GENERALLY ACCEPTED AGRICULTURAL AND MANAGEMENT PRACTICES FOR BEEKEEPING AND APIARY MANAGEMENT

MANAGEMENT OVERVIEW

Due to their large numbers, easy transportation, and special adaptation for efficient foraging (e.g. dance language), European honey bees (Apis mellifera L.) play a critical role in Michigan and US agriculture. The value of the primary fruit and vegetable crops in Michigan that depend on pollination was approximately $422 million in 2005. Inadequate pollination of fruit and vegetables results in greatly diminished yields and reduced quality (McGregor, 1976). At least 60 of Michigan's important fruit and vegetable crops (including apple, blueberry, cherry, cucumber, and pumpkins) rely on honey bee pollination. Without honey bees to supply pollination services, much of Michigan's rich fruit and vegetable production would not be possible, and producers would be forced out of business. In short, Michigan's agricultural industry would be devastated. Nationally, the value attributed to honey bee pollination is estimated to be $14.6 billion per year (Morse and Calderone, 2000).

Despite the importance of honey bees, the beekeeping industry has struggled since the introduction of two parasitic mites to the US in the mid 1980's. The introduction of the Tracheal Mite (*Acarapis woodii*) and Varroa mite (*Varroa descructor*) has nearly eliminated the feral (wild) honey bee population in the US (Kraus and Page, 1995). The number of beekeepers managing honey bee colonies also declined due to the more complicated management requirements caused by the mites. In 1993, Michigan's Apiary law was changed to open the state for free movement of honeybee colonies as beekeepers sought to take colonies to southern states where they could better manage for mite control during the winter months. In recent years, Michigan beekeepers have moved bees to California for almond pollination, Florida for pickle pollination and to Maine for blueberry pollination. Michigan has become a migratory beekeeping state.

The Michigan Department of Agriculture provides inspection service to beekeepers needing a certificate of health for movement of their bees. However, because of the varied requirements for health certificates for movement, many of them voluntary, there is not a reliable estimate of the number of colonies moved into and out of the state each year.

During the spring of 2009, Michigan beekeepers returned more than 46,000 migratory colonies of honeybees to Michigan from overwintering locations in Florida. Bees are known to return to Michigan from Georgia, California, and Texas, as well as other southern states. In addition, Michigan beekeepers obtain packaged bees, "nucs", and queen bees for the establishment of new colonies or to replace overwintered colonies that died for a number of reasons.

Beekeepers now use an array of management tools, including miticides, antibiotics, and insecticides for the management of mites, the small hive beetle (Aethina tumida), brood diseases, and microsporidian parasites.

MANAGEMENT PRACTICES

Understanding some basic bee biology and beekeeping will facilitate your inspection of the hives, gauging of quality/strength of the hives, and help maximize the use of bees for your pollination.

Social Structure: Honey bees are social insects and only the sterile female workers do all the in-hive work (cleaning, drying nectar into honey, feeding young) and outside work (foraging for water, pollen, nectar and propolis, and colony defense). The queen's only job is to lay about 2,000 eggs per day and releases queen mandibular pheromone to let the workers know that she is present and healthy. The males' (drones) only job is to mate with queens and are produced only during May to August. A typical colony of bees has about 30,000 – 60,000 workers, one queen and a few to hundreds of drones. About 1/3 of these workers are foragers. Foragers show flower constancy so they tend to focus on flowers of a single species, resulting in more efficient pollination.

Internal Factors Affecting Foraging Behavior: To provide adequate pollination, honey bee colonies must be of sufficient strength, free of diseases and parasites, have a laying queen, and have adequate "brood" (immature stages which include eggs, larvae and pupae). A newly installed package bee colony, with 2 lbs of bees, would start with about ~9,000-11,000 workers and would not be considered ready for pollination work. Such a colony would concentrate heavily on brood rearing and only have about 1,000-2,000 foragers. Stronger colonies would send out about 30% of bees as foragers. A typical median strength over-wintered colony would have about 30,000 workers and can send out 10,000 foragers. With adequate resources, colonies can develop a work force of 60,000 or more workers at the peak of the season. Brood frames should be inspected for the presence of chalkbrood, American and European foulbrood, parasitic mites and symptoms of virus or other pathogens of honeybees. In general, 3-5 frames of solid brood suggest a fertile queen and a healthy colony. Bees should be periodically inspected for presence of Nosema disease.

External Factors Affecting Foraging Behavior: Environmental factors affect honey bee foraging. Bees do not work in the rain and work less on cloudy days. Foraging activity is positively related to temperature, with a linear relationship from 60-90°F. Foraging activity slows when it gets too hot (over 90°F). High winds (above 20 mph) will alter or inhibit flying activity, with bees choosing flight paths that are less affected by wind. As an example, honey bees placed for pollination of orchards will concentrate their efforts near the orchard floor under windy conditions, leaving the orchard crop poorly pollinated. By contrast, bumble bees can forage at lower temperature and lower light conditions.

Hive Density Recommendations: Because Varroa mites had wiped out most of our feral (wild) honey bee populations, recommended rates for pollination prior to 1987 have to be increased to compensate for the lack of "free" honey bees. The table below lists recommended rates for hive density. From an economic point of view, it is best to start with the highest number of hives you can afford, and then alter your hive count based on your observations. As new fruit and vegetable varieties are released, review pollination recommendations made by the developer, and then monitor pollination activity.

Table 1. Recommended density of honey bee colonies (per acre) for Michigan crops

Crop	Colonies	Notes
Apple	1-3	The more dwarf varieties need more hives
Sweet cherry	1	Balaton may need more
Pear, Plum, Peach	1	
Blueberry	3	Cultivars vary in their dependence on pollination
Cranberry	3	
Raspberry, strawberry	1	
Grape	0	Wind pollinated
Pickles (hand harvested)	1	
Pickles (machine harvested)	2-3	

One of the primary limitations to keeping bees is the real or perceived interaction between the bees and the people who live in or use the surrounding area. To overcome this problem, a hive density limit is proposed that minimizes potential conflicts between people and honeybees, assuming that beekeepers follow the management practices outlined in this document. (In the recommendations below, "undeveloped property" means any idle land that has no structures or facilities intended for human use or occupancy. Property used exclusively for streets, highways, or commercial agriculture is considered undeveloped property.)

Table 2a. Recommended density of honey bee colonies relative to lot size

Lot/Acreage	Number of Colonies
Up to 1/4 acre (1/4 acre=10,890 sq. ft., roughly 50 ft. x 215 ft.)	2
More than 1/4 acre, less than 1/2 acre (1/2 acre = 21,780 sq. ft., roughly 100 ft. x 218 ft.)	4
More than 1/2 acre, less than 1 acre (1 acre = 43,560 sq. ft., roughly 150 ft. x 290 ft.)	6
1 acre or more	8

Table 2b. Recommended density of honey bee colonies regardless of lot size

Condition	Number of Colonies
If all hives are situated at least 200 feet in any direction from all property lines of the lot on which the apiary is situated,	No limit
As long as all adjoining property that falls within a 200-foot radius of any hive is undeveloped property	No Limit

Hive Placement: Correct placement of hives is an important consideration for responsible beekeeping in urban/suburban situations. Hives must be located in a quiet area of the lot, not placed directly against a neighboring property unless a solid fence or impenetrable vegetative barrier not less than six feet high forms the property boundary. Keep hives as far away as possible from roads, sidewalks, and rights of way. Hive entrances should face in such a direction that bees fly across your property. If this is impossible, use barriers (hedges, shrubs, or fencing six to twelve feet high) to redirect the bees' flight pattern.

Swarming: Swarming is a natural instinct of honeybees that occurs chiefly from spring to early summer. Swarms should be collected to prevent their becoming a nuisance. Honeybee colonies can and should be managed to prevent or minimize swarming. For example, brood chamber manipulation, colony division, adding supers for brood rearing and honey storage, and replacing old or failing queens can all reduce the swarming impulse. These and other management practices to control swarming are explained in detail in good beekeeping textbooks. Beekeepers who learn of a swarm should take reasonable measures to see that the swarm is retrieved.

Provision of Water: Beekeepers should assure an adequate source of fresh water for their bees prior to establishing an apiary. Where adequate fresh water from a nearby pond or stream is not available, beekeepers should establish a water source that will be available throughout the active flight season. Bees prefer a sunny place where they can gather surface moisture, for example wet sand or gravel or the edge of a birdbath. If you establish such water sources, your bees will become habituated to them and will be less likely to visit swimming pools or hot tubs. Remember that in very hot weather, bees use a large amount of water to maintain temperature and humidity within the hive.

Queens: In most cases, European honeybees are considered gentle. When a colony exhibits unusually defensive characteristics (stinging or attempting to sting without provocation), or exhibits a frequent tendency to swarm, it is the beekeeper's duty to re-queen from European stock. Queens should also be replaced as they get older, or as they begin to fail to ensure that the colony maintains strong numbers of healthy brood.

Robbing Behavior: When nectar is scarce, honeybees may rob honey from other hives. Under such conditions, beekeepers should work hives for only a very short time,

if at all. Exposing honey (especially sticky honeycombs) outdoors often encourages robbing. All spilled honey should be cleaned up immediately. To prevent robbing, buildings and trailers used for honey extraction must be made bee-proof, as far as is practicable.

Transportation of Hives: Beekeepers must take appropriate care when transporting hives of honeybees. All loads of hives and supers of honey should be secured. Bees being transported should have entrance screens or be secured under netting.

Migratory Movement of Honeybees and use of Consolidation Yards: Migratory beekeeping practices include the use of temporary consolidation yards where beekeepers bring hundreds to thousands of honeybee colonies together to facilitate inspection and shipment of colonies for migratory purposes. Likewise large number of colonies may be temporarily unloaded upon return from migratory movement.

Beekeepers must be aware of the impact caused by congregating large numbers of colonies in one location, and take appropriate steps to mitigate the impact to their neighbors. In most cases it is to the beekeepers benefit to quickly disperse excess colonies from a consolidation yard. However, unforeseen factors including weather and the timing of pollination needs can inhibit the dispersal of colonies and must be taken into account when deciding where to unload the bees.

During periods of cold, honeybees cluster in the colony and little or no activity is observed. On sunny or mild days, honeybees will leave the colony for cleansing flights, but they quickly return to their colony. Overwintering large numbers of colonies in one location has benefits to the beekeeper and is considered an acceptable practice as long as the beekeeper arranges to disperse the colonies before the bees become active in the spring.

Honeybees being prepared for migratory movement are brought to one location to facilitate loading and shipping. A beekeeper may consolidate from 100 to several thousand colonies of honeybees in one location, depending on the number of colonies to be placed on a truck, and the number of trucks to be loaded at a single time. If warm weather is anticipated, large numbers of colonies should not be consolidated in a location where they can impact developed properties.

The beekeeper must anticipate the length of time colonies will be at the site and provide adequate food and water to address the foraging needs of the colonies for the time of year. The beekeeper must anticipate the time needed to complete inspections, prepare the colonies for movement, and schedule transportation to move the bees. A beekeeper must provide a consolidation yard with enough setback from developed property that, with appropriate food and water resources, the beekeeper will mitigate the activity of honeybees around neighboring homes and farmsteads. Chart 2B addresses setback distances for normal beekeeping activity and should not be considered a guide for consolidation yards.

Colonies brought to Michigan from southern states are, in general, stronger than colonies that were overwintered in Michigan. When moved into Michigan, southern raised colonies will have an active field force and will immediately begin searching for water and food resources. Adequate food and water must be provided no later than at the time the bees are unloaded. A consolidation yard must be located so that the distance from developed properties coupled with adequate food and water resources prevents honeybees from invading developed properties.

Disbursal of colonies from receiving yards to pollination or honey production locations should occur as soon as possible. It is to the beekeepers advantage to minimize the number of times bees are moved. For this reason, unload large numbers of colonies further from neighbors if constraints of weather or the timing of pollination activities prohibits immediate movement.

Recommendations for Considerate Hive Management: Beekeepers should take into account that weather conditions influence bee behavior and plan to work bees when conditions are favorable. They should make sure that neighbors are not working or relaxing outdoors when they open hives and should try to perform hive manipulations as quickly as possible, with minimum disturbance to the bees. Extended hive manipulations, particularly removing honey, should be carefully planned to accommodate neighbors' activities. Beekeepers should use smoke when working bees and should smoke hive entrances before mowing or trimming in the hive area. Clippings and exhaust should be directed away from hive entrances.

Adherence to the following list of beekeeping and apiary management practices will help beekeepers avoid conflicts with neighbors and demonstrate good beekeeping management:

1. Situate hives away from lot (property) lines and occupied buildings.
2. Locate hives away from roads and areas frequented by pedestrian and animal traffic.
3. In populated areas, uses fences and hedges as screens to conceal hives and to elevate the bees' flight path. Vegetation and fences also serve as windbreaks.
4. Do not situate hives on or next to utility right- of -ways (power lines, pipelines or underground cables).
5. Avoid placement of hives near schools, recreation areas, picnic grounds or other locations that may result in adverse honey bee/public interactions.
6. Provide a water source so the bees don't fix on neighborhood swimming pools, birdbaths, livestock/pet water sources, etc. The water source must be established before the weather gets hot so the bees are trained to it. Provide fresh water on a regular basis.*
7. Keep no more than 4 hives on a lot less than ½ acre.

8. Maintain gentle colonies. If hives become defensive, determine the cause and requeen with gentle stock if necessary. Skunks are often the reason for hives to suddenly become defensive.
9. Work bees when neighbors are not in their yard. Minimize robbing behavior.
10. Manage hives for swarm prevention.
11. When mowing the grass in front of hives, direct the clippings and exhaust away from the entrance.
12. Share your enthusiasm and knowledge of beekeeping with the community.

Common water sources include birdbaths, pebble filled sections of gutter with end caps, plastic wading pools and entrance feeders. Pieces of carpet screen stapled to wooden frames, styrofoam floats, and stones and pebbles provide ample footing for the bees to prevent drowning. The addition of salt (water softener, pickling, and sea) or sugar often aids in the training process of honey bees.

HEALTH CARE

Disease Control: There are a number of honeybee diseases and pests, of which American Foulbrood (AFB) is the most serious. Other brood diseases, including European Foulbrood, Chalkbrood, Nosema, and viruses must be considered when caring for honeybee colonies. Beekeepers should be extremely cautious about mixing hive equipment or purchasing hives from sources that are not certain to be disease-free. Finally, it is incumbent on beekeepers to manage parasitic mites and other pests responsibly for both colony health and honey quality.

Pest Management during Pollination: Always make growers mindful that honeybees are active on their farm and that they need to follow appropriate practices to protect your honeybees. The use of broad-spectrum insecticides when flowers are open should always be avoided. Pesticide labels, as well as precautions regarding honeybee toxicity to a pesticide or combination of pesticides should be heeded by growers.

Bee hives should be removed immediately after pollination if post-bloom pesticide applications are planned. By monitoring for pest problems carefully during bloom, growers can help minimize the need for pest control. If an insecticide application is necessary during bloom, the compounds that are least toxic to bees should be used, with careful observation of the pollinator-restrictions on the label. If an application is required, the beekeeper should carefully determine whether the bees need to be moved prior to the application event.

In general dusts, wettable powers and emulsifiable concentrate formulations are more harmful to honey bees. Applications conducted in the morning or daytime are not as safe for bees as evening applications. Ask the grower to inform the beekeeper before a spray so that colonies can be moved or shut down for 1-2 days with wetted-burlap

blocking entrances, especially if highly toxic insecticides have to be used. This database lists the toxicity of various pesticides to honey bees: http://apiculture.com/databases/pesticides.htm.

Our appreciation to the Maine State Beekeepers Association for allowing us to use their excellent material in this document. Their full document can be seen at mainebeekeepers.org.

DEFINITIONS

Apiarist and beekeeper: A person keeping bees

Apiary: A place where honeybee hives are kept

Apiculture and Beekeeping: The management of beehives

Bee sting: Injury sustained and inflicted by a worker honeybee

Beehive: Removable framed housing for a honeybee colony

Brand: Identification for marking frames and hives

Consolidation Yard: a location where large numbers of colonies are placed temporarily to accommodate migratory shipping needs or winter management practices.

Flight path: The distinct route taken by many bees leaving from or returning to their hive

Foraging bees: Bees seeking water or food - Bees naturally forage flowers for nectar and pollen. In abnormal circumstances, when natural sources of food and water are scarce, bees may forage supplies of animal feed, water or protein.

Hive: A honey bee hive, being a nucleus colony or a standard size colony

Honey extraction: The removal of honey from combs

Honey flow: The gathering of nectar from flora by honeybees

Honeycomb: Removable frames, containing wax cells which house honey, pollen, and/or brood (eggs, larvae, pupae)

Package bees: A number of adult bees, with or without a queen, contained in a ventilated shipping cage transported via USPS or other carriers

Pollination: The transfer of pollen by honeybees from anthers to stigmas of flowers for the purpose of plant fertilization

Robbing: Bees attempting to access honey stored or spilled in another hive

Strong hive: A populous honeybee colony

Super: Box or boxes containing frames placed above the bottom or brood

Swarm: Cluster of flying mass of honeybees including workers, queen, and drones

Water supply: Taps, hoses, pools, hot tubs, streams, ponds, puddles, etc.

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