CONTRIBUTED PAPER

Conservation status, threats, and information needs of small mammals in Alaska

Amanda Droghini1 | Katherine S. Christie2 | Rachel R. Kelty1 | Paul A. Schuette1,3 | Tracey Gotthardt2

1Alaska Center for Conservation Science, University of Alaska Anchorage, Anchorage, Alaska, USA
2Threatened, Endangered, and Diversity Program, Alaska Department of Fish and Game, Anchorage, Alaska, USA
3Marine Mammals Management, US Fish and Wildlife Service, Anchorage, Alaska, USA

Abstract

Small mammals are under-represented in conservation research relative to other mammals. We assessed the conservation status of 36 small mammal species in Alaska, USA using the Alaska Species Ranking System (ASRS). We also surveyed taxonomic experts to identify threats, conservation actions, and research priorities for five small mammal species of high conservation priority. The ASRS evaluates species’ population status, biological vulnerability, and information needs. According to this ranking system, 86% (n = 31) of species were of moderately high conservation priority. Species of highest priority included three species endemic to Alaska and four bats (Order Chiroptera). Most species (n = 24) had low biological vulnerabilities, but high information needs. Taxonomic experts identified direct and indirect climate change effects as important threats for three of the five species assessed. They listed population monitoring, habitat modeling, genetic diversity, and response to climate change as high priorities for future research. Agencies can use the ASRS with expert elicitation to set priorities for research and monitoring. For example, we highlight the need to monitor population trends, which were unknown or uncertain for all species. Finally, we underscore the importance of accounting for data deficiencies to avoid conflating sparse information with low conservation priority.

KEYWORDS
conservation assessment, conservation prioritization, conservation ranks, data deficient species, endemic species, extinction risk, Sorex pribilofensis, threat status, threatened species

1 | INTRODUCTION

Conservation practitioners and natural resource managers are frequently tasked with prioritizing funding for species based on extirpation risk or vulnerability to threats. To aid with prioritization, practitioners often use ranking systems, such as those developed by the International Union for the Conservation of Nature (IUCN) and by NatureServe (Master et al., 2012; IUCN, 2012). These ranking systems assign a status to a species by evaluating...
and scoring that species using a set of criteria. While ranking systems have been useful in prioritizing species conservation efforts, one of the limitations of such ranking schemes is how they account for uncertainty in data-deficient species. When data are scarce or absent, species may receive a special status designation (e.g., data-deficient for the IUCN or unrarkable for NatureServe). In less extreme cases, assessors can score some questions as unknown or select a range of answers to express uncertainty (Master et al., 2012; IUCN, 2012). These designations of uncertainty allow assessors to assign a conservation status to a species even though they lack the data necessary to score a subset of criteria reliably. Yet if designations of uncertainty have no influence on the rank calculation, a low-risk status may be assigned to species with unknown population trends (e.g., Master et al., 2012). As a result, it can be more difficult to justify funding for data-deficient species than species with higher rankings because of more complete or accurate data (Jetz & Freckleton, 2015).

Small mammals (i.e., bats, shrews, rodents, and lagomorphs) compose over 75% of the Earth’s extant mammalian diversity (Entwistle & Stephenson, 2000). They function as primary consumers, insectivores, vectors of disease, and focal prey species (Ceballos & Brown, 1995; Entwistle & Stephenson, 2000). Some, like pocket gophers (Geomylidae) and other fossorial rodents, alter physical and biotic processes to such an extent that they are considered ecosystem engineers (Beca et al., 2021). Despite their diversity and ecological importance, however, we know little of their population sizes, trends, and threats. According to the IUCN Red List, 16% of rodent species worldwide are listed as data-deficient, compared with 7% of carnivores and 4% of even-toed ungulates (Jetz & Freckleton, 2015). This lack of data for small mammals precludes accurate conservation assessments under most ranking systems. By inferring missing data, Jetz and Freckleton (2015) predicted that more than 50% of data-deficient rodents were actually at risk.

Addressing data deficiencies in small mammal taxa is challenging. Small mammals receive less funding than other mammalian groups and are under-represented in the conservation literature (Entwistle & Stephenson, 2000). Entwistle and Stephenson (2000) suggest that this lack of conservation attention may in part be due to the challenges of studying small and often cryptic species. In addition, for funding agencies and the public, small mammals are typically seen as lacking economic value and have less appeal than charismatic megafauna (Entwistle & Stephenson, 2000). Whatever the causes, the conservation attention afforded to small mammals is not indicative of information needs or resilience.

The conservation status of species at the global scale generally does not reflect threats and vulnerabilities at local scales (Breininger et al., 1998; Hartley & Kunin, 2003). Thus, many jurisdictions develop their own ranking systems that are more representative of the scale of their area of inference (Breininger et al., 1998; Gotthardt et al., 2012; Millsap et al., 1990). In 2007, the Alaska Department of Fish and Game’s Threatened, Endangered, and Diversity Program (ADF&G TED) identified the need for a state-specific ranking system to evaluate the conservation status of vertebrate taxa in Alaska. It collaborated with the state’s Natural Heritage Program, the Alaska Center for Conservation Science (ACCS), to create the Alaska Species Ranking System (ASRS). The ASRS was modeled after a prioritization ranking system developed for the Florida Game and Freshwater Fish Commission (Millsap et al., 1990) and modified to be relevant to Alaska’s ecological conditions and user needs (Gotthardt et al., 2012).

Alaska has a unique geography and glacial history that has resulted in the evolutionary divergence of many taxonomic groups, including small mammal taxa that do not occur anywhere else in the United States (Cook et al., 2001; Hope et al., 2015; Lanier et al., 2015). Unlike other states in the U.S., threats from human development are low. In recent years, however, there has been concern about the effects of climate change on vegetation, disturbance regimes, and ecological communities (Hope et al., 2015; Tape et al., 2006; Tape et al., 2016).

In this paper, we used a conservation ranking system, the ASRS, to summarize the status, biological vulnerability, and information needs of 36 small mammal species in Alaska. We also elicited expert opinion to identify threats, conservation actions, and research priorities for a subset of five highly-ranked small mammal species. By synthesizing results from these two sources, we provide a comprehensive assessment of the conservation status of small mammal species in Alaska and provide recommendations to guide future activities. This information will be used to assist funding agencies and resource managers as they set priorities for research and monitoring. Furthermore, the methodology described herein provides an example of how ranking tools and expert elicitation can lead to valuable insights on the relative vulnerability of a wide range of species despite data deficiencies.

2 | METHODS

2.1 | The Alaska Species Ranking System

The ASRS was developed in 2007 by ACCS and the ADF&G TED Program. Gotthardt et al. (2012) described
the system in detail; we provide a brief summary here. The ASRS assesses each taxon (species, subspecies, or population) using 16 multiple-choice variables grouped into four categories. The first three categories focus on aspects of the taxon’s population status (Status), biological vulnerability (Biological), and extent of current knowledge and management needs (Action). The fourth category contains variables that allow for flexibility in sorting the ranking results (Droghini et al., 2021). This system requires documentation when answering all variables, but allows for scoring when information is lacking.

The ASRS provides a Status score, a Biological score, and an Action score for each taxon assessed. Collectively, these categories assess a taxon’s risk of extirpation in Alaska. Status scores are the sum of individual scores for two variables that measure trends in population size and distribution. High Status scores indicate currently declining populations or shrinking distributions. Biological scores are the sum of individual scores for five variables that reflect different aspects of a taxon’s distribution, abundance, life history, and ecology. High Biological scores suggest greater vulnerability to extirpation. Action scores are the sum of individual scores for four variables that reflect the current state of knowledge of the taxon’s distribution, population trend, limiting factors, and the current extent of conservation efforts. High Action scores denote greater information needs due to lack of knowledge or conservation action. Five supplemental variables, not used directly in the ranking process, are useful to sort and categorize taxa to answer specific biological or management questions.

Each variable in the Status, Biological, and Action categories is scored on a scale ranging from −10 (lowest conservation concern) to 10 (highest concern). Missing data are assigned a value of 0, which allows uncertainty to be incorporated in the ranking without the variable receiving the lowest score. Variable scores are summed within each category to provide overall category scores. Thus, the score for the Status category, which contains two questions, can range from −20 to 20. Similarly, the score for the Biological category has a potential range from −50 to 50 and the score for the Action category has a potential range from −40 to 40. Supplemental variables are not scored.

2.1.1 | Assessing conservation priority from category scores

When determining which taxa should be a high priority for conservation, some users of the ASRS prefer a categorical approach as an alternative to using the quantitative scores. To accommodate these users, the ASRS produces a final rank that indicates conservation priority for each taxon assessed. The overall scores for the Status, Biological, and Action categories are not summed, but are grouped based on numerical thresholds that are presented in Gotthardt et al. (2012). To generate categorical groupings, Status scores are assigned to one of three groups: (1) high, indicating the population trends or distribution trends are known to be decreasing; (2) unknown, if both population trends and distribution trends are unknown; and (3) low, if trends do not fit into the above two groups. Biological scores are placed in high and low groupings based on their score relative to all other species ranked using the ASRS (n = 492 vertebrate taxa; Gotthardt et al., 2012), with high including the top 2/3rds of the scores and low including the remaining 1/3rd. Action scores are also placed in high and low groups depending on whether the score is above zero (high) or equal to or less than zero (low). The qualitative groupings for Status, Biological, and Action are then joined in nine different combinations and assigned a numerical category on a scale of 1 to 9 (Table 1). The nine categories are then collapsed into a four-tiered color code that indicates the level of conservation need: red (high priority), orange (moderately high priority), yellow (moderate priority), and blue (low priority) (Table 1). As an example, a species that scored high in all three of the scored categories (Status, Biological, and Action) would receive a numerical rank of I and a color code of red; it would be considered a taxon of highest conservation priority (Table 1).

2.1.2 | Assessment process

We selected 36 small mammal species and subspecies to be included in the ranking (Table 2). We included all taxonomically valid species listed as Species of Greatest Conservation Need in Alaska’s State Wildlife Action Plan (ADF&G 2015) and six additional species that are widely distributed in the state. This final list of 36 species represents nearly all native small mammal species that regularly occur in Alaska. We excluded the following species from our assessment: hoary bat (Lasiurus cinereus), Yuma myotis (Myotis yumanensis), muskrat (Ondatra zibethicus), North American deermouse (Peromyscus maniculatus), Western heather vole (Phenacomys intermedius), and Western jumping mouse (Zapus princeps). With the exception of the muskrat, these species have restricted ranges in Alaska and are therefore not considered stewardship species (ADF&G 2015). A list of small mammal species native to Alaska is available in our dataset through the Knowledge Network for Biodiversity (KNB) data repository (Droghini et al., 2021).
The core of the ASRS evaluation process involves synthesizing information in a systematized way to quantify scores for each of the 16 variables (Figure 1). From 2017 to 2020, trained assessors conducted extensive literature reviews. Initial searches included information specific to Alaska populations, but were expanded to include other information when Alaska-specific information was lacking. A first assessor developed a species’ account (a detailed summary of literature used to answer each of the 16 variables) and conducted an initial scoring. Raw data, scores, and documentation of data sources were entered into a Microsoft Access database. Afterward, a second assessor read the species’ account and scored the taxon without consulting the scores of the first assessor. When assessors disagreed on a score, they discussed the question and consulted additional sources. The assessment was then sent to a taxonomic expert for external review. When the review was complete, assessors updated scores following the expert’s recommendations and published species accounts and scores on the ASRS website (https://accs.uaa.alaska.edu/wildlife/alaska-species-ranking-system/). These data are also available on the KNB data repository (Droghini et al., 2021).

2.2 | Expert elicitation to assess threats and research priorities

In 2019, we surveyed taxonomic experts to obtain their opinions on threats, conservation actions, and research priorities for five species: northern flying squirrel (Glaucomys sabrinus), Alaska marmot (Marmota broweri), little brown myotis (Myotis lucifugus), collared pika (Ochotona collaris), and northern bog lemming (Synaptomys borealis). These five species were a subset of the 36 ASRS ranked species and were selected because they had the highest Biological and Action scores (with the exception of island endemic species and peripheral species). Status scores were not considered in the selection process because 92% of taxa were assigned a score of unknown for both questions in this category (Table 2). For each of the five selected species, we identified 3–5 taxonomic experts, and defined an expert as a scientist who had been directly involved in a research project investigating the species in Alaska.

Using an online survey tool, we asked experts a series of seven questions (Table 3; Droghini et al., 2021). The first four questions assessed the effects of a possible
| Taxonomic order | Scientific name | English common name | Status | Biological | Action | ASRS rank | Conservation priority | NS rank | IUCN rank |
|-----------------|-----------------|---------------------|--------|------------|--------|-----------|-----------------------|---------|-----------|
| Chiroptera      | Lasionycteris noctivagans<sup>a</sup> | Silver-haired bat | 0 | −7 | 16 | S4,G3G4 | Least concern |
| Chiroptera      | Myotis californicus<sup>a</sup> | California myotis | 0 | −7 | 16 | S4,G5 | Least concern |
| Chiroptera      | Myotis evotis/keenii<sup>a</sup> | Long-eared (Keen’s) myotis | 0 | −7 | 16 | Least concern |
| Chiroptera      | Myotis volans<sup>a</sup> | Long-legged myotis | 0 | 3 | 32 | Orange IV | Moderately high | S3S4, G4G5 | Least concern |
| Eulipotyphla    | Sorex jackson<sup>b</sup> | St. Lawrence Island shrew | 0 | 8 | 32 | S3,G4 | Least concern |
| Eulipotyphla    | Sorex pribilofensis<sup>b</sup> | Pribilof Island shrew | 0 | 14 | 32 | S3,G3 | Least concern |
| Rodentia        | Marmota broweri<sup>b,c</sup> | Alaska marmot | 0 | −6 | 12 | S3,G4 | Least concern |
| Chiroptera      | Myotis lucifugus<sup>c</sup> | Little brown myotis | 0 | −25 | 8 | S3,G3 | Least concern |
| Eulipotyphla    | Sorex cinereus | Cinereus shrew | 0 | −42 | 32 | S5,G5 | Least concern |
| Eulipotyphla    | Sorex eximius | Western pygmy shrew | 0 | −38 | 32 | S5,G5 | Least concern |
| Eulipotyphla    | Sorex minutissimus | Holarctic least shrew | 0 | −36 | 40 | S4,G5 | Least concern |
| Eulipotyphla    | Sorex navigator | Western water shrew | 0 | −30 | 40 | S4,G5 | Least concern |
| Eulipotyphla    | Sorex obscurus | Dusky shrew | 0 | −38 | 32 | S4,G5 | Least concern |
| Eulipotyphla    | Sorex tundrensis | Tundra shrew | 0 | −38 | 32 | S5,G5 | Least concern |
| Eulipotyphla    | Sorex ugyunak | Barren ground shrew | 0 | −32 | 32 | S5,G5 | Least concern |
| Lagomorpha      | Lepus othus<sup>b</sup> | Alaska hare | 0 | −38 | 4 | S4,G3G4 | Least concern |
| Lagomorpha      | Ochotona collaris<sup>c</sup> | Collared pika | 0 | −27 | 4 | S3S4,G5 | Least concern |

(Continues)
| Taxonomic order | Scientific name          | English common name          | ASRS category scores | ASRS rank | Conservation priority | NS rank | IUCN rank | Status | Biological | Action | ASRS rank | Conservation priority | NS rank | IUCN rank |
|----------------|--------------------------|-----------------------------|----------------------|-----------|-----------------------|---------|-----------|--------|------------|--------|-----------|-----------------------|---------|-----------|
| Rodentia       | Dicrostonyx groenlandicus | Northern collared lemming   | 0                    | −32       | 24                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Lemmus trimicronatus      | Nearctic brown lemming      | 0                    | −42       | 12                    | Orange V| Moderately high | S5,G5  | Least concern |         |           |                       |         |           |
|                | Microtus longicaudus       | Long-tailed vole             | 0                    | −38       | 32                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Microtus miurus           | Singing vole                | 0                    | −32       | 24                    |         |           | S5,G4,G5| Least concern |         |           |                       |         |           |
|                | Microtus oeconomus        | Root vole                   | 0                    | −38       | 24                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Microtus pennsylvanicus   | Meadow vole                 | 0                    | −44       | 32                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Microtus xanthognathus     | Taiga vole                  | 0                    | −38       | 32                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Myodes gapperi            | Southern red-backed vole     | 0                    | −28       | 32                    |         |           | S4,S5,G5| Least concern |         |           |                       |         |           |
|                | Neotoma cinerea           | Bushy-tailed woodrat         | 0                    | −19       | 32                    |         |           | S4,G5  | Least concern |         |           |                       |         |           |
|                | Peromyscus keeni          | Northwestern deermouse      | 0                    | −36       | 20                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Zapus hudsonius           | Meadow jumping mouse        | 0                    | −26       | 32                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Glaucomyx sabrinus         | Northern flying squirrel    | 0                    | −27       | 24                    |         |           | S5,G5  | Least concern |         |           |                       |         |           |
|                | Marmota caligata          | Hoary marmot                | 0                    | −32       | 4                     |         |           | S4,G5  | Least concern |         |           |                       |         |           |
|                | Urocitellus parryi        | Arctic ground squirrel      | 0                    | −40       | 4                     |         |           | S5,G5  | Least concern |         |           |                       |         |           |
| Rodentia       | Synaptomys borealis       | Northern bog lemming        | −5                   | −23       | 32                    | Yellow VIII | Moderat | S5,G5  | Least concern |         |           |                       |         |           |
|                | Marmota monax             | Woodchuck                   | −5                   | −17       | 12                    | e       |           | S5,G5  | Least concern |         |           |                       |         |           |
threat on a species’ distribution (scope) and population size (severity), the expected timing of the threat, and uncertainty regarding the magnitude of its impacts (Table 2). The questions assessing threats were adapted from the NatureServe Conservation Status Assessment (Master et al., 2012), which has been widely adopted by scientists and conservation practitioners (e.g., Flagstad et al., 2019; Johnson et al., 2013; Tuberville et al., 2015) and is part of an international effort by the conservation community to standardize threat assessments (Salafsky et al., 2008). We identified seven threats and adapted them to what we thought was relevant to Alaska’s small mammals. Taxonomic experts had the option to add other threats that they deemed relevant. Three additional questions asked respondents to identify conservation actions that would mitigate threats, hypothesize about the direction of future distribution trends, and identify research priorities (Table 2).

Once surveys were completed, we calculated the proportion of respondents that selected each response for every threat listed. If more than 60% of respondents selected the same response, this response was used as the final score. If fewer than 60% of respondents agreed on a response, we concluded there was no consensus and no final score was chosen. For the research prioritization question, respondents were hypothetically given USD 10 million (M) to allocate to different research topics (Table 2). Weighted mean budget allocations for each research topic were calculated by multiplying each possible dollar amount ($0M–$10M in increments of $1 M) by the proportion of respondents who selected each amount. These budget amounts were then summed to obtain a weighted dollar amount for each research topic.

### RESULTS

Using the ASRS, we evaluated the conservation status of 36 small mammal species across 4 orders and 7 families. Our assessment included 19 rodents (Order: Rodentia), 3 lagomorphs (Order: Lagomorpha), 9 shrews (Order: Eulipotyphla), and 5 bats (Order: Chiroptera).

Of the 36 species we assessed, none were classified as high conservation priority (red), 86% were classified as moderately high (orange), 5.5% as moderate (yellow), and 8.4% as low (blue) (Table 2). Within the moderately high category, the highest-ranked species were those with unknown Status, moderate Biological scores, and high Action scores (Table 1). The seven species with this rank were three species endemic to Alaska (Alaska marmot; *Marmota broweri*, St. Lawrence Island shrew; *Sorex jacksoni*, and Pribilof Island shrew; *S. pribilofensis*) and four bat species largely restricted to Southeast Alaska

#### Table 2 (Continued)

| Taxonomic order | Scientific name | English common name | Status | Biological | Action | ASRS rank | Conservation priority | NS rank | IUCN rank |
|-----------------|-----------------|---------------------|--------|------------|--------|-----------|-----------------------|---------|-----------|
| Rodentia        | Myodes rutilus  | Northern red-backed vole | 0      | −38        | 0      | −8        | Blue VI         | S5,G5   | Least concern |
| Lagomorpha      | Lepus americanus| Snowshoe hare       | 0      | −34        | 0      | −8        | Blue IX         | S5,G5   | Least concern |
| Peripheral species |            | Endemic to Alaska.  |        |            |        |           |                      |         |            |

*Note: Peripheral species to Alaska.*
(Lasionycteris noctivagans, Myotis californicus, M. evotis, and M. volans). The remaining 24 species in the moderately high priority category had unknown Status, low Biological scores, and high Action scores. Seventy-three percent of rodents and 77% of shrews fell into this category (Table 2).

Two species were considered moderate priority: northern bog lemming (Synaptomys borealis) and
TABLE 3 Questions posed to taxonomic experts to assess threats, conservation actions, and research priorities for five species of conservation concern in the state of Alaska

| Questions                                                                 | Description of answer choices |
|---------------------------------------------------------------------------|--------------------------------|
| 1. What is the scope of each threat?                                      | Percent of population affected.|
| 2. What is the estimated severity of each threat?                         | Expected reduction in population size.|
| 3. What is the estimated timing of each threat?                           | Number of years until onset.    |
| 4. What is the level of uncertainty associated with each threat?          | High, moderate, or low.         |
| 5. If climate change continues unabated, what do you expect will happen to this species’ range in Alaska in 50 years? | Expand, contract, remain the same, or unknown. |
| 6. List possible conservation actions that would mitigate threats.        | Open-ended.                     |
| 7. If given a budget of $10 million for research on this species over a 5-year period, how would you allocate resources? | From $0 to $10 million in increments of $1 million. |

*Adapted from the NatureServe Conservation Status Assessments (Master et al., 2012).

*Possible threats were: (1) deforestation, (2) direct climate change effects, (3) climate-induced vegetation change, (4) disease/parasites, (5) habitat loss from development, (6) competition/predation by native species, and (7) competition/predation by non-native species.

*Research themes were: (1) monitoring status and trends, (2) climate change research, (3) research on disease/parasites, (4) introduced species, (5) development and/or deforestation, (6) habitat modeling, and (7) genetic diversity and adaptation.

Biological scores for small mammal species ranged from −46 to 14 (of a possible −50 to 50) with a median score of −32. When grouped by taxonomic order, bats had the highest median score (score = −7). Median Biological scores for rodents (−32), shrews (−36), and lagomorphs (−38) were comparatively low. The species with the highest Biological scores were 2 island-endemic shrews, the Pribilof Island shrew (score = 14) and the St. Lawrence Island shrew (8).

Action scores ranged from −8 to 40 (of a possible −40 to 40) with a median score of 24. When grouped by order, shrews had the highest median Action scores (score = 32), followed by rodents (24), bats (16), and lagomorphs (4). Two shrews received the maximum possible score (40) for this category: the Holarctic least shrew (Sorex minutissimus) and the western water shrew (S. navigator). More than 50% of species received the highest possible score for 3 of the 4 variables in this category. Sixty-nine percent of species had high management needs (indicating the absence of conservation laws, harvest regulations, and management plan), 81% had high monitoring needs (indicating no current monitoring of statewide population trends), and 64% had high research needs (indicating very little knowledge of factors limiting or regulating population growth).

3.2 Expert elicitation of threats and research priorities

We received 23 completed surveys: five surveys per species with the exception of northern bog lemming, for which we were able to identify only three experts. For the northern flying squirrel, habitat loss and deforestation received the highest threat scores, although the geographical scope was small and severity was slight for both threats (Figure 2a). The majority of respondents agreed that climate-induced vegetation change was an important threat for the northern bog lemming, with a large scope and slight-moderate severity. For Alaska marmot and collared pika, climate-related threats received the highest scope and severity scores. For collared pika, respondents assessed the threats of direct climate change effects and climate-induced vegetation change as large to pervasive in scope and moderate in severity. The two climate change-related threats were assessed as large to pervasive in scope for the Alaska marmot, the severity of these threats was considered to be serious (Figure 2a), and the timing of these threats was expected to occur in the next 10 years (Droghini et al., 2021). Disease/parasites was an important threat for the little brown myotis, with a pervasive scope and extreme severity. For all species except little brown myotis, experts expressed high woodchuck (Marmota monax). These species had moderately high Biological scores and high Action scores, but a low Status score because their distributions are thought to be expanding in Alaska. Only three species were considered low conservation priority: snowshoe hare (Lepus americanus), northern red-backed vole (Myodes rutilus), and American red squirrel (Tamiasciurus hudsonicus).

3.1 Scores for individual categories and variables

Status scores ranged from −10 to 0 out of a possible range from −20 to 20. Population trends were unknown for all 36 species and 33 species had unknown distribution trends (Table 2).
uncertainty about the effects of disease/parasites and competition/predation by non-native species (Droghini et al., 2021). There was also high uncertainty about the effects of climate change on northern flying squirrel and little brown myotis. All respondents expected Alaska marmot and collared pika to experience range...
contractions in the next 50 years, while all respondents expected little brown myotis to expand its range within that same timeframe (Figure 2b). When asked to recommend conservation actions for each species, climate change mitigation was highlighted for Alaska marmot and collared pika, changing hunting and trapping regulations for the Alaska marmot, and changing forestry practices for little brown myotis and northern flying squirrel. Protecting known habitat was identified as important for little brown myotis, northern flying squirrel, and northern bog lemming, and collecting more information was recommended for all species except northern flying squirrel. Disease treatment and prevention was identified as an important conservation action for little brown myotis.

When asked to allocate $10 million to different research topics, experts recommended monitoring population trends, research on genetic diversity and adaptive capacity, and habitat modeling for all species, with budget allocations ranging from $1.6M to $2.9M (Figure 2c). They considered research on response to climate change important for Alaska marmot ($2.8M) and collared pika ($2.8M) while research on response to human development and deforestation was recommended for northern flying squirrel ($1.9M), little brown myotis ($1.4M), and northern bog lemming ($1.8M). Respondents allocated comparatively little funding to research on introduced species and on disease/parasites ($0–$1.2M; Figure 2c).

4 | DISCUSSION

Although small mammals are of high ecological value, they receive less conservation attention than other mammalian groups such as carnivores and ungulates (Cornwall, 2018; Entwistle & Stephenson, 2000). At the global scale, this lack of conservation attention is inversely related to diversity, rates of extinction, and information needs (Ceballos & Brown, 1995; Entwistle & Stephenson, 2000; Jetz & Freckleton, 2015). Few studies, however, have considered the conservation needs of small mammals at national or subnational scales where funding and research priorities are typically established. Our goal was to identify the conservation status, threats, and information needs of small mammals in Alaska to help agencies set priorities for funding, research, and monitoring.

We evaluated the conservation status of small mammals in Alaska, including their population trends, threats, and information needs, using the ASRS and an expert-based threat assessment. Of the 36 species assessed using the ASRS, 86% (n = 31) were assigned a moderately high conservation priority. This ranking was driven by high information needs, including unknown population trends, incomplete knowledge of range and distribution, and incomplete understanding of the factors that limit or regulate population size.

The seven highest ranked species within the moderately high category had unknown Status scores and high Biological and Action scores. These species were bats largely restricted to southeastern Alaska and small-ranged endemic species (the Alaska marmot, the Pribilof Island shrew, and the St. Lawrence Island shrew). Recent research in Alaska has greatly improved our understanding of bat species diversity and their ranges in the state (e.g., Blejwas et al., 2014, 2021); nevertheless, important knowledge gaps, such as population trends and impacts of anthropogenic disturbances, still exist (Jung et al., 2014). Bats also have several traits, such as low reproductive rates and specialized habitat requirements that make them susceptible to extinction (Boyles & Storm, 2007; Safi & Kerth, 2004). Meanwhile, small-ranged endemic species are typically considered at high risk of extinction because of their small population sizes, small range sizes, low genetic diversity, and the potentially high impact of stochastic threats (Hartley & Kunin, 2003). Endemic species that are cold-adapted with restricted ranges, such as the Alaska marmot, may be especially vulnerable to warming temperatures and altered alpine vegetation communities (Baltensperger & Huettmann, 2015a; Hope et al., 2015).

4.1 | Threats to small mammals in Alaska

Three of the five species in our threat assessment ranked high for scope and severity of threats: little brown myotis, Alaska marmot, and collared pika. The little brown myotis is vulnerable to Pseudogymnoascus destructans, the fungus that causes white-nose syndrome. In the eastern U.S., populations of little brown myotis declined by over 80% within 2 years of infection (Langwig et al., 2015). The disease was detected in the western U.S. for the first time in 2016. Although the taxonomic experts we surveyed expressed uncertainty about when white-nose syndrome would arrive in Alaska, most (4 out of 5) respondents considered this to be a serious threat should it be detected in Alaska. A recent study of bat hibernacula in Southeast Alaska, however, indicated that cold temperatures, combined with small colony size, may lead to a slower spread of white-nose syndrome within the state (Blejwas et al., 2021).

Alaska marmot and collared pika, both of which are alpine specialists, were perceived to be vulnerable to direct climate-related effects and climate-induced
vegetation change. Changes in air temperature, snow conditions, and vegetation communities are expected to affect several aspects of these species’ biology and ecology, including their thermoregulation, diet, distribution, and dispersal capacity (Berteaux et al., 2017; COSEWIC, 2011; Hope et al., 2015). Concern for collared pika has been fueled by research on their southern congener, the American pika, which have experienced range contractions at lower elevation sites with warming summer temperatures and decreasing winter snowpack (Beever et al., 2011). Recent studies have demonstrated substantial flexibility in diet and behavior that may in part buffer this species from climate change (Hall & Chalfoun, 2019; Smith, 2020). Nevertheless, collared pika survival is strongly related to climatic patterns (Morrison & Hik, 2007) and respondents were in agreement that both collared pika and Alaska marmot would contract their ranges over the next 50 years. The Alaska marmot occurs in the northernmost mountain range in North America and this, combined with its restricted range and low genetic diversity, makes the species vulnerable to climate change (Gunderson et al., 2012). These factors likely contributed to the high scores for scope, severity, and timing of the climate change threats assessed in our expert elicitation.

There was substantially more uncertainty related to the effects of climate change on northern flying squirrel and little brown myotis than the alpine specialists, indicating our lack of understanding of how these forest-dwelling species will respond to changing conditions in Alaska. Respondents also recorded high uncertainty with regards to the threats of disease, parasites, and introduced species in Alaska, indicating our lack of understanding of how biotic effects influence small mammal populations. Interestingly, respondents allocated relatively few research dollars to these topics, suggesting that questions regarding population status, adaptive capacity, and habitat modeling were more urgent.

Under this system, all small mammal species that we assessed are ranked least concern, with the exception of the Pribilof Island shrew, which is listed as endangered. NatureServe subnational ranks for Alaska have the same geographic scope as the ASRS; under the NatureServe ranking system, fewer species are listed as high (S1) to moderately high (S2, S3) conservation priority.

Unlike the ASRS, the NatureServe system evaluates threats and the ecological viability of habitats in its scoring framework. All else being equal, species in intact habitats with few direct human threats are of lower conservation priority than species in degraded habitats exposed to many threats. Compared to most other U.S. states, criteria used in the NatureServe ranking system such as area of occupancy and percentage of area of high ecological integrity may not be as relevant in Alaska, which has a limited anthropogenic footprint (Reynolds et al., 2018). Flagstad et al. (2019) noted that the NatureServe ranking system may lead to a bias of lower conservation need for species and ecological systems in Alaska.

4.3 Limitations of the ASRS and threat assessment

Limitations of the ASRS include the difficulty in prioritizing species for which population status is unknown, unclear assessment criteria, and deciding which taxa to include in the ranking. First, unknown population trends and distribution trends precluded any small mammal species from being considered of high conservation priority under the ASRS, as there must be evidence of decreasing trends for a species to be assigned to the highest priority category. Without careful interpretation, a ranking structure that requires information on population trend creates bias against highly data deficient taxa such as small mammals. For this reason, we argue that the ASRS categorical ranks for data deficient groups are not directly comparable to better-monitored groups such as landbirds and marine mammals. Instead, we recommend sorting individual variables and category scores in different ways so that species with unknown Status scores are still considered when creating candidate lists of potential priority species; Millsap et al. (1990) provides several examples for a similar ranking system.

Second, because the ASRS was designed to accommodate all vertebrate taxa, some criteria may not be suitable or meaningful to certain groups. For example, the absence of management plans or harvest regulations for small mammals in the state promotes higher Action scores but does not necessarily reflect an urgent need for reduced bag limits or an explicit management plan.

4.2 Comparisons to other ranking systems

NatureServe and IUCN ranks are not directly comparable to the ASRS because of differences in geographic scope and ranking criteria. With respect to poorly studied species, the largest difference among these three systems is that the ASRS explicitly evaluates information needs and assigns higher conservation ranks to species with major information gaps. Nevertheless, it can be worthwhile to compare the relative ranking of species to understand how these differences might influence our assessment of extinction risk. The IUCN Red List is global in scope.
Future versions of the ASRS should more explicitly assess the adequacy or necessity of harvest regulations and management actions based on the impacts of human activities such as harvest pressure.

Finally, decisions about which taxa to include can affect the proportion of priority species. We decided not to assess six regularly occurring species to focus our efforts on assessing Species of Greatest Conservation Need (ADF&G, 2015). We do not think that excluding these species artificially inflated the proportion of species considered to be of concern. Only one of these species, the muskrat, is widespread and common in Alaska. The other five species would likely have ranked as being of moderately high conservation concern because of their restricted ranges and limited knowledge of their populations in Alaska. A more consequential decision was our decision not to include any taxonomic rank below the species level. If we had included subspecies and populations in our assessment, the proportion of priority taxa would certainly have been higher, as occurred in a previous version of the ASRS (Gotthardt et al., 2012). Excluding all subspecies and populations fails to acknowledge taxa with isolated ranges, unique ecologies, or distinct evolutionary histories (Cook et al., 2001; Millsap et al., 1990). At the same time, many small mammal subspecies in Alaska have been described from only a few specimens and a small set of morphological differences. In such cases, we recommend assessing taxonomic validity prior to ranking.

While the ASRS ranking process does not typically include an expert-based threats assessment, we demonstrate the value of such an assessment by identifying vulnerabilities and research priorities not captured by the ASRS. That being said, conducting an expert elicitation requires an additional time investment that may not be possible for every species assessed by the ASRS. We therefore recommend that assessors conduct expert elicitation to complement the ASRS ranking system for a subset of highly-ranked species. Expert reviewers have been shown to rank threats with which they have experience as more urgent and deserving of further research (Donlan et al., 2010). Therefore, our expert elicitation may be biased by the area of expertise of survey respondents. In general, we found that reviewers allocated research dollars evenly across topics (the greatest amount allocated to any topic was $5M) without any clear bias toward their area of expertise. However, our group of experts did not include any disease or invasive species specialists, which may have resulted in lower scores and/or budget allocations for these threats. As a result, the effect of disease (other than for bats), parasites, and invasive species on small mammal communities in Alaska may be underestimated and warrants further investigation. Although we focused only on small mammals in this paper, the limitations that we highlight here have implications for all taxa assessed by the ASRS.

4.4 | Recommendations for conservation actions and research priorities

Effective conservation and management requires knowledge of species’ biology, ecology, and taxonomy (Entwistle & Stephenson, 2000). Incomplete or inaccurate knowledge may lead to incorrect assessments of extinction risk, and limit our ability to predict and mitigate threats. Our results illustrate our limited understanding about the biology and ecology of small mammals in Alaska. These findings are not unique to Alaska. Rather, several ranking systems at global and regional scales have highlighted strong data deficiencies for shrews, bats, and rodents (Jetz & Freckleton, 2015; Millsap et al., 1990).

A major priority identified in this study was the need to monitor population trends, which were unknown or uncertain for all species we assessed. Most small mammals in Alaska are not monitored annually by government agencies and the monitoring that is conducted is typically highly localized or only supported for a few years. While preferable to the absence of any monitoring effort, sporadic, and isolated efforts do not provide robust data on statewide population trends, which require long-term and extensive investments. Although funding for small mammal research is limited, we believe there is considerable potential to develop monitoring programs that address information needs while benefiting existing research. For example, documenting changes in the abundance of small mammals provides valuable insights on the transmission of human diseases (e.g., tick-borne diseases) and on the ecology of threatened and harvested species, including furbearers, waterfowl, and raptors (e.g., Béty et al., 2002; Ecke et al., 2017; Schmidt et al., 2018). The value of monitoring small mammals clearly extends beyond the target species, though this fact is not often recognized by funding agencies or the public.

Based on their experience conducting small mammal surveys in Alaska’s National Parks, Cook and MacDonald (2006) recommended a specimen-based monitoring framework that would involve opportunistic sampling over three or 4 days; in an earlier report, they also recommended developing relationships with fur trappers to collect additional specimens (Cook & MacDonald, 2003). Nonlethal and noninvasive field methods have also been evaluated in other northern ecosystems (Fauteux et al., 2018; Villette et al., 2016). Agencies can achieve cost-effective monitoring through opportunistic sampling, sharing logistical costs with other...
projects, or using a river-based approach rather than traveling by air (Baltensperger & Huettmann, 2015b; Cook & MacDonald, 2006).

Small mammals play important ecological roles as herbivores, seed dispersers, and prey. In Alaska, the paucity of data on population size, shifts in distribution, and basic ecology hinders our ability to assess the health of small mammal populations, including endemic species. The ASRS and expert-based threat assessment are complementary approaches that provided a robust framework for identifying the conservation status, threats, and information needs of small mammals, and could be applied to other taxa as well. This information is particularly valuable for resource managers and conservation practitioners who are tasked with prioritizing funding and determining effective conservation and management actions. For some species and taxonomic groups, addressing knowledge gaps is urgent given the rapid pace of climate change and related ecosystems effects.

ACKNOWLEDGMENTS
The authors are thankful to the scientists that reviewed the ASRS assessments: A. Baltensperger, K. Blejwas, C. Brandt, A. Gunderson, A. Hope, H. Lanier, L. Olson, and J. Reimer. The following experts participated in the survey: V. Bakker, A. Baltensperger, A. Bidlack, K. Blejwas, D. Causey, E. Flaherty, J. Hagelin, H. Lanier, T. Lee, S. Morrison, T. Mullet, L. Olson, V. Patil, S. Pyare, J. Reimer, K. Rubin, P. Schuette, R. Shively, and W. Smith. The authors thank K. Finan for her illustration of the ASRS assessment process. T. Fields, T. Gotthardt, and K. Walton made important contributions to earlier versions of the ASRS. M. Carlson, J. Hagelin, C. Krenz, T. Nawrocki, and three reviewers provided valuable feedback to the manuscript. The Alaska Department of Fish and Game and the University of Alaska Anchorage provided financial support for this project. Amanda Droghini led the writing of the manuscript. All authors contributed to revising the manuscript and approved of its publication.

DATA AVAILABILITY STATEMENT
All data supporting this research are available through the Knowledge Network for Biocomplexity data repository: https://doi.org/10.5063/F15719GS. The repository includes a list of small mammal species native to Alaska, a copy of our online threats assessment survey, and aggregated responses from the survey. We also provide conservation assessments from the ASRS and associated scores in a machine-readable format.

ETHICS STATEMENT
Institutional ethics review was not required for this work. All survey participants consented to their responses being used in this study and we ensured anonymity by amalgamating responses.

ORCID
Amanda Droghini https://orcid.org/0000-0001-6692-2348
Paul A. Schuette https://orcid.org/0000-0002-3016-7544

REFERENCES
Alaska Department of Fish and Game (ADF&G). (2015). Alaska Wildlife Action Plan. Juneau, AK, USA. Available online: https://www.adfg.alaska.gov/index.cfm?adfg=wildlifediversity.swap#.
Baltensperger, A. P., & Huettmann, F. (2015a). Predicted shifts in small mammal distributions and biodiversity in the altered future environment of Alaska: An open access data and machine learning perspective. PLoS One, 10, e0132054.
Baltensperger, A. P., & Huettmann, F. (2015b). Predictive spatial niche and biodiversity hotspot models for small mammal communities in Alaska: Applying machine-learning to conservation planning. Landscape Ecology, 30, 681–697.
Beca, G., Valentine, L. E., Galetti, M., & Hobbs, R. J. (2021). Ecosystem roles and conservation status of bioturbator mammals. Mammal Review. Advanced online publication. https://doi.org/10.1111/mam.12269
Beever, E. A., Ray, C., Wilkening, J. L., Brussard, P. F., & Mote, P. W. (2011). Contemporary climate change alters the pace and drivers of extinction. Global Change Biology, 17, 2054–2070.
Berteaux, D., Gauthier, G., Domine, F., Ims, R. A., Lamoureux, S. F., Lévesque, E., & Yoccoz, N. (2017). Effects of changing permafrost and snow conditions on tundra wildlife: Critical places and times. Arctic Science, 3, 65–90.
Béty, J., Gauthier, G., Korpimäki, E., & Giroux, J.-F. (2002). Shared predators and indirect trophic interactions: Lemmings cycles and arctic-nesting geese. Journal of Animal Ecology, 71, 88–98.
Blejwas, K. M., Lausen, C. L., & Rhea-Fournier, D. (2014). Acoustic monitoring provides first records of hoary bats (Lasiurus cinereus) and delineates the distribution of silver-haired bats (Lasionycteris noctivagans) in Southeast Alaska. Northwestern Naturalist, 95, 236–250.
Blejwas, K. M., Pendleton, G. W., Kohan, M. L., & Beard, L. O. (2021). The milieu Souterrain Supericiel (MSS) as hibernation habitat for bats: Implications for white-nose syndrome. *Journal of Mammalogy*, 102, 1110–1127.

Boyles, J. G., & Storm, J. J. (2007). The perils of picky eating: Dietary breadth is related to extinction risk in insectivorous bats. *PLoS One*, 2, e672.

Breininger, D. R., Barkaszi, M. J., Smith, R. B., Oddy, D. M., & Breininger, D. R., Barkaszi, M. J., Smith, R. B., Oddy, D. M., & Provancha, J. A. (1998). Prioritizing wildlife taxa for biological diversity conservation at the local scale. *Environmental Management*, 22, 315–321.

Ceballos, G., & Brown, J. H. (1995). Global patterns of mammalian diversity, endemism, and endangerment. *Conservation Biology*, 9, 559–568.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2011). COSEWIC assessment and status report on the collared pika Ochotona collaris in Canada. Ottawa, ON.

Cook, J. A., Bidlack, A. L., Conroy, C. J., Demboski, J. R., Fleming, M. A., Runck, A. M., Stone, K. D., & MacDonald, S. O. (2001). A phylogeographic perspective on endemism in the Alexander Archipelago of southeast Alaska. *Biological Conservation*, 97, 215–227.

Cook, J. A., & S. A. MacDonald. (2006). *Mammal inventory of Alaska's National Parks and Preserves, Arctic Network*. NPS/AKRARCN/NRTR-2004/01, Arctic Network Inventory & Monitoring Program, National Park Service, Alaska Region, Fairbanks, AK.

Cook, J. A., & S. O. MacDonald. (2003). *Mammal inventory of Alaska's National Parks and Preserves, Wrangell-St. Elias National Park and Preserve*. Annual Report 2001-2002, Idaho State University, Boise, ID.

Cornwall, W. (2018). Should it be saved? *Science*, 361, 962–965.

Donlan, C. J., Wingfield, D. K., Crowder, L. B., & Wilcox, C. (2010). Using expert opinion surveys to rank threats to endangered species: A case study with sea turtles. *Conservation Biology*, 24, 1586–1595.

Droghini, A., Kelty, R., Christie, K., Schuette, P. & Gotthardt, T. (2021). Data from: Conservation status, threats, and information needs of small mammals in Alaska. *Knowledge Network for Biocomplexity*. https://doi.org/10.5063/F15719GS

Ecke, F., Angeler, D. G., Magnusson, M., Khalil, H., & Hörnfeldt, B. (2017). Dampering of population cycles in voles affects small mammal community structure, decreases diversity, and increases prevalence of a zoonotic disease. *Ecology and Evolution*, 7, 5331–5342.

Entwistle, A. C., & Stephenson, P. J. (2000). Small mammals and the conservation agenda. In A. C. Entwistle & N. Dunstone (Eds.), *Priorities for the conservation of mammalian diversity: Has the panda had its day?* (pp. 119–140). Cambridge University Press.

Fauteux, D., Gauthier, G., Mazeronne, M. J., Coallier, N., Béty, J., & Berteaux, D. (2018). Evaluation of invasive and non-invasive methods to monitor rodent abundance in the Arctic. *Ecosphere*, 9, e02124.

Flagstad, L. A., Boggs, K. W., Boucher, T. V., Carlson, M. L., Anjanette Steer, M., Bernard, B., Lema, P., Aisu, M., & Kuo, T. (2019). Assessing the gap between conservation need and protection status for select rare ecosystems in Alaska. *Conservation Science and Practice*, 1, e47.

Gotthardt, T. A., Walton, K. M., & Fields, T. L. (2012). Setting priorities for Alaska’s wildlife action plan. *Alaska Natural Heritage Program, University of Alaska Anchorage, AK*. Retrieved from https://accs.uaa.alaska.edu/publications/

Gunderson, A. M., Lanier, H. C., & Olson, L. E. (2012). Limited phylogeographic structure and genetic variation in Alaska’s arctic and alpine endemic, the Alaska marmot. *Journal of Mammalogy*, 93, 66–75.

Hall, E., & Chalfoun, A. D. (2019). Behavioural plasticity modulates temperature-related constraints on foraging time for a montane mammal. *Journal of Animal Ecology*, 88, 363–375.

Hartley, S., & Kunin, W. E. (2003). Scale dependency of rarity, extinction risk, and conservation priority. *Conservation Biology*, 17, 1559–1570.

Hope, A. G., Waltari, E., Malaney, J. L., Payer, D. C., Cook, J. A., & Talbot, S. L. (2015). Arctic biodiversity: Increasing richness accompanies shrinking refugia for a cold-associated tundra fauna. *Ecosphere*, 6, 159.

International Union for Conservation of Nature (IUCN). (2012). *IUCN red list categories and criteria: Version 3.1* (2nd ed.). IUCN.

Jetz, W., & Freckleton, R. P. (2015). Towards a general framework for predicting threat status of data-deficient species from phylogenetic, spatial and environmental information. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 370, 1–10.

Johnson, P. D., Bogan, A. E., Brown, K. M., Burkhed, N. M., Cordeiro, J. R., Garner, J. T., Lepitizki, D. A. W., Hartfield, P. D., Mackie, G. L., Pip, E., Tarplesy, T. A., Tiemann, J. S., Whelan, N. V., & Strong, E. E. (2013). Conservation status of freshwater gastropods of Canada and the United States. *Fisheries*, 38, 247–282.

Jung, T. S., Blejwas, K. M., Lausen, C. L., Wilson, J. M., & Olson, L. E. (2014). Concluding remarks: What do we need to know about bats in northwestern North America? *Northwestern Naturalist*, 95, 318–330.

Langwig, K. E., Hoyt, J. R., Parise, K. L., Kath, J., Kirk, D., Frick, W. F., Kilpatrick, A. M., & Foster, J. T. (2015). Invasion dynamics of white-nose syndrome fungus, midwestern United States, 2012–2014. *Emerging Infectious Diseases*, 21, 1023–1026.

Lanier, H. C., Gunderson, A. M., Weksler, M., Fedorov, V. B., & Olson, L. E. (2015). Comparative phylogeography highlights the double-edged sword of climate change faced by arctic- and alpine-adapted mammals. *PLoS One*, 10, e0118396.

Mastor, L. L., Faber-Langendoen, D., Bittman, R., Hammoner, G. A., Heidel, B., Ramsay, L., Snow, K., Teucher, A., & Tomiano, A. (2012). *NatureServe conservation status assessments: Factors for evaluating species and ecosystem risk*. NatureServe.

Millsap, B. A., Gore, J. A., Runde, D. E., & Cerulean, S. I. (1990). Setting priorities for the conservation of fish and wildlife species in Florida. *Wildlife Monographs*, 111, 3–57.

Morrison, S. F., & Hik, D. F. (2007). Demographic analysis of a declining pika *Ochotona collaris* population: Linking survival to broad-scale climate patterns via spring snowmelt patterns. *Journal of Animal Ecology*, 76, 899–907.
Reynolds, J. H, Trammell, E. J & Taylor, J. J. (2018). Migration’s foundation: Ecological intactness of Alaska’s ecosystems. Alaska Park Science. Retrieved from https://www.nps.gov/articles/aps-17-1-13.htm.

Safi, K., & Kerth, G. (2004). A comparative analysis of specialization and extinction risk in temperate-zone bats. *Conservation Biology, 18*, 1293–1303.

Salafsky, N., Salzer, D., Stattersfield, A. J., Hilton-Taylor, C., Neugarten, R., Butchart, S. H. M., Cox, N., Collen, B., Master, L. L., O’Connor, S., & Wilkie, D. (2008). A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Conservation Biology, 22*, 897–911.

Schmidt, J. H., McIntyre, C. L., Roland, C. A., MacCluskie, M. C., & Flamme, M. J. (2018). Bottom-up processes drive reproductive success in an apex predator. *Ecology and Evolution, 8*, 1833–1841.

Smith, A. T. (2020). Conservation status of American pikas (*Ochotona princeps*). *Journal of Mammalogy, 101*, 1466–1488.

Tape, K., Sturm, M., & Racine, C. (2006). The evidence for shrub expansion in Northern Alaska and the Pan-Arctic. *Global Change Biology, 12*, 686–702.

Tape, K. D., Christie, K., Carroll, G., & O’Donnell, J. A. (2016). Novel wildlife in the Arctic: The influence of changing riparian ecosystems and shrub habitat expansion on snowshoe hares. *Global Change Biology, 22*, 208–219.

Tuberville, T. D., Andrews, K. M., Sperry, J. H., & Grosse, A. M. (2015). Use of the NatureServe Climate Change Vulnerability Index as an assessment tool for reptiles and amphibians: Lessons learned. *Environmental Management, 56*, 822–834.

Villette, P., Krebs, C. J., Jung, T. S., & Boonstra, R. (2016). Camera trapping provide accurate estimates of small mammal (*Myodes rutilus* and *Peromyscus maniculatus*) density in the boreal forest? *Journal of Mammalogy, 97*, 32–40.

**How to cite this article:** Droghini, A., Christie, K. S., Kelty, R. R., Schuette, P. A., & Gotthardt, T. (2022). Conservation status, threats, and information needs of small mammals in Alaska. *Conservation Science and Practice, 4*(6), e12671. https://doi.org/10.1111/csp2.12671