IUCN Assessments for North American *Bombus* spp.

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Assessments completed December 2014

Document updated March 2, 2015

Bombus occidentalis on *Solidago canadensis*. Photo by R. Hatfield

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Table of Contents

INTRODUCTION

Before detailing the methods, it is important to note that we have attempted to apply the best possible methods Bumble bees are important pollinators of wild flowering plants and crops. They are generalist foragers, and thus do to evaluate the extinction risk of North America's bumble bees in a manner that is consistent with the IUCN framework. A key part of the IUCN framework is assessing changes that have occurred within the last 10 years (or 3 generations, whichever is longer). As such, this ten year timeframe is integral to the methods we have applied and describe below. When applying the IUCN Red List Criteria to broadly distributed invertebrates with short lifespans, and very little to no population data, some interpretation and use of best professional judgment is required. Some of the challenges of applying these criteria have been noted by others, most notably Cardoso et al. (2011, 2012; but see Collen & Böhm 2012). Nevertheless, the IUCN Red List Criteria provide the international standard for evaluating extinction risk in a manner consistent among regions and taxonomic groups. These methods were developed in coordination with IUCN Red List Specialists and in consultation with European colleagues who have finished their regional Red List assessments. Please direct any questions about these methods to Rich Hatfield at the Xerces Society (rich@xerces.org).

IUCN Red List Criteria Documents:

Full document: http://www.iucnredlist.org/documents/RedListGuidelines.pdf

This is the key document for the IUCN assessments. While the entire document is worthwhile, the key sections that pertain to our analysis are highlighted below:
- 2.2: Nature of the Categories (page 7-10)
- 2.3: Nature of the criteria (page 13-15)
- 3.1: Data availability, inference and projection (page 16-17)
- 4.1 Population and population size (page 20)
- 4.5: Reduction (criterion A) (page 25-26)
- 4.9: Extent of occurrence (criteria A and B) (page 31-34)
- 5-5.1: Guidelines for Applying Criteria A (page 42-44)
- 10-10.3: Guidelines for Applying the Categories DD, NT, and NE (page 62-65)

Summary 1 page document: http://www.iucnredlist.org/documents/2001CatsCrit_Summary_EN.pdf

This one page document provides a summary of the five criteria used to evaluate extinction risk.

METHODS FOR IUCN ANALYSIS

Data set

Williams et al. (in press) assembled a database of nearly 300,000 electronic records for specimens of North American *Bombus* species (sensu: Williams 2013) from academic, research, citizen science and private collections. Most contributions to the database include records of all *Bombus* held by an institution or individual, but in order to reduce bias associated with collections, in cases where only select taxa had been digitized, we dropped that entire collection from the database. We further removed all records lacking species-level determinations or other essential label data. We used Google Earth and ArcGIS 10.0 (ESRI 2010) to verify, correct or add georeference information for many records with insufficient or inaccurate location data. We individually dropped records that were well outside the known range of a species if the determiner could not be verified as a knowledgeable melittologist. We did not include three of the 46 North American species (*B. distinguendus, B. neoboreus* and *B. polaris*) in these analyses because of small sample size and/ or incomplete geographic coverage in collections. The final dataset includes 202,198 specimen records housed in nearly 150 collections in North America and elsewhere.

Analyses

We evaluated changes in each species' spatial distribution over time using extent of occurrence (EOO) and a measure of persistence (described below) We also assess changes in each species' relative abundance, which we consider to be an 'index of abundance relevant to the taxon', as specified by the IUCN Red List Categories and Criteria (IUCN 2012). For both the EOO and persistence calculations we divided the database into historical (1805 – 2001, N=128,572) and current (2002-2012, N=73,626) records. This timeframe was chosen as IUCN criteria stipulate that species decline must have been observed over the longer of three generations or 10 years.

Extent of Occurrence

Since the historical database had significantly more records, and therefore could lead to an over estimate of range loss due to an increased chance of including more records near the edge of each species' range, we rarefied the historic data set by randomly selecting 73,626 records from the historical time period to use in the EOO measurement. Using z-tests for differences in proportion, we ensured that the relative abundance of each species in the subsampled historical data was not significantly different from the relative abundance of that species in the original database. To measure changes in each species' EOO, we first used a k-nearest neighbors approach to create local convex hulls for each species in each time period (Getz et al. 2007).

Generally we used the "minimum spurious hole covering" rule proposed in Getz et al. (2007). However, since the ranges of most North America bumble bees are large, our "spurious holes" frequently included large expanses of inhospitable habitat for bumble bees (e.g. The Gulf of Alaska). After the local convex hull polygons were created, we clipped the polygons to the North American continent to remove large patches of unoccupied habitat (e.g. Great Lakes).

Using the areas calculated from these polygons, we compared the current area to the historical area to determine change in home range size (See individual species maps below).

Sampling Effort

Since we used presence-only records that primarily came from museum specimens for our analysis of changes in range size, sampling effort likely played a significant role in species presence or absence from a particular region. To account for varying sampling effort and avoid overestimating range loss, we created sampling density rasters from the presence points of all bumble bee species, in both the current time period and the random sample of the historical time period (using ArcGIS 10.2). For each species we calculated the relative difference in sampling density in areas where the EOO from the historic time period did not overlap with the EOO from the current time period. Using the area of this non-overlapping polygon, we calculated the average sampling density for both time periods. For species that experienced range loss in the current time period, and had a lower sampling density than historical levels, we adjusted our estimates of range loss to account for the change in effort. We did not adjust the change in range estimates for species that had a higher sampling density in the current time period.

Persistence

To determine species' persistence within their home range, we divided the continent into 50 km x 50 km grid cells. We used 50 km grid cells to be consistent with previous European and North American *Bombus* spp. analyses (Williams et al. 2007; Colla et al. 2012) and because the data in the historical database were georeferenced from specimen label locality descriptions, which are sometimes inaccurate at smaller spatial scales (Wieczorek et al. 2004). For each time period we divided the number of grid cells occupied by each species by the total number of grid cells occupied by all species. Then, the value from the current time period was divided by the value from the historic time period to detect changes in persistence over time. While the metric that we report is not truly a measure of range size, it does provide a measure of each species' persistence within its home range.

Relative Abundance

To evaluate changes in the relative abundance (RA) of each species, we divided the full database into historical (1805-2001) and current (2002-2012) and calculated the RA of each species in each time period. Then, to estimate changes in RA, we divided the current RA by the historical RA. In addition to comparing the historical time period to the most recent decade, we also broke the database up into ten ten-year periods, plus one time period covering all records prior to 1913 and calculated the RA of each species in each time period (e.g. pre-1913 = period 1, 1913-1922 = period 2). Then, using time as the explanatory variable and RA as the independent variable, we conducted a linear regression to assess longer-term trends in each species' RA (see individual species graphs). To assess extinction risk for several species we used a linear trendline to project future declines. We used the x-intercept as the theoretical point of extinction.

Average Decline

To evaluate overall population trends, we calculated the mean difference between the three measures reported above (EOO, persistence, and relative abundance) from the current time period (2002-2012) and the historical time period (1805-2001). This measure calculates how much the combined measures of EOO, persistence, and relative abundance have declined from historic values. For species that have experienced an average increase from historic levels, their average decline is reported as 0%.

IUCN Red List Categories and Criteria

We assigned each species to a preliminary IUCN Red List Category (IUCN 2012) by looking at the quantitative measures (changes in range loss, persistence, and relative abundance), range maps, sampling effort, recent literature, and using best professional judgment. We assigned IUCN Red List Criteria based on the data that was available, and each species range size, as well as the degree of confidence that we had in population estimates. Because there are limitations in evaluating extinction risk using museum specimen data (presence-only data collected by many individuals in a non-random manner), we generally erred on the side of categorizing a species as less threatened than was justified by quantitative analysis alone. The selection of Red List Categories for each species can be greatly informed (and changed, if necessary) by the field experiences, species-specific knowledge, and collective best professional judgment of the North American bumble bee experts.

Literature Cited – Methods only (see end of document for citations from ind. spp. accounts)

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Williams, P. H., M. B. Araújo, and P. Rasmont. 2007. Can vulnerability among British bumblebee (*Bombus*) species be explained by niche position and breadth? Biological Conservation **138**:493–505.

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Species: *Bombus affinis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 54.68%
Persistence in current range relative to historic occupancy: 29.77%
Current relative abundance relative to historic values: 7.46%

Average decline: 69.36%

Preliminary IUCN Category: Critically Endangered, Endangered; CR, EN
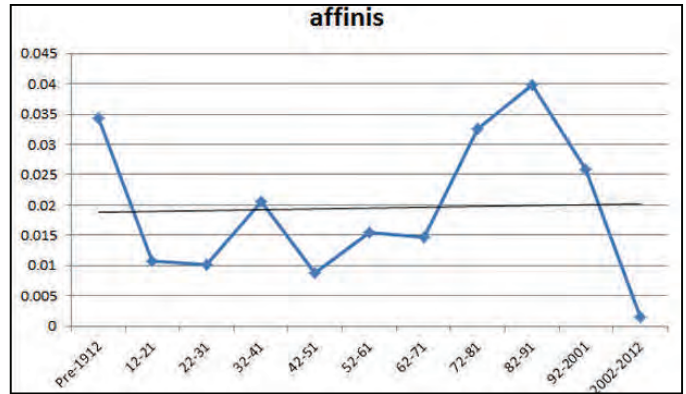**IUCN Criteria:** CR A2b; EN A2c

Figure 1: Relative abundance trends of *Bombus affinis*

Justification (Notes): Historically common and broadly distributed in the Upper Midwest and Eastern North America, *Bombus affinis* has recently experienced serious declines in relative abundance, persistence and distribution across its range. Despite dramatically increased awareness and survey effort for *B. affinis*, numerous regional studies have reported local extirpations and declines in this species (reviewed in Jepsen et al. 2013), and range-wide studies have found relative abundance declines up to 95% (Cameron et al. 2011a), and range losses of 70 to 87% in recent years (Colla et al. 2012, Cameron et al. 2011a). Consistent with these findings, our analysis found *B. affinis* has exhibited a 92.54% relative abundance decline over the past decade, suggesting a Critically Endangered Red List category for this species. Note that the Average Decline of 69.36% (based on relative abundance, persistence, and range loss) points toward an Endangered Red List category (very near the cut-off for Critically Endangered). Since the range loss detected in our analysis (45.32%) is much lower than that reported in other studies (87% in Cameron et al. 2011a, considering only the U.S. range; 70% in Colla et al. 2012, considering U.S. and Canada range), we elected to use the Relative Abundance Decline to estimate Past Reduction, rather than Average Decline. This species is listed as Endangered in Canada (COSEWIC 2010) and has been petitioned for Endangered Species Listing in the United States (Jepsen et al. 2013). Based on our recent analysis, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Critically Endangered Red List category at this time.
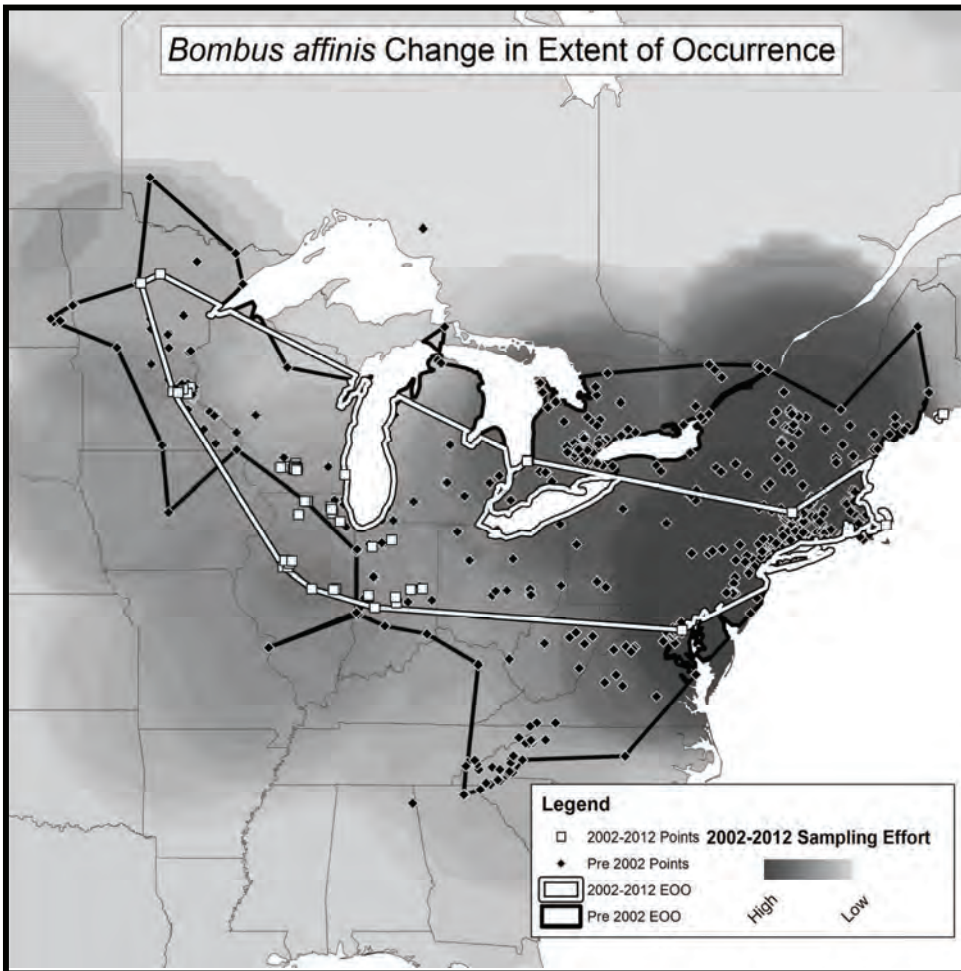

Figure 2: Map used to measure range decline for *Bombus affinis*

Species: *Bombus appositus*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 82.57%
Persistence in current range relative to historic occupancy: 85.57%
Current relative abundance relative to historic values: 46.65%

Average decline: 28.40%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus appositus*

Justification (Notes): According to our analysis, this western North American species has not experienced serious declines in recent years. In our analysis, the average decline of 28.40% (influenced largely by relative abundance decline) suggests that this species qualifies as Near Threatened based on criterion A2. However, while this species' relative abundance has been declining since a high peak in the 1960s-70s, it has increased in last decade compared to the decade prior, and over a long time period, the relative abundance regression is essentially flat. Extent of occurrence (EOO) and persistence declines have been minimal. We have confidence in the EOO decline in the western portion of this species' range, since there has been significant sampling effort in these areas in the past decade, but more sampling is needed in northeastern and southeastern portions of its range. Much of this species' range is in under-sampled areas, except for a few pockets with high survey effort where this species is generally well-represented. Overall, based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, including field experience of several western bumble bee experts, we recommend this species for the Least Concern Red List category at this time.
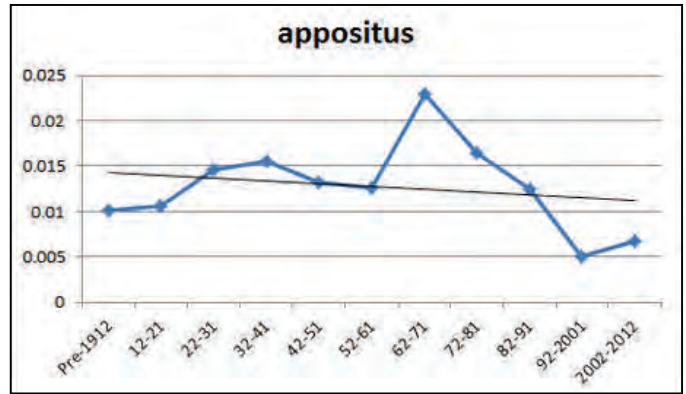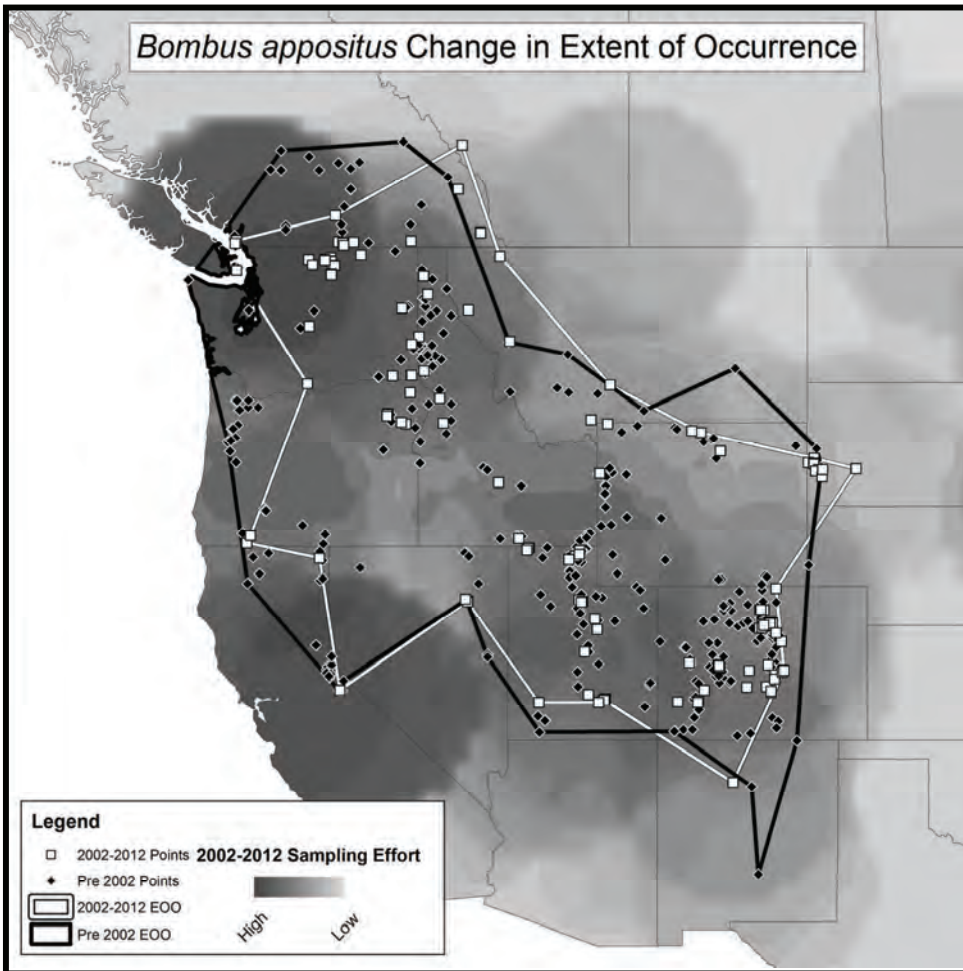

Figure 2: Map used to measure range decline for *Bombus appositus*

Species: *Bombus auricomus*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 88.62%
Persistence in current range relative to historic occupancy: 88.98%
Current relative abundance relative to historic values: 50.08%

Average decline: 24.11%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus auricomus*

Justification (Notes): This species occurs broadly throughout the eastern United States and Canada. In our analysis, the average decline of 24.11% suggests that this species qualifies as Near Threatened based on criterion A2. However, since the bulk of the range loss for this species was in the Great Plains, which has generally been poorly sampled, we recommend a Least Concern Red List Category at this time. This species is common in areas was sampling effort has been high. This is consistent with a number of studies suggesting that this species is common and relatively abundant in much of its range (e.g., Grixti et al. 2009, Hines and Hendrix 2005, Johnson 2009, Colla et al. 2012). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
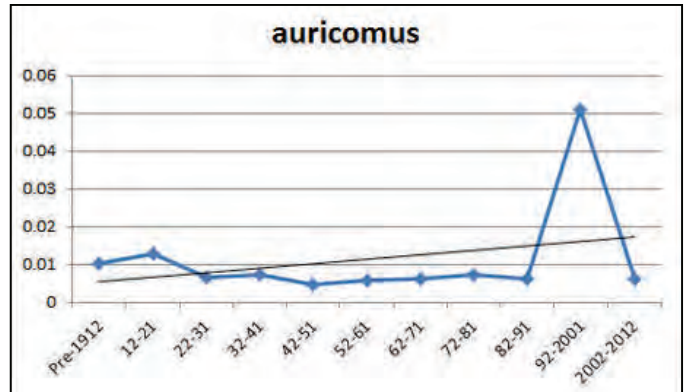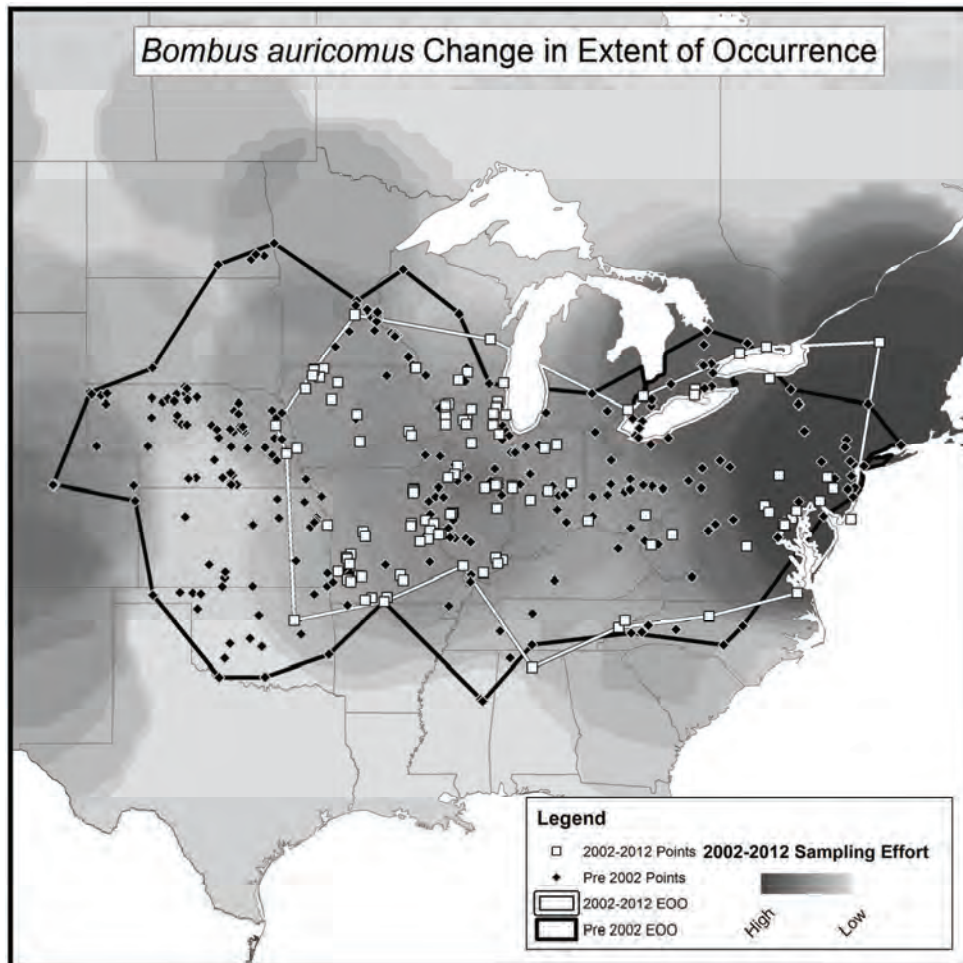

Figure 2: Map used to measure range decline for *Bombus auricomus*

10

Species: *Bombus balteatus*
Assessment Level: Regional
Status: Delayed for taxonomic status
Current range size relative to historic range: 69.58%
Persistence in current range relative to historic occupancy: 103.00%
Current relative abundance relative to historic values: 34.61%

Average decline: 30.93%

Preliminary IUCN Category: Data Deficient; DD
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus balteatus*

Justification (Notes): This high-elevation species has been under-surveyed and its status is poorly known in both Europe and North America. There is a lack of recent and historic sampling in the majority of this species' North American range (especially the northern part), which makes each of the measures (EOO, persistence, relative abundance, and average decline) difficult to interpret. Climate change is a threat throughout this species' range, but specific climate-driven impacts to this species have not been documented. More information in North America is needed to evaluate threat and potential decline.
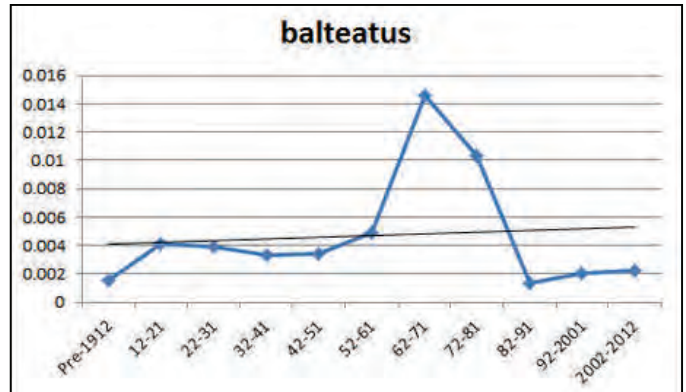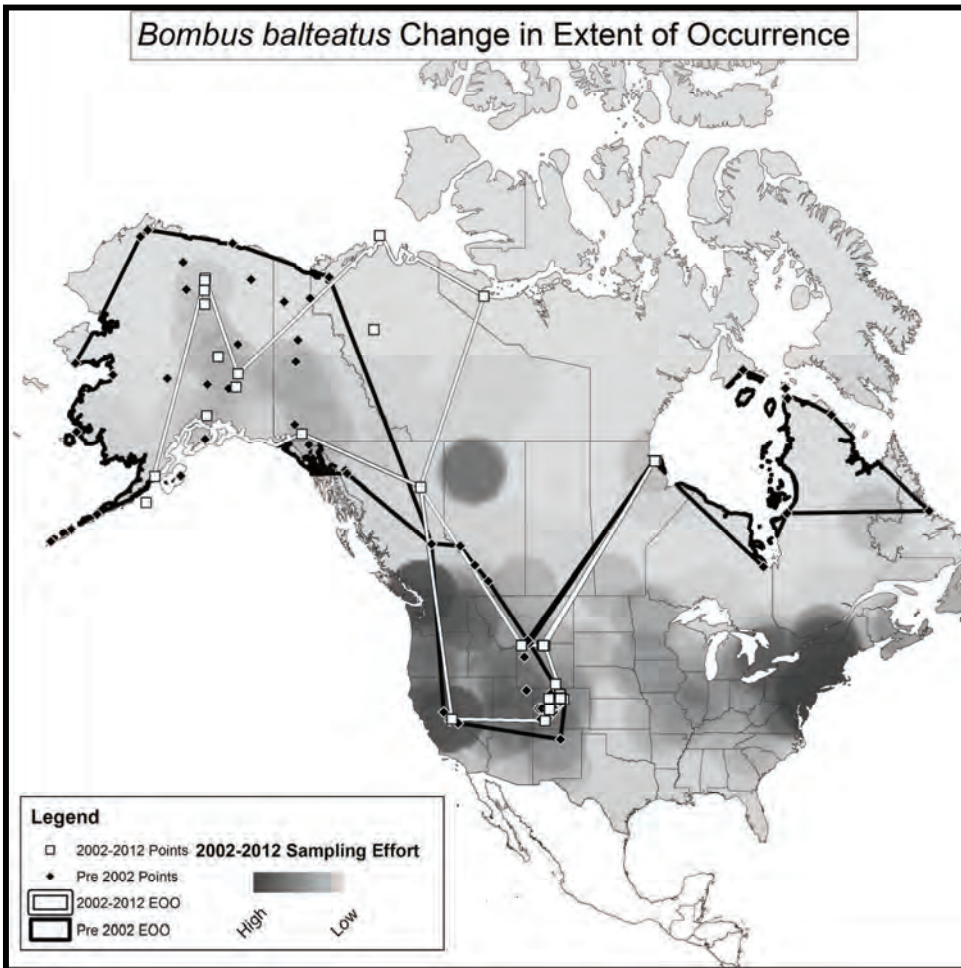

Figure 2: Map used to measure range decline for *Bombus balteatus*

Species: *Bombus bifarius*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 119.78%
Persistence in current range relative to historic occupancy: 94.13%
Current relative abundance relative to historic values: 126.53%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus bifarius*

Justification (Notes): This widespread species is common across most of its range and has increased in both relative abundance and range in the last decade (2002-2012). Our analyses indicate it should be classified as Least Concern.
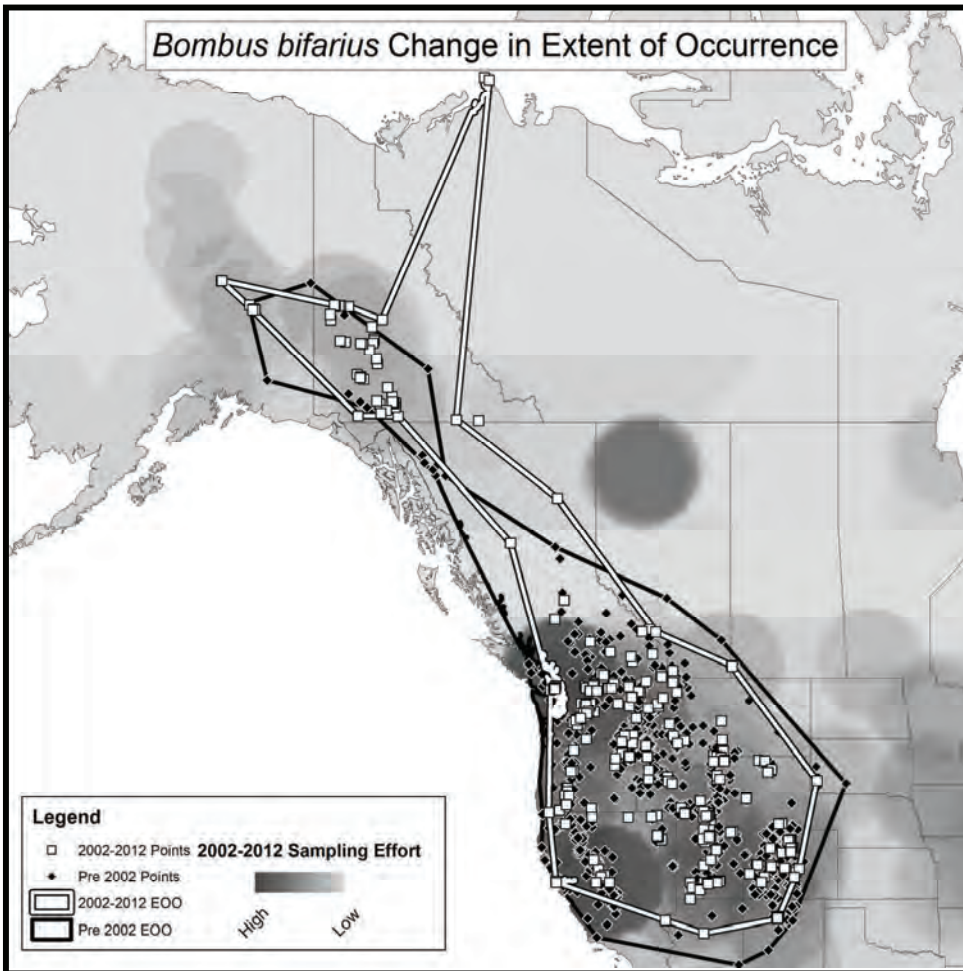

Figure 2: Map used to measure range decline for *Bombus bifarius*

Species: *Bombus bimaculatus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 96.56%
Persistence in current range relative to historic occupancy: 204.77%
Current relative abundance relative to historic values: 188.19%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus bimaculatus*

Justification (Notes): Our analysis is consistent with other studies which show this eastern North American bumble bees remains common, is increasing in relative abundance in some areas, and is not of conservation concern. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
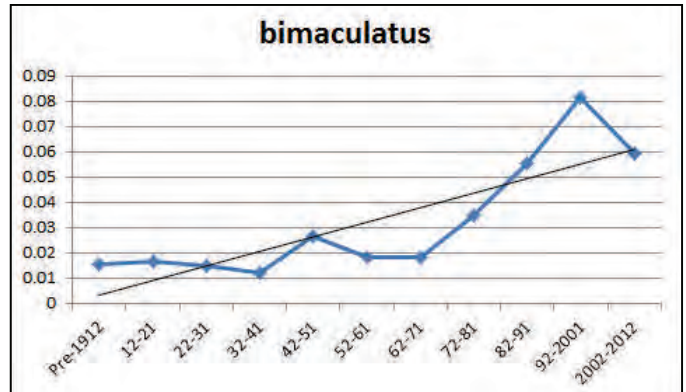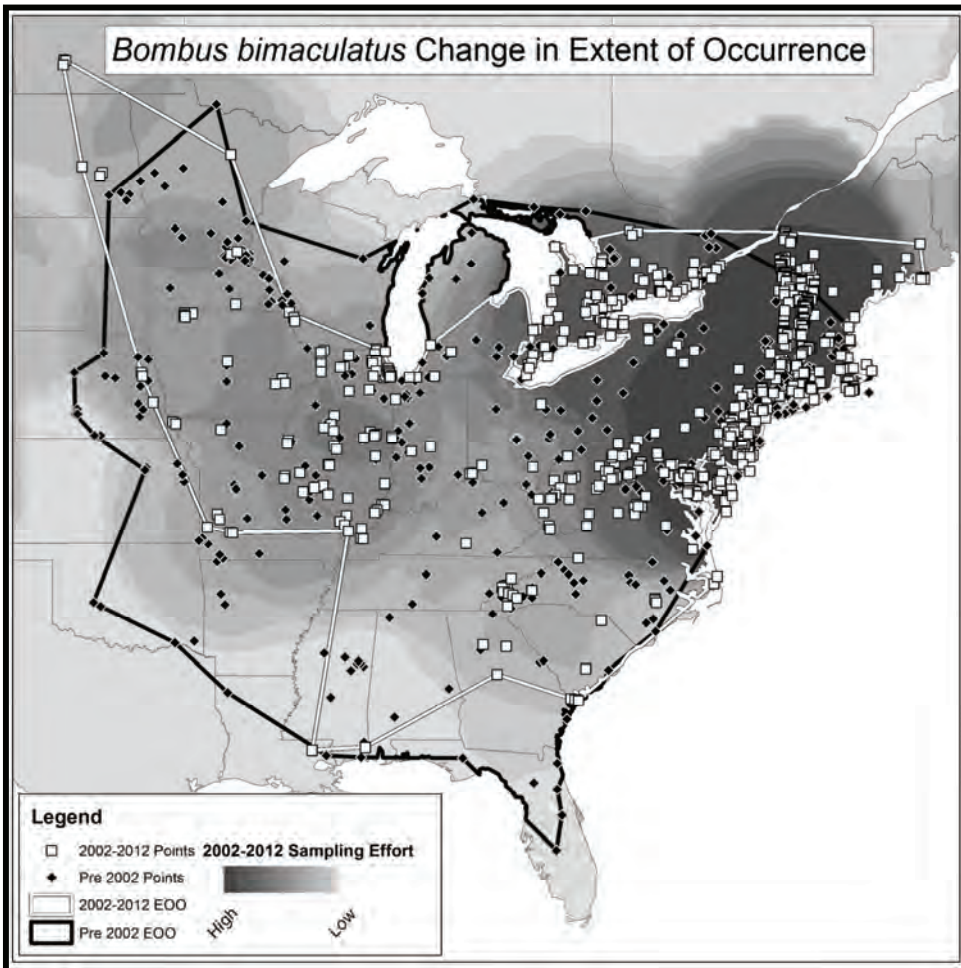

Figure 2: Map used to measure range decline for *Bombus bimaculatus*

Species: *Bombus bohemicus*
Assessment Level: Regional
Status: Delayed for cross-continental distribution
Current range size relative to historic range: 3.72%
Persistence in current range relative to historic occupancy: 9.16%
Current relative abundance relative to historic values: 2.82%

Average decline: 94.77%

Preliminary IUCN Category: Critically Endangered; CR
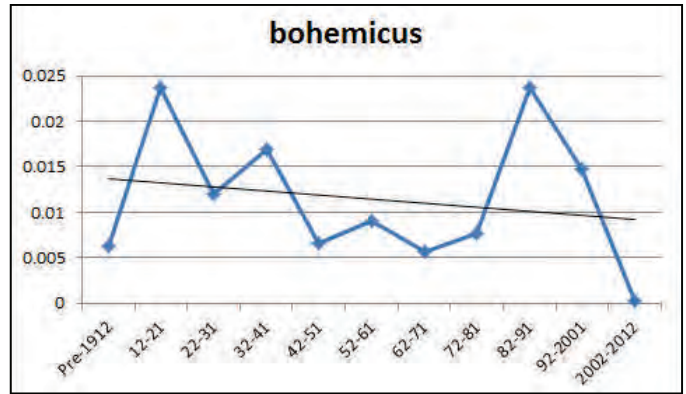**IUCN Criteria:** A2bc

Figure 1: Relative abundance trends of *Bombus bohemicus*

Justification (Notes): This cuckoo bumble bee occurs in only approximately 7 sites now. Its population reduction is suspected to have been >80% in the past decade based on a 97.18% decline in relative abundance between recent (2002-2012) and historic (1805-2001) time periods and a 96.28% decline in EOO between recent & historic time periods. Since this *Psithyrus* species uses both *Bombus terricola* and *B. affinis* as hosts and we know that there has been a decline in the availability of these hosts, we can apply criterion A2c (decline in habitat quality). We are not comfortable using criteria C & D since historic sites have not been revisited and we lack population level data. This review includes *Bombus ashtoni.*
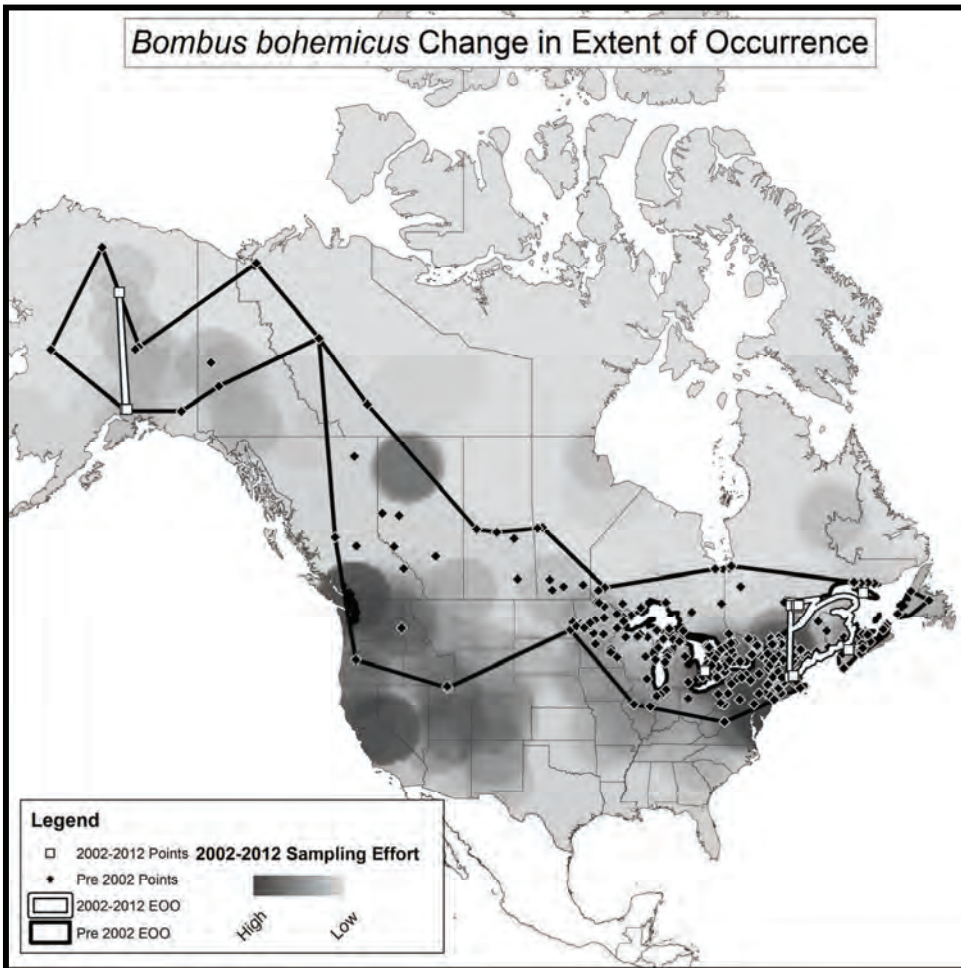

Figure 2: Map used to measure range decline for *Bombus bohemicus*

14

Species: *Bombus borealis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 92.98%
Persistence in current range relative to historic occupancy: 98.78%
Current relative abundance relative to historic values: 86.91%

Average decline: 7.11%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus borealis*

Justification (Notes): Our analysis suggests that this eastern North American species has not experienced serious declines over the last decade. Specifically, the average decline of 7.11% (based on relative abundance, range, and persistence) suggests a Least Concern category for this species. This is consistent with findings from other studies in which significant declines in this species have not been found (e.g., Colla and Packer 2008, Colla et al. 2012). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
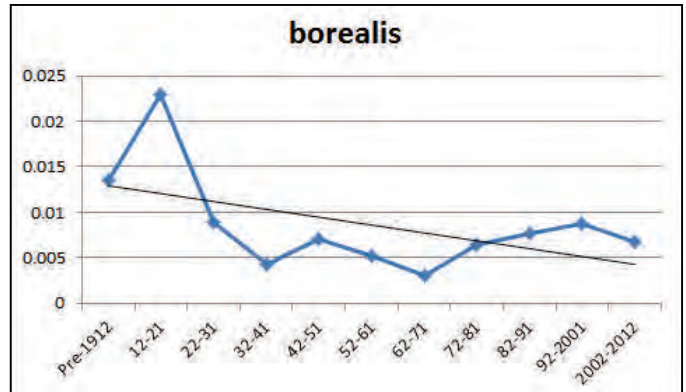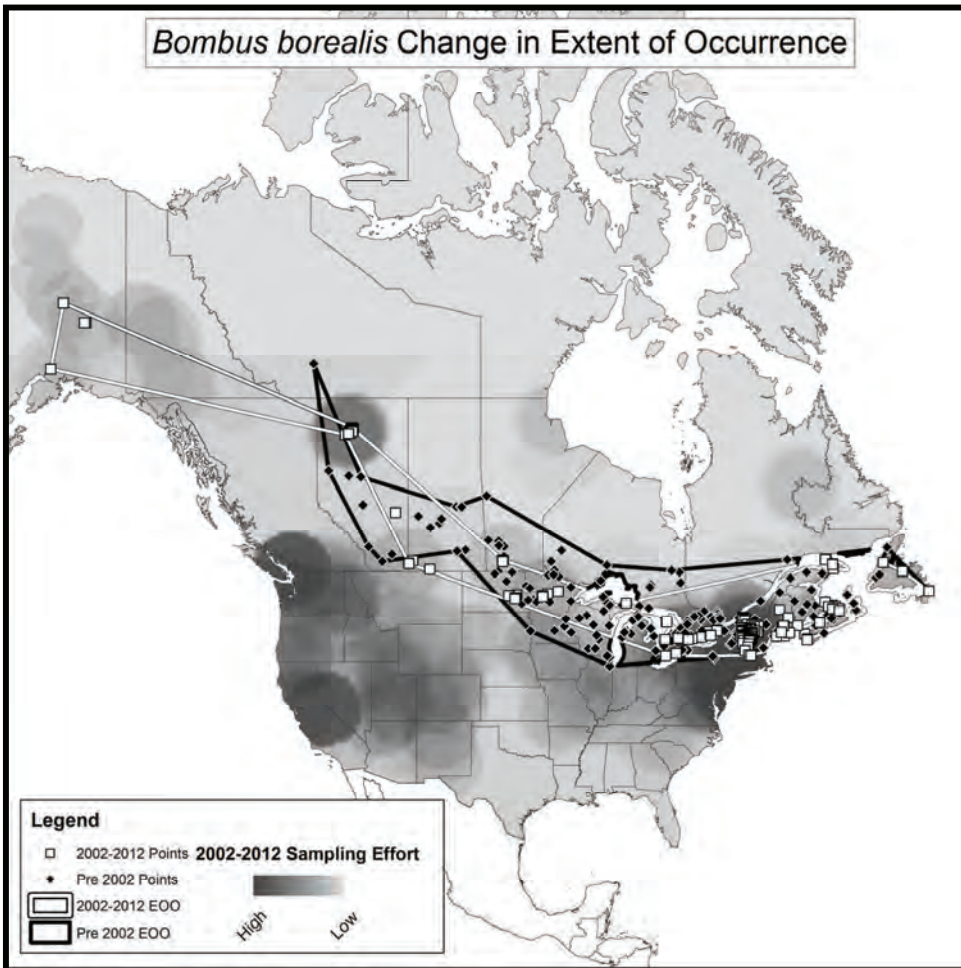

Figure 2: Map used to measure range decline for *Bombus borealis*

Species: *Bombus caliginosus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 58.75%
Persistence in current range relative to historic occupancy: 33.69%
Current relative abundance relative to historic values: 15.60%

Average decline: 63.99%

Preliminary IUCN Category: Vulnerable; VU
I**UCN Criteria:** A2bc

Figure 1: Relative abundance trends of *Bombus caliginosus*

Justification (Notes): These analyses suggest very high population decline range-wide, including range size reductions, persistence reductions, and relative abundance declines. The EOO and relative abundance values suggest an EN (Endangered) Red List category, but we have questions about the sampling effort that has occurred in the past decade within this species' historic range. More surveys are needed within this species' historic range. This is particularly true because this species co-occurs with *Bombus vosnesenskii* (a very common bee that is difficult to discern from *B. caliginosus* in the field) and many collectors/observers may miss this species because of that. In light of this, we are recommending this species for Vulnerable (rather than Endangered) Red List category.
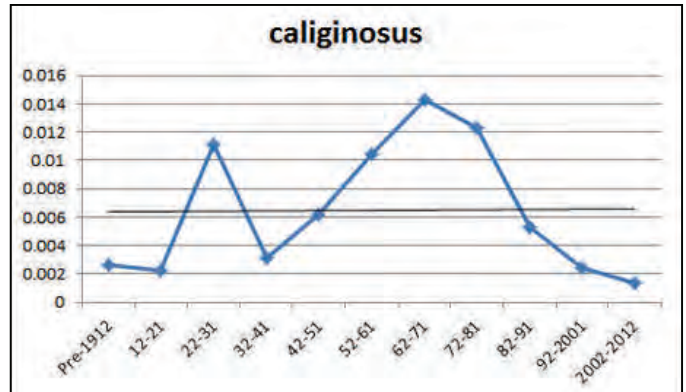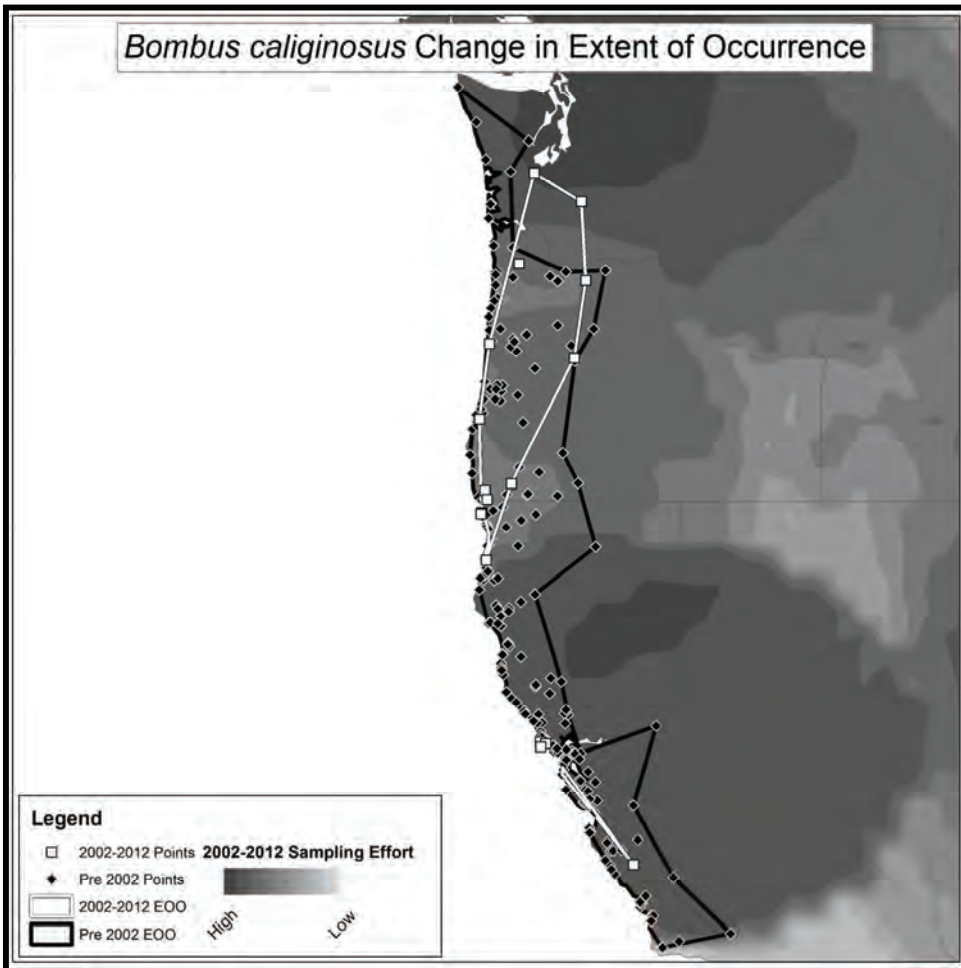

Figure 2: Map used to measure range decline for *Bombus caliginosus*

Species: *Bombus centralis*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 107.48%
Persistence in current range relative to historic occupancy: 88.61%
Current relative abundance relative to historic values: 81.27%

Average decline: 7.55%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Justification (Notes): This species is widely distributed across the
Mountain West and does not appear to have undergone range con-

Figure 1: Relative abundance trends of *Bombus centralis*

striction in recent years, nor has relative abundance declined dramatically. This finding is consistent with other reports that this species is moderately common in most of its range (Williams et al. 2014). Specific threats have not been identified for this species. Our analysis of population trends, published reports of bumble bee decline, along with the assessors' best professional judgment, lead us to recommend this species for the Least Concern Red List category.
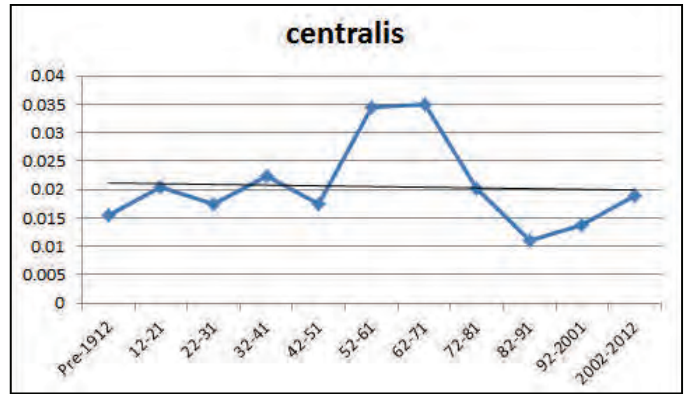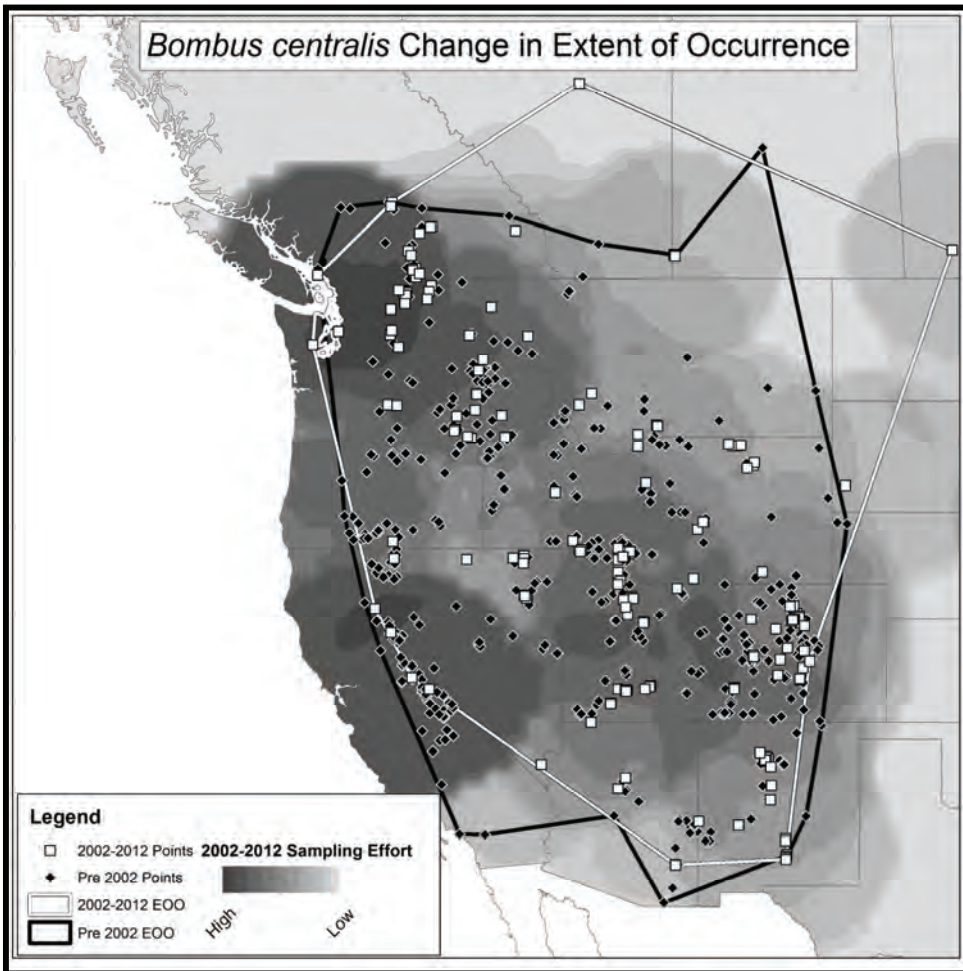

Figure 2: Map used to measure range decline for *Bombus centralis*

Species: *Bombus citrinus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 98.54%
Persistence in current range relative to historic occupancy: 124.16%
Current relative abundance relative to historic values: 130.12%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus citrinus*

Justification (Notes): According to our analyses, this eastern North American bumble bee has not declined in distribution or relative abundance in the past decade. This is consistent with other studies, e.g. Colla et al. (2012), which found high persistence of this species in historically occupied areas, and no significant declines in relative abundance over the time periods examined. Note that the abundance and distribution in this species likely depend on abundance and distribution of host species, which remain common. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time. Subgenus *Psithyrus,* hosts= *B. bimaculatus, B. impatiens,* and *B. vagans.*
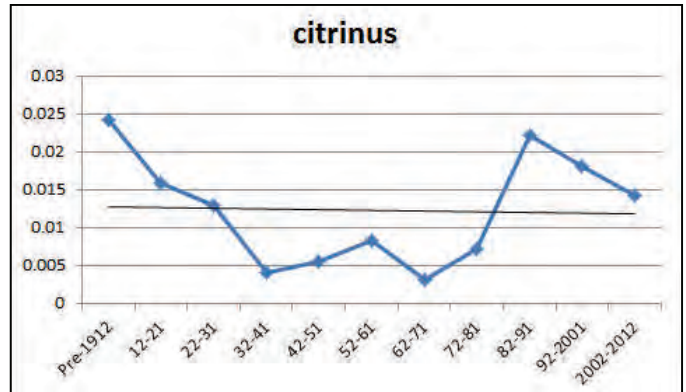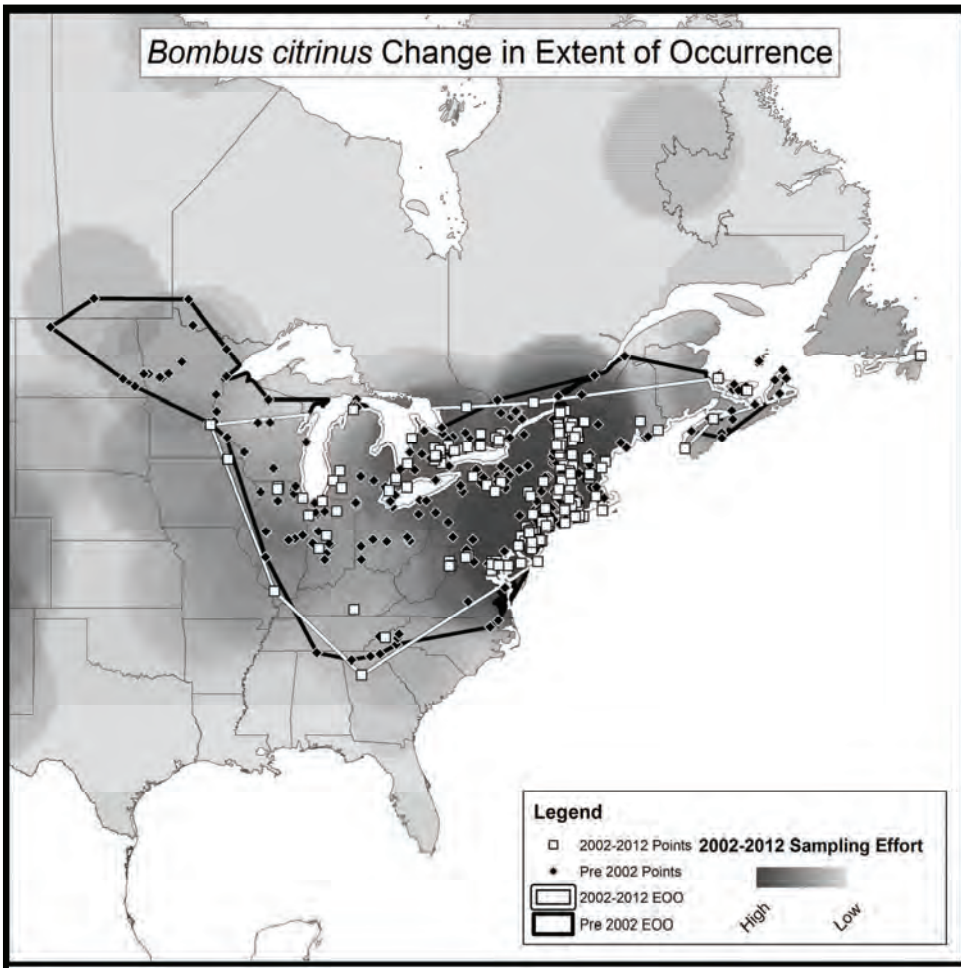

Figure 2: Map used to measure range decline for *Bombus citrinus*

Species: *Bombus crotchii*
Assessment Level: Regional
Status: IUCN Accepted
Current range size relative to historic range: 74.67%
Persistence in current range relative to historic occupancy: 20.48%
Current relative abundance relative to historic values: 2.32%

Average decline: 67.51%

Preliminary IUCN Category: Endangered; EN
I**UCN Criteria:** EN A2bc

Figure 1: Relative abundance trends of *Bombus crotchii*

Justification (Notes): This species is limited in distribution to south-western North America. It was historically common in the Central Valley of California, but now appears to be absent from most of it, especially in the center of its historic range. The past decline of 67.51% (based on EOO, persistence, and relative abundance) suggests that this species should be listed as Endangered (EN) using criteria A2bc. The A2c criterion includes a decline in habitat quality; in the northern Central Valley there has been extensive agricultural intensification and the southern part of its range is experiencing rapid urbanization. Note that recent collection effort has not been sufficient throughout this species' historic range, although there has been a moderate level of sampling in the recent decade. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Endangered Red List category at this time.
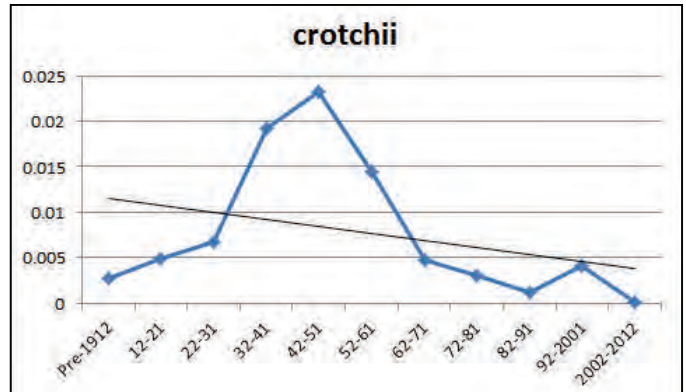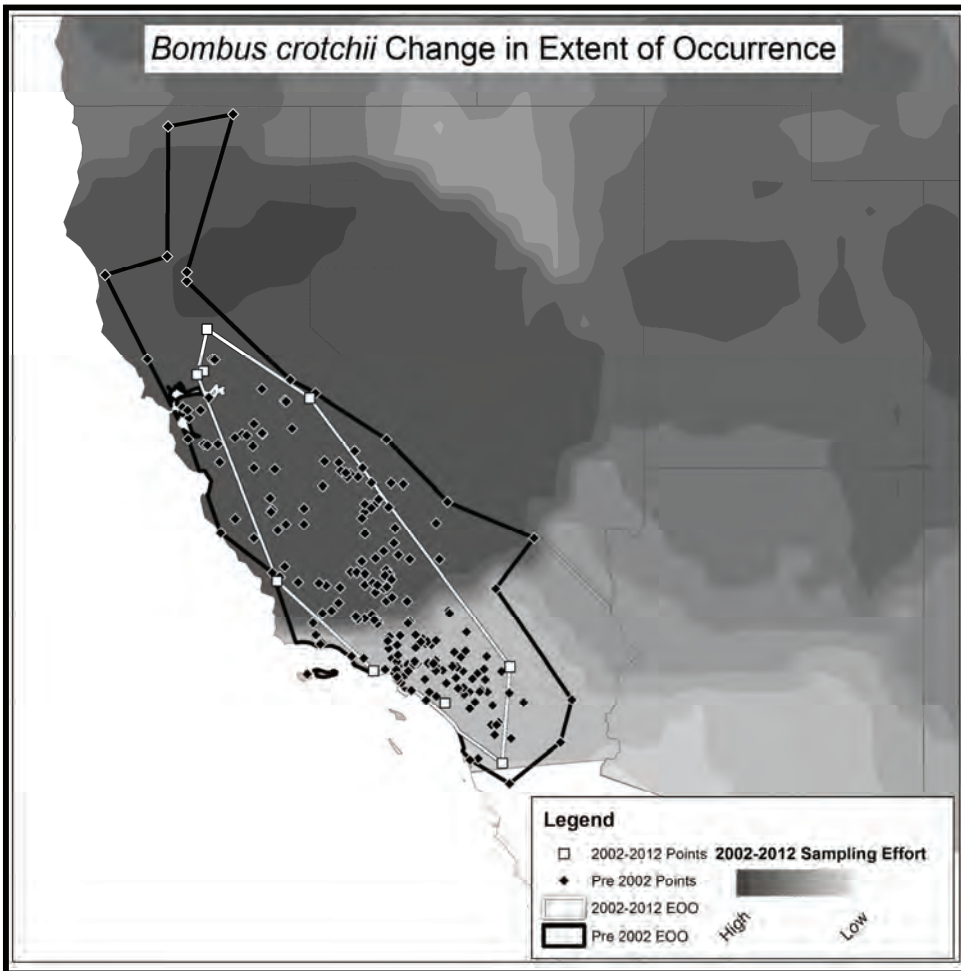

Figure 2: Map used to measure range decline for *Bombus crotchii*

Species: *Bombus cryptarum*
Assessment Level: Global
Status: Delayed for cross-continental distribution
Current range size relative to historic range: 28.94%
Persistence in current range relative to historic occupancy: 268.16%
Current relative abundance relative to historic values: 71.87%

Average decline: 0.00%

Preliminary IUCN Category: Data Deficient; DD
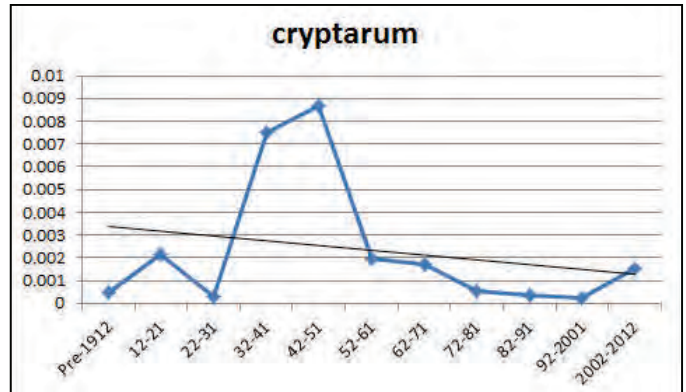**IUCN Criteria:**

Figure 1: Relative abundance trends of *Bombus cryptarum*

Justification (Notes): In North America, recent analysis suggests that this species remains common throughout its range, and has in-creased in relative abundance. The average decline of 0% suggests a Least Concern category for this species in North America. Similarly, in Europe, the regional IUCN Assessment for *B. cryptarum* lists this species as Least Concern in view of its "wide distribution, presumed large overall population and no major threats". However, additional research should be conducted to determine the population trend of this species in Europe, and the status of this species in Asia. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Data Deficient Red List category at this time.
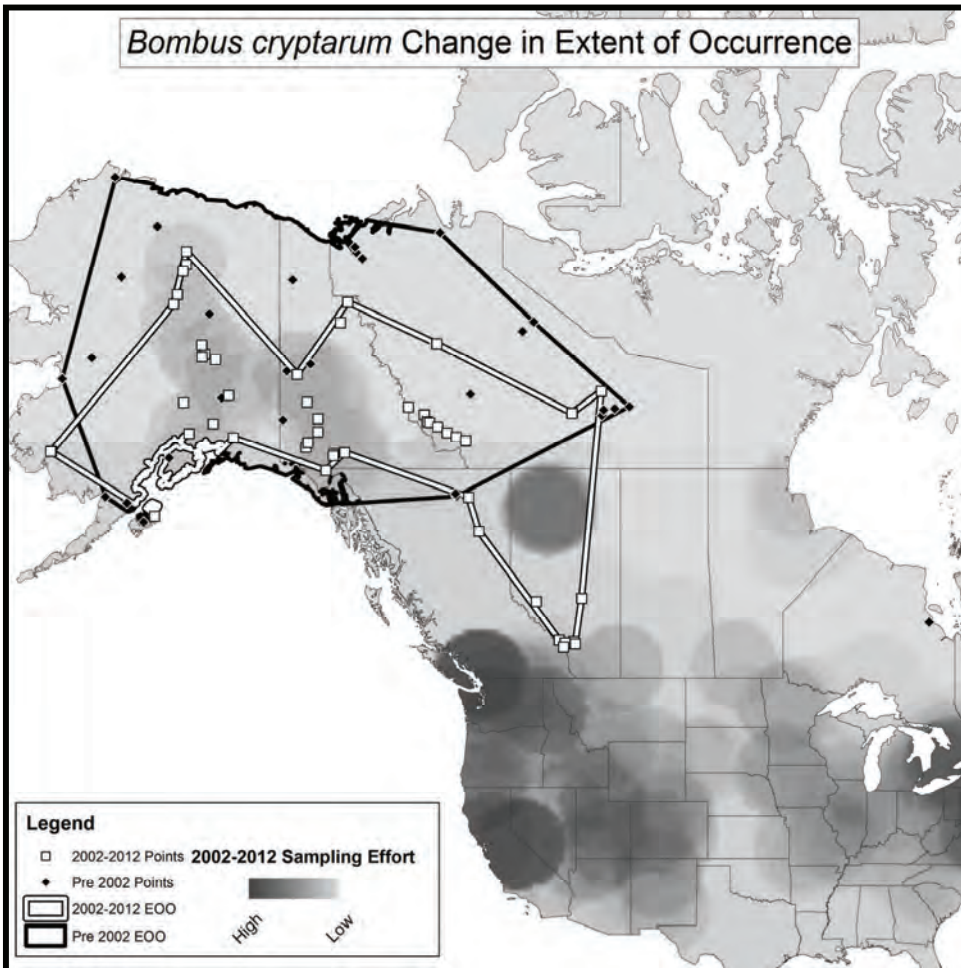

Figure 2: Map used to measure range decline for *Bombus cryptarum*

Species: *Bombus distinguendus*
Assessment Level:
Status: Delayed for cross-continental distribution
Current range size relative to historic range: 0.00%
Persistence in current range relative to historic occupancy:
Current relative abundance relative to historic values: 3789.38%

Average decline: 0.00%

Preliminary IUCN Category: Data Deficient; DD
IUCN Criteria:

Justification (Notes): In North America, there are only 23 total records in the database from this species. This is not enough data to build EOO polygons or analyze changes in relative abundance, persistence, or range. North American data points toward a Data Deficient Red List Category at this time. In Europe, the regional IUCN Assessment for this species lists it as Vulnerable due to an estimated population decline of over 30% in the last ten years, based on decline in the area of occupancy (AOO) and extent of occurrence (EOO). European declines are linked to habitat loss and changes in agricultural practices (especially removal of the majority of clover fields that this species needs for forage) in the region (European IUCN Assessment).
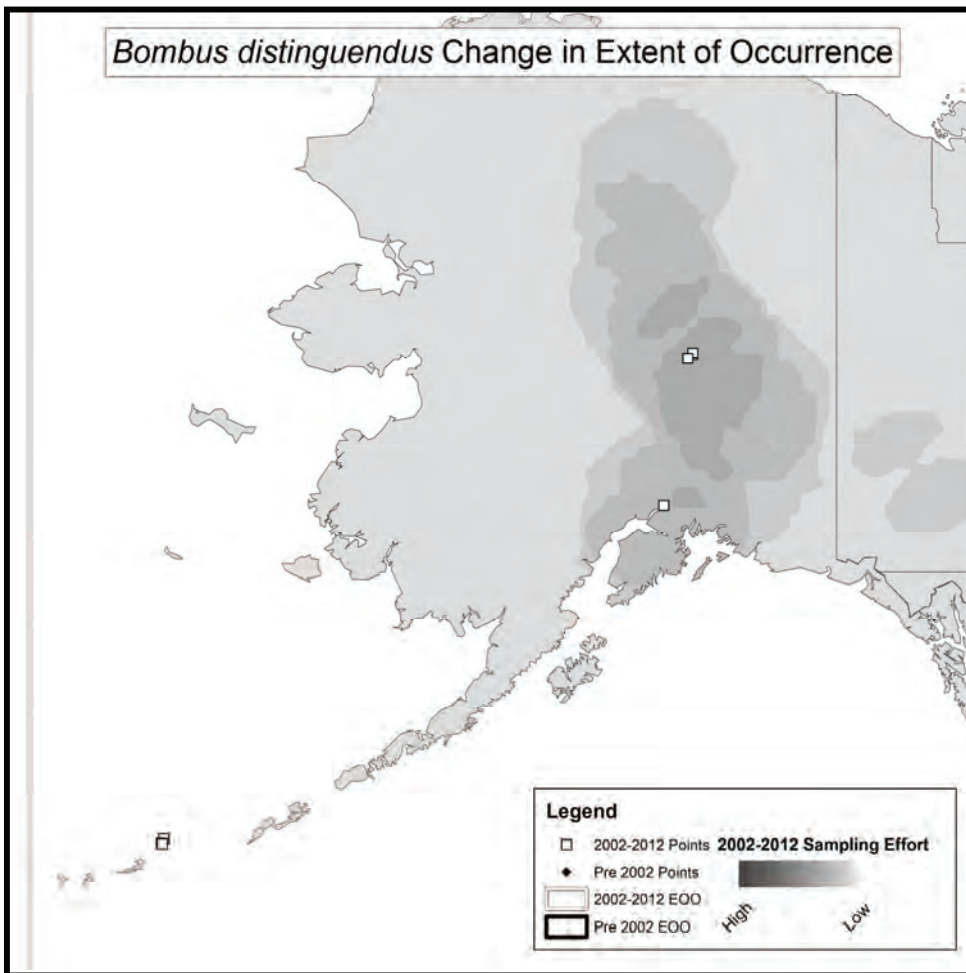

Figure 2: Map used to measure range decline for *Bombus distinguendus*

Species: *Bombus fervidus*
Assessment Level: Global
Status: Submitted
Current range size relative to historic range: 86.98%
Persistence in current range relative to historic occupancy: 85.84%
Current relative abundance relative to historic values: 38.04%

Average decline: 29.71%

Preliminary IUCN Category: Vulnerable; VU
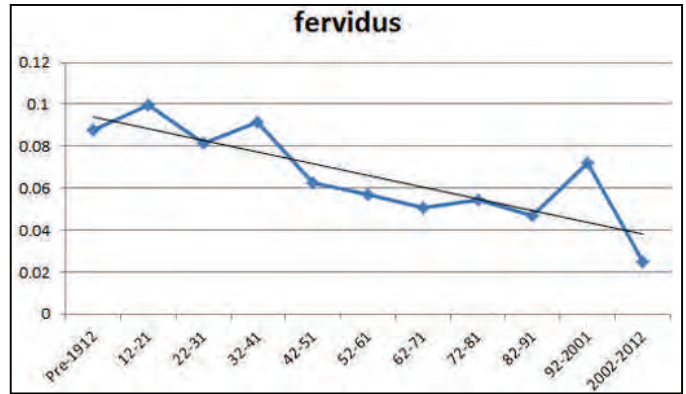**IUCN Criteria:** A2b

Figure 1: Relative abundance trends of *Bombus fervidus*

Justification (Notes): A number of studies have demonstrated abundance and persistence declines in this eastern North American species (e.g., Colla et al. 2012, Colla and Packer 2008, Giles and Ascher 2006). Consistent with these studies, our analysis shows decline in relative abundance over the time period examined, as well as long term steady decline. If this species' relative abundance continues to decline at the same rate, we project that the species will go extinct in the next 70 to 80 years. The most recent time period shows the lowest relative abundance of all time periods. The relative abundance decline in the past decade has been nearly 50% from mean. Although the persistence value is relatively high and the EOO loss has not been that great, the changes in relative abundance justify the Vulnerable category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Vulnerable Red List category at this time. Includes *B. californicus.*
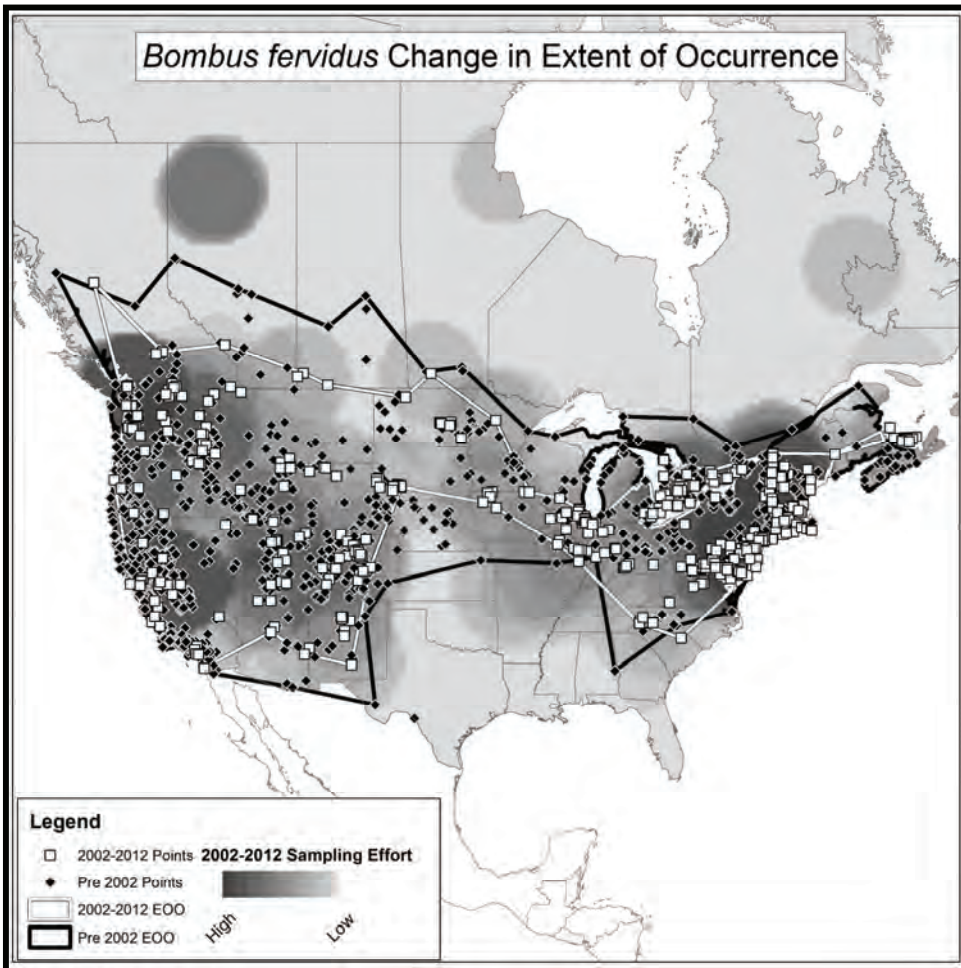

Figure 2: Map used to measure range decline for *Bombus fervidus*

Species: *Bombus flavidus*
Assessment Level: Global
Status: Delayed for cross-continental distribution
Current range size relative to historic range: 68.58%
Persistence in current range relative to historic occupancy: 95.39%
Current relative abundance relative to historic values: 64.53%

Average decline: 23.83%

Preliminary IUCN Category: Least Concern; LC (Regionally) DD Globally
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus flavidus*

Justification (Notes): In North America, this species has not experienced serious declines in relative abundance, persistence, or range in recent years. The average decline value of 23.83%, along with published reports of bumble bee decline and the assessors' best professional judgment, suggest a Least Concern Red List category in this region.

In Europe, this species is also recommended for the Least Concern Red List category, in light of its wide distribution, presumed large overall population with a stable population trend, and no major threats.

In Asia, the distribution and population status of this species are unknown, and the importance of Asian populations to the overall species security is unclear. As such, we recommend this species for a Data Deficient Red List Category at this time.
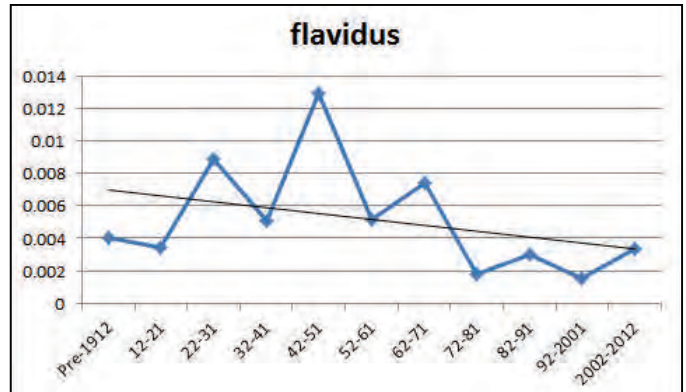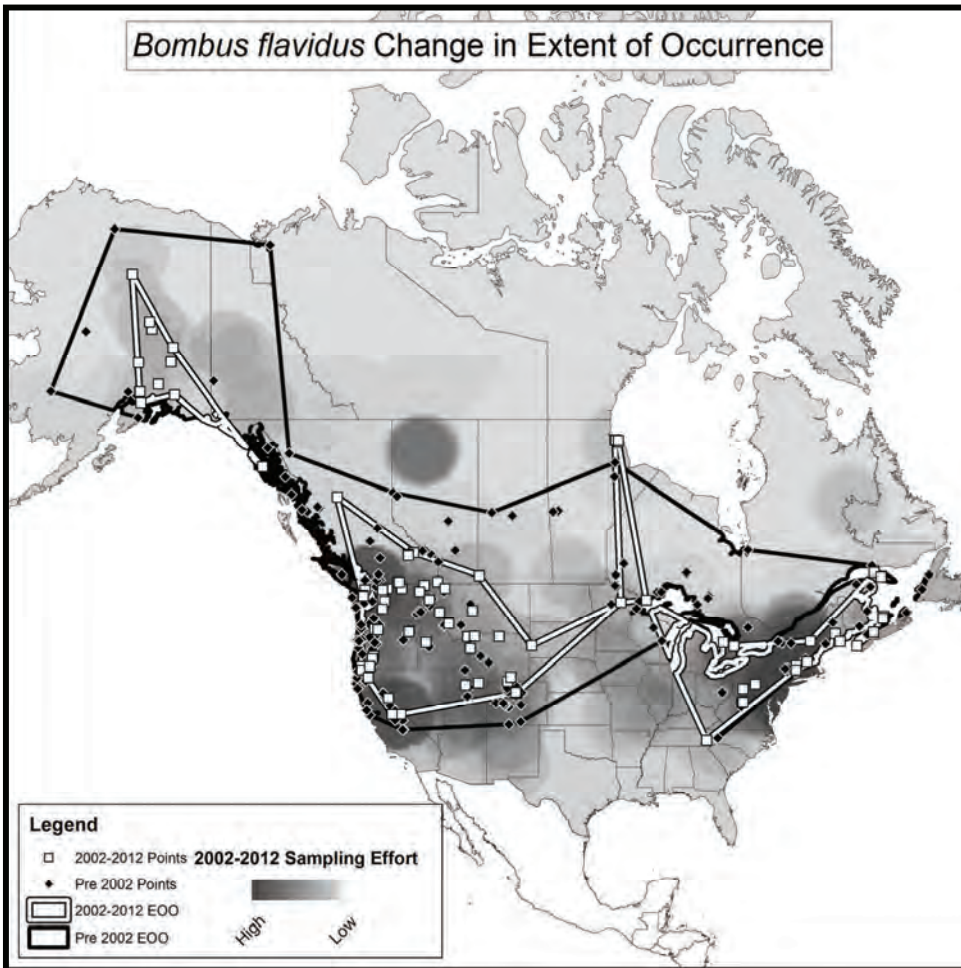

Figure 2: Map used to measure range decline for *Bombus flavidus*

Species: *Bombus flavifrons*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 79.45%
Persistence in current range relative to historic occupancy: 131.91%
Current relative abundance relative to historic values: 161.79%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
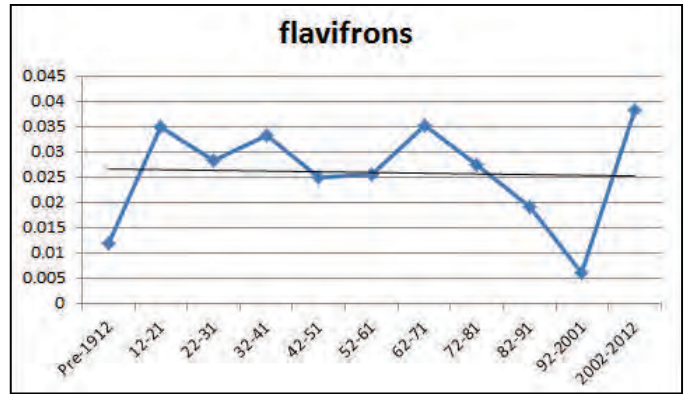**IUCN Criteria:**

Figure 1: Relative abundance trends of *Bombus flavifrons*

Justification (Notes): Our analysis suggests that this western North American species has not experienced declines in relative abundance, range, or persistence in recent years. Specifically, the average decline of 0% suggests a Least Concern category for this species. This finding is consistent with other reports of this species being common throughout its range (Williams et al. 2014). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
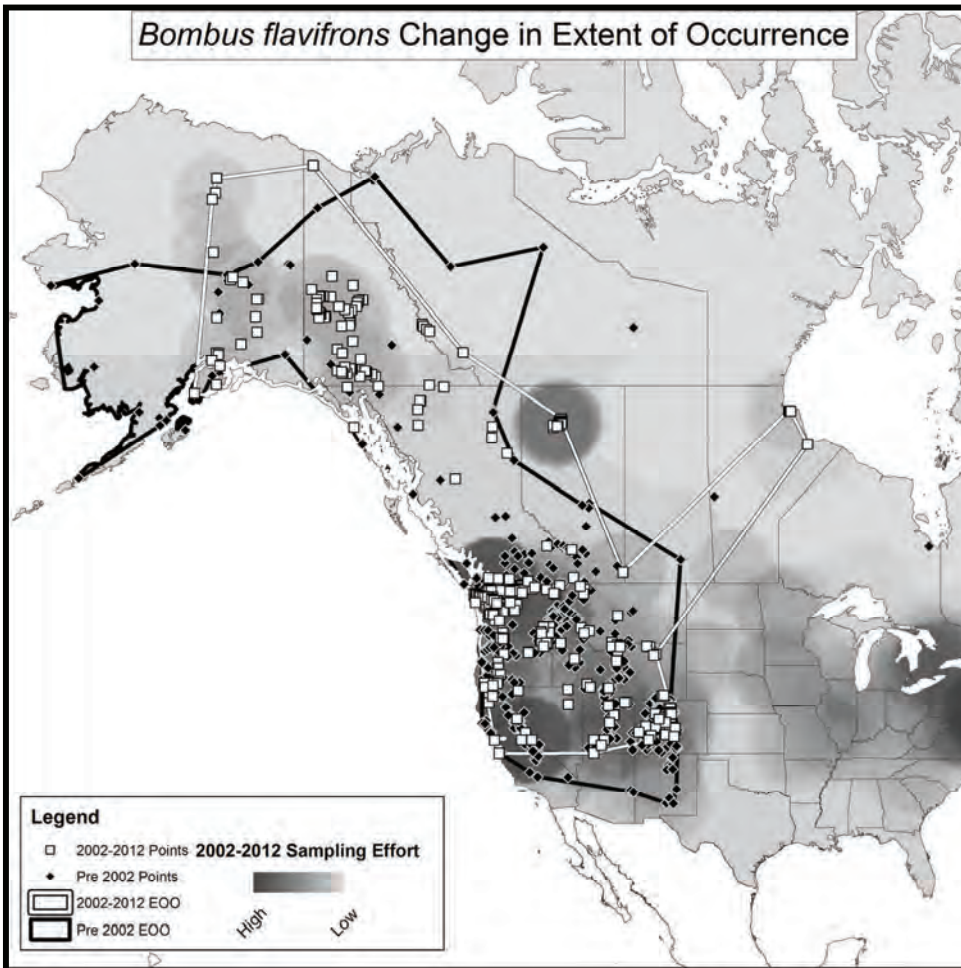

Figure 2: Map used to measure range decline for *Bombus flavifrons*

Species: *Bombus franklini*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 55.55%
Persistence in current range relative to historic occupancy: 32.84%
Current relative abundance relative to historic values: 15.38%

Average decline: 65.41%

Preliminary IUCN Category: Critically Endangered; CR
IUCN Criteria: A2abce, B1ab, B2ab, C2ai, D

Figure 1: Relative abundance trends of *Bombus franklini*

Justification (Notes): R.W. Thorp's unpublished surveys have revealed that, since 1998, the populations have decreased to the point of being not seen at all in 2004 or 2005, with only one individual found in 2006. Because extensive surveys of the area within which *B. franklini exists* have, as of 2006, uncovered only one individual, but similar surveys in the first three years (1998-2000) uncovered individuals at many historic and seven new sites, it can be concluded that the extent of population is decreasing severely. Though further investigation would be required to determine the exact number of extant *B. franklini*, based on their limited range, it can be assumed that their populations are decreasing to dangerously low levels, and therefore need protection, which it has not yet legally received.
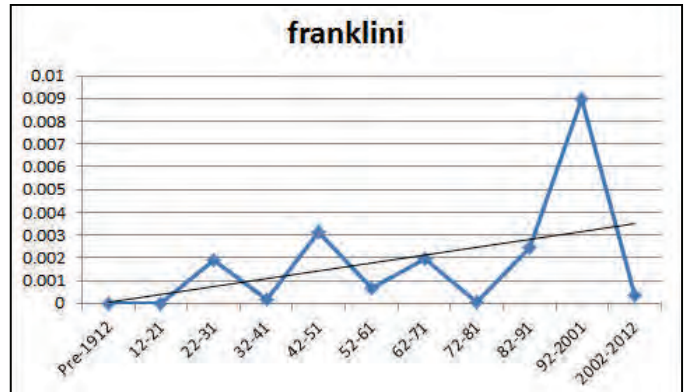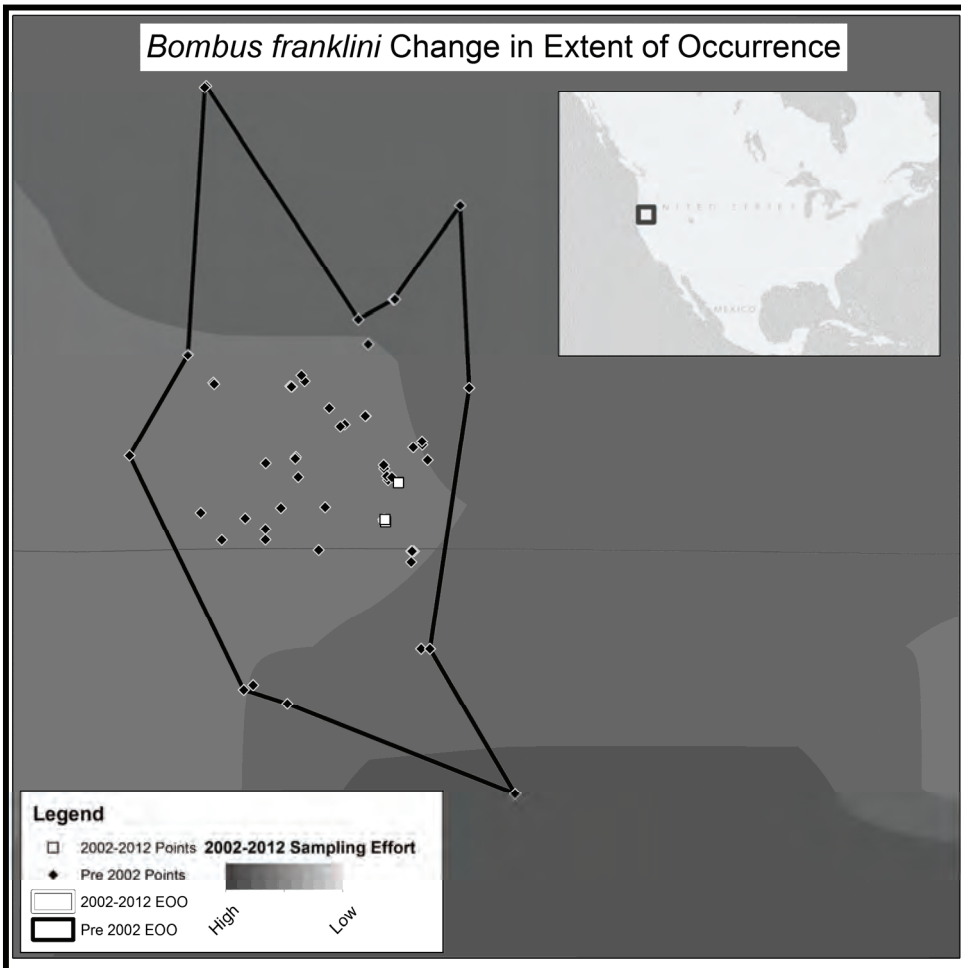

Figure 2: Map used to measure range decline for *Bombus franklini*

Species: *Bombus fraternus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 71.38%
Persistence in current range relative to historic occupancy: 43.33%
Current relative abundance relative to historic values: 14.40%

Average decline: 56.96%

Preliminary IUCN Category: Endangered; EN
IUCN Criteria: ENA2b, VUA2c

Figure 1: Relative abundance trends of *Bombus fraternus*

Justification (Notes): According to our analysis, this North American species has exhibited declines in relative abundance and EOO over the past decade. In addition, this species' long-term downward trend in relative abundance is near significant; if the same rate of decline in relative abundance continues, this species could potentially go extinct within 80-90 years. There are huge gaps in recent (as well as historic) collection effort, especially in Oklahoma, Kansas, Nebraska, western Texas, and the Dakotas, yet there has been significant range loss in the northern and southern parts of its range where collection effort has been more consistent. Thus, we have high confidence in the EOO decline of 28.62%, probably due to habitat alterations. We selected criterion A2bc based on a decline in Relative Abundance, EOO, and habitat quality. Habitat modification over the past 10 years (insecticide use, grassland conversion to agriculture) has been severe in the region where this species occurs. These results are consistent with other findings of decline in this species (e.g. Colla et al. 2012, Grixti et al. 2009). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Endangered Red List category at this time.
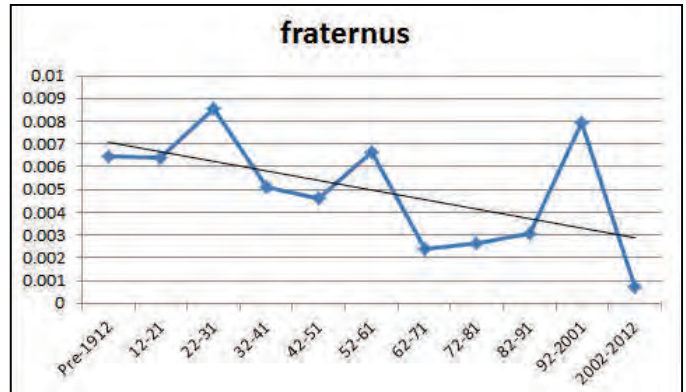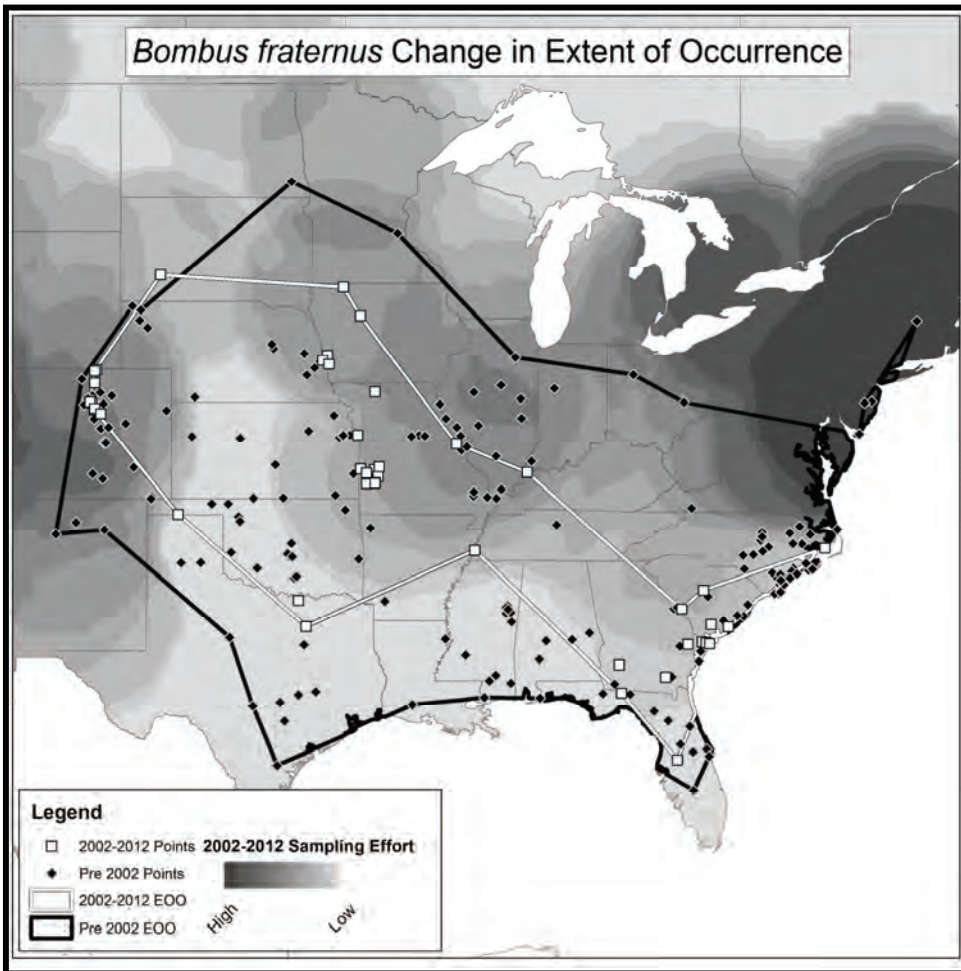

Figure 2: Map used to measure range decline for *Bombus fraternus*

Species: *Bombus frigidus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 39.69%
Persistence in current range relative to historic occupancy: 161.88%
Current relative abundance relative to historic values: 116.34%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus frigidus*

Justification (Notes): According to our analyses, this widely distributed northern North American species has not declined in relative abundance or persistence measures, over the time period examined. Although the EOO measure shows a 60.31% loss, many of the areas that the species has apparently been lost from haven't been sampled in the recent time period. It has been found in most areas that have been re-sampled in the recent time period. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
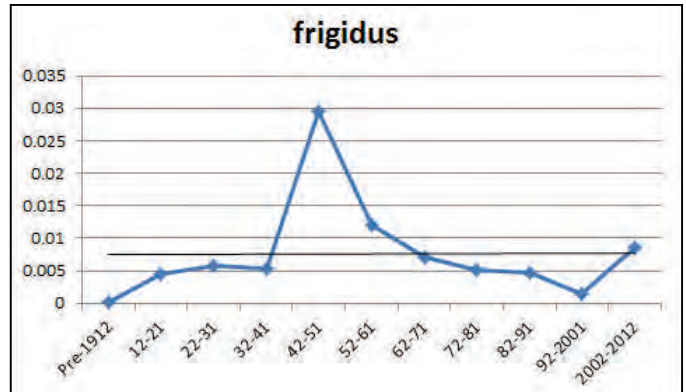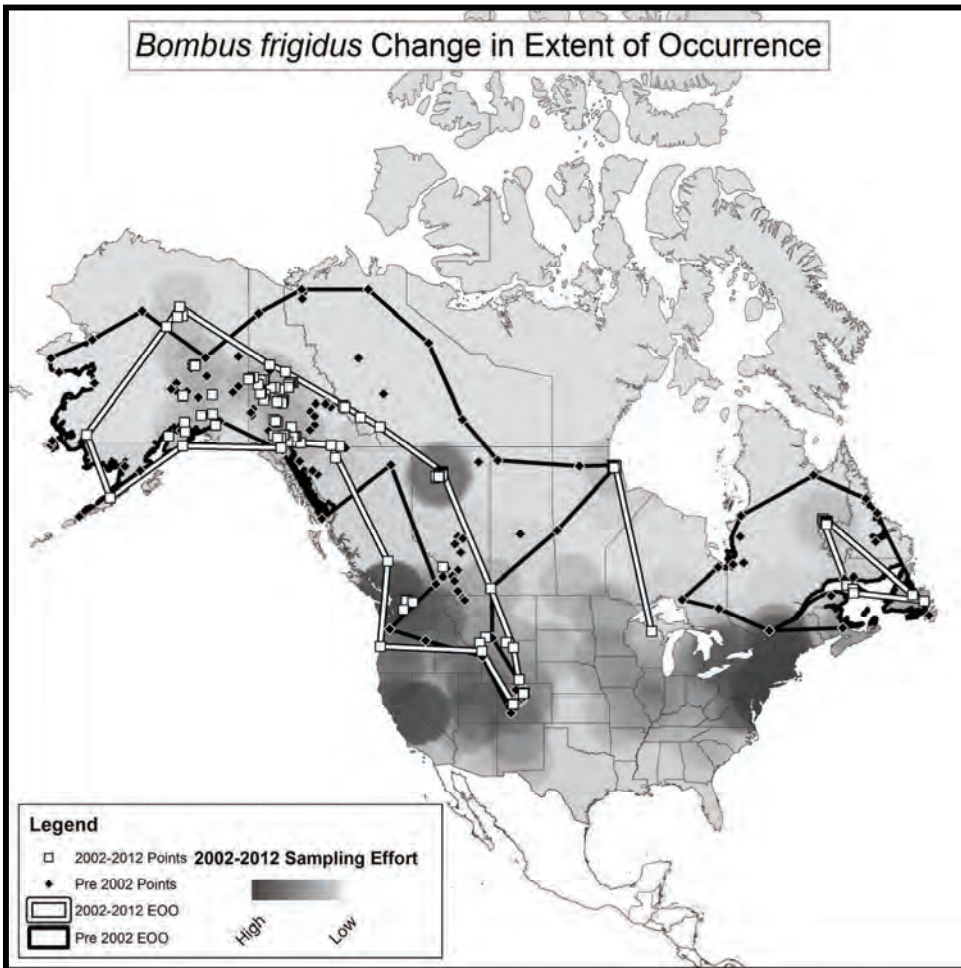

Figure 2: Map used to measure range decline for *Bombus frigidus*

Species: *Bombus griseocollis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 90.21%
Persistence in current range relative to historic occupancy: 166.87%
Current relative abundance relative to historic values: 215.25%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus griseocollis*

Justification (Notes): Our analysis suggests that this North American species remains common through its range, and has increased in relative abundance. The average decline of 0% suggests a Least Concern category for this species. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
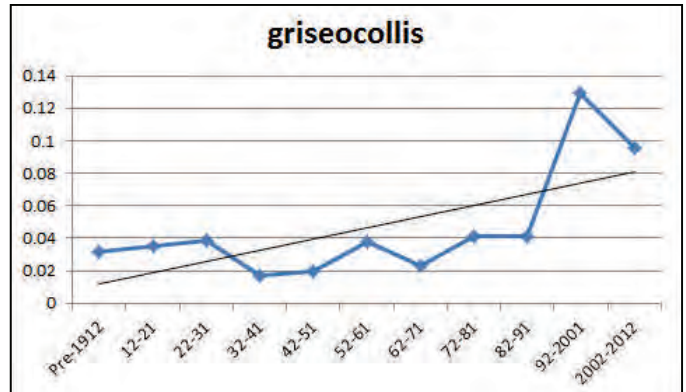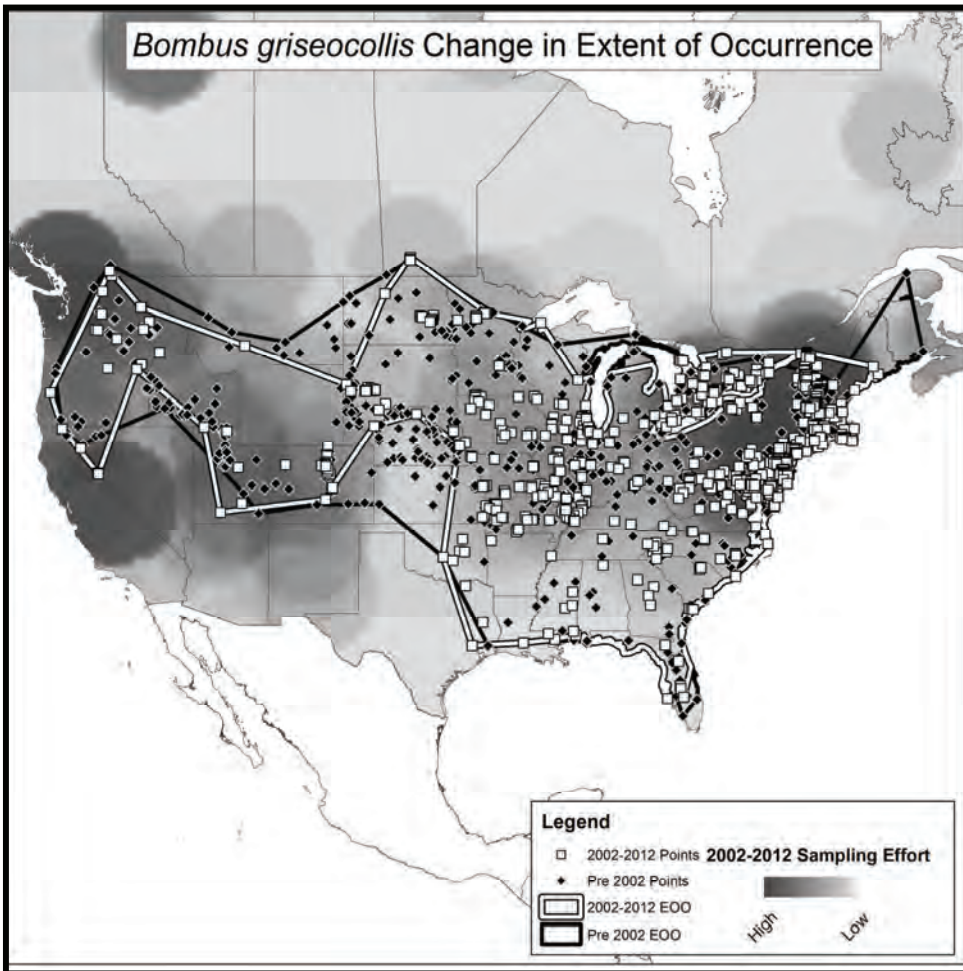

Figure 2: Map used to measure range decline for *Bombus griseocollis*

Species: *Bombus huntii*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 92.49%
Persistence in current range relative to historic occupancy: 60.98%
Current relative abundance relative to historic values: 70.51%

Average decline: 25.34%

Preliminary IUCN Category: Least Concern; LC
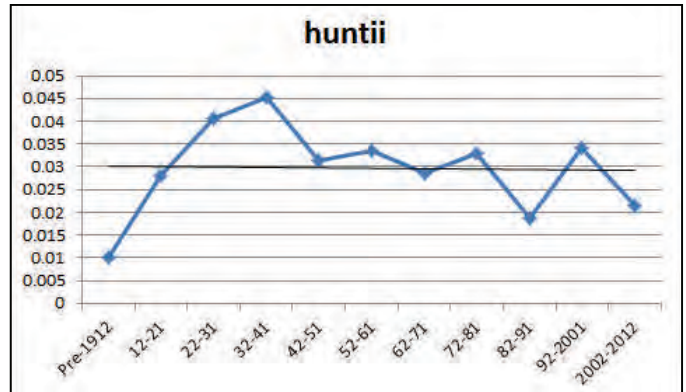**IUCN Criteria:**

Figure 1: Relative abundance trends of *Bombus huntii*

Justification (Notes): According to our analyses, this western North American species has not exhibited notable declines over the time period examined. Based on the average decline of 25.34%, this species qualifies as Near Threatened using criterion A2. However, since this is one of the more common bees in the intermountain west, and since the extent of occurrence (EOO) decline (apparent range loss) has primarily occurred in under-sampled areas, we are not comfortable using the Near Threatened category. Based on calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
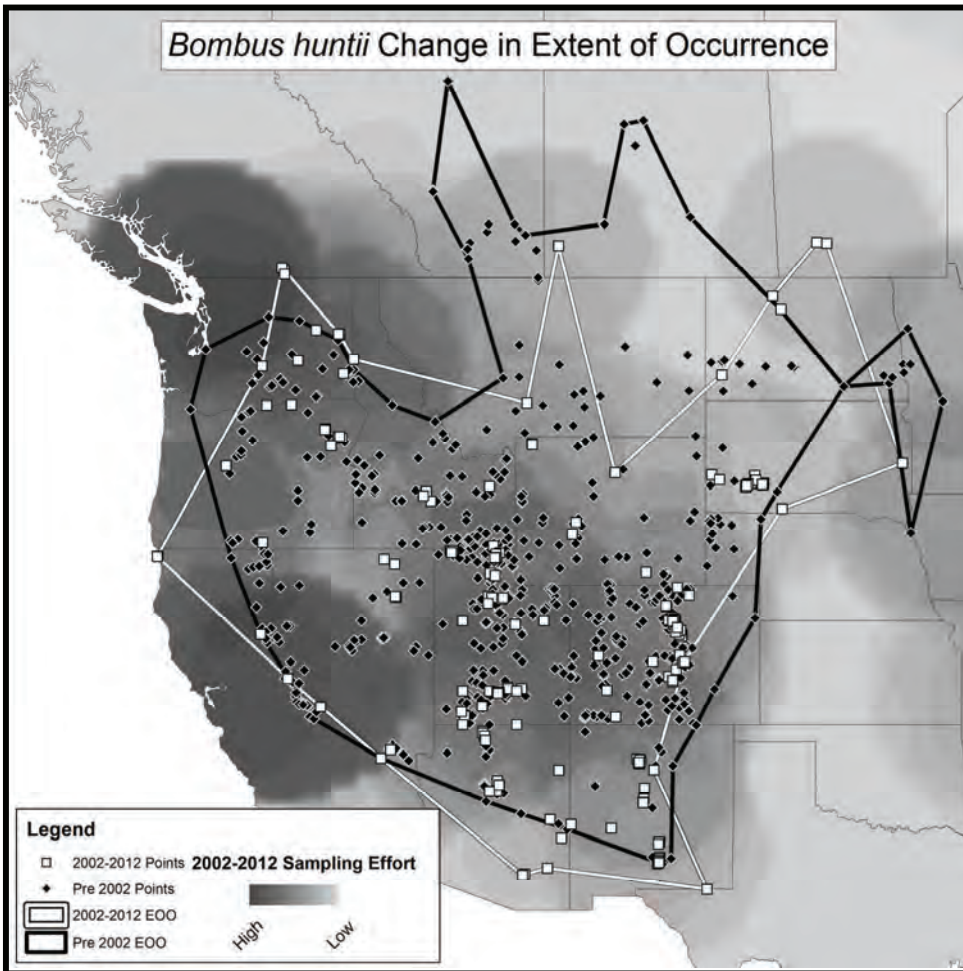

Figure 2: Map used to measure range decline for *Bombus huntii*

Species: *Bombus hyperboreus*
Assessment Level: Regional
Status: Delayed for taxonomic status
Current range size relative to historic range: 0.00%
Persistence in current range relative to historic occupancy: 27.01%
Current relative abundance relative to historic values: 38.82%

Average decline: 78.06%

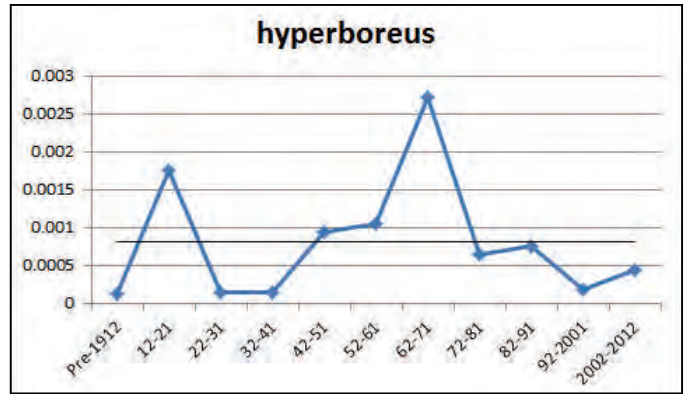**Preliminary IUCN Category:** Data Deficient; DD
IUCN Criteria: N/A

Figure 1: Relative abundance trends of *Bombus hyperboreus*

Justification (Notes): In Europe, this species is listed as Vulnerable, based on a continuing decline in the extent of occurrence, the area of occupancy and the number of mature individuals. The species is experiencing extreme fluctuations in the number of mature individuals. It's status as an inquiline (cuckoo bee) in the nests of other bumble bees, including the declining *B. polaris*, is likely to influence population stability. Although the known area of occupancy (AOO) is 420 km², it is believed that the species occupies a larger area in Europe, but still less than 2,000 km².

In North America, the average decline of 78.06% (based on range, persistence, and relative abundance decline) points toward an Endangered Red List Category, however the region where this species occurs has been under-sampled in both historic and current time periods, making assessment of population trends difficult. As such, North American assessors suggest a Data Deficient Red List Category for this region.
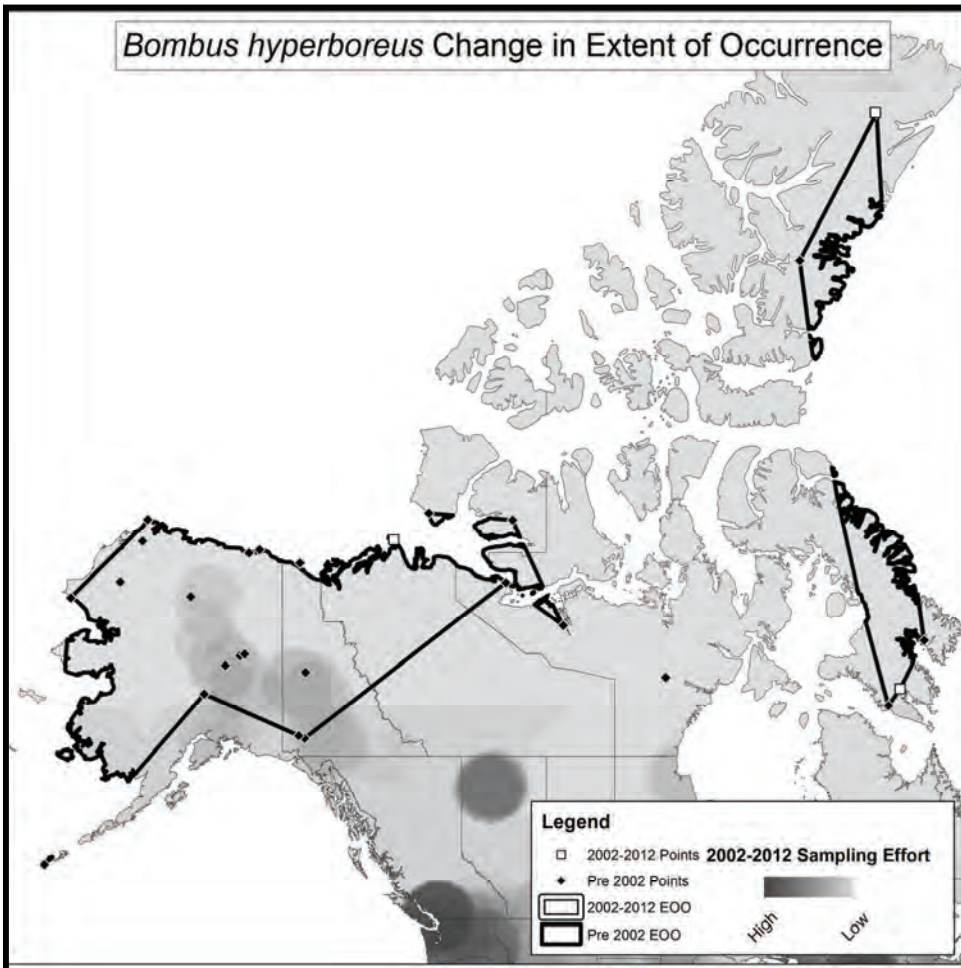

Figure 2: Map used to measure range decline for *Bombus hyperboreus*

30

Species: *Bombus impatiens*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 97.50%
Persistence in current range relative to historic occupancy: 158.62%
Current relative abundance relative to historic values: 294.17%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus impatiens*

Justification (Notes): *Bombus impatiens* is one of the most wide-spread and abundant species in the Eastern United States and adjacent Canada, and appears to be expanding in range due to accidental escapes of managed colonies into the wild, outside of the species' native range. Consistent with other studies, our analyses do not show declines in this species range, persistence, or relative abundance. Based on the above calculations and trends, along with published reports of bumble bee decline (e.g., Colla et al. 2012) and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
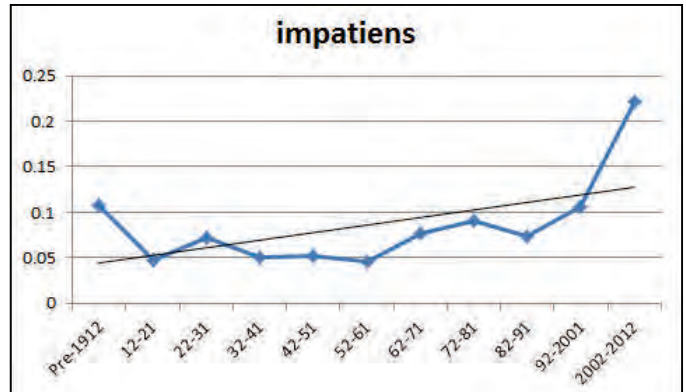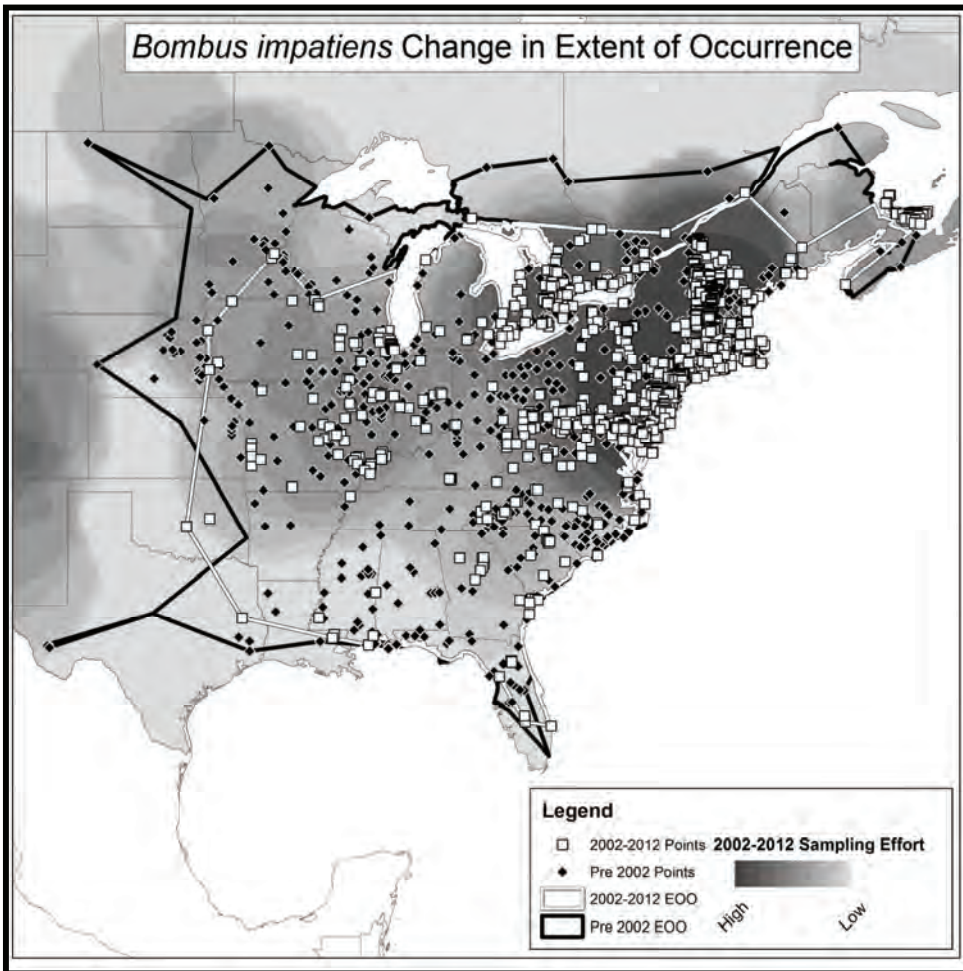

Figure 2: Map used to measure range decline for *Bombus impatiens*

Species: *Bombus insularis*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 89.31%
Persistence in current range relative to historic occupancy: 86.28%
Current relative abundance relative to historic values: 87.29%

Average decline: 12.37%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus insularis*

Justification (Notes): Declines in abundance or range of this widely distributed North American species have been relatively low, range-wide. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best pro-fessional judgment, we recommend this species for the Least Concern Red List category at this time. Note, however, that this spe-cies should be frequently re-evaluated for any population changes and threats. This is particularly important since this species has declined in some parts of its range, and since it is dependent upon strong populations of its' host bees for survival, many of which are in decline. In the subgenus *Psithyrus*; hosts=*B. rufocinctus, B. ternarius, B. terricola, B. occidentalis, B. nevadensis, B. californi-cus (=fervidus), B. appositus*.
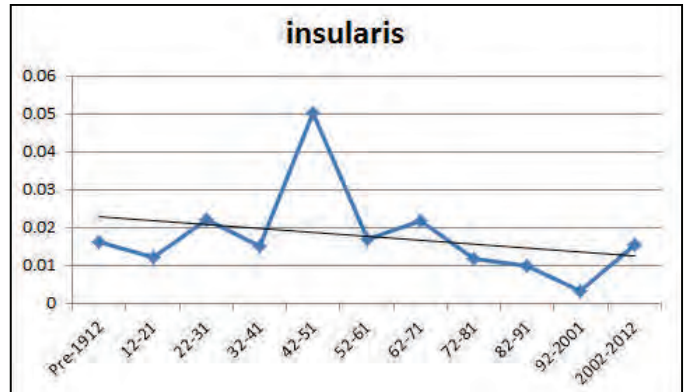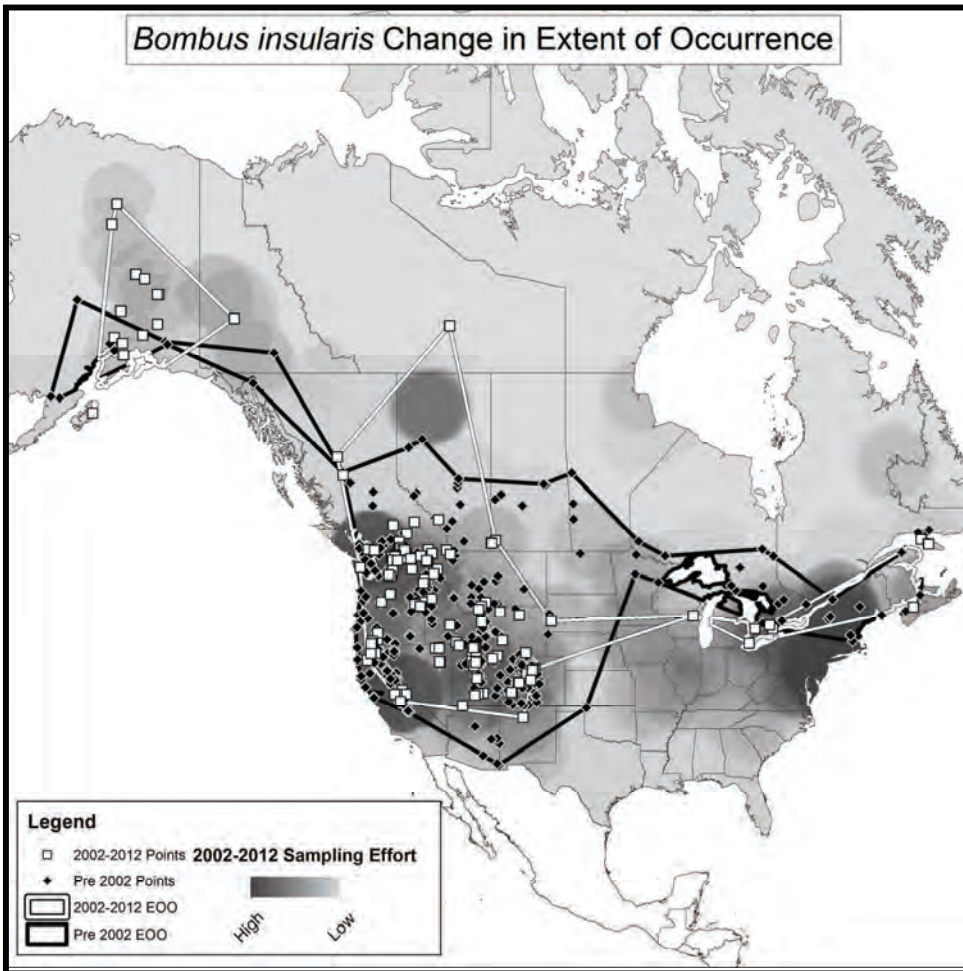

Figure 2: Map used to measure range decline for *Bombus insularis*

Species: *Bombus jonellus*
Assessment Level: Regional
Status: Delayed for cross-continental distribution
Current range size relative to historic range: 35.83%
Persistence in current range relative to historic occupancy: 198.31%
Current relative abundance relative to historic values: 294.02%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus jonellus*

Justification (Notes): In Europe, this species is listed as Least Concern in view of its wide distribution, presumed large overall population, and stable population trend (European IUCN Assessment). In North America, this species has apparently increased in relative abundance and persistence, while declining in range in recent years. There are very few historic records of this species; interestingly, the historic range is three times larger even though there are 1/3 as many historic records as current records. Overall, the average decline value of 23.83% over the past decade suggests a Least Concern Red List category in this region. In Asia, the distribution and population status of this species are unknown, and the importance of Asian populations to the overall species security is unclear. As such, we recommend this species for a Data Deficient Red List Category at this time.
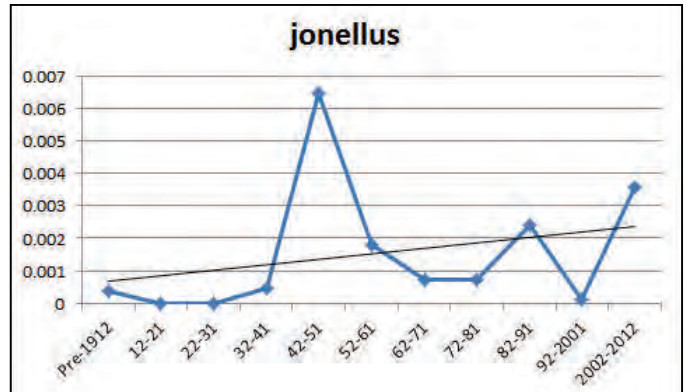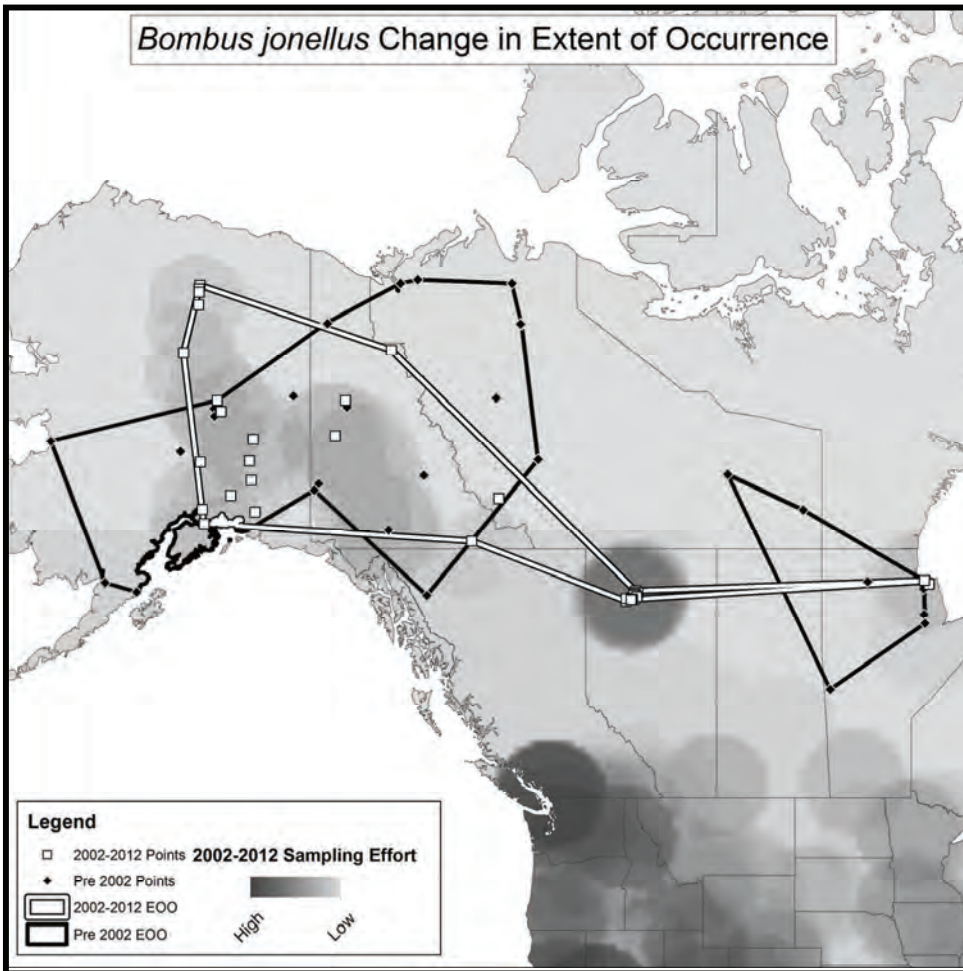

Figure 2: Map used to measure range decline for *Bombus jonellus*

Species: *Bombus melanopygus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 71.48%
Persistence in current range relative to historic occupancy: 99.33%
Current relative abundance relative to historic values: 81.85%

Average decline: 15.78%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus melanopygus*

Justification (Notes): This somewhat widespread western North American species is apparently common across most of its range, and has not been found to be exhibiting serious decline in either range or relative abundance. Our analyses indicate it should be classified as Least Concern at this time.
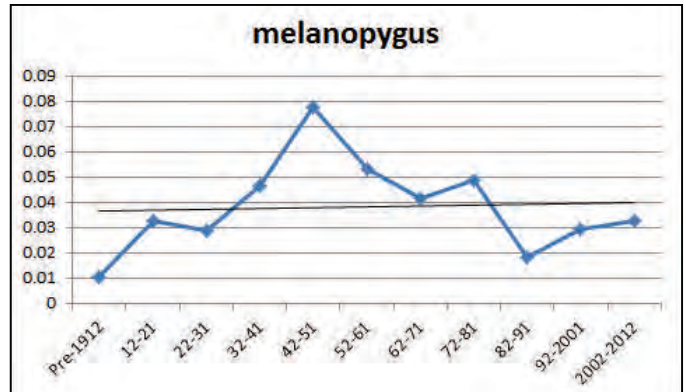

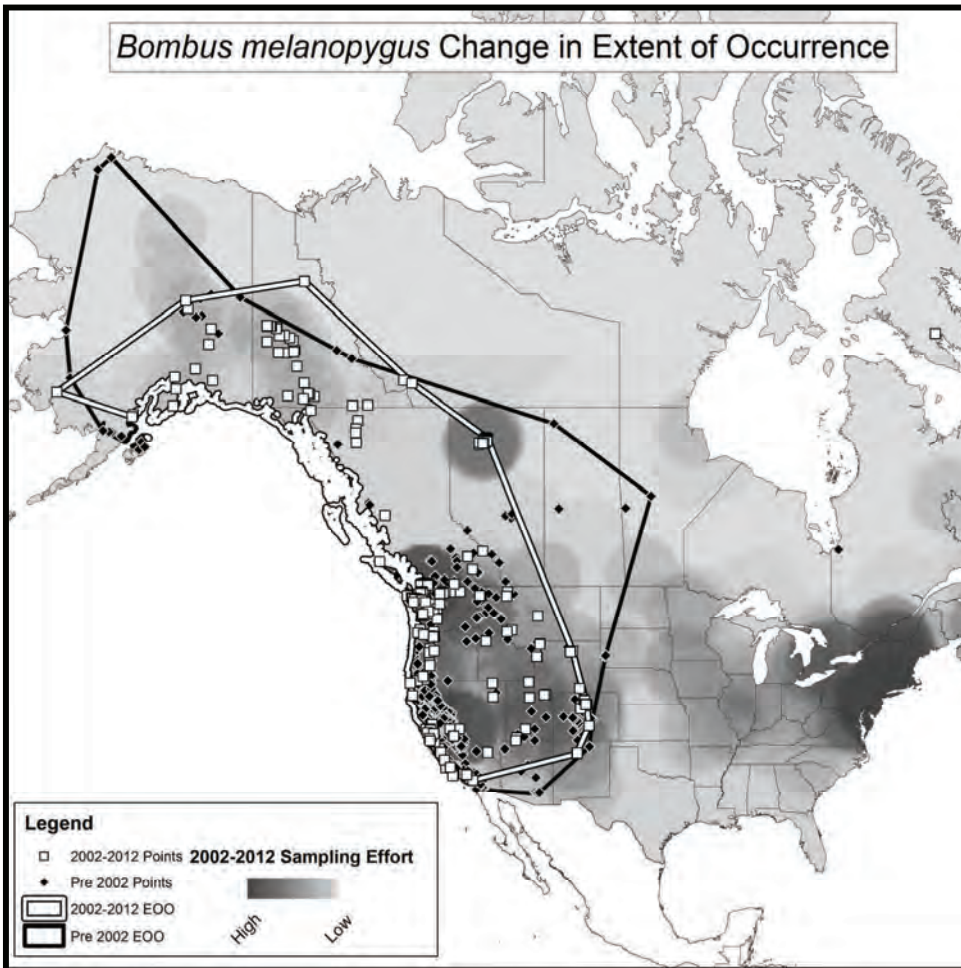Figure 2: Map used to measure range decline for *Bombus melanopygus*

Species: *Bombus mixtus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 51.94%
Persistence in current range relative to historic occupancy: 141.35%
Current relative abundance relative to historic values: 263.61%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Justification (Notes): This North American species is considered moderately common throughout its mostly Western range

Figure 1: Relative abundance trends of *Bombus mixtus*

(Williams et al. 2014), and was not found to have undergone declines in our analyses. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
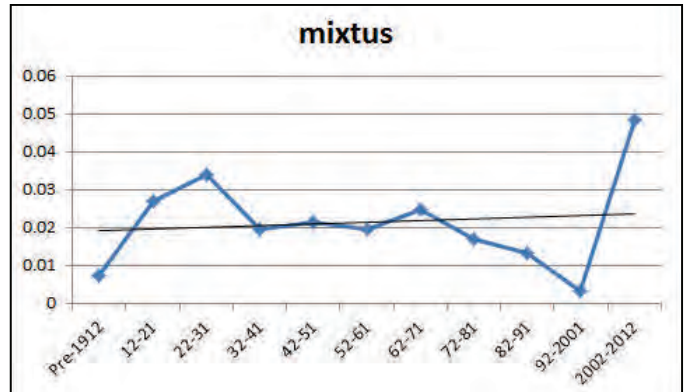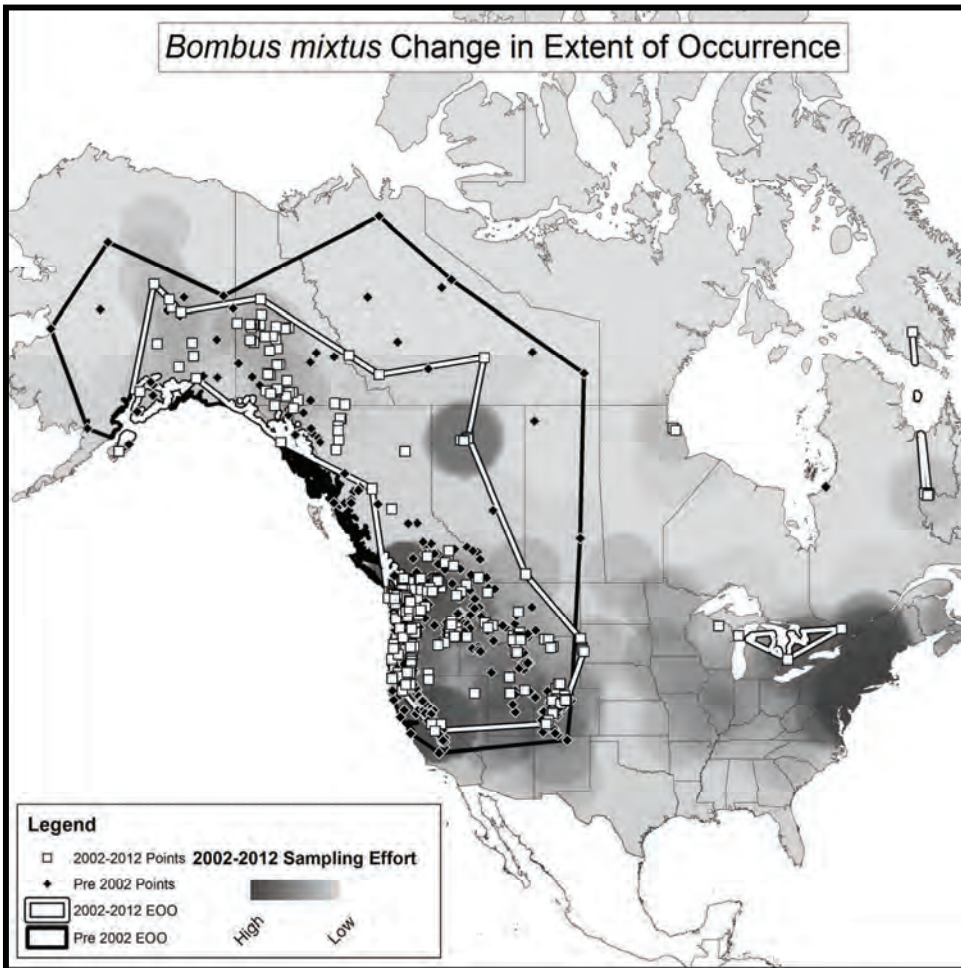

Figure 2: Map used to measure range decline for *Bombus mixtus*

Species: *Bombus morrisoni*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 81.87%
Persistence in current range relative to historic occupancy: 27.49%
Current relative abundance relative to historic values: 17.43%

Average decline: 57.74%

Preliminary IUCN Category: Near Threatened; NT
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus morrisoni*

Justification (Notes): This western North American species has declined in relative abundance by 82.57% over the past ten years, and persistence declines have also been high (>70%). The EOO appears relatively stable, since most declines have been in the interior of the species' range. Note that the Intermountain West, which is the heart of this species' range, is generally an under-sampled area. However, there are large areas within this region that appear to have been well-sampled in recent years with limited detection of this species, e.g., western Nevada and the Four Corners area (see attached map). R. Thorp (pers. comm. 2014) notes the absence of this species in recent surveys at the well-surveyed Southwestern Research Station in Arizona. In other well-sampled areas of Utah, this species appears to be maintaining high numbers (J. Strange and T. Griswold pers comm. 2014). More research is needed to evaluate the status of this species throughout its range, especially eastern Oregon and Washington, and western Nevada. Overall, this species is uncommon, and appears to be declining in parts of its range (Williams et al. 2014). Although our analysis points towards a Red List status of Endangered for this species, we are recommending Vulnerable at this time, in light of the various uncertainties presented above (e.g. limited sampling in parts of the species' range; changes in habitats sampled in some areas; and apparent security of this species at a few known sites).
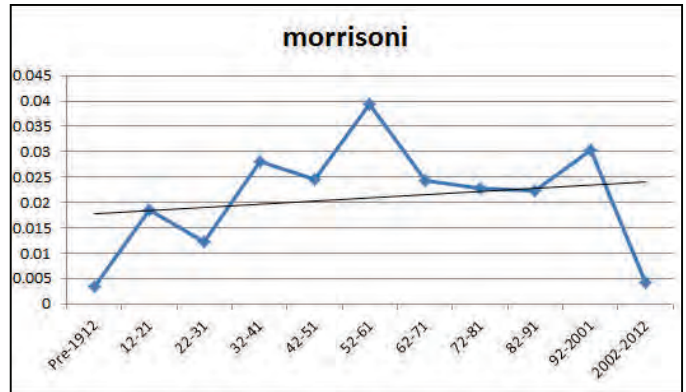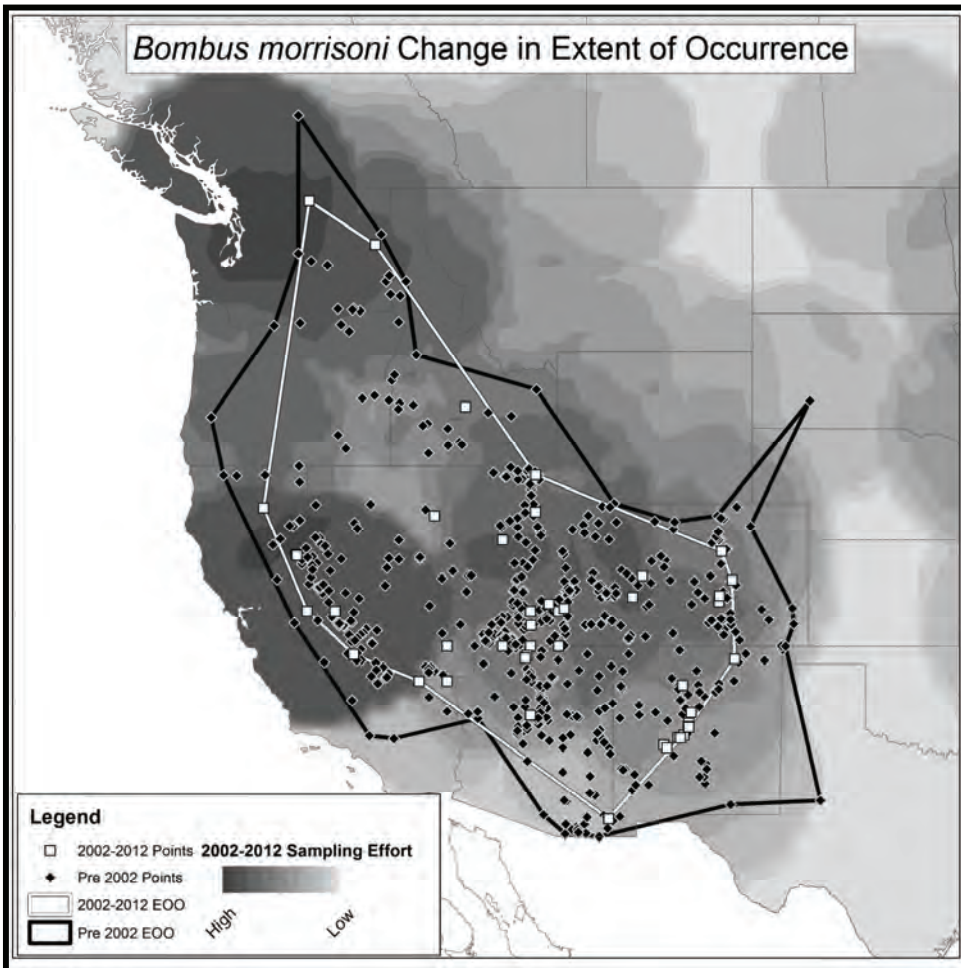

Figure 2: Map used to measure range decline for *Bombus morrisoni*

Species: *Bombus neoboreus*
Assessment Level:
Status: Delayed for taxonomic status
Current range size relative to historic range: 0.00%
Persistence in current range relative to historic occupancy:
Current relative abundance relative to historic values: 0.00%

Average decline: 0.00%

Preliminary IUCN Category: Data Deficient; DD
IUCN Criteria:

Justification (Notes): The distribution of this species is restricted to far northern North America, where collection has been limited. There are only 57 known records for this species. This is not enough data to build EOO polygons or analyze relative abundance for this species. Additional surveys for this species are needed. As such, we recommend the Data Deficient Red List category at this time.
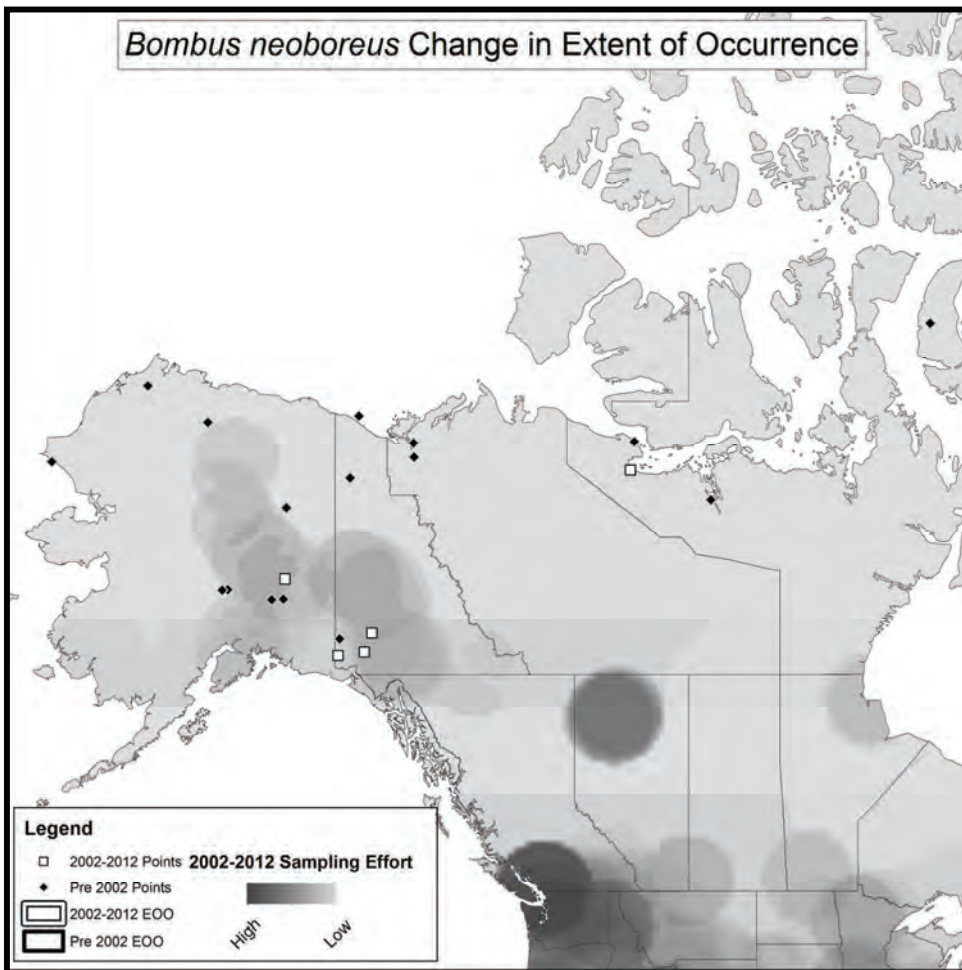

Figure 2: Map used to measure range decline for *Bombus neoboreus*

Species: *Bombus nevadensis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 104.71%
Persistence in current range relative to historic occupancy: 84.78%
Current relative abundance relative to historic values: 64.08%

Average decline: 15.48%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus nevadensis*

Justification (Notes): According to our analysis, this western North American species has not declined significantly in range, persistence, or abundance over the time period examined. Specifically, the average decline of 15.48% suggests a Least Concern category for this species. Similarly, reports from the literature do not suggest recent threats or declines in this species (NatureServe 2014). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
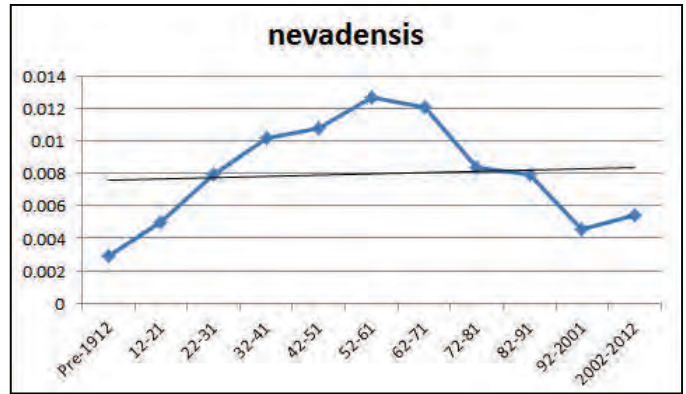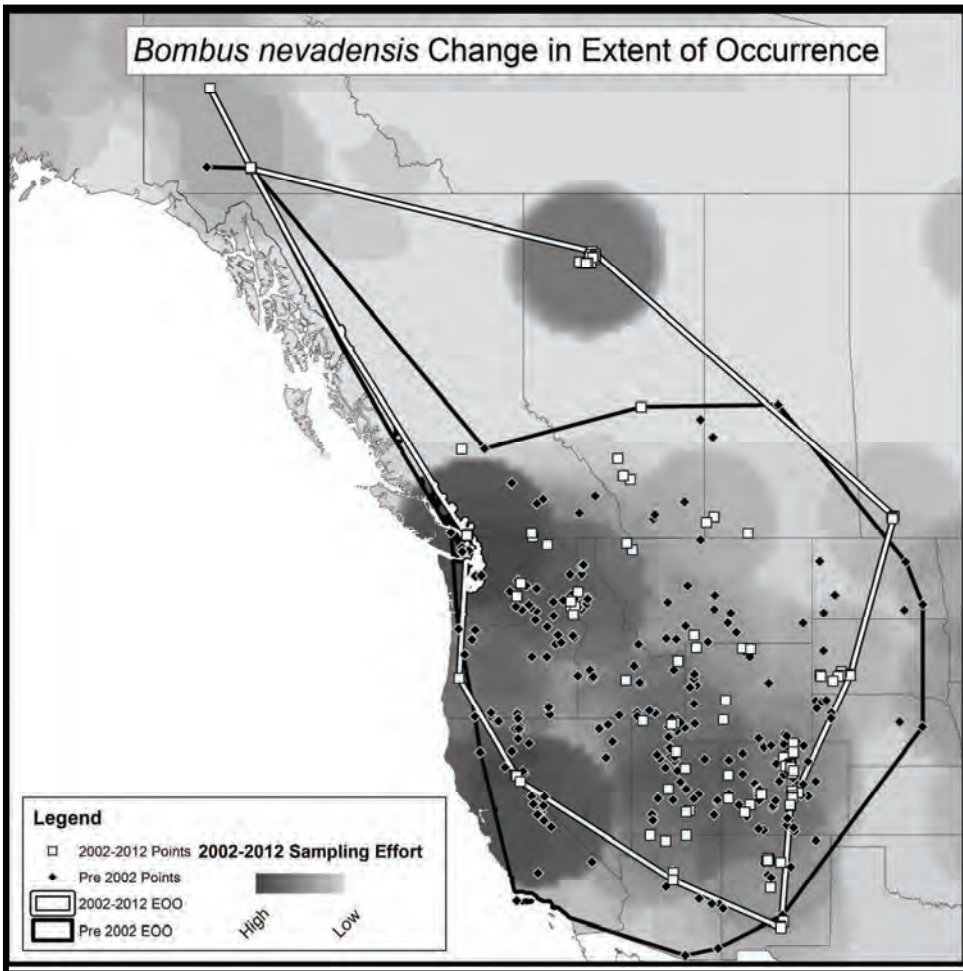

Figure 2: Map used to measure range decline for *Bombus nevadensis*

Species: *Bombus occidentalis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 77.96%
Persistence in current range relative to historic occupancy: 72.56%
Current relative abundance relative to historic values: 28.51%

Average decline: 40.32%

Preliminary IUCN Category: Vulnerable; VU
I**UCN Criteria:** A2be

Figure 1: Relative abundance trends of *Bombus occidentalis*

Justification (Notes): Historically broadly distributed in western North America, *Bombus occidentalis* has experienced serious declines in relative abundance, persistence, and range in recent years (Hatfield et al. 2014, Cameron et al. 2011a, Thorp 2008). The average decline value of 40.32% over the past decade (based on relative abundance, persistence, and range declines) suggests a Vulnerable Red List Category for this species. This finding, along with published reports of bumble bee decline and the assessors' best professional judgment, leads us to recommend this species for the Vulnerable Red List category at this time. The use of criterion A2b (where population reduction is suspected) can be justified by changes in relative abundance. Criterion A2e may be justified by the potential effects of pathogens or parasites on *B. occidentalis* populations (e.g., Cameron et al. 2011a).
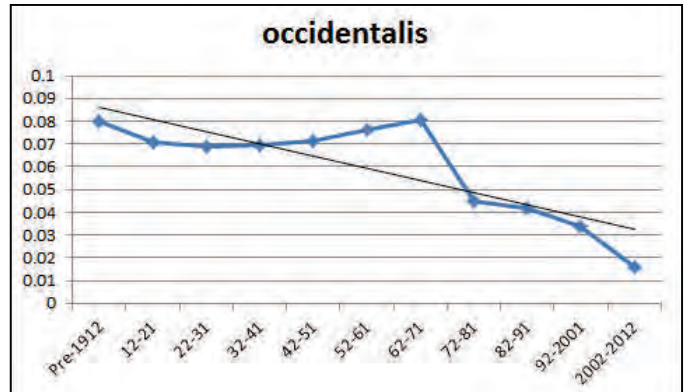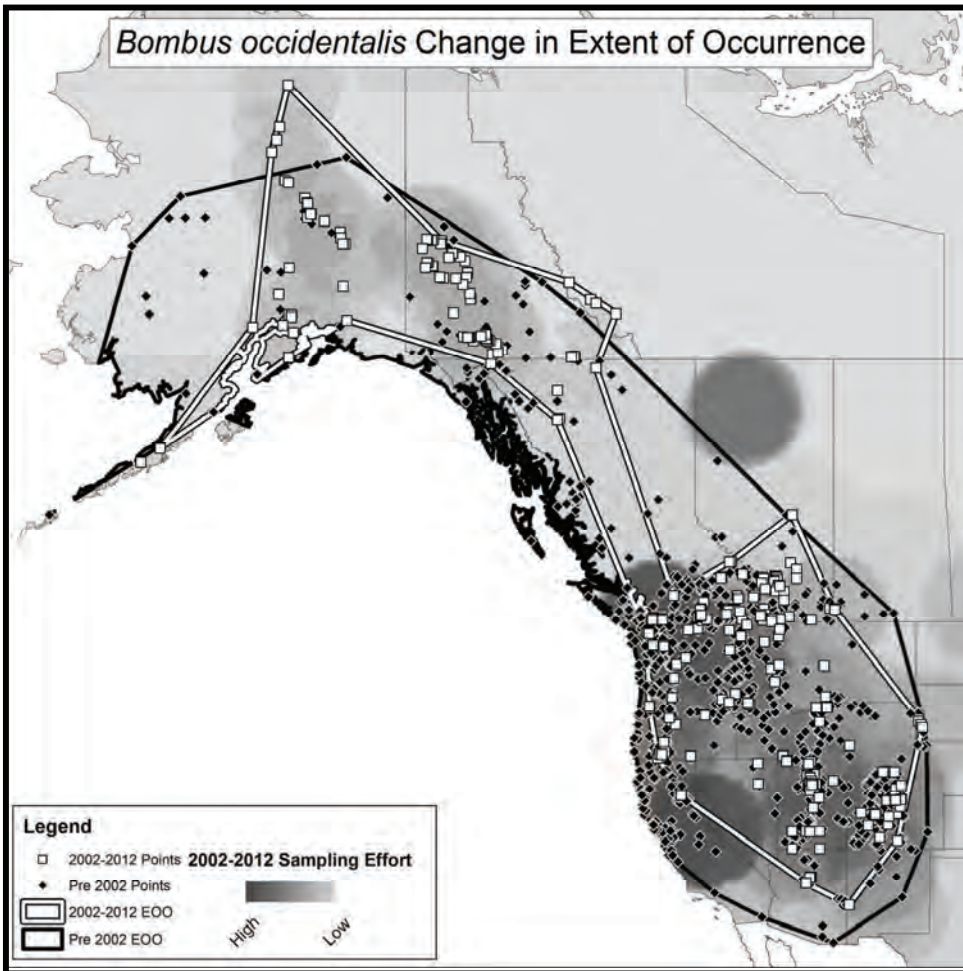

Figure 2: Map used to measure range decline for *Bombus occidentalis*

Species: *Bombus pensylvanicus*
Assessment Level: Global
Status: Submitted
Current range size relative to historic range: 81.18%
Persistence in current range relative to historic occupancy: 53.24%
Current relative abundance relative to historic values: 11.44%

Average decline: 51.38%

Preliminary IUCN Category: Vulnerable; VU
IUCN Criteria: A2be

Figure 1: Relative abundance trends of *Bombus pensylvanicus*

Justification (Notes): *Bombus pensylvanicus* EOO decline is most severe in northern areas, which have been well sampled (although it doesn't look like this species was ever that abundant in those northern areas). Its relative abundance trend has been slowly moving downward until recently, when the downward trend has become much sharper (but is not statistically significant). The Cameron et al. (2011) study estimates a 23% range loss, we found a range loss of ~50% along with a 50% drop in persistence and 88.56% drop in relative abundance for this species. [We used the A2c criterion for EOO for *B. morrisoni*; although these two species have similar estimates for EOO decline, we decided not to use EOO criteria for *B. pensylvanicus* because it has such a large historic range that includes so many areas that have not been well sampled recently]. Criterion A2e was used for: "population reduction suspected based upon effects of introduced pathogens or parasites" (Cameron et al. 2011 - this study showed a significantly higher prevalence of individuals infected with *N. bombi* than stable species - 15.2% of individuals collected were infected). This review includes *B. sonorus*. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Vulnerable Red List category at this time.
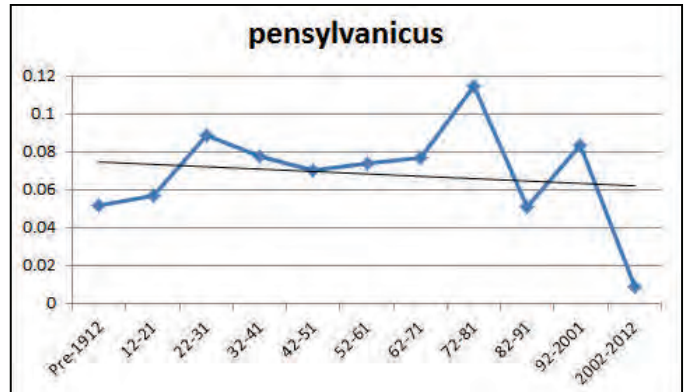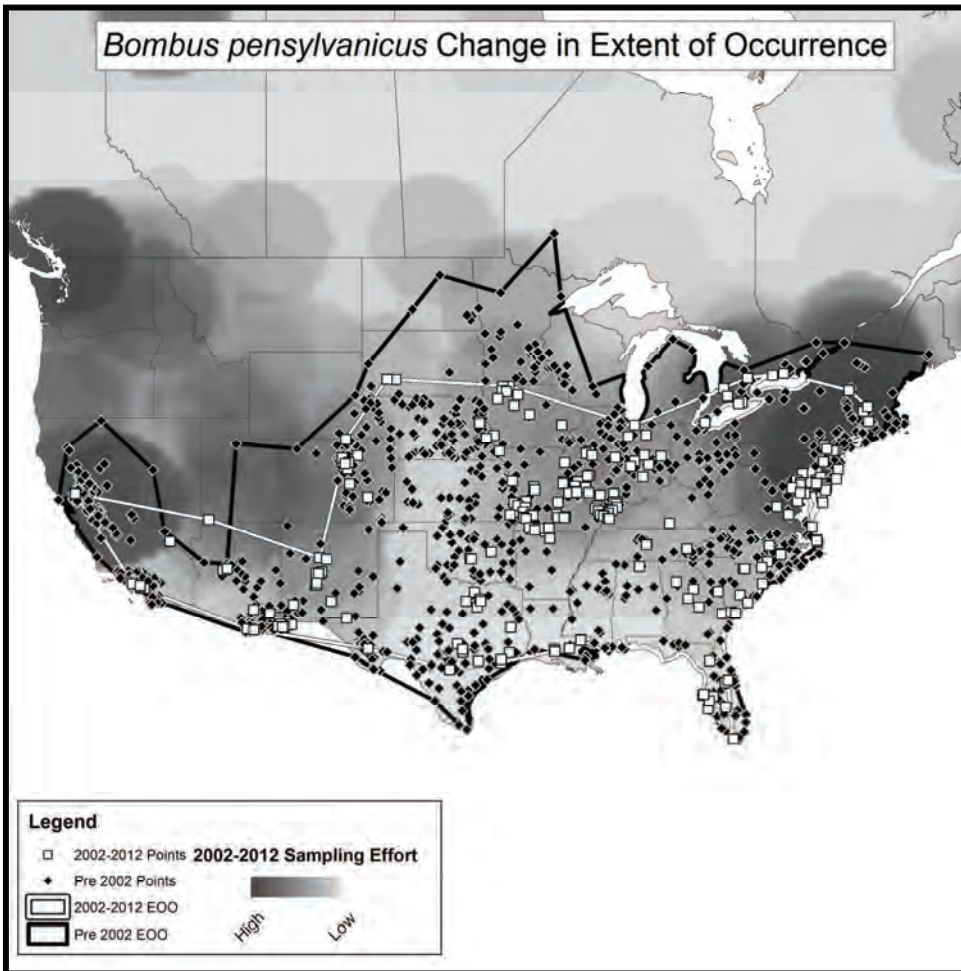

Figure 2: Map used to measure range decline for *Bombus pensylvanicus*

Species: *Bombus perplexus*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 93.97%
Persistence in current range relative to historic occupancy: 166.31%
Current relative abundance relative to historic values: 92.19%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus perplexus*

Justification (Notes): According to our analysis, this North American species has not experienced serious declines in relative abundance, persistence, or range in recent years. This finding is consistent with other studies that have found this species to be relatively stable, both regionally and range-wide (e.g. Colla et al. 2012, Colla and Packer 2008, Grixti et al. 2009). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
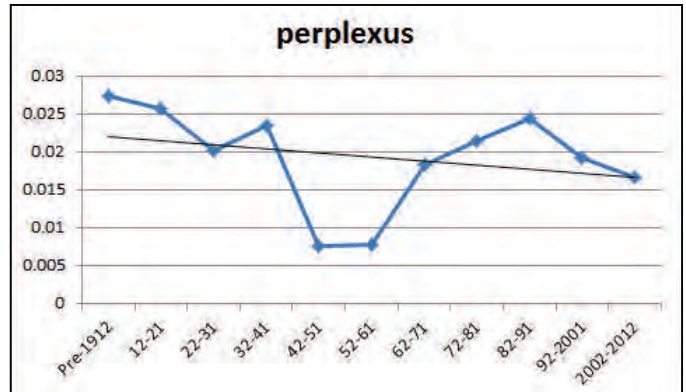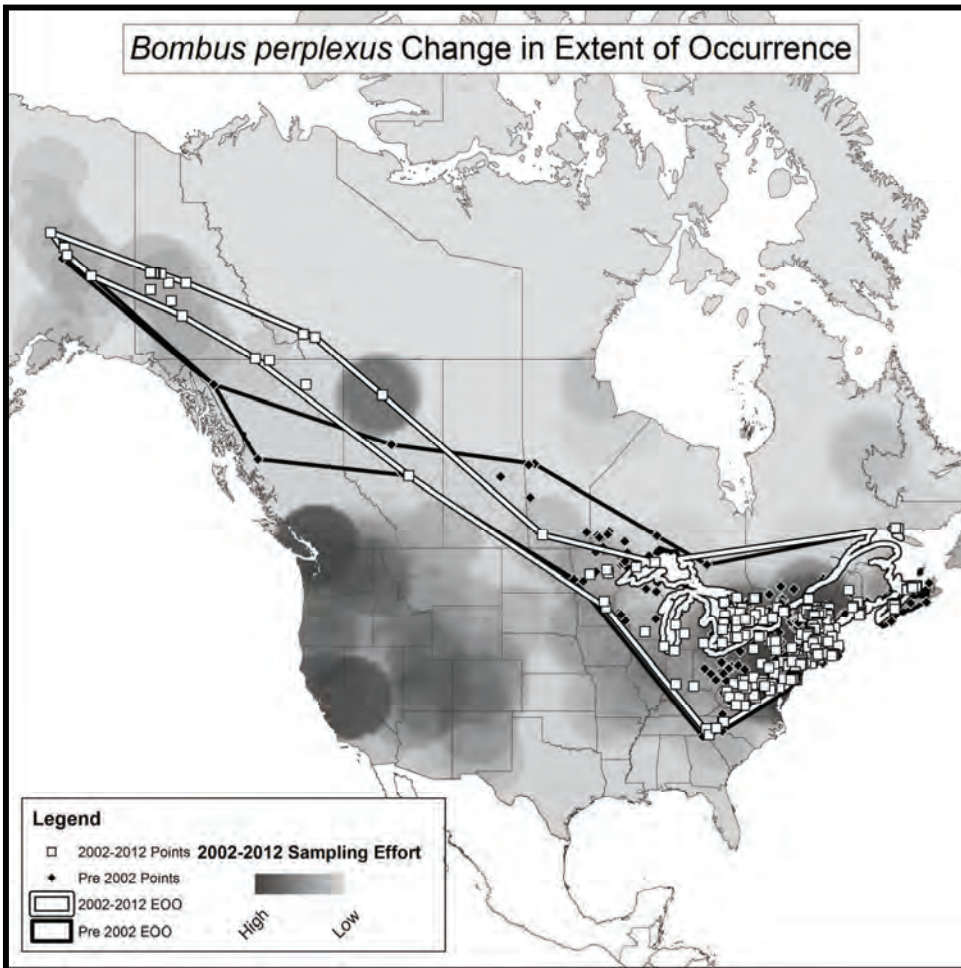

Figure 2: Map used to measure range decline for *Bombus perplexus*

Species: *Bombus polaris*
Assessment Level:
Status: Delayed for taxonomic status
Current range size relative to historic range: 0.00%
Persistence in current range relative to historic occupancy:
Current relative abundance relative to historic values: 0.00%

Average decline: 0.00%

Preliminary IUCN Category: Data Deficient; DD
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus polaris*

Justification (Notes): In North America, there are just 46 records of this species from the current time period, and the entirety of this species' range has been relatively under sampled in both historic and current time periods, making assessment of population trends difficult. More research throughout this species' range is needed. As such, North American assessors suggest a Data Deficient Red List Category for this region.
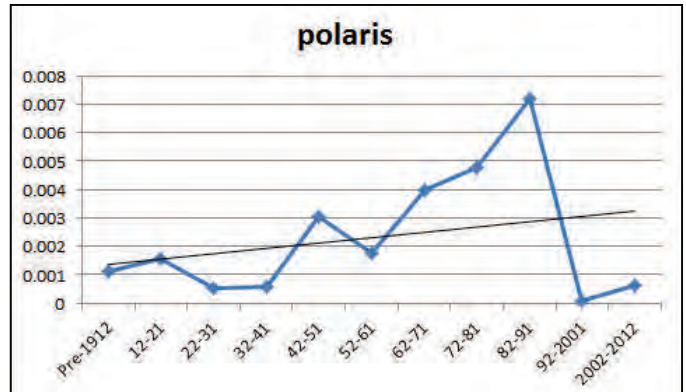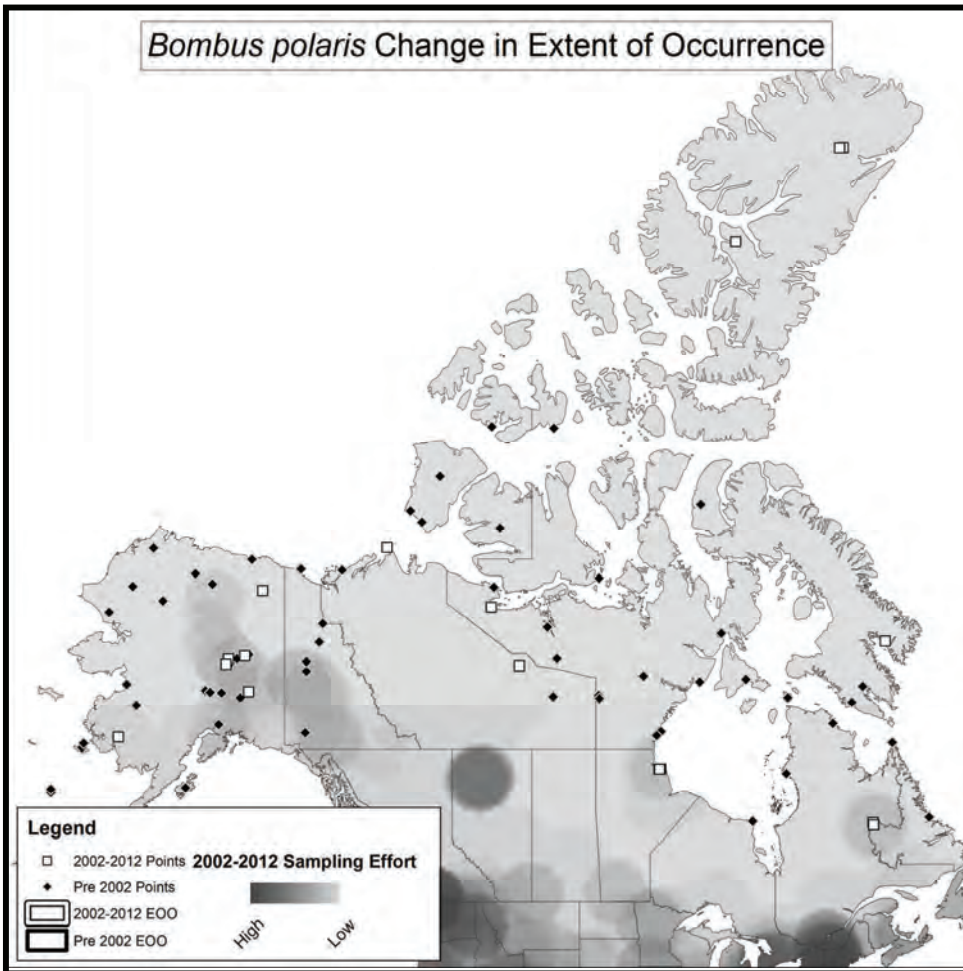

Figure 2: Map used to measure range decline for *Bombus polaris*

Species: *Bombus rufocinctus*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 91.45%
Persistence in current range relative to historic occupancy: 106.47%
Current relative abundance relative to historic values: 154.88%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus rufocinctus*

Justification (Notes): According to our analysis, this widespread North American species has not exhibited range-wide decline in recent years. Specifically, the average decline of 0% (based on relative abundance, persistence, and range) suggests a Least Concern category for this species. Note that this analysis did not consider the Mexican distribution of this species, however, since this species is known from very few records in a small area of Mexico (Labougle 1990, ECOSUR 2014), the Mexican data would not have significantly impacted the above results. Our findings are consistent with other reports that the species is stable or increasing throughout the eastern and central portions of its range (Colla and Packer 2008, Grixti et al. 2009, Colla et al. 2012). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.

Figure 2: Map used to measure range decline for *Bombus rufocinctus*

43

Species: *Bombus sandersoni*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 98.83%
Persistence in current range relative to historic occupancy: 142.65%
Current relative abundance relative to historic values: 87.37%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus sandersoni*

Justification (Notes): According to our analysis, this North American species has not experienced serious declines in relative abundance, persistence, or range in recent years. Specifically, the average decline of 0% suggests a Least Concern category for this species. Colla et al. (2012) found no significant changes in relative abundance of this species range-wide over the time periods examined, although this study did flag *B. sandersoni* as of conservation concern due to low persistence between 1991-2009 in historically occupied areas. However, a large number of recent (2010-2012) records of this species range-wide have helped alleviate concerns about the persistence of this species. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
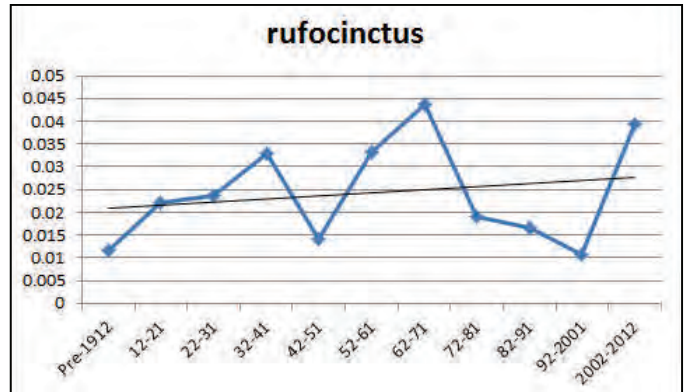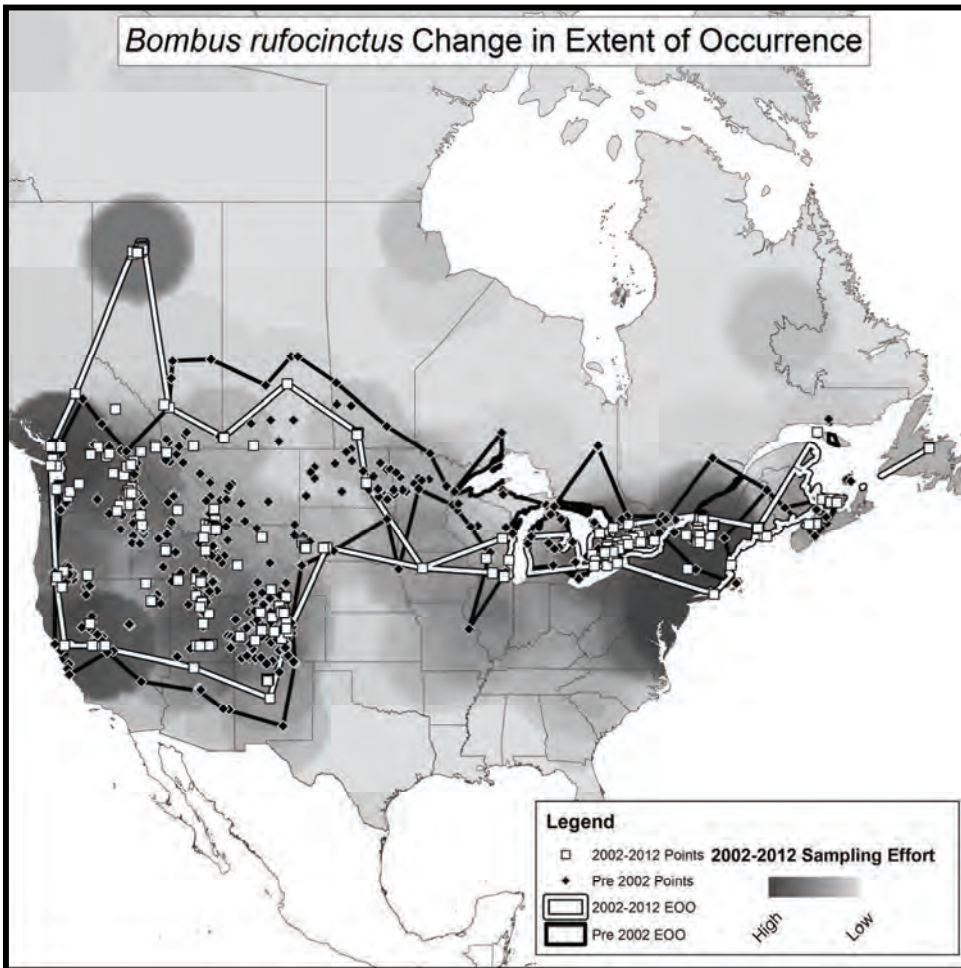

Figure 2: Map used to measure range decline for *Bombus sandersoni*

Species: *Bombus sitkensis*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 31.92%
Persistence in current range relative to historic occupancy: 89.46%
Current relative abundance relative to historic values: 76.08%

Average decline: 34.18%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus sitkensis*

Justification (Notes): According to our analysis, this western North American species has not experienced serious declines in relative abundance or persistence in recent years. The apparent extent of occurrence (EOO) loss for this species is misleading, being largely influenced by a few widely scattered records from areas have been under-sampled in recent years. Therefore we are not relying heavily on the EOO measure for this species in our assessment. Average decline in relative abundance and persistence (excluding EOO) is 17.23%, suggesting a Least Concern Red List category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
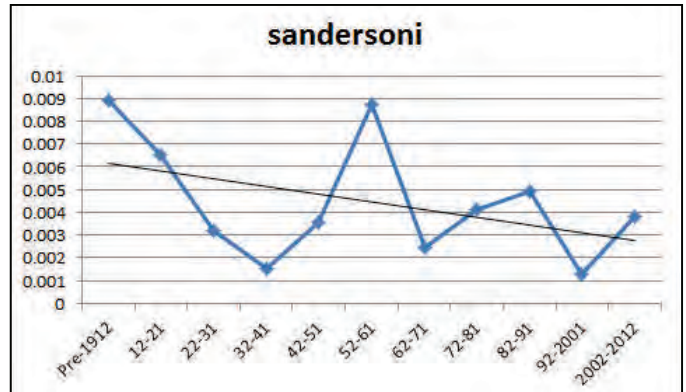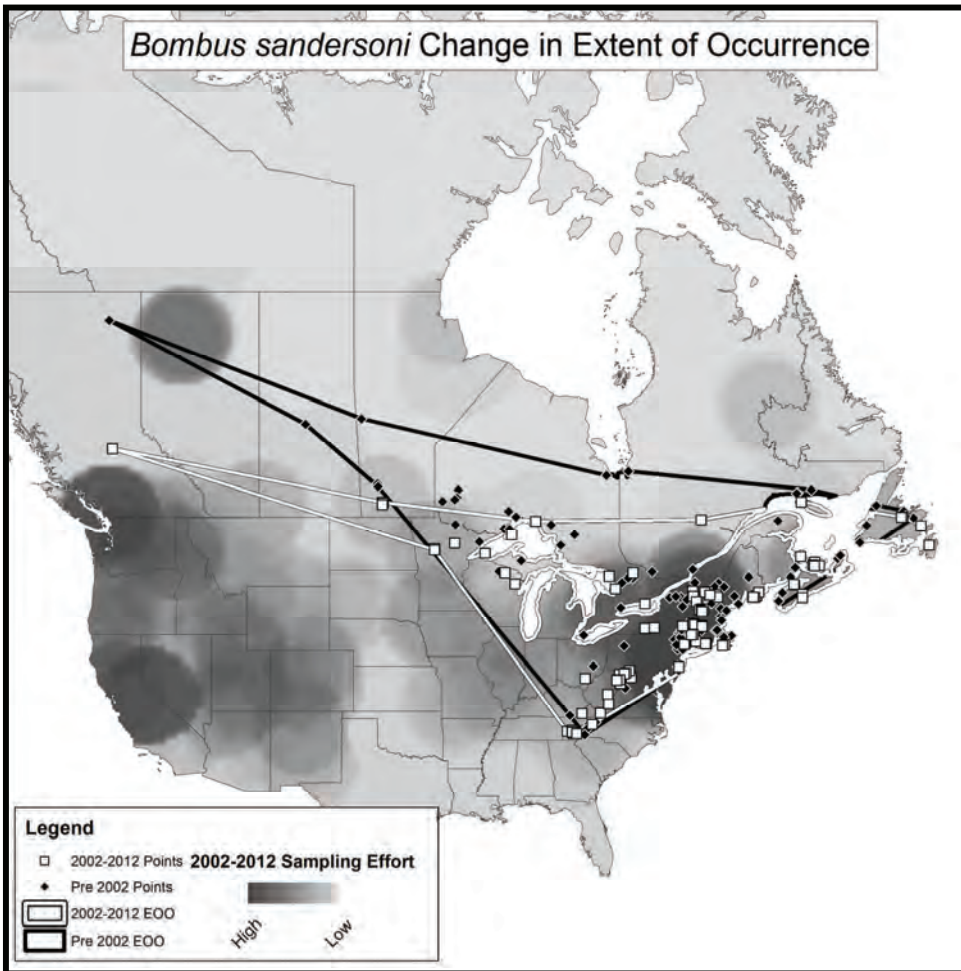

Figure 2: Map used to measure range decline for *Bombus sitkensis*

45

Species: *Bombus suckleyi*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 42.61%
Persistence in current range relative to historic occupancy: 15.95%
Current relative abundance relative to historic values: 9.89%

Average decline: 77.18%

Preliminary IUCN Category: Critically Endangered; CR
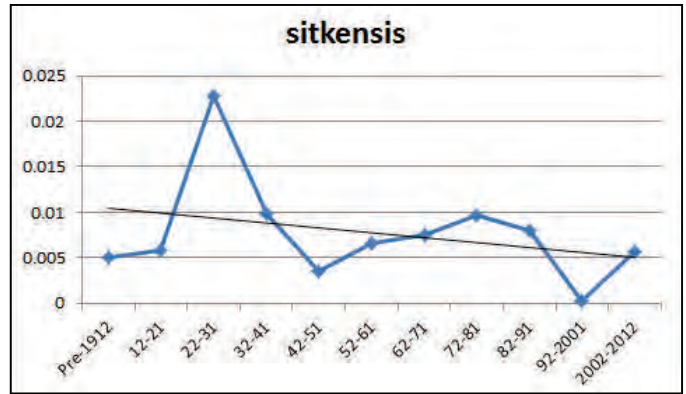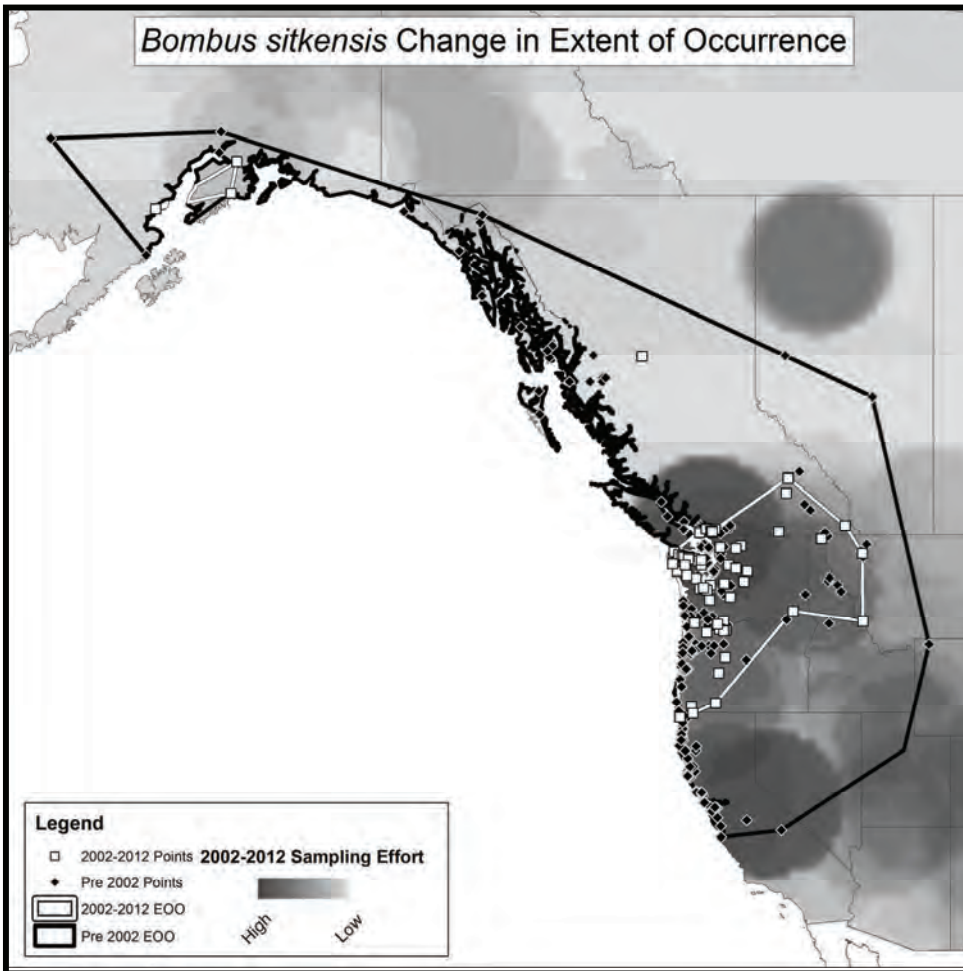**IUCN Criteria:** EN A2ce; CR A4be

Figure 1: Relative abundance trends of *Bombus suckleyi*

Justification (Notes): According to our analysis, this western North American species has experienced rapid declines in relative abundance in recent years. The decade by decade relative abundance regression shows a gradual decline since the 1940s, and the relative abundance regression over just the past 50 years is highly significant (R-squared value of nearly 1; showing a continued steep decline). If we project the 50 year relative abundance regression into the future, it falls below the x-axis in the next 10 years. Notably, this species' regression mirrors that of *B. occidentalis*, a primary host. Both the past decline in relative abundance (90.11% over the past 10 years) and predicted future decline in relative abundance (based on 50-year regression) justify a Critically Endangered listing, using criterion A2be + A3b. Note that the range and persistence of this species have also declined, however, since some historic sites have not been re-sampled and since we only have records of this species in approximately six general localities for the current time period, we were not comfortable using those measures of decline. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Critically Endangered Red List category at this time.
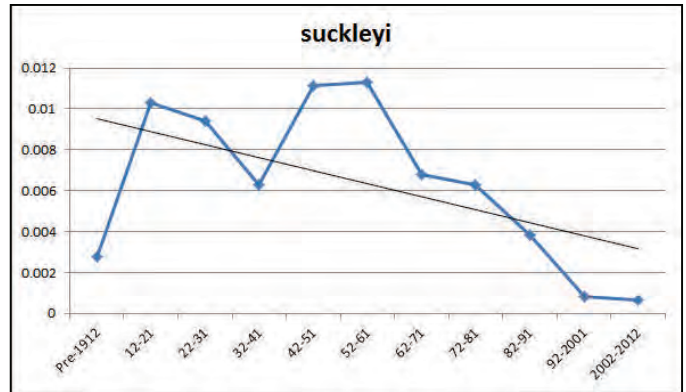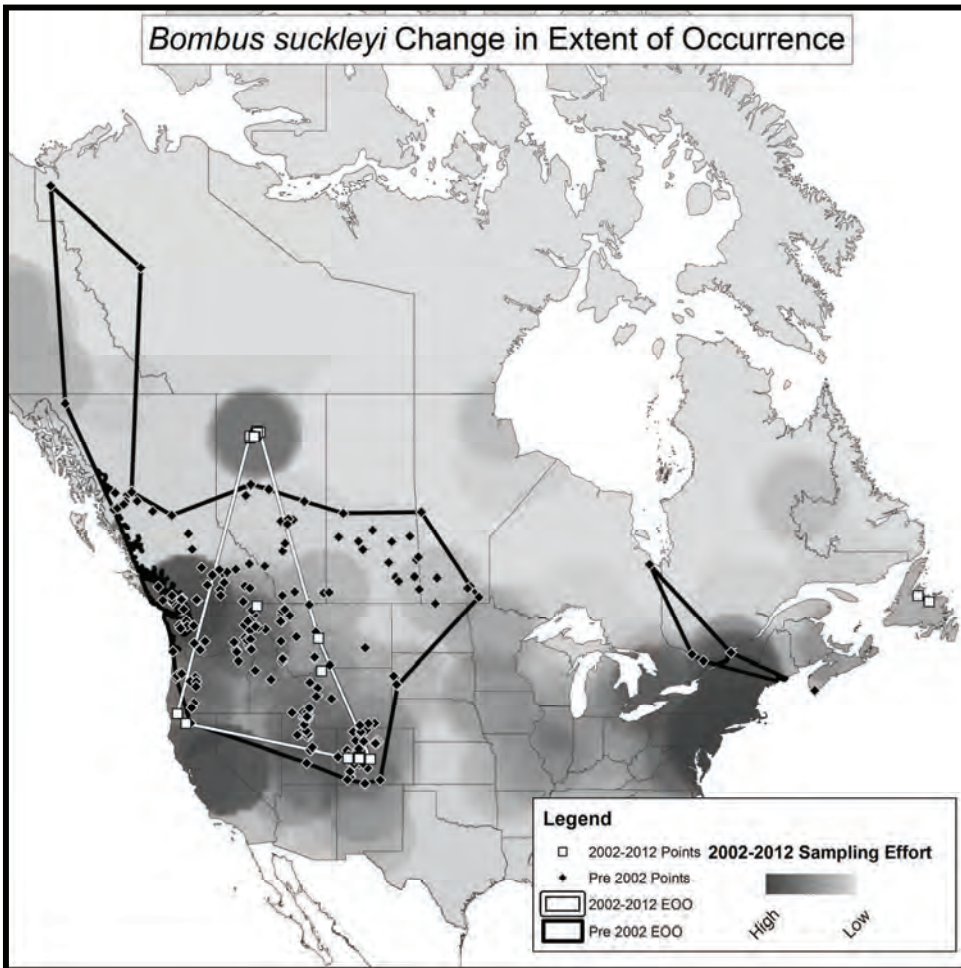

Figure 2: Map used to measure range decline for *Bombus suckleyi*

Species: *Bombus sylvicola*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 90.03%
Persistence in current range relative to historic occupancy: 82.86%
Current relative abundance relative to historic values: 96.41%

Average decline: 10.23%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus sylvicola*

Justification (Notes): According to our analysis, this North American species has not experienced serious declines in recent years. Specifically, the average decline of 10.23% (based on relative abundance, persistence, and range) suggests that this species qualifies for the Least Concern category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.

Figure 2: Map used to measure range decline for *Bombus sylvicola*

Species: *Bombus ternarius*
Assessment Level: Global
Status: Published
Current range size relative to historic range: 69.05%
Persistence in current range relative to historic occupancy: 103.61%
Current relative abundance relative to historic values: 162.21%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus ternarius*

Justification (Notes): According to our analysis, this North American species has not experienced serious declines in relative abundance, persistence, or range in recent years. This finding is consistent with other studies that have found this species to be relatively stable, both regionally and range-wide (e.g. Colla et al.2012, Colla and Packer 2008, Grixti et al. 2009). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
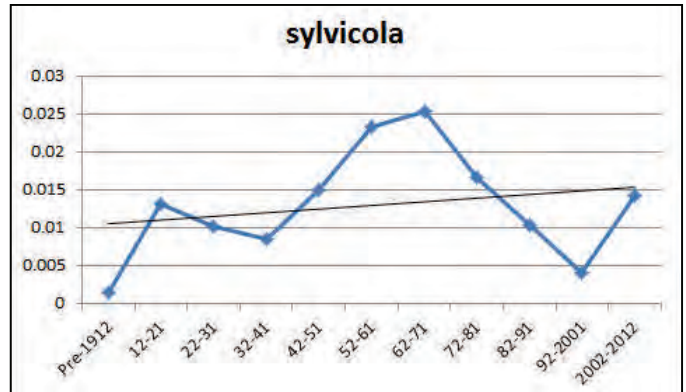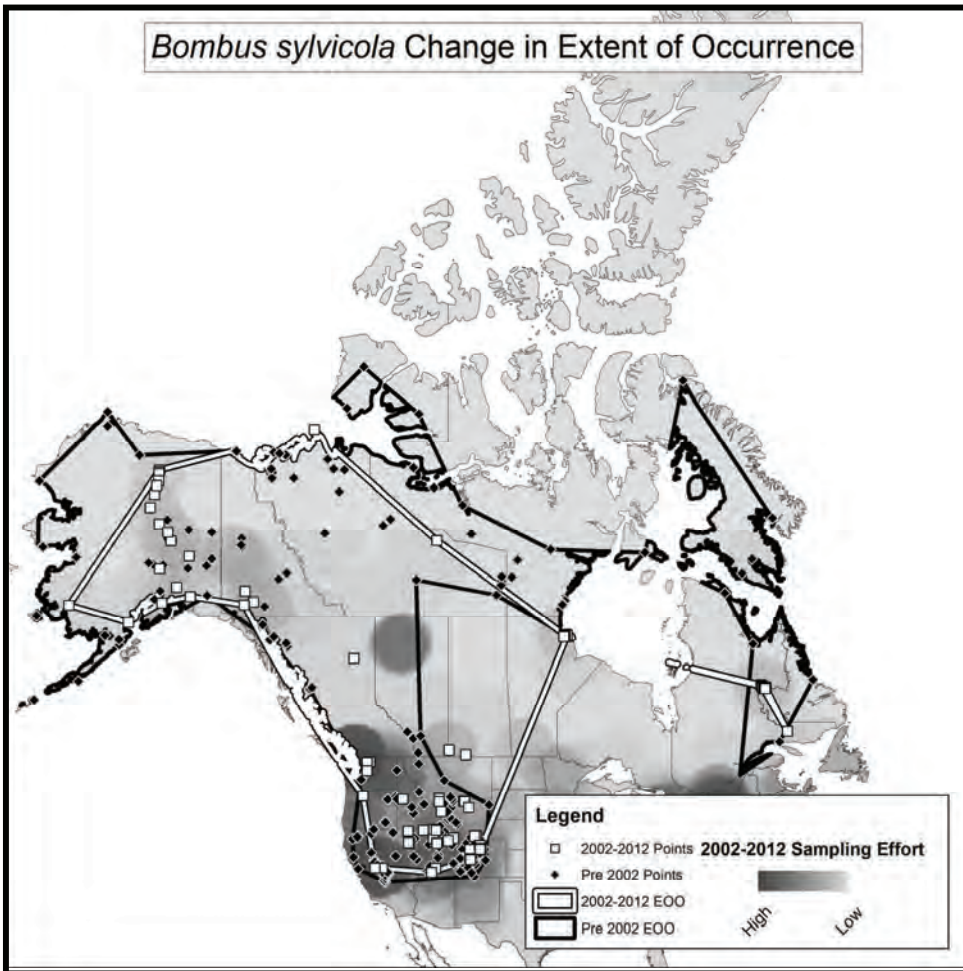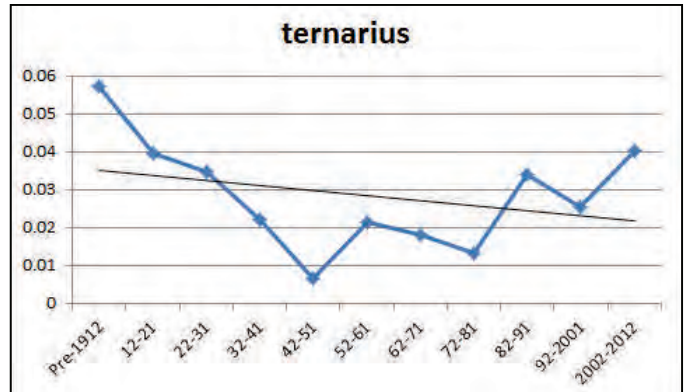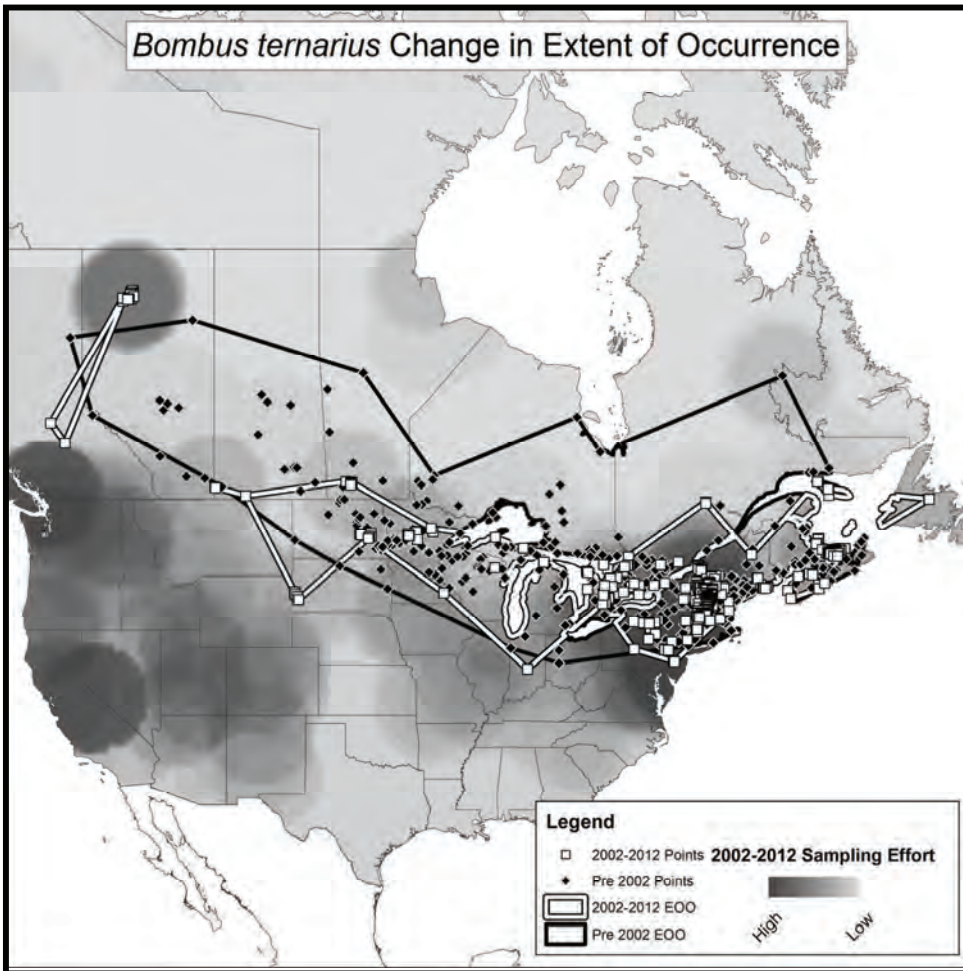

Figure 2: Map used to measure range decline for *Bombus ternarius*

Species: *Bombus terricola*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 63.69%
Persistence in current range relative to historic occupancy: 67.32%
Current relative abundance relative to historic values: 19.17%

Average decline: 49.94%

Preliminary IUCN Category: Vulnerable; VU
IUCN Criteria: A2b

Figure 1: Relative abundance trends of *Bombus terricola*

Justification (Notes): According to our analysis, this North American species has declined over 30% in both range and persistence across its entire range, with particularly high (>80%) declines in relative abundance over the time period examined. Moreover, examination of long-term trends reveals that the species' relative abundance in the current decade is lower than any other decade, and the relative abundance change from the mean relative abundance has been greater than 66% in the past decade. Our metric that is least sensitive to variation in collection effort is persistence, and to a lesser degree relative abundance, and both of those metrics suggest that this species should at least be classified as Vulnerable, if not Endangered. The average decline of 49.94% (including relative abundance, persistence, and range) suggests a Vulnerable Red List Category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Vulnerable Red List category at this time.
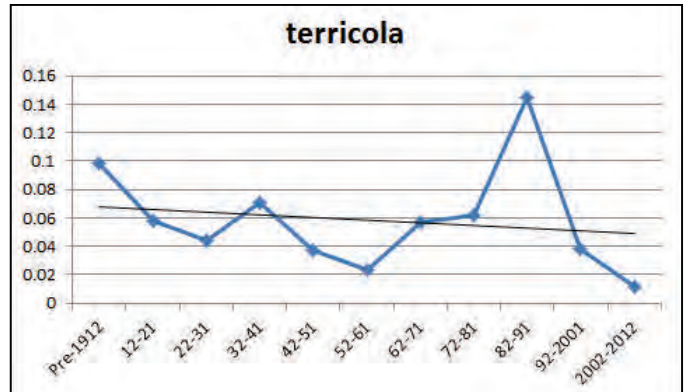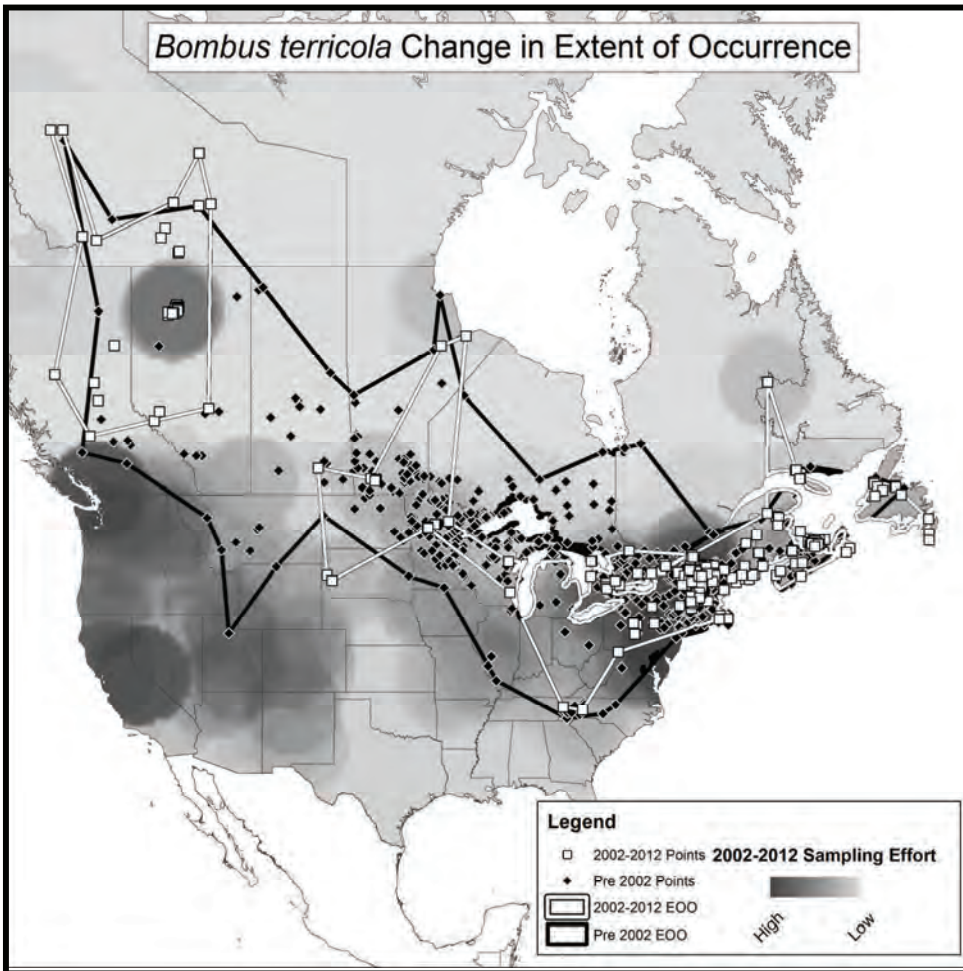

Figure 2: Map used to measure range decline for *Bombus terricola*

Species: *Bombus vagans*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 106.68%
Persistence in current range relative to historic occupancy: 103.69%
Current relative abundance relative to historic values: 108.97%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus vagans*

Justification (Notes): According to our analysis, this widespread North American species has not experienced serious declines in recent years. Specifically, the average decline of 0% (based on relative abundance, persistence, and range) suggests that this species qualifies for the Least Concern category. This finding is consistent with other studies that have found this species to be relatively stable, range-wide (Colla et al. 2012). Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.

Figure 2: Map used to measure range decline for *Bombus vagans*

Species: *Bombus vandykei*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 72.82%
Persistence in current range relative to historic occupancy: 59.99%
Current relative abundance relative to historic values: 163.71%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
IUCN Criteria:

Figure 1: Relative abundance trends of *Bombus vandykei*

Justification (Notes): This western North American species has apparently declined in occupied area in southern California, although range-wide, it is increasing in relative abundance, and the range and persistence declines are not large. The average decline of 0% (based on relative abundance, persistence, and range) suggests that this species qualifies for the Least Concern category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
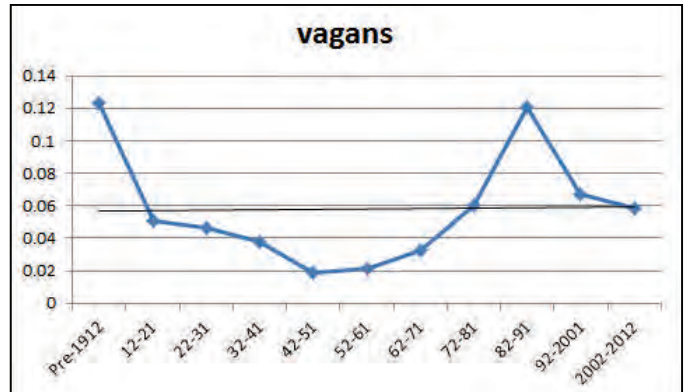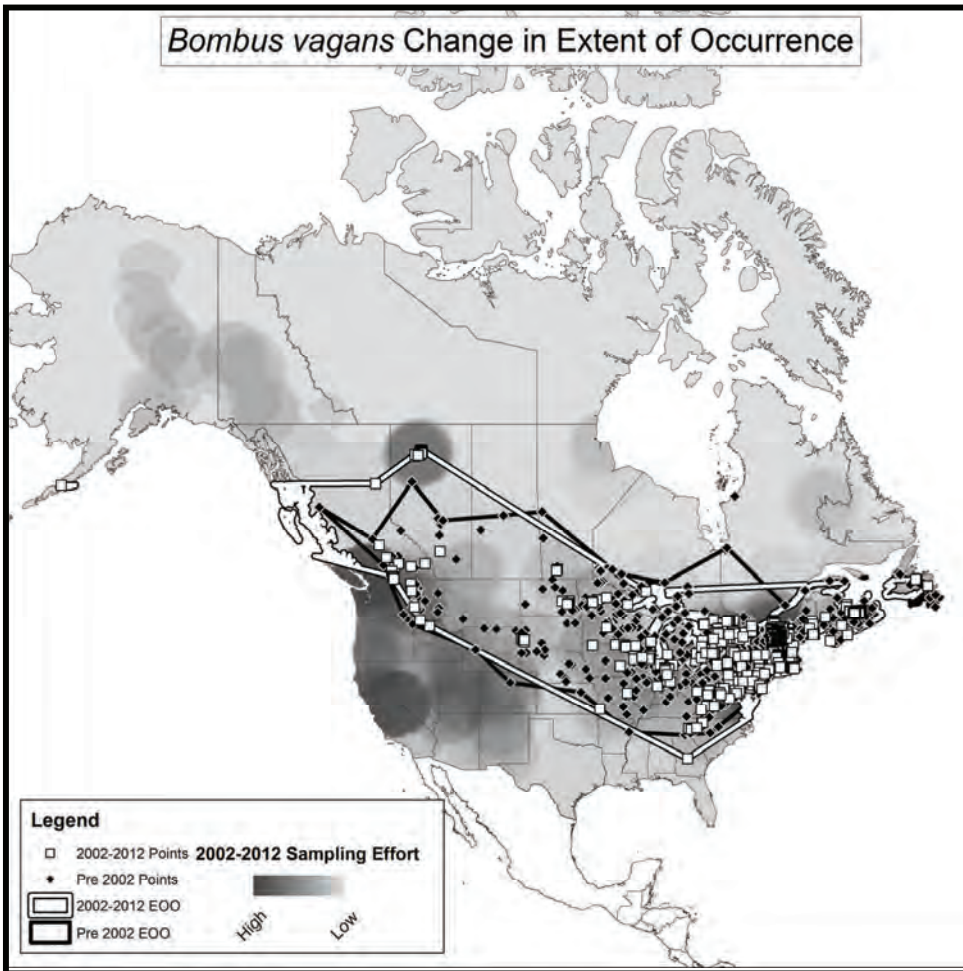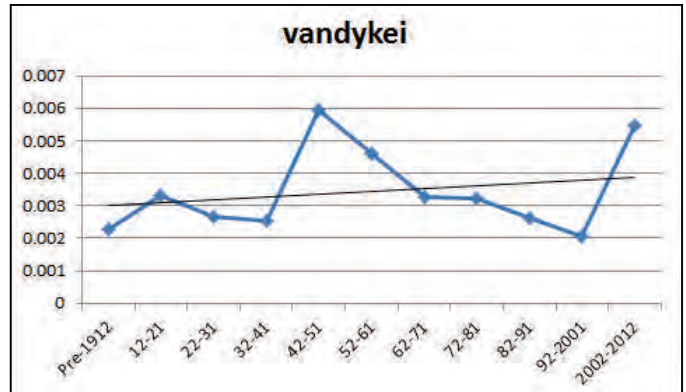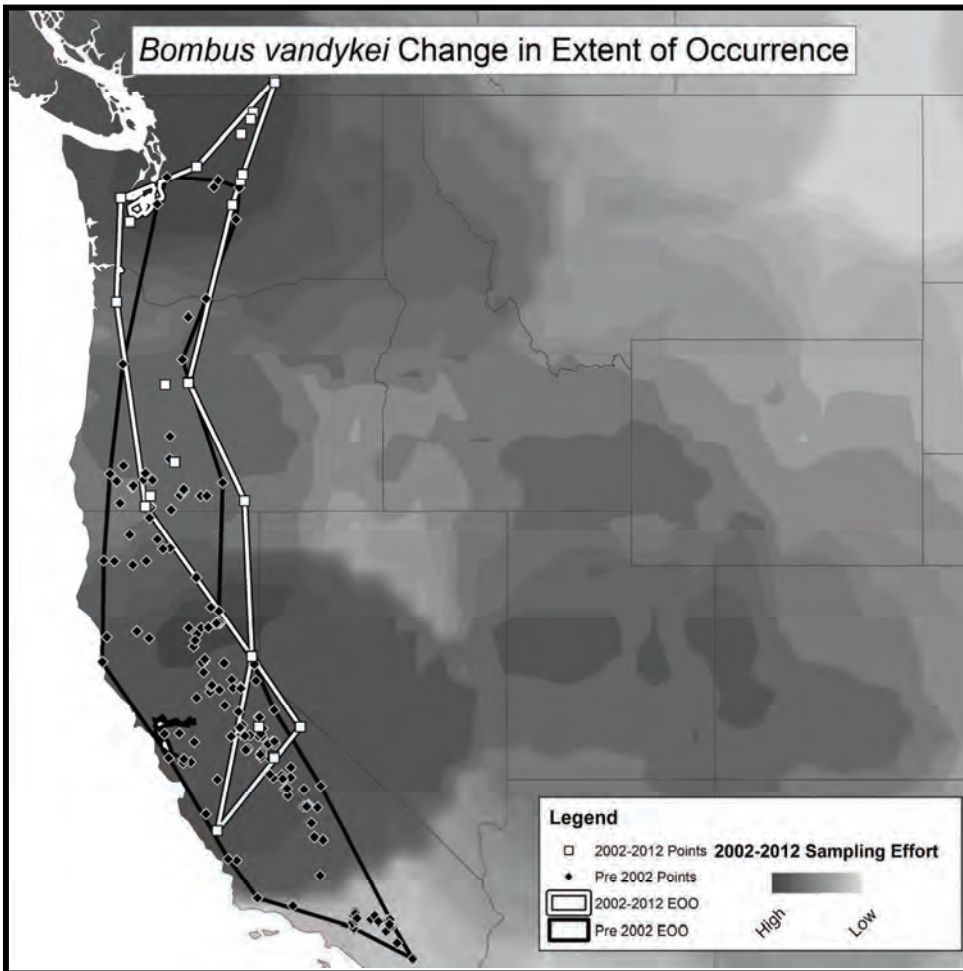

Figure 2: Map used to measure range decline for *Bombus vandykei*

Species: *Bombus variabilis*
Assessment Level: Global
Status: Delayed for taxonomic status
Current range size relative to historic range: 56.77%
Persistence in current range relative to historic occupancy: 0.00%
Current relative abundance relative to historic values: 0.00%

Average decline: 81.08%

Preliminary IUCN Category: Critically Endangered; CR
IUCN Criteria: A2bc
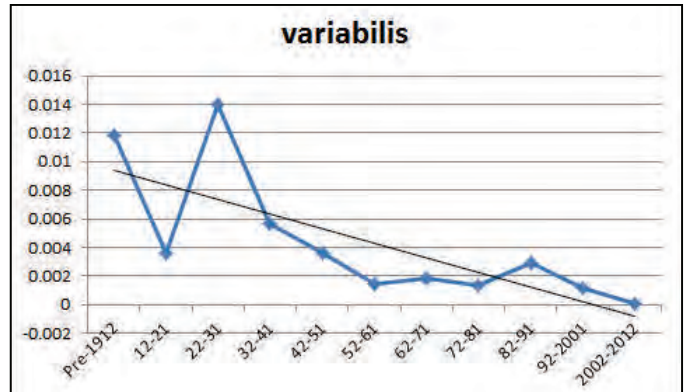
Figure 1: Relative abundance trends of *Bombus variabilis*

Justification (Notes): This species is considered one of the rarest of all North American bumble bee species, having been collected only a few times in the past twenty years, and not at all in the last decade (Williams et al. 2014 and supporting database). The decade by decade relative abundance trend has been consistently downward since the 1920s, reaching zero in the recent decade (see Figure 1). This *Psithyrus* species uses *B. pensylvanicus* as a host; it historically occurred in the northern part of *B. pensylvanicus'* range, which is where *B. pensylvanicus* has declined most severely. The species has exhibited 100% decline in relative abundance, EOO, and persistence between the recent (2002-2012) and historic (1805-2001) time periods, pointing toward a Critically Endangered Red List Category for this species in this region. In South and Central America, there are very few known records of this species (Rémy Vandame 2014, pers. comm.), and the status of this species is unclear. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Critically Endangered Red List category at this time.

Figure 2: Map used to measure range decline for *Bombus variabilis*

Species: *Bombus vosnesenskii*
Assessment Level: Global
Status: IUCN Accepted
Current range size relative to historic range: 89.30%
Persistence in current range relative to historic occupancy: 76.50%
Current relative abundance relative to historic values: 122.30%

Average decline: 0.00%

Preliminary IUCN Category: Least Concern; LC
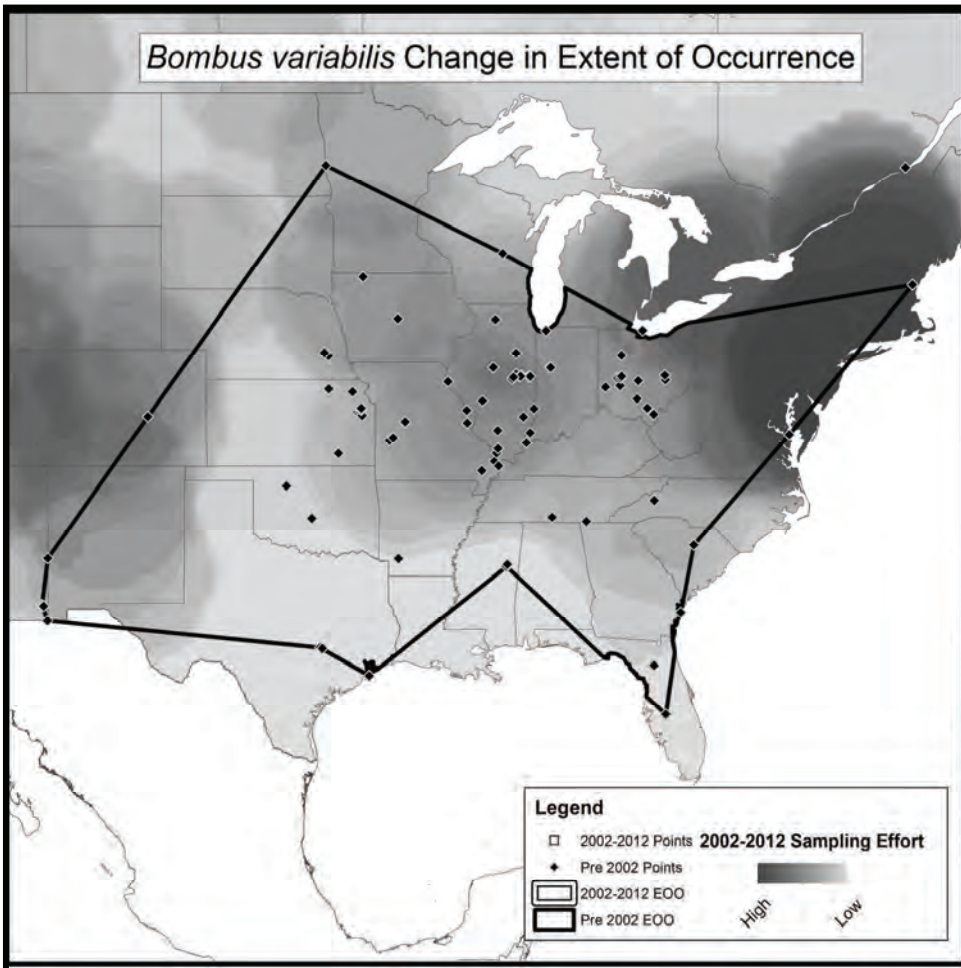**IUCN Criteria:**

Figure 1: Relative abundance trends of *Bombus vosnesenskii*

Justification (Notes): Although this western North American species has a modest range, it is often by far the most common bumble bee where it occurs, particularly in urban and agricultural settings (McFrederick and Lebuhn 2006, Rao and Stephen 2010). Like several others in its subgenus, this species seems to be increasing in at least some parts of its range (NatureServe 2014), and also expanding in range (Fraser et al. 2012). According to our analysis, this species has increased in relative abundance in recent years, and has not declined significantly in range or persistence. The average decline of 0% (based on relative abundance, persistence, and range) suggests that this species qualifies for the Least Concern Red List category. Based on the above calculations and trends, along with published reports of bumble bee decline and the assessors' best professional judgment, we recommend this species for the Least Concern Red List category at this time.
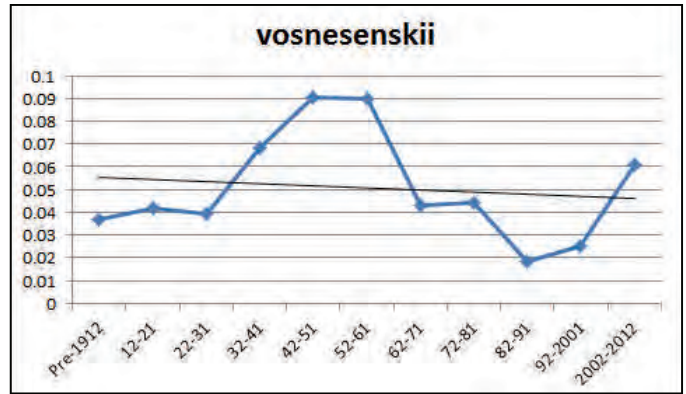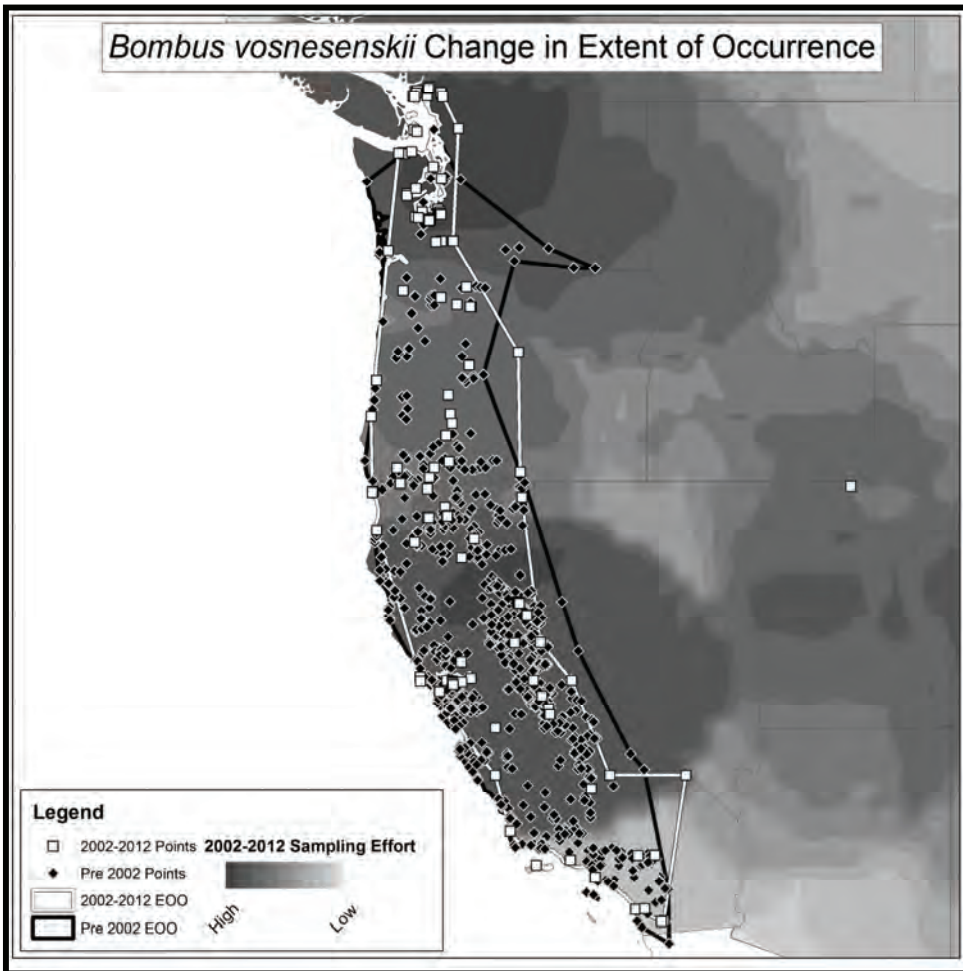

Figure 2: Map used to measure range decline for *Bombus vosnesenskii*

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