BC Agriculture in the Classroom Foundation

Unit Plan:

Beekeeping as Agriculture and Environmental Education

Bees are essential pollinators for much of the world's food supply. Honeybees are particularly important, because they can be managed by beekeepers (apiarists), to support crop pollination. Given the recent decline in honeybee populations, public interest in beekeeping has boomed; but there are few opportunities for secondary school students to learn about honeybees, and few resources available to teachers to bring honeybees into the classroom. This apiary-based unit is an excellent tool to improve students' food literacy and the practice of beekeeping is inherently place-based and project-based. This unit would best fit with an Environmental Science 11/12 course, however it can easily be modified for a variety of other courses.

Suggested Grade/Subject Levels

Environmental Sciences 11

Environmental Sciences 12

Science 9

Science 10

Life Sciences 11

Science for Citizens 11

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Teacher Guide

While we have chosen to direct this unit towards science courses, there is an enormous potential for cross-curricular tie-ins. For instance the history of beekeeping with a Socials Studies course; the economics of beekeeping and Business Education courses; honey harvesting and Food Studies courses; and of course any number of connections to English Language Arts. The following are the Curricular Competency links for high school Science Courses, followed by individual course content connections.

Curricular Competencies

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest
- Collaboratively and individually plan, select and use appropriate investigation methods, including field work and lab experiments, to collect reliable date (qualitative and quantitative)
- Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data
- Ensure that safety and ethical guidelines are followed in their investigations
- Experience and interpret the local environment
- Seek and analyze patterns, trends, and connections in data, including describing relationships between variables (dependent and independent) and identifying inconsistencies
- Analyze cause-and-effect relationships
- Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions
- Consider social, ethical, and environmental implications of the findings from their own and others' investigations
- Contribute to care for self, others, community, and world through individual or collaborative approaches
- Contribute to finding solutions to problems at a local and/or global level through inquiry
- Communicate scientific ideas, claims, information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations
- Express and reflect on a variety of experiences, perspectives, and worldviews through place

Content Connections

Science 9

- Sustainability of systems; First Peoples knowledge of interconnectedness and sustainability

Science 10

- Applications of genetics and ethical considerations

Environmental Science 11

- Diversity in Local Ecosystems (species and their ecological roles, relationships and interactions in ecosystems)
- Sustainability in Local Ecosystems (unsustainable and sustainable ecosystem practices)
- Conservation and Restoration of Ecosystems (environmental stressors challenge ecosystem integrity, health, and sustainability; engagement in ongoing and potential stewardship projects)

Life Sciences 11

- Taxonomy principles for classifying organisms
- Unifying characteristics of the evolutionary continuum across the kingdoms

Science for Citizens 11

- Agriculture practices and processes (chemicals used in agriculture, environmental impacts, impacts of personal choices)

Environmental Science 12

- Land Use and Sustainability (global food security and technologies, land management and personal choices)
- Global Environmental Changes (environmental ethics)

Credit

Many of these lessons have been adapted from Carmichael, Marilyn (1999) The Bee Unit Plan for Grade 8-11 originally posted by the BC Agriculture in the Classroom Foundation.

Teacher Background

> *"Honeybees pollinate the seeds of our imagination, carrying with them mysteries and wonders digestible only through hands-on immersion. In other words, to understand the vast interconnectedness of our living world, we only need to drink from the sweet teachings of honeybees. Apiary-based learning provides attachment points for the acquisition of new skills and transformational experiences for all who participate." (King, 2013)*

Of society's many environmental challenges, the plight of the honeybee is one that certainly catches the public's interest and imagination (Rockridge, 2010). Indeed, bees pollinate 70% of the world's food supply and the honeybee is one of our most important pollinators (Arbol, 2012). News of large-scale, unexplained losses of forager bees, known generally as Colony Collapse Disorder (CCD) and its link to neonicotinoid pesticides continue to make headlines years after CCD's initial discovery in North America in 2005 (Vanengelsdorp, et al, 2009).

Honey bees are not only economically important, but they are also ecologically fascinating creatures. Despite having tiny brains, as a colony, they have sophisticated navigation, reproductive, and communication strategies (Bishop, 2005). Furthermore, they have a certain fuzzy cuteness that is hard to ignore once you see it. You might say honey bees are charismatic microfauna. Beekeeping is popular in rural areas, and hobbyists appear to be increasing in urban settings across British Columbia (van Westendorf, 2014).

Experiential and outdoor-based educational activities - such as beekeeping - are known to be effective at tools for improving student understanding of and appreciation for the environment (Saylan and Blumstein, 2011). In today's world, youth have few opportunities for direct experiences with nature. This has led to a devaluing and a disconnect with the natural world (Louv, 2008). One way to inspire and inform children to develop caring and connection with the earth and their food is through place-based education experiences (Sobel, 2005).

Beekeeping is the tending of honey bees for the purposes of collecting honey (or wax, or propolis, or royal jelly, or brood), providing pollinations services to farmers, or for breeding (Langstroth, 1853). Honey bees are considered agricultural livestock and is thus regulated in BC by the Ministry of Agriculture. Because of the recent globalization of honey bee diseases and pests beekeepers must also be scientists. The Ministry of Agriculture recommends that all beekeepers be up to date on current hive management practices, bee ecology, pest ecology, integrated pest management, provincial regulations for pest management, local municipal regulations and bylaws, food safety regulations, commercial packaging regulations, etc. (van Westendorf, 2014).

From an educator's perspective, bees are an excellent lens to study ecology, entomology, natural history, evolution, pollination, mutualism, commensalism, predation, chemistry of wax products, mathematics of honeycomb production, physics of flight, agriculture - all of which fit into current BC Curriculum for various courses within grades 8-12. In short, honey bees are an ideal subject for interdisciplinary study.

Principles

This proposed curriculum for beekeeping is a lens for agricultural and environmental education in the secondary school classroom in BC and has the following central themes: ecoliteracy, interspecies bonds, place-based learning, and project-based learning.

One way of describing environmental education is the development of ecoliteracy in students. Ecoliteracy, as described by Capra (1999), has four key components. It is based on the principles of ecology, experiencing them in nature, and thereby acquiring a sense of place. It incorporates constructivist education principles which emphasizes the child's search for patterns and meaning. It uses multidisciplinary, project-based learning. And finally, ecoliteracy implements the principles of ecology to nurture the learning community and share leadership.

Erdogan (2011) suggests that an effective environmental education program improves three things in a learner: environmental knowledge; environmental affect (comprised of a willingness to act, attitude, and sensitivity); and responsible environmental behaviour (actions that protect the environment). Contact with animals is one way to improve all three for learners. Rautio (2013) suggests that environmental educators can validate our place as human animals within nature by studying specific species-to-species relationships. What better way to remember our connectivity to nature, than study the beautifully complex and intriguing super-organisms that are largely responsible for pollinating one third of our global food supply?

The point of experiential environmental education is to foster empathetic relationships between humans and the rest of the natural world (Goralnik, et al., 2014). This fostering must be rooted in an authentic learning environment with real-world applications; it must be rooted in a particular *place*. The study of place, suggests Capra (1999), "enables us to widen our focus to examine the interrelationships between disciplines" having a positive effect on student motivation, engagement, and self-efficacy. Apiary-based education fits this context of place. It requires a high level of woodworking craft, animal husbandry, rooted in an outdoor apiary space (often associated with a more natural setting like a garden), and is often taught through a teacher-student apprenticeship relationship, and fits well with project-based learning (King, 2013).

Barron (1998) notes that project-based learning must be based on a 'driving question' that probes beyond simple answers. He suggests project-based learning can be supported with scaffolding: to communicate processes, coach students, illicit articulation, or use problems and contrasting cases to keep students on track. It requires students to self-assess and revised often; it triggers metacognitive engagement. According to Barron, students engage best when inquiry based activities are designed with social-organization principles of: small groups, peer review, public presentations. Lastly, project-based learning has a final product which the learners will publicly present at the end of the course.

Apiary-based learning fits project-based learning very well. A driving question might be, 'what animal husbandry techniques affect colony health and honey production?' Given the seasonal nature of agricultural cycles, honey harvest, winter preparations, spring nectar flow, and summer swarm prevention are all natural presentation and product moments.

Unit Overview

So you're thinking of starting an apiary. Great! Generally speaking, you should being by apprenticing with, or taking a course from a reputable local bee master who has raised bees in your climate. Once you have a handle on the basics, be aware of ministry guidelines (links in the resource section at the end), especially for pest control and bee health.

A long standing joke in beekeeping circles is that if you ask 10 beekeepers for their opinion on hive management techniques, you'll get 11 different answers. How you practice beekeeping will be informed by your personal values and your overall purpose: colony health, honey production, pollination services, educational purposes, aesthetic or lifestyle choices, etc. In all animal husbandry, the bottom line is the health of your stock; your bees. So for example, if your purpose of colony health outranks your purpose of honey harvesting, then make sure you leave plenty of honey for the bees to overwinter. Be practical, be pragmatic, be humane, and be open to learning from the bees. Like students in your classroom, honey bees will teach you more about your craft than you could ever learn from a book.

This unit consists of 12 lessons that can be used individually or in series over the course of a semester. Student worksheets and additional support materials are provided at the end of the teacher guide.

Lessons in this unit are as follows:

1. Why Beekeeping and a History of Beekeeping
2. Bee Life Cycle
3. Bee Dissection
4. The Value of Bees
5. Bee Ecology
6. Bee Senses
7. Economics of Beekeeping
8. Hive Construction
9. Hive Inspection
10. Bee Diseases and Integrated Pest Management
11. Honey Harvest
12. Waxworks Lab

Student handouts include:

Worksheet 1: Honeybee Biology
Worksheet 2: Honeybee Dissection
Activity Sheet 1: Values and Attitudes Towards Honeybees
Information Sheet: Hive Inspections

Support materials include:

Starting an Apiary: Safety, Risk Management, Insurance, Regulations
Sample letter to neighbors
Sample letter to parents
Resources
References

Lesson 1 – Why beekeeping and a history of beekeeping

Objectives

Students will gain an understanding of the how and why of beekeeping, where it came from and its importance. They will learn how bees are useful for humans and learn new vocabulary.

Information

- 6000 BC - Rock painting of ancient honey gatherer, Bicorp, Spain
- 1450 BC - Egyptian tomb painting of beekeepers extracting, storing honey, Tomb of Rehk-mi-Re

Materials

- Variety of honeys for tasting, toothpicks

Activities

1. Hook: Invite students to taste a variety of honeys and describe the different flavours, etc.
2. Brainstorm with students 'why beekeeping'. Accept all possible answers. You can complete discussion with the following ideas:
    a. hobby
    b. honey production
    c. wax production and waxworks
    d. other products: pollen, propolis, royal jelly (health foods), venom (to treat arthritis)
    e. pollination services for farmers and gardeners
    f. other interests: ecology, environment, agriculture, woodwork, gardening, business
3. Discuss advantages and disadvantages of beekeeping
    a. low maintenance form of animal husbandry, etc.
4. Discuss vocabulary (below)
5. Have students brainstorm possible markets for products from the hive.

Possible extensions

- Have students develop a market study and/or business plan.
- Have students create a class label for a product.
- Bring other products (or photos) in class and discuss their use.

Vocabulary

- apiarist, apiculture, beekeeping, honey, wax, propolis, royal jelly, venom, pollen, pollinator, pollination

Lesson 2 – Life Cycle

Objectives

Students will learn about the honey bee life cycle.

Materials

- Demonstration hive (glassed container with a frame of live bees)
- Artifacts from beekeeping in bins: smoker, hive tool, honeycomb, wax product, etc.
- TED Talk: Anand Varma: A thrilling look at the first 21 days of a bee's life. (6min) https://www.youtube.com/watch?v=6-tqiaPoS2U
- Video: New York Times: No Glass Ceiling for Worker Bees. (2min) http://www.nytimes.com/2014/09/09/science/no-glass-ceiling-for-worker-bees.html?emc=eta1&_r=0
- PBS. Nova: Tales from the Hive. (54min) https://www.youtube.com/watch?v=FtKqic69xVo

Activities

1. Hook: Have students examine artifacts in bins and have them list questions for 5 minutes.
2. Invite students to examine live honey bees in demonstration hive up close. Answer any immediate questions that come up.
3. Present videos and/or have students read Information sheet.
4. Have students complete Worksheet 1: Honey bee biology

Possible extensions

- Discuss: are Western honey bees an invasive species to North America?
- Write a diary of a honey bee from day one to the end of its life.
- Write a children's book showing the different stages of development and activity of a honey bee.

Vocabulary

- casts: worker, drone, queen
- life stages: egg, larva, pupa
- resources: pollen, nectar, bee bread, royal jelly, propolis
- reproduction: colony, virgin queen, mated queen, nuptial flight, swarming, absconding

Lesson 3 – Bee Dissection

Objectives

Students will perform a dissection and learn the key anatomy of honey bees - how each form fits its function.

Materials

- Dissecting microscopes, or smartphone microscopes (instructions to build: http://www.geekosystem.com/smartphone-microscope-diy/).
- Prepared honey bees
- Dissecting tools: dish, blades, tweezers, probes,
- Slides of honey bee mouthparts and legs
- Bee model
- Pictures: Parts of the Worker Bee Hind Leg; Honey Bee Head and Mouthparts, Honey Bee Stinger
- Worksheet 2: Honey Bee Dissection

Activities

Bee dissection

1. Obtain dead worker bees for dissection from a beekeeper or from your hive: use mostly workers and some drones. Freeze overnight. Preserve in 70% ethyl alcohol, if not dissected soon. Another option is to order them from a laboratory supply company you may use through your school
2. Provide Worksheet 2: Dissection
3. Have students read through the lab and all instructions before obtaining equipment and bees
4. Have students perform dissection and complete worksheet
5. Students may reference bee model or other reputable internet sources to help label parts

Vocabulary

- head: ocellus, compound eye, antenna, mandible, proboscis, hairs
- thorax: 2 sets of wings, 6 legs
- hind leg: femur, tibia, rake, pollen press, comb, pollen basket, tarsi
- abdomen: trachea, honey stomach, Nasanov gland, pheromone, wax gland
- stinger: poison sac, barbed lancets, stylet

Lesson 4 – The Value of Bees

Objectives

Students will learn a system of values and attitudes towards other living things. Students will examine their own values and attitudes towards honey bees.

Information

By secondary school, most students will have preconceptions of honey bees based on personal experience or prior knowledge. Students' preconceptions can be misconceptions or can be based on negative attitudes towards bees, or towards insects, in general. For authentic and positive learning experiences, it is helpful for students to examine their own preconceptions and feelings. This activity is intended to be done before the first colony inspection, and again near the end of the course, for students to see if their attitudes have changed.

Materials

- Sticky notes
- Worksheet 3: Values and attitudes towards honey bees

Activities

1. Mingle game: On sticky notes, have students write a value of honey bees on Side A and a concern on Side B. In an open area, have students mingle silently with stickies held before them, high-fiving others they agree with; first side A, then side B. Have students find a partner and describe their Side A, then another partner with Side B. Open debrief for whole class:
    a. What were common values and concerns? Why?
2. Continuum opinion: Gather students to an open area. Draw a line on the ground. One side is agree, the other is disagree. Ask students to position themselves on a continuum between agree and disagree when you read aloud the below statements. Open debrief:
    a. What were easiest/hardest choices and why?
    b. Could you rank your top/bottom?
    c. Did you answer based on your inner opinions or how you want to be?
    d. How do a person's attitudes affect their actions?

Statement	Attitude
Honeybees are beautiful creatures and are a good mascot for nature.	Aesthetic
Beekeeping is a good example of human mastery and control over nature.	Dominionistic
Honeybees play an important role in complex ecological webs, as pollinators, etc.	Ecological
I love honeybees! They are valuable in and of themselves.	Humanistic
Honeybees should be treated with respect and dignity.	Moralistic
Keeping bees is a great way to connect with the great outdoors.	Naturalistic
Bees, like all bugs, are dangerous, scary, icky, or boring.	Negativistic
Bees are fascinating. I'm interested in their how their bodies work, their behavior, and their social structure.	Scientific
I like honeybees because I like eating honey, and I like eating the food they pollinate..	Utilitarian

3. Have students complete Worksheet 3. Not for grading. Collect and set aside for students to compare at the end of the unit. Open debrief:
    a. Does this framework make sense - anything you'd change?
    b. What are society's strongest attitudes?
    c. How do a society's attitudes affect its actions?

Possible extensions

- Write a journal entry for each lesson of the unit. In the journal, evaluate which attitudes and values are presented by the teacher, by fellow students, and by self.
- Discuss which category best fits honey bees: wild, feral, captive, domesticated, or companion. Write an essay or produce a video to support your claim.

Vocabulary

- Values: aesthetic, dominionistic, ecological, humanistic, moralistic, naturalistic, negativistic, scientific, utilitarian.

Lesson 5 – Bee Ecology

Objectives

Students will learn how honey bees fit into their ecosystem, their roles, advantages, and challenges.

Materials

- cones or boundary markers for game

Activities

1. Lecture/slide show on honey bee natural history, ecology, and pollination (teacher to create)
2. Systems theory: Have students write down as many factors in a honey bee's life as possible. List may include: prey for predators (e.g. bears, birds, wasps), pollinator for flowers, domesticated by humans, host for parasites, host for beneficial organisms (e.g. gut flora), weather, security of hive, proximity to food and water, hive size, colony size, genetics, etc.
3. Activity: game outside: choose 2 people to stay equally distant from, don't communicate, go!
    a. Debrief: components of system: chaotic, no communication, competitive, individualistic, active and dynamic, interdependent, some actors have more leverage, some actors create delayed effect, rules and boundaries and structure.
    b. Introduce the concept of influence diagrams: https://en.wikipedia.org/wiki/Influence_diagram
    c. Have students create an influence diagram from their list of factors in a bees' life
4. Pollination chart
    a. Have students research key local flowering plants that provide pollen and nectar for honey bees.
    b. Develop a list of important or interesting facts for chart. For example: typically first and last bloom dates, nectar or pollen or both, colour of pollen, taste of honey, flower colour, plant type (fruit tree, nut tree, invasive weed, ornamental plant, garden vegetable, etc.), typical location (street, lawn, garden, farmer's field, forest, etc.), a picture of the flower, etc.

Possible extensions

- Write a children's story told from the perspective of a bee using ecologically correct information.
- Create an influence diagram demonstrating how honey bees communicate with one another in the hive.
- Create a family tree for Hymenoptera.

Vocabulary

- ecology, evolution, pollination, parasitism, mutualism, commensalism, predator/prey, mimicry
- taxonomy: bees, wasps, wild bees, bumble bees, honey bees
- influence diagram

Lesson 6 – Bee Senses

Objectives

Students will perform an experiment to study how honey bees use their vision and smell and demonstrate learning while foraging.

Materials

Folding table, granulated sugar, water, mixing containers, volume measuring tools, petri dishes, fake flowers (coloured paper), paper to record data, flower-based scents (orange blossom extract, vanilla extract, etc)..

Activities

1. Teacher finds a nearby honey bee foraging site.
2. Discuss honey bee senses, or have students read this information sheet:
    a. http://resources21.org/cl/files//project203_5846/inf6%20bee%20senses.htm
3. Using standard scientific experiment design principles, students observe bee behaviour, develop a question, develop a testable hypothesis, design an experiment to test hypothesis, perform test, and consider results. Possible questions:
    - what concentration (0%,10%,25%,50%) of sugar water attract bees most?
    - what coloured flowers attract bees most?
    - which scents attract bees most?
    - do switching locations of sugar water dishes, scents, or coloured flowers confuse the bees? Can they adjust?
4. Students submit a formal lab report discussing their findings.

Possible extensions

- Compare senses and learning of honey bees with other organisms.

Vocabulary

- foraging, sugar solution, concentration, scent, learning

Lesson 7 – Economics of Bee Keeping

Objectives

Students will learn the ecological and economic importance of pollination services and honey bee products.

Activities

1. Lecture / slide show: describe the role of wild and domesticated bees for crop pollination of local, regional, and global agricultural systems. Support with statistics on cost/benefits of local pollination services; example for blueberry farmers.
2. Research Project: The journey of one meal**.** (Inspired by Michael Pollan's book, The Omnivore's Dilemma) The task: Choose a favourite meal. How does food in this meal get from the field to my table? List the ingredients, and tell their story. Research must include:
    - pollination requirements for each plant product - and the plant feed for each animal product - on the menu.
    - farming/gathering/fishing practices: what part of the world, land use, soil type and soil requirements, water use, electricity use, fuel use, inputs such as fertilizers or pesticides, equipment involved, labour (local or migrant, labour-intensive or mechanized)
    - people involved: families of workers, distributors, processors, retailers, companies
    - food processing: how ingredients are combined, food safety, nutrition, packaging
    - where in the world, distance, method and costs of travel, food miles, carbon footprint
    - money: costs and profits of retail vs production, who profits?
    - government oversight and regulations re: labelling, food safety, ingredient contents, nutritional information, etc.
    - ethics: fair trade, carbon footprint, organic farming
    - politics: trade agreements, trade restrictions, farming quotas, or tariffs
    - culture: importance of the food in an ethnic group or a nation's traditions
3. Students formally present findings to class. Bonus if they prepare the meal for sampling!

Possible extensions

- Book report of one of the following non-fiction topical books on honey bees: *Robbing the Bees, Bee Time, The Incomparable Honeybee and the Economics of Pollination*, or another suitable title.
- Have a mock job fair, for which each student researches a job related to honey bees: beekeeper, farmer, apiculturalist, inspector, geneticist, breeder, honey supplier, bee equipment supplier, hobbyist, pollination contractor, etc. Present resumes, job-wanted ads, mock interviews, etc.

Vocabulary

- economics, pollination, culture, pollination services, agricultural inputs (fertilizers, pesticides, water), soil nutrients, migrant labour, food miles, carbon footprint, food labelling, food safety, nutritional information, fair trade, quotas, tariffs.

Lesson 8 – Hive Construction

Objectives

Students will learn the importance of hive design for honey bee health. Students will construct a hive.

Information

Humans have used many containers to house honey bees. All modern hives are based on Langstroth's 'bee space' (3/8 inch or 7.5 mm, give or take 1.5mm) - that is in the spacing bees use to separate their sheets of honeycomb. Modern honey bee hives - including Langstroth, Warre, and top bar - all ensure that structures in the hive are no more than 3/8 inches apart, otherwise honey bees will fill the space with 'burr comb', which makes inspections difficult.

Materials

- Woodworking tools (safety glasses, hammer, nails, paint brushes, paint).
- A prefabricated hive, ready for assembly or materials and extra tools to build one from scratch. Instructions (including dimensions and material recommendations) posted at: http://www.ontariobee.com/sites/ontariobee.com/files/document/construction.pdf

Activities

1. Discuss the elements of a good home. What do honey bees need in a home?
    a. Answers include: shelter from weather, temperature control, moisture control, security from predators, etc.
2. Discuss the 'bee space' as an observation of bee behaviour to help humans manage honey bees.
3. Discuss each structure of the hive and its importance in maintaining a safe, secure home for the bees (after all, they can abscond if they don't like it!).
4. Build the hives. Ensure proper woodworking safety standards are followed.

Possible extensions

- Build extra materials, such as nuclear boxes (nucs).
- Design, draft, cost out, build and compare use of different hive types (Langstroth, Warre, top bar, etc.).
- Math and geometry of woodworking projects.

Vocabulary

- **Brood Box:** Box where the queen is living and eggs are laid
- **Honey Super (super):** Box where queen does not have access to and honey is stored
- **Queen Excluder:** Mesh that goes on top of the brood box and prevents the queen from entering the super.

- **Frames:** Where bees draw wax cells to deposit honey, pollen, brood. 10 frames per box, can be plastic or wood, with foundation or without
- **Foundation:** Plastic sheet that has a hexagon pattern imprinted on, bees will draw wax cells
- **Inner cover:** One on top and one on the bottom of the hive, has a small entrance for bees
- **Screened bottom board:** Bottom of hive, allows ventilation and varroa to fall off the bees on the ground out of the hive
- **Telescoping Hive Cover:** Lid, top of hive
- **Nuc Box:** 5 frame mini hive
- **Hive Set-Up: (**Bottom to Top) Screened Bottom Board**,** Brood Box**,** Queen Excluder**,** Honey Super(s)**,** Inner Cover**,** Telescoping Hive Cover.

Lesson 9 – Hive Inspection

Objectives

Students will learn common practices for inspecting a honey beehive, monitoring and maintaining colony health, promoting honey production, preventing swarm behaviour, preventing stings, and treating stings.

Materials

- Hive tool, smoker, bee brush, protective gear (veil, suit, leather or surgical gloves)
- Information sheet: Hive Inspections (below)
- Work sheet: Colony Inspection Data (below)

Activities

1. Lecture or have students read Information sheet: Hive inspections
2. Inspect hives every 7-9 days between Spring start up and Winterizing (Feb to Oct in Vancouver)
    a. Focus on one aspect of hive management each visit with briefs before and debriefs after
    b. Delegate tasks once students gain confidence
    c. Assign a record keeper each visit to list data on Colony Inspection Sheet.

Possible extensions

- Hive management foci:
    - Autumn: harvest, reduce colony size, IPM, and feed
    - Winterize: insulate, reduce moisture (tip), IPM, and feed
    - Spring buildup: install new packages of bees into hives, catch swarms, split overwintered hives, IPM, and feed
    - Summer: raise new queens, IPM and monitor honey flow

Vocabulary

- **Hivetool:** Multi-purpose tool for most activities in and around the hive
- **Smoker:** Calms the bees by disrupting their pheromone communication. Burn only organics (cotton, etc)
- **Bee brush:** to sweep bees off of surfaces. Especially useful during honey harvest.
- **Protective gear**: veil, bee suit, gloves

Lesson 10 – Bee Diseases and Integrated Pest Management

Objectives

Students will learn integrated pest management principles and key honey bee pathogens and predators.

Activities

1. Lecture: principles of integrated pest management (IPM): study host and pest life cycles for opportunities to minimize damage to host, take preventative measures, monitor host health and pest activity, only apply treatments (e.g. pesticides) once certain pest populations thresholds are met. Define organic agriculture, prophylactic pesticide use and IPM.
2. Group activity 1: Groups of 3-4 assigned a pathogen, parasite, or predator of honey bees. Groups research symptoms, diagnosis, causes, life cycle of pest, how disease is spread, prevention, treatments, advantages/disadvantages of each treatment, cite references.
3. Group activity 2: Within the original group of 3-4, assign each student a letter (A, B, C, D), then create new groups using those letters (all A's together, B's etc). In new group, students each pitch importance of his/her disease topic. Then by group consensus, students allocate an imaginary research budget to study bee diseases. Class debrief:
    a. What makes each disease important and why?
4. Individual follow-up activity: each student reflects on which diseases their group prioritized, and why.

Possible extensions

- Develop, use, and assess effectiveness of IPM plans honey bee pests at school apiary.
- Compare life cycles of honey bee pests with other parasites and pathogens
- Class debate on the advantages/disadvantages of prophylactic pesticide use, integrated pest management, non-treatment, and organic treatment.
- Lab: perform Nosema spore counts. Method: http://www.ontariobee.com/sites/ontariobee.com/files/document/Nosema%20Detection%20Info%20Sheet_0.pdf
- Lab: perform Varroa mite counts. Method: http://www.ontariobee.com/sites/ontariobee.com/files/document/Copy-of-varroa-sampling-EN.pdf

Vocabulary

- Varroa destructor, Nosema cerana, Tracheal mites, AFB & EFB & chalkbrood, Wasps, pesticide exposure, neonicotinoids, prophylactic, integrated pest management, treatment-free, organic.

Lesson 11 – Honey Harvest

Objectives

Students will learn the uses of honey and will harvest honey from school apiary.

Materials

- bee brush, extra supers, bee-proof netting, de-capping tools, honey extractor, honey-gated bucket, filters, jars, lids, labels, (and lots of towels for cleanup!).

Activities

1. Discuss uses for honey: food, burn wound dressing, certain floral varieties are medicinal.
2. Discuss source of honey flavour (mainly nectar).
3. Discuss variety of honey harvest techniques: crush and filter, centrifuge, melt and separate. I recommend centrifuge.
4. Harvest honey from school apiary and put it all in jars.

Possible extensions

- Cooking with honey: 4 lessons available from Kohuch, Michelle (2008) BC Honey: The Natural Sweetener for Home Economics 8-12. BC Agriculture in the Classroom Foundation. http://www.aitc.ca/bc/uploads/summerinstitute/BC%20Honey.pdf
- Design honey jar labels.
- Sell jars for school fundraiser.

Vocabulary

- centrifuge, extractor, harvest

Lesson 12 – Waxworks Lab

Objectives

Students will learn the structure and function of wax from a honey bee's and a human's perspective.

Materials

- hot plate or burner, double boiler (wax melts below water's boiling temperature, but catches fire not much higher above it), deep metal containers for drip candles, plastic yoghurt containers, filter (e.g. cheesecloth), molds, wicks, olive oil, vitamin E, oil-based flavour drops (peppermint, chocolate, etc).
  Note: wax is difficult to clean off of equipment. It is recommend to use old equipment and storing it separately from other kitchen equipment.

Activities

1. Refine wax in a double-boiler. Melt wax from school apiary (old comb on frames, burr comb collection, wax cappings from honey harvest), pour into plastic yoghurt containers, let solidify. Honey will sink and wax will rise and everything else will settle in between.
2. Candle-making methods: drip, mold, tea light, or sheet rolls.
3. Lip balm production: mix olive oil with melted wax, add vitamin E drop and a flavour drop.

Possible extensions

- Make other wax-based products: Car wax, furniture wax, surfboard wax, moustache wax.
- Study the role of thermodynamics in waxworks.
- Study the role of hydrophilic and hydrophobic material in waxworks.
- Compare process of wax refining to crude oil refining.

Vocabulary

- refining, double-boiler

Worksheet 1: Honey Bee Biology

Name: _____ Date: _____

1. Complete the following table about honey bee casts

	Queen	Worker	Drone
Sex (male or female)			
Key physical traits (how you can tell them apart)			
Number of individuals in a typical colony			
Purpose in life			
Daily tasks			
Genetic ploidy (number of chromosomes)			
Days of development from egg to adult			
Lifespan of an adult			
Typical cause of death			

2. Name the 4 life stages of a honey bee life cycle. _____
_____

3. Explain the nuptial flight._____
_____
_____

4. Explain swarming _____
_____

Worksheet 2: Honey Bee Dissection

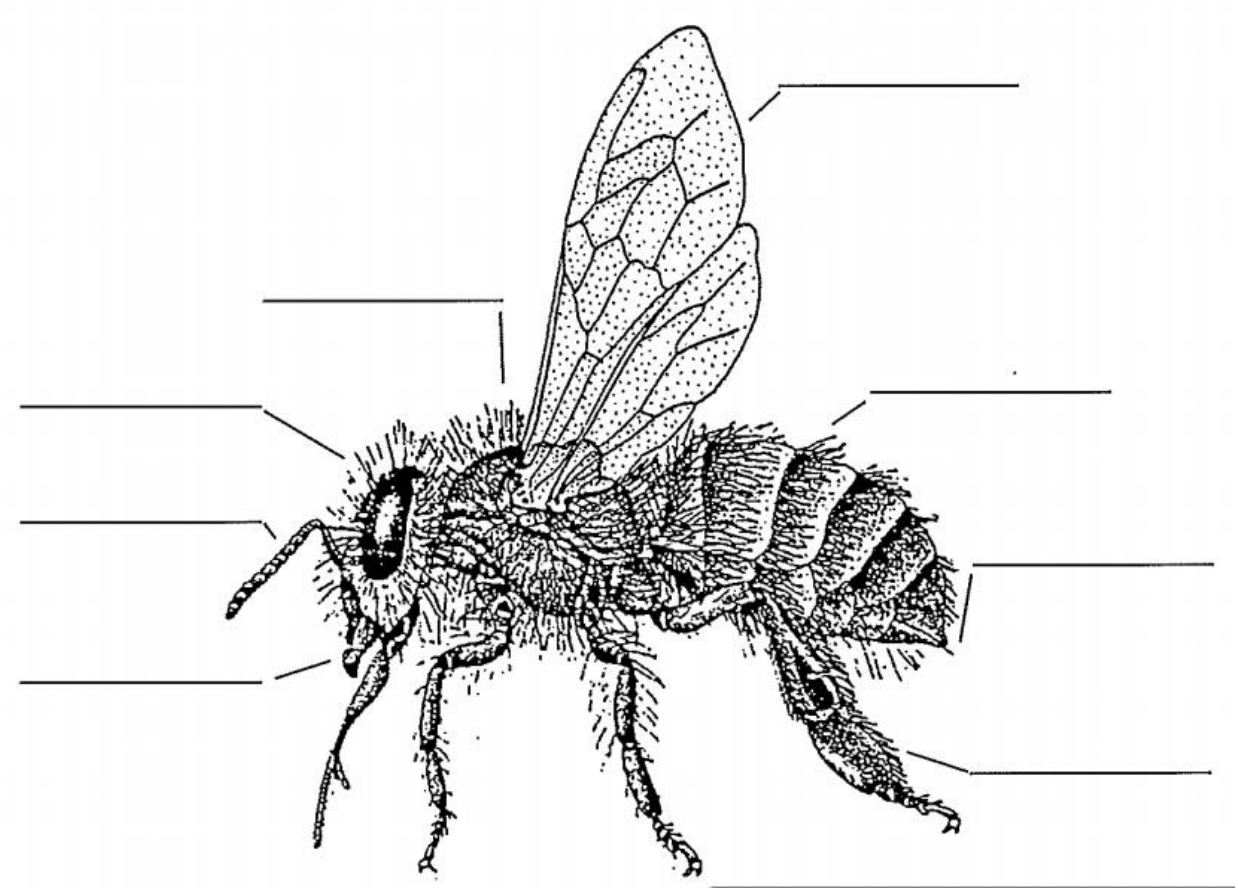
Name: _____ Date: _____

What is the scientific name of the Western honey bee? _____

Part 1 - General Anatomy

Place one worker bee in your dissection dish. Observe the general anatomy of the bee.

1. Number of pairs of legs? _____
2. Number of wings? _____
3. Number of body sections? _____
4. Names of body sections? _____,_____,_____
5. Label the following parts on the picture below: head, thorax, abdomen, antenna, mouthparts, pollen basket, wings, legs, stinger
6. Observe the abdomen with a hand lens. How many segments do you count? _____
7. Examine the hairs closely. What do you notice?_____
8. Why do you think bees are so hairy? _____



Part 2 – Head and Mouthparts

1. Dissect the head of the bee. Try to identify the following parts: ocellus, antennae, compound eyes, mandible, and proboscis.

2. Search online for reputable sources to find the function of each part:
    a. ocellus _____
    _____
    b. antennae _____
    _____
    c. compound eye _____
    _____
    d. mandible _____
    _____
    e. proboscis _____
    _____

3. Examine a slide (or online image) of honey bee mouthparts and draw a diagram of the head. Label the parts listed above in question 1.

Part 3 – Hind Leg

1. Dissect the hind leg of the bee. Try to identify the following parts: femur, tibia, tarsi, pollen basket, pollen press, rake, and comb.

2. Search online for reputable sources to find the function of each part:
    a. pollen basket _____
    _____
    b. pollen press _____
    _____
    c. combs _____
    _____

3. Examine a slide (or online image) of honey bee hind leg and draw a diagram. Label the parts listed above in question 1.

Part 4 – Abdomen and Stinger

1. Dissect the abdomen of the bee. Try to identify the following parts: carapace, wax glands, Nasanov gland, spiracle, trachea, honey stomach, stinger (poison sac, barbed lancets).

2. Search online for reputable sources to find the function of each part:
    a. carapace _____
    _____
    b. wax glands _____
    _____
    c. Nasanov gland _____
    _____
    d. spiracle and trachea _____
    _____
    e. honey stomach _____
    _____
    f. poison sac _____
    _____
    g. barbed lancets _____
    _____

3. Examine a slide (or online image) of honey bee abdomen and draw a diagram. Label the parts listed above in question 1.

Worksheet 3: Values and Attitudes Towards Honey Bees

Name: _____ Date: _____

Instructions

Your answers are not graded. Please answer honestly. On a scale of 1 (lowest) to 10 (highest), rate the relative importance of the following statements about honeybees?

	1	2	3	4	5	6	7	8	9	10
Honeybees are beautiful creatures and are a good mascot for nature.										
Beekeeping is a good example of human mastery and control over nature.										
Honeybees play an important role in complex ecological webs.										
I love honeybees! They are valuable in and of themselves.										
Honeybees should be treated with respect and dignity.										
Keeping bees is a great way to connect with the great outdoors.										
Bees, like all bugs, are dangerous, scary, icky, or boring.										
Bees are fascinating. I'm interested in their how their bodies work, their behavior and their social structure.										
I like honeybees because I like eating honey and eating foods they pollinate.										

Which statement is most important to you and why?

The previous question was based on Kellert's framework of basic attitudes towards insects. Use Table 1 to answer the questions bellow:

Table 1: Basic attitudes towards honeybees

Aesthetic	Bees are physically attractive and have symbolic appeal.
Dominionistic	Bees must be mastered and controlled.
Ecological	Relationships between bees and other species within an ecosystem are important.
Humanistic	Bees have a strong emotional affect.
Moralistic	Bees should be treated rightly and without cruelty.
Naturalistic	Bees allow for enjoyment of the great outdoors.
Negativistic	Primary orientation of fear, dislike, or indifference toward bees.
Scientific	Bees have interesting physical attributes, taxonomic classification, and biological functioning.
Utilitarian	Bees provide practical value to humans (e.g. honey production).

1. Which attitudes are your 'gut reactions' towards insects, in general? _____
   _____
2. Which attitudes are your 'gut reactions' towards bees? _____
   _____
3. Which attitudes are you 'thoughts of the mind' towards bees? Do your thoughts and guts differ? Why? _____
   _____
   _____
   _____
4. Have your attitudes changed over time? If so, why? _____
   _____
   _____
   _____
   _____

Information Sheet: Hive Inspections

Purpose of Inspections

- monitoring and maintaining colony health
- promoting honey production
- preventing swarms

Key Tips

- **3+5+13=21.**
  - Worker eggs hatch after 3 days. Larvae are capped 5 days later. Adults emerge 13 days later.
  - Monitoring stages of brood (eggs, larvae and pupae) allows you to make informed management decisions. For example:
    - eggs, larvae, pupae present: normal
    - only eggs and larvae: queen started laying 4-8 days ago
    - only eggs and pupa: a brood break, a new queen introduced
    - only pupae: queen stopped laying (dead, swarmed, honey-blocked) 9-20 days ago
    - dead larvae seen: brood disease (EFB or chalkbrood)
    - dead pupae seen: brood disease (AFB, sackbrood, chilled brood, etc)
    - many pupae: colony population about to increase (1 frame of brood hatches as 2 frames of bees)
    - few eggs: colony population about to decrease (common in autumn)

- **7 frames of brood**
  - colony is strong, able to handle most diseases, able to keep hive clean, able to maintain a stable population, and is on the verge of swarming
  - can be split into nucs
  - can start honey production (add a honey super)
  - can be maintained: every week by putting 2 frames of capped brood (pupae) up into the honey super, and replacing them with 2 empty frames

- **Re-queen every year or two**
  - by splits, swarm replacement, or introducing a new queen

Basic Bee Biology

3 different castes of bees:

- 1 queen: lives for 4-7 years in the wild, beneficial to re-queen every year, lays up to 2000 eggs per day. Put on a diet before swarming, leaves the hive with half of the worker bees.
- Several hundred drones: Males, haploid! (only one set of chromosomes), comes from an unfertilized egg, only role to fertilize the virgin queen on her mating flights. Dies in the process. Gets killed or kicked out of the hive at the end of summer.
- 60 000 female worker bees: Live for 4 weeks in the summer, several months in the winter. Tasks progress from housekeeping duties to guard bees to foragers.

Worker: Egg 3 days, Larvae: 5 days Pupa: 13 days Total: 21 days
Drone: Egg 3 days, Larvae 6.5 days, Pupa: 14.5 days, Total: 24 days
Queen: Egg 3 days, Larvae 5.5 days, Pupa: 7.5 days, Total: 16 days

Swarming

Natural way of reproduction for bees. When hive gets too crowded bees prepare for swarming by raising new queens. Swarm (queen) cells are normally located at the bottom of the frame. Any time after the swarm cells have been capped the old queen and about half the worker bees leave as a swarm. The old queen will land somewhere nearby and all the bees will cluster around her in a big ball. From there the bees will send out scouts to look for a new hive. Once a suitable location is found the entire swarm will leave to the new location.

Swarms are bad for the beekeeper since

a. it reduces the honey yield
b. gets the neighbours all worked up

How to prevent swarming:

a. give the bees plenty of space
b. re-queen every year (a young queen is less likely to swarm)
c. remove all queen cells when you find them during a hive inspection! If you miss only one there will be a swarm!
d. when swarming is imminent (queen has been on a diet!) remove queen and put her into a nuc box, remove all but one or two queen cells. The hive will re-queen itself.

How To Catch a Swarm

When the swarm is clustered they are easily caught and moved to a new hivebox. Check out Youtube for great examples

Hive Inspection Theory

Once every 7-9 days the beekeeper should inspect the hives. He/She looks for:

- ample storage of nectar and pollen
    - nectar is at the top of a frame
    - pollen below
    - brood below that
- presence and performance of the queen
    - if queen spotted and queen is big; good
    - if queen spotted and queen is small and no eggs, she might be getting ready for swarming
    - if you can't find the queen, don't worry. If eggs present; queen was here within the last three days, most likely she is still there and you are good
    - brood pattern should be solid and big
- signs of disease
    - such as: American Foulbrood, Varroa mites, chalkbrood, Nosema, etc.
    - send a sample to the ministry for testing (free service)
    - ask provincial inspector to come out for an inspection (free service)
    - treat according to Ministry regulations
    - Do not treat prophylactically and only add approved substances to your hives!
    - Don't treat with the honey supers on!
- signs of Varroa
    - deformed wings (caused by deformed wing virus (DWV) which is spread by Varroa)
    - mites present on the bees
    - natural drop on the bottom board
    - measure with alcohol wash or powdered sugar method
    - treat when necessary (see BC Ministry of Agriculture factsheets on beekeeping)
- swarm queen cells
    - bees are getting ready to swarm. Decide to either split the hive or repress swarming.
    - Split: find the queen and move her to a nuc box, along with 5 frames of *young* bees and honey and pollen resources. Leave the old colony with its swarm cells to produce a new queen - should be laying in 20-30 days.
    - Repress: Remove queen cells, add more empty frames in the brood chamber and honey super. Monitor closely every 7-9 days
- supersedure cells
    - old queen is failing and is being replaced by the bees. Re-queen or let them re-queen themselves.
- presence of a honey flow
    - fresh white wax is present as burr comb on frames, add honey supers once the last one is half full.

General Guidelines

Make sure you are not in a rush! Take your time but work consistently and with purpose. If you leave the hive open for too long robbing could be the result. If you get stung apply more smoke, if you get stung a lot, close the hive and come back in a couple of days. Make sure you are not wearing rings as the swelling resulting from a sting could lead to the loss of your finger!

Inspection Procedure:

1. Smoke the bottom and upper entrance with a few puffs of smoke
2. Remove telescoping hive cover, place upside down on the floor
3. Lift inner cover, lean upside down against the front entrance so that bees can walk into the hive
4. Apply more smoke
5. Remove honey super (if present), place at an angle on top of the telescoping hive cover on the floor so you don't squish bees. Beware honey supers can get very heavy!
6. Remove queen excluder and place next to hive
7. Apply more smoke if bees are "boiling" out of the hive
8. Remove frame 1 or 10 (outside frames). Queen is least likely to be on that frame. Note presence of eggs, pollen, nectar, queen cells, and diseases.
9. Lean frame against outside of hive
10. Now you have space to slide the next frame out and inspect it. When completed, slide it against the edge
11. Proceed as in 10 for the next 8 frames. When completed return the very first frame to the empty spot on the outside, add queen excluder, honey super, inner cover and telescoping hive cover. Repeat in 7-9 days.

Honey Harvest

Remove honey and start mite treatment right away. Honey frames need to be at least ¾ capped. Remove wax cappings and extract using honey extractor (centrifugal force). Avoid robbing by keeping honey inaccessible to bees. Honey spoils if added to water or heated. Make sure honey is at least 83% sugar otherwise it might ferment. Filter and bottle and enjoy! You can borrow an extractor from the Richmond Beekeepers Association or get it extracted and bottled by a CFIA approved facility (e.g. Campbell's Gold Honey Farm in Langley, www.bchoney.com)

Wax Harvest

Collect wax from cappings or from 3+ year old frames. There are several methods to refine the wax and remove the excess 'gunk'. The easiest method is to wrap the wax in a cheesecloth, place in water in a double-boiler, boil until the wax melts and floats to the top, remove the cheesecloth (and gunk), let the water/wax cool, then remove the cooled, hardened wax.

Once the wax has been purified, it can be put to many uses, including:

- Creating foundation for new frames,
- making candles (rolled, poured, dipped, molded) and crafts (batik),
- creating personal care products (lip balm, hand cream, moustache wax),
- creating wood and leather products (shoe and furniture wax), etc.

Worksheet 4: Colony Inspection Data

Name: _____ Date: _____

Instructions

You must enter a great deal of information into this table and you could quickly run out of room. In order to help conserve space, you will use special codes for much of the information. The Key for your data entry codes are on the reverse of this handouts.

Colony Name/#:								
Date	**Strength**	**Brood Stage**	**Brood Condition**	**Food Stores**	**Feed**	**Diseases**	**Treatment**	**Other comments**

Key to data entry

Date: MM/DD/YYYY of visit
Strength:

- Frames of brood/Frames of bees
- Height in D (deep), S (shallow), N (nucleus box)
- e.g. 7/13 2D = 7 frames of brood, 13 frames of bees in 2 deep boxes (1 brood, 1 honey super)

Brood stage:

- Q: see queen
- E: eggs
- L: larvae
- P: pupae
- A: all E,L,P
- Qcell: note supersedure or swarm, and action taken

Brood condition:

- E: even
- SS: slightly spotty
- S: spotty
- AND
- H: healthy
- D: brood disease present

Food stores:

- Frames of Pollen/Frames of Honey
- e.g. 3/6 = 3 frames pollen and 6 frames of honey (single brood chamber ready for winter)

Feed:

- What feed (type and quality) did you add, if any?
- Pollen: # of frames
- Patty: # of 1 lb patties
- Honey: # of frames
- Syrup: # of litres
- Dry sugar: to prevent winter starvation

Diseases

- AFB: American Foulbrood
- EFB: European Foulbrood
- Sac: Sacbrood
- CB: Chalkbrood
- VM: Varroa mites
- TM: Tracheal mites (confirm w/ microscope)
- Nos: Nosema (confirm w/ microscope)

Treatment:

- Include beginning + end dates of treatments applied.

Starting an Apiary: Safety, Risk Management, Insurance, Regulations

Beekeeping is medium-to-low risk school activity. Here are a few risks and how to mitigate:

1. **Public relations.** If you as a teacher wish to start a school apiary, you must make allies with your school leaders, parents, and neighbours. Below are sample letters to neighbours and parents.

2. **Stings** are the most important risk. Since foragers rarely sting, the danger is around the hives and during inspections. Most people react to stings normally; swelling and localized pain can be treated with benadryl and acetaminophen. On rare occasions, people have severe reactions and need to use an epi pen. I suggest:
    a. choosing gentle breeds of honey bees to keep. e.g. Carniolan
    b. choosing a relatively secluded location for the apiary, where flight paths do not intersect foot paths
    c. educating students on safe beekeeping practices and use of protective gear
    d. connecting with your school nurse to print class info on special health concerns and equip a first aid kit and carry it with you to each inspection.
    e. Printing out your class listing medical concerns.

3. **Insurance**. Check with your school board if you have necessary insurance. Extra insurance can be bought through the BC Honey Producers' Association. http://www.bcbeekeepers.com/

4. **Local regulations**. It is worth checking your local provincial and municipal regulations for setting up an apiary. The City is very supportive of urban beekeeping. To support proper bee health management and to support public safety, the City has developed a set of guidelines (link below). The guidelines offer best practices for keeping hives in community gardens, in residential lots, on rooftops, and on commercial properties. Number of hives per site are typically limited to 2, but if you want more, usually you can find a number of agreeable neighbours to host nearby. Guidelines on keeping bees in the City of Vancouver, visit: http://vancouver.ca/people-programs/beekeeping.aspx

Sample letter to neighbours

Dear Neighbours,

As part of an Urban Agriculture course scheduled to run next year, we are planning to install two honey bee hives at *X location*. Before starting work on the project, we are hosting an information evening for nearby residents.

The following are a few points about bee behaviour, and what you might expect to see:

1. In all likelihood, the only thing you'll notice will be better fruit in your gardens. Honeybees generally fly 5 meters (~20 feet) above ground level and will fly as far as 2 km from their hives, so they tend to be relatively inconspicuous in the neighbourhood.

2. Neighbours in dry areas will sometimes complain about bees visiting their neighbour's ornamental pool to get a drink. We don't expect this to be an issue with our rain forest climate, but it can always be alleviated by leaving out pots of water near the hives.

3. Understandably, many people worry about possible bee aggression. Unlike wasps and hornets, honey bees will only act aggressively in defense of their hive. We've selected Carniolan and Italian bees to work with. These two bees are bred for gentle, non-aggressive behaviour. We will keep the beehives in an enclosure with 8 foot high fencing to prevent people and/or dogs from getting close to the hives. The hives will also be secured to the ground to prevent them from falling over.

4. As part of their natural urge to reproduce, bees will occasionally take their queen and half of their workers to go looking for a new home. This is called swarming, and it can happen in springtime or in the early summer. Swarming can usually be predicted and managed before the bees ever leave their hives. (This can be done by early re-queening, by culling queen cells, or by inducing a natural hive split). Occasionally though, a swarm will get away. The important thing to realize is that when bees do swarm, they are at their least aggressive. If you've ever seen someone with a "bee beard", you'll have witnessed a swarm. Without a hive to protect, swarming bees are gentle, and can be easily rehived. The teacher sponsor of this school project is well experienced with the keeping and maintaining of bee hives.

A meeting will be held at the school on Monday, May 9th to share information about the project. We will meet in room C301 just inside the main entrance doors at 7:00pm.

Sincerely,

Principal

Sample letter to parents

Dear Parents:

Your child has expressed interest in engaging in Beekeeping at our school as part of a club and/or course. These activities offer unique opportunities for students to explore nature and develop agricultural skills. However, there are also risks that we wish to bring to your attention.

Rationale:

This is a club and/or course where your child will be given an opportunity to learn practical skills in tending organic gardens and keeping honeybees. Students will study bee ecology, integrated pest management, hive management, wax production and honey production. Students will also work in the lab with microscopes, honey-extractors, and wax-melting equipment. Your son will leave this club and/or course with a lasting appreciation for these agricultural arts.

Organization:

Beekeeping and Gardening Club meets Tuesdays and/or Thursdays during lunch. Beehives are located at *X location*. Students will always be accompanied by teachers at the beekeeping site.

Safety & Supervision:

There are relatively few risks associated with gardening. However, working with honey bees puts students at risk for stings, which may result in mild or severe local reactions, and in extreme cases, anaphylaxis. Each teacher sponsor is an experienced beekeeper; at least one will be present to offer guidance during visits to beehives. Students will be provided safety instructions and protective clothing - including veils and gloves - to prevent bee stings. In case a sting does occur, teachers will be carrying an epi-pen and Benadryl to treat for swelling, if needed.

If you are comfortable with this activity selection for your child please sign and return the permission slip below. If you have any questions please feel free to reach us at *phone and email*

Sincerely,

Teachers

********** (detach along this line) **********

I hereby give permission for my child/ward, _____ (print child's name) to participate in Beekeeping activities for the remainder of the 2014-2015 school year. I understand the inherent risks of these activities and have been encouraged to seek clarification on these matters.

_____	_____	_____
Signature	Parent/Guardian Name	Date

Resources

1. Suppliers
    a. Two Bees Apiary, http://www.twobeesapiary.com/
    b. Urban Bee Supplies, http://www.urbanbeesupplies.ca/
2. News and information
    a. American Bee Journal, http://www.americanbeejournal.com/
    b. Bee Source, http://www.beesource.com/
    c. Scientific Beekeeping, http://scientificbeekeeping.com/
    d. The Practical Beekeeper (minimal interventions): http://www.bushfarms.com/bees.htm
3. Organizations and Clubs
    a. BC Honey Producers Association, http://www.bcbeekeepers.com/
    b. Richmond Beekeepers Association, http://richmondbeekeepersca.wordpress.com/
4. Regulations and Guidelines
    a. BC Ministry of Agriculture, http://www.agf.gov.bc.ca/apiculture/factsheets/index.htm
    b. City of Vancouver, http://vancouver.ca/people-programs/beekeeping.aspx
5. Courses
    a. Honeybee Center in Surrey, courses, http://www.honeybeecentre.com/

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