Why honeybees need weeds; they're *medicinal!*

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ABSTRACT:

This paper reviews the importance of honeybees and how colony losses remain at unsustainable levels of 30 to 40 percent annually. It also covers the importance of forage for honeybee health and its ability to strengthen individual and colony immune response that is not possible when bees are fed sugar and protein replacements. While forage is crucial to honeybee health and survival, Washington State has noxious weed laws and practices in place that systematically remove important forage plants without replacing them. The removal of these plants costs millions of dollars and often kills more than the targeted "noxious" or "invasive" weeds. These actions are costly, destructive beyond the targeted plant to be removed, and unsustainable for the health of pollinators in Washington State.

Introduction: The importance of honeybees.

> ***"We are one poor weather event or high winter bee loss away from a pollination disaster," Dr. Jeff Pettis, USDA ARS, Oct, 2012 National Stakeholders Conference on Honey Bee Health.***

One third of managed honeybee colonies in the U.S. have died each year for the past eight years. Honeybee colony losses have always been a part of beekeeping, but losses rose to 30 to 40 percent in 2006 and continue today (Walsh, 2013; USDA, 2012). For beekeepers, losing one third of their livestock a year is now a heartbreaking reality. If one third of the nation's beef cattle died each year, "we'd be calling out the national guard," (vanEngelsdorp TED2008). Instead, about 10 million colonies have died over eight years. At a current value of about $200 each, the replacement cost is $2 billion and it has been borne by beekeepers alone (USDA, 2012).

People understand more about the importance of the foods enabled by pollinators than of the pollinators themselves. Good nutrition is an important part of human health. We understand the importance of a varied diet with foods rich with polyphenols and antioxidants – colorful fruits and vegetables that bring subtle nutrients to our bodies that strengthen our immune systems and help us combat pathogens and threats. Fruits, vegetables and, indeed, one third of the food we eat are available due to the work of pollinators like birds, some mammals and especially insects. The most important agricultural pollinator is the managed honeybee (Walsh, 2013; USDA, 2012).

In addition to pollination services worth $15 billion in today's U.S. agricultural system (Walsh, 2013), honeybees give us honey. Bees make honey from nectar that is gathered from many flowers. The nectar is stored in the bee mid-gut where enzymes from the bees start to change the nectar into honey. In the hive, bees store the nectar/enzyme mixture in cells, evaporate out the excess water, and honey results. Raw honey is a powerhouse of nutrients containing amino acids, enzymes, flavonoids, ascorbic acid, carotenoid-like substances, organic acids, and such minerals as potassium, iron, manganese, cobalt and copper. It also contains polyphenols, especially flavonoids and phenolic acids, powerful antioxidants that are antimicrobial, antifungal, antioxidant and aid in the chelation of toxic heavy metals (Othurry et al, 2011).

While bees gather nectar, they pollinate plants. It's a lovely dance between stationary flowering plants that need to exchange pollen and the bees that do the work for them (vanEngelsdorp, TED2008). Flowers get pollinated, bees get food, and we all get a rich variety of healthy fruits and vegetables. Just as the fruit and vegetables we eat are good for us, bees get important nutrients when they pollinate flowers. Research shows how natural nectars and pollens provide immune-building chemicals for honeybees that are not found in sugar and protein substitutes (DiPasquale et al 2013, Johnson et al 2012).

Honeybees live as a colony year-round. They store honey and pollen so the colony can live during winter and in times when little or no nectar is available, such as during long, hot dry spells. A honeybee colony needs to store at least 70 pounds of honey and 500 to 600 square inches of pollen to survive through months of a cold, wet Pacific Northwest winter (WSBA Certification materials). The surplus food must be found and stored during a short flowering season with an intense nectar flow. Without available flowering plants from early spring through late fall, bees cannot get enough food to sustain the colony year round.

In terms of critical forage, bees in Washington State face laws and practices that remove vast areas of important forage without policies or coordinated efforts to replace those plants. Moreover, existing control methods that target some noxious or invasive plants also kill other key honeybee forage that is not designated as noxious or invasive plants.

The Washington State Noxious Weed Board recognizes "how serious the decline of pollinators can be" and agree that "noxious weed control and pollinator preservation are not mutually exclusively endeavors" (NWCB Report, 2014). Hopefully, beekeepers, weed boards and state agencies can work more closely to refocus plant eradication goals and revise laws, policies and actions to make Washington State more hospitable to honeybees and beekeepers. By keeping or replacing forage plants now being eradicated, we will provide important nutrition for honeybee colonies.

The importance of nutrition for the honeybee colony

> ***Honey constituents up-regulate (strengthen) detoxification and immunity genes in the western honeybee, (Mao et al, 2013).***
>
> ***Proper pollen nutrition enhances stress resistance, helps bees defend against pesticide exposure, decreases susceptibility to viruses, and helps bees resist negative impact of pests and diseases,"***
> ***Dr. Marla Spivak, UMN Bee Squad April 2014 Management Issue.***

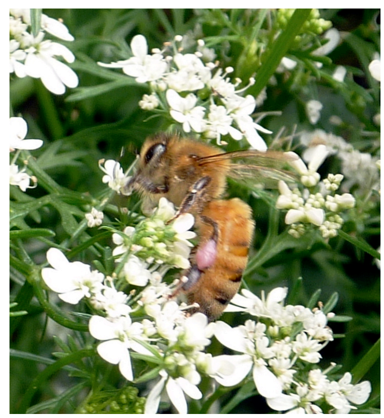
Health, for honeybee colony, is defined by having an absence of disease and also by having many well-nourished individuals capable of raising young and resisting pathogens, parasites, infections, insecticides, and periods of nectar dearth. Adult bees need to be well nourished to raise healthy young bees that, in turn, will raise the next generation of bees for the colony. Malnourished larvae become impaired adults with a shortened life span, reduced weight and reduced wing and body size – all of which effect the bee's ability to forage and bring home food for future generations of bees (Brodschneider and Crailsheim, 2010).

With its crowded living conditions and closely related nest mates, a honeybee colony is plagued by a large number of pest and pathogens. Individual honeybees have far fewer detoxification genes than other insects (Claudianos et al, 2006). Honeybees compensates by bringing compounds to the hive that boost their individual and colony immune responses; propolis, nectar and pollen.

Nature's Detox Program for Honeybees – Propolis, Nectar and Pollen

Scientists have found that constituents in propolis, nectar and pollen are important to strengthening the immune response in honeybees.





*(Photos from left) *Returning foragers line up to bring pollen to the hive. *Honeybee getting strawberry nectar which means we get strawberries, an important immune-building food for humans. *Who knew that cilantro pollen is pink?*

Bee weapons come from plants that contain polyphenols, the chemicals that plants use for their own defense against ultraviolet radiation and pathogens. Polyphenols include lignans, stilbenes, flavonoids and *phenolic acids*. Scientists do not fully understand all of the actions and interactions of polyphenols, but they know their value in slowing human degenerative diseases like cancer and heart disease (Manach et al, 2004).[1]

[1] That's why we're told to eat at least five helpings of fruit and vegetables a day – the chemicals found in those foods are good for us.

There are two primary types of *phenolic acids* – those derived from benzoic acids and those derived from cinnamic acids. Benzoic acids include antioxidant properties as found in tea, mangos and brightly colored berries. Cinnamic acids consist primarily of caffeic, ferulic, sinapic and *p-coumaric acids*. Coffee, artichokes, blueberries, kiwis, plums, cherries, apples and whole grains have high concentrations of p-coumaric acids (Manach et al, 2004).

P-coumaric acids work by interacting with and strengthening the P450 detoxification genes. P450 genes are the principal Phase I detoxification enzymes in organisms, especially insects, which help them metabolize foreign substances (Mao, Schuler and Berenbaum, 2012).

Honeybees have fewer P450 genes than other insects (Claudianos et al 2006):

- Mosquitos have 106 P450 genes,
- Flies have 85, but
- Honeybees have only 46.[2]

Of the several chemicals found to induce the P450s genes, *p-coumaric acid* is one of the strongest inducers. In honeybees, p-coumaric acid encodes 31 specific Phase I, Phase II and Phase III enzymes that metabolize mid-gut bacteria, microbes and pesticides (Mao, Schuler and Barenbaum, 2012). P-coumaric acid, found in honey and in the cell walls of pollen, "trigger surges of activity in genes needed for detoxifying chemicals or for making antimicrobial agents" (Milius, 2013). Compounds in propolis, nectar and pollen interact with p-coumaric acid with additive or even synergistic effects to regulate detoxification and strengthen the immune response in honeybees (Mao, Schuler and Berenbaum, 2012).

[2] Humans also have fewer P450 genes than do some other animals – 57 functional P450s (Nelson et al, 2004), and humans also benefit from foods rich in polyphenols that boost our immune systems. Maybe human health is more closely linked to bees and the foods that they pollinate than we recognize.

Honeybees enhance the colony-level defenses by using highly antimicrobial tree resins within the hive. When mixed with wax, these resins become propolis. When propolis is abundant in the hive, it lowers hive bacteria levels and strengthens the immune response in larvae and young bees (Heinecke, 2011b; Simone, Evans and Spivak, 2009). The same chemical processes that allow propolis to strengthen the honeybee immune response also happen when bees bring nectar and pollen to the hive (Di Pasquale et al 2013; Mao et al, 2012; Claudinos, 2009; Escuardo et al, 2006).

Nectar provides the colony with carbohydrates as well as amino acids, enzymes, flavonoids, polyphenols, ascorbic acid, organic acids, and such minerals as potassium, iron, manganese, cobalt and copper (Othurry et al, 2011).

Pollen is the only source of protein for the honeybee colony. It contains lipids, starch, steroids, vitamins and minerals. Pollen enables bees to produce jelly that feeds larvae, the queen, drones and older worker bees. Pollen positively influences metabolism, immunity and tolerance to such pathogens as bacteria, viruses and microsporids. It reduces the honeybee susceptibility to pesticides and helps honeybees tolerate parasites (Di Pasquale et al, 2013).

Pollens have different levels of proteins and amino acids (Huang, 2010), and pollens with especially high levels of protein induce the highest level of gland development in young bees (DiPasquale et al 2013). Huang (2010) evaluated several single source pollens and found that ragweed (Ambrosia), cattail (Typha) and Mexican poppy (Kallstoemia) decrease worker longevity. Single source pollens that slightly improve worker longevity include desert broom (Baccharis) and dandelion (Taraxacum). The best pollens are found in cottonwood (Populus) and *blackberry* (Rubus) (Huang, 2010).

In summary: Nutritional diversity can shape bee health. Honeybees need a variety of season-long plants to provide enough food for the colony to live all year long. Chemicals in propolis, nectar and pollen help to strengthen individual and colony responses to pathogens, pests and parasites. This is important because individual honeybees have fewer detoxification genes than other insects. Bees are generalist pollinators (Ostiguy, 2010). In a diverse and healthy ecosystem with many flowering plants available all season long, bees get the variety of nectar and pollen needed to provide food for the colony and to strengthen and detoxify the hive. Blackberry pollen has been found to be especially high in immune-strengthening nutrients.

A closer look at blackberry honey and pollen

The highly antimicrobial properties of honey have been known for thousands of years, and are attributed to phenols found in the honey. Phenolic acids are used to study honey from flowers of citrus, rosemary, sunflowers, Eucalyptus and chestnut, to name a few, and recently were used to study the different compounds and antibacterial activity of Rubus (blackberry) honey in Spain (Escuardo et al 2011).   Like Western Washington, the Northwest region of Spain, Galicia, has growing conditions that favor blackberry plants, which colonize abandoned agricultural land and are found in mixed forests and in areas that also include clovers and other legumes.

Studying 23 different samples of honey from 2008 to 2010, Escuardo et al (2011) found 65 pollen types. Blackberry pollen was the most dominate in each honey sample, accounting for 45 percent of the pollen, a level that corresponds to monofloral blackberry honey. The polyphenol content of the blackberry honey is recognized as having great scientific and therapeutic interest due to its strong antimicrobial activity (Escuardo et al 2011).

Blackberry pollen has important properties for honeybees. All pollen has the ability to positively influence metabolism, immunity and tolerance to such honeybee colony pathogens as bacteria, viruses and reducing sensitivity to pesticides. Blackberry pollen was found to have more proteins and antioxidants than other pollens evaluated, with nearly double the proteins and amino acids and almost five times the antioxidant capacity as Cistus pollen (Di Pasquale 2013):

Nutritional factor contents in different pollen (Di Pasquale, 2013)

Pollen diet	**Proteins**	**Sugars**	**Amino Acids**	**Antioxidants**
Cistus	12	5.2	11.9	103
Erica	14.8	4.8	16.27	196
Castanea	21.6	5.0	18.68	399
Rubus	22	6.7	19.98	475
Mixed	17.6	5.4	16.71	293

with Cistus, Erica, Castanea and Rubus pollen.

Di Pasquale et al (2013) show that the quality of pollen influences the bee tolerance to Nosema ceranae, a particularly virulent parasite that infects the honeybee intestinal tract. While infection by Nosema ceranae decreased bee survival, high quality pollen nutrition increased the survival of both healthy bees and those infected with the parasite. When colonies were exposed to Nosema ceranae and fed only one floral pollen source, blackberry pollen was found to be the most beneficial to honeybee survival (Di Pasquale et al 2013).

Clearly, natural nectar and pollen is important to honeybee health. Honey and pollen from blackberries is especially health promoting (Di Pasquale et al 2013, Escuardo et al 2012, Huang 2010). Blackberry also is the most important plant to non-migratory beekeepers in Western Washington (Honeybee Work Group, March 2014). It is the only plant that provides adequate nectar for honeybees in Western Washington to store enough surplus food for winter survival and give non-migratory beekeepers some extra honey to harvest. But, many blackberries are listed as Class C noxious weeds in Washington, and beekeepers report that vast expanses of blackberry are being removed and no replacement forage is being planted.

Perhaps it’s time to rethink the importance of blackberries in Western Washington. Indeed, perhaps it is time to redefine the importance of many plants considered to be noxious or invasive to our land. At the very least, it is time to give weighted consideration to the importance of forage for honeybee health, and it's time to put systems into place where forage is replaced after important food sources for bees are removed due to their listing as noxious weeds.

This is not the kind of weed being proposed for honeybees, but who knows? Perhaps this honeybee forager knows of secrets found in the nectar and pollen of this kind of "weed."

Noxious weeds in Washington

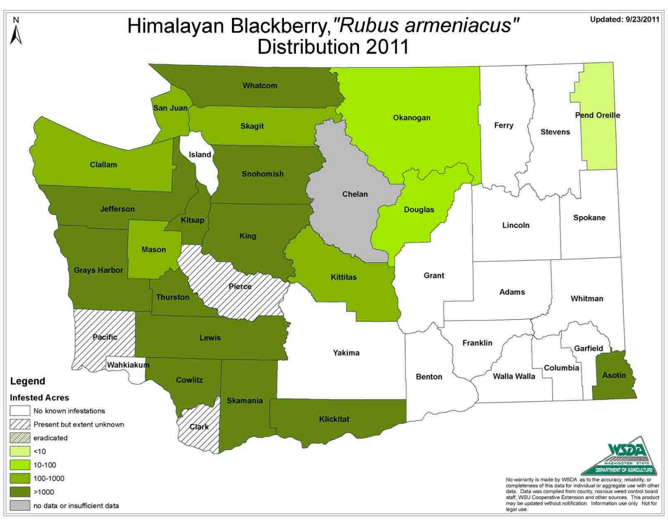
In Washington State, a "noxious" weed is a term used for a plant that is difficult to control and which may be considered to be destructive to agriculture and natural resources (NWCB, 2014). The determination is based on a plant's beneficial uses weighed against the detrimental impacts: "Some plants provide erosion control, ornamental value, medicinal properties, or nectar and pollen for bees, but their ecological or economic impacts outweigh the beneficial uses" (NWCB, 2013).

There are many reasons for plant removal. In some cases, plants are removed to support restoration of animal species (e.g. habitat near salmon-rearing streams) or to remove non-native species that outcompete native plants (e.g. knotweeds displacing native willow habitats) (NWCB 2014). Sometimes, plants are controlled to increase safety along state highways. The concern is when important pollinator forage plants are removed, for whatever reason, and not replaced with forage of equal value.

Of the 142 plants on the Washington State noxious weed list (NWCB.wa.gov), 27 are important pollinator forage plants and include knapweeds, knotweeds, thistles, blackberry, English ivy, and Russian olive (Heinecke, 2011a). Of those 27:

- Six are listed as Class A weeds with eradication required by law,
- Fifteen are listed as Class B weeds where control may be decided at the local level or may be designated for mandatory control by the State weed board, and
- Six are listed as Class C weeds; counties can decide on removal or control.

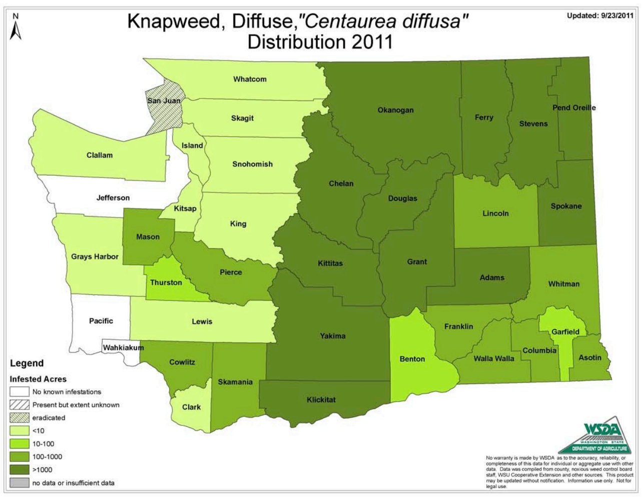
Himalayan blackberry (Rubus armeniacus) is among the listed Class C weeds. It is widely distributed in Western Washington (NWCB 2014), and local jurisdictions can decide whether and how to control. While the weed board does not mandate control of blackberry plants, vast tracts are being removed across Western Washington by counties, cities, park districts and other jurisdictions (Honeybee Working Group, 2014.) The cumulative effect of eradication on honeybees and beekeepers in Western Washington is unknown.



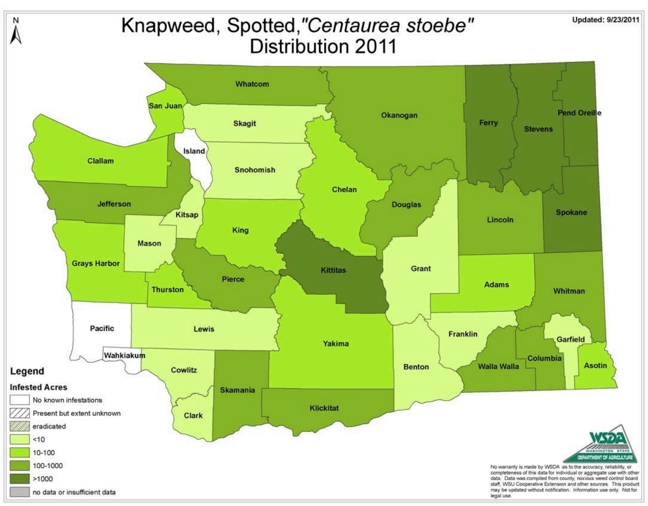
Himalayan Blackberry is a Class C listed noxious weed in Washington, and control is determined at the local level. Blackberry is the most important forage plant for beekeepers in Western Washington. Many beekeepers are seeing the steady removal of this plant through control efforts of separate jurisdictions. Darker green indicates more expansive plant distribution.

Control methods used on knapweeds and thistles kill most or all broad-leafed plants in the area and have long-term residual effects.

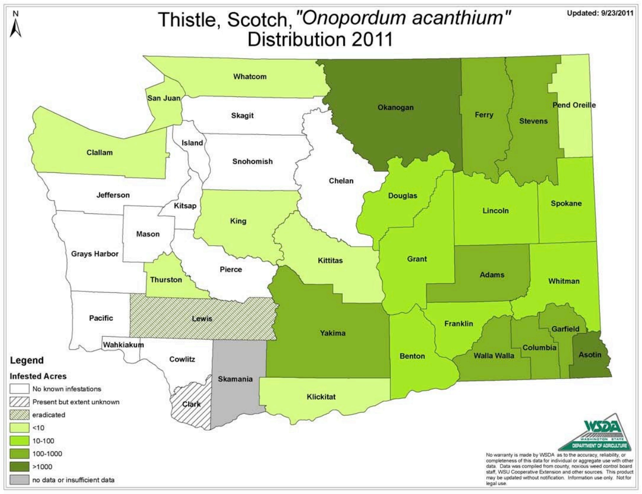
Among the Class B listed plants are knapweeds and thistles. These plants are important forage for bees (Heinecke, 2011a) and produce highly prized honey varieties (Honeytraveler.com). Defined as "noxious" weeds, they are controlled throughout Washington State (NWCB.wa.gov). Looking more closely at just four of these plants shows their distribution, reasons for "noxious" listing, and long-term residual effect of control methods used on these bee-friendly forage plants in Washington.



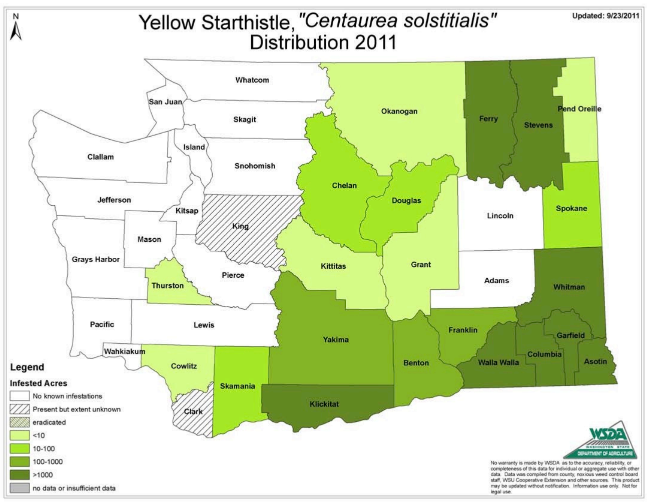
Diffuse knapweed – Class B is considered noxious because it has little value as food for cattle and limited seasonal value for big game. Its spread is said to increase costs for ranchers, decrease plant diversity, increase soil erosion and perhaps pose wildfire hazards (NWCB.wa.gov). Darker green indicates more expansive plant distribution.



Spotted knapweed – Class B also is said to have little value as food for cattle, it is said to increase costs for ranchers and is said to degrade wildlife habitat and plant diversity. Darker green indicates more expansive plant distribution.



Scotch thistle* – *Class B *is considered noxious because infestations can reduce forage production for cattle and it has limited land use for livestock. Darker green indicates more expansive plant distribution.*



Yellow star thistle -- Class B *is reported as being potentially toxic to horses, but the plant is not highly palatable to livestock. A horse must eat 80% to 100% of its body weight in near starving conditions to be affected (Turner et al 2011). Yellow star thistle is being eradicated throughout Eastern Washington. Darker green indicates more expansive plant distribution.*

Examining the distribution maps for these knapweeds and thistles, only two counties are not affected by at least one of these plants: Pacific and Wahkiakum. When these plants are removed, they are not replaced with non-targeted forage plants. We strip vast areas of these important pollinator-friendly forage plants in large part because food for cattle, other livestock and big game is determined to be more important than food for pollinators. Which begs the question, if one-third of cattle were dying each year, would one of our responses be to take away a big portion of their food?

One critical issue is the eradication of important pollinator forage plants without weighted consideration of recent research data on the importance of pollen to strengthen immune defenses for honeybees. Moreover, the chemicals recommended to use on these four plants kill other broad-leafed pollinator-friendly plants in the area with long-term residual effects.

Recommended controls for the knapweeds and thistles listed above include broad-spectrum herbicides (Tordon, Milestone, Curtail, Dicamba, Redeem and 2, 4-D). While knapweeds and thistles are targeted, the herbicides kill most or all other broad leafed forage plants in the area using chemicals that allow only grass to grow for two to 18 months, and for up to four years. (pnwhandbooks.org). The other plants killed include clovers and other legumes, vetches and mints which are important pollinator plants and not designated as noxious weeds needing to be controlled.

From productive forage lands for honeybees ………… to a desert of grass.

In the effort to control yellow star thistle, all broadleaf forage plants are destroyed.

Weed control in Washington State costs millions of dollars.

While Washington State weed laws “are considered some of the best in the nation” (NWCB 2014), knowing the scope of plant control and determining actual costs and methods used to control plants is a daunting project. To understand the full scope and cost of control requires getting information from each state agency, county and local jurisdiction involved in noxious and invasive weed control across the state.

To designate plants for control, the Washington State Noxious Weed Control Board gets input from local weed boards and its own advisory committee, and works with state agencies, counties and local weed boards to classify plants, set control priorities and monitor actions (NWCB 2014). Each state agency has its own goals for plant control (NWCB 2014):

- *Agriculture* has two focus areas – statewide weed program and wetland/marine program. Two of its priority areas are to control knotweed and spartina.
- *Ecology* works with other jurisdictions for a variety of invasive aquatic projects, including knotweed eradication.
- *Fish and Wildlife* controls plants as part of its vegetation management plan.
- *Parks and Recreation* control for specific plants that include knapweeds and knotweeds.
- *Transportation* manages plants along 100,000 acres of state highways.

Additionally, each county and local weed control board has its own goals and priorities, as do other jurisdictions: cities, parks department, non-governmental organizations, non-profit groups, etc.

According to the Washington Invasive Species Council, “Given current tracking systems, a fully accurate figure for state expenditures for noxious weed control is probably not attainable” (2007). In 2007, the Washington State Invasive Species Council reported $15.6 million expended for noxious weed control through five state agencies.
The 2011 – 2013 figures are more than $23 million with four agencies reporting:

These figures do not include county, city and local jurisdiction weed control funds.

Agency	**2006 - 2007** [3]	**2011 - 2013** [4]
Agriculture	$ 3,824,483	$ 7,699,482[5]
Ecology	$ 1,250,702	$ 1,041,000[6]
Fish and Wildlife	$ 2,417,631	[7]
Natural Resources	$ 716,161	$ 5,308,725
Transportation	$ 7,463,649	$ 9,425,724
Reported Weed Control Budgets	**$15,672,626**	**$23,474,931**

SUMMARY AND CLOSING: There is little doubt that state, county and local workers follow state laws for noxious weed removal and respond to political interests for land use. But, for too long, the needs of pollinators have been overlooked or outweighed, with a devastating cumulative effect on honeybees and beekeepers in Washington. While research shows that honeybees need a variety of season-long forage plants, in Washington we spend millions of taxpayer dollars each year often using long-term acting chemicals that strip our land of important pollinator forage plants that are not replaced.

We deprive important food for honeybees and other pollinators when we eliminate and do not replace pollinator-friendly forage plants. While each jurisdiction may be concerned only with its priority for weed control, there is a cumulative effect of removing vast areas of pollinator forage. Indeed, Washington has become so inhospitable to bees and beekeeping that when tree fruits finish blooming many commercial beekeepers pack up their bees and take them to the Midwest states where forage is better (Honeybee Working Group, 2014). There is not enough forage in Washington State to sustain the bees.

[3] WA State Invasive Species Council 2007 Report to the Legislature
[4] Agency figures provided through public records requests, Natural Resources and Transportation
[5] Agriculture public records request; does not include $6,000,000 federal funds
[6] From NWCB 2014; for aquatic invasive plant project grants to local jurisdictions
[7] Fish and Wildlife weed control funds not reported at time of publishing paper

Commercial beekeepers that stay in Washington to pollinate seed crops can do so because their contracted seed farmers plant acres of nutritionally valuable forage. The seed farmers provide forage, such as clover, to sustain the honeybees until seed crop flowers are ready to pollinate (Honeybee Working Group, 2014). Our ecosystem is so out of balance that seed farmers and beekeepers must make sure there is enough food to sustain honeybees so the bees can pollinate seeds that will become our future food.

Is this what we want for our ecosystems in Washington State?

> ***The key to controlling the observed decline in bee populations probably more than anything else lies in efforts to preserve areas that can act as suitable pollination habitats." Dhruba Naug, Colorado State University, 2009***

Does habitat loss explain recent honeybee colony losses?

Yes. Naug (2009) found that nutritional stress impacts any number of pathogens that colonies can withstand, and notes that past and current land use practices in the U.S. have resulted in much of America's crop land and open land becoming a homogeneous resource desert for bees. Further, Naug (2009) provides evidence that the extent of pollinator-friendly open land is an important predictor of colony loss: five of the 10 states with the lowest percent of colony losses were among the top 10 states with the highest proportions of pollinator-friendly open land, and include Nebraska, New Mexico, North and South Dakota. Conversely, Florida, New York, Ohio and Pennsylvania have some of the highest colony losses and some of the lowest open land values.

Can farmers benefit when land is planted with pollinator-friendly flowers?

Yes, according to Rufus Isaacs and Brett Blaauw of Michigan State University. More and better forage benefits the honeybee. It also benefits native pollinators and, moreover, can provide a significant financial reward for farmers. Isaacs and Blaauw (2014) found that farmers of pollinator-dependent crops boosted their yields by 10 to 20 percent when they converted nearby marginal acreage to fields of wildflowers. Honeybees were used to pollinate (blueberries, in this case), but farmers found that the number of native pollinators greatly increased over a period of two to four years due to the presence of bee-friendly flowers planted near crops. Where wild bees were more abundant, more flowers turned into blueberries. Those berries were larger and had more seeds. Farmers' yields increased.

In February 2014, the U.S. Department of Agriculture announced it would spend about $3 million to reseed lands with plants that appeal to bees (USDA 2014). The overall aim of the program is to give bees and farm animals better quality food. Efforts are focused on five states: Michigan, Minnesota, Wisconsin, North Dakota and South Dakota. No such efforts are currently happening in Washington State.

Can we afford to ignore or dismiss what we are doing to our ecosystem?
Are we willing to do something about it?

Some actions for Washington State could include:

- Determine a statewide agenda with an organized and active group of Washington State beekeepers to address forage and other beekeeping concerns.

- Enact legislation and policies that require using control methods that retain non-targeted forage and replace removed honeybee forage with plants that are not noxious or invasive.

- Get beekeepers on the state advisory panel and board of the Washington State Noxious Weed Control Board to advocate for decisions that benefit honeybees.

- Get more beekeepers to serve on local weed control boards to advocate for decisions that benefit honeybees, beekeepers and pollinators.

- Work with state agencies and city, county, parks and other jurisdictions to better understand weed control goals and to advocate on behalf of pollinator-friendly management practices.

- Start or expand pollinator-friendly acreage, rights of way along highways, community gardens and public spaces.

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