Grupo de investigación Ecología de Zonas Áridas

CENTRO ANDALUZ PARA LA EVALUACIÓN Y SEGUIMIENTO DEL CAMBIO GLOBAL

Aplicaciones de los modelos de nicho a estudios de Cambio Global y Biología de la Conservación.

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Réplica del IV taller de modelización de nichos ecológicos (27-30 Mayo 2008)

¿Qué es el Cambio Global?

“Son las consecuencias ambientales no deseables de la adaptación del medio a las necesidades humanas.”

Cambio Global: componentes importantes

- Cambio climático

- Degradación, reducción y fragmentación de los hábitats naturals (cambios de uso del suelo)

- Pérdida de biodiversidad e intercambios bióticos (especies invasoras)

- Cambios en los ciclos biogeoquímicos.

Cambio Global y Biología de la conservación

Por supuesto todos estos componentes afectan directa o indirectamente a las especies y al funcionamiento de los ecosistemas

¿Y esto que tiene que ver con los modelos de nicho?

…veamos varios ejemplos

Cambio Climático

Nature, 2002

Future projections for Mexican faunas under global climate change scenarios

A. Townsend Peterson*, Miguel A. Ortega-Huerta†, Jeremy Bartley‡, Victor Sánchez-Cordero§, Jorge Soberón||, Robert H. Buddemeier‡ & David R. B. Stockwell¶

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§ *Departamento de Zoología, Instituto de Biología, Apartado Postal 70-153;*
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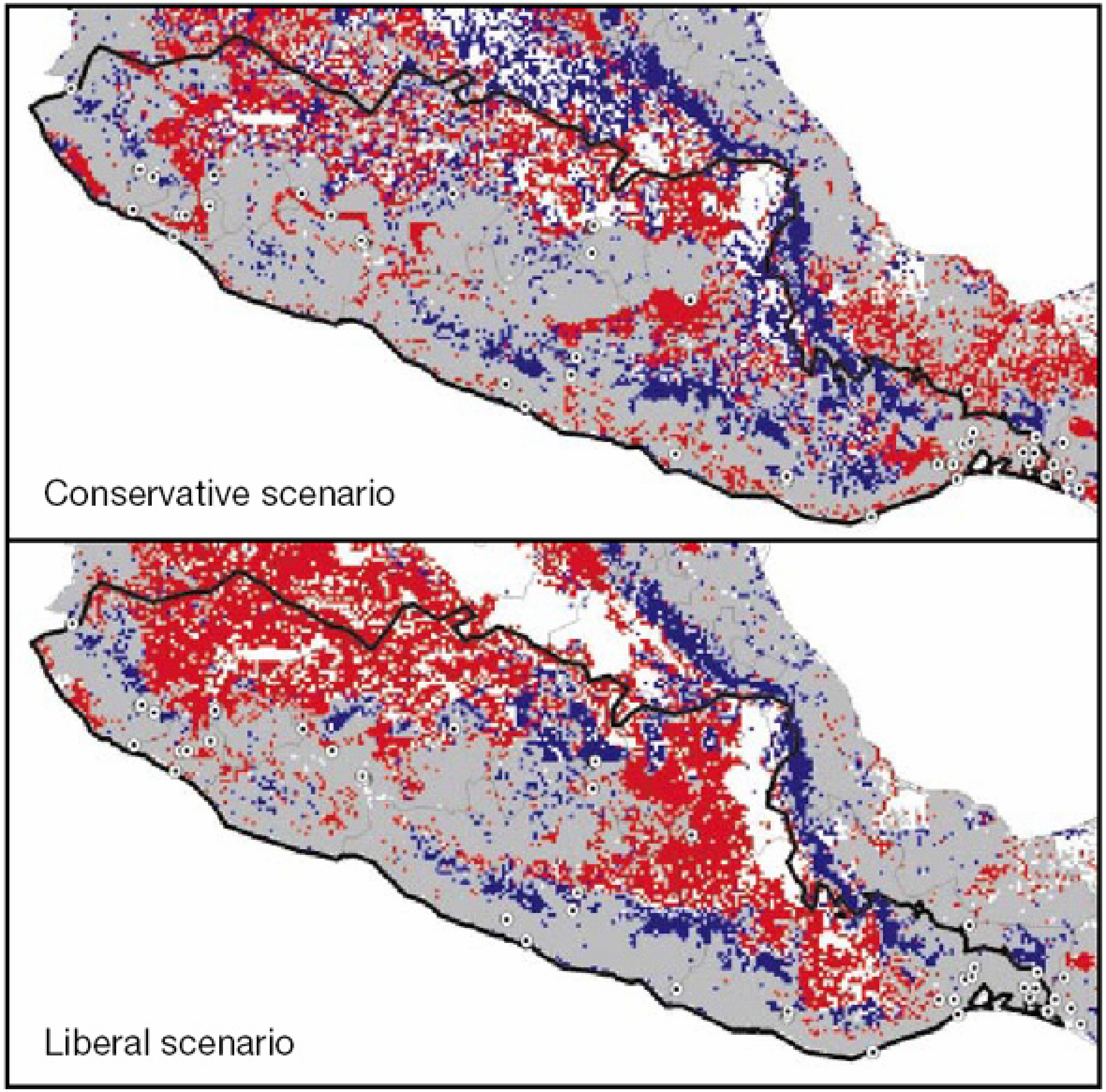
¶ *San Diego Supercomputer Center, University of California, 9500 Gilman Drive,*



¿Qué pasaría con el hábitat potencial?

Gris: habitables ahora y en el futuro

Rojo: desaparece

Azul: habitable

Blanco: no habitable

Peterson et al., 2002

Global Ecology & Biogeography, 2003

RESEARCH REVIEW

Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful?

RICHARD G. PEARSON* and TERENCE P. DAWSON

Environmental Change Institute, School of Geography and the Environment, University of Oxford, 1 A Mansfield Road, Oxford OX1 3SZ, U.K. E-mail: richard.pearson@eci.ox.ac.uk

ABSTRACT

Modelling strategies for predicting the potential impacts of climate change on the natural distribution of species have often focused on the characterization of a species' bioclimate the complexity of the natural system presents fundamental limits to predictive modelling, the bioclimate envelope approach can provide a useful first approximation as to the potentially dramatic impact of climate change on biodiversity.

Modelizan la distribución potencial de varias especies bajo distintos escenarios de cambio

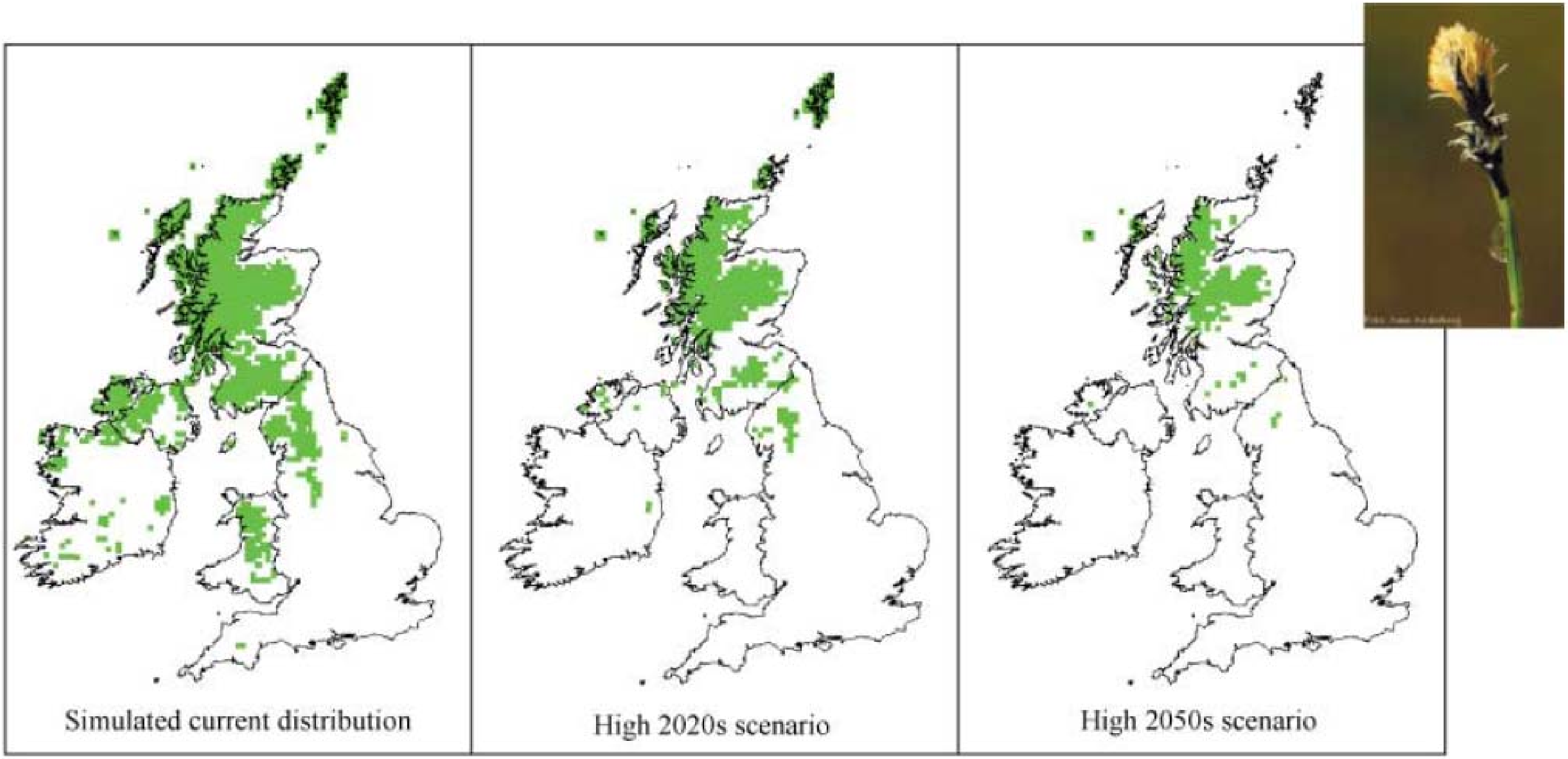


Fig. 1 Simulated redistribution of suitable climate space for stiff sedge (*Carex bigelowii*) under future climate scenarios in Great Britain and Ireland as predicted by the SPECIES model (Pearson *et al.*, 2002). Climate change scenarios are those of Hulme & Jenkins (1998). Suitable climate space is expected to be lost, with a general migration northwards as the climate changes.

Pearson & Dawson, 2003

ENVIRONMENTAL SCIENCE & POLICY 9 (2006) 116–128

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Modelling climate change impacts on species' distributions at the European scale: implications for conservation policy

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ARTICLE INFO

Published on line 19 January 2006

Keywords:

ABSTRACT

The availability of suitable climate space across Europe for the distributions of 47 species chosen to encompass a range of taxa (including plants, insects, birds and mammals) and to reflect dominant and threatened species from 10 habitats was modelled for the current

Modelizan la distribución potencial de varias especies para toda Europa bajo distintos escenarios de cambio

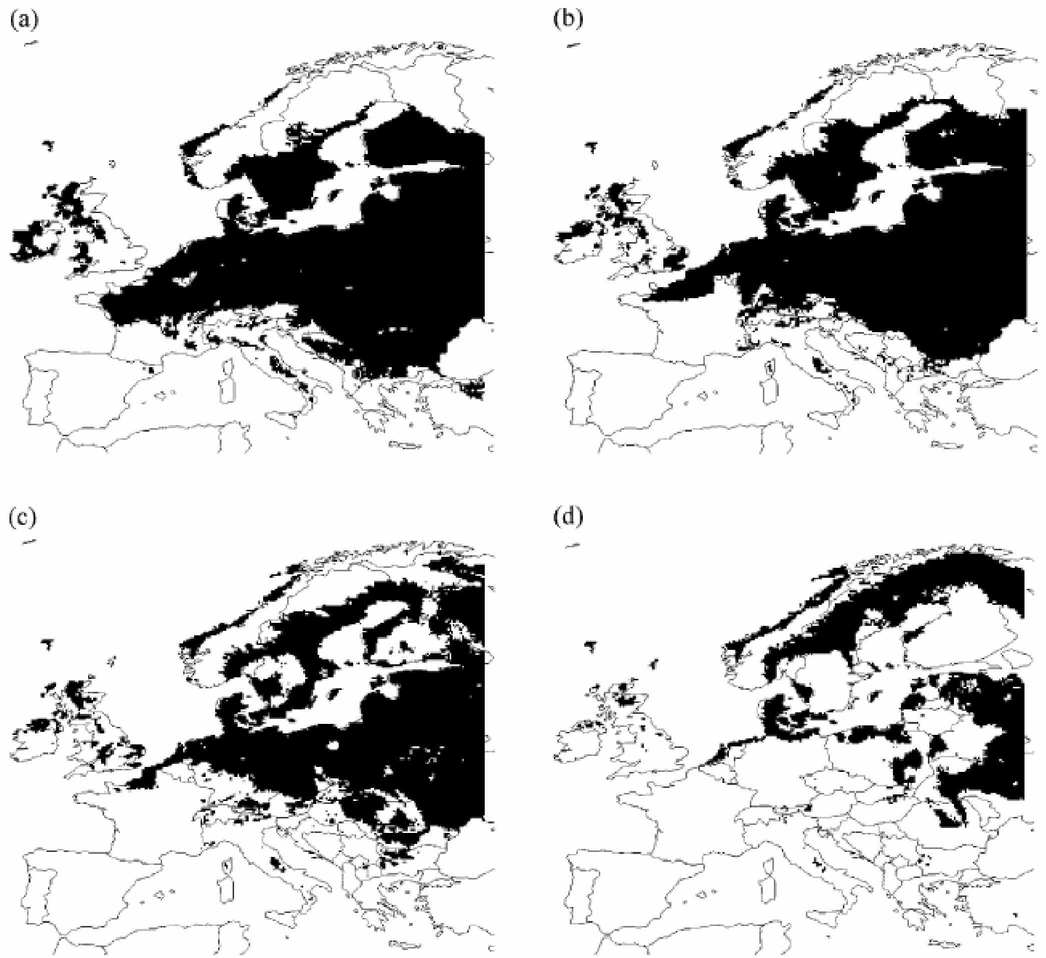

Fig. 2 – Simulated climate space for *C. crex*: (a) baseline (1961–1990); (b) HadCM3 A2 2020 scenario; (c) HadCM3 A2 2050 scenario and (d) HadCM3 A2 2080 scenario.

Harrison et al., 2003

Comparan los modelos de nicho ecológico con otros tipos de modelo para ver si realmente dan resultados similares.

Global Change Biology (2006) **12**, 2272–2281, doi: 10.1111/j.1365-2486.2006.01256.x

The ability of climate envelope models to predict the effect of climate change on species distributions

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†Department of Ecology and Evolution, Stony Brook University, 636 Life Science Building, Stony Brook, NY 11794, USA

Abstract

Climate envelope models (CEMs) have been used to predict the distribution of species under current, past, and future climatic conditions by inferring a species' environmental requirements from localities where it is currently known to occur. CEMs can be evaluated for their ability to predict current species distributions but it is unclear whether models that are successful in predicting current distributions are equally successful in predicting

Cambio de usos del suelo

(calidad del hábitat)

Diversity and Distributions, (Diversity Distrib.) (2007) **13**, 324–331

BIODIVERSITY RESEARCH

Assessing changes in habitat quality due to land use changes in the spur-thighed tortoise *Testudo graeca* using hierarchical predictive habitat models

J. D. Anadón[1*], A. Giménez[1], M. Martínez[2], J. A. Palazón[2] and M. A. Esteve[2]

[1]*Área de Ecología. Departamento de Biología Aplicada, Universidad Miguel Hernández, Edif. Torreblanca, Campus de Elche, 03202 Elche, Alicante, Spain and* [2]*Departamento de Ecología e Hidrología, Universidad de Murcia, Campus de Espinardo 30100, Murcia, Spain*

ABSTRACT

In this study we propose a model-building approach based on the hierarchical integration of the main environmental factors (climate, topography/lithology, and land uses) determining the distribution of the spur-thighed tortoise in south-east Spain. Data on the presence/absence of the species were primarily based on information derived from interviews to shepherds. The hierarchical modelling exercise consisted of three steps. First, we constructed a model for the entire region using climate vari-

16. Aplicaciones: Cambio Global & Biología de la Conservación

Modelizan la distribución potencial en base a variables ambientales y luego ven qué parte de la distribución se pierde debido a los usos del suelo no favorables para la especie

Hierarchical pred

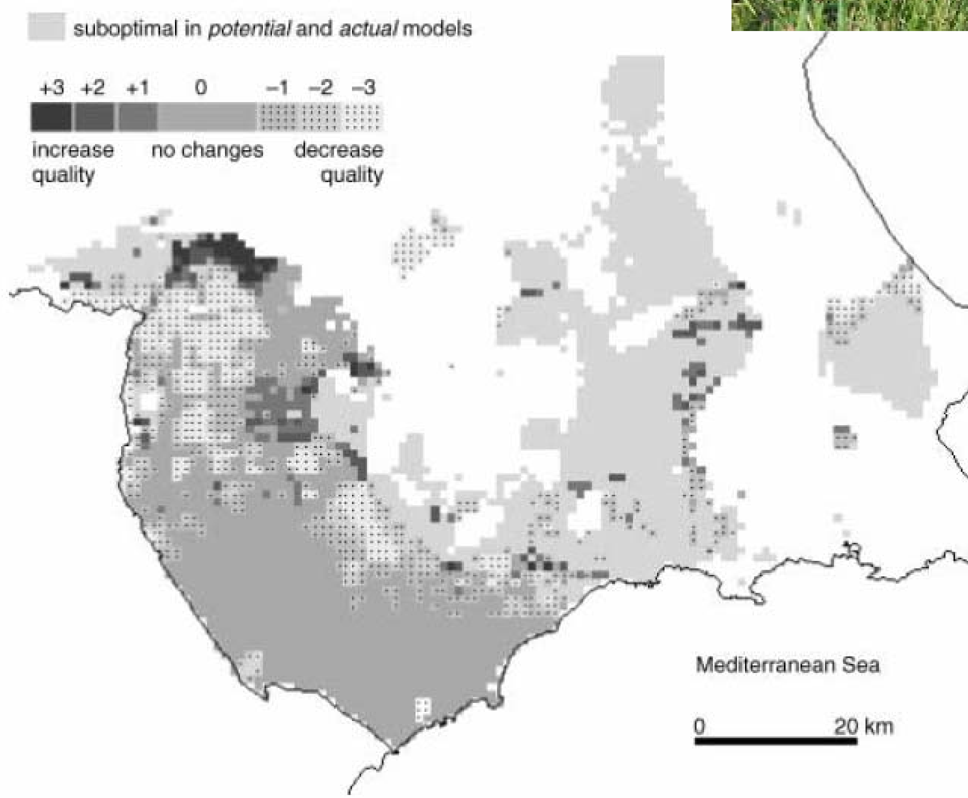

Figure 2 Changes in the probability of presence of *Testudo graeca* between the *potential* and the *actual* model. Changes are given as the difference between the habitat quality class of the *potential* and *actual* model.

Anadón et al., 2007

16. Aplicaciones: Cambio Global & Biología de la Conservación

ECOLOGICAL MODELLING 195 (2006) 229–236

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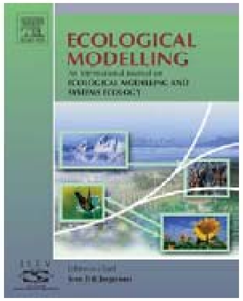

Tracking population extirpations via melding ecological niche modeling with land-cover information

A. Townsend Peterson[a,*], *Victor Sánchez-Cordero*[b], *Enrique Martínez-Meyer*[b], *Adolfo G. Navarro-Sigüenza*[c]

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ARTICLE INFO

Article history:
Received 24 December 2004

ABSTRACT

We explored a new approach to tracking population losses in poorly known species across broad spatial scales, based on integration of tools from ecological niche modeling with data

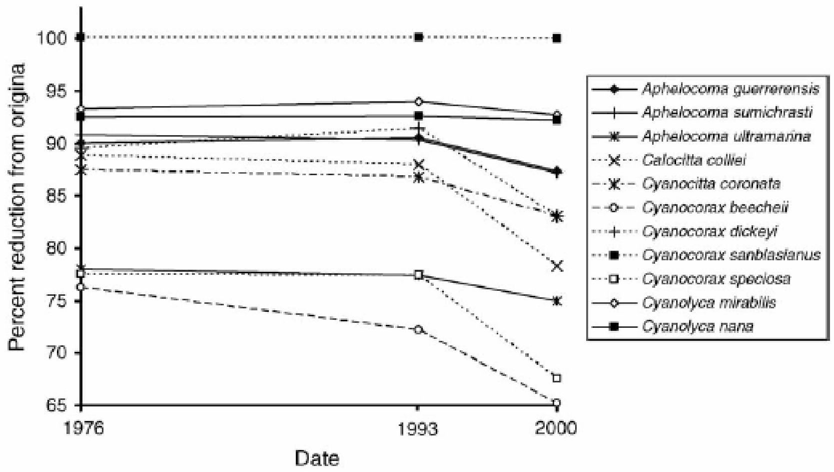

Fig. 3 – Summary of projected percent loss of distributional area for each of the 11 endemic species treated in this study.

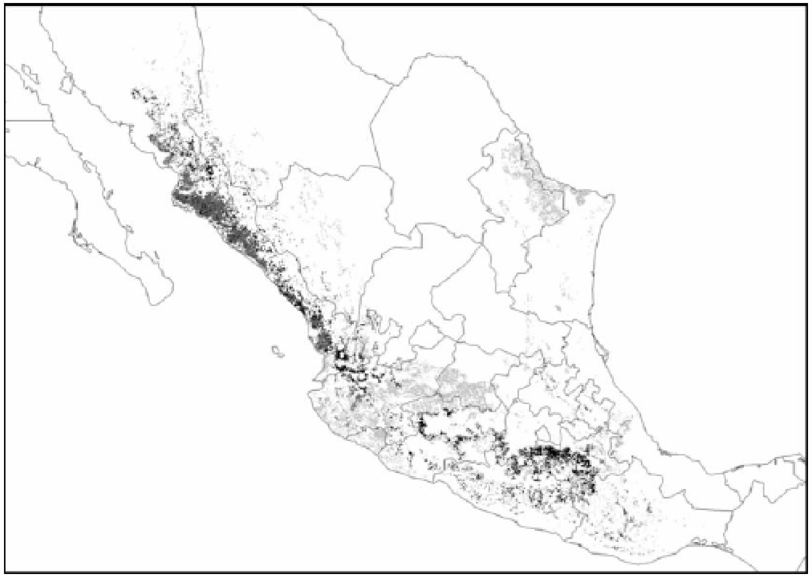

Fig. 4 – Geographic foci of population losses across 11 endemic species of Mexican corvids, as reconstructed in this study. Light gray, 1 species lost; medium gray, 2 species lost; black, 3–4 species lost.

Modelizan la distribución potencial en base a variables ambientales y luego ven qué parte de la distribución se pierde debido a los usos del suelo que hay en diferentes años (1976, 1993, 2000)

Peterson et al., 2006

Especies invasoras

16. Aplicaciones: Cambio Global & Biología de la Conservación

VOLUME 78, NO. 4 *THE QUARTERLY REVIEW OF BIOLOGY* DECEMBER 2003

PREDICTING THE GEOGRAPHY OF SPECIES' INVASIONS VIA ECOLOGICAL NICHE MODELING

A. TOWNSEND PETERSON

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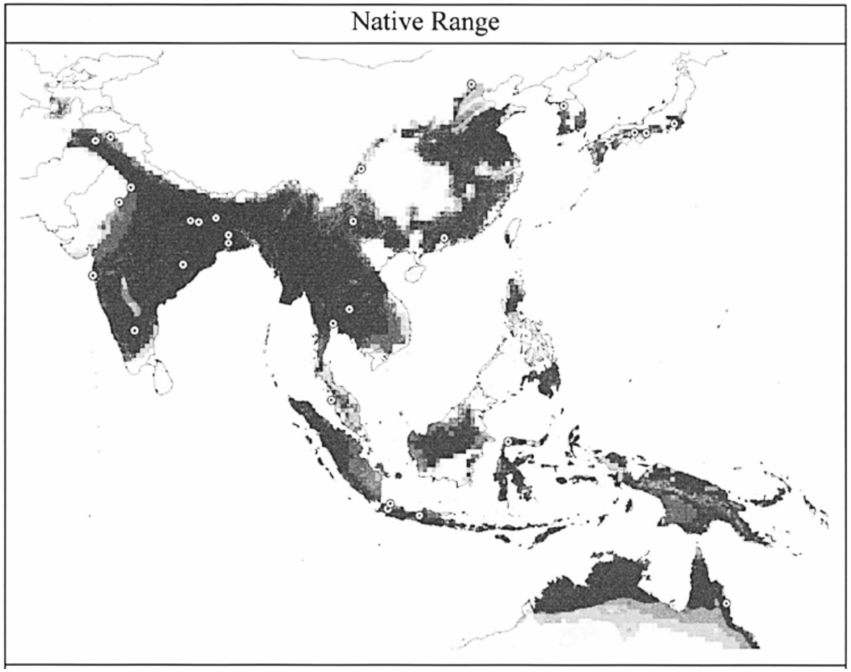
16. Aplicaciones: Cambio Global & Biología de la Conservación



Zonas delimitadas en negro ya invadidas (y detectadas por el modelo como alta probabilidad de presencia)

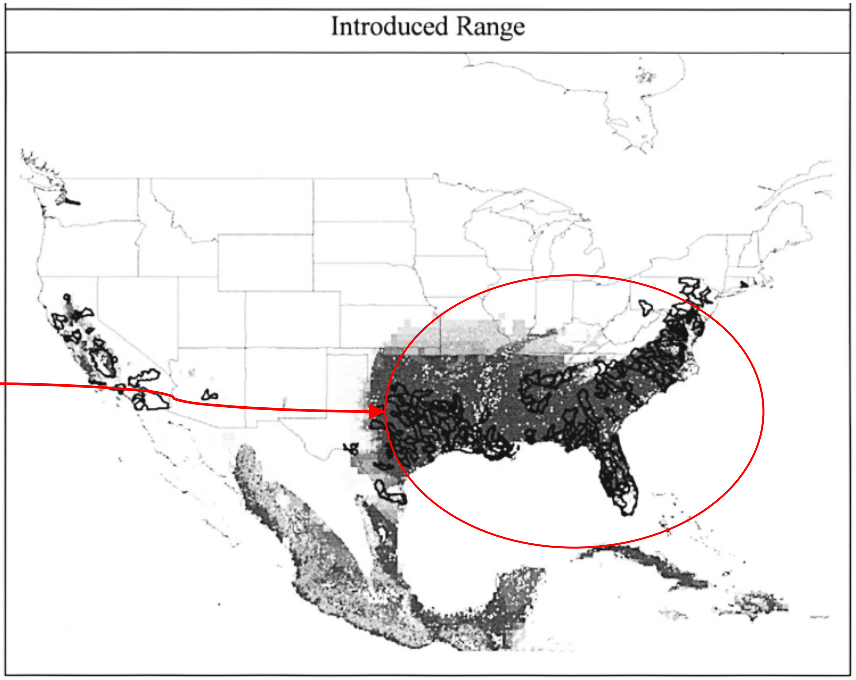


FIGURE 2.
Ecological niche model for *Hydrilla verticillata*, projected onto its native distributional area in Southeast Asia and the Australo-Pacific region (top), and its invaded distributional area in North America (bottom). Darker shading of areas indicates greater confidence in prediction of presence. Watersheds actually invaded by the species are shown in black.

Peterson et al., 2006

Estiman el modelo de nicho sobre la distribución nativa y luego proyectan las condiciones sobre el área de invasión. Validan con las zonas ya invadidas.

PloS One, 2007

OPEN ACCESS Freely available online

PLoS one

Highly Pathogenic H5N1 Avian Influenza: Entry Pathways into North America via Bird Migration

A. Townsend Peterson*, Brett W. Benz, Monica Papeş

Natural History Museum and Biodiversity Research Center, The University of Kansas, Lawrence, Kansas, United States of America

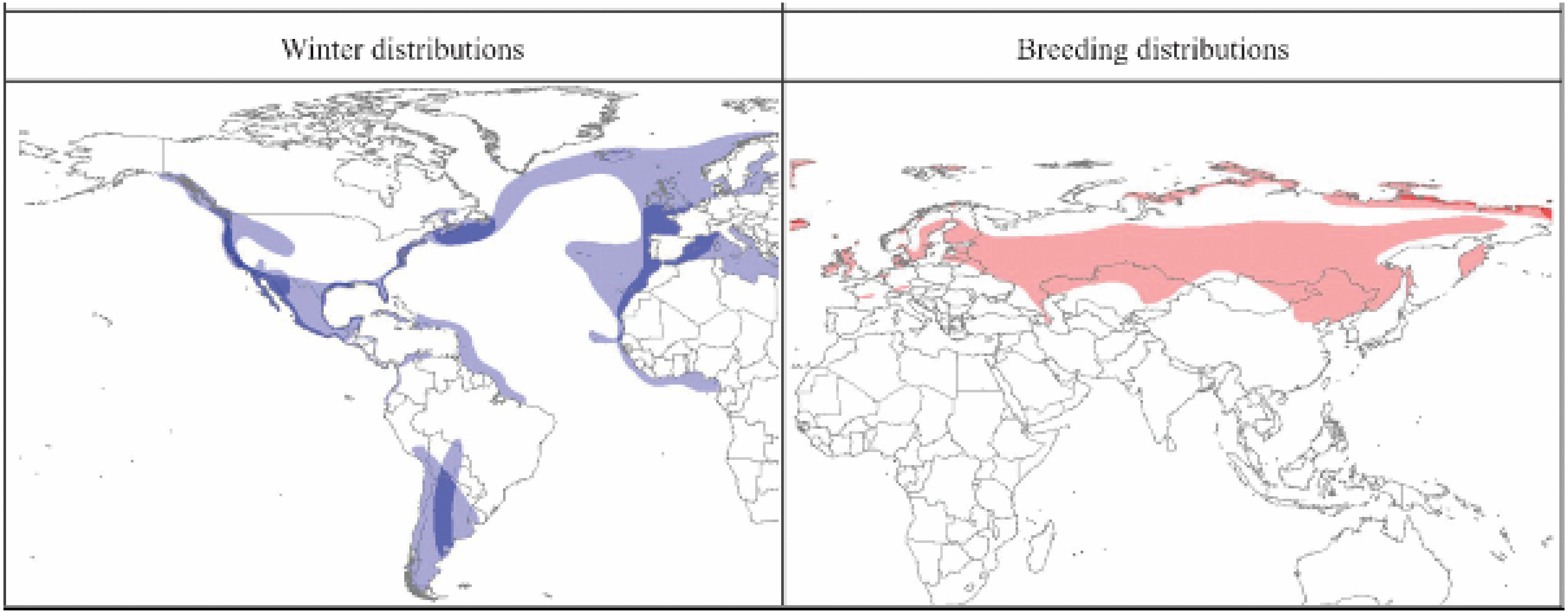
Given the possibility of highly pathogenic H5N1 avian influenza arriving in North America and monitoring programs that have been established to detect and track it, we review intercontinental movements of birds. We divided 157 bird species showing regular intercontinental movements into four groups based on patterns of movement—one of these groups (breed Holarctic, winter Eurasia) fits well with the design of the monitoring programs (i.e., western Alaska), but the other groups have quite different movement patterns, which would suggest the importance of H5N1 monitoring along the Pacific, Atlantic, and Gulf coasts of North America.

Citation: Peterson AT, Benz BW, Papeş M (2007) Highly Pathogenic H5N1 Avian Influenza: Entry Pathways into North America via Bird Migration. PLoS ONE 2(2): e261. doi:10.1371/journal.pone.0000261

INTRODUCTION

Flu viruses have long been known to circulate in birds [1], which led to intensive studies of avian influenzas in the middle twentieth century [2,3]. The emergence of a highly pathogenic influenza A strain H5N1 in the past several years—beginning in Southeast Asia and now spreading into Africa, the Middle East, and Europe [1,4–9]—has brought this issue again to the forefront of global attention. The fear is a global influenza pandemic—this highly pathogenic H5N1 strain (hereafter referred to as "HP-H5N1") is associated with human case fatality rates reportedly higher than in 2005). Finally, late in 2005, HP-H5N1 appeared in Turkey, Romania, Taiwan, and Croatia (all in Oct. 2005), and later (late 2005–early 2006) in Cyprus, Saudi Arabia, Kuwait, and Iraq. As of April 2006, the virus had been detected across almost all of Europe, in numerous southern Asian countries, as well as in 5 African countries (Burkina Faso, Cameroon, Egypt, Nigeria, Niger), and by October 2006 the list had expanded to include Sudan, Ivory Coast, and others.

To summarize, from an initial southeastern appearance in Asia, HP-H5N1 spread up the Pacific coast as far as Japan and Korea.



Peterson et al., 2007

Estiman el modelo de nicho sobre la distribución nativa y luego proyectan las condiciones sobre el área de invasión. Ven el riesgo de epidemia por gripe aviar.

Biol Invasions (2007) 9:723–735
DOI 10.1007/s10530-006-9072-y

ORIGINAL PAPER

Modelling the potential geographic distribution of invasive ant species in New Zealand

Darren F. Ward

Received: 10 August 2006 / Accepted: 26 October 2006 / Published online: 29 November 2006

Abstract Despite their economic and environmental impacts, there have been relatively few attempts to model the distribution of invasive ant species. In this study, the potential distribution of six invasive ant species in New Zealand are modelled using three fundamentally different methods (BIOCLIM, DOMAIN, MAXENT). Species records were obtained from museum collections in New Zealand. There was a significant relationship between the length of time an exotic species had been present in New Zealand climate variables for BIOCLIM, but not DOMAIN or MAXENT. Widespread species had a greater commission error. A number of regions in New Zealand are predicted to be climatically suitable for the six species modelled, particularly coastal and lowland areas of both the North and South Islands.

Keywords Invasive ants · BIOCLIM · DOMAIN · MAXENT · Species distribution modelling

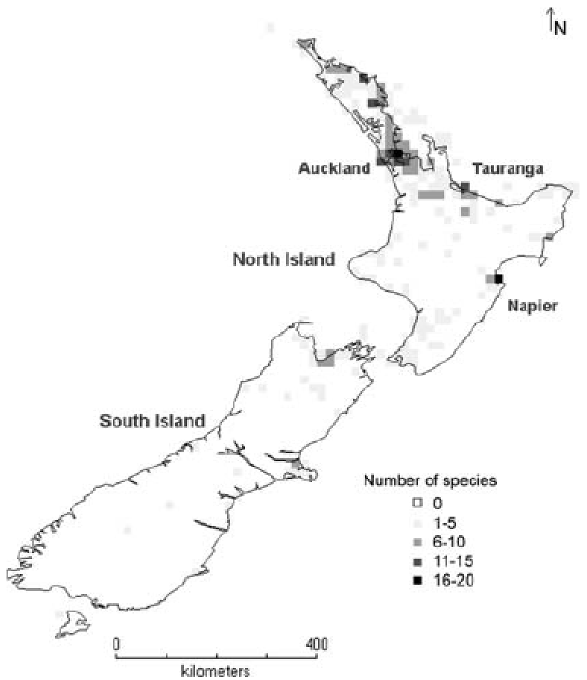
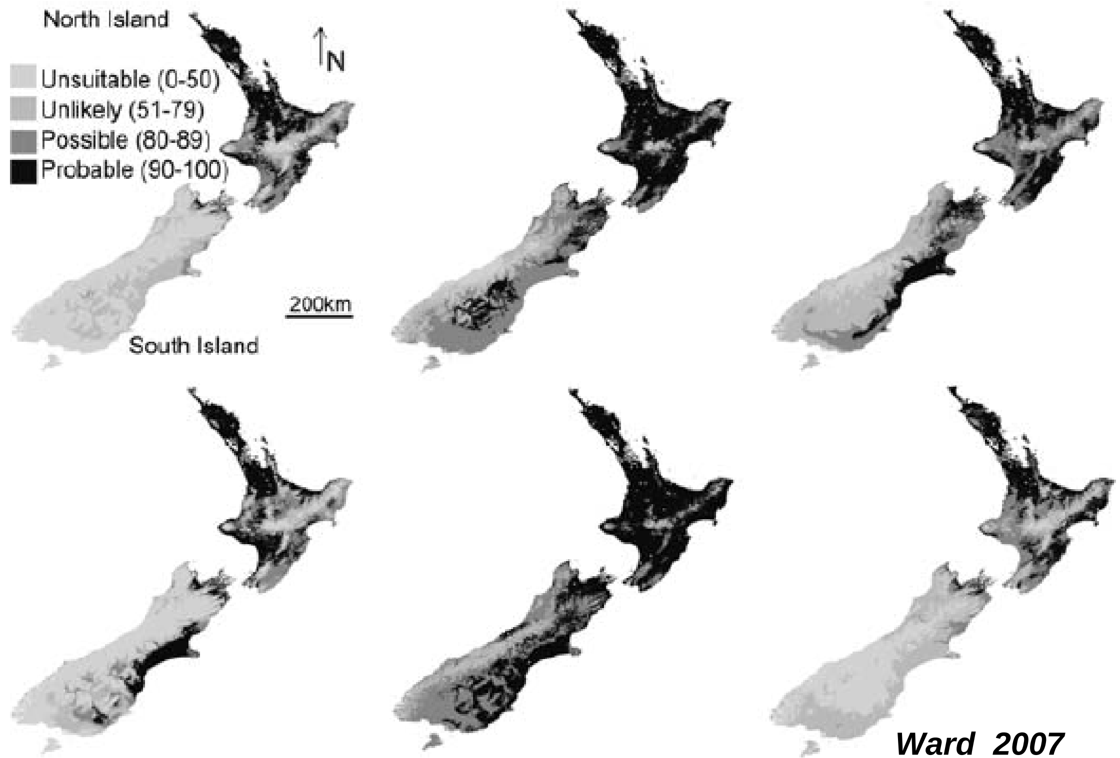


Fig. 1 The current distribution of exotic species in New Zealand (mapped on 20 × 20 km scale). Points off the main islands represent small offshore islands

Toman los puntos de presencia de 6 especies de hormigas invasoras en Nueva Zelanda



Predicen la dimensión que puede tener la invasión.

Ward 2007

Especies invasoras: un buen review

BioScience, 2001

Articles

Predicting Species Invasions Using Ecological Niche Modeling: New Approaches from Bioinformatics Attack a Pressing Problem

A. TOWNSEND PETERSON AND DAVID A. VIEGLAIS

Especies invasoras: una patente

United States Patent 7,308,392Peterson December 11, 2007 Processes and systems for predicting biological species invasions

Abstract
Methods and systems are disclosed for predicting species invasions. Native species occurrence information and native environmental information are received. At least one ecological niche model is formulated based on the native species occurrence information and the native environmental information. Target environmental information corresponding to an alternative geography is received. The ecological niche model is projected onto the alternative geography to predict characteristics of an invasion of the species.
Inventors: **Peterson; Andrew Townsend** (Lawrence, KS) Assignee:**The University of Kansas** (Lawrence, KS)
Appl. No.: **10/167,884**Filed: **June 12, 2002**

Cambio Global

(Cambio climático + Cambio usos del suelo)

16. Aplicaciones: Cambio Global & Biología de la Conservación

Journal of Herpetology, Vol. 41, No. 4, pp. 733–740, 2007

Effects of Land-Cover Transformation and Climate Change on the Distribution of Two Microendemic Lizards, Genus *Uma*, of Northern Mexico

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[3]*Instituto de Ecología, A. C.-Centro Regional Chihuahua, Km. 33.3 Carretera, Chihuahua-Ojinaga, Ciudad Aldama, Código Postal 32900, Apartado Postal 28, Chihuahua, México*

ABSTRACT.—Two species of the Fringe-Toed Lizard, *Uma exsul* and *Uma paraphygas*, are restricted to small areas of sand dunes in the Chihuahuan Desert, where land cover transformation has increased dramatically in recent years and future climatic changes are expected to be severe. The current geographic distribution of each species was estimated by ecological niche modeling using the Genetic Algorithm for Rule-set Prediction (GARP). A recent land-use map was used to determine areas where habitat has been transformed by human activities, and niche models were projected under two simulated climatic scenarios and for two periods of time (2020 and 2050) to estimate their future potential distributions. Results indicate a high degree of anthropogenic habitat transformation within the distribution of *U. exsul*, and an important reduction of its distribution by 2050. For *U. paraphygas* land cover transformation is less severe, but a complete collapse of its current distributions is expected in the future because of climate change. Despite the uncertainty involved, the general trends seem highly feasible and immediate conservation actions are recommended.

Sobre la distribución potencial "enmascaran" el hábitat perdido debido a la transformación del uso del suelo (actual) y el hábitat que se perdería bajo distintos escenarios de cambio climático.

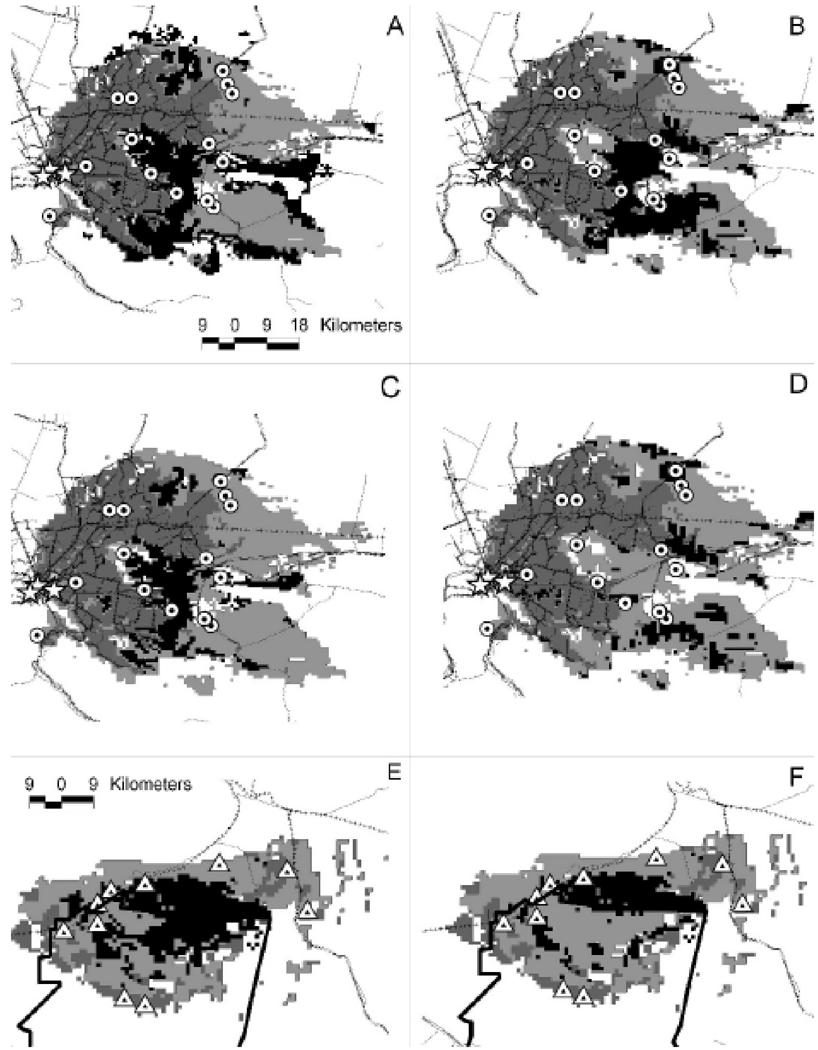

FIG. 2. Potential distributions models of *Uma exsul* for (A) conservative climate change scenario (SRES B2) for 2020, (B) liberal climate change scenario (SRES A2) for 2020, (C) SRES B2 for 2050, and (D) SRES A2 for 2050, and of *Uma paraphygas* for (E) SRES B2 for 2020, and (F) SRES A2 for 2020. The whole distributional range for 2050 under the two climatic scenarios is expected to disappear for 2050; thus, maps are not shown in the figure. Colors correspond to light-grey = distributional areas lost by habitat conversion; dark-grey = current potential distribution, black = predicted distribution remaining in future. Black border indicates the Biosphere Reserve of Mapimí, black and grey lines area highways and roads, white stars are main cities.

Ballesteros-Barrera 2007

The Lichenologist 40(1): 63–79 (2008)
doi:10.1017/S0024282908007275 *Printed in the United Kingdom*

Conservation of the rare British lichen *Vulpicida pinastri*: changing climate, habitat loss and strategies for mitigation

Mark D. BINDER and Christopher J. ELLIS

Abstract: Autecological information targeted towards rare and threatened lichen species is severely lacking. This study adopts the rare British lichen *Vulpicida pinastri* as a case study species and examines its ecological response to emerging threats: climate change and the recurrent loss of its primary habitat (juniper scrub). We used predictive niche modelling to examine the response of *V. pinastri* to a range of present-day climatic variables. A successful model was projected for a period during the 2050s based on IPCC climate change scenarios (UKCIP02 data), and threat was estimated as the proportional change in bioclimatic space. To estimate the potential range now and during the 2050s, projected bioclimatic space was masked by a habitat map equivalent to (i) the

Hacen un modelo climático con las condiciones actuales y:

-Proyectan a climas futuros

-Enmascaran el hábitat con un mapa de distribución de enebro actual y del futuro.

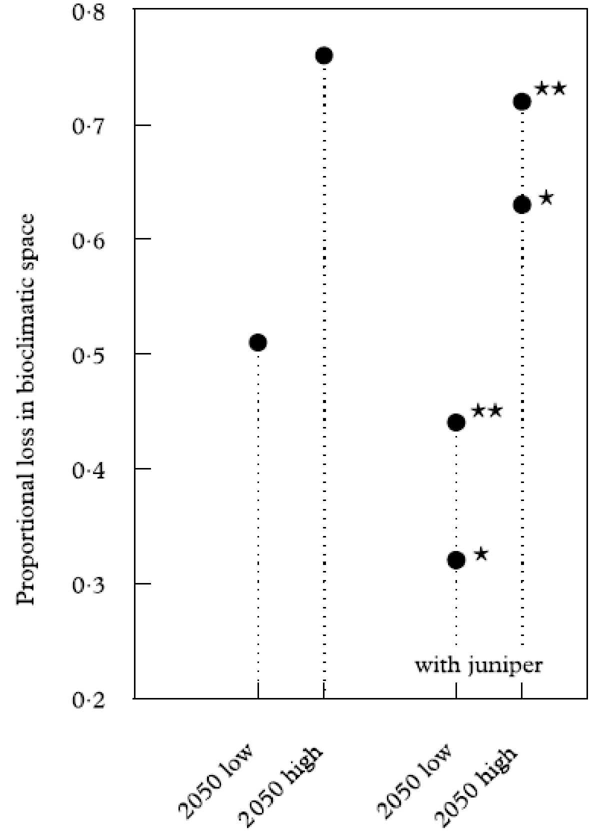

FIG. 5. Proportional loss of bioclimatic space for *Vulpicida pinastri*, calculated (i) between the present-day and 2050s low and high emissions scenarios [i.e. between Fig. 3A and Fig. 4A(a) & B (a)] between present-day projected range with application of the juniper habitat mask (Fig. 3B) and projected future range with a juniper habitat mask equivalent to the present-day distribution of juniper* [Fig. 4A(b) & B(b)] and based on forecasting the existing rates of juniper decline** [Fig. 4 A(c) & B(c)].

Binder & Ellis 2008

Biología de la Conservación

Journal for Nature Conservation ▮ (▮▮▮▮) ▮▮▮–▮▮▮

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Journal for Nature Conservation

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Prioritisation of Mexican lowland rain forests for conservation using modelled geographic distributions of birds

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Natural History Museum, The University of Kansas, Lawrence, Kansas 66045, USA

Received 8 March 2007; accepted 23 January 2008

KEYWORDS
Mexico;
Rain forest;
Birds;

Summary

Mexican humid lowland tropical forests have seen extensive perturbation and deforestation in recent decades, and, as such, effective conservation planning is crucial. We developed ecological niche models and predicted geographic distribu-

16. Aplicaciones: Cambio Global & Biología de la Conservación

Modelizan el hábitat potencial de 89 especies de aves y establecen prioridades de conservación en base a la riqueza de especies(porque su hábitat potencial está amenazado por la deforestación).

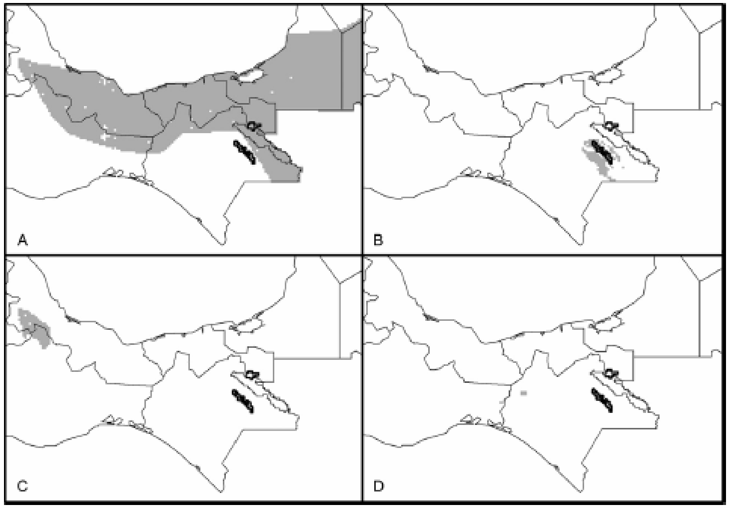


Figure 1. Example distributional models for four species developed in this study: (A) *Pipra mentalis*; (B) *Myrmotherula schisticolor*; (C) *Hylorchilus sumichrasti*; and (D) *H. navai*. Shown with black lines are the priority areas detected in this study.

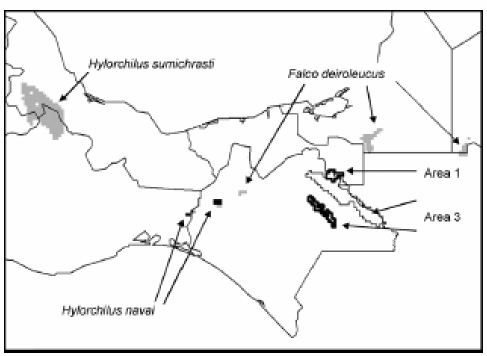


Figure 2. First three areas identified by the pixel-based prioritisation analyses, which added 79, 4, and 3 species to the system, as well as the predicted distributions of the three species (*Falco deiroleucus*, *Hylorchilus sumichrasti*, *H. navai*) that did not fall in any of the three areas.

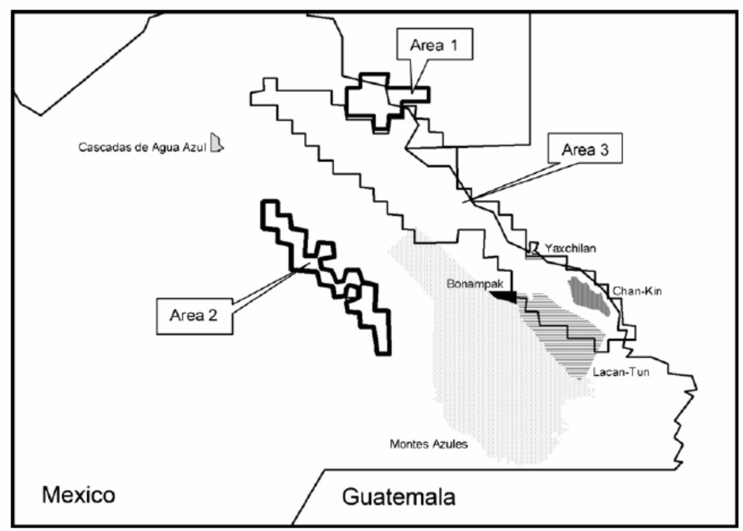


Figure 3. Areas identified in the prioritisation analyses in relation to existing protected areas in northern Chiapas.

Toribio & Peterson 2008

16. Aplicaciones: Cambio Global & Biología de la Conservación

Diversity and Distributions, (Diversity Distrib.) (2007) **13**, 890–902

BIODIVERSITY RESEARCH

Modelling ecological niches from low numbers of occurrences: assessment of the conservation status of poorly known viverrids (Mammalia, Carnivora) across two continents

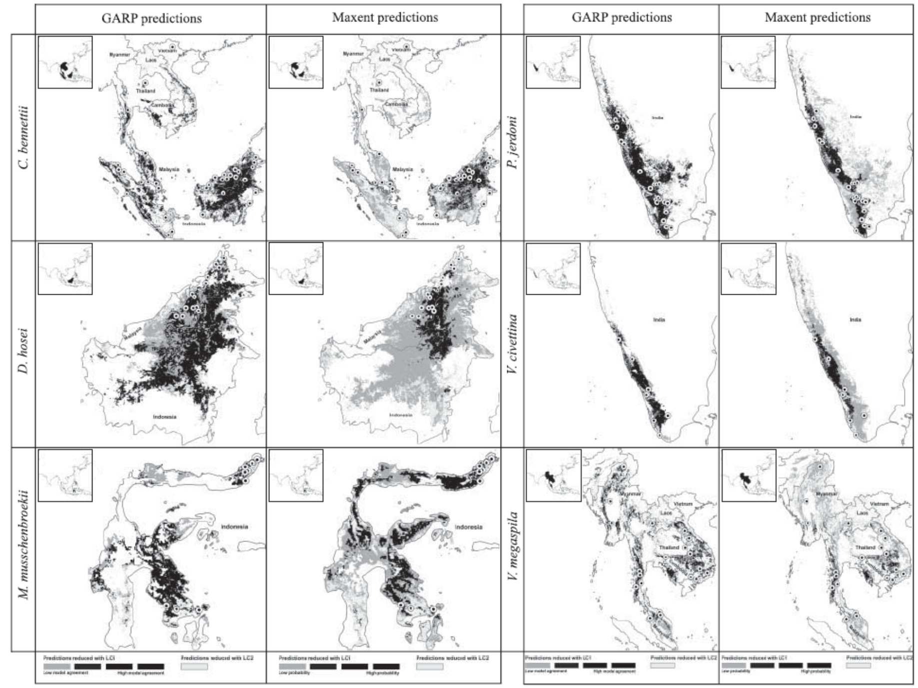
M. Papeş[1] and P. Gaubert[2]*

[1]*Natural History Museum and Biodiversity Research Center, The University of Kansas, 1345 Jayhawk Boulevard, Lawrence, KS 66045-7561, USA,* [2]*Département Milieux et Peuplements Aquatiques, Muséum National d'Histoire Naturelle, UR IRD 131 – UMS MNHN 403, 43 rue Cuvier, 75005 Paris, France*

ABSTRACT

The conservation of poorly known species is difficult because of incomplete knowledge on their biology and distribution. We studied the contribution of two ecological niche modelling tools, the Genetic Algorithm for Rule-set Prediction (GARP) and maximum entropy (Maxent), in assessing potential ranges and distributional connectivity among 12 of the least known African and Asian viverrids. The level of agreement between GARP and Maxent predictions was low when < 15 occurrences were available, probably indicating a minimum number below that necessary to obtain models with good predictive power. Unexpectedly, our results suggested that Maxent extrapolated more than GARP in the context of small sample sizes. Predictions were overlapped with current land use and location of protected

Modelizan la distribución potencial de 12 especies de mamíferos…



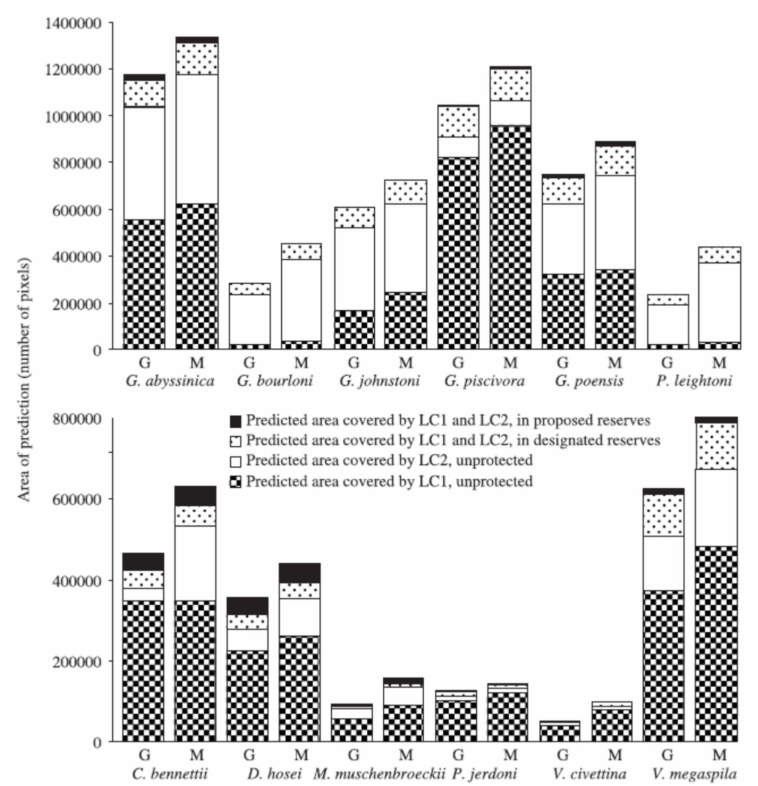


Figure 3 Extent of areas predicted present by GARP (G) and Maxent (M), which overlap with restricted land-cover layer (LC1), moderate land-cover layer (LC2), and designated and proposed reserves. African species are shown in upper panel and Asian species in lower panel.

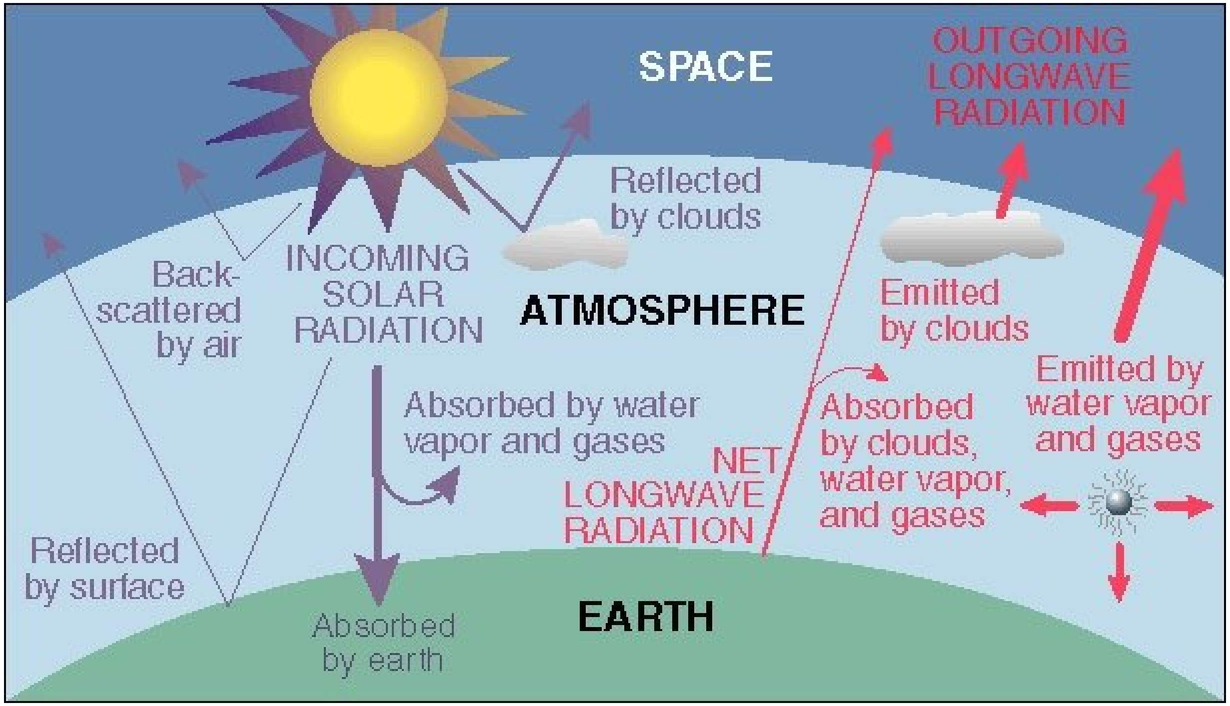
Y estiman si las reservas de la IUCN protegen suficientemente sus hábitats

Papes & Gaubert . 2007

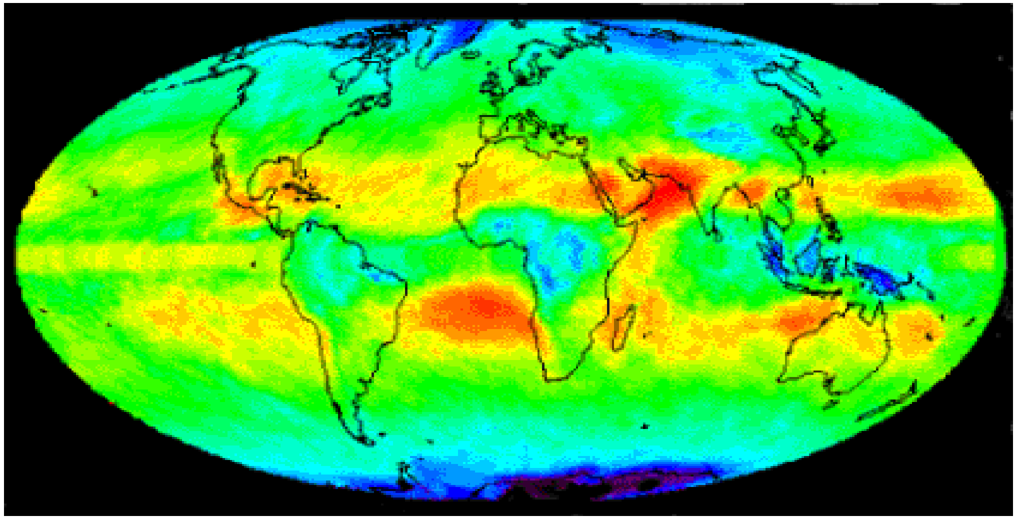
Modelos de nicho y Funcionamiento ecosistémico

¿Qué factores son importantes en el control de la distribución de las especies?

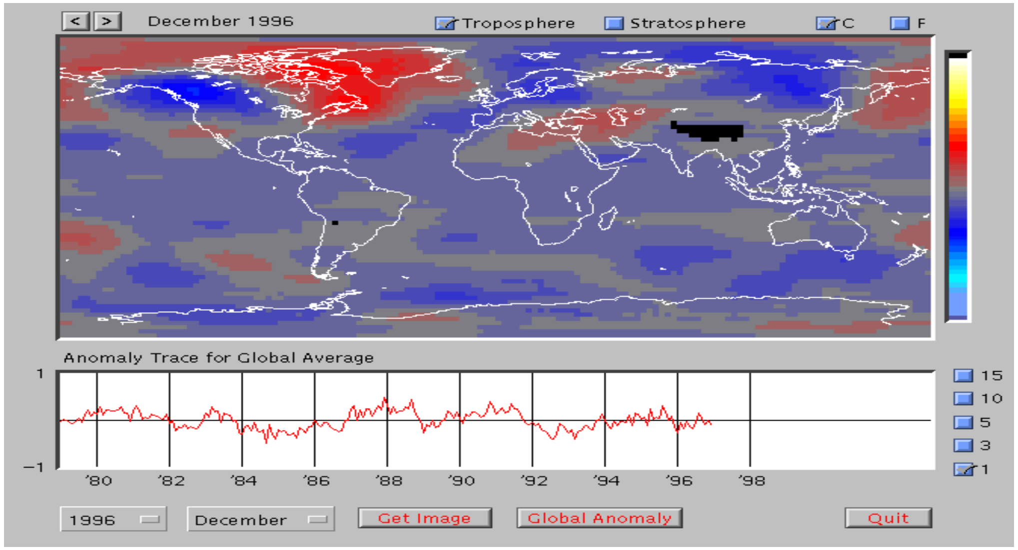
Los factores últimos tienen que ver con los requerimientos de energía de las especies.



La energía sola provee…

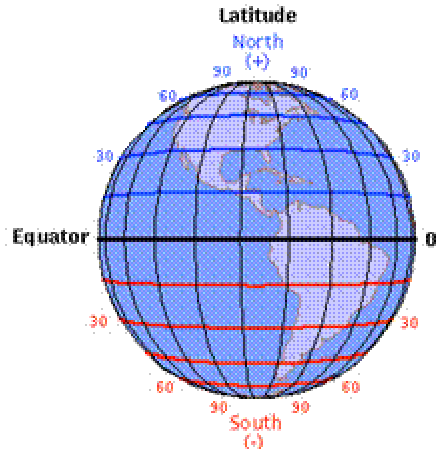


Luz
(cantidad y calidad)



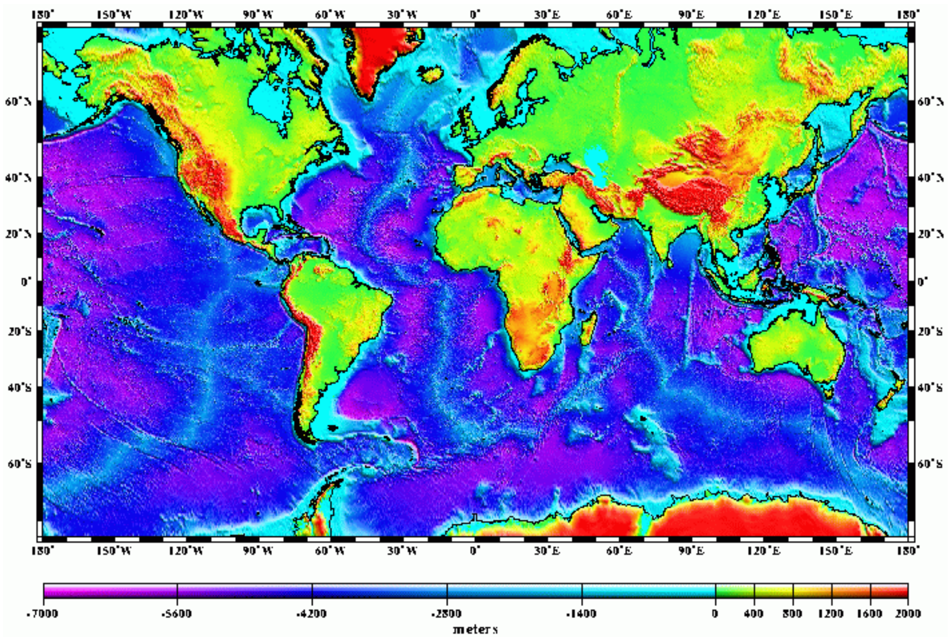
Calor

¿Qué factores afectan la radiación solar y la temperatura?



Microsoft Illustration

Latitud



Topografía:

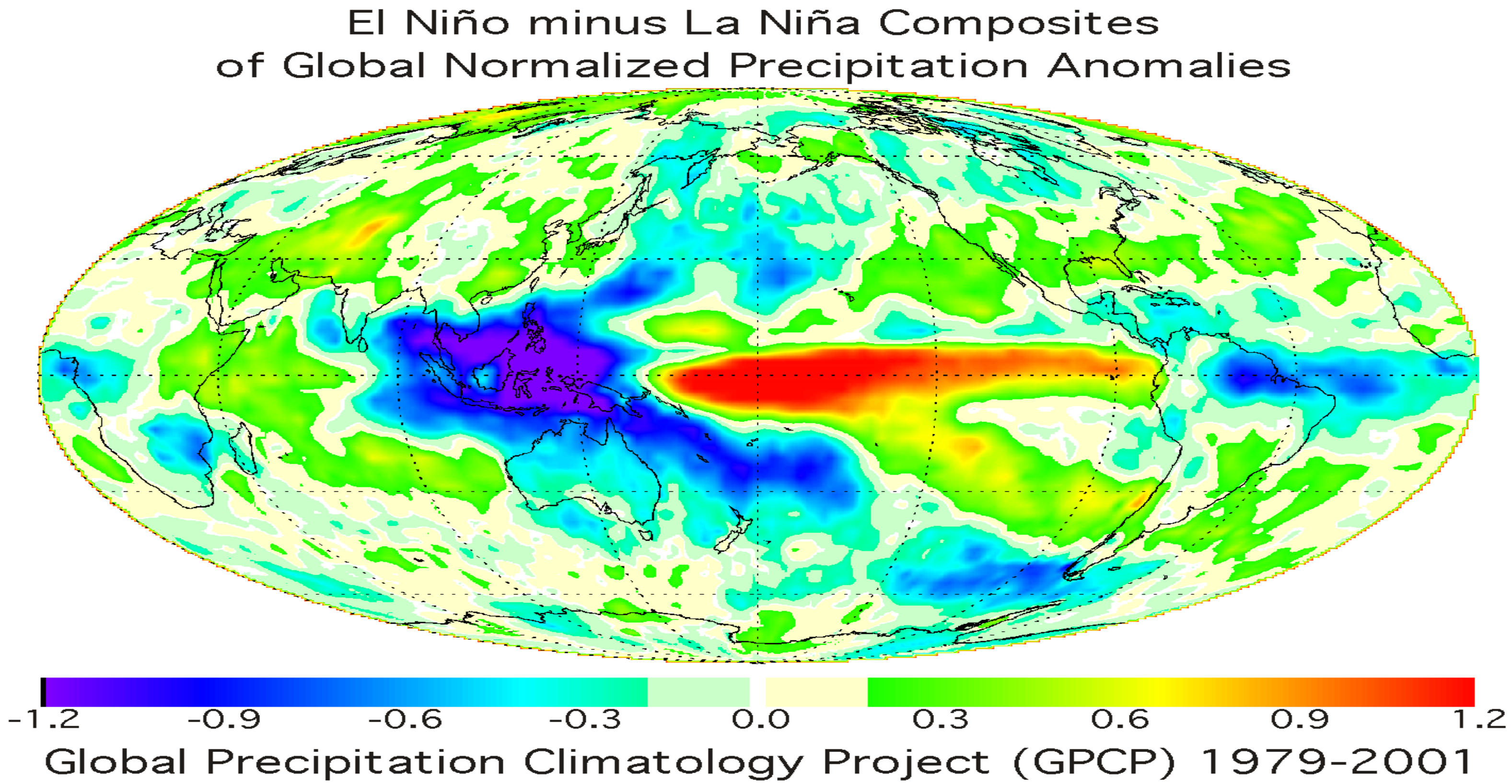
Elevación

Pendientes

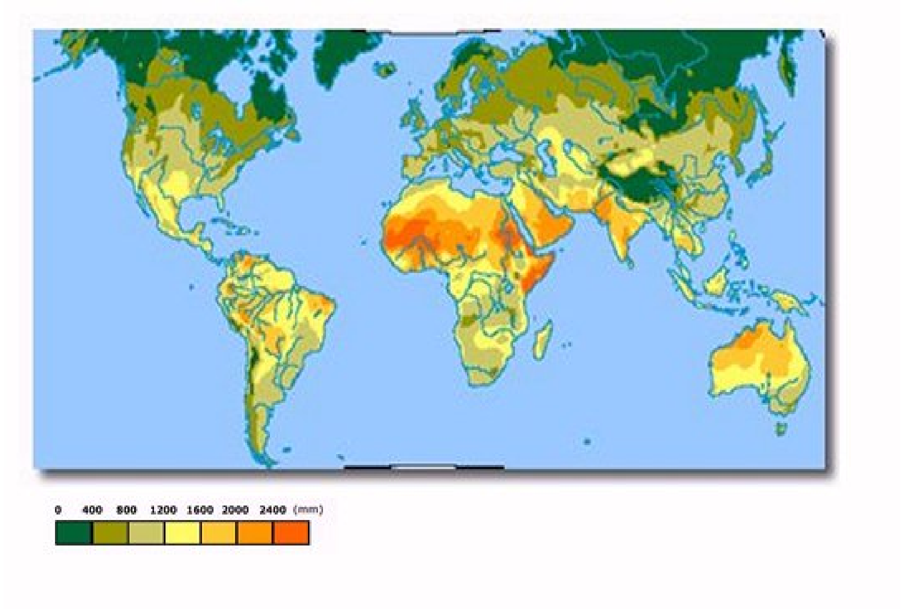
Orientación de pendientes

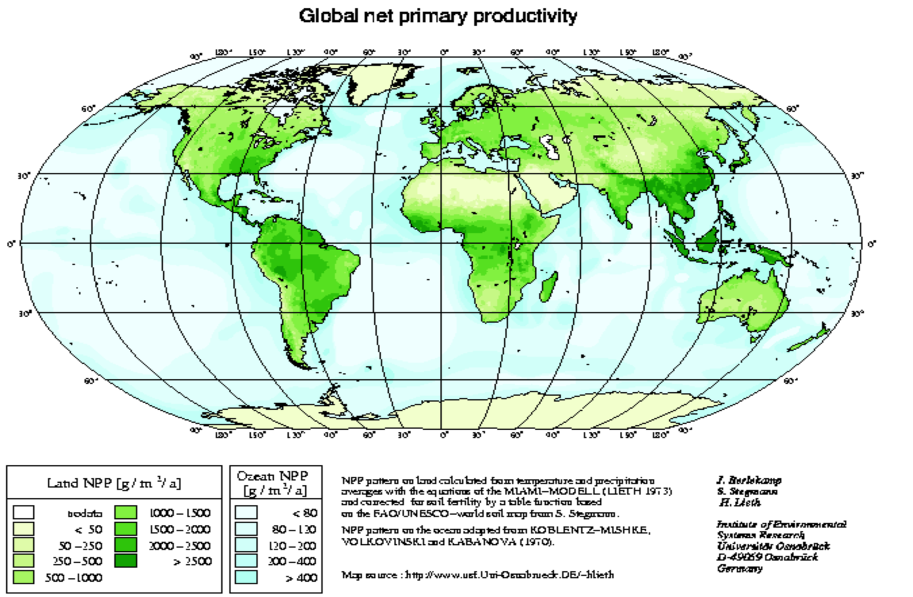
Pero la energía no lo es todo…

La vida también requiere agua



Existen también manifestaciones funcionales de la interacción de estos factores



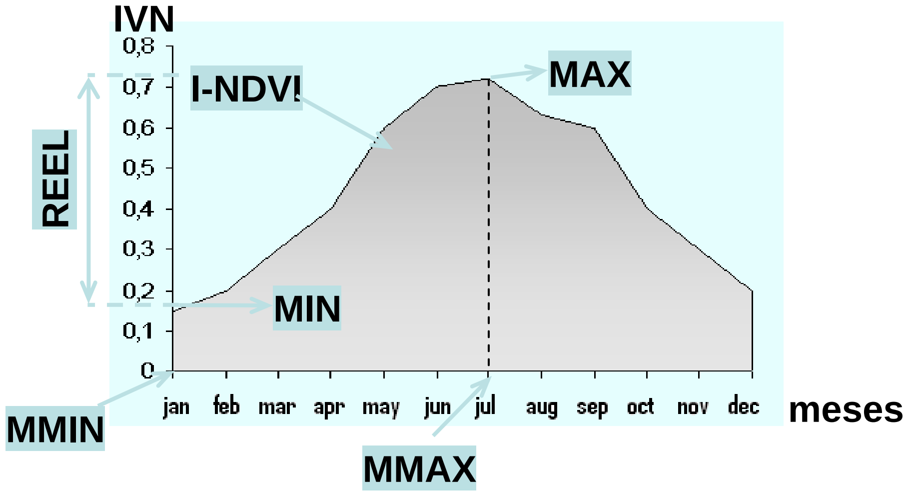


evapotranspiración **productividad**

El IVN (*NDVI*) es un buen estimador del funcionamiento ecosistémico (intercambio de materia y energía en los ecosistemas).

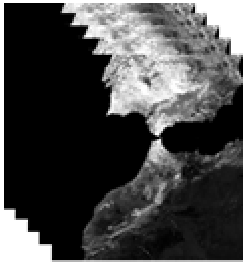
- Atributos espectrales relacionados con el funcionamiento de los ecosistemas

  - **IVN-I: -> NPP, fPAR**
  - *MAX: -> Máxima actividad*
  - *MIN: -> Mínima actividad*
  - *RREL: -> Estacionalidad*
  - *MMIN: -> Fenología*
  - *MMAX: -> Fenología*

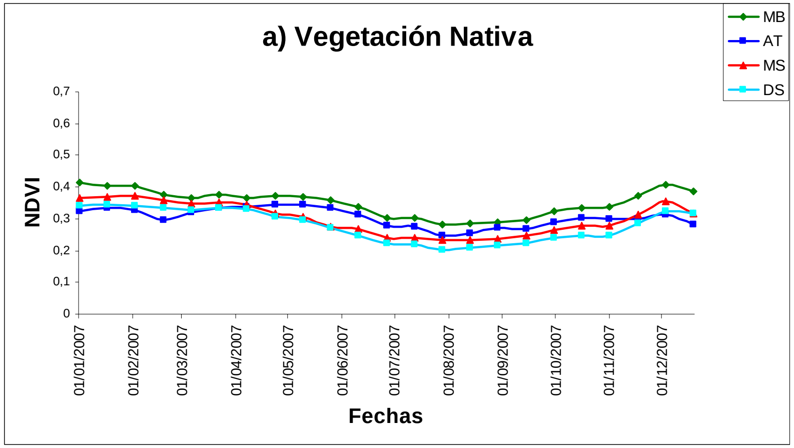


- Tendencias en el funcionamiento ecosistémico (test no-paramétrico Mann-Kendall)

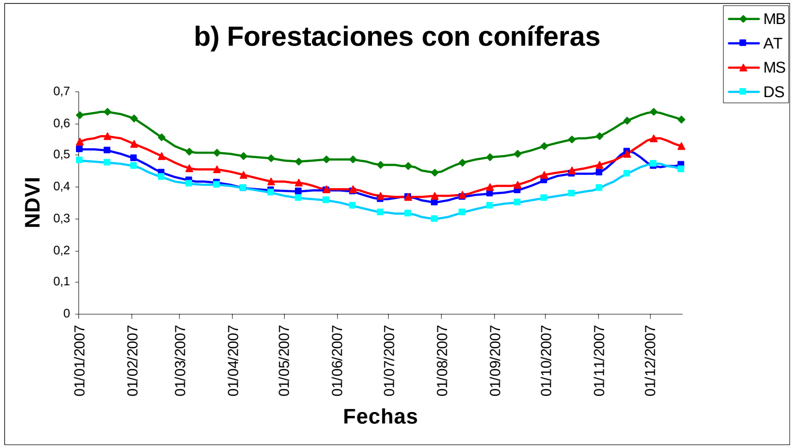
Imágenes de satélite:
Serie temporal de IVN NOAA-GIMMS
(8X 8 km), (1982-2000)

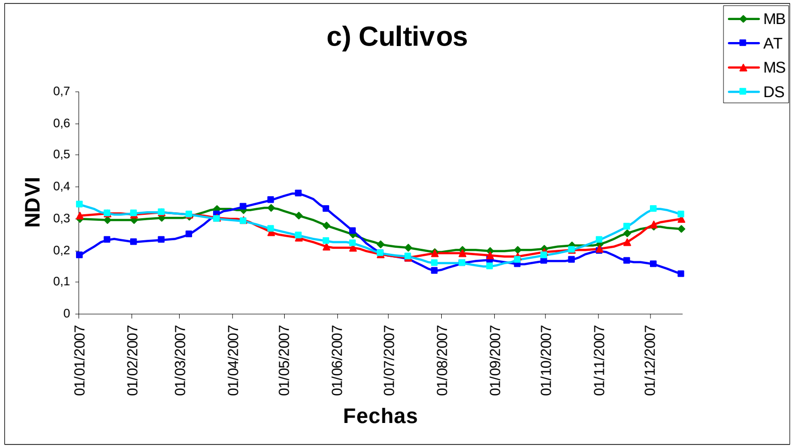


Además, el funcionamiento ecosistémico depende del uso del suelo…



…por lo que puede ser una buena herramienta para evaluar el Cambio Global





Cabello et al. 2007

Además, por imágenes de satélite se pueden seguir fácilmente las variables que controlan la distribución de algunas especies….

Ecology, 89(5), 2008, pp. 1414–1427

BOTTOM-UP AND CLIMATIC FORCING ON THE WORLDWIDE POPULATION OF LEATHERBACK TURTLES

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Abstract. Nesting populations of leatherback turtles (*Dermochelys coriacea*) in the Atlantic and western Indian Oceans are increasing or stable while those in the Pacific are declining. It has been suggested that leatherbacks in the eastern Pacific may be resource limited due to environmental variability derived from the El Niño Southern Oscillation (ENSO), but this has yet to be tested. Here we explored bottom-up forcing and the responding reproductive output of nesting leatherbacks worldwide. We achieved this through an extensive review of leatherback nesting and migration data and by analyzing the spatial, temporal, and quantitative nature of resources as indicated by net primary production at post-nesting

En resumen…

La evaluación de los impactos del cambio global

Dentro de los impactos tenemos:

- Impactos por cambios en el clima
- Impactos por cambios en los usos del suelo
- Impactos en el funcionamiento: si el funcionamiento cambia, podemos determinar una alerta de que algo está cambiando, bien sea el uso del suelo, o el funcionamiento de los ecosistemas por cambios en la temperatura, o los 2

El seguimiento del cambio global

- Una herramienta muy útil son los sensores remotos, debido a que la información tiene alta resolución espacial y es repetitiva en el tiempo (y además, hay una tendencia a que sea gratis!)
- Si con parámetros del satélite caracterizamos el funcionamiento: podemos seguir como este cambia e intentar relacionarlo con otras cosas
- Y además, el funcionamiento alterará el nicho de las especies.

Muchas gracias