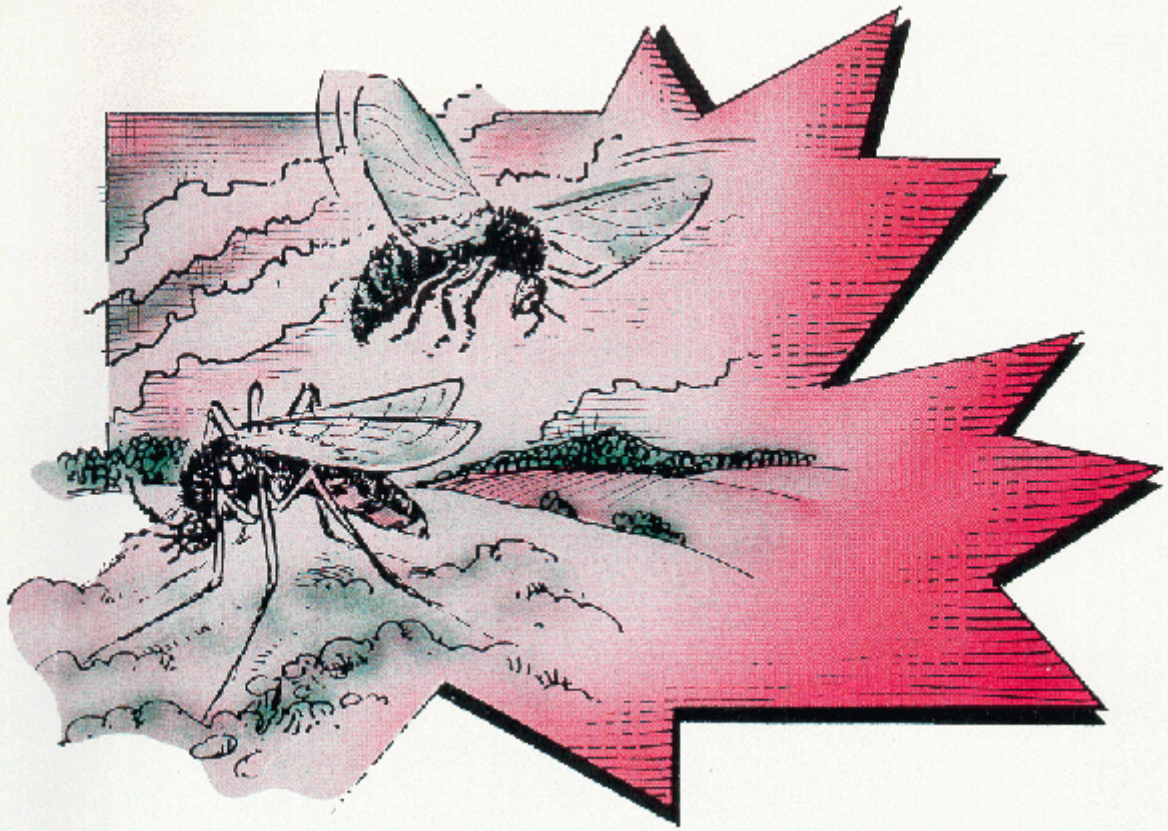

MOSQUITO AND BITING FLIES MODULE **MODULE – INSECTES PIQUEURS**

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

CONNAISSANCES FONDAMENTALES REQUISES POUR LA FORMATION SUR LES PESTICIDES AU CANADA

CAPCO

Health Canada Santé Canada

MOSQUITO AND BITING FLIES MODULE

BASIC KNOWLEDGE REQUIREMENTS

FOR

PESTICIDE EDUCATION IN CANADA

AUSSI DISPONIBLE EN FRANÇAIS

Prepared by the National Task Force on Pesticide Education, Training and Certification

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BASIC KNOWLEDGE REQUIREMENTS
FOR PESTICIDE EDUCATION IN CANADA
MOSQUITO AND BITING FLIES MODULE

The Mosquito and Biting Flies category includes the application of insecticides for control of adult mosquitoes and black flies in buildings, recreation areas and urban areas and the control of mosquito and black fly larvae in water. This category includes only ground application and does not cover aerial application which is contained in a separate category.

The knowledge requirements described in this module are additional to the knowledge requirements detailed in the Applicator Core, common to all certification categories. This module adds details to sections of the Core, where it is necessary to include Mosquito and Biting Flies specific information. An outline of the knowledge requirement for the Mosquito and Biting Flies module is presented on the following page. This outline shows which sections of the Core have been expanded in the module.

The knowledge requirements provided here is the information a trainer would use to provide training to an applicator on the responsible use of pesticides. It is targeted to the trainer for teaching purposes and is not intended as an applicator manual.

In addition to the applicator core, modules have been developed for the following categories:

Aerial
Agriculture
Aquatic Vegetation
Forestry
Fumigation
Greenhouse
Industrial Vegetation
Landscape
Mosquito and Biting Flies
Structural

MOSQUITO AND BITING FLIES MODULE

CONTENTS

Category: MOSQUITO AND BITING FLIES

Concept: REGULATIONS

General Objective: To understand pesticide regulations that relate to control of mosquitoes and black flies.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Provincial or territorial legislation may apply to the application of pesticides for control of mosquitoes and black flies: **1) To bodies of water on private and crown land;** **2) In urban areas;** **3) That are restricted;** **4) By aerial application, especially over urban centres.** **This legislation may require permits, public hearings or environmental impact assessments.** **Check with provincial or territorial pesticide regulatory officials in advance of a mosquito or black fly control program.**	**Know that provincial or territorial legislation may apply to pesticide applications for control of mosquitoes and black flies.**	**Describe why provincial or territorial regulatory officials should be contacted before planning a control program for mosquitoes and black flies.**

Category: MOSQUITO AND BITING FLIES

Concept: HUMAN HEALTH - CHOLINESTERASE TESTING

General Objective: To understand the safety concerns when applying pesticides which might affect blood cholinesterase levels.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Organophosphate or carbamate insecticides, which may be used in programs to control mosquitoes and black flies, inhibit cholinesterase. Cholinesterase is an enzyme in the blood that affects the nervous system and the way the brain sends messages to different parts of the body.	**Know that cholinesterase testing is important when applying organophosphate or carbamate insecticides on a regular basis.**	**Identify the blood test that applicators should have when handling organophosphates or carbamates on a regular basis and describe why.**
Cholinesterase levels can vary widely between individuals and therefore it is important to know an individual's level of cholinesterase before handling these insecticides.		
Applicators who handle these insecticides on a regular basis should have: **1) A baseline test to determine cholinesterase enzyme levels before starting a control program;** **2) A regular blood test to check cholinesterase levels during the control program.**		**Identify when an applicator should have a cholinesterase test.**

Category: MOSQUITO AND BITING FLIES

Concept: PESTICIDE SAFETY - MOSQUITO AND BLACK FLY CONTROL PROGRAMS

General Objective: To understand the safety concerns when applying pesticides for mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The application of pesticides in populated areas can concern the public. Be aware of surrounding human activity at all times. **To reduce bystander exposure:** **1) Make applications, if possible, when human activity is at a minimum;** **2) Take precautions that humans do not come in direct contact with the applied material;** **3) Undertake a public notification program to inform when, where and what pesticides will be applied to an area.**	**Know what precautions to take when applying pesticides in populated areas.**	**List the precautions to take when applying pesticides in populated areas.**

Category: MOSQUITO AND BITING FLIES

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT

General Objective: To understand environmental concerns and guidelines to protect the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Rivers, streams, sloughs, ponds, marshes and other wetland areas, which can breed black flies and mosquitoes, may support fish and wildlife. Mosquito and black fly larvae may be a food source for insects, fish and other animals. Applications of pesticides made to standing or flowing water may harm other organisms living in the water and alter the ecosystem.	**Know the potential harmful effects of insecticide applications made for mosquito and black fly control. Understand that mosquitoes and black flies are an important part of the food chain.**	**Describe the potential harmful effects of insecticide applications for mosquito and black fly control. Identify the importance of mosquitoes and black flies in the food chain.**
When planning a larvicide program, areas of high fish and wildlife value should be identified and a protective strategy developed. These areas include back channels of streams and rivers, which are often fish rearing areas, weedy shorelines of lakes, which are essential for waterfowl and fish, and drainage ditches connected to fish bearing waters.	**Be aware of valuable fish and wildlife habitat that should be protected.**	**Identify areas of high fish and wildlife value that should be protected.**
Other areas may be designated as sensitive based on importance for food supplies, drinking water and recreational activities. Prevent pesticide drift into these areas. **Examples of sensitive areas include:** **- apiaries;** **- provincial parks;** **- conservation areas, nature reserves and wildlife management areas;** **- public swimming holes;** **- areas devoted to the cultivation of crops;** **- any water body whose end-use is for human consumption.**	**Know what other areas may be sensitive.**	**List other sensitive areas.**

Category: MOSQUITO AND BITING FLIES

Concept: ENVIRONMENT - PROTECTING THE ENVIRONMENT

General Objective: To understand environmental concerns and guidelines to protect the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Guidelines for environmental protection: - **a larvicide program is generally more effective than an adulticide and may disperse less insecticide into the environment;** - **do not apply inappropriate pesticides to waters used for drinking and recreational activities (refer to the label and regulatory guidelines);** - **do not apply inappropriate pesticides to fish habitat identified as non-target areas by local fisheries authorities;** - **beekeepers in proposed treatment areas should be notified when adulticides may pose a hazard to the colonies;** - **prevent contamination from drift;** - **the area of application must be properly measured and the recommended rate of insecticide must be properly calculated and applied to prevent over-application.**	**Know the guidelines for preventing harmful environmental effects.**	**Describe the guidelines for preventing harmful environmental effects.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - INTRODUCTION

General Objective: To provide a general introduction to mosquito and black fly biology.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insects		
Insects are a group of animals that as adults have segmented bodies, 6 legs, and an outer skeleton. Most biting insects are in the fly order Diptera. There are four families that contain most of the biting flies: mosquitoes (Culicidae), black flies (Simuliidae), biting midges (Ceratopogonidae), and deer and horse flies (Tabanidae). In these families, it is only the females that take blood and only a few attack man or domestic animals.	**Know what insects are.**	**Describe insects.**
	Know the order and families of most biting flies.	**Identify the order and families of most biting flies.**
	Know that in these families only females take blood and only a few attack man and domestic animals.	**Identify that in these families only females take blood, and only a few attack man and domestic animals.**
Biting fly species differ with location and season. Knowledge of local or important biting fly species is critical for good control measures. Mosquitoes and black flies are the most important biting flies. In some regions of Canada other biting flies such as stable flies and horn flies may also be important pests of humans and livestock, and both sexes may bite.	**Know which biting flies are considered as pests.**	**Identify the biting flies that are considered as pests.**
Biting flies feed on blood, causing irritation and discomfort to humans, and to domestic and wild animals and are potential disease and parasite vectors. These insects can cause severe economic losses through reduced livestock production, reduced efficiency of outside workers, reduction in recreation activity, reduced real estate values and in some cases, the spread of disease.	**Know the harmful effects of biting flies.**	**Describe how biting insects reduce animal production and human activity.** **Lists some ways that biting flies can cause economic losses.**
All flies, including biting flies, have a single pair of membranous wings, and one pair of knobbed structures behind the wings, which are the remnants of the second set of wings of other insect groups. They have well-developed compound eyes and other sensory structures used to find hosts. In the biting members the mouthparts are adapted for either piercing (mosquitoes) or slicing the skin (the other three families). Salivary fluid is secreted to prevent coagulation of the blood while the fly is feeding. The saliva often causes allergic reactions, from swelling and irritation at the site of the bite up to anaphylactic shock for severely allergic individuals, and can introduce viruses and parasites into the bite.	**Know the main characteristics of mosquitoes and black flies, and how they feed.**	**Describe the main characteristics of mosquitoes and black flies and how they feed.**
	Know the harmful effects of salivary fluid.	**Describe the harmful effects of salivary fluid which is secreted during feeding.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - INTRODUCTION

General Objective: To provide a general introduction to mosquito and black fly biology.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Biting flies have four stages in their life cycle: egg, larva, pupa and adult. The blood taken by females is used for egg development. Both males and females feed on flower nectar.	Know the basic life stages of biting flies and why adult female flies need blood. Understand that both males and females feed on nectar.	List the four life stages of biting flies and identify why adult female flies need blood. Identify the common food of both males and females.
The immature stages of each family differ markedly in form and in their ecology. Larval mosquitoes are primarily filter feeders in small, shallow and still water bodies. Larval black flies are filter feeders living only in running water. Biting midge larvae are found in wet substrates (including marine and fresh water shorelines, wet soil and in organically rich substrates such as dung). Larval deer and horse flies are predators and/or detritus feeders in wet and damp soils.	Know the basic ecological differences between the feeding sites of the larvae of biting flies.	Describe the habitat and feeding requirements of the larvae of mosquitoes, black flies, biting midges and deer and horse flies.
As almost all control measures are restricted to the mosquito and black fly groups in shallow still water or rivers and streams, the module will not concentrate on these families.	Understand that almost all control measures are restricted to mosquitoes and black flies.	Identify that almost all control measures are restricted to mosquitoes and black flies.
Carefully plan mosquito and black fly control programs. Accurately identify the flies; not all are pests and not all need to be controlled. Some species prefer specific hosts and may feed exclusively on birds rather than mammals. Identification also helps in locating breeding sites of biting flies.	Know why identification is important.	Identify the reasons for accurate identification.

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mosquitoes		
There are over 70 different species of mosquitoes in Canada, which differ in their size, colour, body features, habitat and host preference. Female mosquitoes feed on blood causing irritation and discomfort to humans, animals and birds. In Canada, some mosquitoes transmit diseases such as Western equine encephalitis, St. Louis encephalitis, and dog heartworm.	**Know why mosquitoes may need to be controlled.**	**Identify why mosquitoes may need to be controlled.**
Description: Female mosquitoes have mouthparts that pierce the skin. They take blood for egg production. Males have bushier antennae and non-piercing mouthparts, which are used to feed on nectar. Mosquito larvae (wrigglers) are cylindrical with a breathing tube or siphon and their bodies are covered with distinctive hairs, which are used for identification. Mosquito pupae are "comma" shaped.	**Know the basic characteristics of mosquitoes.**	**Describe male and female mosquitoes and describe a mosquito larva and pupa.**
Life Cycle: There are four stages in the mosquito life cycle: **1) Eggs are laid singly or in rafts in stagnant water, on vegetation, or on moist soil in areas that will be flooded with water.** **2) Larvae, or "wrigglers" have specialized breathing tubes so they can live in water. Larvae feed on organic matter in the water and develop through 4 growth stages or instars before changing into pupae.** **3) Pupae, or "tumblers", are also aquatic. Pupae do not feed.** **4) Adults.**	**Know the life cycle of mosquitoes.**	**Describe the life cycle of mosquitoes.**
Habitats: Mosquito larval habitats vary greatly. Any site that holds water for over a week may be a suitable habitat for mosquitoes. Fast-running water is not suitable.	**Know the characteristics of mosquito breeding sites. Understand that fast-running water is not suitable.**	**List characteristics of mosquito breeding sites. Identify that fast-running water is not suitable.**

Prime mosquito breeding habitats are those that:

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Appear year after year; **2) Are surrounded by vegetation.**		
Habitats may include: **a) snow melt pools;** **b) floodwater pools (such as roadside and drainage ditches, pools along creeks and rivers, standing water in low areas in fields and woodlands);** **c) artificial ponds (such as sewage lagoons, sludge beds, holding ponds, ornamental ponds, abandoned foundations, poorly maintained swimming pools, dug-outs and fire reservoirs);** **d) artificial containers (such as rain barrels, tires, bird baths and roadside catch basins);** **e) irrigation ditches.**	**Know mosquito habitats.**	**List mosquito habitats.**
Hosts: Mosquitoes find a host by using odour, movement, colour, lactic acid, and carbon dioxide. Some mosquitoes prefer mammals like humans, cattle or horses, while others prefer birds or reptiles.	**Know how mosquitoes are attracted to hosts.** **Know that different mosquitoes prefer different hosts.**	**Describe how mosquitoes are attracted to hosts.** **List possible hosts.**
Seasonal Abundance: There are three variations in seasonal abundance: **1) Some types of mosquitoes have only one generation per year. Eggs hatch in the spring in snow melt pools. Once the adults emerge, they will lay eggs in areas that will be flooded again next spring.**	**Know the seasonal variations that different mosquito species have.**	**Describe the seasonal variations of different mosquito species.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2) Some types of mosquitoes have several generations per year. Females lay their eggs in areas around pools that will flood after rainfall. Each major rainfall floods the eggs, which then hatch. The larvae will develop, and the resulting adults will again lay eggs around the edges of the pools. The number of generations per year will depend on the number of times the pools flood and dry.		
3) Some types of mosquitoes will breed throughout the summer. The adult females over winter and in the spring will lay their eggs in standing water.		
Activity: Most adult mosquitoes are most active around sunset and sunrise when the winds are low, temperatures are warm, and relative humidity is high. Individual mosquitoes may travel up to 20 km, depending on the type of terrain and habitat in which they live and the species of mosquito.	**Know when mosquitoes are most active.**	**Describe when mosquitoes are most active.**
Mosquito Management: Mosquitoes cannot be eradicated. The purpose of a control program is to keep the numbers at an "acceptable" level. This level may vary depending on whether the mosquito is a nuisance pest or a disease vector. An acceptable level may also differ between communities due to public tolerance and expectations. To achieve successful control, mosquito management programs should generally be conducted for a community rather than individuals.	**Understand the purpose of a mosquito control program.**	**Identify the purpose of a mosquito control program.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The following items should be considered before beginning an IPM program: **- the mosquito species making up the local populations;** **- the closeness of mosquito sources to residential sources on private land;** **- the relative importance of each species of mosquito in terms of numbers, annoyance levels and health risks;** **- any notification requirements of the impending spray program that may be required in some provinces or territories;** **- the location of sensitive areas and suggested buffer zones for these areas;** **- the possibility of reducing or eliminating the source;** **- the number and types of application equipment required;** **- the amount and type of insecticide best suited to the local problem;** **- the effectiveness of the insecticides and the procedures used to apply them;** **- the mode of action of the insecticide;** **- the non-target organisms or potential biological control organisms present in water bodies, and possible insecticide impacts upon these organisms;** **- whether further control is necessary;** **- whether resistance to insecticides is occurring.**	**Know the basic considerations for a mosquito control program.**	**Describe the basic considerations for a mosquito control program.**
Accurate mosquito identification is important. Samples should be identified by a qualified taxonomist or someone trained in mosquito identification by a taxonomist.	**Know who should identify mosquitoes.**	**Describe who should identify mosquitoes.**
IPM program for mosquito control should be planned carefully to be effective. There are three basic components to a mosquito monitoring program: **1) Larval surveys, larval identification, and mapping of breeding sites;** **2) Adult mosquito surveys and identification;**	**Know the basic parts of a mosquito control program.**	**List the basic parts of a mosquito control program.**

Category: MOSQUITO AND BITING FLIES

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General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
3) Population monitoring of mosquitoes and establishing action thresholds.		
Importance of Mosquito Surveys		
1) Determine the extent of the problem and the types of mosquitoes causing the problem.	**Understand why mosquito surveys are important.**	**List reasons for conducting mosquito surveys.**
2) Provide information to evaluate the effectiveness of the mosquito control program.		
3) The results of trapping could identify an important and unmapped area, such as a hidden tire dump in the woods close to houses.		
Larval Surveys		
Mosquito larvae are found in standing water. Surveys can either determine the location and kind of mosquitoes present or the relative abundance of each species present.	**Know what larval surveys can determine.**	**List what larval surveys can determine.**
Equipment needed for larval surveys include a white metal or plastic dipper (500 mL capacity), containers with lids to collect larvae, and maps to record the breeding sites.	**Know what equipment is needed for larval surveys.**	**Describe the equipment needed for larval surveys.**
The steps for larval surveys are:	**Know the steps for larval surveys and the information to record for each breeding site.**	**List the steps for larval surveys and the information to record for each site.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Locate and map each possible breeding site. Maps can be topographical, aerial photographs or schematic. 2) Record the following information on each site: a) larval abundance; b) stage(s) of the mosquito larvae; c) size of the pools; d) times of occurrence; e) notes on the presence of natural enemies and adjacent sensitive areas.		
Larvae should be collected weekly at designated locations. Spot-checks of other sites help to obtain a more complete picture of the species present. Collections from temporary water should be made a couple of days after a major rainfall.	Know where and how often larval collections should be made.	Describe where and how often larval collections should be made.
Collecting technique: Skim the surface of the water in places where aquatic vegetation or floating debris offer protective cover for the larvae. Larvae of many species sink to the bottom rapidly when disturbed and remain there for several minutes. Remain quietly near pools where mosquitoes breed so the larvae may be picked up with a dipper, large pipette or long handled aquaria net as they come back to the surface. If temporary pools are too shallow to use a 500 mL dipper, an aquarium net may be used for collecting larvae. On sunny days sample facing into the sun. A shadow will cause mosquitoes to take avoidance action and will have a negative effect on counts.	Know how to collect mosquito larvae.	Describe how to collect mosquito larvae.
Estimate larval abundance using the ranking sampling technique. This method ranks the pool as without larvae, or with larvae at a low, moderate or high level. Use this information along with location to determine which areas need to be treated first. To rank a pool:	Know how to estimate larval abundance.	Describe how to estimate larval abundance.

Category: MOSQUITO AND BITING FLIES

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General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Take 5 samples from a pool. If the number of larvae in 5 samples exceeds 31, the pool is rated as "high". **2) If the number is less than 31, then take 5 more samples. If only 1-2 larvae are collected in 10 samples the site is rated as "low".** **3) If no larvae are collected, the site is rated as "nil".** **4) If the number of larvae is between 3-30, the site is rated as "moderate".** **5) If the surface area of the larval breeding site is greater than 50 x 50 m, then 20 samples must be taken.**	**Know how to rank a pool.**	**Describe how to rank a pool.**
Because fourth instar larvae are the largest and most easily identified, earlier instar larvae can be collected and reared through to fourth instar by keeping them in containers at room temperature and feeding them small amounts of fish food if necessary.	**Know that the fourth instar larva is easiest to identify.** **Know how to rear earlier instar larvae to this stage.**	**Identify which stage of larvae is easiest to identify.** **Describe how to rear earlier instar larvae to this stage.**
For identification and/or shipping, larvae must be preserved properly to retain their natural form. Place them in hot (not boiling) water for a few seconds and then preserve them in small vials of 70-95% alcohol. No more than 25 larvae should be placed in one vial. Place a label with the locality, date and name of collector written in waterproof pen or pencil inside the vial. Stopper the vial tightly.	**Know how to kill and preserve mosquito larvae.**	**Describe how to kill and preserve mosquito larvae.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Adult surveys can be carried out in several ways: **1) Biting counts;** **2) Landing-biting collections;** **3) The New Jersey light trap;** **4) The CDC (Centre for Disease Control) carbon dioxide trap;** **5) Insect net.**	**Know the ways adult surveys can be carried out.**	**List the ways to carry out adult surveys.**
Biting Counts: Count the number of mosquitoes landing on an exposed forearm during a specified time period (3-5 minutes during periods of high mosquito activity) to obtain an index of the adult mosquito biting population.	**Know how to conduct biting counts.**	**Describe how to conduct biting counts.**
Landing-Biting collections: Collect all the mosquitoes coming to bite using an aspirator and a retention cage during a specified time period (3-5 minutes). This not only gives an index of the population, but you can also identify the species.	**Know how to conduct landing-biting counts.** **Know what additional information can be gained from landing-biting collections.**	**Describe how to conduct landing-biting counts.** **Identify the additional information that can be gained from landing-biting collections.**
The number of mosquitoes coming to bite is a useful index. More than 1 mosquito per minute indicates that they may be annoying to the public. The level of tolerance will vary between communities.	**Know what number of mosquitoes coming to bite may be considered annoying to the public.**	**Identify the number of mosquitoes coming to bite per minute which may cause annoyance.**
Biting counts and landing-biting collections vary with the time of day, the collection point, weather conditions, and the attractiveness of the collector to the female mosquito. Some species are not highly attracted to humans and will not be readily collected in biting counts or landing-biting collections.	**Know the factors which cause biting counts and landing-biting collections to vary.** **Understand the limitations of these two types of surveys.**	**List the factors which cause biting counts and landing biting collections to vary.** **Identify the limitations of these two types of surveys.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
New Jersey Light Traps are standard traps that use a 25 Watt incandescent light bulb to attract mosquitoes and an electric fan to draw them into a container that contains an insecticide. Empty the traps daily or weekly. Sort the mosquitoes from other insects collected in the trap. The number of mosquitoes collected provides a more complete picture of the adult mosquito problem and allows for comparisons to be made of mosquito density in various parts of a control program during the season and from year to year.	Know how to use the New Jersey light trap. Know the advantage of the New Jersey Light Trap.	Describe how to use the New Jersey light trap. State the advantage of the New Jersey Light Trap.
The New Jersey Light Trap may give a misleading picture of mosquito abundance and nuisance levels because it also catches mosquitoes that do not bite people. Catches are decreased by full moon and low night temperatures.	Know the disadvantages of the New Jersey Light Trap.	Identify the disadvantages of the New Jersey Light Trap.
Not all mosquito species are equally attracted to light traps. Using carbon dioxide with the light trap or using a CDC carbon dioxide trap can attract additional mosquitoes. Traps can also be baited with animals to attract mosquitoes.	Know how to attract additional mosquitoes to light traps.	Describe how to attract additional mosquitoes to light traps.
CDC Carbon dioxide traps: Because many nocturnal insects are attracted to light, mosquitoes must be sorted from the other insects in the trap. Using carbon dioxide with a trap instead of light also attracts many insects, including mosquitoes. Some species of mosquitoes are not as attracted to light and may not appear in light traps. There is more maintenance involved because the carbon dioxide source is usually replaced nightly.	Know the advantage and disadvantage of a CDC carbon dioxide trap.	Identify the advantage and disadvantage of a CDC carbon dioxide trap.
Insect nets: Checking mosquito activity with an insect net will provide information on relative numbers and species between sites. The net is swept in a figure 8 pattern in front as the individual walks about the site for a period of 3-5 minutes. The collector should be at the site for 3-5 minutes before sweeping to allow sufficient time to attract the mosquitoes. Sites should be sampled during the same time period and by the same individual.	Know how to use an insect net.	Describe how to use an insect net.

Category: MOSQUITO AND BITING FLIES

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General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
For both types of traps, and net sampling, location is important. Locate traps where information on annoyance levels is needed (e.g., a residential area). A source of electrical power is needed. A good spot is the backyard of a home on a quiet street away from highly-illuminated areas and close to shrubbery. There should be no larval breeding sites nearby.	**Know where to locate traps.**	**Describe where to locate traps.**
The number of female mosquitoes caught per trap per night is a useful index. A catch of more than 25 females per trap per night in the same vicinity (or average of 25 or more for several traps) indicates they may be annoying to the general public. The number of public complaints will depend on their tolerance to mosquitoes.	**Know how many female mosquitoes per trap per night may indicate that population levels are high enough to cause annoyance.**	**Identify the number of female mosquitoes per trap per night that may indicate that population levels are high enough to cause annoyance.**
Mosquito Control		
Personal Protection: Wear light coloured long-sleeved shirts and pants and use repellents. Repellent-impregnated mesh clothing is also available. Only use citronella-based repellents on infants and small children as other repellents may cause irritation if rubbed into the eyes. Also, small children may ingest and/or absorb repellents into their skin at greater concentrations.	**Know the options for personal protection.**	**List and describe options for personal protection from mosquitoes.**
Non-Chemical Control		
The best non-chemical control method is permanently eliminating larval breeding sites.	**Know cultural control methods.**	**Identify cultural control methods.**
Draining potential breeding sites, and removal of containers that could hold water are examples of cultural control methods. Some ponds and sloughs can be drained or filled in. The impact on other wildlife habitat must be considered before deciding to drain an area. The draining of sensitive areas requires permission from provincial and municipal government officials. Low areas and ditches can be dredged to ensure that they drain quickly following rain. Containers like tires and rain barrels can be emptied.	**Know how to eliminate larval breeding sites.**	**Describe how to eliminate larval breeding sites.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Screens and proper building maintenance will keep mosquitoes from entering buildings. This is a method of physical control of mosquitoes.	**Know how to prevent mosquitoes from entering buildings.**	**Describe how to prevent mosquitoes from entering buildings.**
Fish that feed on mosquito larvae can control mosquitoes in areas where fish can be released and survive. For example, the fathead minnow has been used as a predator of mosquito larvae. This type of control method is considered biological control.	**Know that fish can be an option for biological control of mosquitoes.**	**Identify a biological option for mosquito control.**
Chemical Control		
Mosquito larvicides are insecticides that kill mosquito larvae. Larviciding controls mosquitoes before they become a problem. The use of a larvicide is preferable to controlling adult mosquitoes because larvae are relatively confined and concentrated (adults are widely dispersed and less easily controlled). Larviciding programs are more effective, more economical and use more precise application techniques than do adulticiding programs.	**Know what a mosquito larvicide is and why it is preferred over adulticiding.**	**Define mosquito larvicide and describe why it is preferable to adulticiding.**
Larviciding programs for residential areas should concentrate on the treatment of habitats within a radius of at least 2-5 km beyond the targeted residential area.	**Know the size of the area to be treated in a larviciding program.**	**Describe the size of the area to be treated in a larviciding program.**
Mosquito larval control agents can be classified into the following groups: **1) Contact larvicides must come in contact with the pest to be effective. Some contact larvicides have a residual effect and can kill emerging larvae for some time after application.** **2) Growth regulators act like the insects' own hormones. They disrupt the normal development of the larvae which die before becoming adults.**	**Know the main groups of larvicides.**	**List and describe the main groups of larvicides.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
3) Microbial larvicides contain microorganisms and poisons produced by microorganisms. After they are eaten, the microorganisms, or a poison the microorganisms produce, kill the larvae. They are more host specific, but occasionally, such as in the case of Bacillus thuringiensis var. israelensis, may control other insect species such as chironomids.		
Larvicides come in a variety of formulations including briquettes, granules, solutions, suspensions and emulsions. Most mosquito control programs use both emulsions and granules.	**Know the formulations of larvicides.**	**List the formulations of larvicides.**
Emulsions are emulsifiable concentrates diluted in water for spraying. They are easily applied with hydraulic sprayers, mist blowers and aerial equipment.		**Describe emulsions and identify how they are applied.**
Granules can be more easily distributed than the coarse droplets from hydraulic sprayers. Using granules minimizes drift and allows confirmation of distribution and density, if the granules are light in colour. They can penetrate vegetation that surrounds or emerges from mosquito breeding sites. This is valuable in late summer when vegetation is dense and high in and around pools of water. Granules can be applied with manual, motorized back-pack, truck-mounted or aerial application equipment.		**Describe granules.** **Identify the benefits of using this formulation.** **Identify methods of application.**
When selecting a larval control agent consider the following: **- type of larval habitat to be treated;** **- sensitivity of the area where the larval habitat is located;** **- presence of non-target organisms and the effect of the larvicide on them;** **- the community's resources and larvicide costs;** **- the type of application equipment available.**	**Know what factors to consider when choosing a larvicide.**	**List the factors to consider when choosing a larvicide.**
Applications of larvicides must be made to known breeding sites when the majority of larvae are mid-way through their development. This is usually when the larvae are 0.5 to 1.0 cm long. Because larvicides do not control pupae or eggs, treat after	**Know when larvicides should be used.**	**Identify when larvicides should be used.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
the egg stage and before the pupal stage. Re-treatment may be required if another hatch of eggs occurs after adequate rainfall.		
All larval stages are susceptible to microbial larvicides, providing they are actively feeding. An area should be treated when larvae are in the third instar, going into the fourth, to catch "stragglers" hatching out later.	**Know when to apply microbial larvicides and growth regulators.**	**Identify when to apply microbial larvicides and growth regulators.**
Growth regulators must also be applied at a critical stage. They affect hormones in the larvae or the formation of the outer covering of the larvae.		
The area treated with microbial larvicides should be surveyed 24-48 hours following application to evaluate the level of control and determine the need for re-treatment.	**Know when an evaluation of control should be made.**	**Identify when an evaluation of control should be made.**
Mosquito adulticides are insecticides used for controlling adult mosquitoes.	**Know what an adulticide is.**	**Define a mosquito adulticide.**
Adulticiding programs are usually conducted only when adults are severely annoying, or when there is a threat of disease and therefore a need for rapid control, and in conjunction with a larviciding program.	**Understand when adulticiding programs are conducted.**	**Identify when adulticiding programs are conducted.**
Mosquito adulticides are contact insecticides. The following methods can be used:	**Know the application methods for adulticides.**	**Describe the application methods for adulticides.**
1) A residual spray is applied to surfaces on which mosquitoes rest, usually vegetation. Mosquitoes are killed when they come in contact with the spray. Some products can be effective for several days.		
2) A low volume space spray or fog to kill flying mosquitoes. This application must be made when mosquitoes are active in the early morning, evening and overnight.		
The effectiveness of the adulticiding program should be monitored by conducting adult surveys before and after adulticiding.	**Know how to assess the effectiveness of an adulticiding program.**	**Describe how to assess the effectiveness of an adulticiding program.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - MOSQUITOES

General Objective: To understand mosquito biology and control.

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Black Flies		
There are about 150 different types of black flies in Canada. A few species are serious pests. Adult females of most species feed on blood causing irritation and discomfort to humans, domestic and wild mammals and birds. Black flies can also cause severe economic losses to livestock producers through reduced beef and milk production. In Canada they can also transmit parasites to wild and domestic animals. Only a protozoan blood parasite in domestic birds is of economic significance.	**Know why black fly control may be necessary.**	**Identify why black fly control may be necesary.**
Description: Adult flies are small (1-5 mm). They have short thick antennae with 9-11 segments. Their legs are short and their body is stout, with a humpbacked appearance. The two wings are broad. Many species are black or darkly coloured. The female black flies have short, cutting mouthparts, which slice the skin creating a blood pool from which they feed. The males do not have developed biting mouthparts but feed on plant nectar, as does the female. The nectar is used for their energy requirements.	**Know the general black fly characteristics.**	**Describe the general black fly characteristics.**
Life Cycle: The larvae and pupae live only in flowing water. The larvae attach to clear substrates in the current. By secreting a silk pad onto the substrate and then using rows of hooks on the tip of the abdomen, they attach to the pad. The larva can then extend its head fans into the current and filter small particles from the moving water. The larvae pass through 5-8 moults before pupating. The larval period may last from three weeks to two months for summer developing species or from fall to spring for winter developing larvae. **For pupation, the larvae spin slipper-shaped cocoons of silk to attach to the substrate. Larvae generally move to protected areas with lower stream flow to spin their cocoons.** **After emerging from the pupal cocoon, the adults float, in a small bubble of air, to the surface and then fly to the shore to rest while their new outer skeleton hardens. Mating usually occurs soon after emergence, before blood feeding.**	**Know the life cycle of black flies.**	**Describe the life cycle of black flies.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pest black fly species have two types of egg development in the female. One form can lay a batch of eggs developed from larval reserves and then seek a blood meal for a subsequent batch. Other species must take blood for the first batch and all subsequent batches of eggs.		
Most females lay between 200 and 500 eggs which hatch within a few days to several months, depending on the species. Eggs are laid on floating vegetation or on the water where they sink to the bottom.		
Habitat: Larvae and pupae live only in flowing fresh water. They attach themselves firmly to stable rocks, sticks or plants in areas with currents. Areas where larvae and pupae are found include riffle sections of streams and the outlets of lakes, beaver ponds, and artificial reservoirs. Some types live in temporary streams that dry up in the summer months.	**Know the habitats of black flies.**	**Describe black fly habitats.**
Hosts: Black flies find a host by using odour, movement, colour and carbon dioxide. Black flies cannot bite through clothing but will crawl under clothing. They are attracted to dark colours, and to lactic acid found in sweat and will crawl into hair or under clothing to bite. On animals they swarm around the head, crawl into the fur or feathers and congregate in the ears and nostrils.	**Know how black flies locate a host, where they bite and the symptoms they cause.**	**Describe how black flies find a host, where they bite and the symptoms they cause.**
On livestock, bites may be most numerous on the underside and ears of the animals. On humans, bites are common around the hairline, the neck, behind the ears and around the ankles.		
Reaction to the bites is usually a round swollen area at the bite site. Among some livestock, numerous bites have caused anaphylactic shock. In people exposed to black flies, symptoms may include headache, fever, nausea and swollen glands, or be as severe as anaphylactic shock.		

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Seasonal Abundance: Most black flies have only one generation per year and over winter in the larval or egg stage. In the southern boreal forest region they are most abundant in June and July. In southern Canada, black flies are numerous from May to mid-June although in certain areas black flies are developing as a nuisance through the summer and into September. In northern Canada, black flies do not appear until late July or early August.	**Know when black flies are most abundant.**	**Describe when black flies are most abundant.**
Activity: Black flies are usually active when temperatures are above 10 - 12 C, and when winds are less than 5 km/h. They bite during daylight hours, usually in early morning, late afternoon or evening before dusk. They become more aggressive on cloudy days and when storms are approaching. They usually do not bite in buildings, tents or vehicles. Livestock are bothered less inside a shelter.	**Know when black flies are active.**	**Describe when black flies are active.**
Black flies may disperse actively, with individuals flying 30-40 km, or disperse passively, with individuals carried by the wind for 100 + km.	**Know how far black flies can disperse.**	**Describe how far black flies can disperse.**
Black Fly Management: Black flies cannot be eradicated. The purpose of a control program is to keep numbers at an "acceptable" level. This level may be different depending on whether the black flies are nuisance pests or transmit disease. An acceptable level may also differ between communities due to public tolerance and expectations.	**Understand the purpose of black fly control programs.**	**Identify the purpose of black fly control programs.**
Plan black fly control programs carefully to be effective. There are three basic parts to a control program:	**Know the basic parts of a black fly control program.**	**List the basic parts of a black fly control program.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Larval surveys, larval identification and mapping of breeding sites; **2) Adult black fly surveys and identification of pest populations;** **3) Population monitoring of black flies.**		
Accurate black fly identification, at least to species group, is important because not all black flies are pests. Samples should be identified by a qualified taxonomist or someone trained in black fly identification by a taxonomist.	**Know why identification is important and who should identify black flies.**	**Describe why identification is important and who should identify black flies.**
Black Fly Surveys		
1) Determine the extent of the problem and the types of black flies causing the problem. **2) Provide information to evaluate the effectiveness of the control program.**	**Understand why surveys are important.**	**Describe why surveys are important.**
Surveys are important because not all black flies feed on humans and livestock and do not need to be controlled.		
Surveys must include records of: **a) dates, times and severity of attacks;** **b) weather records;** **c) adults for identification;** **d) larvae for identification;** **e) maps of larval breeding sites.**	**Know what records must be kept.**	**List items to record for surveys.**
Larval Surveys		

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Surveys should start soon after rivers and streams are open in the spring and continue at weekly intervals throughout the season while the flies are active. Survey larval breeding sites by checking rocks, twigs, logs and other vegetation in the water. Artificial substrates such as light coloured ceramic tiles or weighted survey tape may be placed on the stream bottom to collect larvae and to determine the numbers present. These artificial substrates may also be used to determine the effectiveness of the control program.	**Know how larval surveys are conducted.**	**Describe how to conduct a larval survey.**
Adult Surveys: Survey adults in several ways: **1) Sweep around livestock or human volunteers.** **2) Place a dark blue cloth (30.5 cm square) in your lap. Wait two minutes, then record the number of black flies that land on the cloth and fold their wings during a one minute interval.** **3) CDC carbon dioxide traps: Black flies are attracted to the carbon dioxide and are drawn into a collection container by a fan.** **4) Carbon dioxide baited silhouette traps: The trap is shaped like a cow. Black flies are drawn into the trap's collection chamber when they come to bite.**	**Know how to conduct adult surveys.**	**List and describe ways of conducting adult surveys.**
Black Fly Control **Personal and Livestock Protection: Personal protection includes avoidance, wearing light-coloured long-sleeved shirts and pants with tight fitting cuffs and wearing repellent. Nets are also available to protect the head.** **Livestock may be moved indoors to prevent black fly bites. Outdoors, livestock should have access to shade or darkened shelters. Repellents and adulticides may be applied using sprayers or oilers.**	**Know how to protect yourself and livestock from black flies.**	**Describe how to protect yourself and livestock from black flies.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Non-Chemical Control: Manipulating the environment to reduce the number of black fly breeding sites is a form of cultural control. Elimination of breeding sites is not practical as it normally involves major construction and habitat destruction.	**Know that elimination of breeding sites is not practical.**	**Describe what can be done to reduce black fly breeding sites, by cultural control.**
During planning of water control structures such as dams, modifications can be made to reduce the black fly breeding sites by having a sheer unobstructed drop for water into a deep pool instead of a gradual slope. As well, outflow can be constructed in duplicate and water flow can be alternated between the two outflows at 3-5 day intervals.	**Know what can be done to reduce black fly breeding sites when building a new dam.**	**Describe what can be done to reduce black fly breeding sites when building a dam.**
Aquatic and trailing vegetation can be managed along water channels to reduce black fly oviposition and resting sites.	**Know what can be done to vegetation to reduce black fly breeding sites.**	
Check with provincial or territorial pesticide regulatory officials before making alternations to water ways.	**Know that you must check with regulatory officials before changing waterways.**	**Identify that you must check with regulatory officials before changing waterways.**
Chemical Control		
Larvicides: Most insecticides applied to water will control only larvae, not eggs or pupae. Therefore, larval surveys are critical to determine the species present and the stage of the flies.	**Understand why it is important to determine the species present and stage of development.**	**Identify why it is important to determine the species present and stage of development.**
Black fly larvicides can be classified into 2 groups based on their mode of action:	**Know the groups of black fly larvicides.**	**List and describe the groups of black fly larvicides.**

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Contact larvicides must come in contact with the pest to be effective.		
2) Microbial larvicides contain microorganisms. After they are eaten, the microorganisms, or a poison the microorganisms produce, kill the larvae. They are more host specific than contact larvicides and have less effect on non-target organisms.		
Timing of Larviciding Applications: Applications should be made when most of the larvae are about 6 mm long. Microbial insecticides are only effective against larvae that are feeding. Late, final instar larvae starting to pupate may not feed. Regular inspection is required to determine this stage.	Know the best time for larviciding.	Describe the best time for larviciding.
Treatment location: Depending on the situation, treatments providing appreciable comfort include larviciding of breeding sites in a radius of 3 to 11 kilometres. Applications should be made at intervals along the stream. The interval length will depend on the size of the stream or river. Optimum locations are immediately above rapids, above dams and at outlets of lakes and ponds where there is a high concentration of nutrients for the larvae to feed on. Stream turbulence is needed to ensure adequate mixing of the larvicide. Wide streams will need more than one injection point across their width. Lake outlets will need to be treated in the lake ahead of the outlet to ensure proper mixing of the insecticide at the lip.	Know the best treatment locations.	Describe the optimum treatment locations.
Application: The larvicide may be injected into the stream by suspending a container equipped with an adjustable valve to regulate the flow of the larvicide from the container into the stream. It is generally appropriate to apply the larvicide across the entire width of the running water. The treatment time varies between products and can range from 1-15 minutes to 15-30 minutes. Check the product label for this information.	Know how to apply the larvicide.	Describe how to apply the larvicide.
Assessment: Monitor upstream untreated sites and downstream treated sites for larval density before and after application.	Know when and how to assess larvicide effectiveness.	Describe when and how to assess larvicide effectiveness.

Category: MOSQUITO AND BITING FLIES

Concept: PEST MANAGEMENT - BLACK FLIES

General Objective: To understand black fly biology and control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Assess effectiveness within 24 hours of application by counting the number of larvae remaining in the treated area as compared to both the number counted just before application and the number on upstream sites. Tiles and tapes are commonly used in larval counts to assist in accuracy.		
Dead larvae may adhere to the rocks, debris, and vegetation after treatment and should be differentiated from live larvae. Live larvae will curl and wriggle when removed from the water; dead larvae are usually straight, discoloured and immobile.		
Adulticides: Adulticides are used to kill adult black flies. Adulticiding is usually done only when adult black flies are severely annoying and is done in conjunction with larviciding.	**Know what an adulticide is and when to use one.**	**Define an adulticide and identify when to use one.**
The same methods used in controlling mosquito adults can be used to control black flies.	**Understand that the methods of controlling black fly adults is the same as those used for mosquitoes.**	**Identify that the control of black fly adults is the same as the control of mosquito adults.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques for mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mosquito larvicides may be applied with: **- hand or manual backpack sprayer;** **- motorized back pack sprayer;** **- truck mounted sprayer;** **- manual or motorized granular applicator.**	**Know what equipment can be used to apply mosquito larvicides.**	**List types of equipment that can be used to apply mosquito larvicides.**
Black fly larvicides are applied manually with a container that has a control valve or stop-cock to regulate the flow. Plastic water carrying containers are often used for this purpose. Back pack sprayers are effective in treatments of narrow streams.	**Know what equipment to use to apply black fly larvicides.**	**List the equipment to use to apply black fly larvicides.**
For adult mosquito and black fly control use: **1) A residual spray applied to surfaces on which mosquitoes and black flies rest, usually vegetation; or** **2) A low volume space spray or fog to kill flying mosquitoes and black flies.**	**Know what application methods to use for adult mosquito and black fly control.**	**List and describe the application methods to use for mosquito and black fly control.**
Residual sprays are used in specific areas that require protection or as a barrier treatment to prevent the migration of mosquitoes and black flies into an area (e.g., industrial work areas, private yards, playing fields, parks and gold courses).	**Know where to use residual sprays.**	**Describe where to use residual sprays.**
Use hand-held sprayers, manual or motorized back-pack sprayers or truck mounted sprayers to apply residual sprays.	**Know what equipment can be used for residual sprays.**	**List the equipment that can be used for residual sprays.**
Space sprays from a cloud of small droplets that are suspended in the air and drift to come in contact with adult mosquitoes and black flies. The droplets should be within the 5 to 20 micron range and should remain close to the ground.	**Know what a space spray is.**	**Describe what a space spray is.**
Use space sprays when mosquito or black fly activity is optimum and winds are less than 10-12 km/hour. **The best time to spray is when there is a temperature inversion, when cooler air is trapped close to the ground with warmer air above. Droplets will remain suspended in the air for longer periods of time.**	**Know when to use space sprays.**	**Describe when to use space sprays and identify the best weather conditions.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques for mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Two types of ground equipment used for space sprays: **1) Thermal foggers use heat to vaporize the insecticide into a highly visible dense fog of insecticide mixed with diesel fuel.** **2) Ultra low volume (ULV) sprayers, also known as "cold foggers" use concentrated insecticide with no carrier. The ULV sprayer produces a mist of very fine droplets. ULV spraying is preferable as a carrier is not needed and the spray is not dense and does not present a traffic hazard when insecticides are applied near roads.**	**Know the types of equipment used for space sprays.**	**List and describe the types of equipment use for space sprays.**
Choice of equipment for residual spraying or space spraying will be determined by the community's local climate, geography and hydrology and resources.	**Know the factors that determine the choice of equipment for residual or space spraying.**	**List the factors that determine the choice of equipment for residual or space spraying.**
Truck mounted sprayers may be used for mosquito larviciding or for residual spraying. They have components similar to agricultural sprayers except they have no boom. Insecticide is delivered through a hose and single nozzle or by ejecting insecticide through nozzles into a stream of air. The treatment width refers to the total width over which liquid or granules is applied in one pass and is about 90 m. Ideally, the sprayer should travel at right angles to the direction of the wind.	**Know what truck mounted sprayers may be used for, and how they operate.**	**Describe what truck mounted sprayers may be used for, and how they operate.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Sprayers have the following components: **- tanks;** **- pumps;** **- agitators;** **- filter;** **- controls;** **- pressure gauge;** **- plumbing;** **- structural framework;** **- nozzles;** **- clean water tank.**	**Know the various components that sprayers are made of.**	**List the eight main components of sprayers.**
Tanks		
Tanks to hold the spray mixture are available in a variety of shapes, sizes and materials. Desirable features of a tank are: **- corrosion resistance;** **- strength (reinforced);** **- shaped to aid agitation;** **- easy to fill;** **- easy to clean;** **- have graduated markings;** **- have baffles to prevent sloshing.** **The most common shape of tanks are oval and cylindrical. Rectangular tanks and flat bottomed tanks are most difficult to agitate and clean.** **Tank size should be proportional to the sprayer output.**	**Know the desirable features of a spray tank.**	**List the desirable features of a spray tank.**
Pumps		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pumps provide the flow of spray mixture from the tank to the nozzle. Pumps should be suitable for the spray application and should provide: **- required output and operating pressure;** **- power supply.** **Choose a pump with sufficient capacity for:** **- the number of nozzles;** **- the size of the nozzles;** **- the agitation requirements;** **- sufficient agitation of the pesticide;** **- an oversize of 20 percent.**	**Know the important features of pumps.**	**List the important features of pumps.**
Agitators		
Agitation mixes the formulated pesticide and carrier together, preventing the suspended pesticides from settling out. The amount of agitation depends on the type of formulation used. It is important that adequate agitation occurs. Both under and over agitation can reduce pesticide performance.	**Know why agitation is required.**	**Identify why agitation is required.**
Two types of agitation systems commonly used: **- mechanical;** **- hydraulic.** **Mechanical systems use paddles to stir the contents of the tank, whereas hydraulic systems use special agitation nozzles in the tank to create spray mixture movement in the tank.**	**Know the common types of agitation systems.**	**List and describe the main types of agitation systems.**
Filters		

Category: MOSQUITO AND BITING FLIES

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General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Filters prevent any foreign particles and undissolved pesticides in the spray mixture from damaging the pump or plugging the nozzles.	**Know why filtration is required.**	**Identify why filtration is required.**
Filters can be installed: **- in the tank opening, to prevent debris from entering the tank during filling;** **- between the tank and the pump, to protect the pump from damage;** **- after the pump, to remove finer particles before entering the spray lines;** **- in the nozzle bodies, to prevent the nozzles from clogging.**	**Know where filters can be installed.**	**Describe where filters can be installed.**
Filter mesh size should be scaled from coarsest at the tank opening to finest at the nozzle. Follow the nozzle manufacturers recommendations.	**Know how to select the correct filter.**	**Identify where the information on filters can be found.**
Controls		
Two common control systems are: **- pressure control systems;** **- volume control systems.**	**Know how control systems work.**	**List and describe how control systems work.**
Pressure control systems use a pressure regulating valve (PRV) to maintain a constant operating pressure. Volume control systems (volumetric) allow the operating pressure/ nozzle output to vary according to forward speed/engine RPM.		
Controls can be manually or electronically operated. Items such as spray monitors and controllers may improve the application of pesticides by supplying the operator with more information.		
Plumbing		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Under-sized hoses and fittings can severely reduce the capacity of any pump. Flow restrictions create a drop in pressure, resulting in a non-uniform nozzle output. Common sources of flow restriction are: - under-sized boom plumbing; - under-sized controls or fittings; - kinked hoses; - under-sized or clogged filters or nozzles.	Understand how plumbing will affect the pressure.	List common plumbing problems which affect the pressure.
Pressure Gauge		
The pressure gauge measures the operating pressure. A pressure gauge is used to initially set the sprayer at the desired pressure and can be observed for changes in pressure as an indicator of problems.	Understand why a pressure gauge is used.	Identify why a pressure gauge is used.
Gauges are available as either liquid filled or dry. A liquid filled gauge dampens pressure pulsations resulting in a steadier reading. Pulsation dampers are available for dry gauges.	Know the important features of pressure gauges.	Describe the important features of pressure gauges.
The maximum pressure indicated on the gauge should be approximately twice the intended operating pressure.		
Gauges should sense the pressure as near to the nozzles as possible.		
Nozzles		
- meter the amount of spray delivered; - atomize the liquid into droplets; - disperse the droplets in specific patterns.	Understand what a nozzle does.	List the things a nozzle does.
Nozzles are available in a wide range of types, sizes and materials. Nozzles are classified on the basis of the type of spray pattern that is developed.	Know how nozzles are classified.	Describe how nozzles are classified.
Pesticide labels may recommend specific types of nozzles. Follow label directions.	Know that nozzle recommendations may be on the pesticide label.	Identify pesticide labels as a source of nozzle recommendation.

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Clean Water Tanks		
All sprayers or application sites should be equipped with a clean water tank. They provide clean water for emergencies and to perform routine tasks such as nozzle and hand cleaning.	**Understand why all sprayers should be equipped with a clean water tank.**	**Identify the importance of a clean water tank.**
Hand sprayers and manual back-pack sprayers have the following components: **- reservoir;** **- nozzle system;** **- pumping device;** **- plumbing system.**	**Know the components of hand and back-pack sprayers.**	**List the components of hand and back-pack sprayers.**
These sprayers are designed to deliver a volume of liquid to a target in dispersed droplets. The pump moves the solution from the reservoir to the nozzle and supplies the pressure needed for atomization. Uniform pressure is essential to obtain uniform nozzle performance. Some sprayers have a built-in pressure regulator; on those that do not, one can be added in-line. The pressure is created in the pump and stored in the pump reservoir. Most hand and back-pack sprayers should be operated at 275 to 310 kpm for insecticides.	**Know how hand and back-pack sprayers work.**	**Describe how hand and back-pack sprayers work.**
The control valve regulates the flow of pressurized solution from the pump reservoir to the nozzle. A screen strainer in the wand prevents particles from plugging the nozzle.		
Hand and back-pack sprayers are suited to spraying small areas that are not easily accessible by truck.	**Know where hand and back-pack sprayers are used.**	**Identify where hand and back-pack sprayers are used.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Motorized back-pack sprayers have the following components: **- gasoline engine;** **- spray tank;** **- spray hose;** **- direct drive blower or regenerative pump;** **- nozzle;** **- strainer;** **- liquid valve;** **- padded frame with shoulder straps.**	**Know the components of a motorized back pack sprayer.**	**List the components of a motorized back pack sprayer.**
Nozzles are changed to provide different spray droplet sizes and discharge volumes.	**Know that changing nozzle sizes will affect droplet sizes and discharge volumes**	**Identify that changing nozzle sizes will affect droplet size and discharge volumes.**
Some sprayers can be used to apply a mist for residual spraying; others apply granules for mosquito larviciding.	**Know the uses for this sprayer.**	**Identify the uses for this sprayer.**
Manual granular applicators are common seed and fertilizer spreaders that are adapted for mosquito control. They consist of: **- a bucket or sack that holds a few kilograms of granules;** **- a handle that spins a plate under the bucket or sack. The plate hurls the granules that falls onto it outwards in all directions.**	**Know the basic components of a manual spreader.**	**Describe a manual spreader.**
They are difficult to calibrate.		
Thermal foggers have the following components: **- a gasoline engine;** **- insecticide pump;** **- an air compressor;** **- combustion chamber;** **- fog distributor head into which the insecticide is injected and finely atomized by a venturi.**	**Know the components of a thermal fogger.**	**List the components of a thermal fogger.**
Thermal foggers vaporize insecticide, which condenses to form a fine cloud of droplets on contact with the cooler air outside the machine.	**Know how thermal foggers work.**	**Describe how thermal foggers work.**
Some fogging machines have a two stage combustion system which preheats insecticide, and then mixes it with hot exhaust.		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT COMPONENTS

General Objective: To understand the technology of equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Ultra low volume cold foggers have the following components: **- insecticide tank or hose to draw insecticide into the pump;** **- gasoline engine;** **- insecticide suction and discharge lines;** **- positive displacement gear pump;** **- gear motor for driving the pump;** **- controller to regulate the gear motor;** **- pressure gauge;** **- ultra low volume droplet generator.**	**Know the basic components of a ULV fogger.**	**Describe the basic components of a ULV fogger.**
These machines dispense low volumes of insecticide in droplets that are less than 20 microns. The concentrated insecticide is forced through an air stream where the insecticide is sheared into fine droplets. **The ultra low volume droplet generator may be a spinning or revolving disk or sleeve.**	**Know how ULV foggers work.**	**Describe how ULV foggers work.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - PESTICIDE CALCULATIONS

General Objective: To understand how to calculate the correct amount of pesticide to be used.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pesticide Calculations		
Know the size of the treatment area. It can be obtained either by measuring the area to be treated or from maps.	**Understand that it is important to know the size of the treatment area.**	**Identify that it is important to know the size of the treatment area.**
Total pesticide required = treatment area x pesticide rate. **Area covered per tank = tank size divided by sprayer output.**	**Know how to determine the total pesticide required, area covered per tank, amount of insecticide required per tank, total number of tanks, volume of solution required for the final load, pesticide required for the final load.**	**Describe how to determine the total pesticide required, area covered per tank, amount of insecticide required per tank, total number of tanks, volume of solution required for the final load, pesticide required for the final load.**
Output refers to the volume of spray or the weight of granules that is applied to a unit area.	**Understand output.**	**Define output.**
Pesticide per tank = pesticide rate x area covered per tank.		
Pesticide rate refers to the weight/volume per unit area/ unit volume that is recommended on the label.	**Understand pesticide rate.**	**Define pesticide rate.**
Total number of tanks = treatment area divided by area covered per tank.		
Volume of spray mixture for partial tank = area left to treat x sprayer output.		
Area left to treat = Total area - area already treated.		
Amount of pesticide for partial tank = pesticide rate x area covered by the partial tank.		
Mosquito Larvicides		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - PESTICIDE CALCULATIONS

General Objective: To understand how to calculate the correct amount of pesticide to be used.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mosquito larvicide rates are given in: **- kg/ha for granules;** **- ml/ha for liquid formulations;** **- number of briquettes per 100 sq m for briquette formulations.**	**Know the units of measure on labels for mosquito larvicides.**	**List the units of measure on labels of mosquito larvicides.**
To determine the amount of larvicide required, calculate the size of the water body by taking several measurements of width and length of the water body to determine the average length and width. Large water bodies like sloughs are usually treated by aerial application.	**Know how to calculate the area of a water body to be treated with a mosquito larvicide.**	**Describe how to calculate the area of a water body to be treated with a mosquito larvicide.**
Area = average length x average width.		
To determine the total larvicide required, multiply pesticide rate by area.	**Know how to calculate the total larvicide required.**	**Describe how to calculate the total larvicide required.**
Black Fly Larvicides		
The carry of a larvicide is how far the product will be carried downstream and remain effective. Carry is dependent upon: **- stream flow;** **- the amount of suspended matter;** **- vegetation in the stream.**	**Know what carry is, and list the factors upon which carry is dependent.**	**Describe what carry is, and list the factors upon which carry is dependent.**
Carry must be considered when determining the rates to be used to treat a stream.		
The larvicide rate is determined by: **- the carry of the stream;** **- the population of black fly larvae in the stream;** **- the stream volume.**	**Know how the larvicide rate is determined.**	**List what to consider when determining the larvicide rate.**
Black fly larvicide rates are given in ml/L of stream volume.	**Know how to calculate stream flow and the amount of black fly larvicide required.**	**Describe how to calculate stream flow and the amount of black fly larvicide required.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - PESTICIDE CALCULATIONS

General Objective: To understand how to calculate the correct amount of pesticide to be used.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1) Calculate stream flow in m^3/sec (m^3/sec = average depth (m) x average width (m) x average velocity (m/sec): **a) Measure average stream depth. Calculate the average depth of a stream by taking several measurements of depth.** **b) Measure average stream width.** **c) Measure average velocity by using a flowmeter, or by timing a floating object over a measured distance of at least 10 m. When timing a floating object the average velocity is approximately 0.67 of the surface velocity for streams with a rocky bottom, 0.8 for a gravel bottom and 0.9 for a mud bottom.** **Example: 10 m in 5 seconds = 10 m/5 sec = 2 m/sec x 0.8 (gravel bottom) = 1.6 m/sec.** **d) Multiply depth x width x velocity.** **Example: 0.5 m x 5 m x 1.6 m/sec stream flow = 4 m^3/sec.** **2) Calculate the amount of larvicide required:** **a) Choose the amount of time to apply the larvicide from the label.** **Example: 15 minutes** **b) Use the stream flow calculated in part 1. Stream flow is 4 m^3/sec = 4000000 mL/sec.** **(1 m^3 = 1000000 mL).** **c) Find the pesticide rate from the label in mL/L.** **Example: 0.01 mL/L = 10 ppm.** **d) Determine the amount of product to be applied per second.** **(1 ppm = 0.000001 mL/mL).** **(10 ppm = 0.00001 mL/mL).** **0.00001 mL/mL x 4000000 mL/sec = 40 mL product/ sec.**	**Know the units of measure on labels for black fly larvicides.**	**Identify the units of measure on labels for black fly larvicides.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - PESTICIDE CALCULATIONS

General Objective: To understand how to calculate the correct amount of pesticide to be used.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
e) Determine the amount of product required for the total time period (15 min.) **1 sec application = 40 mL product.** **15 min. application = 15 min x 60 sec/min x 40 mL product/sec = 36000 mL product.** **= 36 L product.**		
Mosquito and Black Fly Adulticides		
Residual sprays for mosquito control:		
A. To treat the inside of a building, such as a campground activity centre, or a park information centre, determine the total area to be treated, including walls and ceiling in m^2. **- end walls = length x height.** **- side walls = length x height.** **- ceiling = length x width.** **Add these measurements together to obtain the total area to be treated.**	**Know how to calculate the area of a building.**	**Describe how to calculate the area of a building.**
Multiply pesticide rate x total area to obtain the amount of product needed.	**Know how to calculate the amount of product needed for indoor residual sprays.**	**Describe how to calculate the amount of product for indoor residual sprays.**
B. To treat vegetation outdoors find the rate given on the adulticide label in: **1) mL/L of spray solution: determine the volume of spray solution (L) of the sprayer and multiply pesticide rate (mL/L) x volume of spray solution (L) to obtain mL of product required.** **2) mL/ha: calculate the area to be treated (ha) and multiply by pesticide rate (mL/ha) to obtain mL of product required.**	**Know how to calculate the amount of product needed for outdoor residual sprays.**	**Describe how to calculate the amount of product needed for outdoor residual sprays.**
Space Sprays		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - PESTICIDE CALCULATIONS

General Objective: To understand how to calculate the correct amount of pesticide to be used.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A. Thermal fogging rates are given in L/ha. Calculate the area to be treated (ha) and multiply by pesticide rate (L/ha) to obtain L of product required.	**Know how to calculate the amount of product needed for space sprays.**	**Describe how to calculate the amount of product needed for space sprays.**
B. ULV rates are given in flow rate of adulticide per minute. The label will indicate the appropriate speed of the vehicle to use for the chosen flow rate.		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calibration Objectives		
The two objectives of calibration are: **- to determine the correct output of the machine;** **- where possible, to ensure that the spray or granule will be applied uniformly.**	**Know why equipment must be calibrated.**	**Describe why equipment must be calibrated.**
Equipment should be calibrated: **- when new;** **- at the start of the season;** **- when travel speed or nozzles are changed;** **- for ULV applications the sprayer must also be calibrated when the insecticide is changed.**	**Know when to calibrate equipment.**	**List the times equipment should be calibrated.**
Application Uniformity		
Application uniformity affects pesticide performance. Non-uniform application will result in localized areas with application rates that are too low or too high, which subsequently reduces the effectiveness of pesticides. When using chemical insecticides, over application may damage the ecosystem, whereas under application may lead to retreatment of the area.	**Understand the importance of application uniformity, and how non-uniform application can occur.**	**Describe the importance of application uniformity and the effects of non-uniform application.**
Non-uniform application can occur when localized variations within the total application area cause: **- variations in travel speed;** **- variations in pressure with liquids;** **- variations in granule flow rates with granules;** **- variations in treatment width.**		**List causes of non-uniform application.**
For any type of calibration, it is important that the test treatment conditions be as similar as possible to actual treatment conditions. For example, if an insecticide is applied with the applicator moving through water, then the calibration of the equipment used should be done with the applicator moving through water, at the same speed or pack as in an actual insecticide application.	**Know that it is important to calibrate equipment under the same field conditions found during application.**	**Identify that it is important to calibrate equipment under the same field conditions found during application.**
Manual Granular Applicator		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
To calibrate: **1) Measure and record a test distance. The distance should be at least 30 m, but the longer the distance, the more accurate the calibration.** **2) Using un-impregnated granules, if possible, measure the treatment width. Determine the test area (m^2): Test area = length (m) x width (m).** **3) Apply the granules to the test strip. Walk at a steady speed and turn the handle consistently to make sure the treatment width is constant and the application is uniform.** **4) Calculate the amount (kg) of granules applied to the test area.** **5) To find the granular output (kg/ha) of the applicator, multiply the amount of material applied to the test area (kg) by 10000 m^2/ha, and divide by the test area (m^2).** **Output (kg/ha) = Amount (kg) x $\frac{100000 m^2/ha}{\text{test area } (m^2)}$** **6) Adjust operator speed and/or treatment width until the output is the same as the pesticide rate.**	**Know how to calibrate a manual spreader.**	**Describe how to calibrate a manual spreader.**
Manual Hand or Back-pack Sprayer **To calibrate:** **1) Measure and record a test distance. The distance should be at least 30 m, but the longer the distance, the more accurate the calibration.**	**Know how to calibrate a hand or back-pack sprayer.**	**Describe how to calibrate a hand or back-pack sprayer.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2) Using water in the spray tank, measure the treatment width. Determine the test area (m^2): Test area = length (m) x width (m).		
3) Spray the test strip. Maintain steady speed and pressure.		
4) Calculate the amount (L) of water applied to the test area.		
5) To find the sprayer output (L/ha), multiply the amount of water applied to the test area (L) by 10000 m^2/ha, and divide by the test area (m^2). Output (L/ha) = Amount (L) x $\frac{10000 m^2/ha}{\text{test area } (m^2)}$		
6) Adjust operator speed and/or treatment width until the output is the same as the pesticide rate.		
Motorized Back-pack Sprayer		
To calibrate:	**Know how to calibrate a motorized back-pack sprayer.**	**Describe how to calibrate a motorized back-pack sprayer.**
1) Set the throttle at a comfortable running speed for the applicator and the machine. Mark this position on the machine.		
2) Set the chemical opening valve.		
3) Determine the treatment width using un-impregnated granules or water.		
4) Calculate the distance needed to walk to cover 1/10 ha.		
5) Find the pesticide rate of on the label. Calculate the amount of insecticide needed to treat 1/10th ha.		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
6) Fill the hopper half full of granules or water and adjust the chemical opening valve so that the granular or spray swath width will cover 1/10 ha when the calculated distance has been covered. This will take several tries and adjustments before you obtain the correct opening (granules) or nozzle (spray) for the time required to walk a tenth of a hectare.		
Truck Mounted Sprayers		
Sprayers are calibrated by determining the volume of solution sprayed over a measured area in a given time period.	**Know how to calibrate a truck mounted sprayer.**	**Describe how to calibrate a truck mounted sprayer.**
Example: **litres/minute = litres/ha** **ha/minute**		
1) Calculate the output of the sprayer in litres/minute.		
2) Calculate the area covered per minute. **Speed (m/min) x swath width (m) = m^2/min** **m^2/min / 10,000 m^2/ha = ha/min**		
3) Calculate the volume sprayed per minute. **L/min = L/ha** **ha/min**		
4) Calculate the area which one tank will cover. **Tank size (L) = ha** **L/ha**		
Thermal Foggers		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Different models of foggers will have different calibrating instructions.	**Know that different models of foggers will have different calibrating instructions.**	
To calibrate a Tifa (thermal) fogger:	**Know how to calibrate a Tifa fogger.**	**Describe how to calibrate a Tifa fogger.**
1) Fill both the insecticide tank and the fuel tank.		
2) Start the engine.		
3) Open the fuel control valve to start the combustion chamber.		
4) The air temperature gauge should read between 95E F and 105E F.		
5) Set the formulation pressure control valve at 25 lbs. pressure.		
6) Set particle size selector valve indicator on desired setting according to manufactures instructions. Always use a dry fog setting because if the fog is too wet the droplets will drop to the ground faster and be less effective.		
7) The fog output table contained in the manufacturer's instructions indicate the gallons per hour covered by varying the particle selector valve setting. Based on this amount adjust the speed of the vehicle to apply the correct rate in L/ha assuming a 90 m swath.		
8) Turn formulation shut-off valve to "fog" position.		
Adjust the vehicle speed, if needed, to apply the correct rate of insecticide.		

ULV Sprayers

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand how to calibrate equipment used in mosquito and black fly control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Before calibration of an ultra low volume sprayer, a sample of droplets must be taken for measurement to ensure that the droplets are within an effective range. Each adulticide has a specific range of droplet sizes that are most effective, and which will be stated on the label.	Know that droplet measurement must be conducted before calibrating an ultra low volume sprayer.	Identify why droplet measurement must be conducted before calibrating an ultra low volume sprayer.
Pass a teflon coated slide through the fog 1 m away from the nozzle. Using a compound microscope measure the droplets and calculate the mass median diameter. If the droplets do not fall within the effective size range specified on the insecticide label, change the ULV droplet generator and re-check droplet size. Each ULV sprayer will have instructions specific to this procedure.	Know the procedure for measuring droplet size.	Describe the procedure for measuring droplet size.
To calibrate an ultra low volume sprayer: 1) Remove the insecticide discharge line from the sprayer head and insert the end into another container. 2) Read the insecticide label to determine the flow rate. 3) Set the appropriate flow rate on the flow controller scale. 4) Turn on the insecticide flow. When the insecticide is flowing fully through the lines with no air bubbles measure the amount of insecticide flowing through the lines for one minute. 5) Adjust the flowmeter until the correct amount of insecticide is collected. 6) Travel at the speed indicated on the label for the chosen flow rate. This process must be repeated with each insecticide.	Know how to calibrate an ultra low volume sprayer.	Describe how to calibrate an ultra low volume sprayer.

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT MAINTENANCE

General Objective: To understand the equipment maintenance procedures.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Proper maintenance of the application equipment minimizes the chance of a breakdown, increases the service life and minimizes the chance of accidental leaks and spills.	**Understand the importance of a proper maintenance program for application equipment.**	**Identify the importance of a proper maintenance program for application equipment.**
Sprayer Maintenance		
Rinse the equipment thoroughly at the end of each spraying day by flushing them with clean water, or with solvents for thermal or ULV foggers, as indicated in the manufacturer's instructions. Flush the pump, hoses and nozzles. Check all screens, nozzles and filters and clean them if necessary. Assess the sprayer for wear and replace worn or damaged parts. Critical parts to check include the agitator, regulator, and pressure gauge for accurate operation. Check couplings and clamps for seal and hose flex points for wear. Wash the sprayer and dispose of rinsate only where residues will not cause any adverse environmental harm. Follow directions on the label and provincial regulations.	**Know how to maintain sprayers.**	**Describe how to maintain sprayers.**
Decontaminate the sprayer when changing from one type of pesticide to another. Decontamination procedures vary depending on the pesticides being used. Consult the pesticide label or manufacturer's representative for specific recommendations.		
For granular application equipment: **1) Never leave granules in the hoppers for extended periods of time as they can absorb moisture and harden into lumps.** **2) Before using the applicator make sure that moving parts are free of corrosion.** **The abrasive nature of some granular formulations will require that all moving parts of the equipment be frequently greased or oiled. Excessive lubrication can accumulate the granules, dust and dirt which can cause rapid wear and possible interfere with the operation of the equipment.**	**Know how to maintain granular application equipment.**	**Describe how to maintain granular application equipment.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - EQUIPMENT MAINTENANCE

General Objective: To understand the equipment maintenance procedures.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
To prepare equipment for storage: **- thoroughly clean the equipment, wearing appropriate protective clothing;** **- lubricate all moving and vital parts. Follow the manufacturer's recommendations;** **- check the equipment for worn parts and replace them;** **- store the equipment where it will not be damaged by other equipment, livestock or weather.**	**Know how to prepare equipment for storage.**	**State how to prepare equipment for storage.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - ENVIRONMENTAL CONDITIONS

General Objective: To understand the influence of environmental conditions on the application procedure.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray Drift		
Before beginning any application, evaluate the weather conditions at the site to assess the spray drift potential.	**Know the importance of evaluating weather at the site before applying pesticides.**	**Identify the importance of evaluating weather conditions.**
Minimize spray drift by: **- spraying under favourable weather conditions;** **- choosing suitable application equipment;** **- correctly operating the application equipment;** **- using drift control agents;** **- choosing a formulation that is less subject to drift.**	**Know how spray drift can be minimized.**	**List methods of minimizing spray drift.**
For residual spraying and larviciding, control droplet spray drift by minimizing the number of small (fine) droplets that the nozzles produce. The droplet size decreases as nozzle size (output) decreases and pressure increases.		
A specific nozzle output can be obtained by using a variety of nozzle/pressure combinations. A small nozzle operated at high pressure can have the same nozzle output as a larger nozzle at a lower pressure. Reduce drift potential by using larger nozzles and lower pressures.		**Describe the nozzle, pressure combination that gives lower drift.**
Selecting the maximum recommended sprayer output will require larger nozzles, which produce larger droplets and in turn will reduce drift.		**Describe how maximum sprayer output can reduce drift.**
Users should verify drop size every time they change formulations and even when they change lots or batches of a formulation. Sometimes there is a lot of variation between two batches of the same formulation. Enough sometimes that you have to recalculate everything including dosages.		
Favourable weather conditions are those that will not reduce the efficacy of the pesticide or increase the potential of environmental damage.	**Know what weather conditions must be considered when applying pesticides.**	**List weather factors to consider when applying pesticides.**

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - ENVIRONMENTAL CONDITIONS

General Objective: To understand the influence of environmental conditions on the application procedure.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Consider: **- air and ground temperature;** **- relative humidity;** **- wind speed and direction;** **- impending weather conditions;** **- water quality.**		
Temperature		
High temperatures may: **- reduce effectiveness of certain pesticides;** **- increase droplet evaporation;** **- create a temperature inversion.**	**Know how temperature may adversely affect the application of pesticides.**	**Describe how temperatures adversely affect the application of pesticides.**
High temperatures, combined with low relative humidity, increase the rate at which airborne droplets evaporate. Evaporation decreases droplet size resulting in droplets that are more prone to drift.		
A temperature inversion is a condition where air at ground level is cooler and more stable than air above the ground. The inversion prevents very fine spray droplets from settling, allowing them to remain suspended in the air for long periods of time. This is the ideal condition for application of space sprays for control of flying mosquitoes and black flies.	**Know the characteristics of a temperature inversion and why it is favourable for space sprays.**	**Describe a temperature inversion and why it is favourable for space sprays.**
Wind		
Increases in wind speed will increase the potential for spray drift. Maximum acceptable wind speeds and temperatures may be referenced on the label or by provincial recommendations/legislation. If spray drift occurs, stop the application, even though wind speeds may be acceptable.	**Know how wind may adversely affect the application of pesticides.**	**Describe how wind may adversely affect the application of pesticides.**
No-wind conditions can cause insecticide sprays to remain suspended in air, which can be blown later onto sensitive areas. A 2 km/h wind is generally adequate.		

Category: MOSQUITO AND BITING FLIES

Concept: APPLICATION TECHNOLOGY - ENVIRONMENTAL CONDITIONS

General Objective: To understand the influence of environmental conditions on the application procedure.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Water Quality		
Factors such as temperature, sediment, pH, presence of salt content in the water that is mixed with pesticide may affect pesticide performance.	**Understand how water quality may affect the performance of the pesticide.**	**List and describe ways water quality could adversely affect the performance of a pesticide.**
The pH of a spray solution can have a significant affect on the performance of some pesticides. The active ingredient of some pesticides decreases in effectiveness when the spray solution is alkaline.		
The rate at which chemical breakdown occurs depends on: **- the pH of the water;** **- the amount of chemical added to a fixed amount of water;** **- the water temperature;** **- the length of time the solution is left in the spray tank.**		
Refer to the pesticide label or to provincial publications for specific recommendations.	**Know where to obtain specific recommendations for water quality.**	**Identify where to obtain specific recommendations for water quality.**

Category: MOSQUITO AND BITING FLIES

Concept: PROFESSIONALISM - MOSQUITO AND BLACK FLY CONTROL

General Objective: To know and understand the principles which enable an applicator to deal effectively with the public.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Mosquito and black fly control often occurs in densely populated areas. Public concerns regarding the application of insecticides must be clearly addressed. The community must understand and appreciate what is involved in controlling mosquitoes and black flies. A carefully planned communications program is important. Information can be communicated in a variety of ways to inform as many people as possible within a community. The public must understand the basic biology of the biting fly, why and when control is important, and the risks and benefits of a control program.	Know the importance of a public relations program	Describe the importance of a public relations program.
Some examples of the components of a communications program include: - exhibits at local shopping malls, public buildings and schools; - news releases; - slide presentations at schools to civic groups, professional societies, associations, etc.; - interviews in the field by television media; - guest spots on talk shows; - a mosquito or black fly telephone service; - notification prior to spray programs (i.e., through newspaper, advertisements, mailings); - following notification the applicator must be prepared to meet with those objecting to the spray program; - communicate to the public the considerations being made for buffer zones for sensitive areas.	Know what types of activities may be included in public relations program	List activities which may be included in a public relations program.
Landowners should be contacted to receive permission for access, inspection and, if required, treatment of any breeding sites.	Know why landowners should be contacted.	Identify why landowners should be contacted.
Applicators may wish to consider membership in various biting fly control associations to receive information and support from peers.	Understand the benefits of being a member of a biting fly control association.	Identify the importance of being a member of a biting fly control association.