The PREDICTS Project: Projecting Responses of Ecological Diversity In Changing Terrestrial Systems

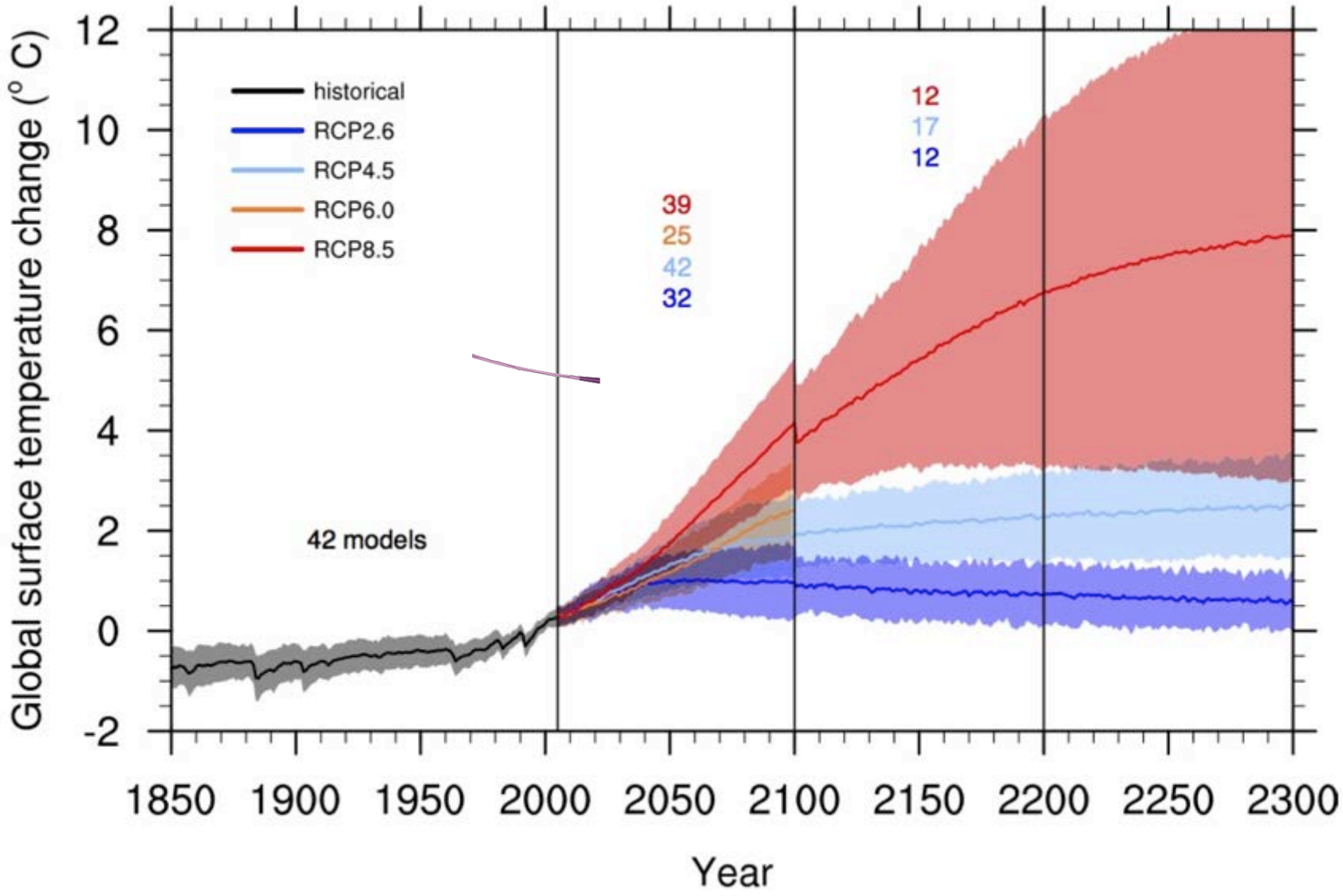
Adriana De Palma

Lawrence Hudson, Andy Purvis and The PREDICTS Team

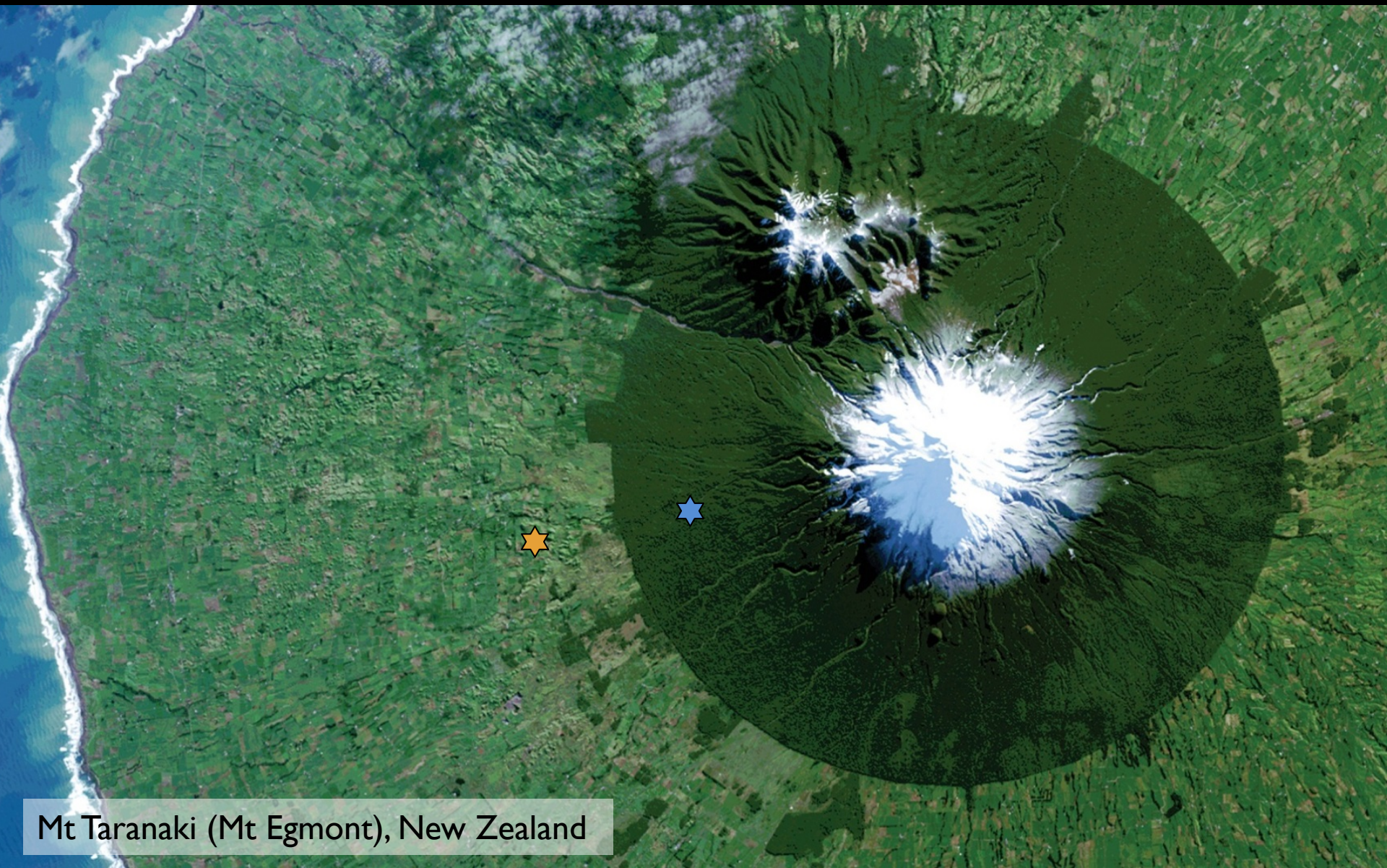
Land-use change is a major threat

Living Planet Report 2016

Can we model land-use like climate?

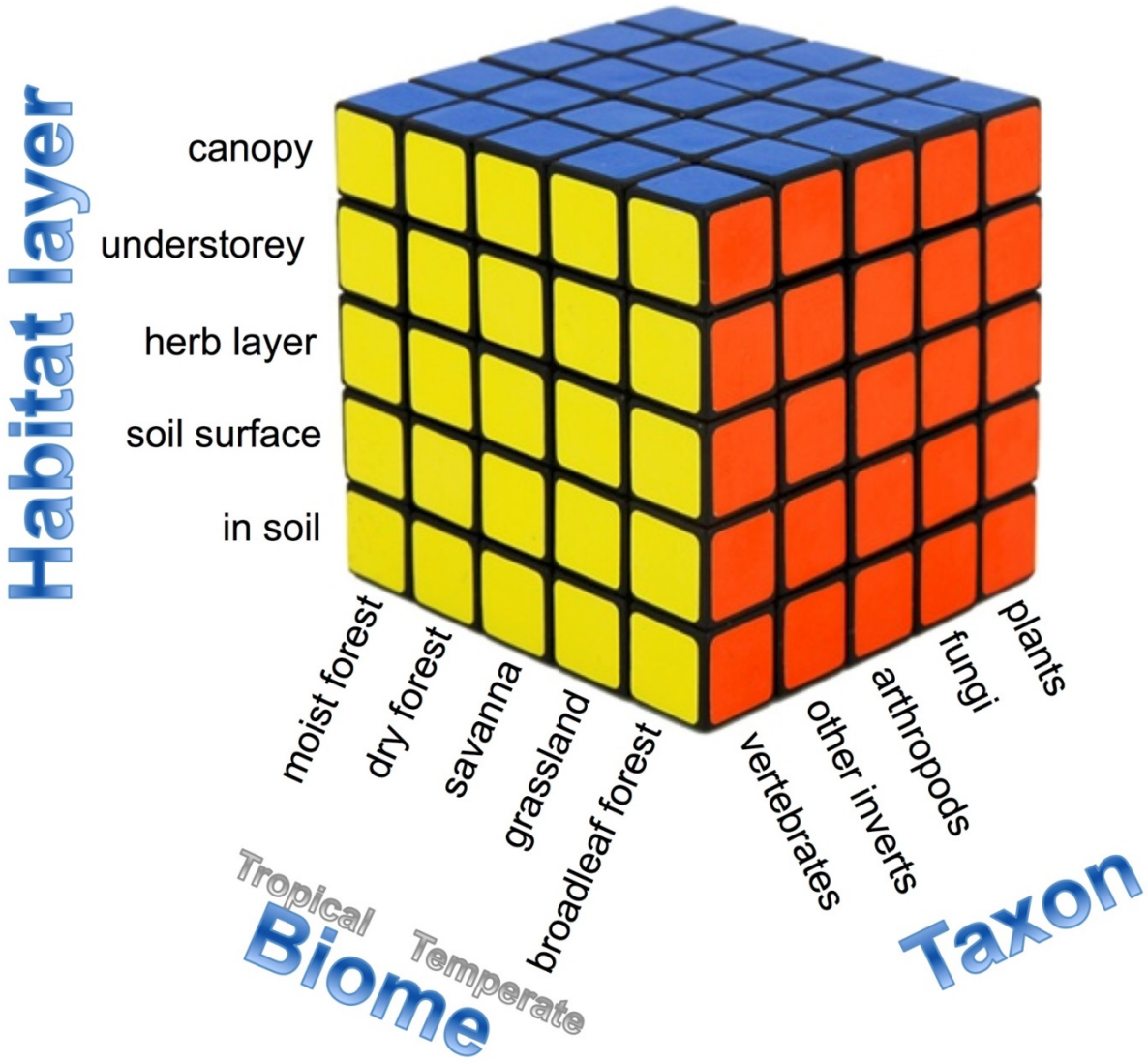


Dose-response relationships

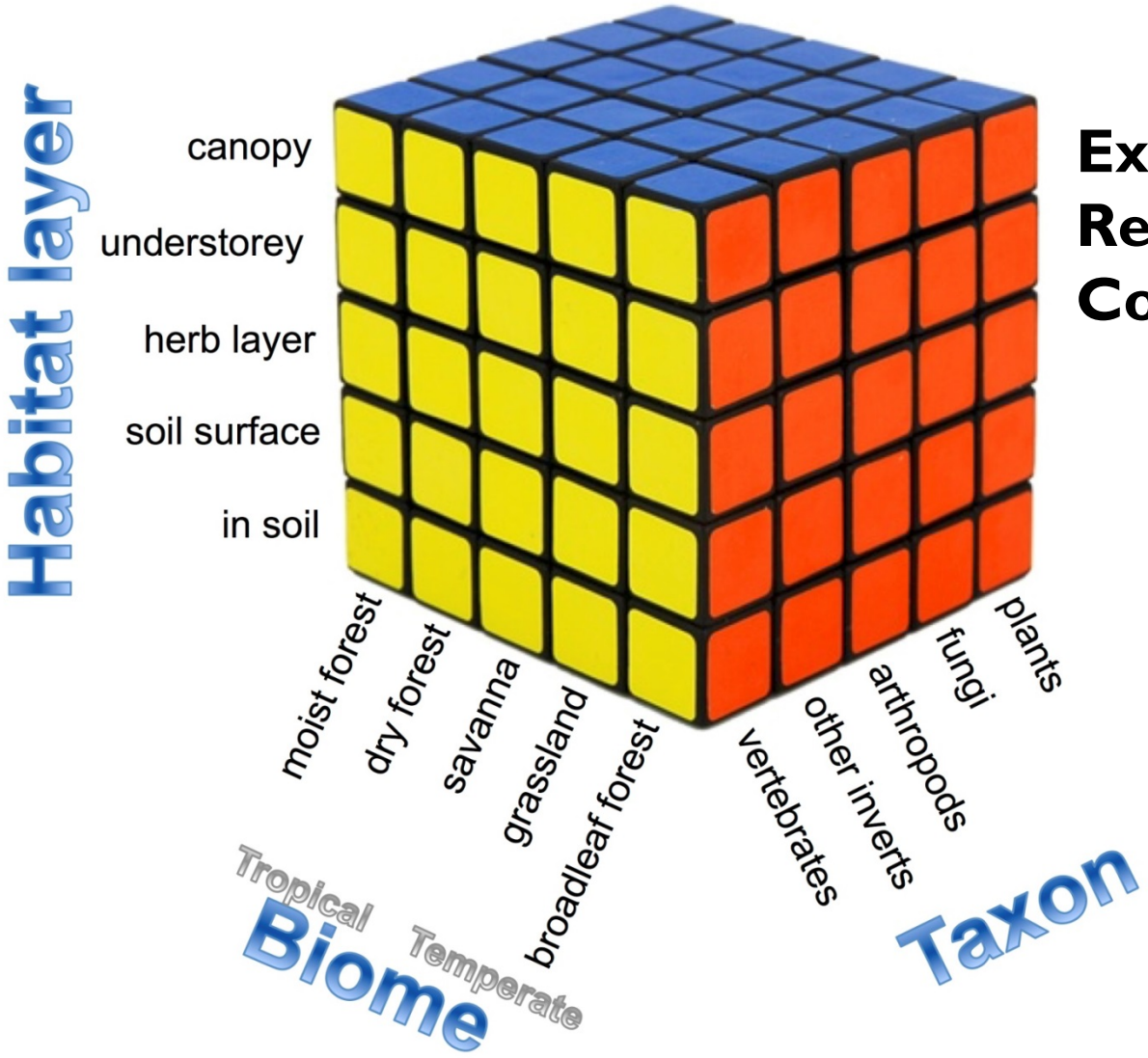


Mt Taranaki (Mt Egmont), New Zealand

Responses to threats vary

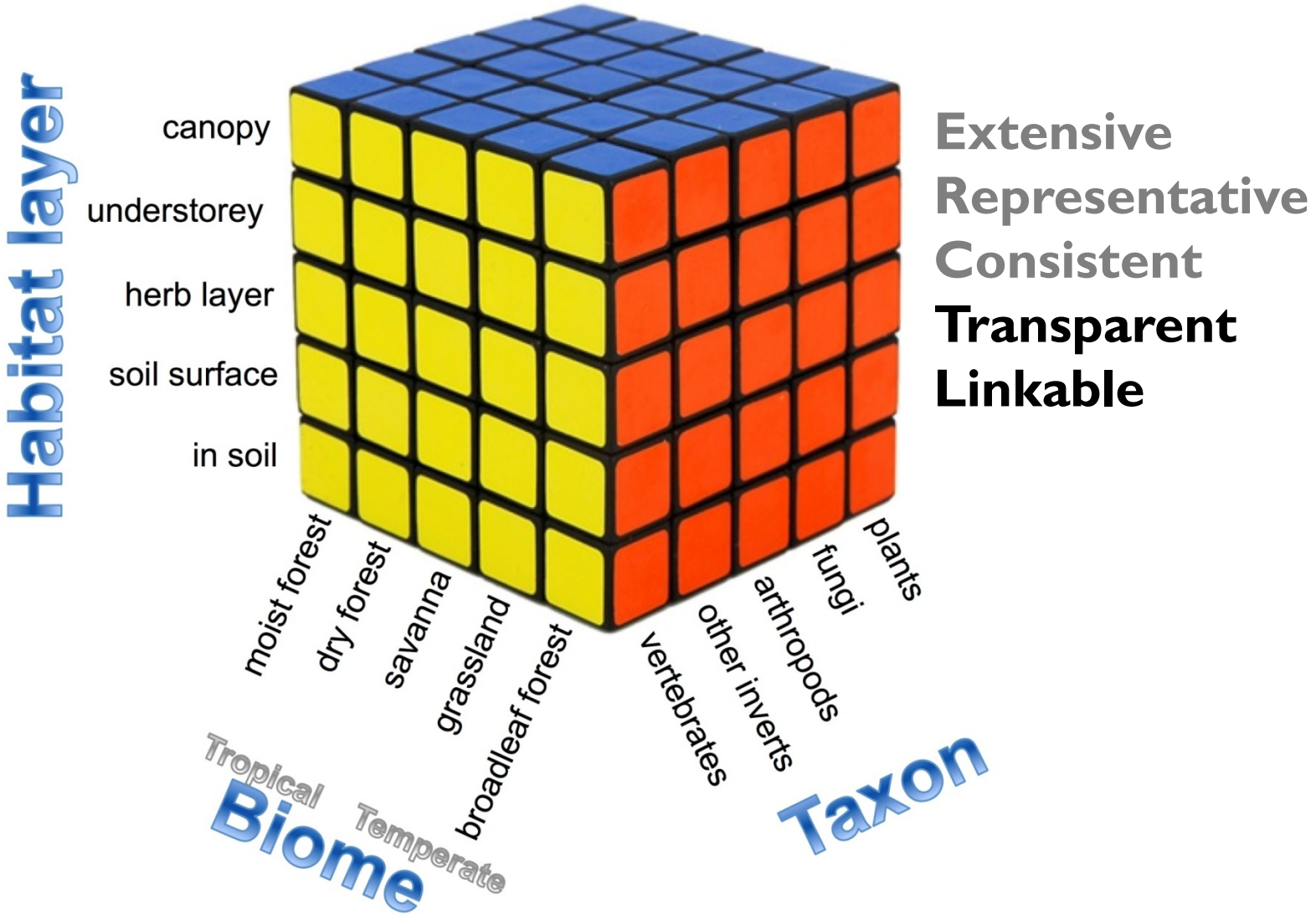


Responses to threats vary



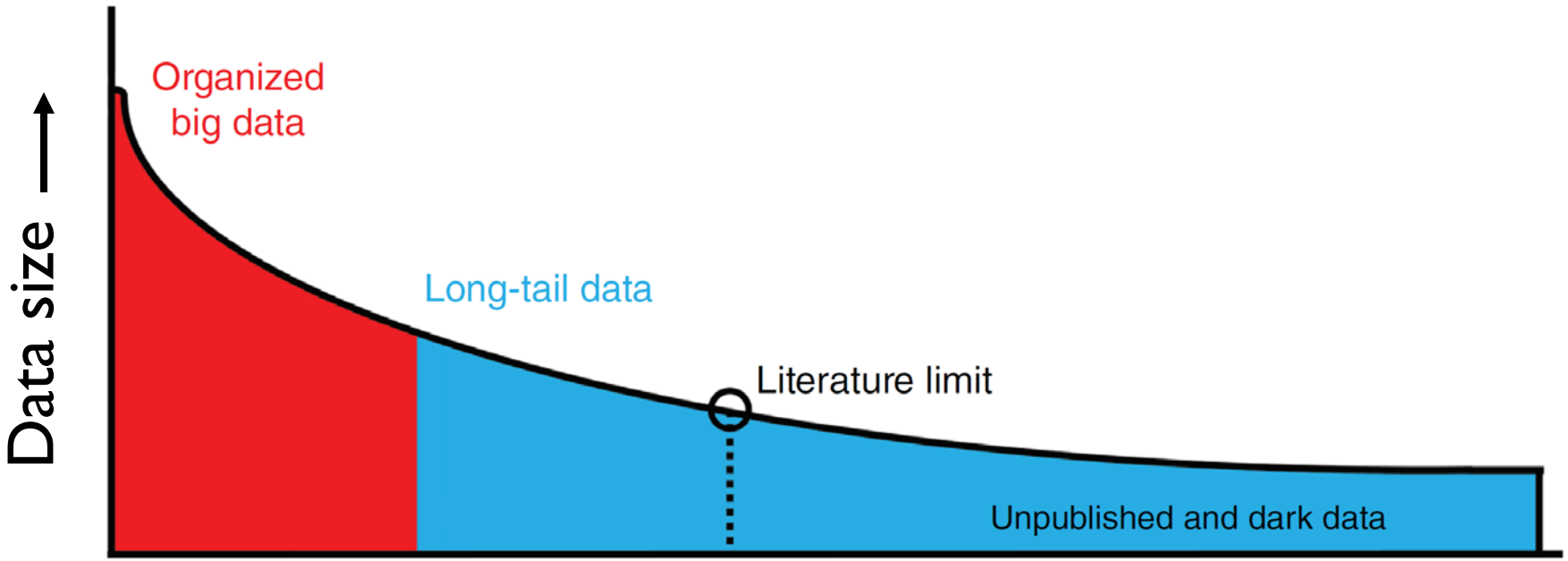
Extensive
Representative
Consistent

Responses to threats vary



Extensive
Representative
Consistent
Transparent
Linkable

The long tail of small data



Big data from small data: data-sharing in the 'long tail' of neuroscience

Adam R Ferguson[1], Jessica L Nielson[1], Melissa H Cragin[2], Anita E Bandrowski[3] & Marvann E Martone[3,4]

NATURE NEUROSCIENCE VOLUME 17 | NUMBER 11 | NOVEMBER 2014

Product of many

NATURAL HISTORY MUSEUM

UNEP WCMC

UCL

Imperial College London

Microsoft Research

US University of Sussex

Product of many

Hundreds of data contributors

NATURAL HISTORY MUSEUM

UNEP WCMC

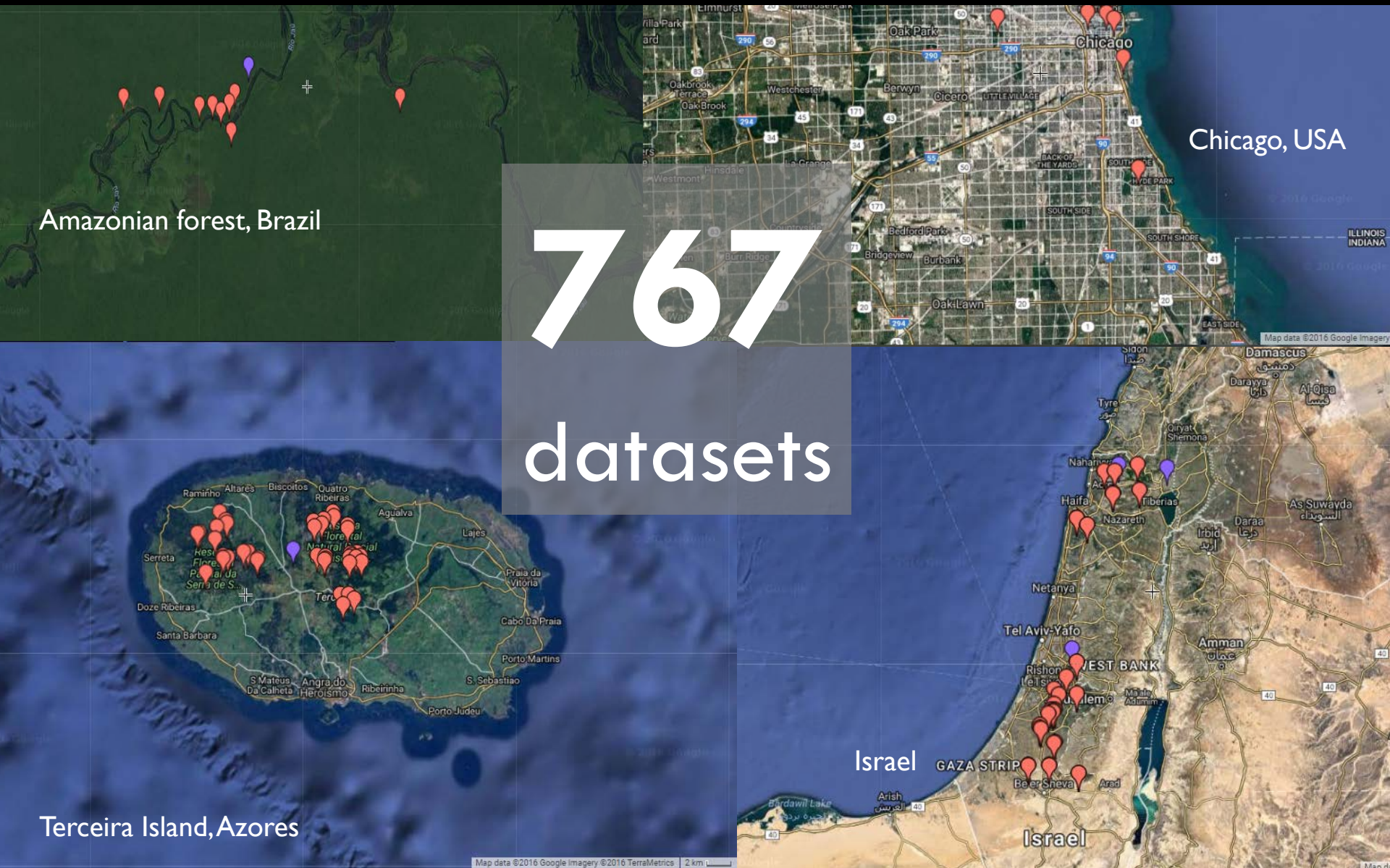
UCL

Imperial College London

Microsoft Research

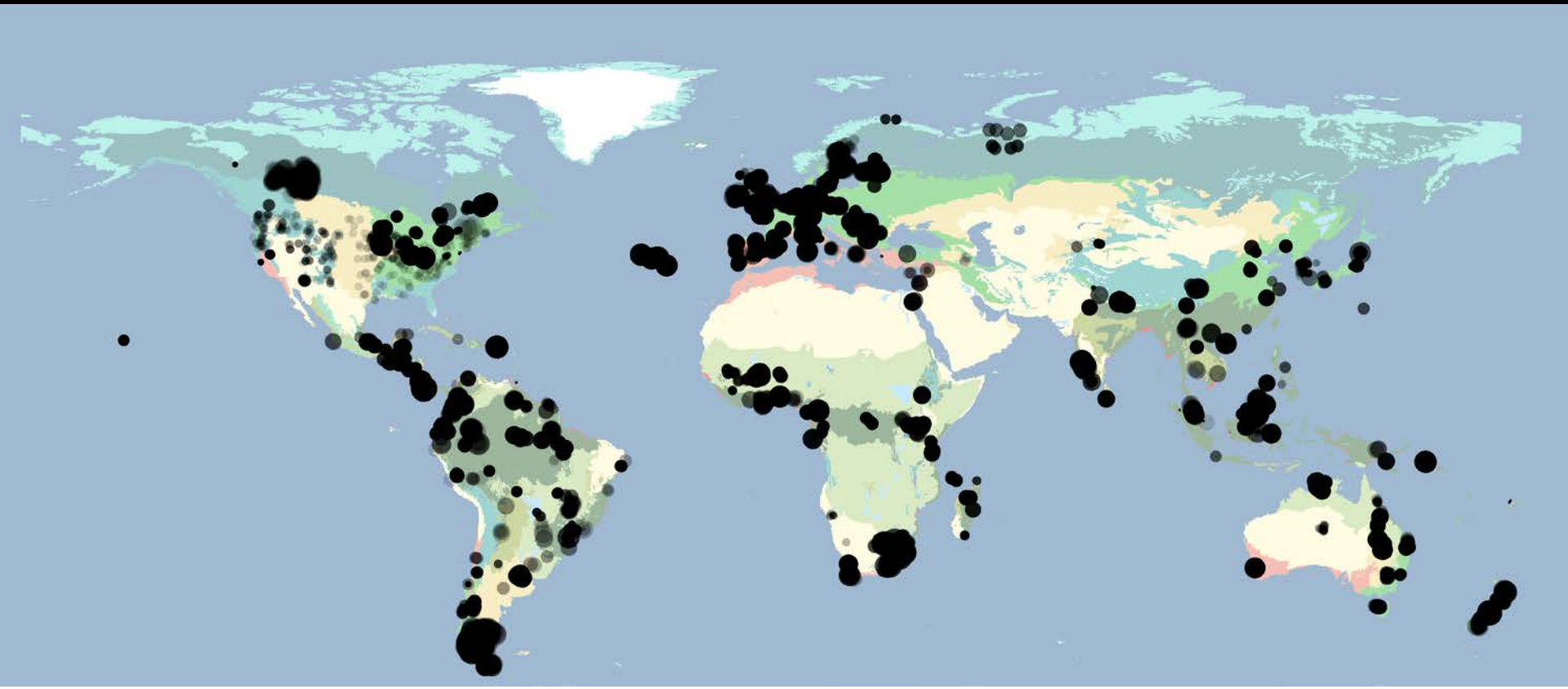
US University of Sussex

The result: the PREDICTS Database



Projecting Responses of Ecological Diversity in Changing Terrestrial Systems

Predicts



NATURAL HISTORY MUSEUM

UNEP WCMC

UCL

Imperial College London

Microsoft Research

University of Sussex

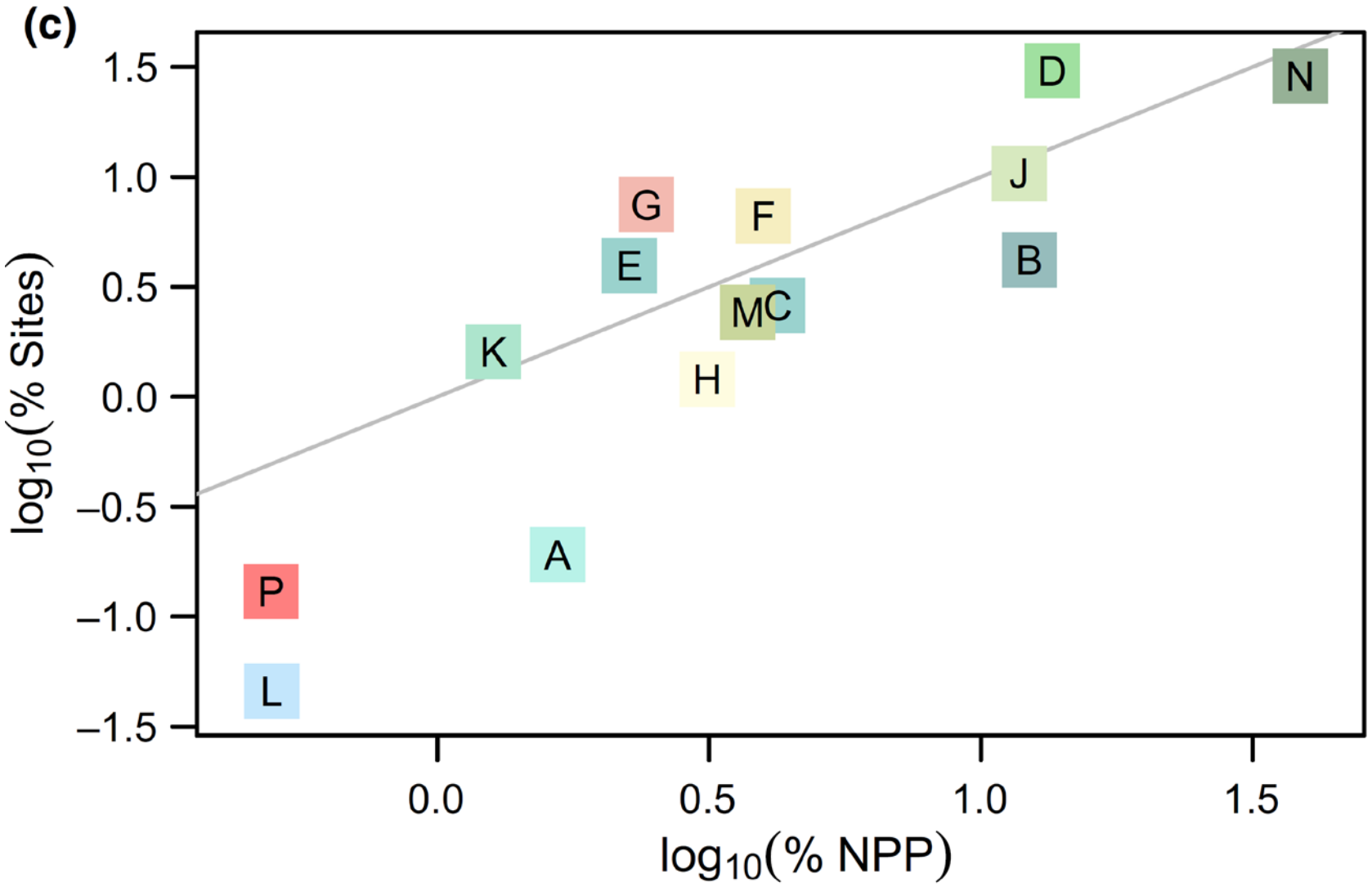
Variables:

- Land use
- Human population
- Proximity to roads

- 730 data sets
- 29,057 sites
- 97 countries
- 3,391,317 data points
- 50,477 species

Regular checks of geographic coverage:

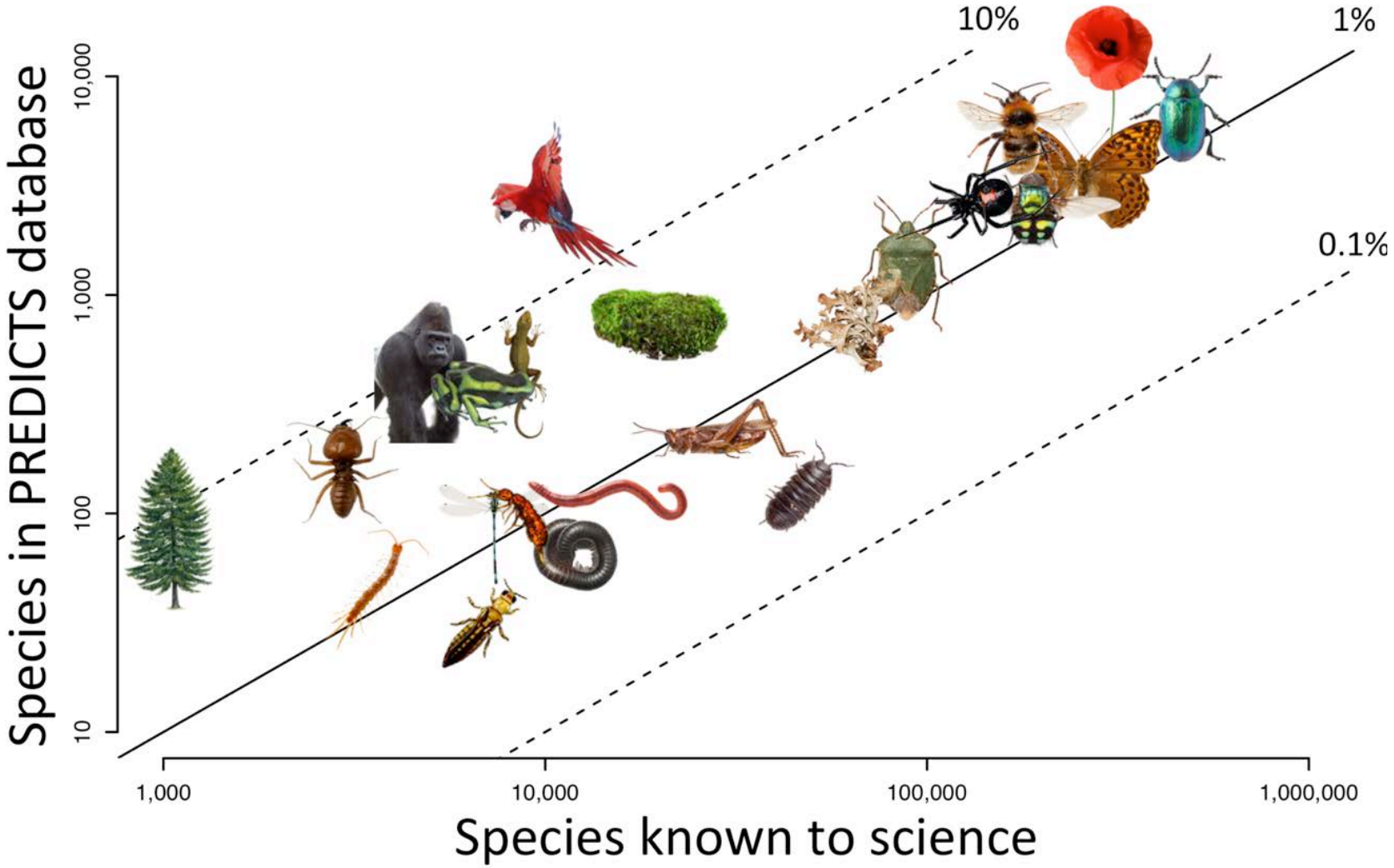
32,078 sites; 98 countries; 14 biomes; 304 ecoregions



Hudson et al. 2017 *Ecol & Evol*; **data.nhm.ac.uk**

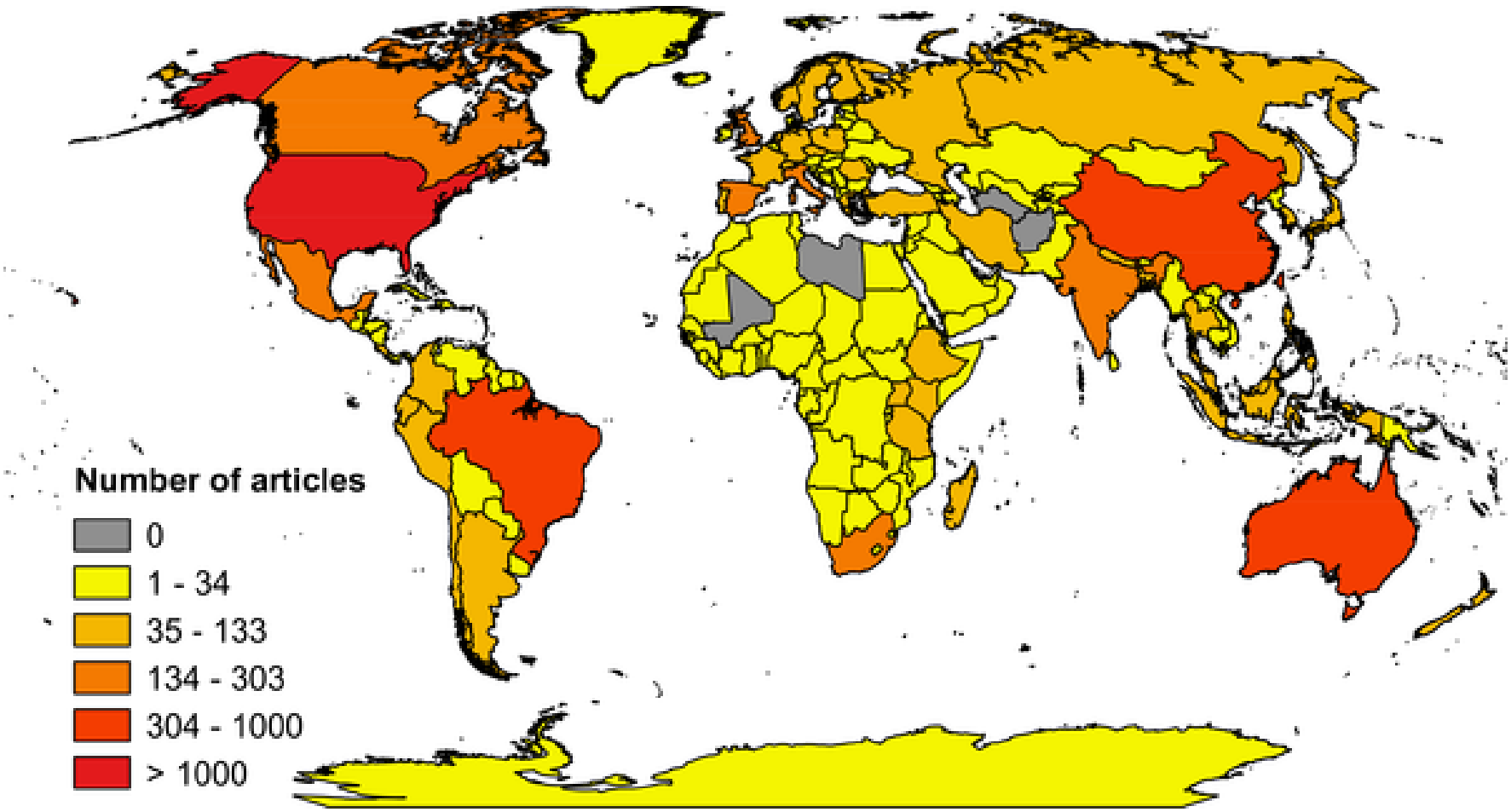
Regular checks of taxonomic coverage:

52,195 species; 3,857,790 samples; 65.4 million counted individuals



Hudson et al. 2017 *Ecol & Evol*; **data.nhm.ac.uk**

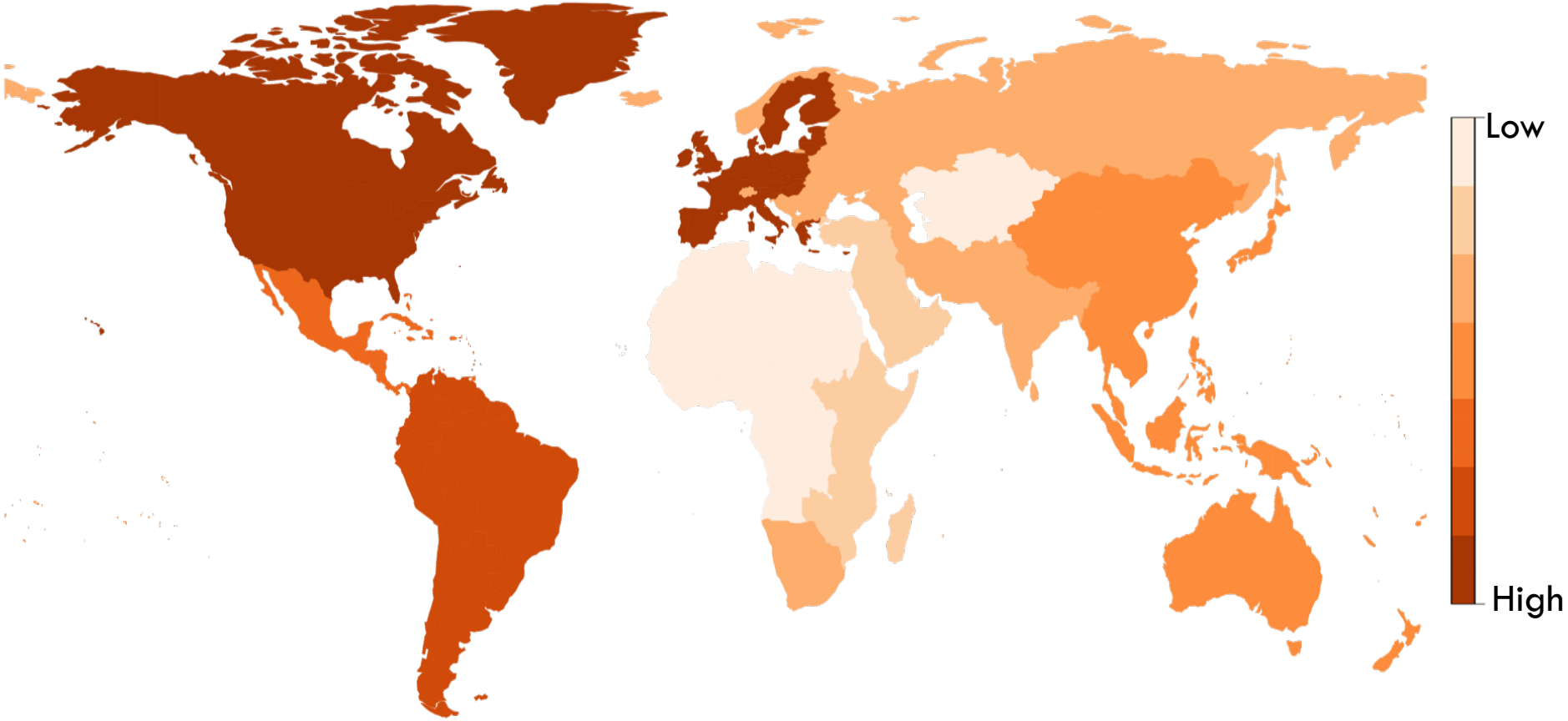
The literature is biased so PREDICTS ≠ Systematic Review



Wilson *et al* (2016) PLOS Biology 14(3): e1002413

PLOS | BIOLOGY

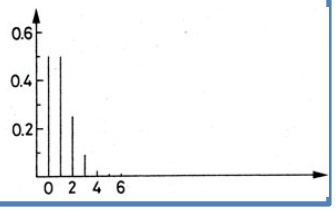
The literature is biased so PREDICTS ≠ Systematic Review



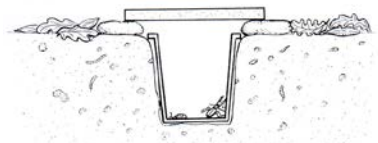
Archer *et al* (2014) Oikos, 123: 401-407

Consistent data structure

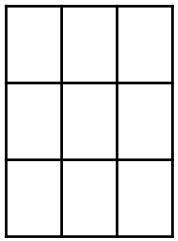
Study 1

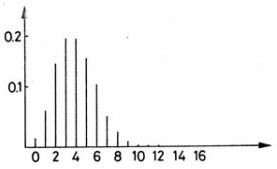


Study 2

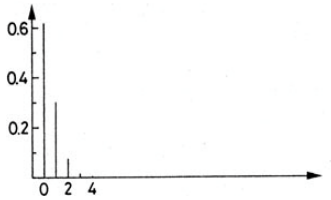


Study 3





Study 4



Land use x intensity matrix

Land use x intensity matrix

Land use x intensity matrix

Land use x intensity matrix

Land use x intensity matrix

Land use x intensity matrix

Coffee and Cow by Freepik

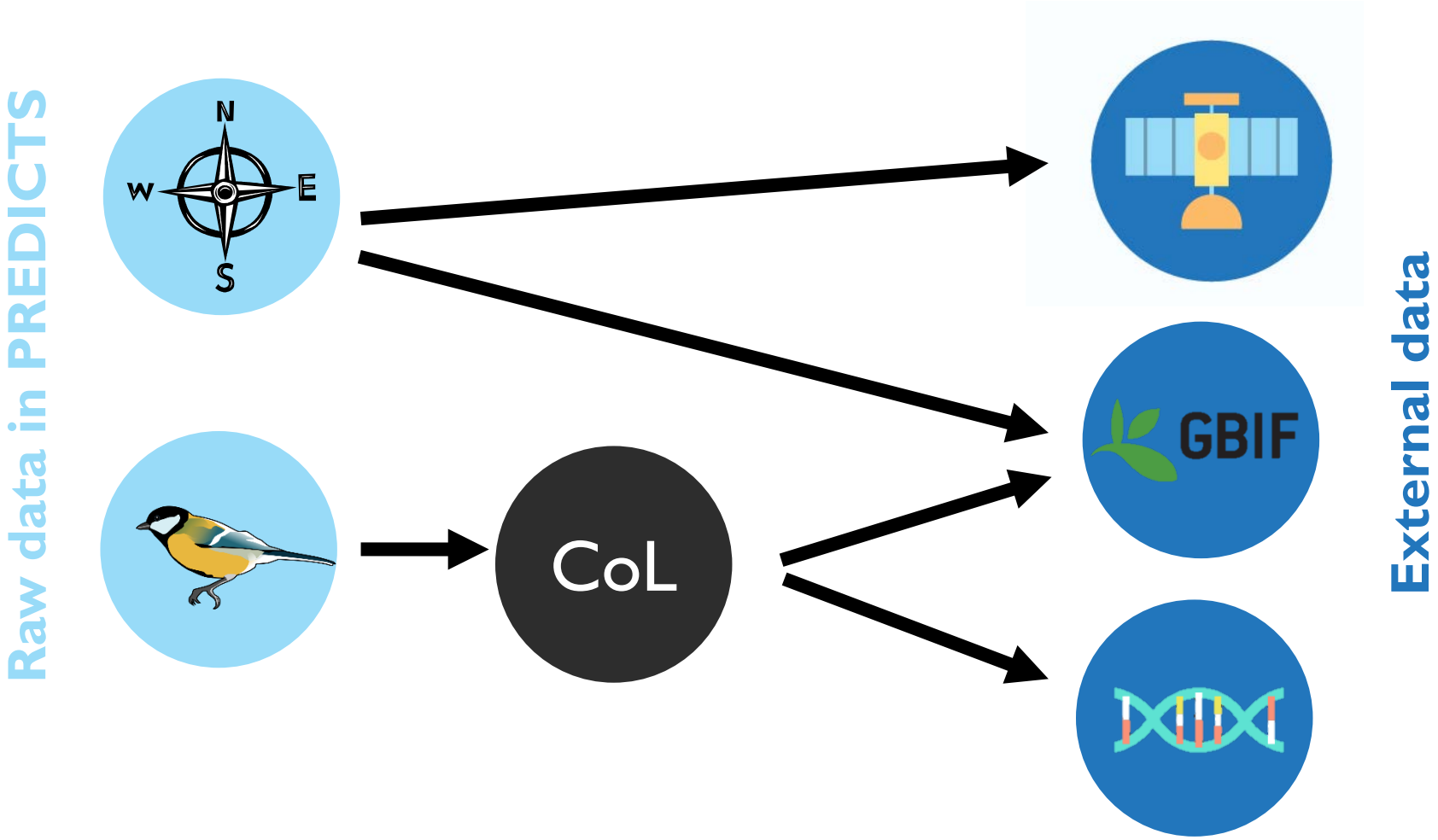
Land use x intensity matrix

Land use class	Minimal use	Light use	Intense use
Primary vegetation (composed of native vegetation, which is not known to have been destroyed during historical times)	Any threats identified are very minor (e.g., very light use) or very limited in the scope of their effect (e.g., hunting of a particular species of limted ecological importance).	One or more threats of moderate intensity (e.g., selective logging) or breadth of impact (e.g., bushmeat extraction), which are not severe enough to markedly change the nature of the ecosystem.	One or more threats that is severe enough to markedly change the nature of the ecosystem (e.g., clear-felling).
Mature Secondary Veg	…	…	…
Intermediate Secondary Veg	…	…	…
Young Secondary Veg	…	…	…
Plantation forest	…	…	…
Cropland (land people have planted with herbaceous crops)	Low-intensity farms, typically with small fields, mixed crops, crop rotation; little or none of the following – inorganic fertilizer, pesticide, ploughing, irrigation, mechanization.	Medium-intensity farming typically showing some but not many of: large fields, annual ploughing, inorganic fertilizer, irrigation, fixed crops, mechanisation, monoculture.	High-intensity monoculture farming, typically with many of: large fields, annual ploughing, inorganic fertilizer, pesticide, irrigation, fixed crops, mechanisation, monoculture.
Pasture	…	…	…
Urban	…	…	…

Database described in Hudson, Newbold et al. 2014 *Ecol & Evol*

Validation and Repeatability

Linkable open data



Satellite by watchtaxinyc, DNA by danielcampos, both at Vecteezy.com
Blue tit by pesasa at ClipartsFree.net

Transparency

Received: 22 April 2016 | Revised: 10 September 2016 | Accepted: 22 September 2016

DOI: 10.1002/ece3.2579

ORIGINAL RESEARCH

WILEY Ecology and Evolution Open Access

The database of the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) project

Lawrence N. Hudson[1*] | Tim Newbold[2,3*] | Sara Contu[1] | Samantha L. L. Hill[1,2] | Igor Lysenko[4] | Adriana De Palma[1,4] | Helen R. P. Phillips[1,4] | Tamera I. Alhusseini[5] | Felicity E. Bedford[6] | Dominic J. Bennett[4] | Hollie Booth[2,7] | Victoria J. Burton[1,8] | Charlotte W. T. Chng[4] | Argyrios Choimes[1,4] | David L. P. Correia[9] | Julie Day[4] | Susy Echeverría-Londoño[1,4] | Susan R. Emerson[1] | Di Gao[1] | Morgan Garon[4] | Michelle L. K. Harrison[4] | Daniel J. Ingram[10] | Martin Jung[10] | Victoria Kemp[11] | Lucinda Kirkpatrick[12] | Callum D. Martin[13] | Yuan Pan[14] | Gwilym D. Pask-Hale[1] | Edwin L. Pynegar[15] | Alexandra N. Robinson[5] | Katia Sanchez-Ortiz[16] | Rebecca A. Senior[14] | Benno I. Simmons[4] | Hannah J. White[17] | Hanbin Zhang[16] | Job Aben[18,19] | Stefan Abrahamczyk[20] | Gilbert B. Adum[21,22] | Virginia Aguilar-Barquero[23] | Marcelo A. Aizen[24] | Belén Albertos[25] | E. L. Alcala[26] | Maria del Mar Alguacil[27] | Audrey Alignier[28,29] | Marc Ancrenaz[30,31] | Alan N. Andersen[32] | Enrique Arbeláez-Cortés[33,34] | Inge Armbrecht[35] | Víctor Arroyo-Rodríguez[36] | Tom Aumann[37] | Jan C. Axmacher[38] | Badrul Azhar[39,40] | Adrián B. Azpiroz[41] | Lander Baeten[42,43] | Adama Bakayoko[44,45] | András Báldi[46] | John E. Banks[47] | Sharad K. Baral[48] | Jos Barlow[49,50] | Barbara I. P. Barratt[51] | Lurdes Barrico[52] | Paola Bartolommei[53] | Diane M. Barton[51] | Yves Basset[54] | Péter Batáry[55] | Adam J. Bates[56,57] | Bruno Baur[58] | Erin M. Bayne[59] | Pedro Beja[60] | Suzan Benedick[61] | Åke Berg[62] | Henry Bernard[63] | Nicholas J. Berry[64] | Dinesh Bhatt[65] | Jake E. Bicknell[66,67] | Jochen H. Bihn[68] | Robin J. Blake[69,70] | Kadiri S. Bobo[71,72] | Roberto Bóçon[73] | Teun Boekhout[74] | Katrin Böhning-Gaese[75,76] | Kevin J. Bonham[77] | Paulo A. V. Borges[78] | Sérgio H. Borges[79] | Céline Boutin[80] | Jérémy Bouyer[81,82] | Cibele Bragagnolo[83] | Jodi S. Brandt[84] | Francis Q. Brearley[85] | Isabel Brito[86] | Vicenç Bros[87,88] | Jörg Brunet[89] | Grzegorz Buczkowski[90] | Christopher M. Buddle[91] | Rob Bugter[92] | Erika Buscardo[93,94,95] | Jörn Buse[96] | Jimmy Cabra-García[97,98] | Nilton C. Cáceres[99] | Nicolette L. Cagle[100] | María Calviño-Cancela[101] | Sydney A. Cameron[102,103] | Eliana M. Cancello[104] | Rut Caparrós[25,105] | Pedro Cardoso[78,106] | Dan Carpenter[107,108] | Tiago F. Carrijo[109] | Anelena L. Carvalho[79] | Camila R. Cassano[110] | Helena Castro[52] |

*These authors contributed equally to this work.

Alejandro A. Castro-Luna[111] | Rolando Cerda B.[112] | Alexis Cerezo[113] | Kim Alan Chapman[114] | Matthieu Chauvat[115] | Morten Christensen[116] | Francis M. Clarke[117] | Daniel F.R. Cleary[118] | Giorgio Colombo[119] | Stuart P. Connop[120] | Michael D. Craig[121,122] | Leopoldo Cruz-López[123] | Saul A. Cunningham[124] | Biagio D'Aniello[125] | Neil D'Cruze[126] | Pedro Giovâni da Silva[127] | Martin Dallimer[128] | Emmanuel Danquah[21] | Ben Darvill[129] | Jens Dauber[130] | Adrian L. V. Davis[131] | Jeff Dawson[132] | Claudio de Sassi[133] | Benoit de Thoisy[134] | Olivier Deheuvels[135,136] | Alain Dejean[137,138,139] | Jean-Louis Devineau[140] | Tim Diekötter[141,142,143] | Jignasu V. Dolia[144,145] | Erwin Domínguez[146] | Yamileth Dominguez-Haydar[147] | Silvia Dorn[148] | Isabel Draper[105] | Niels Dreber[149,150] | Bertrand Dumont[151] | Simon G. Dures[4,152] | Mats Dynesius[153] | Lars Edenius[154] | Paul Eggleton[1] | Felix Eigenbrod[155] | Zoltán Elek[156,157] | Martin H. Entling[158] | Karen J. Esler[159,160] | Ricardo F. de Lima[161,162] | Aisyah Faruk[163,164] | Nina Farwig[165] | Tom M. Fayle[4,166,167] | Antonio Felicioli[168] | Annika M. Felton[169] | Roderick J. Fensham[170,171] | Ignacio C. Fernandez[172] | Catarina C. Ferreira[173] | Gentile F. Ficetola[174] | Cristina Fiera[175] | Bruno K. C. Filgueiras[176] | Hüseyin K. Fırıncıoğlu[177] | David Flaspohler[178] | Andreas Floren[179] | Steven J. Fonte[180,181] | Anne Fournier[182] | Robert E. Fowler[10] | Markus Franzén[183] | Lauchlan H. Fraser[184] | Gabriella M. Fredriksson[185,186] | Geraldo B. Freire-Jr[187] | Tiago L. M. Frizzo[187] | Daisuke Fukuda[188] | Dario Furlani[119] | René Gaigher[159] | Jörg U. Ganzhorn[189] | Karla P. García[190,191] | Juan C. Garcia-R[192] | Jenni G. Garden[193,194,195] | Ricardo Garilleti[25] | Bao-Ming Ge[196] | Benoit Gendreau-Berthiaume[197] | Philippa J. Gerard[198] | Carla Gheler-Costa[199] | Benjamin Gilbert[200] | Paolo Giordani[201] | Simonetta Giordano[125] | Carly Golodets[202] | Laurens G. L. Gomes[203] | Rachelle K. Gould[204] | Dave Goulson[10] | Aaron D. Gove[205,206] | Laurent Granjon[207] | Ingo Grass[55,165] | Claudia L. Gray[10,208] | James Grogan[209] | Weibin Gu[210] | Moisès Guardiola[211] | Nihara R. Gunawardene[206] | Alvaro G. Gutierrez[212] | Doris L. Gutiérrez-Lamus[213] | Daniela H. Haarmeyer[214] | Mick E. Hanley[215] | Thor Hanson[216] | Nor R. Hashim[217] | Shombe N. Hassan[218] | Richard G. Hatfield[219] | Joseph E. Hawes[220] | Matt W. Hayward[221,222,223] | Christian Hébert[224] | Alvin J. Helden[220] | John-André Henden[225] | Philipp Henschel[226] | Lionel Hernández[227] | James P. Herrera[228] | Farina Herrmann[55] | Felix Herzog[229] | Diego Higuera-Diaz[230] | Branko Hilje[231] | Hubert Höfer[232] | Anke Hoffmann[233] | Finbarr G. Horgan[234,235] | Elisabeth Hornung[236] | Roland Horváth[237] | Kristoffer Hylander[238] | Paola Isaacs-Cubides[239] | Hiroaki Ishida[240] | Masahiro Ishitani[241] | Carmen T. Jacobs[131] | Víctor J. Jaramillo[242] | Birgit Jauker[243] | F. Jiménez Hernández[244] | McKenzie F. Johnson[100] | Virat Jolli[245,246] | Mats Jonsell[247] | S. Nur Juliani[248] | Thomas S. Jung[249] | Vena Kapoor[250] | Heike Kappes[251] | Vassiliki Kati[252] |

Transparency

Received: 22 April 2016 | Revised: 10 September 2016 | Accepted: 22 September 2016

DOI: 10.1002/ece3.2579

ORIGINAL RESEARCH

WILEY Ecology and Evolution Open Access

The database of the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) project

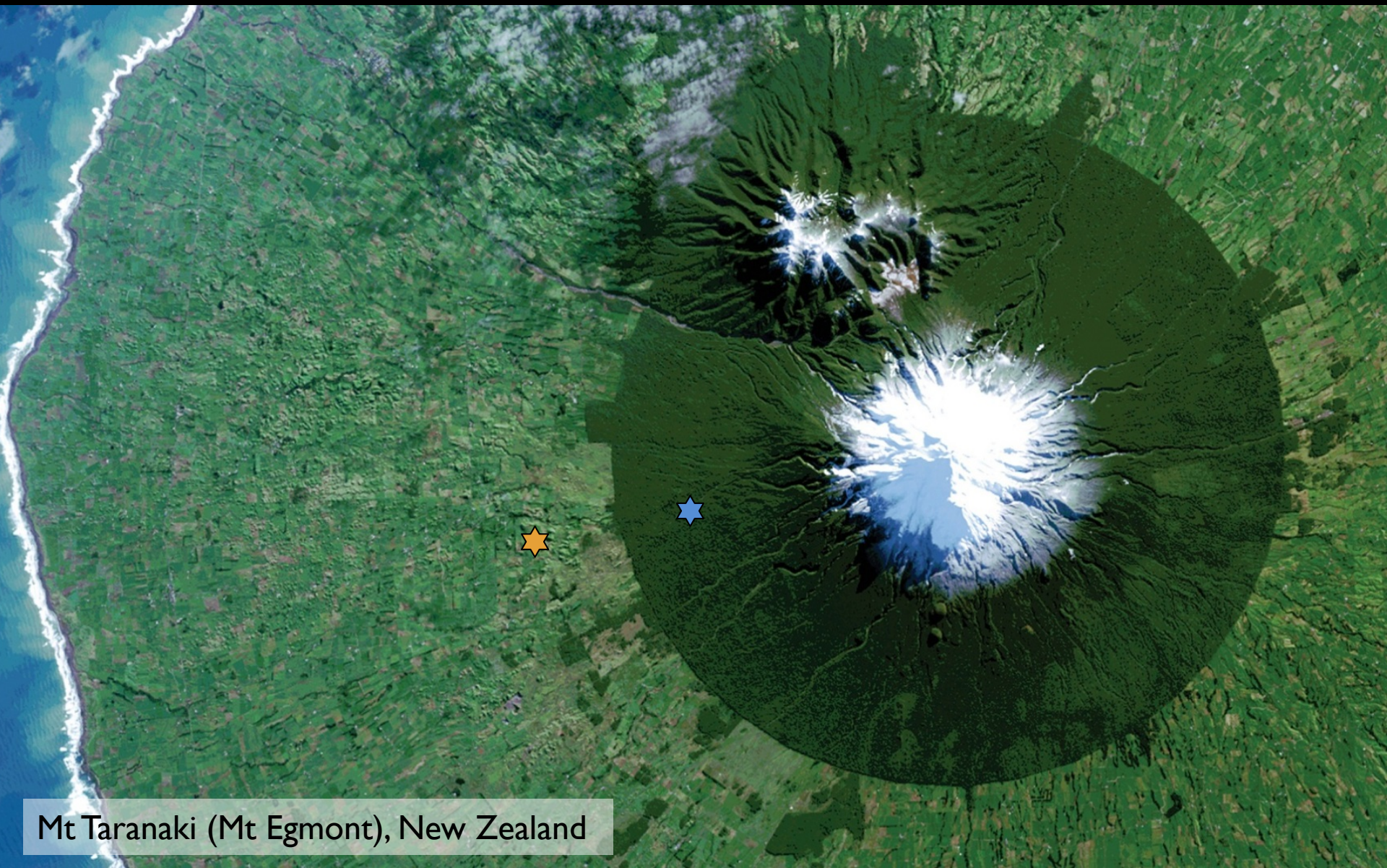
Lawrence N. Hudson[1*] | Tim Newbold[2,3*] | Sara Contu[1] | Samantha L. L. Hill[1,2] | Igor Lysenko[4] | Adriana De Palma[1,4] | Helen R. P. Phillips[1,4] | Tamera I. Alhusseini[5] | Felicity E. Bedford[6] | Dominic J. Bennett[4] | Hollie Booth[2,7] | Victoria J. Burton[1,8] | Charlotte W. T. Chng[4] | Argyrios Choimes[1,4] | David L. P. Correia[9] | Julie Day[4] | Susy Echeverría-Londoño[1,4] | Susan R. Emerson[1] | Di Gao[1] | Morgan Garon[4] | Michelle L. K. Harrison[4] | Daniel J. Ingram[10] | Martin Jung[10] | Victoria Kemp[11] | Lucinda Kirkpatrick[12] | Callum D. Martin[13] | Yuan Pan[14] | Gwilym D. Pask-Hale[1] | Edwin L. Pynegar[15] | Alexandra N. Robinson[5] | Katia Sanchez-Ortiz[16] | Rebecca A. Senior[14] | Benno I. Simmons[4] | Hannah J. White[17] | Hanbin Zhang[16] | Job Aben[18,19] | Stefan Abrahamczyk[20] | Gilbert B. Adum[21,22] | Virginia Aguilar-Barquero[23] | Marcelo A. Aizen[24] | Belén Albertos[25] | E. [illegible] | Maria del Mar Alguacil[27] | Audrey Alignier[28,29] | Marc Ancrenaz[30,31] | [illegible] | Alan N. Andersen[32] | Enrique Arbeláez-Cortés[33,34] | Inge Armb[illegible] | Víctor Arroyo-Rodríguez[36] | Tom Aumann[37] | Jan C. Axm[illegible] | Adrián B. Azpiroz[41] | Lander Baeten[42,43] | Adama B[illegible] | John E. Banks[47] | Sharad K. Baral[48] | Jos Barl[illegible] | Lurdes Barrico[52] | Paola Bartolommei[53] | [illegible] | Péter Batáry[55] | Adam J. Bates[56,57] | [illegible]ro Beja[60] | Suzan Benedick[61] | Åke Berg[illegible] | Dinesh Bhatt[65] | Jake E. Bickne[illegible]J. Blake[69,70] | Kadiri S. Bobo[71,72] | Roberto Bóç[illegible] | Katrin Böhning-Gaese[75,76] | Kevin J. Bonham[77] | Paulo A. V. Bo[illegible] Borges[79] | Céline Boutin[80] | Jérémy Bouyer[81,82] | Cibele Bragagn[illegible] S. Brandt[84] | Francis Q. Brearley[85] | Isabel Brito[86] | Vicenç Bros[87,88] | Jör[illegible]unet[89] | Grzegorz Buczkowski[90] | Christopher M. Buddle[91] | Rob Bugter[92] | Erika Buscardo[93,94,95] | Jörn Buse[96] | Jimmy Cabra-García[97,98] | Nilton C. Cáceres[99] | Nicolette L. Cagle[100] | María Calviño-Cancela[101] | Sydney A. Cameron[102,103] | Eliana M. Cancello[104] | Rut Caparrós[25,105] | Pedro Cardoso[78,106] | Dan Carpenter[107,108] | Tiago F. Carrijo[109] | Anelena L. Carvalho[79] | Camila R. Cassano[110] | Helena Castro[52] |

*These authors contributed equally to this work.

Alejandro A. Castro-Luna[111] | Rolando Cerda B.[112] | Alexis Cerezo[113] | Kim Alan Chapman[114] | Matthieu Chauvat[115] | Morten Christensen[116] | Francis M. Clarke[117] | Daniel F.R. Cleary[118] | Giorgio Colombo[119] | Stuart P. Connop[120] | Michael D. Craig[121,122] | Leopoldo Cruz-López[123] | Saul A. Cunningham[124] | Biagio D'Aniello[125] | Neil D'Cruze[126] | Pe[illegible]ovâni da Silva[127] | Martin Dallimer[128] | Emmanuel Danquah[21] | Ben Darvill[129] [illegible]ber[130] | Adrian L. V. Davis[131] | Jeff Dawson[132] | Claudio de Sa[illegible]oisy[134] | Olivier Deheuvels[135,136] | Alain Dejean[137,138,139] | [illegible] Diekötter[141,142,143] | Jignasu V. Dolia[144,145] [illegible] Dominguez-Haydar[147] | Silvia Dorn[148] [illegible] Bertrand Dumont[151] | Simon C[illegible]enius[154] | Paul Eggleton[1] | [illegible]artin H. Entling[158] | Karen J. Esler[159,160] | [illegible]83,164] | Nina Farwig[165] | Tom M. Fayle[4,166,167] | [illegible]Felton[169] | Roderick J. Fensham[170,171] | [illegible]Catarina C. Ferreira[173] | Gentile F. Ficetola[174] | [illegible]runo K. C. Filgueiras[176] | Hüseyin K. Fırıncıoğlu[177] | [illegible]178] | Andreas Floren[179] | Steven J. Fonte[180,181] | Anne Fournier[182] | [illegible]Fowler[10] | Markus Franzén[183] | Lauchlan H. Fraser[184] | [illegible]briella M. Fredriksson[185,186] | Geraldo B. Freire-Jr[187] | Tiago L. M. Frizzo[187] | Daisuke Fukuda[188] | Dario Furlani[119] | René Gaigher[159] | Jörg U. Ganzhorn[189] | Karla P. García[190,191] | Juan C. Garcia-R[192] | Jenni G. Garden[193,194,195] | Ricardo Garilleti[25] | Bao-Ming Ge[196] | Benoit Gendreau-Berthiaume[197] | Philippa J. Gerard[198] | Carla Gheler-Costa[199] | Benjamin Gilbert[200] | Paolo Giordani[201] | Simonetta Giordano[125] | Carly Golodets[202] | Laurens G. L. Gomes[203] | Rachelle K. Gould[204] | Dave Goulson[10] | Aaron D. Gove[205,206] | Laurent Granjon[207] | Ingo Grass[55,165] | Claudia L. Gray[10,208] | James Grogan[209] | Weibin Gu[210] | Moisès Guardiola[211] | Nihara R. Gunawardene[206] | Alvaro G. Gutierrez[212] | Doris L. Gutiérrez-Lamus[213] | Daniela H. Haarmeyer[214] | Mick E. Hanley[215] | Thor Hanson[216] | Nor R. Hashim[217] | Shombe N. Hassan[218] | Richard G. Hatfield[219] | Joseph E. Hawes[220] | Matt W. Hayward[221,222,223] | Christian Hébert[224] | Alvin J. Helden[220] | John-André Henden[225] | Philipp Henschel[226] | Lionel Hernández[227] | James P. Herrera[228] | Farina Herrmann[55] | Felix Herzog[229] | Diego Higuera-Diaz[230] | Branko Hilje[231] | Hubert Höfer[232] | Anke Hoffmann[233] | Finbarr G. Horgan[234,235] | Elisabeth Hornung[236] | Roland Horváth[237] | Kristoffer Hylander[238] | Paola Isaacs-Cubides[239] | Hiroaki Ishida[240] | Masahiro Ishitani[241] | Carmen T. Jacobs[131] | Víctor J. Jaramillo[242] | Birgit Jauker[243] | F. Jiménez Hernández[244] | McKenzie F. Johnson[100] | Virat Jolli[245,246] | Mats Jonsell[247] | S. Nur Juliani[248] | Thomas S. Jung[249] | Vena Kapoor[250] | Heike Kappes[251] | Vassiliki Kati[252] |

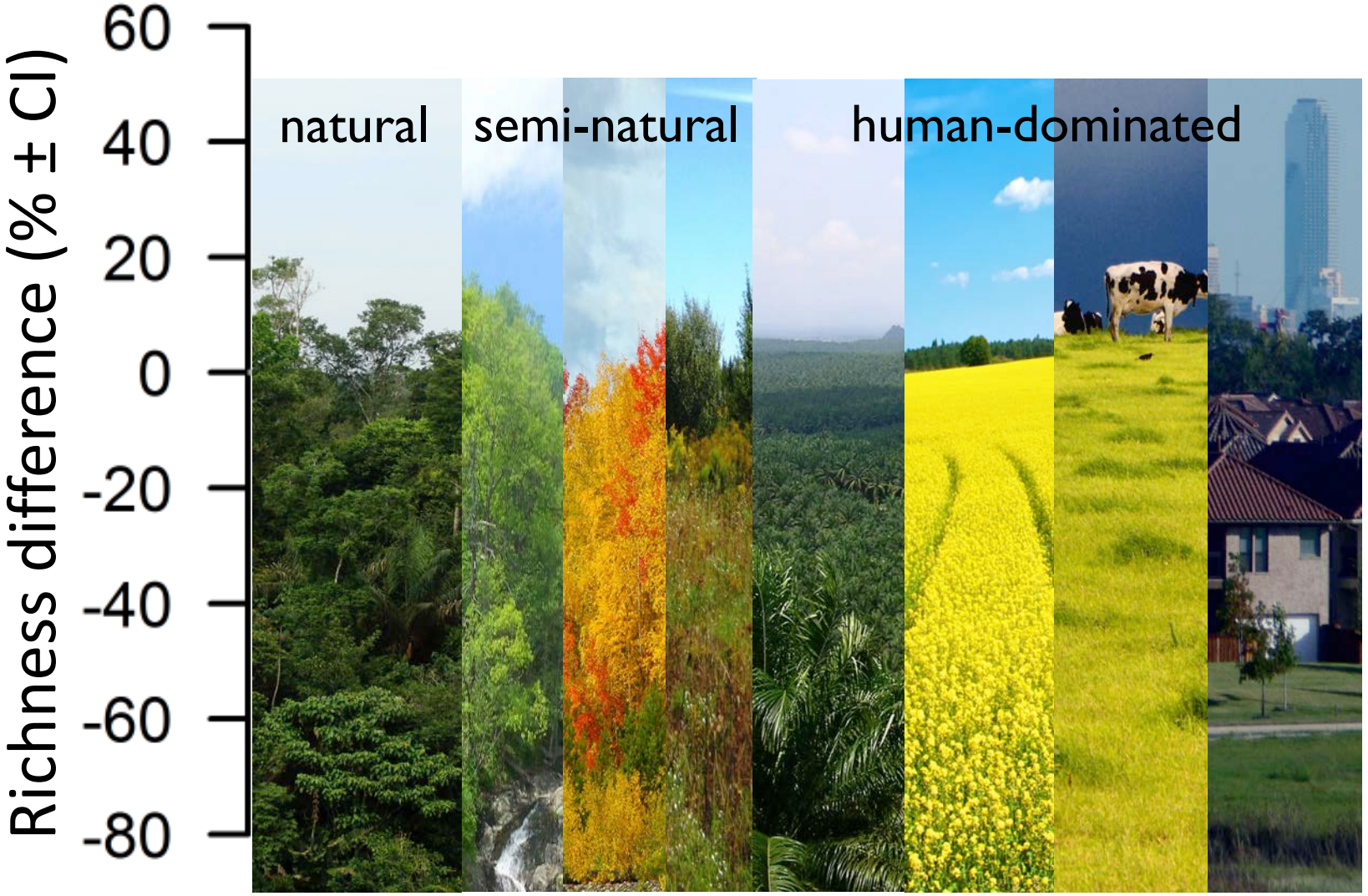
NHM Data Portal

Using the data to model dose-response relationships



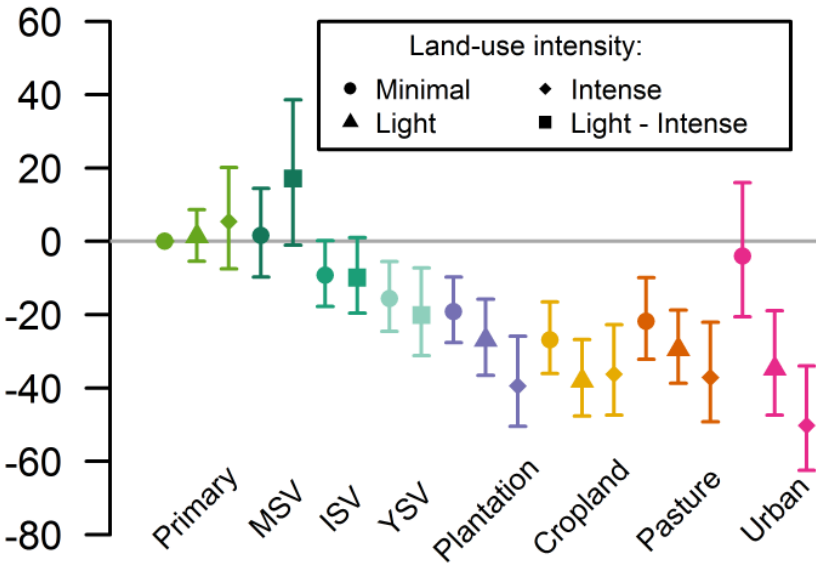
Mt Taranaki (Mt Egmont), New Zealand

Broad scale biodiversity:
Species Richness



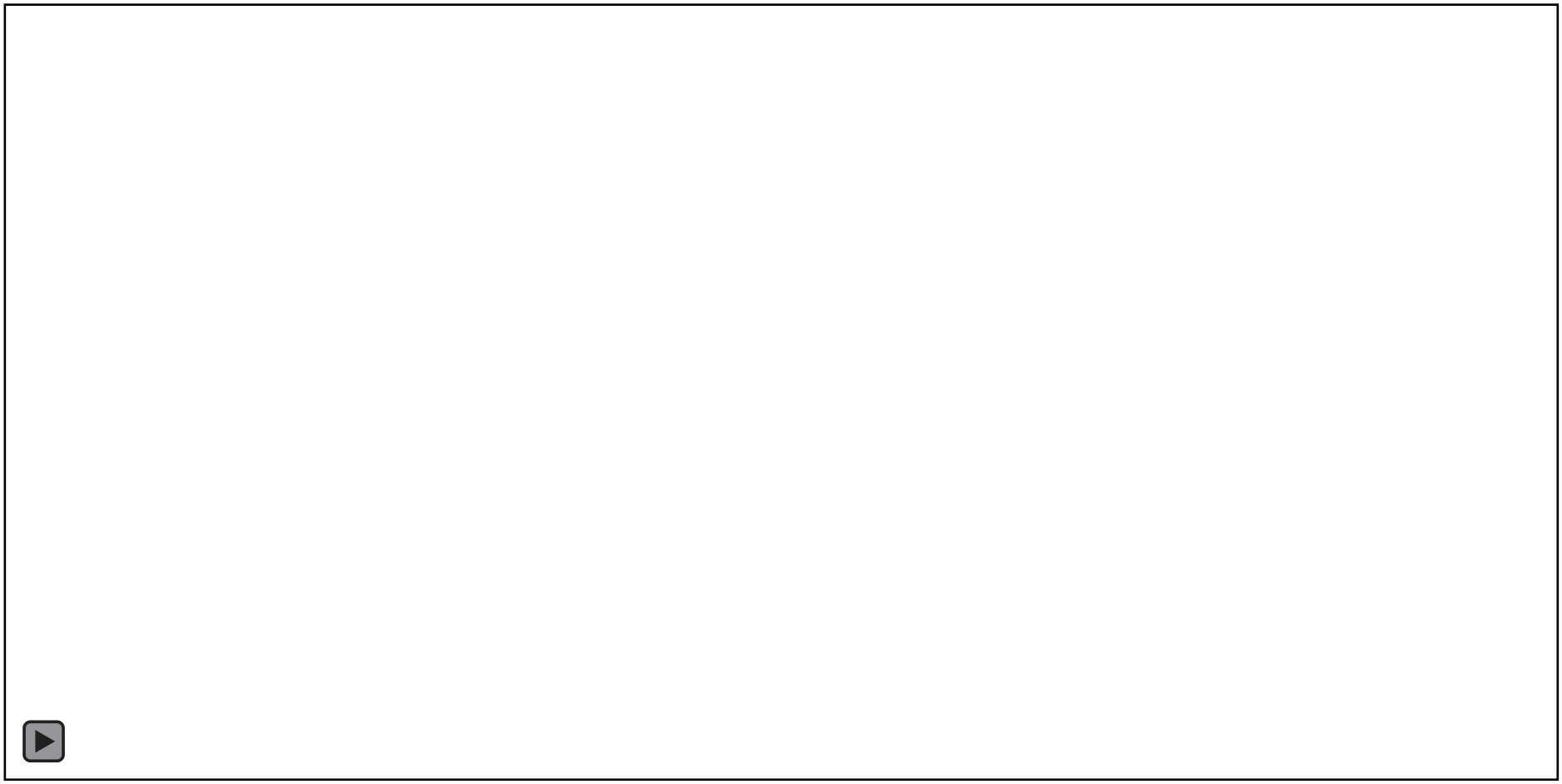
Newbold, Hudson et al. 2015 *Nature* 520:45-50

PREDICTS: built for prediction



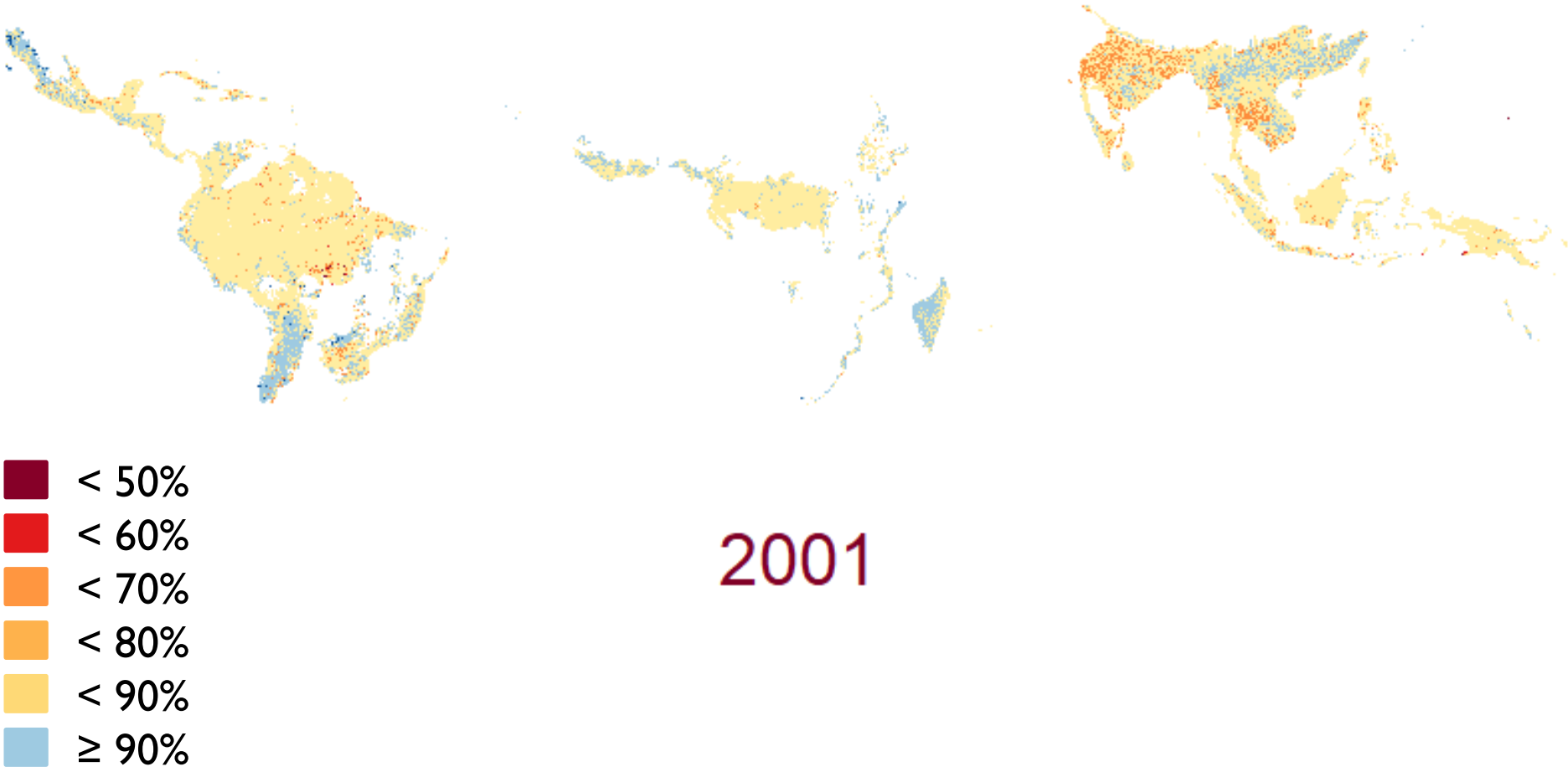
×

PREDICTS: built for prediction



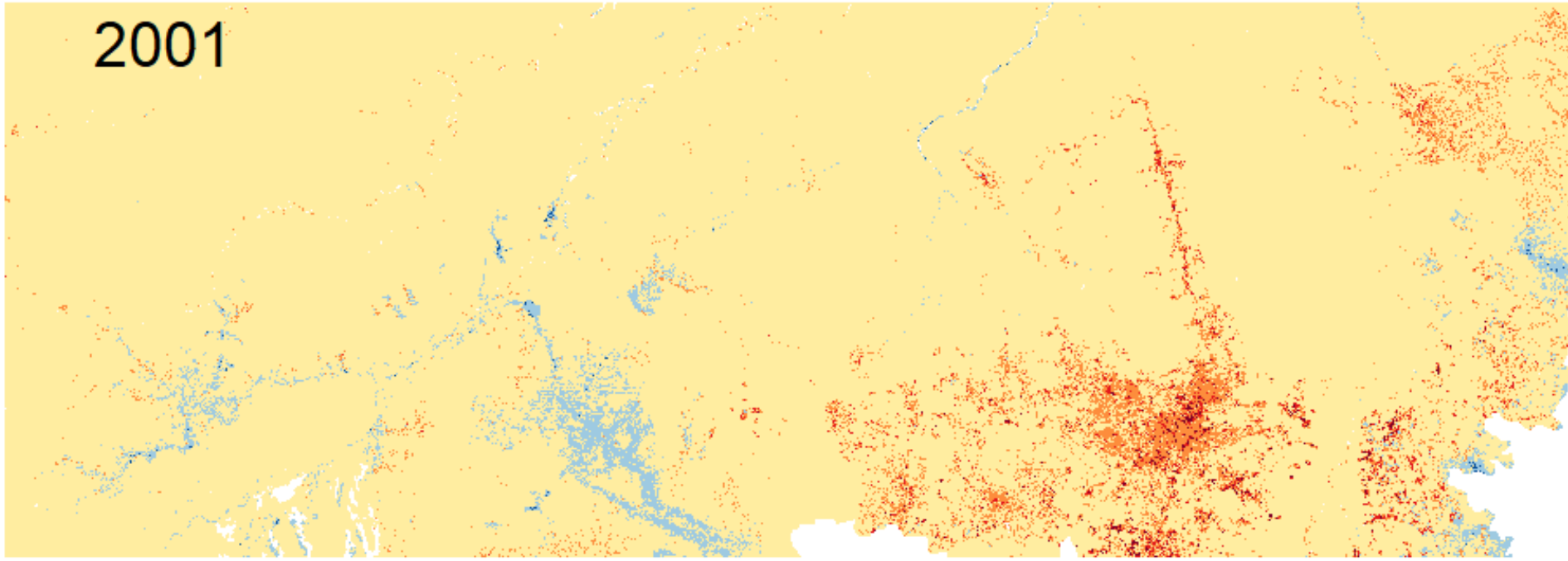
AIM 6.0

PREDICTS: built for prediction



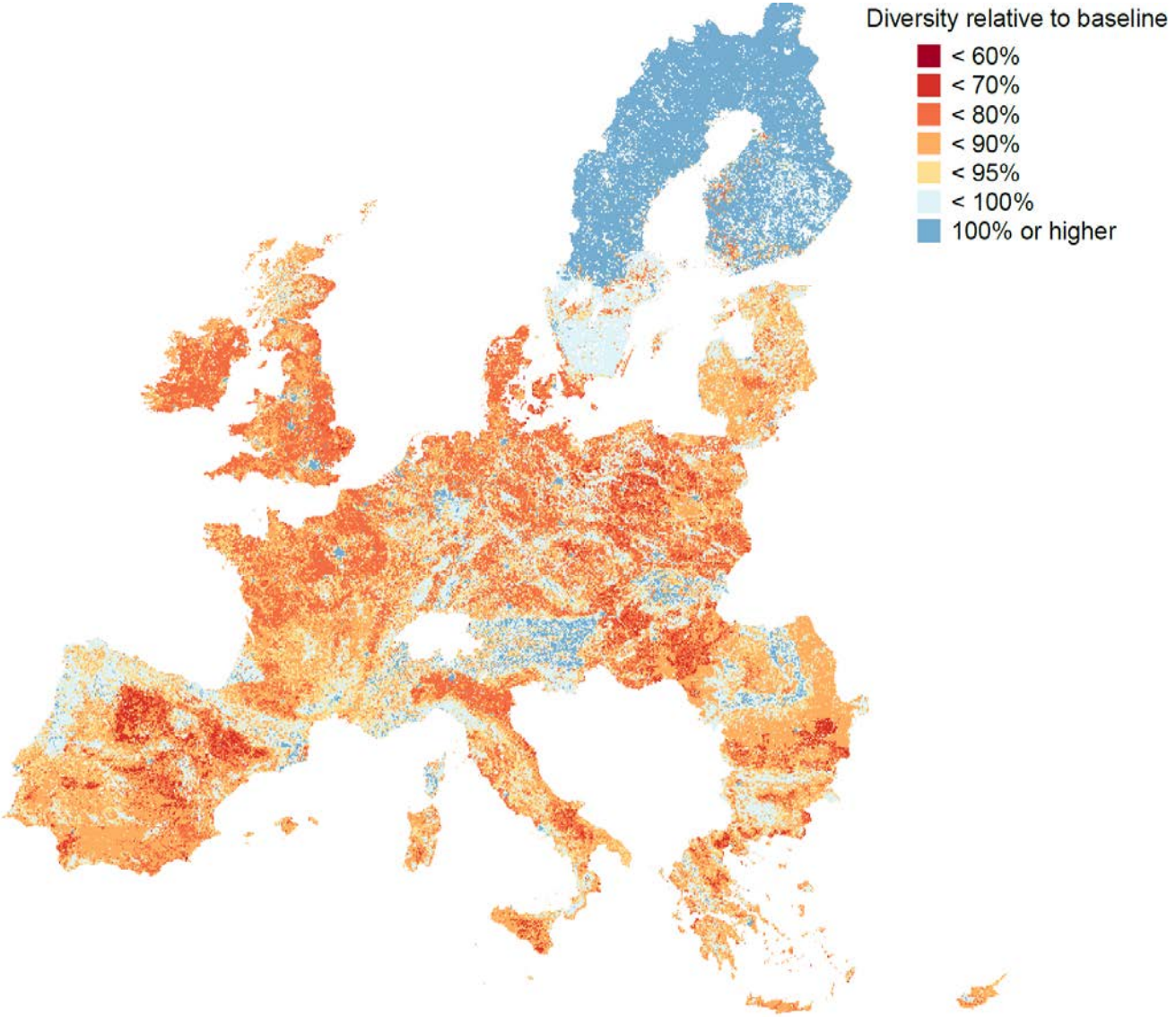
De Palma, Hoskins *et al*, in pre

PREDICTS: built for prediction



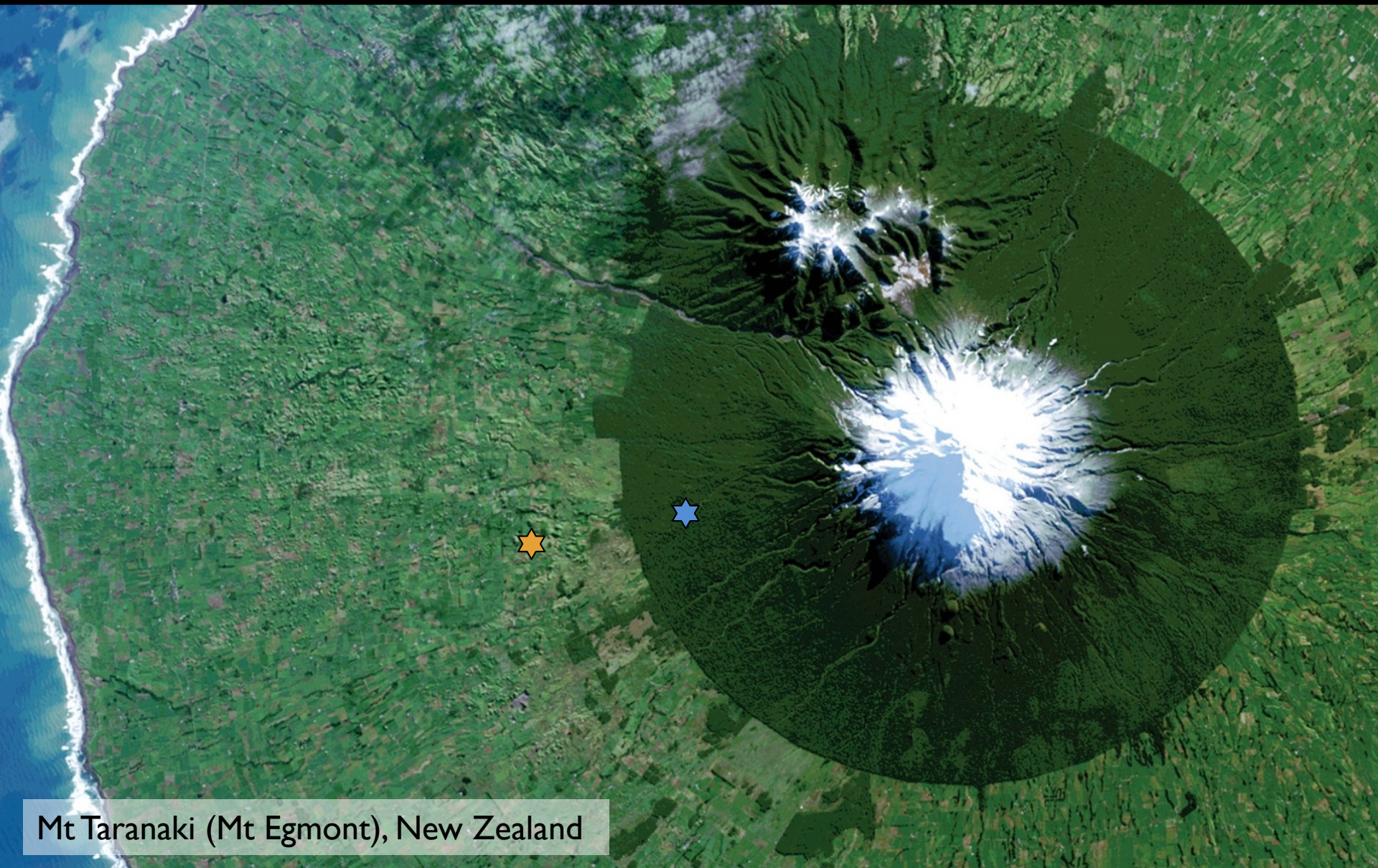
De Palma, Hoskins *et al*, in pre

Taxon-specific models:
Species diversity of bees



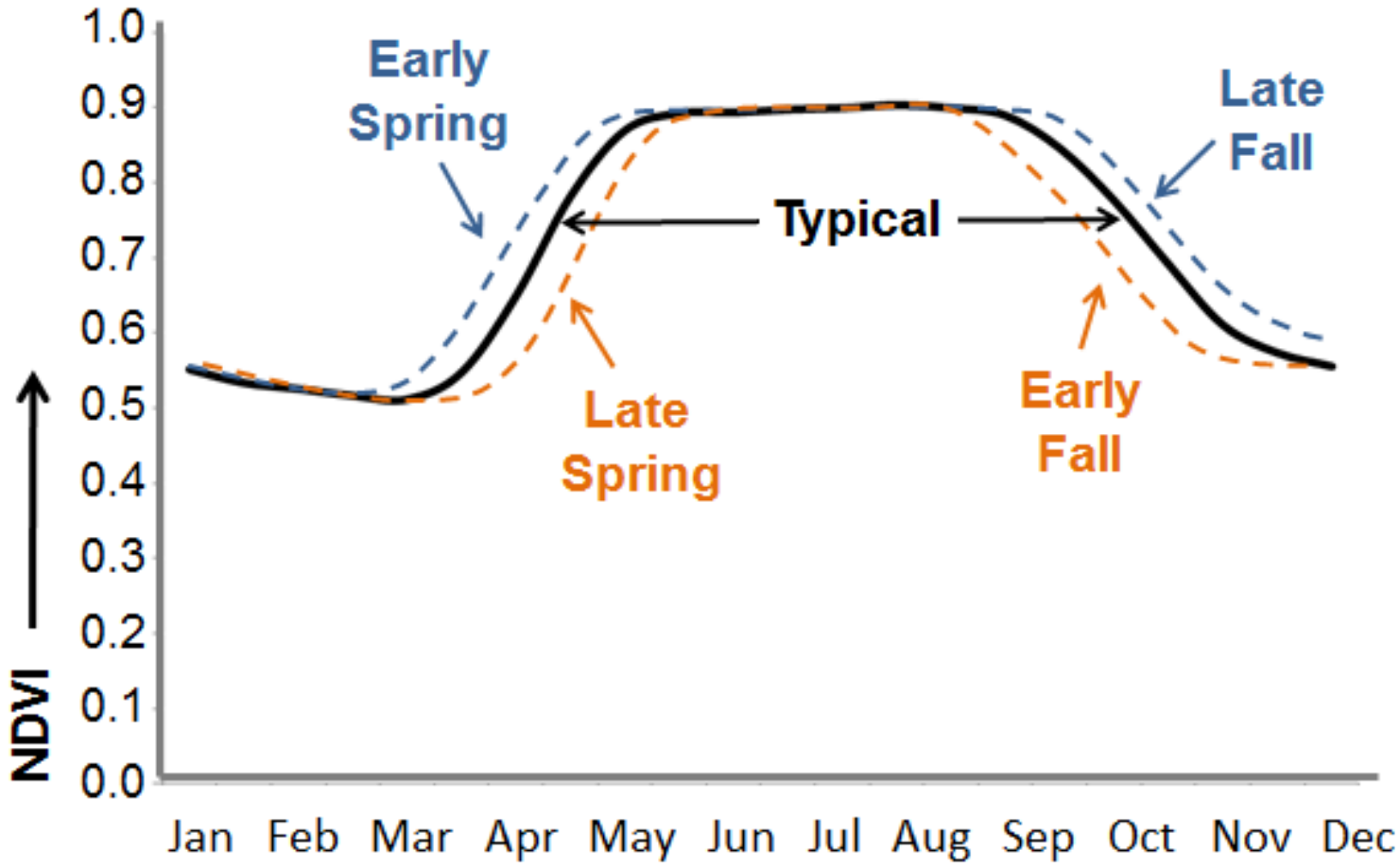
De Palma et al, in review, *Diversity and Distributions*

Potential limitation: space-for-time substitution



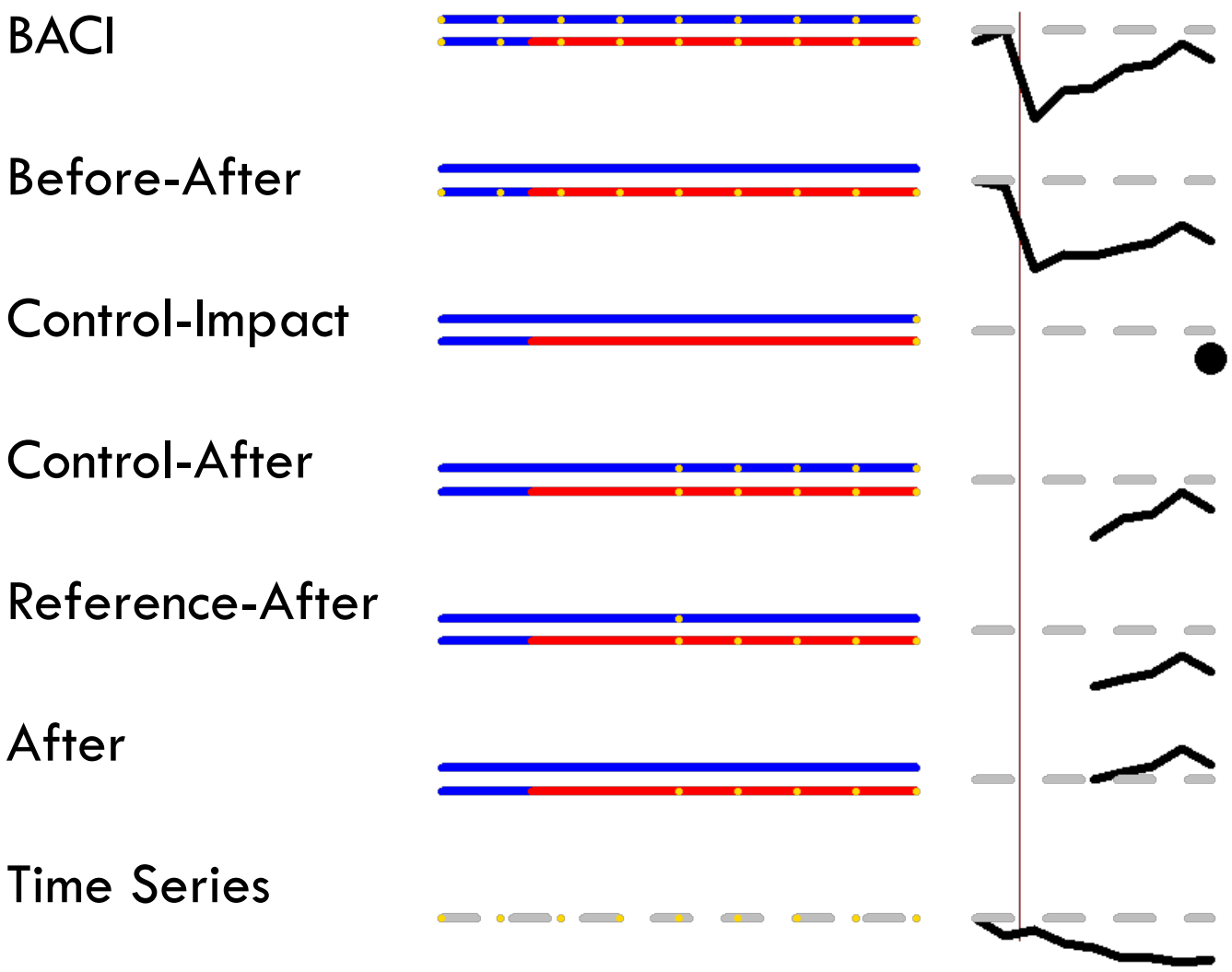
Mt Taranaki (Mt Egmont), New Zealand

Time series: time-for-time substitution



http://forwarn.forestthreats.org/

Next Stage: from space to time



Thanks to everyone involved

Andy Purvis

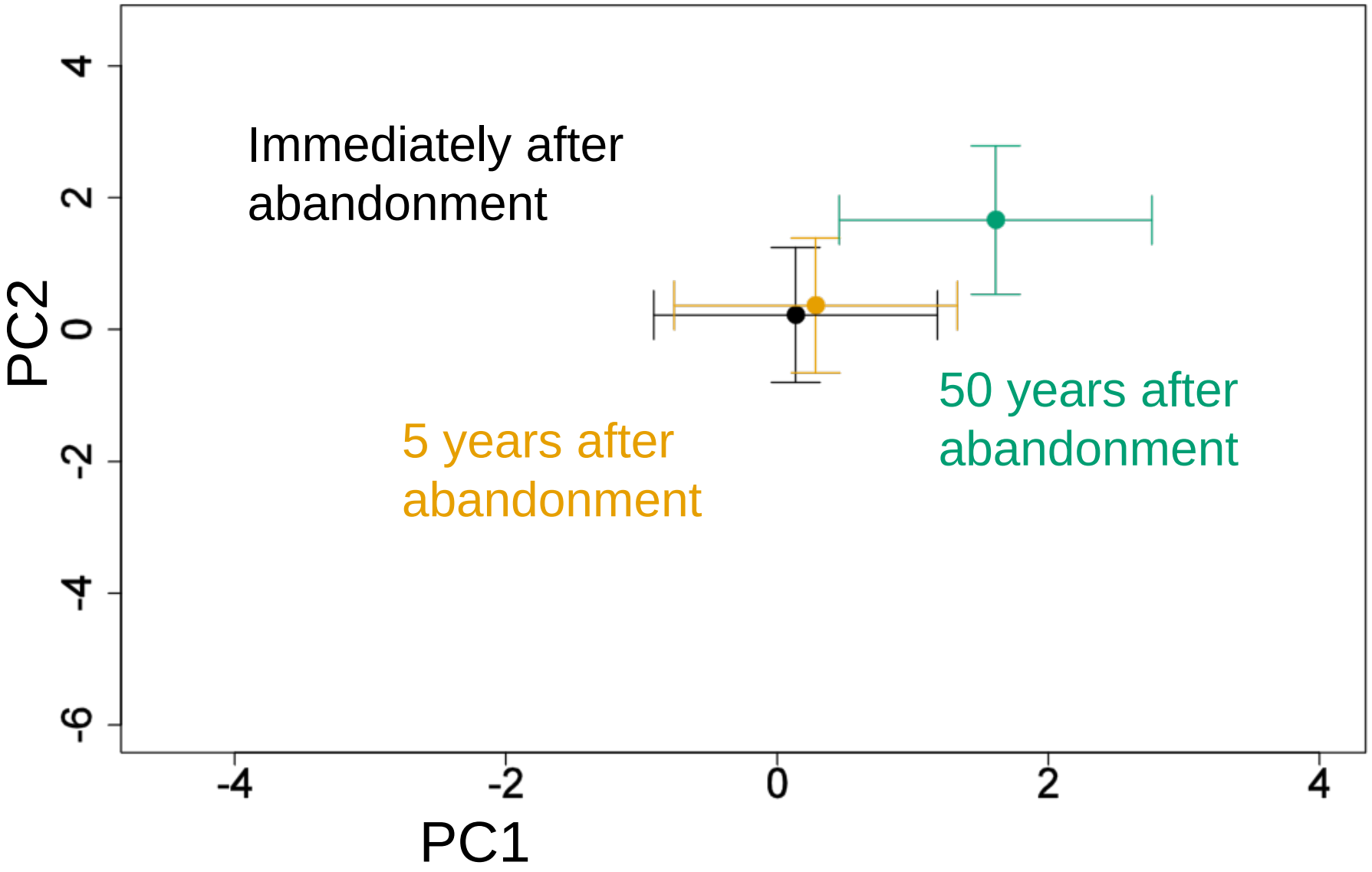
Lawrence Hudson

Tim Newbold

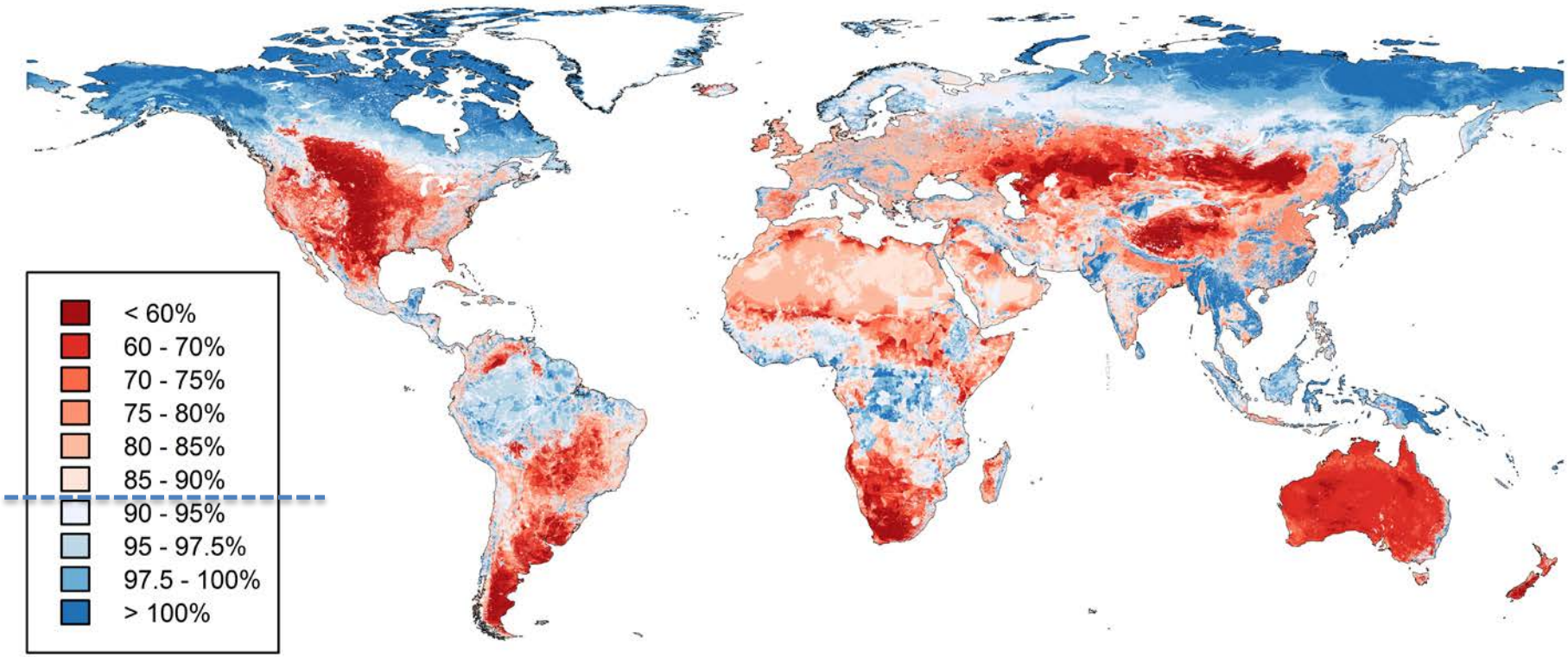
Susy Echeverria-Londoño

Natural History Museum · UNEP · WCMC · UCL · Imperial College London · Microsoft Research · University of Sussex

Next Stage: from space to time



Broad scale biodiversity:
Biotic Intactness Index



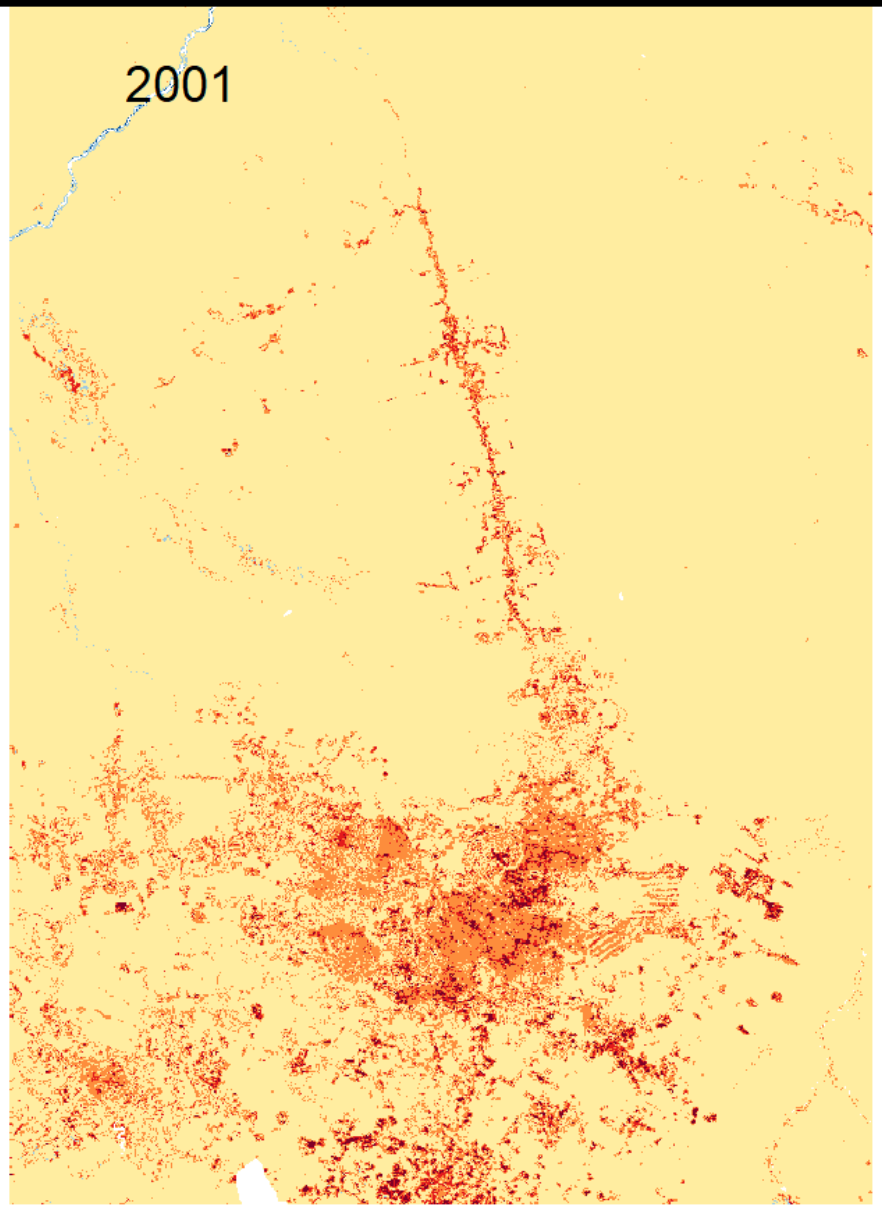
Global average = 84.6%

(Planetary Boundary = 90%)

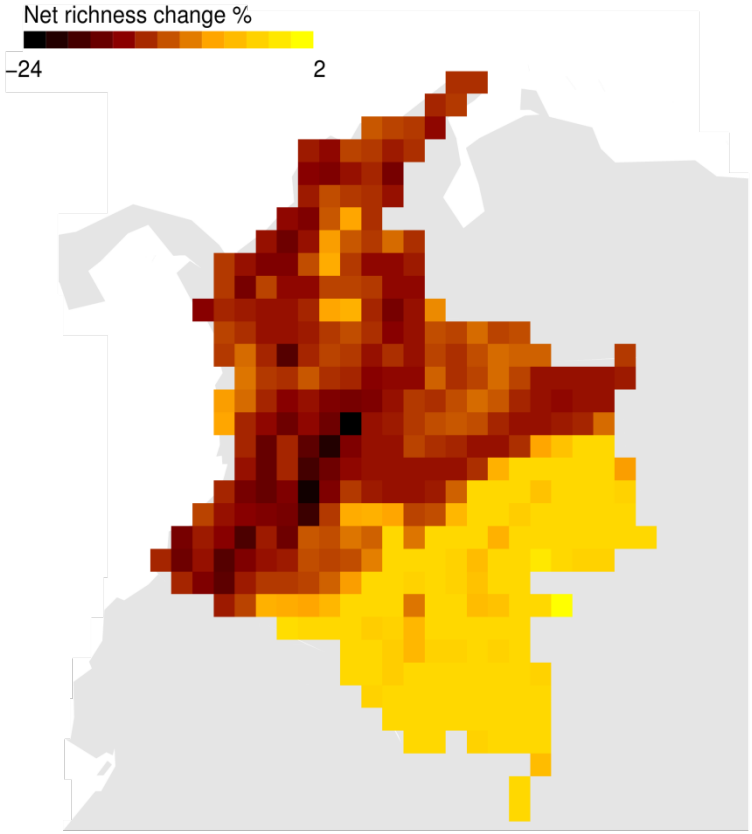
Newbold et al. 2016, *Science* 353:288-291.

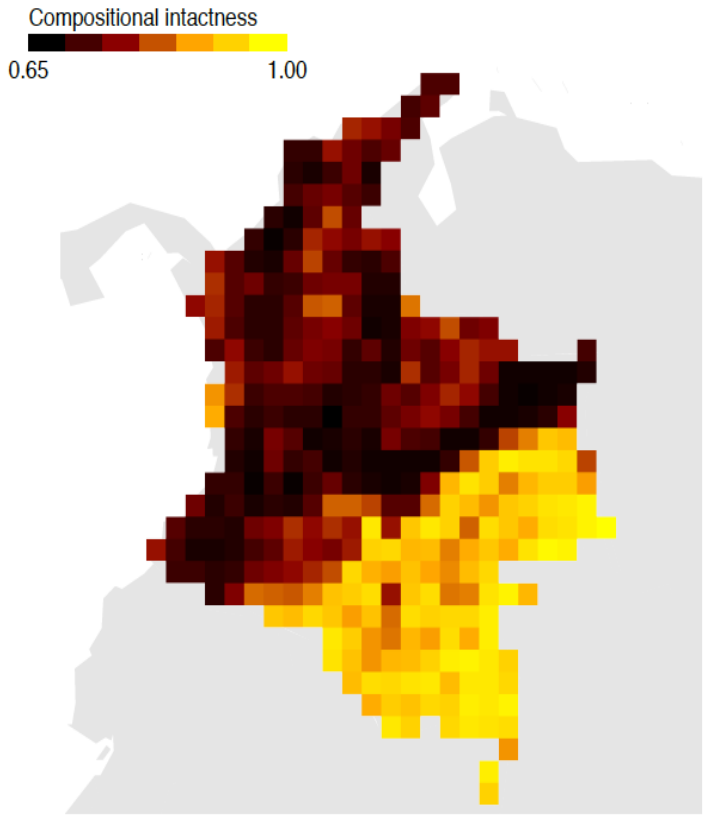
PREDICTS: built for prediction

< 50%
< 60%
< 70%
< 80%
< 90%
≥ 90%



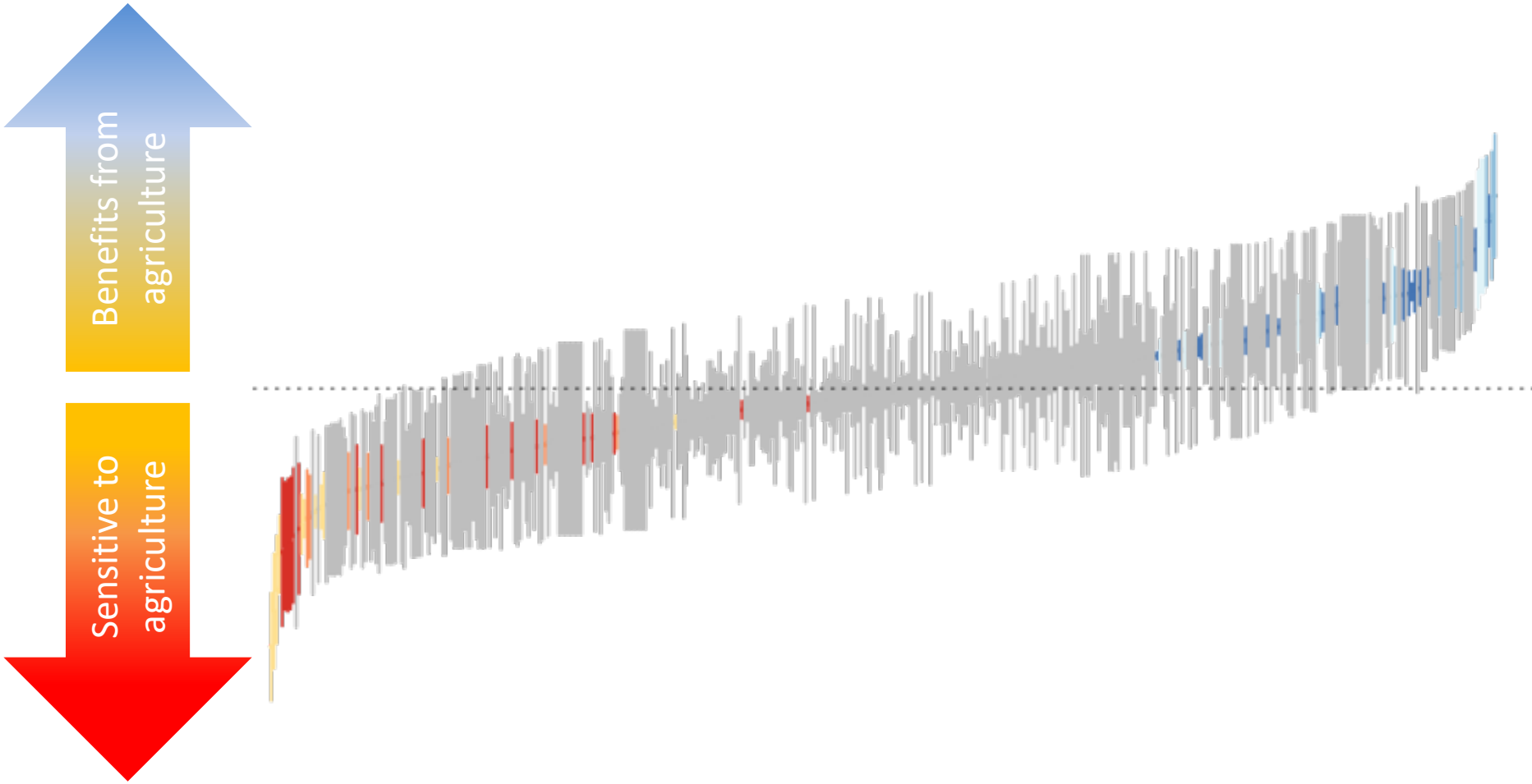
Focus on particular regions



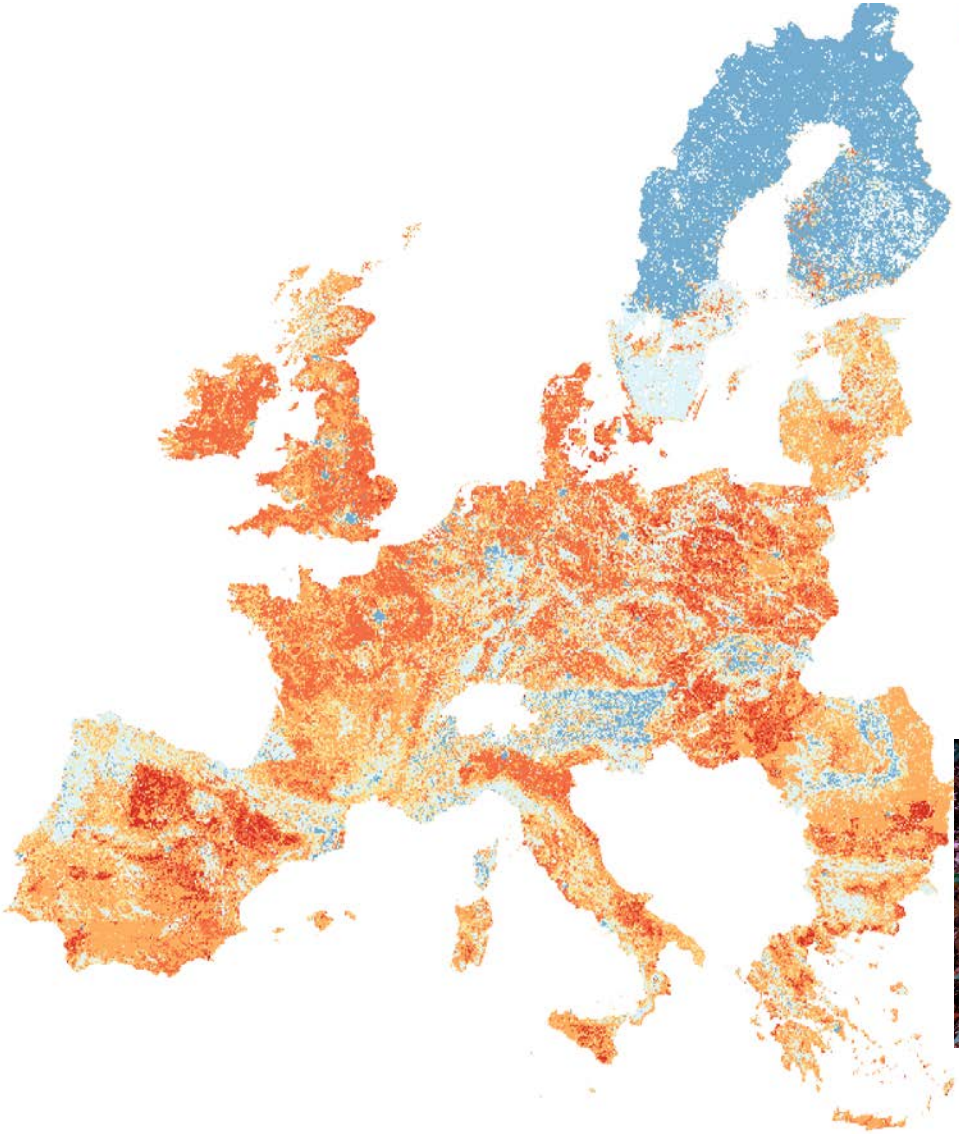


Higher impact in the identity than the number of the species:
Impacting ecosystems services

Species-specific responses

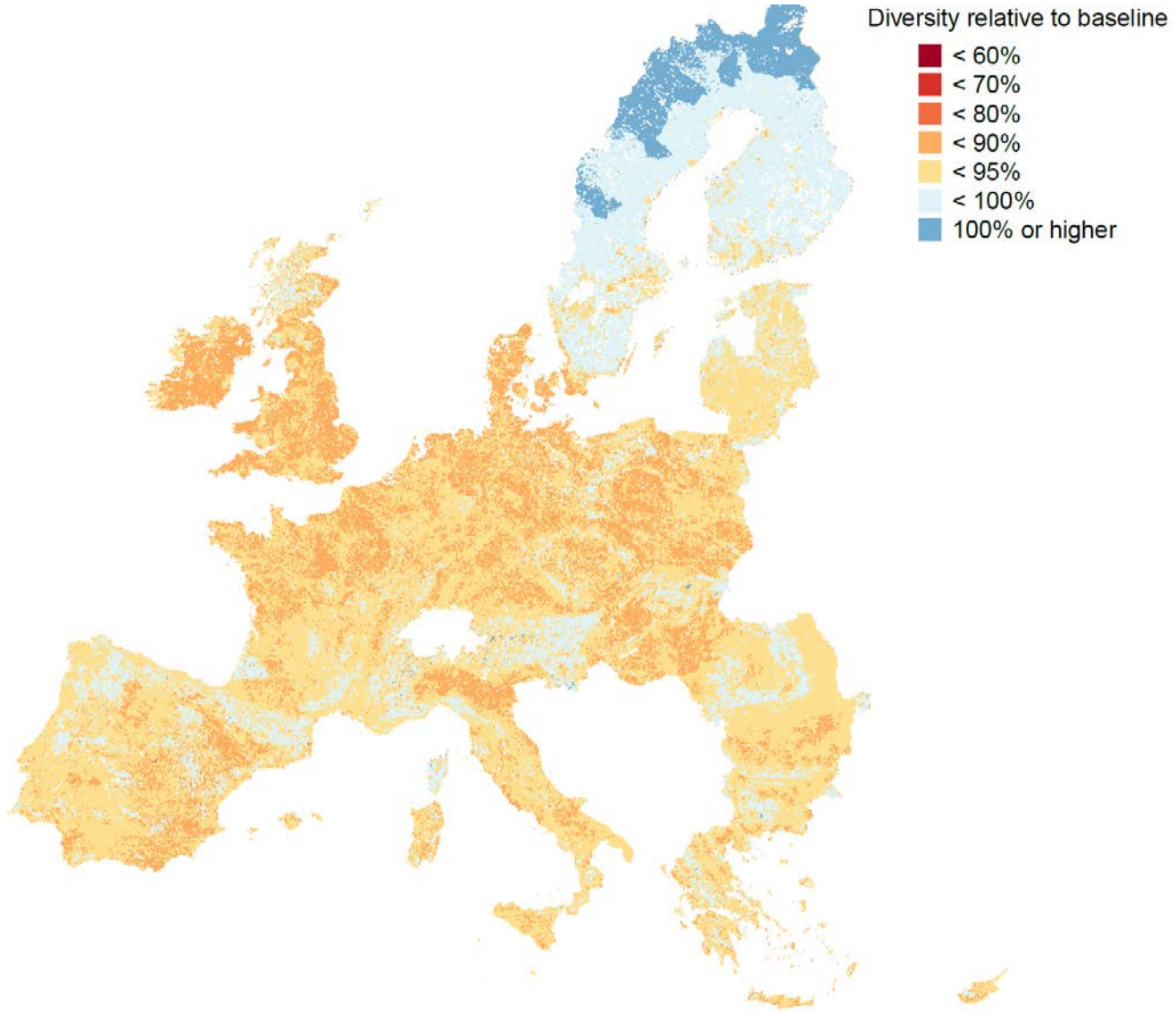


Taxon-specific models:
Species diversity of bees



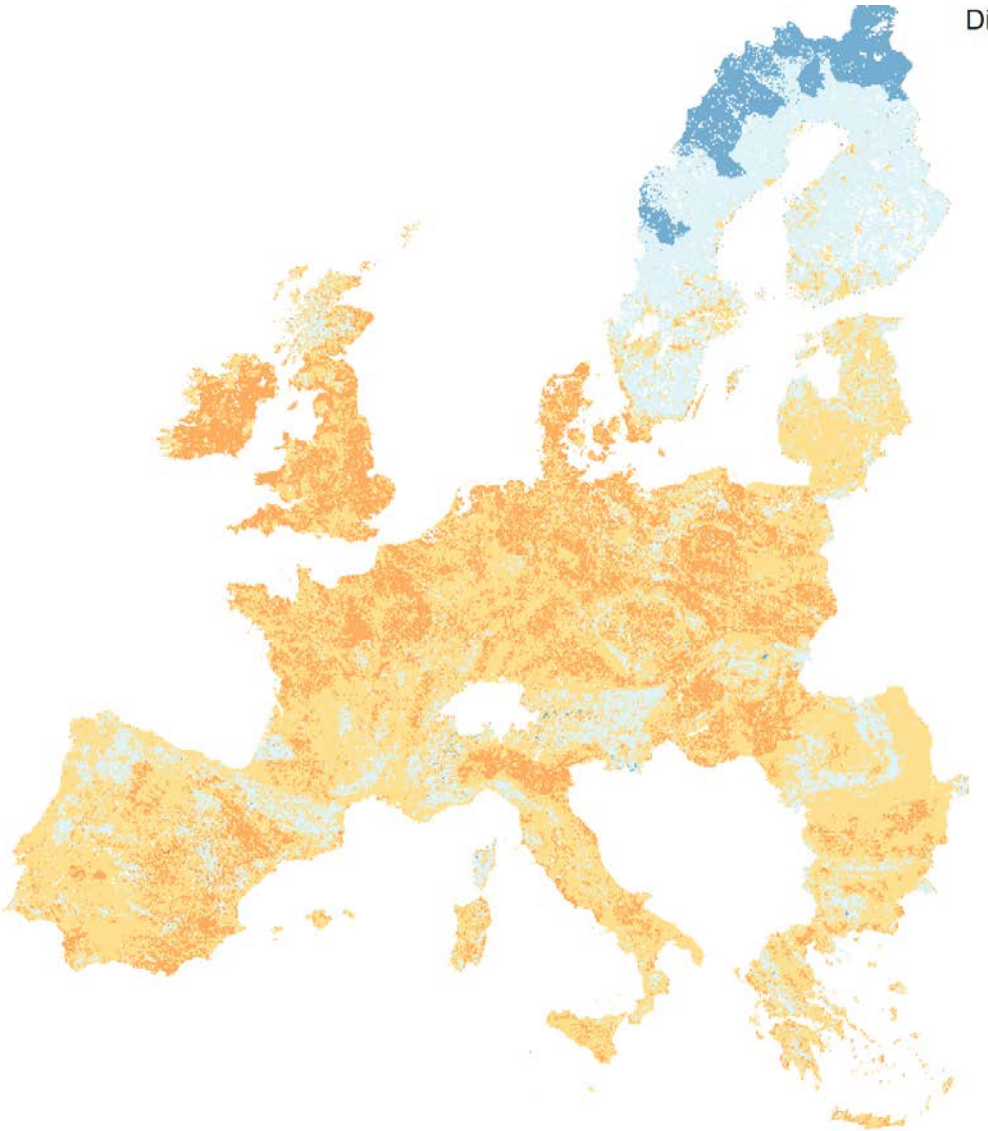
De Palma et al, in review, *Diversity and Distributions*

Taxon-specific models:
Phylogenetic diversity of bees



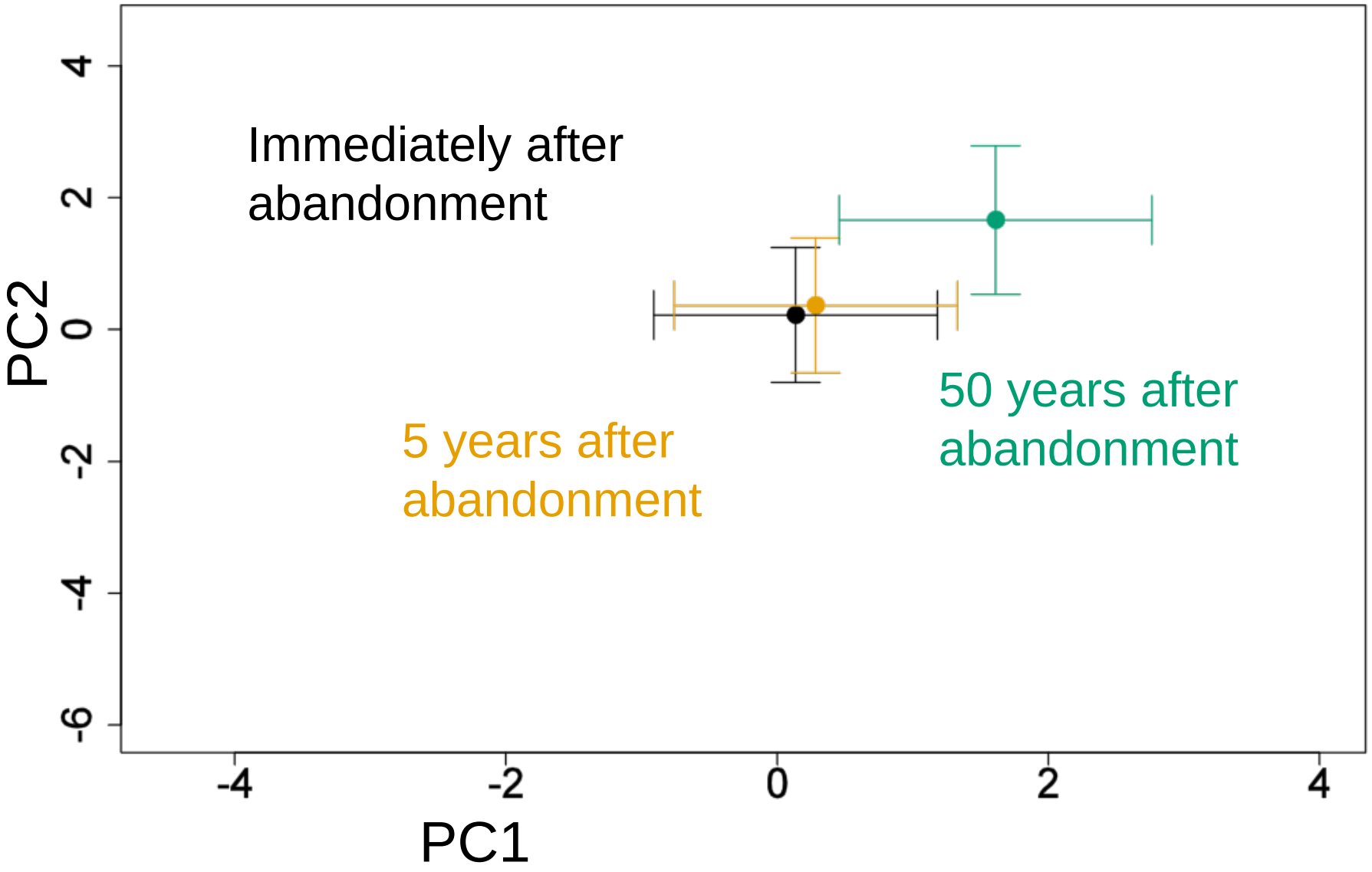
De Palma et al, in review, *Diversity and Distributions*

Taxon-specific models:
Phylogenetic diversity of bees



De Palma et al, in review, *Diversity and Distributions*

Next Stage: from space to time



Tracked correspondence and permissions