Ecosystems: living communities
The energy cycle

Mike Gillman:
There are two main ways of defining what we mean by an ecosystem. Some people talk of organisms that share similar conditions. But a more useful definition is to talk about how organisms interact, how they work as a system. This is what Arthur Tansley had in mind when he coined the phrase and that's what we mean by ecosystem in this course.

So ecosystems are all about interactions and if we are going to get to grips with ecosystems we have got to get to grips with those different interactions. But hang on. There's billions and billions of different interactions between millions of different species. Now obviously we are not going to be able to analyse every single last one of those but what we can do is look at the different types of interaction. Luckily, there's not so many of those. It's all about energy and nutrients. The ultimate energy source is the sun. And most plants interact with it using photosynthesis to turn the sun's energy into their own chemical energy. That energy is then passed on through a range of different feeding interactions. One way to classify all the different types of interactions is according to whether organisms have a net gain or a net loss from any interaction whether they win or lose. Any win or loss of nutrients or energy may be vital. Winning or losing can affect whether any one organism survives or dies. There are six possible outcomes that are observed in natural systems: commensalism – in which one species gains and there is no affect on the other species; mutualism in which both species gain; parasitism predation and herbivory, where one species loses and one gains; and competition, where both species lose or both individuals within a species lose. Analysing interactions like this helps us to understand what's going on in the ecosystem. It can also help us define an ecosystem's boundaries, which aren't always as clear cut as you might think.

Vince Gauci:
"You could have a very simple ecosystem that has an apparent boundary in a pond or a lake. But the situation then gets a bit more complicated because you then have run off from the surrounding hills and that brings nutrients into the lake. And so it's not quite as easy as you think it might be."

Mike Gillman:
So interactions help us define the boundaries of an ecosystem. But in order to understand the functioning we need much more detailed information. We need to know about energy. We need to know about the rate of transfer. We need to know about the route of transfer and we need to know about the efficiency of transfer. And that brings us back to the primary source of energy – the sun.

Vince Gauci:
"We have got a wave form of energy coming through the atmosphere from the sun in light. And that gets converted to a chemical form of energy. Now that chemical form of energy uses carbon and so you are making sugars and starches. Of all the sunlight that comes into the earth's atmosphere about eight per cent is trapped by green plants through photosynthesis and we call that gross primary productivity. Now of that eight per cent about fifty per cent is immediately respired out so the carbon that has been fixed then leaves the plant. The remaining fifty per cent goes into building the plant tissues and that could be leaves and stem but also into leaving a little extra for a bad day – winter time. There will be some that's stored away in roots and rhizomes and a little bit will also go into reproduction so the manufacture of seeds."

Mike Gillman:
There are four ways in which the plant's energy can be passed on within the ecosystem. It can be stored as perennial biomass; it can pass as dead tissue to decomposers; it can get

eaten with its energy passing on to herbivores, or it can be passed on through what is called soluble losses.

Vince Gauci:
“Some of this carbon that has gone into the plant and leaks out through it's roots, this form of carbon could be considered a loss from the plant but actually the plant is investing in a process that actually assists it.”

Mike Gillman:
It may be a loss to the individual plant but it can be thought of as an investment in the whole ecosystem; a kind of plant tax if you like and it can make a huge difference.

Vince Gauci:
“If you consider the trees in forests, they develop these interactions with what we call Mychrorhyzi. Now these Mychrorhyzi do something that the plant can't. They are particularly good at taking nutrients out of the soil. In giving those nutrients to the plant in return they will get a source of carbohydrate or sugar, which sustains them. About a quarter of carbon loss from the plant goes into this Mychrorhyzi . And this interaction is actually responsible for a huge amount of what we call soil respiration, that is the CO2 that is lost from the forest floor. So it's tremendously important in terms of recycling carbon in an ecosystem.”

Mike Gillman:
It's not always a win win scenario. Some net production is simply lost, washed away or leeched out. No system is perfectly efficient and ecosystems are no different. Some are more efficient than others. Understanding the types of interactions and the flow of energy and nutrients is vital to understanding how ecosystems work.