**Environmental Impact Assessment**
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**Lecture - 37**
**EIA Methods for Ecology (Definitions and Concepts)**

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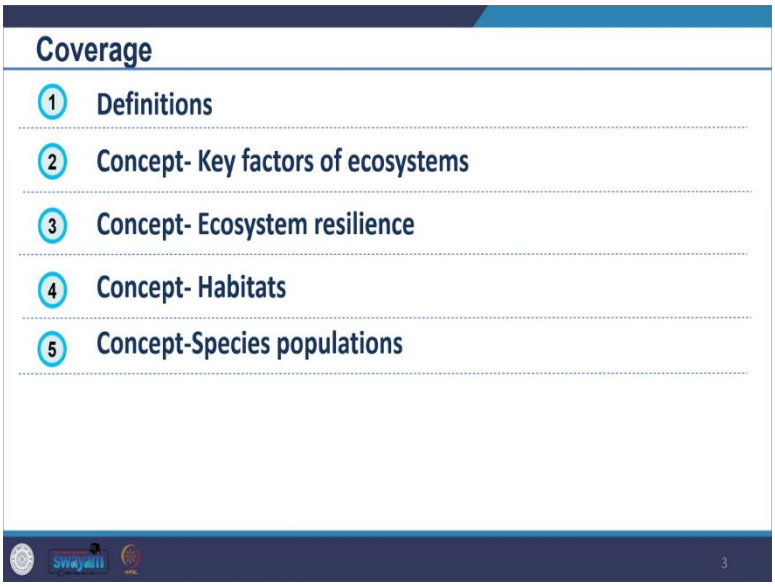


Welcome to the course, Environmental Impact Assessments. In these sessions, we will look at how to evaluate ecological impacts, when we do EIA. And in this particular session in this segment first, we will get familiar with some definitions and concepts related to ecological impacts.

And accordingly, our coverage will include that will look at the key factors of ecosystems, then we will look at ecosystem resilience what it means, and what are various aspects of resilience, then we will look at the terminology habitat and what our concern should be, and then we will look at species population what does it means and how do we take care of it.

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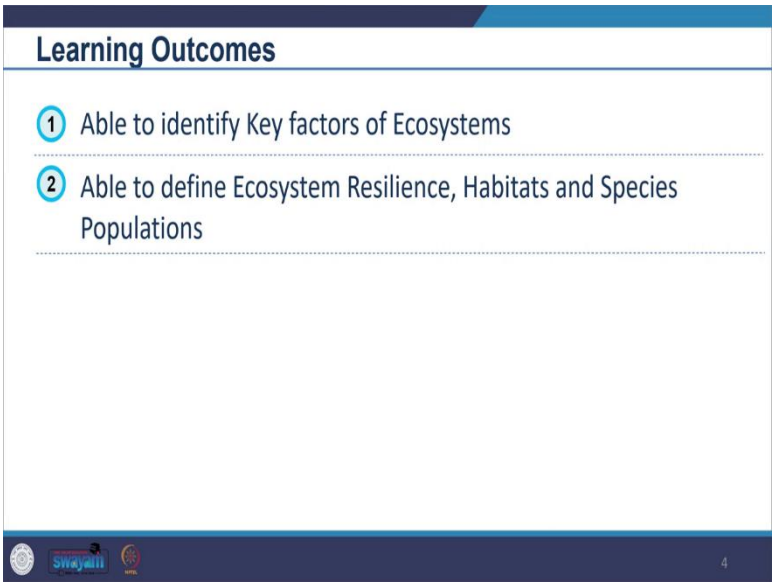


So accordingly, our learning outcomes will be that after completion of this particular session, you should be able to identify key factors of ecosystems and then you should be able to define ecosystem resilience,

habitat, and species population. So, we have already seen legislation related to ecology in India and we have also seen some examples from across the world. So, that parts you might reflect on what we have provision in India, but today we will focus on the definitions and concepts and then move on to the methods part. So, evaluating ecological impact is said to be very challenging because one thing is that it is a very complex interaction.

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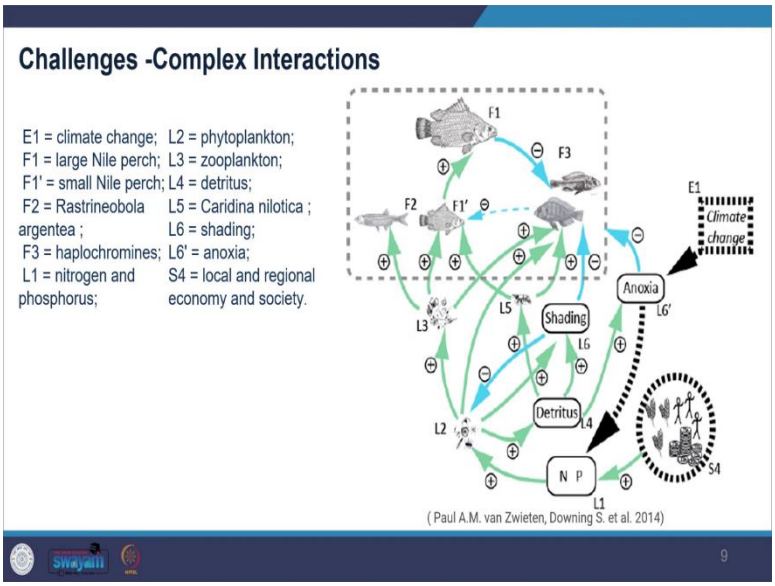


So, there is interaction at the like spatial levels and then also at various temporal scales, so it happens in different geographies, and then it also happens at different periods, so that is why it is very complex. And therefore, it also needs, very like you have to be very careful what kind of change would happen because of the planned or the proposed development.

So, in the figure, you can see how the interaction is happening, you can look at the green arrows, you can look at the green arrows which represent the growth process the blue arrows represent the mortality process, and thick dotted lines and arrows represent complex system interaction which is happening here. So, you see how this is just a very one example of looking at how the interaction is happening.

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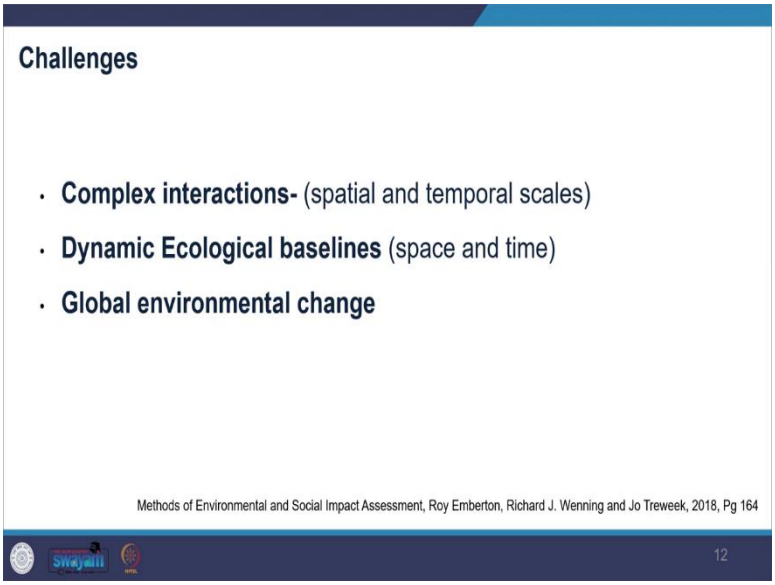


So, the other reason for its being very complex is that even the ecological baseline is very dynamic and it is dynamic in the space as well as in time, so it is constantly changing and so, whenever you do, prepare the baseline, then it might be difficult to determine what kind of changes are happening naturally, or they are happening because of the proposed project, so that is another level of challenge we see in this area.

Further, we see that there are also impacts, continuous impacts of the environmental change global environmental change. So, because of climate change, the situation is also constantly changing and it is changing very rapidly therefore it is becoming more difficult to establish the baseline condition as the changes are very rapid.

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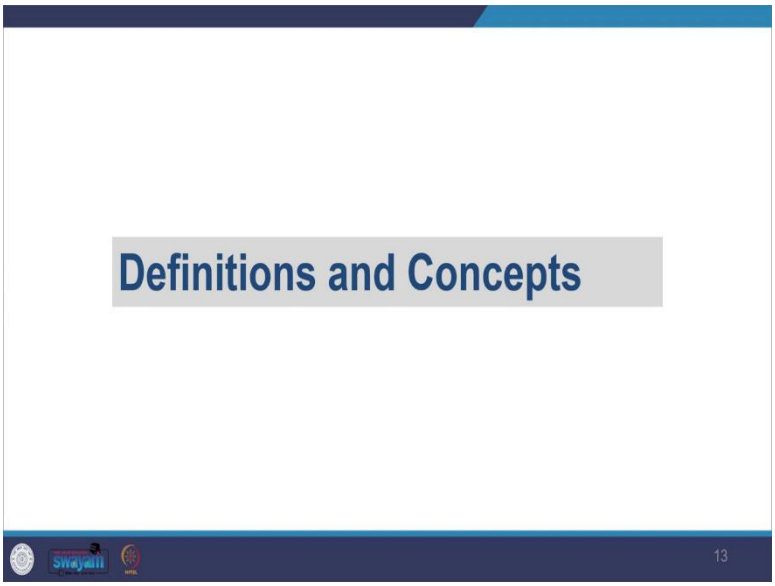

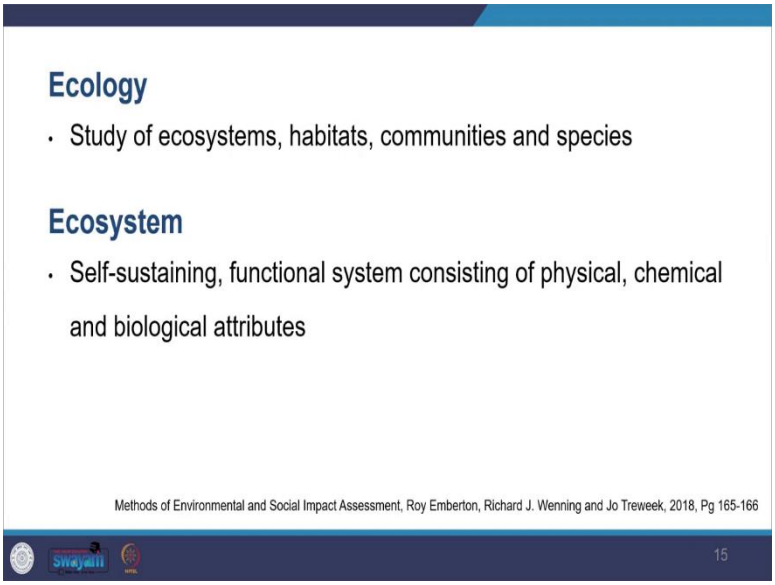


So, now looking at the definitions and concepts we see ecology, and ecology is the study of ecosystems, it is the study of habitats, it is the study of communities and species and it is very important to understand, what these are and how they are interrelated. So, how these species are interrelated, how does the habitat work, and how does the ecosystem work? An ecosystem is said to be very self-sustaining and it is a functional system where with the interaction and all the relationships, it exists on its own and has all the dimension physical, chemical, and biological qualities in an ecosystem, so that is what ecology studies about.

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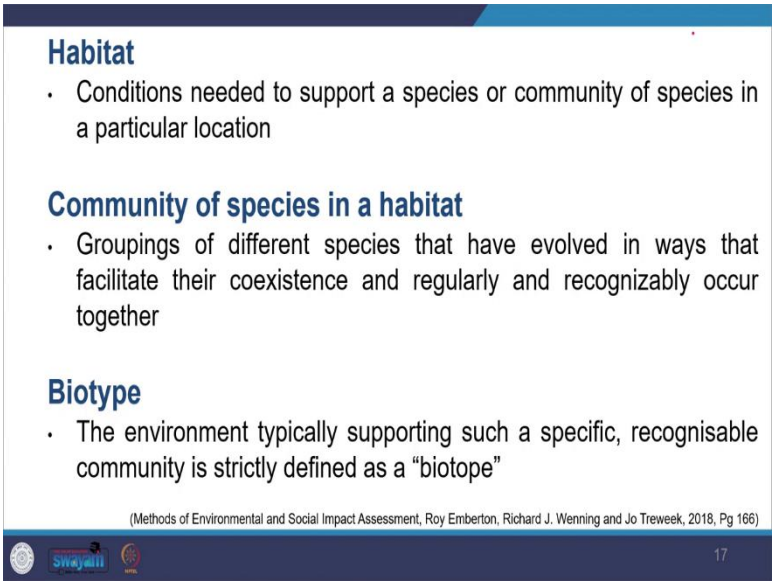


Then looking at habitat, what is habitat? Habitat is a condition that is required to support a species or a community of species in a particular location, so wherever those conditions are required that is conditions are defined as the habitat. Then we also see a community of species in a habitat, which is like, when we say community, we mean a grouping of different species that have evolved in a way that allows they to live together and co-exist and they are generally seen together, you will be able to find them together all the time, so that is what is said as a community of species in a habitat.

And then you have biotype, which is again a very typical environment, which supports specific and even that you can recognize the community like a biotype it is identifiable. And you will see that all these terms

are interchangeable they are more or less representing the same thing and then you will also find that one term is used for the other.

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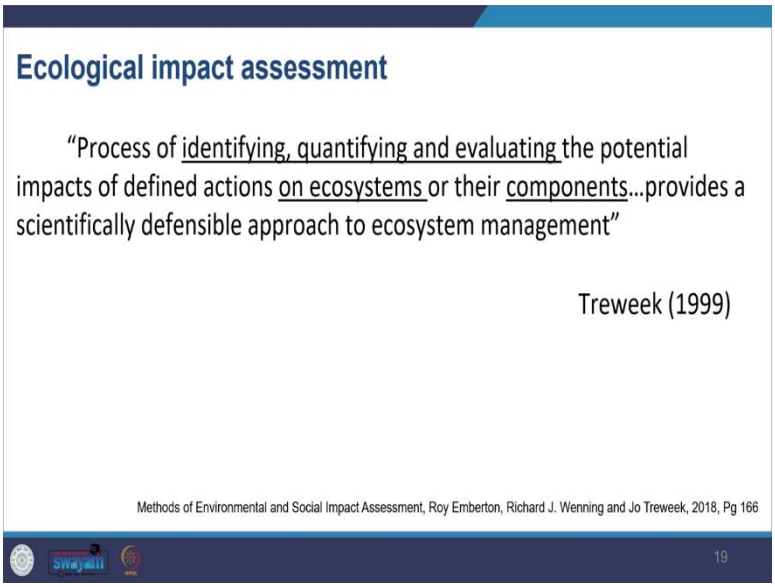


When we undertake assessments related to ecology, then we identify, we evaluate, we take stock of things, and we also assess the impact of the kind of development that is going to happen and we are going to see what kind of impact will happen on the biodiversity, what kind of impact will happen on the ecosystem, and what kind of impact will happen on ecosystem services. So, you are familiar with all these terms now biodiversity, ecosystems, and ecosystem services, so we test what will happen on these.

So, all the EIA procedure of identification, quantification, and evaluation of potential impact is taken care of and it is taken particularly in the case of biodiversity ecosystems, and ecosystem services. So, it is important that in the scoping stage, while you undertake ecological impact assessments, you also identify the receptors or the features. So, when we say receptor, we mean the elements that will be receiving all these kinds of changes. So, the receptor or the feature that is likely to be sensitive, which can be impacted by it, with the range of activities that will happen because of this proposed project, so it is very important to take care of that.

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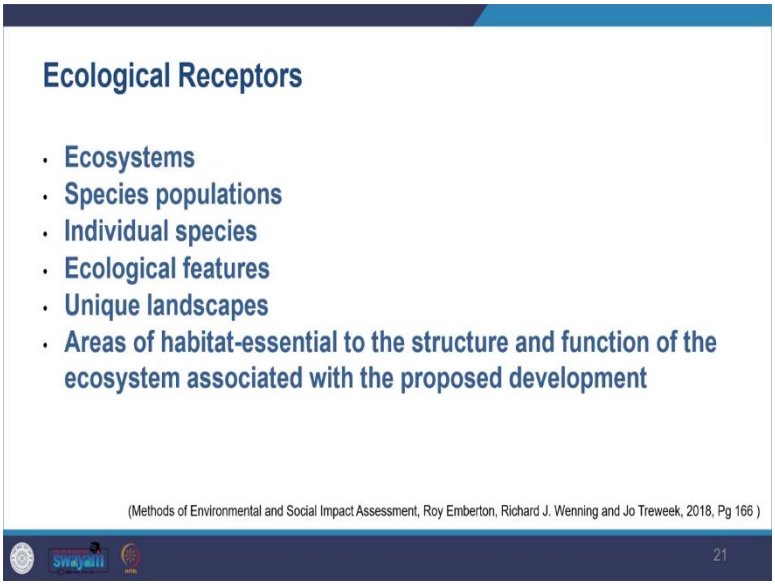


And if you see what are the different kinds of ecological receptors, then you see you have ecosystems, and then you have a species population, then you have individual species, which can be receptors, any specific which are endangered, it can be an ecological feature, and then it can also be a unique landscape. Further, we see that it can also be the area of habitat which is essential for the project itself, so these all can be the ecological receptor and you need to identify them at the stage of scoping itself.

So, when you are in the scoping stage, you should also confirm what development you are going, you are whether it is compatible with maintaining biodiversity or not, so you need to take care of that. So, whatever you are planning, whether that project is, what kind of activities will take place because of that project they are compatible with maintaining the biodiversity or not. So, that was about the certain aspect which you take care of.

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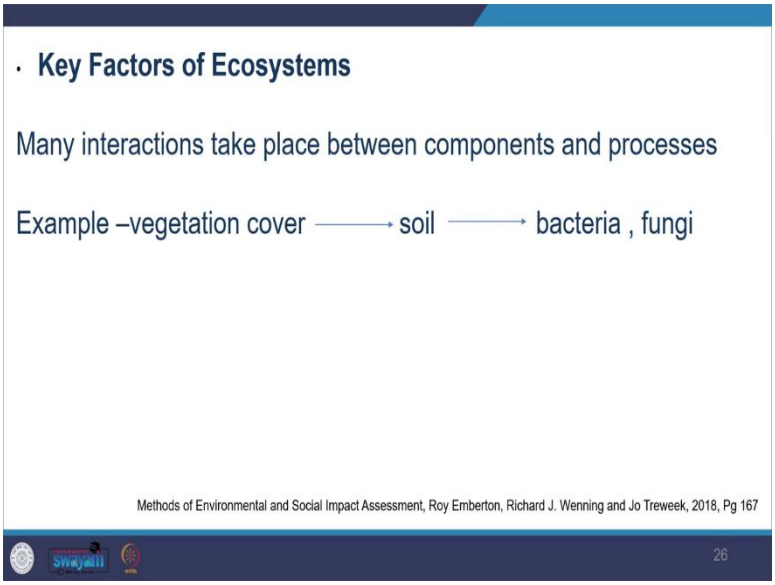


Now, we will look at the key factors of ecosystems. So, one of the very important aspects of the ecosystem is that many interactions take place between components, and then the interaction not only between components but also between the processes, and these interactions are many times very delicate. So, where there any kind of change can influence the way, they interact and then the total outcome might change.

So, for example, you see a change in the vegetation cover can change the soil and then the soil can further change the bacteria and fungi and so on. Change in one component can cause an effect that can be difficult to identify or predict and there can be an impact on the food chain, there can be impact on energy flow, impact on cooling effects, and the temperature of a place, so a lot of things can vary. Climate changes can affect other factors, like it can also changes in the geomorphology, hydrology, and soil conditions that can happen at a global or ecosystem scale.

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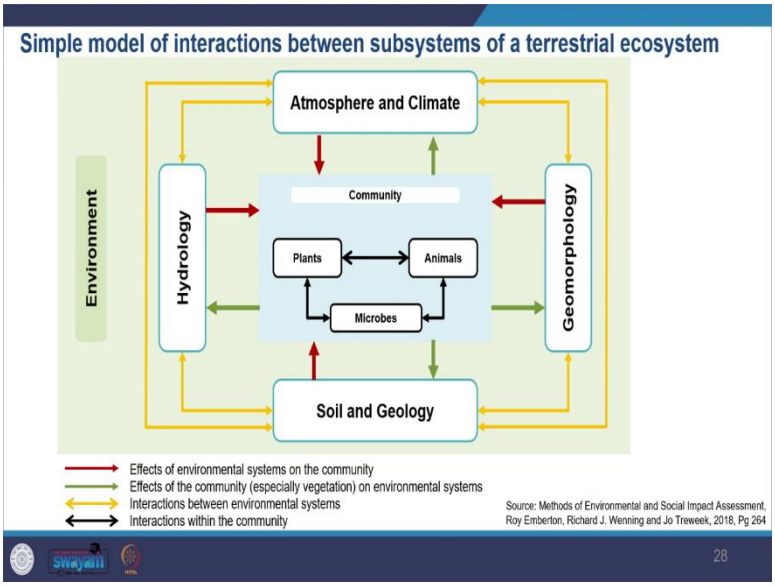


In this image, you can see a simple model of interactions between subsystems of a terrestrial ecosystem, you can see how the environmental systems affect the community, then how a community like a plant, animal, and microbes affect the environmental system, and you can see the interaction between environmental systems, in the center you can see how interaction is happening within the community.

So, you can even witness a change in climate because the change is because of the change in geomorphology, hydrology, and soil condition, it can happen at any scale. So, now trying to understand, that was the typical aspects of the ecosystem, that it is cons, their constant interaction, and how one change can impact the other change.

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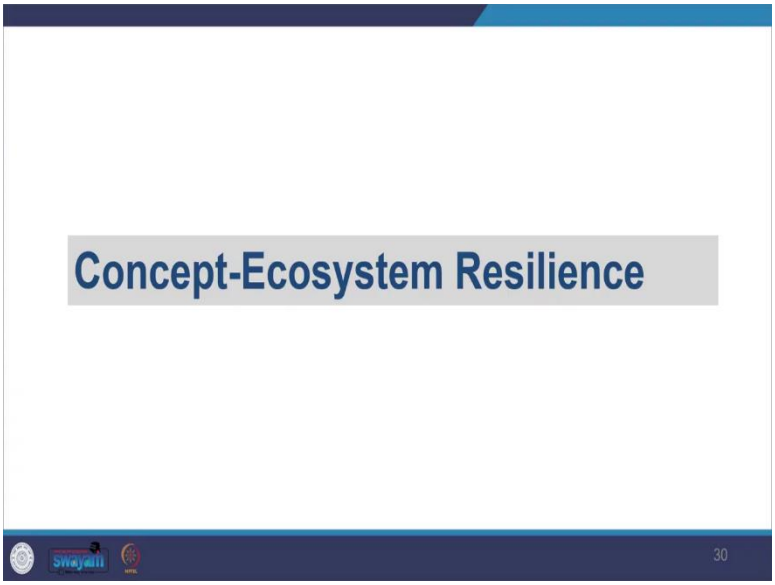



So, now looking at ecosystem resilience, what does this mean? So, ecosystem resilience means stability, how stable is your environment, how fragile or sensitive it is to the changes, and how resilient it is? When we say resonance, how, what is the capacity to recover and recreate whatever destruction has been done? So, all these attributes are very very important for the ecosystem from the impact assessment point of view, particularly when you are doing ecological impact assessment. So, from that point of view these aspects are very important, so let us try to understand these terminologies.

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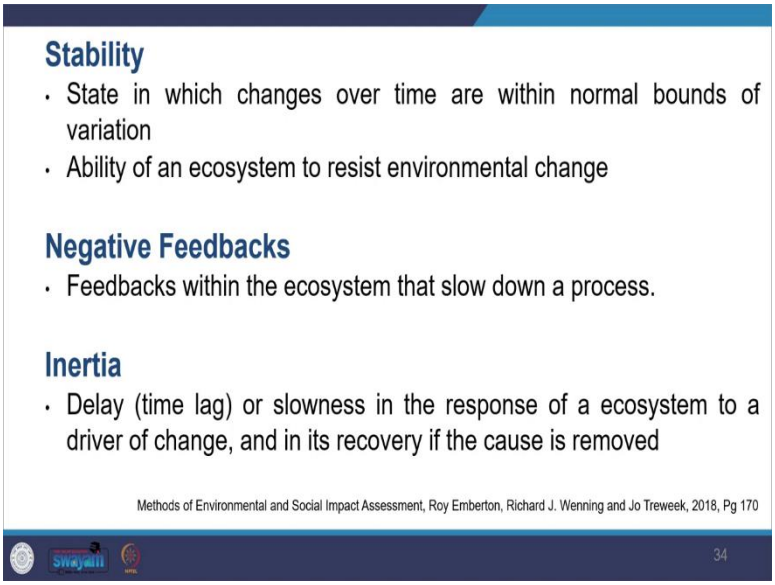


So, when we say stability what do we mean by stability? So, by stability, we want to say that, it is the state in which changes happen over time and these changes are within normal bounds of variation. So, those changes are happening but it is in the normal boundary range so that it does not affect the stability of the environment and it can resist any kind of environmental change. So, any drastic change would not happen it would cope up within those variations.

Within this, we also see there is a term called negative feedback. So, this is the feedback, negative feedback which is, which exists within the ecosystem that slows down a process. So, environments by themselves will slow down any process so that it does not drastically change or cross its limit from where it cannot regain it.

Another term is inertia, which is like delay time lag or slowness in the response. So, how the ecosystem would respond, it will have some slowness in that and so that it allows recovery whenever the things are removed, whatever external impact is happening, when they are removed it allows the ecosystem to recover, ecology to recover.

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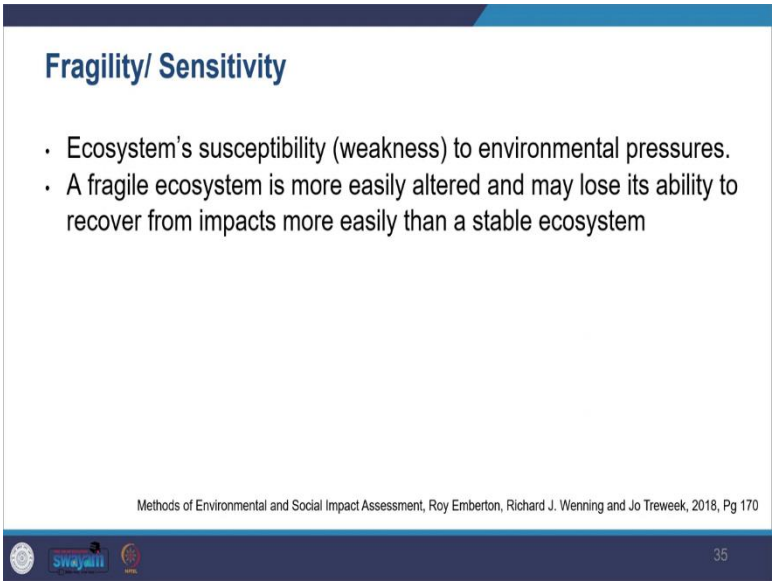


Looking, at the term Fragility / Sensitivity. So, it is the ecosystem's weakness or susceptibility to environmental pressure. So, how weak any particular system is, is what we mean by fragility or sensitivity. A fragile ecosystem is more easily, it can, if a system is fragile then it is said to be very easily affected or it will quickly change because of any kind of pressure and it will lose its ability to recover, so it might be not the same anymore, it will not be able to get back to normal if it is very fragile. So, that also affects the stability of the ecosystem, so more the fragile the system is it is less stable.

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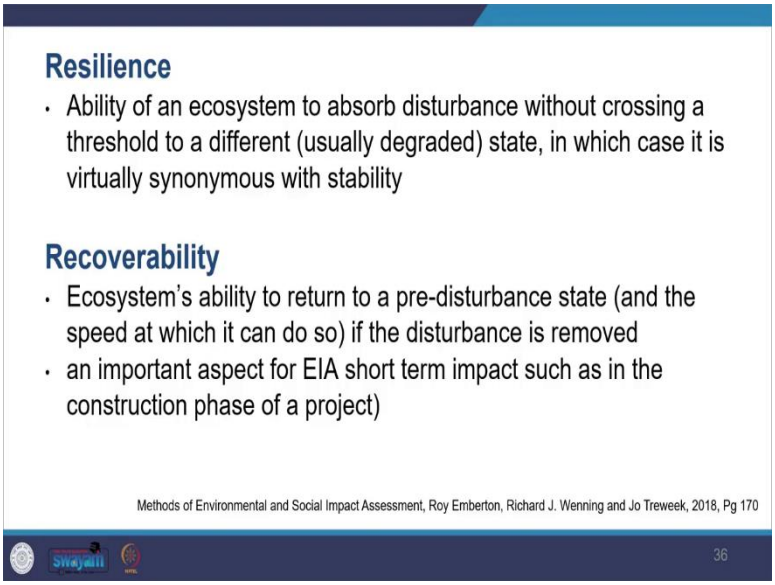


So, now looking at the resilience part of it. So, an ecosystem can absorb disturbances, so how capable the system is to absorb any kind of disturbance whatever happens, and get back to normal without crossing its threshold to a different where it changes its form. So, this can also be said as resilience can be also said as stability.

Likewise, we see the term recoverability, which is like an ecosystem's ability to return to its pre-disturbance state. So, how well it can get back to that and the speed at which it can do it, so how fast it can recover if the disturbance is removed.

So, this recoverability is an important aspect for EIA and especially for the short-term impact because when you are doing construction or certain things and if the ecosystem can recover, whatever temporary changes, whatever activities are going on, when it is removed, then if it can recover for that matter temporary air pollution because of the construction, so when the construction work gets over it can recover itself in due course of time. So, these are very important aspects when you are taking care of EIA.

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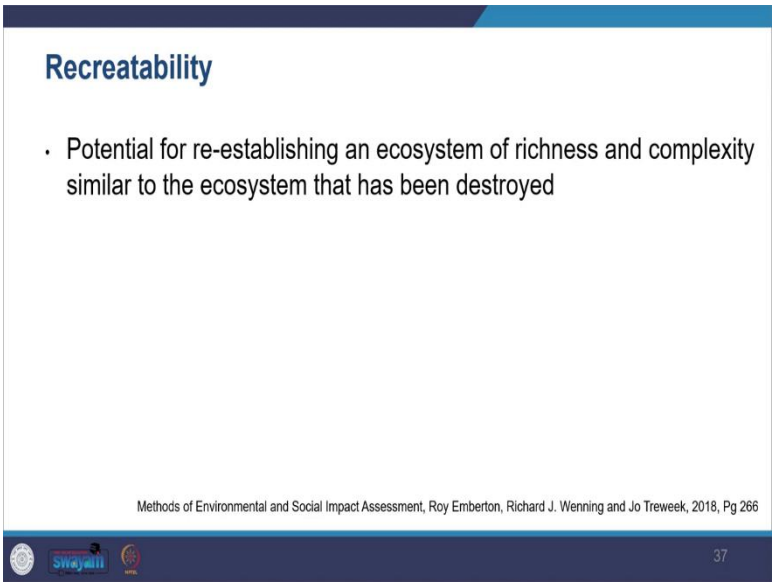


Then another term, you look at is Recreatability. So, that is the potential for re-establishing an ecosystem of richness and complexity, similar to the ecosystem that has been destroyed. So, how much it will be able to become, what it was in its original shape? So, that ecosystem can come back to its original form, so that is repeatability, how much it can recreate it.

So, we see that understanding such properties helps to determine which mitigation approach will be suitable for a place and an impact. So, once you know these things, the pattern of that system you will be able to come up with mitigation, appropriate mitigation of solutions. So, if you find that the ecosystem is resonance and whatever changes are happening, it will be able to recover. So, then, in that case, you do not need to have a mitigation, mitigation is not required.

And if it is the other way round that the ecosystem cannot recover, it is very fragile, and does not have the required resilience which is needed, then you need to have mitigation measures or you might not be able to take those projects in place. It is also said that technically, it is nearly impossible to come back to the original state.

So, as a professional you need to learn to differentiate these contexts and processes, so what is going to happen, what is going to recover, what is not going to recover, what mitigation has to take place, what is what procedure? So, you need to understand these.

So, similarly, you need to understand the time lag for recovery, and how much time it will take, also you need to understand how to develop appropriate mitigation measures and this might be different for different.

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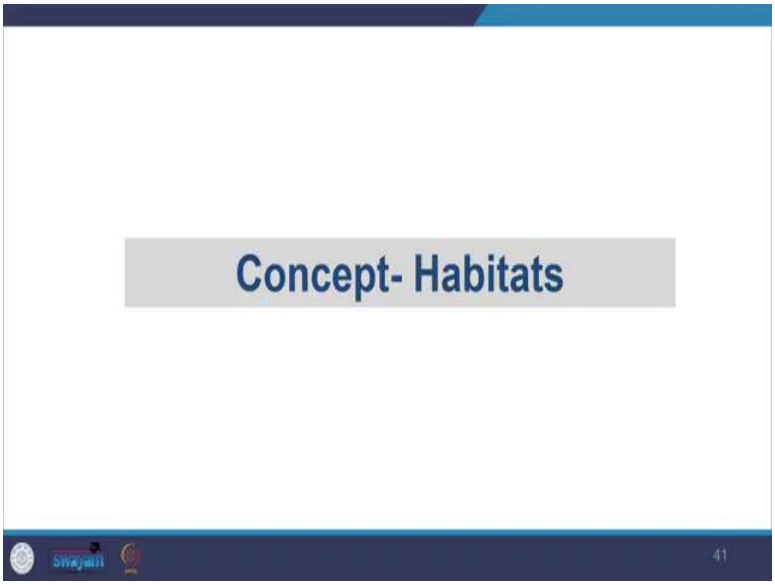


So, now looking at the term habitat here, we look at are number of aspects of the habitat that determine the performance of the environment, like how it can absorb different impacts that it is going to encounter because of the proposed development. So, those aspects which will allow it to absorb, if you look at it, it is the species composition.

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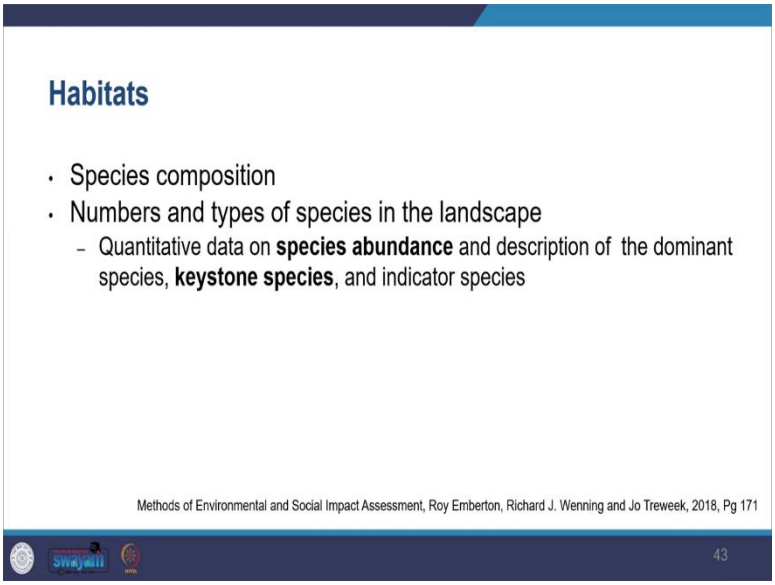


So, what is species composition, species composition refers to like the numbers and types of species in that particular context to the landscape. So, if you look at these species composition, what species are there, it is advisable to undertake quantitative data, so it is suggested that you should take quantitative data on species abundance, what all species are there, how much they are there? And apart from quantitative, you should also describe the major species or the keystone species, we have learned about this term before.

And then, there are also indicator species, like the species which tell you like what is going on in this, whether the environment is normal or it is polluted, and such studies are important in the detailed survey.

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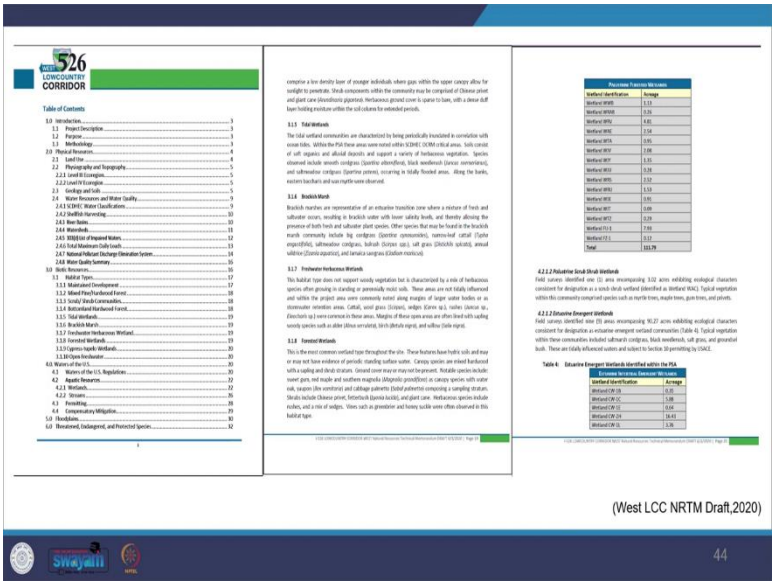


So, here you see, how in this particular example, they have taken in the I have taken this from the low country corridor project. And then, you see how they have taken 3.0 biotic resources, habitat types, they have given all those descriptions here in the center you can see and then in the right-hand side, you can see how they have quantified, how much area is within each kind of wetland.

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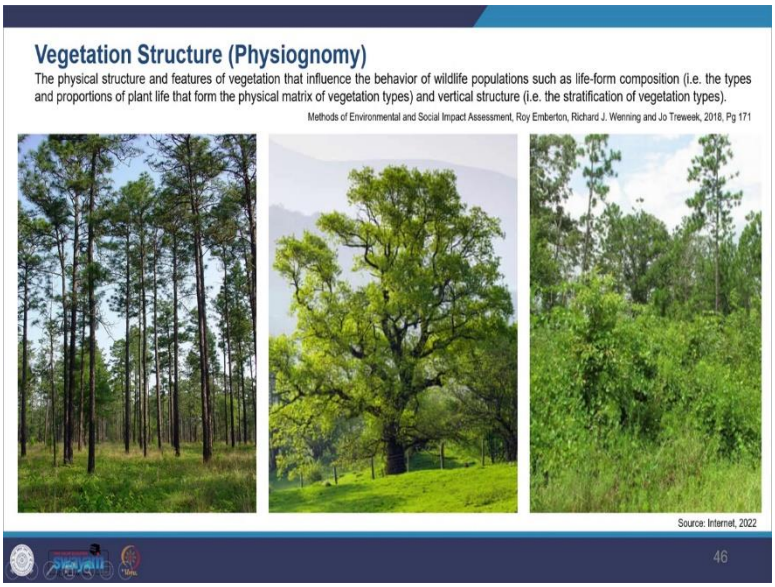


So, in this also you need to take care of the vegetation structure. The physiognomy, so what do we mean by vegetation structure? So, in this particular, when we look at vegetation structure, we look at the physical structure and what kind of features of vegetation are there and that influences what kind of wildlife population would be there in that particular form or the composition of vegetation and also, we see the vertical structure that and how it is stratified of the stratification of the vegetation type.

So, in the image, you can see different structures and wildlife which it could hold would vary accordingly. So, you can see tall trees and then you can see the moderate height and the shrubs and then according to that the wildlife changes, what it would hold there.

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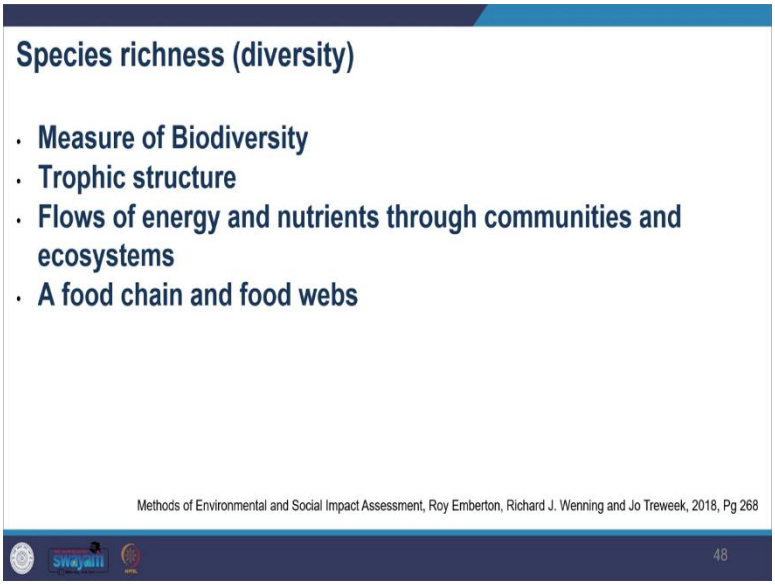


So, within this, you also look at a species richness, like how diverse is it, so not just the quantity of it, but then how many varieties are there, and you also measure the tropic structure, you also look at the flow of energy and nutrients through communities and ecosystems, how each one is important there and what kind of role it is doing taking? And then you also identify the food chain to understand this energy route. It is very important to have this understanding because it helps you to develop mitigation strategies.

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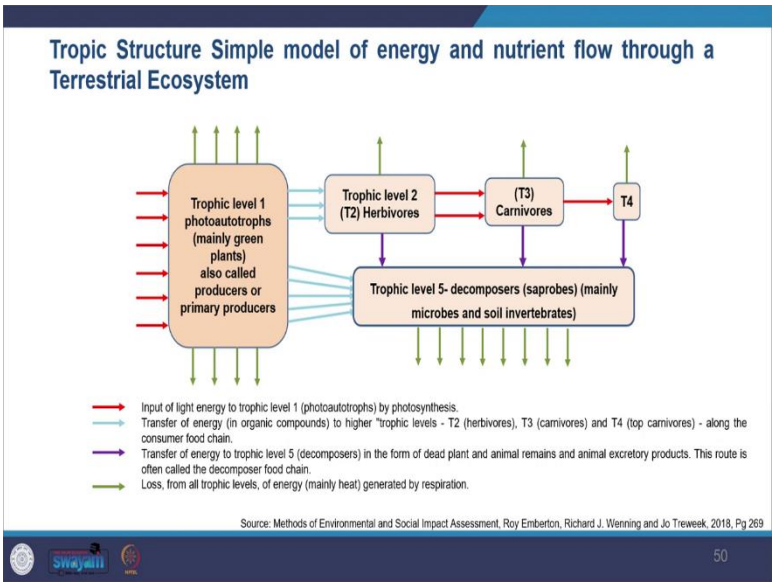


So, in the image, you can see the energy and nutrient flow through the terrestrial ecosystem, in the left side, you can see the input of light energy through the tropical level one, mainly the green plants, then you can see how the transfer is happening to the tropical level two, like herbivorous and then also tropical level five the decomposers like which are microbes and soil invertebrates, and you see how the transfer is going on taking place from t3 level carnivores followed by t4 and t5. So, you see how they are interdependent and how one system is supporting the other one. So, these understanding are, is important, but these understanding can take years of study.

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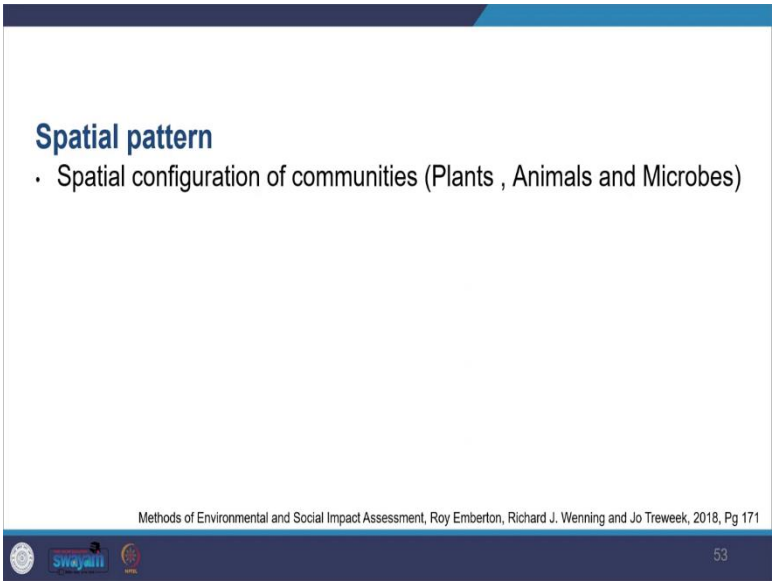


And then in this also you will notice that there are spatial patterns and you can see that also, there is the configuration of communities like where you would find what kind of plant, what kind of animals, what kind of microbes, and these special patterns usually change gradually. So, you would see that when you move across the places, you will keep on seeing those variations.

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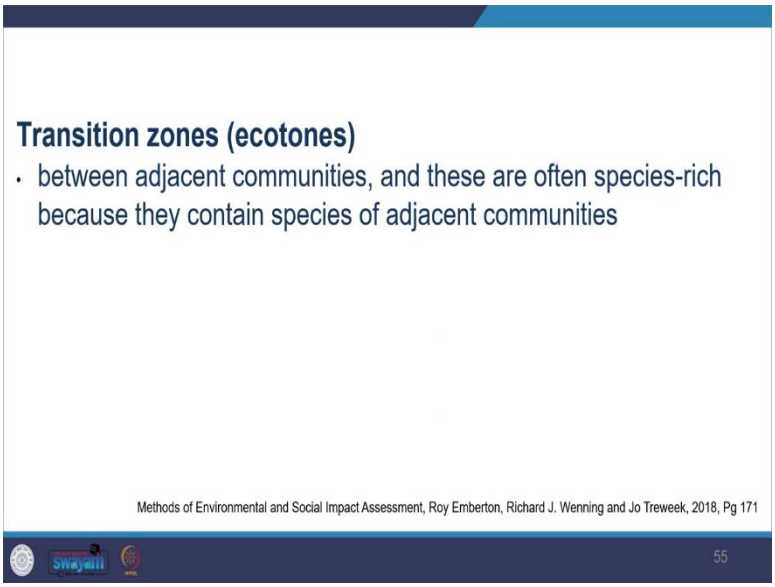


And you would also find transition zone, another term for ecotones. So, where there is a sudden transition in the geographical area of one species type to the other, you would see those differences.

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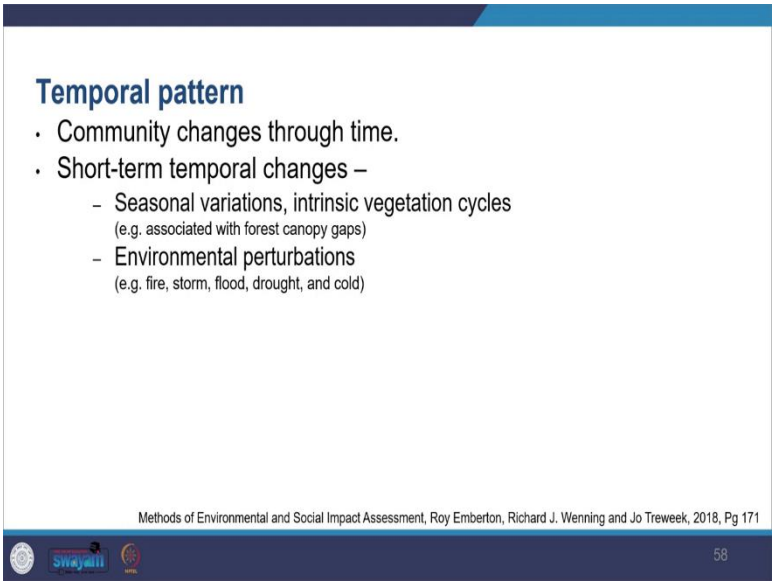


And then you also see that there are temporal patterns, so there can be variation with time also in the same spatial geographical area, there can be variation. So, you seek community changes through time these plants, animals, and microbes would change with time. As you can see some changes are short-term changes including seasonal variation, and it will change with the vegetation cycle like how there is a canopy, there is and then there is springtime, then there is fall time, and then so the vegetation time, would coverage should would also change.

And then they, so these are like easily identifiable. And then, so these short-term changes are not very much of concern but then there can be environmental alarms like fire storms, flood droughts, and cold, so these can also have an abrupt pattern.

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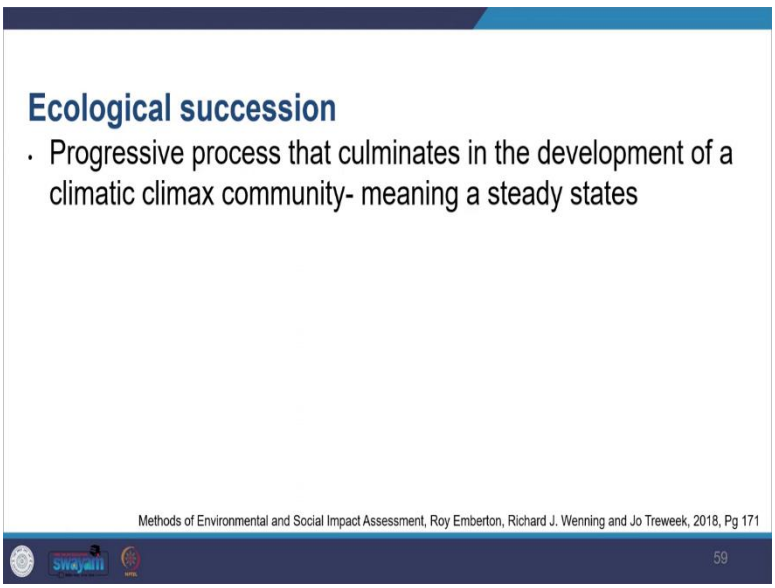


Another term, you would see is ecological succession, which means a progressive stage-wise process that would culminate together, when all those steps taken together would come and become stable and they will develop into a climatic climax community that means a very stable community and you also call it biomes.

So, it would reach a steady state, so the ecological succession which means the progressive step, eventual slow steps, and then they come together those changes one after they are happening like, there might be new species coming old species and they would no longer fight but start cohabiting the place and then they would reach a very stable situation.

, however, it is seen that it is very difficult to predict succession accurately because of how the biomes are identified and have a wide range within themselves, so it feels like we have already seen biomes. So, we see that it already has a lot of diversity, so it is very very difficult to predict the succession, what kind of changes are happening, and what kind of stages they are crossing.

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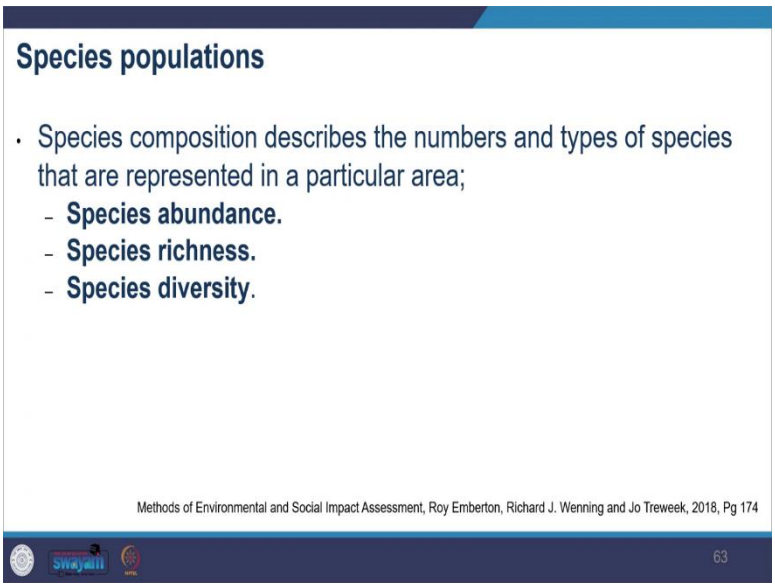


Now, coming to another topic, we are looking at species populations. So, species population means the composition, like how the species are what is the quantity, and how are they distributed? So, species composition at where you describe the numbers of how many species are there in each species how many numbers are there, and types of species and types of species in that particular area of your concern.

So, to undertake a very meaningful study, you need to, you need information on species abundance and you need to measure all these species richness, when we say richness we mean diversity, what kind of diversity is there? So, you also have term species diversity. So, species richness is the number of species represented in an area, so what is like, it is like how many species are there, so that was species richness and then the species diversity is like how many varieties are there related to their abundance like how many variety, how many numbers of each variety.

So, in addition to richness diversity, you undertake individual species, particularly, those that are considered, and you take stock of those also species that are important to understand the conditions required to maintain the population. So, there might be some species that are very key to that place to maintain the habitat.

So, this might be needed for species of conservation concern or species that are used to indicate environmental change. So, environmental change and then you also have these species also you see pollution indicator species and these are pollution indicator species.

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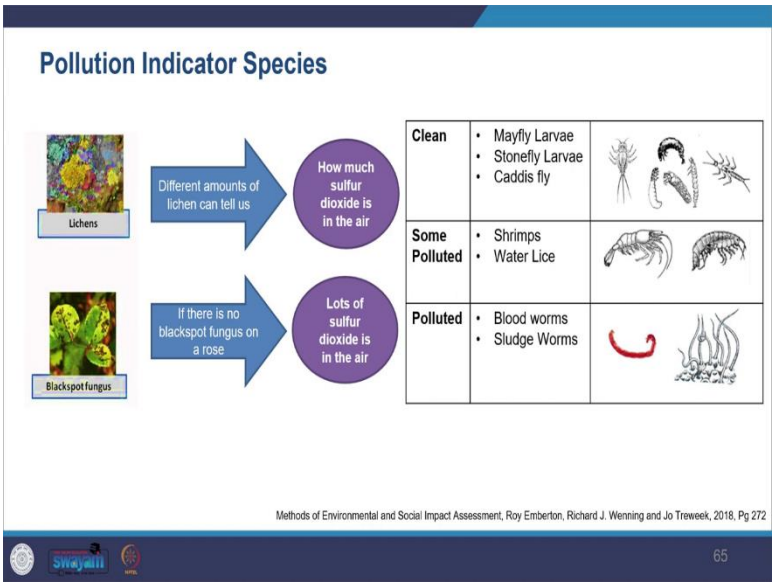


For example, lichens are considered to be a pollution indicator species. They can be used as air pollution indicators and the kind of environment they sustain indicates that there is a certain level of pollution. So, you would, in this image, you would see various legends and black spot fungus, so if they are present, it indicates that there is a problem with the air quality. Then there are other like when you have other kinds of species, which you see, which indicates whether the water is clean or it does have some level of pollution or it is completely polluted with and have blood worms and sludge worms and so on.

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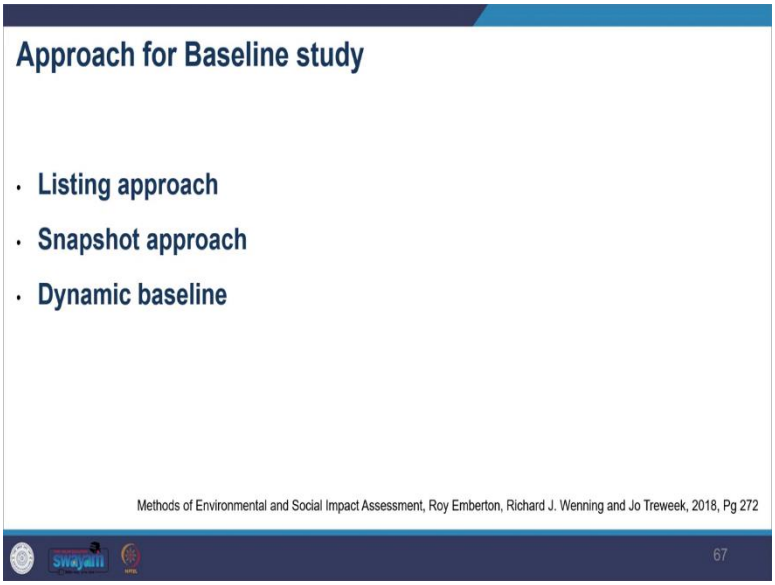


So, you may take, for undertaking all these things you may take the listing approach, you will prepare the list of species, you may take the snapshot approach, you may also prepare a dynamic baseline. So, it is you need not just to prepare a list or document but you might also need to have a dynamic baseline showing how it is changing with time, and how it is changing with the geographies, you are considering.

So, that actually allows you to predict what will happen and you would also see that many species can tolerate short-term environmental variations, so when your project is going so many of them have the recovery capacity, so then they can recover it but you also need to see what happens in the long term. So, whenever the changes are slowed species are usually able to overcome that but if the changes are very rapid then they are not able to overcome that and for most of this work you would require a specialist.

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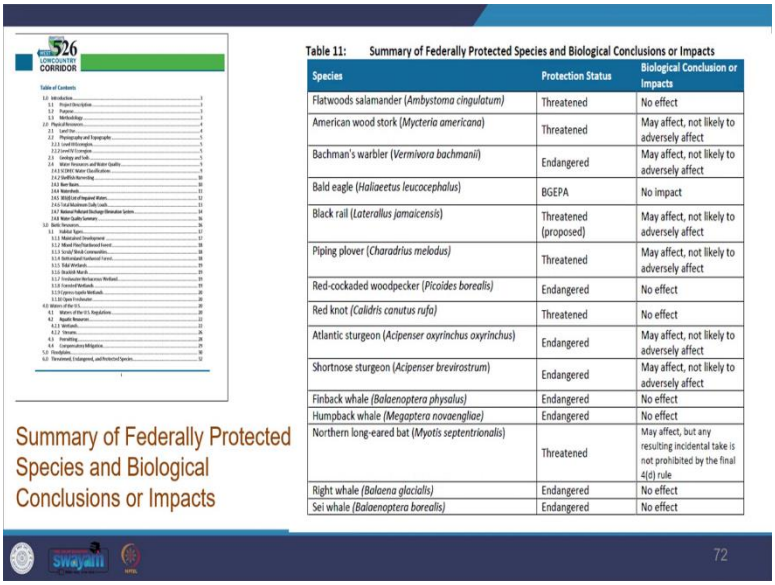


Table 11: Summary of Federally Protected Species and Biological Conclusions or Impacts

| Species | Protection Status | Biological Conclusion or Impacts |
|---|---|---|
| Flatwoods salamander (*Ambystoma cingulatum*) | Threatened | No effect |
| American wood stork (*Mycteria americana*) | Threatened | May affect, not likely to adversely affect |
| Bachman's warbler (*Vermivora bachmanii*) | Endangered | May affect, not likely to adversely affect |
| Bald eagle (*Haliaeetus leucocephalus*) | BGEPA | No impact |
| Black rail (*Laterallus jamaicensis*) | Threatened (proposed) | May affect, not likely to adversely affect |
| Piping plover (*Charadrius melodus*) | Threatened | May affect, not likely to adversely affect |
| Red-cockaded woodpecker (*Picoides borealis*) | Endangered | No effect |
| Red knot (*Calidris canutus rufa*) | Threatened | No effect |
| Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) | Endangered | May affect, not likely to adversely affect |
| Shortnose sturgeon (*Acipenser brevirostrum*) | Endangered | May affect, not likely to adversely affect |
| Finback whale (*Balaenoptera physalus*) | Endangered | No effect |
| Humpback whale (*Megaptera novaengliae*) | Endangered | No effect |
| Northern long-eared bat (*Myotis septentrionalis*) | Threatened | May affect, but any resulting incidental take is not prohibited by the final 4(d) rule |
| Right whale (*Balaena glacialis*) | Endangered | No effect |
| Sei whale (*Balaenoptera borealis*) | Endangered | No effect |

So, here you can see how from the same project, I have taken the snip here you can see the summary of the protected species here and then how, what is the protection status, and what kind of biological conclusions or impacts one is drawing. So, for this flatwoods salamander, you will have no effect, American Woodstock you may not likely be adversely affected, so the entire summary is prepared.

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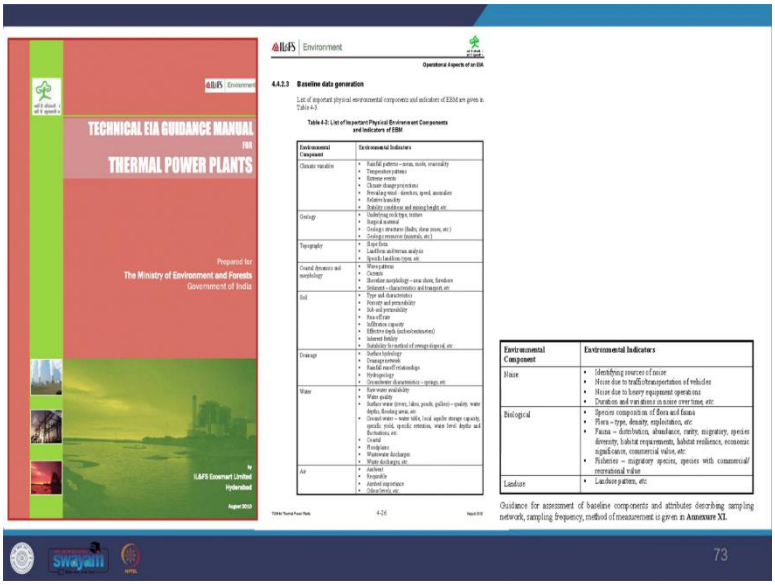


Likewise, you can see from the technical EIA guidance manual, that I have just picked up the thermal power plant you have all said most of the sector manuals are there, so from that also you can refer to what kind of baseline data generation is required and for here you can look at in the right-hand side, the biological component what kind of environmental indicators will be required in Indian context as well. So, you see species composition of flora and fauna, flora type density exploitation flow. Fauna distribution abundance, rarity, migratory, and so on, and fisheries, so you see in our context as well what kind of collections we do to study or create the baseline study.

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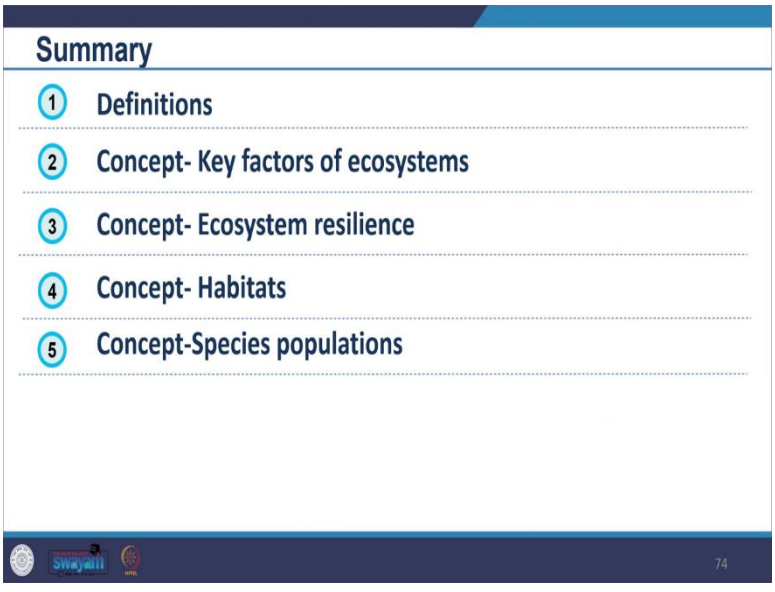


So, that was for this session, we covered the definitions and concepts. So, we looked at the key factors of ecosystems, we looked at the ecosystem resilience and we tried to understand various aspects of it. Then we looked at the habitat and then we looked at the species population.

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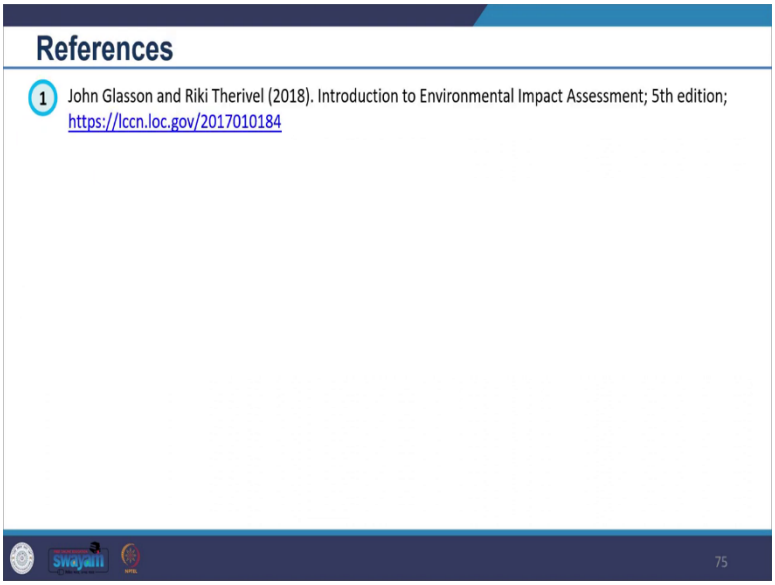


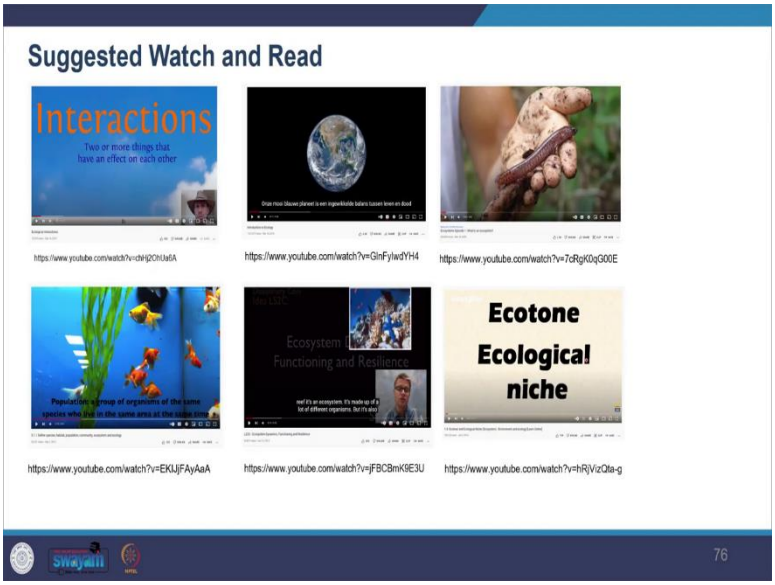


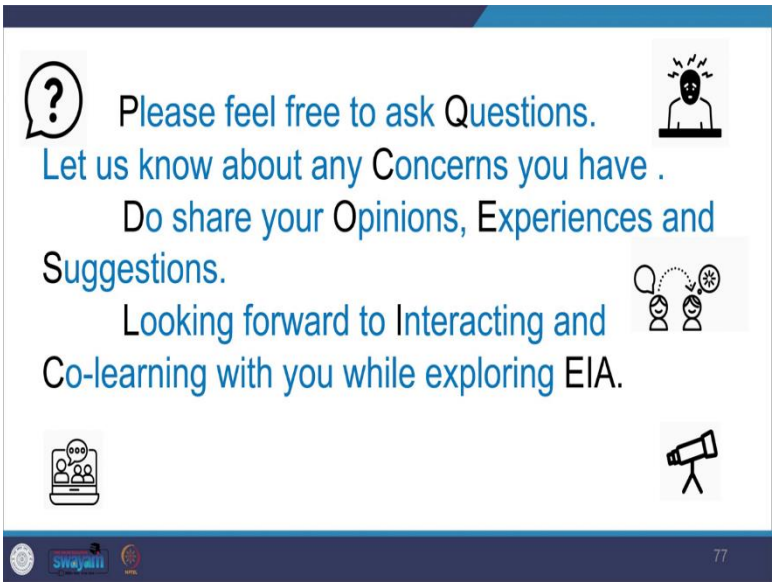


So, these were, this was our key references for this particular session and there are certainly suggested watch and read for you, if you want to learn more, explore more from this. So, please feel free to ask questions, let us know about any concerns you have, do share your opinions, experiences, and suggestions. Looking forward to interacting and co-learning with you while exploring EIA. Thank you.