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Research Article

A re-assessment of priority amphibian species of Peru

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Abstract

Peru supports approximately 588 amphibian species, of which 492 have been assessed on the IUCN Red List of Threatened Species. Of these, 111 are classified as Threatened, with 69 species classified as Critically Endangered or Endangered. In addition, 140 amphibian species remain Data Deficient. We re-assessed the conservation status of 38 amphibian species originally identified as potentially Threatened by von May *et al.* (2008), using the IUCN Red List Categories and Criteria. Fourteen species assessments changed as a result of re-assessment, of which eight changed from Data Deficient to Threatened; two changed from Data Deficient to Near Threatened and Least Concern respectively; two were up-listed from Least Concern to a Threatened status; two were down-listed. None of the changes were due to a known genuine change since the previous assessment. All changes were justified by an increase in knowledge. The eight species with a change from Data Deficient to a Threatened category belonged to four anuran families: Craugastoridae, Dendrobatidae, Hemiphractidae and Telmatobiidae. The reasons for a change in assessment status were: changes in taxonomy, distribution, population status, threat status, or previously incorrect information. The main threat affecting re-assessed amphibian species was habitat loss, with other threats including pollution, disease outbreaks, and collection for the pet trade. Only 53% of the re-assessed species were found to occur in a protected area. Findings of this study indicate the continuing fragility of many Peruvian amphibians and highlight the need for improving their protection and for further research into their population status and threats.

Key words: declining amphibians, threatened species, extinction risk assessment, conservation

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Introduction

Peru supports approximately 588 amphibian species [1], of which some 278 (48%) are known to be endemic [2]. This is partly due to the large number of life zones in the country (84 life zones and 17 transitional zones) [3], including the unique and complex range of habitats and ecological conditions which occur in the montane and pre-montane forests, grasslands, and deep valleys within the Andean Cordillera and surrounding regions [4]. Between January 2010 and October 2014, 49 new amphibian species were described for Peru [2], highlighting the importance of this country's speciose amphibian fauna and the need for continued taxonomic research in this large, megadiverse country. According to the latest version of The IUCN (International Union for Conservation of Nature) Red List of Threatened Species (the IUCN Red List), there are currently 111 Threatened amphibian species in Peru, of which 28 are classified as Critically Endangered, 41 as Endangered and 42 as Vulnerable [5]. In addition, more than two-thirds of these species are endemic [6] and 140 amphibian species in Peru are classified as Data Deficient [5] due to a lack of knowledge about many aspects of species ecology, including: population status, distribution outside their type locality, and current threats. The most recent check list for Peruvian amphibians was presented by Aguilar *et al.* [7] listing 538 described species for Peru. Catenazzi and von May [4] reviewed this list in addition to two online databases (AmphibiaWeb [2] and Amphibian Species of the World [1]), and consulted with other herpetologists, concluding that 571 species (550 anurans, 3 salamanders, and 18 caecilians) were known to occur in Peru by early 2014. As of 17 June 2015, the two leading online databases for amphibian taxonomy list the following numbers of amphibian species for Peru: AmphibiaWeb: 561 species, Amphibian Species of the World: 588 species.

The state of conservation knowledge on Threatened amphibians in Peru was assessed by von May *et al.* in 2008 [6], compiling a list of 83 amphibian species for which field data were available, including species listed in the IUCN Red List and the Peruvian government's Servicio Nacional Forestal y de Fauna Silvestre (formerly the Instituto Nacional de Recursos Naturales) threatened species list. This research highlighted a number of issues relating to conservation and further research requirements, including improved surveys and monitoring of these species. Due to a lack of information at the time, 28 (34%) of the species within the 83 originally examined either had not been assessed in the IUCN Red List, or

were assessed as Data Deficient. Since 2008, there have been increasing reports of threats to habitats and amphibian species in the country [8, 9, 10-13], resulting in a pressing need to assess the extinction risk of these species, which may aid in their conservation and that of their habitats.

In this paper we re-assessed the extinction risk of a sub-set of the amphibian species originally identified as potentially Threatened by von May *et al.* in 2008 [6] using the IUCN Red List Categories and Criteria [14]. The IUCN Red List is widely recognized as the most comprehensive, objective global approach for evaluating the extinction risk of plant and animal species [5]. The IUCN Red List identifies particular species at risk of extinction [5], which is essential for formulating species action plans and conservation action. As a result of our present study, the IUCN Red List updated the threat status of several of these species during 2013 and 2014.

Recently, the Peruvian government issued an updated list of Threatened and Near-Threatened fauna (henceforth, the national list) that included amphibians, reptiles, birds, mammals, and invertebrates [15]. Four categories, Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT) were considered in this national assessment process (although NT is not regarded as Threatened by the IUCN), and volunteer scientists who participated in this process followed the IUCN Red List methodology for regional assessments. We compared the number of Peruvian amphibians included in each category according to both the IUCN Red List and the national list. As in von May *et al.* in 2008 [6], we included the NT category to allow comparisons between both lists. This comparison was motivated by the previously observed discordance between the IUCN Red List and the national list (see Fig. 2 in [6]). Finally, we propose a correction to the national list because it includes two amphibian species not known to occur in Peru.

Methods

A sub-set of 39 Peruvian amphibian species, originally presented in Appendix 2 of von May *et al.* [6], were used for this study. All species listed in Appendix 2 of this study were originally listed as Data Deficient, Least Concern or Not Evaluated. However subsequent assessment/re-assessment after publication of von May *et al.* [6] changed seven to a Threatened category (Vulnerable, Endangered or Critically Endangered). Since the publication of the original paper by von May *et al.* [6], six species had undergone taxonomic revisions, resulting in name changes. *Gastrotheca monticola* was split into two species (*G. monticola* and *G. lojana*, of which only the former was re-assessed); *Hyalinobatrachium lemur* was synonymised with *H. pellucidum*; *Phrynopus ayacucho* was placed into the genus *Oreobates* (now *Oreobates ayacucho*); *Ranitomeya biolat* and *R. lamas* were synonymised with *R. sirensis*; and *R. intermedia* was synonymised with *R. imitator*. In addition, in 2014, after the re-assessment process had taken place, *Cochranella croceopodes* was synonymized with *Rulyrana saxiscandens* [16]. *R. saxiscandens* was previously assessed as Endangered, but given the change in taxonomic concept the species needs to be re-assessed. Since this occurred after the re-assessment process, we did not include it in the analysis.

We used the IUCN Species Information Service (SIS) database for entering, storing and managing data on each species, as well as for querying results. The primary database fields included: Geographic Range, Population, Habitat and Ecology, Threats, Conservation Actions, Taxonomy and Assessment Information. Distribution maps depicting species ranges and used as proxies for the extent of occurrence (EOO) or area of occupancy (AOO) were drawn or revised for each species using ESRI ArcMap (version 10.2). We also used information from field observations and published studies (i.e., studies reporting the infection caused by the chytrid fungus (e.g., [9]); presence/absence in natural protected areas (e.g. [7])). We followed the same criteria used in IUCN species assessments [14] in

order to assign threats to each species. Information on threats faced by other amphibians is also available in Table 3 in [7].

To update each assessment, three main methods were used: email, online forum and primary literature. The first involved email discussion with experts in the field. These were often researchers who had published original information on each species, as well as those actively conducting research in the field. The second involved issuing a call to experts in Peruvian herpetology through the Herpetólogos Perú list server to solicit information, and creating a new online forum on iNaturalist to collate this information (www.inaturalist.org): the Perú *Amphibian Red List Assessment* Forum (<http://www.inaturalist.org/projects/peru-amphibian-redlist-assessment-forum>). The forum allowed researchers and, in some cases, citizen-scientists, to post their observations and provide feedback on the draft IUCN Red List assessments. This facilitated reaching a wider audience and allowed findings to be documented that may otherwise have gone unrecorded. The open, easy-to-use online format made documenting these data relatively simple. Although reports of many amphibian species, endemic to Perú were recorded on this forum, relatively few (less than 20) comments related to the species under re-assessment. This may be due to the small geographic distribution range of many of the species along with lack of survey effort.

The third method of obtaining information on the status of the amphibian species involved searching literature published since 2008. This comprised a range of peer-reviewed and other publications, including on-line internet resources. Websites containing relevant information were consulted, but the material was always confirmed with experts in the field. Once information had been collated and documented in SIS, each species was re-assessed using the current versions of the *IUCN Red List Categories and Criteria* and the *Guidelines for Using the IUCN Red List Categories and Criteria* [14]. Once completed, all submitted assessments were reviewed by at least one external Reviewer designated by the Amphibian Red List Authority (RLA), and finally, consistency was checked by the Red List Unit before being published on the IUCN Red List.

Results

A total of 38 Peruvian amphibian species were re-assessed. Fourteen species re-assessments (37%) resulted in a change of status, while the remaining 24 remained unchanged (Appendix 1). Of the 14 species that underwent an assessment change, eight changed from Data Deficient to Threatened (21%), two changed from Data Deficient to Near Threatened and Least Concern respectively (5%), two were up-listed from Least Concern to Threatened (5%) and two were down-listed (5%). None of the changes in assessment were as a result of a known genuine change in status since the previous assessment; all were due to an increase in knowledge of one or more factors (IUCN criteria A–E) used to evaluate if a taxon belongs in a Threatened category (e.g. population reduction, small population size and decline) [14]. The species that changed from Data Deficient to Threatened came from four anuran families: Craugastoridae, Dendrobatidae, Hemiphractidae and Telmatobiidae. Twenty-four species (63%) had no change in their assessment status. Of these, 11 were Least Concern and nine were Data Deficient, with the remaining four listed as Vulnerable, Endangered, or Critically Endangered.

Species assessments changing from Data Deficient and up-listed species

Appendix 2 summarises the main reasons for changes in assessment status, which can be broadly classified into five categories, due to changes in: taxonomy, distribution, population status, threat status, or inaccurate information. For all species, new information or a combination of the above factors was responsible for a change in assessment status.

Of the 12 species with a change in status that was not a down-listing, three had new information on distribution (*Ameerega pongoensis*, *Oreobates ayacucho* and *Ranitomeya flavovittata*) and were previously assessed as Data Deficient. Two species (*Phrynopus peruanus* and *Telmatobius atahualpai*) were experiencing habitat loss or fragmentation. For two species, there was a reduction in population status or number of mature individuals noted (Silverstone's Poison Frog *Ameerega silverstonei* and *Telmatobius timens*). Two species, *Pristimantis ornatus* and *Pristimantis cruciocularis*, were previously assessed based on information that is now considered inaccurate or inaccurate application of criteria. Both of these species were presumed to have much wider distributions. New information relating to specific threats and/or new information on distribution were the biggest factors leading to a change in assessment of nine species (*Ameerega pongoensis*, *Ameerega silverstonei*, *Gastrotheca atympana*, *Oreobates ayacucho*, *Phrynopus peruanus*, *Pristimantis pardalinus*, *Ranitomeya flavovittata*, *Telmatobius atahualpai* and *T. timens*).

Down-listed species

As a result of taxonomic revisions, *Hyalinobatrachium lemur*, formerly assessed as Endangered, was synonymised under *H. pellucidum*. This change resulted in the known distribution of *H. pellucidum* being much larger, thus being classified as Near Threatened. *Ranitomeya biolat* and *R. lamasi* were recently synonymised under *R. sirensis*. This synonymy resulted in a much larger distribution, and thus, the species was down-listed from Endangered to Least Concern.

Species with no change

No new information was available for over half of the species re-assessed. These 24 species (63%) comprised 15 genera, with five species belonging to the genus *Ranitomeya*. The only two caecilians to be re-assessed (the Ringed Caecilian *Siphonops annulatus* and *Epicrionops bicolor*) retained the same status. Of the nine species still listed as Data Deficient, a continuing lack of data was the main reason for a lack in change of status.

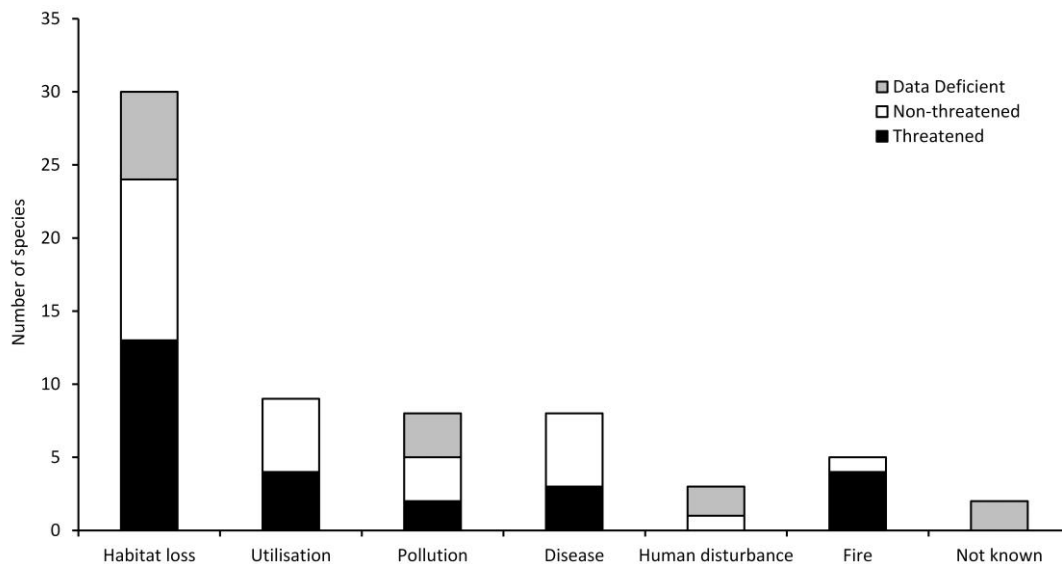


Fig. 1. Major threats affecting both threatened and non-threatened species in this reassessment.

Threats

The main threat affecting the 38 re-assessed species was habitat loss, primarily due to logging and agriculture, with 29 (76%) species being affected (Appendix 1). Other threats included pollution from mining operations, chytrid infection, tourism development resulting in disturbance and habitat loss, and collection for the pet trade. Figure 1 shows the threats affecting Threatened (Critically Endangered, Endangered and Vulnerable), non-Threatened (Near Threatened, Least Concern) and Data Deficient species. For four of the species, the threats were unknown. The biggest threats to species of *Ranitomeya* are potential habitat loss due to logging and illegal collecting for the pet trade, though the degree to which the latter is a problem remains unknown. Human-induced fires are considered a threat to two montane species: *Phrynopis peruanus* and *Pleurodema marmoratum*. The Harlequin Frog *Atelopus patazensis*, one of the most highly Threatened species (CR), is threatened primarily with chytridiomycosis and stream mining operations.

Presence in protected areas

A total of 20 species (53%) are known to occur in at least one protected area (Appendix 1), a figure based on the known occurrence of each species. An additional five species may occur in protected areas, but this needs further clarification. Five Threatened species (*Atelopus patazensis*, *Phrynopis peruanus*, *Phrynopis tautzorum*, *Pristimantis ornatus* and *Pristimantis pardalinus*) are not known to occur in any protected areas. These species urgently need protection of their type locality due to their limited distribution. The remaining nine Data Deficient species are not known to occur in protected habitats, but since their distributions remain poorly known, additional data may change this status. Five species are known to be in protected areas in at least part of their range.

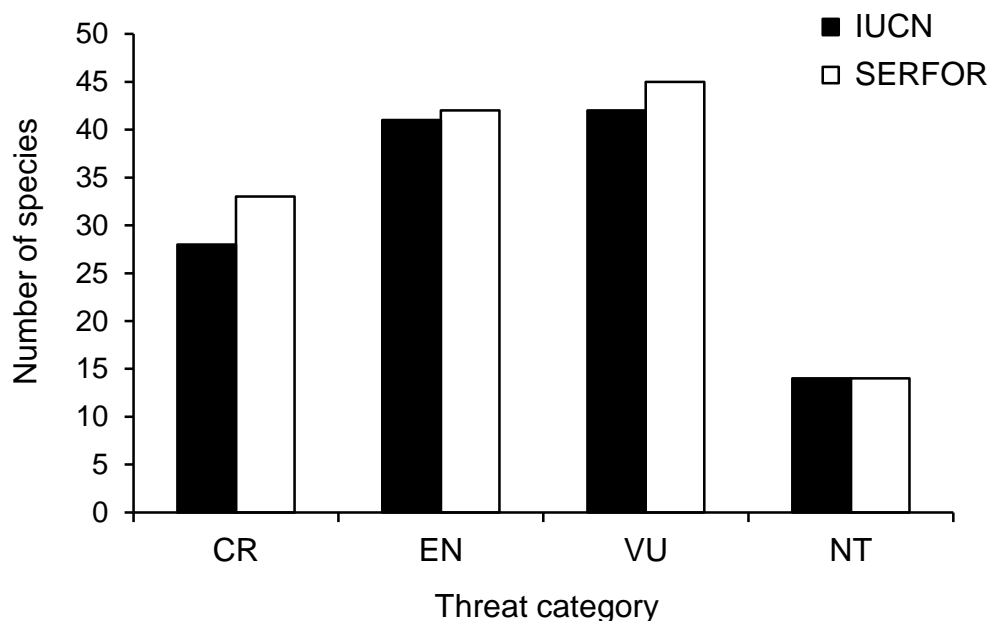


Fig. 2. Threatened amphibian species in Peru, according to The IUCN Red List (IUCN) and the national list (SERFOR; Servicio Nacional Forestal y de Fauna Silvestre, previously INRENA).

Comparison between the IUCN Red List and the national list of Threatened species

The number of Peruvian amphibians included in each category according to The IUCN Red List was very similar to the number of Peruvian amphibians included in the national list [15] (Fig. 2). A thorough inspection of the national list further revealed that the occurrence of two amphibian species, *Hemiphractus bubalus* and *Psychrophrynella wettsteini* in Peru is uncertain given that no collections of voucher specimens (or photographic vouchers) are available from the country.



Fig. 3. Species with a change in assessment. A. *Pristimantis pardalinus*. Photo R. von May; B. *Phrynopus peruanus*. Photo R. von May; C. *Pristimantis cruciocularis*. Photo A. Angulo; D. *Ranitomeya flavovittata*. Photo A. Angulo; E *Telmatobius timens*. Photo A. Catenazzi; F. *Pleurodema marmoratum*. Photo A. Catenazzi.

Discussion

This re-assessment of 38 amphibian species of Peru has resulted in improved understanding and consequent changes in assessment of 14 species on The IUCN Red List of Threatened Species. Eight of these species changed their status from Data Deficient to a Threatened category and two were up-listed from Least Concern to Threatened, demonstrating the potential fragility of many endemic Peruvian species. Despite an improved knowledge of the distribution and population status of these species, basic distributional and life history data are still lacking. The lack of information on the remaining nine Data Deficient species should be of great concern, considering the continued decline in many Threatened species in Peru and of their habitats. The IUCN Red List Index (RLI) measures trends in the overall extinction risk of sets of species, as an indicator of trends in the status of biodiversity [17]. The RLI is based on the movement of species status through the IUCN Red List Categories [17]. However, since no species in this re-assessment underwent a known genuine change, this tool could not be used.

It is encouraging that, for Peruvian amphibians, there is currently more congruence between The IUCN Red List of Threatened Species and the national list of threatened fauna recognized by the Peruvian government (Figure 2). The close similarity between both lists is in part a result of the application of the IUCN Red List methodology in Peru's national assessments of threatened and near-threatened wildlife [15], and represents a considerable improvement over a previous national assessment [18].

Threats to species

Habitat loss was identified as a major threat to over three quarters (76%) of the 38 amphibian species in this re-assessment. Globally, loss and alteration of habitats is cited as one of the biggest factors contributing to amphibian declines [19, 20, 21] and is considered a major threat to amphibians in Peru [4]. The Global Amphibian Assessment (GAA) identified habitat loss as affecting 89% of all Threatened species in the New World [22]. In the majority of cases, individual species are being affected by multiple threats. This may result in synergistic interactions and possible population declines, both of which have been documented in many amphibian populations worldwide [23, 24, 25].

According to Catenazzi & von May [4], the most Threatened amphibian species in Peru belong to five amphibian families: Craugastoridae, Telmatobiidae, Bufonidae, Dendrobatidae and Centrolenidae. Findings from our re-assessment of Peruvian species support this statement, with 21% of the total re-assessed belonging to two of these families: Dendrobatidae and Craugastoridae. In Peru, the two main threats to dendrobatids appear to be habitat loss due to agriculture [26] and illegal harvesting for the pet trade [6, 27, 28]. The latter could be an increasing problem for these and other species within the genera *Ranitomeya* and *Ameerega* [28, 29]. The extent of these threats is largely unknown for most of the poison dart frogs belonging to *Ranitomeya*, where additional research is required.

Over half (60%) of the species with a change in threat status belong to Craugastoridae, specifically in the genera *Pristimantis* and *Phrynopis*. Species belonging to these genera are terrestrial breeding frogs that are threatened with habitat loss, primarily through agricultural expansion in the form of extensive cattle grazing [30]. The majority are high-elevation species, usually with small ranges, and are vulnerable to human habitat modification. Grass burning to fertilise fields and subsequent habitat loss have resulted in reported habitat decline in some areas, especially in the case of *Phrynopis peruanus* and *Oreobates ayacucho* [31]. The remaining six species within these genera are all assessed as Data Deficient, with virtually no information available on population, distribution, or threats affecting these species.

Several members of the Telmatobiidae are at risk from water pollution, chytridiomycosis, intensive livestock farming and collection for food [4, 9, 32, 33, 34]. *Telmatobius atahualpai* and *T. timens* are threatened due to pollution of water bodies, intensive livestock farming driving habitat loss and chytridiomycosis [9, 35]. They could also be threatened by harvesting for human consumption and impacts of introduced freshwater species [4]. Chytridiomycosis has been cited as a key threat to amphibian populations within Peru [4, 9, 36], especially those within *Atelopus* and *Telmatobius* genera [9, 10, 13, 37]. Synergistic interactions between disease and habitat loss could be exacerbating population losses of *T. atahualpai* and *T. timens*, which are currently assessed as Near Threatened and Critically Endangered, respectively.

All known individuals within *Gastrotheca atympana* (family: Hemiphractidae) were recorded in a reserve, Pampa Hermosa National Sanctuary, which is surrounded by primary forest. However, the area is facing ongoing threats including encroaching illegal logging, slash and burn agriculture, mining activities and road construction [38]. It is estimated that 85% of the habitat beyond Pampa Hermosa's buffer zone has been lost due to deforestation [39]. Although classified as Vulnerable (VU D2) in this latest assessment, due to the potential severity of the threats, future assessments may further up-list this species. In addition, protection of the primary forests surrounding this reserve is required.

Species in protected areas

This study revealed that 53% of the species examined had some part of their known distributions within a protected area. The remaining species either have no formal protection or the degree of protection is unknown. This is consistent with recent findings at the global level [40]. Considering that habitat loss is the main threat to amphibians in Peru [4], there is an urgent need to protect these species' habitats. Of the re-assessed species, just three (8%) occur within Manu National Park, which is Peru's second largest protected area [9]. However, in recent years, in frog communities between 1,200 m and 3,700 m asl, 47% fewer frog species of Manu's montane forests were recorded in 2008/2009 compared to 1999 [9]. The causes of the declines are unknown, but chytridiomycosis appears to be the main suspect in declines [41], and has been implicated in at least 10% of the species re-assessed. These findings are of concern and strongly suggest that additional conservation strategies are required to address population declines when diseases are identified as a potential driver.

Changes in species' taxonomic resolution

Changes in taxonomy, and therefore in the biological concept of the assessed populations/species, have the potential to significantly impact species' extinction risk assessments [42]. In the case of taxonomic splits (a common scenario where cryptic species complexes are concerned), while it is possible that extinction risk may increase or decrease, as ranges become more circumscribed and assuming threats continue, many species will likely experience an increase in their extinction risk. Similarly, in the case of taxonomic synonymizations, while extinction risk can increase or decrease, it is likely to decrease as ranges typically increase with the amalgamation of new populations into the new species concept. In this instance, the scenario of decreased extinction risk is evidenced by our results, where the synonymy with *Ranitomeya biolat* and *R. lamasi* rendered the previously Endangered *Ranitomeya sirensis* as Least Concern, and the synonymy of *Hyalinobatrachium lemur* into *H. pellucidum* changed the latter species' assessment from Endangered to Near Threatened. While it is difficult to predict exactly how extinction risk may change as a result of taxonomic change (these will vary on a case by case basis), we should expect to see more changes in extinction risk assessments as more changes take place in amphibian taxonomy.

Implications for conservation

Up-to-date Red List assessments are crucial for understanding the geographic distribution, population size and threats which may affect species, all of which are required for effective conservation programmes. Our research will enable conservation programmes and protection to target the specific needs of these species. In addition, our research has highlighted three further areas as priorities for future work. First, basic life history information on the ecology, distribution and threats affecting species needs to be collected for the remaining nine Data Deficient species. For many of these species, records only exist for the holotype or a limited number of specimens collected at the type locality, particularly those within the genus *Phrynopus* (e.g. *Phrynopus bufoides*, *P. kotosh* and *P. oblivius*). Surveys and monitoring are required to determine their distribution and abundance, as well as threats affecting these species. Second, there is a need for more detailed information on the status and degree to which threats are impacting the highly Threatened species, assessed as Critically Endangered or Endangered. In particular, further research, monitoring and protection are required for *Atelopus patazensis*, *Phrynopus peruanus*, *P. tautzorum*, *Pristimantis pardalinus* and *Telmatobius timens*, which are experiencing population or habitat declines, or both. Third, some Least Concern species appear to be at risk of becoming Near Threatened in the coming years, especially *Pleurodema marmoratum* and *Rhinella limensis*, populations of which appear to have declined and are under increasing threats. Therefore, programmes to monitor their population status are required.

It is important that findings of studies such as the ones reported here make it into relevant conservation plans and national policy. By virtue of being published on The IUCN Red List of Threatened Species the information is publicly available and can be used to inform granting agencies where to best channel their conservation investments. In addition, the authors are committed to ensuring that relevant national authorities are made aware of updates and changes to inform necessary policy action. We are also committed to sharing the results of this study and engage in discussions with relevant parties and stakeholders.

Overall, our findings indicate the continuing fragility of many Peruvian amphibians and highlight the need for improving their protection and for further research into their population status and threats.

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Appendix 1. Assessment status and change for the 38 re-assessed Peruvian amphibian species; known threats to species and recorded presence in protected areas.

Vernacular name	Species name	Previous assessment	Current assessment	Change	Threats	Presence in protected areas
None	<i>Ameerega macero</i>	LC	LC	No change	Localised habitat loss due to agriculture; illegal harvesting.	Manu National Park, Alto Purús National Park, Machiguenga and Amarakaeri Communal Reserves in Peru; Serra del Divisor National Parks and Extrativista Alto Juruá Reserve in Brazil.
None	<i>Ameerega pongoensis</i>	DD	VU B1ab(iii,v)	DD to Threatened	Encroaching agriculture threatens habitat; illegal harvesting.	Occurs within the Cordillera Escalera Regional Park. It may possibly occur within the Cordillera Azul National Park.
Silverstone's Poison Frog	<i>Ameerega silverstonei</i>	DD	EN B1ab(iii,v)	DD to Threatened	Habitat clearance for agriculture; illegal harvesting.	Cordillera Azul National Park.
Harlequin Frog	<i>Atelopus patazensis</i>	CR A2ae; B1ab(iii,v)	CR A2ae; B1ab(iii,v)	No change	Chytridiomycosis, stream mining operations and heavy metal pollution.	Not known to occur in any protected areas.
None	<i>Rulyrana saxiscandens</i> , (formally <i>Cochranella croceopodes</i>)	DD	DD	No change	Habitat loss through agriculture, building roads and residential developments; tourism.	Unknown.

None	<i>Epicrionops bicolor</i>	LC	LC	No change	Potential habitat loss due to agriculture; water pollution.	Los Illinizas Ecological Reserve and Tapichalaca Biological Reserve, Ecuador; Manu National Park, Peru and potentially overlapping with other protected areas.
Santiago Poison Frog	<i>Excidobates captivus</i>	LC	LC	No change	Illegal gold mining; possibly chytrid infection.	May possibly occur within the Santiago-Comaina Reserve, but this remains uncertain.
None	<i>Gastrotheca atympana</i>	DD	VU D2	DD to Threatened	Ongoing habitat loss due to illegal logging, slash and burn agriculture, mining activities and road construction.	380 ha Pampa Hermosa Reserve, Peru but the surrounding forest needs protection.
None	<i>Gastrotheca monticola</i>	LC	LC	No change	Habitat destruction and degradation due to agricultural activities.	Podocarpus National Park, Ecuador; Cutervo National Park and Private Conservation Area Huiquilla, Peru.
None	<i>Hyalinobatrachium pellucidum</i> ¹	EN B1ab(iii)	NT	Down-listed	Habitat destruction and degradation due small holder logging.	May occur in Cayambé-Coca Ecological Reserve and Sumaco Napo Galeras National Park, Ecuador.
None	<i>Noblella lynchi</i>	DD	DD	No change	Unknown.	Unknown.
None	<i>Nymphargus chancas</i>	DD	DD	No change	Loss and fragmentation of habitat due to agriculture.	May occur within Ecuador.
None	<i>Oscaecilia bassleri</i>	LC	LC	No change	Unknown.	Yasuní National Park and possibly Limoncocha Biological Reserve, Ecuador; possibly occurs in Allpahuayo

None	<i>Oreobates ayacucho</i>	DD	EN B1ab(iii)	DD to Threatened	Habitat loss due to overgrazing; construction of major gas lines.	Mishana National Reserve, Peru. Unknown.
None	<i>Phrynopus bufoides</i>	DD	DD	No change	Encroaching agriculture, cattle breeding and pollution.	Unknown.
None	<i>Phrynopus kotosh</i>	DD	DD	No change	Possibly agriculture, cattle breeding and pollution.	Unknown.
None	<i>Phrynopus oblivius</i>	DD	DD	No change	Possibly agriculture, cattle breeding and pollution.	Unknown.
None	<i>Phrynopus paucari</i>	DD	DD	No change	Possibly agriculture, cattle breeding and pollution.	Unknown.
None	<i>Phrynopus peruanus</i>	DD	CR B1ab(iii)	DD to Threatened	Habitat loss due to fires and cattle herding.	Not known to occur in any protected areas.
None	<i>Phrynopus pesantesi</i>	DD	DD	No change	Unknown.	Unknown.
None	<i>Phrynopus tautzorum</i>	CR B2ab(iii)	CR B1ab(iii)	No change	Possibly livestock farming.	Not known to occur in any protected areas.
None	<i>Pleurodema marmoratum</i>	LC	LC	No change	Livestock farming, fires and chytrid infection.	Titicaca National Reserve. May occur in other protected areas.
None	<i>Pristimantis cruciocularis</i>	LC	VU B1ab(iii)	Up-listed	Habitat loss due to agriculture.	Pampa Hermosa National Sanctuary and Yanachaga-Chemillén National Park, Peru.
None	<i>Pristimantis flavobracatus</i>	DD	DD	No change	Habitat loss due to agriculture.	Close to, but not within, the Yanachaga Chemillén National Park, Peru.

None	<i>Pristimantis melanogaster</i>	DD	EN B1ab(iii)	DD to Threatened	Habitat loss due to agriculture, cattle breeding and wood extraction; infection remains a threat.	Private Conservation Area Huiquilla, Peru.
None	<i>Pristimantis ornatus</i>	LC	EN B1ab(iii)	Up-listed	Deforestation resulting in loss of habitat.	Not known to occur in any protected areas.
None	<i>Pristimantis pardalinus</i>	DD	CR B1ab(iii)	DD to Threatened	Overgrazing and human settlements.	Not known to occur in any protected areas.
None	<i>Ranitomeya benedicta</i>	VU B1ab(iii,v)	VU B1ab(iii,v)	No change	Habitat loss due to logging and agriculture; illegal harvesting.	Occurs in the Cordillera Azul National Park.
None	<i>Ranitomeya flavovittata</i>	DD	LC	DD to LC	Habitat loss due to logging and agriculture; illegal harvesting.	Tamshiyacu-Tahuayo Reserve.
Imitating Poison Frog	<i>Ranitomeya imitator</i>	LC	LC	No change	Logging; collection for pet trade though effect remains unknown.	Cordillera Azul National Park.
None	<i>Ranitomeya sirensis</i> ¹	EN B1ab(iii)	LC	Down-listed	Logging; collection for pet trade though effect remains unknown.	Yanachaga Chemillén National Park, El Sira Reserve, Manu National Park, Bahuaja-Sonene National Park and Tambopata National Reserve, Peru.
None	<i>Ranitomeya summersi</i>	EN B1ab(iii,v)	EN B1ab(iii,v)	No change	Logging; collection for pet trade though effect remains unknown.	May occur in Cordillera Azul, Peru.
None	<i>Ranitomeya uakarii</i>	LC	LC	No change	Agricultural growth; collection for pet trade.	Tamshiyacu-Tahuayo and Pacaya Samiria Reserves, Peru; may occur in other

Spotted Poison Frog	<i>Ranitomeya vanzolinii</i>	LC	LC	No change	Tourism development and disturbance; collection for laboratory experiments.	reserves including in Pacaya-Samiria. Due to its widespread distribution it may occur in several reserves.
None	<i>Rhinella limensis</i>	LC	LC	No change	Unknown.	Bocatoma Canal Imperial Protected Forest; May occur in Rio Rimac Reserved Zone, Lomas de Ancón Reserved Zone and Lachay National Reserve, Peru, but this needs confirming.
Ringed Caecilian	<i>Siphonops annulatus</i>	LC	LC	No change	Pollution of water bodies; possibly chytrid infection.	Due to its widespread distribution it may occur in several reserves.
None	<i>Telmatobius atahualpai</i>	DD	NT	DD to Near-Threatened	Intense livestock farming, pasture burning and livestock-driven water pollution; possibly chytrid infection.	Río Abiseo National Park, Peru.
None	<i>Telmatobius timens</i>	DD	CR A2ace	DD to Threatened		Apolobamba National Integrated Management Natural Area, Bolivia; Upper Manu National Park and Megantoni National Shrine, Peru.

¹ These two species underwent taxonomic changes after the original assessment. *Hyalinobatrachium lemur* was synonymised under *H. pellucidum* and *Ranitomeya biolat* and *R. lamasi* were subsumed into *R. sirensis*.

Appendix 2. Main reasons for change for the 14 Peruvian amphibian species which had a change in status.

Species	New 2014 assessment proposal	Change	Reason for change
<i>Ameerega pongoensis</i>	VU B1ab(iii,v)	DD to Threatened	New information available on distribution, survey efforts and degree of threats affecting the species and its habitats.
<i>Ameerega silverstonei</i>	EN B1ab(iii,v)	DD to Threatened	New information gathered on population status and threats.
<i>Gastrotheca atympana</i>	VU D2	DD to Threatened	Further searches of the type locality have revealed only one specimen. There is also additional information on threats which may increase the isolation of this species.
<i>Hyalinobatrachium pellucidum</i>	NT	Down-listed	<i>Hyalinobatrachium lemur</i> was synonymized under <i>H.pellucidum</i> .
<i>Oreobates ayacucho</i>	EN B1ab(iii)	DD to Threatened	New information has been found relating to the distribution and threats affecting this species.
<i>Phrynopus peruanus</i>	CR B1ab(iii)	DD to Threatened	Further individuals have been found and there is additional information on the threats affecting this species.
<i>Pristimantis cruciocularis</i>	VU B1ab(iii)	LC to Threatened	New information on distribution and given the documentation at the time.
<i>Pristimantis melanogaster</i>	EN B1ab(iii)	DD to Threatened	New information on distribution.
<i>Pristimantis ornatus</i>	EN B1ab(iii) (revised from NT)	LC to Threatened	Incorrect data used previously. There is uncertainty surrounding tolerance to habitat disturbance.
<i>Pristimantis pardalinus</i>	CR B1ab(iii)	DD to Threatened	New information regarding sampling efforts, state of habitat and degree of threat to this species.
<i>Ranitomeya flavovittata</i>	LC	DD to LC	Resolution of taxonomic status and more information on distribution, relative abundance and threats.
<i>Ranitomeya sirensis</i>	EN B1ab(iii)	Down-listed	Taxonomic revision

<i>Telmatobius atahualpai</i>	NT	DD to Near-Threatened	New information on population and threats.
<i>Telmatobius timens</i>	CR A2ace	DD to Threatened	Newly available data on new sites and population trend as a result of extensive surveys of areas where it was once common.

Appendix 3. Distribution of all 38 re-assessed Peruvian species. Full distribution information can be found at <www.iucnredlist.org>.

Species	Distribution
<i>Ameerega macero</i>	Southeastern and central Peru: in Manu, Urubamba and the Altos Purus River drainages and the Ucayali River drainage.
<i>Ameerega pongoensis</i>	Six geographical localities in eastern San Martín region and one locality in southwestern Loreto region, Peru.
<i>Ameerega silverstonei</i>	Endemic to the Cordillera Azul, Huánuco Region, Peru. It has also been introduced to the Tarapoto area of San Martín Region.
<i>Atelopus patazensis</i>	Quebrada Los Alisos, in the vicinity of Pataz, Pataz province, region of La Libertad, in an inter-Andean valley of the northern portion of the Cordillera Central in northwestern Peru.
<i>Rulyrana saxiscandens</i> , (formally <i>Cochranella croceopodes</i>)	Two geographical localities: near Tarapoto, and at 730 m asl at Cataratas de Ahuashiyacu on a north-west to south-east ridge north of Tarapoto Province, in San Martín Region, northern Peru. It is likely to occur much more widely.
<i>Epicrionops bicolor</i>	Pacific slopes of the Andes in Colombia (Department of Valle del Cauca) and Ecuador (Provinces of Cotopaxi and El Oro), and the Amazonian slopes of the Andes in southern Ecuador (Zamora Chinchipe Province) and southern Peru (Regions of Junín and Cusco).
<i>Excidobates captivus</i>	Northwestern Peru, where it is known only from the lowland valley formed between the Cordillera del Condor and the Cerros de Campanquis, and from southern Ecuador, near Panguintza.
<i>Gastrotheca atympana</i>	Pampa Hermosa Reserve at 1,540 m asl in Tarma Provincia, Junín Region, in the Río Chanchamayo Valley in the Cordillera Oriental of Peru. It has not been found outside of the reserve.
<i>Gastrotheca monticola</i>	Andean slopes around the Huancabamba Depression region, Loja Province, southern Ecuador; and Amazonas, Cajamarca and Piura regions, northern Peru.
<i>Hyalinobatrachium pellucidum</i> ¹	Three localities in Napo province on the Amazonian slopes of the Ecuadorian Andes, and from the west slope of Abra Tangarana, north-east of San Juan de Pacaysapa, Lamas Province, region of San Martín, Peru. It is possible that it may occur more widely, in the intervening area between the known sites in Ecuador and Peru.
<i>Noblella lynchi</i>	East slope of Abra Chinchillo, 42 km north of Balsas, Chachapoyas Province, Region of Amazonas, Peru.
<i>Nymphargus chancas</i>	West slope of Abra Tangarana, north-east of San Juan de Pacaysapa, Lamas Province, Region of San Martín, Peru.

<i>Oscaecilia bassleri</i>	Western Amazon basin and on the lower Amazonian slopes of the Andes. It has been recorded from Ecuador (Napo and Pastaza provinces) and eastern Perú (regions of Amazonas, Loreto and Madre de Dios).
<i>Oreobates ayacucho</i>	Four geographical localities: Rapi, near Chiquintirca, Provincia La Mar, Ayacucho Region, Peru; Ayacucho Region, Peru; and in two localities near the town of Qollpas (Cerros Animasniocc and Cerro Atampa), Chiquintirca district, province of La Mar, Ayacucho Region, Peru.
<i>Phrynopus bufoides</i>	Approximately 8 and 14 km southwest (airline) of the village of Paucartambo, Pasco Region, Peru, at La Victoria and Laguna Manchay in Pasco Region, Perú.
<i>Phrynopus kotosh</i>	Known 10.8 km west of Huancapallac, in the eastern part of the Cordillera Central, Province of Huánuco, Region of Huánuco, Perú.
<i>Phrynopus oblivius</i>	Vicinity of Maraynioc in the Vitoc Valley, Province of Tarma, Region of Junín, Peru.
<i>Phrynopus paucari</i>	Bellavista, Pasco Region, Perú.
<i>Phrynopus peruanus</i>	Cordillera Oriental in the puna of Maraynioc, in the Vitoc Valley, Junín Region, Perú.
<i>Phrynopus pesantesi</i>	Southern slopes of the Huaguruncho and Tarata peaks, in Huachón District, Pasco Province, Pasco Region, Perú.
<i>Phrynopus tautzorum</i>	Southeast of Maraypata, near Laguna Gwengway, province of Ambo, region of Huánuco, Perú.
<i>Pleurodema marmoratum</i>	Central Peru to central Bolivia, northeastern Chile and marginally into northwestern Argentina. In Perú the species is present in the Regions of Ancash, Arequipa, Ayacucho, Lima, Cusco, Huancavalica, Junín and Pasco.
<i>Pristimantis cruciocularis</i>	Pampa Hermosa, San Alberto and northeast of Tingo María, in Cordillera Azul in the Regions of Junín, Pasco and Huánuco, Perú; from within the Yanachaga-Chemillén National Park (Pasco) and its buffer zone and within the Llamaquizú Basin.
<i>Pristimantis flavobracatus</i>	District of Chontabamba, Province of Oxapampa, Region of Pasco, Perú. It is possible that this species may occur more widely.
<i>Pristimantis melanogaster</i>	Three geographic localities in the Region of Amazonas, northern Perú near the crest of the northern part of the Cordillera Central, and at Área de Conservación Privada Huiquilla.
<i>Pristimantis ornatus</i>	Five geographic in the Province of Pasco, Region of Pasco, Perú.
<i>Pristimantis pardalinus</i>	Vicinity of the village of Huasahuasi in the district of Huasahuasi, province of Tarma, region of Junín, Perú.
<i>Ranitomeya benedicta</i>	Distributed throughout the lowland forests of Pampas del Sacramento, in San Martín and Loreto regions, northeastern Peru.
<i>Ranitomeya flavovittata</i>	Six localities, most of which are in the Tamshiyacu–Tahuayo Communal Reserve of northeastern Perú, except for two records: one from Río Yavari and another further south from nearby Genaro Herrera.

<i>Ranitomeya imitator</i>	Lower Amazonian in north central eastern Perú (Departamentos: Huánuco, Loreto, San Martín).
<i>Ranitomeya sirensis</i> ¹	Upper Amazonian basin in central eastern and southeastern Perú (Regions of Loreto, San Martín, Ucayali, Pasco, Junín, Huánuco, Cusco, Madre de Dios), Brazil (State of Acre) and Bolivia (Department of Pando).
<i>Ranitomeya summersi</i>	Nine geographic localities in the central Huallaga Canyon and surrounding semiarid valleys, including both sides of the Rio Huallaga, into the southernmost edge of the Cordillera Escalera and to the northwestern edge of the Cordillera Azul, in the region of San Martín, northern Perú.
<i>Ranitomeya uakarii</i>	Lowland Amazonian rainforests of Brazil (States of Acre and Amazonas), Colombia (Departments of Amazonas and Caquetá), Guyana (Potaro-Siparuni) and Perú (Regions of Huánuco, Loreto, Madre de Dios and possibly Ucayali).
<i>Ranitomeya vanzolinii</i>	Pre-montane cloud forest in southern Peru to lowland rainforests of Brazil. It has been often observed on the eastern versant of Cordillera El Sira and in western Brazil near Porto Walter, Acre state. It has also been recorded in Cusco, Pasco and Ucayali Regions in Peru and Acre state in Brazil, possibly also occurring in Amazonas state in this country.
<i>Rhinella limensis</i>	Pacific coast of Peru extending from Pisco north to Sechura desert.
<i>Siphonops annulatus</i>	Widely distributed through tropical South America, ranging from east of the Andes from northern Colombia, Ecuador, Perú, Venezuela and French Guiana, south to Amazonian Brazil and Bolivia, and then from northeastern Brazil south to southern Brazil and northern Argentina, appearing to be disjunct in the open vegetation diagonal of Brazil. In Argentina, this species is found in the southern part of Misiones. In Bolivia, it is found in Beni, La Paz, Pando and Santa Cruz.
<i>Telmatobius atahualpai</i>	Restricted to the westernmost ridge of the Cordillera Central of northern Perú (in the Regions of Amazonas, San Martín and La Libertad).
<i>Telmatobius timens</i>	Valle de Tojoloque, Franz Tamayo Province, La Paz department, western Bolivia and from at least four streams on the north slope of Abra Acjanaco pass.