

## Global Conservation Status of Turtles and Tortoises (Order Testudines)

ANDERS G.J. RHODIN<sup>1,8,\*</sup>, CRAIG B. STANFORD<sup>2</sup>, PETER PAUL VAN DIJK<sup>3,8</sup>, CARLA EISEMBERG<sup>4</sup>,  
LUCA LUISELLI<sup>5</sup>, RUSSELL A. MITTERMEIER<sup>3</sup>, RICK HUDSON<sup>6</sup>, BRIAN D. HORNE<sup>7</sup>,  
ERIC V. GOODE<sup>8</sup>, GERALD KUCHLING<sup>9</sup>, ANDREW WALDE<sup>6</sup>, ERNST H.W. BAARD<sup>10</sup>,  
KRISTIN H. BERRY<sup>11</sup>, ALBERT BERTOLERO<sup>12</sup>, TORSTEN E.G. BLANCK<sup>13</sup>, ROGER BOUR<sup>14</sup>,  
KURT A. BUHLMANN<sup>15</sup>, LINDA J. CAYOT<sup>16</sup>, SYDNEY COLLETT<sup>4</sup>, ANDREA CURRYLOW<sup>2</sup>,  
INDRANEIL DAS<sup>17</sup>, TOMAS DIAGNE<sup>18</sup>, JOSHUA R. ENNEN<sup>19</sup>, GERMÁN FORERO-MEDINA<sup>20</sup>,  
MATTHEW G. FRANKEL<sup>21</sup>, UWE FRITZ<sup>22</sup>, GERARDO GARCÍA<sup>23</sup>, J. WHITFIELD GIBBONS<sup>15</sup>,  
PAUL M. GIBBONS<sup>24</sup>, GONG SHIPING<sup>25</sup>, JOKO GUNTORO<sup>26</sup>, MARGARETHA D. HOFMEYR<sup>27</sup>,  
JOHN B. IVERSON<sup>28</sup>, A. ROSS KESTER<sup>8</sup>, MICHAEL LAU<sup>29</sup>, DWIGHT P. LAWSON<sup>30</sup>,  
JEFFREY E. LOVICH<sup>31</sup>, EDWARD O. MOLL<sup>32</sup>, VIVIAN P. PÁEZ<sup>33</sup>, ROSALINDA PALOMO-RAMOS<sup>34</sup>,  
KALYAR PLATT<sup>35</sup>, STEVEN G. PLATT<sup>36</sup>, PETER C.H. PRITCHARD<sup>37</sup>, HUGH R. QUINN<sup>38</sup>,  
SHAHRIAR CAESAR RAHMAN<sup>39</sup>, SOARY TAHAFE RANDRIANJAFIZANAKA<sup>40</sup>, JASON SCHAFFER<sup>41</sup>,  
WILL SELMAN<sup>42</sup>, H. BRADLEY SHAFFER<sup>43</sup>, DIONYSIUS S.K. SHARMA<sup>44</sup>, SHI HAITAO<sup>45</sup>,  
SHAIENDRA SINGH<sup>46</sup>, RICKY SPENCER<sup>47</sup>, KAHLEANA STANNARD<sup>4</sup>, SARAH SUTCLIFFE<sup>4</sup>,  
SCOTT THOMSON<sup>37,48</sup>, AND RICHARD C. VOGT<sup>49</sup>

<sup>1</sup>Chelonian Research Foundation, Lunenburg, Massachusetts USA [rhodincrf@aol.com]; <sup>2</sup>University of Southern California, Los Angeles, California USA [stanford@usc.edu; a.currylow@gmail.com]; <sup>3</sup>Global Wildlife Conservation, Austin, Texas USA [ppvandijk@globalwildlife.org; rmittermeier@globalwildlife.org]; <sup>4</sup>Charles Darwin University, Darwin, Northern Territory, Australia [carla.eisemberg@cdu.edu.au; sydney.collett1@gmail.com; kahleana.stannard@students.cdu.edu.au; sarahruthsutcliffe@gmail.com]; <sup>5</sup>Institute for Development Ecology Conservation and Cooperation, Rome, Italy [l.luiselli@ideccngo.org]; <sup>6</sup>Turtle Survival Alliance, Charleston, South Carolina USA [rhudson@turtlesurvival.org; awalde@turtlesurvival.org]; <sup>7</sup>Wildlife Conservation Society, New York, New York USA [bhorne@wcs.org; sgplatt@gmail.com]; <sup>8</sup>Turtle Conservancy, New York, New York USA [eric@turtleconservancy.org; ross@turtleconservancy.org]; <sup>9</sup>University of Western Australia, Perth, Western Australia, Australia [gerald.kuchling@uwa.edu.au]; <sup>10</sup>CapeNature, Cape Town, South Africa [ebaard@capenature.co.za]; <sup>11</sup>U.S. Geological Survey, Western Ecological Research Center, Riverside, California USA [kristin\_berry@usgs.gov]; <sup>12</sup>Associació Picampall de les Terres de l'Ebre, Amposta, Spain [albertb@tinet.org]; <sup>13</sup>Cuora Conservation Center, Deutschlandsberg, Styria, Austria [info@cuora.org]; <sup>14</sup>Laboratoire des Reptiles et Amphibiens, Muséum National d'Histoire Naturelle, Paris, France [bour.roger@gmail.com]; <sup>15</sup>Savannah River Ecology Laboratory, University of Georgia, Aiken, South Carolina USA [kbuhlmann@earthlink.net; wgibbons@uga.edu]; <sup>16</sup>Galapagos Conservancy, Fairfax, Virginia USA [lcayot@galapagos.org]; <sup>17</sup>Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia [idas@unimas.my]; <sup>18</sup>African Chelonian Institute, Ngaparou, Senegal [fondsdev@yahoo.fr]; <sup>19</sup>Tennessee Aquarium Conservation Institute, Chattanooga, Tennessee USA [jre@tnaqua.org]; <sup>20</sup>Wildlife Conservation Society and Turtle Survival Alliance, Cali, Colombia [gforero@wcs.org]; <sup>21</sup>Surprise Spring Foundation, Prescott, Arizona USA [mf4250@gmail.com]; <sup>22</sup>Museum für Tierkunde, Senckenberg Dresden, Germany [uwe.fritz@senckenberg.de]; <sup>23</sup>Chester Zoo, Upton by Chester, Chester, United Kingdom [g.garcia@chesterzoo.org]; <sup>24</sup>Avian & Exotic Veterinary Care, Portland, Oregon USA [pmsgibbons@gmail.com]; <sup>25</sup>Guangdong Institute of Applied Biological Resources, Guangzhou, China [gsp621@163.com]; <sup>26</sup>Satucita Foundation, Aceh, Indonesia [jokoguntoro@gmail.com]; <sup>27</sup>University of the Western Cape, Bellville, South Africa [mdhofmeyr@gmail.com]; <sup>28</sup>Earlham College, Richmond, Indiana USA [johni@earlham.edu]; <sup>29</sup>Hong Kong Wetlands Conservation Association, Hong Kong, China [michael.mwn@gmail.com]; <sup>30</sup>Oklahoma City Zoo and Botanical Garden, Oklahoma City, Oklahoma USA [dlawson@okczoo.org]; <sup>31</sup>U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona USA [jeffrey\_lovich@usgs.gov]; <sup>32</sup>Tucson, Arizona USA [e.o.moll@gmail.com]; <sup>33</sup>Universidad de Antioquia, Medellín, Colombia [vivianpaez1@gmail.com]; <sup>34</sup>Universidad Autónoma de Ciudad Juárez, Chihuahua, Mexico [rpalram@yahoo.com]; <sup>35</sup>Turtle Survival Alliance, Yangon, Myanmar [kalyarplatt@gmail.com]; <sup>36</sup>Wildlife Conservation Society, Yangon, Myanmar [sgplatt@gmail.com]; <sup>37</sup>Chelonian Research Institute, Oviedo, Florida USA [chelonianri@gmail.com]; <sup>38</sup>Turtle Conservation Fund, Kirksville, Missouri USA [doublehq@aol.com]; <sup>39</sup>Creative Conservation Alliance, Dhaka, Bangladesh [caesar@conservationalliance.org]; <sup>40</sup>Regional Direction of Environment Ecology and Forest and University of Toliara, Madagascar [atsimoandrefana.meef@gmail.com]; <sup>41</sup>James Cook University, Townsville, Queensland, Australia [jason.schaffer1@jcu.edu.au]; <sup>42</sup>Millsaps College, Jackson, Mississippi USA [will.selman@millsaps.edu]; <sup>43</sup>La Kretz Center for California Conservation Science, University of California, Los Angeles, California USA [brad.shaffer@ucla.edu]; <sup>44</sup>WWF-Malaysia, Petaling Jaya, Selangor, Malaysia [dsharma@wwf.org.my]; <sup>45</sup>Hainan Normal University, Haikou, China [haitao-shi@263.net]; <sup>46</sup>Turtle Survival Alliance, Lucknow, India [shai@turtlesurvival.org]; <sup>47</sup>Western Sydney University, Penrith, New South Wales, Australia [r.spencer@westernsydney.edu.au]; <sup>48</sup>Museu de Zoologia da Universidade de São Paulo, Ipiranga, São Paulo, Brazil [scott.thomson321@gmail.com]; <sup>49</sup>Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil [dickturtlevogt@gmail.com]

\*Corresponding author

**ABSTRACT.** – We present a review and analysis of the conservation status and International Union for Conservation of Nature (IUCN) threat categories of all 360 currently recognized species of

extant and recently extinct turtles and tortoises (Order Testudines). Our analysis is based on the 2018 IUCN Red List status of 251 listed species, augmented by provisional Red List assessments by the IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG) of 109 currently unlisted species of tortoises and freshwater turtles, as well as re-assessments of several outdated IUCN Red List assessments. Of all recognized species of turtles and tortoises, this combined analysis indicates that 20.0% are Critically Endangered (CR), 35.3% are Critically Endangered or Endangered (CR+EN), and 51.9% are Threatened (CR+EN+Vulnerable). Adjusting for the potential threat levels of Data Deficient (DD) species indicates that 56.3% of all data-sufficient species are Threatened. We calculated percentages of imperiled species and modified Average Threat Levels (ATL; ranging from Least Concern = 1 to Extinct = 8) for various taxonomic and geographic groupings. Proportionally more species in the subfamily Geoemydinae (Asian members of the family Geoemydidae) are imperiled (74.2% CR+EN, 79.0% Threatened, 3.89 ATL) compared to other taxonomic groupings, but the families Podocnemididae, Testudinidae, and Trionychidae and the superfamily Chelonioidae (marine turtles of the families Cheloniidae and Dermochelyidae) also have high percentages of imperiled species and ATLs (42.9–50.0% CR+EN, 73.8–100.0% Threatened, 3.44–4.06 ATL). The subfamily Rhinoclemmydinae (Neotropical turtles of the family Geoemydidae) and the families Kinosternidae and Pelomedusidae have the lowest percentages of imperiled species and ATLs (0%–7.4% CR+EN, 7.4%–13.3% Threatened, 1.65–1.87 ATL). Turtles from Asia have the highest percentages of imperiled species (75.0% CR+EN, 83.0% Threatened, 3.98 ATL), significantly higher than predicted based on the regional species richness, due to much higher levels of exploitation in that geographic region. The family Testudinidae has the highest ATL (4.06) of all Testudines due to the extinction of several species of giant tortoises from Indian and Pacific Ocean islands since 1500 CE. The family Testudinidae also has an ATL higher than all other larger polytypic families ( $\geq 5$  species) of Reptilia or Amphibia. The order Testudines is, on average, more imperiled than all other larger orders ( $\geq 20$  species) of Reptilia, Amphibia, Mammalia, or Aves, but has percentages of CR+EN and Threatened species and an ATL (2.96) similar to those of Primates and Caudata (salamanders).

**KEY WORDS.** – IUCN Red List; chelonians; imperiled; endangered; threatened; Average Threat Level; Asia; Geoemydinae; Testudinidae; Reptilia; extinction

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ ([www.iucnredlist.org](http://www.iucnredlist.org)) is the global standard for threat assessments and determination of conservation status of all species of animals and plants on Earth. Assessments of threats, extinction risk, and conservation status of all tortoises and freshwater turtles are officially provided to the IUCN Red List by the IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG; [www.iucn-tftsg.org](http://www.iucn-tftsg.org)), which has produced status assessments for unevaluated and re-evaluated taxa on a continuous basis since 1982. Documenting the overall conservation status and percentage of threatened species of tortoises and freshwater turtles is important to understanding how seriously these taxa are threatened with extinction, how they compare with other imperiled taxa, and how threat levels for individual species and groups change through time. The global turtle conservation community needs these assessments to conduct analyses of the current conservation status of all turtles, but especially species with rapidly changing status levels, to help guide both prescriptive and reactive conservation policies and strategies for time-sensitive implementation of effective conservation efforts. Due to lengthy production times between draft assessments by the TFTSG via regional workshops and their eventual

publication as official IUCN Red List accounts, many of these TFTSG provisional status assessments have languished for years and have not yet appeared on the IUCN Red List; nearly one third of all turtle and tortoise species are not yet included on the current IUCN Red List. To make these provisional TFTSG assessments available in a more timely fashion, the Turtle Taxonomy Working Group (a committee of the TFTSG) has published brief, updated conservation status assessments based on these drafts (Turtle Taxonomy Working Group [TTWG] 2010, 2011, 2012, 2014, 2017). Previous provisional TFTSG Red List assessments have also been published as recommendations ahead of formal IUCN Red List publication (TFTSG 1989; TFTSG and Asian Turtle Trade Working Group [ATTWG] 2000; Horne et al. 2012).

To further assess and more effectively summarize the current conservation status of all turtles and tortoises in a single, comprehensive analysis, we provide here a combined review of the current official 2018 IUCN Red List (including published marine turtle assessments as determined by the IUCN Marine Turtle Specialist Group) and a review and analysis of the most current TFTSG Provisional Red List assessments of the conservation status of all previously unevaluated or re-evaluated tortoise and freshwater turtle species. This augmented TFTSG Red