtwohill, Co. Cork.
Website: https://www.fotawildlife.ie/education/ Contact: education@fotawildlife.ie
This field trip for junior cycle and senior cycle ecology. Focus on a grassland habitat. Group of 20-120 students. Price €17 per student.

Cloncannon Biofarm
Moneygall, Roscrea, Co. Tipperary
Website: http://cloncannonbiofarm.com/leaving-certificate-programmes/
Contact: sean@cloncannonbiofarm.com
This field trip focuses on senior cycle ecology and for agricultural science students.
The habitat studied is a grassland habitat. Price €10 per student.

Birr Outdoor Education Centre Roscrea Rd, Seefin, Birr, Co. Offaly.
Website: https://www.birroec.ie/ecology/ Contact: info@birroec.ie
Field trip for junior cycle and senior cycle ecology. Focus on a grassland habitat.

Burren Outdoor Education & Training Centre. Turlough, Bell Harbour, Co. Clare.
Website: https://burrenoec.com/field-studies/ Contact: burrenoec@lcetb.ie
Field trip for both junior cycle and senior cycle ecology. Focus either on a rocky shore habitat or a woodland habitat. Workbooks are provided to students.

APPENDIX IV – CPD RESOURCES FOR JUNIOR CYCLE SCIENCE, TRANSITION YEAR SCIENCE, AND LEAVING CERTIFICATE BIOLOGY.

SCIENCE TEACHER LEARNING FOR IMAGINATION AND SUSTAINABILITY EPI·STEM-HEA CPD RESOURCE INITIATIVE

ECOLOGY- A STUDY OF THE RELATIONSHIP BETWEEN ORGANISMS AND THEIR ENVIRONMENT

JUNIOR CYCLE SCIENCE

GERALDINE MOONEY SIMMIE,
MARTHA COSGRAVE & TARA E. RYAN

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EPI·STEM National Centre for STEM Education
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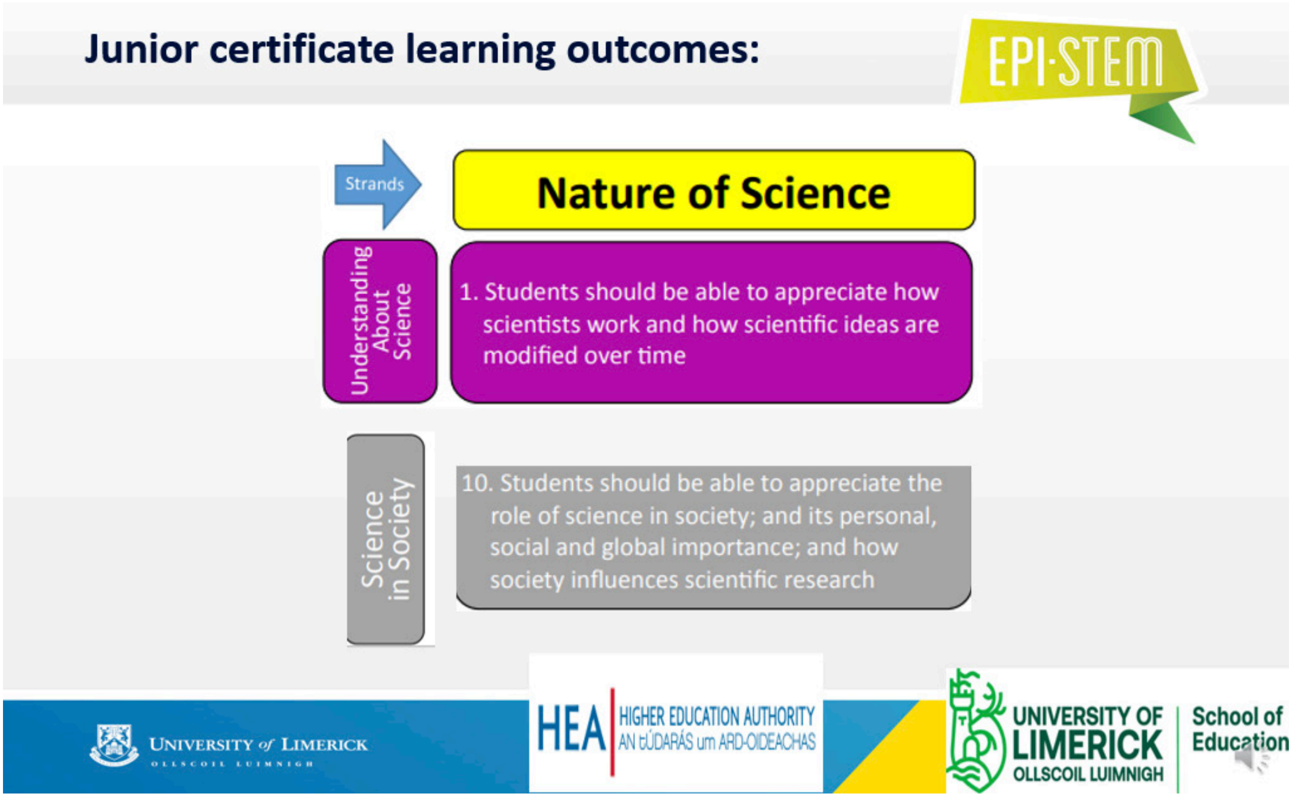
This is the first podcast in a series of ten podcasts that were designed and development by the research design team at EPI·STEM to support teacher professional development in relation to teaching young people in Irish secondary schools the topic of ecology.

The Ecology podcasts are designed and narrated by Martha Cosgrave. Martha is a Research & Development Officer with this HEA funded project in EPI·STEM and is currently in her final year of a four-year science education degree at the School of Education in the University of Limerick.

Ecology is a branch of biology that deals with the relationships between organisms, including humans and the physical environment culminating in the planet itself. The first four podcasts were designed for upskilling teachers in content related to the learning outcomes in the Junior Cycle, the fifth podcasts give ideas and suggestions for scientific inquiry and investigations that may interest students in Transition Year and the final five podcasts, from 6 to 10 were designed with the Senior Cycle outcomes in mind. We have given examples of active pedagogical approaches that can be used to support interactive learning, recognition of prior learning, active pedagogies, simulations, and use of technology enhanced learning, use of cross-curricular links, suggestions for formative assessment and connectivity to pedagogical wellbeing.

We are compiling a booklet to go with the pod-casts and we will await your feedback and suggestions after that for how we might continue to provide you with state-of-the-art pedagogical materials and access to some wonderful resources available that can help when teaching science and ecology for understanding, building a rich skillset connected to Nature of Science and seeking to emulate how scientists work in practice, and working with science and values/ethics so that students can use their transferable skills for inquiry in combination with ethics to learn how to contribute in co-constructing a just democratic society and sustainable global world.


Junior certificate learning outcomes:
EPI·STEM
Strands
Nature of Science
Understanding About Science
1. Students should be able to appreciate how scientists work and how scientific ideas are modified over time
Science in Society
10. Students should be able to appreciate the role of science in society; and its personal, social and global importance; and how society influences scientific research
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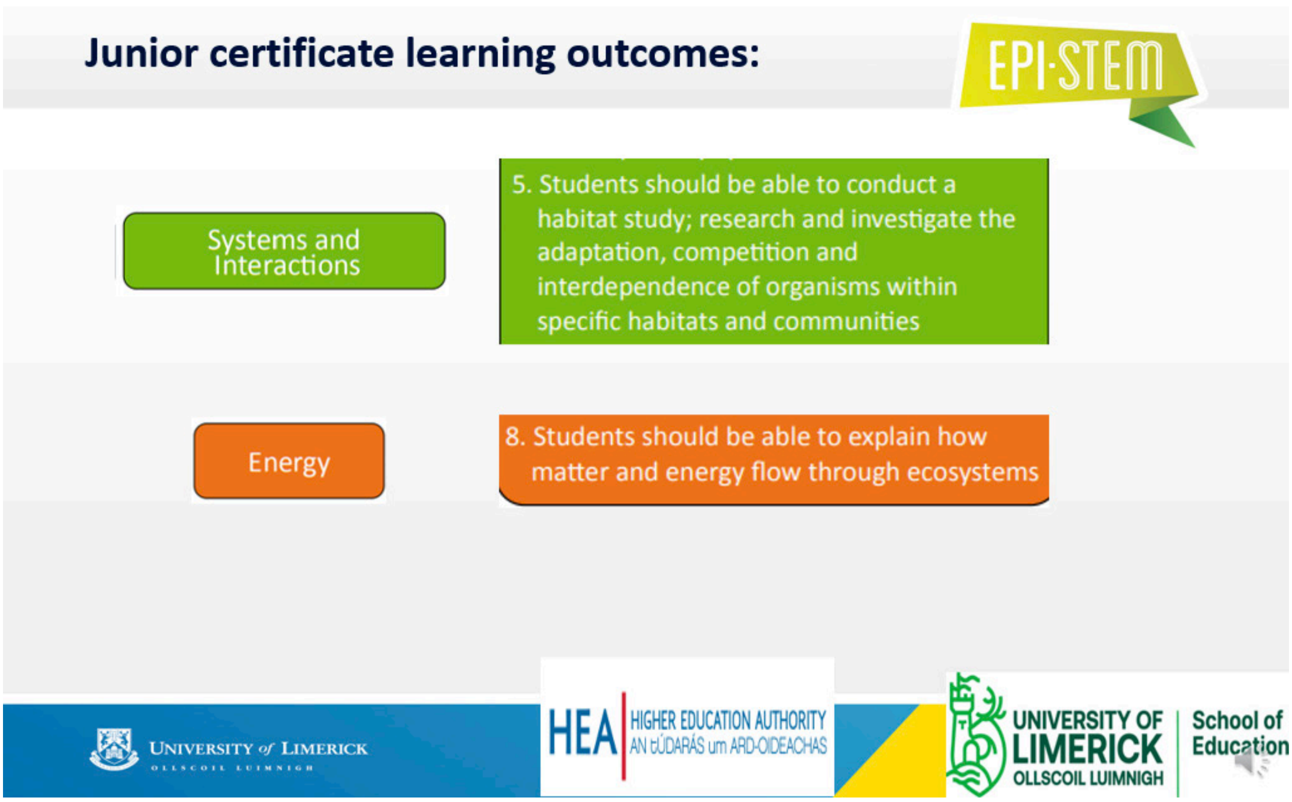
Junior certificate learning outcomes:
EPI·STEM
Systems and Interactions
5. Students should be able to conduct a habitat study; research and investigate the adaptation, competition and interdependence of organisms within specific habitats and communities
Energy
8. Students should be able to explain how matter and energy flow through ecosystems
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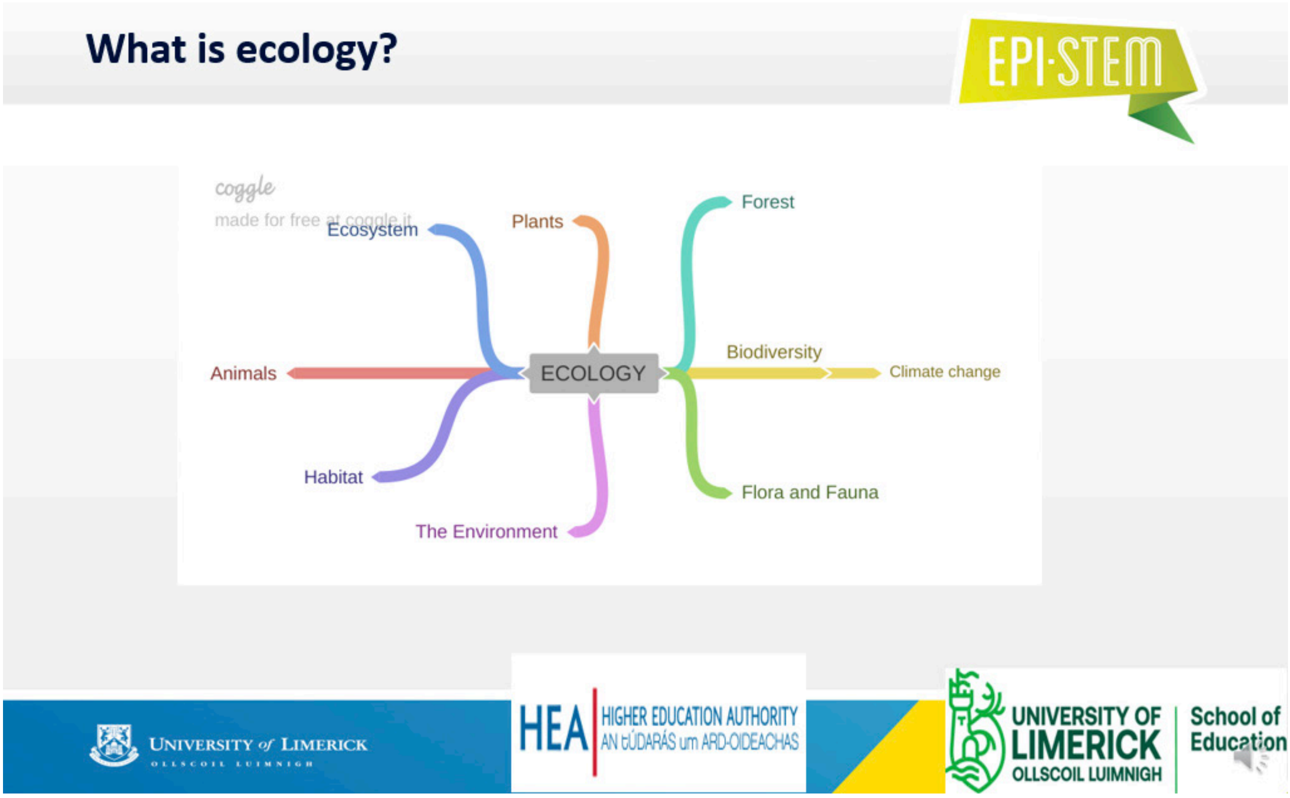


Mind maps are simple tools that can be used to determine the level of previous knowledge that students have. If we ask students to create a mind map of buzzwords that students associate with ecology. This useful tool gives us an idea of the level of knowledge students have. Students can also refer back to the mind map once the topic is completed and add the new buzzwords that they have learned.

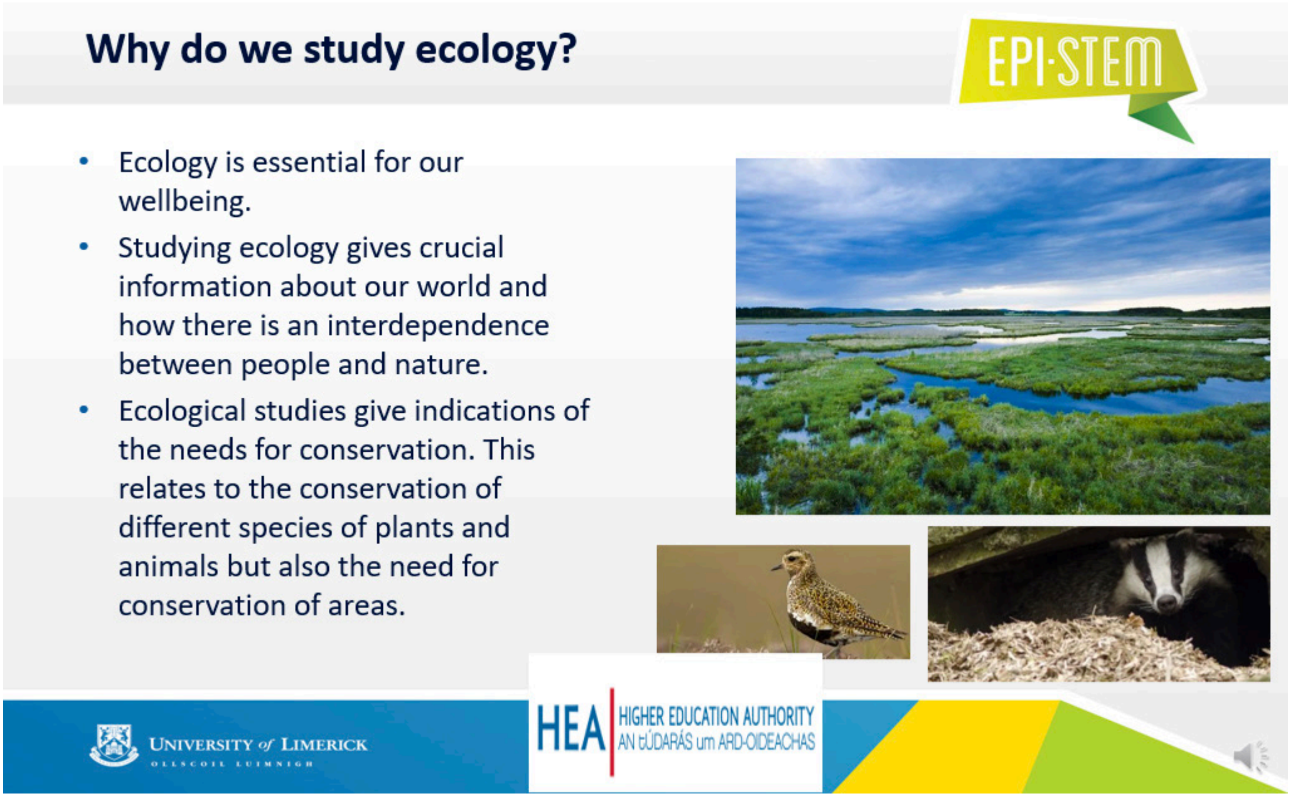
This image shows an example of a mind map that may be created by students. Some of the simple keywords may be present.

Coggle is a website which can be used to create mind maps interactively with students. https://coggle.it/

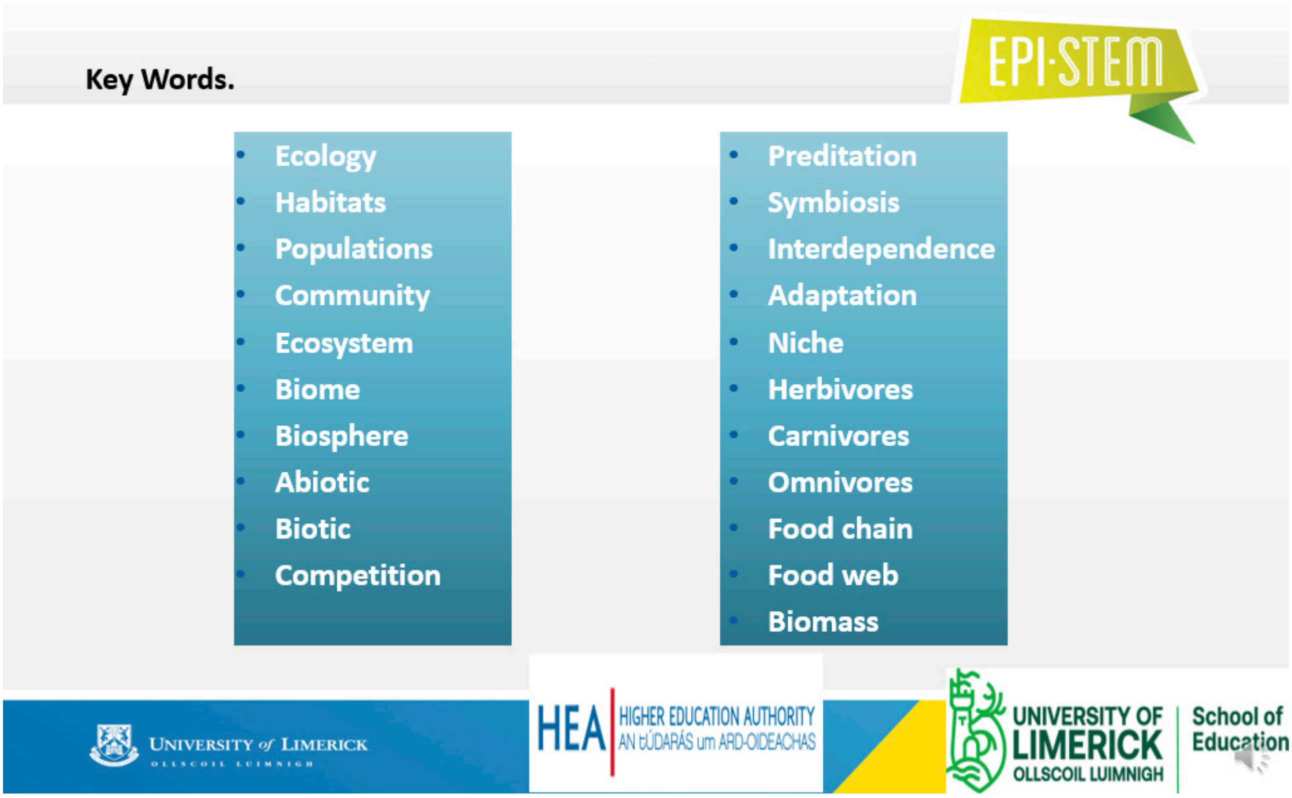
Using the mind maps created in the class we can ask students to this about the definition of ecology?

Instead of giving students the definition straight away we could ask students to think about the word and their understanding.

An example of a definitions is - Ecology is the study of living things and how they interact with their environment and each other.



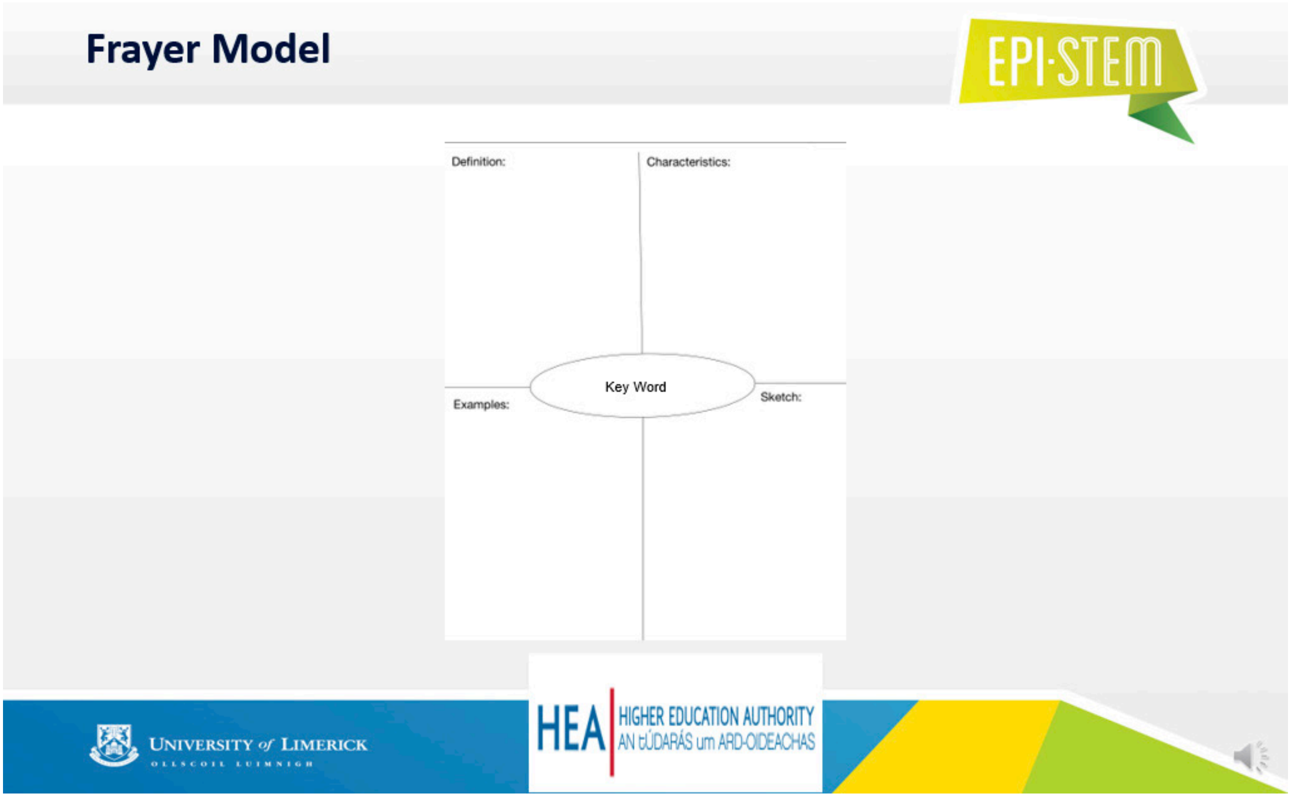
Students need to have a appreciation for the importance of ecology for the living world therefore it is essentials for students to know why we study ecology.

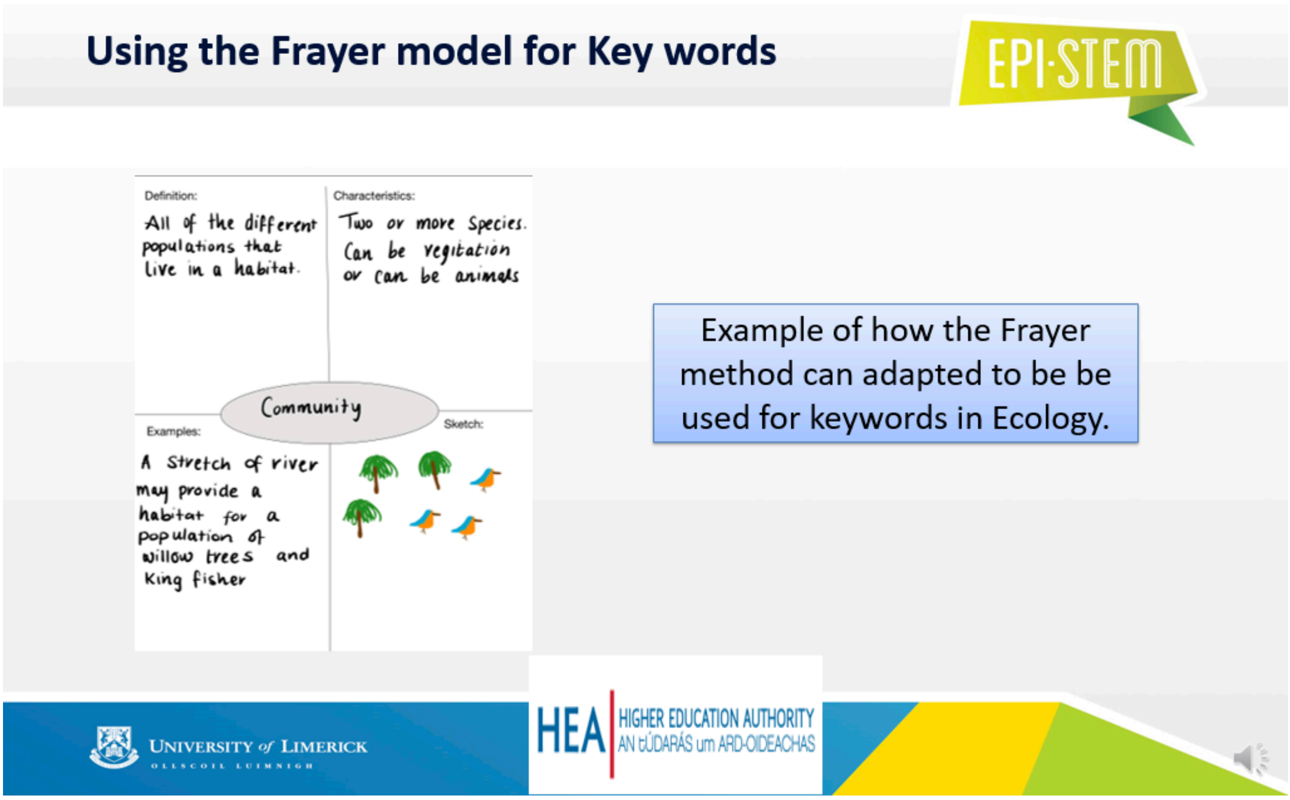


There are a number of keywords connected to ecology as can be seen in this list but how can we as teachers ensure that our students have an understanding of these words?

When moving through the content if the students are lacking and understanding of these words then it can lead to students misunderstanding the information.

The Frayer model can be used by teachers to get students to engage with the material instead of just taking note of definitions the students need a true understanding to create these models.





This model can be used in several different ways.

Assessing the Knowledge – Ecology Bingo!

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Predator	Niche	Biotic Factors	Ladybird	Symbiosis
Ecology	Food chain	Prey	Flora	Ecosystem
Fauna	Community	**FREE**	Habitat	Adaptation
Interdependence	Biome	Competition	Biomass	Food Web
Abiotic Factors	Prey	Rabbit	Biosphere	Parasitism

Students draw a table (3X3) and pick nine of the keywords at random from the table shown.

The teacher reads out the definitions or description for the keywords and the students must match the definition to their keyword.

The first student to match their 9 words with the definitions wins!!!

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Definition List Link Ecology Bingo 2.pdf

Engaging students and gaining interest.

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- Create an ecosystem in a bottle.
  – Gives students hands on experience and something that they can monitor.

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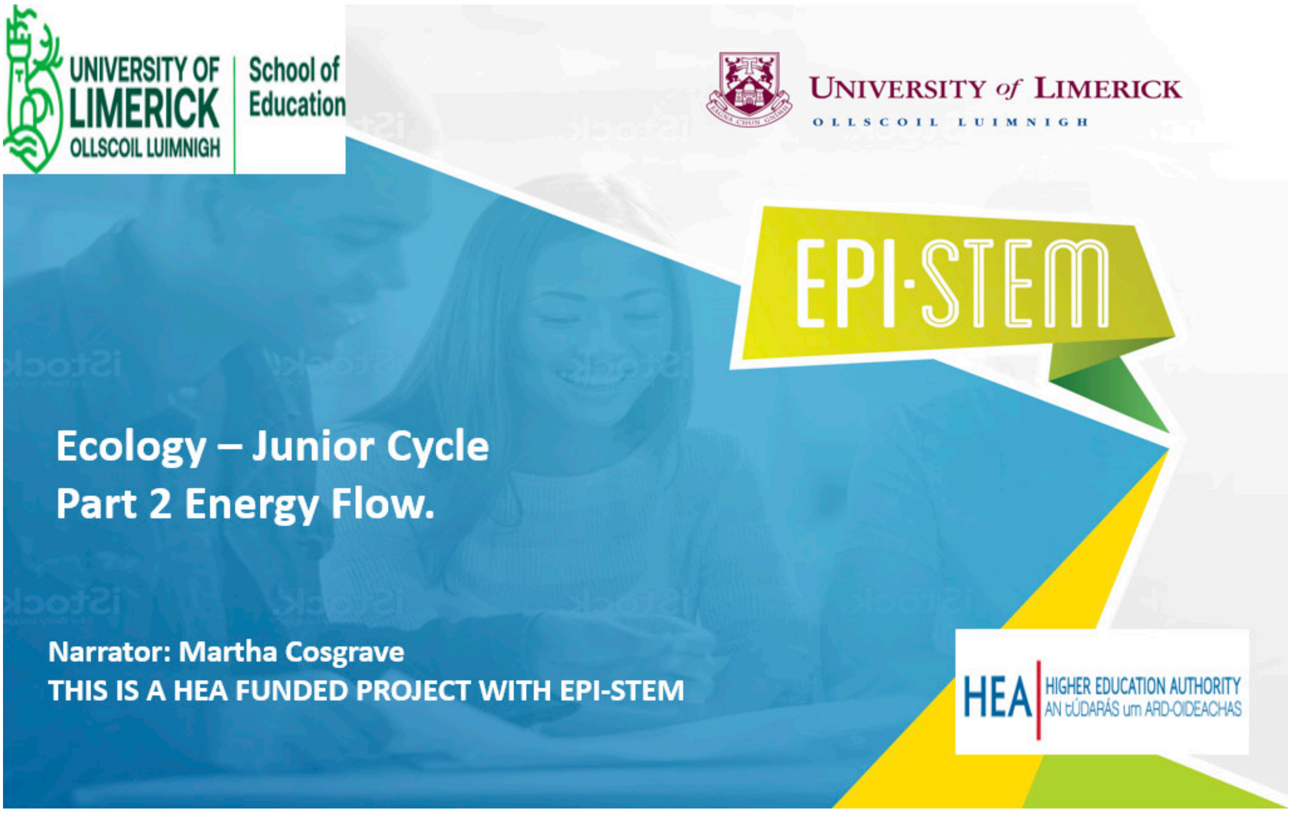
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EPI·STEM
Ecology – Junior Cycle
Part 2 Energy Flow.
Narrator: Martha Cosgrave
THIS IS A HEA FUNDED PROJECT WITH EPI-STEM
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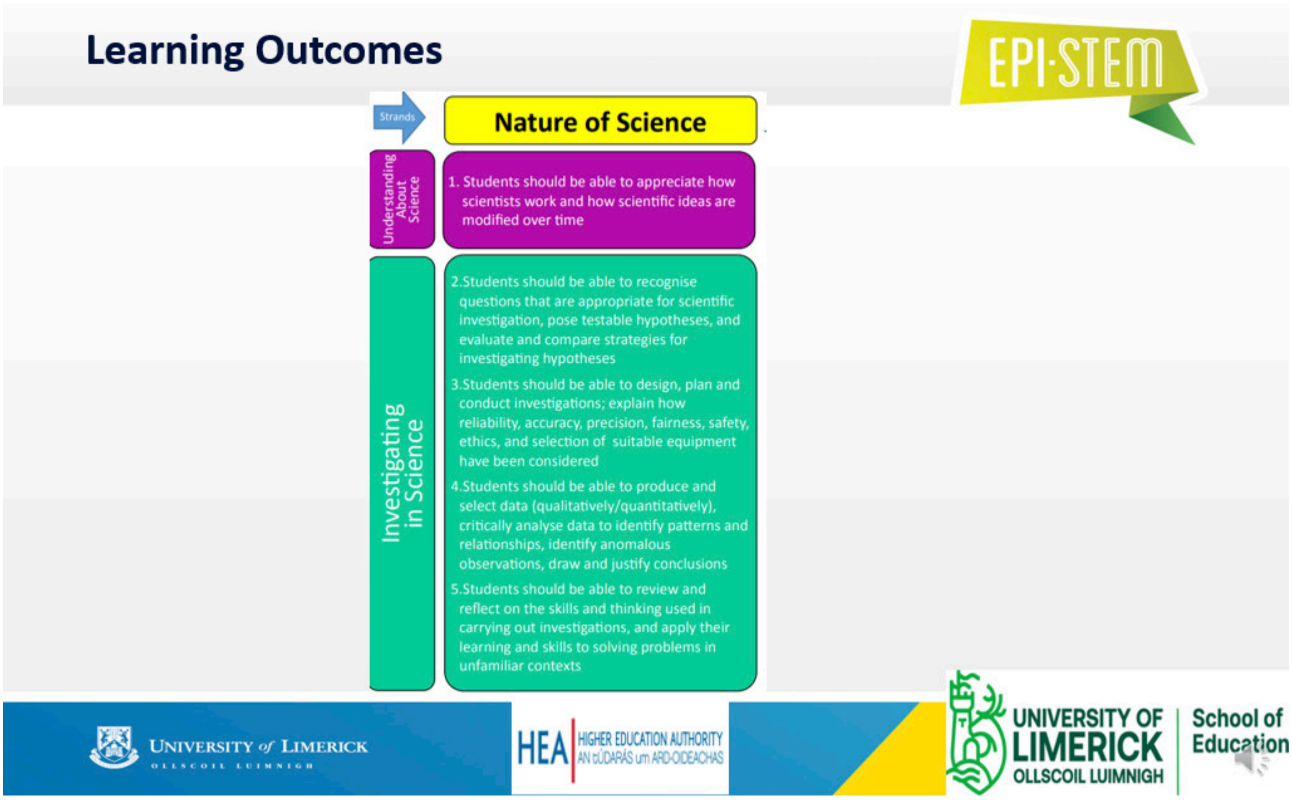
Learning Outcomes
EPI·STEM
Strands
Nature of Science
Understanding About Science
1. Students should be able to appreciate how scientists work and how scientific ideas are modified over time
Investigating in Science
2.Students should be able to recognise questions that are appropriate for scientific investigation, pose testable hypotheses, and evaluate and compare strategies for investigating hypotheses
3.Students should be able to design, plan and conduct investigations; explain how reliability, accuracy, precision, fairness, safety, ethics, and selection of suitable equipment have been considered
4.Students should be able to produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions
5.Students should be able to review and reflect on the skills and thinking used in carrying out investigations, and apply their learning and skills to solving problems in unfamiliar contexts
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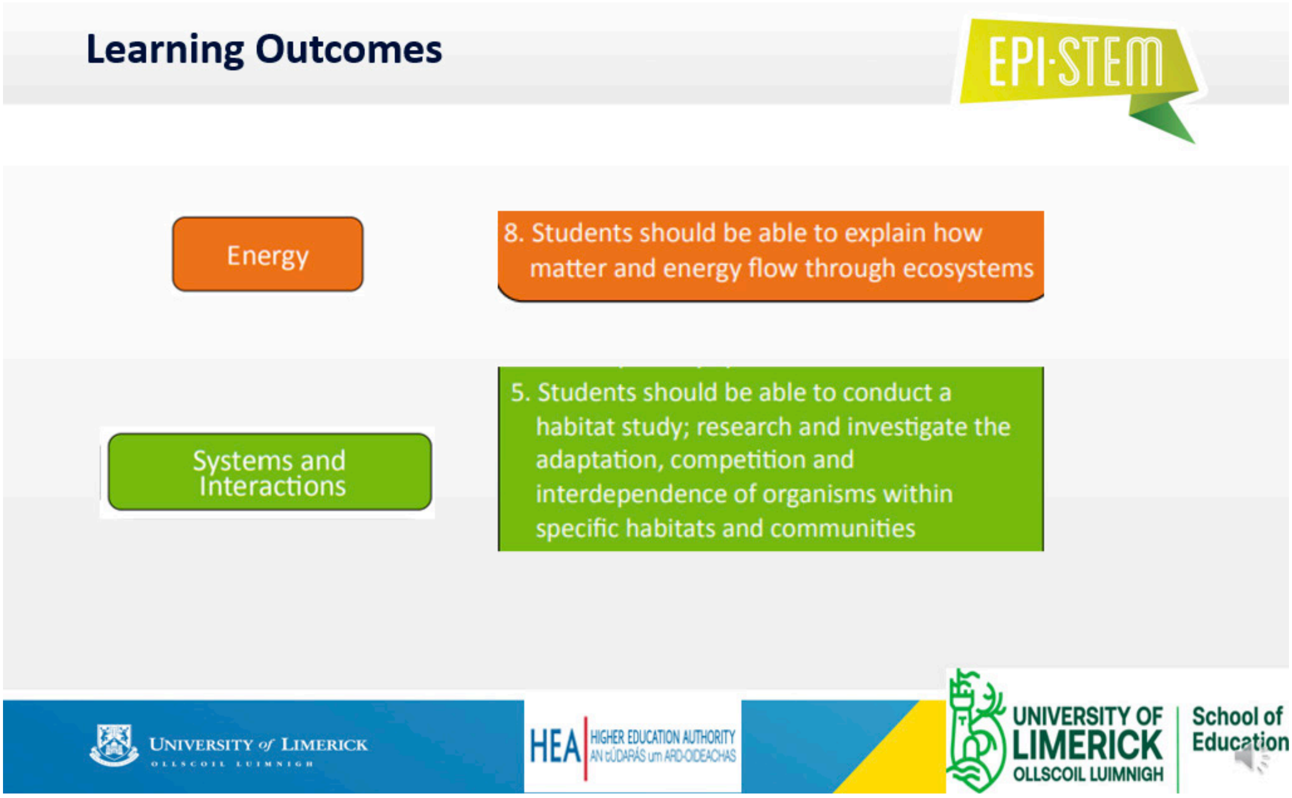
Learning Outcomes
EPI·STEM
Energy
8. Students should be able to explain how matter and energy flow through ecosystems
Systems and Interactions
5. Students should be able to conduct a habitat study; research and investigate the adaptation, competition and interdependence of organisms within specific habitats and communities
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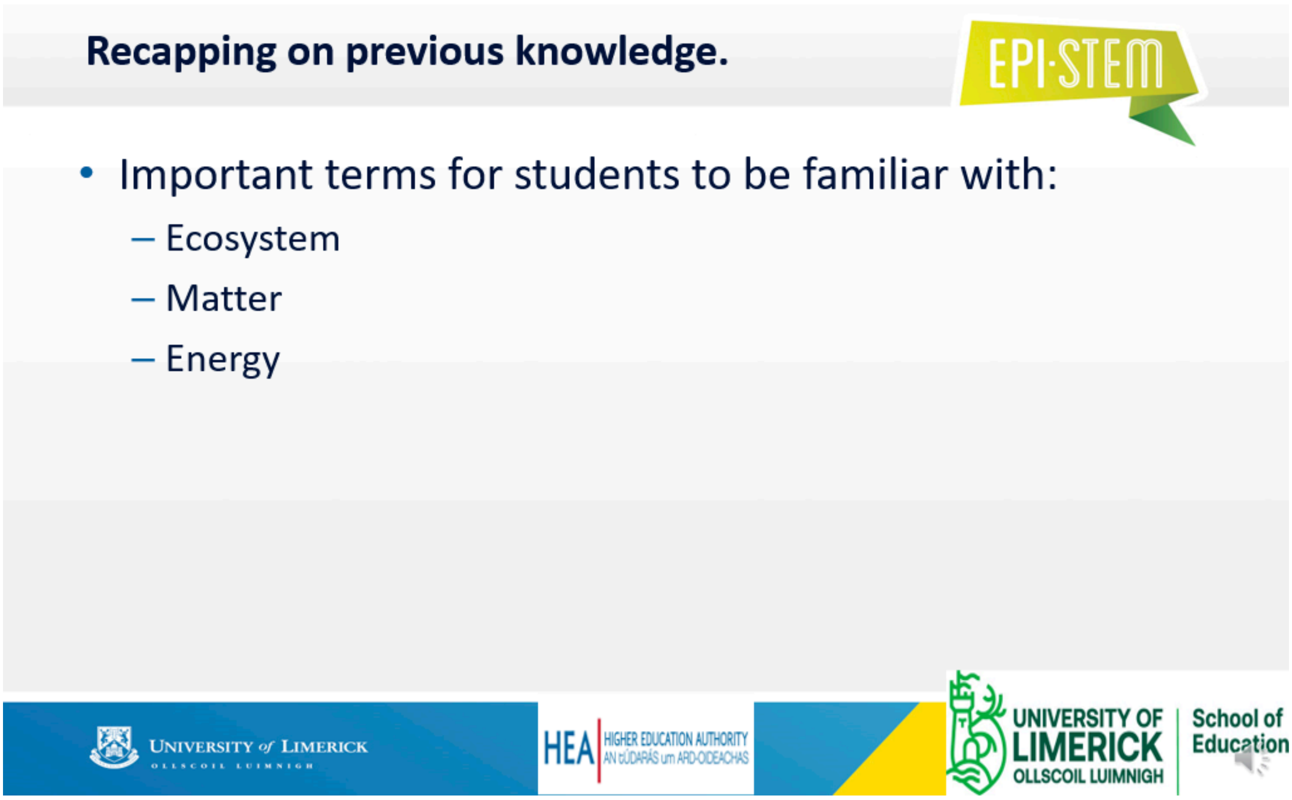
Recapping on previous knowledge.
EPI·STEM
• Important terms for students to be familiar with:
– Ecosystem
– Matter
– Energy
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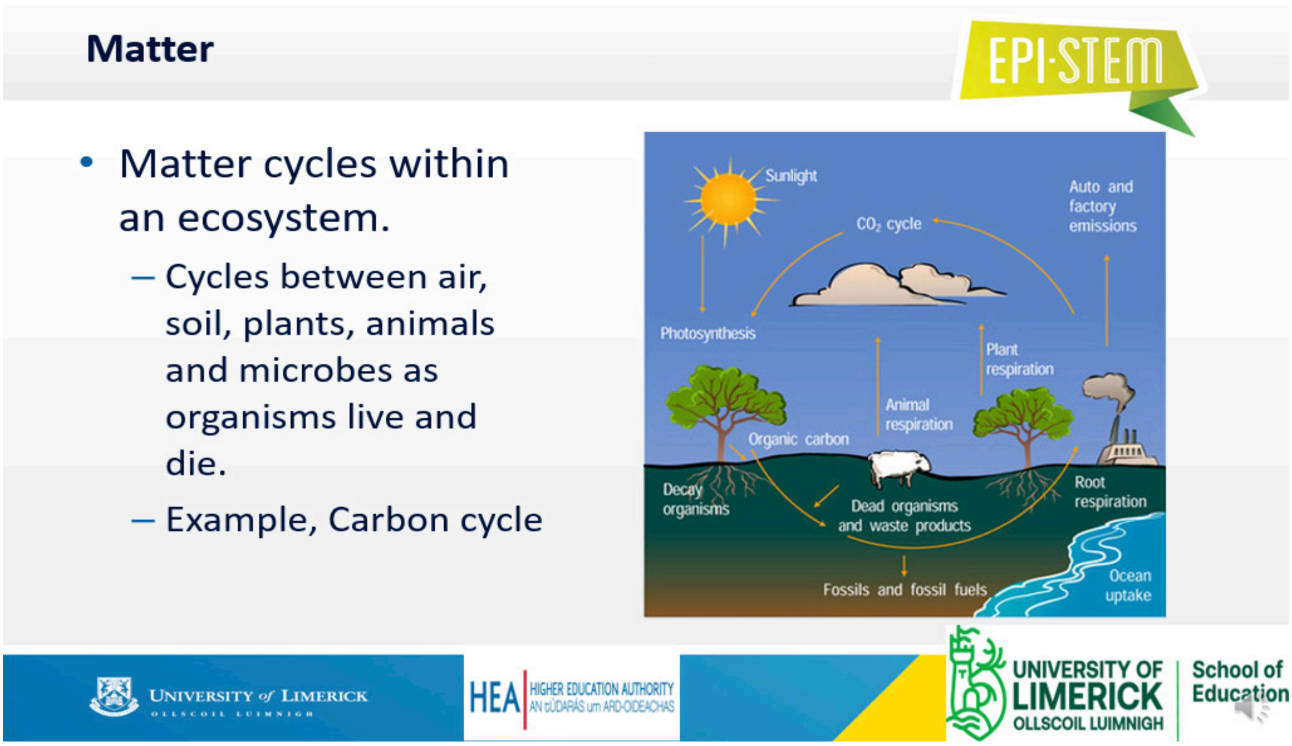
This activity makes students think about the concept on a deeper level. The students are not just given a correct answer. They must think about the concept and the words before creating their meaning.

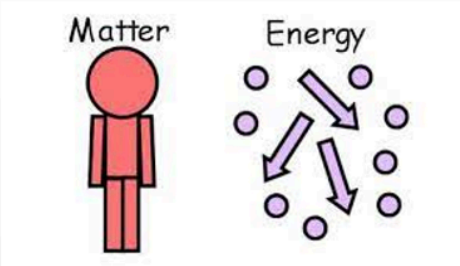
The teacher could then allow an open discussion where the students give their meanings, and the teacher could provide feedback.



Primary producers use energy from the sun to produce their own food in the form of glucose, and then primary producers are eaten by primary consumers who are in turn eaten by secondary consumers, and so on, so that energy flows from one trophic level, or level of the food chain, to the next.

The teacher could make a link back to the law of conservation where we know that energy cannot be created or destroyed. Just transferred from one form to another.

Matter V's Energy



Matter	Energy
Has mass, takes up space.	The ability to do work.
Measurable mass	No measurable mass
Has volume	No volume
Examples: Solids, liquids and gases.	Examples: Sunlight, sound and heat.

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Food chains.

- A Food chain represents a series of organisms that are dependent on the next for a transfer of **matter** and **energy** in the form of food.

Interactive activity for students Click here

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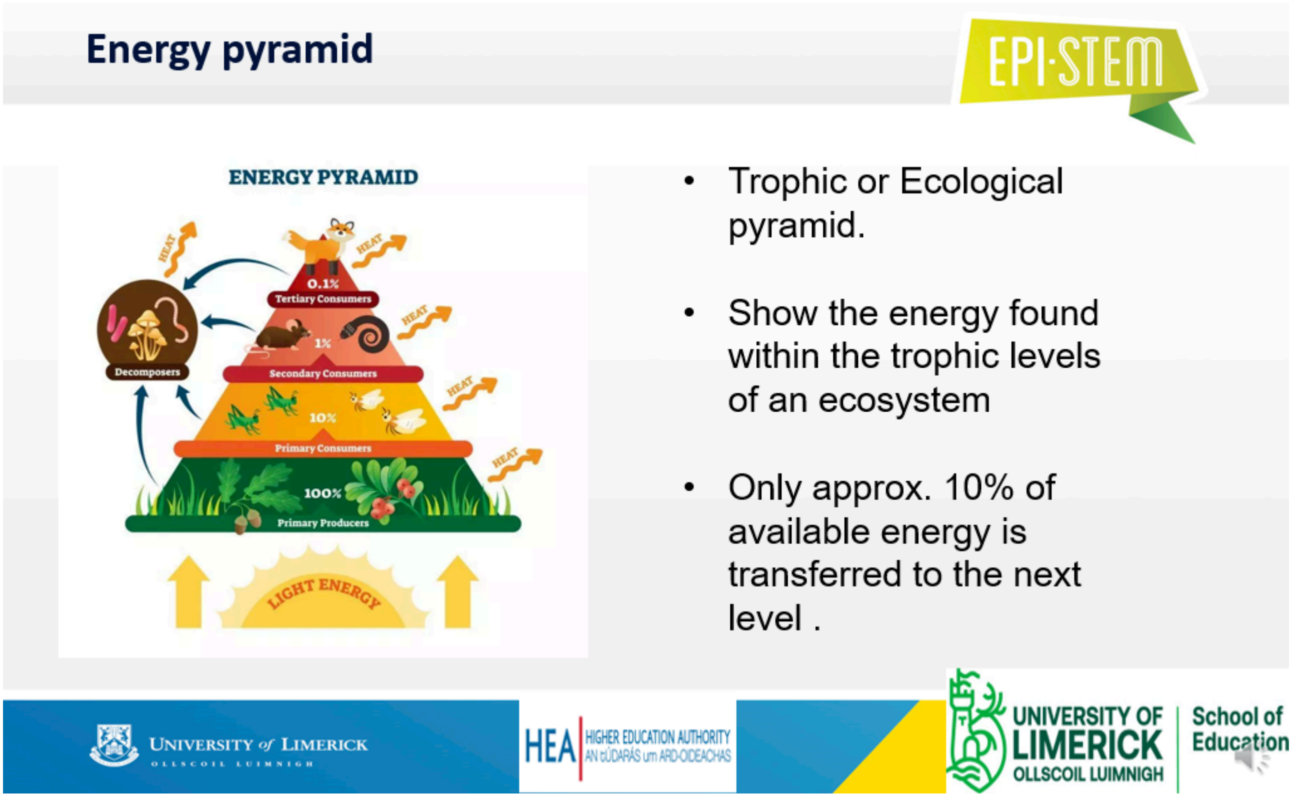
Interactive food chain activity.



Trophic or Ecological pyramid.

Show the energy found within the trophic levels of an ecosystem

Only approx. 10% of available energy is transferred to the next level. The other energy is used up on life processes, discarded as waster or just not consumed. The flow of energy is only in one direction.

Ask student to think about what energy is used by the life processes, how can they represent the energy efficiency. Sankey diagram.

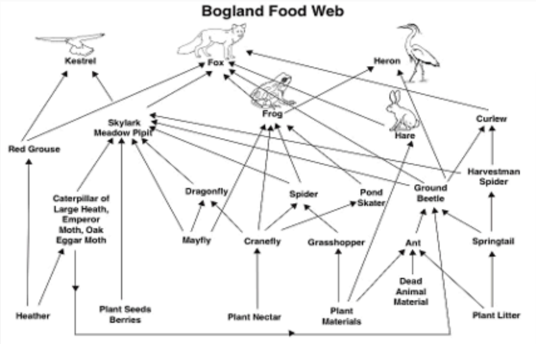
Cross curricular links to Maths

- Calculating the energy converted to heat.
- Calculating the energy passed on to the next organism.

- [Building an energy pyramid lesson.]

What is a food web?

A food web consists of all of the different interconnected food chains in a single ecosystem.



Model matter and energy transfer. Arrows represent the transfer of matter and energy stored in tissue when organism eats it.

This can be a tricky subject for students to come to terms with. Students can have issues with understanding the true meaning of a food wed.

The activity on the next slide can gives students a better understanding in a fun interactive way.

This activity allows students to differentiate between food chains and food webs. What is the difference between the two?

Students could be asked to think about what happens if a species in the web disappears from the ecosystem.

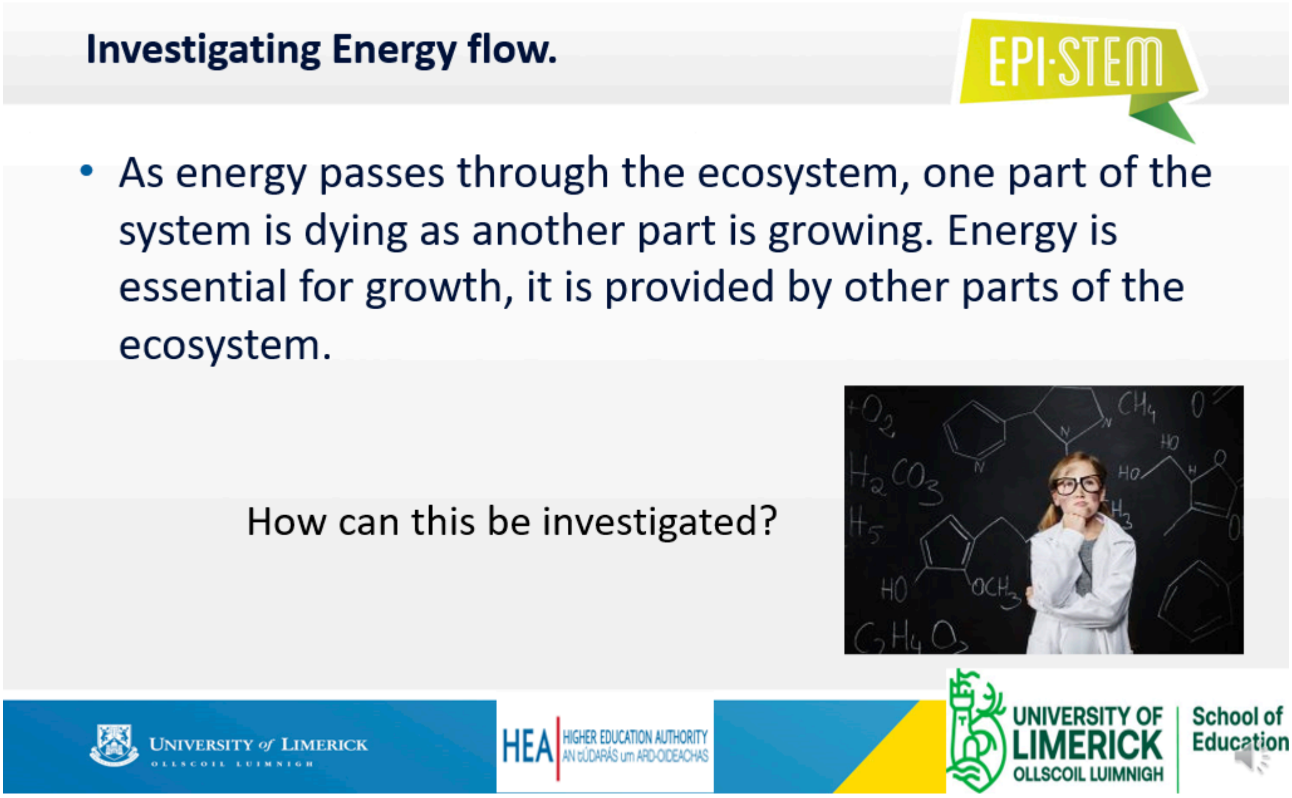
What effect would an invasive species have on the web?

Students can then be asked to think about the effects that a loss of biodiversity has on an ecosystem, what are the lasting effects? What effect could climate change have?

This video link shows the effect that the introduction of a species can have on an ecosystem.

Students could be asked to make note of 3 important points during the video to ensure that students are engaged.

Talking point – Class discussion surrounding the introduction of a species to an ecosystem.



Students will have to come up with a hypothesis and think about the control being used.

Independent Variables – Fruit, bread, cheese. Must be a food source bread or soft fruit gives the best result.

Dependent Variable – Microorganism growth.

Equipment –

- 3 Sealable plastic bags
- Water
- A piece of soft fruit (Apple, Banana, peach, pear)
- Slice of bread
- Slice of cheese
- Control – source of dry food placed in the sealed plastic bag.

As the micro-organisms grow on the food source it will decrease in mass.

Changing variables –

- use vinegar instead of water. (Changing pH)
- Refrigerate the samples.
- Change food source to citrus (Different pH)

Safety Precautions – micro-organism spores can cause illness if inhaled. Keep the bags sealed for the duration of the investigation.

This activity was taken from the Sparking Science teacher resource book (Gill education).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EPI·STEM
Ecology 3 - Junior Cycle
Adaptation
Narrator – Martha Cosgrave
THIS IS A HEA FUNDED PROJECT WITH EPI-STEM
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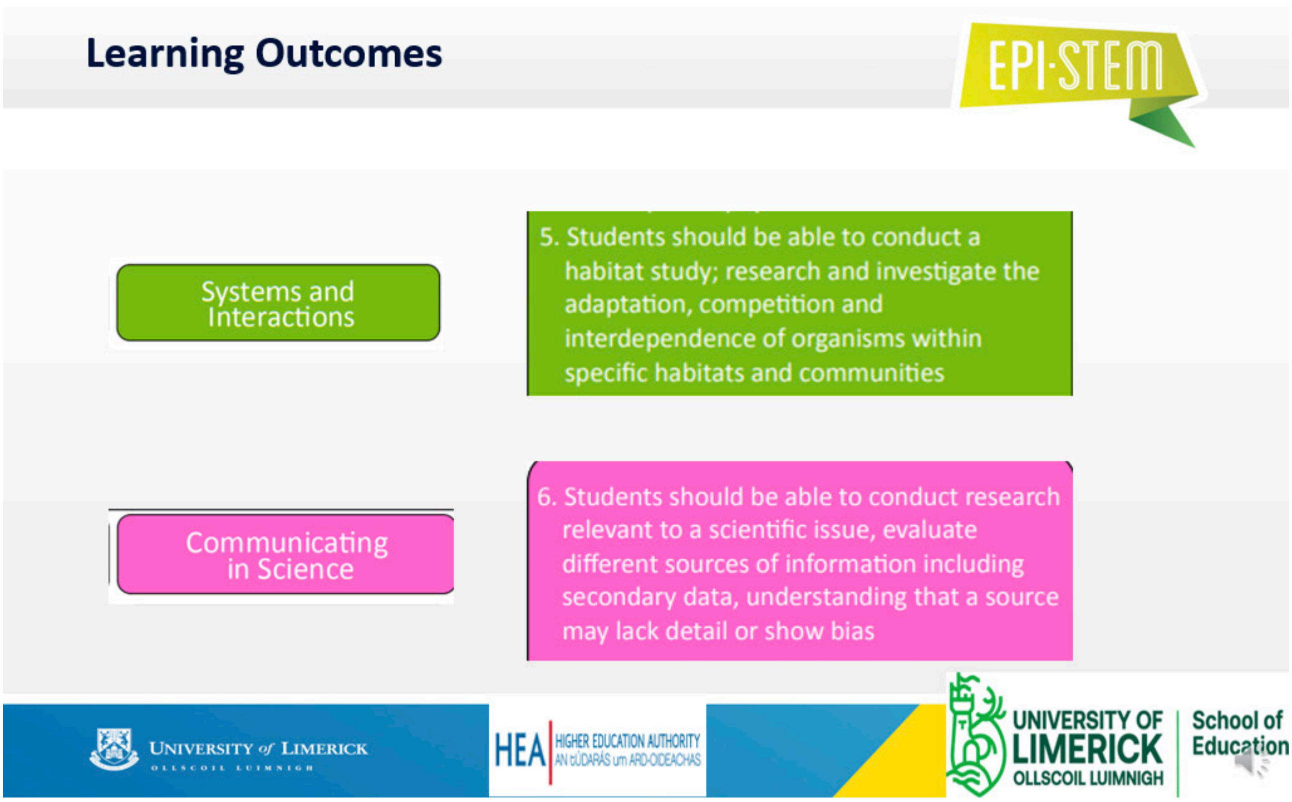
Learning Outcomes
EPI·STEM
Systems and Interactions
5. Students should be able to conduct a habitat study; research and investigate the adaptation, competition and interdependence of organisms within specific habitats and communities
Communicating in Science
6. Students should be able to conduct research relevant to a scientific issue, evaluate different sources of information including secondary data, understanding that a source may lack detail or show bias
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Ask Students to identify what animals in these images have adaptation and what advantage the adaptation has for the animal.

All the animal in the images have some adaptations.

This is a good opportunity to have students critically think about what adaptation are and how adaptations benefit different animals.

Students could be asked to compile a list of adaptations of animals. The important point that students have to recognise is why the animal has adapted a certain way.

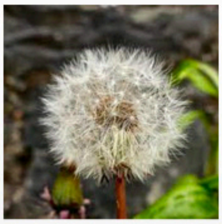
Battle of the beaks.

Interactive activity where students use different utensils to simulate the beaks of different birds.

Teacher notes Click Here

Student worksheet Click Here

Which plants have adaptations?

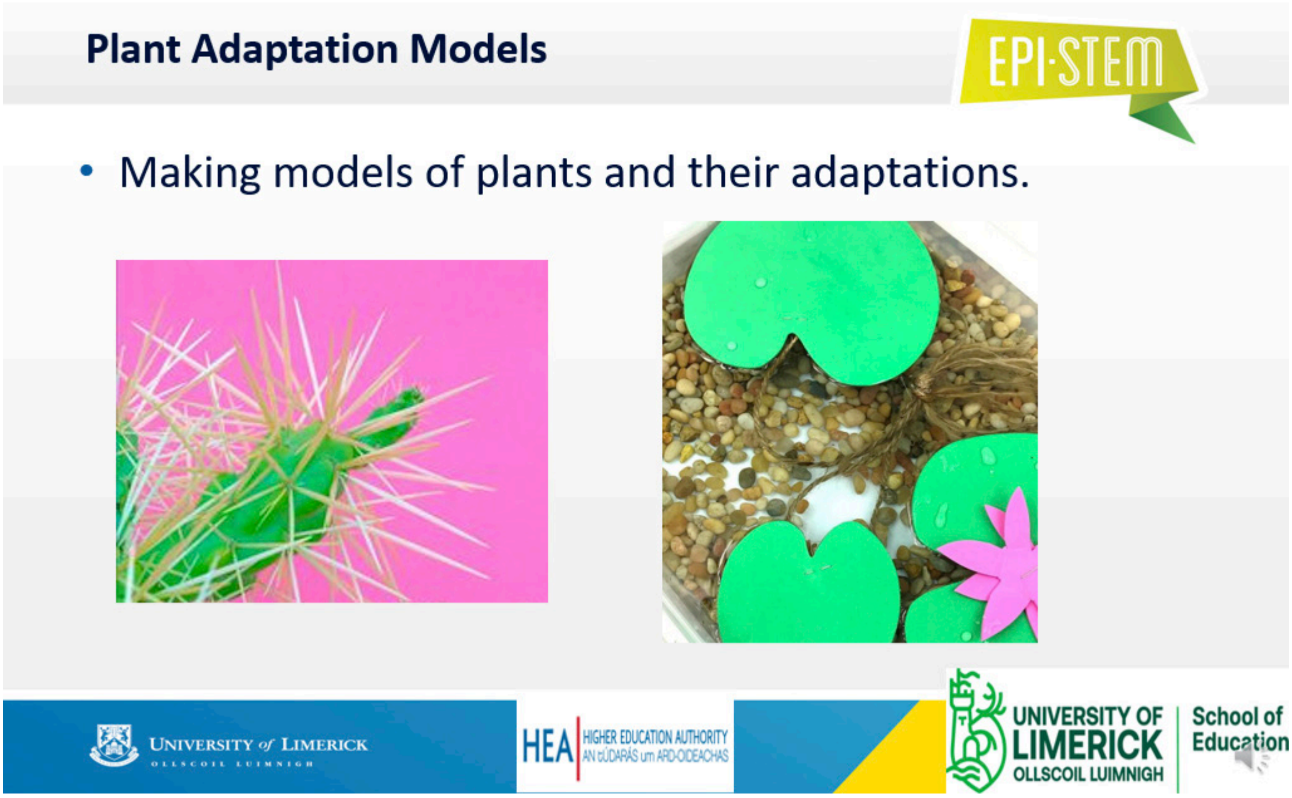


Ask Students to identify what animals in these images have adaptation and what advantage the adaptation has for the animal.

All the animal in the images have some adaptations.

This is a good opportunity to have students critically think about what adaptation are and how adaptations benefit different plants.

Students could be asked to compile a list of adaptations of plant. The important point that students must recognise is why the animal has adapted a certain way.



- Students can research a plants adaptation
- Students think about how they could model this adaptation.
- Promotes critical thinking and active learning.

Cactus could be made from playdoh and cocktail sticks
Water lilies could be made from green foam and wool for roots.
Other plants could be made from pipe cleaner and wool.

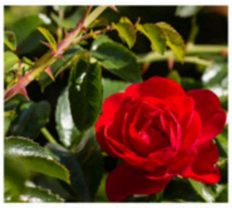
YouTube Links

- Venus Fly trap
- Pitcher plant
- Sunflower seastar
- Cheetah
- Feenec Fox

Exam Question 2022

Organisms can evolve and adapt, making them better suited to their environment. The organisms pictured below have adaptations that help them survive in their habitats. A fox is an omnivore (an animal that eats plant and animal matter). A rose bush is an autotroph (an organism that makes its own food).

Fox



Rose bush

(b) Describe one way a fox is adapted to help it survive in its habitat.

(c) Describe one way a rose bush is adapted to help it survive in its habitat.

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Exam Question 2019 Question 8.

EPI·STEM

(c) Ice sheets are the natural habitat of animals such as polar bears. State one adaptation of polar bears that makes them suited to this habitat.

(d) Would you expect the population of polar bears to increase or decrease as ice sheets melt?

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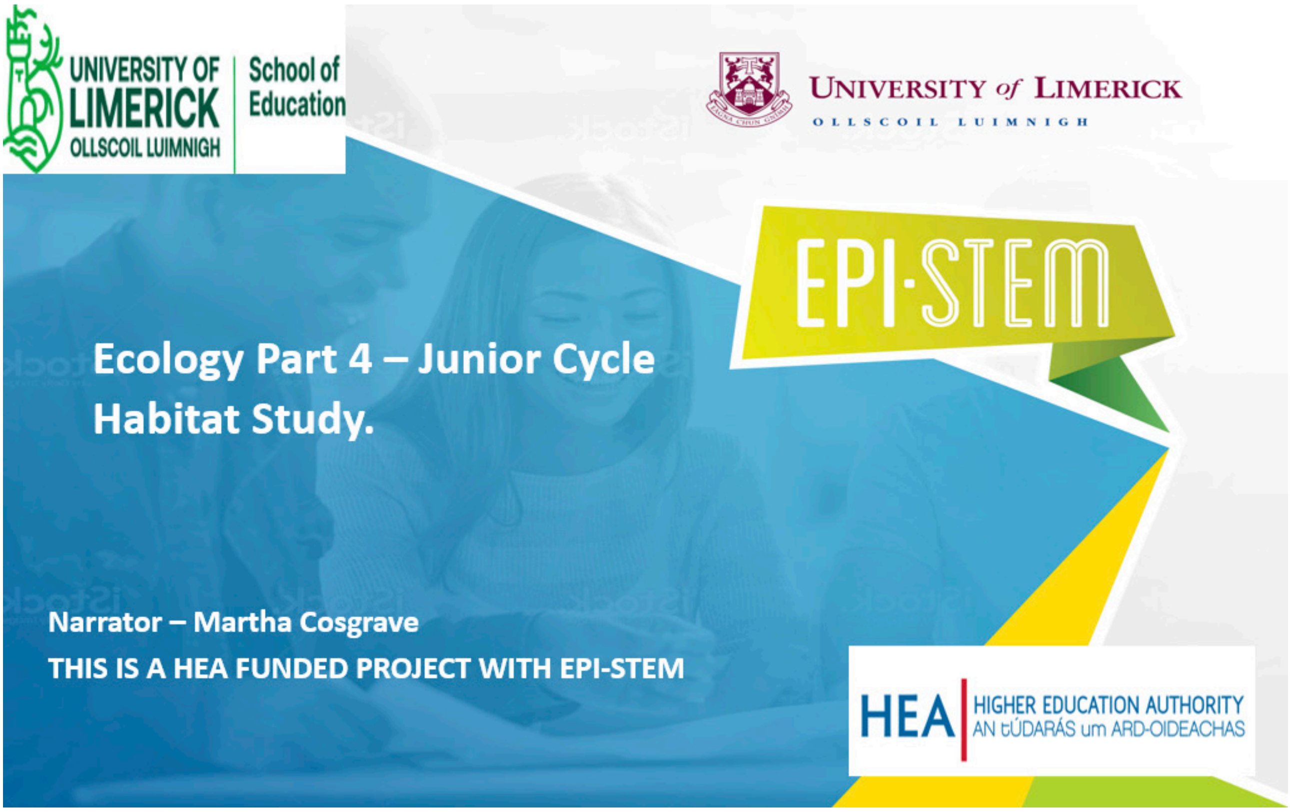

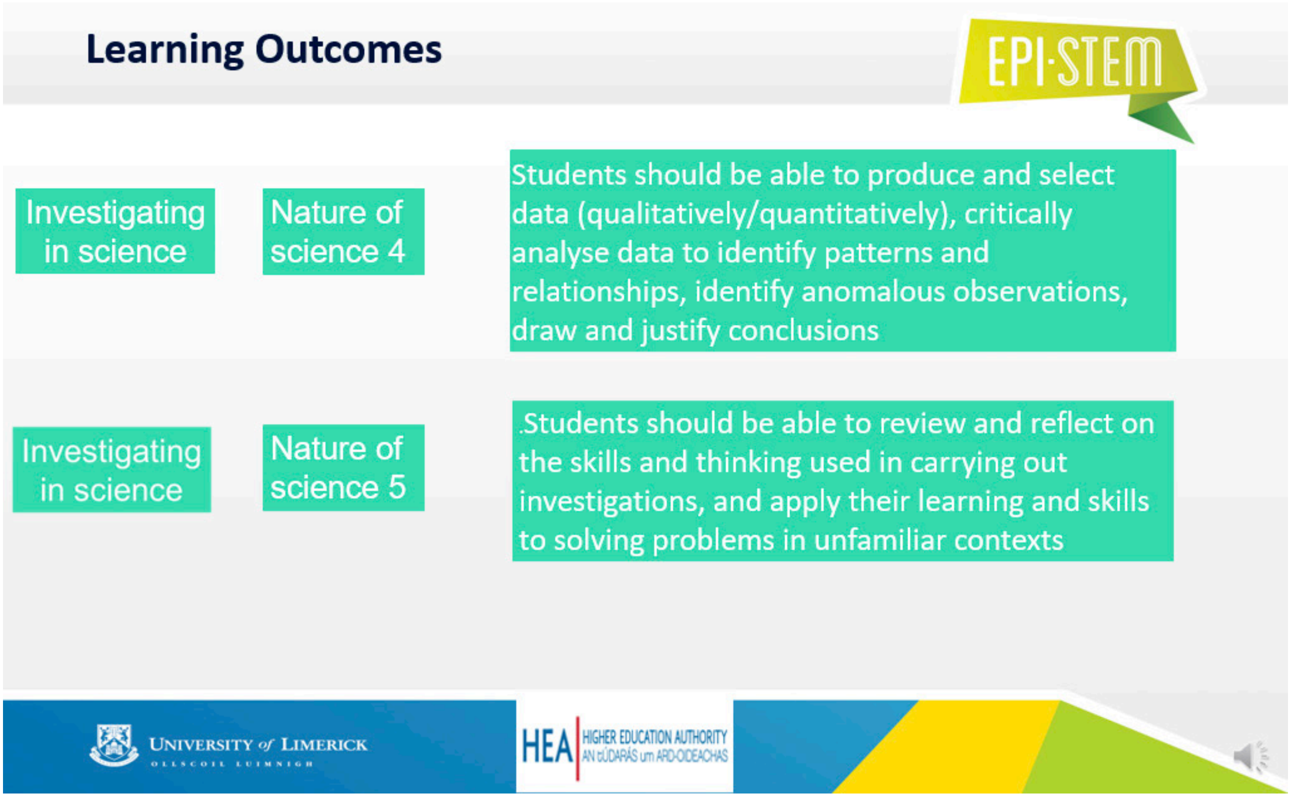
Learning Outcomes
EPI·STEM
Investigating in science
Nature of science 4
Students should be able to produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions
Investigating in science
Nature of science 5
.Students should be able to review and reflect on the skills and thinking used in carrying out investigations, and apply their learning and skills to solving problems in unfamiliar contexts
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Learning Outcomes
EPI·STEM
Systems and interactions
Biological world 5
Students should be able to conduct a habitat study; research and investigate the adaptation, competition and interdependence of organisms within specific habitats and communities
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Checklist needed for Field study.

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- ❑ Pre visit to area.
- ❑ Hazard identification statement
- ❑ Have a list of local phone numbers (Doctors, Hospitals, Gardaí, rescue services etc.)
- ❑ Two fully charged mobile phones.
- ❑ Basic first aid kit.
- ❑ Students fully informed of hazards in the area and the safety precautions.
- ❑ Students fully informed on appropriates clothing/gear required for trip.
- ❑ Plastic jars/bags for collection, avoid using glass.
- ❑ Leave a detailed outline of the plan including the location of trip with a responsible person and notify this individual if there are any changes.

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Why is it important to study habitats?

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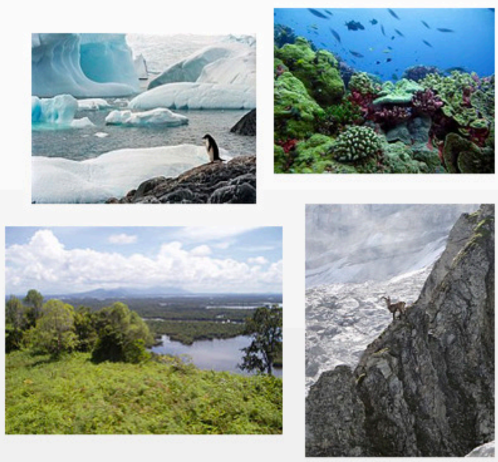
- It informs us as to how human actions are affecting habitats.
- Allows us to develop different ways to preserve life in habitats.
- Gives information about different living organisms in the habitat.
- Gives us a deeper understanding of the of how the plants and animals interact.



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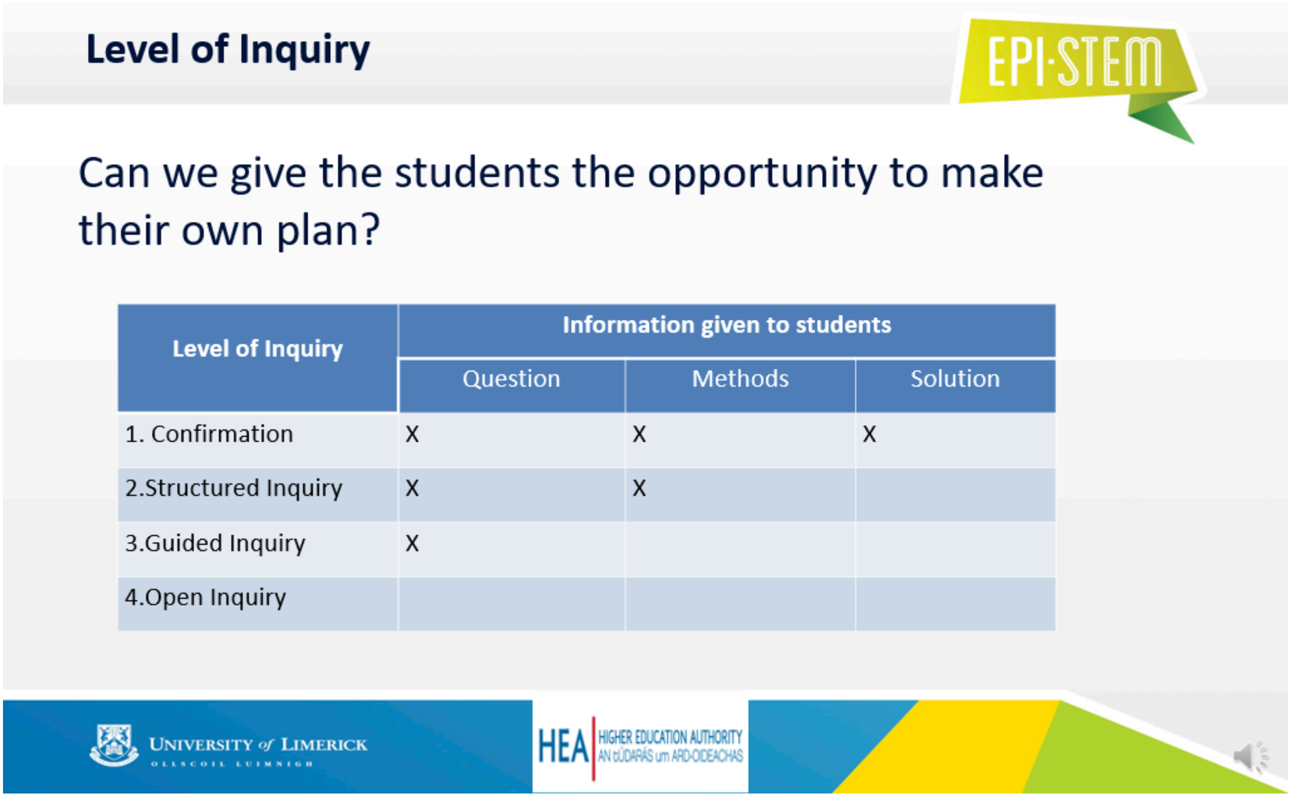


Level of Inquiry

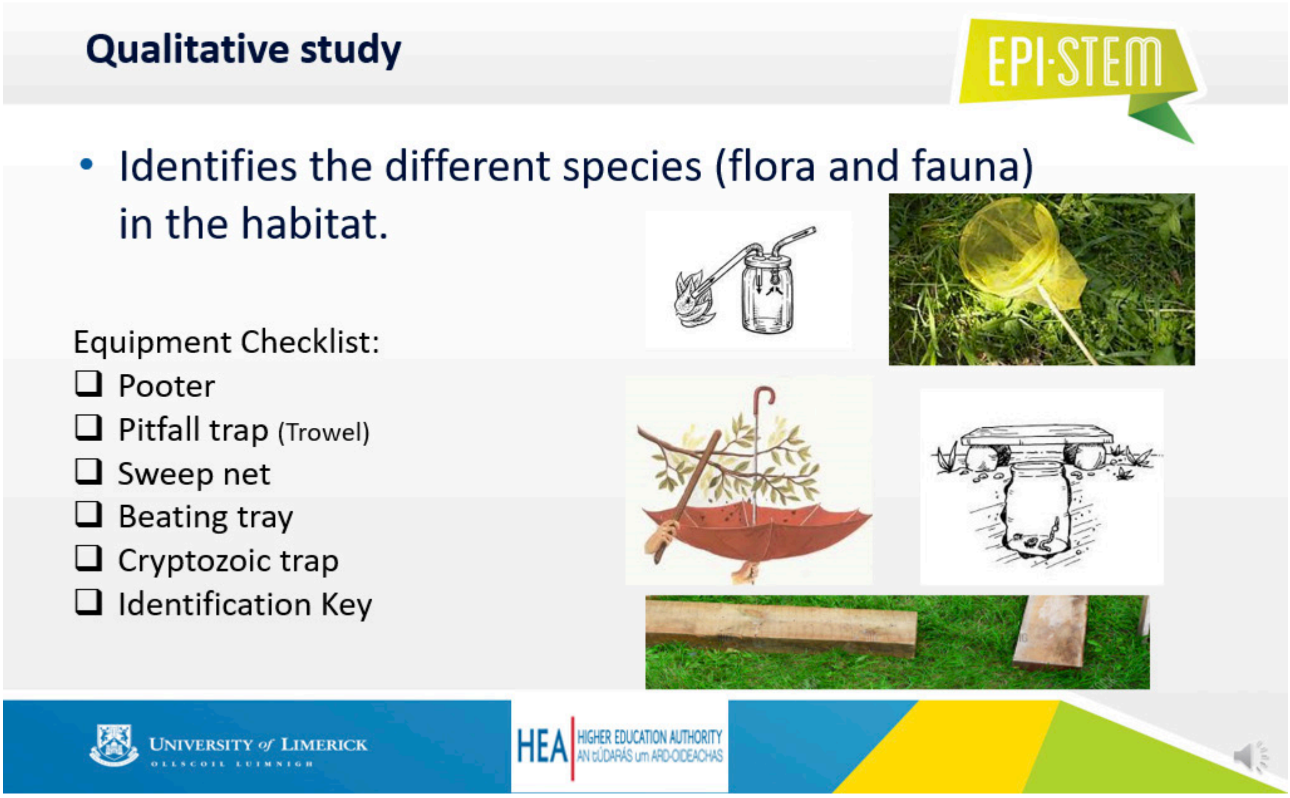
Can we give the students the opportunity to make their own plan?

Level of Inquiry	Information given to students		
	Question	Methods	Solution
1. Confirmation	X	X	X
2.Structured Inquiry	X	X	
3.Guided Inquiry	X		
4.Open Inquiry			

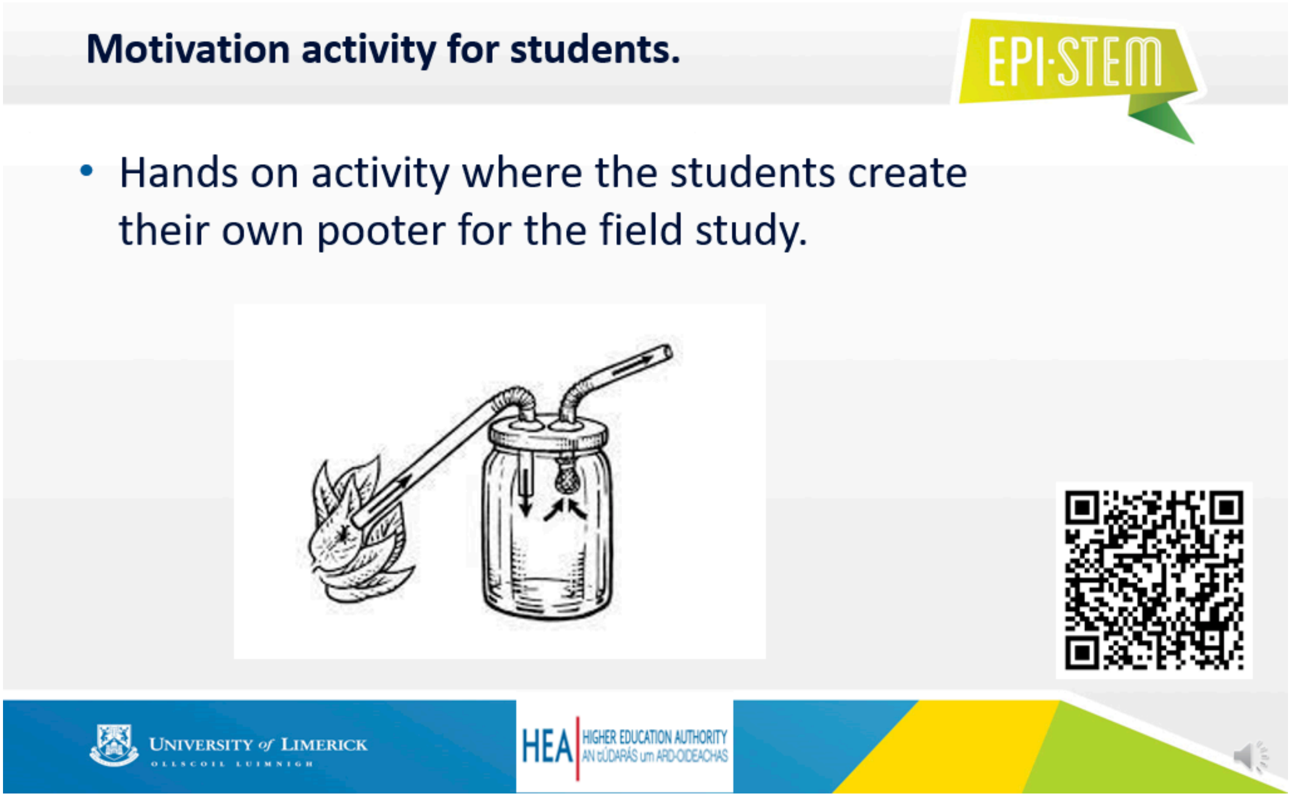
It is important that we keep inquiry to the forefront of our minds when looking at the field study relating to ecology.

Can we give students the opportunity to become the decision maker and we become facilitators of the learning??

A way to approach this could be to give the student the equipment and let them think about how to use it. It could be introduced the class before, and the students given an allocated amount of time to create a method to use the different equipment. The teacher can use prompts to help the students along, but the students should be given the opportunity to be creative and enjoy this method of investigation.



This is a checklist that can be used to ensure that the correct equipment is brought to the area.



This hands-on activity can be done with different materials students bring from home. Student can be creative have to think critically about what they want out of the investigation. The teacher could encourage students to think about selecting items which would have been thrown out as waste but are now being used for something else. (Encouraging the reuse of materials/ sustainability).

Quantitative Study

- Collect numerical data about the species in the habitat.

Equipment checklist:

- ❑ Quadrat
- ❑ Line transect.

Environmental factors.

Equipment checklist

- ❑ pH meter
- ❑ Thermometer
- ❑ Light meter

Ecology habitat studies provide an opportunity for teachers to explore the school grounds and the local area. There should be a spot somewhere on school grounds where a habitat study could be carried out. This would include Hedgerows which are an area that can be sometimes forgotten.

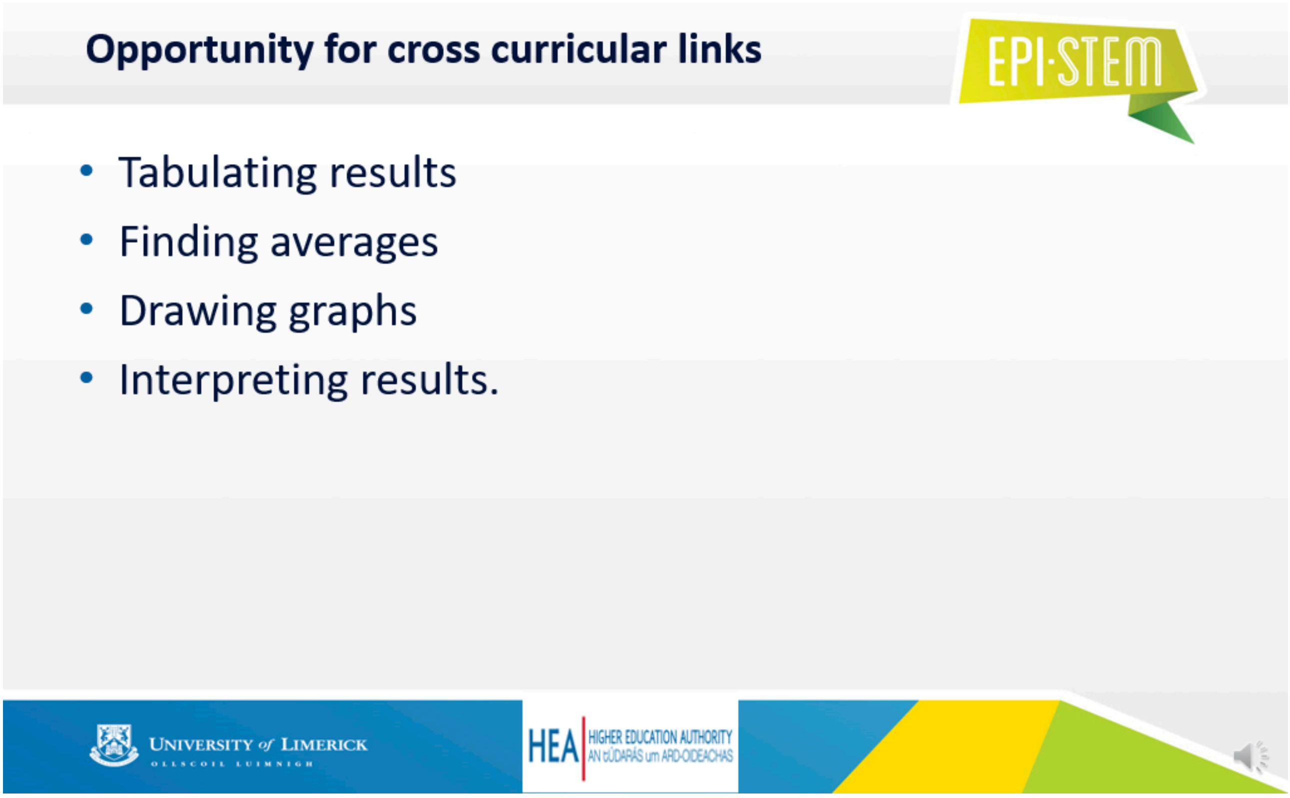
Bringing students off the school grounds can increase motivation and provide an opportunity for increased engagement.

Suggested talking points

- Acidity of soils, will it differ? Link back to acids and bases

The link in notes provides an option for schools that have no vegetation where the study could be carried out.

Options for field trips. https://taytopark.ie/schools-groups/grassland-ecology


Opportunity for cross curricular links
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• Tabulating results
• Finding averages
• Drawing graphs
• Interpreting results.
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Encourage students to make their own decisions with regards to the sources of error. Student will have to analyse their own results and reflect on their work.

Simple strategy encourages critical thinking and gives the students an opportunity to think for themselves.

Areas to prompt:

- Sample size
- Human error
- Changing conditions.
- Is there a control?

Sample Exam Question

EPI·STEM

Question 14 **30 marks**

A group of students carried out a habitat study.

(a) Use some of the words in the list to name the pieces of equipment shown below, which can be used in a habitat study.

Beating tray **Pooter** **Net** **Pitfall trap**

Picture	Name
	
	

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Sample Exam Question

EPI·STEM

(b) The students also used a quadrat during their habitat study.
What shape is a quadrat? Describe how the students might have used the quadrat.

In one part of the habitat, the students used the quadrat 30 times and found that a certain species was present on 18 occasions. Calculate the percentage frequency of that species.

Calculation

Junior Cycle Final Examination
Science – Common Level

20

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SCIENCE TEACHER LEARNING FOR IMAGINATION AND SUSTAINABILITY
EPI·STEM-HEA CPD RESOURCE INITIATIVE

ECOLOGY- A STUDY OF THE RELATIONSHIP BETWEEN ORGANISMS AND THEIR ENVIRONMENT

TRANSITION YEAR SCIENCE

GERALDINE MOONEY SIMMIE,
MARTHA COSGRAVE & TARA E. RYAN

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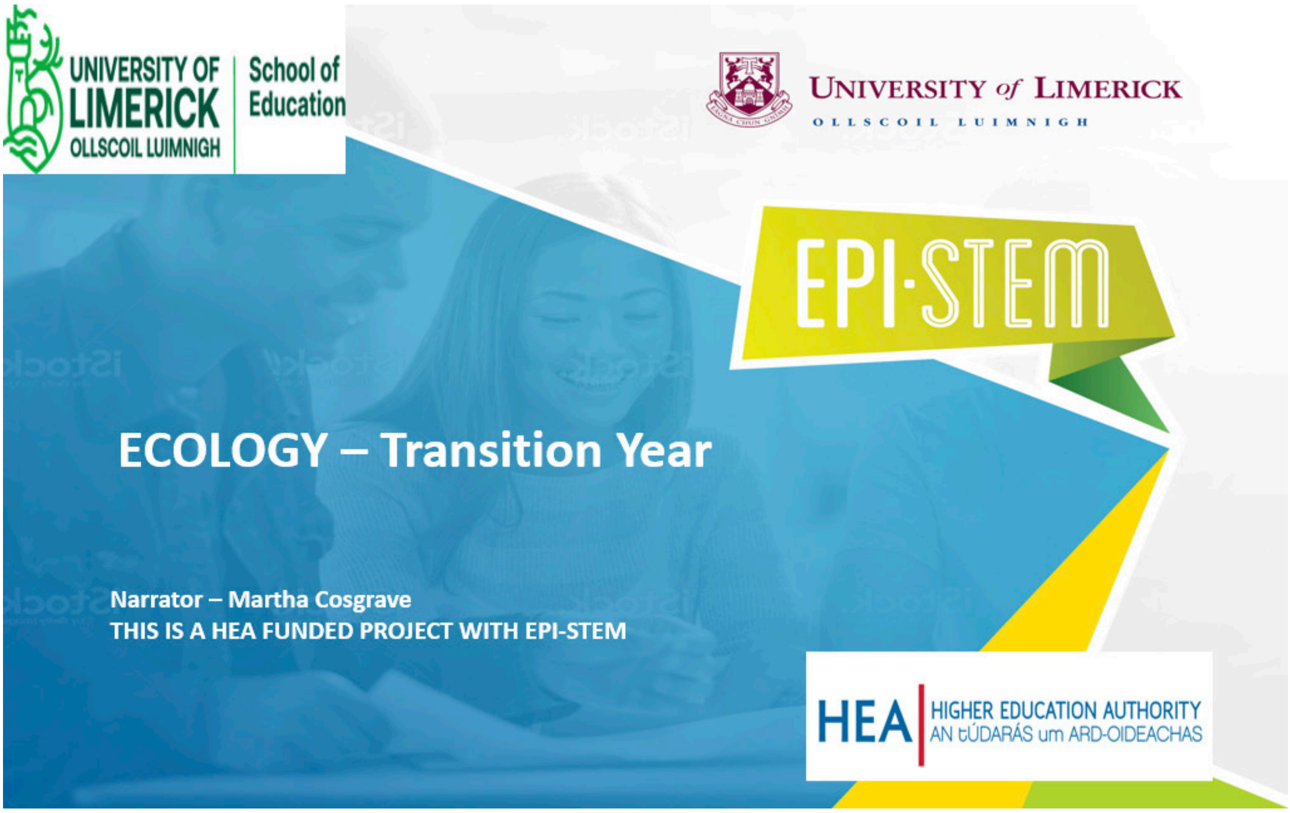

Transition Year is a year to explore scientific inquiry based on the interests of students and with the support of the science teacher and resources. Here we outline four different examples as stimulus to further research and study. Three studies are relation to organisms in Ireland, two organisms that have proven themselves valuable to the Irish landscape [woodland; air] and one species that is increasing in population growth due to the problems of over-fishing and climate change. We also provide you with an example of how-to teacher biodiversity through setting up space for this in the school grounds. There are links where interested students can begin their research project through starting to find more information and ask some crucial questions and start to develop the keen sense of the ecologist in relation to environmental protection.

Leisler bat

- Native bat to Ireland
- Biggest of Ireland Bats
- Flies higher than any other species in Ireland
- Rarely found in the UK and across Europe
- Ireland has a substantial population of these bats.
- This is why the Irish population is considered of international importance.

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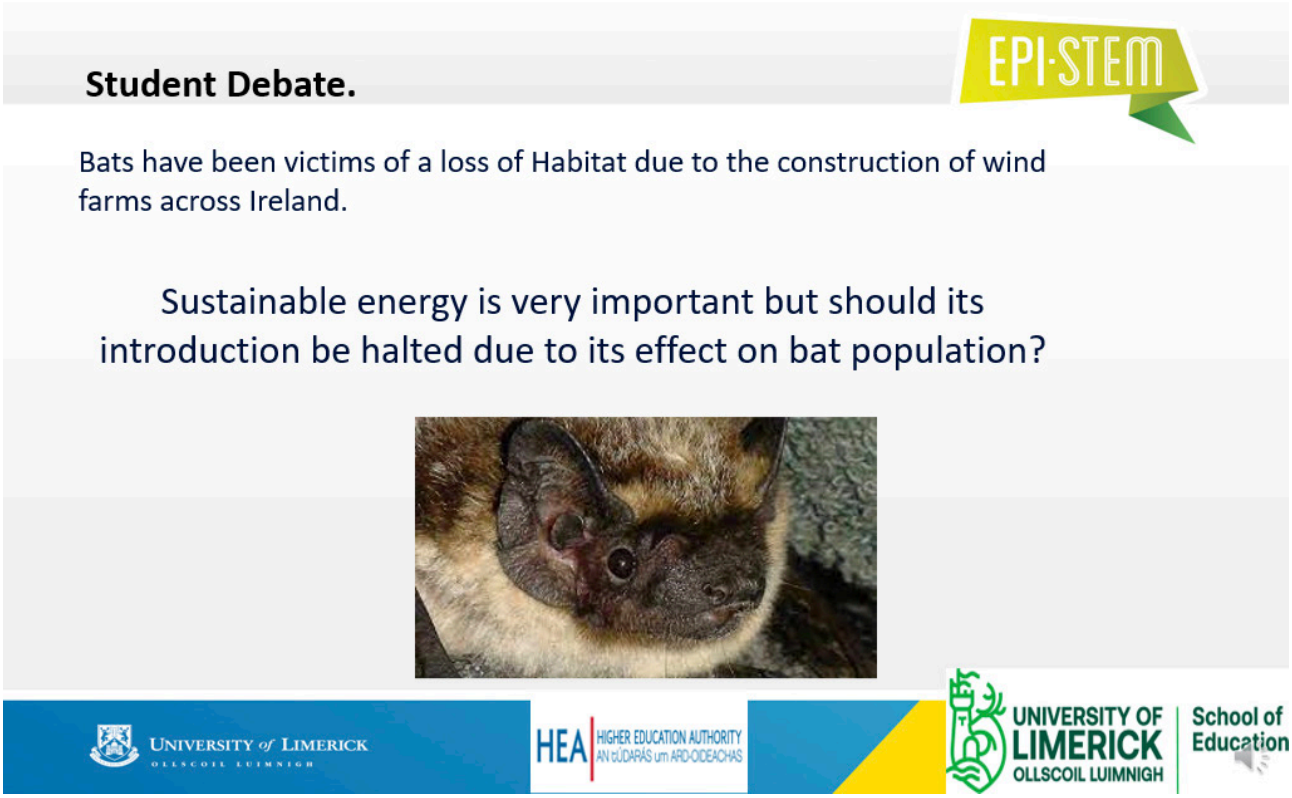


Leisler bat is a high-flying bat that flies at the same height as the turbines.
Create 2 debating teams, One for pro wind farms and one for pro bat habitat.
Give the students time to research the topic and then allow the debate to take place. Ensure that each team member has a job and knows their role.

Suggested information:
https://www.batconservationireland.org/wp-content/uploads/2013/09/BCIreland-Wind-Farm-Turbine-Survey-Guidelines-Version-2-8.pdf
https://ecofact.ie/wind-farm-bat-surveys/

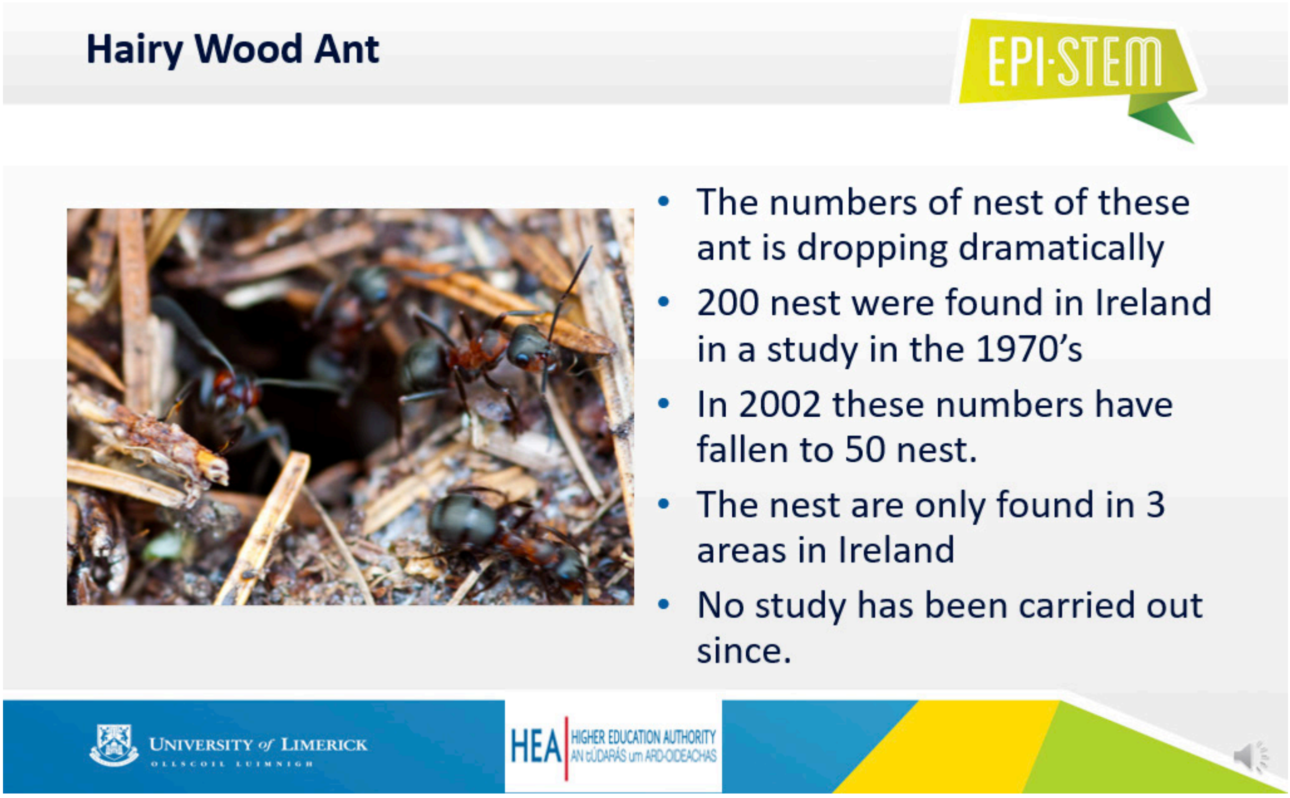
Teacher information: https://www.ucd.ie/scienceforschools/BatsTYBookSmall.pdf pg. 76

A keystone species is an organism that helps to define an entire ecosystem.
The hairy wood ant is a keystone species here in Ireland.

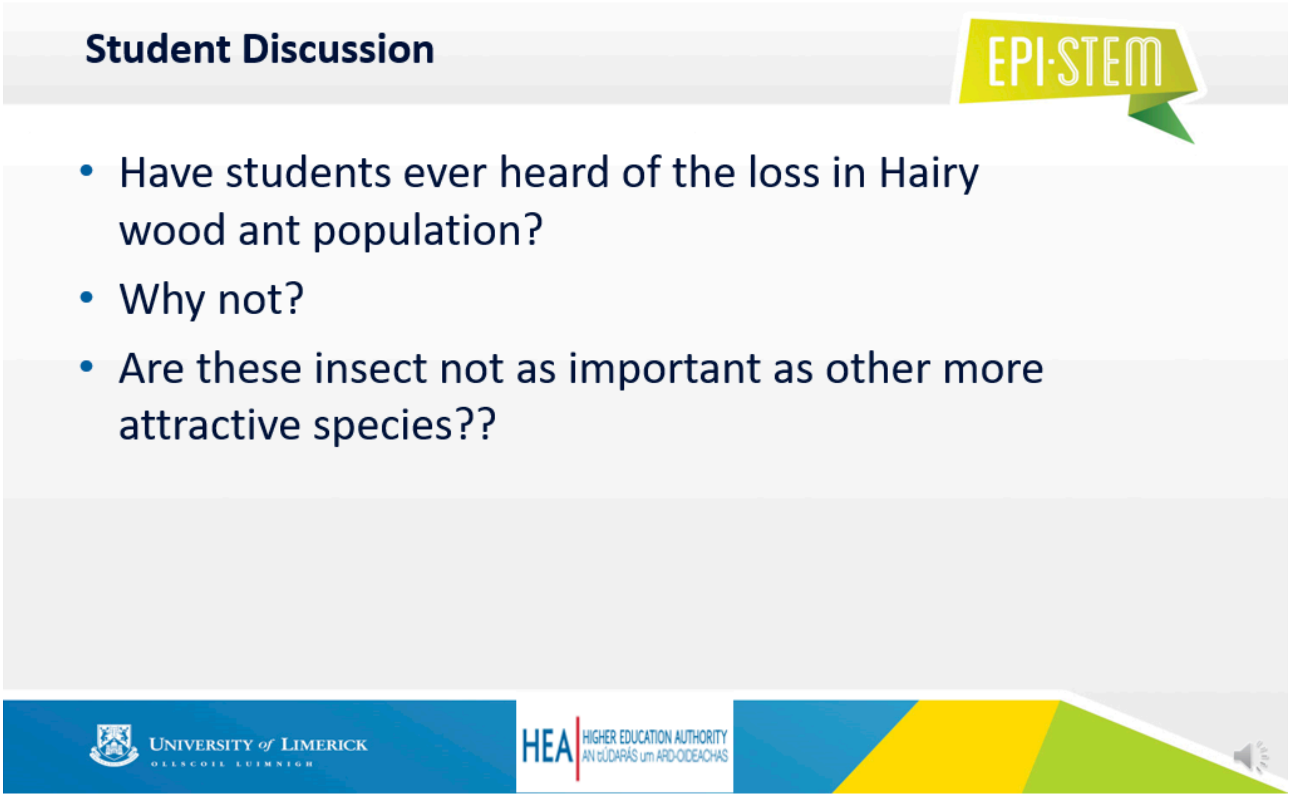
1.In their woodland habitat the hairy wood ants are soil engineers, they turn the soil which allows air, water, and nutrients to be dispersed throughout the soil.

2.They assist in seed dispersal as they carry seeds to their nests and eat the body of the seed, this means that the seed can still germinate and grow into new plants.

3.These ants have a symbiotic relationship with aphids. The ants protect the aphids from predators and the aphids produce the honeydew that the ants eat.



The numbers of these ants are dropping dramatically. In the 1970's during a study there were 200 nests found. In 2002 only 50 nests were recorded. The hairy wood ant is only found in 3 locations across Ireland. Since 2002 there has been no further study of this species although it classified as a near threatened species on the International Union for Conservation of Nature red list.



Opening a discussion with students give the students an opportunity to have their say. Questions to asl the students are, have they ever heard of this Ant species? Did they know anything about the decline in their population?

Why have they not heard of this species that is threatened? Why are we more focused on other species of animals? Are insects not as important?

How can we help biodiversity in school grounds?

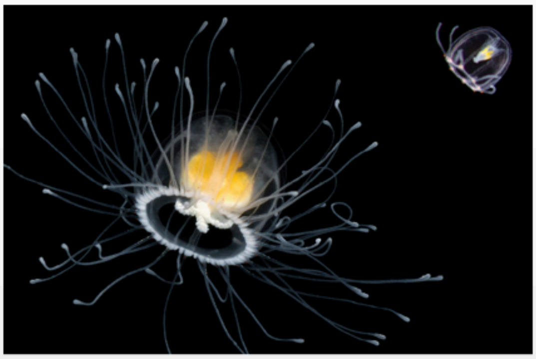
- Planters

Bug Hotels

Could these be made with the help of other classes, woodwork, construction?

Jellyfish

- Not real fish.
- They are invertebrates.
- No brain, heart, eyes or bones.
- A jellyfishes mouth is used for both eating and removing waste.
- Jellyfish are believed to have been in existence before the dinosaurs.
- They use their mouth for transportation by squirting water form their mouth they propel themselves through the water.
- Stinging tentacles are used to catch and stun prey.



There are a number of jellyfish species that are seen around the Irish coast line. Here are 6 examples of jellyfish found in our coastal waters.
Barrel jellyfish
Blue jellyfish
Common (Moon) jellyfish
Compass jellyfish
Lion's Mane jellyfish
Japanese Man O'War

- Barrel jellyfish - can form large blooms every year off Rosslare and Wexford Harbours, however, it is rarely found anywhere else in large numbers.

- Blue jellyfish – the highest numbers of this species are found off the south and west coasts, at times it can be found throughout the entire Celtic Sea.

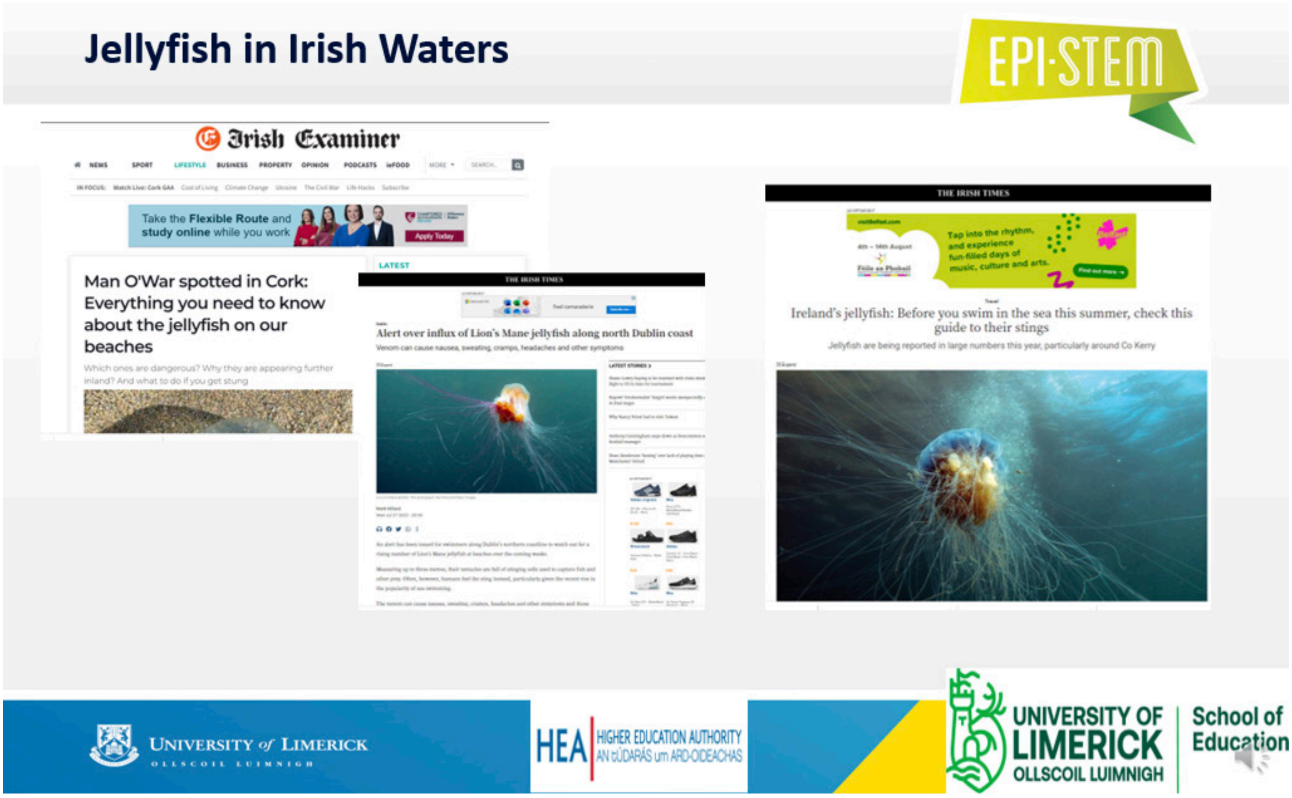
- Common jellyfish - this is the most come jellyfish in Irish waters and is most often found in harbours and estuaries. It can sometimes form very dense blooms.

- Compass jellyfish - found in highest numbers off the south and west coasts, and at times can be found throughout the entire Celtic Sea.

- Lion's Mane jellyfish - prefers the cooler waters of the Irish Sea and especially the waters off Dublin. Recently an increase has been seen in waters off the East Coast and some very large jellyfish have been observed on beaches in this area.

- Portuguese Man O'War – although this species is not technically a jellyfish, this close relative appears in Irish waters during bouts of good weather. A south westerly wind carries them from their tropical habitats.

1 Blue jellyfish – Sting.
2 Common jellyfish – mild sting
3 Portuguese Man O'War – severe sting
4 Compass jellyfish – Severe sting
5 Barrel jellyfish – No tentacles – prolonged exposure can cause allergic reactions.
6 Lions mane jellyfish – severe sting.



During the summer months there are an influx in the number of jellyfish spotted in Irelands coastal waters. But why?

The reason for the increased number of jellyfish is a combination of overfishing and climate change.

Due to overfishing, there are not enough fish to eat the jellyfish when they are smaller. This leads to larger numbers of jellyfish.

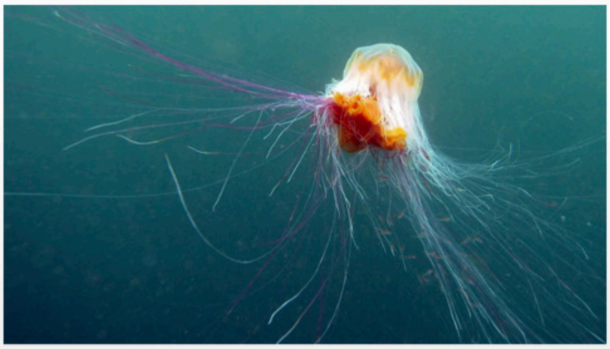
Climate change is heating up the earth which includes the oceans. Jellyfish are showing their resilience to the increase in temperatures and can thrive in warm, deoxygenated waters, while other fish die.

Class Discussion – Climate change and Sustainability

- Climate change is having an increased impact on ecosystems across the world.
- Climate change and overfishing are having a detrimental effect on the ecosystems in our oceans.
- Ask students to discuss the topic in groups and use their discussions to start a larger class discussion.

Food chains and Food webs

- Give students time to research and complete a food chain and food chain which involves one of the jellyfish previously mentioned.
- Remove the predator linked to the jellyfish and discuss the difference this makes to the chain with students.



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EPI·STEM-HEA CPD RESOURCE INITIATIVE

ECOLOGY- A STUDY OF THE RELATIONSHIP BETWEEN ORGANISMS AND THEIR ENVIRONMENT

LEAVING CERTIFICATE BIOLOGY

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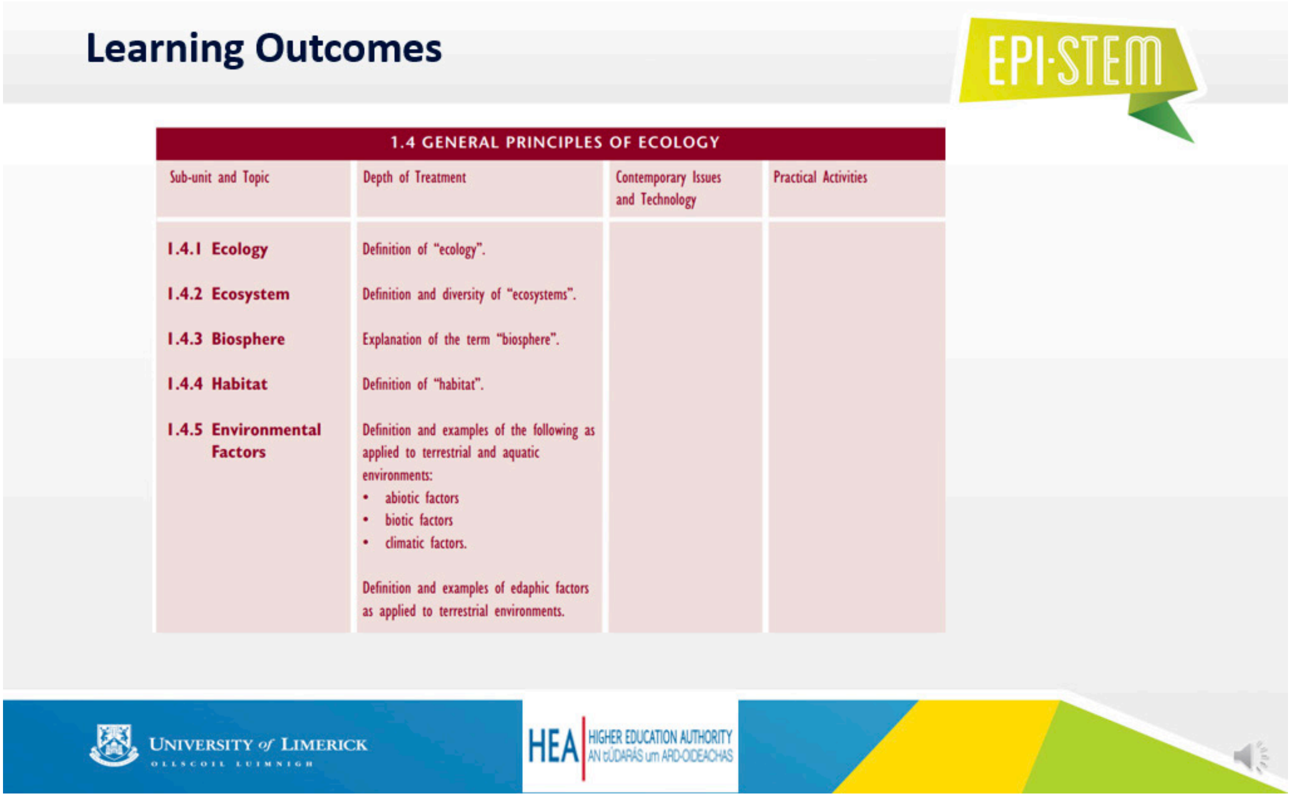
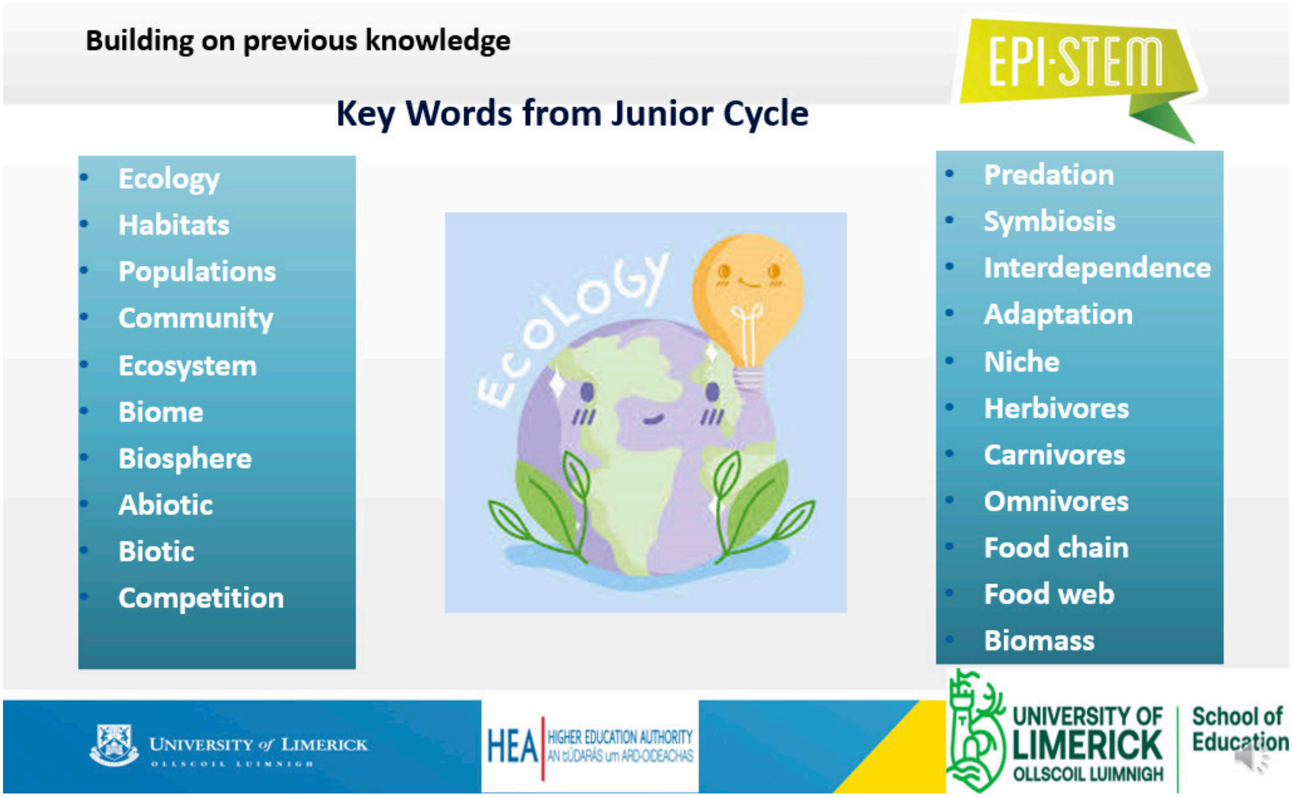
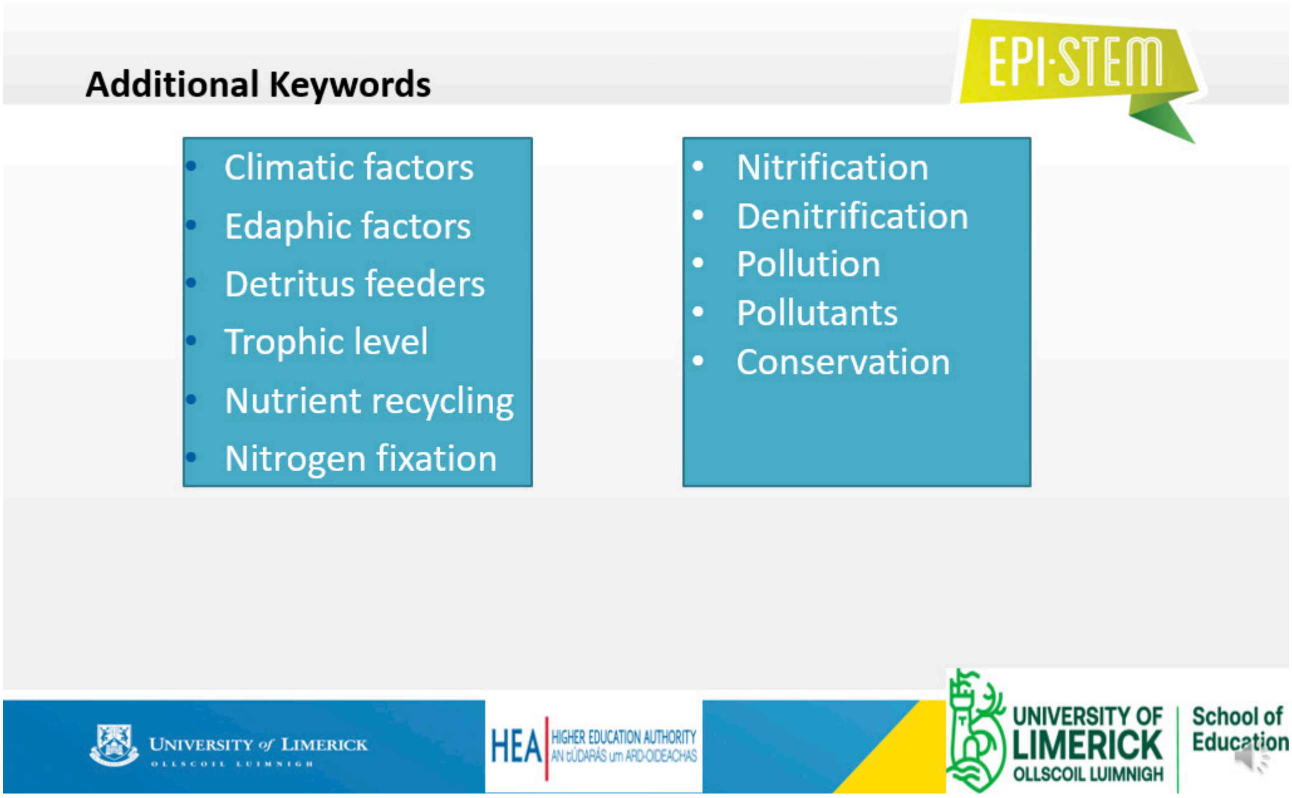


1.4 GENERAL PRINCIPLES OF ECOLOGY			
Sub-unit and Topic	Depth of Treatment	Contemporary Issues and Technology	Practical Activities
1.4.1 Ecology	Definition of "ecology".		
1.4.2 Ecosystem	Definition and diversity of "ecosystems".		
1.4.3 Biosphere	Explanation of the term "biosphere".		
1.4.4 Habitat	Definition of "habitat".		
1.4.5 Environmental Factors	Definition and examples of the following as applied to terrestrial and aquatic environments: • abiotic factors • biotic factors • climatic factors. Definition and examples of edaphic factors as applied to terrestrial environments.		



Leaving certificate Biology students would have a great base of knowledge collected from the junior cycle science.

If students can recall their previous knowledge, then building on this knowledge is easier.



As in the junior cycle definitions are required for the leaving certificate ecology syllabus.

Students can be given prompts to help memorised this definition. Mind maps or Flash cards can be helpful for students.

The Frayer method can again be used to help with definition.

Assessing the Knowledge – Keyword Bingo!

Predator	Niche	Biotic Factors	Nitrogen Fixation	Symbiosis
Ecology	Food chain	Prey	Flora	Detritus feeders
Fauna	Community	Conservation	Nitrification	Adaptation
Interdependence	Biome	Competition	Biomass	Food Web
Abiotic Factors	Pollution	Edaphic factors	Biosphere	Parasitism

Students draw a table (3X3) and pick nine of the keywords at random from the table shown.

The teacher reads out the definitions or description for the keywords and the students must match the definition to their keyword.

The first student to match their 9 words with the definitions wins!!!

Different Ecosystems

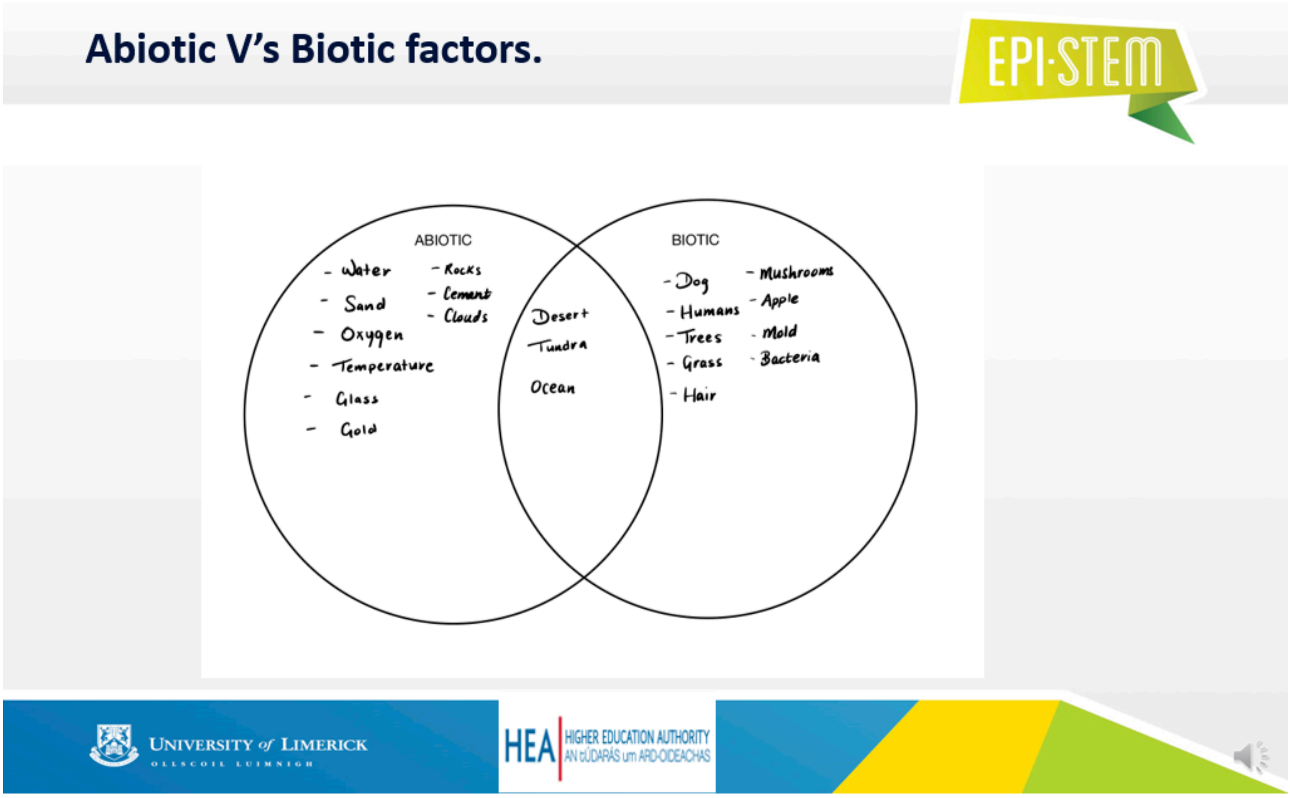
Examples of Ecosystems		
Ecosystem	**Features**	**Samples Locations**
Temperate deciduous forest	Warm summers, rain plentiful	Western Europe (Ireland), Eastern USA.
Desert	Low Rainfall	Sahara Desert, Gobi Desert
Tropical Rainforest	High temperatures and high rainfall	Brazil, West Africa, parts of South East Asia.
Grassland	Mid Temperatures, low rainfall	Steppes of Asia, pampas in South America, prairies in North America.
Freshwater	Non-salty water	Rivers, lakes, wetlands
Marine	Salt water	Seashores and oceans

Here we have a table which outlines examples of different ecosystems.

Environmental factors

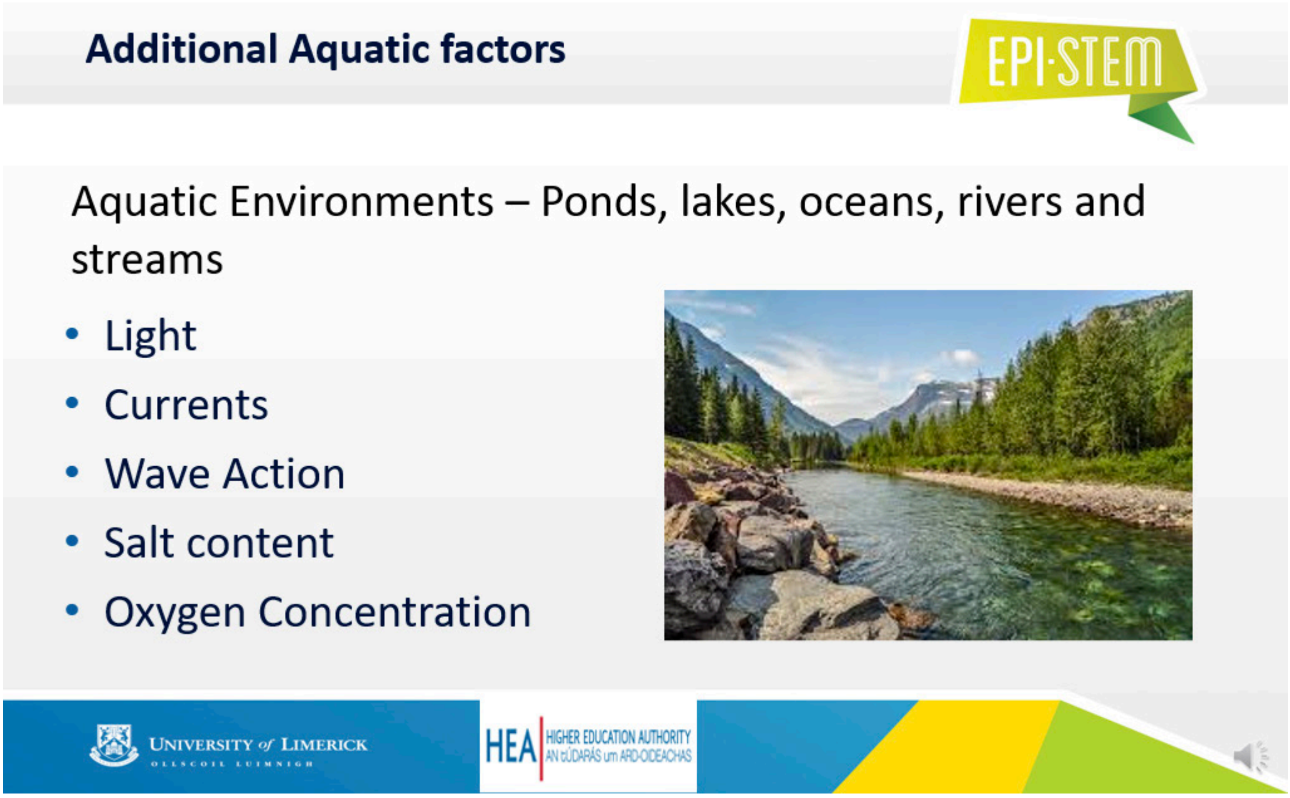
Factor	Definition	Examples
Abiotic	Non-living factors	Altitude, Aspect, Steepness, exposure, currents
Biotic	Living Factors	Food Predation, pollination, seed dispersal, Human Interaction.
Climatic	Long-term weather factors	Temperature, Rainfall, Humidity, light intensity, wind, salinity.
Edaphic	Soil factors	Soil pH, type, organic matter content, water, air, and mineral content.

Environmental factors are split into four different categories. These factors affect living things by their variation in levels and from season to season.



Students can sometimes have issues distinguishing between abiotic factors and biotic factors. Using a Venn diagram can help students to differentiate between the two and have a much clearer understanding.

Students need to be able to comfortably differentiate between abiotic and biotic factors.



Light - Water interferes with light penetration. Plants are limited to the upper layer of water and plants which attach to the bottom can only grow in shallow waters.

Currents - Plants can be carried away if they are not attached to a surface in some way.

Animals can avoid this as they can move away from the faster flowing water.

Wave action – Waves can cause physical damage to organisms. Some animals have adapted and produced a shell e.g., barnacles. Seaweeds are flexible to avoid damage.

Salt content – Most aquatic organisms have adapted to a freshwater environment. If the external solution is unsuitable the organisms have issues with osmoregulation.

Oxygen concentration - The concentration of oxygen is much lower in water than in air.

Organisms have adaptations to extract oxygen from water.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EPI·STEM
Ecology – Leaving Certificate
Energy flow through the ecosystem.
Narrator – Martha Cosgrave
THIS IS A HEA FUNDED PROJECT WITH EPI-STEM
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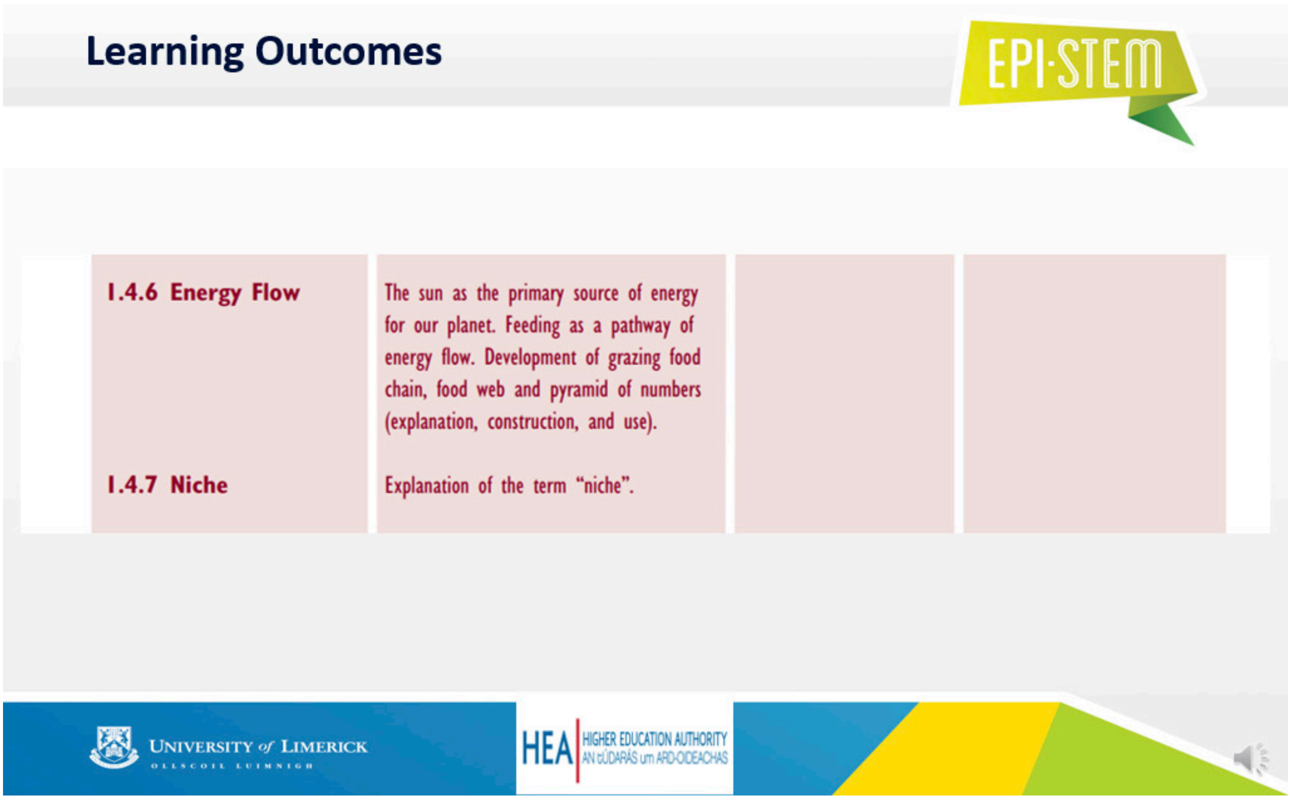
Learning Outcomes
EPI·STEM
1.4.6 Energy Flow
The sun as the primary source of energy for our planet. Feeding as a pathway of energy flow. Development of grazing food chain, food web and pyramid of numbers (explanation, construction, and use).
1.4.7 Niche
Explanation of the term "niche".
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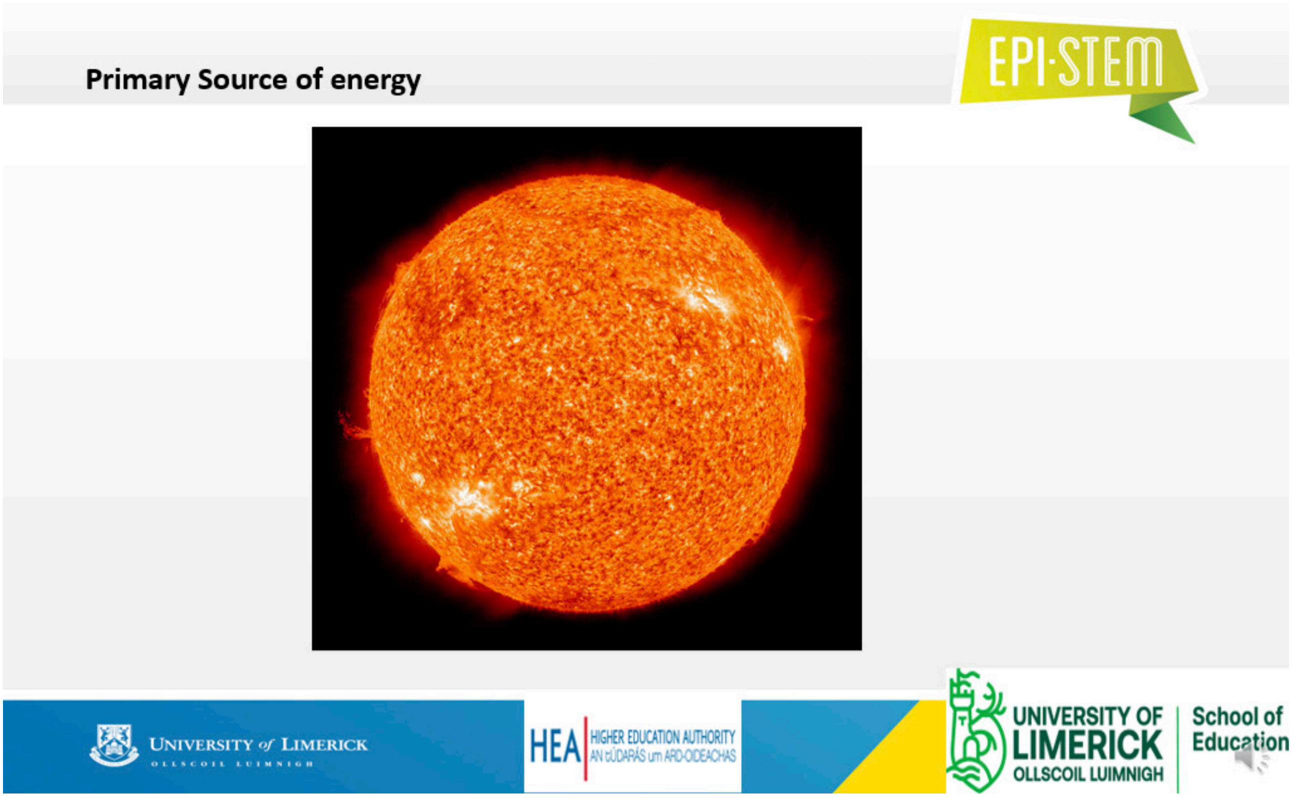
From the junior cycle curriculum students have an understanding of energy flow in an ecosystem.

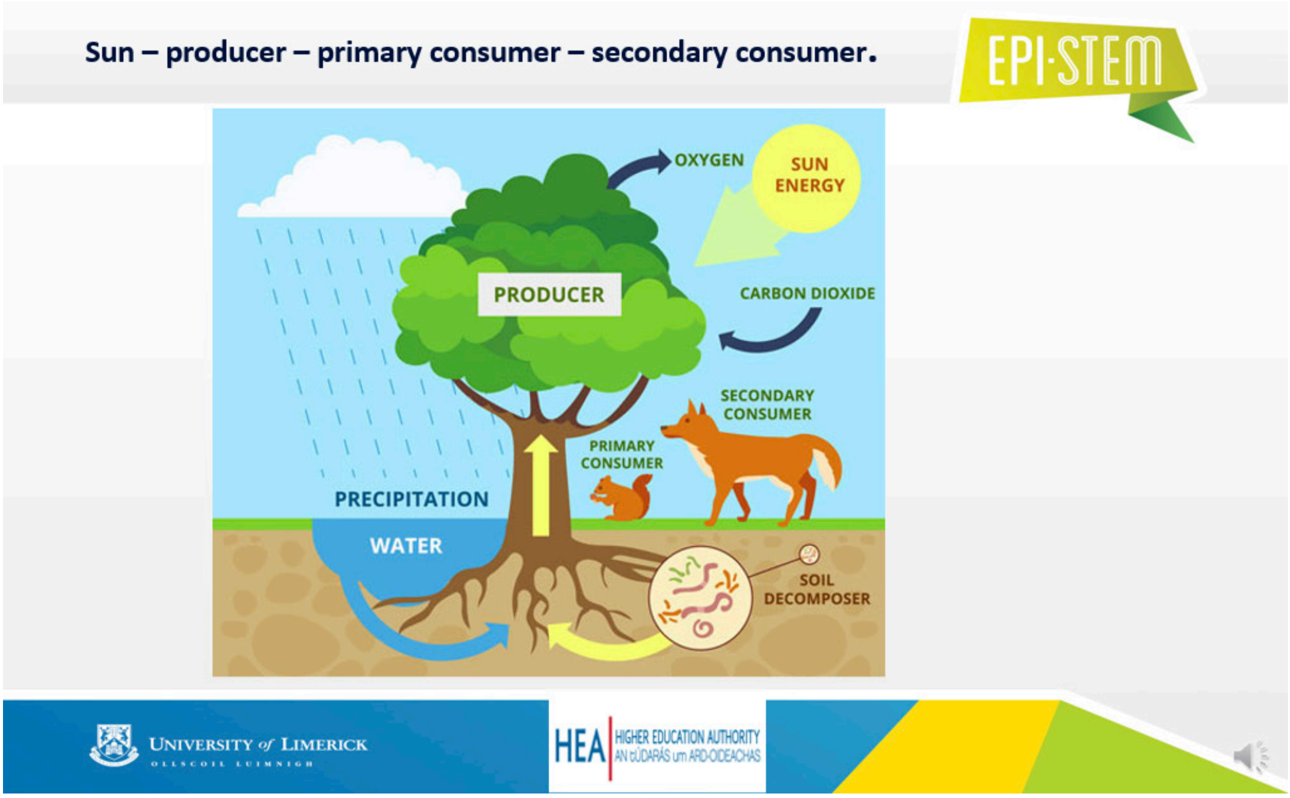
They have a basic understanding of food webs and food chains and how energy and matter differ.

Key Words:

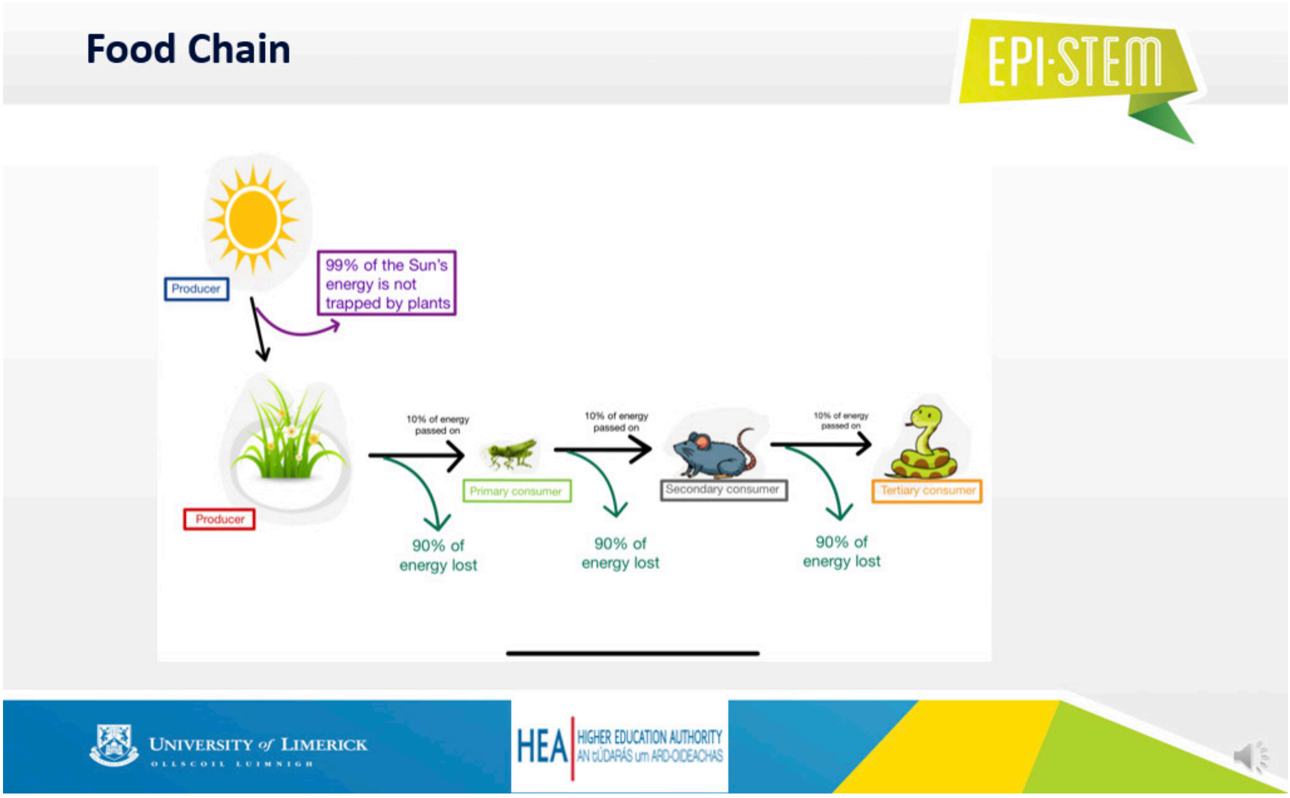
- Producer
- Consumer
- Decomposer
- Primary, secondary, and tertiary consumer.



An ecosystem needs a constant input of energy from an external source. Our students must be comfortable with the understanding that the primary source of our energy for our planet is the sun.



Trophic levels: The Sun provides energy in the form of food for the producer. The producer provides energy for the primary consumer. Etc.

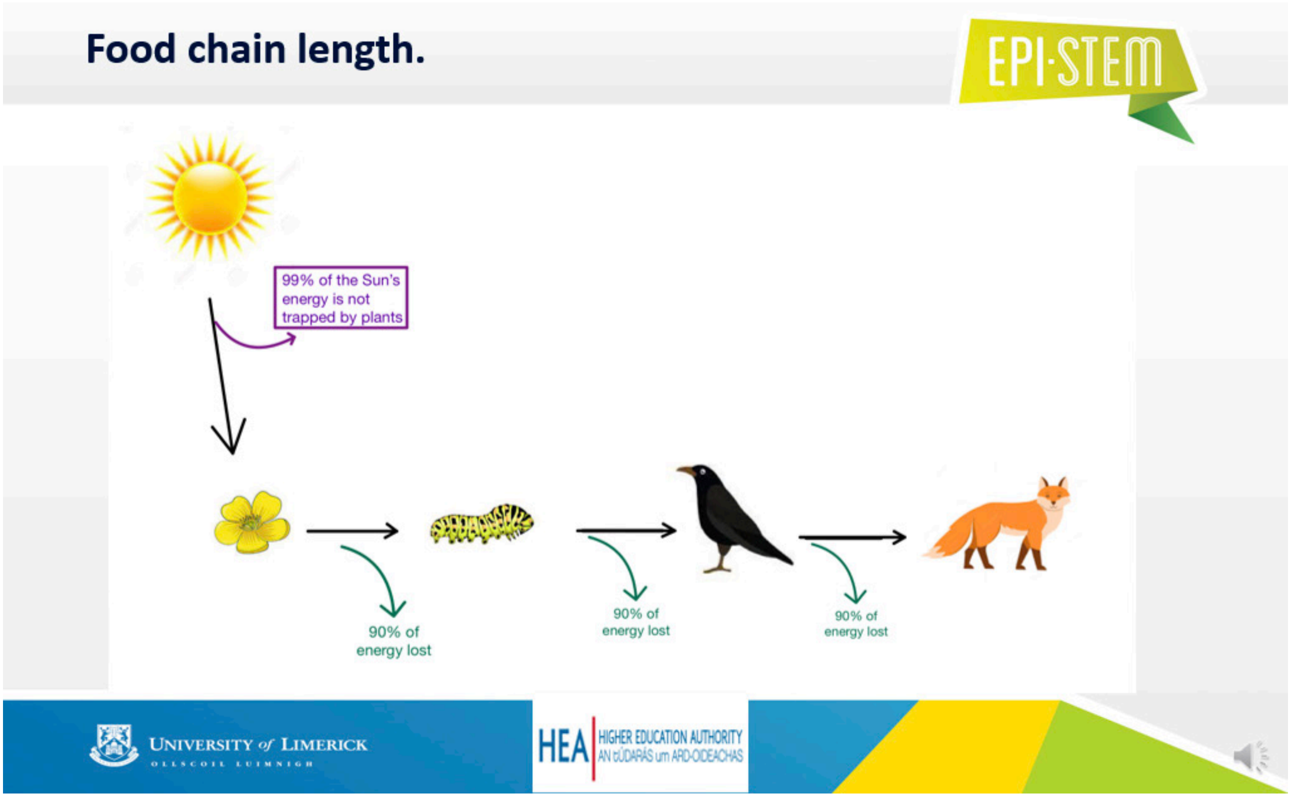


A food chain is a sequence of organisms in which one is eaten by the next member in the chain.

In this food chain the sun is the producer. The plant uses energy of the sun to create food in the form of glucose. The grasshopper is the primary consumer as it eats the plant. The rat is the secondary consumer, and the snake is the tertiary consumer. In this case the snake is the top consumer.

As 90% of the energy is lost where does this energy go?

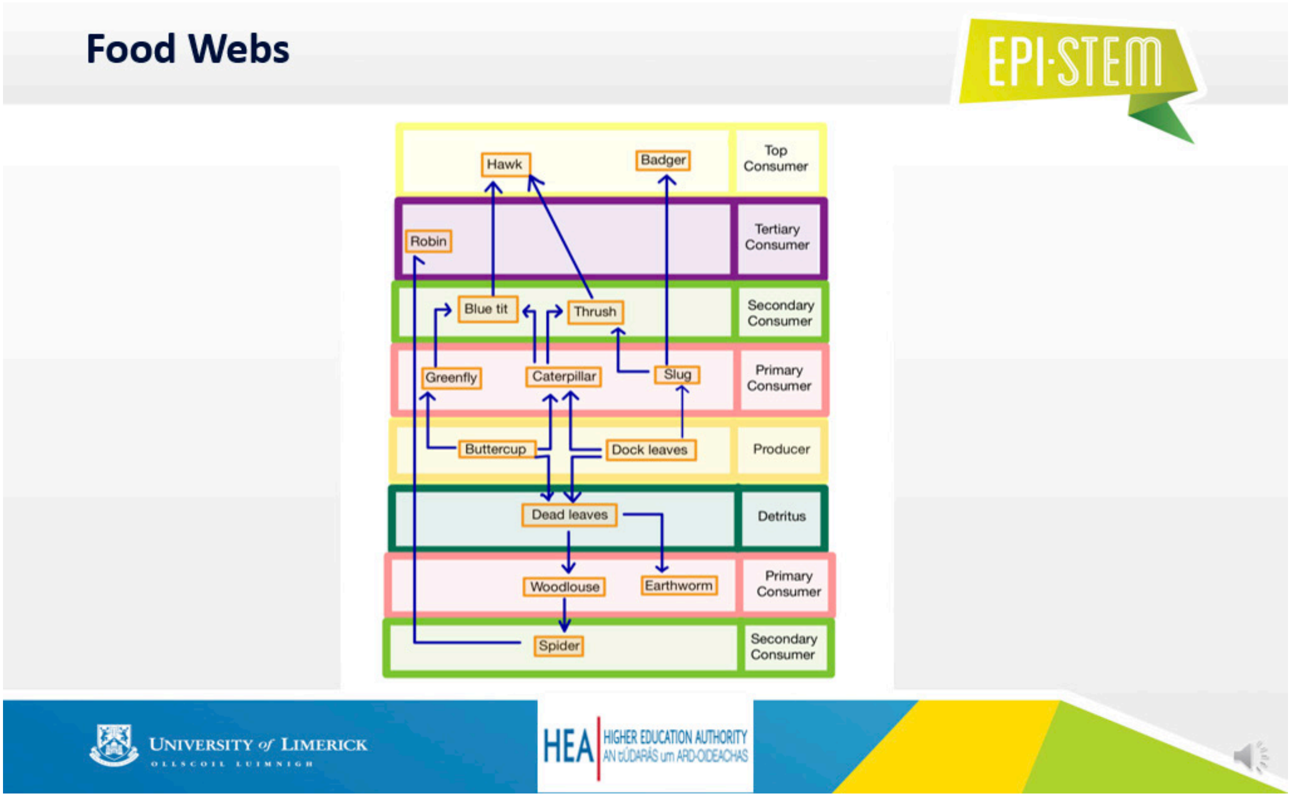
Why are food chains short? How do you think populations are affected as we move up through the pyramid?



As we already know only approximately 10% of the energy is passed from one trophic level to the next. The other 90% of the energy is used by the organism or is lost as heat or waste. Therefore, the amount of energy passed along the chain decreases. Therefore, the length of the chain is short. The fox must use lots of energy to get its prey (blackbird). So, if something was to hunt the fox it would use too much energy hunting. This is why the chain ends with the fox.

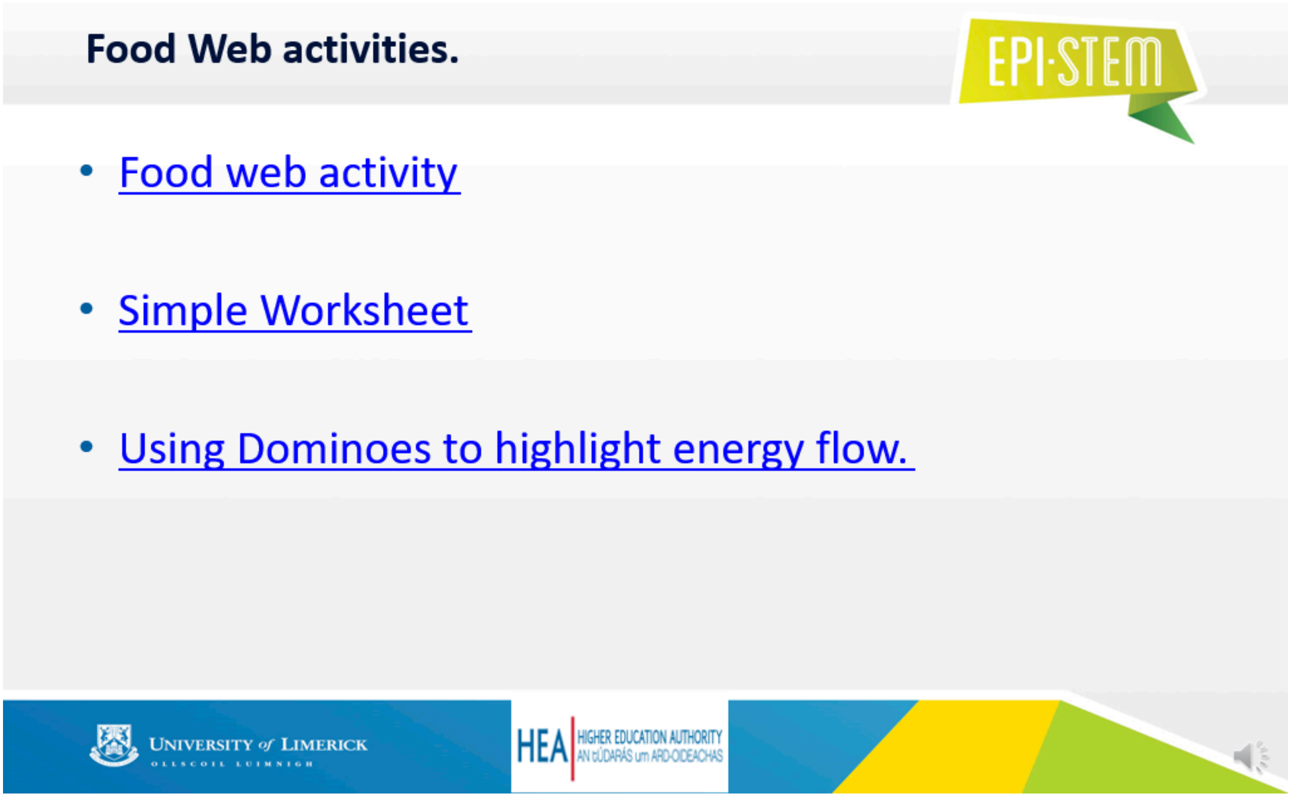
This may seem like a simple exercise however, giving students time in the classroom to interact with food chains can be very useful for students as they are engaging directly with the content.

These activities can prove very useful as the students are building their own food chain and in turn are learning by doing.



A food web consists of two or more interlinked food chains. These webs show the feeding inter-relationships in an ecosystem. They model flow of energy through an ecosystem.
This shows an example of a food web found in a grassland habitat. Visual aids are extremely important for students and practicing drawing and labelling food webs can help students to gain confidence constructing these webs.

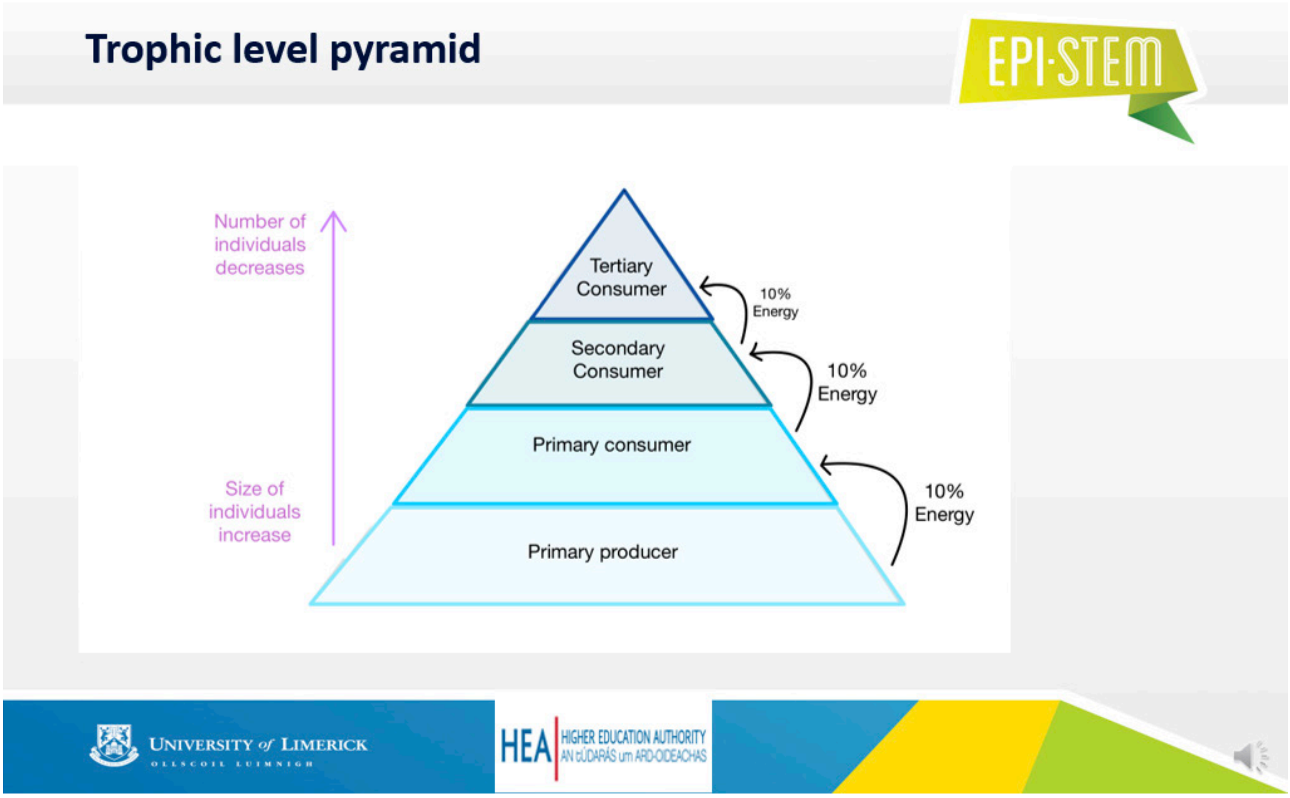
Speaking to students about the importance of links in the food web is important. Links higher up in the food web rely on the lower links. Even though Badgers don't eat dock leaves, they wouldn't last long if there weren't any dock leaves because then the slugs wouldn't have anything to eat.



Food web tag. Activities that take place outside the classroom and encourages active learning.

Worksheet has extension opportunity for students to make their own food web.

Energy flow though the eco system is important for students to understand and has previously been covered in the junior cycle curriculum. Therefore, this should just be reinforced for students.


Trophic level pyramid
EPI·STEM
Number of individuals decreases
Size of individuals increase
Tertiary Consumer
Secondary Consumer
Primary consumer
Primary producer
10% Energy
10% Energy
10% Energy
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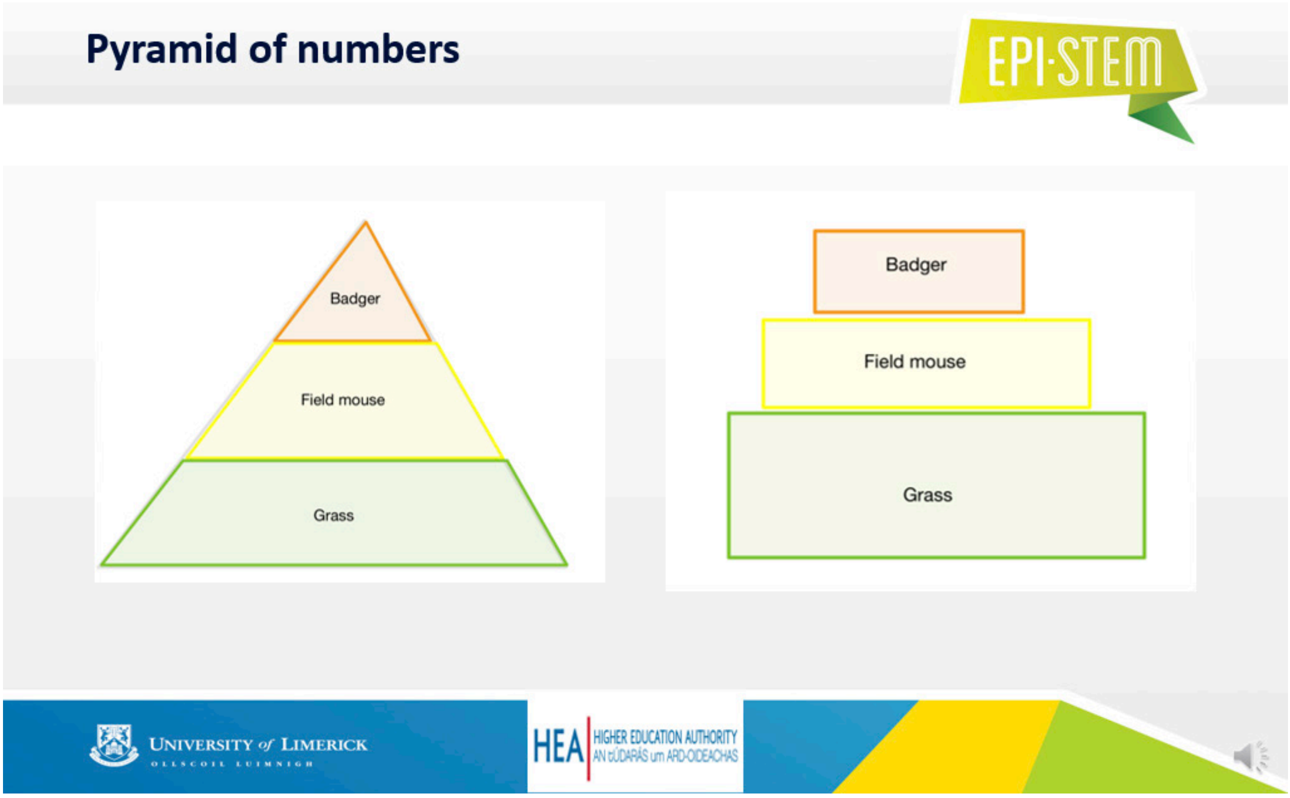


A pyramid of numbers represents the numbers of organisms at each trophic level in the food chain. The number of organisms usually decreases as we move up through the food chain.

This is due to the high energy loss at each trophic level. This means there is less energy available for the organisms as we move up along the chain.

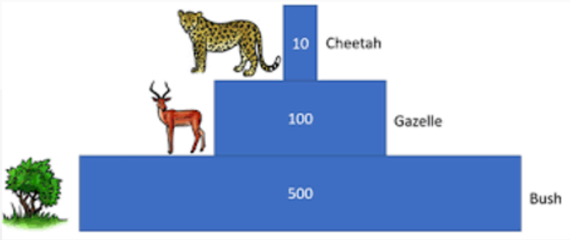
The organism size also increases as we move along the chain.

The example given on this slide is the food chain Grass → Field Mouse → Badger. There is an abundance of grass to feed the mouse. There are fewer mice than grass, there are fewer badgers.

Steps to creating a pyramid of numbers

EPI·STEM

1. Identify and count the primary producer and place them on the base of the pyramid.
2. Count the different consumers and include them based in their status. Identify the primary and secondary consumer.
3. Place the top consumer (tertiary consumer) on the top of the pyramid
4. Construct the pyramid so that the area/volume of each level is proportional to the number of organisms found.



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Sample Question

EPI·STEM

- Sample question for students
- Draw the following food chain
  - Rabbits(3) Dandelions (15) Fox (1)

- Construct the pyramid of numbers for the chain.

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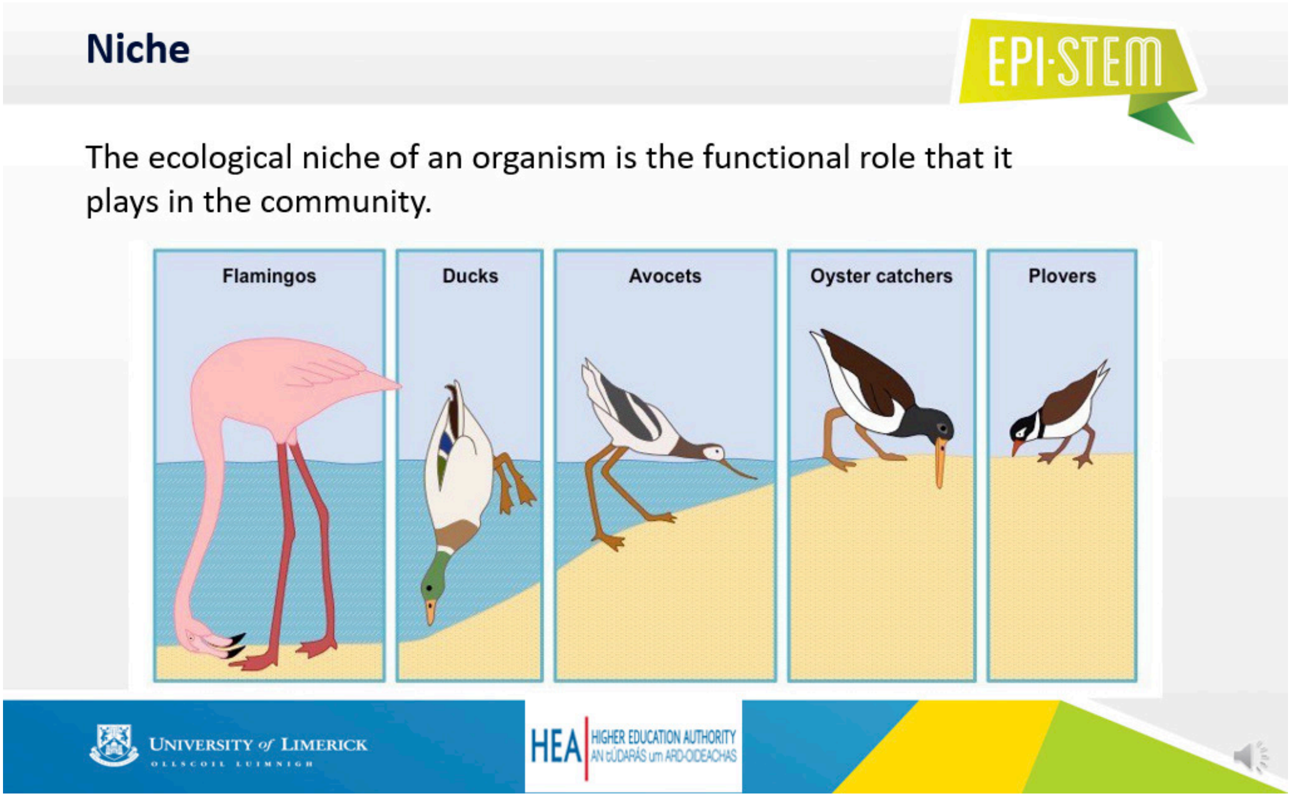

An organisms niche includes what it eats, what it is eaten by, how it interacts with other organisms and its abiotic environment.

Two species with identical niches cannot survive in the same habitat for long.

This would lead to competition between the two species.


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EPI·STEM
Ecology Part 2 - Leaving Cert
Nutrient Recycling
Narrator – Martha Cosgrave
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Learning Outcomes
EPI·STEM
1.4.8 Nutrient Recycling
Nutrient recycling by organisms: definition. Outline of the Carbon Cycle and the Nitrogen Cycle. (Names of micro-organisms are not required).
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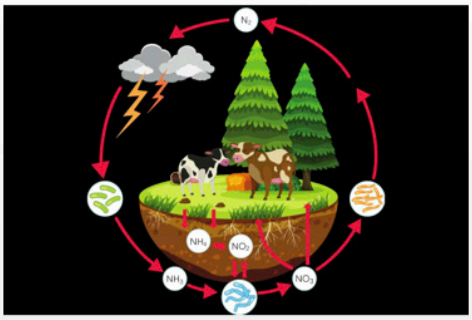
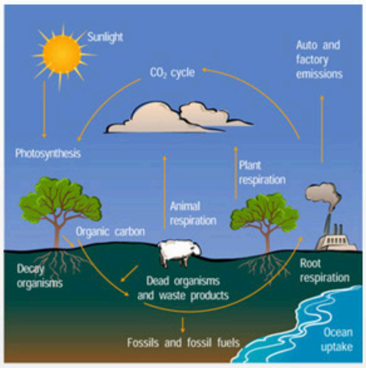
Nutrient Recycling

Elements are exchanged between the living and non-living components of an ecosystem.





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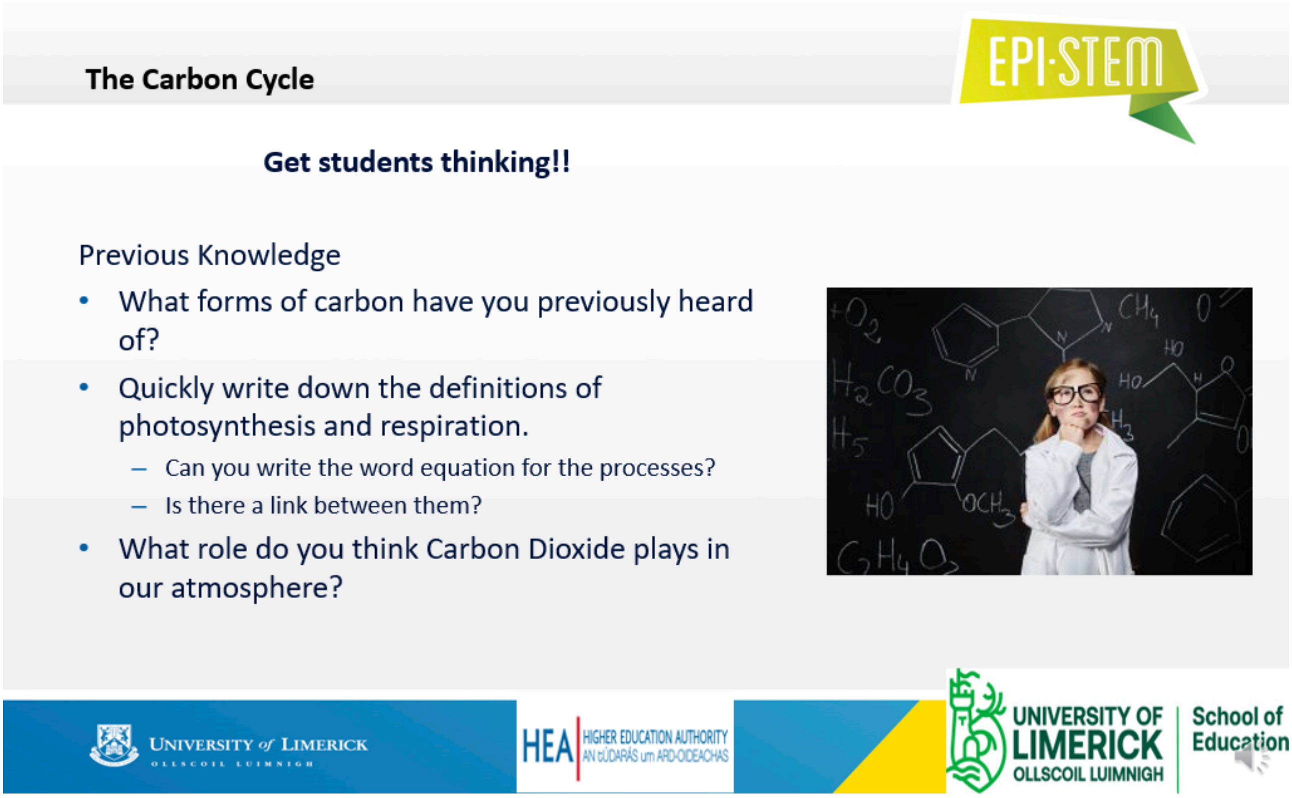


What forms of carbon have you previously heard of?

- Carbon Dioxide
- Calcium Carbonate
- Hydrocarbon
- Carbohydrates

Photosynthesis definition – processes where plants/algae use energy from the sun to convert carbon dioxide and water to glucose and oxygen.

- Word Equation: Carbon dioxide + Water → Glucose + Oxygen
- Chemical Equation: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Respiration definition – a process involving chemical reaction that break down nutrient molecules in living cells to release energy. There is aerobic respiration and anaerobic respiration.

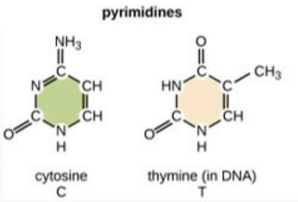
- Word Equation: Glucose + Oxygen → Carbon dioxide + Water
- Chemical Equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

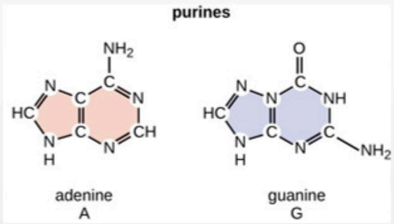
Links – The equations have the same compounds present. The reactant for respiration and the products for photosynthesis. And the reactants of photosynthesis are the products of respiration.

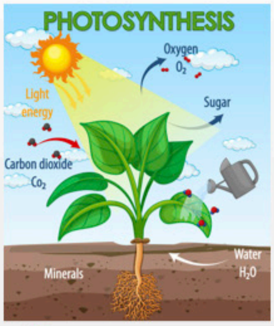
Carbon dioxide traps heat and is known as a greenhouse gas.

Why is Carbon important?

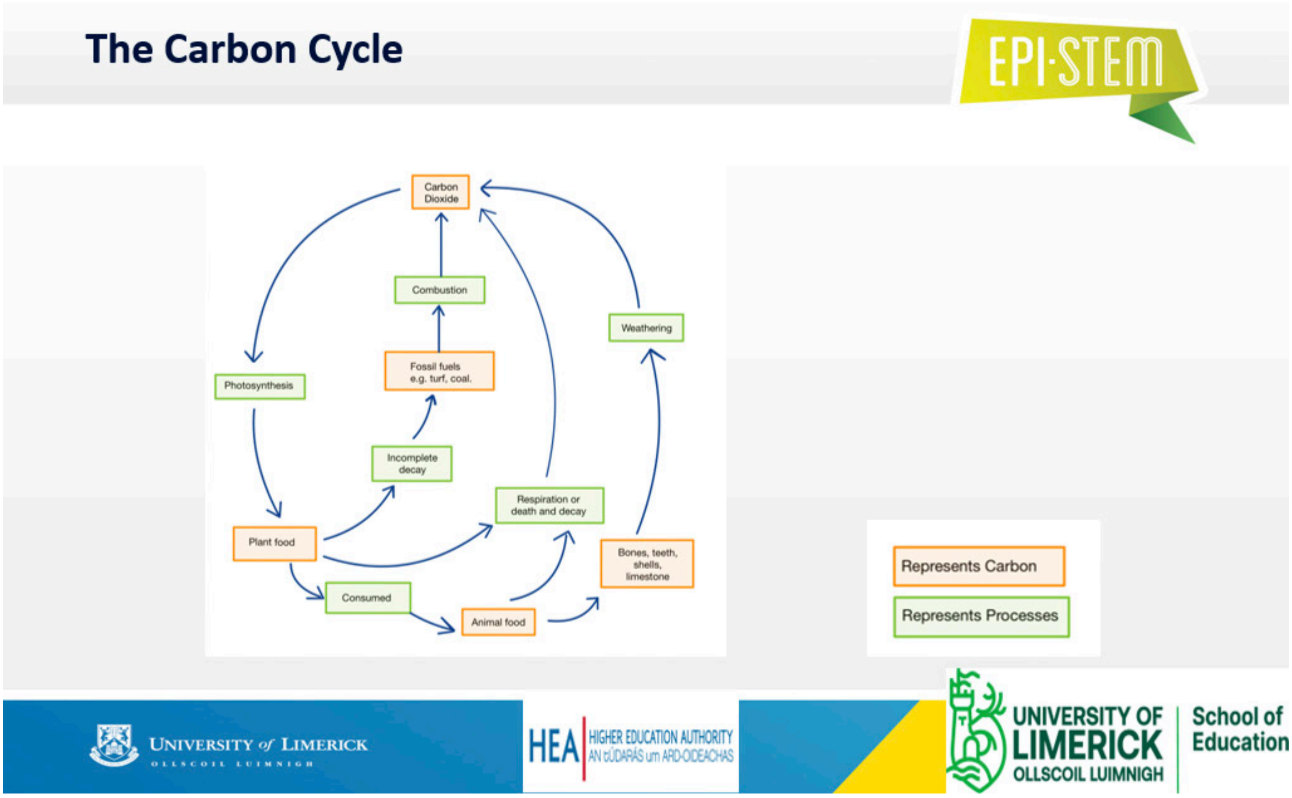
- It is essential for life.
- Chemical backbone of life on earth.
- Carbon is needed for plants to photosynthesise and grow.
- Carbon is needed in the atmosphere as it maintains the temperatures on Earth.







Prompt students to think about other reasons.



Students need to know the Carbon Cycle and be able to describe it.

Is essential for all life forms.

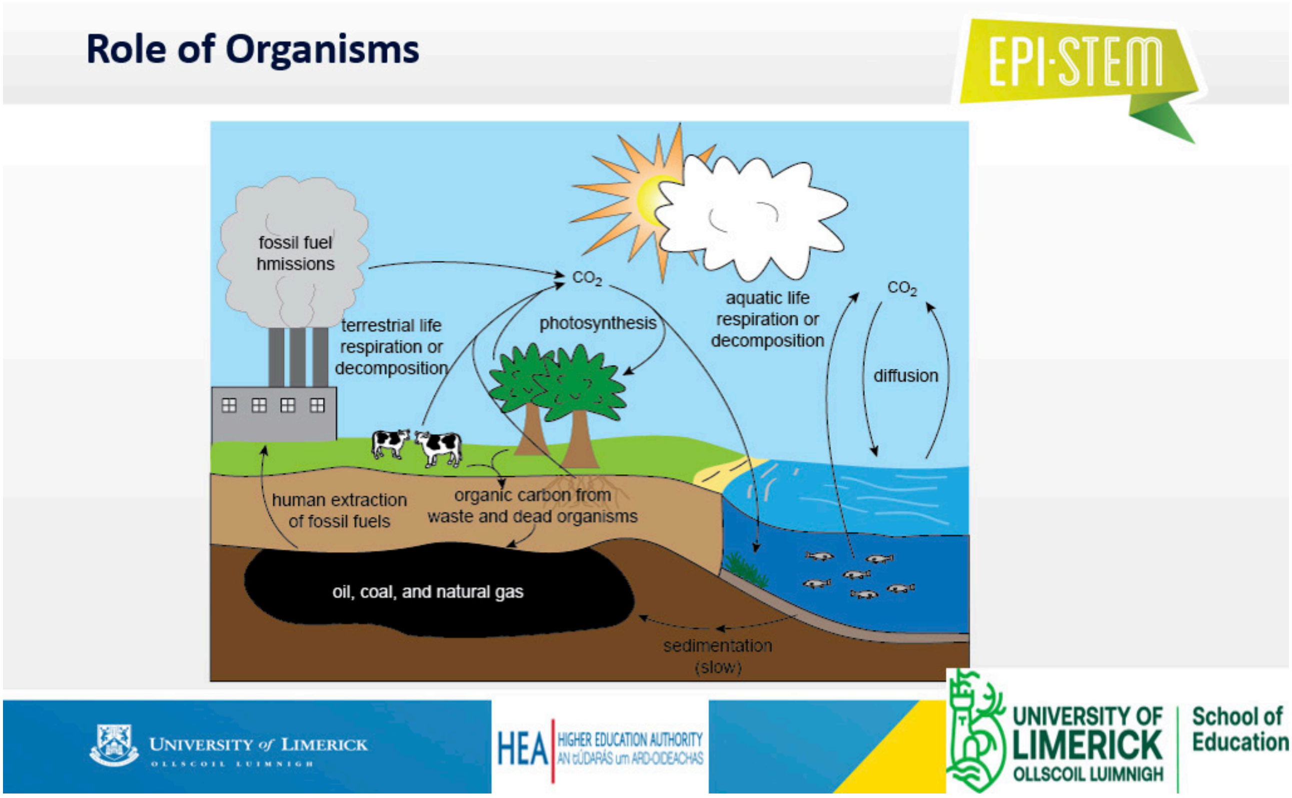
Plants remove carbon from environment by photosynthesis, return it by respiration.

Animals take in carbon by eating plants, release carbon by respiration.

Micro-Organism return carbon to the environment when they decompose dead plants and animals.

Carbon is in a constant state of moving.

We are part of the carbon cycle. Breathing in air, eating dinner or driving a car are all examples of parts of the carbon cycle.



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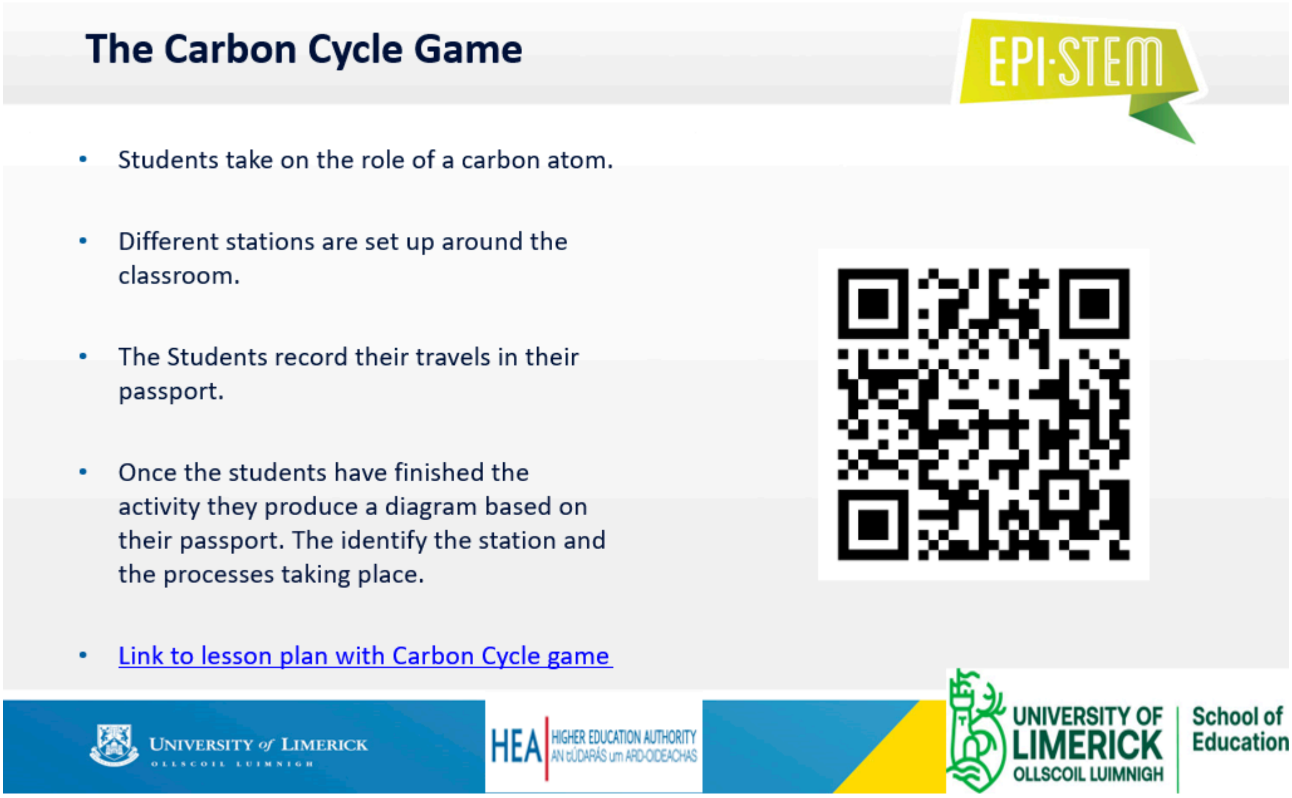
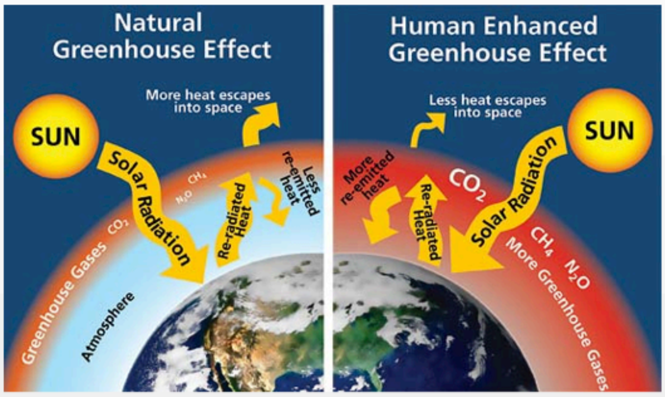


This is students learning by doing. Instead of the students being stationary they are moving around and learning by doing.

This activity was taken from the Royal Society of Chemistry website.

Research Investigation & Talking Point - Global Warming.

- Open a class discussion about the subject of global warming and carbon.
- What do students think regarding the causes of global warming? Can it be linked to carbon?
- What effect does increased carbon dioxide levels have on Earth? Is there a solution?
- Invite students to conduct a research investigation and to report their findings – encourage new thinking

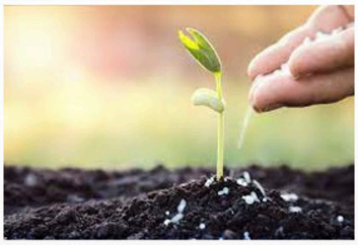


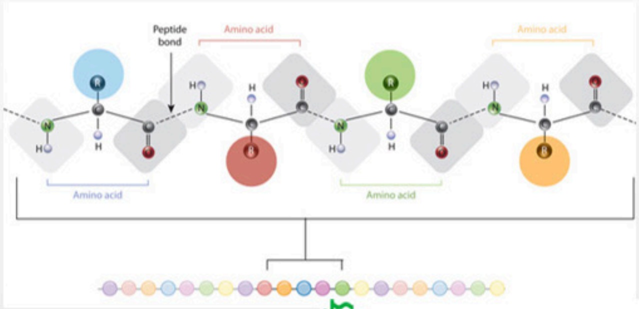
Human-Enhanced Global Warming has become a serious issue in recent decades on planet Earth.

Get students to research and identify the sources of the problem, to write a brief research reporting with their findings and the links to resources that give information about this. Allow student to indicate their preferred aspect in this investigation, so that you have differentiation of learning and have tapped into the motivation of the learners. Invite students to report back their piece of this puzzle in different ways, some through oral presentation, some through written case notes, other by way of audio or video. When inviting the students to report back to the class remember to give recognition to new ideas and new thinking suggested. At this moment in time the world needs new thinkers in our collective search for new solutions and for co-constructing the world differently.

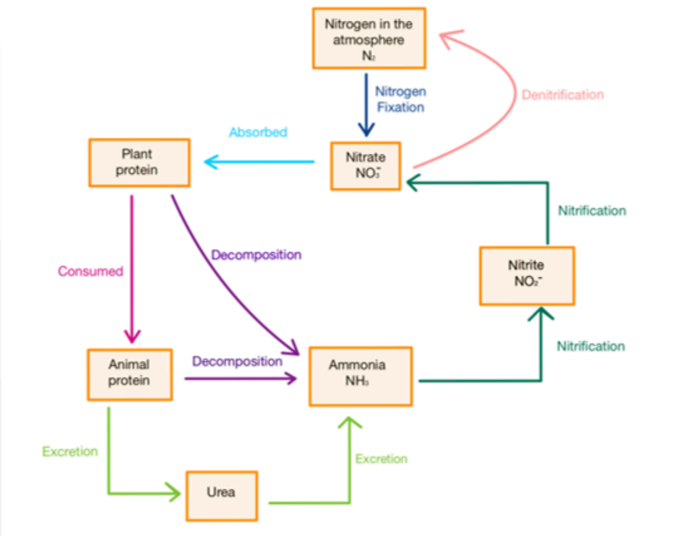
Why is Nitrogen important?

- Essential for sustaining life on Earth.
- Core component of Amino acids
  - Building blocks of proteins.
  - Key element of DNA and RNA.
- Plays a key role in plant growth.
- Enhances soil quality.





The Nitrogen Cycle

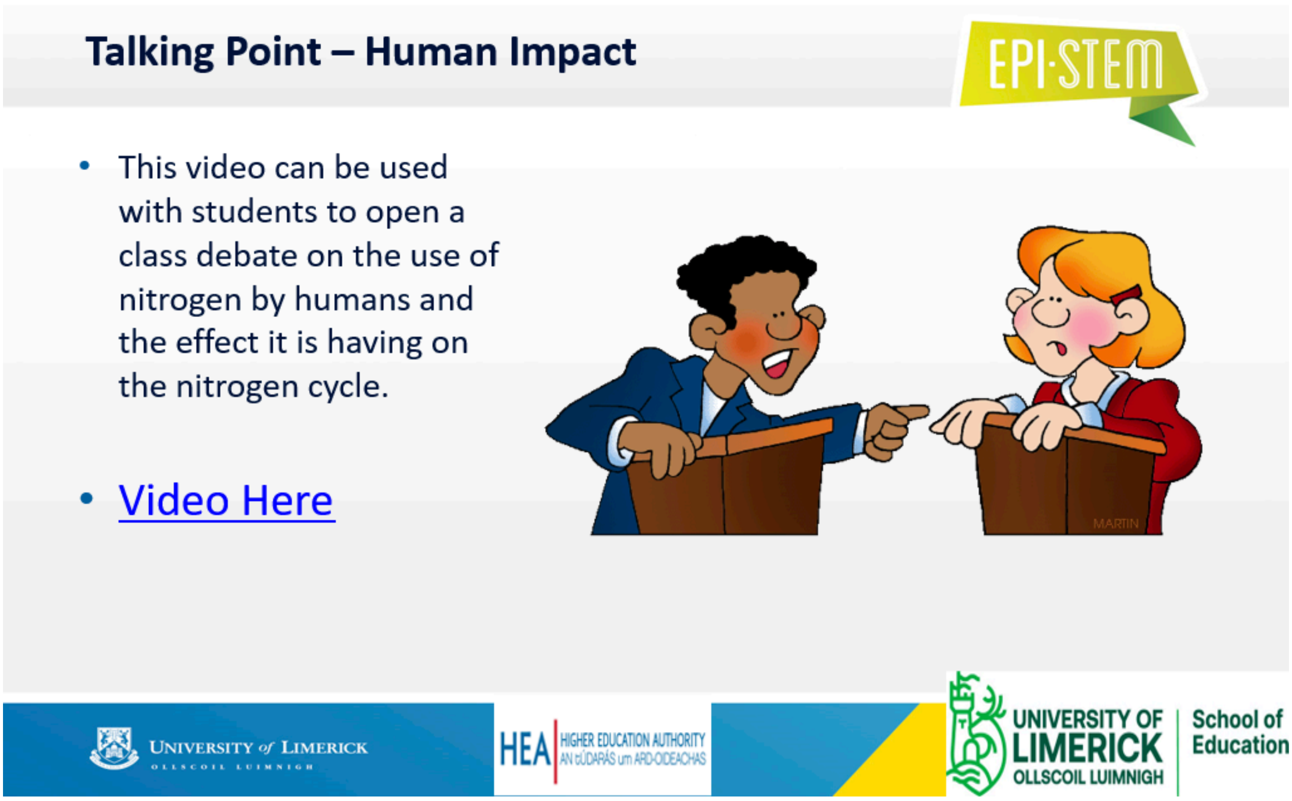


The function of the nitrogen cycle is to take Nitrogen from the air and make it available for living things to use.

The nitrogen used is then converted back to the nitrogen in air.

The form of Nitrogen that is readily available around us is inert or unreactive. The flow in the Nitrogen Cycle as well as the Carbon Cycle has several points where linkages can be made with chemistry and biochemistry.

QR code linked to Nitrogen cycle game.



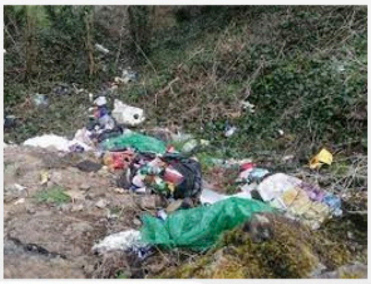
Play video until 2 min 40 sec.

Learning outcomes

1.4.9 Human Impact on an Ecosystem	"Pollution" – definition, areas of effect, its control. Study the effects of any one pollutant. Definition of "conservation". "Waste management" – problems associated with waste disposal. Importance of waste minimisation.	Pollution: the ecological impact of one human activity. Outline of any one practice from one of the following areas: agriculture, fisheries, or forestry. Role of micro-organisms in waste management and pollution control.	

Pollution

- Domestic
- Agricultural
- Industrial



Air Pollution

- Air Pollution Simulation click here

This activity brings back skills which students have previous experiences of from the junior cycle. Students must critically think about the information they obtain and the source of this information.

Having students research information encourages students to become more hands-on. As students complete their research the teacher can circulate the room providing students with prompts and formative feedback.

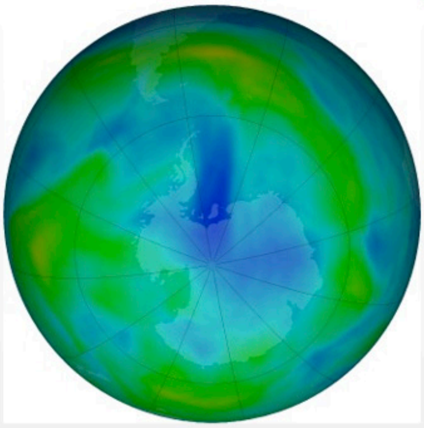
As each group is presenting the other groups must come up with a question to ask the group presenting, this encourages all students to engage and actively listen.

Link to some information:https://www.teachengineering.org/content/cub_/lessons/cub_air/cub_air_lesson08_ozone.pdf

Ozone depletion

This link to the NASA website provides a real life image of the Ozone layer over the course of the year and previous years.

[NASA Ozone Watch]



Ozone layer 24th June 2022

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Conservation

- The wise management of existing natural resources in an ecosystem.

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Ask students if they have heard of any conservation efforts.
Students make be familiar with bee conservation from wildflower gardens.

Conservation of Honeybee in Ireland https://www.youtube.com/watch?v=JMhvcd0KbEI

Ted Talk

EPI·STEM

- Video shows how fishing villages are tackling overfishing.
- Video Here

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Encourages students to think about conservation and the different that small changes can make to conservation. Brings in the critical thinking and encourages students to think about ethical issues.

Conservation Practices.

EPI·STEM

Area	Conservation Practices
Agriculture	Mixed farming, crop rotation, Biological controls, Gene Banks.
Fisheries	Appropriate fishing net size, Quotas, Re-stocking.
Forestry	Re-planting, using a broadleaf/conifer mix.

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Waste Management

Agriculture
- Slurry
- Plastic

Causes:
- Eutrophication
- Pollution

Solution:
- Storing and recycling slurry appropriately.
- Disposing of material appropriately

Fisheries
- Fish offal
- Plastic netting

Causes:
- Pollution

Solution:
- Composting fish waste, creating fertiliser.
- Disposing of plastic material appropriately.

Forestry
- Tree tops, branches.
- Sawdust.

Causes:
- No negative effect

Solution:
- Waste products are allowed to slowly decay naturally and release nutrients back to forest floor.
- Sawdust recycled to make MDF.

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Does it have to be waste??

- Waste products can be turned around and used for good purposes.
  - Anaerobic Digestion - uses microorganism to convert feedstocks to **electricity** and the “waste” product can be used as a **fertiliser**.
  - Fish waste is converted to pig and chicken **feed** in Killybegs Co. Donegal.
  - Fish waste is also being used as a **fertiliser** in agriculture.

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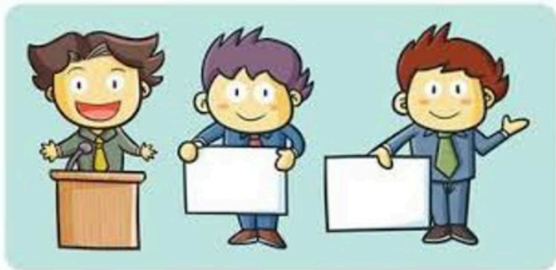
Waste disposal problems

Give the students the floor!!

- Group students into groups of 3/4.
- Gives each group a topic
- Allow students time to research the topic.
- Each group presents the information found.



Topic ideas:
Disease
Toxic chemicals
Nutrient release
Sea pollution
Landfills
Incinerators

Role of micro-organisms – Organic matter.

- Clip showing fruit and vegetables decomposing [Click Here.]

This video clip shows biodegradation in slow motion.

Sewage is composed of waste from toilets, bathrooms or industry and rainwater from drains. Primary treatment involves the physically filtering and screening waste and allowing it to settle. Large objects and solids are removed.

Secondary treatment is a biological process. This uses bacteria and fungi to break down organic matter. The liquid waste is aerated to allow the breakdown,
Tertiary treatment removes mineral nutrients such as phosphates and nitrates.

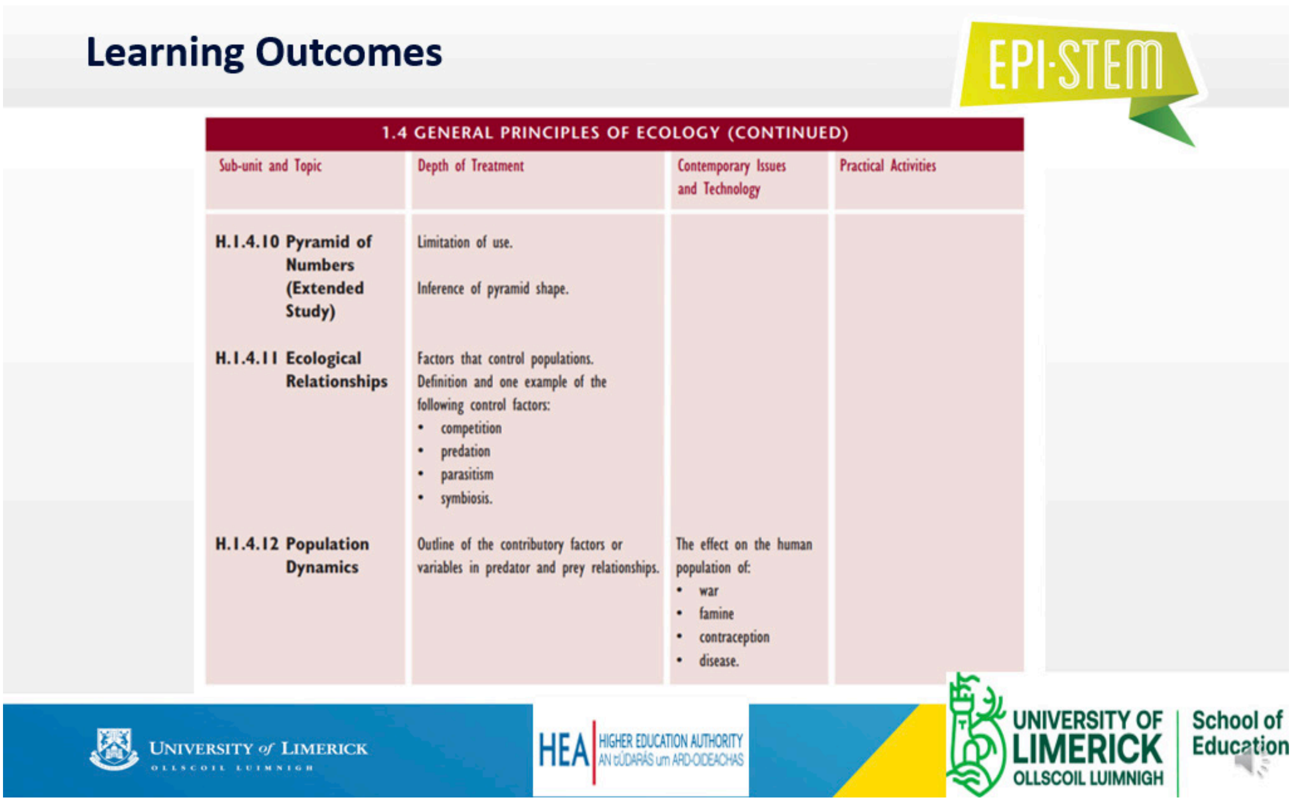
On this slide there is a link to a national geographic video which goes through the process of wastewater treatment.

Reduce – reuse - recycle is a way to control waste production.

Reduce – this can be done by reducing our need for goods and looking at the packaging being used unnecessarily.

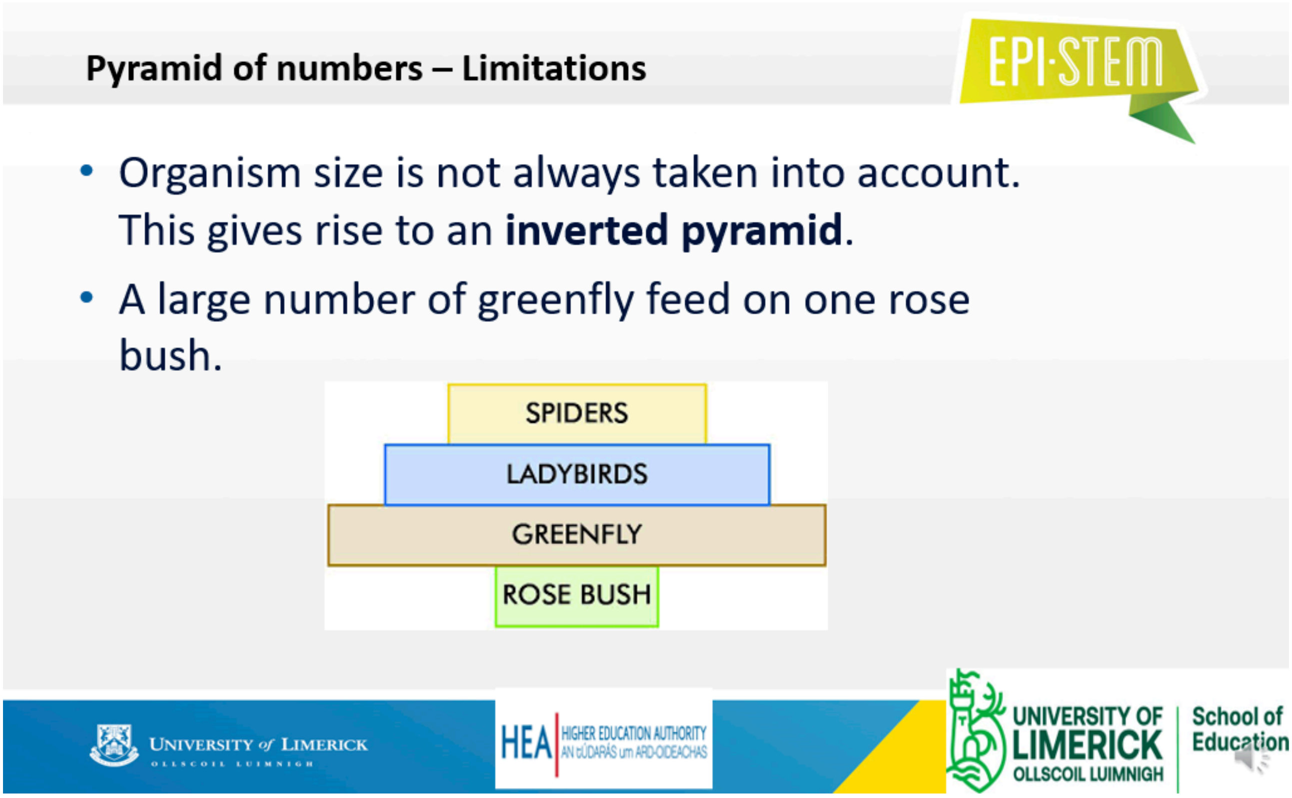
Reuse – reuse objects that would be usually discarded. Example is reusing glass jars and glass bottles. Donating our clothing and getting any new clothes from second hand outlets.

Recycling – materials are nowadays collected, treated, and reformed into new products. Paper and plastics are examples. Organic matter can be broken down by oxygen requiring bacteria into compost and used in soils to improve the growth of plants.

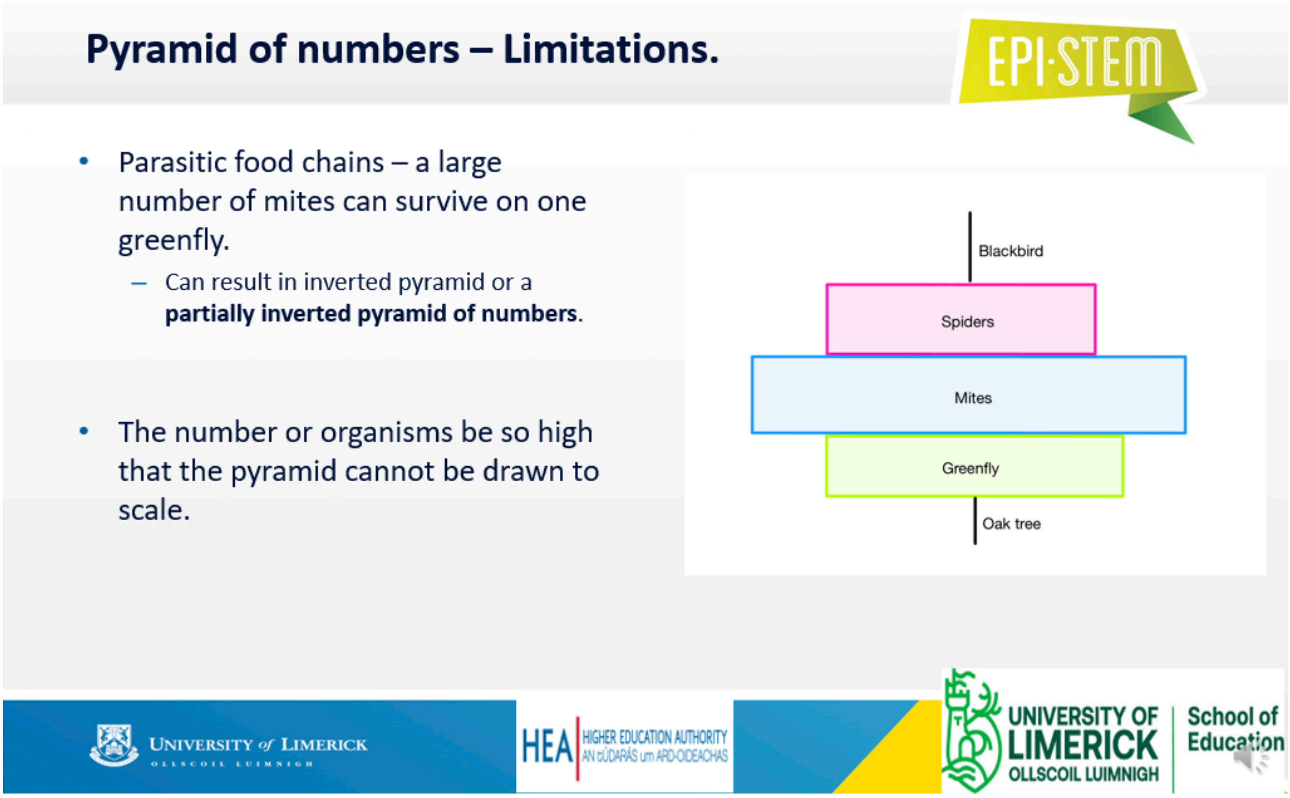


1.4 GENERAL PRINCIPLES OF ECOLOGY (CONTINUED)

Sub-unit and Topic	Depth of Treatment	Contemporary Issues and Technology	Practical Activities
H.1.4.10 Pyramid of Numbers (Extended Study)	Limitation of use. Inference of pyramid shape.		
H.1.4.11 Ecological Relationships	Factors that control populations. Definition and one example of the following control factors: • competition • predation • parasitism • symbiosis.		
H.1.4.12 Population Dynamics	Outline of the contributory factors or variables in predator and prey relationships.	The effect on the human population of: • war • famine • contraception • disease.	

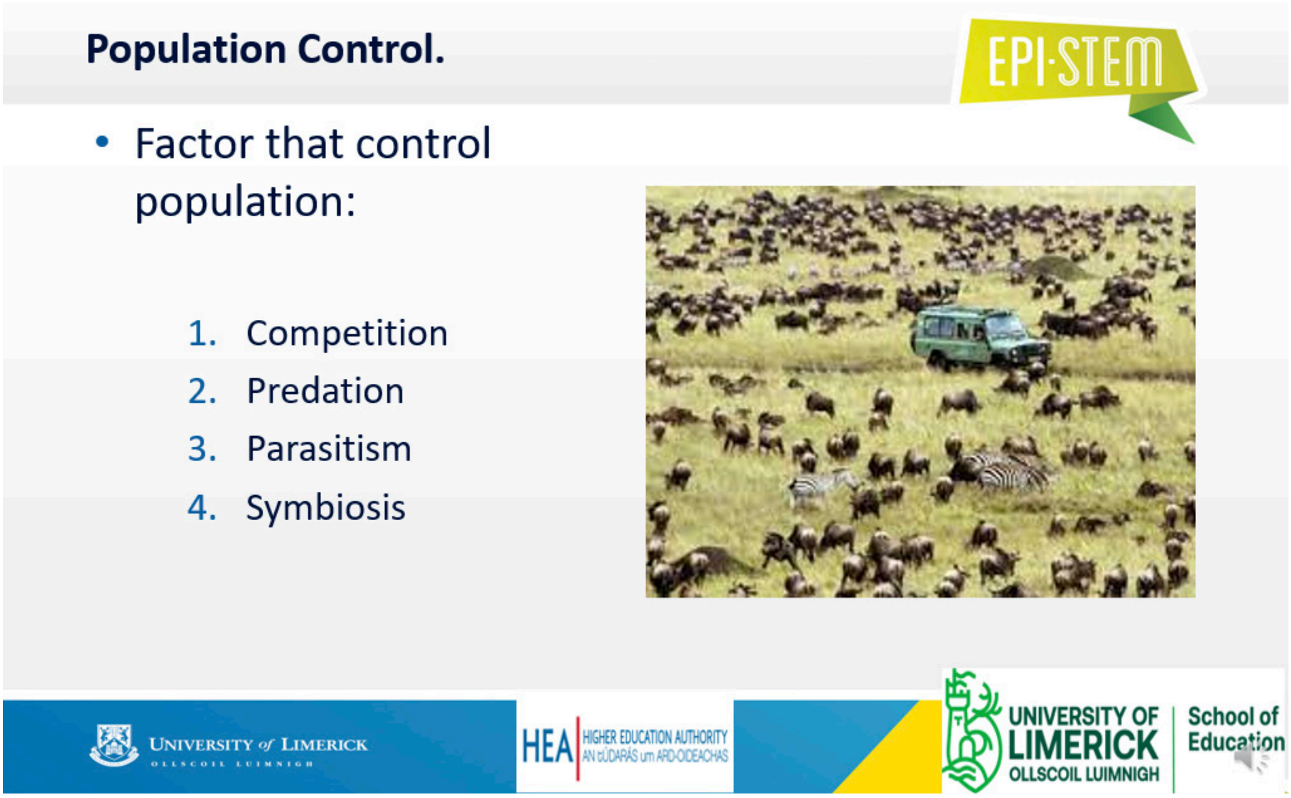


A pyramid of numbers represents the number of organisms at each trophic level in the food chain. The size of organisms is not considered, looking at this pyramid there are a large number of greenflies which is represented by the largest rectangle. All the greenfly lives in the one rose bush. This can be represented using an inverted pyramid.



Another limitation of a pyramid of numbers is the representation of a parasitic food chain. When representing these food chains, a partially inverted pyramid of numbers should be used. One oak tree can feed millions of greenflies. These greenflies can host a greater number of mites. The spiders then feed on the greenfly and therefore the mites that life on the greenfly.

The final limitation is the scale of the pyramid. Is it possible to represent the millions of mites compared to the one oak tree?



As we know the definition for population is all the members of a species living in an area. There are factors that have an impact on population. These factors help to maintain a balance in the population numbers. This is the balance of nature.

This ensures that the population remains close to what the habitat can support.

The factors are:

- Competition
- Predation
- Parasitism
- Symbiosis

Competition: occurs when organisms actively struggle for a resource that is in short supply. Competition reduces the number of organisms. Intra-specific competition takes place between members of the same species. An example of this is two brown bears competing for territory for feeding. Inter-specific competition occurs between members of different species. An example is different bird species competing for food.

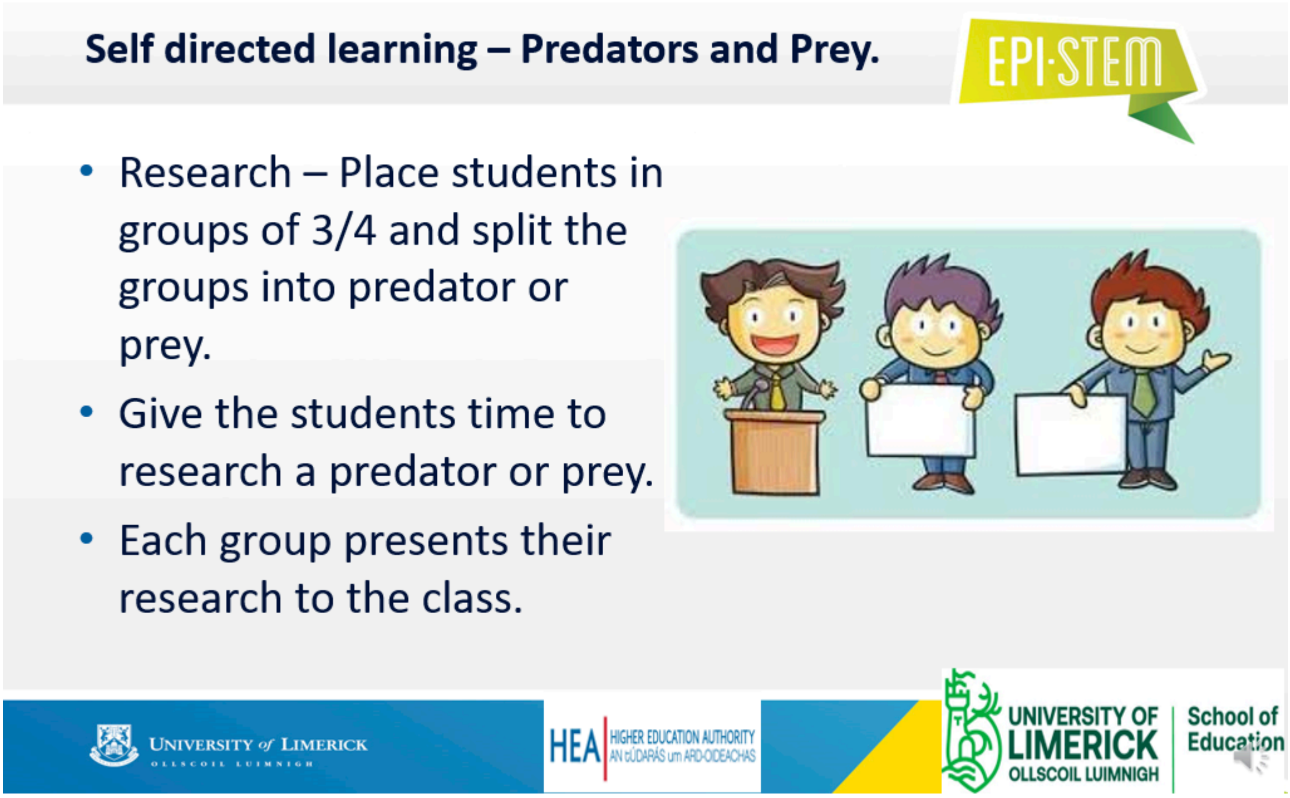
This slide provides a link for a simulation which shows competition.

There are two different types of competition. Contest competition and scramble competition. Contest competition is an active physical contest between two individual organisms, one individual gets all the resources. An example of contest competition is how birds or deer defend a territory. In scramble competition all of the competing individuals get some of the resources. This competition may mean that none of the individuals get enough resources to thrive. An example of scramble competition is the overcrowding of seedlings in a flowerbed.

Species need to avoid competition if they are to survive. Species do this by adapting to their environment.

- A grass plant produces large quantities of pollen increasing its chance of reproducing.
- Blackbird 'song' to warn competitors to stay away.
- Yellow petals of buttercups to attract insect pollinators.
- Bacteria in soil secrete chemicals to inhibit their competitors.
- The caterpillar of the cabbage white butterfly chews on cabbage leaves, while the adult butterfly drinks nectar from flowers

Predation is the catching, killing, and eating of another organism. An example of predation is the brown bear catching and killing salmon. Another includes a ladybird catching and killing aphids.



Self-directed learning.

Give students opportunity of completing their own research on predators and prey.

Place students into groups of three or four this is a great opportunity for mixed ability grouping and peer teaching. Give the group a topic of predator or prey.

Students take a predator or prey and research their adaptations.

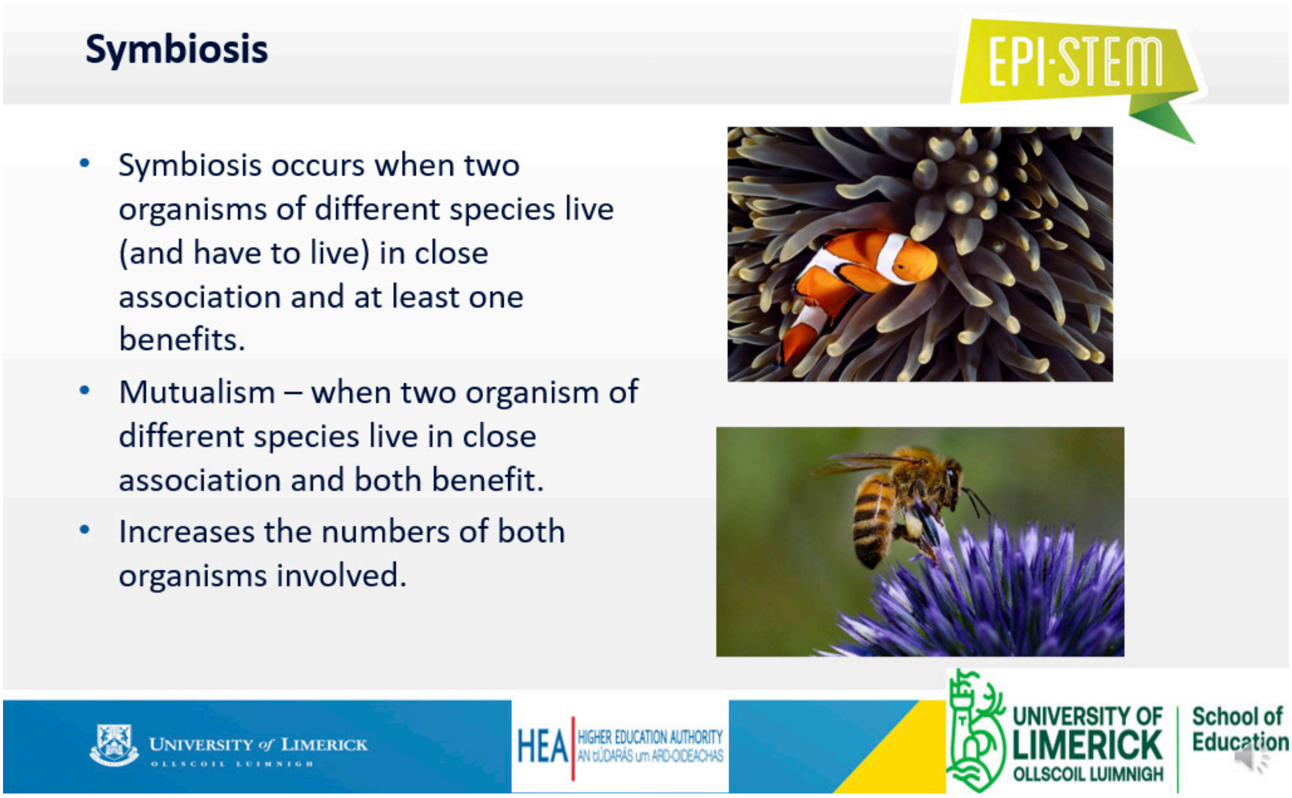
Once the students complete their research, they present it to the class.

Parasites live in or on the body of the host.

Exoparasites live outside of the body of the host. Examples fleas on dogs, mosquitoes or leeches on human’s skin.

Endoparasites live inside the host. Examples liver fluke in sheep and cattle. Potatoes blight, fungus in potatoes. Tapeworms or hookworms in the human body.

Weaken their host but do not kill.



Parasitism is a form of symbiosis; the parasite gets the benefit, and the host is harmed. Mutualism is when both organisms benefit from the association.

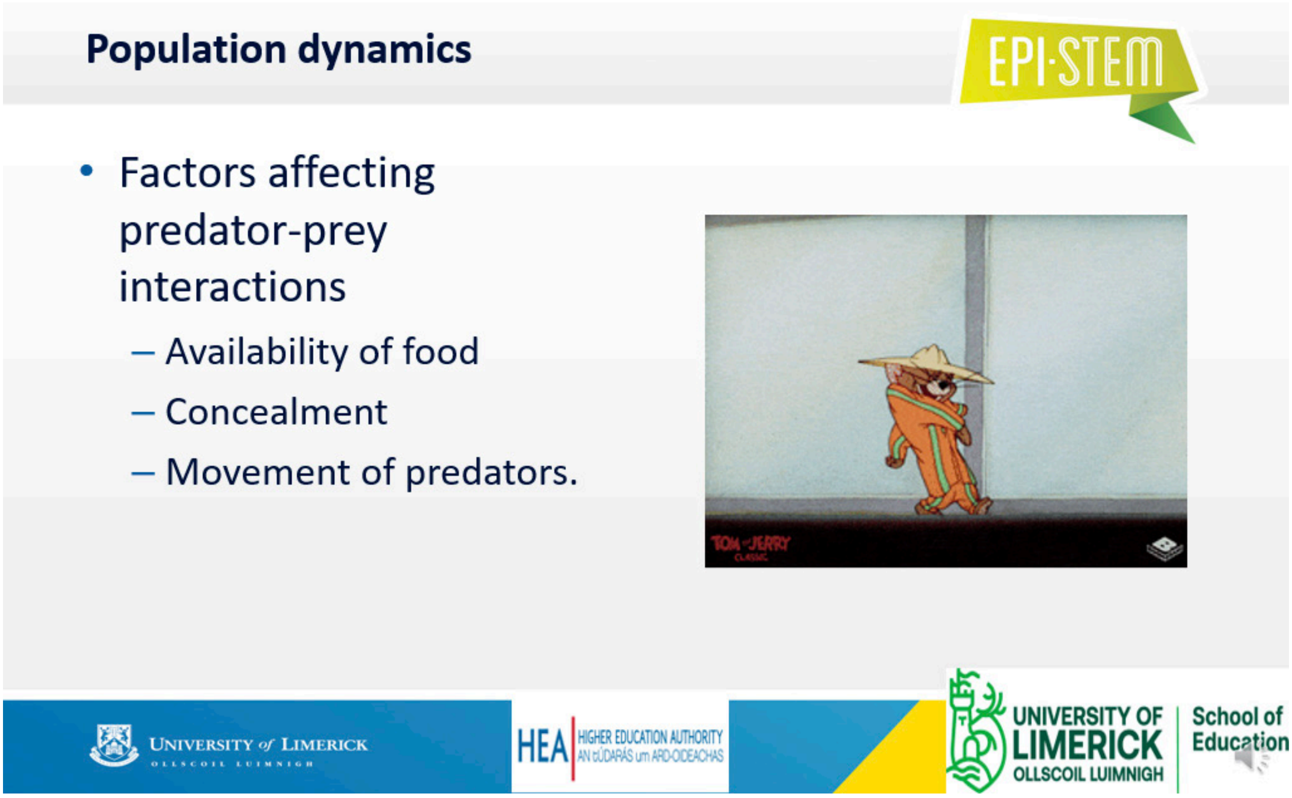
The anemone provides the clownfish with protection and shelter, while the clownfish provides the anemone nutrients in the form of waste while also scaring off potential predator fish
Bee acts as a pollinator for the plant while the plant provides the bee with food.

Other examples of mutualism
Cellulose digesting bacteria in the mammalian intestine. The bacteria get food, shelter, warmth, and moisture.

Bacteria in the large intestine of humans. The bacteria produce vitamins B and K while the bacteria get food and shelter.

Lichen which are composed of algae and fungus, algae get protection minerals and support and fungus get food.

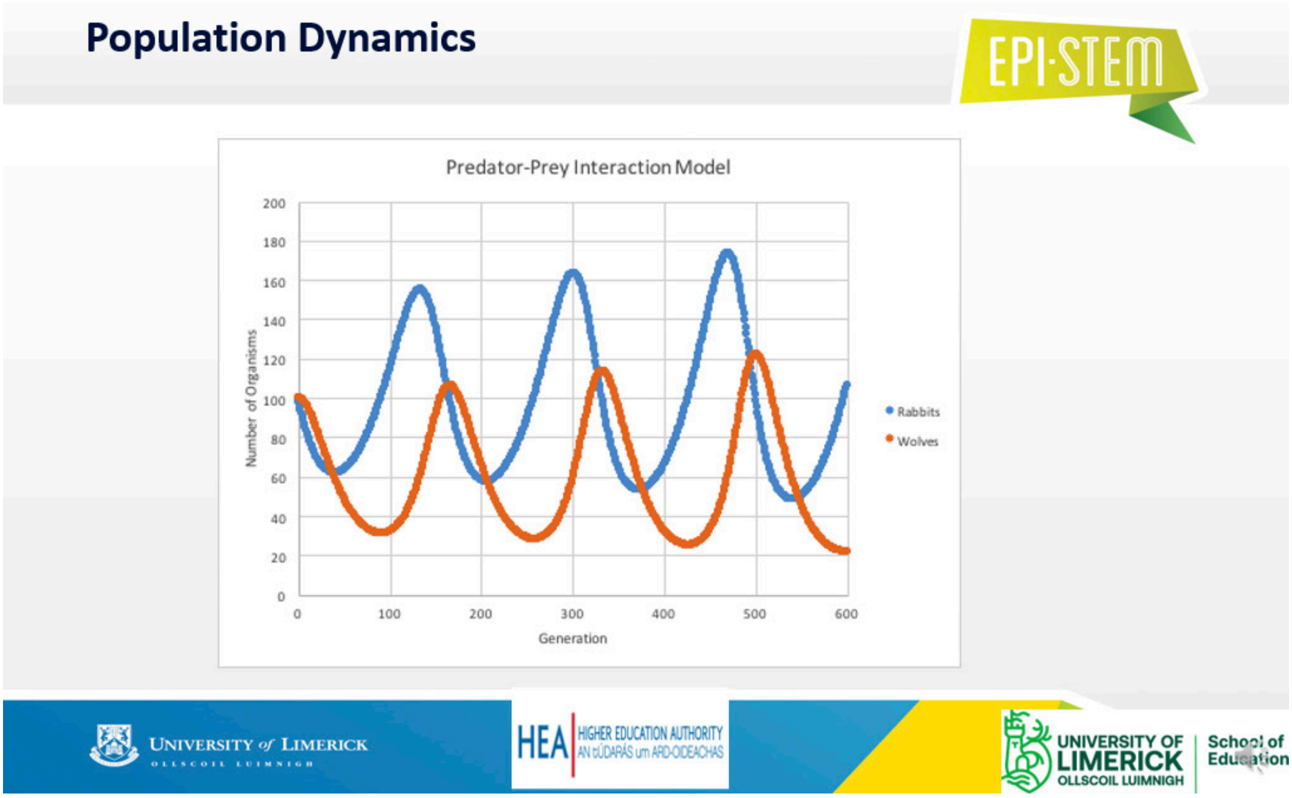
Nitrogen fixing bacteria in the nodules of some plants (clover) bacteria get food, shelter and anaerobic conditions and clover gets nitrates.



Population dynamics refers to the factors that cause a change in population numbers.

The numbers of predators and prey are interrelated. As the number of preys increase the numbers of predators increase and as the numbers of prey decrease the numbers of predator decrease.

The factors that affect predator prey interactions are:
Availability of food, concealment, and movement of predators.

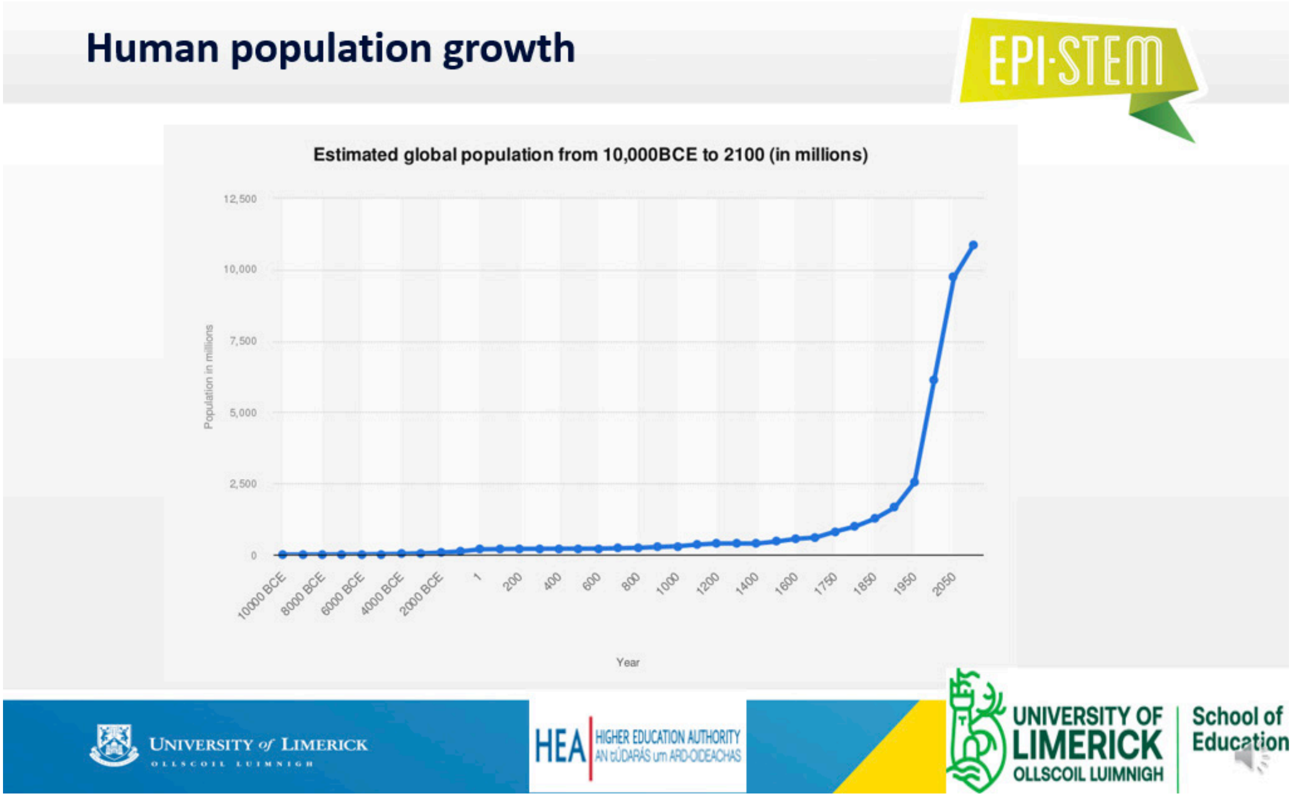


Have students study the graph and interpret the information.

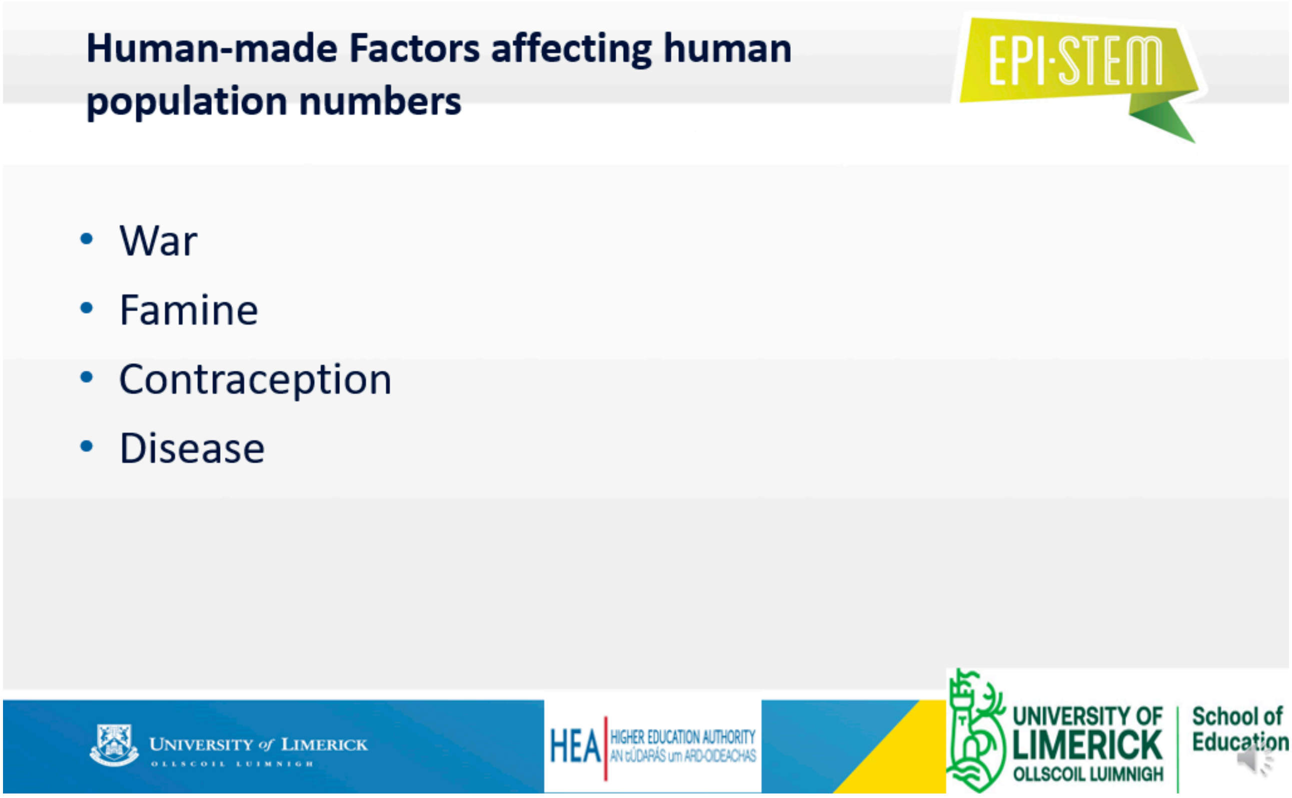
Students should recognise that as the numbers of rabbits increases the numbers of wolves increases. Therefore, there is more rabbits being killed and the numbers start to decline.

This then results in fewer foxes which is why we note a decline in the population.

As the numbers of predators falls the number of prey increase and this continues in a cycle.



The population has grown very rapidly since 1850. The world's population is increasing by approximately 75 million people per year, Experts expect that the population will stabilise in 2100 at 10 billion. The increase in population is caused by reduced death rates, better medicine, improved sanitation and public health, better access to resources, diet, and exercise. 1850 marks the start of the Industrial Revolution and more people coming to live and work in urban settings and receiving waged labour. While public health and access to leisure time was denied for many years to most people, there were incremental improvements and finally several breakthroughs that supported improved public health services and better diets and access to education and the concept of a good life. The population of the planet went over the 7 billion marks for the first time in 2010. The world is divided in relation to these gains and there are many parts of the world today where people die from starvation, famine, diseases and where large populations of poor people and women fail to receive access to education and resources for a good and shared life.



There are a number of human-made factors that influence the growth of the human population. Examples of these factors are war, famine, contraception, and disease.

War - reduces population as a result of death rate. Temporary effect: a baby boom (increase in birth rate) follows.

Famine – reduces population numbers. The lack of food leads to malnutrition and death due to disease or starvation.

Contraception – use of contraception has decreased birth rate and rate of population growth, especially in developed countries.

Disease – improved disease control methods have reduced and death rate and caused an increase in human numbers.

Contact details

Register for on-line CPD resources: https://epistem.ie

EPI•STEM project: Resources

Contact: Helen Fitzgerald, Senior Executive Administrator

Email: helen.fitzgerald@ul.ie

This on-line CPD project [HEA funded] is an initiative with EPI•STEM for science and mathematics secondary teachers in Ireland. The research-led development team include:

Geraldine Mooney Simmie, Niamh O'Meara, Merrilyn Goos, Stephen Comiskey, Ciara Lane, Tracey O'Connell, Vo Van De, Tara E. Ryan, Martina Scully, Jack Nealon, Daniel Casey, Keith Kennedy, Martina Ryan, Annette Forster, Céren O'Connell, Martha Cosgrave, Veronica Ryan, Gemma Henstock

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EPI·STEM HEA ONLINE CPD RESOURCES BOOKLET SUPPORTING SCIENCE TEACHERS WITH LEARNING OUTCOMES

JUNIOR CYCLE, SENIOR CYCLE & TRANSITION YEAR SCIENCE CURRICULUM

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