Forestry Commission

# Western Spruce Budworm (*Choristoneura freemani*), *Eastern Spruce Budworm (Choristoneura fumiferana)* *Black-Headed Budworm (Acleris gloverana and Acleris variana)* – Contingency Plan

## INTRODUCTION

1. Serious or significant pests require strategic-level plans developed at a national level describing the overall aim and high-level objectives to be achieved, and setting out the response strategy for eradicating or containing outbreaks.
2. The UK Plant Health Risk Group (PHRG) has commissioned, following identification by the UK Plant Health Risk Register, pest-specific contingency plans for those pests which pose the greatest risk and require stakeholder consultation.
3. The purpose of these pest-specific contingency plans is to ensure a rapid and effective response to outbreaks of the pests or diseases described. They are designed to help government agencies anticipate, assess, prepare for, prevent, respond to and recover from pest and disease outbreaks.
4. Contingency planning starts with the anticipation and assessment of potential threats, includes preparation and response, and finishes with recovery.

### Anticipate

5. Gathering information and intelligence about the pest, including surveillance and horizon scanning.

### Assess

6. Identifying concerns and preparing plans.
7. Setting outbreak management objectives

### Prepare

8. Ensuring staff and stakeholders are familiar with the pest.

### Response

9. Identifying the requirements for either containing or eradicating the pest or disease, including work to determine success.
10. The Defra Contingency Plan for Plant Health in England (in draft) gives details of the teams and organisations involved in pest and disease response in England, and their responsibilities and governance. It also

describes how these teams and organisations will work together in the event of an outbreak of a plant health pest.

**Recovery**

11. When the response strategy has been effective or when the response is not considered feasible, cost effective or beneficial.

## Scope

This contingency plan was prepared by the Forestry Commission's cross-border Plant Health Service for use at country and national levels. It should be used in England in conjunction with the Defra Plant Health Contingency Plan, which is being developed by Defra and APHA and which will provide details of the level of response required and by whom, depending on the scenario. Forestry Commission England's Forest Services division will use Operational Guidance Bulletin (OGB)17b 'Managing Incidents in the Forestry Commission' in conjunction with its own incidence response plan for relevant incidents. The Scottish Government has a generic plan in place which is under review, and the Welsh Government will develop similar documents detailing its management of outbreaks.

When an outbreak becomes of UK- or Great Britain-wide concern, the UK Chief Plant Health Officer will form an outbreak management team to co-ordinate the activities in the different countries. Outbreaks which occur in non-woodland situations are managed by APHA's Plant Health and Seeds Inspectorate (PHSI).

Initially the four Lepidoptera budworms (*Acleris gloverana, Acleris variana, Choristoneura freemani* and *C. fumiferana*) were considered in separate contingency plans. However, following consultation with expert entomologists who highlighted that the distribution and control methods across the four species were comparatively similar, it was felt that they merited amalgamation into one plan. Detailed pest background information for each individual species is given in appendices one to four

This contingency plan falls into three main parts:

- official action following a presumptive diagnosis;
- official action following the confirmation of an outbreak; and
- background information about the pests.

This plan will be updated following new information or changes in policy or contact details. (Last updated November 2016).

## Objectives of this plan

- To raise awareness of the potential threat posed by *Choristoneura freemani, Choristoneura fumiferana, Acleris gloverana* and *Acleris variana*, therefore ensuring that stakeholders are aware of the symptoms caused by infestation by these pests.
- To provide guidance on steps to be taken when symptoms of attack by *C. freemani, C. fumiferana, A. gloverana* and/or *A. variana* are observed.
- To ensure that infestations of *C. freemani, C. fumiferana, A. gloverana* and/or *A. variana* are managed promptly with the aim of eradicating pioneer populations of these moths.
- To ensure that all relevant Forestry Commission staff, as well as the staff of other government agencies and local authorities are conversant with the contents of this contingency plan so that effective and immediate action is implemented.
- To ensure that good communications are put in place so that all stakeholders (including the media) are kept fully informed, at regional and national levels, of the scale of infestation.

## Anticipation and assessment

1.1. **Western spruce budworm (*Choristoneura freemani*)** (Freeman) (Lepidoptera: Tortricidae) is a serious and destructive pest of a broad range of conifer species.

1.1.1. Its native range covers North America.

1.1.2. *C. freemani* occurs principally on *Pseudotsuga menziesii* (Douglas fir) and also on other forest trees such as *Abies concolor* (white fir), *A. grandis* (grand fir), *A. lasiocarpa* (sub-alpine fir), *Larix occidentalis* (western larch), *Picea engelmannii* (mountain spruce), *P. glauca* (white spruce) and *P. pungens* (blue spruce).

1.1.3. It is considered to be one of the most serious defoliating forest pests in western parts of North America.

1.1.4. It is officially absent from the UK.

1.2. **Eastern spruce budworm (*Choristoneura fumiferana*)** (Clemens) (Lepidoptera: Tortricidae) is a serious and destructive pest of fir (*Abies*) and spruce (*Picea*) species.

1.2.1. Its native range covers North America.

1.2.2. *C. fumiferana* occurs mainly on *Abies* and *Picea* species., but it can also be found on *Pseudotsuga* and *Pinus* (pine) species, and occasionally on *Tsuga* (hemlock) and *Larix* (larch) species.

1.2.3. *C. fumiferana* is one of the most widely distributed forest insects in North America, and is considered to be the most destructive defoliator of boreal and sub-boreal mixed spruce-and-fir forests in the USA and Canada.

1.2.4. It is officially absent from the UK.

1.3. **Western black-headed budworm (*Acleris gloverana*)** (Walsingham), (Lepidoptera: Tortricidae) is a serious and destructive pest of Picea species as well as other conifer genera.

1.3.1. Its native range covers North America.

1.3.2. *A. gloverana* occurs mainly on *Picea* species, but also on *Abies and* fir *Tsuga* species, and on *Pseudotsuga menziesii .*

1.3.3. *A. gloverana* is a serious concern in western Canada and north-western USA, where it causes extensive defoliation leading to loss of wood production and limited top-killing and whole-tree mortality.

1.3.4. It is officially absent from the UK.

1.4. **Eastern black-headed budworm (*Acleris variana*)** (Fernald), (Lepidoptera: Tortricidae) is a serious and destructive pest of *Abies* and spruce species. It was previously considered to be the same species as *A. gloverana*.

1.4.1. Its native range covers North America.

1.4.2. *A. variana* attacks mainly *Abies balsamea* and to a lesser extent *Picea glauca*. It can also feed on other *Picea* spp., particularly in southern Ontario, Canada.

1.4.3. *A. variana* is almost identical to *A. gloverana* in biology and morphology. However, it is regarded as having more limited damage potential because of the frequent heavy defoliation of Abies species in the presence of *A. variana* is often linked to the impacts of other pests, such as balsam woolly aphid (*Adelges piceae)* (Miller),.

1.4.4. It is officially absent from the UK.

## Preparation

2.1. ***Choristoneura freemani*** is listed in Annex IAI of the EU Plant Health Directive 2000/29/EC as a non-European *Choristoneura* species.

2.1.1. It is an EPPO A1 quarantine pest (OEPP/EPPO, 1979).

2.1.2. It has been placed on the UK Plant Health Risk Register with an unmitigated risk rating of 60/125 and a mitigated risk rating of 20/125. The current mitigation listed on the risk register is regulation.

2.1.3. EPPO has prepared a datasheet about the pest under its previous name of *Choristoneura occidentalis*.

2.2. ***Choristoneura fumiferana*** is listed in Annex IAI of the EC Plant Health Directive 2000/29/EC (as a non-European *Choristoneura* species).

2.2.1. It is an EPPO A1 quarantine pest. (OEPP/EPPO, 1979)

2.2.2. It has been placed on the UK Plant Health Risk Register with an unmitigated risk rating of 75/125 and a mitigated risk rating of 25/125. The current mitigation listed on the risk register is regulation.

2.2.3. EPPO has prepared a datasheet about the pest.

2.3. ***Acleris gloverana*** is listed in Annex IAI of the EU Plant Health Directive 2000/29/EC (as non-European *Acleris* species).

2.3.1. It is an EPPO A1 quarantine pest. (OEPP/EPPO, 1979)

2.3.2. *A. gloverana* has been placed on the UK Plant Health Risk Register with an unmitigated risk rating of 75/125 and a mitigated risk rating of 25/125. The current mitigation listed on the risk register is regulation.

2.3.3. EPPO has prepared a datasheet about the pest.

2.4. ***Acleris variana*** is listed in Annex IAI of the EU Plant Health Directive 2000/29/EC (as non-European *Acleris* species).

2.4.1. It is an EPPO A1 quarantine pest. (OEPP/EPPO, 1979)

2.4.2. *A. variana* has been placed on the UK Plant Health Risk Register with an unmitigated risk rating of 27/125 and a mitigated risk rating of 9/125, arising from its lower damage potential. The current mitigation listed on the risk register is regulation.

2.4.3. EPPO has prepared a datasheet about the pest.

## Legislation

2.5. A list of the relevant legislation which can influence a response is listed in Appendix 5.

# Response

## Official action following a presumptive diagnosis

This section applies to all species covered by this contingency plan.

### Trigger

3.1. The key indicators which would trigger a response are findings or reports of:

- characteristic egg clusters or silken thread shelters in trees;
- larvae found on trees; or
- live adult moth(s) found on nursery stock or in the wider environment (e.g. discovered by amateur moth trappers).

These can be reported by nursery growers, woodland owners or managers, or members of the public.

### Roles

3.2. In England, a duty officer from Forestry Commission England or the Animal & Plant Health Agency (APHA) will act as a point of contact for incidents, and it is their job to assign a response officer to incidents when they occur. Similar arrangements are expected to be in place for Scotland and Wales. The response officer investigates and reports back to the Defra Contingency Core Group (CCG), which is an ad hoc group put together in response to a notification, and which is usually chaired by the Chief Plant Health Officer. Country teams in Scotland and Wales will fully manage the outbreak in accordance with their own generic contingency plans, but will provide updates to the Defra Contingency Core Group (CCG) for information purposes and for Defra to report to UK Ministers and the European Commission (EC).

3.3. The response officer will gather information including the location, likely origin, host or commodity, level of damage, extent of outbreak and risk of spread. The CCG will comprise plant health officials and specialists from Defra's Plant Health Risk Group. In England, based on the information fed back to it, the CCG will decide on the alert status (black, amber or red), which will determine the level of response (see Appendix 5 for alert status table). In Scotland and Wales, the CCG can advise on alert status and the appropriate response. If required the CCG may request the relevant organisation/s to set up an incident management team (IMT) to resolve the incident.

### Holding consignments and restricting movements and planting

3.4. Until further investigation, no host tree material shall leave the outbreak site, and local tree management operations will be halted until the suspected case is confirmed as a false alarm. The extent of the site will be determined by the incident management team controller.

### Preliminary trace forward / trace backward

3.5. Depending upon the pathway of entry, investigation to trace forwards and backwards will be carried out to identify other potentially contaminated stock or sites. This will include forestry contractors, suppliers, propagators and wholesalers, including any potential hosts on the identified pathways, where appropriate.

**Surveying to determine whether there is an outbreak**

3.6. A suspected outbreak of *C. freemani, C. fumiferana, A. gloverana and/*or *A. variana* is most likely to be detected by general surveillance as well as investigation of any defoliation episodes on host tree species. It could also be detected during a nursery inspection or following a report from forestry or arboriculture practitioners, or a member of the public, describing pine, larch, fir or spruce trees with silken thread shelters and needle loss. The UK also has an extensive network of amateur moth trappers who might also detect the pest. Detection might also occur during inspections of imported host material.

3.7. If there is evidence of the presence of *C. freemani, C. fumiferana, A. gloverana and/*or *A. variana*, follow-up inspections in line with ISPM 6 (guidelines for surveillance) should gather information about:

- the likely origin of the pest;
- the geographical location and ownership of the affected site(s), including any abiotic factors which might influence the outbreak, such as public access, proximity of suitable forest planting, etc. All survey data, whether positive or negative, should be geo-referenced and mapped;
- the hosts infested at the site (species, variety, development stage, etc.);
- when and how the pest was detected and identified (including photographs of symptoms);
- the level of pest incidence and, where appropriate, life stages present;
- the extent and impact of damage;
- recent imports or movements of host plants or host plant products into and out of the affected site;
- movement of people, products, equipment and vehicles, where appropriate;
- relevant treatments applied to host plants which might affect development of symptoms or detection and diagnosis of the pest;
- the history of the pest on the site, place of production or in the area; and

- the likely biodiversity impacts of any control, including any duty of care obligations under the Natural Environment & Rural Communities Act (2006), which applies to England and Wales. Scotland has similar legislation in the form of the Nature Conservation (Scotland) Act 2004.

3.8. Suspect material from infested trees in the wider environment should be either:

(a) triple wrapped in robust plastic bags; or

(b) double-wrapped in robust plastic bags and the bags placed inside a secure box or vial and sent immediately to the Tree Health Diagnostic & Advisory Service at Forest Research for diagnosis. Suspect insects should be preserved in alcohol and sent in a similar manner. The samples should be accompanied by information about the date when the samples were collected, the location (address, postcode, GPS) and contact details of the person collecting the samples. The address is: Tree Health Diagnostic & Advisory Service, Forest Research, Alice Holt Lodge, Gravel Hill Road, Wrecclesham, Farnham, Surrey, GU10 4LH.

Samples collected from nurseries by APHA's PHSI staff should be sent to Fera Science Ltd. for analysis.

### Confirmation of a new outbreak

3.9. Positive identification of *C. freemani, C. fumiferana, A. gloverana* and/or *A. variana* can only be made in the laboratory, using defined diagnostic protocols. (EPPO, 2009; Ioos et al., 2009) On-site inspection by a Forest Research entomologist or experienced plant health officer from the Forestry Commission, Natural Resources Wales or APHA is part of the confirmation process. However, it is expected that DNA analysis will be required for rapid assessment because of these species' minor differences from one another. Samples should only be removed from the site by trained individuals using safe and appropriate equipment and operating according to biosecurity guidelines.

## Official Action following confirmation of an outbreak

This section applies to all species covered by this contingency plan.

### Strategic actions on confirmation

3.10. On positive confirmation, the following should be initiated:

- notify Westminster Ministers and senior Defra and FC officials;
- set up regular (determined by scale of outbreak) Lead Government Department (LGD) meetings to keep partners aware of the current status, actions and possible future requirements, and to agree a communications strategy;
- notify the Devolved Administrations and the EC; and
- discuss with stakeholders.

3.11. In most instances the Forestry Commission (in England and Scotland) is likely to appoint an incident controller and an incident management team. For outbreaks in nurseries in England and Wales, APHA would take the lead, and in Scotland it would be Scottish Government's Horticulture and Marketing Unit (HMU). The Welsh Government would take the lead in Wales. Forestry Commission England's Forest Services will work to the generic Defra contingency plan (in draft), which will be enacted in response to a confirmed *C. freemani, C fumiferana, A. gloverana* and/or *A. variana* outbreak. Forestry Commission Scotland and the Welsh Government will have similar documents detailing their management of outbreaks.

3.12. Initial efforts will aim to eradicate new outbreaks following the procedures set out below. Failing eradication, efforts will concentrate upon containment.

**Communication**

3.13. The incident controller will set up a management structure to carry out the functions of incident management. The outbreak will determine the size and nature of the structure. Identification of, and liaison with, key stakeholders are crucial parts of this process.

**Surveillance**

3.14. To determine the extent of the outbreak a delimiting survey should be set up as soon as possible after the first finding of *C. freemani, C fumiferana, A. gloverana* and/or *A. variana.* This is to determine the geographical limits of the infested area and to demarcate a regulated area. There are two elements to the delimiting survey:

1. based on experience in North America (see second bullet point below), an intensive survey of host trees must be carried out within at least a 1km radius of the first tree(s) found to be infested. The

survey will look for host species showing signs of infestation, such as silk webbing on the buds (early in the year), bark or foliage, and loss of new foliage due to larval feeding. This loss of foliage might extend to old foliage when population densities of the pest are high; and

2. general surveillance in the wider area, which can be ground or aerially based, using access routes appropriate to the distribution of host trees in the area. This could include line transects outwards to at least 10km, along which visual inspection of host trees is carried out at regular intervals (e.g. every 50-100m) to estimate the full extent of the spread. A grid-based system could also be employed, depending on the distribution of host trees, and, as indicated below, deployment of pheromone traps on a grid basis to supplement visual surveys.

- Since wind dispersal of both young larvae on silken threads and of flying adult females can be extensive (potentially hundreds of kilometres), a region-wide alert with general surveys should be issued in addition to the intensive survey close to the initial infested area. Although widespread movement of budworm adults has been recorded in their native ranges in North America, these tend to occur when populations have reached plague levels in some areas. (Anderson and Sturtevant, 2011) Anderson and Sturtevant (2011), in modelling movement of *C. fumiferana*, concluded that long-distance movement from high-density population centres was wind-assisted and, at least in their study area, not particularly influenced by availability of host tree species. However, they also quoted the finding that, during migration, flying moths (both male and female) are able to locate host trees and descend to colonise them. Nealis and Régnière (2004) studied migration of spruce budworm, and demonstrated that female moths showed higher likelihood of migration at high population densities, especially when local food supply was reduced as a result of defoliation.

- It is reasonable to conclude that long-distance migrations are less likely in low density, pioneer populations in the UK, where food supply is not limited. Therefore, surveillance at local scales should remain a priority, but increased awareness in more-remote forests containing host trees should be included in contingency planning.

3.15. Once the presence of the pest is confirmed in the area, its distribution can also be determined using pheromone traps during the flight period in July and August for *C. freemani* and *C. fumiferana,* and in August and September for *A. gloverana* and *A. variana*. However, these timings are based on the lifecycles in North America. The phenology of the lifecycle in Britain, for any or all of the budworm species, might differ from the North American timings. The suggested trap timings of all the species given here will need to be kept under review with reference to the actual phenology in Britain.

**Demarcated zones**

3.16. A statutory regulated (demarcated) area should be established as soon as possible after the discovery of an outbreak of *C. freemani, C fumiferana, A. gloverana and/*or *A. variana*. This is to help minimise the spread of the pest within the infested area, and to prevent human-assisted transport to areas outside it. Because of a lack of knowledge about how these species would respond in a British forest environment, the exact size of the demarcated zones required is unclear., However, the suggestion is that an initial demarcated area of at least 20km around the infested trees will need to be established, within which measures to prevent the movement of all potentially infested host material should be implemented. These measures should include a prohibition on the movement of untreated host material likely to harbour any of the pest life stages. (Such host material would include living trees, cut branches, and any parts of the tree with branches, with or without needles). Subsequently, the size of the regulated area might need to be increased, depending on the spread of *C. freemani, C fumiferana, A. gloverana* and/or *A. variana.*

3.17. Nurseries within the 20km demarcated area will be inspected for the presence of *C. freemani, C fumiferana, A. gloverana* and/or *A. variana,* and will have their plant passporting for related conifer plants suspended until the presence or absence of any of the pests within the nursery and the 20km area can be determined.

3.18. The level of uncertainty about how these three species would respond and disperse if they were present in Britain is reflected in the relative uncertainties about surveillance and the size to be assigned to the demarcated area. Both of these aspects would be clarified and defined once surveillance procedures began in the event of an outbreak, and once intelligence has been gathered on the distribution patterns of these species in the British forest environment.

## Tracing forwards and backwards

3.19. Depending upon the pathway of entry, tracing forwards and backwards to identify suspect material will be conducted to identify other potentially contaminated stock or sites.

If the infested trees have been recently planted, i.e. within the previous three years, the supplying nursery must be traced and inspected for the presence of of *C. freemani, C fumiferana, A. gloverana* and/or *A. variana*. In addition, any supplies of conifer planting material from the nursery over the previous three years should be traced to their final planting sites and inspected for the presence of *C. freemani*, *C. fumiferana,* A. gloverana and/or *A. variana.*

## Pest management procedures

3.20. Depending on the location of the new outbreak, statutory plant health notices (SPHNs) will be issued, either by the Forestry Commission or Natural Resources Wales in woodland situations, or by APHA or the Scottish Government's HMU in non-woodland situations. Timely issue of SPHNs, and action on them, are vital if new outbreaks are to be contained and eradicated. It should be made clear at the outset that the costs of any remedial actions required will be borne by the landowner. The Forestry Commission, Natural Resources Wales, APHA or the HMU will need to consider whether direct intervention by government is required to ensure a rapid response to reduce the risk of spread.

3.21. The management programme should focus on a phased removal of the worst affected host species from the outbreak site, leading to all infested trees being removed. Because of the life cycle of *C. freemani, C fumiferana, A. gloverana* and *A. variana,* it is essential, if an outbreak is discovered in late spring or early summer, that the affected trees are removed as quickly as possible. This will limit the number of larvae developing into moths.

Use of *Bacillus thuringiensis* could help supress the presence of *C. freemani, C. fumiferana, A. gloverana* and/or *A. variana*. This, in addition to silvicultural methods such as thinning and fertilisation, could be tried as control options. However, significantly more evidence of the effectiveness of *B. thuringiensis*, and in particular of any impact from pesticide applications on native insect fauna, would need to be gathered before it could be approved by the Chemicals Regulation Division (CRD)for use in the UK on budworm species.

**Disposal**

3.22. Material which has been confirmed as infested shall be dealt with as follows:

a) Infested material for planting, as well as all other material in the consignment will either be re-exported to the country of origin or it will be burned or deep buried.

b) Where a small number of mature infested trees are involved it might be possible to high-prune large branches to destroy the local infestation. All branches with buds shall be removed and destroyed, preferably by burning on site. The larvae and cocoons can be associated with the bark of the tree, so movement of barked timber should be restricted, with the timber ideally being debarked in situ. If removed from site, potentially infested bark should be disposed of by a licensed incinerator.

c) If burning of large volumes of wood is necessary in a woodland situation, advice should be sought from Forest Research on whether monitoring for *Rhizina inflata*, a fungus which can proliferate on post-fire sites, is required. If so, Forest Research will provide a protocol. However, because the risk is related only to the cambium layer, debarking and destruction of bark (by burning or chipping) is sufficient to reduce further spread.

d) Burning on site must comply with the appropriate waste management regulations applied by the Environment Agency in England, Scottish Environment Protection Agency (SEPA) and Natural Resources Wales.

e) In exceptional circumstances, if material must be moved from the site during the adult flight period of July and August for *C. freemani* and *C. fumiferana,* and late August and September for *A. gloverana* or *A. variana*, it should be transported with a protective covering to ensure that all material is contained, and taken immediately, without being stored elsewhere, to an approved incinerator or burn site, or to an approved landfill site where it can be buried deeply in the ground. Alternatively, sawmills and processors could be authorised to receive infected material, provided they have facilities to remove and dispose of the bark. The phenology of the lifecycle in Britain, for any or all of the three species, might differ from the North American timings. The suggested transport timings of all the species given here will need to be kept under review with reference to the actual phenology in Britain.

f) If more than a few infested trees are found during survey, local measures to eliminate the moth will not be effective. Larger-scale aerial application of an approved pesticide should be considered in order to attempt eradication before the moth becomes fully established. Although *Bacillus thuringiensis* is an effective agent, it might not always result in eradication, even when applied optimally. Consideration should also be given to use of a knock-down insecticide if there are good prospects for eradication. This would require emergency legislation, approval and careful planning and consultation. Refer to:

Pesticide register of UK register products

Pesticides regulations

**Public outreach**

3.23. It is crucial to have public support for the management programme and to help with general surveillance. Engaging the public will require the provision of timely, balanced and accurate information regarding monitoring and control. It will also provide opportunities for them to participate in monitoring and reporting suspect trees using the Tree Alert reporting tool and the Observatree volunteer tree health monitoring programme,. Information, subject to available budget, can be made available through newspapers, radio, TV, the internet, magazines, publicity materials and social media, and should be targeted locally, especially within the infested and regulated areas, but also regionally and nationally according to the size, spread and number of the outbreak or outbreaks

3.24. It is important to provide information on the location and size of the infected and regulated areas, statutory and voluntary responsibilities, rates of spread, management options, how the disease might have arrived and could be spread, and the wider effects on British forestry. Managing this level of public engagement will require a central communications office capable of handling large numbers of enquiries and providing general and specific information. Liaison with communications and press offices from other countries will be required for cross-border outbreaks.

## Review measures in the case of prolonged official action

3.25. Where eradication proves impossible, efforts should shift to containment, with the focus moving from outbreak management for eradication to a plan for containing the outbreak as much as possible. A review of the management programme should be undertaken regularly (at least annually) to determine the success and cost-effectiveness of the measures in the longer term. This review will involve consultation with stakeholders and should include:

- evaluation of the effectiveness of current measures;
- evaluation of the economic impact and cost-effectiveness of continuing existing measures;
- consideration of further measures to strengthen containment and eradication actions;
- consideration of statutory obligations and impact on import and export procedures;
- consideration of alternative approaches or the cessation of statutory action.
- consideration of biodiversity impacts following control - this to be compared with consideration of the impacts on biodiversity of not undertaking control actions.

## Criteria for declaring a change of policy and reviewing the contingency plan

3.26. This and other contingency plans will be reviewed annually to accommodate any significant changes in pest or pathogen distribution, dispersal, refinement of surveillance techniques, legislative changes or changes in policy. When and if policy makers in the country or countries affected deem that eradication is no longer achievable, there will be a move towards containment. The criteria for determining such a break point could be based on a proportion of host species lost, a set number of hectares lost, number of individual outbreaks, resources needed or a combination of these. However, this will be determined by the policy makers in the country or countries affected. Further details can be found in the Defra generic plan (and the equivalent Scottish and Welsh documents when they are available).

In circumstances where official action is no longer considered appropriate, stakeholders should be consulted and a timetable and mechanism agreed for the removal of official measures and for the dissemination of information about managing the pest as appropriate.

The plan should only be re-consulted upon if significant new information is presented which affects the approach to outbreak management.

All the species are listed in the EU plant health legislation, so consultation is required with the EU if a change of management from eradication to containment is proposed, because there is a legal obligation to continue to take action against such pests.

## Criteria for declaring eradication

4.1. Because of the life cycle of the moths, an outbreak can be declared eradicated if, after three years of monitoring, there are no indications of pest presence. As indicated in paragraphs 3.13 and 3.14, continuing surveillance using ground surveys for larvae, ground and aerial surveys for signs of defoliation, and supplementary pheromone or light trap monitoring, should be used to determine the presence or absence of the budworm pests.

## Appendix 1: Pest Background Information – *Choristoneura freemani*

### Identity of organism and quarantine status

Species name: *Choristoneura freemani* (Freeman) (Lepidoptera: Tortricidae)

Synonyms: None

Common name: Western spruce budworm

UK risk rating: Unmitigated 60/125; Mitigated 20/125

EU status: Absent.

EPPO status: A1 list

UK status: Absent

**Hosts** (Source: EPPO datasheet)

*Choristoneura freemani* occurs principally on *Pseudotsuga menziesii, but* also on other forest trees such as *Abies concolor*, *A. grandis*, *A. lasiocarpa*, *Larix occidentalis*, *Picea engelmannii*, *P. glauca* and *P. pungens*. These host plants can be found in northern and central European forests.

### Life history

(Source: EPPO datasheet)

Adult flight and egg laying by the females, take place in summer (July and August), and the eggs hatch in about 10 days. The newly hatched larvae do not feed, but spin silken shelters among lichens and, especially, under bark scales where, as second-instar larvae, they hibernate over winter. During the following spring, the emergent larvae mine into old needles until bud-swell, and then bore into the buds and feed on the growing needles. Later they form loose webs among the growing tips, and feed on new needles. The larvae pass through six instars (stages), followed by pupation in June under silken shelters in the branches.

### Life cycle

(Source: EPPO datasheet: http://www.na.fs.fed.us/spfo/pubs/fidls/westbw/fidl-wbw.htm)

Egg masses are located on the undersides of needles, and are initially green, but become translucent white when they hatch and the larvae emerge. Each female can lay up to 150 eggs. Native *Tortricidae* and other micro-moths might also lay their eggs on conifer needles in a similar mass.


**Figure 1:** *C. freemani* egg mass and emergent larvae. Source: USDA Forest Service - Region 2 - Rocky Mountain Region; Bugwood.org

Newly hatched and second-instar larvae do not feed, and they overwinter in silken hibernacula (shelters). Once feeding begins in the spring, the larvae pass through four further feeding instars, with mature larvae reaching approximately 25mm in length. Feeding takes place initially on new foliage, but larvae will also feed on older foliage if new foliage is outstripped,


**Figure 2:** *C. freemani* larva. Source: W.M Ciesla, USDA, Bugwood. org

Pupation takes place within the webbed foliage during late June and early July.

**Figure 3:** Pupa of *C. freemani* in silken webbing. Source: David McComb, USDA Forest Service; Bugwood.org


**Figure 4:** Newly emerged adult and empty pupal case of *C. freemani.* Source: USDA Forest Service - Region 4 - Intermountain , USDA Forest Service; Bugwood.org

### Distribution of the organism

*C. freemani* is is confined to western North America, where it is a serious pest throughout British Columbia and the Pacific Coast and Rocky Mountain states. Outbreaks were first recorded in 1909 on Vancouver Island (British Columbia, Canada), and in Idaho (USA) in 1922. *C. freemani* is absent from the rest of the world.

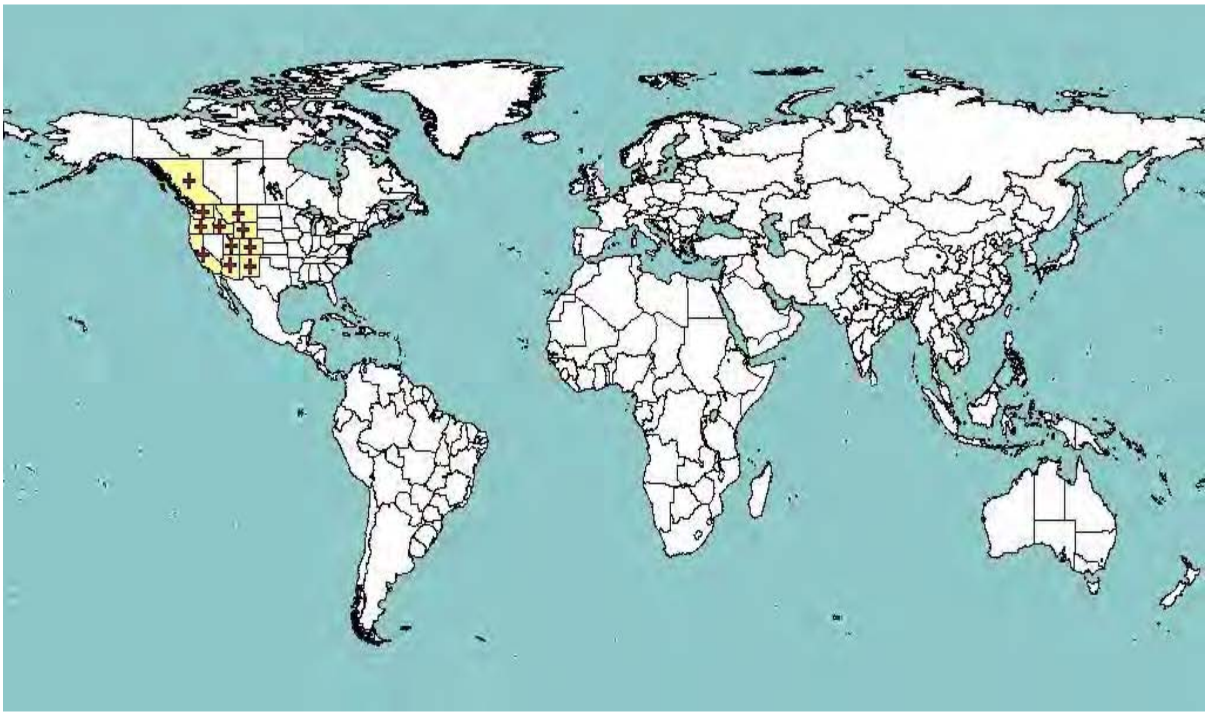

**Figure 5:** Distribution of *C. freemani* as of October 2015. Crosses represent sub-national records. (EPPO PQR database)

### Damage impact and controls

*C. freemani* is one of the most destructive forest defoliators in western North America. Heavy and repeated attacks can lead to top death of the trees and tree mortality. Feeding begins on buds and new foliage and, if populations are relatively small, are confined to these parts of the tree. All new foliage can be destroyed if populations are high. Feeding then takes place on older foliage, leading to complete defoliation and potential death of the affected tree.


**Figure 6:** Defoliation caused by *C. freemani*. Source David J. Moorhead, University of Georgia; Bugwood.org


**Figure 7:** Landscape-scale damage of grand fir in Oregon caused by *C. freemani*. Source: USDA.

Fellin and Dewey (1992) provided a valuable description of the feeding damage caused to different parts of the host trees of *C. freemani*.

***Impact on cones and seeds***

(Source: http://www.na.fs.fed.us/spfo/pubs/fidls/westbw/fidl-wbw.htm)

*C. freemani* larvae can feed heavily on the staminate flowers and developing cones of host trees. The resultant decline in seed production can have a serious impact on seed yield in areas of propagation, and for natural regeneration on forest sites. This could have impacts on plant production for stocking and re-stocking in plantations.

Feeding might not always be restricted to a single cone. Smaller larvae can feed on newly developing conelets, leading to their becoming desiccated and dropping from the tree.

Damage can be very severe, and cone production low, in some stands of *Pseudotsuga menziesii*, particularly at high *C. freemani* densities. Top-death of some host trees arising from repeated heavy defoliation can reduce cone production for many years, even when *C. freemani* populations subside.

***Impact on regeneration and young stands.***

(Source: http://www.na.fs.fed.us/spfo/pubs/fidls/westbw/fidl-wbw.htm)

*C. freemani* can affect smaller host trees (<1.5 m tall), which can impact on regeneration of a site. This is particularly the case when larvae fall from the canopies of mature trees above young trees. These young trees have limited foliar capacity, and are easily damaged or killed by relatively small populations of the moth. However, this impact can be mitigated by the action of natural enemies prevalent on the forest floor. Conifer host trees can be completely defoliated after several years of sustained attack, leading to top-death and loss of growth increment. This also makes the trees vulnerable to secondary pests and fungal infections. Many trees are almost entirely defoliated after three or more years of sustained larval feeding, and increases in diameter and height are sharply reduced.

### *Impact on mature stands*

Because outbreaks of *C. freemani* can persist for several years, repeated defoliation results in loss of growth increment, top-death and occasional tree mortality. Radial growth losses of up to 25% can be experienced over five years of defoliation. Dominant trees tend to be the first to be attacked, and are also able to produce adventitious foliage, helping the tree to survive.

Such heavy attacks can make the trees vulnerable to attacks by other biotic damaging agents such as Douglas fir beetle (*Dendroctonus pseudotsugae;* Hopkins), and the fir engraver beetle (*Scolytus ventralis;* LeConte).

### Control

(Source: http://www.na.fs.fed.us/spfo/pubs/fidls/westbw/fidl-wbw.htm)

Aerial application of *Bacillus thuringiensis* subsp. *kurstaki* is the main method of direct intervention to reduce populations of *C. freemani*. Information about regular spray programmes in British Columbia is distributed to land owners and the public via the British Columbia Ministry of Forests, Lands & Natural Resource Operations (https://www.for.gov.bc.ca/rsi/ForestHealth/Western_Spruce_Budworm.htm). Such programmes are effective in reducing large and geographically widespread populations of the moth.

Other more locally applied control methods include the use of chemical insecticides such as trunk injection with emamectin benzoate. (Fidgen *et al,* 2013*)* However, such methods are not practical for large-scale application, but could be useful in containing or attempting eradication of small, pioneer populations of the moth.

Applications of baculoviruses against *C. freemani* do not appear to be sufficiently effective in reducing *C. freemani* populations (Otvos *et al*., 1989), despite a relatively high natural incidence of baculoviruses. The larval mortality from baculovirus infections tends to increase with increasing moth population. (Nealis *et al*, 2015)

Natural enemies such as the parasitoids *Glypta fumiferanae*, *Apanteles fumiferanae* and *Phytodietus fumiferanae,* in combination with natural infections from baculoviruses, can reduce populations of *C. \freemani.* (Nealis *et al,* 2009)

Those species are present in the USA and Canada, in the area of natural distribution for the budworm. Since the budworm is not currently present in the

UK, we are not able to know whether there would be any natural predation from British parasitoids.

Long-term management of *C. freemani* outbreaks includes silvicultural methods to reduce the impact of the moth on susceptible forests. Such approaches include promotion of species diversity, and reducing the density of trees in a stand. In general, the encouragement of age and species mixtures over a wide geographic area appears to be a key factor in reducing the scale of infestation by the moth.(https://www.for.gov.bc.ca/rsi/ForestHealth/Western_Spruce_Budworm.htm)

**Main pathways**

(Source: EPPO DS)

Passive wind dispersal can occur when larvae "balloon", or spin long silken threads which they use to drift in the wind, and spread is also ensured by moth flight. Genetic analyses confirm that dispersal occurs frequently between different populations of *C. freemani* which are separated by up to 350km, but is less common over greater distances. (Flower *et al*, 2014) The principal pathways for transfer of *C. freemani in* international trade are whole plants and cut branches of conifer hosts, which could carry all life stages except adults (i.e. eggs, larvae, especially hibernating first and second instars in silken hibernacula, and pupae).

**Import controls**

(Source: EPPO DS)

Prohibition of the importation of plants and cut branches of *Abies*, *Larix*, *Picea* and *Pseudotsuga* from affected countries, as recommended by EPPO (OEPP/EPPO, 1990) for other North American insect pests of conifers, is the appropriate measure to prevent introduction of *C. freemani*.

## Appendix 2: Pest Background Information – *Choristoneura fumiferana*

### Identity of organism and quarantine status

| | |
|---|---|
| Species name: | *Choristoneura fumiferana* (Clemens) (Lepidoptera: Tortridicae) |
| Synonyms: | none |
| Common name: | Eastern spruce budworm |
| UK risk rating: | Unmitigated 75/125; Mitigated 25/125 |
| EU status: | Absent |
| EPPO status | *Choristoneura fumiferana* is on the EPPO A1 list. |
| UK status: | Absent |

The following information is based on the EPPO datasheet about *C. fumiferana*, which is available at https://gd.eppo.int/taxon/CHONFU/documents.

### Life history

The adults appear in July or August, depending on geographical area, and females lay egg masses on the undersides of needles. Each female lays approximately 200 eggs. The eggs hatch in about 8-12 days, and the tiny larvae spin silken hibernacula in old staminate flower cups, under bark scales or lichens, and in bark crevices. They moult in the newly constructed hibernacula and remain there until spring. No feeding occurs before hibernation. The over-wintered, second-instar larvae emerge from the hibernacula shortly before the vegetative buds begin to expand, and mine within the old needles or into the unopened buds, or feed upon the early-opening staminate flowers if they are available. Eventually, the growing larvae move to the opening vegetative buds, where they feed under a protective silken web. As the shoots expand, the larvae spin loose webs among the needles, from which they move on to the new foliage. There are six larval instars, four of which are feeding stages. Larvae feed on new foliage through May and June, then pupate and emerge as moths by mid-July.

**Life cycle**

Egg masses are located on the undersides of needles, and are initially green, but become translucent white when they hatch and the larvae emerge. Each female can lay up to 200 eggs.

**Figure 1**: Eggs of *C. fumiferana* on the underside of a fir needle. Source: Natural Resources Canada.

Newly hatched and second-instar larvae do not feed, and they overwinter in silken hibernacula. Once feeding commences in the spring, there are four further feeding instars with mature larvae reaching approximately 25mm in length. Feeding takes place initially on new foliage, but larvae will also feed on older foliage if new foliage resources are outstripped.


**Figure 2**: Larva of *C. fumiferana*. Source J. Dewey, USDA; Bugwood.org.

Pupation takes place within the webbed foliage during late June and early July.


**Figure 3**: Adult and pupa of *C. fumiferana.* Source USDA Forest Service; Bugwood.org.

## Hosts

*C. fumiferana* occurs mainly on *Picea* and *Abies*, but can also be found on *Pseudotsuga*, *Pinus* and, occasionally, on *Tsuga* and *Larix*. It particularly attacks *Abies balsamea*, *Picea* glauca and *P. rubens* in eastern North America, and *A. lasiocarpa*, *P. engelmannii*, *P. glauca* and *Pseudotsuga menziesii* in western North America.

Several significant host plants of *C. fumiferana* are widely grown in European forests and plantations (e.g. *Pseudotsuga menziesii*, *A. lasiocarpa*, *P. engelmannii* and *P. glauca*).

## Distribution of the organism

*C. fumiferana* occurs across the northern parts of North America and some of the Rocky Mountain states, but is absent from the rest of the world.

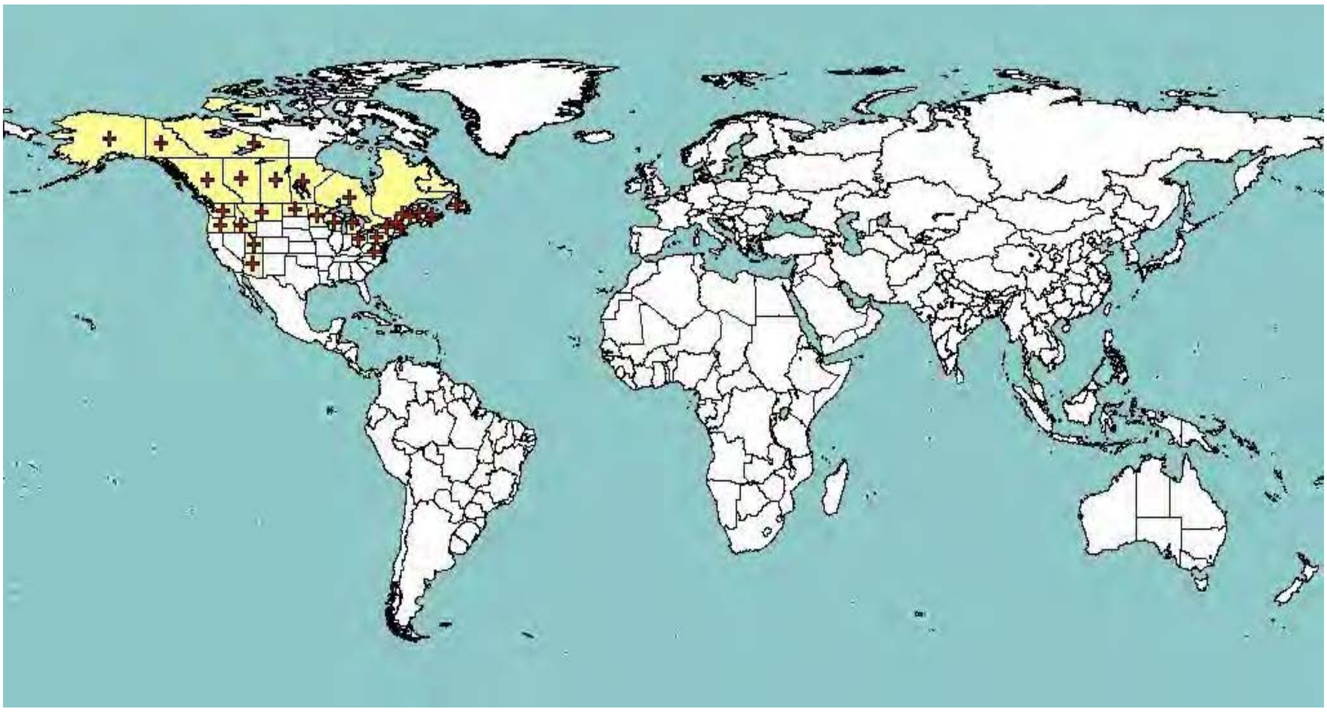

**Figure 4:** Distribution of *Choristoneura fumiferana* as of October 2015.Crosses represent sub-national records. (EPPO PQR database)

**Damage, impact and controls**

*C. fumiferana* is one of the most widely distributed forest insects in North America, and is a highly destructive pest in *Abies* and *Picea* forests of the eastern USA and Canada. Severe outbreaks have been recorded since the mid-1930s in Ontario, then through Quebec into the Atlantic region, and many trees have been killed. Outbreaks have also been recorded in the west: in British Columbia, Idaho, Montana, Oregon and Washington.


**Figure 5:** *C. fumiferana* defoliation and damage on spruce. Source, J. O'Brien USDA; Bugwood.org


**Figure 6:** Extensive defoliation of Balsam fir caused by *C. fumiferana*. Source S. Katovich USDA; Bugwood.org

In light and moderate infestations, damage is restricted to partial loss of the new foliage, especially in the upper portion of the crown. Partially consumed needles on the webbed branch tips turn bright reddish-brown during midsummer. In heavy, persistent infestations, the complete crop of new foliage can be consumed over several successive years, with vegetative buds and developing shoots being killed during the early stages. For example, in *Abies*, tree mortality may be observed after approximately five years of successive defoliation. In addition, trees which have been infested are more susceptible to secondary pests.

## Control

There are only two active ingredients registered for direct insecticidal control of *C. fumiferana* in Canada; *Bacillus thuringiensis* subsp. *Kurstaki,* which is the main method of direct intervention, and the insect growth regulator Tebufenozide (Mimic®) which is not currently approved for use in the UK. Both insecticides are regarded as the most specific to Lepidoptera, with very low non-target impacts, and they must be ingested to act on the larval feeding stages (targeting fourth and fifth-instar larvae. However, neither agent has been shown to give 100% population reduction, so they tend to be used for suppression and containment rather than eradication.

Mating disruption has been used for many years for management of spruce budworm by reducing mating success. (Rhainds *et al*, 2012) However, despite considerable research and field applications, there has been relatively little success in providing consistent population suppression. As Rhainds *et al* (2012) point out, this is mainly due to: (1) difficulties in obtaining accurate population estimates at low population density to help forecast the onset of plagues; (2) potential behavioural adaptations in which females enhance their mating success when the atmosphere is treated with pheromone; and (3) long-range dispersal of females by flight. (Females can be blown up to 600 km.)

Natural enemies (e.g. *Apanteles fumiferanae*, *Omotoma fumiferanae*) might limit populations of the pest between population peaks, and inundative releases of *Trichogramma minutum* have been made (Smith *et al*., 1990). Baculoviruses and cytoplasmic polyhedroviruses have been recorded among *C. fumiferana's* natural microbial enemies, but they appear to have relatively little impact except at higher population densities. (Lucarotti *et al,* 2004) However, these, along with silvicultural methods such as changing tree species mix, thinning, and application of fertilisers, are long-term population management tools, and are not suitable for immediate population reduction towards eradication.

## Main pathways

Extensive dispersal of *C. fumiferana* occurs during periods of high populations. Passive wind dispersal might occur in the first larval instar in late summer or in the second larval instar in early spring the following year, aided by their habit of 'ballooning'. Dispersal can also occur during moth flight, with distances of up to 600km through wind dispersal having been recorded. (Dobesberger *et al* 1983) The principal pathways for transfer of *C. fumiferana* in international trade are whole plants and cut branches of conifer hosts, which could carry all life stages except adults (i.e. eggs, larvae, especially hibernating first and second instars in silken hibernacula, and pupae).

**Import controls**

The importation of live plants and cut branches of conifers (*Abies*, *Larix*, *Picea*, *Pinus* and *Pseudotsuga*) from North America is prohibited under the EU Plant Health Directive, because of the threat posed not only by *C. fumiferana*, but also by other North American pests and diseases. This measure, if strictly applied, should prevent the introduction of *C. fumiferana*.

## Appendix 3: Pest Background Information – *Acleris gloverana*

### Identity of organism and quarantine status

Species name: *Acleris gloverana* (Walsingham) (Lepidoptera: Tortricidae)

Synonyms: Formerly considered to be one species, *Acleris variana* (Fernald), but now split into *A. gloverana* (western distribution) and *A. variana* (eastern distribution – See Appendix 4)

Common name: Western blackhead budworm

UK risk rating: Unmitigated risk high 75/125; mitigated risk low 25/125

EU status: Absent

EPPO status: A1 list

UK status: Absent

Source (EPPO datasheet on quarantine pests; http://www.fs.usda.gov/detail/r10/forest-grasslandhealth/?cid=fsbdev2_038380; http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5191790.pdf.)

### Native Distribution

*A. gloverana* occurs in northern California, areas of the Rocky Mountains, British Columbia, Yukon, the North West Territories and Alaska. Its range overlaps that of *A. variana* in the eastern fringe of its distribution.

### Hosts

*A. gloverana* mostly infests *Tsuga heterophylla,* but it also readily attacks *Abies* spp. *Picea* spp., especially Sitka spruce (*P. sitchensis),* and *Pseudotsuga menziesii*.

### Life history

Adult moths of *A. gloverana* emerge and fly in August and September, when females lay their eggs singly on the undersides of needles on the edges of the tree crown. Females can lay up to 150 eggs, with an average of about 80. (Schmiege and Crosby, 1970) Unlike other budworms covered in this contingency plan, the overwintering stage is the egg, which hatches in the following spring to coincide with bud burst, which occurs in May or June, depending on latitude.

Young larvae immediately start feeding on the bases of extending needles or into buds which have not yet expanded. The first two instars continue feeding in the expanding buds and new needles, but from the third instar onwards more extensive feeding takes place, including feeding within the silken webs which the larvae spin. Later instars (there are either four or five feeding instars) can also feed on older foliage. Characteristically, needles are not consumed entirely, and this can result in a messy appearance with partially eaten needles turning red, giving heavily attacked trees a 'scorched' appearance. (Schmiege and Crosby, 1970)

Pupae are formed in the webbed feeding sites from mid-July to late August, a stage which lasts for about 10 to14 days before the new generation of adults emerges.


**Figure 1:** Late-instar larva of *A. gloverana*. Source T. Gray, Canadian Forest Service; Bugwood.org


**Figure 2:** Pinned museum adult of *A. gloverana*. Source Todd M. Gilligan and Marc E. Epstein, TortAI: Tortricids of Agricultural Importance, USDA APHIS ITP; Bugwood.org

**Figure 3:** Adult *A. gloverana* on foliage in a natural resting posture. Source **Edward H. Holsten, USDA Forest Service; Bugwood.org**

**Damage and impact**

Depending on the attack density of the pest population, defoliation can be extensive, with a tendency for the effects to be greatest near the tops of trees and on the canopy edges. This reflects the preference of adults to attack dominant and co-dominant trees within a stand. Partial feeding, resulting in needle breakage, but not complete consumption, results in reddening of the foliage, which starts in June and continues through July, depending on latitude. Top death and, at very high attack density, whole-tree death can occur.


**Figure 4:** Foliage discolouration after *A. gloverana* attack. USDA Forest Service - Region 10 - Alaska; Bugwood.org

## Distribution of the organism

*A. gloverana* occurs in the boreal forest areas of the western USA and Canada as far south as the Sierra Nevada and Cascade ranges in California.

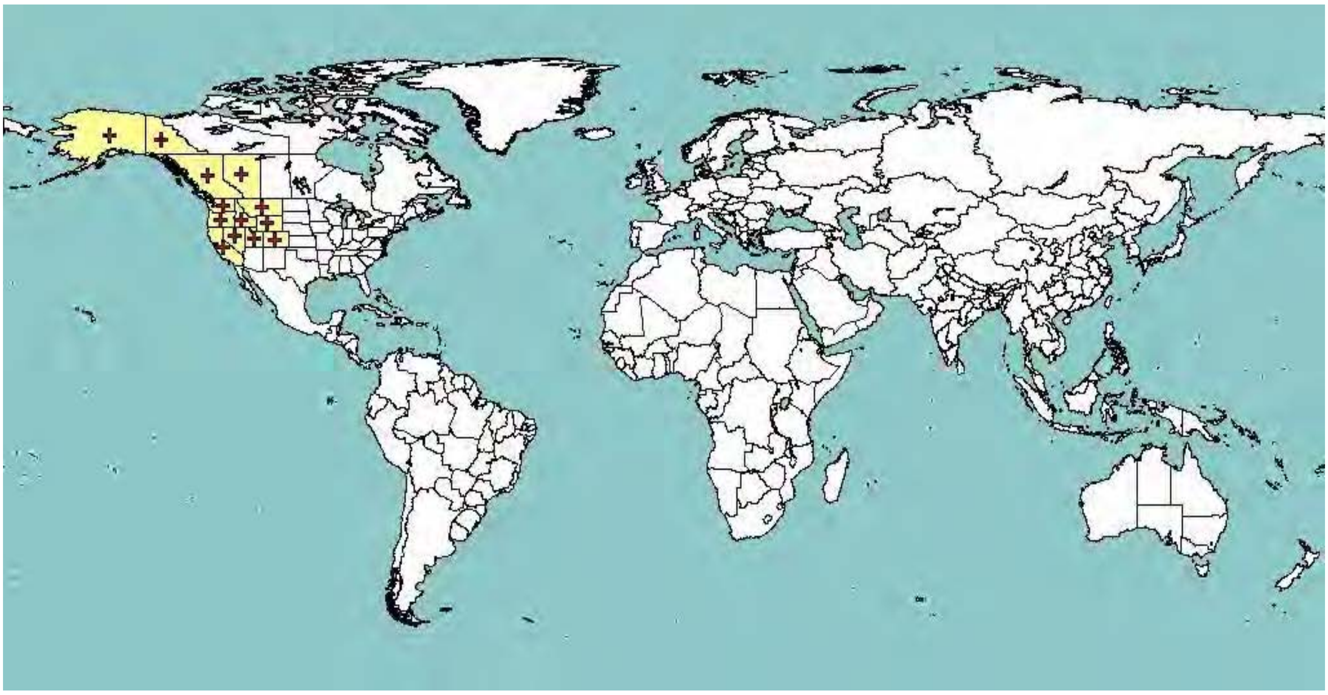

**Figure 5:** Distribution of *A. gloverana* as of September 2015. Crosses represent sub-national records. (EPPO PQR database)

## Main pathways

Dispersal of *A. gloverana* occurs during the adult flight period in late August and September. Adults are strong fliers and are attracted to light (which provides an additional means of monitoring for the presence of the moth). It does not appear that passive dispersal in the larval stage occurs, because the young larvae feed within the buds and young needles.

International movement of the moth is only likely to occur on plants or cut branches (including foliage) of hosts, which might hold eggs (which overwinter from late August to early June), young larvae (within buds or young needles), and mature larvae and pupae (in silk-wrapped groups of needles).

## Control

Outbreaks of *A. gloverana* are periodic and are not usually as severe as those of *C. Freeman (see Appendix 1)*, so there has been relatively little direct application of pesticides to reduce populations. (Koot, 1991) Following early trials with *Bacillus thuringiensis* var *kustaki*, there are now several *Bt* products registered for use against this pest. These include *Bt kurstaki* and *Bt aizawai*, both of which are effective against feeding larvae. However, it appears that these agents are used to strategically reduce local populations rather than suppress them on a broad scale.

There are many natural enemies, such as insect and bird predators, parasitoids, and microbial agents, which reduce populations of the moth, but none have been used in classical or augmentative biological control programmes. Cold, wet summer periods affecting larval performance also contribute to population decline. (Koot, 1991)

Pheromones have been identified and synthesised, and are valuable tools for monitoring population densities of the moth (Nealis *et al*, 2010), but they do not appear to have been tested for mating disruption.

Recent work on the prospects for silvicultural management suggests that thinning and spacing operations, especially in younger plantations, can result in increases in population size and damage. (Nealis *et al,* 2004; Nealis and Turnquist, 2010) Longer-term population management requires assessment of the age and tree species structure of a stand, avoiding large areas of young regenerating stands of western hemlock, combined with modifying thinning regimes when an insect outbreak is imminent to reflect the greater risk to trees older than20 years.

Overall, therefore, there are no recommendations for eradication, and all existing strategies rely on knowledge of the dynamics of the pest and locally applied *Bt* or silvicultural treatments to prevent large population increases.

## Import controls

Identified pathways for international movement of *A. gloverana* include plants for planting and cut branches (including foliage) of host trees. These could hold all life stages other than adults (i.e. overwintering eggs, young feeding larvae within buds or expanding needles, older feeding larvae, and pupae within silk-covered groups of needles). Current EU regulations prohibit the importation of these pathways for all identified tree hosts of *A. gloverana* and, if applied rigorously, these controls should prevent the introduction of the pest from North America to the UK and the rest of Europe.

## Appendix 4: Pest Background Information – *Acleris variana*

### Identity of organism and quarantine status

Species name: *Acleris variana* (Fernals) (Lepidoptera: Tortricidae)

Synonyms: Formerly considered to be one species, *Acleris variana* (Fernald), but now split into *A. gloverana* (western distribution, see Appendix 3) and *A. variana* (eastern distribution)

Common name: Eastern blackheaded budworm

UK risk rating: Unmitigated risk low 27/125; Mitigated risk low 9/125

EU status: Absent

EPPO status: A1 list

UK status: Absent

Source (EPPO datasheet on quarantine pests; http://www.gov.ns.ca/natr/protection/ipm/; http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5191790.pdf.)

### Native Distribution

In Canada, *A. variana* occurs throughout the main conifer forests from Newfoundland and Cape Breton Island (Nova Scotia) to Saskatchewan and eastern Alberta. In the USA, *it* occurs in the north-eastern states of Connecticut, Maine and New York, and in south-eastern areas.

### Hosts

*A. variana* infests mainly *Abies balsamea* and to a lesser extent *Picea glauca*. It can also feed on other *Picea spp*., particularly in southern Ontario, Canada.

### Life history

In eastern Canada, adult *A. variana* fly during August and September. Females deposit their eggs singly on the undersides of needles towards the top of the tree. In cage experiments, mean oviposition (egg-laying) rates of 53-83 eggs per female have been recorded. It is probable that adult food is critical in egg production. The survival rate in the egg stage is relatively stable at about 89%, and egg mortality is largely caused by infertility and failure to hatch. The egg is the overwintering stage; hatching coincides with bud burst in the following May or June, depending on average temperatures.

The emerging larvae bore into new needle bases to feed. The needles of a single shoot are enough to maintain one larva during the first three instars. Males, and about 50% of females, have four instars, while the other 50% of females have five instars. As shoots elongate, the fourth (and fifth) instar larvae feed within a protective web which they spin over the needles. Final-instar larvae are able to complete development on old foliage of *Abies balsamea*.

Larval survival is affected by parasitism and weather. Pupation, lasting about 20 days, occurs in the feeding sites from mid- or late July until late August. Some larvae can fall from the foliage, even though food supply is adequate, and then pupate in the shrub layer. First adults appear in early August. In cages, male budworms lived for about 14 days and females for 28 days.

Increases in density of *A. variana* have been linked to periods of low rainfall. In the Green River area of north-western New Brunswick (Canada), when accumulated degree-days above 5.5°C exceeded 1169, there was a general increase in populations of this species, and a decrease when temperatures were less favourable. (Miller, 1966)


Figure 1: Larva of *A variana*. Source: Connecticut Agricultural Experiment Station, Connecticut Agricultural Experiment Station; Bugwood.org


**Figure 2:** Pinned museum specimen of adult *A. variana.* Source: Todd M. Gilligan and Marc E. Epstein, CSU; Bugwood.org

### Damage and impact

The impacts of *A. variana* on forests are not always attributable to the larval feeding of the pest alone, because impacts (up to 100% defoliation of the current season's shoots) are also frequently associated with other pests of *Abies* *balsamea*, such as the balsam woolly adelgid, *Adelges piceae.* (Miller, 1966) *Abies* spp. appear to be able to survive up to two years of severe defoliation without top-killing or a marked reduction in radial increment. Larvae of *A. variana* emerge when the buds of *A. balsamea* are opening. Based on the absence of larval feeding in the buds, it appears that up to five years of repeated attacks would be required to kill established trees. Outbreaks of *A. variana* in Canada have been reported to collapse after 2 years.


**Figure 3:** Initial damage arising from *A. variana* attack. Source: Rick West, Canadian Forest Service; Bugwood.org

**Distribution of the organism**

*A. gloverana* occurs in the boreal forest areas of the western USA from the Sierra Nevada and Cascade ranges in California, northward to coastal British Columbia and Yukon (Canada), eastward to western Alberta, and southward in the Rocky Mountains.

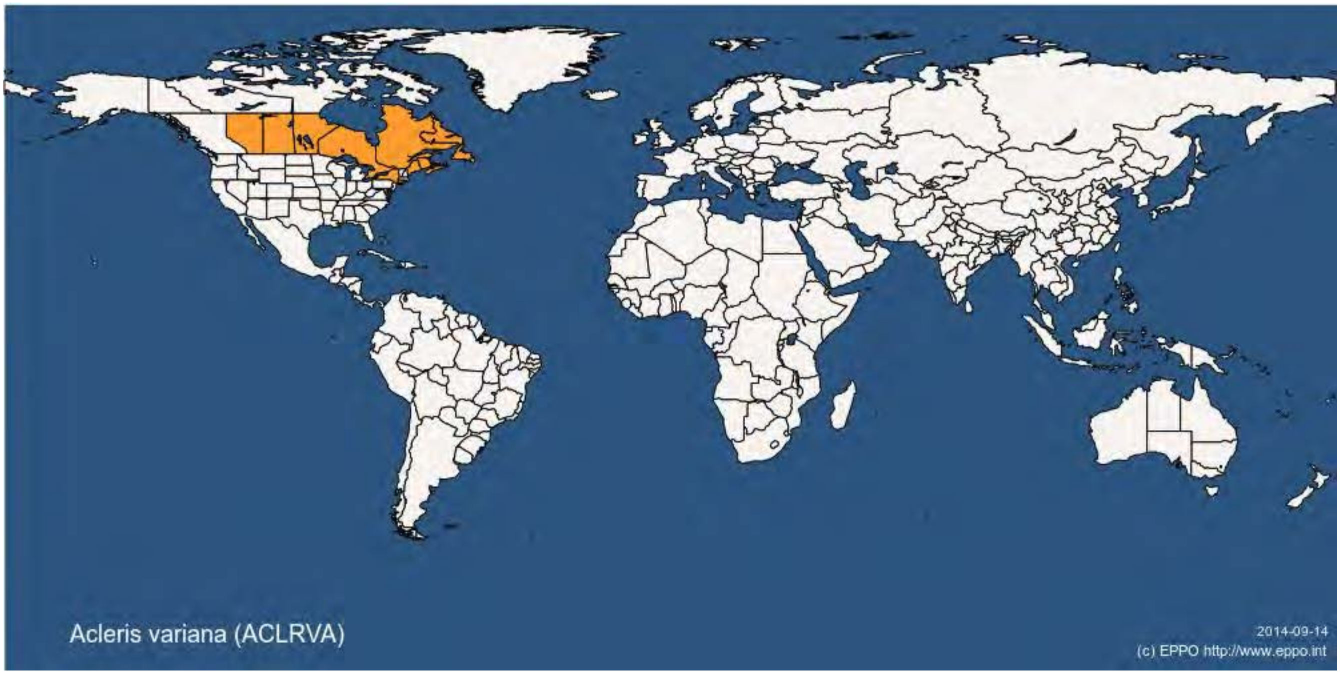


Figure 4: Distribution of *A. variana* (EPPO PQR database)

**Main pathways**

Dispersal of *A. variana* occurs during the adult flight period in late August and September. Adults are strong fliers and are attracted to light, (which provides an additional means of monitoring for the presence of the moth). It does not appear that passive dispersal in the larval stage occurs, because the young larvae feed within the buds and young needles.

International movement of the moth is only likely to occur on plants or cut branches (including foliage) of hosts which may hold eggs (which overwinter from late August to early June), young larvae (within buds or young needles), mature larvae (in silk-wrapped groups of needles) and pupae (also in silk-wrapped needles).

### Control

Since outbreaks of *A. variana* are periodic and not usually as severe as those of either *C. fumiferana* or the closely related *A. gloverana,* there has been only limited research into application of pesticides to manage populations. Trials with *Bacillus thuringiensis* have had limited success and do not appear to be part of current management against this pest. (West and Carter, 1992)

There are many natural enemies, such as insect and bird predators, parasitoids, and microbial agents, which reduce populations of the moth, but none have been used in classical or augmentative biological control programmes. As with *A. gloverana,* cold, wet summer periods affecting larval performance are also contributory factors in population decline. (Koot, 1991)

Pheromones have been identified and synthesised and are valuable tools for monitoring population densities of the moth (Gries *et al*, 1994), but do not appear to have been tested for mating disruption.

Overall, therefore, there are no recommendations for population eradication, and all existing strategies rely on knowledge of the dynamics of the pest and on natural factors which reduce the populations from their periodic peaks.

### Import controls

Identified pathways for international movement of *A. variana* include plants for planting and cut branches (including foliage) of hosts. These could hold all life stages other than adults (i.e. over-wintering eggs, young feeding larvae within buds or expanding needles, older feeding larvae, and pupae within silk-covered groups of needles). Current EU regulations prohibit the importation of these pathways for all identified tree hosts of *A. variana* and, if applied rigorously, these controls should prevent the introduction of the pest from North America to the UK and the rest of Europe.

**Appendix 5 – Alert status levels for an outbreak (based on alert status levels for draft Defra generic contingency plan).**

| ALERT | STATUS | COMMAND LEVEL |
|---|---|---|
| White | Plant pest or disease with potential for limited geographical spread | Instigate incident management plan involving operational command at appropriate level, and follow Standard Operating Procedures or scientific advice where applicable. |
| Black | Significant plant pest or disease with potential for limited geographical spread | Instigate of incident management plan, usually involving joint tactical and operational command at appropriate level, and follow plant pest or disease- specific response plans where applicable. |
| Amber | Serious plant pest or disease with potential for relatively slow but extensive spread leading to host death and/or major economic, food security or environmental impacts | Instigate of incident management plan, usually involving joint strategic and tactical command, and follow plant pest or disease-specific response plans where applicable. |
| Red | Serious or catastrophic plant pest or disease with potential for rapid and extensive geographical spread leading to host death and/or major economic, food security or environmental impacts | Instigate of incident management plan involving strategic, tactical and operational command, and follow plant pest or disease-specific response plans where applicable. |

## Appendix 6: Relevant legislation

### Domestic:

The Waste Management Licensing (Scotland) Regulations 2011

The Environmental Permitting (England and Wales) Regulations 2010

Natural Environment and Rural Communities Act 2006

Plant Health (Forestry) Order 2005

Plant Health Act 1967

Forestry Act 1967

Pesticides regulations

Pesticide register of UK register products

### European:

EC Council Directive 2000/29/EC

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