

Integrated Mosquito Management Principles for Piggeries



Version 4



Foreword

Japanese encephalitis virus was detected for the first time in domestic pigs in Australia in February 2022. It was recognised that more detailed information was needed to enable the pig industry to effectively manage mosquitoes at piggeries to support public and pig health outcomes.

The National Vector Management Group was formed in March 2022 to develop a guide for mosquito management for piggeries. The group included representatives from the pig industry, state control-of-use regulators, medical entomologists, health departments and agricultural departments.

In developing the content for the guide the group considered the following risk factors:

- Environmental conditions of a piggery, including sources of standing water
- Mosquito life cycle and ecology
- Non-chemical alternatives for mosquito control
- Effectiveness of chemicals against target mosquitoes
- Pig health
- Worker health and safety
- Non-target species
- Food residues
- Ease and availability of proposed interventions

Based on consideration of these factors the first version of “Integrated mosquito management principles for piggeries” was published on 15 March 2022. Subsequently, assessment of additional chemicals was undertaken by the Control-of-Use experts in the group and where sufficient evidence was available, emergency permit applications were submitted to the APVMA. The second edition of the ‘Integrated mosquito management principles for piggeries’ document included chemicals made available for use at piggeries under emergency use permits. Subsequent editions have been updated to reflect renewed permits and add additional guidance including videos.

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Photo credit: Stephen Doggett

Introduction

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Mosquito management is required because they bite and transmit viruses that cause disease, including Japanese encephalitis. On farm, mosquito management that relies only on controlling adults is not effective or sustainable. An effective mosquito management program is only achieved by targeting all stages of the mosquito life cycle using a combination of methods. This is called integrated mosquito management, and it is the best way to reduce mosquitoes to protect workers and pigs. It requires a combination of:

- Environmental management to reduce breeding and resting sites
- Larviciding (treating the larvae)
- Adulticiding (treating the adults)
- Ongoing monitoring and surveillance
- Record keeping.

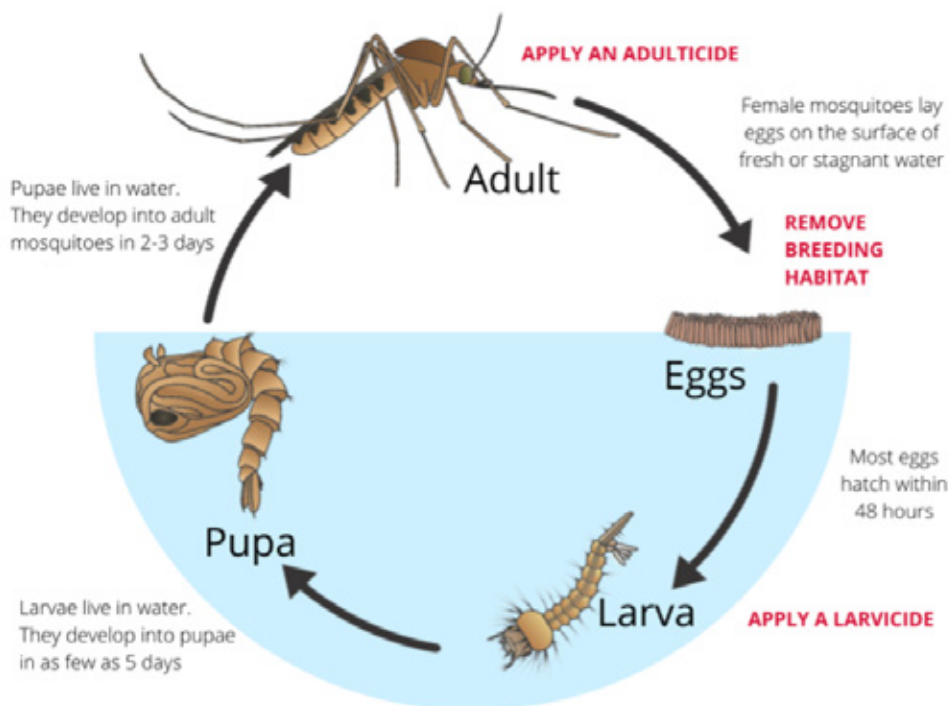


Figure 1: Diagram showing the *Culex* mosquito lifecycle with integrated mosquito management intervention points.

Mosquitoes

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Mosquitoes lay eggs on or around any source of fresh, waste or stagnant standing water in natural or constructed places including effluent (i.e., effluent ponds), dams, rainwater or septic tanks, scrap metal piles, old drums, farm equipment, roof gutters, buckets, puddles, creeks, ditches, and marshy areas.

When they hatch, larval mosquitoes (known as wigglers) remain in the water where they hatched. They then complete their development, and within 7-10 days, emerge as adults.

Adult mosquitoes prefer sheltered, cool, and dark places to rest, and tend to be on the underside of objects or plant foliage to avoid getting wet. They are most active at dawn, dusk, and into the evening but can also be active during the day.

Adult mosquitoes generally don't live longer than 3 weeks but will bite and blood feed every 3-4 days. During their life adult mosquitoes may travel up to 5km from where they hatched.



Photo credit: Stephen Doggett

Figure 2: Eggs (*Culex annulirostris*)

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Photo credit: Stephen Doggett

Figure 3: Larvae (*Culex annulirostris*)



Photo credit: Stephen Doggett

Figure 4: Adult (*Culex annulirostris*)

Environmental management of mosquitoes

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Environmental actions to reduce the mosquito load around piggeries include:

- Implement a schedule to ensure mosquito breeding surveillance is conducted regularly (who, when, where and how).
- Document all surveillance of breeding sources and all control activities undertaken to eliminate breeding.
- Assess natural and man-made environments on farm to ensure:
 - » proper drainage is maintained – grade uneven land, fill depressions, repair irrigation leaks.
 - » dams/channels storing water/effluent do not have
 - overgrown vegetation and debris that may promote harbourage of mosquitoes,
 - shallow edges/slopes which is ideal for mosquito breeding
 - adjacent waste storing stockpiles that may hold water post rain event,
 - obstructions that stop water inflow, making water stagnant and ideal for breeding.
- Reduce standing water sources and remove anything in the open that has the potential to hold water e.g. old equipment, scrap metal heaps, old drums, buckets, troughs and unused tyres.
- Fill potholes or other areas around the piggery that collect water.
- Ensure gutters, downpipes, and drains around buildings are free of debris that prevents the free flow of water. Trim overhanging tree branches.
- Ensure effluent drainage is free flowing, flushed regularly and does not pool.
- Where practical seal uncovered water storage such as tanks or other large containers, or screen with 1mm mesh. If this is not possible manage water flow so that the same water does not sit undisturbed for more than 8 days to avoid mosquito larvae completing development to adulthood.
- Unless being used as an application point for adulticide chemicals, reduce vegetation around the piggery and ponded areas to minimise areas where adult mosquitoes can congregate.
- Ensure all windows and doors in employee facilities are covered by well-maintained mosquito-proof screens.



Figure 5: Examples of water sources where mosquitoes breed

Chemical management of

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Chemical use for mosquito control should be conducted by people authorised to use chemicals in accordance with state/territory training and licensing requirements.

Do not apply chemicals that are not registered for use on pigs to pigs, pig feed or surfaces that pigs may contact.

For effective chemical management:



- Always use chemicals strictly as per the product label
- Seek professional advice if you are unsure about how to use a chemical
- Preferably use a licensed pest control operator
- Keep records of pest control activities on your property and around your piggery
- Restrict chemical use strictly to areas required to be treated

Impacts of chemical misuse

Chemical residues in pork are a trade and food quality risk.

Not using chemicals in accordance with environmental protection statements or labels can create risks to bees, wildlife, aquatic life and people.

The following guidance provides recommendations for products that may be suitable for piggery situations. They reflect chemical use patterns that have been risk-assessed and approved for mosquito control in commercial pest control operations and public health responses to mosquito-borne disease outbreaks. Product lists are not exhaustive. Always ensure you read and comply with product permits, labels and directions for use.





Water Sources				
Location	Larval control	Adult control	Recommendations	Videos
Waste-water structures around piggeries (effluent ponds, drains, septic tanks, retention tanks, ponds, basins)	✓		<p>Frequency and Timing Reapplication every two weeks or as required following rainfall or evidence of additional mosquito activity (an abundance of mosquito larvae).</p> <p>Products</p> <ul style="list-style-type: none"> VectoLex WG Biological Larvicide (APVMA #55919; active ingredient <i>Bacillus sphaericus</i>) 	 Watch Video
Natural wetlands, water bodies and floodwaters including fresh and salt water swamps, marshes, lagoons and pools	✓		<p>Frequency and Timing Reapplication every 2 weeks (liquid), 4 weeks (pellets), 3 months (briquets) or as required following rainfall or evidence of additional mosquito activity (an abundance of mosquito larvae).</p> <p>Products</p> <ul style="list-style-type: none"> Vectobac wg biological larvicide water dispersible granule (APVMA #52642; <i>Bacillus thuringiensis</i> subsp. <i>Israelensis</i>) 	 Watch Video

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Water Sources




Location	Larval control	Adult control	Recommendations	Videos												
<p>Natural wetlands, water bodies and floodwaters including fresh and salt water swamps, marshes, lagoons and pools including where livestock may drink.</p>			<p>Do not apply briquet or pellet products directly into water containers accessible to livestock. Do not allow access to water containers treated with granule products until product has dissolved. Do not apply to water bodies used for aquaculture.</p> <p>Frequency and Timing</p> <p>Reapplication every 2 weeks (liquid), 4 weeks (pellets), 3 months (briquets) or as required following rainfall or evidence of additional mosquito activity (an abundance of mosquito larvae).</p> <p>Release of water treated with Methoprene:</p> <p>Release of treated water off-farm involves a duty of care to consider environmental consequences.</p> <p>No retention period is required for the release of treated water off-farm when using solid methoprene formulations as these release methoprene over an extended period and concentrations are expected to remain below the ANZECC guidance value of 0.2 µg/L.</p> <p>When using liquid formulations the following periods should be considered prior to releasing treated water off-farm:</p> <table border="1" data-bbox="853 1015 1653 1345"> <thead> <tr> <th>Average Water Depth</th> <th>Retention Period</th> </tr> </thead> <tbody> <tr> <td>20cm</td> <td>14 days</td> </tr> <tr> <td>40cm</td> <td>7 days</td> </tr> <tr> <td>60cm</td> <td>4 days</td> </tr> <tr> <td>80cm</td> <td>2 days</td> </tr> <tr> <td>100cm</td> <td>1 day</td> </tr> </tbody> </table>	Average Water Depth	Retention Period	20cm	14 days	40cm	7 days	60cm	4 days	80cm	2 days	100cm	1 day	 Watch Video
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<p>Standing man-made and potable waters including troughs, dams and tanks that hold drinking water for livestock or people, and other man-made water sources including wheel ruts, channels and drains</p>				 Watch Video  Watch Video												

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Water Sources

Location	Larval control	Adult control	Recommendations	Videos
			<p>Products</p> <p>Use products that have no withholding period for livestock drinking treated water when used as directed. Suggestions are listed below:</p> <ul style="list-style-type: none"> • Prolink XR Briquets Mosquito Growth Regulator (APVMA #58061, <u>emergency use PER93296</u>; active ingredient 18g/kg s-methoprene) • Prolink Liquid Larvicide Mosquito Growth Regulator (APVMA #58063, <u>emergency use PER93296</u>; active ingredient 50g/L s-methoprene) • Prolink Pellets Mosquito Growth Regulator (APVMA #58064, <u>emergency use PER93296</u>; active ingredient 40g/kg s-methoprene) • Nomoz Mosquito Larvicide with Prolink (APVMA #59560; <u>emergency use PER93296</u>; active ingredient 40g/kg s-methoprene) • Prolink Prosand Mosquito Growth Regulator (APVMA #59598; active ingredient 4g/kg s-methoprene) • VectoPrime FG Biological Larvicide Fine Granule (APVMA #82315; active ingredient 1g/kg s-methoprene, 400ITU/ mg <i>Bacillus thuringiensis</i> subsp. <i>israelensis</i>) • Culithor Granular Mosquito Growth Regulator (APVMA #69802; <u>emergency use PER93296</u>; active ingredient 12g/kg s-methoprene) • Biopren 50 Liquid Mosquito Larvicide (APVMA #62020, <u>emergency use PER93296</u>; active ingredient 50g/L s-methoprene) • Biopren 4GR Mosquito Larvicide (APVMA #62018, <u>emergency use PER93296</u>; active ingredient 4g/kg s-methoprene) • Prolink Liquid Larvicide Concentrate (APVMA #89714; <u>emergency use PER93296</u>; active ingredient 205.2g/L s-methoprene) 	 <p>Watch Video</p>  <p>Watch Video</p>

Residual treatment outside pig sheds and piggery infrastructure



Location	Larval control	Adult control	Recommendations	Videos
<p>Residual coarse spray treatment outside animal housing (solid exterior walls, eaves, boot change areas, workshops, and other cool, dark areas outside pig housing or handling facilities)</p>			<p>Frequency and Timing</p> <p>High infestation – apply weekly</p> <p>Medium to Low infestation – one treatment then as required pending surveillance of adult mosquito activity.</p> <p>Products</p> <p>Use products that include label directions for use in and around agricultural/farm buildings or animal housing. Suggestions are listed below:</p> <ul style="list-style-type: none"> • Fendona Plus 60 SC Insecticide (APVMA #80739; active ingredient 60g/L alpha-cypermethrin) • Other registered products containing 60g/L alpha-cypermethrin as the only constituent (emergency use PER93322) • Prolong Ultra Fly and Litter Beetle Insecticide (APVMA #66483; active ingredient 25g/L betacyfluthrin) • Other registered products containing 25g/L betacyfluthrin as the only active constituent (emergency use PER93322) • Solfac Duo Residual Insecticide (APVMA #68410; active ingredient 50g/L imidacloprid, 25g/L betacyfluthrin) • Other registered products containing 50g/L imidacloprid + 25g/L betacyfluthrin as the only active constituents (emergency use PER93322) • Seclira WSG Insecticide (APVMA #83011; active ingredient 400g/kg dinotefuran) • Other registered products containing 400g/kg dinotefuran as the only active constituent (emergency use PER93322) 	<p style="text-align: center;">  Watch Video </p> <p style="text-align: center;">  Watch Video </p>

Staff facilities

Location	Larval control	Adult control	Recommendations	Videos
<p>Residual coarse spray treatment in and around staff facilities associated with pig production areas (smoko areas, toilet and shower facilities, office areas)</p>			<p>It is recommended that a licensed pest controller is engaged to treat these areas.</p> <p>Frequency and Timing</p> <p>High infestation – apply weekly</p> <p>Medium to Low infestation – one treatment then as required pending surveillance of adult mosquito activity.</p> <p>Products</p> <p>Use products that include label directions for use in and around agricultural/farm buildings or animal housing. Suggestions are listed below:</p> <ul style="list-style-type: none"> • Fendona Plus 60 SC Insecticide (APVMA #80739; active ingredient 60g/L alpha-cypermethrin) • Other registered products containing 60g/L alpha-cypermethrin as the only constituent (emergency use PER93322) • Prolong Ultra Fly and Litter Beetle Insecticide (APVMA #66483; active ingredient 25g/L betacyfluthrin) • Other registered products containing 25g/L betacyfluthrin as the only active constituent (emergency use PER93322) • Solfac Duo Residual Insecticide (APVMA #68410; active ingredient 50g/L imidacloprid, 25g/L betacyfluthrin) • Other registered products containing 50g/L imidacloprid + 25g/L betacyfluthrin as the only active constituents (emergency use PER93322) • Seclira WSG Insecticide (APVMA #83011; active ingredient 400g/kg dinotefuran) • Other registered products containing 400g/kg dinotefuran as the only active constituent (emergency use PER93322) 	 <p>Watch Video</p>



Fogging


Location	Larval control	Adult control	Recommendations
Fogging in and around pig housing, abattoirs and meat processing establishments when pigs are present			<p>Frequency and Timing Apply morning and evening where mosquitoes are present. Do not spray directly onto pig food or water.</p> <p>Products The following products may be applied when pigs are present with a nil withholding period.</p> <ul style="list-style-type: none"> • Py-Bo Natural Pyrethrum Insecticidal Concentrate (APVMA #53738; active ingredient 320g/L piperonyl butoxide, 80g/L pyrethrins) (emergency use PER93322) <p>Do not use products other than those listed above when pigs are present.</p>
Fogging outside pig housing and other farming infrastructure			<p>There is a greater risk of off-target impacts associated with fogging applications, due to the potential for fine droplets and mist to drift while airborne. Some chemicals formulated for thermal fogging can be reasonably persistent in animal tissues and the environment, representing a trade and environmental risk near areas where pigs are housed or handled. Particular care is recommended if fogging insecticides which contain deltamethrin, cypermethrin, bifenthrin or dinotefuran.</p> <p>Frequency and Timing High infestation/Japanese Encephalitis virus activity – daily treatments. Apply early in the morning before temperature starts to rise. Apply to mosquito resting sites. Medium to Low infestation – weekly treatment pending surveillance for adult mosquitoes. Apply early in the morning before temperature starts to rise.</p> <p>Products Use products that have no withholding period when applied as directed to outside areas associated with animal production, e.g.,</p> <ul style="list-style-type: none"> • Py-Bo Natural Pyrethrum Insecticidal Concentrate (APVMA #53738; active ingredient 320g/L piperonyl butoxide, 80g/L pyrethrins) (emergency use PER93322)

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Fogging




Location	Larval control	Adult control	Recommendations
			<ul style="list-style-type: none"> • Other registered products containing 320g/L piperonyl butoxide + 80g/L pyrethrins as the only active constituents (emergency use PER93322) • Py-Omni Insecticide with Natural Pyrethrum (APVMA #65321; active ingredient 160g/L piperonyl butoxide, 40g/L pyrethrins)Py-Zap Insecticide with Natural Pyrethrum (APVMA #60610; active ingredient 160g/L piperonyl butoxide, 40g/L pyrethrins) • Pyrate Natural Insecticide (APVMA #88596; active ingredient 160g/L piperonyl butoxide, 40g/L pyrethrins) • Pyzap Insecticide (APVMA #61779; active ingredient 160g/L piperonyl butoxide, 40g/L pyrethrins) • Other registered products containing 160g/L piperonyl butoxide + 40g/L pyrethrins as the only active constituents (emergency use PER93322) • Py 40 Insecticide (APVMA #32712; active ingredient 120g/L piperonyl butoxide, 40g/L pyrethrins) • Other registered products containing 120g/L piperonyl butoxide + 40g/L pyrethrins as the only active constituents (emergency use PER93322) • Py Insecticide Fog (APVMA 32710; active ingredient 12g/L piperonyl butoxide, 4g/L pyrethrins) • Other registered products containing 12g/L piperonyl butoxide + 4g/L pyrethrins as the only active constituents (emergency use PER93322) • ALDI Pyrethrum 4-20 Mill Special Ready-to-use Insecticide Spray (APVMA #48326; active ingredients 20g/L piperonyl butoxide, 4g/L pyrethrins) • Other registered products containing 20g/L piperonyl butoxide + 4g/L pyrethrins as the only active constituents (emergency use PER93322) • Garrards Pyrethrin Drift Insecticide (APVMA #55684; active ingredients 24g/L piperonyl butoxide, 4g/L pyrethrins) • Other registered products containing 24g/L piperonyl butoxide + 4g/L pyrethrins as the only active constituents (emergency use PER93322) • Professional use only – Stryker Insecticide (APVMA #87533; active ingredient 590g/L piperonyl butoxide, 60g/L pyrethrins)

Pigs and people

Location	Larval control	Adult control	Recommendations	Videos
<p>Pigs Topical – short-acting</p>			<p>Frequency and Timing</p> <p>Apply twice daily where infestations are severe. Use as required where mosquito bites are observed on pigs.</p> <p>Products</p> <p>The following product may be applied to pigs with a nil withholding period.</p> <ul style="list-style-type: none"> • Repel-X Insecticidal and Repellent Spray (APVMA #52274; active ingredients 20g/L diethyltoluamide, 5g/L citronella, 2g/L pyrethrins, 8g/L piperonyl butoxide) • Vetsense Insecta Repellent Spray (emergency use PER92185); active ingredients 1.5g/L pyrethrins, 3g/L N-octylbicycloheptene dicarboximide, 2.7g/L piperonyl butoxide, citronella oil) • Aristopet Animal Health Flea and Tick Concentrate for Dogs, Cats, Puppies, Kittens and Ornamental Birds (emergency use PER93295); active ingredients 10g/L pyrethrins, 18g/L piperonyl butoxide, 30g/L N-octyl bicycloheptene dicarboximide) <p>Seek veterinary advice before applying any other product directly to pigs</p>	 <p>Watch Video</p>

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Pigs and people

Location	Larval control	Adult control	Recommendations	Videos
Pigs Topical – residual			<p>Frequency and Timing Apply in accordance with emergency use PER93284 with a retreatment interval of 14 days.</p> <p>Products The following products may be applied to pigs with a 14-day withholding period.</p> <ul style="list-style-type: none"> • Y-TeX Brute Pour-On for Cattle (APVMA #56165; active ingredient 87g/L permethrin (25:75 cis:trans)) • Other registered products containing 87g/L permethrin (25:75 cis:trans) as the only active constituent (emergency use PER93284) • Shield 40mg/mL Pour-On Solution for Horses (APVMA #64870; active ingredient 40g/L permethrin (80:20 cis:trans)) • Other registered products containing 40g/L permethrin (80:20 cis:trans) as the only active constituent (emergency use PER93284) • Vetsense Permetrol Insecticidal Spray and Rinse Concentrate for Dogs and Horses (APVMA #60919; active ingredient 40g/L permethrin (25:75 cis:trans)) • Other registered products containing 40g/L permethrin (25:75 cis:trans) as the only active constituent (emergency use PER93284) <p>Seek veterinary advice before applying any other product directly to pigs</p>	 Watch Video
People			<ul style="list-style-type: none"> • Wear light coloured, loose-fitting clothes including long pants, and long-sleeved shirt; and covered shoes. • Use registered repellents that contain diethyltoluamide (DEET), picaridin, or oil of lemon eucalyptus. • Apply the insect repellent on all exposed skin during your workday. • Read the label for reapplication times. 	

Other considerations

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Monitoring and Record-keeping

A template Mosquito Management Plan and Monitoring record is available on the [Animal Health Australia Farm Biosecurity website](#). These and other mosquito and biosecurity management resources for piggeries are also available on the Animal Health Australia [Farm Biosecurity Website](#).

Risks to bees

An [advisory for beekeepers](#) has been prepared to raise awareness of mosquito insecticide control around piggeries, and on public and private lands. The Integrated Mosquito Management Principles for Piggeries are designed to have minimal negative impacts on beekeeping.

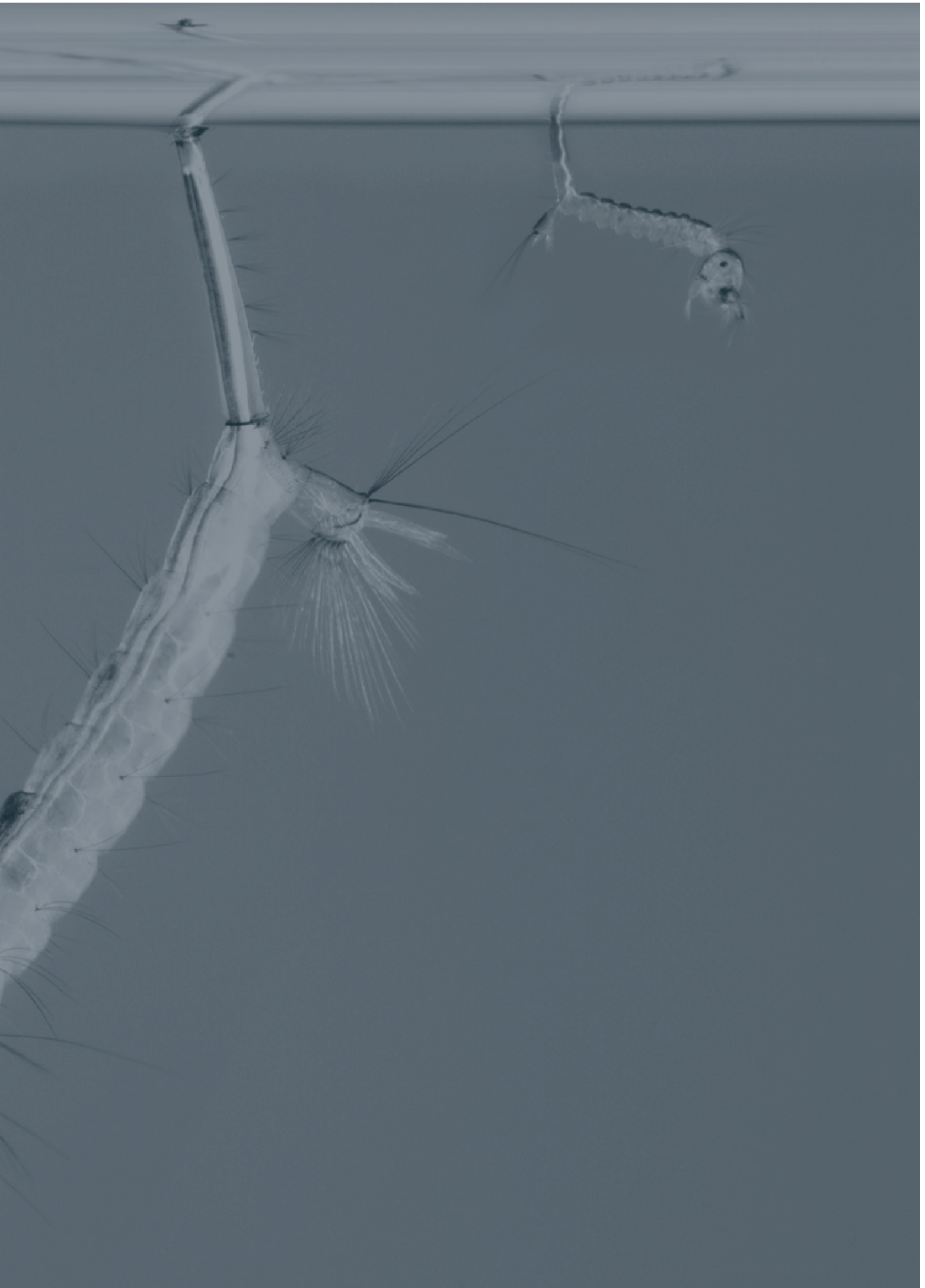
Risks to aquatic species

The sub-committee on Aquatic Animal Health (SCAAH) was consulted on potential risks of mosquito insecticide control around piggeries to aquatic species. The Integrated Mosquito Management Principles for Piggeries are designed to have minimal negative impacts on aquatic species. Methoprene (excepting slow-release formulations) is the only chemical listed for water treatment where a time period for release of waters into the environment should be observed to protect very early crustacean life stages.

Further research

The Integrated Mosquito Management Principles for Piggeries will be adjusted over time to reflect:

- increased understanding of best practice mosquito control for piggeries
- improved methods to control mosquitoes around piggeries with particular emphasis on non-chemical alternatives





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