# POLLINATORS IN PERIL

## A systematic status review of North American and Hawaiian native bees

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# EXECUTIVE SUMMARY

While the decline of European honeybees in the United States and beyond has been well publicized in recent years, the more than 4,000 species of native bees in North America and Hawaii have been much less documented. Although these native bees are not as well known as honeybees, they play a vital role in functioning ecosystems and also provide more than $3 billion dollars in fruit-pollination services each year just in the United States.

For this first-of-its-kind analysis, the Center for Biological Diversity conducted a systematic review of the status of all 4,337 North American and Hawaiian native bees. Our key findings:

- Among native bee species with sufficient data to assess (1,437), more than half (749) are declining.
- Nearly 1 in 4 (347 native bee species) is imperiled and at increasing risk of extinction.
- For many of the bee species lacking sufficient population data, it's likely they are also declining or at risk of extinction. Additional research is urgently needed to protect them.
- A primary driver of these declines is agricultural intensification, which includes habitat destruction and pesticide use. Other major threats are climate change and urbanization.

These troubling findings come as a growing body of research has revealed that more than 40 percent of insect pollinators globally are highly threatened, including many of the native bees critical to unprompted crop and wildflower pollination across the United States.

For this report we assembled a list of all valid native bee species and their current conservation status as established by state, federal or independent researchers. We then conducted a comprehensive review of all literature on those species as well as records documenting their occurrence. From that research we identified those bees with sufficient data to assess their status, including current and historical range, behavioral observations and studies, arriving at the first comprehensive analysis of the status of North American and Hawaiian native bees.

We also highlight five native solitary bees species that are seriously imperiled. These remarkable, underappreciated pollinators offer a snapshot of the threats driving the alarming declines in many native bee species — declines that must be reversed to save these irreplaceable native bees and the health of the ecosystems that depend on them.

# INTRODUCTION

Bees are in serious trouble. Native bees indispensable to the health of the natural world are declining globally due to accelerating threats from agricultural expansion, habitat loss and climate change. [1][2] They are perilously underprotected.

Bees are the world's primary pollinators. With more than 20,000 species globally, they are an essential component of functioning ecosystems. [1][3] Without their pollination services, many wild plants and cultivated crops would be unable to thrive. [1][4][5] But bees are declining across the planet, [2][6][7][8] with more than 40 percent of insect pollinators — primarily native bees — highly threatened. [8]

For this report we undertook the first comprehensive review of the status of all 4,337 native bee species in North America and Hawaii. The report showcases the results of our overview and highlights five extraordinary native bees that are in need of immediate help to survive. Our analysis concludes that more than 50 percent of native bee species for which sufficient data is available are declining, while 24 percent are in serious peril.

The honeybees (*Apis mellifera*) most Americans associate as essential for food production are actually an introduced species from Europe. [9] The majority of native bees in North America are solitary, ground-nesting species that collect everything from pollen, nectar, leaves, petals and floral oils to be used as adult food sources, larval provisions or nest linings. Almost 90 percent of wild plants are dependent on insect pollination, making bees indispensable pollinators in most ecosystems. [1][8] Pollination services provided by bees contribute to seed sets and plant diversity, [1][2] as well as crop pollination that provides 35 percent of the global food supply or one of every three bites of food. [8] Native bees contribute to a significant portion to annual crop value, [10] are critically important to their ecosystems and can be more effective pollinators than honeybees. [11] Native bees have profoundly shaped the world around us; they are a keystone to many habitats and have inspired our culture, from children's rhymes about bumblebees to the poetry of Emily Dickinson. Without these tiny, tireless creatures our world would be a less colorful and interesting place.

# STATUS OF NORTH AMERICAN BEES

Bees are declining globally, [6][7][8] including in North America. The most comprehensive global report thus far on the status of pollinators found that more than 40 percent of them, mostly bees, are facing extinction. [2] Europe is now tracking these declines, finding that 9.2 percent of European native bees are threatened with extinction and 37 percent are declining. [8][12] Their assessment likely greatly underestimates the magnitude of the threats because more than half the bee species native to Europe are too data-deficient for scientists to evaluate their status. [12]

Prior to our analysis, a similar comprehensive overview had never been conducted for North American and Hawaiian bees. Status review provides critical new information that should spur more extensive study and protection of North American and Hawaiian native bees.

### a. Methodology

Past attempts to understand the status of North American native bees provided the foundation for our review, including the Xerces' Society Red List of Bees; NatureServe Explorer's list of bees and their conservation status; and the IUCN's Bumblebee Specialist Group report. However, these works focus only on small snapshots of current trends in North America's bees. The Xerces Society Red List names only 57 bees of conservation concern, [13] while NatureServe Explorer provides a conservation rating (Figure 1) for 287 North American native bees [14]. The IUCN's Bumblebee Specialist Group, which looked at all species of North American bumblebees, determined that 28 percent, or 13, of all North American bumblebee species, are threatened or endangered. [15]

The limitations of past studies make clear that there is an urgent need for scientists to devote research efforts to native bees. Some of the information used to determine conservation status in these lists has not been updated in a decade or longer. Given the rapid rate of habitat destruction, massive increases in pesticide use and broad disruptions caused by climate change, the current status of these bee species could very likely be direr than presented.

For this analysis, we reviewed all bees native to North America and Hawaii, a figure often given as more than 4,000, which we found to be 4,337 described and valid native bee species as of January 2016. They are valid species based on Intergraded Taxonomic Information System (itis.gov) through the World Bee Checklist Project (2008-2009).

For our analysis we used the best existing available data. We found that only 7.28 percent of North American and Hawaiian native bees had a global conservations status (refer to Figure 2). This number includes the seven yellow-faced Hawaiian bees protected under the Endangered Species Act, bees listed by the Committee on the Status of Endangered Wildlife in Canada, or COSEWIC; on the Xerces Red List and on federal or state lists of species of concern.

| Global Rank | Definition |
|---|---|
| GX | Presumed Extinct (species)/Eliminated (ecological communities and systems) |
| GH | Possibly Extinct (species)/ Eliminated (ecological communities and systems) |
| G1 | Critically Imperiled |
| G2 | Imperiled |
| G3 | Vulnerable |
| G4 | Apparently Secure |
| G5 | Secure |

Figure 1: Global rank for conservation status definition. Definitions and rank obtained from NatureServe. (http://www.natureserve.org/conservation-tools/conservation-status-assessment)

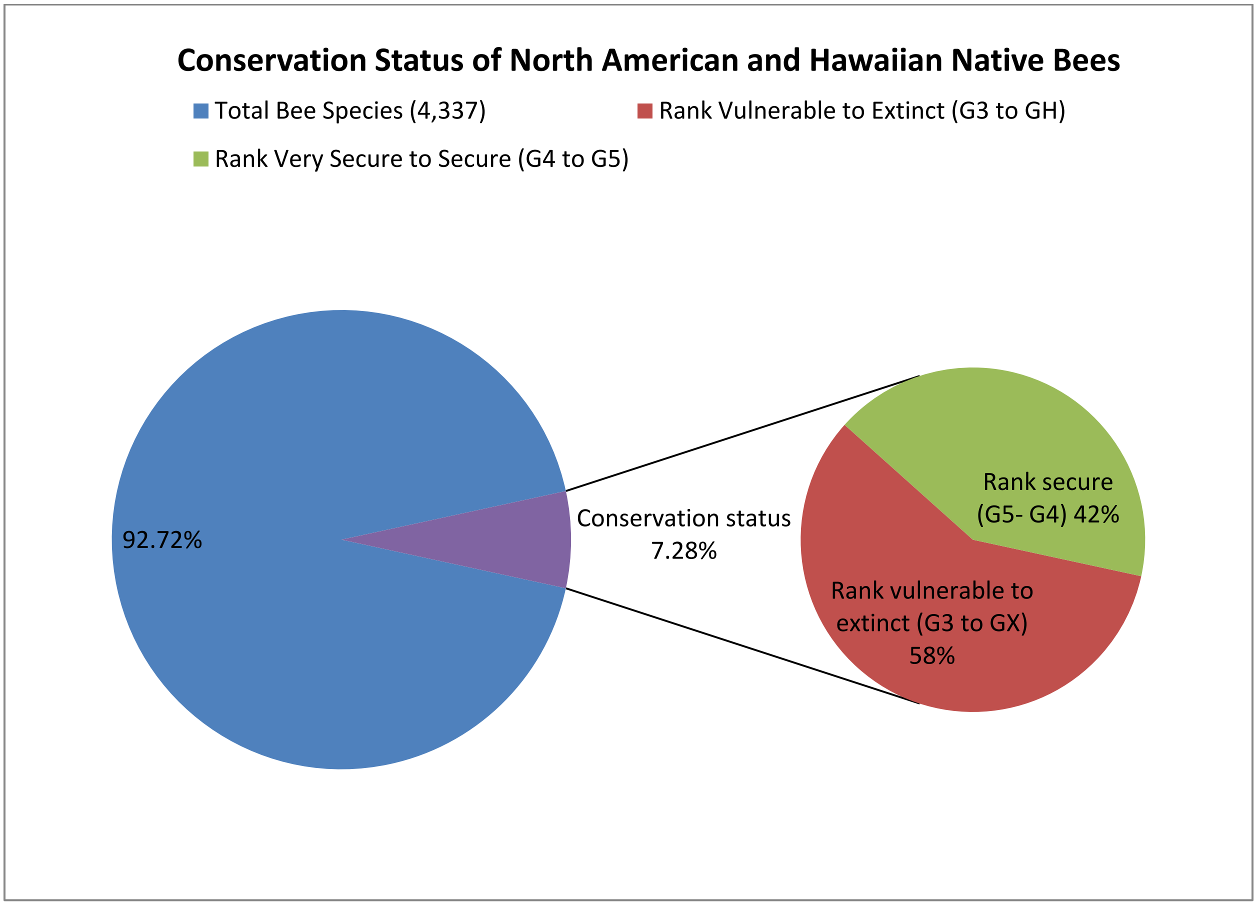


Figure 2: North American and Hawaiian native bees that hold a global conservation status.

Based on these existing databases and lists, more than half of all the native bees holding a conservation status (58 percent, or 184) are in trouble (Figure 2). That number encapsulates species that are: possibly extinct; critically imperiled; imperiled; and vulnerable (GX to G3), and is a finding that illustrates the dire status of these insects.

To better understand the status of native bees, we expanded further on existing scientific information to identify additional bees in decline. Through a literature and occurrence record review, we began by identifying native bees without conservation ranking that had, at a minimum, current and historical range available and behavioral records from floral and nesting studies or observations. We excluded from the assessment species that have only been described, with no additional information, or collected a handful of times, to ensure those bees would not skew the study results toward a larger declining population. This process of narrowing the assessment to counter data gaps follows the methodology of the European Red List for bees.

Our analysis yielded abundant results that greatly contribute to existing knowledge of native bees. We were able to analyze the status of an additional 1,121 native bees, without previously existing conservation statuses, based on current and historical range as well as behavioral data that allowed for an assessment. Combining this list with the existing data on bees with conservation statuses, we were able to analyze 1,437 species, or 33 percent of all native bee species described in North America and Hawaii.

### b. Findings

We found that 24 percent of native bees (347) are imperiled, and population declines are occurring in 52 percent of native bees (749).

Many of these bees are endemic or have a highly restricted range, while others were once widespread but have been disappearing over the past several decades. All of these bees have something in common: Their habitat is shrinking, and so are their floral and nesting opportunities. A primary driver of their declines is agricultural intensification, which includes habitat destruction, widespread planting of monocultures and toxic pesticide use.

There is an urgent need for more research to better understand the bee species without current data. The number of imperiled and declining bee species would undoubtedly be clarified as higher if additional and current data were available.

However, we do know that many of these currently unrankable bees are often found in areas of great environmental degradation. Those include monocultures created by the escalating acreage planted only in crops such as pesticide intensive corn and soybeans. More research is urgently needed to better assess the threats to native bees so we can understand how to protect them. One study found that between 2008 to 2013, wild bee abundance declined across nearly a quarter of the United States, with California's Central Valley and the Midwest's Corn Belt ranking among the lowest in wild bee abundance. [16] This reduction in bee abundance was due to intense agricultural use of those areas. [16]

Clearly immediate action is needed if we are going to stop the widespread decline of native bees.

## CASE STUDIES

**Yellow carpet solitary bee (*Andrena blennospematis*)**

Photo by Doug Wirtz

Though it lacks the familiar fuzziness and bright colors of many other bee species, a close look at the yellow carpet solitary bee reveals its dark, olive-green coloring and pale striped abdomen. [17] This beautiful bee's life is so intertwined with the life of the flower it depends on that they share the same name, yellow carpet (*Blennosperma nanum*). [17][18] The yellow carpet solitary bee depends solely on this plant genus for the pollen it needs to produce its offspring;

[17][18] the bee's fate is completely tied to its specialized flower, and therefore the health and survival of the pockets of California vernal pool ecosystems where they live. [5][18][19][20]

The yellow carpet solitary bee faces myriad threats, including severe reduction in habitat and other factors such as pesticide use, grazing and climate change. Habitat loss and modification is the primary threat facing the species because the vernal pool and upland habitats essential to its life cycle are being destroyed at alarming rates. [21][22][23] As much as 90 percent of the extant historic vernal pool habitat has been lost. [22] Three-quarters of it was lost by 1997, and by 2005 roughly 137,000 acres of vernal pool grassland had been lost in California's Central Valley. [24][25] An astounding additional 47,306 acres of vernal pool habitat was lost just between 2005 and 2012, despite conservation efforts put in place by the U.S. Fish and Wildlife Service's 2005 Vernal Pool Recovery Plan. [22][23] This loss is mainly due to agriculture, [22][23][24] with increased pesticide use posing an escalating threat to the yellow carpet solitary bee. [26][27][28][29][30]

This loss of the yellow carpet solitary bee's habitat is reflected in the reduction of range, occurrence records and population size. [17][20][21] These bees are endemic to the vernal pool and upland habitat of Central California and the Bay Area [14][17] and went from occurring in 11 counties to being confirmed in only one county in the last decade. [20][21] The loss of the yellow carpet solitary bee is mirrored in the decline and possible loss of its specialized host (*Blennosperma* spp.), permanently changing the composition of the vernal pool ecosystem. [1][5][18][19][20]

### Sunflower leafcutting bee (*Megachile fortis*)

Photo by Sam Droege / USGS Bee Inventory and Monitoring Lab

The sunflower leafcutting bee is the largest and most distinctive of all native North American leafcutting bees. [31] It is one of the few species within its genus to nest in the soil, instead of finding a hole in wood to rear its brood. [9][32] The bee uses its large mandibles or "bee teeth" to dig into hard packed soil, excavating a tunnel more than four times its length. [31]

The floral host for this grassland species is the sunflower (*Helianthus annuus*), which provides a pollen source for the brood. [14][31][32] This bee times its emergence and foraging with the bloom time of its bright-yellow host and could once be seen darting around sunflower patches from the Great Plains to Arizona. [33]

The sunflower leafcutting bee's grassland habitat is declining across its entire range, leaving it without forage and nesting habitat. [14] More than 90 percent of North America's natural grasslands have been converted to agricultural use, putting prairies among the rarest biomes in America [7] and replacing natural plant communities with monocultures of wheat and corn. [33] From 2006 to 2011, more than 1 million acres (530,000 hectares) of U.S. grasslands were lost. [34] This conversion caused massive losses of nectar and pollen resources, reducing the range and abundance of the bee. [14][33][35] This important habitat has been declining since the 1950s, a decline that is expected to continue, with recent numbers revealing that states in sunflower leafcutting bee's range, [31][36] including Nebraska, South Dakota and Texas, have the highest agricultural conversion rates in the United States. [37]

The sunflower leafcutting bee's floral host, the sunflower, is grown commercially in several states, including North Dakota and South Dakota. [38] However, sunflower monocultures can be detrimental to the bee, because they result in an overall loss of nesting sites. [39][40] In addition, the use of pesticides on the sunflower crop has been shown to harm and even kill solitary bees like the sunflower leafcutting bees. [1][14][27] Sublethal impacts caused by pesticides include decreased fitness, reduced brood rearing and reduced female production, all of which lead to smaller populations that can eventually cause local to large-scale extinctions. [27][29] Other threats to these bees are rangeland grasshopper spraying, grazing and climate change. [14] If current trends of land conversion and land-use practices continue, the already shrinking population of the sunflower leafcutting bee is projected to decline by more than 80 percent. [14] Soon this important creature may disappear from sunflower fields if steps are not taken to safeguard its future.

**Wild sweet potato bee (*Cemolobus ipomoeae*)**

Photo by Sam Droege / USGS Bee Inventory and Monitoring Lab

The wild sweet potato bee is the only known species in the world in its genus. [3] Its name, *Cemolobus*, means "lobed snout," referring to the three-lobed section on its face — the only bee to have this particular feature. [41] It is a floral specialist, foraging only on morning glory flowers (*Ipomoea*), especially wild sweet potato blooms (*Ipomoea pandurata*). [3][41][42][43] The bee emerges and is seen foraging in June and July, at the peak of flowering season for its hosts. [41][42]

Both the plant and the bee are found east of the Great Plains, from Missouri to Pennsylvania, in deciduous forest or at forest edges in the eastern United States. [41][42][43][44][45] The bee was once prevalent in forested areas, but due logging and land conversion has decreased in range and abundance. [46][47] It is also threatened by agricultural intensification and urban sprawl: As the bee's once-pristine habitat

[45] is paved or plowed over, [46] its nesting and forging opportunities are greatly reduced, causing population declines. [4][48] Its floral host is not as fragile as some other native plants, and can survive in a built environment, but occurrence records show that this unique bee does not adapt well to developed landscapes. [45][49]

The wild sweet potato bee was once most common in Illinois, yet has not been collected there since 2001 and before that had not been regularly collected in the state since the late 1970s. [45] Many of the counties in which it was once prevalent are now expanding towns or agricultural areas. [37][45][46][50] With its habitat continuing to be lost to development, this unique and once ubiquitous insect is now rarely seen.

**Gulf Coast solitary bee (*Hesperapis oraria*)**

Photo by John Bente

The Gulf Coast solitary bee is one of 34 bee species within the family Melittidae native to North America [3] and is the only bee within its genus to be found east of the Mississippi. [51] The species is also monolectic, meaning it forages on one plant and no others: the coastal plain honeycombhead (*Balduina angustifolia*), which provides for all its pollen and nectar needs. [51][52]

Endemic to a narrow band of barrier islands along the Gulf Coast, from eastern Mississippi to northwestern Florida, the bee nests in the deep sandy soil of dunes and forages on its specialized flower. [51] It emerges late in the season, exiting its ground nest from September to October — the peak bloom time of the coastal plain honeycombhead. [51][52] The honeycombhead is a self-incompatible plant, meaning it cannot reproduce without the help of this specialized bee, which transfers pollen from flower to flower. [51] Both flower and bee are thus heavily reliant on each other, and as one declines so does the other. Due to the bee's highly restricted host and range, the species has a high extinction risk.

The bee's entire range is estimated to be less than 38 square miles, and all known occurrences are in danger from development and hurricanes. [14] The Gulf Coast solitary bee only produces one generation a year, and any disturbance of this small population or its brood brings it closer to extinction. [51] Its distribution is becoming increasingly fragmented by urban growth, and remaining populations are becoming increasingly isolated. [51] The bee also has to contend with unrestricted recreation and aerial applications of broad-spectrum insecticides to control biting flies and mosquitoes. [51] The Gulf Coast solitary bee has never been found on the mainland despite its host flower's presence there, meaning that if its barrier islands habitat is further degraded, the bee will cease to exist.

The inevitable results of restricted range, isolated populations and habitat degradation are already playing out, as this bee is no longer found in one of the three counties where it was known to exist. [14] It is also disappearing in other portions of its small range, including Choctawhatchee Bay, Pensacola Bay and Perdito Bay. [14] Without prompt action to conserve this species, it is likely to disappear.

**Macropis cuckoo bee (*Epeoloides pilosula*)**

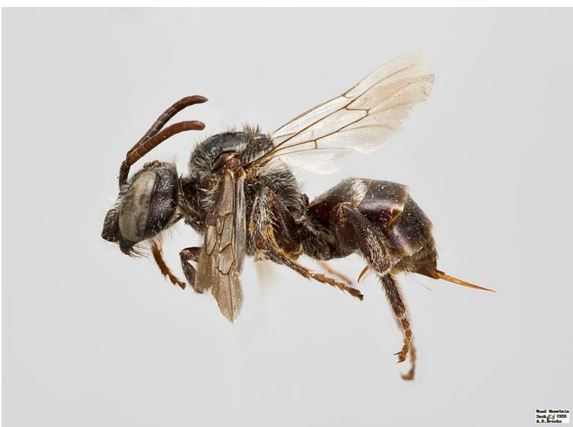

Photo by The Packer Lab-Bee Tribes of the World

The macropis cuckoo bee is the only species of the cleptoparasitic tribe Osirini present in the United States and Canada, and is one of only two species of *Epeoloides* worldwide. [3][53] Cleptoparasitism is a form of feeding in which one bee's larvae feeds on food provided for a host larva. [3] The macropis cuckoo bee is an obligate cleptoparasitic of *Macropis* species. [54][55] Cleptoparasitic or cuckoo bees enter the nest of another bee (usually host specific) and lay their own egg in the cell. [3][56] Either the female cleptoparasite kills the host egg before leaving, or her larva destroys the host egg as it matures. [56][57] Hosts of the macropis cuckoo bee are bees species within *Macropis* (*M. nuda, M. ciliate, M. steironematis* and *M. patellata*), from which its name comes. [53]

The macropis cuckoo bee is a specialist, dependent upon nest aggregations of its *Macropis* hosts, and is often located in or near yellow or fringed loosestrife (*Lysimachia* spp.) habitat. [53][58] The loss or reduction of its host's nest is the main threat to the species. [55] Since *Macropis* species are dependent upon yellow or fringed loosestrife for pollen and floral oils, they are vulnerable to the loss or reduction of this plant. [55] Loosestrife plants are vulnerable to habitat loss and degradation as well as poor water quality since they're found in swamps and along streams and ponds edges. [55]

The macropis cuckoo bee was historically distributed in much of eastern and central North America and southern Canada. [53][54] A lack of records since 1942 led to the speculation that this species was extinct [53][54] until the thrilling discovery of two males in Nova Scotia in 2004. [53][54] Its only known locality in the United States today is in New London, Conn., where it was discovered in June 2006 [14][59] — the first record of the bee in the United States since 1960. [59]

After the bee's rediscovery, some efforts have been made to protect it: It was listed as "endangered" in Connecticut in 2010 [60] and as "endangered" in Canada under the COSEWIC in May 2011. [14] The macropis cuckoo bee is considered "the most threatened and endangered bee species in New York (and the Northeast)." [61]

Despite more attempts to locate the bee, unfortunately it has not been found in any of its previous range in the United States. [54][59] The story of the macropis cuckoo provides an important lesson that a species should not have to decline to the point of being presumed extinct before receiving protection. Additional protections are still needed to ensure that this unique bee survives and recovers from the brink of extinction.

## CONCLUSIONS

Native bees face myriad threats and are in desperate need of protection to safeguard their future. They contribute more than $3 billion in fruit-pollination services annually. [62] And these unique insects, and their pollination services, are vital to the survival of ecosystems. Our lives and culture would be significantly impoverished without these hardworking, underappreciated and declining animals.

The data compiled in this report offers a snapshot of magnitude of threats native bee species face and the extent of their decline. These findings are in line with those found globally and demonstrate the necessity of more research to fill the data gaps. But what we already know is troubling and should inspire us to act: 24 percent of data-sufficient native bees are imperiled, and 52 percent show population declines. We need to take aggressive steps to better understand and protect our precious bee species before it is too late.

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