



## Progress on ecosystem risk assessment 2014-15

### Red List of Ecosystems Steering Committee, March 2015

The IUCN Red List of Ecosystems (RLE) programme continues to grow rapidly in several areas.

#### Development of listing criteria and their application

**Listing criteria.** Version 2 of the RLE Categories and Criteria (Keith et al. 2013<sup>1</sup>) was formally adopted as a global standard for ecosystem risk assessment at the IUCN Council meeting in May 2014. A preliminary version of guidelines for the application of the Red List of Ecosystems categories and criteria was published in *Philosophical Transactions of the Royal Society B* (Rodríguez et al. 2015<sup>2</sup>) in January 2015. Input on the preliminary version will contribute to a revised and expanded version, the *IUCN Red List of Ecosystems Guidebook: Categories, Criteria and Application*, expected for release in the second half of 2015.

A joint meeting of the Commission on Ecosystem Management (CEM) and the Species Survival Commission (SSC) was held in Cambridge in January 2014 to discuss technical issues and opportunities for integrated development<sup>3</sup>. Two policy perspectives discussing a range of issues and challenges related to the Red List of Ecosystems, including several raised at the CEM/SSC Cambridge workshop, have been written. The first of these was published online in April 2014 (Boitani et al. 2014<sup>4</sup>), and the second was published online in April 2015 after several editorial delays (Keith et al. 2015<sup>5</sup>). Both articles will appear in a future issue of *Conservation Letters*.

Research and development work on the Red List of Ecosystems criteria was recognised in the 2013 and 2014 horizon scans of global conservation issues, the Australian Ecology Research Award 2013 and as a finalist for the Eureka Prize on Environmental Research 2014. The scientific paper describing the Red List of Ecosystems method and its theoretical context (Keith et al. 2013) has received more than 24,000 views on the PLoS ONE website alone (<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0062111>). It has an Altmetric of 184, placing it in the top 0.1% of articles tracked.

**Standards Committee.** A multi-disciplinary Committee for Scientific Standards (CSS) was convened in July 2014 to prepare guidelines for application of the Red List of Ecosystems criteria and provide technical advice on Red Listing projects. The committee includes

<sup>1</sup> <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0062111>

<sup>2</sup> <http://rstb.royalsocietypublishing.org/content/370/1662/20140003>

<sup>3</sup> A report of the meeting can be found at:

[https://cmsdata.iucn.org/downloads/cem\\_ssc\\_rle\\_workshop\\_jan2014\\_final\\_report\\_web.pdf](https://cmsdata.iucn.org/downloads/cem_ssc_rle_workshop_jan2014_final_report_web.pdf)

<sup>4</sup> <http://onlinelibrary.wiley.com/doi/10.1111/conl.12111/abstract>

<sup>5</sup> <http://onlinelibrary.wiley.com/doi/10.1111/conl.12167/abstract>



expertise in terrestrial, freshwater and marine ecosystem ecology, classification and mapping, remote sensing, conservation planning and ecological modelling (Annex 1). The CSS held its first meeting in March 2015, hosted by the Finnish Environment Institute in Helsinki.

**Ecosystem typology.** Work has begun on a framework for a global ecosystem typology. This work is led by terrestrial, freshwater and marine experts within the CSS and was initiated at the CSS meeting held in Helsinki in March 2015 after some preparatory work by the RLE team. IUCN Red List Unit staff have been invited to participate in the evolving work. Documentation of progress will be available in the second half of 2015 (for more information or to get involved, contact the RLE team through [Rebecca.MILLER@iucn.org](mailto:Rebecca.MILLER@iucn.org)).

**Research and Development.** A research project addressing key issues for the development of the Red List of Ecosystems protocol is underway. The project is jointly funded by the Australian Research Council (ARC), IUCN through a MAVA Foundation grant, and two Australian government conservation agencies. Two postdoctoral fellows (Dr Nick Murray, Dr Lucie Bland) and one PhD student have been appointed to the project. The project is addressing several research questions, including spatial and thematic scaling, quantification of ecosystem degradation, development of ecosystem models and a framework for a global ecosystem typology. To date, the RLE team has produced 22 peer-reviewed scientific publications (listed in Annex 2).

Additionally, as part of a MAVA Foundation grant and an IUCN-Moore grant, Provita and EcoHealth are currently exploring the scientific basis for application of criteria C, D and E with limited or sparse data. The approach includes data mining different databases as well as state-of-the-art modelling techniques. Three scientific papers are in progress regarding this research, including one about the applications of RLE on policy and management programs at different spatial and administrative scales. The RLE national teams of Costa Rica and Colombia are involved in this initiative.

**Application tools.** The RLE team continues to develop tools and tutorials to support the application of the RLE criteria. Existing tools include guidance documents for practical application of the criteria, an expanding portfolio of detailed case studies, and an Excel calculator to help use data estimates to determine the correct category and criteria. Guidelines for developing conceptual models of ecosystem dynamics and spatial tools for application in ArcGIS, QGIS and R, as well as remote training resources, are in development. Tools and tutorials will be distributed via the Red List of Ecosystems website ([www.iucnredlistofecosystems.org](http://www.iucnredlistofecosystems.org)).

**Database.** The development of the RLE database is ongoing. At this moment, a conceptual model and the fields associated with each component have been defined (Figure 1). The

spatial component of the database is crucial to the development of an efficient and powerful information resource to support conservation activities. Similarly, the connectivity with other IUCN databases (i.e., with other knowledge products) is a major consideration in the development process. In order to achieve connectivity between the different databases, the RLE team has begun engaging with the IUCN Red List Unit, including meetings at the IUCN World Parks Congress in Sydney (November 2014) to discuss technical issues, as well as exploration of the use of the IUCN Red List of Threatened Species habitat classification and threat classification schemes in both databases. A prototype RLE database should be ready by end-2015.

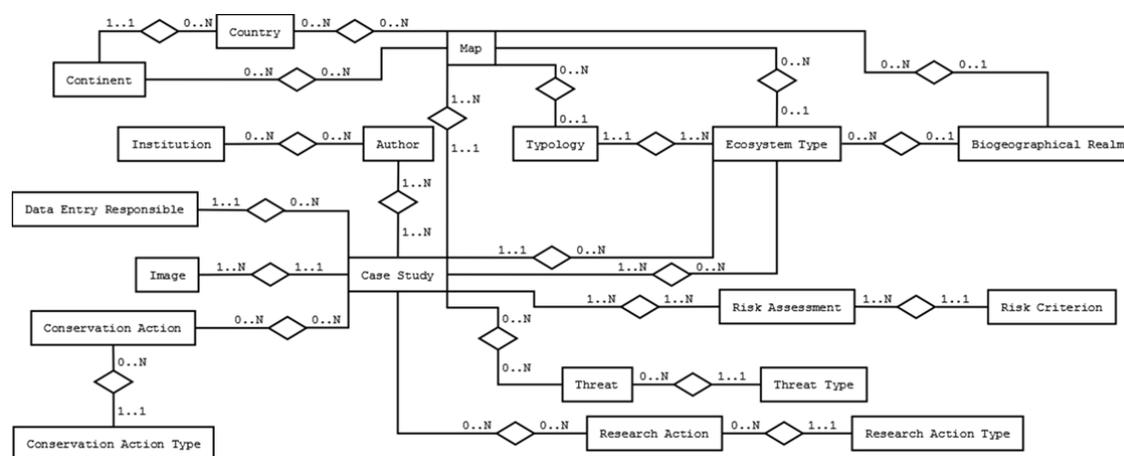


Figure 1. Conceptual model of the RLE database.

## Assessments

**Americas.** The Americas project continues to make progress. The typology and basic spatial data are now almost complete for both continents, excluding boreal North America, which is awaiting progress on the circumpolar boreal vegetation map. Descriptions of the 600 ecological systems have been reviewed and are complete for temperate North America and Mexico. These identify characteristic native biota and the principal threats affecting each ecosystem type. The ecological systems are each assigned to vegetation macrogroups to enable analysis at that level. The descriptions for the 200 units (based on vegetation macrogroups) in South America are in progress, and do not yet include information on key processes and interactions or threats, while those for Central America and the Caribbean are also ready as advanced drafts. The completed descriptions are expected to be ready by April 2014. Other available regional and global databases are being identified and downloaded in order to facilitate and complement the analyses (these include databases on



global forest change and croplands, among others). Data analyses will commence shortly and results are expected to be available later this year.

National Red List assessments are well advanced in several South and Central American countries. A preliminary Red List of Ecosystems assessment has been completed for El Salvador, while work is at varying stages in Bolivia, Colombia, Chile, Costa Rica, Ecuador, Paraguay, Peru, Uruguay, Venezuela, and several large regions (states, watersheds) in Brazil.

**Australia.** A workshop was held in Australia to introduce the Red List of Ecosystems to agency representatives and establish a network of ecosystem scientists and spatial scientists. The workshop was sponsored by the Australian Centre for Ecological Analysis and Synthesis (ACEAS). The outcomes include a review of listing processes in existence across Australian jurisdictions, a new set of 11 case studies applying the criteria to a sample of contrasting terrestrial, freshwater and marine ecosystems (see Annex 2) and groundwork for a strategy to carry out a systematic risk assessment for the Australian continent. These outputs are available early online in a special issue of *Austral Ecology*, which will be published by mid-year 2015.

**Africa.** Substantial progress has been made towards preliminary Red List assessments of ecosystems in African countries, including Senegal and Morocco. A project has been initiated to commence a preliminary assessment of ecosystems in Madagascar, while negotiations are underway to develop similar initiatives in central and east African countries. These initiatives will provide the opportunity to explore how RLEs can inform practical application and decision-making (conservation and land/water use action), as well as piloting integration with other conservation knowledge products.

**Asia.** In north Asia, a Red List case study has been completed for a tidal mudflat ecosystem spanning three countries around the Yellow Sea. The study has generated interest in Chinese research institutions and several collaborators have expressed interest in taking assessments forward to other priority ecosystems. Colleagues in IUCN's China office are working towards increasing the exposure of the Red List of Ecosystems to governments when China hosts the first World Ecosystem Forum in the second half of 2015. Indeed there is also interest in China at the regional level to complete Red Lists of Ecosystems for administrative/political units.

**Europe.** The RLE team is working closely with institutions in Norway, Finland, Switzerland and France in the implementation of national Red Lists of Ecosystems. Norway and Finland are producing updates of inaugural assessments published within the last five years, while France and Switzerland are initiating their first Red Lists of Ecosystems. A meeting was held in Helsinki in March 2015 to convene a planning group to initiate an arctic/boreal ecosystem specialist group and eventually a Red List of Ecosystems assessment project. Key interests



were identified to take the idea forward to a strategic project description. IUCN is also providing input to a European Union project to develop a Red List of habitat types found in the EU28 nations. The RLE team has provided critical comment on the project's listing criteria for habitat types and convened a training workshop for lead assessors in Brussels in June 2014.

### **Influencing policy development**

**Legislative initiatives.** Three national governments (Norway, Finland, and Australia) are well advanced in their considerations to adopt IUCN Red List of Ecosystems categories and criteria as national standards for listing threatened ecosystems under biodiversity legislation. Norway and Finland have agreed timetables to proceed with their second national assessments with decisions on the adoption of IUCN RLE criteria due this year. The RLE team has a close working relationship with officials from both countries, and continues to offer scientific advice in support of their decision making processes through informal communications and face-to-face meetings. Australia has convened a three-member expert panel with IUCN representation to assist deliberations on the adoption of IUCN criteria for both species and ecosystems across all state and national jurisdictions. The RLE team is also in contact with the Rwandan government to support implementation of its newly enacted biodiversity legislation, which includes provisions for listing threatened ecosystems.

**National assessments.** National assessments for Red Lists of Ecosystems are underway in many other countries with support from IUCN, including Venezuela, Colombia, Chile, El Salvador, Costa Rica, Senegal, Morocco, Madagascar, Rwanda, Finland and Norway. In Madagascar, a project is underway to test the integration of multiple knowledge products including Red Lists of Ecosystems and Threatened Species, together with Key Biodiversity Areas.

A policy perspective was prepared by invitation on the role of Red Lists of Ecosystems in valuing nature, published in early 2015 by the Australian Committee for IUCN.

### **Communications**

**Website.** The Red List of Ecosystems website ([www.iucnredlistofecosystems.org](http://www.iucnredlistofecosystems.org)) was launched on September 2012. Since then, the process of publishing all content in the three official IUCN languages has continued. At present, 90% of all content is published in English, Spanish and French, including the latest scientific publications: Keith et al. (2013) is available in all three IUCN languages, while Rodríguez et al. (2015) is available in English and will soon

be also available in Spanish and French (including their respective appendices). News stories and updates are regularly published (16 news releases and 23 media coverage items since January 2014). To date, the website has received 27,000 visits from around the world (Figure 2). In the period Jan 1<sup>st</sup> 2014 – March 25<sup>th</sup> 2015, the number of sessions reached 14,614, with 46,506 pages visited. The role of RLE social media has increased in importance since September 2012, with more than 4,000 followers in Facebook and 1,900 in Twitter currently.

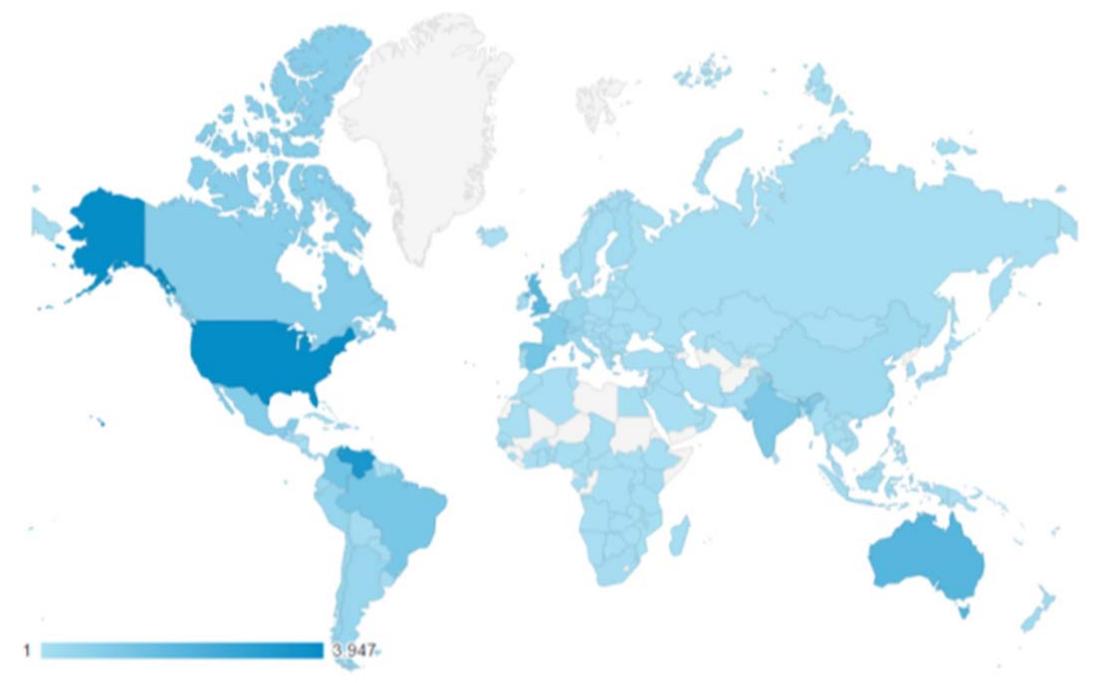


Figure 2. Geographical use of the RLE website ([www.iucnredlistofecosystem.com](http://www.iucnredlistofecosystem.com)) since its launch in September 2012 at the V IUCN World Conservation Congress (Jeju, South Korea).

***Ecosystem photography contest.*** The Second IUCN Red List of Ecosystems Photo Contest was held between July 25<sup>th</sup> and October 5<sup>th</sup> 2014, with the participation of amateur photographers from all over the world. A total of 235 photos were submitted for judging representing ecosystems from Africa, America, Antarctica, Asia, Europe and Oceania. A selection of entries was on display at the IUCN World Parks Congress in Sydney in November 2014, where the results of the contest were also announced. The competition attracted many quality entries and generated keen interest at the Congress. A video highlighting the Contest’s semi-finalist photos was prepared and published on the RLE website



([www.iucnredlistofecosystems.org](http://www.iucnredlistofecosystems.org)), and on RLE social networks (Facebook and Twitter). The winning photos are also available on the RLE website.

The Third IUCN Red List of Ecosystems Photo Contest is currently in the initial stages of planning, with the goal of announcing the outcomes during the first World Ecosystem Forum to be held in China in October 2015.

**Brochures and video.** An RLE informational brochure and video were prepared for distribution at the IUCN World Parks Congress. The brochure is available on the RLE website in English (translation to the other official IUCN languages underway). The video will be soon available on the website.

Currently the RLE website is under redesign so as to be more versatile and more effectively integrate the requirements of RLE users. The new version will be available in late-2015.

**Conference presentations.** The Red List of Ecosystems team contributed to four sessions at the IUCN World Parks Congress in Sydney (November 2014). This included a joint session with the IUCN Red List of Threatened Species team on the value of IUCN Red Lists to monitoring and for management, and a session focused on the 'reality of risk' which explored how building links between ecosystem and social vulnerability assessments can better inform decision-making (with particular focus on disaster risk reduction and ecosystem-based adaptation to climate change). Participation in the Congress greatly increased exposure of the Red List of Ecosystems to potential end users and contributors.

Invited plenary presentations on the Red List of Ecosystems were delivered at conferences for the joint meeting of ecological societies of Australia and New Zealand (Auckland, November 2013); the Phylogeny, Extinction Risks and Conservation meeting hosted by the Royal Society (London, March 2014); IUCN's symposium on Valuing Nature (Brisbane, June 2014); the Society for Conservation Biology Oceania meeting (Fiji, July 2014); and the XI International Forum on Nature Conservation (Málaga, Spain, January 2015). Presentations were also delivered at the Cambridge Conservation Forum Summer Symposium (Cambridge, UK, June 2014), the 'Red List at 50' event hosted by the Zoological Society of London (October 2014), the annual meeting of the International Council on Mining and Metals (October 2014), and a Seminar at Trinity College Dublin (which attracted participation from the National Parks and Wildlife Services), among others.

### **Building capacities**

IUCN has provided training and technical support to several groups in Africa, Australia, America and Europe:

- West Africa: A workshop was held in Dakar in July 2012 to train participants from West African countries and invite contributions to the development of the criteria.
- The Australian Centre for Ecological Analysis and Synthesis funded a training workshop for government agencies and ecosystem scientists in Brisbane in March 2013. Follow up includes changes in policy and procedures within Australian government agencies, a review of listing processes (Nicholson et al. 2015<sup>6</sup>) and a special issue of *Austral Ecology* with 14 scientific papers.
- Brasilia, April 2014: Brazilian RLE: six case studies and Guyra (Paraguay). This training was in the context of the Ecosystem Alliance Project, which includes Brazil and Paraguay.
- European Red List of Habitats project, funded by the European Commission. A training workshop to introduce Red List of Ecosystems concepts and techniques was convened by the RLE team in Brussels in June 2014. Although IUCN RLE Version 2 criteria will not be applied in this project, IUCN continues to inform the development of assessment methods by project leader Alterra.
- Bogotá, September 2014: Universidad Javeriana and Conservation International – Colombia, and CATIE (Costa Rica).
- Brasilia, August 2014: Brazilian RLE: six case studies and Vida Silvestre (Uruguay)

In April 2015, an international training course will be held at the CATIE headquarters, in Costa Rica. IUCN-Sur, ORMACC and national delegates from Latin America will participate. Topics covered in the course include: preparation of data, application of the RLE Categories and Criteria, and discussion about the applicability of RLE at national and global scales.

## Conclusion

In the relatively short time that RLE has been in existence, significant progress has been made, such that demand outstrips the ability to supply. In meeting demand, the RLE team endeavours to balance delivery with quality of delivery. Key challenges for the immediate future include:

- a) completing and publishing the results of a preliminary Red List assessment for the terrestrial ecosystems of the Americas;
- b) testing integration of RLE with other knowledge products mobilized by IUCN at national and sub-national levels;
- c) resolving scientific challenges in applications of RLE criteria and categories;
- d) developing a global framework for an ecosystem typology to assist integration of national, regional and global Red Lists;
- e) seeking and achieving data-set compatibility;

---

<sup>6</sup> <http://onlinelibrary.wiley.com/doi/10.1111/aec.12148/abstract>



- f) testing application of RLE in terms of conservation and land/water use action on the ground; and
- g) seeking a broader funding base to achieve, global, national and regional RLE objectives.

With the vagaries and implication of climate change (risk, disasters, ecosystem and land/water use changes), and the ever increasing demands placed on nature, the role of RLE is clear and unequivocal: to provide ecosystem risk analyses, and diagnoses of the causes of risk and degradation, on which conservation and land/water use action can be based. Future development of the RLE will contribute to the achievement of the Sustainable Development Goals and the Aichi targets, as well as national and regional targets for nature conservation and improved human well-being worldwide.

### Annex 1: RLE Committee for Scientific Standards Membership (as of March 2015)

Additional representatives attended the inaugural meeting (March 2015), including Jonathan Higgins (freshwater ecosystems; The Nature Conservancy), Teemu Tahvaneinen (freshwater mire ecosystems, boreal ecosystems; University of Eastern Finland), Kenric Osgood (oceanic ecosystems; National Oceanic and Atmospheric Administration), Arild Lindgaard (national Red Listing, ecosystem classification; Norwegian Environment Agency).

Name	Role	Location	Institution
David Keith	Chair	Australia	Centre for Ecosystem Science, University of New South Wales
Jon Paul Rodriguez	Steering Committee, risk assessment	Venezuela	Instituto Venezolano de Investigaciones Cientificas, Provita
Florencia Sangermano	spatial analysis	USA	Clark University
Pat Comer	spatial analysis	USA	NatureServe
Carlos Zambrana-Torello	ecosystem processes, spatial modelling	USA	EcoHealth Alliance
Kate Rodriguez-Clark	risk assessment, ecosystem function	Venezuela	Instituto Venezolano de Investigaciones Cientificas
Mark Spalding	marine ecosystems, classification	UK	Cambridge University, The Nature Conservancy
Emily Nicholson	risk assessment, ecological modeller	Australia	Deakin University
Tracey Regan	risk assessment, ecological modeller	Australia	Arthur Rylah Institute
Jason Link	marine ecosystem processes	USA	National Oceanic and Atmospheric Administration (NOAA)
Edward Gregr	marine classification	Canada	Management & Environmental Studies (RMES) University of British Columbia
Eva Ramirez-Llodra	deep sea classification & processes	Norway	Norwegian Institute for Water Research
Janet Franklin	spatial modelling, terrestrial ecosystems	USA	Arizona University
Franz Essl	freshwater ecosystems	Austria	University of Vienna
Tytti Kontula	boreal & marine ecosystems	Finland	Finnish Environment Institute
Jeanne Nel	freshwater ecosystems	South Africa	Council for Scientific and Industrial Research (CSIR)
Matt Hansen	remote sensing, forest ecology	USA	Maryland University
Justin Moat	spatial modelling, mapping & classification	UK	Royal Botanic Gardens Kew
Alberto Basset	transitional waters, classification	Italy	Università del Salento
Susan Wisser	vegetation classification and description	New Zealand	Landcare Research
<b>Adjunct members</b>			
Rebecca Miller	RLE programme officer	UK	IUCN
Tina Oliveira-Miranda	RLE programme officer	Venezuela	Provita
Nick Murray	RLE research fellow	Australia	Centre for Ecosystem Science, University of New South Wales
Lucie Bland	RLE research fellow	Australia	The University of Melbourne

## Annex 2: Referred Publications to date<sup>7</sup>

26. Keith, D.A., Rodríguez, J.P., Brooks, T.M., Burgman, M.A., Barrow, E.G., Bland, L., Comer, P.J., Franklin, J., Link, J., McCarthy, M.A., Miller, R.M., Murray, N.J., Nel, J., Nicholson, E., Oliveira-Miranda, M.A., Regan, T.J., Rodríguez-Clark, K.M., Rouget, M. and Spalding, M.D. (in press). The IUCN Red List of Ecosystems: motivations, challenges and applications. *Conservation Letters* [doi: 10.1111/conl.12167].
25. Rodríguez, J.P., Keith, D.A., Rodríguez-Clark, K.M., Murray, N.J., Nicholson, E., Regan, T.J., Miller, R.M., Barrow, E.G., Bland, L.M., Boe, K., Brooks, T.M., Oliveira-Miranda, M.A., Spalding, M. and Wit, P. (2015) A practical guide to the application of the IUCN Red List of Ecosystems criteria. *Phil. Trans. R. Soc. B* 370: 20140003. [doi: 10.1098/rstb.2014.0003]
24. Keith, D.A. (2015) Assessing and managing risks to ecosystem biodiversity. *Austral Ecology* 40, in press. [doi:10.1111/aec.12249]
23. English, V. and Keith, D.A. (2015). Assessing risks to ecosystems within biodiversity hotspots: a case study from southwestern Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12177]
22. Auld T.D. and Leishman M.R. (2015) Ecosystem risk assessment for Gnarled Mossy Cloud Forest, Lord Howe Island, Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12202]
21. Barrett S. and Yates C.J. (2015) Risks to a mountain summit ecosystem with endemic biota in southwestern Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12199]
20. Burns E.L., Lindenmayer D.B., Stein J., et al. (2015) Ecosystem assessment of mountain ash forest in the Central Highlands of Victoria, south-eastern Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12200]
19. Clark G.F., Raymond B., Riddle M.J., et al. (2015) Vulnerability of Antarctic shallow invertebrate-dominated ecosystems. *Austral Ecology* 40, in press. [doi: 10.1111/aec.12237]
18. Crespin, S.J. and Simonetti, J.A. (2015) Predicting ecosystem collapse: Spatial factors that influence risks to tropical ecosystems. *Austral Ecology* 40, in press. [doi: 10.1111/aec.12209]
17. Metcalfe, D.J. and Lawson, T.J. (2015) IUCN risk assessment of Coastal Lowland Rainforests of the Wet Tropics Bioregion, Queensland, Australia. *Austral Ecology* 40, in press.
16. Murray N.J., Ma Z. and Fuller R.A. (2015) An IUCN Red List of Ecosystems assessment of the Yellow Sea tidal flat ecosystem. *Austral Ecology* 40, in press. [doi:10.1111/aec.12211]
15. Pisanu P., Kingsford R.T., Wilson B. and Bonifacio R. (2015) Status of connected wetlands of the Lake Eyre Basin, Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12203]

---

<sup>7</sup> Most of these publications are available on [www.iucnredlistofecosystems.org](http://www.iucnredlistofecosystems.org), along with additional non-referred publications (in multiple languages whenever possible).

14. Tozer M.G., Leishman M.R. and Auld T.D. (2015) Ecosystem risk assessment for Cumberland Plain Woodland, New South Wales, Australia. *Austral Ecology* 40, in press. [doi:10.1111/aec.12201]
13. Wardle, G.M., Greenville, A.C., Frank, A.S. K., Tischler, M., Emery, N.J. and Dickman, C.R. (2015) Ecosystem risk assessment of Georgina gidgee woodlands in central Australia (Qld, NT, SA). *Austral Ecology* 40, in press.
12. Williams. R.J., Wahren C.-H., Stott K.A.J. et al. (2015) An IUCN Red List Ecosystems Risk Assessment for Alpine Snow Patch Herbfields, South-Eastern Australia. *Austral Ecology* 40, in press.
11. Nicholson, E., Regan T.J., Auld, T.D. et al. (2015). Towards consistency, rigour and compatibility of risk assessments for ecosystems and ecological communities. *Austral Ecology* 40, in press. [doi:10.1111/aec.12148]
10. Keith, D.A., Rodriguez, J.P. and Barrow, E.G. (2015). Assessing and monitoring risks to ecosystems: IUCN's new global standard. In P. Clarke, J. Fitzsimons and P. figgis (eds.) 'Valuing nature: protected areas and ecosystems.' Australian Committee of the International Union for Conservation of Nature, Brisbane.
9. Keith, D.A. (2014) Separating risks from values in setting priorities for plant community conservation. *Applied Vegetation Science* 17: 384-384.
8. Hansen, M.C., Potapov, P.V., Moore, R. et al. (2013) High-resolution global maps of 21st-century forest cover change. *Science* 342: 850-853.
7. Keith, D.A., Rodríguez, J.P., Rodríguez-Clark, K.M., Nicholson E., Aapala, K., Alonso, A., Asmussen, M., Bachman, S., Basset, A., Barrow, E.G., Benson, J.S., Bishop, M.J., Bonifacio, R., Brooks, T.M., Burgman, M.A., Comer, P., Comín, F.A., Essl, F., Faber-Langendoen, D., Fairweather, P.G., Holdaway, R.J, Jennings, M., Kingsford, R.T., Lester, R.E., Mac Nally, R., McCarthy, M.A., Moat, J., Oliveira-Miranda, M.A., Pisanu, P., Poulin, B., Regan, T.J., Riecken, U., Spalding, M.D. and Zambrano-Martínez, S. (2013) Scientific foundations for an IUCN Red List of Ecosystems. *PLoS ONE* 8(5): e62111. <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0062111>
6. Rodríguez, J.P., Rodríguez-Clark, K.M., Keith, D.A., Barrow, E.G., Benson, J., Nicholson, E. and Wit, P. (2012) IUCN Red List of Ecosystems. *Sapiens* 5: 6–70.
5. Rodríguez J.P, Rodríguez-Clark K.M., Keith D.A., Barrow E.G., Comer P. and Oliveira-Miranda M.A. (2012) From Alaska to Patagonia: the IUCN Red List of continental ecosystems of the Americas. *Oryx* 46(02): 170-171.
4. Rodríguez, J.P., Rodríguez-Clark, K.M., Baillie, J.E., Ash, N., Benson, J., Boucher, T., Brown, C., Burgess, N.D., Collen, B., Jennings, M., Keith, D.A., Nicholson, E., Revenga, C., Reyers, B., Rouget, M., Smith, T., Spalding, M., Taber, A., Walpole, M., Zager, I. and Zamin, T. (2011) Establishing IUCN Red List Criteria for Threatened Ecosystems. *Conservation Biology* 25: 21–29. [doi: 10.1111/j.1523-1739.2010.01598.x]



3. Keith, D.A. (2009) The interpretation, assessment and conservation of ecological communities. *Ecological Management and Restoration* 10: S3-S15.
2. Nicholson, E., Keith, D.A. and Wilcove, D.S. (2009) Assessing the threat status of ecological communities. *Conservation Biology* 23:259-274.
1. Rodriguez J.P., Balch J.K. and Rodriguez-Clark K.M. (2007) Assessing extinction risk in the absence of species-level data: quantitative criteria for terrestrial ecosystems. *Biodiversity and Conservation* 16:183–209