ACCOUNTING FOR BIODIVERSITY IN SAN MARTÍN, PERU

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PRETORIA, OCTOBER 2019

CONSERVATION INTERNATIONAL

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- Background to the project
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- Basic definitions
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Background

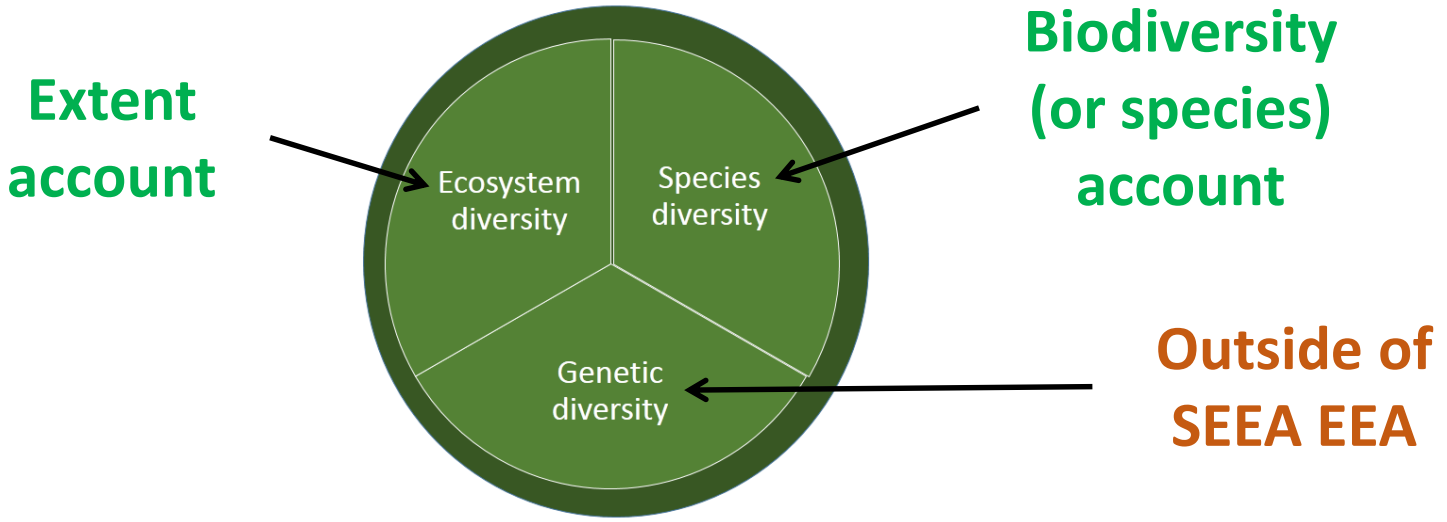
- This case study draws from a project to pilot ecosystem accounting for the region of San Martín, Peru. This was developed through a core partnership between the **Government of Peru** and **Conservation International** (CI), together with many others, including a biodiversity analysis led by the **Commonwealth Scientific and Industrial Research Organisation** (CSIRO).
- The pilot originated under CI's **Ecosystem Values and Accounting (EVA)** initiative funded by the **Gordon and Betty Moore Foundation**. EVA's aim is to design and field-test a replicable and scalable framework for incorporating nature's benefits into societal decision-making processes. EVA's ultimate goal is to make explicit the relevance of natural capital to the economy, and to inform the development and implementation of more sustainable policies and practices.

Overall goal

- The main aim of this pilot was to develop an operational model of ecosystem accounting that can be used in other regions of Peru and, ultimately, be scaled up to the national level.
- The ecosystem accounting approach we present here addresses gaps in the current SEEA framework by describing and implementing new methodologies.
- The key policy decisions that could be informed by ecosystem accounting, including those relevant to species and biodiversity generally.

Biodiversity in the SEEA-EEA

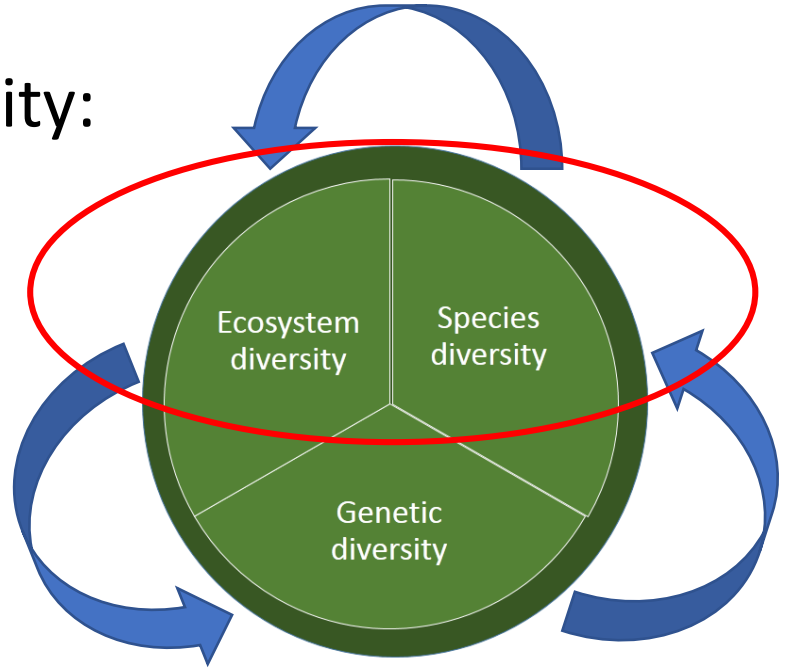
Three components to biodiversity:



…the measurement of biodiversity is focused on the assessment of diversity of species, although changes in the diversity of ecosystems is also an important output, derived from the measurement of changes in ecosystem extent and condition (SEEA EEA, 2013).

Biodiversity in the future SEEA-EEA

Three components to biodiversity:



…an important advance is understanding the need for the SEEA to recognize more clearly that biodiversity encompasses three levels of ecological organization – ecosystems, species and genes – and that all of these are inter-connected (Technical Expert Meeting, 2019).

What is Biodiversity?

Convention on Biological Diversity (CBD), 1992 defines biodiversity as:

> *"Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"*

How do we measure biodiversity?

Measuring the diversity of a species generally incorporates estimates of "richness." Also referred to as **alpha-diversity**, species richness is a common way of measuring biodiversity and involves counting the number of individuals – or even families – in a given area.

Researchers have created several indices which measure species biodiversity, the most popular are the ***Simpson Index*** and the ***Shannon Index***.

Source: The Environmental Literacy Council

How do we measure biodiversity?

Describing changes in biodiversity within or between ecosystems is called **beta-diversity**. Measures of beta-diversity indicate the difference in species richness between two different habitats or within a single community at different points in time.

Source: The Environmental Literacy Council

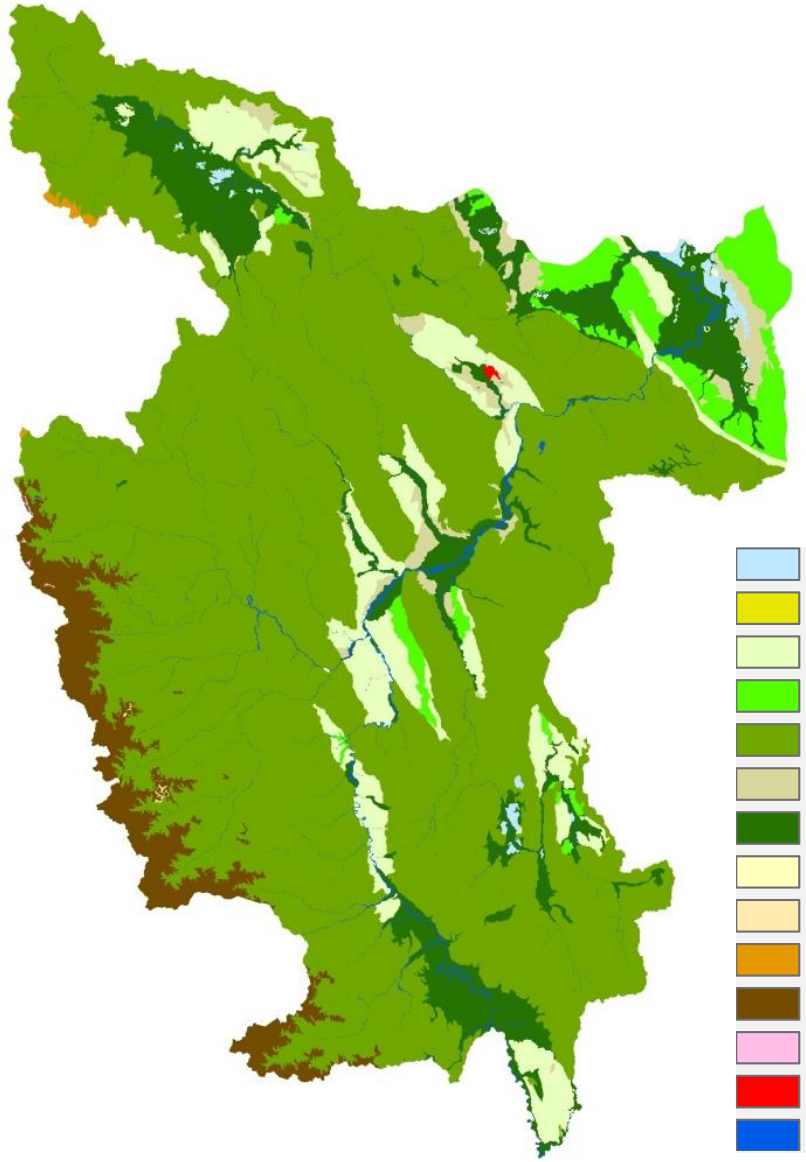
How do we measure biodiversity?

Gamma-diversity estimates the total biodiversity within an entire region. To arrive at a total estimate, researchers may set up sample plots around the region and count all species within the plots.

Source: The Environmental Literacy Council

Why San Martín?

Biome	Ecosystem
Forests	Aguajal
	Bosque Humedo de Colina Alta
	Bosque Humedo de Colina Baja y Lomada
	Bosque Humedo de Montana
	Bosque Humedo de Terraza Alta
	Bosque Humedo de Terraza Baja y Media
Shrub & Grasslands	Matorral Arbustivo
	Paramo
	Pajonal Altoandino
Water bodies	Other waterbodies
	Bofedal
	Cocha
	Herbazal Hidrofitico

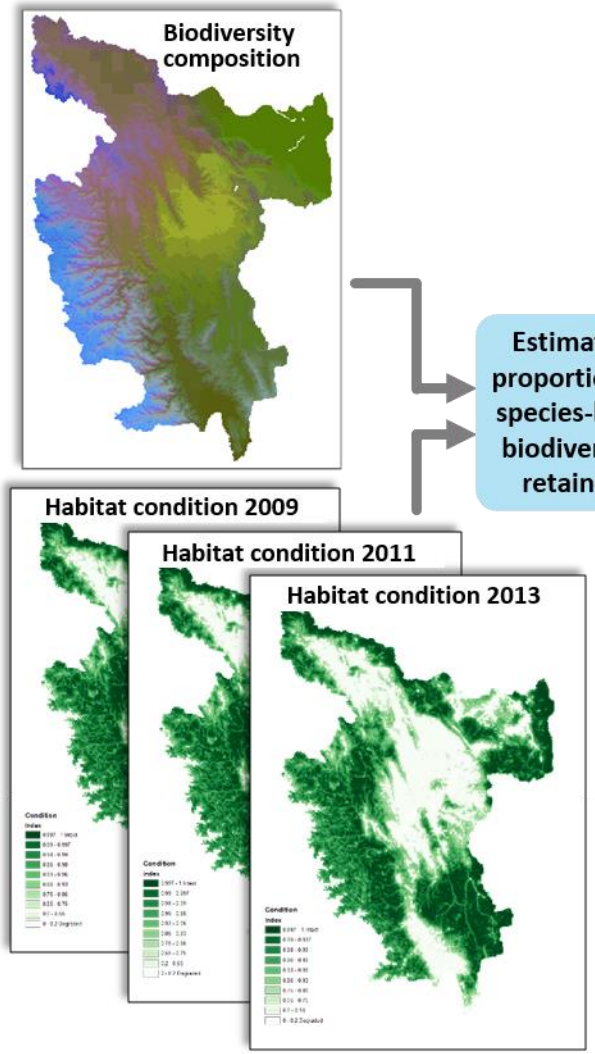


Source: MINAM 2009; 2012

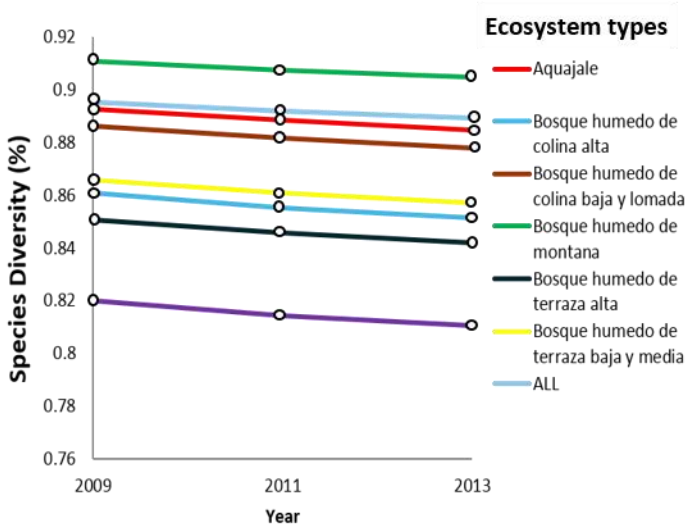
Our approach (cont.)

- To capture general patterns of biodiversity distribution and change, the **first approach** used was a modelling method called Generalized Dissimilarity Modelling (GDM).
- This is a community-level (Beta biodiversity) modelling method that allows differences in environmental conditions to be represented in terms of their effect on species composition for whole biological groups.
- It is then possible to compare the expected ecological similarity of any location with all other locations in the modelled environmental space.
- This allows the environmental uniqueness of a location, and its contribution to regional biodiversity, to be assessed.
- Using this method, it is then possible to determine the impact of anthropogenic land degradation on the long-term persistence of biodiversity. GDM models were developed for vertebrates, vascular plants and invertebrates.

Our approach illustrated



Estimated proportion of species-level biodiversity retained



Ecosystem type	Invertebrates (% biodiversity retained)			Vascular plants (% biodiversity retained)			Vertebrates (% biodiversity retained)		
	2009	2011	2013	2009	2011	2013	2009	2011	2013
Palm swamps	90.3%	90.1%	90.0%	87.0%	86.9%	86.8%	91.2%	91.1%	91.1%
Humid forest with high hills	88.3%	87.8%	87.4%	89.2%	88.8%	88.4%	83.7%	83.3%	83.1%
Humid forest with low hills	87.7%	87.3%	86.9%	88.6%	88.2%	87.8%	83.2%	82.8%	82.6%
Humid montane forest	91.1%	90.8%	90.5%	91.1%	90.7%	90.5%	87.5%	87.3%	87.1%
Lowland terra firme forest	86.5%	86.0%	85.6%	86.1%	85.5%	85.1%	80.9%	80.5%	80.3%
Floodplain forest	86.7%	86.2%	85.8%	86.6%	86.1%	85.7%	81.9%	81.5%	81.3%

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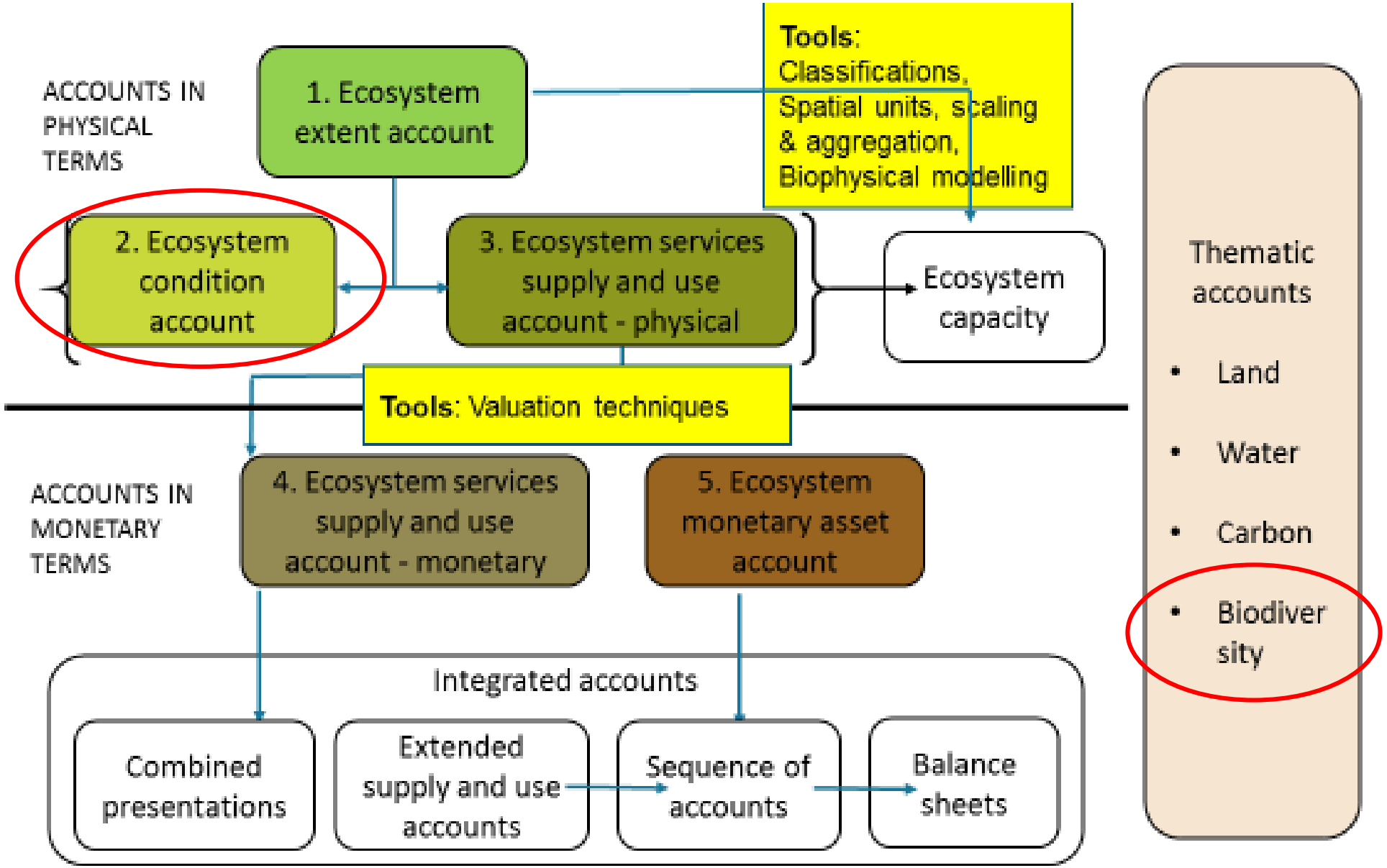
CONSERVATION INTERNATIONAL
GORDON AND BETTY MOORE FOUNDATION
PERÚ Ministerio del Ambiente
perú sanmartín GOBIERNO REGIONAL

Our approach (cont.)

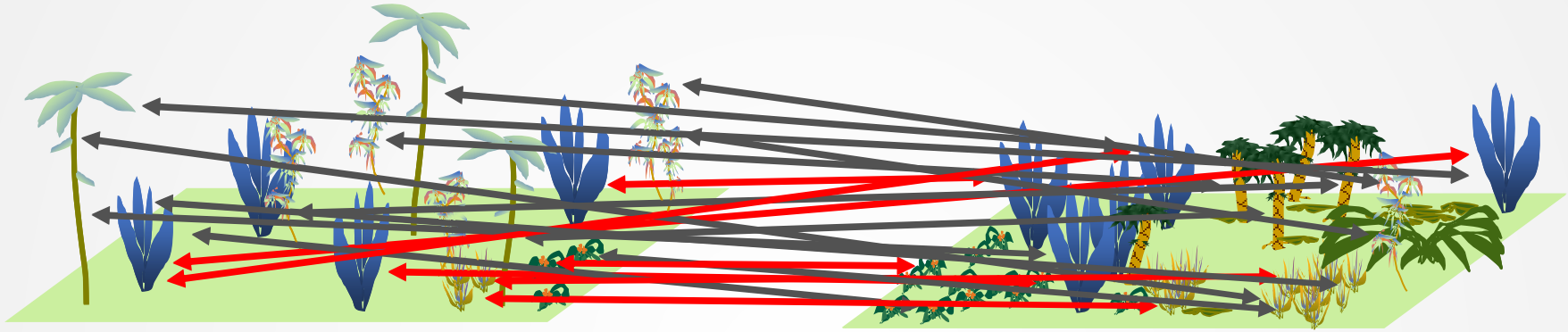
- The **second approach** focused on threatened species and the areas where they live. Some species have high value from ecological, economic, and/or social perspectives. Threatened species are often the focus of conservation because they are the most at risk of extinction.
- Habitat change was measured within: 1) specific, predicted species distributions; and 2) places important for threatened species.
- There were two species for which data were available on their predicted distributions: 1) the yellow-tailed woolly monkey; and 2) the San Martín titi monkey (locally known as Mono tocón).
- For important places, Key BiodiversityAreas (KBAs) were used, which are places of international importance for the conservation of biodiversity (Langhammer et al., 2007).
- A total of nine KBAs were identified in San Martín. Species range data were available for two threatened species – the **yellow-tailed woolly monkey** and the San Martin **titi monkey**. Change in ecosystem extent and ecosystem condition was measured for each KBA and each threatened species.

SEEA-EEA Framework



SEEA

Generalized Dissimilarity Model (GDM)



- GDM is a statistical technique for modelling compositional dissimilarity (beta diversity)
- It measures the proportion of species in a given biological group (e.g., reptiles) occurring at one location that do not occur at a second location – as a function of the environmental characteristics of these two locations.
- It is used to predict the compositional dissimilarity between any two locations within the region, regardless of whether biological data are available for these locations.

Source: Biodiversity futures | Tom Harwood & Andrew Hoskins |

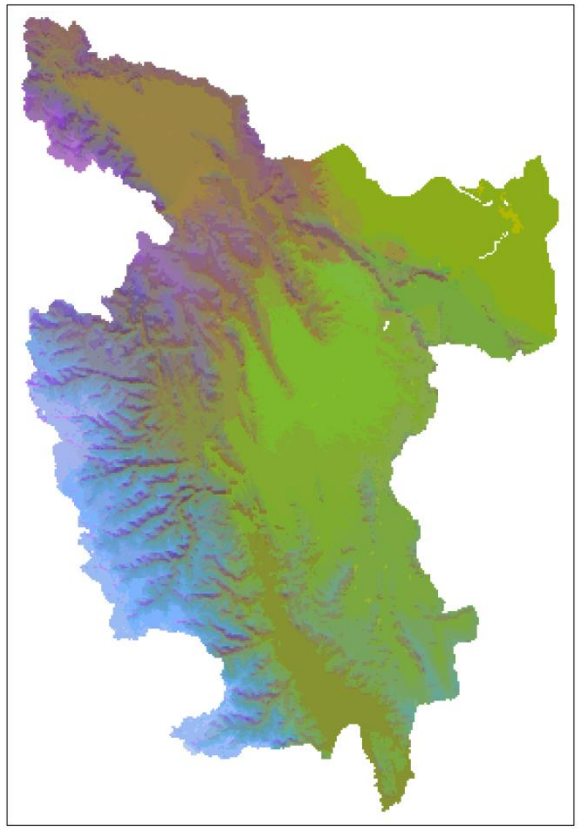
Results

The GDM model represents the original biodiversity composition of the region (prior to land use change)

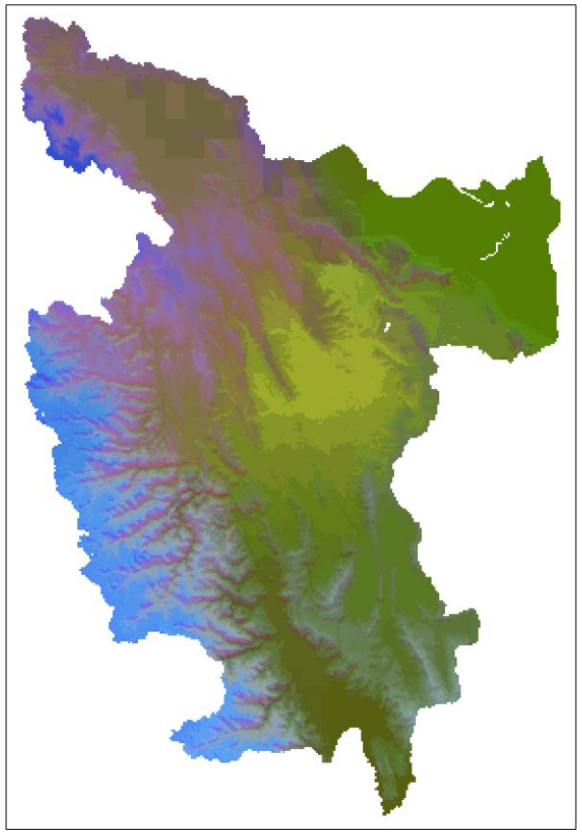
Similar color = similar biodiversity

Different color = different biodiversity

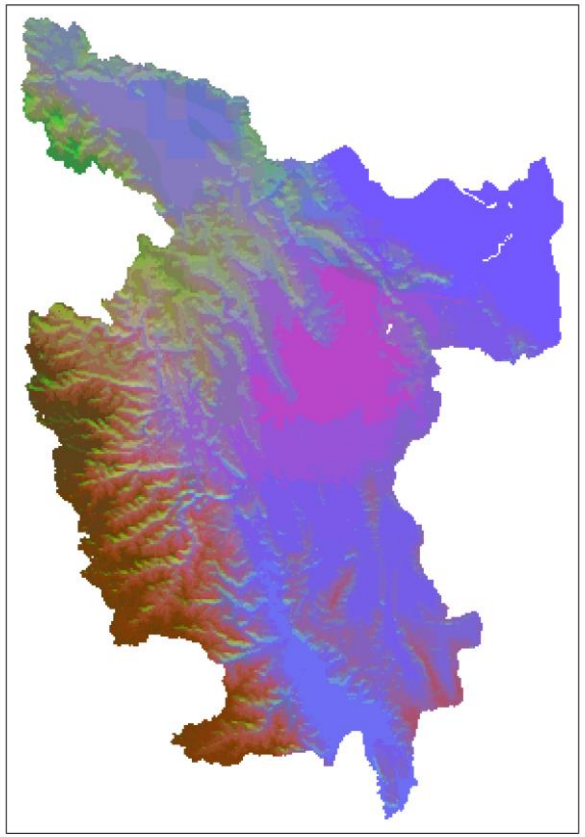
Invertebrates



Plants



Vertebrates



Results for the first approach

- The results of the first approach (using GDM) showed decline across the three taxonomic groups over the accounting periods.
- There was an ongoing loss of approximately 0.8% of species as a function of habitat condition change between 2009 and 2013.
- For a biodiverse group, such as invertebrates, this may represent the loss of many species per year.

within different forest ecosystems

Ecosystem asset	Invertebrates (% biodiversity retained)			Vascular plants (% biodiversity retained)			Vertebrates (% biodiversity retained)		
	2009	2011	2013	2009	2011	2013	2009	2011	2013
Palm swamps	90.3%	90.1%	90.0%	87.0%	86.9%	86.8%	91.2%	91.1%	91.1%
Humid forest with high hills	88.3%	87.8%	87.4%	89.2%	88.8%	88.4%	83.7%	83.3%	83.1%
Humid forest with low hills	87.7%	87.3%	86.9%	88.6%	88.2%	87.8%	83.2%	82.8%	82.6%
Humid montane forest	91.1%	90.8%	90.5%	91.1%	90.7%	90.5%	87.5%	87.3%	87.1%
Lowland terra firme forest	86.5%	86.0%	85.6%	86.1%	85.5%	85.1%	80.9%	80.5%	80.3%
Floodplain forest	86.7%	86.2%	85.8%	86.6%	86.1%	85.7%	81.9%	81.5%	81.3%

aggregated across ecosystem types

San Martín				
Biodiversity group	Original % biodiversity retained	2009 % biodiversity retained	2011 % biodiversity retained	2013 % biodiversity retained
Invertebrates	100%	88.4%	88.0%	87.7%
Vascular plants	100%	88.1%	87.7%	87.4%
Vertebrates	100%	84.7%	84.4%	84.2%
Overall biodiversity retained	100%	87.1%	86.7%	86.4%

Results for the first approach (cont.)

- A composite index for the overall condition of each ecosystem type was estimated as the mean average of the biodiversity condition and fragmentation.
- Results show that the extent and condition of each ecosystem type between 2009, 2011 and 2013 declined.

San Martín								
Ecosystem asset		Benchmark	2009		2011		2013	
		Extent (Ha)	Extent (%)	Condition	Extent (%)	Condition	Extent (%)	Condition
Forests	Palm swamps	28,353	98.7%	0.90	98.4%	0.90	98.1%	0.90
	Humid forest with high hills	382,089	53.3%	0.63	49.5%	0.62	48.0%	0.61
	Humid forest with low hills	193,040	82.7%	0.79	79.6%	0.78	78.0%	0.77
	Humid montane forest	3,618,298	82.0%	0.81	80.2%	0.80	79.5%	0.79
	Lowland terra firme forest	102,942	51.7%	0.63	50.2%	0.63	48.9%	0.61
	Floodplain forest	472,582	40.0%	0.57	37.9%	0.56	36.9%	0.55

Results for the second approach

- The results for specific species and places (KBAs) indicate a variation in change in extent and condition of features.
- There has been little change with the yellow-tailed woolly monkey, but there was large variation in change with the San Martín titi monkey. Similarly, there was quite a big variation in change between the nine KBAs evaluated.

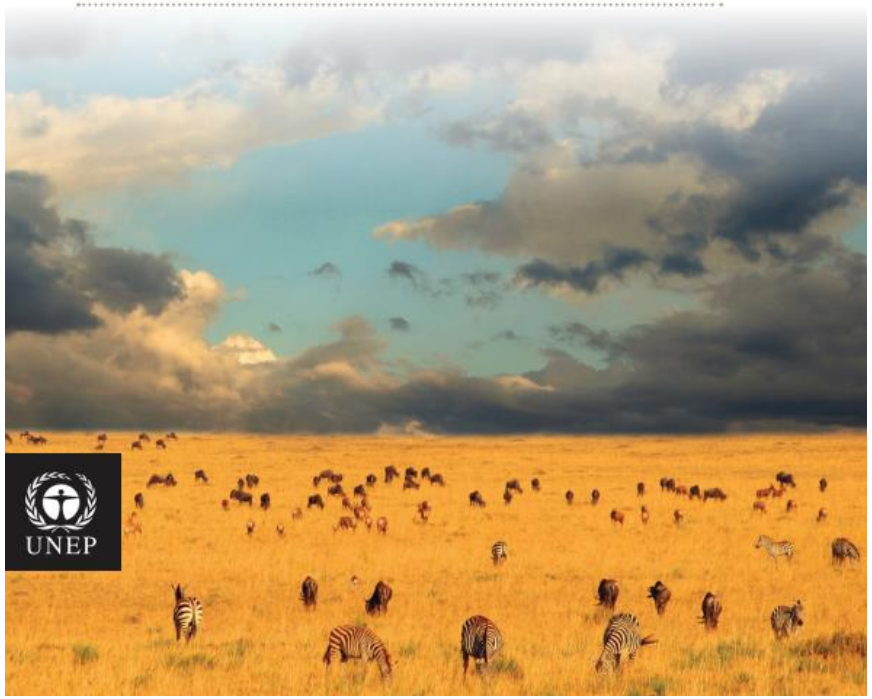
San Martín								
Biodiversity values		Benchmark	2009		2011		2013	
		Extent (ha)	Extent ha/(%)	Mean condition	Extent ha/(%)	Mean condition	Extent ha/(%)	Mean condition
Species distributions	Yellow-tailed woolly monkey	103,142	97,225 (94.3%)	0.867	96,714 (93.8%)	0.810	96,509 (93.6%)	0.806
	San Martín titi monkey	984,577	396,066 (40.2%)	0.653	365,836 (37.2%)	0.652	354,418 (36%)	0.643
Key Biodiversity Areas (KBAs)	Moyobamba	87,839	35,770 (40.7%)	0.547	33,832 (38.5%)	0.534	33,089 (37.7%)	0.531
	Jesús del Monte	4,481	4,479 (99.9%)	0.990	4,475 (99.8%)	0.989	4,474 (99.8%)	0.987
	Parque Nacional Cordillera Azul	481,772	476,919 (99%)	0.979	476,496 (98.9%)	0.978	476,424 (98.9%)	0.976
	Río Abiseo y Tayabamba	192,405	185,073 (96.2%)	0.925	184,462 (95.9%)	0.921	184,035 (95.6%)	0.915
	Laguna de los Cóndores	212,197	202,380 (95.4%)	0.925	201,784 (95.1%)	0.923	201,572 (95%)	0.920
	Abra Pardo de Miguel	1	1 (100%)	0.790	1 (100%)	0.790	1 (100%)	0.790
	Abra Tangarana	3,694	3,533 (95.7%)	0.920	3,513 (95.1%)	0.918	3,497 (94.7%)	0.912
	Entre Balsa Puerto y Moyobamba	155,950	117,523 (75.4%)	0.829	108,019 (69.3%)	0.844	104,538 (67%)	0.836
	Tarapoto	170,729	113,360 (66.4%)	0.821	111,225 (65.1%)	0.822	109,202 (64%)	0.815

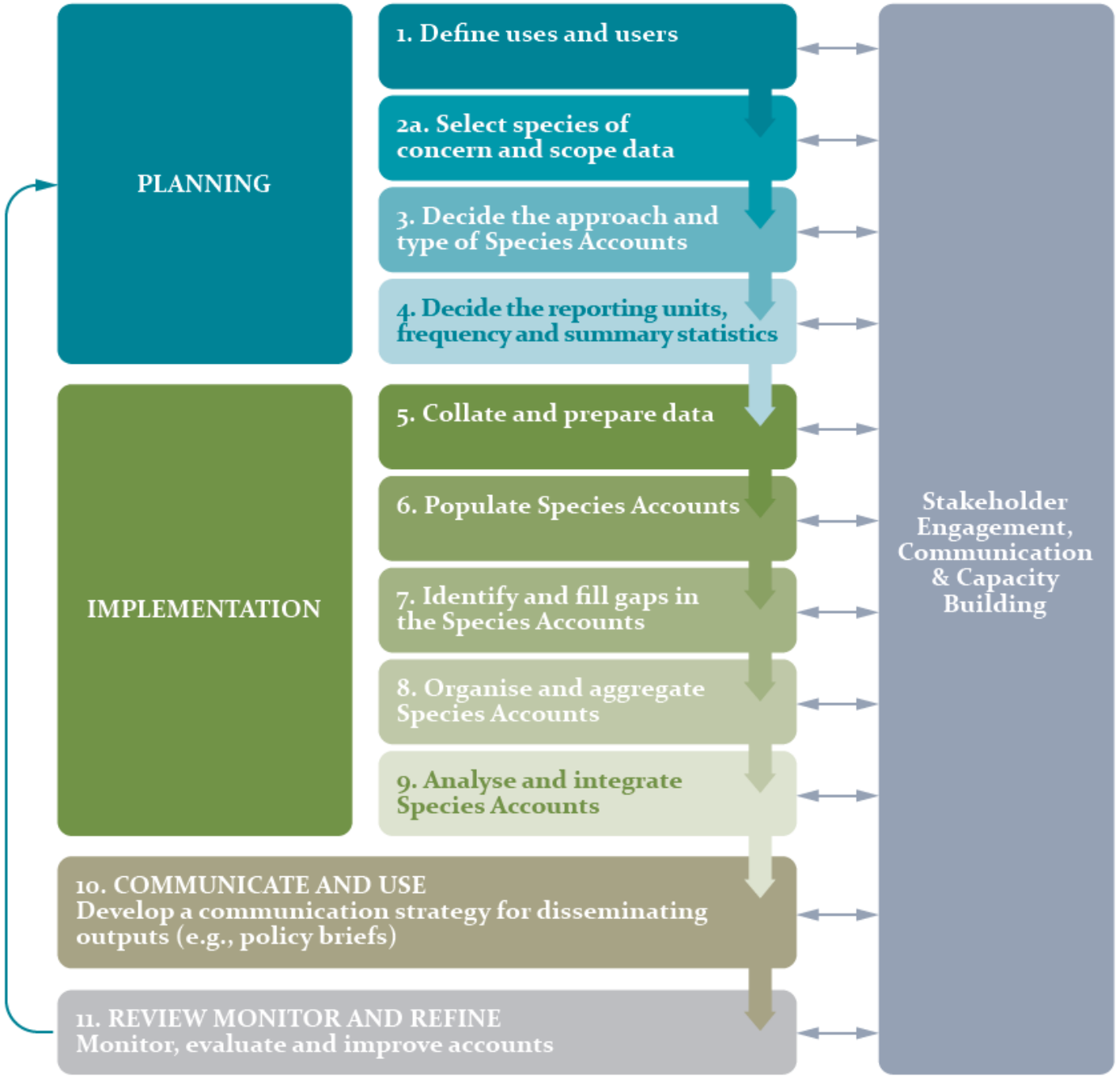
Summary

- Both ecosystem extent and condition were measured, with biodiversity providing key information on the condition and health of ecosystems for 2009, 2011 and 2013 using two approaches.
- In addition to the ecosystem condition account, we produced various thematic accounts including a Biodiversity Account (Species Account) which reports on biodiversity values independent of ecosystem types, but was also used as an input for the Ecosystem Condition Account by reporting biodiversity values by ecosystem type.

Useful resource

EXPLORING APPROACHES FOR CONSTRUCTING SPECIES ACCOUNTS IN THE CONTEXT OF THE SEEA-EEA

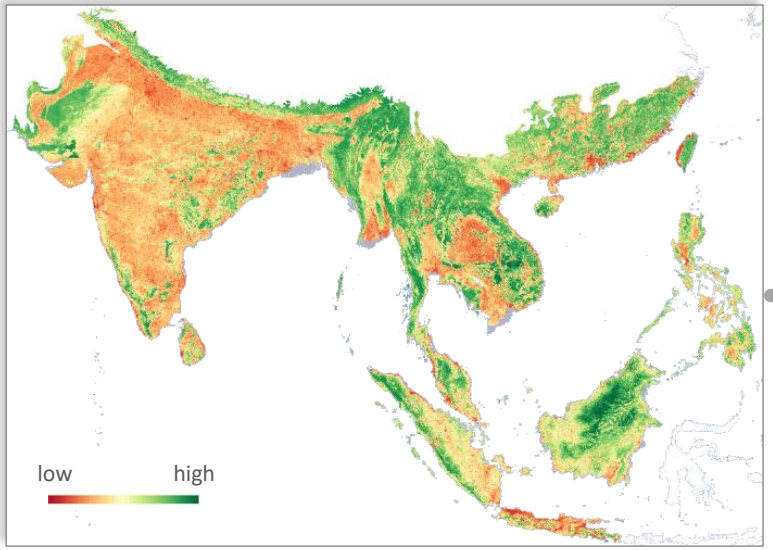




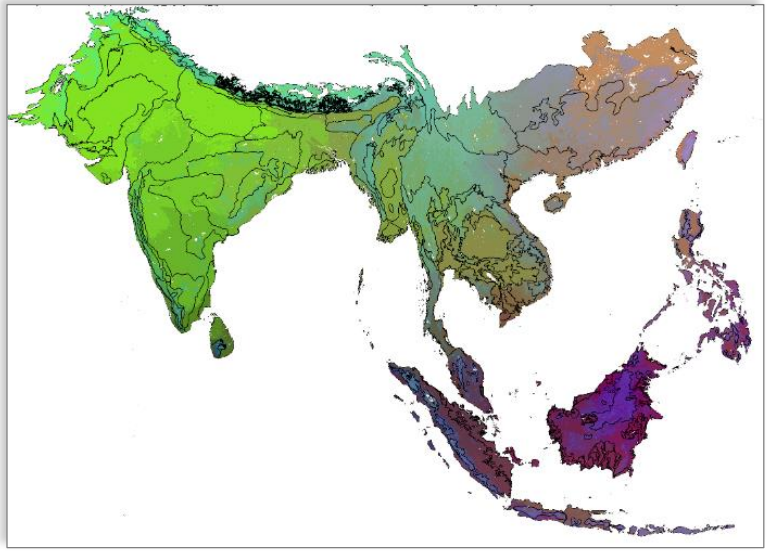

GLOBAL BIODIVERSITY INDICES

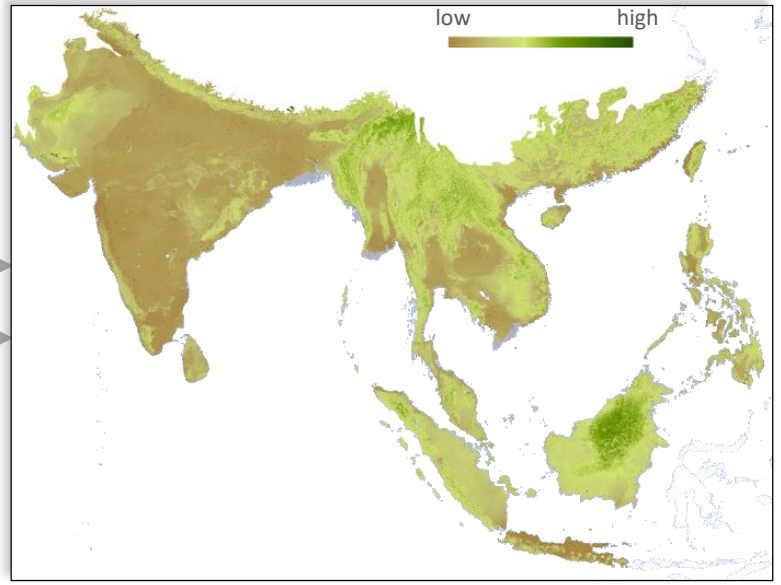
Biodiversity Habitat Index (BHI)

Local habitat condition (intactness) - statistical downscaling of land-use change using MODIS remote sensing



Biologically-scaled environments (ecosystems)
- modelling of spatial variation in biodiversity composition (beta diversity) using data for > 400,000 species

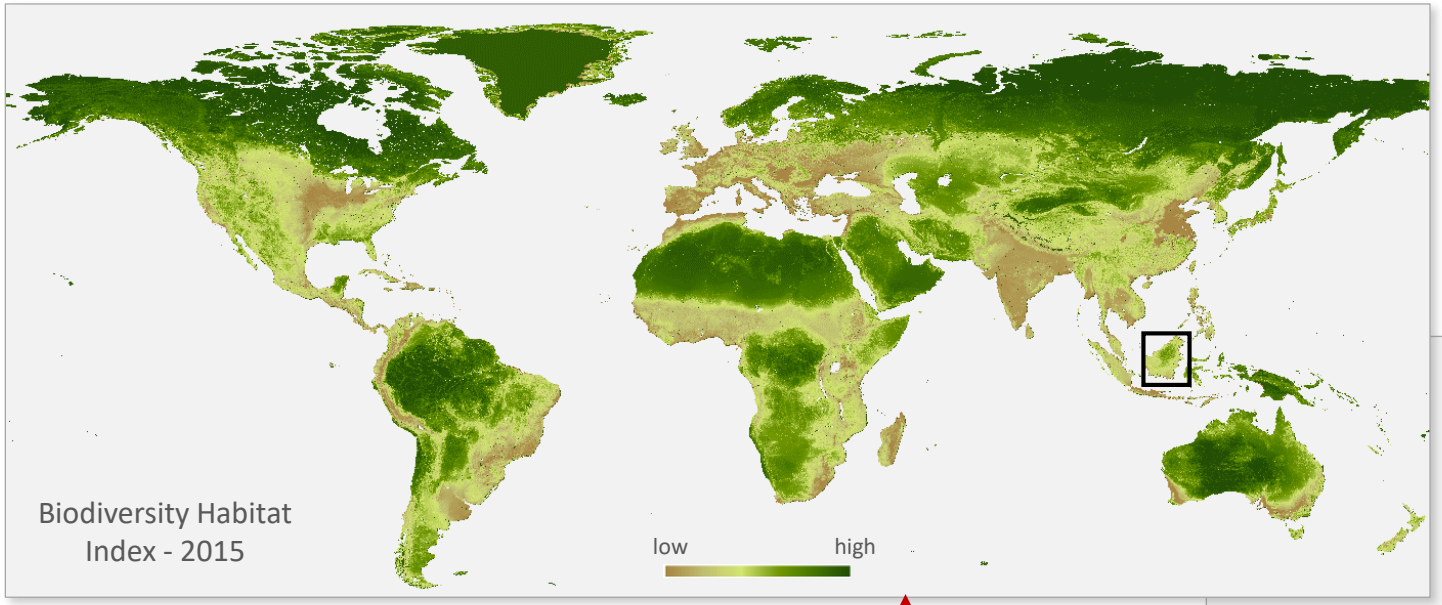


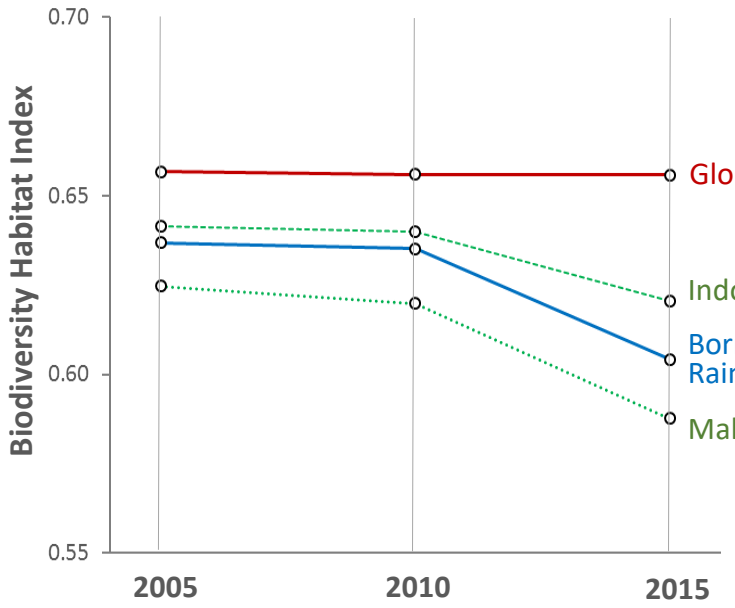


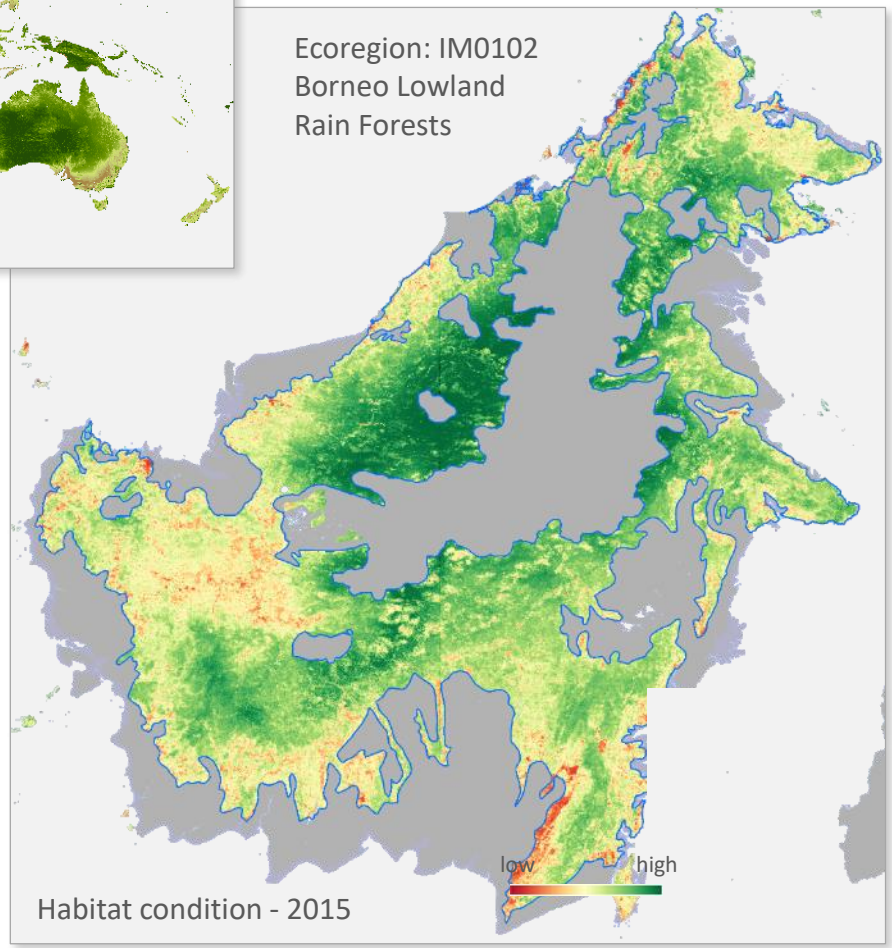
Biodiversity Habitat Index (BHI)
- estimated proportion of habitat remaining within biologically-scaled environments

Derived at 1km grid resolution across the entire land surface of the planet

The BHI is calculated at any spatial unit, e.g., country, region, the entire planet

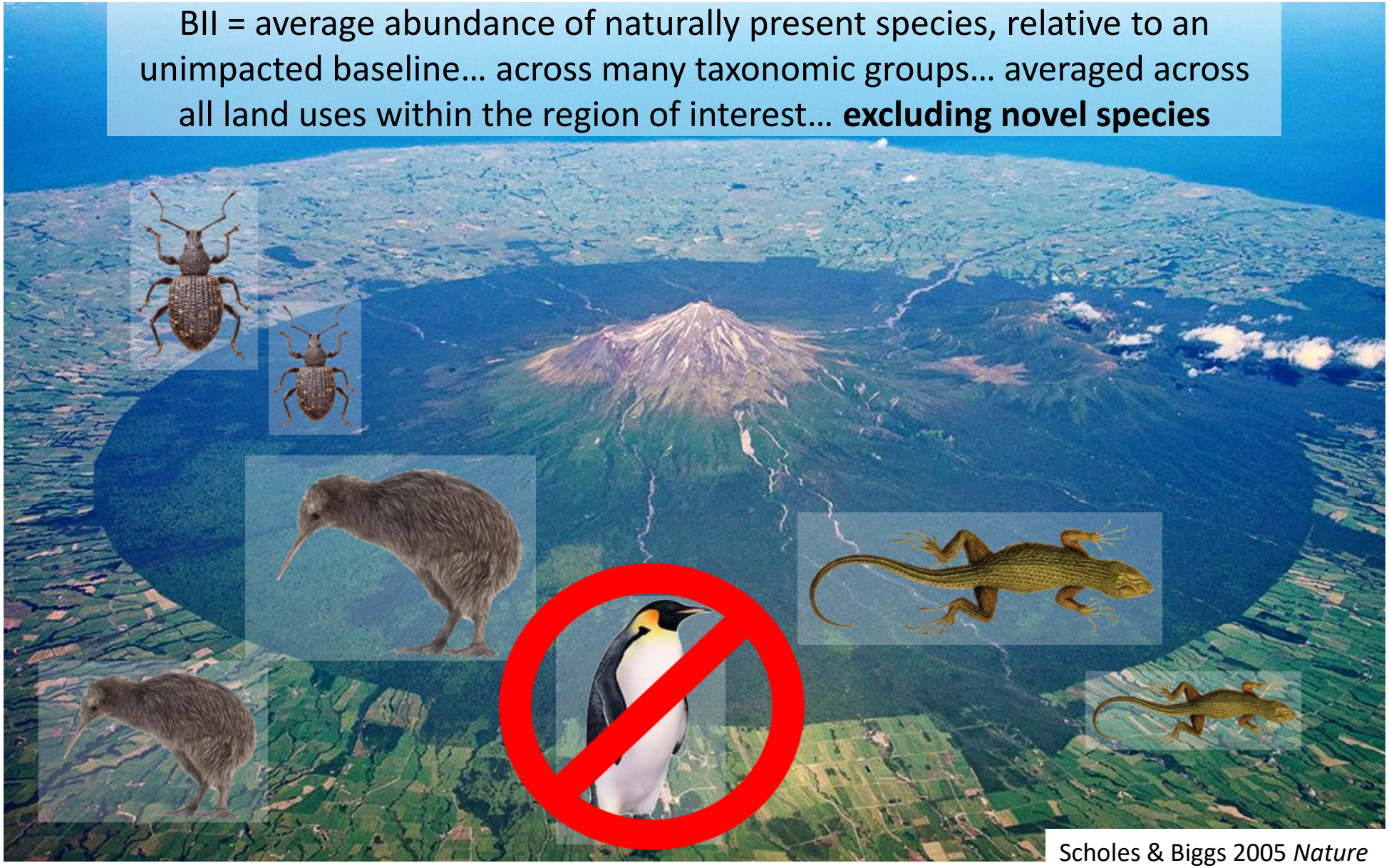






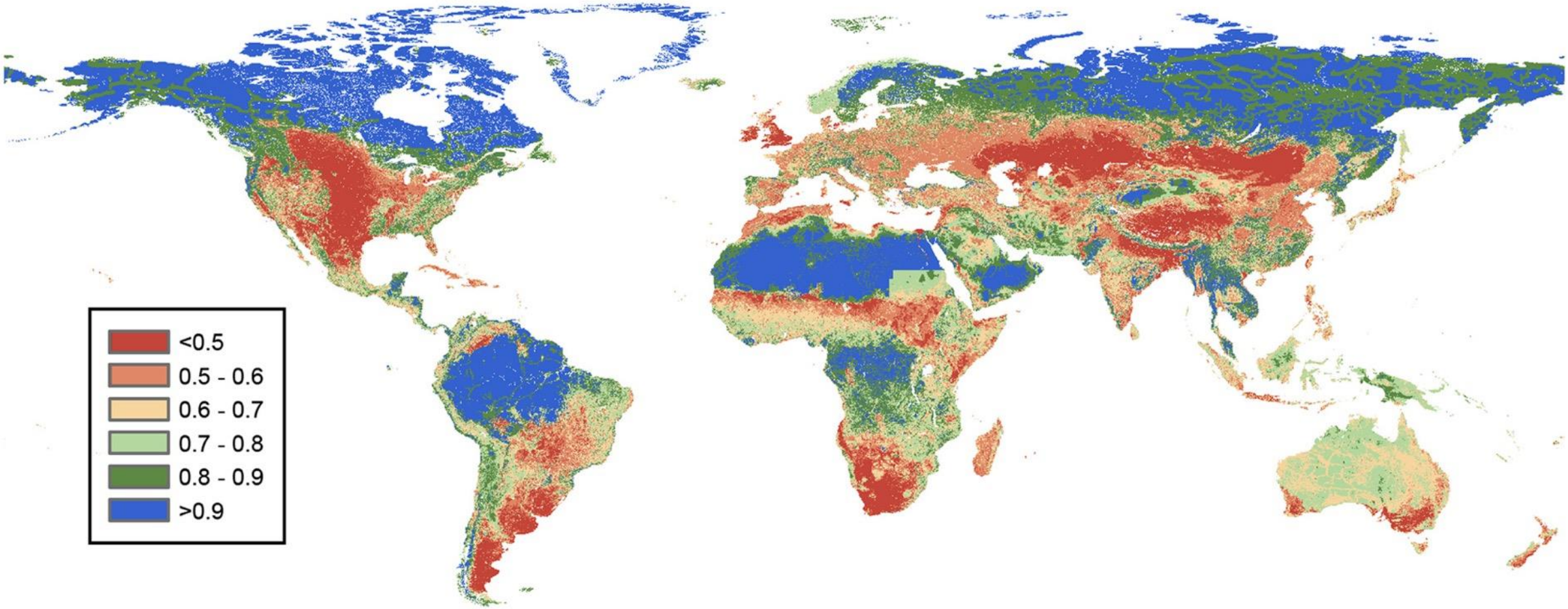
Biodiversity Intactness Index (BII)

BII = average abundance of naturally present species, relative to an unimpacted baseline… across many taxonomic groups… averaged across all land uses within the region of interest… **excluding novel species**



Scholes & Biggs 2005 *Nature*

BII is projected using maps of the relevant pressures



Sanchez-Ortiz et al. in preparation


THANK YOU!