Introduction

The US National Native Bee Monitoring Research Coordination Network (RCN) held its second interactive virtual workshop on October 22, 2021. The focal topic of the workshop was articulating bee conservation goals, and how they might be met through a national-scale native bee monitoring. The workshop featured five speakers from various conservation perspectives: nonprofit, federal government, environmental consulting, state government, and academia. Speaker presentations were interspersed with breakout group discussions to gather community input on questions, concepts, and issues in native bee monitoring related to each speaker's ideas. Topics of discussion were centered around how to incorporate multiple conservation goals and perspectives into one national native bee monitoring plan.

Demographic summary of attendees

Table 1. Summary of invitees (n = 425) and attendees (n = 156) of the RCN workshop on existing bee monitoring efforts by employment sector.

	Invited	Attended
Academic	204	74
Federal	104	37
State	43	19
Nonprofit	32	16
Consultant	14	4
Extension	7	2
Industry	8	2
County	4	2
Tribal	4	0
N/A	5	0

Table 2. Summary of invitees (n = 425) and attendees (n = 156) of the RCN workshop on existing bee monitoring efforts by location in USDA Farm Production Regions. Regions do not include Alaska, Hawaii, Canada, or International invitees/attendees so these are shown as distinct categories.

	Invited	Attended
Northeast (MD, DE, DC, NJ, PA, NY, RI, CT, MA, VT, NH, ME)	83	36
Mountain West (MT, ID, WY, CO, NV, UT, AZ, NM)	73	26
Pacific West (WA, OR, CA)	54	17
Lake States (MN, WI, MI)	38	16
Corn Belt (IA, MO, IK, IN, OH)	40	13
Northern Plains (ND, SD, NE, KS)	23	9
Appalachia (KY, TN, WV, VA, NC)	33	8
Southern Plains (TX, OK)	15	8
Southeast (AL, GA, SC, FL)	10	1
Canada	14	8
Delta (AR, LA, MS)	10	2
International	12	3
Alaska	6	4
N/A	10	3
Hawaii	4	2

List of speakers

- Sarina Jepsen and Rich Hatfield, The Xerces Society for Invertebrate Conservation, on continental-scale bee monitoring
- Jenn Servis, U.S. Fish and Wildlife Service, on data needs for Endangered Species Act listing and recovery
- Elizabeth Crisfield, Strategic Stewardship Initiative, on data use cases for a national bee monitoring strategy
- Elizabeth Crone, Tufts University, on monitoring multiple bee life stages
- Rachael Winfree, Rutgers University, on monitoring for rare bee species conservation

Synthesis of breakout group discussions

Breakout 1

What data are needed to take conservation action to protect and maintain populations of native bees, including: identifying and prioritizing the species most at risk of extinction, and identifying conservation interventions that will effectively maintain those species' populations?

The native bee monitoring community overwhelmingly agreed that data on native bee species distributions should be collected through a national native bee monitoring plan. Suggested measures to assess through monitoring included native bee species abundance, occurrence, presence, and absence. Gathering information about species distributions through bee monitoring may lead to more conclusive estimates of species ranges. Pairing these current results with historic data from museum collections or previous surveys would also allow estimates of range expansion or contraction. Bee habitat was a second, frequent topic of discussion. Collecting data on floral species abundance, presence, or absence through a national native bee monitoring plan could lead to determining ranges of host plants for wild bees and better understanding bee species habitat associations or preferences. To connect data on bees and data on plants, there were multiple suggestions to assess species interactions, including observing foraging and nesting usage of plants by native bees. Data identifying both bees and plants can be collected together through environmental DNA (eDNA), and gathering eDNA was commonly mentioned. However, eDNA identifications rely on previously determined DNA barcodes; therefore, there were also repeated suggestions to gather data that would allow for a barcode library to be created or for existing libraries to be supplemented. Metabarcoding is an emerging technique that uses eDNA to simultaneously identify bee and plant species present in a sample; data collected through national native bee monitoring efforts would contribute to the development of metabarcoding methods. There are additional issues with eDNA sampling and its ability to capture comprehensive community-level data.

When asked to describe the purpose of collecting bee monitoring data, consensus emerged along three points. The first point of consensus was to use such data to establish baseline information on native bee species distributions and species ranges along with habitat distribution and range. This is straightforward, critical information, but we lack these basic data for most U.S. native bee species and many bee habitats. Pollinator conservation faces a major barrier on this point and is struggling to advance without a greater understanding of where native bee species and their habitats are currently found. The second point of consensus on the purpose of collecting national-scale native bee monitoring data uses the collected baseline information to begin tracking bee species population trends and habitat distribution trends and identify threats facing both native bee species and their habitats. There are multiple data use cases under this umbrella, including comparing current and historic data on bee species and their habitats to explore range expansion or contraction, entering current data into predictive models to estimate future population and habitat distribution trends, and locating or confirming rare bee habitats (with rare plants and/or rare bee species) or bee habitats with high bee or plant biodiversity. Such data could also be used to assess extinction risk or species vulnerability through incorporating population trends and threats. If monitoring persists through time and occurs over the course of habitat change or restoration, indicator bee or plant species could be observed that respond well to managed or natural change. The third point of consensus on the purpose of collecting national-scale bee monitoring data was to inform policy and restoration efforts. National scale species distribution data on native bees would support Species Status Assessments conducted by the U.S. Fish and Wildlife Service. Regional or state-level data would support status assessments for state Species of Greatest Conservation Need lists. Other related beneficiaries of these data include NatureServe and the International Union for the Conservation of Nature (IUCN). Combining information on bee species distributions with information on bee habitat distributions would provide a strong foundation on which to build future monitoring, land management, or conservation efforts and could inform policy related to bee or plant conservation. For example, native bee monitoring and habitat assessment could determine where habitat restoration work may be necessary and evaluate restoration outcomes. This could promote adaptive management strategies or determine best practices in pollinator habitat restoration. Further, understanding threats facing native bees or plants could lead to more effective or appropriately tailored mitigation measures.

A related but less frequently mentioned point of consensus on the purpose of collecting bee monitoring data was the development and testing of standardized protocols to inventory, survey, or monitor native bees. Detecting bee species presence, absence, or occurrence requires more complex field methods, and the necessity of obtaining these data requires that methods to collect them be developed and tested. Doing so through a national initiative provides credibility to an effort potentially laden with uncertainty and difficulty.

How could a national monitoring program gather those data?

The native bee monitoring community largely agreed that any national scale native bee monitoring program must rely on standardized, systematic sampling methods; however, specific components of these methods suggested by the community varied widely. There was strong support for a sustained bee monitoring protocol that is repeated over time, though the suggested time frames included weekly, monthly, seasonally, or yearly. Reasons for repeated monitoring include tracking population trends and observing or tracking phenology of both bees and plants. There were two competing points of consensus on spatial arrangement of monitoring sites: 1) a spatially gridded approach or 2) a targeted habitat approach. Existing bee monitoring programs employ both strategies with distinct motivations. Spatial grids, such as those delineated by The Xerces Society's Bumble Bee Atlases or the Generalized Random-Tessellation Stratified (GRTS) survey design method used by the North American Bat Monitoring Program, provide greater statistical rigor and simplify incorporation of collected data into species distribution models (SDMs). Related to this, there were multiple requests to incorporate survey effort into a national native bee monitoring protocol, which would add further statistical rigor to the data and support inclusion in SDMs. A targeted habitat approach, such as that employed by the Empire State Native Pollinator Survey, would allow for greater understanding of bee-habitat associations. Other areas to target include those that have historic survey data or areas with little existing information. Targeted bee surveys could fill in geographic gaps in current knowledge of bee distributions. There were also repeated suggestions to target a subset of U.S. native bee taxa through standardized sampling. Accurate identification of surveyed specimens is critical. Identifying specimens of all bee species gathered through a national-scale bee monitoring effort would overwhelm an already backlogged network of skilled taxonomists; therefore, surveying bee species that can be easily identified would mitigate this potential issue while still gathering data on bee species distributions across the U.S. Targeting bee species that are easily identified from photos taken in the field would promote non-lethal sampling methods and open up identification to a wider network of taxonomists. Much of the feedback regarding specific sampling methods mentioned pursuing non-lethal options, including photos, targeted or timed netting, mark/recapture, removing leg segments for DNA analysis, and targeted or timed visual observations on flowers. Lethal sampling methods were mentioned as an option in cases where it was deemed necessary to confirm species identification, with the caveat that lethal methods be employed in a sustainable manner that would not harm bee populations.

A tiered or multi-level approach using standardized, systematic sampling protocols was also frequently suggested. There were multiple suggestions on how to establish tiers or levels; for example, by geography, with different protocols by country, region, state, or locality. Another possibility considers conservation status, with more intensive sampling for at-risk species and broader, less frequent sampling when assessing bee communities or common species. Partnering or taking inspiration from existing programs that do similar work was also mentioned; these include the Migratory Bird Joint Ventures program administered by the U.S. Fish and Wildlife Service and the Amphibian Research and Monitoring Initiative administered by the U.S. Geological Survey. Other existing programs to partner with may also be found at the state or local level through parks, conservation organizations, or wildlife agencies. Flexibility and adaptability of a national native bee monitoring protocol were also requested to accommodate resources and infrastructure associated with potential partners.

Another avenue of partnership in national native bee monitoring is citizen science. There were many suggestions to leverage public interest in native bee conservation; indeed, citizen science is the backbone of multiple existing native bee monitoring efforts, including the Oregon Bee Atlas, the Bumble Bee Atlases run by The Xerces Society, and the upcoming Pennsylvania Bee Monitoring Program. Documentation produced by the RCN could include information, guides, or resources for members of the public who are interested in or are currently conducting native bee monitoring. iNaturalist is a popular photo-based observation platform with thousands of submissions featuring native bees; promoting continued use of this platform and using currently available data could provide information on bee species distributions. However, statistical analyses using iNaturalist data must find some way to account for survey effort. Bee monitoring could be incorporated into existing BioBlitzes, which are citizen science events during which members of the public observe and record organisms of various taxa. These events are often repeated at the same locations, potentially providing a means of tracking population trends over time. Citizen scientists have demonstrated aptitude in many bee monitoring methodologies. One frequently suggested type of data to collect through a national native bee monitoring program is information on nest location or substrate. Encouraging citizen scientists to observe and record possible nest site locations may be helpful as professional scientists work to develop means to quickly detect and safely monitor bee nests in the field. Collecting observational data on bee species, plant species, and nest site locations may not prove immediately useful, but such information could lead to future improvements in bee survey methods.

There were three common requests related to infrastructure associated with the collection of native bee monitoring data. The first infrastructure request was the establishment or determination of a central repository or website for national native bee monitoring data. This, along with an active campaign, could encourage digitization of existing collections that may not be publicly accessible otherwise. A national repository should be accessible by everyone interested or engaged in native bee monitoring to submit, search, and download digitized data. The second infrastructure request called for increasing institutional support for skilled taxonomists to identify bee specimens. A national monitoring effort may target easy to identify taxa; however, skilled taxonomists already face a backlog of specimens to verify, and a national effort will add to the workload. Expanding taxonomic capacity is necessary for the successful implementation of a national native bee monitoring plan. The third infrastructure request was the support or designation of a national native bee specimen reference collection and DNA barcode library. A national reference collection would be used to train taxonomists and verify identifications and could be paired with DNA barcodes gathered through future monitoring efforts to aid in building a national barcode library.

You have just heard about bumble bee monitoring. How can monitoring projects inform and improve conservation actions for other groups of native bees?

Habitat management resulting from bumble bee monitoring likely benefits other native bee species, as they have some overlapping habitat requirements. Monitoring these managed areas could inform how other bee species use them. Some methods used in bumble bee monitoring could be transferred to other bee species, especially larger-bodied, more distinctive species, including non-lethal visual observations and photographs as specimen records. Some non-bumble bee species are easy to identify on the wing. All bees caught while sampling for bumble bees could be recorded and databased, with the additional potential to contribute to DNA barcode libraries. Mapping and analytical tools created for bumble bees can be used in a similar fashion for other bee species, though the data may be much more sparse. This could be a first step in determining where to survey other bee species. Monitoring for other species of native bees will have many of the benefits that monitoring has provided to bumble bees. Gathering this data will close data gaps on species distribution and population status, providing baseline data critical for future conservation actions. Such monitoring could reveal species of concern or declining habitat, aid in identifying stressors, and support future decisions regarding land management and species conservation policy.

Breakout 2

During the first breakout, we discussed the data that would be most useful for people to collect to inform extinction risk and conservation actions. Now, with the ESA in mind, what additional data should be collected to inform future listing and recovery decisions (beyond the national listing workplan)? Note what data should be collected, the purpose, and how a monitoring program can collect those data?

This question was posed to supplement a similar question asked in Breakout 1, and as such, the answers and suggestions were very diverse, reflecting the varying expertise and perspectives of the native bee monitoring community. Some suggestions appeared multiple times, though overall there were no points of strong consensus.

The most frequent suggestion to supplement native bee species and habitat distribution was to collect climate data to observe climatic effects on bee species and their habitats and determine any climate change-related impacts on bee species populations and habitat persistence. For example, phenological shifts in bees and plants may be observed over time; gathering climate data would allow a direct connection to be made between temperature, moisture, or wind and bee or plant abundance. A related suggestion was to collect microhabitat information, including % bare soil, soil pH, presence of pollinator plantings, and temperature, moisture, and wind conditions at each sample site. Understanding soil conditions where bees are sampled could contribute to assessments of nesting resources, which was another suggestion made by the community. Other habitat-related suggestions for data to supplement native bee species or habitat distribution included nutritional values of blooming plants present while sampling and habitat or landscape history, including recent change, surrounding habitat type(s), measures of quality, and connectivity. There were also many suggestions made regarding the assessment of threats to native bee species and habitat. These included pesticide use within and surrounding sampling sites, presence, abundance, or pressure of parasites or pathogens, and the role or risk of establishment of non-native plants or bee species. A third category of suggestions were related to native bee populations, including survival rates throughout life cycles, yearly changes in population size, and gathering genetic or genomic data to assess taxonomy, diversity, and susceptibility to threats.

Broadly, gathering data on abundance and distribution along with supplementary data on climate, habitat condition, threats, and populations would provide a detailed assessment of the current status of native bee species and their habitats. We would gain a better understanding of what bee species are present, the locations of their habitats, and the factors that most threaten their existence. This could determine future sampling locations, if adjustments need to be made to protocols, and inform monitoring goals; in other words, these data are a means of prioritizing native bee species and habitats to protect. If bee populations are changing, we could potentially observe and determine the rates of change. A protocol including genetic sampling would allow monitoring of genetic diversity of bee populations over time. Assessing risks or threats to native bee species could lead to a greater understanding of their effects, monitoring them over time, and possibly predicting future outcomes facing at-risk or threatened bee species. Monitoring over time may reveal species populations trends, and collecting supplementary data could potentially illustrate reasons for population change. A rigorous protocol may allow for quantification of population stressors or supporters, possibly expanding to understanding the consequences and outcomes of native bee species loss. Additionally, rigorous species and habitat information would contribute to ecological niche or habitat suitability models. The effectiveness of conservation efforts and actions, including restoration, mitigation, and species recovery, could be assessed with these data, and strategies and locations for future efforts could also be determined. Related to conservation policy, these supplementary data would provide more complete information for Species Status Assessments conducted by the U.S. Fish and Wildlife Service for bee species petitioned for listing under the Endangered Species Act. Further, for states that may not have regulatory authority over insects precluding them from inclusion as Species of Greatest Conservation Need, these data could support efforts to grant this authority and allow states to engage in and secure funding for bee conservation. Working in collaboration with other organizations and entities to gather and manage this data would demonstrate broad institutional support for native bee monitoring, may lead to more efficient conservation efforts, and could identify larger scale regional factors that may be influencing bee species and habitat distribution.

The native bee monitoring community made many suggestions as to how a national monitoring program could collect these supplementary data. Strategic partnerships and collaboration were frequent suggestions. Identifying existing agencies or infrastructure to conduct or support national native bee monitoring efforts is critical; pairing that with a tiered administrative structure consisting of national coordination and regional deployment and management may create a strong institutional framework that could support sustained monitoring efforts. Employing academic rigor and research methods along with government or nonprofit infrastructure or capacity was often suggested. As a starting point, gathering existing information on bee species distributions would inform locations or species at risk or of concern. Using this information to conduct targeted bee species or habitat surveys was mentioned multiple times. Suggestions for how to target varied, including at-risk species, easy to ID species, focal bee community types, expanding on interesting citizen science results, revisiting previously surveyed bee populations, or surveying areas with little existing data. Targeted bee species surveys should include a variety of bee body sizes and life histories to inform feasibility of broader monitoring efforts, and recording floral associations of surveyed bees would provide habitat information to support future efforts. Efficient field methods that gather habitat, weather, and bee species information would provide the most information with a lower amount of effort. Another group of suggestions called for broad scale monitoring across habitat types and regular monitoring of established populations; rigorous and extensive methods that would benefit from the aforementioned partnerships and tiered administrative structure. More specific suggestions on collecting national-scale bee monitoring data included incorporating genetic methods, using citizen science, and encouraging digitization of survey data on a common platform. To gather DNA or eDNA, access to proper cold storage is required, which could emerge from partnerships or collaborations. Gathering DNA or eDNA would support a national effort to build an eDNA library and support barcoding and metabarcoding efforts nationwide. If lethal sampling is required, collecting male specimens only may minimize population effects. To encourage citizen science, incentives were suggested as a means of bridging the access gap for underrepresented groups of people. Citizen scientists would require training to conduct surveys; developing a specific protocol for them may also encourage participation.

What changes in policy are needed to improve conservation of bee communities?

The current policy framework to protect native bees is limited. At the state level, many states do not have regulatory authority over the conservation of insects. This is a significant barrier to native bee conservation; allowing states this authority would allow them to list bee species as Species of Greatest Conservation Need in their 5 or 10 year State Wildlife Action Plans, which in turn would provide state resources to support conservation and monitoring efforts. To gain federal protection, bee species can be listed as endangered or threatened under the Endangered Species Act (ESA), administered by the U.S. Fish and Wildlife Service (USFWS). Other legislation exists to support bee conservation, including multiple Farm Bill programs typically administered or implemented through the U.S. Department of Agriculture Natural Resources Conservation Service and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) administered by the Environmental Protection Agency. Suggested improvements to the ESA included allowing the listing of Distinct Population Segments of invertebrates along with individual species and to relax data requirements for extremely rare species protection in cases of data deficiency. There were also suggestions for formalized threatened habitat protection similar to that provided by the ESA. The Conservation Reserve Program administered by the U.S. Department of Agriculture Farm Service Agency could be used to promote bee habitat restoration. Suggestions to improve FIFRA included conducting risk assessments for native bees, not just honey bees; better regulation of inactive pesticide ingredients such as adjuvants and surfactants, improved regulation of seed-treated pesticide application, particularly for pesticides with known harmful impacts on bees; and tracking pesticide applications across landscapes to better understand and ultimately model exposure risk for native bees. Calls for more funding were made to support bee conservation through the USFWS Partners for Fish and Wildlife Program, post-fire and other habitat restoration work on federal land, survey programs for bee species and habitat, and taxonomic support to verify and update identifications of bee species. Candidate Conservation Agreements or Agreements with Assurances, administered by the USFWS, could be created to protect bee species or their habitats. Agencies could collaborate with each other and with non-agency partners to conduct regional landscape assessments to find high-priority areas for bee conservation, and more broadly, agencies and academics could work together to align management and research needs. Lastly, more distinction should be made between honey bees and native bees. Outreach and education efforts from federal and state agencies could distinguish native bee habitat, life history, and ecological importance from that of honeybees, which are very different. The National Pollinator Protection Action Plan from 2014 could be amended to emphasize and distinguish native bees from honey bees, including species that may not be agriculturally important. Recognizing the intrinsic value of native bee species through federal and state policy would support and promote bee monitoring and conservation.

Breakout 3

Who are the conservation users of the data produced by a national native bee monitoring strategy, what are conservation uses of native bee data, and how could a monitoring program help capture these data?

There was strong consensus among the native bee monitoring community that end users of data produced by a national native bee monitoring strategy will most likely be state agencies, who would greatly benefit from such data but generally do not have the capacity to collect it themselves. Similarly, Natural Heritage programs, connected through the NatureServe network, operate at the state level through government, academia, or as NGOs, and would also be a primary end user of national native bee monitoring data. Other suggested end users with some consensus included federal agencies, academia, and nonprofit conservation groups; these are broad categories that encompass many types of end users. Another frequently suggested group of end users were land managers, a phrase used to describe state, federal, and private entities working in lands that may serve as native bee habitat. In addition, there were many types of end users that were mentioned less frequently but who nonetheless stand to benefit from national native bee monitoring data: private landowners, tribal groups, environmental consultants, policy makers, municipal agencies, industry groups (solar or wind energy, real estate developers), and landscape architects. Broadly speaking, many groups would benefit from access to national native bee monitoring data. However, the data may not need to be directly accessed in raw form by some end users; in these cases, providing summaries or syntheses would meet their needs.

Strong consensus emerged on one broad use case for national native bee monitoring data: the justification for decision making regarding native bee species in multiple contexts. Four contexts were suggested. 1) National bee monitoring data can inform species status or rank assessments for government agencies and NGOs. The U.S. Fish and Wildlife Service conducts Species Status Assessments (SSAs) for species petitioned for listing under the Endangered Species Act; SSAs are data-intensive, and those that have been conducted for bees have had limitations owing to data availability. These data would support state lists of Species of Greatest Conservation need outlined in State Wildlife Action Plans and support emerging regional collaborations to identify and conserve these species. More broadly, national bee monitoring data would determine species range, which in turn could inform models of species distribution and occurrence. With sustained modeling, species populations trends could be observed, providing additional information to update status or rank assessments. 2) National bee monitoring data can inform land management decisions and support funding for land management efforts. These data could determine how to prioritize and where to locate bee conservation or habitat restoration efforts, help identify the best methods in these efforts, and assess their effectiveness and outcomes. They could be used to regulate pesticide use and support agricultural mitigation efforts on both populations of and pollination services by native bees. 3) National bee monitoring data can inform public outreach efforts, promoting public education on conservation or management practices that benefit native bees along with providing accessible information on bee population status. Through a national native bee monitoring program, members of the public could be trained in data collection, curation, and native bee species identification. This in turn could increase public buy-in and support for native bee conservation nationally. 4) National bee monitoring data could be gathered and shared publicly through a centralized repository for data collected through surveys. This supports the other use cases presented here as well as being its own end product of a national native bee monitoring program.

To gather data to support these end users and use cases, a broadly applicable bee monitoring program well-connected to professionals in multiple sectors may lead to greater buy-in from the community and ultimately provide a robust assessment of native bee species and habitat status. Collaborating with existing data collection and curation efforts including but not limited to Natural Heritage through NatureServe, The Xerces Society Bumble Bee Atlas projects, the National Phenology Network, federal native bee labs of the U.S. Geological Survey and the U.S. Department of Agriculture, and academic researchers would provide a strong foundation for national-scale bee monitoring. Considering and aiming to incorporate the needs and infrastructure of all collaborators may lead to greater adoption of a national native bee monitoring program by the bee monitoring community. Additionally, a national bee monitoring program should engage members of the public in some capacity. This can include sharing data publicly, developing a citizen science protocol and training members of the public in implementation, and creating educational products on native bee species, populations, and conservation. The sampling protocol(s) developed for a national native bee monitoring program should be standardized for all participants. Common suggestions for this protocol included repeating methods across time and space, allowing for targeted species or habitat surveys to reduce geographic reach if necessary; establishing basic data quality requirements for inclusion; using non-lethal methods as much as possible, particularly when surveying rare or at-risk bee species; and recording some measure of effort or details on how surveys were conducted. Tiers or modules for a standardized bee monitoring protocol were also mentioned. There were many suggestions for what to collect through a national native bee monitoring program to support these end users and use cases: bee species distributions and population trends, floral associations, habitat associations, nesting substrate, threats, and outcomes of mitigation or restoration efforts. Lastly, data collected through a national native bee monitoring program should be stored and shared in an open, centralized national database; this was a very frequent suggestion. This is also an opportunity for partnership, as there are existing platforms (GBIF and SCAN were mentioned) that could be employed in this manner. If this effort were to require its own database, there are models for amphibians and bats managed by the U.S. Geological Survey that could be reworked for native bees. An ideal platform would have an interactive dashboard displaying what data has been collected by location, have clear metadata standards (such as Darwin Core), and some public-facing webpage(s) that summarize and synthesize the data.

What are the desired conservation outcomes for bees?

The first conservation outcome of a national native bee monitoring program is to understand the current population status and range of U.S. native bee species. From this, the native bee monitoring community seeks to ensure the persistence of U.S. native bee species by keeping common species common, improving population health, identifying species of concern and taking actions to conserve their populations, identifying keystone species that indicate habitat quality, reversing population declines, increasing species ranges, and ultimately preventing extinctions or listing of additional bee species as endangered or threatened. Identifying and implementing land management practices that benefit the greatest diversity of native bee and plant species across multiple habitat types and landscapes to ensure species persistence is another conservation outcome of national native bee monitoring. Protecting pollination services, both managed and unmanaged, through native bee monitoring and reducing reliance on managed honey bees as service providers may further promote native bee conservation. Sharing data on findings and outcomes may allow native bee conservation practices and interventions to become more standardized and more effective. This can generate greater awareness of all species of native bees and lead to public confidence and buy-in for a national native bee monitoring program. There was debate here within the bee monitoring community regarding the specificity of conservation goals, targets, or outcomes and transparency to the public related to creating and achieving those outcomes. If successful, awareness of native bees could grow among the public, potentially integrating native bees into U.S. conservation culture more broadly.

Breakout 4

What information is needed to understand life history stages or vital rates to best inform conservation interventions for imperiled wild bee species, and how do we go about getting those data at a large scale?

The native bee monitoring community had strong consensus on three categories of life history information that would better inform native bee conservation: nesting, survival, and foraging. Nesting is notoriously difficult to assess for most native bee species and generally requires intensive effort to locate and monitor nest sites. Owing to this, many suggestions asked simply how to find nests to survey. A national scale native bee monitoring program could develop and test native bee nest survey methods to begin to answer this question. As nest survey methods become established, additional areas of inquiry that could be answered through nest monitoring include nest structure, materials used in nest construction, effects or influence of various nest substrates, nest density, frequency and size of nest aggregations. Specific suggestions made related to these questions include developing metrics to assess site suitability for native bee nesting for soil type, moisture, or leaf availability and aiming to model site suitability or nest density. Behaviorally, understanding how bees find nest site locations and exploring nest site fidelity could inform conservation practices; in addition, understanding how habitat and the surrounding landscape may influence nest site selection could influence how or where conservation efforts for native bee nesting are implemented. Related to nest site selection and establishment, assessing rates of nest success through fecundity could be a measure of conservation efficacy. Fecundity measures include number of mating events per individual, number of eggs laid, and number of male and female offspring. For solitary bees, the number of nests per female could be assessed; for bumble bees, assessing influences of queen production could be useful.

Related to nest success, survival of native bees at each life stage was frequently mentioned as information that could inform conservation efforts. In particular, assessing overwintering survival was a common request for a national native bee monitoring program. Solitary native bees overwinter in their nests as larvae or pupae; for most species, little is currently known about how long larval or pupal life stages last and how many individuals survive each life stage. Quantifying rates of survival and understanding reasons for loss at larval and pupal life stages could lead to the development of native bee conservation strategies that mitigate loss and promote nest survival. For social native bees, observing queen survival over winter would serve a similar purpose. These measures likely vary across species and may change with different habitat associations; therefore, assessing them within multiple habitats could further bolster the efficacy of native bee conservation efforts. For adult solitary bees, monitoring the number of adult bees that emerge from nests in the spring and recording when emergence occurs by degree days would assess survival to the adult life stage and phenological timing; the latter could be reconciled with plant phenology to assess effects of climate change and the potential for phenological mismatch. For social native bee species, observing the survival and emergence of queens and workers would serve a similar purpose. The length of nest diapause is another question; it can continue through multiple winters, and little is known about how often this happens or reasons it occurs. Additionally, native bees can have one or multiple generations emerge in a growing season; understanding voltinism patterns across multiple species could lead to more targeted conservation efforts. Monitoring length of adult lifespan and assessing degree days until nest establishment and provisioning begins would assess survival throughout the adult life stages and could also be connected to plant phenology and weather patterns to assess climate change effects on native bee species. Broadly, identifying critical life stages may increase the efficacy of native bee conservation. Along with survival, native bee monitoring could assess population metrics that would inform conservation efforts. These include population size required for continued species viability, growth rates, sex ratios, immigration and emigration rates, recruitment success, and metapopulation structure. Additionally, monitoring native bee populations over time could increase understanding of natural fluctuations in population size within and across growing seasons; year over year population change can be dramatic for native bees, and little is known about why or how that happens. Sustained monitoring could also measure bee species response to natural resource fluctuations.

Most feedback about the structure of a native bee monitoring program includes incorporating floral associations into bee species observations. Monitoring floral associations could reveal or clarify plant-pollinator networks across habitat types, landscapes, and geographic regions to determine host plants that support the most individual bees, the most bee species, or at-risk bee species. This would support the conservation of native bee species by identifying plant species to use in mitigation or restoration efforts. Further, gathering information about the use of floral resources could lead to targeted conservation practices that support native bee physiology or metabolic function. This information includes the nutritional value of floral resources used by native bees, how and what floral resources are used in nest provisioning, the amount of floral resources required for each life stage of native bees, how floral resource use changes over the growing season, whether forage gathered in one growing season influences the size or success of the next generation of native bees, and understanding the energetic dynamics of foraging and floral resource use. Flying from nest sites to foraging sites expends energy, though how much energy is expended, how much is gained through foraging activity, and how far bees fly between nests and foraging sites generally remains unknown for most native bee species. Related to foraging distance, maximum dispersal distance to find mates or nest sites is also poorly understood. Understanding how native bees move through their landscapes to find nesting sites, foraging sites, and mates could lead to more effective conservation measures that support these efforts. Habitat quality and landscape connectivity may influence native bee movement and could be assessed across habitat types and geographic regions through a national native bee monitoring program. Observing habitat use over the growing season or life cycle of native bees could reveal behavioral patterns that could be supported through conservation efforts. Quantifying measures of habitat such as forage or nest substrate availability or quality and monitoring effects of these measures on bee species survival could determine habitat suitability standards and lead to more effective conservation. Further, monitoring plant phenology in native bee habitat could be linked to monitoring bee phenology to assess effects of climate change and inform timing of implementing conservation strategies or monitoring efforts.

Beyond these three overarching areas of life history or vital rate information that could guide or improve conservation efforts, the native bee monitoring community suggested other areas of interest that could be pursued through a national monitoring program. Assessing native bee species susceptibility to multiple threats, including pathogens, parasites, and pesticide exposure, could lead to specific conservation targets addressing these threats. Better understanding each of them by measuring pathogen loads, identifying parasites or parasitoids and the conditions under which they thrive, and quantifying total exposure and risk adverse effects from pesticides along with monitoring how these threats affect different life stages and transfer between colonies, nests, or generations of native bee species would further support and inform conservation efforts. Observing the influence of and interactions between abiotic and biotic factors on vital rates at each life stage could reveal environmental effects that may help or hinder conservation strategies. Exploring climatic tolerance to find thermal limits for bee species could inform climate change mitigation efforts for native bee populations. Integrating existing data on bee populations with climate data could reveal trends in emergence timing. Other ecological concepts including generalist or specialist life histories, social or phenotypic plasticity, presence of non-native species, and competition within and between native bee species and with non-native bee species could all potentially be assessed through national scale bee monitoring and inform conservation efforts. Lastly, if species-level information is difficult to gather, understanding when there is sufficient information to generalize about native bee species to the guild level can increase confidence in the efficacy of native bee conservation.

To gather life history and vital rate information at a large scale, the native bee monitoring community provide a robust list of ideas that can, as with the life history and vital information itself, largely be categorized into three overarching areas: natural history studies, nest searching and monitoring, and combinations of laboratory and field work. Life history and vital rate information is largely gathered through observational studies that fall under the purview of natural history; one reason so little is known about life histories and vital rates of native bee species is that there are very few funding opportunities for natural history work. Strategic partnerships and collaborations between academic institutions, government agencies, and NGOs are a way to mitigate this; seeking funding sources outside of traditional means may be another. Conducting small, locally focused observational studies following a standardized protocol could gather this information using fewer resources; these results could be combined at the national scale to identify national trends. More fine scale collection of natural history data in multiple locations could increase the precision and accuracy of available information on native bee species phenology, range, and habitat use. Survey sites should be randomly selected to avoid potential bias in detecting declining growth; selecting sites where bees are abundant may cause this to occur. A national network of such sites and studies could be compelling enough to get federal funding, though there are challenges to establishing and maintaining a network of this nature. Another approach, instead of a large network of small, low-intensity sites, could be a few larger, more intensive research projects that identify key pieces of information to support the development of a national standardized protocol. The native bee monitoring community suggested several ways academic institutions could contribute by gathering natural history information on individual native bee species throughout their life stages, developing and testing protocols to be conducted throughout the growing season and over multiple years, and financially supporting these efforts. Through this testing, life history or vital rate measures could be identified and found suitable for undergraduate lab exercises, citizen scientists, or primary school groups to collect, creating new partnerships, promoting native bee conservation, and increasing public buy-in to support these efforts.

Many in the native bee monitoring community suggested that nest searching and monitoring efforts are critical to the success of a national native bee monitoring program. Suggestions for how to gather this information varied. A citizen science approach, similar to the existing Queen Quest program, could train members of the public to search for and identify ground or cavity nests. BioBlitzes could also be employed, where a group of citizen scientists intensively searches a target area, such as a park or preserve, for native bee nests. However, these approaches may rely on well-developed nest searching methods for use by the public. Nest searching methods are not well-developed for professional researchers, therefore this may be a barrier to deploying these ideas. The native bee monitoring community suggested two solutions: targeting nest aggregations, which may be easier to locate and use for educational purposes, or gathering information that may inform the development of reliable nest searching efforts through citizen science. Another approach, instead of citizen science, could be a collaborative effort involving professional researchers for which rigorous and reliable nest searching and monitoring methods are developed and tested. For ground-nesting native bees, this may involve refining scent training for dogs to locate nests or assessing multiple components of opportunistically discovered nests, including soil texture and moisture, casting within nests to determine structure, or digging up nests to observe structure, location and status of progeny, and soil condition. This could lead to the development of soil condition standards that could be used to survey for ground nests more broadly. Continuing to develop ground-nesting traps was also suggested; these methods remain promising but have yet to produce consistent results. For cavity-nesting native bees, trap nests in nest boxes have been used successfully in experiments and could be placed and monitored in multiple habitat types and landscapes to assess those influences on nest success. Gathering habitat information, such as plants present, may inform search methods for naturally-occurring cavity nests. Some of these trap nests would need to be removed to observe nest construction materials, though most nests could be x-rayed to observe progeny inside without lethal effects. For both nesting types, developing monitoring strategies for construction, provisioning, and emergence was suggested, potentially through the use of cameras, either motion sensing or infrared, or the use of mark-recapture or telemetry techniques. Monitoring nest structure and survival is an opportunity to assess nest parasitism, forage availability, and surrounding habitat quality, which are all potential influences on nest success. Information gathered on soil quality for ground nesting or plants present for cavity nesting could be scaled up with national spatial datasets on soils and plants to assess nesting suitability more broadly. Additionally, landscape genomics methods could be used to triangulate nest site locations.

Combining field observations with lab work could provide a comprehensive assessment of native bee life history strategies. Careful observations of native bee nests in the field paired with controlled experiments on nest survival could determine factors that influence nest establishment and success. Egg rearing experiments to assess survivorship can be done in the field through egg cards and in the lab under controlled conditions. Stressors such as nutrition, temperature, pesticide exposure, and pathogen pressure could be tested in lab experiments. Analyzing the nutritional value of forage resources can be done in the field through gathering pollen and observing floral visitation rates. In the lab, floral nutrition can be assessed through feeding experiments and pollen chemical analysis. Lastly, foraging can be observed in the field through telemetry or mark-recapture; these methods can also be used in enclosure experiments under controlled conditions. All of these combinations of field and lab work can provide information to tailor and target conservation practices and increase their effectiveness.

The native bee monitoring community made multiple suggestions for additional methods to gather native bee life history and vital rate information to aid in developing conservation strategies. Collecting existing literature on nesting, foraging, and survival could inform a series of comprehensive literature reviews; creating a central repository for this literature would provide easy access to interested parties. Tracking phenological trends for native bees and flowers with existing iNaturalist data could inform initial efforts for more rigorous observations. Life history and vital rate observations are easier to gather for large-sized social native bees, such as the bumble bees; creating a task force to develop strategies to gather this information for smaller-sized, solitary bees may be beneficial. Population genetic structure has been assessed for bumble bees in different habitats in the UK; conducting similar assessments in the U.S. and incorporating other native bee species would show how the landscape may or may not be supporting native bee populations. An example protocol used for birds is the Monitoring Avian Productivity and Survivorship (MAPS) protocol employed by the Institute for Bird Populations (IBP). The MAPS protocol was developed specifically to assess vital rates and features a standardized, nationally applied sampling protocol. Further, IBP partners with the Bird Genoscape Project to use eDNA to track bird migration. A national scale native bee monitoring program could incorporate eDNA into its protocols through non-lethal leg sampling of adult bees or through metabarcoding associated with pollen collection. A detailed natural history approach for national scale native bee monitoring that may involve gathering genetic material may require the establishment of target native bee species to selectively sample as opposed to broad sampling of all 4,000+ species of native bee in the U.S. There were many suggestions on how to establish target native bee species. An overview of current and historic native bee survey data could determine potential candidates. Selecting species by guild would ensure greater diversity in potential candidates. Through geography, target bee species could be determined by areas with little sampling or areas with high native bee biodiversity. Establishing regions delineating native bee biogeography across the U.S. was repeatedly suggested. Lastly, target bee species could be determined by life history habits or functional traits, including nesting preference, forage strategies, or sociality. For all targeting methods, the native bee monitoring community suggested finding commonalities across guilds that would allow generalizations for similar species. Another suggestion was to develop and test sampling protocols on common species before trying them on rare native bee species. Though these data are not often institutionally supported, assessing life history and vital rates are critically important for the future of native bee conservation. One attendee suggested addressing this lack of support explicitly by “building in some kind of risk mitigation for people with a lot of pressure to produce results.” Gathering this information through a national scale native bee monitoring program is a unique opportunity and would benefit academics, government agencies, and NGOs.

Are there elements of bumble bee data collection that could be replicated for other groups of wild bees?

While there was little consensus from the native bee monitoring community on this point, there were a lot of ideas. Bumble bees have served as target species in native bee monitoring owing to their large size and their relative simplicity in identification from photos. Groups of other native bee species to target for a national scale monitoring program were suggested by the professional community. Cavity-nesting bee genera including *Osmia*, *Megachile*, *Hylaeus*, and *Ceratina* spp. were suggested to study in trap nests. For ground-nesting bees, soil nesting and mark-recapture work similar to that done for bumble bees has been conducted for solitary bee species in the genera *Colletes* and *Andrena* by graduate students in the Northeast; learning from this work and expanding it to other species in these or other genera could be part of a national scale native bee monitoring program. Bumble bee monitoring projects generally involve non-lethal visual observations, including photo-based identification, mark-recapture methods, telemetry techniques, and video surveys. Photo identification of solitary bees is often difficult; therefore, two possible solutions to this issue were posed by the native bee monitoring community: 1) Determine solitary bee species that are large, charismatic, and easy to identify through photos, possibly *Agapostemon* spp. or *Megachile* spp.; and 2) Take large numbers of photos and videos of solitary bees to train people identifying bees from photos on iNaturalist as well as emerging AI algorithms, including Seek by iNaturalist and BeeMachine. Mark-recapture methods, though intensive, have been applied to smaller solitary native bee species, though telemetry technology does not currently have tracking sensors small enough for smaller bee species. Nest searching, excavating, and monitoring efforts conducted with bumble bees could be replicated for smaller solitary native bee species. Finding bumble bee nests relies on observing bees flying into and out of them, making transfer of this idea from large, social bumble bees to small, solitary native bees potentially difficult. However, bee genera with species that establish ground nests communally or in aggregation, including *Agapostemon*, *Andrena*, *Centris*, and *Diadasia*, could be targeted for nest searching and monitoring efforts. A national scale native bee monitoring program could make a broad request for anecdotal nest observations to inform nest searching methods. Nests located in the fall could be marked and returned to in the spring for further observation on behavior and survival. Once abandoned, nests could be excavated and analyzed to inform pest presence, eDNA, or other emerging techniques such as using dogs to detect nests or genetic analyses to determine nest size or density. While bumble bees are multivoltine and hatch multiple generations throughout a growing season, this may not be feasible to monitor in other native bee species; it may simply be easier to observe and record vital rates for univoltine species. Components of The Xerces Society's Bumble Bee Atlas projects, including reliance on citizen scientists, photo-based identification, standardized survey protocols, and a grid-cell based spatial layout could all be adapted for use with other native bee species. Monitoring of other native bee species could be incorporated into existing bumble bee monitoring programs; this would encourage continued data collection on bumble bees while expanding our knowledge of other native bee species populations. Academic studies of museum data to inform bumble bee population trends over time could be replicated for other native bee species. Bumble bee taxonomic expertise is more broad and reliable than that of other native bee species; expanding this capacity is crucial for the success of a national native bee monitoring program. Species distribution and occupancy models have been created for many bumble bee species; with more data, these could be replicated for other native bee species. Lastly, existing bumble bee monitoring efforts have shared their data and made it publicly accessible; these principles should be transferred to other native bee species monitoring efforts as well.

Breakout 5

What do we gain if we move beyond a conservation framework that focuses on individual species to conservation of multiple rare species within bee communities, and how could a national monitoring program assess bee communities at a large scale?

There was broad consensus among the native bee monitoring community that a community conservation framework for native bees and their habitats would generate greater buy-in from supporting institutions and organizations and the general public. A community-based approach may be more effective, in that encompassing multiple bee species could lead to a greater overall conservation benefit. A community approach incorporates both species abundance and species diversity to obtain a more complete picture of surveyed habitats or ecosystems. Monitoring for multiple bee species may lead to the encounter of rare bee or plant species, including those not previously known to be rare. Aiming to preserve genera of bees may lead to the preservation of rare species within those genera. A community conservation approach avoids conflicts associated with species-centric approaches. Sometimes what is beneficial for one species is detrimental for another; this approach aims to provide general support for many species and their habitats. This is the motivation for Multi-species Conservation Programs, an existing institutional framework administered by regional, state, or local entities. A community-based conservation approach for native bees may be more efficient, in that limited resources are used to conserve multiple bee species and in turn, assess multiple native bee habitats. More data can be gathered on more species of native bees and plants in less time. Gathering this volume of information quickly could reveal functional roles or niches of and interactions between individual species within native bee communities. Stressors may be revealed to have more broad-ranging effects than previously thought, or they may be observed to have limited impacts. Community-based monitoring could track population trends of multiple species simultaneously and observe complementary shifts among them; for example, if an increase in the population of one species corresponds with the decrease in the population of another. This leads to real-time knowledge of the emergence of potentially vulnerable native bee species, allowing for early intervention to restore declining populations. It could also lead to the determination of indicator species of bee population health. Monitoring bee communities would likely involve some sort of habitat assessment, potentially incorporating native bee habitat conservation into native bee community conservation. A community conservation approach would preserve plant-pollinator relationships. Habitat resources, including soil types and plant species with hollow stems, could be monitored and become part of native bee community conservation. Restored sites to support native bees will also support plants, non-target insects, and potentially other species up the food chain. If rare habitat types are targeted for monitoring efforts, rare plants, rare non-target species, and rare native bee species could all be conserved; targeting habitats was suggested to be an easier conservation approach over targeting native bee species, though the definition of rarity was debated. Rare species may be declining, threatened, or otherwise at-risk, or they may be healthy populations limited by habitat availability. A community conservation approach would require broad collaborations, partnerships, and coordination; such a network could more easily leverage existing resources and share infrastructure and would be more suited for greater support from public, private, and other funding entities. Such work could identify new or confirm existing native bee diversity hotspots or rare plant habitats. Monitoring relationships between plants and pollinators in managed and unmanaged habitats could provide information on native bee ecosystem services; however, gaining a greater understanding of native bee community dynamics could also support conservation from the intrinsic value of the bees' existence. The breadth of this approach could guide broad-scale decision making, aiding government agencies, NGOs, resource managers, and land managers in making choices to promote or preserve native bee species and their host plants in areas of active management or under preservation. It encourages a focus on ecosystem function, promoting ecological resilience in the face of climate change. However, two tradeoffs to a community based native bee monitoring and conservation approach were mentioned. Regulatory frameworks for conservation are typically species-focused, therefore a community approach may struggle to find strong regulatory support. Generalizing across bee communities may miss observations of rare or vulnerable species or populations; methods required to obtain general community information may not be intensive enough to detect rare bees. Broadly, there are multiple benefits to a community-based native bee monitoring and conservation approach, including greater effectiveness, efficiency, and feasibility in observing, tracking, and preserving diverse and abundant native bee communities.

To assess native bee communities through a national scale native bee monitoring program, the native bee monitoring community largely agreed that there first needs to be robust baseline information established on current native bee species distributions, ideally paired with comparisons to historic records to determine population trends over time. There were many calls for a tiered, modular, or stratified approach, with broad, regional-level studies to track native bee community and population trends paired with intense, local-level studies associated with individual bee species or habitats of interest. Using existing infrastructure, including that associated with university field stations, arboretums, botanic gardens, NEON or LTER sites, Master Gardeners, community science programs, and undergraduate or primary school groups, could simplify the establishment of this kind of network. Consensus emerged for standardized sampling protocols consistently applied over space and time to obtain information on native bee population trends and effects of stressors. Gathering data and sharing it publicly through a centralized database was suggested. Targeting bee species was not suggested here, rather, targeting plant species or habitats was frequently mentioned. Target plants or habitats could be rare, to gather information on potentially vulnerable species or communities, or they could be common, to encourage broad participation by professional and community scientists. Common plants and habitats can support rare or specialist bee species; potential plant genera to target in this way include *Vaccinium*, *Helianthus*, *Solidago*, and *Cercis*. Engaging citizen scientists with a community-based native bee monitoring effort could promote awareness of a different conservation framework, in which rare species are monitored among a suite of common species, encouraging a more holistic view of native bee habitat and increasing public understanding of the value of biodiversity. There are existing efforts that could inform a community approach to a national scale native bee monitoring program; for example, by collecting native bee specimens and recording the plants collected from, the Oregon Bee Atlas is building a database of bee community information in Oregon. The Empire State Native Pollinator Survey targeted rare habitats and selected pollinator species in their surveys, and the grid cell approach of The Xerces Society's Bumble Bee Atlas projects ensures spatial uniformity. The North American Bat Monitoring program applies a standardized protocol across grid cells to monitoring bat populations, relying on professional and community science partners to conduct the surveys. The National Phenology Network conducts similar efforts for plant and animal phenology. Many of these efforts share their data publicly. To determine habitat quality, the U.S. could look to the European list of indicator native bee species that when present, indicate high quality habitat, and when absent, indicate poor quality habitat; replicating this with information from national-scale monitoring would inform future monitoring efforts and create an important conservation tool. Regulatory frameworks to look to include Multi-Species Conservation Programs and Conservation Opportunity Areas; both are regional or state frameworks that could be leveraged to support community based native bee monitoring. Data gathered through assessing bee communities as part of a national scale native bee monitoring program could be used to build capacity for or incorporate eDNA efforts or some other genetic or genomic component, such as the global Barcode of Life (BOLD) sequencing project or the state-based California Conservation Genetics Project (CCGP). Comparing native bee population genetics across time and space would be a fruitful use case of national scale native bee monitoring data. Another suggested use case was to improve and inform rigorous statistical modeling schemes, including multi-species occupancy modeling.

How could a monitoring program be designed to measure the impact of conservation interventions on bee communities?

The native bee monitoring community had little consensus here. The answers to this question were largely speculative and presented with the caveat that more baseline information is needed on native bee abundance, diversity, and population trends before the effects of conservation interventions on bee communities can be reliably measured. Standardized and repeated surveys were frequently suggested, potentially paired with long term vegetation monitoring plots such as the AIM sites of the Bureau of Land Management or the Forest Inventory and Analysis (FIA) sites of the U.S. Forest Service. Monitoring habitat conditions would be a necessary component of a program measuring effects of conservation interventions on native bee communities. A before/after intervention survey protocol was suggested to establish control conditions from which to compare the effects of conservation interventions. Native bee and plant communities will likely change more rapidly early in the intervention process; therefore, more monitoring may be needed initially to observe these changes. These measurements can be compared with control sites where interventions were not taken to measure the impacts on native bee and plant communities. The timing of surveys to monitor the effects of conservation interventions was debated among the native bee monitoring community; while there was agreement that surveys should be conducted across seasons, there was no consensus about timing of surveys within a growing season. Time scales from multiple times a week to monthly were mentioned, more intensive sampling schemes would be more likely to observe more phenological change in the native bee and plant communities. Multiple survey methods were suggested to avoid bias in sampling the native bee community, including pan traps, netting, photos, recorded visual observations, and videos or camera traps. Implementing eDNA methods was suggested to broadly record native bee and plant communities in response to conservation interventions at large scales. Additionally, the community did not reach consensus on which species to monitor; instead, the merits of targeting threatened species or surveying the entire native bee community in response to conservation interventions were debated. Measuring persistence of native bee and plant species, not just presence or absence, was suggested to emphasize the efficacy of conservation interventions. These interventions should have clear goals to determine the most effective and efficient native bee and plant monitoring scheme. This scheme could be tested on existing conservation projects before being nationally implemented. However, national implementation may require multiple schemes for flexibility and/or a tiered scheme with varying methods employed regionally and locally. There are unique learning opportunities within an intervention-based native bee monitoring scheme. First, engaging community scientists could educate the public on effective conservation interventions for native bees and how effectiveness is determined. Next, this kind of scheme could be used in an adaptive management framework, where conservation interventions and native bee monitoring practices are tested iteratively and adjusted to achieve the most effective suite of methods. Under this framework, all methods and data would be shared publicly so others could replicate and implement these efforts. Also, assessing native bee communities in response to conservation interventions could further inform how sampling affects native bee populations. There is limited information on this subject currently, and it is an important information gap to fill in a national native bee monitoring program. Lastly, information gathered from a community-based native bee monitoring program could be used to secure long-term funding for these efforts to continue; sustained sampling will provide the most robust data on population trends and impacts on native bee communities from conservation interventions.