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Poorly Vetted Conservation Ranks Can Be More Wrong Than Right: Lessons from Texas Land Snails

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Abstract:	Setting priorities for scarce conservation dollars requires an accurate accounting of the most vulnerable species. For many invertebrates, lack of taxonomic expertise, low detectability and funding limitations are impediments to this goal, with conservation ranks usually based on expert opinion, the published literature, and museum records. Because of biases and inaccuracies in these data, they may not provide an accurate basis for conservation ranks, especially when compared to de novo field surveys. We assessed this issue by comparative examination of these data sources in re-ranking the conservation status of all 254 land snail taxa reported from Texas, USA. We confirmed 198 land snail taxa, including 34 new state records. Our assessment of the entire land snail fauna of Texas resulted in 1) a near doubling of recommended Species of Greatest Conservation Need (SGCN) and 2) a 79% turnover in the makeup of SGCN taxa. Field sampling strongly outperformed museum and literature data in the encounter rate of both the entire fauna and all SGCN species, with the latter two demonstrating bias towards larger-bodied species. As a result, conservation priorities based solely on expert opinion, museum and literature records may be more wrong than right, with taxon-appropriate, targeted sampling required to generate accurate rankings.
Keywords:	conservation status assessments, natural heritage inventory, Gastropoda, sampling bias
Manuscript Classifications:	12: Zoology; 12.300: Zoology - General
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Question	**Response**
Response to Reviewers:	Editorial comments: Reviewer 3 makes many cogent points and is brusk about it. Most of these concerns, though substantive, can be addressed with additional verbiage in the text. [However, note that the authors are only about 500 words short of reaching the limit (7500). →For clarification, does the word count include figures, tables, and citations?] To address a couple of the R3's comments would entail a major revision—a huge undertaking: 1. the examination of the most important national museum collections and 2) the incorporation of Texas Parks & Wildlife Dept's central database land snail survey records. [TPWD includes the equivalent of a state Natural Heritage Program or Nature Serve state affiliate.] To my mind, we can handle these two major issues with paragraph(s) on "the limitations of this study" and 'recommendations for future research"--particularly with respect to the national museum collections. Seems to me that it is harder to address their decision to not incorporate the TPWD field survey data. Simplistically, I'd guess they'd either have to incorporate this data-entailing a major revision--or provide good reason for not doing so. •These are addressed with additional text. We appreciate where the reviewer is coming

from, but these are not useful resources in this particular group (and state). More detailed response below.

Finally, if this manuscript proceeds to publication, I recommend you consider inviting the authors to submit a full page plate of snail shell images. Our Journal is multidisciplinary; the manuscript is rather specialized, taxonomically—albeit with an approach and purpose that is more broadly applicable. It seems to me that some images would add significantly to the interest of a broader segment of the readership. The images then, would be of snails that would have the most interest—the oldest museum accessions, the rarest species, the largest, the smallest, the most ornate, a sampling of the range of sizes and shapes, etc.
•Done.
Comments from the Associate Editor to the Authors
I find your paper very interesting, entailing an impressive underlying effort and expertise. It is taxonomically specialized, but the approach and purpose are broadly applicable and thus quite suitable for NAJ. As would be expected, the reviewers point out minor errors, ask for additional citations, request additional clarification and elaboration, and the like. These are not problematic in themselves, but the maximum length for a research article is 7500 words and you are at about 7000. So, it may be difficult to adequately address most of these and stay within the limit—particularly as you begin to address some of their more substantive issues.

~ It appears that Reviewer 2 is asking that you to include more information about the conservation status changes—either in Table 2 or in a new table--and provides a sample format for a new table. Seems to me, that we'd want to include species-specific into—although, of course, most species did not previously have a conservation rank. Anyway, maybe you can devise a way to address Revr2's request. [I realize that by choosing NAJ, you are choosing to provide a case example for an approach that can be broadly applied. Thus, summarizing the changes in Fig 3 meets the needs of a generalist audience. However, both reviewers are invertebrate zoologists, so I think that in trying to accommodate a specialist's interest and to improve the value of the paper as a handy reference, it would indeed be valuable to show the 'before and after' results on a species-specific basis.]
•Done. Added to Table.

~ Reviewer 2 notes that some of the species you treat as endemics, have ranges that are not limited to Texas—s/he names a couple. The reviewer notes that in these cases S ranks should be used, not G ranks—as is your intent/practice.
•These were all double-checked and corrected if needed. The reviewer is right this was our intent and usual practice.

Reviewer 3 has made two comments each of for which, ostensibly, an adequate response would entail a major revision: 1) examination of the major, national terrestrial snail museum collections and 2) incorporation of the field survey data of the Texas affiliate of NatureServe. All research efforts have limitations in resources and effort. The examination of the entire collections at two, in-state repositories, required considerable effort in themselves. Including information from yet more collections would have been better, of course, but probably not feasible. I think it would be adequate for you to include a paragraph that specifies the limitations of the study and identifies the next steps in improving the conservation status categories or makes recommendations for further research.
•Addressed below and in text.

However, the failure to incorporate TPWD 'central database' of snail inventory info seems more problematic. I'm not familiar with this database; Reviewer 3 apparently is. Possibly, there are cogent reasons for not including such data—for example, considerable overlap with the data from the two museum collections you thoroughly examined. At any rate, my admittedly simplistic conclusion is that either you should make explicit why this information was not utilized OR examine and include this info. The former keeps us in the minor revisions category; the latter would entail a major revision. Given the 'strong connection' between the conservation status category system and NatureServe and its state natural heritage program affiliates, this issue must somehow be adequately addressed.
•Addressed below and in text. For a variety of staffing and political reasons there is

virtually no data in that central database.

Comments to the Authors from Reviewer 2 [apparently exported from pdf version—that pdf was provided to AE, but not uploaded to Editorial Manager]
•Introduction Page 1, Line 38: Please expand the discussion on rarity to include how NatureServe uses of range extent, area occupied, number of populations, size of populations, population viability and environmental specificity to assess conservation status. I think this would be useful to the reader.
oWe added this list to give examples of some ways of measuring rarity, but we do not think there is space in this manuscript, nor is it the focus here to expand it a great deal. We do discuss more the difference between area of occupancy and range extent below in response to other review comments and think that serves a similar purpose.

•Introduction Page 1, Line 48: Citation needed for sentence ending in “and range”.
oRevised to accurately cite Cardoso et al and added Kellner citation.

•Introduction Page 2, Line 33: Citation needed for sentence ending in “serious threat”.
oCitations included for both points.

•Methods Page 1, Historical Data, Line 38: Citation needed for Turgeon in sentence ending in “subsequent revisions”.
oAdded.

•Methods Page 6, Statistical Analysis, Line 7: Coma required after the word "validation".
oAdded.

•Results Page 2, Museum, Scientific Literature …, Line 11: I have a question, should this number be 198 or Is 203 correct?
o203 sites were sampled, we confirm 198 taxa in the state. We clarify in the text what value we were presenting (confirmed species, rankable species, etc.)

•Results Page 2, Museum, Scientific Literature …, Line 48: Table 2 lists the number of snails receiving ranks 1- 5 without identification of changes. Please identify rank changes in Table 2, or add an additional table with rank changes referring to it in text and change text identifying current Table 2 (preferred), or change wording of current sentence for Table 2 to reflect its actual content.
oWe added initial ranks as well as current rankings to Table 1 (previously Table 4) so they can be compared side-by-side. We also clarify the wording of the header/reference to Table 2.

•Results Page 3, Evaluation of the Texas …, Line 50 referencing statement, "possessing apparently stable populations in protected areas (e. g. species restricted to national parks).": Why suggest dropping NPS species from SGCN status? If these species are of limited distribution, or small populations, or high environmental specificity, then because their populations are well protected and currently stable does not preclude them from all of the stochastic issues (e. g. drought, climate change) that make small populations subject to collapse. You either need to further support your reasoning in the discussion or change your decision to remove some, all, most of these species from SGCN status. I need to know about which species and why they were recommended for removal from SGCN status because they were protected and stable.
oThe most important factor leading to species endangerment is habitat loss, and national parks are about as secure from direct anthropogenic impacts as are any properties in the country. Climate change is an issue that influences all species, the risks from climate change are exacerbated by land management threats (the Texas Conservation Action Plan also says this). Relative to other species, those in NPS are in a better situation than other taxa because they don't have to worry about many of the other threats on private/ unprotected lands. IUCN red list explicitly says that small range endemism is not sufficient for critical conservation concern designation per se (i.e. it is not a threat in and of itself although as the reviewer points out, it MAY increase a species' sensitivity). We wish that NatureServe methodology had the same caveat, but just the opposite, small range endemics are automatically assigned high imperilment. We added to the text justification for our reasoning. Ranks were never adjusted more than one level from the recommended NatureServe calculator rank (e.g.

S1 to S2, or S2 to S3) with no species being moved from S3 to S4."
oWe indicated which species these were in Table 1 (previously Table 4).

•Discussion Page 2, Evaluation of Conservation …, Line 48 referencing statement, "the change does not represent an Increase In Imperilment status of species since last evaluated,": Can you expand on this and briefly discuss why you suspect land snails are still doing well in Texas. Is the ecological integrity of snail inhabit still of high quality? If so, why (remoteness, protection within public property reserves, on ranch lands protected from public disturbance/development, etc.)?
oThe focus of this article is really on the ranking process, rather than the snails themselves. So often we are leaving snail-specific information out of the writing and focusing on the broader process. We are not trying to downplay the effects of humans on these landscapes and habitats. They are substantial in some regions and are reflected in some of our ranks in the "threat" portion of the ranking, but that did not drive the overall pattern of changes in ranks. It is also the case that many of the SGCN snails occur in regions with very low population densities. In the last sentence of this paragraph we elaborate on what our evidence suggests, we are seeing differences in the list due to the limited and biased nature of the data used to formulate initial rankings. We do think our work and rankings will allow declines to be observed in the future as we used a standardized sampling method and have reported that data to the state agency.

•Discussion Page 3, Evaluation of Conservation …, Line 58: Should (Figure 3) not reference Figure 2 or possibly Figure 1 (probably both)?
oYes. Corrected.

•Figure 1: Is it possible to identify vegetation type on this figure? I think this would be useful information to the reader. If not, could you add an appendix listing vegetation types sampled by region?
oAt the scale of this image, there are so many vegetation types that it would be unreadable. Even at a full wall-size poster they are hard to view. An Appendix that is a listing of items like" Clayey Blackbrush Mixed Shrubland, Riparian Cypress, Salty Prairie, etc. does not seem like it would add much information for the reader unless it was linked to site. We also do not want to put the entire database up as an appendix available freely online because we are concerned with protecting the locality information of rare snails that are sometimes targets for collection or destruction of localities due to concerns by private landowners (or state agencies) of perceived difficulty when a threatened species is present. We propose to add a line to the text about the full database being available upon request of the authors. We also added the link to the TEAM mapping system in the text and figure legend so readers can go directly to the zoomable version of these vegetation maps.

•Figure 2: Legend makes it look like colors for >20 and for 0 samples are the same.
oCorrected. 0 should be an empty square.

•Figure 3: What does the asterisk refer to in the "Extant but recorded as extinct or possibly extinct in state*" category of Figure 3. [AE: never mind. I see that the captions are listed on pages apart from the pertinent figures and tables]
oAcknowledged

•how can you be sure they were erroneous if you admittedly and intentionally did not include the entire state in your surveys?
oAdded the word unsupported to clarify here. These are records where the museum specimen that provided the evidence for this state record was a misidentification. It is conceivable that the species occurs in the state but there is no evidence for it. The only evidence for it occurring on the state list was an error in identification. We use the language "taxa confirmed to occur in the state" to make this clear.

•Table 3: Text states that 173 (86%) taxa received new ranks, but the table lists 123 (62%) in the change column. [AE: I presume that this is because the 'text' involved all taxa, but the table does not—only the major ll families]
oThe table only looks at the subset that are in the most species rich families.

•Results Page 3, Evaluation of the Texas …, Line 31: How is SGCN status ascertained

from Table 4? Please add that information to table and identify changes by species (no change, added, dropped) to table. [AE: perhaps this is most easily addressed by adding a column for what the 'official' status is—or what it was prior to your research]
oAdded a column to the table listing the rank assigned to each taxon prior to our work. This also resolves what the reviewer perceived as missing from Table 2. We believe this addition gets at what was requested in the Table the reviewer suggests.
oNote identifying all G1 & G2 (S1 & S2) added to Table legend.

oProvide a source for such a broad statement. The sources listed are case specific and do not support the statement.
Added e.g. to make clear that these are examples, not references that review the data sources for conservation status assessments. We are not aware of such a reference. Also modified so it is clear we refer to initial assessments, rank reviews and revisions such as we conduct here would likely incorporate field collected data by agency staff or contracts with taxon experts.
Comments to the Authors from Reviewer 3
•Results of your study are based on the assumption that conservation status assessments primarily rely on museum records and published literature. This is not the case; especially in the case of museum records. States (and Canadian provinces) use museum records either as a supplement, or often not at all, when assessing conservation status. Published literature is most often supplemented with field surveys (albeit often not as comprehensive as yours) either conducted "in house" by staff at state wildlife agencies or through contractual arrangements with experts.
oThis is a good point for us to clarify but may be somewhat taxon-specific. We added to the text to clarify. We are examining the best way to go about testing and revising existing rank hypotheses. Is lit/museum enough? Can you save money by only using those resources or do you have to contract an expert to do field work? We found you really cannot get high-quality data that way.
oIt is unrealistic to assume that for 30,000 invertebrate taxa in Texas (actually that's just insects and arachnids I think), there were so many experts sufficiently familiar with each taxa that they could ignore lit and museum records and rely on their personal intimate knowledge.

•Information from the Texas Parks and Wildlife Department central database includes data from such surveys. It appears from your methodology you did not utilize this data. You should contact TPWD to incorporate this site specific information into your dataset as it is likely the most valuable data in terms of number of occurrences and method by which the data was obtained (i.e. field surveys- which you stress are more important than other methods). Also, if you are going to compare data collection methods including museum collection records, also include records from the major U.S. museums which hold perhaps thousands of such records of land snails from Texas, rather than just the two Texas museum collections you consulted.
oAddressed below.

•You provide several shortcomings and inherent problems with current conservation status assessments. Offer solutions as to how to overcome these shortfalls. Solutions should carefully weigh the benefits of more accurate and complete data (as clearly outlined in your study) with the cost of time, effort, and resources required to undertake such a study as yours by the typical state wildlife agency. Your study fails to address the fact that state wildlife conservation assessments, are, by their nature, designed to encourage revision. They are not peer reviewed research yet are still made available publicly and utilized in conservation status assessments because they are still a "rigorous and consistent method for evaluating the relative imperilment of both species and ecosystems based on the best available science" (NatureServe Conservation Status Assessment description: https://www.natureserve.org/conservation-tools/conservation-status-assessment).
oThis comment addressed with the comment below as they both reflect the same issues.

You state, "Before initiating a species conservation assessment, data should be carefully evaluated for sampling biases and erroneous species identification data." You obtained species status information from Texas Parks and Wildlife Department (the agency responsible for monitoring SGCN species in Texas). You should be aware that their most recent (2012) Texas Wildlife Action Plan is the SECOND revised plan

following the first plan issued in 2005 (as required by the Federal Government to issue a revision every ten years). The first plan contained NO TERRESTRIAL SNAILS. The authors of the latest revision decided wisely to include land snails in their conservation status assessment, albeit with very limited baseline information, in order to begin the process of conserving this vanishing fauna in the state. If inaccuracies or inconsistencies in data were used as a key factor in determining which taxonomic groups were considered to include in the plan (and careful analysis of sampling bias and erroneous species IDs is initiated such as yours), terrestrial snails, and several other groups, would never be included. State Wildlife Grant (SWG) rules dictate that no federal dollars allocated by U.S. Federal SWG program can be used to conserve wildlife UNLESS they are included on a state's Wildlife Action Plan. The inclusion of land snails makes available conservation dollars that would not be available otherwise.
oWe agree with the reviewers' comments and we have tried to clarify our stance. If we gave the impression that our work was a criticism of the status assessment and SGCN process, it was unintentional. Quite the contrary, as the reviewer points out, the kind of work that we did is an important step between the initial listing of species on the list and determining what needs to be done next.
oAs stated by this reviewer, the inclusion of land snails and initial rankings on the Texas Wildlife Action Plan is what allowed the funding of this work through a State Wildlife Grant. The funding and subsequent revision of rankings based on more solid evidence is the system acting exactly like they should. We revised this sentence and others in the introduction and methods to make the process clear for readers and acknowledge the double-bind natural resource managers may encounter.

•Finally, it appears you did not share your data set with TPWD. If you wish to see this array of changes you propose in Texas land snail conservation status ranks, this information is integral to realization of that goal. State biologists will need to see your raw data to update their central databases and make appropriate updates to Sranks for Texas landsnails and also to share this data with NatureServe so updated Granks can be assigned. If you have already done this, it is not reflected in your manuscript.
oWe have shared our data set and rankings with TPWD and add a statement reflecting this to the manuscript. We had shared it several years ago but apparently it takes 5+ years for this information to actually be integrated into the state's databases and websites for a variety of staffing and political reasons.

ADDITIONAL COMMENTS ON THE SUBMITTED MANUSCRIPT below
•There is no such organization as the Texas Natural Heritage Inventory
oThe reviewer is correct, "natural heritage inventory" is a generic term for these institutions that take on unique titles in each state. Natureserve uses the term "natural heritage programs" but since this paragraph specifies the Texas system we will adjust to the proper term in that state.

•Conservation ranks, at the state level, were usually established using these methods when taxa were assessed for the FIRST time; when only baseline data was easily obtainable.. Subsequent rank reviews most often incorporate field observation (either by state wildlife staff or contracted biologists) and peer-reviewed literature. The mere listing of a species as SGCN by its nature prompts field site review of state occurrences to document range extent, occupied habitat, and viability. The results of these field assessments are incorporated into future rank reviews and allocation of SWG funding dollars.
oClarified in the text. The Tx snails were first ranked and included in the rank list for the state ~10 years before this project. This project was funded to contribute data for the first rank review.

•you address errors inherent in museum records and expert opinion in the following paragraphs but fail to mention the other two methods you include here- published localities and agency reports. If you are not going to address them as sources of error in conservation ranking, remove them from your comments.
oThese were included in the following paragraph but we used slightly different terms for them "primary and gray" literature. We revised the writing to use the same term for clarity.

•how were museum records verified? Why weren't major national museum repositories (USNM, AMNH, MCZ, ANSP) consulted? For example, there are 6200 Texas records

	of land, freshwater, and marine mollusk lots in the MCZ alone (not separated by habitat but searchable by state or species). Even if only 10% of these are Texas land snails, that would account for 620 records not utilized in your museum records dataset. oThe details of verification are just a bit later in the paper in the Methods so we leave those details there. oUsing every available datapoint would be best, but there is a trade-off between optimal and feasible. We added our rationale to the text. There is little Texas material, comparatively, in the National museums outside of the Hubricht collection (Field Museum); much of the mid-20th Century stuff around the country is duplicate material that Cheatum et al sent around which we capture from the Perot Museum collections. The Hubricht collection is included in our dataset. The other largest collection would be Pilsbry's collections in the Academy of Natural Sciences of Philadelphia, but that is entirely captured in our literature dataset as it was all used for his Monograph on land snails. Aside from there not being extensive novel materials in those major collections, with the limited funds available, our time and money was focused on the huge task of re-identifying all Texas materials in the largest collections of that material, those in Texas. •missing citation here; also Turgeon does not appear in the literature cited list oThank you. The sentence with this reference was cut in the streamlining of the manuscript. •where are they located? oAdded to text. Dallas and El Paso. •why not use TPWD heritage database records? oSome state's natural heritage database is a very useful and comprehensive source of data. That cannot be said of the land snail portion of the TPWD heritage database. The Texas Natural Diversity Database has 14 records for 9 land snail species. Only two of these records (for Daedalochila hippocrepis and Euchemotrema leai cheatumi) are not from the primary literature. We added information to the text to this effect to explain why there were not incorporated. •denied by whom? why? oThe Texas General Land Office. We have tried to be cautious in our writing here to avoid pointing fingers in a way that could be interpreted politically. That public office in Texas administers several of the type locality sites and officially denied us permission to sample or observe the snails on their lands. They declined to explain their reasoning or change their position, despite repeated requests from TPWD. In a few other cases it was private landowners that could not be contacted or denied permission. We don't think it is useful to get into this in a journal article but we add the requested info to the text. •The elimination of area of occupancy leads to bias in your conservation status assessment. It is one of the most important fields utilized when calculating granks. See Smith et al. 2020 The power, potential, and pitfalls of open access biodiversity data in range size assessments: Lessons from the fishes. Ecological Indicators iss. 11 oThe reviewer is correct, we allude to this issue when we state that we use a conservative estimate of rarity, EOO, extent of occurrence that tends to overestimate range and therefore perhaps underestimate rarity in organisms with patchy habitat distributions, such as land snails. However, the Smith study, while examining a much better documented group and one that has different habitat constraints (freshwater fishes) seems to claim that use of AOO or EOO essentially gives the same rankings, which would support our use in our study. We add this to the text along with caution that our rankings should in this way be understood as potentially underestimating species' rarity. •Why as TPWD not consulted to obtain data points from their central database? This information is an integral part in the assigning of the current status ranks in the state. It wold have been particularly useful where SGCN species were not found in museum databases you checked or when you did not find these species in your surveys. Consult with TPWD and include this information in your analysis. Further, site specific information from this study should be shared with TPWD so it can be incorporated into their central database (there is nothing in the paper to indicate this has been done).

	The addition of such information will undoubtedly make conservation status ranking for Texas land snails more vigorous and lead to better informed conservation practices for the SGCN taxa found in the state (which is presumably one of the criticisms of the methodology you outline in the paper). oAs mentioned above, this database has 14 snail records, only 2 were not from the primary literature and those specimens were not available for vetting. It is not a useful data source at the moment. oAs above, we were working with TPWD, they funded the project. We contributed this to TPWD in the form of a report and georeferenced locality data at the conclusion of the grant 2 years ago. We added this information to the Methods where we discuss deposition of museum vouchers. oThe data arising from this project will eventually be used by TPWD to add site specific data to their database, but it takes time (>5 years) for records to make their way into that database. •rank calculation dates vary by species. What is the source for this statement? oCitation added. Pers comm from the director of the Texas Natural Diversity Database. We could not find a published or documented source. •you ignored citation Thompson, F. 2006. Some land snails of the genus Humboldtiana from Chihuahua and western Texas. Bulletin of the Florida Museum of Natural History 46(3): 61-98. oThe relevance of this paper to our list would be the elevation of Humboldtiana presidii to species status. We include it as a full species (not subspecies) in our list, so we do incorporate this work in that way. Thompson 2006 does elevate H. presidii but does not add new localities or records, so we do not include it separately in our database. We do not list every reference included in our database in this literature cited section as they do not appear in the manuscript itself. This would be available upon request from the corresponding author. •How did you account for species with global distributions that extend into Mexico. For such species, the Srank would NOT necessarily correspond to the Grank and Global ranks include rank information from ALL countries not just the United States. There are taxa on this list with Granks that are not strict Texas endemics and therefore should be assigned an Srank NOT a Grank. Correct these in Table 4. At first glance, examples include Rabdotus pilsbryi, Holospira hamiltoni, but there may be others. oAll species that occur outside of Texas (including other US states and countries) are denoted with an S rank and Tx endemics with a G rank as the reviewer states. We double checked each one and corrected the ones that did not follow this pattern.

RESEARCH ARTICLE

Title: Poorly vetted conservation ranks can be more wrong than right: lessons from Texas land snails.

Running head: Evaluation of conservation ranks

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Word count: Abstract: 203, Main Body: 4,498.

ABSTRACT:

Setting priorities for scarce conservation dollars requires an accurate accounting of the most vulnerable species. For many invertebrates, lack of taxonomic expertise, low detectability and funding limitations are impediments to this goal, with conservation ranks usually based on expert opinion, the published literature, and museum records. Because of biases and inaccuracies in these data, they may not provide an accurate basis for conservation ranks, especially when compared to *de novo* field surveys. We assessed this issue by comparative examination of these data sources in re-ranking the conservation status of all 254 land snail taxa reported from Texas, USA. We confirmed 198 land snail taxa, including 34 new state records. Our assessment of the entire land snail fauna of Texas resulted in 1) a near doubling of recommended Species of Greatest Conservation Need (SGCN) and 2) a 79% turnover in the makeup of SGCN taxa. Field sampling strongly outperformed museum and literature data in the encounter rate of both the entire fauna and all SGCN species, with the latter two demonstrating bias towards larger-bodied species. As a result, conservation priorities based solely on expert opinion, museum and literature records may be more wrong than right, with taxon-appropriate, targeted sampling required to generate accurate rankings.

Index terms: conservation status assessments, natural heritage inventory, Gastropoda, sampling bias

INTRODUCTION

While numerous criteria have been used to set natural resource protection and management priorities (Asaad et al. 2017), a central focus continues to be the conservation of imperiled species. Setting rare-species conservation and management targets, however, requires an accurate accounting of the most vulnerable species (Kirchhofer 1997, Beissinger et al. 2000, Salafsky 2008). In the United States, the NatureServe Conservation Status assessment (NatureServe 2015) is the primary tool used by Natural Heritage Programs to assess species vulnerability. Similar to the IUCN Red List of Threatened Species assessment, it provides a consistent methodology for incorporating rarity measures (e.g. range extent, area occupied, number of populations, etc.), trends, and threats to evaluate conservation status (de Grammont and Cuarón 2006). The ranking process minimizes data deficient/ unrankable designations (Lewis and Senior 2011) to prevent genuinely imperiled but data-deficient (DD; or unrankable, NU) species from being overlooked during conservation planning. However, a data deficient designation could be preferable to erroneous rankings if the underlying data is insufficient. Our study investigates the accuracy of initial ranks and the most efficient way to develop an evidence base for accurate rankings of a diverse invertebrate group.

For the diverse invertebrate species that feature prominently on rare species lists, low detectability (Kellner and Swihart 2014), lack of taxonomic expertise and funding for systematic field surveys (Cardoso et al. 2011), and are impediments to data-driven conservation assessments. As a result, initial conservation assessments in these groups often rely on expert opinion, museum records, and published literature. Unfortunately, such data have a high potential for significant error and bias. Expert opinion can be problematic in terms of conscious or unconscious biases related to both motivation (e.g. favoring ‘pet’ taxa or species restricted to loved habitats and regions) and research accessibility (Martin et al. 2012), and is derived, at least in part, on museum and literature data. And, while museum collections represent an enormous investment of time and effort from curators and collectors, lots are often misidentified, with error rates approaching 70% for some groups (Goodwin et al. 2015). As a result, naïve use of museum records without expert verification can produce inaccurate estimates of species abundance and distribution (Nekola et al. 2019). Museum records are also subject to geographic bias with sampling often being more prevalent in proximity to the institution or adjacent to highways and other access points (Palmer 1995, Soberón 2000). Body size bias is also present with large, easily visible taxa overrepresented (Nekola et al. 2019).

The use of *de novo* (new) field surveys conducted to minimize bias across the entire range of available habitats within a given geographic region may make conservation rankings more robust but can be costly in terms of both funding and person-hours. Are such costs warranted? Is additional field work a justifiable expense in the conservation ranking process? To address this issue, we re-assess the conservation status of all Texas land snails (e.g. Figure 1), based not only on literature surveys and reverification of all available holdings from the two largest global repositories for Texas material, but also on new field surveys from over 200 sites across the state. Based on these data, we examine the magnitude of proposed changes to the Texas land snail rankings, SGCN list, as well as the relative importance of expert opinion, literature and museum records, and new field surveys in evaluating existing ranks.

METHODS

Ranking Framework and Data

Much ranking activity in the USA is underwritten by the State and Tribal Wildlife Grant (STWG) program. To be eligible, a taxonomic group must be incorporated into a state wildlife action plan (WAP). The goal is to provide Species of Greatest Conservation Need (SGCN) with proactive protection so that regulatory intervention via state and federal endangered species law is never required. The process for establishment and evaluation of SGCNs within a WAP is: 1) initial assessment based usually on expert input; 2) critical evaluation of this initial assessment based on literature, museum, and field data; 3) revision of ranks based on these data; and 4) removal of those species not warranting SGCN designation. This study is focused on steps 2 and 3.

While the first Texas WAP did not consider land snails, they were incorporated in 2005 (TPWD 2005). Initial ranks were based primarily upon expert interpretation of species accounts provided in The Aquatic and Land Mollusca of Texas series (Cheatum and Fullington 1971, 1973, Fullington and Pratt 1974) and solicitation of expert input on threats (pers. comm. K.E. Perez). These species were then tracked within the Texas Natural Diversity Database (TXNDD) of the Texas Parks & Wildlife Department (TPWD). In the subsequent 15 years, 14 land snail locality records have been entered into the TXNDD (Bob Gottfried, personal communication).

Historical Data: Collection of Museum and Literature Records

We considered two forms of historical data in our reassessment of Texas land snail conservation ranks: 1) verified museum records from the two largest global repositories of Texas material combined with 2) selected literature reports.

All Texas lots were verified from two Texas museums: the Perot Museum of Natural History in Dallas, Texas and the University of Texas El Paso (UTEP) Centennial Museum

Collection in El Paso, Texas. These house the two most extensive land snail holdings in the world for Texas land snail material. Both were also assembled and curated by the most active Texas land snail taxonomists of the 20th Century. We did not verify or incorporate museum records from other national collections because 1) they are very limited in terms of Texas material, with the vast majority representing duplicate lots from either the Perot or UTEP or 2) they have been reported previously in the scientific literature. For example, almost all Texas specimens in the Academy of Natural Sciences at Drexel University holdings were published in Henry A. Pilsbry's papers.

We examined every individual in every lot in the Perot and UTEP collections and verified species identification of each. "Lots" are used in snail collections as a storage unit for one to many individuals of a single species of snail from a unique sampling instance (same time and place). In our dataset, we excluded lots that were indicated as "drift" because these cannot be confidently assigned to a specific population location or confidently related to extant vs. subfossil shells. We also excluded lots of fossil or subfossil shells as they do not contribute useful conservation data. Mixed lots (i.e. lots containing one or more misidentified individuals belonging to a different species) were split into multiple lots of single species. Verification of species identifications was conducted by the co-author with taxonomic expertise for a given group (co-authors: JN, KEP, BH). If a single co-author was unable to confidently assign an identity, we used group consensus.

A second dataset of localities was generated by extracting records from all published literature on Texas land snails. We omitted accounts that did not identify precise localities (e.g. 'south Texas'). To minimize redundancy, we only encoded those literature records absent from the museum lot data. We were able to retrieve most of the county-occurrence data of Hubricht

(1985) through incorporation of all Texas lot records in the Hubricht Collection at the Field Museum of Natural History.

We did not include the 14 records (9 species) from the Texas Natural Diversity Database because only two (one each for *Daedalochila hippocrepis* and *Euchemotrema leai cheatumi*) were not already included in the museum data. Additionally, the validity of their identifications could not be independently verified.

Ecological Data: *De Novo* Field Collections

De novo field collections were designed to 1) confirm persistence of SGCN populations at historic sites, and 2) document the snail fauna across the state from a wide range of habitat types. We attempted to sample at least one extant site for each previously listed SGCN species. While we were able to document ~2/3 of previously designated species, we were denied permission to visit historic locations for the remainder by the Texas General Land Office or private landowners.

Sites not previously surveyed for land snails were also investigated. We used the above database of historical records to identify gaps in sampling effort, and, based on prior experience, prioritized regions and vegetative communities that were most likely to support diverse faunas. We also targeted unique / undersampled vegetative communities near the state border, especially when species not previously recorded from Texas occurred nearby. Our aim was to sample two examples of each identified vegetation community for land snail biodiversity from sites as widely separated as possible. We accomplished this though use of the TPWD Texas Ecosystem Analytical Mapper (TEAM; TPWD 2019). TEAM uses underlying geology, slope, remotesensing data and extensive field ground-truthing (>14,000 sites) to identify nearly 400 vegetation types across the state and is publicly accessible online (https://tpwd.texas.gov/gis/team/).

In each ecological community sample, the fauna was documented using the method of Cameron and Pokryszko (2005) in which high-quality microhabitats are non-randomly targeted within a tenth hectare region. Random sampling does not perform well for land snails because sites are mostly covered in inappropriate microsites supporting very low shell densities (Cameron and Pokryszko 2005). Unless appropriate microsites are targeted, too few shells will be encountered to provide a robust picture of community richness and abundance. To document the entire fauna, we used a combination of encounter methods, including eye and hand searching of coarse debris and woody cover, sweep netting of arboreal vegetation, and sieving of leaf litter. Protocols for the latter are outlined in Nekola & Coles (2010) and Nekola (2014a). All identifications were subjected to the same verification procedures as above for museum records.

Evaluation of Conservation Status Ranks

All land snail taxa previously reported or encountered in the state were considered. Non-native species were automatically assigned an exotic status (SNA) and not further assessed. Taxonomic uncertainty precluded in-depth assessment of several other taxa, especially those whose species-concepts remain unresolved or which require soft-body anatomy for verification (e.g. Succineidae and all slugs). These species were assigned a ‘taxonomy uncertain’ status. Taxa erroneously reported from the state (i.e. records derived from misidentifications or outdated or incorrect taxonomy), were assigned ‘not applicable’ (not applicable at the state level). Species were given state-level ranks (S) unless they were endemic to Texas, in which case global ranks (G) were assigned.

All remaining valid taxa were ranked using the NatureServe Rank Calculator Version 3.186 (NatureServe 2015). This tool assigns ranks ranging from 1 (critically imperiled) to 5 (secure) using a point and rule-based system that considers scaled and weighted trend, rarity, and threat factors. Population trend data is not available for any Texas land snail species and were thus not used. Species were initially ranked by the team member with taxonomic or regional expertise in the group. Rankings were then evaluated by the group and revised by group consensus.

Rarity factors included range extent (calculated as the minimum area convex hull required to encompass all museum and field sampling records) and number of occurrences (number of museum and field-based records from locations greater than 1 km apart). Area of occupancy was not used because of incomplete sampling across all habitats in the state. Because range extent likely overestimates coverage in patchily-distributed organisms, our rankings may be more liberal than is warranted (e.g. being biased to assigning a less threatened status). However, a recent multi-taxon approach found little difference when comparing the use of range extent and area of occupancy at a landscape scale (Smith et al. 2020).

Threat factors were estimated for each region of the state and then applied to species found in those areas; these regional threat profiles are presented in the Appendix. Species-specific threats were also incorporated and were often related to habitat management, conversion and alteration (e.g. prescribed fire, residential and commercial development, livestock farming and timber production, etc.). Threat responses were based on literature (e.g. Nekola [2002] for fire) and the combined field experience of the authors. We attempted to identify the scope and severity of each threat assessed but acknowledge that few empirical studies document changes in abundance and distribution of land snails in response to specific threats. A small number of taxa also faced specific extralimital threats beyond the generic threats for a region, often related to the impact of global climate change.

Given that the most serious threats to land snails are land development and other direct human actions (Lydeard 2004), we chose to adjust conservation ranks for those species that have large populations residing within well protected properties, such as National Parks (indicated in Table 1). This aligns with the IUCN Red List (IUCN Standards and Petitions Committee 2019) species assessment approach in which small range endemism is not sufficient for critical conservation concern designation, although it may increase a species' sensitivity. Ranks were never adjusted more than one level from the recommended NatureServe calculator rank (e.g. S1 to S2, or S2 to S3) with no species being moved from S3 to S4. We anticipate this will allow conservation resources to be invested in species limited to more threatened private lands.

A small number of species reported from the state were not encountered in the museum surveys or field collections. For these, range extent and number of occurrences were inferred from the available literature.

Statistical Analysis

We determined whether each changed species rank was related to altered taxonomic concepts, museum lot misidentifications, new field observations or a combination of these factors. We also evaluated the efficiency of museum, scientific literature, and ecological data to encounter 1) the entire fauna and 2) our updated list of SGCN taxa only. Separate datasets were assembled for all verified museum lots from the Perot and UTEP collections (N = 3,968), unique literature records (N = 2,249), and all lots from community samples made by the authors (N = 2,341). For the entire snail fauna, each dataset was randomly sampled without replacement with

10,000 replicates to construct species accumulation curves with 95% confidence intervals. The species accumulation curves for each dataset were then compared using visual assessment of the 95% confidence envelopes. The process was repeated for accumulation of SGCN taxa only across the entire dataset. Analysis was conducted in R 3.5.2 (R Core Team 2015, code available on request).

To test for association between 1) snail species size and rank and 2) size and whether an account represented a new state record, we conducted a Chi-square test of independence using updated ranks. Fisher Exact tests of independence were used in instances of sparse data. Species that were unrankable due to insufficient data or taxonomic uncertainty were removed for assessment of conservation status rank by size, and species that were unrankable due to insufficient data were removed for assessment of new state record by size. Taxa were grouped by shell size (minute, small, medium, large or minute-small, medium-large) using maximum shell dimension following the database of Nekola (2014b). Analysis was conducted in R 3.5.2 (R Core Team 2017).

RESULTS

Museum, Scientific Literature, and Ecological Records

6,309 specimen records from both from museums and new field sampling serve as the basis for this evaluation of conservation status ranks (database available upon request). Field sampling was conducted at 203 sites (Figure 2) representing 81 vegetation types, which were each sampled between 1 and 10 times. Field sampling resulted in >100,000 individuals from 2,341 specimen records. Materials from field sampling are vouchered at the Sam Houston State University Natural History Museum (SHSUSnail002626 – 003847) or in the collection of author

JN. Georeferenced locality records were reported for eventual inclusion in the TNDD. State-wide patterns of species richness (and sampling intensity) are shown in Figure 3.

Evaluation of the Texas Land Snail Fauna and Conservation Status

Our assessment of 254 taxa resulted in a dramatic revision of Texas' documented land snails, including 34 new state records and removal of 13 previously reported taxa. Determinations of uncertain occurrence in the state (SU) and taxonomic uncertainty (TU) further altered the state list. In our study, we confirm 198 taxa (species and subspecies) from the state (excluding species ranked SU and TU), including 40 state-endemic species (20%) and 34 non-native taxa (17%). Some historical records could not be confirmed from museum or field collections, and many species records were based on misidentified museum specimens perpetuated in published reports. Of the 198 rankable taxa (taxa that are extant in the state and not unrankable due to uncertain taxonomy or status) 173 (87%) received a new state conservation status rank (percentage of taxa in each rank category in Table 2). Rank changes included 1) taxa receiving a state rank for the first time, 2) taxa receiving a more or less imperiled rank, 3) rankings for extant taxa previously recorded by NatureServe as extinct or possibly extinct, 3) and additions or removals from the list of Texas species. Forty-three taxa (18%) were unrankable due to taxonomic (N = 31) or status (N = 12) uncertainty including 6 species only recorded as dead shells in beach drift. Rank changes were unevenly distributed across families. In the two most commonly encountered families, Helicodiscidae (8 taxa) and Helicinidae (2 taxa), 100% of species underwent rank changes, and none of the 10 most species-rich families had fewer than 50% of species change rank (Table 3). In general, species were more likely to increase in ranking (i.e. less imperiled than previously thought) than decrease (Figure

4). Of the taxa evaluated, 60 ranks (25.4%) derived from the NatureServe rank calculator were further revised based on expert consensus. These were revised in three ways: 71.7% to a more secure status, 13.3% to reflect higher imperilment, or 15% to reflect uncertainty such as taxonomic uncertainty. Of rank changes, 6% were the result of museum collection validation, 33% new field collections, 28% both, and 22% due to revised taxonomy.

The previous Texas SGCN list included 36 land snail species. Our rankings increased that to 67 recommended taxa with 22 species removed from the list and 53 taxa added (Table 1). Only 14 of the previous SGCN species were retained. Thus our revisions produced a 79% turnover in the species included on the prior Texas SGCN list. Additions to the list include new state records, new species described since the last TPWD review, undescribed new species discovered during this study, subspecies encountered during this study and not previously tracked, and, most importantly, minute snails that had been under-sampled or overlooked in the ranking process. Species that we recommend be removed from the SGCN list include those that are more common than previously reported or likely represent invalid taxa.

Efficiency of historical record compilation vs. new field work

Of new state records, both native and non-native; 32% were the result of museum collection validation, 55% field collections, and 12% both. Using the museum dataset as a basis for comparison we examined the efficiency of literature-derived and ecological sampling datasets in encountering the entire fauna and only SGCN species (S1-S3/G1-G3; Figure 5). For the first ~200 observations, literature records fall within the 95% CI for museum data, but then after 200-250 records, literature samples underperform museum samples for all species and for rare species. For the first ~500-700 records field sampling is within the 95% CI of museum records, but past that point ecological samples outperform museum samples for all species and rare species, becoming increasingly better as the number of observations increases.

Impacts of snail size on status of taxa

Whether or not a taxon represented a new state record was marginally correlated with shell size, with new records being more likely for small or minute taxa (χ = 2.81, df = 1, N = 214, P = 0.094). Similarly, species conservation rank was marginally correlated with shell size, with medium-large taxa being more likely to receive more imperiled status ranks (χ = 7.93, df = 4, N = 154, P = 0.098).

DISCUSSION

In this study, we evaluated a method for rapidly collecting the evidentiary basis needed for accurate, objective (well-vetted) rankings. Using a combination of validated museum records, accumulated scientific literature records, and a taxon-appropriate field sampling strategy that targets ecological communities rather than species, we re-ranked all Texas land snails. In the case of Texas land snails, museum and literature records give a relatively accurate picture of snail diversity in some ways (e.g. high diversity and endemism in sky-island mountains of the Trans-Pecos region). However, beyond broad strokes, the picture is less accurate (e.g. the underrepresentation of small-minute taxa and prevalence of misidentifications) and existing conservation status ranks were not supported. While we found that previously ranked taxa were, on average, less imperiled than previously thought, the lack of objective status assessments for most taxa resulted in a serious underestimation of the imperilment of the state’s land snails as a whole: twice as many species warrant designation as species of greatest conservation need (SGCN) than was previously understood.

Evaluation of Conservation Status Ranks for Texas' Land Snails

Although the number of land snails recommended for SGCN designation increased by nearly 100%, the change does not appear to primarily represent an increase in the imperilment status of species since last evaluated, nor is it an artifact of a more conservative ranking methodology (i.e. assuming worst-case scenarios during the ranking process). Indeed, previously ranked taxa were more likely to receive a less imperiled status ranking, suggesting that the increased number of imperiled species resulted from a more comprehensive, less-biased assessment. The overrepresentation of large and medium sized snails and complete absence of minute snails on the previous SGCN list reflects a bias that was also recently documented in the major museum collections for this fauna (Nekola et al. 2019). The recommended, revised SGCN list includes 34% minute taxa; with different size classes now represented proportionally to their prevalence in the state fauna (Table 4). Even considering that larger snails are more likely to have small ranges and higher imperilment, this indicates that the SGCN list now better reflects snail diversity.

In the present study, 78% of the evaluated taxa previously lacked state-specific conservation status ranks, and over half of the species that did have pre-existing ranks underwent status revisions. For a small number of taxa, status may have genuinely changed since ranks were initially calculated in the 1980s and 1990s, but the majority of changes are due to 1) information collected since original ranking, 2) changes in the criteria used to rank species, and

3) changes in taxonomy (sensu Butchart 2005). We do not suggest that the land snail fauna of Texas is secure, but that the previous rankings were uninformative.

Given the incompleteness of land snail records, even in relatively well-sampled regions (Lydeard 2004), documentation of new state records in Texas was not surprising. New state records were derived from 1) surveys at the periphery of the state for species with known ranges nearby (43% of new records); 2) documentation of introduced and/ or anthropophilic species (30%); 3) sampling in sky-islands and/ or historically undersampled micro-habitats (50%); and 4) rectification of unpublished or mis-identified museum specimens (33%). Because new records can be assigned to more than one of these categories, the above percentages sum to >100%. Considering incomplete sampling across most regions of the state (Figure 2 & 3) and the failure of rarefaction curves to reach an asymptote (Figure 5), additional state records seem likely. However, we also rectified several erroneous and unsupported (by museum specimens) state records, and given the number of remaining taxa with uncertain taxonomy or status, future studies, particularly those employing molecular techniques to resolve uncertain taxonomy, will likely result in additional removals from the state species list. We also demonstrated there is unknown diversity to be discovered.

Conservation Status Rankings for Invertebrates: Lessons Learned.

Conservation Biology has long been considered a ‘crisis discipline’ (Soule 1985) as time-sensitive conservation decisions are made with imperfect or incomplete data. Setting species targets remains a central focus in biological conservation, requiring an accurate accounting of the vulnerability of species. Comprehensive status assessments for groups of taxa are an important step in the conservation process. Particularly for invertebrate groups that contain high numbers of imperiled taxa but receive relatively little conservation attention, status assessments may be an effective tool for bringing attention to these groups (Hutchins 2018). But however critical, initial conservation status assessments are most often based on expert opinion, museum data, and primary literature (e.g. Taylor et al. 2007, Clausnitzer et al. 2009, Johnson et al. 2013), and inaccurate ranks based on errors and biases endemic to these data sources may result in the misdirection of limited resources away from true species of greatest conservation need.

Conservation status rankings conducted with incomplete or inaccurate data may still catalyze valuable conservation effort, drawing attention to knowledge gaps or spurring more detailed assessment by taxonomic experts. Our work indicates that potential Wallacean (lack of distributional data) and Hutchinsonian (lack of ecological / environmental tolerance data) shortfalls (Cardoso et al. 2011) should be considered to determine whether available data is sufficiently unbiased and accurate to estimate conservation status. We propose that assigning an initial conservation status rank of data-deficient (DD) is preferable to assigning a rank from extremely incomplete data. Otherwise, conservation status ranks, and more importantly, conservation priorities based on those ranks may more likely be wrong than right.

We argue that data-deficient, unrankable, and taxonomic uncertainty (TU) designations are concerning enough to warrant additional assessment through targeted surveys, taxonomic work, and life history evaluations. As the sixth mass extinction continues (Dirzo et al. 2014), there is no *a priori* reason to assume that data deficient species are secure, particularly in taxa with inherently high rates of imperilment like mollusks. Indeed, rarity and endemism (both of which are major contributors to imperilment) are parsimonious explanations for data deficiency.

Conclusion

The comparison of museum, literature, and new field collection datasets illustrates that literature can be an important source for single-taxon records but doesn't accurately inform whole fauna or rare species analyses. So long as potential sources of error and bias are recognized, museum collection validation adds valuable information for updating state lists and species ranks and informs field sampling efforts. But for the land snails of Texas the most effective way to evaluate both the entire fauna and rare species, was to conduct a strategically designed field campaign, sampling across major biogeographic provinces and targeting under sampled areas including disjunct/ peripheral habitats. We propose this method has wide applicability to other poorly known invertebrate and plant groups.

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Figures

Figure 1. Examples of land snail species found in Texas displaying a variety of sizes and shapes. A few of the smallest land snails are presented on a U.S. penny (19.05 mm in diameter) to provide context for their size. *Gastrocopta pellucida*, *Helicodiscus nummus*, *Pupoides albilabris* and *Strobilops hubbardi* are in the minute category (<5 mm). *Helicina orbiculata tropica* and *Pseudosubulina cheatumi* are in the small category (5-10 mm). *Anguispira strongylodes*, *Ashmunella amblya*, *Daedalochila hippocrepis*, and *Metastoma roemeri* are in the medium category (10-20 mm). *Euglandina texasiana* is in the Large category (20-40 mm).

Figure 2. Sites examined (N = 203) for single species or community samples. A full list of sites and vegetative communities sampled available upon request from the authors or the TPWD Nongame and Rare Species Program. The full TEAM vegetation maps are available here: https://tpwd.texas.gov/gis/team/.

Figure 3. Left: Number of unique sampling sites per county (museum records and new field collections). Right: Species richness per county (museum records and new field collections). Legend and scale apply to both images.

Figure 4. Change in conservation status ranks for Texas land snails. Categories are not mutually exclusive. * As recorded by NatureServe.

Figure 5. Permutation tests showing 95% confidence intervals from museum records (dashed lines) with species accumulation from literature (bold dashed line) and ecological sampling from this study (solid line) for all species and rare species.

TABLES

Table 1. Conservation status rankings for all evaluated taxa. G ranks were applied to Texas state endemics, and S ranks were applied for Texas populations of taxa that also occur outside of the state. * indicates new state records. # indicates rankings that were adjusted downward due to presence in protected lands. SNA = exotic taxa. SU = taxa that cannot be ranked due to uncertainty about whether they occur in the state. TU = taxa that cannot be ranked due to taxonomic uncertainty. Not applicable = taxa that were incorrectly reported from the state. "?" indicates uncertainty in the status of the species due to taxonomic uncertainty or uncertain provenance (i.e. taxa known only from drift material or which might be non-native). Multiple plausible states denoted by multiple ranks. SGCN taxa are those with ranks of G1 and G2 (S1 and S2).

Table 2. Percentage of heritage ranks assigned to Texas land snails. For simplicity, taxa with multiple plausible character states (N = 9) were assigned to the most imperiled plausible rank.

Table 3. Status or conservation ranking change in the 10 most species-rich families in Texas. Changes include conservation status rank changes as well as addition or removal from species list, assignment of taxonomic uncertain, or exotic status.

Table 4. Size distribution of land snail species from 28 sites from across Texas compared to the size distribution of the previous SGCN list and the SGCN list provided in this report. The new SGCN list is more representative of the fauna.

Figure 1

Click here to access/download;Figure;Figure 1.jpg

Figure 2

Click here to access/download;Figure;Figure 2_compass.jpg

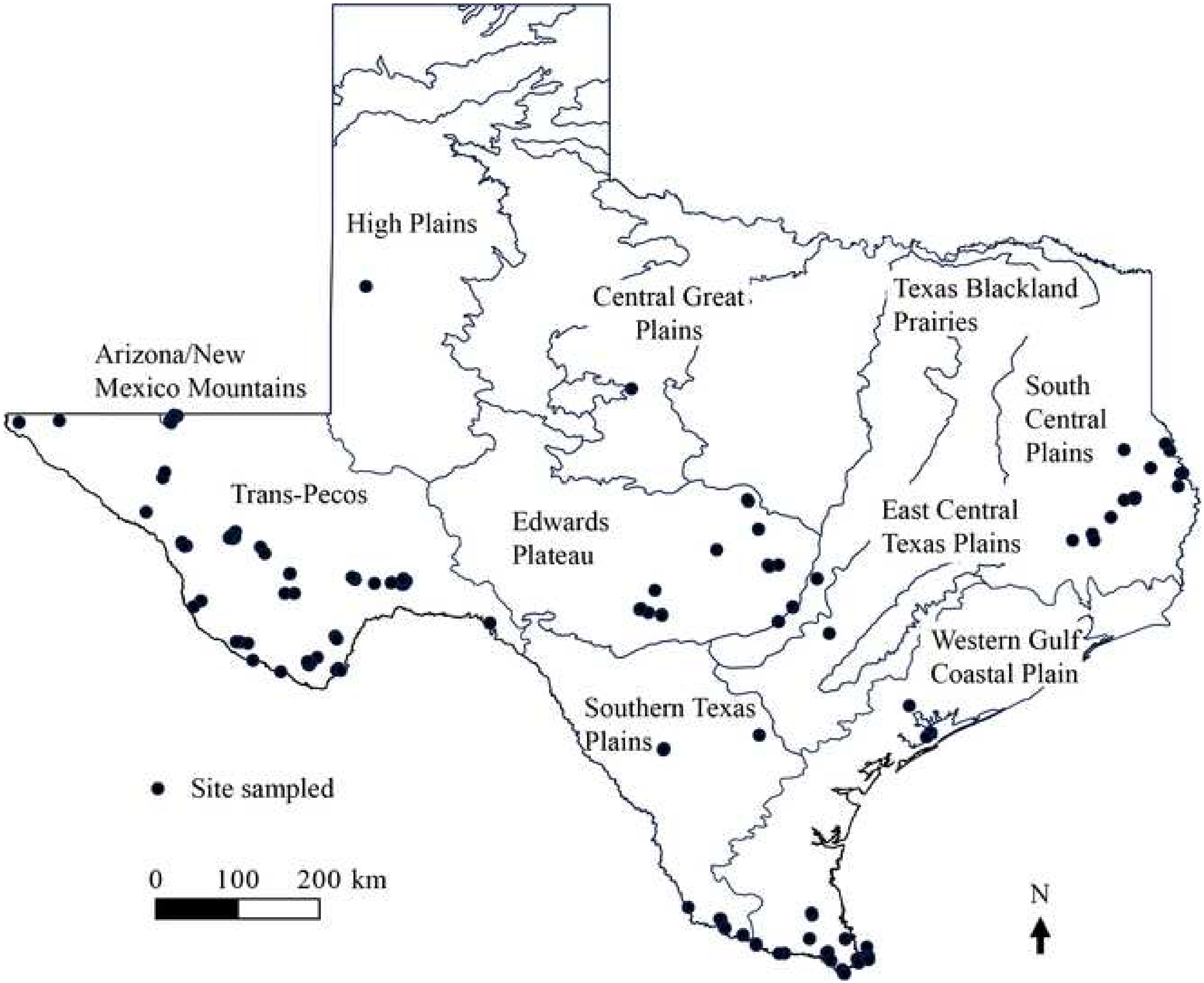

Figure 3

Click here to access/download;Figure;Figure 3 scale correction.tif

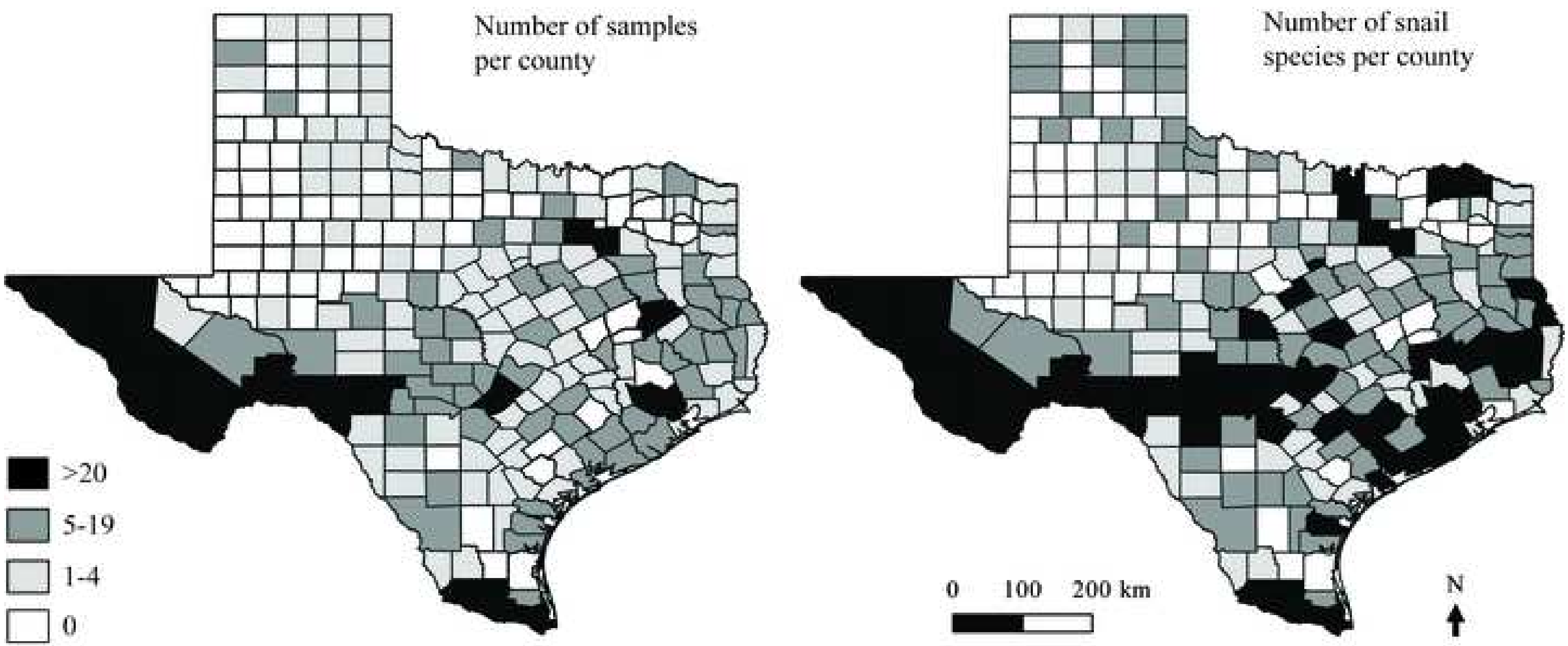

Figure 4

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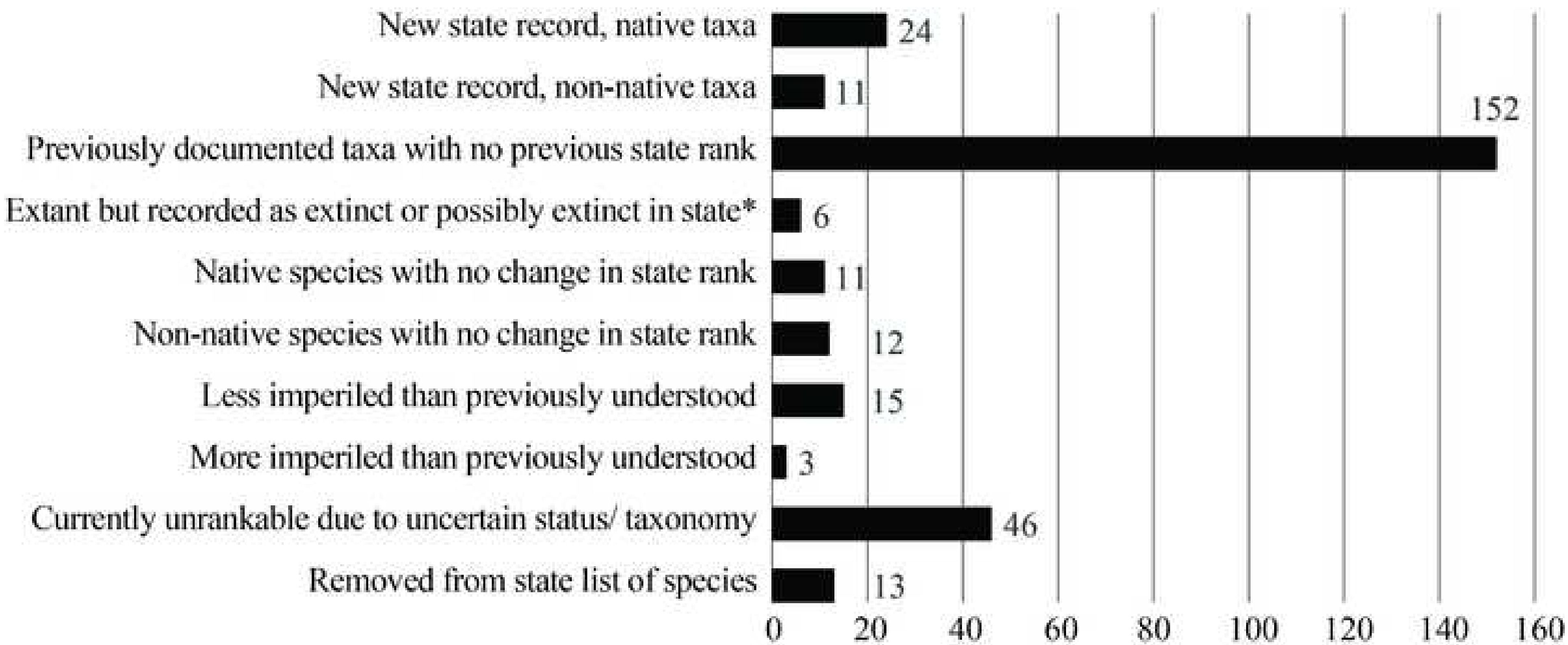

Figure 5

Click here to access/download;Figure;Figure 5 accumulation graphs.jpg

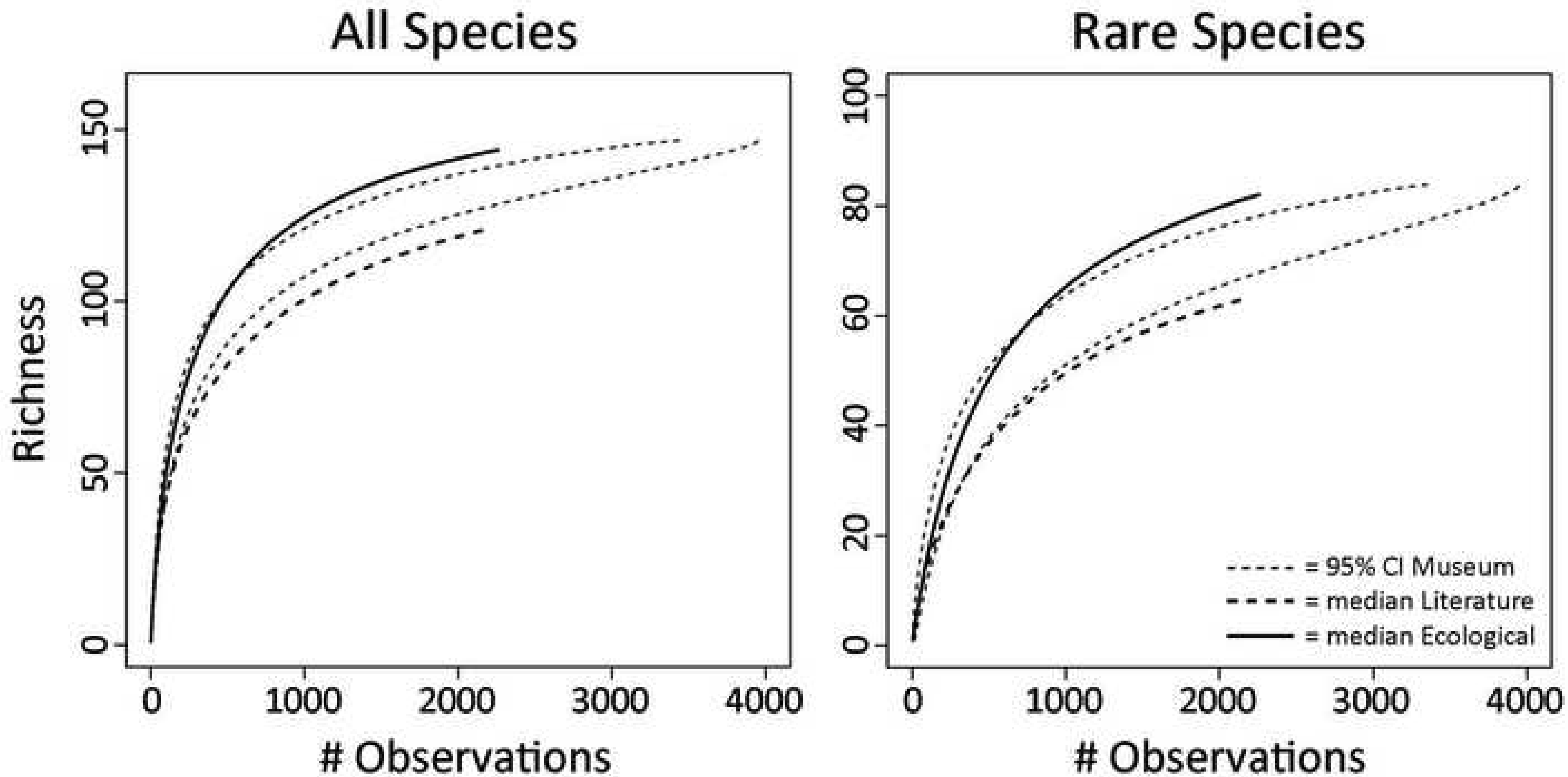

Table 1. Conservation status rankings for all evaluated taxa. G ranks were applied to Texas state endemics, and S ranks were applied for Texas populations of taxa that also occur outside of the state. * indicates new state records. # indicates rankings that were adjusted downward due to presence in protected lands. SNA = exotic taxa. SU = taxa that cannot be ranked due to uncertainty about whether they occur in the state. TU = taxa that cannot be ranked due to taxonomic uncertainty. Not applicable = taxa that were incorrectly reported from the state. "?" indicates uncertainty in the status of the species due to taxonomic uncertainty or uncertain provenance (i.e. taxa known only from drift material or which might be non-native). Multiple plausible states denoted by multiple ranks.

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
*Anguispira alternata**	Say	S5	S3/SNA?	20,000-200,000 km^2	1-5
Anguispira strongylodes	Pfeiffer	S5	S5	200,000-2,500,000 km^2	21-80
Ashmunella amblya	Pilsbry	S3	S2	100-250 km^2	6-20
*Ashmunella amblya cornudasensis**	Pilsbry	S3	G1	<100 km^2	1-5
Ashmunella bequaerti	Clench & W. B. Müller	G1	G3$^{\#}$	<100 km^2	6-20
Ashmunella carlsbadensis	Pilsbry	S1	G3$^{\#}$	100-250 km^2	6-20
*Ashmunella cf. auriculata**	Vagvolgyi	G2	G1	<100 km^2	1-5
Ashmunella edithae	Pilsbry & Cheatum	G1	TU		
Ashmunella mudgei	Cheatum	G1	TU		
Ashmunella n. sp.*			G1	<100 km^2	1-5
Ashmunella pasonis	Drake	S1?	G2$^{\#}$	<100 km^2	1-5
Ashmunella pasonis polygyroidea	Vagvolgyi	not applicable	G1	<100 km^2	1-5
Ashmunella sprouli	Fullington & Fullington	G1G3	TU		
*Belocaulus angustipes**			SNA		
Bradybaena similaris	Férussac	SNA	SNA		
*Bulimulus sporadicus**		not applicable	SNA		
*Carychium exiguum**	Say	S5	S1	<100 km^2	1-5
Carychium mexicanum	Pilsbry	S5	S4	200,000-2,500,000 km^2	21-80
Catinella avara	Say	S5	TU		
*Catinella exile**	Leonard	S2	TU		
Catinella texana	Hubricht	S1?	TU		

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Catinella vermeta	Say	S5	TU		
Ceciliodes acicula	Müller	S5	SNA		
Cecilioides aperta	Swainson	S4S5	not applicable		
Cepaea nemoralis	Linnaeus	S5	SNA		
*Cochlicopa lubrica**	Müller	S5	S3	20,000-200,000 km^2	21-80
Cochlicopa lubricella	Porro	S5	not applicable		
*Coelostemma cf. pyrgonasta**	F. G. Thompson	S1	S1	<100 km^2	1-5
Columella columella	Martens	S5	not applicable		
Columella simplex	Gould	S5	S3[#]	1000-5000 km^2	1-5
Daedalochila ariadnae	Pfeiffer	not applicable	SU		
Daedalochila auriformis	Bland	S4	S3	20,000-200,000 km^2	21-80
Daedalochila chisosensis	Pilsbry	G2	G3[#]	<100 km^2	6-20
Daedalochila dorfeuilliana	I. Lea	S4	S3	200,000-2,500,000 km^2	21-80
Daedalochila gracilis	Hubricht	G2G3	G3	20,000-200,000 km^2	21-80
Daedalochila hippocrepis	Pfeiffer	G1	G2	5000-20,000 km^2	6-20
Daedalochila implicata	von Martens	not applicable	SU		
Daedalochila leporina	Gould	S4	S3	20,000-200,000 km^2	21-80
Daedalochila mooreana	W. G. Binney	G3	G4	200,000-2,500,000 km^2	21-80
Daedalochila oppilata	Morelet	not applicable	S1	<100 km^2	1-5
Daedalochila polita	Pilsbry & Hinkley	G3	TU		
Daedalochila rhoadsii	Pilsbry	not applicable	SU		
Daedalochila scintilla	Pilsbry & Hubricht	G1	SU		
Daedalochila tholus	W. G. Binney	G3	G2	20,000-200,000 km^2	1-5
Daedalochila triodontoides	Bland	S3	S1	<100 km^2	1-5
Deroceras laeve	Müller	S5	S4/SNA?	20,000-200,000 km^2	6-20
Deroceras reticulatum	Müller	S5	SNA		
Diplosolenodes occidentalis	Guilding	S5	SNA		

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Discus cronkhitei	Newcomb	S5	S3[#]	100-250 km^2	6-20
Dryachloa dauca	Thompson & Lee	S2	S1/SNA?	<100 km^2	1-5
Eobana vermiculata	Müller	S5	SNA		
Euchemotrema leai aliciae	Pilsbry	S5	S5	200,000-2,500,000 km^2	81-300
Euchemotrema leai cheatumi	Fullington	S5	G1	5000-20,000 km^2	1-5
Euconulus chersinus	Say	S5	not applicable		
*Euconulus dentatus**	Sterki	S5	TU		
Euconulus fulvus	Müller	S5	S4[#]	5000-20,000 km^2	21-80
Euconulus trochulus	Reinhardt	S5	S5	200,000-2,500,000 km^2	21-80
Euglandina rosea	Férussac	S5	S3/SNA?	20,000-200,000 km^2	6-20
Euglandina singleyana	W. G. Binney	G3	S4	20,000-200,000 km^2	21-80
Euglandina texasiana	Pfeiffer	S1S2	S3	1000-5000 km^2	6-20
Gastrocopta abbreviata	Sterki	S4	S4	200,000-2,500,000 km^2	6-20
Gastrocopta armifera	Say	S5	S4	20,000-200,000 km^2	6-20
Gastrocopta ashmuni	Sterki	S4	S3[#]	250-1000 km^2	6-20
Gastrocopta contrata	Say	S5	S5	200,000-2,500,000 km^2	81-300
Gastrocopta corticaria	Say	S5	S3	5000-20,000 km^2	1-5
Gastrocopta cristata	Pilsbry & Vanatta	S5	S5	200,000-2,500,000 km^2	81-300
Gastrocopta dalliana	Sterki	S2S4	not applicable		
Gastrocopta holzingeri	Sterki	S5	S2	20,000-200,000 km^2	1-5
Gastrocopta pellucida	Pfeiffer	S5	S5	200,000-2,500,000 km^2	>300
Gastrocopta pentodon	Say	S5	S5	200,000-2,500,000 km^2	81-300
Gastrocopta pilsbryana	Sterki	S5	S3[#]	100-250 km^2	6-20
Gastrocopta procera	Gould	S5	S4	200,000-2,500,000 km^2	21-80
Gastrocopta riograndensis	Pilsbry	S3	G2	1000-5000 km^2	6-20
Gastrocopta riparia	Pilsbry	S4	S5	20,000-200,000 km^2	21-80
*Gastrocopta rogersensis**	Nekola & Coles	S3S4	S1	<100 km^2	1-5

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Gastrocopta rupicola	Say	S3	S4	20,000-200,000 km^2	21-80
*Gastrocopta servilis**	Gould	S3S4	S4/SNA?	5000-20,000 km^2	21-80
*Gastrocopta similis**	Sterki	S5	S1	<100 km^2	1-5
Gastrocopta sterkiana	Pilsbry	S2S3?	S5	200,000-2,500,000 km^2	81-300
Gastrocopta tappaniana	C. B. Adams	S5	S4	200,000-2,500,000 km^2	21-80
Glyphyalinia indentata	Say	S5	S4	20,000-200,000 km^2	21-80
Glyphyalinia luticola	Hubricht	S4S5	SU		
Glyphyalinia roemeri	Pilsbry & Ferriss	S3	G4	20,000-200,000 km^2	21-80
Glyphyalinia solida	H. B. Baker	S5	S1	1000-5000 km^2	1-5
Glyphyalinia umbilicata	Cockerell	S5	S5	200,000-2,500,000 km^2	>300
*Glyphyalinia wheatleyi**	Bland	S5	S2	1000-5000 km^2	1-5
Gulella bicolor	Hutton	S5	SNA		
Guppya gundlachi	Pfeiffer	S3	S3	5000-20,000 km^2	6-20
*Guppya sterkii**	Dall	S5	S2	<100 km^2	1-5
Haplotrema concavum	Say	S5	S1	<100 km^2	1-5
Hawaiia alachuana	Dall	S4S5?	TU		
Hawaiia miniscula	A. Binney	S5	S5	200,000-2,500,000 km^2	>300
Hawaiia miniscula neomexicana	(Cockerell & Pilsbry)	S2	TU		
Helicina chrysocheila	Binney	S5	S1?	100-250 km^2	1-5
Helicina fragilis elata	Shuttleworth	not applicable	S1?	100-250 km^2	1-5
Helicina orbiculata orbiculata	Say	S5	S3	20,000-200,000 km^2	21-80
Helicina orbiculata tropica	Pfeiffer	S5	S5	200,000-2,500,000 km^2	21-80
Helicodiscus eigenmanni	Pilsbry	S5	S4	20,000-200,000 km^2	21-80
Helicodiscus n. sp.*			TU		
Helicodiscus notius	Hubricht	S5	S3/SU?	20,000-200,000 km^2	6-20
Helicodiscus nummus	Vanatta	S1S2	G4	20,000-200,000 km^2	21-80
Helicodiscus parallelus	Say	S5	S4	20,000-200,000 km^2	21-80

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Helicodiscus roundyi	Morrison	not applicable	S2	20,000-200,000 km^2	1-5
Helicodiscus scintilla	Lowe	S4	S4	200,000-2,500,000 km^2	6-20
Helicodiscus shimeki	Hubricht	S4S5	not applicable		
Helicodiscus singleyanus	Pilsbry	S5	S4	200,000-2,500,000 km^2	21-80
Helicodiscus tridens	Morrison	S2	S4	20,000-200,000 km^2	6-20
Helix aspersa	Müller	S5	SNA		
Holospira crossei	Dall	G2	not applicable		
Holospira 'danielsi'	Pilsbry & Ferriss	S3S4	TU		
Holospira goldfussi	Menke	S2S3	G3	20,000-200,000 km^2	21-80
Holospira hamiltoni	Dall	S1	S1	<100 km^2	1-5
Holospira mesolia	Pilsbry	G1	G2	1000-5000 km^2	1-5
Holospira montivaga	Pilsbry	G2	G3	20,000-200,000 km^2	21-80
Holospira oritis	Pilsbry & Cheatum	G1	TU		
Holospira pasonis	Dall	S1	S3	20,000-200,000 km^2	6-20
Holospira pityis	Pilsbry & Cheatum	G1	TU		
Holospira riograndensis	Pilsbry	G1	S1	100-250 km^2	1-5
Holospira yucatanensis	Bartsch	S1	S1	100-250 km^2	1-5
Humboldtiana agavophila	Pratt	G1	TU		
Humboldtiana cheatumi	Pilsbry	G2	G2[#]	<100 km^2	1-5
Humboldtiana chisosensis	Pilsbry	G1	G3[#]	<100 km^2	6-20
Humboldtiana edithae	Parodiz	G1	TU		
Humboldtiana ferrissiana	Pilsbry	G2	G1	<100 km^2	1-5
Humboldtiana fullingtoni	Cheatum	G1	TU		
Humboldtiana palmeri	Clench & Rehder	G2	G2[#]	<100 km^2	1-5
Humboldtiana presidii	Pilsbry	G3	G2	1000-5000 km^2	6-20
Humboldtiana texana	Pilsbry	G2	G2[#]	<100 km^2	1-5
Humboldtiana ultima	Pilsbry	G2	G3	5000-20,000 km^2	21-80

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Inflectarius inflectus	Say	S5	S3	20,000-200,000 km^2	6-20
*Laevicaulis alte**	Férussac	S5	SNA		
*Lamellaxis clavulinus**	Potiez & Michaud	S5	SNA		
Lamellaxis gracilis	Hutton	S5	SNA		
*Lamellaxis mauritianus**	Pfeiffer	S5	SNA		
Lamellaxis micra	d'Orbigny	S5	S1/SNA?	<100 km^2	1-5
Lehmannia valentiana	Férussac	S5	SNA		
Limax flavus	Linnaeus	S5	SNA		
Limax maximus	Linnaeus	S5	SNA		
Linisa tamaulipasensis	I. Lea	G3	S5	200,000-2,500,000 km^2	81-300
Linisa texasiana	Moricand	S3S4	S5	200,000-2,500,000 km^2	81-300
Lucidella lirata	Pfeiffer	not applicable	S1/SU	100-250 km^2	1-5
Megapallifera mutabilis	Hubricht	S5	SU		
Mesodon clausus	Say	S5	S4	20,000-200,000 km^2	6-20
Mesodon thyroidus	Say	S5	S4	20,000-200,000 km^2	81-300
Mesomphix friabilis	W. G. Binney	S5	S4	20,000-200,000 km^2	21-80
Mesomphix globosus	MacMillan	S5	S2	1000-5000 km^2	1-5
Metastoma roemeri	Pfeiffer	S4	S5	20,000-200,000 km^2	81-300
Microceramus texanus	Pilsbry	G2	G4	20,000-200,000 km^2	6-20
Microphysula ingersolli	Bland	S5	SU		
Milax gagates	Draparnaud	S5	SNA		
Neohelix divesta	Gould	S3S4	S1	<100 km^2	1-5
Nesovitrea binneyana occidentalis *	Baker	S5	S2[#]	<100 km^2	1-5
Nesovitrea suzannae	Pratt	G1	G1	250-1000 km^2	1-5
Nesovitrea? n.sp.*			S1	<100 km^2	1-5
Opeas pumilum	Pfeiffer	S5	not applicable		
Opeas pyrgula	Schmacker & Boettger	S5	SNA		

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
*Oreohelix neomexicana**	Pilsbry	S3	S1[#]	<100 km^2	1-5
Otala lactea	Müller	S5	SNA		
*Oxychilus cellarius**	Müller	S5	SNA		
*Oxychilus draparnaudi**	Beck	S5	SNA		
Oxyloma salleanum	Pfeiffer	S3	TU		
Paravitrea conecuhensis	G. H. Clapp	S3	S2	20,000-200,000 km^2	6-20
Patera leatherwoodi	Pratt	G1	G1	<100 km^2	1-5
Patera roemeri	Pfeiffer	S3S4	S4	100-250 km^2	21-80
Philomycus carolinianus	Bosc	S5	SNA		
Polygyra cereolus	Mühlfeld	S4	S5	200,000-2,500,000 km^2	21-80
Polygyra septemvolva	Say	S5	not applicable		
Pomatiopsis lapidaria	Say	S5	SU		
Praticolella berlandieriana	Moricand	S3	S3	20,000-200,000 km^2	21-80
Praticolella candida	Hubricht	S2	G3	20,000-200,000 km^2	6-20
Praticolella griseola	Pfeiffer	S3	not applicable		
Praticolella mexicana	Perez		SNA		
Praticolella pachyloma	Menke	S3S4	G2	20,000-200,000 km^2	21-80
Praticolella salina	Perez & Ruiz		G1	1000-5000 km^2	6-20
Praticolella taeniata	Pilsbry	S3S4	S4	20,000-200,000 km^2	6-20
Praticolella trimatris	Hubricht	S2	G3	1000-5000 km^2	6-20
Pseudosubulina cheatumi	Pilsbry	G1	S3[#]	<100 km^2	6-20
*Punctum conspectum**	Reeve	S5	S3[#]	250-1000 km^2	6-20
Punctum minutissumum	I. Lea	S5	S3	20,000-200,000 km^2	6-20
Punctum vitreum	H. B. Baker	S5	S5	200,000-2,500,000 km^2	21-80
Pupilla blandii	E. S. Morse	S4S5	S1	5000-20,000 km^2	1-5
Pupilla hebes hebes	Ancey	S5	S2	1000-5000 km^2	6-20
*Pupilla hebes pithodes**	Pilsbry & Ferriss	S5	S2[#]	<100 km^2	1-5

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
*Pupilla muscorum**	Linnaeus	S5	SNA		
Pupilla sonorana	Sterki	S4S5	S3	<100 km^2	6-20
Pupisoma dioscoricola	C. B. Adams	S3	S4	20,000-200,000 km^2	21-80
Pupisoma macneilli	G. H. Clapp	S5	S2	20,000-200,000 km^2	6-20
Pupoides albilabris	C. B. Adams	S5	S5	200,000-2,500,000 km^2	81-300
Pupoides hordaceus	Gabb	S4	not applicable		
Rabdotus alternatus	Say	S5	S5	20,000-200,000 km^2	81-300
Rabdotus dealbatus	Say	S5	S5	200,000-2,500,000 km^2	81-300
Rabdotus dealbatus neomexicanus	Pilsbry	S5	G1	100-250 km^2	1-5
Rabdotus durangoanus	von Martens	S3S5	TU		
Rabdotus mooreanus	Pfeiffer	S5	S5	200,000-2,500,000 km^2	81-300
Rabdotus pasonis	Pilsbry	S5	S3	1000-5000 km^2	6-20
Rabdotus pecosensis	Pilsbry & Ferriss	S5	TU		
Rabdotus pilsbryi	Ferriss	S5	S2	<100 km^2	1-5
Rabdotus ragsdalei	Pilsbry	G5	G4	200,000-2,500,000 km^2	21-80
Rabdotus schiedeanus	(Pfeiffer, 1841)	S5	S4	20,000-200,000 km^2	21-80
Radiodiscus millecostatus	Pilsbry & Ferriss	S3	S3[#]	1000-5000 km^2	1-5
Rumina decollata	Linnaeus	S5	SNA		
Salasiella sp.*			S1	<100 km^2	1-5
Sonorella cf huecoensis		G1G2	G1	1000-5000 km^2	6-20
Sonorella huecoensis	Gilbertson & Metcalf	G1G2	G1	100-250 km^2	1-5
Sonorella metcalfi	W. B. Müller	S1	G2	<100 km^2	6-20
Sonorella orientis	Pilsbry	G3	G1	250-1000 km^2	1-5
Stenotrema stenotrema	Pfeiffer	S5	SU		
Striatura meridionalis	Pilsbry & Ferriss	S5	S5	200,000-2,500,000 km^2	81-300
Strobilops aenea	Pilsbry	S5	S4	20,000-200,000 km^2	6-20
Strobilops hubbardi	A. D. Brown	S3S4	S1	<100 km^2	1-5

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Strobilops labyrinthicus	Say	S5	SNA?		
Strobilops texasiana	Pilsbry & Ferriss	S5	S5	200,000-2,500,000 km^2	81-300
Subulina octona	Bruguire	S5	not applicable		
Succinea forsheyi	I. Lea	S4	TU		
Succinea greerii	Tryon	S3	TU		
Succinea grosvenori	I. Lea	S5	TU		
Succinea indiana	Pilsbry	S5	TU		
Succinea luteola	Gould	S4	TU		
Succinea paralia	Hubricht	S2	TU		
Succinea solastra	Hubricht	S2S3	TU		
Succinea unicolor	Tryon	S3S4	TU		
Succinea vaginacontorta	C. B. Lee	S2S3?	TU		
*Theba pisana**	Müller	S5	SNA		
Thysanophora hornii	Gabb	S5	S5	20,000-200,000 km^2	81-300
Thysanophora plagiopycta	Shuttleworth	S5	S3	5000-20,000 km^2	6-20
Triodopsis alabamensis	Pilsbry	S4	SU		
Triodopsis cragini	Call	S4	S2	20,000-200,000 km^2	21-80
Triodopsis henriettae	Mazyck	S3	G2	20,000-200,000 km^2	6-20
*Triodopsis hopetonensis**	Shuttleworth	S4S5	SNA		
Triodopsis vultuosa	Gould	S3S4	S3	20,000-200,000 km^2	21-80
Truncatella caribaensis	Reeve	not applicable	S2/SU	1000-5000 km^2	1-5
Vallonia cyclophorella	Sterki	S5	S2	1000-5000 km^2	1-5
*Vallonia excentrica**	Sterki	S5	SNA		
Vallonia gracilicosta	Reinhardt	S5	S3	20,000-200,000 km^2	6-20
Vallonia parvula	Sterki	S4	S3	20,000-200,000 km^2	21-80
Vallonia perspectiva	Sterki	S4	S3	5000-20,000 km^2	6-20
Vallonia pulchella	Müller	S5	SNA		

Species Name	Species Authority	Initial Rank	Rank Assigned in this Study	Range Extent	Number of Occurrences
Ventridens demissus	A. Binney	S5	SNA		
Ventridens intertextus	A. Binney	S5	S1	1000-5000 km^2	1-5
Veronicella moreleti	Crosse & Fischer	S5	SNA		
*Vertigo arizonensis**	Pilsbry & Vanatta	S4	S3[#]	<100 km^2	6-20
*Vertigo cf. chiricahuensis**			S1	<100 km^2	1-5
Vertigo gouldi	A. Binney	S5	not applicable		
Vertigo milium	Gould	S5	S4	200,000-2,500,000 km^2	6-20
Vertigo oralis	Sterki	S5	S1	5000-20,000 km^2	1-5
Vertigo oscariana	Sterki	S4	S2	20,000-200,000 km^2	6-20
Vertigo ovata	Say	S5	S4	200,000-2,500,000 km^2	6-20
Vertigo rugosula	Sterki	S4	S4	20,000-200,000 km^2	6-20
Vertigo teskeyae	Hubricht	S5	SU		
Vertigo tridentata	Wolf	S5	SU		
Vitrina alaskana	Beck	S5	S2[#]	<100 km^2	1-5
Xolotrema fosteri	F. C. Baker	S5	SNA		
Zonitoides arboreus	Say	S5	S5	200,000-2,500,000 km^2	81-300
Zonitoides kirbyi	R. W. Fullington	S2	TU		

Table 2. Percentage of heritage ranks assigned to Texas land snails. For simplicity, taxa with multiple plausible character states (n = 9) were assigned to the most imperiled plausible rank.

Heritage Rank (S or G)	Number of taxa	% of Fauna
1	38	16%
2	29	12%
3	40	17%
4	32	13%
5	25	10%
SNA	34	14%
SU/ TU	43	18%

Table 3. Status or conservation ranking change in the 10 most species-rich families in Texas. Changes include conservation status rank changes as well as addition or removal from species list, and re-assignment as taxonomic uncertain, status uncertain, or exotic status.

Family	Number of Taxa	Taxa with rank changes	Percent change
Polygyridae	41	39	95%
Gastrocoptidae	19	19	100%
Zonitidae	15	14	93%
Bulimulidae	10	10	100%
Urocoptidae	10	7	70%
Helicodiscidae	8	8	100%
Valloniidae	8	8	100%
Vertiginidae	8	8	100%
Humboldtianidae	7	4	57%
Pupillidae	6	6	100%

Table 4. Size distribution of land snail species from 28 sites from across Texas compared to the size distribution of the previous SGCN list and the SGCN list provided in this report. The new SGCN list is more representative of the fauna.

Size Class	Size Value	Percent of taxa in Texas faunal sample	Percent of taxa in previous SGCN list	Percent of taxa in updated list
Minute	(<5 mm)	36.3	0	34.3
Small	(5-10 mm)	18.7	10	13.4
Medium	(10-20 mm)	28.5	46.6	34.3
Large	(20-40 mm)	14.5	43.3	17.9
Very Large	(>40 mm)	2	-	-