Conservation Economics
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Module 4
Threats to wildlife
Lecture 1
Push and pull factors

Namaste!
Today we begin a new module which is Threats to Wildlife. This module will have three lectures: push and pull factors or the localization of species threats through species and ecotoxicology and developmental hazards. So, let us begin with the first one, the push and pull factors that govern the localization of species.
We know that different organisms live in different portions of the earth. So, for instance we find polar bears in the arctic areas, we do not find polar bears in the state of Tamil Nadu. Or we find elephants in the state of Tamil Nadu, but you do not find elephants in Siberia.
Different organisms are found in different locations, the question is why are they found in different locations? What are the factors that govern the abundance and distribution of organisms in different places of the earth? Now, this question falls under the ambit of the field of biogeography.
Biogeography is the study of the geographical distribution of life on earth. It studies the geographical distribution of life, which life is located in which area of the earth and the reasons for the patterns. So, not just a description of which organisms are found there, but also what are the reasons.
Why do we not find polar bears in India? Why do we not find elephants in Siberia? So, the reasons are also studied in this field, the reasons for the patterns one observes on different continents, islands, and oceans. So, this is the field of biogeography. And for different organisms we define the range of the organism.
The range or distribution of a species is the geographical area within which the species can be found. So, for instance India is not a part of the range of polar bears and similarly Siberia is not a part of the range of elephants, but Uttarakhand is a part of the range of elephants, Tamil Nadu is a part of the range of elephants, West Bengal is a part of the range of elephants.
The range of elephants comprises all these locations, but it does not extend to a place like Siberia. So, this is known as the range of a species, the range or distribution of the species is the geographical area within which that species can be found. And when we see that different species are found in different locations, let us first have an overview of the major habitats that we have. Now, habitat as you will remember is the natural home of an organism, it is the natural

abode or home of a species.

Let us before we move forward have a look at what are the different kinds of homes that we have, especially in India. So, we begin with the Alpine Meadows. Now, the term Alpine refers to a very cold mountainous area. Meadow is a grassland. So, Alpine Meadow is a meadow or a grassland that is found in cold mountainous areas, in states such as Jammu and Kashmir or Himachal Pradesh or Uttarakhand. So, this is an image from the Dachigam National Park in Srinagar.

If you look at this Alpine Meadow here we find that there is this hill that is all covered with grasses, there are hardly any trees here because in such locations when you move to a location were which is very high and which is very cold, typically the wind speeds also are very high and in the case of large wind pressures the trees might get uprooted. So, we typically find fewer trees in the Alpine Meadows.

This is another image from Uttarakhand. So, here again we find that this is an Alpine Meadow and it is all full of grasses. Now, the Alpine Meadows would support a large number of species that are dependent on the grasses and these include not just the large sized species such as the tahr, but also includes the smaller size species rats, mice, rabbits and so on.

So, we have Alpine Meadows. Next, we have a look at the Alpine forest, now here again Alpine is a cold mountainous area and this is the forest that is found in a cold mountainous area. Now, typically the Alpine forest will be found in locations where the height is less than that of the Alpine Meadows.

And the most common species that we will find here will be the coniferous trees. Now, these coniferous trees are adapted to a life, which is cold and mountainous. Typically we find that the leaves are very small and the leaves are arranged in such a way that whenever there is snowfall, the snow can fall down on the ground. It does not remain there on top of the trees otherwise; the weight of the snow would lead to the collapse of the tree.

These are the species that are adapted to a life in the alpine forest, we also find a number of animals in these areas. Another habitat that we have in our country is the moist deciduous forest. Now, a deciduous forest is a forest in which the trees shed their leaves in a certain season.

Now, this shedding of leaves can be, say, to prevent the loss of moisture so, in the dry season the leaves will be shed so that the loss of water because of transpiration is reduced. Another option is that we can have shedding of leaves in the winter season to protect the plant from extreme cold.

The forests that are dominated by such trees that shed their leaves in certain seasons are known as deciduous forests. And we have two kinds of deciduous forests in our country. We have the moist deciduous forest which typically has a large amount of moisture that is a larger amount of rainfall and the dry deciduous forest.

This is an image of the moist deciduous forest from Uttarakhand and here we find that this forest is dominated by the Sal trees and Sal associated species. This is an image from a dry deciduous forest in Madhya Pradesh. This dry deciduous forest here again you can find that the floor is completely covered with leaves, and there are very few leaves on these trees.

This is an image that was taken in the season when the trees are shedding their leaves. This forest is dominated by teak and teak associated species, and both these dry deciduous forests and the

moist deciduous forest are very good homes for tigers. Another habitat that we have in our country is the scrub forest.

Now, a scrub forest is found in those locations that have a very great scarcity of water. Typically the climate would be warm or hot and there would be less amount of rainfall. Now, because you have less rainfall, a large variety or a large sized tree cannot be supported in these areas, and so the typical organization would be an open forest.

The canopy is very less, most of the plants that we will have here will be of a short height so, we will find some grasses, we will find some shrubs and we will also find some trees, but typically the trees will also not be very high. Another habitat that we have are the sand dunes.

Now, sand dunes are found in those locations that are even more dry, so here you can see that the sky is completely blue. You do not have a single shade of clouds here. So, this is an image from Jodhpur and this is a sand dune. Now, these trees have been planted in this region. So, that the dunes get stabilized, but the typical vegetation is what you see in this location.

There is hardly any vegetation. We find some grasses, some shrubs, and a few trees, but that is pretty much all. But even in such areas, which have a very much dearth of water here, we also find a large biodiversity and we find some species that are endemic to these regions.

Now, an endemic species is a species that is formed only in one area nowhere else. So, we will find species such as this spiny tail lizard now, this is a species that is adapted to a life of intense sunshine and very less amount of water. So, we find this species in the desert national park for instance.

Another habitat we have in our country are estuaries. Now, estuaries are those areas where a river meets the sea; and typically we will find a gradient of salinity in an estuary from fresh water in the river to a brackish or saline water in the sea and there will be region where the salinity is in between so, we will find a gradient of salinity.

Whenever we find a gradient then typically we also find a large biodiversity, because these areas can support those species that live in freshwater they also support those species that live in salty water and they also support those species that live in salinity conditions that are between fresh water and salty water.

So, these are estuaries. Another habitat we have in our country is the Rann of Kutch. Now, a Rann region is a region which is typically very flat and in the rainy season it gets inundated with water, but then in the other seasons it is parched dry. So, typically you will find very flat regions where you will have certain grasses, there will be a dearth of water and you will find some endemic species such as the Indian wild ass.

This is an image from the Indian wild ass sanctuary. In areas where you do find water, typically the water will be brackish or saline, but these kinds of waters also support organisms such as the flamingos. Another specialized habitat we have in our country are the lagoons. Now, lagoons are those areas where the sea is able to enter into the land; and a lagoon such as the Chilika lake in the state of Odisha, provides a very unique habitat for organisms.

Why, because as in the case of an estuary even in the case of Chilika lake there are certain rivers that are draining into this lake. So, it is getting fresh water from one side, on the other side you have the sea, the Bay of Bengal and you have salty water that is getting in from the other side.

Here as well you will find a gradient of salinity, from very saline water near the sea to fresh water near the river mouth and everything else in between. At the same time Chilika is known for having a less depth of water so, typically the depth of water is less than 60 meters in most of the locations.

Now, that is important because a less depth of water ensures that the sunlight is able to reach from the top of the water column to the bottom. Which means that you have a source of energy everywhere you have light everywhere, which ensures that these sorts of ecosystems like the Chilika lake - they have a very high productivity and because of a good productivity because of all different sorts of variations in salinity we find a large biodiversity in the Chilika lake.

Another habitat we have in our country are the flood plains, such as the Brahmaputra flood plains that we are seeing here in the Kaziranga National Park. Now, flood plains are those areas that are near the river so, when it is the rainy season and the river floods these areas get completely inundated with water.

When that happens, all the plants in these areas or let us say most of the plants that are there in these areas get drowned under water and they die off. Then, in the post monsoon season as the water recedes, you get a ground that is more or less vacant and is also wet. So, in such grounds we get a very heavy growth of grasses.

These flood plains typically support large grasslands and also a large number of herbivorous species. Certain species such as the rhinoceros are endemic to this region. They are only found in these floodplains and they are not found anywhere else.

Another specialized habitat in our country is the shola forest, that you can find in the state of Tamil Nadu or Karnataka. Now, shola forests are a very unique ecosystem, because here we find a dynamic equilibrium between these grasses and these trees. The grasses do not invade into the tree areas and the trees do not invade into the grasses both eat each other in check.

Now, the benefit of such an ecosystem is that you know that an animal can use these grasslands for grazing and whenever it senses danger it can run into these forests to protect itself from the predators. So, these areas support a large diversity of organisms; and we also find a number of endemic organisms in these areas.

Yet another ecosystem or habitat in our country is the equatorial forest. Now, equatorial forest as the name suggests these are the forests that are near the equator. In our country we will find equatorial forests in the islands of Andaman and Nicobar. The equatorial forests are in those areas that are close to the equator and so they are getting a heavy amount of sunshine.

They also get very dense or heavy rainfall. Now, abundance of water and abundance of sunshine means that there is a very profuse growth of vegetation, and the ground gets completely covered so there is a complete canopy closure so, all the the canopies of different trees they touch each other.

Another characteristic of the equatorial forest is that the trees are very tall. So, you can see that this is an elephant for comparison and the size or the height of this tree is much greater than an elephant. Now, because there is a very fast growth of trees, you can also support lumbering or logging operations in these areas and here we are saying that an elephant is being used to pull this log of wood that has just been cut.

Equatorial forests also support a very large amount of biodiversity because there is an abundance of food production in these areas. Another habitat are the mangroves. Now, mangroves are forests that are found at the confluence of land and the sea.

The trees that grow in these forests are adapted to a life that is in between that of a land and the sea. So, typically we will find that they have these very dense roots and these roots are exposed and in certain locations these roots turn up and get exposed to the air they are known as pneumatophores; and they ensure that the roots get aerated.

Similarly, they also have a very unique adaptation that is known as vivipary. Now, in vivipary what happens is that, the the fruits that are formed in these trees they germinate when they are out there in the tree itself. So, the plant forms and once the plant has formed completely and it is a low tide plane, the plant will just drop down and it will get established in the sand that is below.

So, we have very specialized kinds of adaptations that we find in the mangrove trees, and they also support a very large biodiversity because these roots can be used as a shelter. And a number of fishes lay their eggs in the protection of these roots. So, mangroves support a very huge amount of biodiversity.

Yet another habitat that we have in our country is Oceans and Seas, which also have certain specialized organisms. So, our country is blessed with a wide variety of habitats and in each habitat you will find an organism that is found only there and it is not found anywhere else. Now, the question is we have different habitats, but then what governs which organism will be found in which area. So, which brings us to the topic of the distribution of species such as a snow leopard?

We are taking this example of snow leopard, if you plot the locations where snow leopard is found you will get a map such as this. So, the yellow colored region is where the snow leopard is found, and the pink color region is the one where it probably may be found but we do not have very good evidence.

Now, you can observe from this map that snow leopard is found in these mountainous areas, it is not found in our northern plains, it is not found in the Deccan peninsula, it is not found in the desert, it is only found in these areas. Now, the question is why do you find snow leopards only in these areas.

Now of course, the snow leopard has certain adaptations such as when it lives in the snow its color is very much similar to that of this snow so, it is able to camouflage very easily. At the same time it also has a very good amount of fat and the fur coat that it has is able to protect it from the snow.

But then, these are the adaptations that make it possible to live in the snow, the question is why does it live in the snow at all in the first place. Similarly, if we plot the location of coral reefs, now coral reefs are found only in these areas. Now, typically the areas where the coral reefs are found are those oceans, where the ocean temperature is neither very hot nor very cold and you also have clear water; it is not found in muddy waters.

Now the question is why is it found there. Now, one thing that we can note here is that most of the organisms are found in those locations that have a particular sort of climate. So, a coral reef

will be found in those areas that are not very hot nor very cold so, essentially you can mark the oceans where you have a temperature that is a moderate temperature.
In that you can also mark those areas that have muddy waters and those areas that have clear waters, and then you can say yes, this is the location where coral reefs should be found, which brings us to the topic of climate. So, it has been found out that climate plays the largest chunk of goal in deciding or determining where an organism will be found.
And a good way of understanding that climate has the largest impact is by looking at altitudinal zonation. So, what this curve is showing us, is that if you move from the equator towards the poles you find that earlier you will have the tropical forest or the equatorial forest, after that you will find subtropical forest, after that you will find warm temperate forests followed by cool temperate subarctic and arctic regions.
Now, this is occurring when you are moving from the equator towards the poles. However, if you take a location such as this location which is at 10 degrees latitude and if you go and if you start going up a mountain then, what do you find? You find that up to around 1,000 meters, you will find the typical tropical forest in these areas.
But then, from an altitude of 1,000 to 2500 meters we will start observing subtropical forest. Now, remember that this is a location that is very close to the equator, but still you are observing a subtropical forest area. Then, if you move even higher in altitude, you will start finding the warm temperate forest or the warm temperate vegetation.
Now, this brings us to the point that there is something that is common between say this region between 30 and 35 degrees latitude and this region which is at 10 degrees latitude, but is at a greater height. So, what is that common thing, now it turns out that the common thing is the climate.
As we move up a mountain the temperature goes on reducing and so, after a level we will start observing the subtropical forest and the warm temperate forest and so on. So, the trees that are found here, near the equator but, at a greater altitude they will be very similar to the trees that are found here near the sea level, but at a greater latitude.
This is an example that tells us that because of the similarity in climatic conditions we find similar sorts of vegetation, but here again the question is why does this vegetation occur in these areas. So, we are observing that in areas with similar climates we are finding similar vegetation, but the question is why is this vegetation found here.
This brings us to the enfold factors. The question is why are things where they are? And we can say that there are certain factors that pull the species towards them and there are certain other factors that push species away from them. So, these are the pull and push factors.
Pull factors are conditions that attract organisms to any area, such as good amount of food availability and an amiable climate that suits the species. So, if there is a region with an abundant amount of food and with a good climate then, species will come to that area.
On the other hand, there are certain push factors that drive the organisms away from an area, such as the scarcity of food or an inhospitable climate. So, if there is a scarcity of food, if there is a climate that does not suit the organism, probably the organism will not be found there.
For instance we can say that the polar bear is finding a pull factor in the arctic's because it is

getting food in sufficient quantity it is not having any predictors of itself. Whereas, our location such as Madhya Pradesh offers a push factor to the polar bears because their temperatures here are too high and these temperatures are not amiable to the polar bear.

So, we have different push and pull factors and whenever we observe that a certain species is found in certain areas, we can start thinking about the push and pull factors. If we consider this image from the Shivalik hills here we find that these slopes are completely devoid of vegetation.

Whereas these areas are thickly vegetated now, the question is why are these areas bare and why are these areas thickly vegetated? Now, if you start thinking on the lines of push and pull factors, you will start to think that there is something in these areas that is not permitting this vegetation to thrive.

There are certain push factors. What are those push factors? You can observe that these areas are very steep and in these steep areas whenever any soil gets formed with the next rains it falls down. And so these areas are typically devoid of soil now, plants require soil to grow and so, if you do not have a soil here then probably you will not find plants here.

The absence of soil is probably acting as a push factor for the plants in these areas. Another push factor could be the lack of moisture now; these areas are the south facing slopes. Now, Uttarakhand is in the northern hemisphere and so the south-facing slopes will have a greater amount of sunshine as compared to the northern freezing slopes.

And because of an abundance of sunshine the moisture gets evaporated. So, these areas not only have an absence of soil they also have less amount of moisture. So, these could be two push factors that are not permitting the plants to thrive in this area. On the other hand, if you consider this region then the slope is much lesser as compared to this region and because of that the soil is able to remain in this location.

And when you have soil and also you have more moisture because this is not the south facing aspect of this hill. So, you have more soil, you have sufficient amount of moisture and these are acting as pull factors for these plants to thrive in this region.

So, there are push and pull factors that can help us understand why certain organisms are found in certain areas and not in other areas. Now, in this context we can also look at Liebig's law of the minimum. Liebig's law of the minimum states that, the rate of any biological process is limited by that factor in the least amount related to requirement, so that there is a simple limiting factor.

The rate of any biological process including say the growth of plants is limited by that factor that is there in the least amount relative to requirement, so that there is a single limiting factor. Now, what does that mean? Let us consider that in a location where the plants are going plants require several nutrients.

And three most common most important nutrients are nitrogen, phosphorus, and potassium that we call as N P and K. Now, suppose the plants require 1,000 units of nitrogen, but only say 800 units are available, which is 80 percent. Now, in this location for phosphorus a plant requires 200 units of phosphorus, but only 100 units are available; which is only 50 percent of the requirement can be met at this particular site.

For potassium probably the plants need only 100 units, but only 99 units are available. Which

means that it is present in 90 times it is able to meet 99 percent of the requirements of plants. Now, Liebig's law of the minimum states that the rate of growth of plants will be limited by a single factor, they will not have the growth of plants that is limited by all these three factors. There will probably be only a single factor and that single factor is the one that is available in least quantity related to the requirement.

In this case the phosphorus is available in the least quantity related to requirement, because it is able to meet only 50% of the requirements of the plants, others are able to meet 80 percent and 99 percent. So, Liebig's law of the minimum will say that the rate of plant growth will be dependent on the amount of phosphorus in this area.

The rate of any biological process is limited by that factor and least amount related to requirement, so that there is a single limiting factor. Now, why is Liebig's law of the minimum important? Because it is giving us an indication of what could be a push factor in this region.

We can note that the phosphorus - because it is available in a very less quantity related to the requirement - so this lack of phosphorus in this case is acting as a push factor. Another similar concept is the Shelford's law of tolerance, which states that the geographical distribution of a species will be controlled by that environmental factor for which the organism has the narrowest range of tolerance.

There is a certain range of tolerance, for different environmental factors and these ranges of tolerance govern where this species will be found or not. Now, of late what we have observed is that the environmental conditions are changing and so even for those environmental factors for which the organism earlier used to have a narrow range of tolerance it is now possible for organisms to extend their reach; and a good example is of global warming.

Now, it is known that a number of insects are regulated in their distribution because of the temperature. So, a number of species of mosquitoes for instance cannot tolerate a very low temperature, and so because of altitudinal variation of temperatures we will find that in a mountainous area, the mosquitoes or the flies will be found in the lower areas and as we go up we will not find any of these mosquitoes or flies.

Because these species are adapted to a life at higher temperatures, but because of global warming what we are observing is that the temperatures are rising and so even in these higher up locations now, we are having a higher temperature, which is now within the range of tolerance of these flies or mosquitoes. And because of that we are observing that now the flies and mosquitoes are able to invade even higher reaches of the mountains.

Even if the range of tolerance remains the same, if there is an environmental variation that brings more areas into the range of tolerance then the organisms will extend their range. This is the field observation as the mean temperatures are rising the median altitude where mosquitoes are found or where malaria is found is also increasing.

We are seeing this thing practically. Now, another factor that acts as a push factor is Allelopathy now, Allelopathy is the phenomenon in which certain organisms secrete certain chemicals that inhibit the growth of other organisms or that kill away other organisms, and a very good example is antibiotics.

This is a photograph from the Nobel lecture of Alexandra Fleming and here we are seeing that

there is this petri dish on which there is this colony of penicillium which is a moon. Now, this penicillium colony is secreting something and now we know that that something is penicillin the antibiotic, and because of this antibiotic and here we are seeing bacterial colonies which belong to staphylococci.

Here we have staphylococci colonies and in this zone where you have the penicillin, we are seeing that these staphylococci are undergoing lysis. So, the penicillium colony is secreting something that is killing off or inhibiting the growth of these bacteria.

A phenomenon such as this is known as Allelopathy and we find Allelopathy not just in these microorganisms but also in the case of plants. So, if you consider a dry deciduous forest floor and especially one that is dominated by peaks you will find very less vegetation in the ground cover.

Now, why is that so, because the leaves of teak when they fall down, they carry with them a chemical that inhibits the growth of a number of species of plants. So, we find Allelopathy because of these leaves in a dry deciduous forest as well, and in a number of cases we can demonstrate this impact experimentally.

Similar to the impact of teak it is known that in areas that have grasses it is difficult to raise apple trees. So, how do you demonstrate that the grass is doing something through Allelopathy to reduce or to inhibit the growth of the apple trees? Now, remember that in the case of Allelopathy something is being secreted and if there is something that is being secreted if you take that chemical out then, it should still be able to inhibit the growth of the apple saplings.

This is how the experiment is done. So, you take soil in which you have grass, you add water and you take off the runoff. So, here we are adding water and the water is percolating through the soil and the runoff and the water that has been populated down it is collected, and here you have another piece of soil in which you are growing apple tree seedlings and here also you do the same thing.

And you find that, because you are adding water from outside, the grass is able to grow and the apple tree seedlings are also able to grow. There is no difference or there is no mortality or more innovation. Next, what you do is you add water to this grass and you remove this water that has percolated through this grass and soil or has flown over this grass and you add this water to the apple saplings.

Now, you will start to observe that these apple saplings or the seedlings will be showing a very reduced growth as compared to this control. So, in this control we were adding water from outside, in this experiment we are adding that water that has passed through grass and the grass roots; and we are observing that it is now inhibiting the growth of the apple seedlings.

Probably there is something that is coming out of this grass or the soil that is inhibiting the growth of the apple seedlings. Now, how do we prove that it is not something that is coming from the soil? Well we repeat the same experiment, but without the grass.

Now we add water to the soil. We take all the water that has run off or that has populated through this soil and we add that water to the apple seedlings, and here we find that there is no inhibition of growth. So, such an experiment would help us prove that there is something that is being secreted out by the grass, not by the soil and this something is hampering the growth of the

apple seedlings.
This is the classic Allelopathy. Allelopathy can very easily be demonstrated in experimental settings in certain cases we grow two organisms together and we observe, if this organism is able to inhibit the growth of this organism, but at a distance or we can do experiments such as these to demonstrate if something is being secreted out which is inhibiting the growth of the other species.
Allelopathy is a very important push factor for a number of species. Another push factor is predation. Now, predation is the phenomenon in which one species kills or hunts or eats other species for food. So, for instance if there is an area which has a very big population of say wolves.
In those areas we will not find a very big population of deer. So, the deer will try to avoid those areas where you have the wolf population, whereas the wolves will be attracted to those areas that have the deer. So, predation works in these two ways.
A very classic example of predation is how sea urchin regulates the distribution of algae. So, this is a field observation so, here you have the abundance of sea urchin. Now, here sea urchin is the predator that eats up the algae and here we find that in so, this is the abundance of sea urchin and this is the abundance of algae.
And here we find that wherever you have a heavy growth or heavy abundance of sea urchin you do not find the algae, but in those locations where you do not have the sea urchins you have a very good amount of algae. Now, how do we prove that this distribution is because of sea urchin and not because of any other organism.
We show this by experiments. So, the scientists took an area where they were not finding the algae and they experimentally removed the sea urchins in those locations. Experimentally all the sea urchins were picked and moved to other locations. What happens in the absence of the sea urchins, is that the algae start to grow and occupy this area and within a year - so, this experiment ran from July 1959 to July 1960 - within a year the whole area got covered with algae.
If you just remove the sea urchins you find that the algae have come back to this area, which tells us that the sea urchins were doing something to the algae because of which they were not able to thrive in this location. But then, not only does predator govern the abundance of the prey in certain cases the prey also governs the distribution and abundance of the predator.
A good example is those locations where you find deer or sambars and you find tigers in those locations. So, if you have the prey you will find the predators nearby, but in certain situations this goes to the other extreme as well. For example, in the case of Drosophila pachea now Drosophila pachea is a predator species which preys upon a species of cactus.
Now, this species of cactus not only provides food for this Drosophila, but also it secretes or it manufactures a particular sterol that is required for the development of Drosophila. So, if you do not provide this sterol, if you try to grow Drosophila on some other species the Drosophila colony will not be able to establish.
So, in this case this Drosophila pachea or this predator will only be found in those locations on earth where you have this particular cactus. So in this case, the prey is governing the distribution

and abundance of the predator; in this case the prey is acting as a full factor for the predator.
Another factor that governs the distribution is competition, especially interspecific competition. Now, interspecific competition is a phenomenon in which there are two species that are competing against each other. And during this competition it could be say for food or it could be for space, during this competition one of the species is able to to have so much amount of aggression that it drives away the the species from that area.
And a good example is these birds the red wings and the tri colored black birds. Now, this is a field observation. In 1959 on 15th of March it was found that this whole area was covered with redwing territories, but later on on 20th of March it was found that the central region had the blackbird territories and the red wings were displaced out.
So, they could only remain in the periphery, but the central region is now a space where these red wings are no longer found. So, this is an example of interspecific competition that governs the distribution and here the black birds are acting as push factors for the red wings.
They are pushing them away from their original territories. There is nothing else in this area that is unsuitable for the red wings, the red wings could have easily formed their colonies and as they had done previously, but then because these black birds are acting in a push factor so they are pushing them out of this region.
This is another factor that governs the distribution and abundance of species. Another factor is the behavioral factors, such as habitat selection "Habitat selection refers to a hierarchical process of behavioral responses that may result in the disproportionate use of habitats to influence survival and fitness of individuals".
In the case of habitat selection what we are saying is that there are two habitats that are equally suited for an organism, but it so happens that the organism does not prefer one it only prefers the other one; and because of this behavioral response it is possible that the organism will be found only in one habit and will not be found in the other habitat.
And a good example is the chipping sparrow. Now, this experiment was done to demonstrate that habitat selection has both innate and learnt responses; innate means a response that is present from birth and learnt is something that the organism learns after it has been born.
In the case of natural chipping sparrows the wild caught adults if you take this if you take the birds if you catch the birds that have grown in the wild conditions, and if you put them into a situation where they can spend time on pine trees or they can spend time on the oak trees, you will observe that as much as 71 percent of the time is spent of the pine trees so, the majority of time is spent on the pine tree and only 29 of time is spent on the oak trees. Now, in this case what is happening is that the oak can also serve as a habitat for these birds.
It also provides them with shelter, it also provides them with a place where they can boost or nest, but they have a behavioral preference for pine. So, this is an example of a habitat selection. Now, it has an innate component which is present from birth because if you have laboratory reared, birds which have not been exposed to any outside foliage then also we observe a very similar pattern, they spend as much as 67 percent of time on pine when they are released and only 33 percent of time in the oak.
Which means that, this habitat selection or this preference for pine is present from birth, but then

if you have laboratory reared chipping sparrow chicks and you raise them in oak foliage so, when you are raising these chicks you put the oak leaves together with these chicks.

What happens is if this slowly and slowly they develop a preference for oak as well. And when you release them out in the forest you will find that now they are spending 54 percent of their time on oak and 46 percent of their time on pine. Which means that, earlier we were seeing a dramatic preference for pine, but now we are not seeing a preference for pine?

Now the birds have become ambivalent; they spend time in oak roughly as much or a bit more than the time that they spend on pine. So, habitat selection has a learned component as well and habitat selection can be changed. Other factors that govern the distribution of species are things like dispersal. Dispersal is the movement of individuals away from their place of birth or hatching or seed production into a new habitat or area to survive and reproduce.

What we are seeing here is that, if you consider a tree and this tree is giving now a number of fruits and seeds, if all the seeds grow into plants in this same area the area will very soon become overcrowded and there will be a very heavy amount of competition.

So, typically what happens is that there are mechanisms through which these seeds are able to move to other locations. Such as in certain plants you will find that the trees are surrounded by a cotton like ball and then together with the wind they are able to move to other areas, or in certain cases we have movement because of water.

In certain cases we have fruits that are edible so, birds and animals eat these fruits and when they go out to other locations and when they defecate the seeds are also able to reach these other locations. So, this is a phenomenon that is known as dispersal. The movement of individuals away from their place of birth or a hatching or seed production into a new habitat or area to survive and reproduce.

Now, dispersal is different from migration, because in the case of dispersion the organisms are moving not along fixed booths and not in a regular or seasonal manner, but they are moving in search for a better habitat. Now, dispersal is of three different kinds, you can have diffusion which is a gradual movement over several generations across hospitable terrain.

In diffusion you have the organisms that are moving over several generations and the terrain is a good terrain and so slowly and steadily they are moving, such as the movement of lions across the Gir landscape that is diffusion. In certain cases we have the jump dispersal which is a quick movement over large distances often along unsuitable terrain.

There is a quick movement over large distances often across unsuitable terrain; a good example is the dispersal of zebra mussels through ballast water or say the movement of rats on ships. Now, if there are two islands and the first island has rats, the second island does not have rats and between these islands the area is covered with water.

Now, water is an inhospitable terrain for the rats because they cannot swim and they will die if they try to swim over these long distances. But, if a ship is moving from island one to island two, and if the rats are able to get into this ship they will be able to cross this inhospitable terrain very quickly probably in a single generation. So, this is an example of a jump dispersal quick movement over large distances and often across unsuitable terrain.

Another example is the invasion of zebra mussels through ballast water. So, when ships move

from one place to another place to maintain the stability there is a structure called ballast and whenever there is loading of goods then, water is pushed is pumped out of the ballast; and whenever there is unloading of goods water is pumped into the ballast.

And when that happens, whenever there is pumping of water into the ballast, then the organisms that are out there in the lake or in the sea where the ship is located they can also enter into the ballast. And when the ship moves to another location then these organisms are also able to hitchhike, because they are there in the ballast water.

So, the surrounding waters may have become salty and in the salty water these zebra mussels would have died, but because they are inside the ship inside the ballast where there is fresh water, they are able to survive. Now, when they reach another location and when again there is pumping in and out of water then, these zebra mussels can come out and this is an example of a jump dispersal.

Because, there was an inhospitable terrain in terms of high salinated water, which the zebra mussel was able to cross very quickly in one generation or in the span of a few generations. Another mode of dispersal is the secular dispersal, which happens so slowly that the organisms have finally diverged from the original populations, such as the dispersal of humans out of Africa.

So, we have these three different modes of dispersal, and whether a species is found in a location or not also depends on whether it has been able to disperse to that location or not. So, in the example of our two islands, island two did not have a rat population, but if you have a dispersal from island one to island two we will start observing rats in island two as well.

Because island two was able to meet all the other requirements of rats, it was having space it was having food but, till the point that the rats are able to reach that island we will not find rats in that island. Other factors are anthropogenic factors or manmade factors, this clearing of forest or pollution.

In this image we can see that this area is clear-felled now, if humans had not acted here this area would have had the same trees that are found in this area. And human factors are playing a major role in the case of the abundance or distribution of different organisms.

Now, we can understand the reasons why an organism is found in a certain region or not through transplantation experiments. Now, in the case of transplantation experiments what is done is that and the is that a group of organisms is transplanted from a site where they are found, that is this green site to another to other sites where they are not found, such as this yellow site and the red side and there is also control experiment.

Now, if you take organisms from this green zone into the yellow zone and the organisms are able to survive. It would tell us that there is nothing wrong with this area everything is fine it is just that the organisms have not reached to this area, probably because they have not been able to disperse to that area so, it will take a bit more of time, which is our example of rats moving between the two islands.

But, if we do any transplantation experiment from this green to the red zone and the organisms die, then we will see that there is something in this red zone that is not allowing these organisms to thrive. A good example is when algae are shifted to areas that have sea urchins.

So, transplantation experiments are used to determine whether the range is limited or the distribution is limited because the area is inaccessible due to a physical barrier or it is a factor of dispersal that it will take a bit more time, or whether there is a habitat preference.

Or whether the distribution is limited by other species such as because of predation parasitism competition and so on, or whether its distribution is limited by physical and chemical factors. So, transplantation experiments help us decide what is the reason for a particular abundance and distribution or localization of the species.

So, to sum up we can analyze why a particular distribution is there by looking by performing different experiments and by having different observations. If an area is inaccessible such as our second island in the case of rats moving from island one to island two, if there is if everything else is fine but the area is inaccessible we will say that the localization is because of dispersal or absence of dispersal.

But, if the area is inaccessible then if we observe that there is a preference for a particular habit and if there is a habitat selection, then we will say that the localization is because of behavioral aspects. If behavioral aspects are also not there the species has equal preference then, it is possible that the distribution is limited because of predation parasitism competition or disease which are biotic factors.

So, we can perform transplantation experiments and see if it is because of say predation or because of parasitism. But, if that too is not there, if this is there then we will say that other species or biotic components are regulating the distribution, if even that is not there then we will say that it is because of certain physical and chemical factors.

And if we change these physical and chemical factors, say by use of greenhouses or by adding water or by providing fertilizers; we will be able to show whether it is because of a particular physical or chemical factor or because of something else. By doing such experiments by doing such analysis, we can discern what are the push and pull factors that are governing the localization of any particular species.

That is all for today. Thank you for your attention. Jai Hind!