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**Conservation**

This course is a general introduction to conservation. We recommend that this course is taught after at least the ‘Human impacts and biodiversity value’ course, and probably also after the ‘Ecology’ and ‘Evolution’ courses. The evolution and ecology courses cover how the diversity we see today has come about, and how those species and communities interact and function. The human impacts and biodiversity value course shows why this diversity and its destruction is important for human society. This provides all the context necessary for this course, which mainly focuses on what is damaging the natural world and how people try to protect it, rather than why this is an important thing to do.

This course covers the history of the field, as well as what biodiversity is (which is mentioned in other courses) and what is causing its decline and destruction. Conservation does not have infinite resources, so the course then covers prioritisation and what aspects of the natural world people aim to protect. It then moves onto methods, including species-focused methods and protected areas. Finally, something that is often overlooked in conservation biology is the role of people, so the last lecture covers interactions between people and conservation.

***Lecture 1 – Basics of conservation***

This lecture covers the basics of conservation. Firstly, there is a introduction to the global diversity of life and the incompleteness of our knowledge about it. It then moves on to the idea of extinction, the prevention of which is arguably the fundamental aim of conservation, how humans are increasing extinction rates and which species are most at risk. It then presents a whistle-stop tour of the history of Western conservation and discusses how different justifications give rise to different priorities and methodologies. It is important to note that although this lecture covers Western attitudes to nature, this does not imply that it is the only or the most important conceptualisation. However, Western thinking has historically dominated the theory and practice of conservation, and continues to do so into the present day. Comprehending western attitudes to nature, and how they have been spread around the world by colonialism and neo-colonialism, is important in order to fully understand why the natural world is in the state that it is, and why conservation acts in the way that it does.

*Reading*

*Toward a biocultural theory of avoided extinction (2008) Ladle & Jepson – Conservation Letters*

This paper was chosen to try and encourage discussion of extinction, and its importance to conservation. Preventing extinction is often assumed to be the fundamental aim of conserving the natural world. However, other aims are possible, including demographically and ecologically self-sustaining populations, resilient ecosystems, the preservation of areas that are free from human influence, the provision of ecosystem services and benefits to humans including tackling poverty and the importance of natural systems for indigenous peoples.

This paper covers a different caveat to the central role of extinction in conservation, defining what it is. Not only can we define different types of extinction, but it is no longer just a ecological process. We must take account of social factors. The importance of extinction to conservation has made its conceptualisation more complex, as when a species is labelled as being at risk of extinction, the actions of conservation change this risk. Conservation cannot rely solely on the natural sciences to set priorities and define risk, but also has to include the social sciences. The concept of extinction exemplifies this.

*Ripple et al. (2017) Extinction risk is most acute for the world’s largest and smallest vertebrates - Proceedings of the National Academy of Sciences*

Shows how different types of vertebrates are threatened by different processes, and gives an overview of the most important threats (links to the next lecture).

*Glacken (1992) Reflections on the history of western attitudes to nature. GeoJournal*

Gives a history of the Western attitudes towards nature that underpin how nature has been variously damaged or protected historically. Whilst it is not vital to know all the details of this, it is important to understand how the field arose as it has real implications for the different ways that it is practiced in the modern world.

***Lecture 2 – Causes of biodiversity loss***

Now we have seen the history of the movements that have aimed to protect the natural world, we will look at why they are necessary by covering the main threats that the natural world faces. The first part of the lecture uses the case study of rhinos to illustrate the hierarchy of causes from Balmford et al. (2009). The last slide of the four looking at underlying drivers is just one of the potential ones that could be identified. The expansion of the number of middle income and affluent households in China provides an increase in the market for rhino horn for use in Traditional Chinese Medicine, but there are many other cultural, sociological and economic drivers involved as well.

The rest of the lecture covers some of the most important threats to the natural world, as well as secondary problems. The costs of conservation are very important. These are covered in the activity that goes with this lecture, and link to lecture 3. They are vital in deciding where conservation efforts occur. Another crucial take-away message from this lecture is that threats vary according to habitat and species characteristics. Land use change has affected habitats that exist in areas valuable for farming, eg lowlands, climate change affects polar and high altitude species, hunting affects large-bodied species, and invasive species affect island birds. Biology and ecology therefore interact with human activity to produce undesirable conservation outcomes.

*Reading*

*Naidoo et al. (2006) Integrating economic costs into conservation planning - Trends in ecology & evolution*

This gives more information on the types of costs that are associated with conservation, how they are estimated, and why it is important to include them in planning.

*Razgour et al. (2017) An integrated framework to identify wildlife populations under threat from climate change – Molecular ecology*

Shows how species’ characteristics make them more or less vulnerable to particular threats. This work also shows the importance of integrating data from historically separated fields in order to estimate risk and identify those species most likely to be threatened by things such as climate change. An understanding of genetics is vital for conservation, and this links to the DNA basics lecture series.

*Ripple et al. (2014) Trophic cascades from wolves to grizzly bears in Yellowstone - Journal of Animal Ecology*

Provides an example of how it is not just primary human impacts that are important, and how ecology is important in mediating the impact that humans have on the natural world. The removal of an apex predator like the wolf has cascading impacts on the rest of the ecosystem, not just on the wolf which was the target of hunting. Species that have disproportionately large impacts on the ecosystems they live in are discussed in the next lecture.

*Exercise*

The biodiversity/species/habitats that will be preserved by a particular protected area are not the only considerations for protected area designation. Social factors including cost are also important. This exercise is designed to get participants thinking about the different costs associated with conservation, and how they are crucial to deciding which areas of land are protected. Different costs will be more or less important in different contexts. Question 2 is very important, and it is vital to know the difference between one-off costs and ongoing costs. Opportunity costs are different to the other kinds, because they are not paid directly, no one is actually handing over cash. Instead, they are forgone income from other sources.

This exercise is relatively simples, and could easily be expanded or made more complicated. The costs and biodiversity benefits are arbitrary, and the levels were chosen to exemplify different scenarios. These can easily be changed if need be.

***Lecture 3 – Prioritisation***

There are a range of motivations for why people want to conserve the natural world. These different motivations give rise to different aims and methodologies. As well as this, conservation has limited funds and resources so has to find ways to prioritise. There are various ways of doing this, some of which are covered in this lecture. Again, the importance that people put on different aspects of the natural world give rise to different priorities. Eg. if we want to protect as much diversity as possible, then biodiversity hotspots may be a priority. Conservation can act on different levels, and can focus on communities and ecosystems rather than just species. Species do not exist in isolation, and it is important to think about ecological functioning as well as just diversity. Species-level and ecosystem-level work can be connected by focusing on species that are important to ecosystem functioning such as keystones, engineers and apex predators.

Motivations for conservation can be broadly split into two groups. Intrinsic motivations can be thought of as protecting nature for its own sake, because it is thought to be inherently valuable, and have value separate to that which humans give to it. Extrinsic motivations don’t rely on nature having intrinsic value, but rather people are persuaded to conserve things by offering them a reward or banning certain behaviours eg. Payment for Ecosystem Services. Conservation needs to utilise both types to ensure that as many people as possible are motivated to protect the natural world. It is not always tangible value to humans that lead to conservation priorities. Charisma, the animals that humans tend to be interested in due to them being cute, dangerous etc., can also attract conservation investment.

Externalities are a way of conceptualising why so many environmentally damaging activities are economically profitable, linking to lecture 2.

*Reading*

*Callicott, Crowder & Mumford (1999) Current Normative Concepts in Conservation – Conservation Biology*

This paper again highlights why the philosophical underpinnings of our conceptions of nature are important for the practice of conservation. This links to the different levels that conservation can act at. Species-level work tends to use a more compositionalist viewpoint, whereas ecosystem-level work can either focus on diversity (compositionalist) or ecosystem function (functionalist).

*Cetas & Yasué (2017) A systematic review of motivational values and conservation success in and around protected areas - Conservation Biology*

Looks at the evidence for the relative success of projects that have used extrinsic and intrinsic motivations. Even though it may be assumed that paying people may be more effective at motivating them, this research suggests that intrinsic motivations may be more successful. This links to the last lecture in this series, and the links between conservation and social justice. Empowerment of local communities is not only a social goal, but this suggests it may make conservation more effective as well. There will never be a one-size-fits-all solution, different social and cultural contexts will suit different motivators.

*Ripple & Beschta (2012**) Trophic cascades in Yellowstone: the first 15 years after wolf reintroduction - Biological Conservation*

An example of how the reintroduction of certain species can have cascading ecosystem effects and drastically alter ecosystem functioning, in this case an apex predator. It is difficult to study the effects that a single species has on a particular ecosystem, as it is hard to set up counterfactuals. Exclusion experiments can be used to study the effects of particular species and their functional roles, by comparing the state of the habitat inside and outside of exclusion zones. However, it is very difficult to do this at the ecosystem level. The reintroduction of wolves to Yellowstone provided an amazing opportunity to study the effects that an apex predator has, by comparing the states before and after. This also provides an example of how species-focused and ecosystem-level work can be connected.

***Lecture 4 – Endangered species conservation***

We have seen how conservation can at different levels. One of these is the species level. Besides from the inherent value that species can have, the ‘Trophic cascades in Yellowstone’ paper above shows how important conserving certain species can be for ecosystem-level conservation. This lecture starts with two reasons that certain species can be chosen for conservation focus, flagship and umbrella species.

A lot of conservation biology is focused on the small population paradigm. If preventing extinction is fundamental to conservation, as discussed in lecture 1, then small populations should be a priority as by definition they are closer to extinction than large populations. Certain processes make small populations vulnerable to extinction by the very nature of them being small.

The second half of this lecture covers a generalised sequence of events that are often followed when conducting species conservation, including examples of important considerations and methodologies that can be used at each stage.

*Reading*

*Hilbert et al. (2004) Golden bowerbird (Prionodura newtonia) habitat in past, present and future climates: predicted extinction of a vertebrate in tropical highlands due to global warming - Biological Conservation*

An example of research that uses a correlative bioclimatic envelope approach to predicting range size. Should be read in concert with the next paper.

*Kearney (2006) Habitat, environment and niche: what are we modelling? – Oikos*

This paper elaborates on the important distinction between distribution and niches. Bioclimatic envelope studies are not invalid, but it is important to know what they can and cannot tell us. Correlative studies, like the one above that focuses on the golden bowerbird, can show distributions, but they do not explain them. This paper expands on the point from the lecture that to understand what controls distributions, and to accurately predict how they will change in novel conditions, we need to use mechanistic analyses.

*Jones & Merton (2012). A tale of two islands: the rescue and recovery of endemic birds in New Zealand and Mauritius. Reintroduction biology: integrating science and management*

Great example of species-focused conservation can bring species back from the brink of extinction. A vital part of this that is worth discussing is the integration of the work of the traditionally separated *in situ* and *ex situ* conservation communities.

*Exercise*

The aim of this exercise is to think about the design of species-specific conservation programmes. Participants should use the sequence of actions as set out in the lecture. One of the important points here is that there are no one-size-fits-all solutions. The methodologies that will be effective for a particular species depend on the threats that they face, and their biological characteristics. Designing effective species-specific conservation programmes requires careful consideration of both the basic biology of the target species, its current conservation state and the threats that it faces. This exercise can be expanded and made more realistic and complicated by including a budget that constrains what actions are possible.

***Lecture 5 – Conservation inside protected areas***

Conservation is not just carried out on a species-by-species basis. One of the cornerstones of area and place-based conservation is the global protected area estate. This lecture covers different types of them, and what they are designed to do, as well as the theory behind their placement and design. Protected areas have different roles in different countries, and depend on cultural, social and economic contexts as well as biological and ecological considerations. The translation of Island Biogeography into protected area design is a great example of how basic ecological theory and understanding is vital for conservation to be successful. The ‘rules’ described here are not hard and fast rules, but are important considerations.

The use of protected areas is not beyond criticism, after all declines and extinctions have continued while the global protected area estate has continued to grow. Bad design is not the only potential issue. Just setting land aside as a protected area is not enough, there has to be sufficient investment in management for them to be prevent declines and extinctions.

*Reading*

*Joppa & Pfaff (2009) High and far: biases in the location of protected areas - PloS one*

Protected area placement is not just dependent on ecological and biological considerations, it is also dependent on social and economic factors. This paper demonstrates the bias in protected area placement, with placement occurring in areas that are least useful for human activities such as agriculture. Conflict with human interests is minimised, but this also means that species that are not adapted to these high and steep places will not be protected.

*Geldmann et al. (2013) Effectiveness of terrestrial protected areas in reducing habitat loss and population declines - Biological Conservation*

This paper exemplifies the available evidence for protected area effectiveness. Yes there is some evidence for their benefits, in this case the conservation of forest habitat, but there is also uncertainty for their other benefits, for example the maintenance of species benefits. This work also highlights the difficulty of carrying out this kind of research, and the lack of studies that use proper counterfactuals.

*Riggio & Caro (2017) Structural connectivity at a national scale: Wildlife corridors in Tanzania - PloS one*

When considering protected areas, biodiversity will not be sufficiently protected by creating isolated protected areas that are surrounded by human-modified landscapes that are completely inhospitable to wildlife. Maintaining and restoring connectivity are also important. This research shows how potential corridors can be identified and whether they are intact or under threat. It also highlights how connectivity is severely threatened by human activity, and that linear features such as corridors are vulnerable to being severed by land use change and other economic activity.

*Exercise*

This exercise uses Myanmar as an example for assessing protected area placement and design on a national level. There are no right or wrong answers to the discussion questions. By comparing the map of protected areas to the maps of vegetation types and KBAs, participants should be able to identify areas and vegetation types that aren’t covered by the existing protected area estate.

Potential points of discussion:

* Coastal environments such as mangroves are not well-protected, and feature many high-priority KBAs. Mangroves are also very important for human societies, providing ecosystem services such as protection from storms.
* The eastern side of the country is not well-protected, so the Northern Indochina subtropical forests are largely unprotected. The species adapted to this ecosystem may therefore be vulnerable, although it does not contain KBAs.
* The far northern part of the country has extensive protected areas. This area contains some of the last examples of south-east Asian pristine forests that are vital refuges for many important species including tigers. Despite this, could this be improved? This links to the exercise for the final lecture.
* The centre of the country is not well-protected, and this is where agricultural activity is concentrated. Would it be possible or desirable to restore these habitats? Will the opportunity costs of protecting these areas be too large?

***Lecture 6 – People and conservation***

Whilst protected areas are an important part of modern conservation, we cannot just protect the nature inside these areas. Firstly, this excludes large areas of the world that are not formally protected. Secondly, if we think that the nature outside of protected areas is not valuable, or not as valuable as that inside protected areas, we may be worsening the disconnect between humans and nature. If people are not connected to nature, then they will not be motivated to protect it. Conservation is ultimately a social exercise, and so we must consider the role of people in its practice.

The first part of this lecture covers some important types of species that cannot just be conserved using protected areas. Nature does not just exist in unmodified habitats, but how well species do in modified habitats depends on their characteristics, and varies from taxa to taxa. Some generalists can thrive. The lecture then moves on to things that people can do to reduce the impacts of their economic activities and reduce conflict with wildlife. Some of these methods can be controversial, particularly the ones that involve harvesting of wildlife.

When discussing human impacts on protected areas and wildlife populations, there is at temptation to focus on poaching, bushmeat hunting and other similar activities. These headline-grabbing activities certainly have serious negative consequences for biodiversity, but are often carried out by people in developing countries who have few other options for income. However, it is worth bearing in mind that legal resource extraction can be just as damaging for biodiversity. Governments often prioritise economic benefits over environmental protection, so legal activities can be very damaging for the environment.

As well as assessing the impact of conservation on biodiversity, it is also important to assess its impact on people. This history of conservation, and its contemporary practice, is heaving implicated in the processes of colonialism and neocolonialism. As discussed in lecture 1, conservation is dominated by ideas and practice that originated in the Western world and was exported around the world by these processes. These ideas include the importance of wilderness, and the value of people-less nature, which has been used as a justification for the removal and dispossession of indigenous people and communities in developing countries. This continues into the present day, in the fortress conservation model. Postcolonial approaches attempt to identify and critique continuing colonial and neocolonial aspects of conservation.

As well as the effects of conservation on people, involving indigenous people and communities in conservation can be beneficial for the protection of biodiversity.

*Example*

**Indawgyi Lake Biosphere Reserve, Myanmar**

An example of the Biosphere Reserves mentioned in the lecture.

*Reading*

*Agrawal & Redford (2009) Conservation and displacement: an overview - Conservation and society*

An example of postcolonial criticism of conservation, that shows how environmental policies can come at a cost for people. The central question here is whether gains for biodiversity conservation can ever be justified if they oppress people, which in this case takes the form of forcible displacement. The main take away message is that the fortress conservation model relies on the assumption that human presence in protected areas invariably conflicts with biodiversity conservation, which is not necessarily accurate. These topics can form the basis for interesting discussions on the conflict between biodiversity conservation and social justice.

*Arroyo‐Rodríguez et al. (2020) Designing optimal human‐modified landscapes for forest biodiversity conservation - Ecology Letters*

This paper shows how ecological principles can be used to design human-modified landscapes that are beneficial for biodiversity conservation, as well as protected areas as covered in lecture 5. This work takes account of benefits for humans as well as wildlife.

*Ward‐Fear et al. (2019) Sharper eyes see shyer lizards: collaboration with indigenous peoples can alter the outcomes of conservation research - Conservation Letters*

An example of how conservation scientists can benefit from working with indigenous people who can have important skills and experience of the natural world.

*Exercise*

This task brings together a lot of the topics discussed in this lecture and previous ones.

*Suarez-Rubio et al. (2020) Hkakabo Razi landscape as one of the last exemplar of large contiguous forests - Scientific reports*

Shows how important this landscape is, which is in the far north of Myanmar, as mentioned in the exercise of lecture 5.

The rest of this exercise discusses the social and cultural context of the area, and how this interacts with the international conservation efforts which has been led by WCS. This ties into themes of colonialism, social justice and development. Some suggested themes and talking points:

* Places like this that are very high value for conservation are often relatively underdeveloped by humans, so there is little industrial pressure on the natural world. If the lack of development is one of the primary reasons for the high biodiversity, then the obvious thing to do to preserve this is the prevent future development. However, is this fair on the people who live there who may have poor medical facilities and economic opportunities? Are there ways of improving quality of life and conserving biodiversity?
* There is conflict between the view of wildlife as ‘global heritage’ and the fact that people who live with it bear the brunt of the costs associated with conservation. This is the root of conflicts between international NGOs such as WCS and local communities, and emphasises that international conservation organisations must be sensitive to the social context and culture of areas in which they work
* World Heritage Status. There have been criticisms of this in the Lake District in the UK. The uplands in the UK are dominated by treeless ecosystems, which are maintained in this state mainly by sheep grazing. These landscapes have been romanticised in poetry and literature and are seen as the correct way the landscape should look. This Lake District landscape is so famous that it was given World Heritage Site Status by UNESCO. It is now argued that these upland ecosystems would be more biodiverse if grazing pressure was reduced, leading to a greater mosaic of habitats. World Heritage Status could therefore have locked this area in this less biodiverse state.