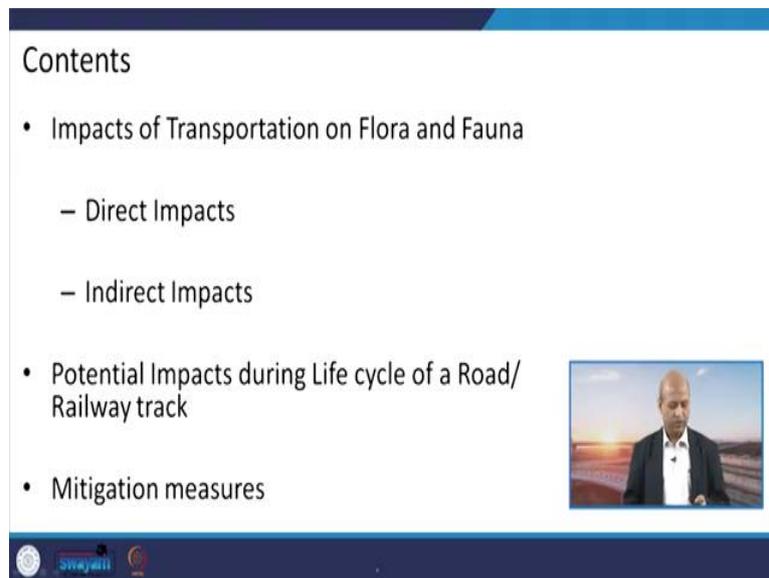


Sustainable Transportation Systems
Professor Bhola Ram Gurjar
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture: 08
Impacts of Transportation Systems - III

Hello friends. So, you may recall last time we discussed the impacts of transportation systems on first of all on different aspects of the environment and then human health. So, immediately our past lecture was on these impacts on the human health.

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The slide is titled "Contents" and lists the following topics:

- Impacts of Transportation on Flora and Fauna
 - Direct Impacts
 - Indirect Impacts
- Potential Impacts during Life cycle of a Road/Railway track
- Mitigation measures

A small video inset on the right side of the slide shows Professor Bhola Ram Gurjar speaking. At the bottom of the slide, there are logos for IIT Roorkee and Swajati.

So, in this particular lecture, we will see the impacts of the transportation on flora and fauna, impacts can be direct or indirect and then different infrastructure like road or railway. So, the life cycle means from construction to repair or use and when road is old, then again we want to construct it. So, all those activities we want to see the potential impacts in life cycle of the road or railway track and at the end we will see the mitigation measures. Means, if there is an impact, particularly negative impact, so, how to mitigate it how to solve the problem related to negative impacts.

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Impacts on Flora and Fauna

- **Direct Impacts:**
 - Loss of Wildlife Habitat
 - Habitat Fragmentation
 - Fauna Traffic Mortality
 - Corridor Restrictions (The Barrier effect)
 - Disturbance and Pollution
 - Traffic Noise
 - Visual Impacts
 - Interruption of biogeochemical cycle
- **Indirect Impacts**
 - Accessibility
 - Ecological Disequilibrium
 - Contamination of the biota
 - Forest fires

The slide features a central illustration of a globe surrounded by silhouettes of various animals and plants. A small video inset in the bottom right corner shows a man in a suit speaking. The slide footer includes logos for Swajili and a page number '3'.

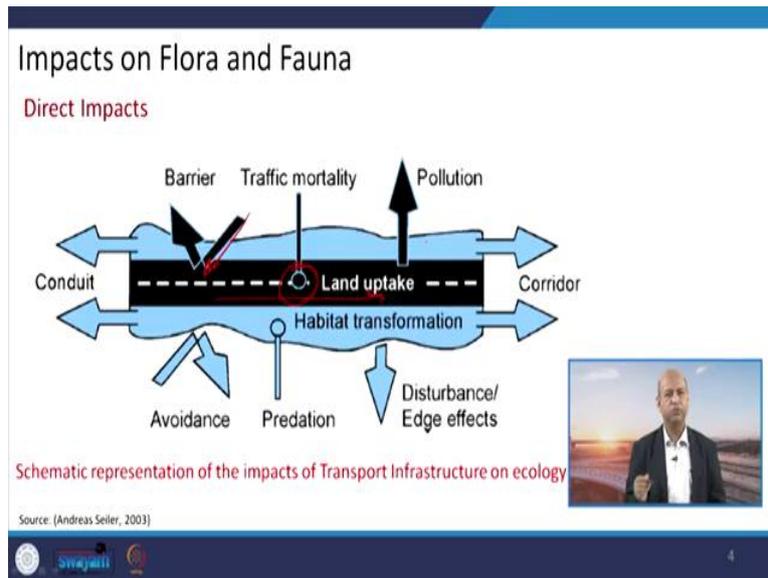
Now, you can see the list, direct impacts. So, direct impacts can be like loss of wildlife habitat directly or fragmentation of habitation of the wildlife and then there are mortality of fauna, fauna means animals, flora means plants life. So, traffic accidents may be there and that is maybe they are of the animals. Corridor restrictions or barriers effects means if there are some railway corridor or road corridor, then it will act like a barrier.

So, we will see in detail how these barriers in place the movements of the animals and also the plant life or ecosystem and then the effect of pollution and noise. And, the visual impacts because of light because there is a cycle of diurnal and cycle from day to night and if it is disturbed, like in the night if traffic is going on. So, there are a lot of lights so, that can also disturb the biological cycle of several species.

Then interruption of biochemical cycles because you have complete these transportation systems construction and uses and there can be indirect impacts also like accessibility to certain facilities of the ecosystem or disequilibrium maybe there ecological disequilibrium may also get created by different activities of transportation systems.

Contamination of the biota, contamination can be of soil or water, etc. In this particular lecture we will just touch it, but later on next lecture, we will see in detail about this and then forest fires means that is also, forest fire sometimes happen naturally, but there can be because of these human activities or human intervention in forest land.

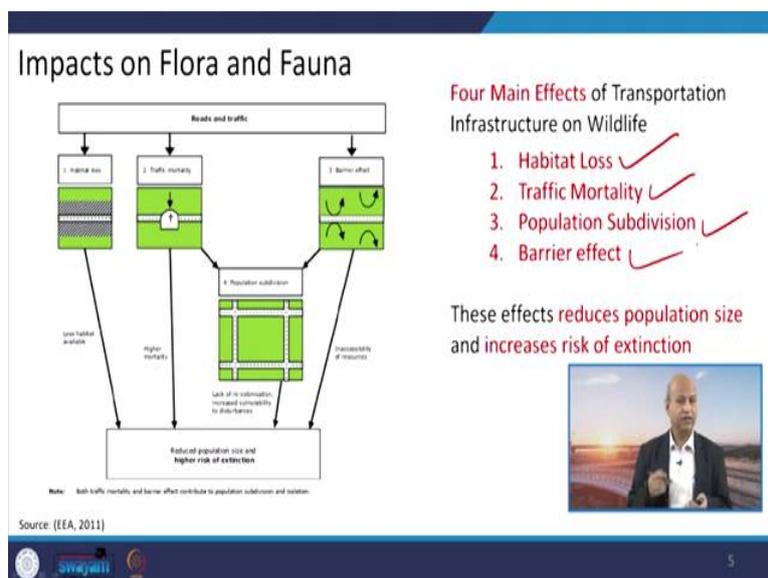
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Well, so, direct impact can be seen in this particular schematic diagram, like if there is some road, etc., so, it takes some part of the forest and because of this particular road, etc., they act as a barrier for natural movement of the animals. So, what will they do? They will come here they will hesitate to cross it, they will go back, so they will avoid.

Similarly, like some animals may try to cross and they may have accident also some mortality may also happen. So, then pollution because of emissions and leakages of oil etc. So, the nearby environment will be polluted. So, all these things happen because of these corridors in the landmasses of forest et cetera.

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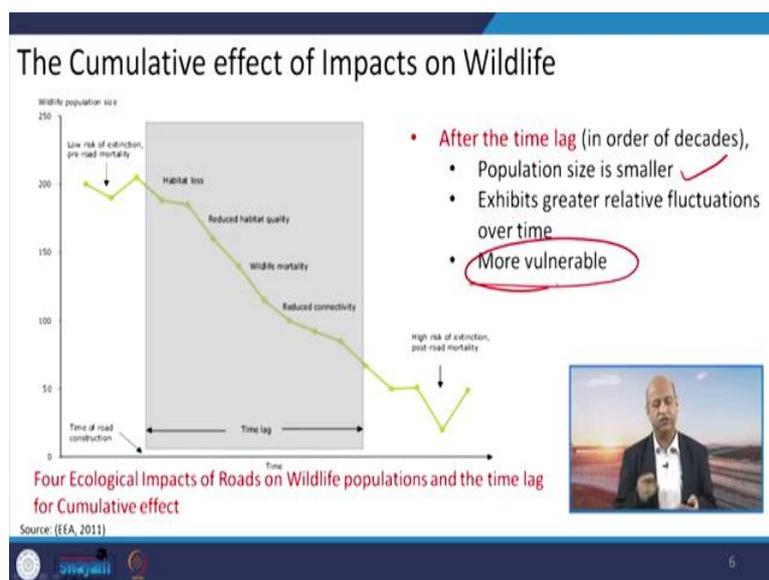


Well, the impacts on flora and fauna can be as we have seen in that list of the direct impacts, like the habitat losses in forest areas, traffic mortality population subdivision, because some species may be influenced larger because of their, habit or their lifestyle. If they move more, they are more prone to have accidents, if some species only, do their activities in a very isolated area.

And, if they do not come in contact with these transportation systems, they may be safe, but then this imbalance also influence in larger scheme of the ecosystem, because species are interdependent on each other. So, if one species is lost, then the complete cycle can get severely disturbed and barrier effect as we have already seen.

So, this can reduce the population size and it can increase the risk of extinction of some particular species and the extinction of one species, can lead to a kind of chain reaction to disturb the life cycle of several species.

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While cumulative effect of impacts can be seen in terms of like population size, and then fluctuation over the time because of different activities and they become more vulnerable when some particular species are not there on which their life were dependent, so, they will be more vulnerable means, they may get different kinds of negative impacts.

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Impacts on Flora and Fauna

Direct Impacts: Loss of Wildlife Habitat

- The natural habitat gets significantly altered by transport Infrastructure.
- May seem negligible at larger scales, but quite serious at local scale, depending on
 - landscape location of the infrastructure and
 - the affected habitat and species
- The transport infrastructure on hilly areas have greater consequences compared to other landscapes



Source: (TRANSGREEN, 2019)

swayam

7

This picture can easily show in a very simple way that how these animals which were crossing their habitat from one point to another naturally, so, now, they have to pass through these railway tracks or roads, and you might have heard in the newspaper, read in the newspaper or heard in the TV, news, etc., that there are several accidents in particularly those tracks which pass through the jungle or forests.

So, this like, it seems sometimes negligible at larger scale, if you see at the big scale, so, some animals are dying, you may if you count you can see these are not big numbers, but those very small numbers are having big impacts on those local ecosystems. And once one local ecosystem get disturbed, it also starts some disturbance to another larger ecosystem. So, we should see things in a very holistic and bigger picture.

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Impact on flora and fauna

Direct Impacts: Loss of Wildlife Habitat

- Infrastructure causes a loss and degradation of habitat due to disturbance effects (grey corridors) and isolation.
- With increasing infrastructure density, areas of undisturbed habitat (white) are reduced in size and become inaccessible.

Source: (Andreas Seiler, 2003)

Now, see very interestingly this picture has shown how these infrastructure developments between animal or forest areas or these habitat areas of animals influence their life. So, see, this was let us say, the forest area the complete one and lot you can see the population large number of animals are there and only this much is the road density means, one road is there, that is fine, maybe for ecotourism, etc.

But if this road passes through, so, you can see one particular area has been delinked or cut from the larger area. So, now, here population was more now population is less, because this particular area has gone away, if there are more roads, then again you can see the species population further decreases.

So, as these density of roads increases, and number of population or species decrease, and finally, the whole area becomes void of these species. So, these kind of things happen, because every animal has some minimum area for their food chain, for their recreation, for their reproduction, all these all these things depend upon certain minimum area of forest area.

But if we disturb them, and that minimum area is cut, then they do not find those areas and their life becomes endangered because they do not meet properly or they are other species on which they are dependent, they are gone away they get frightened by these activities, they fly away or they move away from those areas and ultimately, that area becomes void of animal life and this is in a bigger loss in larger scheme like with increasing infrastructure density, area becomes completely void of or inaccessible to the animals, local animals.

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Impact on flora and fauna

Direct Impacts: Loss of Wildlife Habitat

- Remnant fragments of suitable habitat may eventually become too small and isolated to prevent local populations from going extinct.
- The critical threshold in road density is species specific, but will also depend on landscape and infrastructure characteristics.



Source: (Andreas Seiler, 2003)

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Then direct impacts maybe like mortality, as we have seen, because at some roads, if some animals is crossing and at the same time, if a speedy car or truck or bus is coming, accidents, chances are they are and they may die. So, these kinds of things may happen there and means later on if this thing continues, their population may decrease.

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Impact on flora and fauna

Direct Impacts: Habitat fragmentation (The Barrier effect)

- Consequence of transport infrastructures causing impermeability of roads or railways for animals.
- Roads with high density traffic conditions and high-speed railways makes it impossible for most of the species to pass freely.
- Limits their ability to search for food, shelter, and mating characteristics.



Source: (TRANSGREEN, 2019)

10

And for example, suppose the mother dies. So, those kids of those animals will be hungry and they will not be able to survive. So, that way this whole system get damaged or endangered in a larger scheme. Well, there is barrier effect. Barrier effect in the sense because when these roads etc., cross from one end to another one, they always act like a barrier as we have seen

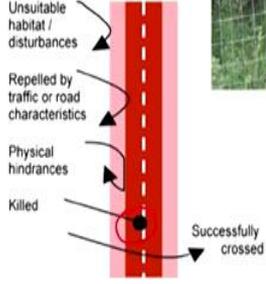
earlier also and in the search of food or shelter, etc., the movement which animals do, they are those movements get restricted.

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Impact on flora and fauna

Direct Impacts: Habitat fragmentation (The Barrier effect)

- Physical barriers includes
 - Completely fenced roads and railways
 - Unsuitable surfaces or crossing objects such as road verges





Source: (TRANSGREEN, 2019; Andreas Seiler, 2003)

11

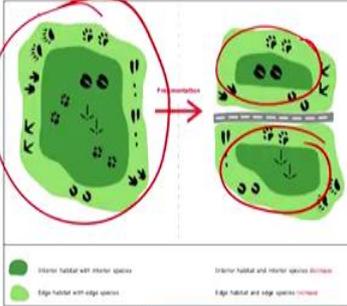
Like you can see this here. So, what happens like some animals will come and they will just feel disturbed and they will go away, another will come. So, like out of these five, six animals, if one tries to cross one may be killed, and only one gets successfully crossed, but do not know whether he or she will be able to come back or not. So, that way their whole daily cycle get disturbed and ultimately they are on losing end.

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Impact on flora and fauna

Direct Impacts: Habitat fragmentation (The Barrier effect)

- When a road cuts through an ecosystem, the sum of the two parts created by the cut is less than the value of the initial whole.
- By slicing through habitat, roads affect an ecosystem's stability and health.
- Roads tend to fragment an area into weaker ecological sub-units, thus making the whole more vulnerable to invasions and degradation.



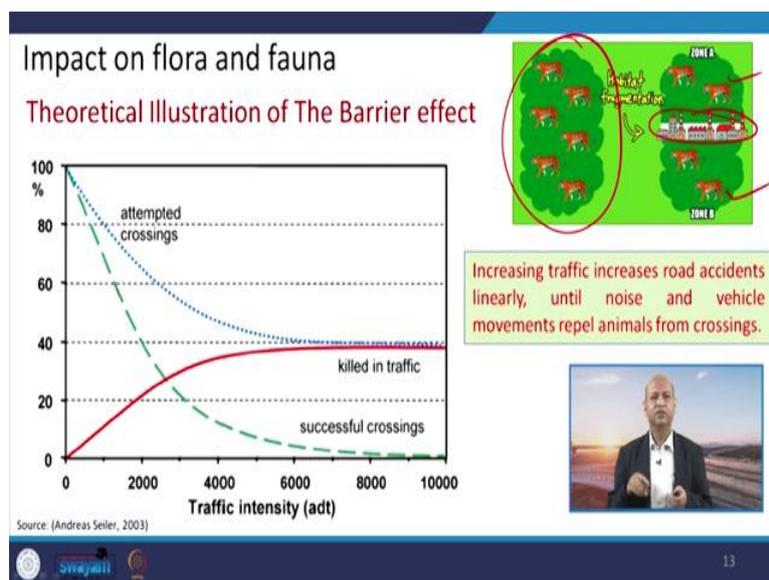

Source: (EEA, 2011)

12

Well, here also this pictorial representation shows very simply this barrier effect, because the, if this ecosystem stability and health is also dependent upon their numbers, because even plant life also depends on these animals, as seeds are thrown away through stools, etc., and from one place to another. So, the whole ecosystem get benefited by their moment.

And, like, if there is a road, let us say, so because of road which area the smaller area, if you add them, so, the sum total is not as big as the single area. Means, if you cut through in different parts, if a bigger ecosystem or area, so, this is not like we are dividing them and animals can live there in a smaller area as it is not so, because the smaller area sum total means there will not be synergy effect or sum total will not be equal in terms of the larger means, the total value will not be equal to this larger area, they will lose many things, many things in terms of ecological needs of animals.

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Here also you can see, it is very simple presentation here, like some animals try to cross, they make attempts and the successful like there and some people know some animals die. So, ultimately the crossing is not there, because animals are no more here also you can see like there were there tigers around like six numbers only representative number and when some, factories there or some road is there means that particular whole ecosystem has been disturbed by some human activity, some anthropogenic activity.

So, the number has reduced to four. So, these are symbolic way, but it can easily show the negative impact of human activities in their ecosystem.

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Impact on flora and fauna

Direct Impacts: Fauna Traffic Mortality

- Most evident and well known negative impact of Transport Infrastructure.
- Mostly affected species includes:
 - Rare species that move long distances and are forced to use transport infrastructures. Ex. Otter, large carnivores such as tigers.
 - Seasonal migratory species such as amphibians (e.g., frogs, toads)



NH 67 (Gundlupet-Ooty Road)
Source: (<http://www.conservationindia.org/>)



Source: (Andreas Seiler, 2003)

14

So, now, you can see means, when mortality occurs of different animals, and if some animals are already endangered, and the particular animals which have habit of moving longer distances in search of their food, so, even they use these roads, etc. and when they are walking on the road, there are chances of some traffic accidents. So, these things may happen.

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Impact on flora and fauna

Direct Impacts: Fauna Traffic Mortality

- Concentration of fauna casualties on roads and railways depends on environmental factors such as:
 - Temperature
 - Precipitation or time of day
 - Ecological factors such as breeding dispersal, food supply, seasonal migrations, age and sex of animals etc.
 - Location, landscape of infrastructure, specifications of roads and traffic density, crop rotation etc.



The National Highway 212 connecting Mysore in Karnataka and Kozhikode in Kerala



Source: (Andreas Seiler, 2003)

15

Like this is also, like on road one deer is killed, and other the factors with the factors like temperature or precipitation, all these ecological factors which are perturbed by these kinds of interventions, human interventions, so, their local habitat is disturbed and ultimately they get killed because they are not used to with these artifacts of human beings.

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Impacts on Flora and Fauna

Direct Impacts: Fauna Traffic Mortality

Factors Influencing the number of Wide life Traffic Accidents positively and negatively

Source: (Andreas Seiler, 2003)

16

Well, if we see these direct impacts in positive and negative sense, sometimes if there are people are aware drivers are aware, then they can slow down if they are more alert. So, these accidents may not happen. But if there are, drivers who does not have much awareness about that particular area, they will just go with the high speed and animals may be killed.

And mitigation measures, means if we do some mitigation measures, we will see at the end of this lecture, so, those are also something which can reduce these traffic accidents. So, but otherwise, if traffic intensity is increasing or a larger number of vehicle movement are there, then accidents may also increase.

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Impact on flora and fauna

Direct Impacts: Aquatic habitat damage: Effect of habitat fragmentation

- Transport development has very serious effects on aquatic ecosystems.
- Erosion from poorly constructed and rehabilitated sites can lead to downstream siltation, ruining spawning beds for fish.
- Constricted channel flows at water crossings can make the current too fast for some species.

Source: (Andreas Seiler, 2003)

17

Well, now, we will see in this particular slide like some erosion may happen means like if there is a river or nallah and because of some human activities, if soil is disturbed and plants are cut or these trees are like deforestation happening then soil erosion occurs. So, a lot of downstream siltation may increase because of those activities and that can again disturb the aquatic life cycle. So, like fish, etc. They can disturb and several species if they do not be able to bear the stress they may die and it may be a problem again the, this food chain.

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Impact on flora and fauna
Direct Impacts: Aquatic habitat damage:
Effect of habitat fragmentation

• Alterations of flood cycles, tidal flows, and water levels can upset trophic dynamics by affecting the life cycle of plankton, and have corresponding effects on the rest of the food chain.

Source: (Andreas Seiler, 2003)

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Similarly, like we construct dams, etc. So, they are natural because some fish travel larger distances from one place to another in their complete cycle. So, there this whole lifestyle get disturbed and this again have negative impact on these plankton, etc. And if there are not in a plankton, which are the food for a small fish and the small fish is food for larger fish, etc. So, the whole food chain get disturbed.

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Impact on flora and fauna

Direct Impacts: Aquatic habitat damage:
Effect of habitat fragmentation

Behavioral barriers

- Occur mostly in **larger species**
- **Avoidance patters** in animals such as not using areas near roads or railways constructed, avoid crossing large open spaces etc.



Source: (TRANSGREEN, 2019)

19

Similarly, if there is like road and these animals which are not used to have these kind of noise, etc., or presence of big columns, they again feel fear and they will not try to cross unless they become habitual, it will take a lot of time.

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Impact on flora and fauna

Direct Impacts: Corridor restrictions

- Most animal species tend to follow established patterns in their daily and seasonal movements.
- When a road intersects or blocks a wildlife corridor, the result is either
 - A **cessation of use of the corridor** because animals are reluctant to cross the road,
 - An **increase in mortality** because of collisions with vehicles
 - A **delay in migration** which may result in the weakening or disappearance of an entire generation of the population.



Source: (Andreas Seiler, 2003)

20

So, most animal species, which follow certain pattern in daily or seasonal movements, so, if we can do survey and accordingly if we give them some passes at corridors, then maybe that can be helpful, we will see those kind of construction activities otherwise, if they are taken in negligence manner then there may be chances of mortality.

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Impact on flora and fauna

Direct Impacts: Corridor restrictions

- On busy roads, the death rate for the local amphibian or other slow-moving animal populations can be as high as one in ten.



The white markings on the overpass are track beds to record animal tracks crossing the overpass



Wild-life corridor- Crossings for animals



Source: [EEA, 2011]

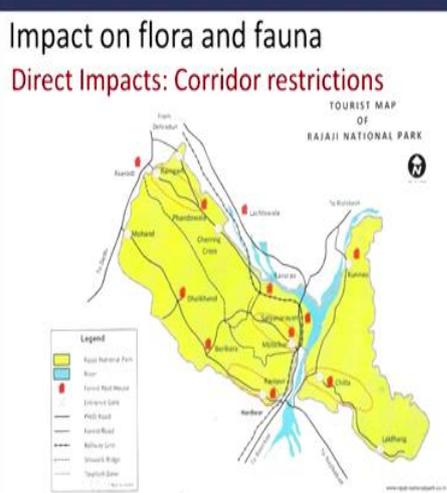
21

So, these kind of in corridors, if we can have the crossing areas for animals that can be very helpful, they can cross one end to another and this may be like natural and the roads, etc., can be below this pass. There may be some underpass also we will see.

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Impact on flora and fauna

Direct Impacts: Corridor restrictions



Legend

- Rajaji National Park
- River
- Forest Road Network
- Entrance Gate
- PHD Road
- Asan Road
- Asan Road
- Shivani Road
- Shivani Road
- Shivani Road



Transport routes running along Rajaji national park, Uttarakhand, India



Source: [https://rajaji-nationalpark.co.in/images/map_rajaji.jpg]

22

This this shows like in Rajaji Park in Uttarakhand in Haridwar district, how many human activities are there because of roads, railway tracks, etc. So, this shows there are so, many anthropogenic interventions in these ecological parks and the wildlife get disturbed.

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Impact on flora and fauna

Direct Impacts: Disturbance and Pollution

- Mountain environment is more sensitive to disturbances than landscape characteristics.
- Some disturbances includes:
 - Hydrological changes such as cuttings and embankments which increases soil erosion, changes in water regime etc.
 - Chemical pollution ✓
 - Polluting oxides, hydrocarbons, particulates and heavy metals released from motor exhausts.
 - De-icing salt in winters causes pollution from sodium and chloride.
 - Contamination from herbicides during summers
 - Gasoline and oil leak during accidents



Source: (TRANSGREEN, 2019)

23

Well, also there are like disturbances through human activities of hydrological changes or chemical pollution. So, all these things also directly or indirectly they influence the complete pattern and like leakages maybe they are of oil or gasoline etc., in waterways, not only the roads but in waterways also.

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Impacts from Water Transport

Olivia Oil Spill 2011, Tristan da Cunha



The 40,170 GT bulk carrier OLIVIA grounded on the Nightingale Island, part of Tristan da Cunha, South Atlantic.

- Leaked 1400 tonnes of Intermediate Fuel and 70 tonnes of Marine diesel
- Oiled approx. 3700 Endangered Northern Rockhopper penguins



Source: (ITOPF, <https://www.itopf.org/in-action/case-studies/case-study/flinterstar-belgium-2015/>)

24

So, this is one example of like oil spillage was there in 2011 and around 1400 tons of fuel and 70 tons of marine diesel was leaked or spilled over and around 3700 endangered northern Rock hopper penguins were affected by this particular spillage, we will see in detail in next lecture on these issues.

(Refer Slide Time: 18:45)

Impact on flora and fauna

Direct Impacts: Traffic Noise

- Traffic Noise is **one of the major factors** polluting natural environments.
- Noise **rarely has an immediate physiological effect on humans**, however **long exposure can induce psychological stress** and eventually lead to **physiological disorder**.
- **Most wild animal species interpret traffic noise as an indicator of the presence of humans** and consequently avoid noisy areas.
 - Ex. Wild reindeer, Elk, Caribou and Brown bear avoid habitats near roads or utilise these areas less frequently.



Source: (Andreas Seiler, 2003)

25

Well, there may be traffic noise as you know, because wildlife has its own background in terms of very calm or chirping of the birds. So, animal life and their sounds are different, but if we are having cars or trucks etc. So, a lot of noise is added and that can disturb the animal life or particularly, birds etc. They feel irritated and they go away from there. So, again their complete cycle gets disturbed.

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Impact on flora and fauna

Direct Impacts: Traffic Noise

- **Birds are very sensitive to traffic noise.**
- **Density of birds are minimum near trafficked roads, as it directly interferes with their vocal communication, territorial behaviour and mating success.**
- **Environmental factors** such as the structure of verge vegetation, the type of adjacent habitat, and the relief of the landscape will **alter the amplitude of the noise** impact thereby influencing both noise spread and species density.



Source: (Andreas Seiler, 2003)

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Plus, like, there are surveys that density of birds or minimum near trafficked roads. So, again it is negative impact, of course, and other environmental factors like different structures, they also influence in addition to the traffic noise.

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Impact on flora and fauna

Direct Impacts: Traffic Noise

- The **species most vulnerable to disturbance and development impacts** includes:
 - Large species
 - Long-lived species
 - Species with relatively low reproductive rates
 - Habitat specialists
 - Species living in open (wetlands) rather than closed (forest) habitats
 - Rare species
 - Species whose populations are concentrated in a few areas



Source: (Andreas Seiler, 2003)

27

So, these species whether they are large or long lived or rare species all those kinds of species has kind of negative attitude towards additional noise.

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Impact on flora and fauna

Direct Impacts: Visual Impacts

- The effects of traffic also include **Visual disturbance**
 - Ex. **Artificial lights or vehicle movement** in forest roads.
- **Artificial lighting has a conflicting effect** on different species of fauna and flora:
 - It can act as a deterrent to deer and a readily accessible insect food supply to bats, but at the same time it can disrupt growth regulation in plants, breeding and behaviour patterns in birds, bats, nocturnal frogs and moth populations.



Source: (Andreas Seiler, 2003)

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Impact on flora and fauna

Direct Impacts: Visual Impacts

- **White (mercury vapour) street lamps** are especially attractive to insects, and therefore also to some aerial-hawking bat species.
- This increases the exposure of bats to traffic and may entail increased mortality due to collisions with vehicles.
- The movement of vehicles (in combination with noise) **can alter behaviour and induce stress reactions** in wildlife.
 - **Ex. Heavy trucks and high-speed trains** produce intensive discontinuous noise, vibration and visual disturbance which has the effect of frightening many mammals and birds.




Source: (Andreas Seiler, 2003)

29

Then there may be like visual impacts in the sense if there are some artificial light and these animals are not used to even plant life get affected with by this artificial light because their whole cycle of day and night get disturbed. So, because of that, again like nocturnal night time frogs, etc.

Their movements get affected and sometimes those insects which get attracted towards light then they also their number get reduced or to eat them when owls, etc., or bats or those kinds of an, these birds, they are animals they try to eat them then they can get collided with the traffic or those lights and they may die. So, these kind of negative impacts maybe because of these visual impacts or light related impacts.

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Impact on flora and fauna

Direct Impacts: Interruption of biogeochemical cycle

- The **flow of nutrients and materials** is a major **determinant in ecosystem structure and function**.
- Road development can easily disrupt it through
 - **Alteration of flows of surface and groundwater**
 - **Removal of biomass** ✓
 - **Relocation of topsoil.** ✓




Source: (World Bank, 1997)

30

Well, if we see these impacts in the bigger picture, so, when we are doing some infrastructure development related to transport, whether it is road or railways, then we do a lot of surface related soil movement etc. and groundwater movement etc. So, the removal of biomass, relocation of the topsoil, all these things are there, and they changes the flow of the nutrients or other functions of the ecosystem.

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Impact on flora and fauna

Direct Impacts: Interruption of biogeochemical cycle

- Human activity can be a major source of nutrients
 - may increase turbidity and BOD.
- Potential impacts can **only be roughly estimated** based on:
 - Nature of the alteration has been established
 - Data on soil erodibility
 - Soil fertility
 - Anticipated human activity
 - Understanding of the nutrient regime and energy flow of the affected ecosystem

Source: (World Bank, 1997)

31

Well, if you want to see this soil fertility and relationship with the human activity, and the, like increase of turbidity, or BOD because of these activities in nearby aquatic environment, they are the direct impacts or interruptions in the biogeochemical cycles that is a big bigger cycle, biogeochemical cycle, we call it and that can be destroyed because those cycles take thousands of years millions of years to have a kind of balance, but because of these activities, if one component got disturbed, then the whole cycle get disturbed.

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Impact on flora and fauna

Indirect Impacts: Accessibility

- Roads increase contact between humans and the natural environment, and leads to ecosystem modification.
- **Vulnerable to human activities** such as recreation, forest and mineral exploitation to colonization and urbanization.
- **Upgrading of existing roads** increases the number of people having accessibility and increases the likelihood of impacts.

Source: (World Bank, 1997)



32

Well, there are certain indirect impacts. For example, like if roads increases the contact between humans and the natural environment, but leads to ecosystem modification means there are positive aspects that we get to connected with farther places or even for ecotourism, but ecosystem get modified and some species or some forest areas, which are fragile, because of certain vulnerable species, they get affected very badly. So, we need to take care of these aspects.

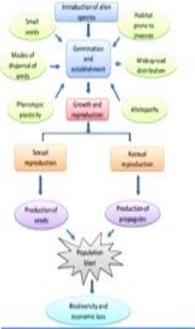
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Impact on flora and fauna

Indirect Impacts: Ecological disequilibrium

- The importation of new plant and animal species along the right-of-way can upset the dynamic balance which exists in ecosystems.
- **Native species face competition** for resources from new arrivals, and predator-prey relationships can be altered, often to the detriment of the native species. Non-native species can gain a competitive advantage because of a lack of natural controls and become dominant.
- The **result is usually a simplified ecosystem which is more vulnerable** to further impacts.

Source: (World Bank, 1997)



33

And, we should try to balance or not to disturb the equilibrium in larger amplitude, otherwise, it would be difficult because like, when we are traveling, sometimes we are eating something

and or some fruit etc., we just throw away some bad habits we have. So, what happens that particular seed will be there.

So, maybe in that particular area, that seed is not very popular, but see this addition of new species in the plants etc., they may disturb the complete their ecosystem, and it is said that, because these non-native species when they are not having the opposite kind of effect, so, they have more chances to grow there and they have this competitive advantage, because there are not competitive species there. And because of that, they are dominant and the locally species may be disturbed totally.

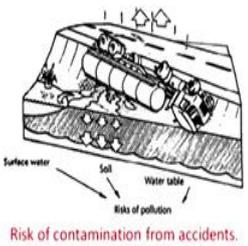
And some time number of these particular these non-native species grow and the complex ecosystem becomes simpler one and simpler one are always vulnerable. Complex ecosystem has more life or good chances of survival in longer term.

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Impact on flora and fauna

Indirect Impacts: Contamination of the biota

- The presence of motor vehicles introduces the potential for contamination of the soil, air, and water adjacent to the road and in the case of surface water, well beyond the immediate surroundings.
- Chronic contamination can become a serious problem for animal species, especially those at the top of the food chain, because of bioaccumulation of pollutant.



Source: (World Bank, 1997)

Contamination of water and air from accidents

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Then like there may be some problems for example, if accidents is there, fire is there. So, air pollution may be there, oil spillage is there, so soil may be contaminated, all those kinds of things may happen because of accidents and accidents again because of traffic accidents. So, they are part of these transportation related influences on the environment.

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Impact on flora and fauna

Indirect Impacts: Forest Fires

- Increases in human activity are associated with more frequent incidents of fires, which can have sudden, severe, and wide ranging impacts.



Forest fire in Dehradun, Uttarakhand, India
(Source: <http://diplopatilak.com/news/national-green-tribunal-halts-deeping-of-iron-in-uttarakhand-for-construction-of-road/>)



Fires due to Road accidents



Source: (World Bank, 1997)

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Well, there may be forest fires, naturally, there are chances that forest fire may occur, but because of these human intervention, sometimes people just throw away some cigarette or something like that. So, that can add into fire or, like as some accident may happen in the forest, so that can create fire in the forest. So, again, these are the indirect impacts, but impacts are there because of traffic and because of transportation.

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Impacts on Crop yield

- Rising temperatures and increased emissions of long lived GHGs have significant negative impacts on Crop yields.
- Short lived Black carbon and ozone impacts temperature, precipitation patterns, radiations in an area and can be toxic to plants.
- Ex. Wheat yield in India in 2010 were 36% lower compared to the 1980s with some densely populated states experiencing 50% relative yield losses.

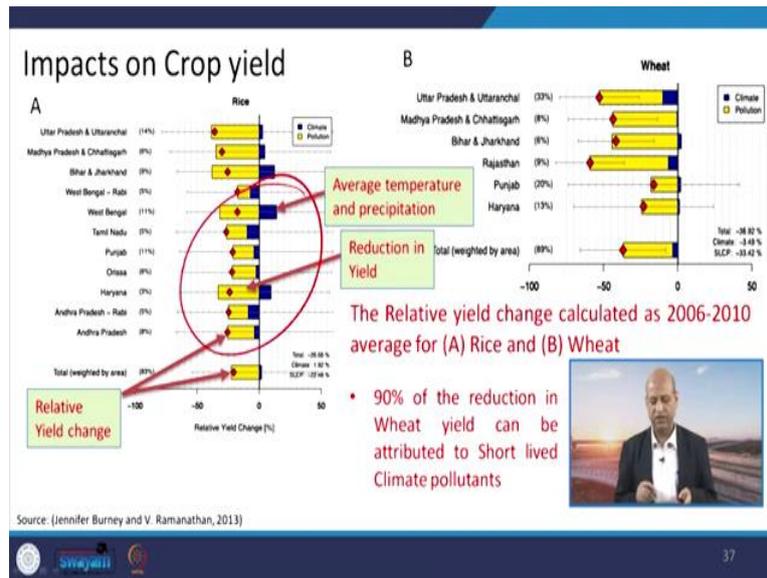


Source: (Jennifer Burney and V. Ramanathan, 2013)

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At the same time, there are negative impacts on crop yield, because as we have already seen that right there are like ozone or there are some pollutants, which can negatively influence the growth of the plants or crops. So, the yield of the crop is lowered down. So, that is again the negative impact on the agriculture activity.

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There are, like these pictures that because of changes in temperature and we have already established the relationship between the temperature because of human activities including transportation, there are in meteorological parameters changes may also occur. So, you can see that there are relationship between the crop yield as well as the average temperature, etc.

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Potential Impacts during the Life cycle stages of a Road and Railway

Life cycle stage	Potential problems
a Planning	Quality of Routing Availability of biodiversity / ecological data
b Construction	Destruction of natural habitats Creation of new artificial habitats Effect on groundwater and surface water Mortality of animals at constructive sites Noise and other emissions and contamination
c Operation	Barrier effect of roads/ railways Mortality of animals, Human casualties and damages Gaseous, liquid and solid emissions from transport Noise pollution Road maintenance
d Removal	Processing and elimination of waste materials

Source: (TRANSGREEN, 2019)

Well, in nutshell, we can say that this life cycle stages and potential problems are related to each other like when we do planning, then also some disturbance is there, we collect ecological data, so we go to the forest or those nearby systems. When we do the construction, then a lot of activities are there and the whole system gets disturbed, when we do operation for several years.

Again, those barrier effects which we have seen or noise pollution or road maintenance related activities, all these activities influence the ecosystem and when all this road is to be reconstructed, then we remove the upper layer, so, how to dispose off that waste material, if we are not disposing those waste material in a proper manner that can also damage the ecosystem.

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Mitigation Measures

Fencing

Culvert with small mesh sized fencing



Source: (Clara Grilo et. al, 2010)

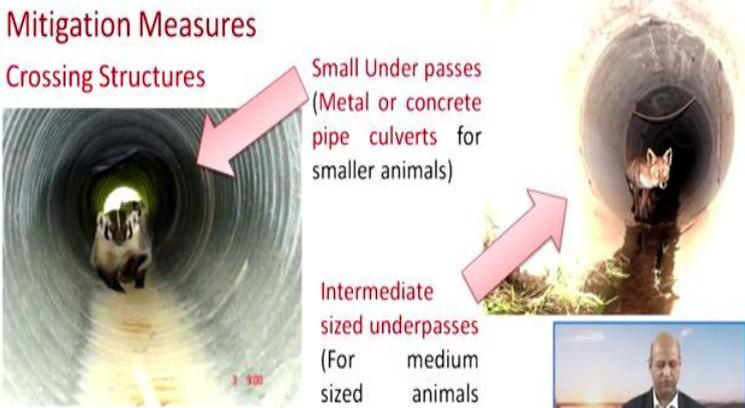
Swajathi

Mitigation Measures

Crossing Structures

Small Under passes (Metal or concrete pipe culverts for smaller animals)

Intermediate sized underpasses (For medium sized animals such as foxes, black bear etc.)



Source: (Clara Grilo et. al, 2010)

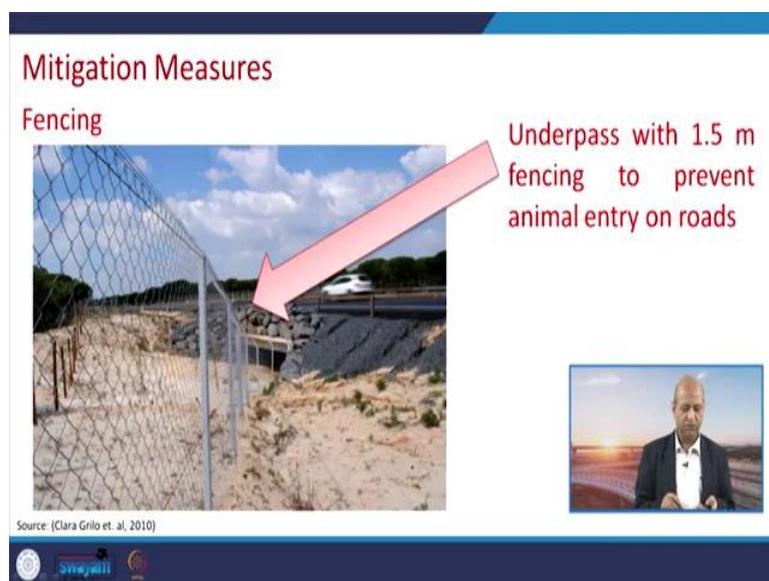
Swajathi

Now, if you want to see the mitigation measures means how to minimize the impact because we need these kinds of infrastructure facilities for movement etc., for our mobility needs. So, we need those transportation systems. So, what is the way, means we use this transportation system, but we do something with minimize the impact on the flora fauna.

So, you can see for example, if we are very sensible, we can have these kind of fencing and there may be some pipe which can allow some small animals, means if we can do good survey in that locality in that forest area, what kind of animals are there what is their daily routine from very small animals to even like elephants, etc.

There are different species we can see their routes etc. And the particular paths which they follow daily, if we can give some basis on those paths, then it may be helpful for them. So, like some underpass maybe they are by pipes and small animals can use them to cross from other one and to another. So, these are the helpful things.

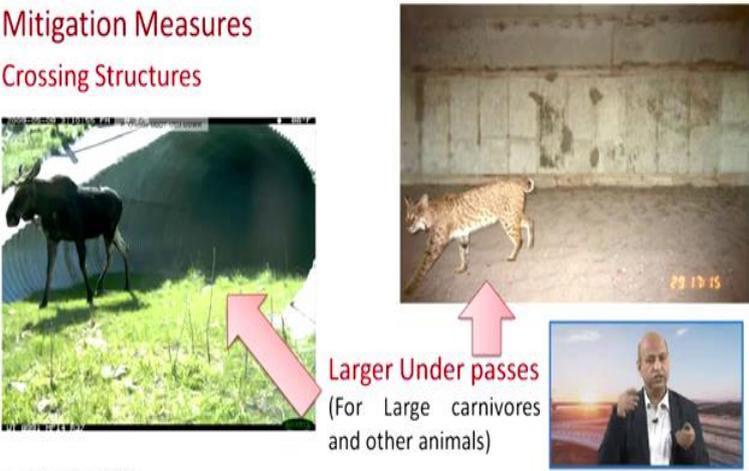
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Similarly means we can check these kinds of fencing can be helpful that animals will not come to the on the road, otherwise there are chances of the accidents. So, these prevention maybe there.

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Mitigation Measures
Crossing Structures



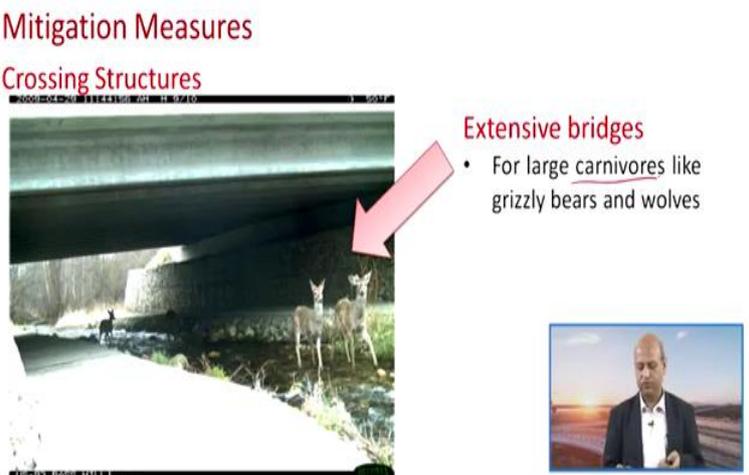
Larger Under passes
(For Large carnivores and other animals)

Source: (Clara Grilo et. al, 2010)

Similarly, these crossing structures means wherever we are providing these crossing structures. So, there may be these fencing so that they do not go on the road whether they use these kind of underpasses.

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Mitigation Measures
Crossing Structures



Extensive bridges

- For large carnivores like grizzly bears and wolves

Source: (Clara Grilo et. al, 2010)

And again, this is another crossing structure. So animals, these larger carnivores, bears, wolves, etc., or deers they can use these kinds of underpasses.

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Mitigation Measures

Crossing Structures



Wildlife overpasses

- Allows full sunlight and precipitation
- Full vegetation growth similar to forests



Source: (Clara Grilo et. al, 2010)

Swajathi

And there may be like earlier we saw these big crossing structures, which are with like plants or trees etc., they may act as a natural passage. So, animals may feel more comfortable, more confident to use these kind of paths.

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Mitigation Measures

Dry ledges



Stone marten using a dry ledge to cross under a road in southern Portugal

Box culvert with dry ledges on sides for passage of smaller animals



Source: (Clara Grilo et. al, 2010)

Swajathi

There may be like in culverts, etc., some structures where small animals they can use it like in light it can be seen. They can use for crossing the roads.

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Mitigation Measures

Escape opportunities from Right of way

Earthen ramps for animals to escape from accidents and for visibility of drivers



Source: (Clara Grilo et. al, 2010)

swayam

Similarly, if there are a species, so, even if by the way some animal is there, so, if some car is coming so, they can have some space to avoid their chances of getting hit by the car, etc.

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Mitigation Measures

Amphibian tunnel

Top graded amphibian tunnel

- Open top allows light and air flow



Source: (Clara Grilo et. al, 2010)

swayam

Mitigation Measures

Paynes Prairie wall



Paynes Prairie wall to prevent Turtles from accessing the roads in Portland



Source: (Clara Grilo et. al, 2010)

Then for some, these animals which are like turtles or frogs etc., which are habitual of land as well as water. So, they need these kinds of things where air and sunlight may be there and these passes can be used by them. This is one more example for turtles, etc. They have been successfully used in certain areas.

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Conclusions

- The Transportation activities **can significantly harm** the Flora and Fauna of an ecosystem.
- **Activities such as** construction activities and traffic through forests, and the light and noise disturbances can have huge impact on animals and plants in the area, disturbing their daily movements, causing fragmentation of their habitats, accidents and reducing their populations.
- **Careful planning** is the only solution for reducing the transport-related impacts, preserving the local flora and fauna.



So, in conclusion, we can say that flora and fauna are affected of course by human activities and transportation sector influence them in a great deal, but if we do proper survey and if we provide, proper means or good mitigation measures, then we can minimize, the negative impacts on the flora and fauna and ecosystems may be kept intact. Otherwise, the negative impact can damage their whole life cycle and we may lose very precious species. So, this is all for today. We need to do careful planning from this perspective also.

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And you can see these additional references, which if you want to know more about these aspects of flora, fauna relationship with the transportation sector, so you can go through these references. And this is all for today. Thank you again for your kind attention, and see you in the next lecture. Thanks again.