Environmental Impact Assessment
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Lecture 39
EIA Methods for Ecology (Impact Prediction and Evaluation)

Welcome to the course Environmental Impact Assessments. In the previous lecture, we studied about like, we have been covering methods involved for ecological impact assessment. So, we had already seen the definition path and we also saw the methods involved for the baseline study. So, today we are going to look at what are the methods involved in impact prediction and how we undertake evaluation based on the impact prediction that we have done.

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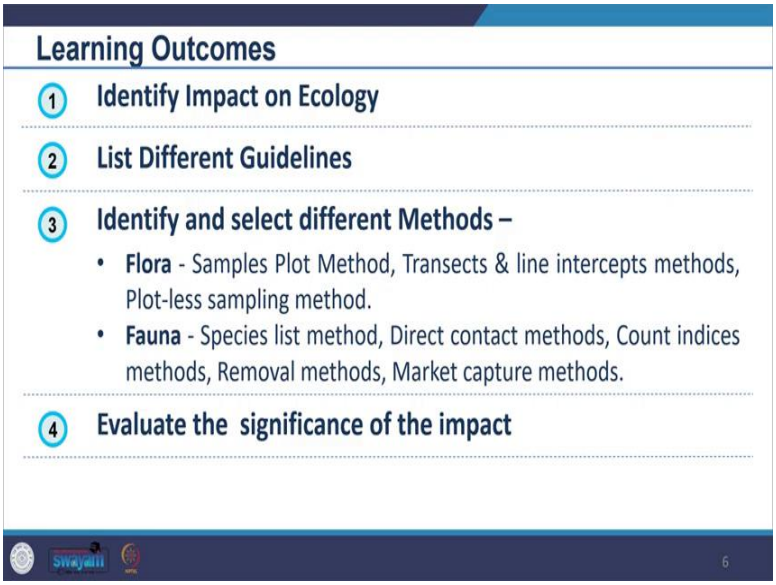

So, accordingly, the coverage would involve that we will look at various impacts on ecology, what are the direct impacts, what are the indirect impacts, residual impacts, and cumulative impacts, and then we will look at the types of impacts as well. Then we will look at different guidelines that are available and then we will look at different methods that are available for assessing the flora, and fauna.

Then we will look at methods that are available for testing the significance of the impact. So, the expected learning outcome is that you should be able to identify different impacts on ecology, what the direct impacts, what indirect, what are residual and cumulative impacts and then you should be able to identify different types of impacts.

Further, you should be able to list different guidelines that are available and then you should be able to identify and select different methods available for assessing flora, and fauna, what kind of impacts are happening and then you should be able to identify methods used for evaluation purpose of testing the significance of the impact.

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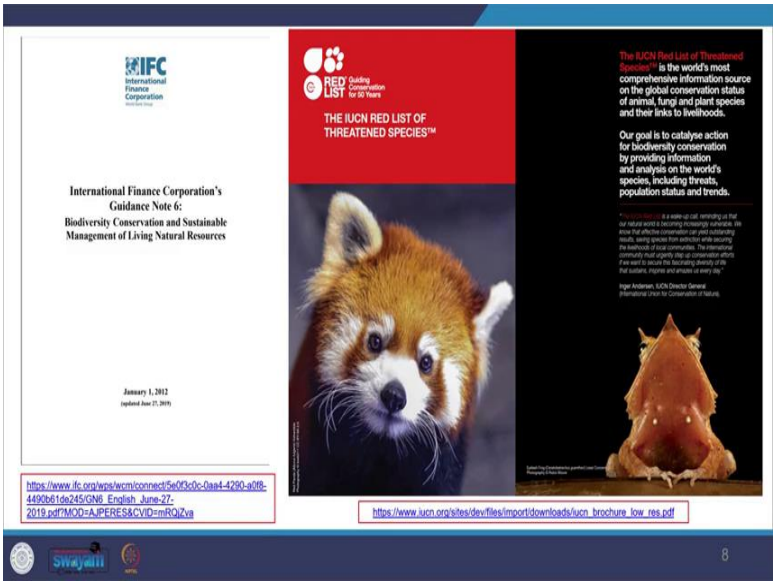

So, moving on, you will see that for impact prediction, in this particular domain, you find IFC guidance on biodiversity conservation and sustainable management of natural resources. And we see that IFC guidance recommends that you can also use an ecosystem approach for evaluation.

And for this, you should also refer to the read list of IUCN which we also discussed in our previous class. So, while you are doing the impact prediction, it is also advisable that you take care that you also have mitigation measures in mind and it is well integrated in the process of impact prediction.

So, not only looking at the impact in isolation but also considering the mitigation measures, recollect the EIA process parts where we studied the impact assessment and mitigation measures. So, what are those processes, and how you should interconnect them? So, the impact can be lesser with the mitigation measures, so, you need to consider this at this point as well.

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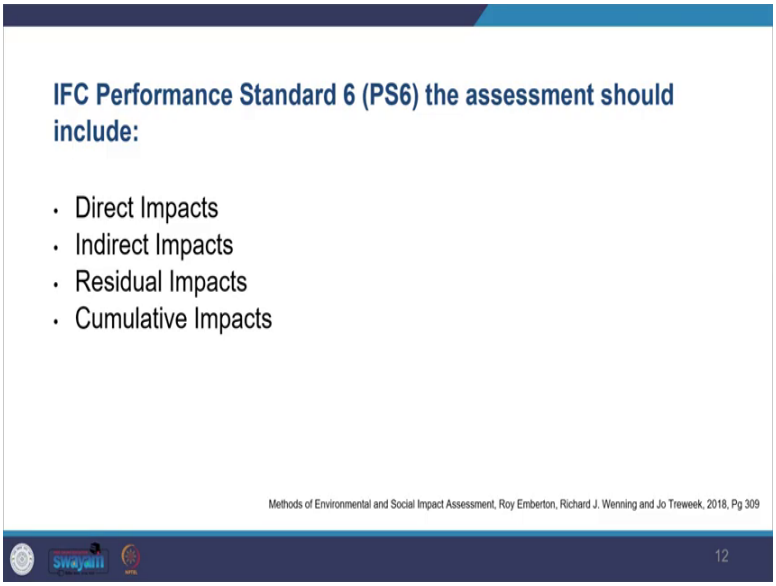

So, it is also important that when you are looking at the impact, you not only look at the direct and indirect impact, but you also look at the residential impact. So, looking at that is also very critical in this case, and

seeing what is residential impact. So, the resident impact is the balance, the remaining impact after mitigation.

So, you have certain development activities, you because of that there are impacts, then you take certain mitigation, you resolve you lessen those impact, but still after those mitigation also you have a certain residual impact. So, that is called residual impact. And one needs to also see that in the overall process, there is no net loss of ecology in the natural habitat.

So, you all saw the terminology what is natural habitats. So, this means you should not lose any ecology at the end of the process concerning the natural habitat. Further, where you are dealing with critical habitat, you may recollect the definitions we studied in the previous session. So, in the case of critical habitat, you should rather focus on net gains, so, you should not lose, not only lose no net gain or loss, but in the case of critical habitat you need to gain there should be gain so you improve the critical habitat.

So, I have seen performance standard 6 gives you like, what is the direct impact, what is the indirect impact, and so on. So, that has to be seen in the area which will be affected by the proposed development.

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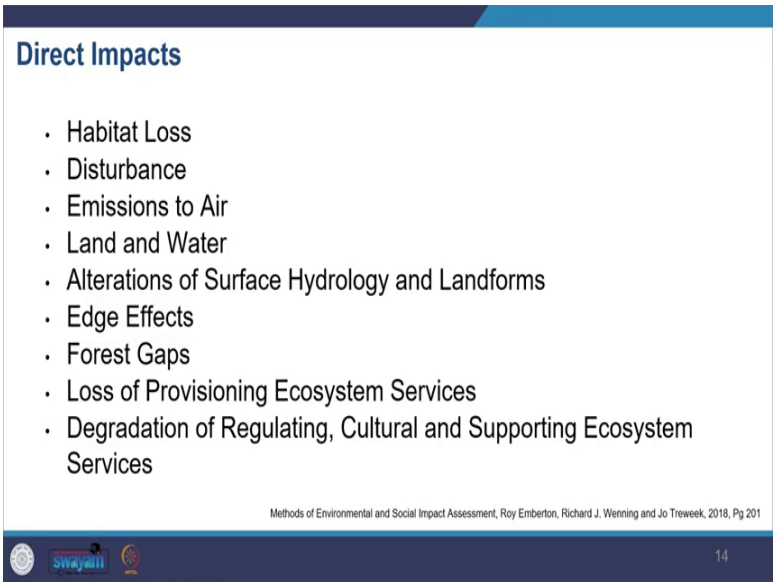

So, looking at the direct impact you have like, there is a range of direct impacts like you can have habitat loss, there can be loss of habitat, there can be disturbances in the habitat, there can be emissions related to air, then there can be deterioration or changes in land and water, and then there can be changes in the surface hydrology and changes in the landform as well.

And then you also have to see edge effects like what happens in the boundaries of this habitat and then there can be forest gaps or there can be like a discontinuity in the forest areas and then there can be loss of provisioning ecosystem services. If you remember, we have studied ecosystem services. So, whatever provisions are there, there can be loss and reduction in those.

And then even there can be a limitation in how much you can access those services, ecosystem services. And then those services like the regulating services, cultural services, and supporting ecosystem services, can have a direct impact.

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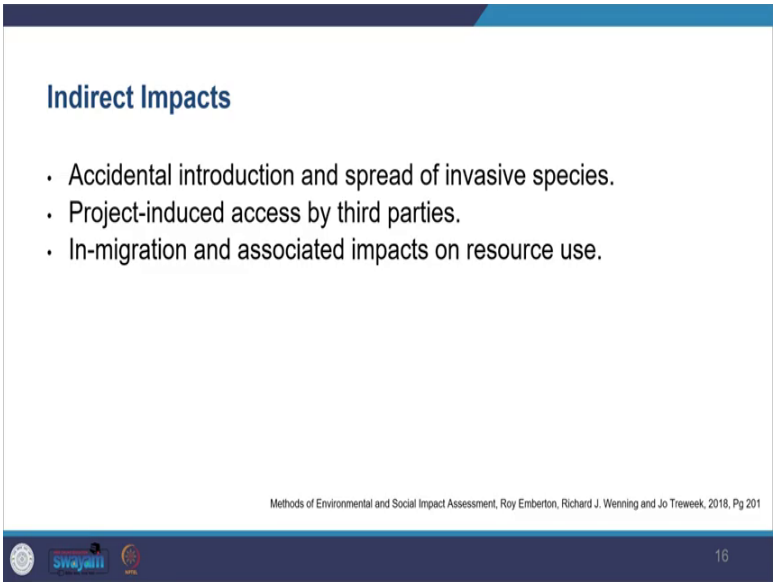

Now, you can also have an indirect impact which might include like there can be accidental introduction of invasive species and then they can spread as well. And then you can also have project-induced third parties which can come here. So, you might be introducing some more things in the area that could be plants or animals.

And then there can be migration and associated impacts on the resource use. So, there can be a lot of people coming in and then there might be people coming in and there might be an impact on how much resource is being demanded and used and exploited in the area.

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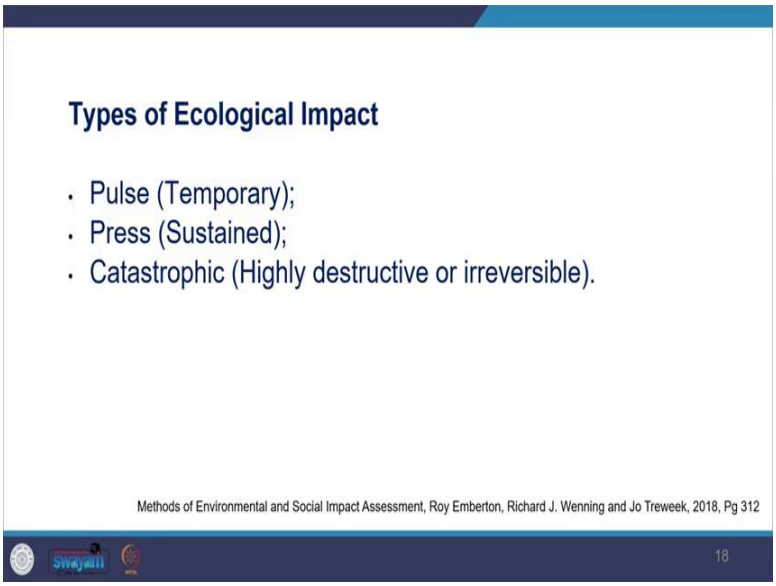

Looking at the types of ecological impact and then there are three types of disturbances which happen that is one is said to be the pulse means very temporary disturbances, and then there is a press, which is like a sustained disturbance, which goes for a longer time. So, those kinds of disturbances can also happen. And then there can be catastrophic like something which has a very intensive impact, negative impact and which you cannot change.

So, you see these kinds of distributions. And then you have, you see that development can, we give often give very negative examples, but then it can have both negative and positive impact on the ecology and it can create habitat, and one can also have a good management system in place. So, just looking at some of the impact types, major broader categories. So, you see that a big threat is habitat destruction and fragmentation.

So, habitat gets lost, and damaged, and there is fragmentation, habitat fragmentation. All these depend on what is already there in the area in the project area. These kinds of damages and fragmentation can happen, because of the range of activities, the sequential range of activities in the project from the phase of construction operation and decommissioning, and in a lot of cases, many cases one cannot avoid distractions.

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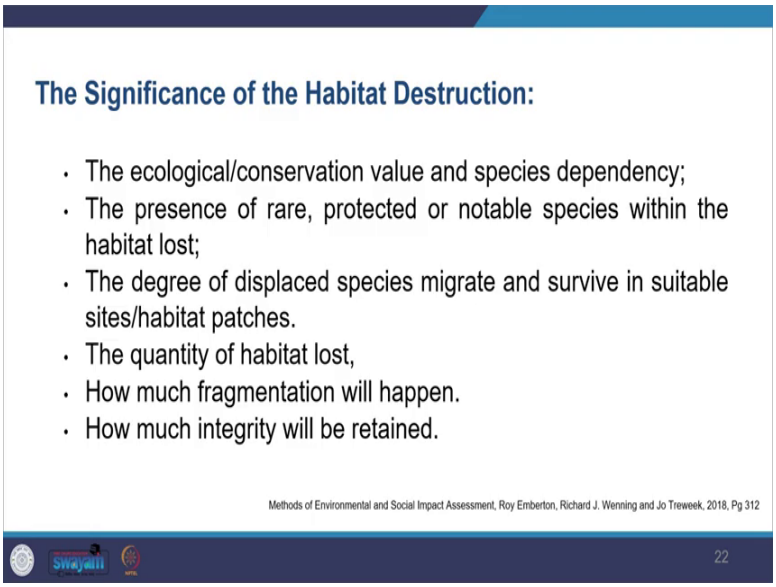

So, the significance of habitat destruction will depend on a range of factors like there are certain factors on that, and how important the significance of that particular impact will depend on. So, you see the ecological conservation value of the habitat, so what kind of value is assigned to that particular habitat? So, based on that the significance would vary and what kind of species are there, and if there are very rare species, notable or protected species, the significance will increase.

Then also, depends on the degree to which the species might be displaced because of the proposed project. What is their capability to migrate to another place and migrate and survive those changes? So, it will also depend on their ability to travel and adapt to the newer places. So, that all will depend on what is available

in the nearby areas how dense are those areas, and will they be the other habitats would be receiving them or not. And then it will also depend on the quantity of habitat loss.

So, how much is being affected, what kind of percentage is affected by the development activity, and how much fragmentation will happen like how much you would, because of the activity, how much it will break down into small pieces? So, that is what we call habitat fragmentation. So, how much will that happen, and because of that, how much integrity will be retained or compromised in the case?

So, how those areas despite interference, can work as one unit. So, it will also, the significance of the bath will also depend on that. And you need to see what will happen to ecotones or edge communities or communities living in the adjoining areas. So, you also need to see that, so, you have already seen what ecotones we have studied before.

So, you also need to look at the indirect impacts the possibility of flood, and so on, which might happen. So, that is how we look at the significance of the project. So, many a time because of the project and the kind of changes that will happen, you see that new obstructions or blockages are created between habitats.

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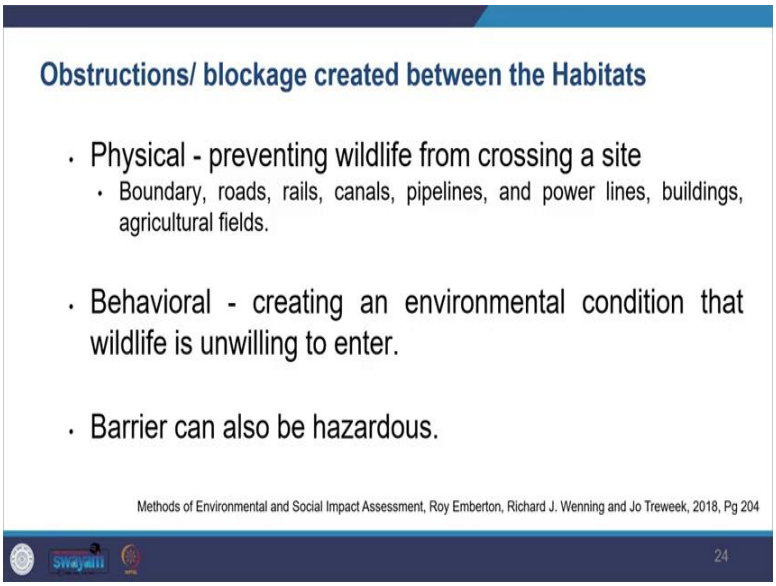

And these blockages can be physical which prevents wildlife from moving from one place to another. For example, you must have most of the time seen that, you have roads, you have rails, you have canals, pipelines, and all these moving, which interferes with the passage of the animals from one place to another or divides their habitat.

So, those can be the physical barriers that one creates, and sometimes one also creates behavioral barriers like creating an environment in which one no longer those wildlife are unwilling to enter. And to those newly created environments. Furthermore, you will see that the kind of barrier that is created can be also dangerous, dangerous to life and a lot of it can cause death while crossing the road many of the animals die, and while crossing the railway track many of the animals die.

So that kind of hazardous situation can also come. Because of habitat fragmentation, there is increased isolation. So, one is the habitat is getting fragmented, plus when these things get fragmented, the habitat also gets isolated. When we say isolated, that means it is getting disconnected from the other areas, and other areas and this interlinkage is very important because that connects the habitat to the larger network of habitats.

So habitat fragmentation, if you look at it, how important it is, it is one of the indicators of unsustainable or sustainable development. And it is given due consideration in the World Bank Environmental Assessment Methods. So, this is used as an indicator of how much habitat fragmentation is happening. So, that is an important impact to look into. So, what happens when such kind of fragmentation happens, is you have small patches of habitats.

Usually, they become very insufficient in terms of resources, like there will be not enough food, water, or sites that are feasible for the population of some of the species and many of the species that reside locally, they become vulnerable to disasters, such as droughts, fire and so on.

You will also see that some of the species need several habitat patches because they keep moving and traveling, so they just do not limit themselves to one patch, but they need several habitat patches. So, small patches are also susceptible to edge effect, so an isolation, edge effect can also happen. So, let us look into what is edge effects.

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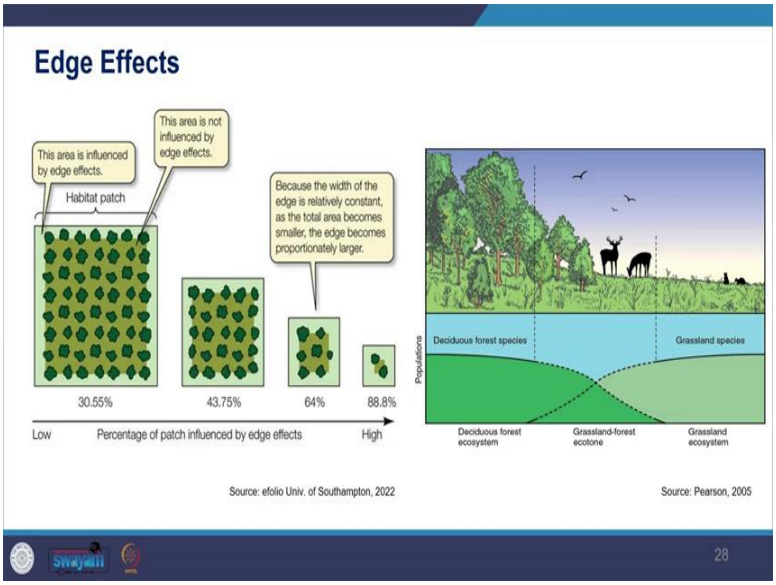

So, edge effects are related to the like something edge meaning boundary, it is related to the increased length of habitat edge. So, more and more you are creating the boundaries like more and more you are exposing it. So, more and more edge is created. So, compared to the total area you have much of the periphery boundary area. So, that is said as edge effects. And when there is a larger edge, then we see that we have more species that live on the edge compared to species that live in the core area.

So, fragmented habitat patches are also susceptible to external impacts like more and more when such fragmentation happens, then they are much more exposed to pollution because of the roads and other things coming here. And then physical damage can also happen because of continuous activities happening and there can be disturbances also. It is seen that some species are more influenced by pollution, physical damage, and disturbances than the actual size of it.

So, they get, really get disturbed by these things and they are sensitive to the pollution and then they also get physically damaged. We also see that when fragmentation happens, edge effects happen then these areas become more susceptible to foreign species that can move from the neighboring areas.

So, trying to understand isolation, what do we mean by isolation? Generally, we see that species travel between habitat patches within larger ecological networks, for example, elephants keep traveling and any impact on the habitat patch, which works as a source or the sink can create isolation. So, no more they can travel, so they are particular (())(16:52).

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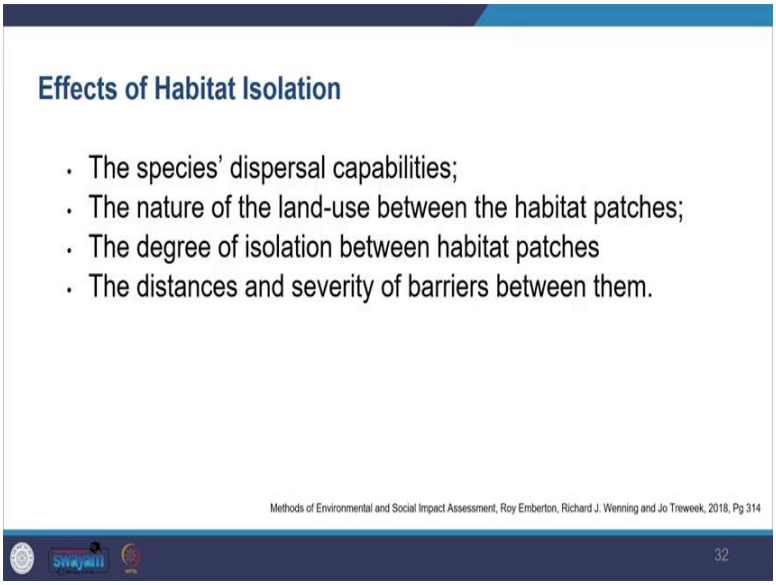

So, because of these things, it affects the species' ability to disperse, where all they can go. So it affects that. And then it also affects the nature of land use between the habitat patches, so how what kind of uses been taking place. Then the degree of isolation between habitat patches also is affected. And then like the distance, what kind of barriers are coming, and then it gets isolated, and many times it does not survive that.

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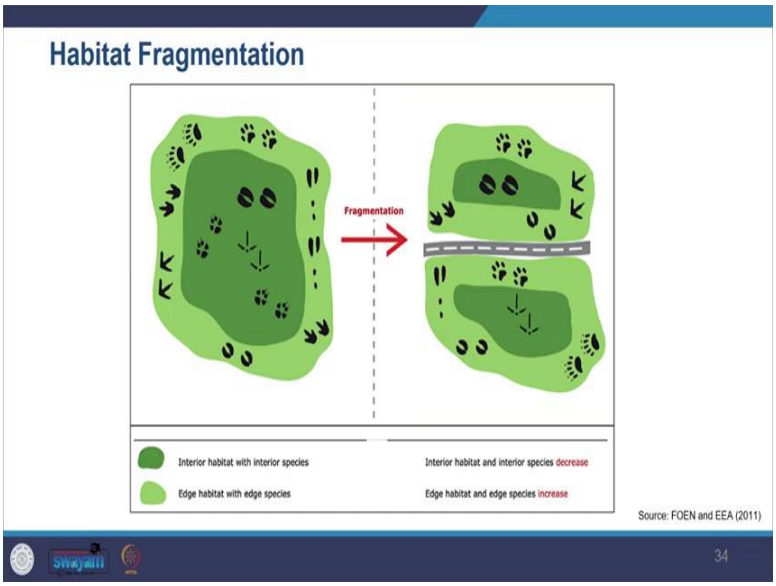

And we also see that habitat fragmentation also limits the regional dispersion of many species. So, species that travel from region to region also limit that and it is said that it is a very serious concern, and it is very much connected to climate change. And this fragmentation has an impact on local ecology. And survival of many species depends on their ability to disperse and how they can move around. And we see that now the challenges are increasing.

So, we see the significance of these barriers that are created, so you are looking at the impact that the barriers are created, then looking at the significance of these barriers. Also very, for example, some species have like efficient dispersal mechanism. And so, they can quickly move away and then they are not really affected, but some species that have low mobility, who do not disperse, would stay there or might vanish after some time.

And they are forced to stay there and they are not able to adjust to the kind of change which is happening. Further, the other kinds of impact we see the habitat damage, wildlife disturbances, and direct mortality where the death can take place.

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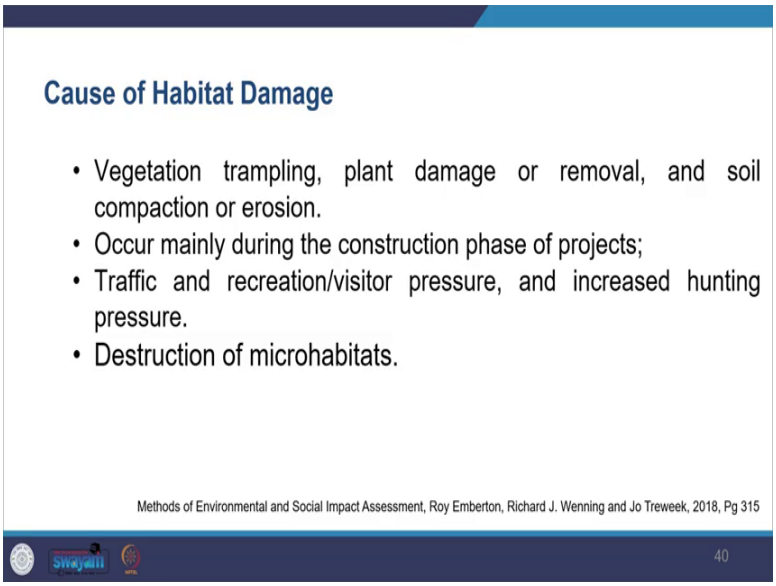

So, we see that there are causes of habitat damage, like you can have vegetation trampling where the movement, this damage to the vegetation, there can be plant damage or you can be removing the plants and then there you might be during the construction you might be compacting the soil and also there can be soil erosions. And mostly these things happen during the construction phase of the project.

And often, it can be irreversible. And then there are other causes like traffic, recreational visitors, pressures and so on. And then there can be also a lot of people have a lot of people hunting. So, all those kinds of things can also happen during the operational phase of the project. So, those are the causes of habitat damage we see. Such kinds of things destroy microhabitats, and then they lead to disturbance in the whole ecosystem.

And it tends to simplify the habitat. So, a lot of the complex things, how they are interrelated, they simplify, and they lose their complexity. So, for example, riverbank stabilization, and development of the Canal. So, like you see the meandering rivers, but then they are straightened and so then it reduces a lot of plants and invertebrates diversity, and it simplifies the habitat.

So, those kinds of changes also happen. The needs of species vary at different lifecycles also. So, some species would have certain requirements of the younger age and then the later so on. So, all those habitats are also changed and that transformation happens.

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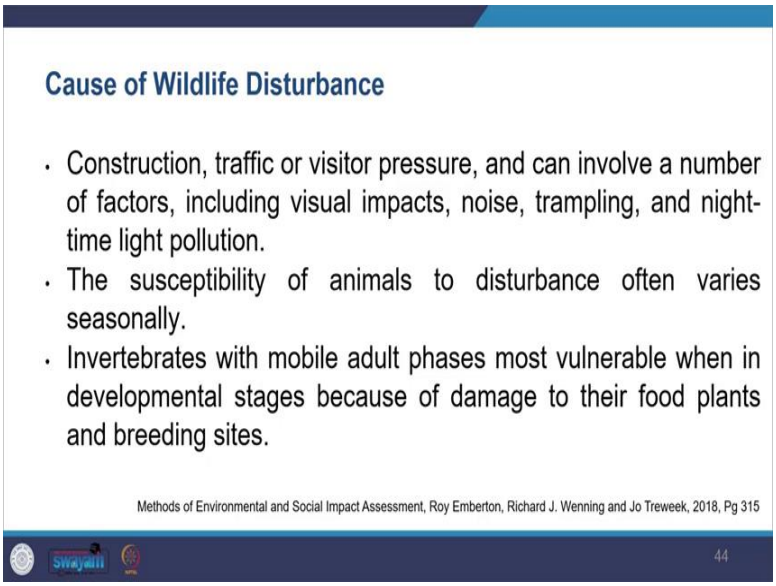

Looking into the wildlife disturbances. So, you see the primary cause of that is the construction, traffic or visitor pressure and then there can be other things also, you can also have visual impact, there is noise, there is like people's movement, frequent movements, people walking around and then there can be also light pollution. So, those kinds of things can happen.

Animals can be susceptible to these disturbances especially as such kinds of problems can be more severe in times of breeding periods. So, you will see such kind of, like, your details of which period might be sensitive, might differ from country to country and from species habitat to habitat. So, it will not be easy for you to identify those periods. So, you need to look out for those guidelines, which help you to find those periods there.

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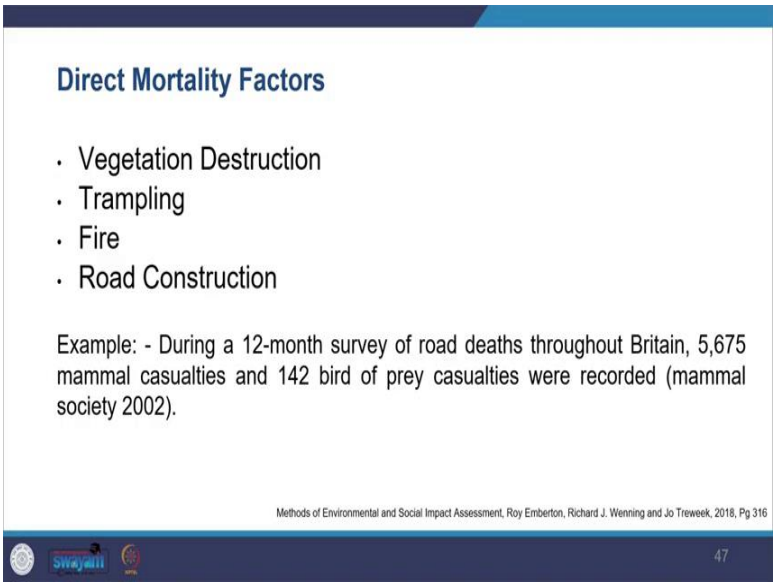

So, another thing, now, looking into the direct mortality, this also happens because of the similar vegetation destruction and trampling and fire. And majorly you see that roads present a serious long-term threat and especially to the animals which need to cross, which need to move. One of the examples was that casualties happened just because of road deaths. So, you can see those examples. So, that was about the second type of impact which you saw. So now moving on to another impact, there is pollution.

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So, there can be pollution with air and water and so on, then and every species would react respond differently to that. So, usually, it is said that the range of the quality is very narrow for the usually for the habitat. And it is very slim for every type of habitat. So, how much they can adjust to the change in quality is very limited. So, any change in the range damages and rest the habitat. And because of the development and not only because of the development sometimes even because of the accidents, there can be changes in the quality level of the environment in the vicinity.

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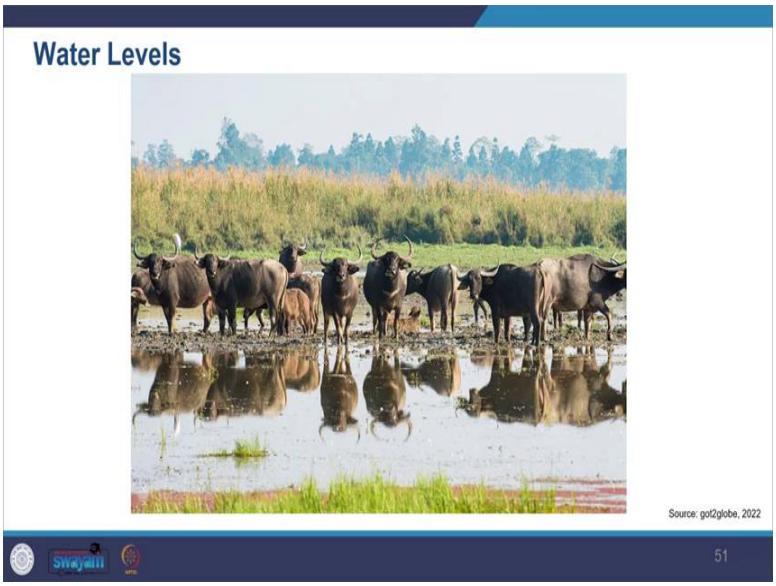

So, particularly looking at the water levels. So, you do see this change in the water level, because of the changes in the both ground level and the surface level. And this causes a major impact. And you see that the seasonal variations are important for the sustainability of the habitat. So, it can be particularly important to how this seasonal variation happens in the marshes, grasslands, wetlands, and so on especially during the breeding seasons. So, these are important things. So, if it does not those variations stop there is a limitation in that it has further impacts.

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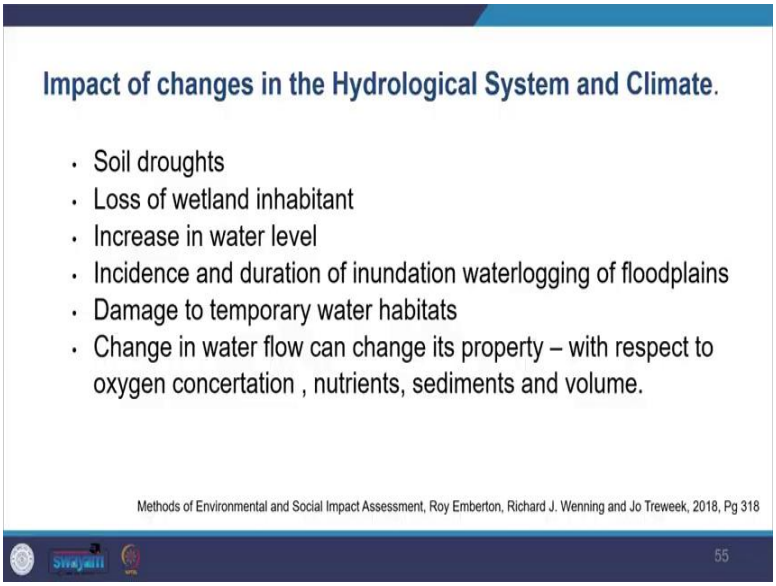

And then you also see the changes in the hydrological system and climate can impact. So, there you can see soil droughts, then you can also see the loss of wetlands and habitats. You also notice that there is also the impact of the increase in the water levels so that also has an impact and like it increases the chances of if the water level increases it increases the chances of inundation. So, how frequently it will happen, and how long it will happen?

So, those things will also change. Then there will be an increase in the waterlogging of the floodplains and then it might adversely affect several of the diversity. And majorly you will see the variations in the ponds and streams would be lesser and then that can impact a lot of animals and plants. So, you see, those ponds and streams are usually very important elements for a lot of animals and plants.

So, you also see that a change in the water flow can change its property also. So, you see the changes in the oxygen concentration, nutrient sediments, and the volume. And these kinds of changes can be irreversible as well. Further, you see that there can be also a change in the competitiveness balance between the species. So, in a lot of species, you might see that some are very adjustable, and adaptable, whereas others are not and might be slow in adapting.

So, if any kind of change happens, then you might see that the situation favors the species that adapt compared to species that do not adapt or are slow in adaptation. So, then your proportion might change and it will give more advantages to the more adapting species. And the less adaptable species might be of high value, high value for the habitat. So, those are things you need to take care of.

So, these were the impacts that we see. So, now, moving on to different guidelines that are available. So, you see that, there are different guidance, which are available for the purpose, but it is also suggested that habitat loss or fragmentation is something that one can identify easily, but it is difficult to predict the secondary impact and cumulative impact. So, those are complex ones. So, you will see guidance on assessment of indirect and cumulative impact provided by, you can see.

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Here, the cumulative effect assessment and practitioner guide you can see here from Canada, which is there, I have given you the link for this download. You also have guidelines from the EC and the European Commission. So, where do you have guidelines for the assessment of indirect and cumulative impacts there? Then you also find guidelines from here you can see a practical toolkit for assessing the cumulative effects of spatial plans and development projects and biodiversity in England, you can see this as well.

So, there are a lot of sector-based and national advice which are available. So, you can see for the UK, you can see for South Africa, then you can also see for Australia, and you can find in India by MOEFCC. So, we have a range of sectors all like what kind of tools and assessment methods have to be used.

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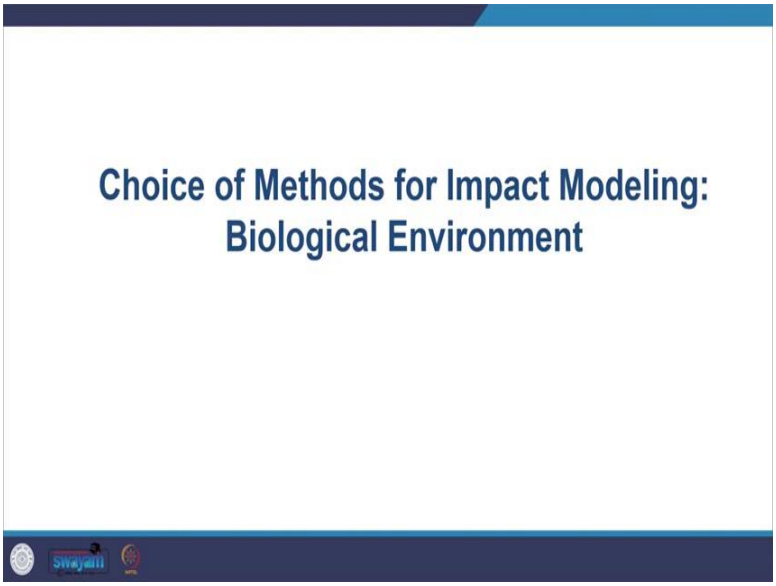

So, looking at the -- I have taken up this from one of the manuals from the thermal power plant, so, how that biological thing impact assessment, what kind of tools are suggested methods are suggested. So, you see that you can collect a sample plot method.

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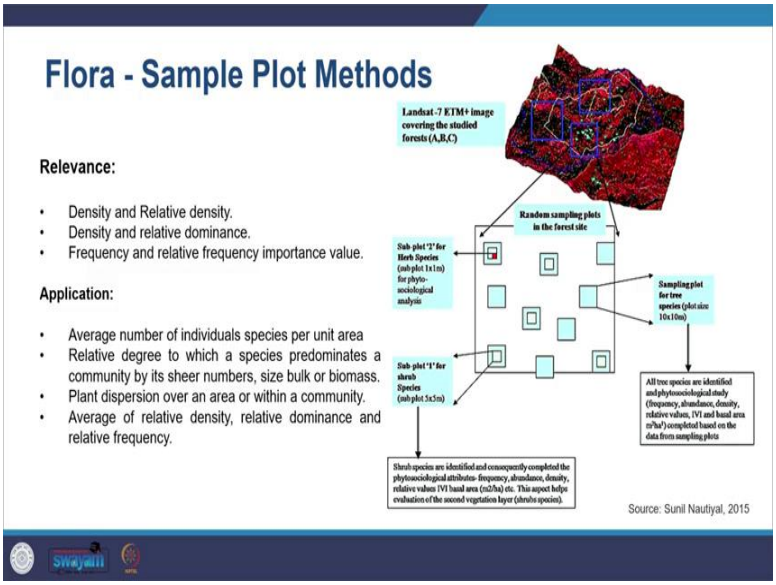

And in that, usually, you cannot survey the entire area. So, you only identify certain pockets for surveys. So, that is how scientists work. So, you can pick up density and relative density in this, relative dominance also can be seen and frequency in relative frequency or important value can be seen here, through sample plot method you can see in the image.

It allows you, it serve a lot of purposes like you can identifying an average number of individual species, you can look at the relative degree to which species, pre-dominates a community, and then plant dispersion over an area. You can also look at the average of relative density, relative dominance, and relative frequency. So, you have certain guidelines, how what kind of sizes and plot sizes you have to use for what kind of types of plants. So, you can see here from the list. The other type is the transects and line intercept methods.

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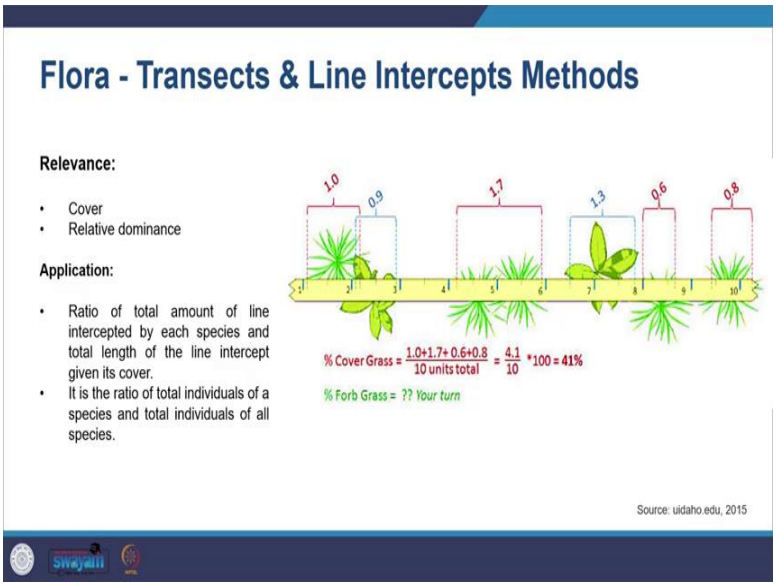

So, for this, as you can see in the diagram, you have one straight line drawn and whatever comes within that you make note of that. So, you look at what is the cover and what is the dominance. So, this one is used for like you create a ratio of the total amount of line intercepted by each species and the total length of line intercepts given its cover and you also take out the ratio of the total individuals of species and total individuals of all the species. So, you take out all those kinds of information. And the benefit of this is that it allows you a rapid assessment of vegetation transition zones.

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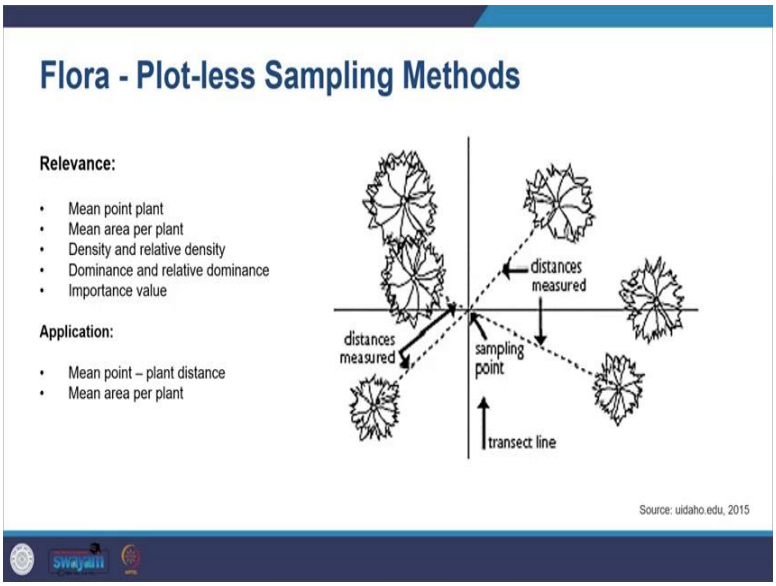

You see the plotless sampling methods. So, you do not identify as a point but you stand at a point and you look at the distance and see what kind of variety you have. So, it is like this you can take the mean point plant, mean area per plant, density and relative density, what are the dominance and relative dominance, and important values, importance values can be seen, and it allows rapid and extensive sampling then the plot method. So, this helps you to do it very fast then. That was for the flora and now, you look at the fauna, you have space species list methods.

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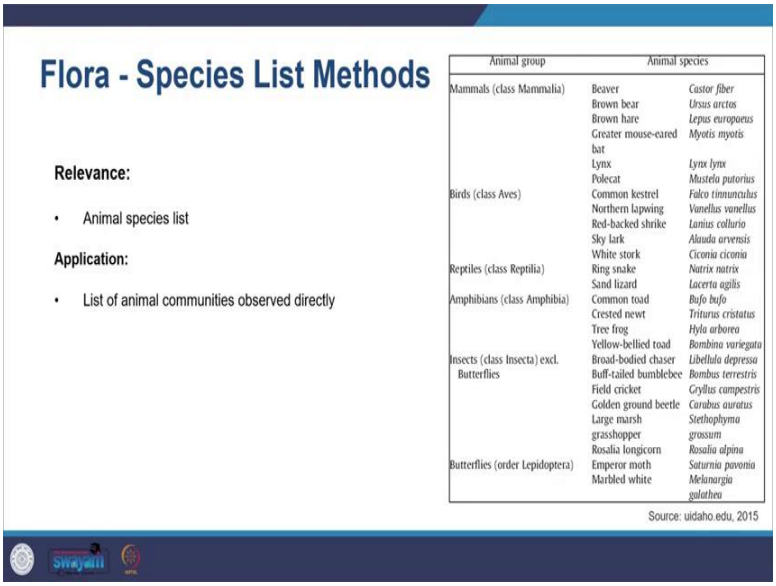

Animal group	Animal species	
Mammals (class Mammalia)	Beaver	*Castor fiber*
	Brown bear	*Ursus arctos*
	Brown hare	*Lepus europaeus*
	Greater mouse-eared bat	*Myotis myotis*
	Lynx	*Lynx lynx*
	Polecat	*Mustela putorius*
Birds (class Aves)	Common kestrel	*Falco tinnunculus*
	Northern lapwing	*Vanellus vanellus*
	Red-backed shrike	*Lanius collurio*
	Sky lark	*Alauda arvensis*
	White stork	*Ciconia ciconia*
Reptiles (class Reptilia)	Ring snake	*Natrix natrix*
	Sand lizard	*Lacerta agilis*
Amphibians (class Amphibia)	Common toad	*Bufo bufo*
	Crested newt	*Triturus cristatus*
	Tree frog	*Hyla arborea*
	Yellow-bellied toad	*Bombina variegata*
Insects (class Insecta) excl. Butterflies	Broad-bodied chaser	*Libellula depressa*
	Buff-tailed bumblebee	*Bombus terrestris*
	Field cricket	*Gryllus campestris*
	Golden ground beetle	*Carabus auratus*
	Large marsh grasshopper	*Stethophyma grossum*
	Rosalia longicorn	*Rosalia alpina*
Butterflies (order Lepidoptera)	Emperor moth	*Saturnia pavonia*
	Marbled white	*Melanargia galathea*

So, you can use all these species lists. So, you can see the range of the list which is there, and then this list of animal communities is observed directly. So, here animal species list with this you can prepare a fauna resource catalog.

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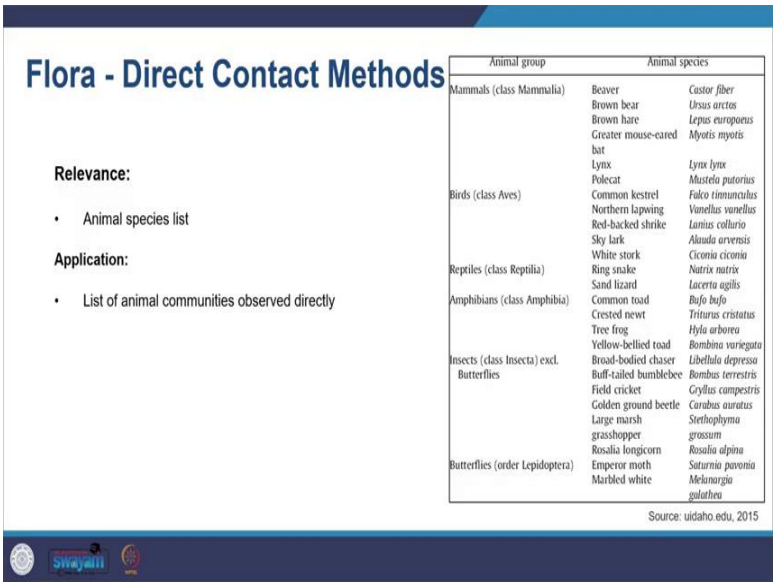

Then you have the direct contact method, then this list of animal communities is observed directly and this method involves collection study, and release of animals.

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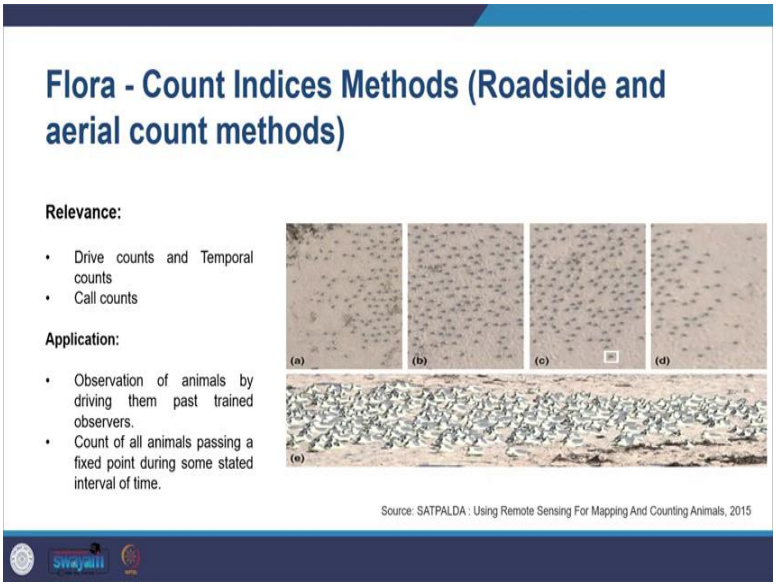

Then you find another method which is the count indices method, roadside, and aerial count methods. So, you drive count and you also see the temporal count and call counts you undertake. So, you can see how you have used it for mapping and counting animals. So, through this, it provides an index for various species in the area. And because you have indexes, it allows comparison through seasons or between sites or habitats.

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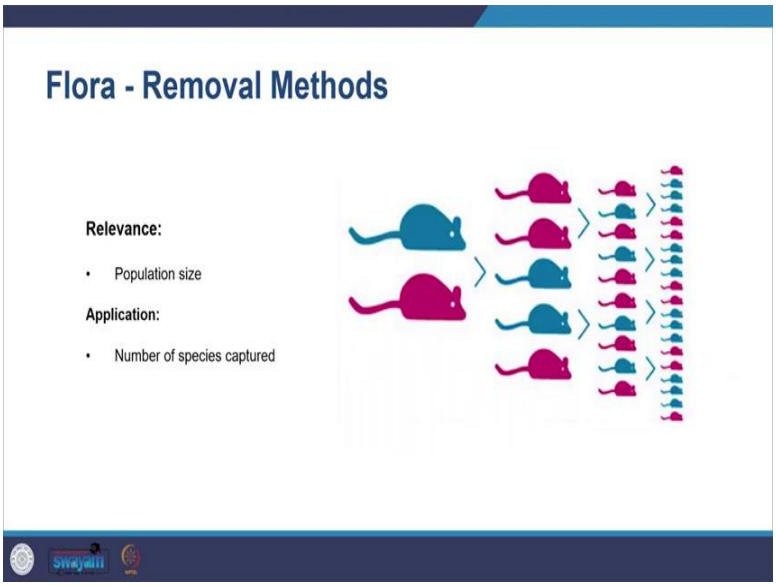

Then you have the removal method which you see is usually used for the population size to determine the population size it is like you number of species captured you look at them and it is usually used for estimating the small mammals such as rodents through the bait it snaps traps. So, through that, you do that.

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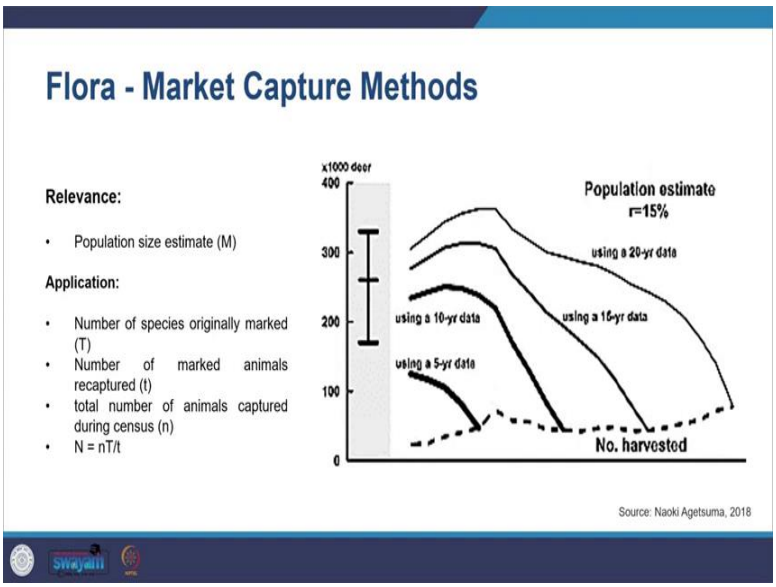

The other type you see is the market capture method, here you estimate the population size. So, you see the number of species originally marked and then the number of marked animals recaptured and the total number of animals captured during the census. So, then that is how you take it out. It involves capturing a portion of the population at some later date and sampling the ratio of marks to the total animal caught in the population.

So, based on that you take it out. So, this was from the manual by MOEFCC. You also find comprehensive collections of documents and bits of advice from the World Bank. So, then there you can also look for a range of updates. So, those links are given to you. Now moving on to looking at the evaluation part of the impact magnitude.

So, after you take out the impact and then now you look at the impact magnitude and significance, how significant it is. So, it is said that GIs are very helpful if you have good data. So, it helps you to integrate and assess how things can be done.

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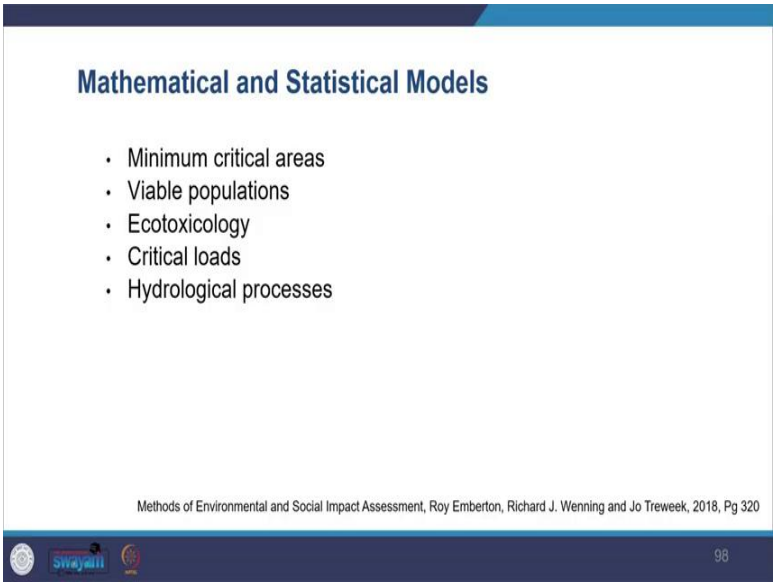

And then you also find mathematical and statistical models like you have minimal critical areas, viable populations, ecotoxicology, critical loads, and hydrological processes. So, all these can be used.

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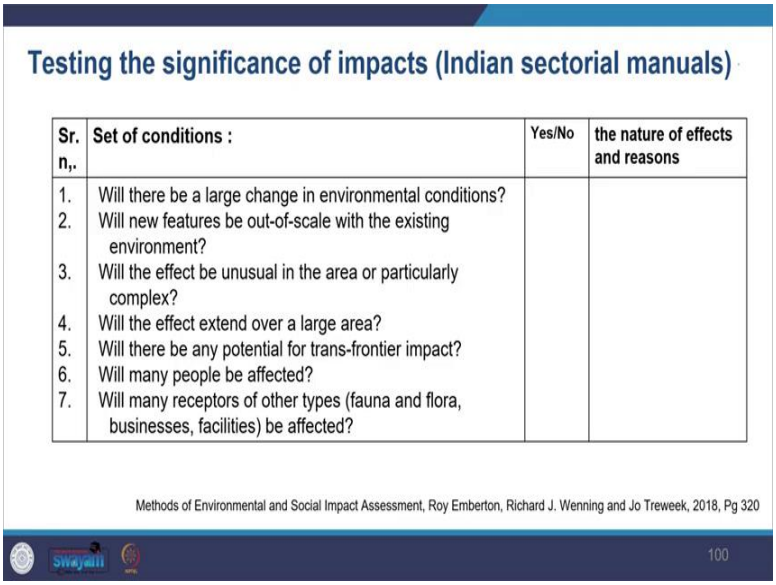

And then from the manual I have taken like kind of judgment one needs to make to test the significance of the impact is like, you look at the following checklist as you look at whether will there be a large change in the conditions, here will new features be out of scale with the existing environments, will the effect be unusual in the area, will the effect extend over a larger area, will there be any potential for transfrontier impact, will many people be affected, will many receptors of the other types flora, fauna, business, facilities will be affected. So, what is the number of effects which will happen?

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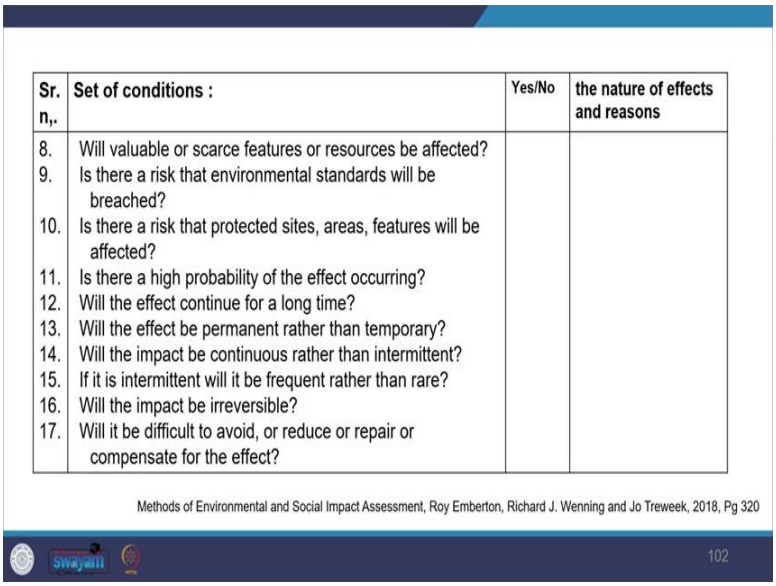

And then will valuable or scarce features or resources be affected? Is there a risk that environmental standards will be breached? Is there a risk that protected site areas featured will be affected? And is there a high probability of the effect occurring? And will the effect continue to be for a long time? Effects are permanent rather than temporary, effects are continuous rather than intermittent.

So, all these kinds of questions are seen and it is difficult to avoid or reduce or repair the compensate for the effect. So, of what kind of compensation is happening for each yes, one needs to answer and then the nature of the effect and reason for it should have to be given, and based on these the judgment is made on the significance of it. So, this was one example of how significance is done. So, we have looked into the different methods of it.

So, looking at the limitation of ecological impact assessments, we see that there is a limitation of knowledge and understanding of the ecosystem of complex interactive processes. So, there is a limitation in that. And there are limitations to the many models which are available. And then we also see that many of the methods are expensive and time-consuming.

And it is also very difficult to get sufficient and sequential data, quantitative data to undertake the baseline conditions. So, we see all those kinds of challenges. And still, we depend heavily on the professional judgment.

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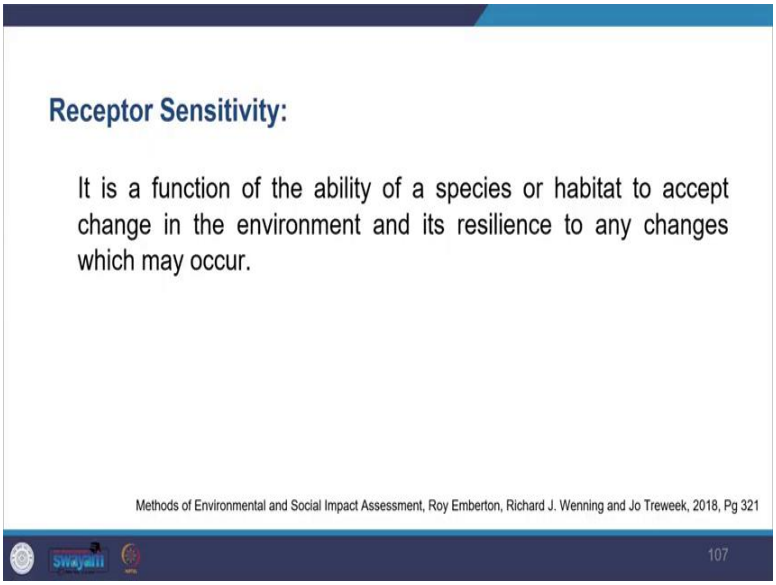

Further, when you see the significance part, you also take care of the receptor sensitivity. So, how the receptor is going to adapt to the changes?

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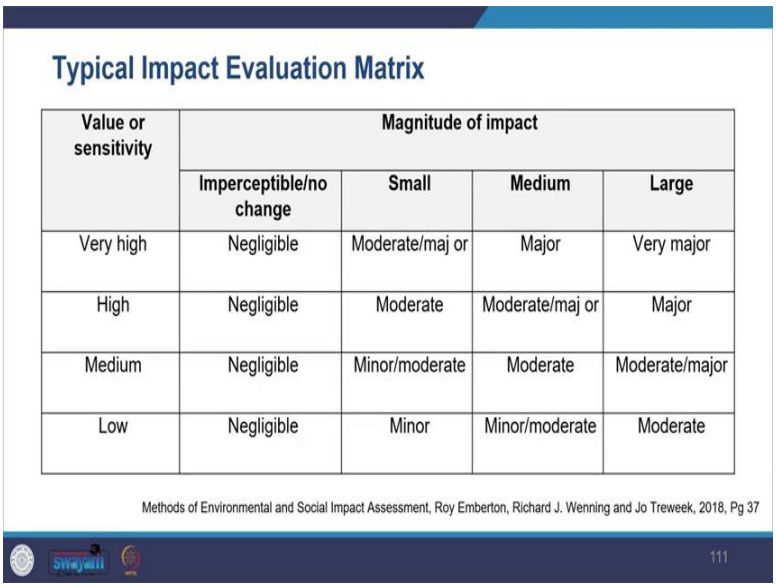

Then all this information can be presented in a matrix format, where you can show the magnitude and sensitivity of the kind of impact that is going to happen.

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So, you can see some of the examples, which are given in the suggested reading. So, when you look at the impact, you not only look at the negative impact, but you can also look at the positive impact and then you need to take a balance between the positive and negative impact and the attempt has to be seen at the net zero impact.

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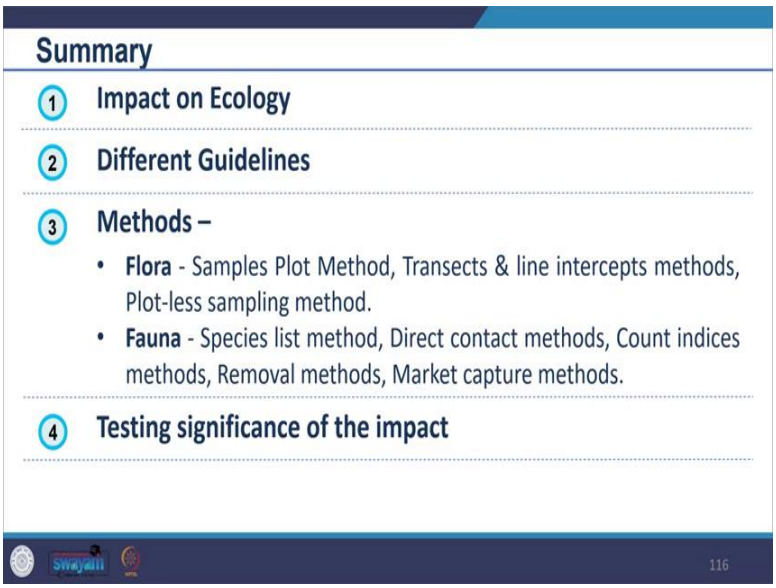

So, that is what we covered today. So, we looked at the impact on ecology, what kind of direct indirect residual and cumulative impact, and the types of impacts. Then, we looked at different guidelines and we looked at certain methods which are available, and then we looked at how the significance is evaluated in the process.

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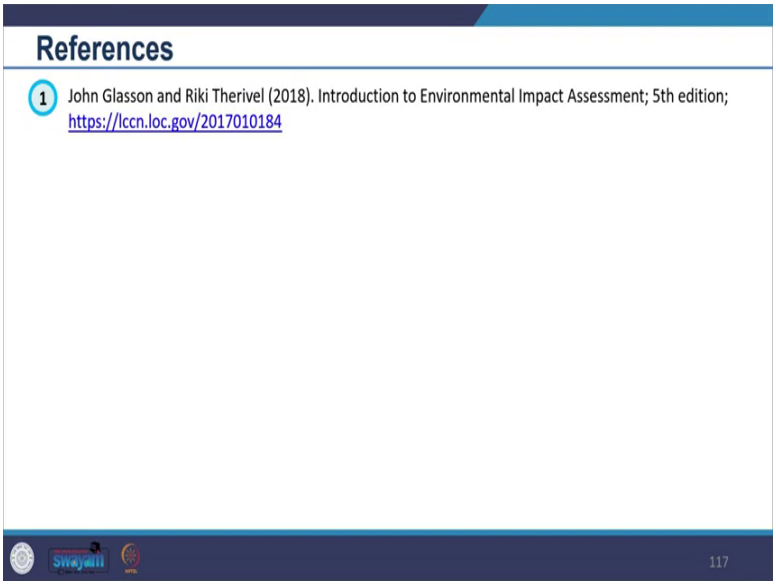

So, this was our key reference for this particular session, we looked at the manual as well as our key textbook for this purpose.

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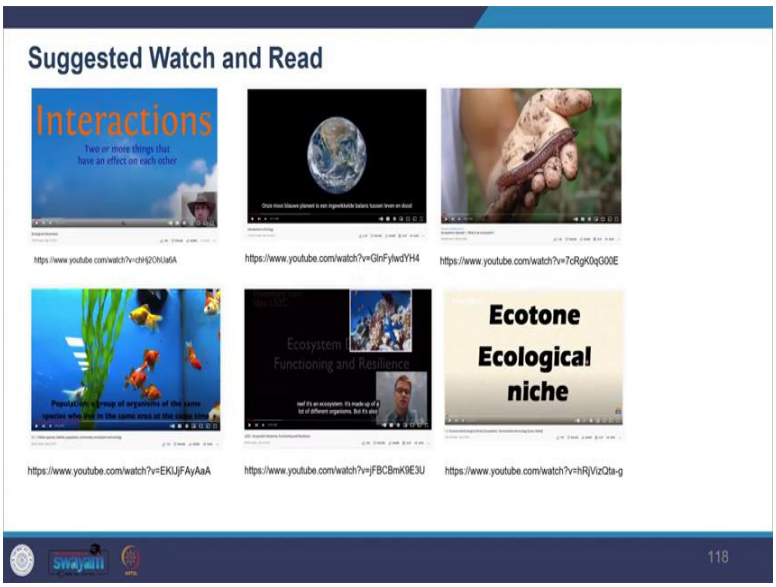

The further you can see the suggested reading because our coverage is limited.

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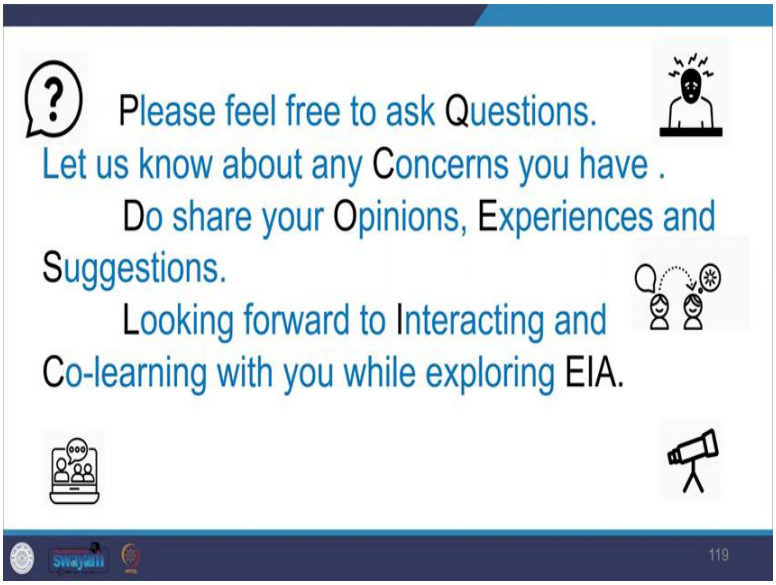

Please feel free to ask questions. Let us know about any concerns you have to share your opinions, experiences, and suggestions looking forward to interacting and co-learning with you while exploring EIA. Thank you.