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Review

Insect pollinator conservation policy innovations at subnational levels: Lessons for lawmakers

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ABSTRACT

Global insect pollinator declines are caused by human behaviors of land uses, habitat alteration, pesticides, and others. Policies—as mutually agreed-upon limits to behaviors to achieve shared values—are necessary for addressing complex social-ecological problems like declines of insect pollinator diversity and abundance. Despite scientific calls and public outcry to develop policy that addresses declines, multi-state agreements have not delivered such legislation nor met basic monitoring needs recommended by experts. In the absence of sweeping international agreements targeting pollinator declines, national and sub-national governments are actively deploying policies to address the pollinator health crisis. Although global monitoring and conservation agreements are needed, small-scale policy innovations represent advances in laws. These sub-national actions are effectively piloting new policy instruments in terms that have proven amenable to polarized political parties. To showcase the spectrum of policy innovations, we examine pollinator-relevant polices passed by US state-level legislatures from 2000 to 2017. This timeframe captures pre- and post-publicity of pollinator declines via colony collapse disorder, the evolving research on neonicotinoids, and highly-visible bee kills. We found 110 new laws covering apiculture, pesticides, awareness, habitat, and research. Together, they narrate an evolution of bureaucratic thinking on insects. Yet when compared to policies proposed by biologists, legislators failed to address four of ten policy targets. In politically divided nations, policies that have successfully appealed to and passed laws through sub-national assemblies are predictive of large-scale conservation bills that could win broad support for national laws and international agreements.

1. Introduction

Nearly 90% of the worlds' flowering plants depend upon insect pollination for reproduction (Ollerton et al., 2011) and animals—including humans—eat those plants. Global populations of insect pollinators are experiencing declinesSS (Potts et al., 2016) due to several compounding stressors (Harrison and Winfree, 2015). A 2016 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) study estimates over 40% of the world's invertebrate pollinators are at risk of extinction mostly bees and butterflies (IPBES, 2016). Losses threaten food security for humans and wildlife as well as global economic stability. Declines are due to loss of forage and nesting habitat and a suite of other environmental stressors including pesticides, pests, and pathogens (Potts et al., 2010; Goulson et al., 2015). This phenomenon received widespread attention with the discovery of an 84% population decline of Monarch butterflies (*Danaus plexippus*) in the winter of 1996–1997 (Semmens et al., 2016) and the identification of colony collapse disorder (CCD) which killed 23% of honey bee (*Apis melifera*) colonies following the winter of 2006–2007 (vanEngelsdorp et al., 2009). The publicity of findings on lethal and non-lethal effects of a new (ca. 1990s) class of nicotine–based pesticides, neonicotinoids, on bees was catalyzed by highly visible bee kills such as the death of 25,000 native bumblebees in a retail store parking lot following the spraying ornamental trees in Hillsboro and Wilsonville, OR with dinotefuran in 2013 (Hunter, 2013). Reinforcing and amplifying public alarm are findings from the International Union for Conservation of Nature's Status and Trends of European Pollinators (STEP) assessment (Nieto et al., 2014) and the listing of the Rusty patched bumblebee (*Bombus affinis*) as an endangered species—the first bee to move from "threatened" to "endangered" status in the US

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(USFWS 2017). Concern for pollinators is surging.

Pollinators include several taxa (bats, birds, bees, flies, wasps, moths, beetles, butterflies, even mosquitoes) that inadvertently pollinate plants while foraging nectar, however bees are the only organisms that also collect pollen (Wilson & Carrill 2016). This makes bees the most effective animal pollinators, responsible for an estimated 90% of all global pollination (Buchmann and Nabhan, 1996). The world's 20,000+ species of native bees and managed bees significantly contribute to agriculture and wildlife forage (Kremen et al., 2002; Hanes et al., 2015; Vanbergen and Initiative, 2013; Kleijn et al., 2015) justifying the level of attention to bees.

In response to declines and in light of our dependence upon insect pollinators, governments are marshaling policies to stem losses of managed and native insect pollinators. Here, policy represents society's collective decisions to pursue certain objectives and goals reflecting what a government chooses to do or not to do to protect a natural resource or environmental quality (Kraft, 2018). Despite calls for specific pollinator policy targets (Dicks et al., 2016; IPBES, 2016) to address this "pollination crisis" (Kearns et al., 1998) as well as invertebrate conservation policy advice (Cardoso et al., 2011), we found no empirical studies of insect pollinator policies to review. Analysis of the policy innovations is needed in order to advise lawmakers or to evaluate the general design, adoption, and diffusion of relevant pollinator conservation policies.

To address this dearth, we first looked to US policy. from 2000 to 2017, a search of "pollinator" and "pollination" shows the United States Congress passed 4 of 31 bills addressing some aspect of pollinator health. (1) The Food, Conservation, and Energy Act of 2008 (H.R.6124) responds to CCD with appropriations "to investigate pollinator biology, immunology, ecology, genomics, and bioinformatics…on various factors… associated with colony collapse disorder, and other serious threats to the health of honey bees and other pollinators, including parasites and pathogens…sub lethal effects of insecticides, herbicides, and fungicides on honey bees and native and managed pollinators" (§7204(h)). Research should be aimed to "promote the health of honey bees and native pollinators through habitat conservation and best management practices" (§7204(h)). (2) The Agricultural Act of 2014 authorizes appropriations through FY18 for pollinator protection research (H.R.2642§7209). (3) The FAST (Fixing America's Surface Transportation) Act of 2015 encourages "pollinator habitat and forage development and protection on transportation right-of ways" via "integrative vegetation management practices…[for] habitat and forage for Monarch butterflies, other native pollinators, and honey bees through plantings of native forbs and grasses, including noninvasive, native milkweed species that can serve as migratory way stations for butterflies and facilitate migrations of other pollinators" (H.R.22§1415). (4) Lastly, in 2013, H Amdt. 189 to H.R.1947, a Federal Agricultural Reform Act, called for improved federal coordination in addressing the decline of managed and native pollinators and to promote their long-term viability. Though few, these laws represent points of consensus in a divided nation. Laws indicate CCD led to serious concern for managed bees and more research, monitoring, and habitat are needed for managed and wild insect pollinators. Despite advances in policy, no sweeping national or international coordinating actions fitting a "crisis" have emerged.

In the absence of comprehensive national legislation, subnational assemblies are authoring insect pollinator laws worthy of attention as policy innovations. US State legislatures reflect the values, opinions, and desires of the populations they represent and require interactions among rural and urban representatives (Donovan et al., 2015). Consequently, policies that emerge from these interactions reflect consensus values, cooperation, and agreement that cross traditional party-line and demographic divides such as right-left, rural-urban, rich-poor, religious-secular, etc. These policies also resonate with economic, scientific, cultural, and legal sectors (Hall et al., 2017a, b). As subnational lawmakers pilot and incubate policy actions, an analysis of these policies reveals areas of agreement amenable to lateral and vertical integration—interstate, nation state, or international—policy transfer (Fischlein et al., 2010).

Below, we catalog and analyze the pollinator-relevant policies passed (new laws) by all US state legislatures from 2000 to 2017. This timeframe captures before, during, and after widely publicized pollinator declines of the mid-2000′s following the naming of CCD (˜2005), related phenomena affecting native bees (OR bee kills 2013), the formation of IPBES (2012) and its pollinator status report (2016), as well as pre- and post-policy innovations surrounding the Obama's Pollinator Health Task Force (2014). First, we outline how we gathered and analyzed policies via content analysis. Then, we provide a thematic analysis of these new laws. We end with a discussion of how these subnational policy innovations fit calls from the science community. Following sustainability science's call to make knowledge usable (Carmen et al., 2015; Mermet, 2018), this subnational policy census and analysis aims to document policy innovations and characterize policy trends for policy interveners. This empirical account enables the lawmaking community to anticipate and improve lateral and vertical transferability of insect pollinator conservation policy.

2. Methods

In 2017, we searched for policy passed by US state and territories' legislative bodies between 2000–2017 using usa.gov and the following terms, stemmed words, and Boolean searches: "pollinator AND policy," "state policy AND pollina*," "pollination," "neonicotinoids," "pesticides," "colony collapse disorder," "beekeeping," "honeybee," and "honey bee." After initial results, we expanded the search to combine each states' name and each search term (e.g. "Illinois AND pollinator"). To ensure all states were captured, we also searched each state and territory legislative website using the above keyword combinations. States' legislature websites vary widely; some limited searching to one year at a time and others prohibited Boolean searches and/or stemmed-word searches. For triangulation, we emailed each state's legislative librarian requesting "pieces of legislation, including date passed, that pertain to pollinators which could include habitat, importance or awareness of bees and pollinators, pesticides and neonicotinoids, research, and apiculture." Responses varied. Some answered directly. The majority referred us to the state public librarian, to whom we re-sent the inquiry. We received answers from 42 states (no responses from AR, GA, LA, MS, MO, PA, SD, WV). For the eight states with no response, we repeated data searches on legislative websites and again found no new results. What resulted were 110 passed laws (Table 1).

For a systematic reading of these 110 legal documents, we conducted a content analysis (Hall and Wright, 2008; Chandelier et al. 2018; Weimer & Vining 2017) using QSR's NVivo 10.0 analytic software. Each policy was read then inductive coding generated thematic categories for further analysis (Guest and McLellan, 2003). Deductive analysis was used to examine the policies' fit with IPBES scientists' ten pollinator policy needs (Dicks et al., 2016). Because all environmental laws target human behaviors (Salzman and Thompson, 2014), policies were categorized by the specific behaviors each targeted: Apiculture practices (e.g. registering hives, inspections, disease management, equipment disposal), pesticide use (e.g. application, licensing, neonicotinoids), research (e.g. funding, CCD), habitat restoration (e.g. conservation, enhancement, development), and awareness (e.g. "pollinator weeks," knowledge needs).

3. Findings

Thirty-six states legislatures passed 110 pollinator-relevant polices during our study period from 2000 to 2017 (Table 1 Fig. 1) and fourteen states did not pass any (Table 2). Policies (1) tightened apiculture standards to manage disease and pests, (2) created task forces to update pest management approaches (pesticide use), (3) established and

Table 1
Pollinator-relevant policy passed by US State-level passed legislatures 2000–2017.

Policy of Title/Description	Category	Date of Effect
AL HB370, 2004 "Further control of honeybees and apiaries "	Apiculture	1/2006
AL SB433, 2011 "An Act to amend…to allow the AL Board of Agriculture…to establish the amount of fees or permits fees "	Apiculture	6/2011
CA AB771, 2007 "An Act to add Article 9.5…the Food and Agricultural Code, relating to agriculture."	Apiculture	10/2007
CA AB1912, 2010 "An Act to add Chapter 28…relating to bees…create the California Apiculture Research Commission in state government"	Apiculture/Research	9/2010
CA AB1789, 2014 "An Act to add Section 12838… relating to pesticides"	Pesticides	9/2014
CA AB1259, 2015"An Act to amend Section 1745.2… and to add Section 14670.14…relating to bees, and declaring the urgency thereof"	Habitat/Apiculture	9/2015
CA AB559, 2015 "An Act to add Section 1021 to the Fish and Game Code, relating to monarch butterflies"	Habitat	2/2015
CA AB2755, 2016 "An Act to add Section 29312 to the Food and Agricultural Code, relating to agriculture"	Apiculture/Research	8/2016
CA SB826, 2016 "An Act making appropriations for the support of the government of the State of California"	Pesticides	6/2016
CO HJR1029, 2017 "Concerning the designation of Interstate Highway 76 as the 'Colorado Pollinator Highway'"	Habitat/Awareness	5/2017
CT SB231, 2016 "An Act concerning Pollinator Health"	Habitat/Apiculture/ Pesticides/ Awareness	5/2016
DE HB407, 2010 "An Act to amend Title 3…relating to the Department of Agriculture"	Apiculture	7/2010
HI SB482, 2013 "A Bill for An Act Relating to Agriculture…it is an important priority to encourage beekeeping operations"	Apiculture	6/2013
HI SB810, 2017 "A Bill for An Act Relating to Environmental Protection"	Pesticides	2/2017
ID S1266, 2014 "An Act Relating to Bees"	Apiculture	3/2014
ID SB1074, 2015 "An Act Relating to the Idaho Honey Commission"	Apiculture	3/2015
IL HB6182, 2016 "An Act concerning transportation"	Habitat	8/2016
IN SB314, 2008 "An Act to amend the Indiana Code concerning agriculture and animals"	Pesticides	7/2008
KS SB437, 2002 "An Act concerning agriculture; relating to plants and plant products, plant pests and plant dealers; certain agriculture commodities"	Apiculture	2/2002
KS SB60, 2017 "An Act concerning agriculture; relating to the Kansas Department of Agriculture"	Pesticides	6/2017
KY SJR177, 2010 "A Joint Resolution directing the… State Apiarist to work with the Transportation Cabinet and with local beekeeping clubs"	Habitat/Apiculture	4/2010
KY HB175, 2010 "An Act Relating to bees"	Habitat/Awareness	3/2010
LA HCR65, 2002 "To Memorialize…US Congress …to keep open the USDA Agricultural Research Service Honeybee Breeding…Laboratory in Baton Rouge"	Apiculture/Research	4/2002
LA HB1400, 2003 "An Act…relative to Apiculture fees, to provide for Apiculture registration and inspection fees""	Apiculture	6/2003
LA HB234, 2012 "To enact R.S. 47:463.155, relative to motor vehicle special prestige plates…save the honeybee"	Apiculture/Awareness	5/2012
LA HB1, 2012 "An Act making annual appropriations for Fiscal Year 2013-2014 for the ordinary expenses of the executive branch of state government"	Apiculture/Pesticides	6/2012
MA S2263, 2014 "Text of the Senate amendment…for the preservation and improvement of land, parks and clean energy in the Commonwealth"	Research	7/2014
MD HB208, 2008 "An Act concerning agriculture- Wild Pollinators Program"	Habitat/Awareness	4/2008
MD HB132, 2016 "An Act Concerning State Government- Pollinator Habitat Plans"	Habitat	7/2016
MD JB830, 2017 "An Act concerning Pollinator Habitat Plans – Plan Contents – Requirements and Prohibition"	Habitat/Pesticides	5/2017
MD SB198, 2016 "An Act concerning neonicotinoid pesticides – Restrictions on Sales and Use (Pollinator Protection Act of 2016)"	Habitat/Pesticides	5/2016
ME Public Act 620, 2006 "An Act to Make Revisions to the Laws Governing Pesticide Control"	Pesticides	5/2006
MI HR309, 2016 "Substitute for House Resolution No. 309. A Resolution to declare June 20-26, 2016, as Pollinator Week in the state of Michigan"	Awareness	6/2016
MI HR120, 2017 "A Resolution to declare June 19-25, 2017, as Pollinator Week in the state of Michigan"	Awareness	6/2017
MN HF976, 2013 "Agriculture Appropriations"	Habitat/Pesticides	5/2013
MN HF2798, 2014 "A bill…prohibiting plants treated with pollinator lethal insecticide from being labeled or advertised as beneficial to pollinators"	Pesticides	5/2014
MN SF698, 2015 "A Bill for an act relating to natural resources; appropriating money from environment and natural resources trust fund"	Research	5/2015
MN HF3353, 2016 "An Act relating to agriculture; establishing voluntary solar site management practices for solar sites"	Habitat	5/2016
MN SF2963, 2016 "An Act relating to natural resources; appropriating money from environment and natural resources trust fund"	Research/Research	5/2016
MN SF3018, 2016 "Solar Site Management"	Habitat	5/2016
MN HF1545, 2017 "A bill for An Act relating to agriculture" (Omnibus Agriculture Bill)	Habitat/Pesticides/ Research	5/2017
MN SF550, 2017 "A Bill for an act relating to natural resources; appropriating money from environment and natural resources trust fund"	Research/Habitat	5/2017
MO SB4722, 2017 "To repeal section 144.010…and to enact in lieu thereof one new section relating to sales taxes associated with honey bees"	Apiculture	2/2017
MT SB0322, 2009 "An Act revising laws related to apiculture"	Apiculture	4/2009
MT HB0265, 2015 "An Act allowing use of alfalfa seed assessments, grants, and gifts for the alfalfa leaf-cutting bee program"	Apiculture	3/2015
MT HB0345, 2017 "An Act revising the definition of 'livestock'… providing that honey bees are included in the definition of 'livestock'"	Apiculture	3/2017
NE LB835, 2004 "An Act relating to agriculture; to amend sections… to change and eliminate provisions of the Nebraska Apiculture Act"	Apiculture	3/2004
NE LB274, 2005 "An Act relating to motor vehicles"	Apiculture	4/2005
NH SB403, 2000 "An Act making an appropriation to the Department of Agriculture…for the inspection of apiaries and honeybee swarms"	Apiculture	8/2000
NH HJR12, 2008 "A Resolution relative to support for research into Colony Collapse Disorder"	Apiculture/Research	5/2008
NJ A1294, 2015 "An Act concerning Apiculture activities and the right to farm, and amending and supplementing P.L.1983, c.31"	Apiculture	7/2015

(*continued on next page*)

Table 1 (*continued*)

Policy of Title/Description	Category	Date of Effect
NJ A1295, 2015 "An Act concerning the regulation of Apiculture activities, and supplementing Titles 4 and 40 of the Revised Statutes"	Apiculture	7/2015
NJ A1296, 2015 "An Act concerning man-made bee hives, and supplementing Title 4 of the Revised Statutes"	Apiculture	7/2015
NJ AJR98, 2016 "A Joint Resolution designating June of each year as "Native Plant Appreciation Month" in New Jersey"	Habitat/Awareness	12/2016
NJ AR216, 2017 "An Assembly Resolution encouraging homeowners to plant native plants that support bee populations and create habitat for pollinators"	Habitat	6/2017
NM HJM01 "A Joint Memorial recommending that New Mexico consider naming the Sandia Hairstreak the official New Mexico Butterfly"	Awareness	2/2002
NM JM062 2008 "A Memorial requesting…Department of Agriculture and the New Mexico State University …Assess the State's Honeybee Population"	Apiculture / Research	2/2008
NM HB0715, 2009 "An Act relating to pesticides; Changing certain applicator licensing requirements"	Pesticides	4/2009
NM HJM004, 2009 "A Joint Memorial requesting that state agencies…work with other agencies… to share information about key wildlife corridors"	Habitat	3/2009
NM HM004, 2010 "A Memorial requesting that state and county agencies…using existing resources, use pollinator-friendly plants in landscaping projects"	Habitat/Awareness	2/2010
NM SJM004, 2017 "A Joint Memorial recognizing the Legislature's support for a voluntary pollinator-friendly plant labeling project at local nurseries"	Awareness	3/2017
NV AB631, 2001 "An Act relating to agriculture; expanding the purposes…quarantine officer may proclaim a quarantine of agricultural commodities"	Apiculture	7/2001
NV SB1266, 2009 "An Act relating to state emblems; designates the Vivid Dancer Damselfly (Argia vivida) as the official state insect of the State of Nevada"	Awareness	4/2009
NY SR1771, 2017 "A Resolution commemorating the 47th Anniversary of Earth Day on April 22, 2017"	Awareness	4/2017
NY AB3004, 2017 "Capital Projects…Biodiversity stewardship and research"	Habitat/Apiculture/ Pesticides/ Research	4/2017
NY AR694, 2017 "Memorializing Governor Andrew M. Cuomo to proclaim June 19-25, 2017, as Pollinator Week in the State of New York"	Awareness	6/2017
OH SB159, 2016 "An Act to amend…'Monarch Butterfly' license plates…with identifying words or markings…designed by Monarch Wings Across Ohio"	Habitat	5/2016
OH SB207, 2017 "An Act to amend sections…state treasury license plate contribution fund"	Habitat/Apiculture	4/2017
OR HB4139, 2014 "An Act relating to pollinator health; and declaring an emergency"	Pesticides/Research/ Awareness	2/2014
OR HB3362, 2015 "An Act relating to pollinator health"	Apiculture/Pesticides / Research	7/2015
OR HCR9, 2015 "Resolved…making pollinator health a priority…existing programs and new opportunities to educate the public about pollinator health"	Awareness	5/2015
PA SR137, 2007 "A Resolution recognizing the importance of pollinators to ecosystem health and agriculture in this Commonwealth"	Awareness	6/2007
PA HR861, 2010 "A Resolution designating the week of June 21 through 27, 2010, as "Pollinator Week" in Pennsylvania"	Awareness	6/2010
PA HR337, 2011 "A Resolution designating the week of June 20 through 26, 2011, as "Pollinator Week" in Pennsylvania"	Awareness	6/2011
PA HR637, 2012 "A Resolution designating the week of June 18 through 24, 2012, as "Pollinator Week" in Pennsylvania"	Awareness	3/2012
PA HR376, 2013 "A Resolution designating the week of June 20 through 26, 2013, as "Pollinator Week" in Pennsylvania"	Awareness	6/2013
PA HR904, 2014 "A Resolution designating the week of June 16 through 23, 2014, as "Pollinator Week" in Pennsylvania"	Awareness	6/2014
PA HR364, 2015 "A Resolution designating the week of June 15 through 21, 2015, as "Pollinator Week" in Pennsylvania"	Awareness	6/2015
PA HR924, 2016 "A Resolution designating the week of June 20 through 26, 2016, as "Pollinator Week" in Pennsylvania"	Awareness	6/2016
PA HR387, 2017 "A Resolution designating the week of June 19 through 25, 2017, as "Pollinator Week" in Pennsylvania"	Awareness/Apiculture	6/2017
RI S3126, 2008 "A Resolution proclaiming the week of June 22-28, 2008 as Pollinator Week in the State of Rhode Island"	Awareness	6/2008
TN HB1671, 2011 "An Act to amend Tennessee Code Annotated, Title 44, Chapter 15, relative to restrictions on keeping honeybees in hives"	Apiculture	5/2011
UT HB0132, 2007 "Registration and license requirements for pesticide businesses and applicators"	Pesticides	3/2007
UT HBO322, 2010 "This bill makes changes to Title 4, Utah Agricultural Code"	Apiculture	3/2010
UT SB0231, 2014 "Agricultural amendments to…the Utah Bee Inspection Act; the Utah Pesticide Control Act; The Utah Nursery Act"	Apiculture/Pesticides	4/2014
UT HB0344, 2017 "Utah Agriculture Code Amendments"	Apiculture/Pesticides	3/2017
VA SB200, 2004 "An Act to amend and reenact § 3.1-610.26:1 of the Code of Virginia, relating to beekeeper assistance"	Apiculture	3/2004
VA HB1331, 2008 "Agriculture and Consumer Services, Department of; recodifying laws pertaining to agriculture"	Apiculture/Research/ Awareness	3/2008
VA SB1471, 2011 "An Act relating to the elimination of certain advisory boards, councils, and other advisory collegial bodies"	Research	3/2011
VA SB259, 2014 "An Act to authorize the issuance of special license plates for supporters of pollinator conservation bearing the legend: protect pollinators"	Awareness	3/2014
VA SB356, 2016 "An Act to amend the Code of Virginia…relating to Virginia Pollinator Protection Strategy"	Habitat/Apiculture / Pesticides/ Research	2/2016
VA SB434, 2016 "An Act…special license plates for supporters of pollinator conservation bearing the legend: Protect Pollinators"	Habitat/Awareness	3/2016
VT H539, 2016 "An Act relating to establishment of a Pollinator Protection Committee"	Habitat/Pesticides/ Awareness	5/2016
WA HB2995, 2000 "An Act relating to apiaries"	Apiculture/Research	3/2000
WA HB2300, 2004 "An Act relating to applying pesticides"	Pesticides	3/2004
WA SB1648, 2007 "An Act relating to agricultural operations, activities, and practices"	Apiculture	4/2007
WA SB6468, 2007 "An Act relating to the taxation of honey beekeepers"	Apiculture	3/2008
WA SB6057, 2015 "An Act relating to stimulating economic development through the use of tax preferences and streamlined tax administration"	Apiculture	3/2015
WA HB278, 2016 "An Act relating to supporting agricultural production, including that of apiarists, through the preservation of forage for pollinators"	Habitat	3/2016
WI JR61, 2013 "A Joint Resolution proclaiming the third week of June as Pollinator Week"	Awareness	2/2014
WY SF0080, 2000 "An Act relating to agriculture and animals; providing an appropriation from the leaf-cutter bee account as specified"	Apiculture	3/2000
WY S3, 2010 "An Act relating to apiaries; providing and amending definitions"	Apiculture	3/2010
WY HB1, 2011 "General government appropriations"	Apiculture	3/2011

(*continued on next page*)

Table 1 (*continued*)

Policy of Title/Description	Category	Date of Effect
WY SEA29, 2012 "General government appropriations"	Apiculture	3/2012
WY HB1, 2013 "General government appropriations"	Apiculture	2/2013
WY HB1, 2014 "General government appropriations"	Apiculture	3/2014
WY SF1, 2015 "General government appropriations"	Apiculture	3/2015
WY SF1, 2016 "General government appropriations"	Apiculture	3/2016
WY HB1, 2017 "General government appropriations"	Apiculture	3/2017

improved pollinator habitat, (4) funded research and monitoring for managed bees and native insect pollinators, and (5) raised public awareness about pollinators. We detail each below.

3.1. Apiculture: bees as livestock

State legislators have a record of responding to changes in the apicultural industry using policy tools to address disease, pests, and other threats for honey bee apiculture and other managed bees. For example, in 1883 to address American foul brood, a bacterial (*Paenibacillus larvae*) disease in honey bees, California State Legislature passed the first state-level apiary inspection law in 1883 authorizing "Inspectors of Apiaries" to inspect for "the disease known as 'foul brood' …in any apiary… and direct the person in charge thereof to destroy all hives ascertained to be so affected" by burying or burning the infected hives and bees (CA §Chapter LVIII, 1883). US Congress passed a similar law, the Honeybee Act, that restricted importing honey bees to prevent the spread of "diseases or parasites harmful to honeybees" amended in 1976 to prevent "undesirable species or subspecies of honeybee," i.e. Africanized honey bees (US Public Law 94–319, 1976). This political responsiveness extends to significant events occurring from 2000 to 2017.

In this study's focal years, most apiculture policy continues to change, clarify, or update existing statutes on disease prevention in apiaries or threats to hive health. States added hive registration requirements (LA HB1400, 2003) and established (OR HB3362, 2015), increased (AL HB370, 2004; MT SB322, 2009), and clarified (ID SB 1266, 2014) registration fees. States clarified penalties for apiaries out of compliance with inspection regulations (DE HB 407, 2010), and for handling, moving, and disposing of used equipment (WA HB2995, 2000; NV AB631, 2001; LA HB1400, 2003; NE LB 835, 2004; MT SB322, 2009; AL SB433, 2011; UT SB0231, 2014; UT HB0344, 2017).

Table 2
Number of insect pollinator policies passed per US state, 2000 – 2017.

# of Policies	# of States	States
0	14	AK, AZ, AR, FL, GA, IA, MS, NC, ND, OK, SC, SD, TX, WV
1–2	22	AL, CO, CT, DE, HI, ID, IL, IN, KS, KY, ME, MA, MI, MO, NE, NV, NH, OH, RI, TN, VT, WI
3–4	6	LA, MD, MT, NY, OR, UT
5–6	3	NJ, VA, WA
7	2	CA, NM
8–9	3	MN, PA, WY

Globally, the fraction of pollinator-dependent crops to all agricultural crops has increased as a percentage of total agricultural production from 3.6% in 1961 to 6.1% in 2006 (Aizen and Harder, 2009). In the US, an estimated 13 varieties of crops depend exclusively upon insect pollination, including watermelon and cocoa (Klein et al., 2007). Although the honey bee is considered the most important commercial pollinator among domesticated bees accounting for approximately 90% of managed pollination (Allsopp et al., 2008), other managed bees are equally or more effective for pollination. Several western states passed policies addressing alfalfa leaf-cutter bees (*Megachile rotundata*), blue orchard bee (*Osmia lignaria*), and other managed species requiring similar registration of "pollination apiary sites" and quarantine policies (MT SB322, 2009; WY S3, 2010; MT HB265, 2015). The Leaf Cutter Bee Fund in Wyoming helps oversee overall health of these managed

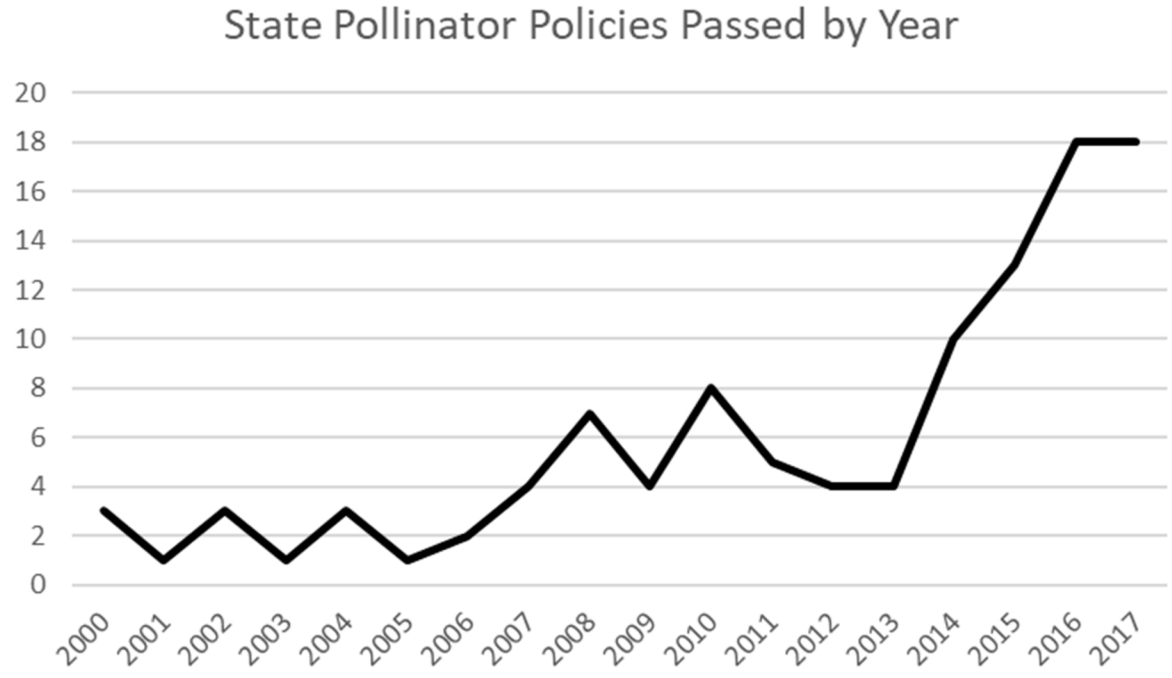

Fig. 1. Number of s tate pollinator policies passed and approved by Legislatures and signed into law by Governors by year.

pollinators, and receives state-appropriated funds to help (WY SF0080, 2000; WY HB1, 2011; WY SEA 29, 2012; WY HB1, 2013; WY HB1, 2014; WY SF1, 2015; WY SF1, 2016; WY SF1, 2017).

In 2005, a variety of ailments leading to honey bee hive die-offs, including mite infestation (*Varroa destructor* and *V. jacobsoni*), was labeled Colony Collapse Disorder (CCD) (vanEngelsdorp et al., 2009). Over the winter of 2006–2007 in the US, an estimated 23% of beekeeping suffered from CCD; those affected lost 45% of their bees (Cox-Foster et al., 2007; vanEngelsdorp et al., 2007). State legislatures mobilized policy to appropriate resources for CCD research and management. In 2008, the New Hampshire legislature appropriated "funds… for the purpose of inspection… [and] additional funding for essential research on colony collapse disorder and urges funds be allocated for regenerating the bee population" (HJR12). Other states passed similar legislation (NM HM62, 2009) or targeted policy to address Varroa mites (*Varroa destructor* and *V. jacobsoni*) (CT Public Act 16–17, 2017). To alleviate economic impact of CCD, Washington state offered "temporary business and occupation tax relief for Washington's apiarists" (SB6468, 2008).

With public calls to protect and enhance bee populations, hobby beekeeping has increased in popularity (Shevory, 2010) despite unintended consequences to native bee populations (Colla and MacIvor, 2017). The rise of hobby apiculturists and apiaries poses new concerns for legislators. In response, states have adjusted classifications of bees as "livestock" for the purposes of distinguishing what is taxed and must adhere to livestock laws (NV AB631, 2001; NE LB275, 2005; WA SB1648, 2007; WA SB6057, 2015; MO SB472, 2017; MT HB345, 2017). Montana defines 'hobbyist beekeepers' as those "who owns a total of no more than five hives" exempting hobbyists from paying registration fees (SB322, 2009). Hawaii hobbyist beekeepers do not need to obtain permits for hives or honey processing because "honeybee populations are declining at a rapid rate" (SB482, 2013). By reducing legal and financial restrictions for hobbyist beekeepers applied to commercial apiaries, states incentivize beekeeping. "The legislature further finds that the best way to make beekeeping an attractive proposition in Hawaii is to make it easier and financially viable for beekeepers" (HI SB482, 2013). Increased legislative attention to the importance of managed and native bee populations evidences a new way of thinking about pollinating insects among lawmakers.

3.2. Evolving views of bees and insects as beneficial: revisiting pesticides

Historically, agricultural statutes have indiscriminately included insect pollinators among other crop pests or bugs. Since 2000, state legislatures are catching codified law up with the "new" notion that not all insects are pests. Beneficial insects, a concept active within integrated pest management (IPM), took a while to enter in agricultural policy related to pesticide application. For example, Maine defines beneficial insect as those" that, during their life cycle, are effective pollinators of plants, are parasites or predators of pests or are otherwise beneficial" (ME Public Act 2006). Similar language is found in IN SB314 (2008).

In light of this evolving view of insects, from 2000 to 2017 many states directed their departments of agriculture (US Department of Agriculture—USDA—partner) and departments of environmental management (EPA partner) to revisit pesticides used, application and disposal rules, pesticide training, licensing, and oversight programs attentive to bees and insect pollinators as beneficial insects. These include: Indiana (IN SB314, 2008), New Mexico (NM HB715, 2009), Maine (ME Public Act 620, 2006), Kansas (KS SB60, 2017), and Minnesota (MN SF550, 2016).

A few state legislatures have targeted the effects of neonicotinoids to explicitly address "declining pollinator health." While many states reiterate the need for compliance with pesticide application requirements and encourage voluntary best management practices for pesticide users (i.e. VA S356, 2016), other states are taking more prescriptive approaches to managing pesticide-pollinator relationships. California's AB 1789 (2014) initiated a reevaluation of four neonicotinoids—thiamethoxam, clothianidin, dinotefuran, and imidacloprid—by July 1, 2018 because data showed "a potential hazard to honey bees." Hawaii's SB810 (2017) amended existing statutes to require permits to apply or plant seeds coated with any type of neonicotinoid after June 30, 2018 stating these "insecticides also have sublethal effects [on insect pollinators], including impaired foraging and feeding behavior, disorientation, weakened immunity, delayed larval development, and increased susceptibility to viruses, diseases, and parasites." Maryland's Pollinator Protection Act of 2016 (SB 198) directs the MD Department of Agriculture to "review the State's pesticide laws and regulations and make recommendations for any changes necessary to ensure state laws and regulations are protective of pollinators" and report the findings and recommendations to the governor. The Act restricts retail sales of neonicotinoids and limits application of neonicotinoids to certified applicators and fines violators (MD SB198, 2016).

In response to findings of neonicotinoids' negative health effects on insect pollinators (Goulson et al., 2015; Tsvetkov et al., 2017; Woodcock et al., 2017), several state legislatures updated pesticide application and licensing rules. Kansas' KS SB60 (2017), directs the State Department of Agriculture to address drifting of pesticides "on non-target organisms… and the likelihood of injury…to pollinating insects," amongst other potential pesticide hazards. States also use the concern for insect pollinators affected by neonicotinoids to revise, update, improve, or strengthen pesticide applicator licensing requirements (WA HB2300, 2004; NM HB715, 2009; OR HB4139, 2014; UT SB0231, 2014; UT HB0344, 2017) as well as "evaluate the effectiveness of pesticide applicator licensing and other requirements…in protecting pollinator health" (VT H539, 2016). Oregon's state legislature explicitly called for updating pesticide training regarding "alternatives to, the appropriateness of, and precautions for pesticide use that may be injurious to the health of bees and other pollinating insects" (OR HB3362, 2015) with similar policies found in Minnesota (MN HF1545, 2017). To pay for increased attention to the safety of insect pollinators, states made new appropriations (LA HB1, 2012) and developed new funding streams. For example, California uses monies from "fines and penalties imposed" from pesticides regulations to support the Department of Pesticide Regulation to "expedite the development of a pollinator protection plan" (CA SB826, 2016).

Finally, Minnesota HF2798 (2014) prohibits labeling or advertising nursery stock plants as "beneficial to pollinators" if it has been treated with "systemic insecticide" effective July 1, 2014. The statute also establishes the definition of a "pollinator lethal insecticide" as "an insecticide absorbed by a plant that makes the plant lethal to pollinators. Pollinator lethal insecticide includes, but is not limited to, the neonicotinoid class of insecticides that affect the central nervous system of pollinators and may cause pollinator paralysis or death" MN HF2798 Subd 28a (2014).

3.3. Addressing pollinator declines: Task forces on pollinator health

Shortly after the formation of the White House's Pollinator Health Task Force, Connecticut (SB231, 2016), Vermont (H539, 2016), and Oregon (HB4139, 2014) established state-level pollinator committees for examining a broad range of pollinator concerns including pesticide use, apicultural practices, wildlife-conservation tasks, habitat loss, and public awareness.

Precipitated by the "Wilsonville Bee Kill" of 2013 where linden (*Tilia* spp.) trees were sprayed with dinotefuran (Hunter, 2013), Oregon's Task Force on Pollinator Health was established in November 2014 to address best management practices explicitly for neonicotinoid use "for avoiding adverse effects from pesticides on populations of bees and other pollinating insects" (OR HB4139, 2014). One outcome of the Task Force was a new OR Department of Agriculture regulation prohibiting the use of neonicotinoids on linden (*Tilia spp.*) trees (ODA

[Oregon Department of Agriculture], 2015).

Connecticut's "Pollinator Advisory Committee" (CT SB231, 2016), is more comprehensive, comprised of the Commissioner of Agriculture, in collaboration with experts from the Connecticut Agricultural Experiment Station and the Department of Energy and Environmental Protection, to ensure "health and viability of pollinator populations… serve as an information resource… and work collaboratively" on pollinator matters. Specifically, they are to "develop best practices for minimizing the airborne liberation of neonicotinoid insecticide dust from treated seeds and mitigating the effects of such dust on pollinators" (CT SB231, 2016). Connecticut's regulation is prescriptive; limiting pesticide usage by defining a pesticide as a specific application amount (2 μg) that results in bee death of 50% or more. This level of detailed technical prescription—typically left to agency regulations within the executive branch—is unique among US state legislature policies. This act allows the Commissioner of Energy and Environmental Protection to "enforce …and establish a fine for the violation of the provisions of this section" (CT SB231, 2016).

Vermont's "Pollinator Protection Committee" was created to "evaluate the causes and occurrences of reduced pollinator ["bees, birds, bats and other insects or wildlife that pollinate flowering plants"] populations… and recommend measures the State can adopt to conserve and protect pollinator populations" (VT H539, 2016). It is composed of: The Secretary of Agriculture, two beekeepers, a dairy farmer, an NGO advocate for pollinator protection, a university employee with pollinator protection expertise, a tree fruit farmer, a vegetable farmer, a licensed pesticide salesperson, and a greenhouse operator. Like Oregon's task force, the Committee is tasked with examining other states including "international pesticide regulations," other states' education and outreach plans for pollinator health, and other states' sources of funding to address pollinator health for the purposes of evaluating "best management practices for application of neonicotinoid pesticides in a manner that avoids harm to pollinators" (VT H539, 2016).

3.4. Creating and managing habitat for pollinators

Strategic landscape-scale planning for pollinator conservation to combat decline requires addressing where insect pollinators live, forage, nest, mate, rear larvae, and over-winter (Vanbergen and Initiative, 2013). Armed with the knowledge of the importance of insect pollinators to food security, economic stability, and voting constituencies, US State legislatures have responded by creating and improving habitat on state lands. Adding this new conservation priority to existing state programs constitutes a shift in how state legislatures view public spaces. These policy actions take several forms.

State agencies' codes of regulations are being updated to include pollinator habitat priorities with and without appropriated funds. In 2010, New Mexico Legislature passed a memorandum requesting "all state and county agencies, municipalities, public schools, colleges and universities, using existing resources, use pollinator-friendly plants in landscaping," recognizing that "pollinators are essential for New Mexico's agricultural economy… bees are important pollinators of chile and other New Mexico products…Native plants tend to provide superior habitats for native pollinators… the unique flora and fauna of New Mexico attract tourism and bring income to the state and could be affected by the loss of pollinators, which help create and preserve New Mexico's beauty" (HJM004). California legislators authorized the Department of Fish and Wildlife to "conserve monarch butterflies and the unique habitats they depend upon for successful migration" through various actions including "habitat restoration on department lands, education programs, and voluntary agreements with landowners," and encourage the department to partner with federal and non-profit "entities that undertake actions to conserve monarch butterflies" (AB559, 2015). These directives mobilize agencies to find solutions within existing projects and often, existing budgets.

Most states legislatures directed agencies to respond opportunistically within existing land management programs such as along rights-of-ways like highways and roads, an approach advanced in the Presidential Memo in Section Three (The White House, 2015). Maryland's "Pollinator Habitat Plan" directs the Department of Natural Resources, Environmental Service, and State Highway Administration in consultation with the Department of Agriculture to "each" establish pollinator habitat plans that "shall include best management practices for the maintenance, creation, enhancement, and restoration" of pollinator habitats (HB132, 2016) requiring those plans to be made "available to the public on its Web site" (HB830, 2017). In Minnesota's "Omnibus Transportation Act," the Commissioner is tasked to "work to create, protect, and enhance pollinator habitat along highway rights-of way" (MN SF1545, 2017). Colorado's designation of Interstate Highway 76 as the "Colorado Pollinator Highway," encourages the Department of Transportation "to implement Integrated Roadside Vegetation Management in coordination with regional planners, local governments, and adjacent landowners in order to better manage a right-of-way to promote pollinator habitat" (CO HJR1029, 2017, CT Public Act 16–17, 2016). Kentucky's State Apiarist is directed to work with the Transportation Cabinet and "local beekeeping clubs throughout the state," and with Department of Fish and Wildlife Resources "to identify plant species that would be most beneficial to bees," as well as identify state-owned rights-of-way that could be reseeded or replanted into pollinator habitat sites that would benefit the bee population of our state" (KY SJR 177, 2010). Other states explore how similar existing right-of-way spaces such as buffers could be used as "pollinator forage zones" (VT H539, 2016; MD HB132, 2016).

In addition to right-of-ways, the management of energy landscapes—which require permitting from state—are directed to aid pollinators. For reclaimed strip mines, Kentucky's General Assembly found "reclamation coal mine sites can benefit from pollinator habitat sites" and directed the creation of a cooperative plan with the Division of Conservation "to locate and protect pollinator sites on reclamation sites" (HB175, 2010). In Minnesota, "site management practices" for photovoltaic arrays may be designed to "provide native perennial vegetation and foraging habitat beneficial to gamebirds, songbirds, and pollinators" (MN HF3353, 2016; MN SF3018, 2016). The policy allows owners to claim "that the site provides benefits to gamebirds, songbirds, and pollinators only if the site adheres to guidance set forth by the pollinator plan provided by the Board of Water and Soil Resources… and, an owner making a beneficial habitat claim must make the site's vegetation management plan available to the public and provide a copy of the plan to a Minnesota nonprofit solar industry trade association" (MN HF3353, 2016, SF3018, 2016). US state legislators are finding pollinator habitat management is complementary to many land uses and a popular use of public lands.

Policy also extends to pollinator habitat enhancement on private lands. For example, New Jersey encourages homeowners "to plant native plants that support bee populations and create habitat for all kinds of pollinator" (AR216, 2017). Various policies support developing best management practices for landowners to replace invasive plants with native plantings that produce "similar levels of pollen and nectar with a similar bloom succession" (WA HB2478, 2016; see also MD HB208, 2008; NJ AJR98, 2016). New Jersey requested their Departments of Environmental Protection and Agriculture "to work together with nurseries and landscapers in the state to develop lists of native plants that would be supportive of these efforts" (NJ AR216, 2017). For residential native bee habitat providers, New Jersey now protects "Man-made native bee hives," defined as "a tube or other apparatus in which bees may nest, and which is installed to attract native bees other than honeybees;" any person who deliberately destroys such hive is "liable to a civil penalty of up to $500 for each offense" (NJ A1296, 2015).

Perhaps the most comprehensive habitat protection signed into law is Minnesota's "Pollinator Habitat Program," requiring the Commissioner of Agriculture to develop "best management practices and habitat restoration guidelines for pollinator habitat enhancement,"

and report to the agriculture and natural resource legislative committee. The report, developed in collaboration with the Pollution Control Agency, Board of Water and Soil Resources, and representatives of the University of MN, must include proposals for establishing a "pollinator bank" to preserve pollinator species, creating "pollinator nesting and foraging habitat…including establishment of pollinator reserves or refuges," and provide criteria to evaluate neonicotinoid pesticides (HF976, 2013). When prairie restorations occur on state land or funded with state money, an "appropriate diversity" of native plantings must be included to provide habitat for pollinators throughout "the growing season" (MN HF976, 2013). To fund this program, MN established the "Pollinator Habitat and Research Account" in the agricultural fund that appropriates money to the University of Minnesota "for pollinator research and outreach" (MN HF 1545, 2017). Funds are appropriated to the Natural Resources Trust Fund, the Pollinator Research and Outreach, and the University of Minnesota until 2020, "for pollinator research and outreach… and establishment of habitat beneficial to pollinators" (MN SF550, 2017).

To fund pollinator habitat and research, state legislatures have created specialty automobile license plates. Ohio's "Monarch Butterfly" license plates identify the state's partnership with "Monarch Wings across Ohio Program," (OH SB159, 2016) and funds from plate sales are used "for protection and preservation of butterfly corridor and educational programs" (OH SB207, 2017). Illinois' Roadside Monarch Habitat Fund's enhancement and restoration projects are supported by license plate sales (HB6182, 2016). Louisiana's "Save the Honeybee" license plates funds (less administrative costs) the Louisiana Beekeepers Association "solely for financial aid for graduate students working on applied honey bee research projects at the USDA Agricultural Research Service Honey Bee Breeding, Genetics and Physiology Research Laboratory" (LA HB234, 2012). Virginia targets both monarchs and bees with the creation of "Protect Pollinators" special license plates (VA SB259, 2014), designating "$15 [per plate] shall be paid into the state treasury and credited to a special non-reverting fund known as the Pollinator Habitat Program Fund…paid annually to the Virginia Department of Transportation …to support its Pollinator Habitat Program" (VA SB434, 2016).

3.5. Policy for increasing awareness of insect pollinators

Public outcry to "save the bees" brought attention to the importance of the other 26,000+ species of pollinators in the world and North America's 4500+ species (Wilson and Carril, 2016). Decline of the honey bee populations has served to shift focus to pollination services provided by native bees (Kremen et al., 2002; Winfree et al., 2007). States used two policy tools to call attention to insect pollinators, declines, and conservation: Designating a state insect and "Pollinator Week." Such politically safe legislative actions are focused on managed bees and native bees, butterflies, bird, and mammal pollinators.

In our research, several states passed legislation designating "state insects" to bring attention to insect pollinators, bees, and butterflies as (MN HJM01, 2002; NV SB166, 2009; KY HB175, 2010). In 2002, New Mexico named the Sandia hairstreak (*Callophrys mcfarlandi*) butterfly the state butterfly, "a native New Mexican butterfly…which contributes to the beauty, diversity and enchantment of the New Mexico landscape" (NM HJM01, 2002).

In 2006, US Congress designated "National Pollinator Week" June 24–30, 2007 to "recognize the importance of pollinators to ecosystem health and agriculture" (US SR580, 2006). The policy highlights decline in "the health and populations of pollinators" as a threat to "global food webs, the integrity of biodiversity, and human health," and seeks to "increase awareness about the important role of pollinators" and to "build support for protecting and sustaining pollinators" by designating a "National Pollinator Week" (US SR 580, 2006). This designation was largely driven by the eNGO Pollinator Partnership that provided "form" text for states to customize and sign their own pollinator week designations (www.pollinator.org). By 2016, all US states had designated pollinator weeks. These designations primarily occurred through the state executive branch (Governor's Office) although five state legislatures passed "Pollinator Week" bills from 2000 to 2017 (RI S3126, 2008; MI HR309, 2016, MI HR120, 2017, NY JO 1771, 2017, PA HR861, 2010, PA HR337, 2011, PA HR637, 2012, PA HR 376, 2013, PA HR904, 2014, PA H364, 2015, PA HR924, 2016, PA HR387, 2017).

All "Pollinator Week" proclamations, shared the following preambles: "pollinator species such as birds and insects are essential partners of farmers and ranchers in producing much of our food supply," pollination plays a vital role in the health of our national forests…and economic development", and that "pollinator species provide significant environmental benefits that are necessary for maintaining healthy, biodiverse ecosystems" (RI S3126, 2008). Additional preambles validate the state role of managing "wildlife habitats" and offering "conservation assistance," but are only found in some proclamations (NY AR694, 2017; PA, HR 861, 2010; PA HR337, 2011; PA HR637, 2012; PA HR 376, 2013; PA HR904, 2014; PA H364, 2015; PA HR924, 2016; PA HR387, 2017).

Most pollinator public awareness policies are simply informative, lack deadlines, actionable items, and appropriated funding, however, such designations constitute starting points for states to tailor and advance conservation actions. For example, Michigan's updated "Pollinator Week" policies now "encourage all citizens to build support for protecting and sustaining pollinators through increased awareness and the implementation of pollinator-friendly best practices that enhance their habitat and strengthen their numbers" (MI HR309, 2016; MI HR120, 2017). New Mexico's reauthorizations of "Bee Aware Day" evidence a progression of policy action. "The people of New Mexico traditionally eat sopapillas with honey, which is becoming scarcer and costlier due to declining bee populations, and many natural remedies used by New Mexicans contain honey" (NM SM103, 2016). A year later, New Mexico's second "Bee Aware Day" added a "voluntary pollinator-friendly plant labeling project at local nurseries around the state (NM SJM004, 2017). Although light on deadlines, actions, or funding, feel-good informational policies offer standing precedent for authoring more substantial amendments capable of achieving conservation outcomes.

3.6. Research for insect pollinators

Complex social-environmental crises require baseline and monitoring data to comprehensively manage problems. US state legislatures are beginning to respond to research needs for understanding and monitoring populations of native bees, and understanding threats to both managed bees and native insect pollinators. Several legislative actions funded CCD research (CA AB1912, 2010; LA HB234, 2012; NH SB403, 2000; NH HJR12, 2008; NM HM62, 2008; OR HB3362, 2015). For the apiculture industry, these include policies supporting existing research facilities (LA HCR65, 2016) and state appropriations for new research (VA SB1471, 2011) including the creation of the California Apiary Research Commission (CA AB1912, 2010).

Legislative funding for research has expanded from a focus on managed pollinators to the importance of native insect pollinator conservation, as these organisms face many of the same threats from environmental stressors, pesticides, pests, and pathogens (Potts et al., 2010), with pests and pathogens being transferred between managed and wild populations (Fürst et al., 2014). Funding for "native" or "wild" insect pollinator research is often embedded in larger policies addressing related matters like habitat loss (MN SF3018, 2016) or outreach (MN SF550, 2017) allocated to state Universities or cooperative extension. These research allocations are for "field studies and research… to support pollinator diversity… to understand, prevent and recover from pollinator losses" (NY AB3004, 2017) and for "pollinator health" in general (MA S2263, 2014). Research for monitoring native bee species diversity and abundances has been prioritized through efforts

Box 1
Ten policies for pollinators from Dicks et al., 2016.

1 Raise pesticide regulatory standards.
2 Promote integrated pest management (IPM).
3 Include indirect and sublethal effects in GM crop risk assessments.
4 Regulate movement of managed pollinators.
5 Develop incentives, such as insurance schemes, to help farmers benefit from ecosystem services instead of agrochemicals.
6 Recognize pollination as an agricultural input in extension services.
7 Support diversified farming systems.
8 Conserve and restore "green infrastructure" (a network of habitats that pollinators can move between) in agricultural and urban landscapes.
9 Develop long-term monitoring of pollinators and pollination.
10 Fund participatory research on improving yields in organic, diversified, and ecologically intensified farming.

like the Minnesota's Native Bee Atlas (MN SF698, 2015), "Statewide Monitoring Network for Changing Habitats in Minnesota," "Data-Driven Pollinator Conservation Strategies," and "Prairie Butterfly Conservation, Research, and Breeding" (MN SF2963, 2016).

States frequently learn from each another, building upon policy design and implementation advances from others: lateral policy transfer (Lutsey and Sperling, 2008). Oregon's "Act relating to Pollinator Health," seeks to learn from other states by "investigating the means used by other states to gather data on populations of bees or other pollinating insects,…Studying proposed and enacted pesticide regulations from other states and countries that are more protective of pollinator health than the pesticide regulations of the United States Environmental Protection Agency," and "Studying public education and outreach plans regarding pollinator health that have been successful in other states" (OR HB4139, 2014; CT Public Act 16–17, 2016).

4. Discussion

The above 110 policies passed from 2000 to 2017 are the work state legislators. Although signed by state governors, the laws analyzed do not include activities of state executive offices or municipal policies. Consequently, they offer a partial picture of insect-pollinator conservation policy landscape in the US. By examining policies that passed and were signed into law, this analysis omits bills.

Although state legislators work in relative anonymity compared to Governors and US Congress, the 7383 state legislators are close to the citizens they serve for addressing pressing problems (Rosenthal, 2009; NCSL [National Council of State Legislators], 2018). In a politically divided US, where 26 Republican-controlled, 19 Democrat-controlled, and 4 split-party controlled state legislatures (2012 numbers, Donovan et al., 2015) passed 110 pollinator-relevant laws in 17 years signifies the prescience of this crisis. This analysis illustrates salient policy innovations that have satisfied political party and constituents' needs. These laws represent legal trends as well as piloted policy actions that constitute political common ground for lateral and vertical policy transfer as templates for future laws. Considering the longevity of most state legislators where incumbents win 93% of the elections and 35 states have no term limits (McDonald & Samples 2006; Donovan et al., 2015), states may be able to incubate these policy innovations to test and improve effectiveness for addressing insect pollinator declines.

These policies reflect state lawmakers becoming more aware of human behaviors and technologies that pose risks to managed and unmanaged native insect pollinators. In the mid-2000s, several state legislatures responded to the pressing needs of beekeeping industry impaired by CCD. At least seven state legislatures responded with tightened apiculture standards to manage disease and pests for managed bees and fund research from 2006–2009.

Legislation articulates public concerns. Widely public images of bee kills circulated through various media, education and outreach efforts by industry groups and NGOs amplified concern. To respond to losses of managed and native insect pollinators, California, Connecticut, Oregon, and Vermont legislatures established new bodies (e.g. task forces and commissions) to update pest management approaches (pesticide use), improve oversight, and fund research. Several state legislatures directed state agencies to establish and/or improve pollinator habitat by planting native plants or alter existing land-management regimes to enhance habitat. Others funded research and monitoring for managed bees and native insect pollinators. Thirty-six states raised public awareness about pollinators directly through "pollinator weeks" or related policies.

Trends include legislators recognizing that not all insects are pests. Consequently, pesticide technologies although good for agriculture, indiscriminately and substantially harm beneficial insects. Legislators were able to pass many "low-hanging" policies that harm few industries and work within existing budgets. Examples of politically achievable yet toothless polices include efforts to garner attention to insect pollinator declines. A few state legislatures developed more comprehensive policies (CA, CT, MN). Although some states appropriated funding for insect pollinator programs (MD, MN, NY, others) and other states (CA) developed new revenue streams from hive registry, new funding mechanisms and appropriations of funds for wide-scale implementation of conservation approaches are needed. In sum, the policies evidence what many scientists know, that policy is slow to catch up to the science—despite a wealth of expert pollination scientists in the US.

Pollinator biologists of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) propose ten policies to safeguard insect pollinators as a global vision for pollinator conservation policy (Dicks et al., 2016; Box 1). On our second read, we coded policy actions into the ten policy targets (Table 3). We found that US state legislatures failed to address four areas advanced by Dicks et al. (2016): diversified farming systems, GM crop risks, incentivize alternatives to agricultural chemicals, and integrated pest management.

Table 3
QSR NVivo nodes coding results –110 policies total (multiple node coding allowed).

Thematic Codes per Dicks et al., 2016 and authors	# of Sources	# of References
1 Conserve and or improve habitat	24	38
2 Diversified farming systems	0	0
3 GM Crop Risks	0	0
4 Incentivize Alternatives to Agricultural Chemicals	0	0
5 Integrated Pest Management	2	3
6 Monitoring	1	1
7 Moving Managed Pollinators	54	96
8 Pesticide Standards	23	48
9 Pollination as Agricultural Input	7	11
10 Research	18	22
11 Awareness (added by authors)	32	43
12 Other (added by authors)	48	66

More comprehensive policy is needed.

5. Conclusion

We outlined 110 subnational policies aimed to address the "pollinator health crisis" passed from 2000 to 2017. We identified trends within conservation policy activities of the 7383 elected US state lawmakers. With a few exceptions (CA, CT, MN, VT), these policies constitute nascent and anemic steps in addressing a pollinator health crisis. Cardoso et al.'s (2011) seven impediments to invertebrate policy describes a political dilemma where lawmakers know little of invertebrates and erroneously think that conserving habitat of larger species (often charismatic fauna) will serve the habitat needs of invertebrates. This, in part, explains some inadequacy. Science has done well to explain much of the world's taxa larger than 1.5 kg but for the majority of smaller animals, much work remains (Wilson, 2016). Insects are understudied taxa with less than 1/5 of species described (Samways, 2015). Consequently, insects are underrepresented in global conservation efforts (Barua et al. 2011). It is little doubt that conservation efforts and policy have yet to align with available scientific knowledge.

Nevertheless, three findings are promising from this analysis. First, publics are becoming more aware and, soon after, alarmed about the implications of pollinator losses. Threats to food security (availability and price) and resulting economic instability are considerable matters of national and international security. Through widespread awareness campaigns, policies suggest that reversing habitat loss and removing the suite of environmental stressors to insect pollinators is achievable. Second, policies passed by state legislatures constitute starting points that can be built upon. Points of consensus are cumulative and provide a precedent for improving law. Third, leaders within the agricultural industry are obvious partners. Managed bees are the responsibility of departments of agriculture. Administratively, native insect pollinators are categorized as "wildlife" falling under the jurisdiction of natural resource and wildlife agencies' subjected to modest budgets and stretched priorities. Research finds these "unmanaged wildlife" make significant contributions to agricultural yield (Winfree et al., 2008; Frankie et al., 2009; Hanes et al., 2015), yet these invisible workers (Peterson et al., 2010) provide services unaccounted in agricultural inputs and obscured in ledgers. Whereas, the insect pollinator health crisis is a matter of food security; and whereas insect pollinator health is in the agricultural sector's best interests, addressing species diversity and abundances of native insect pollinators needs elevated appropriations. The USDA raised concerns about an "impending pollination crisis" in 1991 (Ingram et al., 1996). Long-term monitoring of insect pollinators and research on pollinator-friendly farming systems beyond apiculture (Colla and MacIvor, 2017) are paramount and would benefit from policy prescriptions and appropriations (Dicks et al., 2016) to further unmask contributions of native bees to crop pollination and provide a more accurate model for improving conservation efforts.

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