

A woman with dark hair, wearing a blue t-shirt, sunglasses, and a headset with a microphone, is seated in the cabin of a red aircraft. She is smiling and looking down at a map spread out on her lap. She is holding a blue pen and appears to be marking the map. The aircraft's interior is visible, including the red seats and windows showing a bright, hazy sky.

FOREST HEALTH AERIAL OVERVIEW SURVEY STANDARDS FOR BRITISH COLUMBIA



Ministry of
Forests, Lands, Natural
Resource Operations
and Rural Development

Resource Practices Branch

FOREST HEALTH AERIAL OVERVIEW SURVEY STANDARDS FOR BRITISH COLUMBIA

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FOREST HEALTH AERIAL OVERVIEW SURVEY STANDARDS FOR BRITISH COLUMBIA

INTRODUCTION

The aerial overview survey (AOS) is a landscape-level survey used to detect major forest disturbances caused by insects, diseases, animals, and abiotic factors. The AOS utilizes fixed-wing aircraft and specially trained observers to sketch-map visible disturbances over large areas quickly, and in a very cost-effective manner. The purpose of the survey is to provide a snapshot of forest conditions and the status of disturbance events.

Aerial overview surveys have been used since the 1950s in British Columbia (BC). With changing technology and varying levels of expertise and experience among those conducting the surveys, it was recognized that standards needed to be developed.

The first standards were developed cooperatively between the Canadian Forest Service and the British Columbia Ministry of Forests (now BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD)). The document was produced by the Canadian Forest Service (*Overview Aerial Survey Standards for British Columbia and the Yukon FHN-1, 1997*). It was revised by the province of BC in 2000 (*Forest Health Aerial Overview Survey Standards for British Columbia*) and was approved by the Resource Inventory Committee as an official standard.

The provincial government (currently under FLNRORD) has been conducting the aerial overview surveys (AOS) annually since 1999. Each year the program is reviewed to ensure quality and consistency in data collection and compilation. This has led to several amendments and enhancements to the AOS program, and hence to this revision of the standards manual.

Data collected from the annual aerial overview surveys is used by many interest groups including government agencies, industry, academia, and the public for a wide range of purposes. These include input into government strategic objectives, guidance for management and control efforts related to forest health, usage for research projects, providing national indicators for sustainable forest management, input for timber supply analyses, carbon accounting, climate change effects monitoring, and contributions to the National Forest Pest Strategy *Pest Strategy Information System* (www.ccfm.org/pdf/PestStrat_infosys_2012_en.pdf).

The Canadian Forest Service Forest Insect and Disease Survey spatial records were converted to the provincial spatial data standards, and were incorporated into the provincial geo-spatial database known as the BC Geographic Warehouse (BCGW). This data set has records that began in 1907, with the first description of a western spruce budworm outbreak on southern Vancouver Island. The BCGW data is available publicly through the GeoBC data portal.

PURPOSE FOR ESTABLISHING STANDARDS

The data collected annually during the AOS is the cornerstone of the forest health program in BC. Therefore, it is very important that a quality product is produced and documented. These standards provide for:

- Collection of data that is consistent, quantifiable and comparable across the province;
- A snapshot of aerially visible current forest health conditions for all BC forests, time and budgetary constraints permitting, on an annual basis;
- A comparison of forest health conditions over time;
- An aid in delivering consistent training and mentoring of survey personnel;
- Increased efficiency and expertise of survey crews, resulting in a timely product and decreased costs; and,
- Completion of an accurate, timely spatial database for use by the various clients.

AERIAL OVERVIEW SURVEY METHOD

Initial Planning

Aerial overview surveys are generally conducted from early July through mid-September, to coincide with the optimum damage symptom expressions of major forest health agents in BC (Appendix A). Information about current damage conditions observed during other early season surveys and anecdotal reports inform AOS surveys to ensure adequate coverage of known and historic outbreak areas. Occasionally, special flights are conducted to address specific pests that express themselves either earlier or later than the normal mid-summer flight period. Flights may also continue later into the fall if necessary (due to inclement summer weather and/or wildfire smoke issues during the regular period), as long as the primary damaging agent(s) signatures for the area are still visible. Extension of the survey into the late fall must be approved by the appropriate regional specialist, and areas flown late need to be documented to identify possible under-report disturbances only visible during earlier season surveys (e.g., most deciduous defoliators).

An annual planning meeting is held at a central location in early spring. This meeting is attended by branch and regional forest health specialists who administer the survey, the province-wide survey monitor, the geographic information system (GIS) providers, and the survey personnel. Successes from the previous year are reviewed, improvements are discussed, current forest health agents of concern are highlighted, and a general plan for conducting the current year's program is refined.

A small overlap with the adjacent map is often added, which facilitates the mapping of large disturbances occurring on the map edge, and aids in orientation. The map borders may include additional features such as a small key map to assist in orientation and planning; space to record weather, comments and surveyor information; and a legend describing the added layers. These satellite image-based maps are a significant improvement over the previously utilized topographical maps, which had very few features to accurately tie disturbances to, and came in various scales (difficult to switch between while mapping).

A minimum of two copies of the satellite image-based maps should be delivered to all surveyors by mid-June (or earlier for specific spring surveys). If additional trainee or supervisor personnel will be on board the survey aircraft, further maps can be produced by GIS staff with adequate notice. Prior to the flight, maps should be folded by the surveyors in a fashion that allows for efficient organization in the limited space within the cabin of a small aircraft. All incomplete survey maps (or at least a large percentage of them) should be carried in the plane so plans can be adjusted in the air if required due to flight and visibility conditions. A letter sized key map, showing the entire area to be surveyed with major area features and the map grid is very useful as well for flight planning.

One set of maps on clear film are also produced. These maps generally have all of the same features as the working survey maps, minus the satellite imagery and past survey data, and are used to produce a composite map of the two surveyor's data in preparation for digitizing. (Figure 2).

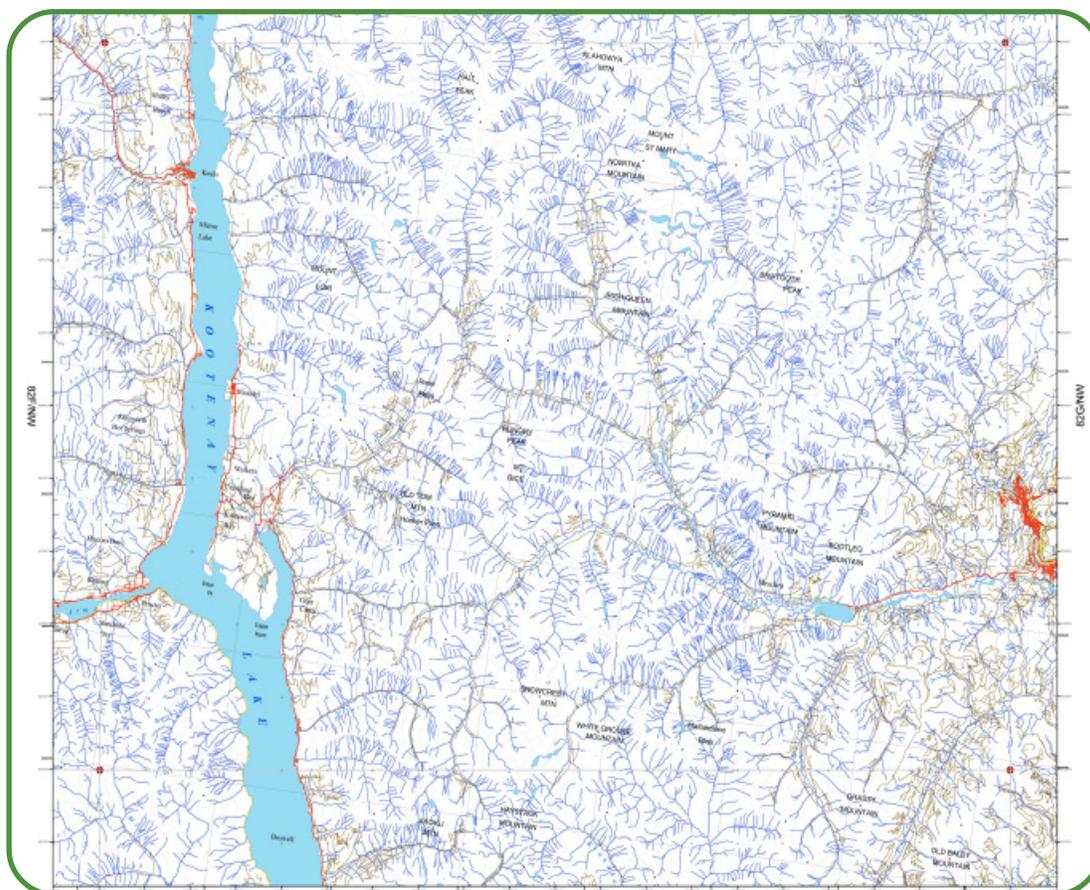


Figure 2. Example of a map printed on clear film.

Survey personnel:

Two trained observers sit on opposite sides of the plane to map visible forest health damage. An additional trainee may map from the seat behind the most experienced surveyor. To become a second seat surveyor, an initial training course followed by a minimum of 15 hours of trainee mapping in varied forest types is required. To be considered an experienced primary surveyor, a minimum of one season of flying second seat (minimum 50 hours) is required. A minimum of two observers and a pilot survey each FLNRORD region.

At a minimum, survey personnel must be comfortable mapping and navigating in the air for five hours, be able to distinguish tree species and damage types from the air and be able to distinguish between the colours red, green, yellow and grey.

Familiarization with local conditions:

Surveyors, particularly those new to an area, need to anticipate what disturbances they may encounter. This includes:

- Reviewing past information such as previous AOS reports, AOS spatial data, and historic forest health damage data for the survey area;
- Reviewing the biogeoclimatic zones for the survey area to determine tree species present, and hence possible damaging agents that may be encountered;
- Contacting personnel in the area that may have observations on current forest health such as FLNRORD staff and forest industry staff;
- Reviewing recent weather activity for the area to determine if the conditions may have affected things such as defoliator feeding patterns or disease incidence; and,
- Becoming familiar with the characteristics and biology of anticipated damaging agents.

Equipment:

Surveyors need to be equipped with abundant pens, a high quality camera with zoom lens, tinted and polarized sunglasses to enhance color differentiation and reduce glare (rose or amber colour is recommended), binoculars, motion sickness and sinus medication as needed, GPS unit with mounting apparatus and extra batteries, a hard board for map sketching, lots of map choices and lunch (Figure 3). A hand held radio with FLNRORD channels and a SPOT satellite GPS messenger are also recommended as backup to the plane communication system. The plane should be equipped with radio headsets, but each surveyor should consider purchase of a high quality personal voice activated noise cancelling headset.



Figure 3. Surveyor equipped for mapping.

To date, sketch mapping by hand directly onto the working maps has been the method of choice in BC. The number and complexity of damaging agents, host tree species and differing severities is very high in most areas of BC, hence digital mapping systems have not been utilized. However, some surveyors bring a tablet with geo-referenced versions of the satellite-based working maps downloaded onto them, to assist in navigation. The benefit of a device such as this must be weighed against the space constraints of a small aircraft cabin and the limited time available to utilize it.

Other jurisdictions (e.g., Alberta, Saskatchewan, USFS Forest Health Monitoring, etc.) are currently using tablet PC based digital mapping technologies to conduct aerial overview surveys. FLNRORD specialists are investigating the potential use of this equipment for use in BC.

Aircraft Selection:

Aircraft selection may largely be determined by local availability. At a minimum, aircraft must be of high-wing configuration for ease of lateral and downward viewing, have seating capacity for at least four, be capable of sustained airspeed of 140 to 250 kilometers per hour (70 - 100 knots), and conversely have the ability to slow to this speed. In remote coastal areas and some northern locations, a float or amphibious plane is often more desirable due to better fuel availability and landing opportunities (Figure 4). In the central and southern interior of the province, wheeled aircraft with fixed or retractable landing gear are usually preferred.

Required performance characteristics for the aircraft will be determined by type of terrain and area of coverage. Over flat and rolling landscape a Cessna 180 or equivalent may be sufficient, while in mountainous terrain an aircraft with stronger performance such as a Cessna 210 or twin-engine Cessna 337 is more appropriate.

Though aircraft availability and type may be a limiting factor, safety should never be compromised. If available, a pilot with local terrain knowledge should be requested.



Figure 4. Float plane utilized in northwestern BC.

Aircraft booking procedures:

To ensure that planes are appropriate/safely maintained and that pilots have the required experience for the task, BC Wildfire Services maintain a list of approved air carriers and pilots. Bookings are usually made through the appropriate BC Wildfire Service Fire Centre. The six regional fire centres have boundaries that roughly correspond with the FLNRORD regional boundaries. The booking is made through the aviation protection officer or their representative, usually in an electronic format. Each fire centre may utilize a slightly different form which is available from the aviation protection officer.

All survey personnel should be familiar with the *Wildfire Management Services Aviation Safety Manual* and the *British Columbia Wildfire Service Pilot Information Guide 2016*¹. These documents describe FLNRORD policy on minimum requirements for air carriers, pilots, specialty flying, flight safety and guidelines, accident reporting and other safety matters.

Aerial observers must wear the appropriate clothing and footwear needed to survive in the event of a forced landing. Layered flight clothing should be made of natural fibres or some other flame-resistant material and footwear suitable for walking long distances in remote rugged terrain should be worn or brought on board.

Prior to each flight, onboard personnel and the ground communications centre(s) should know the intended flight plan and duration. Discussions with the pilot should include locations available for fuel and/or break stops, load levels (passengers and equipment) and elevation, speed, etc., required for the survey. Emergency equipment such as a first-aid kit, emergency locator transmitter beacon and survival gear must be in place and the pilot must review emergency procedures with the passengers prior to each flight. A checklist for the AOS surveyors to review prior to a flight is located in Appendix B.

Check-ins must be made with the appropriate regional BC Wildfire Service Fire Centre via radio at the beginning and end of each flight, and every 30 minutes during the flight. Three standard pieces of information are relayed during each check-in: who you are (aircraft call sign), where you are (simple geographic location), and what you are doing. This is a back-up procedure for the automated flight following system, which all certified aircraft carry. During takeoff and landing, it is important to maintain a quiet cockpit to allow the pilot to concentrate on flight procedures and communications with flight services.

It is important for surveyors to be in frequent communication with the pilot regarding direction, altitude changes, air speed adjustments, fuel considerations, meteorological conditions and ferry time estimates. Be sure to give the pilot adequate notice for course changes, particularly when flying in mountainous or difficult terrain. A minimum flying height of 500 feet (160 m) above ground level must be observed as a safety precaution, such as when crossing ridges between drainages. Be an active participant in the flight; watch for birds, wildfires and other aircraft. Do not hesitate to ask questions or discuss with the pilot anything which causes you concern. While

¹ *Wildfire Management Services Aviation Safety Manual* is an internal document, see your Regional Representative to obtain a copy. The *British Columbia Wildfire Service Pilot Information Guide 2016* is available online at:

https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/aviation/2016_pilot_information_guide_full_page_version.pdf

the observer who chartered the aircraft has jurisdiction over the basic flight procedure, the pilot is ultimately responsible for the aircraft and the safety of the passengers, and may overrule any aspect of the survey plan with respect to aircraft operation and safety. Conversely, if you feel that the aircraft is not being flown in a safe manner, you should terminate the flight.

The *Aviation Safety Manual* outlines three levels of flight issues and how to respond. The most serious is deemed to be an **accident**, where someone is seriously injured or a part of the aircraft becomes damaged. In this case you immediately report the accident to the fire centre senior forest protection officer (SPO), aviation. The second level is termed an **incident** which is described as any aviation occurrence that affects or could affect the safe operation of the aircraft. The least serious issue is called a **hazard**, which is any situation or condition that, if left unattended, could induce an accident or incident. In these last two situations you are required to report the issue to the regional AOS contract administrator and the fire centre SPO as expeditiously as possible.

Weather:

Weather is one of the most critical factors governing the success of an aerial survey and is an essential part of pre-flight planning. Regardless of the prevailing weather, a daily weather forecast should be obtained before the flight to ensure there is good visibility and a minimum ceiling of about 3000 feet above ground level. Local weather information can be obtained from a variety of sources: Environment Canada and other weather prediction sites are readily available on the internet, as are current satellite cloud/smoke cover images and web cameras (Appendix C).

Clear, sunny days are preferred to maximize detection of forest health damage for mapping and photography. Solid high overcast gives the forest a monochromatic look, but is also acceptable. Broken cloud conditions are difficult to map under, as the eyes are forced to adjust every time the light changes between sun and shadow. Since shadows from low sun angle can obscure features early or late in the day, especially in areas of significant topographic relief, the optimum flight period is between mid-morning and mid-afternoon when the sun angle is highest. This is particularly important in the mountains and if the survey continues into the fall when days are shorter and the sun is lower on the horizon. Wildfire smoke and ground fog can also obscure visibility (even on a "sunny" day) and may shift dramatically with the winds and daytime warming, so alternate survey areas should always be planned for.

Apart from good visibility required for the surveyors, the weather should be discussed with the pilot before take-off regarding safety considerations. High winds, low temperatures that can produce carburetor or wing icing, and low cloud in mountain passes can all be serious issues.

Conducting the Survey

Survey personnel responsibilities:

Aerial sketchmapping is challenging. As such, it is important to be well rested and to avoid a change in diet or excessive alcohol the day before a flight. Prior to flying areas on the edge of a surveyor's area of responsibility, a check must be made as to whether the adjacent area has been flown (refer to weekly track file map on the *BC Forest Health Aerial Overview Surveys Blog* (<http://bcfhaos.blogspot.com/>)). If the adjacent area has been flown, ask the surveyor who flew this area for a photo of the map to reference (if the map is not yet posted on the internet) to ensure consistency in these areas. Otherwise, issues with mapping styles, inconsistent severity ratings, and differing damaging agent identification can lead to a poor final product with inconsistencies in the data.

Two observers are employed, one on either side of the plane, to expedite coverage and improve accuracy. Observers should be in constant communication with each other to ensure that they are both aware of forest damage and that it is recorded in a consistent manner. The forward observer is usually the more experienced individual and has the overall responsibility for flight direction, altitude, and speed. With attention to map contours and natural features, the location, size, severity, damaging agent and host species (if more than one host possible) are drawn on the satellite working maps. Depending on flight conditions, landing options, refueling requirements, and surveyor fatigue, a break may be planned mid-day. Total survey time should be limited to five - six hours to ensure a quality product, both from the perspective of best light and mapping skills. If necessary, ferry time can be added to this, but total flying time is not to exceed 8 hours, as noted in the *BC Wildfire Service Pilot Information Guide 2016*.

Flight pattern:

Flight lines are tentatively planned ahead of each flight, but visibility issues often cause in-air changes so lines should only be drawn on the working maps as the flight is conducted (including arrows indicating direction of flight). Flight lines must also be recorded with recreational quality Global Positioning Satellite (GPS) receiver units, from when the plane takes off to when it lands (including any ferry flying with surveyors on board).

There are two types of flight patterns used in aerial overview surveys: grid flying, and contour/drainage flying. The type of flight pattern used can depend on the terrain, surveyor experience and preference, visibility, damage types present, and other factors. The flight pattern type used must provide for full coverage of the area to be surveyed and provide the surveyors with a good view of the terrain to be surveyed. Surveyors need to be able to observe and map disturbances to slightly past the midpoint between survey lines.

The grid flight pattern uses straight, parallel flight lines that follow the mapsheet grid in either east-west or north-south directions. The flight lines typically follow a back and forth pattern across a mapsheet to provide an even coverage of the area to be surveyed. In grid flying (Figure 5), lines are typically 7 - 10 km apart at an elevation of 700 - 1,400 m (2,300 - 4,600 feet) above the ground, depending on surveyor experience, visibility, and level of disturbances. This inter-line distance may be increased up to 14 km by very experienced surveyors, in areas with very low levels of disturbance and very good visibility. Longer flight lines are usually more efficient than shorter lines, and care should be taken to minimize re-crossing of previous flight lines. GPS systems can be used to help the pilot keep the plane on specific lines of latitude or longitude. The grid flight

pattern is typically used in areas of flatter terrain, although it can be successfully used in areas of moderately steep terrain if an appropriate elevation is maintained and visibility is good.

The contour/drainage flight pattern uses flight lines that follow terrain features such as contours, ridges, or drainages (Figure 6). The flight lines must be arranged to provide full coverage of the survey area. Intensity of coverage in the mountains depends on visibility up side drainages from main drainages to the tree line. If a drainage is only flown once (e.g. at the top of the drainage a new drainage is descended into), a slight zigzag pattern should be employed to allow for coverage below the aircraft as well as laterally. Efficiency can be increased if the surveyors are able to arrange the flight lines to minimize overlap and re-crossing of flight lines. Height above the ground is typically much more variable than during grid flying. If an efficient flight pattern is developed in a given year, this track file can be uploaded to the plane in subsequent years, so the lead surveyor can expend more effort on mapping and less on navigation. This flight pattern is typically used in areas of steep or variable terrain and is not recommended for areas in flat or poorly defined terrain. Grid and contour/drainage flying may be combined in certain areas, especially when areas of flat and mountainous terrain are surveyed during the same flight.

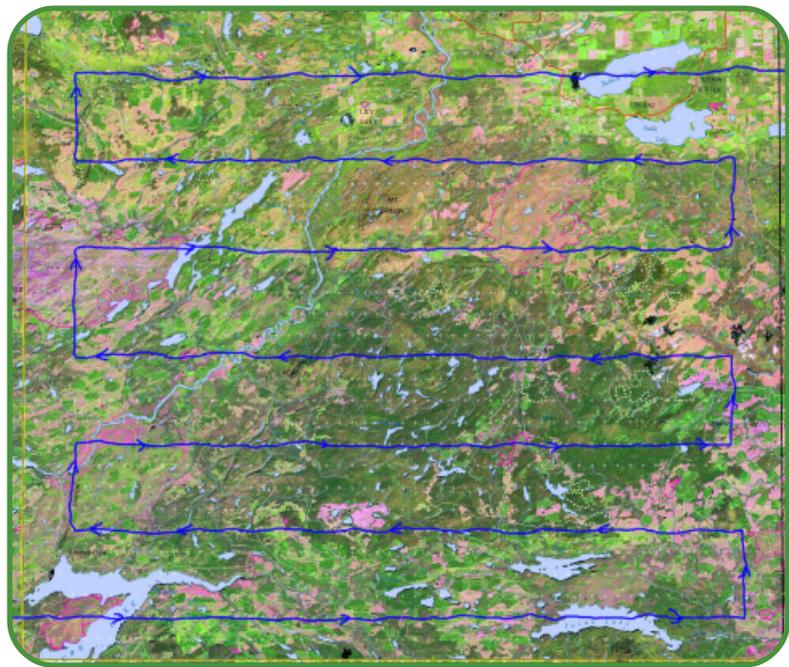


Figure 5. Example of a grid flight pattern used in flatter terrain.

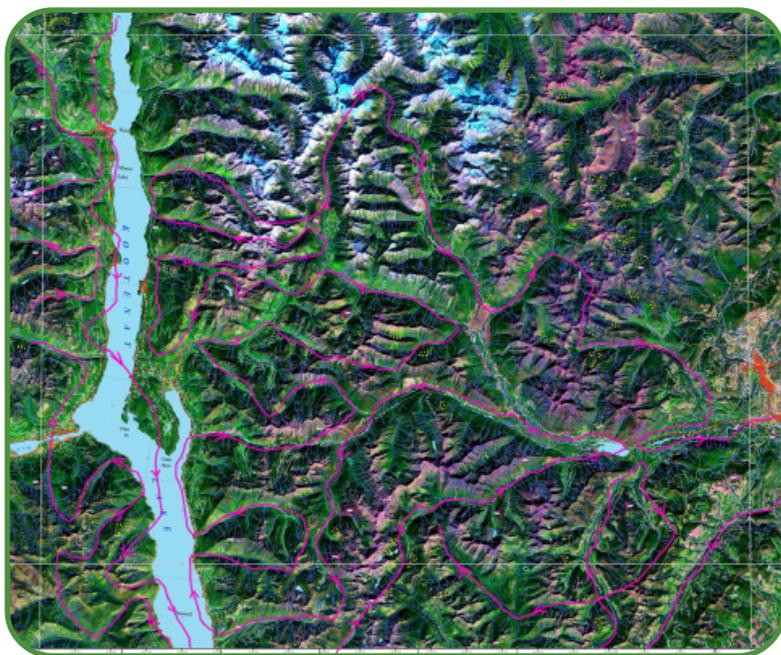


Figure 6. Example of a contour/drainage flight pattern used in mountainous terrain.

Grid and contour/drainage flying may be combined in certain areas, especially when areas of flat and mountainous terrain are surveyed during the same flight.

The grid flight pattern is generally the most efficient and allows for the most coverage per flight hour and hence a lower cost per hectare, so it should be the method of choice if possible. In both methods the plane can circle down to help determine a damage causal agent, though care must be taken not to turn into rising ground in drainage flying.

Aircraft speed should range from 140 to 250 km/h depending on mapping intensity and wind speed.

Type of damage mapped:

All visible, current tree damage is recorded regardless of land ownership or tenure. Typically, only damage to commercial tree species is recorded; however, occasionally damage to non-commercial species such as willow may be recorded if visible and if time permits for special reasons (this information is not included in the AOS database). A standardized Provincial damage code list is used for recording the forest health factor that is causing the damage (Appendix D). Three general categories of damage are mapped:

- 1) **Tree mortality** (caused by bark beetles, animal feeding, root diseases, yellow cedar decline and some abiotic factors) is identified by the foliage colour change on the affected trees: only trees killed within the past year are mapped. Bark beetles are historically responsible for the majority of tree mortality. They primarily attack mature trees and have differing aerial signatures that indicate recent mortality. Mountain pine beetle killed trees first turn chlorotic in the late spring of the year following attack, then then yellowish-orange and finally bright red by mid to late summer. Spruce beetle attacked trees take longer to turn colour with foliage turning chlorotic or purplish grey and only occasionally red, usually 18-30 months after attack. Douglas-fir beetle killed trees usually change colour more quickly, sometimes turning chlorotic in the year of attack, and progressing to bright pinkish-red the following year. Subalpine fir killed by western balsam bark beetle becomes chlorotic the year following attack, turning bright orange then bright red; subalpine fir often retains a dull red colour much longer than other beetle attacked trees. Mortality due to animal feeding tends to be more scattered than that due to bark beetle attack, and trees don't follow a seasonal pattern change: due to feeding occurring throughout various seasons, trees within a damaged stand often exhibit differing stages of foliage decline. Mortality due to root disease tends to occur gradually in small disturbances and is often difficult to detect from the altitude the AOS is conducted without some prior ground-based knowledge of the disease's presence.
- 2) **Trees with foliar damage** (caused by insect feeding, foliage diseases and some abiotic factors). Disturbances usually cover a fairly large area and often all age classes of host trees are affected. Coniferous stands with foliage damage usually exhibit a reddish tinge as a result of insect feeding or foliar disease. Deciduous stands with foliage damage may look grey (result of leaves fully stripped by a defoliator), silver (result of aspen leafminer), thin looking (result of partial defoliation or disease) or brownish (result of damaged leaves remaining on trees, usually caused by foliar fungi or birch leafminer).
- 3) **Aspen and birch decline** (caused by a variety of agents combined). Disturbances are often on the edge of openings and tend to be relatively small polygons. Trees exhibit thinned crowns and/or mortality, depending on intensity.

Surveyors must be familiar with the biology, host tree species and aerial signatures of all forest health agents they may encounter. If the damaging agent cannot be identified during the flight, pictures should be taken to assist with further investigation. The *Field Guide to Forest Damage in BC* is² a good resource for damaging agent and host information and the *Aerial Overview Survey Training*³ course includes many examples of aerial damage as well as an initial practice survey flight.

While assessment of damage severity is somewhat subjective, past aerial overview surveys have proven that experienced personnel can estimate damage location, extent, and intensity fairly accurately and consistently, given the objectives of the AOS and the relatively broad damage severity classes used. Mapping should be done to the best level of detail possible, e.g. several small, higher intensity polygons and/or spots are preferable to one larger, lighter intensity polygon. Accuracy and consistency can be maintained by referring to photo standards (some examples in Appendix E, additional examples in *Aerial Overview Survey Training* materials), use of visual guides (Appendix F), ground reconnaissance of mapped disturbances, periodic flights with other surveyors, comparing your maps to those of other surveyors in areas of overlap, and feedback from quality check flights. It is important to note that only damage that becomes visible during the current survey year is recorded by the AOS – past or cumulative mortality, crown damage due to past years’ defoliation, and other older damage is not recorded, as it is assumed to have been recorded in previous years.

Tree mortality can be recorded as either “spots” or “polygons”. Clumps of up to 50 dead or dying trees are usually mapped as spots: an X is marked at the centre of the clump, and the estimated number of affected trees is recorded. Larger, more continuous areas of mortality are mapped as polygons, where the size and shape of the affected areas are delineated on the map, and a damage intensity rating is applied to the polygon. Five mortality intensity classes are used in BC (Table 1). The intensity of mortality is assessed as an average over the entire disturbance polygon, and includes previously killed standing dead and non-host tree species in the estimated percentage.

For snow or ice damage, including snow press, the mortality categories are used (spots and mortality, Table 1), but damage type needs to be noted in the comments (e.g. main stem breakage or uprooting, main stem bending or leaning; branch breakage).

Foliar damage areas are mapped as polygons, and damage intensity is assigned to each polygon based on the amount of foliage damaged during the past year on all host trees in the polygon (Table 1). Three current damage intensity classes are used for foliar damage, with any cumulative damage that results in mortality recorded as grey once an agent has run its course in a given area.

Aspen and birch decline damage is rated using criteria modified from the USDA Sudden Aspen Decline criteria. Three intensity categories are employed, based on thinning crowns and mortality (Table 1).

² Hard copies available from crown publications at: https://www.crownpub.bc.ca/Product/Details/7610003512_S
Online in .PDF format at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf

³ Training course materials available at: https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/training/

Table 1. Intensity classes used during aerial overview surveys for recording current forest health damage.

Disturbance	Intensity Class	Description
Mortality (bark beetle, abiotic, yellow cedar decline and animal damage)	Trace	<1% of the trees in the polygon recently killed.
	Light	1-10% of the trees in the polygon recently killed.
	Moderate	11-29% of the trees in the polygon recently killed.
	Severe	30-49% of the trees in the polygon recently killed.
	Very Severe	50%+ of the trees in the polygon recently killed.
Foliage Damage (defoliating insect and foliar disease)	Light	Some branch tip and upper crown damage, barely visible from the air.
	Moderate	Noticeably damaged foliage, a third of many trees severely damaged.
	Severe	Most trees sustaining more than 50% total foliage damage.
	Grey	Cumulative foliage damage resulting in mortality, recorded at end of damage agent cycle.
Aspen and birch declines	Light	Characterized by thin crowns and no individuals without visible foliage.
	Moderate	Thin crowns are accompanied by individuals devoid of foliage. Greater than an estimated 50% of individuals have some foliage.
	Severe	Crowns are very thin and greater than 50% of standing stems are devoid of foliage.

Exceptions: Some exceptions are made to the “polygon only” rule for foliar damage. *Venturia* blight damage sometimes affects a small clump of trees (most likely a single clone) within a stand of undamaged suitable hosts, and may be recorded as spot damage. Occasionally needle diseases severely affect host trees that are a very low component of the stand composition. This damage is occasionally recorded as spot damage.

Aspen leafminer damage that is visible from the air tends to have an “all or nothing” signature that has very little discernible tree-to-tree variation in damage. In many areas aspen occurs in mixed rather than pure stands. To most accurately map this damage, procedures were modified in 2012 to record these disturbances in a manner similar to mortality. Severity ratings are based on the percentage of the stand affected, rather than the intensity of the defoliation to the trees, although the defoliator ranges of light, moderate and severe are still used.

Occasionally, cumulative or old mortality is recorded for special purposes, but this is a rare exception.

Other disturbance notations:

The host tree species must be identified for each disturbance (see Appendix G for provincial tree code listings). Some forest health agents will only have one associated tree species, and this can be noted in the map margin. Others however, particularly for abiotic or animal damage, can occur on multiple tree hosts so identification for each disturbance is necessary.

If damage is mapped in young managed stands, an additional modifier of “Y” is added to the disturbance coding.

Further notes of interest can be added and will be recorded in the database comments for that disturbance record.

Completing the Survey

Review working maps and produce composite map:

As soon as possible after the flight, survey personnel should review the working maps to ensure they are legible and meaningful and that disturbance boundaries and mapping styles between the two observers are consistent. Notes should be taken to help identify any unknown damage.

Data from the two working maps must then be transferred in a timely fashion to the clear film base map, with a legend indicating date of survey, names of observers (primary surveyor, secondary surveyor, and any trainees), weather conditions, colour codes used on the map for drawing disturbances, and any other relevant information. Colour codes must be consistent throughout a regional survey area. These final composite maps should be sent as soon as possible (within two weeks of the mapsheet flight) to the Provincial GIS contractor for internet posting as geo-referenced scanned images and digitizing. Examples of the completed scanned and digitized composite maps for the current year are available on the provincial AOS FTP site at: https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/

Weekly reporting:

Immediately after each flight, track files must be downloaded from the GPS unit. The track file naming convention is: contract area, date, surveyor initials (lead surveyor first) (e.g., Omineca_Aug09_18_TFJS). A check must be made of the track file against the drawn track to ensure that all of the flight was recorded. If for whatever reason pieces are missing, these must be promptly digitized and included with the other tracks.

These track files must be sent to the provincial survey monitor weekly in the required format by the requested day of the week. An excel spreadsheet must also be kept (or alternatively, as records in the shapefiles) in the format provided for survey area, including: survey date, company completing the survey (Ministry or other), flight hours, aircraft used (type and company), general comments, source of track file, weather comments, and full names of primary, secondary and trainee (if appropriate) observers.

Identify unknown damage:

Photos and descriptions of unidentified damaging agents should be disseminated within the week to the AOS community through the *BC Forest Health Aerial Overview Surveys Blog*. Local forest health contacts and appropriate Regional Entomologists/Pathologists should also be consulted. If cause of damage cannot be ascertained and the disturbance is accessible, ground reconnaissance must be conducted. Samples of damage and damage agents should be collected (if appropriate) and the *Aerial Overview Survey Ground Confirmation Assessment Record* (Appendix G) must be filled out, with the findings sent to the appropriate regional contact and the provincial survey monitor. It is very important that ground checks, if required, are done as soon as possible, while signs of the damaging agents are still visible and to allow time for experts to re-visit the site(s) if necessary.

If a ground confirmation cannot be done, the damage agent is classified as “unknown (U)” or sub-classified by damage type (e.g., Disease → Foliar = DF) if the specific damage agent is not recognized. Be sure to include the tree species with unknown damage, and to classify the damage as specifically as possible.

Surveyors should send the composite maps to the digitizing contractor as soon as possible, even if there is unidentified damage on the map. The correct damage agent and intensity coding can be added to the spatial database at a later date, and there is no valid need for the surveyors to retain the composite maps any longer than absolutely necessary.

Confirm pest damage new to an area:

It is important for surveyors to be aware of the historical record of disturbances in their survey area. One of the purposes of the AOS is early detection of new pests or range expansion of existing pests. If surveyors suspect a disturbance is caused by a biological agent for which there is either no record, or few records, in the surrounding geographic area, the local regional specialist and the provincial survey coordinator must be informed, and an attempt must be made to directly confirm the causal agent or species on the ground, if at all possible.

AERIAL OVERVIEW SURVEY LIMITATIONS

Care must be taken in interpretation of the AOS data. Area recorded as affected by a specific forest health agent during past surveys cannot be added cumulatively, as new damage may be recorded in all or a portion of the same stands that were previously disturbed. The relatively broad severity classes and known errors of omission must also be considered. For example, calculating accurate mortality volume estimates is not possible since the actual number of trees killed (and consequently volume) is not precise. Spatial accuracy of the data, unless the damage is closely associated with clearly visible geographic references, can be relatively low and thus unreliable for directing operational surveys and treatments. Where more accurate information is required, the AOS data can be used to guide more detailed aerial detection efforts (e.g., heli-GPS surveys).

Not all damage agents are well captured by the AOS. Disease and animal damage, for example, is known to be significantly underestimated during the AOS, as this damage is often not visible from the elevation at which the surveys are typically flown. Timing of the surveys can also be limiting: for example, spruce beetle mortality can be under-reported because foliage changes on dying

trees can happen very rapidly or occur outside the survey period. As noted above, when this information is critical for forest health management, a separate survey may be required during the optimal detection period.

Despite the survey limitations, FLNRORD Forest Analysis and Inventory Branch have used the overview survey data to estimate cumulative and projected volumes of pine killed by the mountain pine beetle, since the data is the most complete record of the outbreak's progress across the province. The annual survey data is also being used by districts to estimate non-recoverable pest-caused losses for incorporation into timber supply reviews. In summary, the survey provides, by far, the most complete spatial and temporal record of major disturbances occurring across the province.

SPATIAL AND ATTRIBUTE DATA CAPTURE (DIGITIZING) STANDARDS

General

Forest Health 'points' and 'polygons' are recorded on Quarter Letter block paper mapsheets (scale 1:100,000) during the overview survey flights. These are then rationalized between observers and transferred to a clear film media at the same scale, already containing an appropriate electronic map base. Data will be in the form of both polygons and point data with associated attributes. Attributes will include pest code, damage class (polygonal data) or number of trees affected (point data), tree species, and additional comments if required.

Specifications

File Format:

All spatial data provided to FLNRORD must be delivered in ESRI Shapefile format with no Z or M values. The Shapefile datum will be NAD 1983, and the Shapefile projection will be BC Albers Conical Equal Area⁴:

Projection: Albers Equal Area

Datum: NAD 83

Units: Metres

Spheroid: GRS 1980

1st standard parallel: 50 0 0.000

2nd standard parallel: 58 30 0.000

Longitude of central meridian: -126 0 0.00

Latitude of true scale: 45 0 0.000

False easting (metres): 1000000.00000

False northing (metres): 0.00000

⁴ For further spatial reference see: <http://spatialreference.org/ref/epsg/3005/>

Positional Accuracy:

Captured spatial data must have a positional accuracy of 1mm at map scale (for 1:100,000 this is 100 m on the ground) when compared to the original paper map 90 percent of the time.

Shapefile Database structure (dbf):

The database must conform to the following structure and specifications (Table 2).

Table 2. Database structure and specifications.

Attribute	Description	Type	Length	Values
NODE_NUM	Unique Polygon Number	Short Integer	6	Unique number per provincial inventory for that year. Spot and Polygonal data must not contain duplicate values.
REGION	Natural Resource Region Code	Text	3	3 letter Region code (e.g. RCB = Cariboo Natural Resource Region), see Appendix A
DISTRICT	Natural Resource District Code	Text	3	3 letter District code (e.g. DCS = Cascades Natural Resource District), see Appendix A
YEAR	Year of infestation	Short Integer	4	Current year (e.g. 2015)
MAP_NUM	BCGS Mapsheet	Text	9	e.g. 082FSE (1:100,000), 092B105 (1:50,000), 104H002 (1:20,000)
FHF	Forest Health Factor	Text	3	3 letter code (e.g. IBM = Mountain Pine Beetle), see Appendix D
SEVERITY	Severity (aka damage class, attack intensity class)	Text	1	T(race), L(ight), M(oderate), S(evere), V(ery severe), G(rey). NOTE: spot infestations always assigned S(evere)
POLY_AREA	Large area of infestation	Double	Width 11, 2 Decimals	Value of hectares calculated from the shape's geometry (ha = m ² /10,000)
SPOT	Spot (aka point) infestation	Text	1	Y(es) or N(o)

Table 2. Database structure and specifications (continued).

Attribute	Description	Type	Length	Values
SPOT_AREA	Area of spot, assigned depending upon NUM_TREES	Floating	Width 13, 2 Decimals	Value only if spot = Y, 1-30 trees assigned value of 0.25 ha 31-50 trees assigned value of 0.50 ha
NUM_TREES	Number of trees in spot infestation	Short Integer	2	Number between 1 and 50, value only if spot = Y
TREE_SP1	Primary tree species if different than default pest/tree combination	Text	3	3 letter code (e.g. AC = Poplar), see Appendix G
TREE_SP2	Secondary tree species if different than default pest/tree combination	Text	3	3 letter code (e.g. AC = Poplar), see Appendix G
YOUNG	Young stands (< 20 years of age)	Text	1	Y(es) or N(o)
GRND_CHK	Ground Checked (confirmed on the ground)	Text	1	Y(es) or N(o)
COMMENTS	Comment field to record extra information	Text	255	If more information is required or data needs to be revisited

Topology Rules:

Polygons

- Similar Forest Health Codes must not overlap; (e.g., if multiple pests are identified in the same polygon, each pest must be represented by their own separate polygon)
- Must be contained within the envelope of the BC Boundary;
- Must not self-intersect;
- Must have a minimum polygon area of 0.001 m² (polygonal areas when captured should be greater than .5 hectare, but after overlaying Forest District/Region boundaries, slivers will occur);

Points

- Must be contained within the envelope of the BC Boundary;
- Must not have duplicate points with the same Forest Health Code.

In addition to these standard topology rules, in order to load the data into the BC Geographic Warehouse, these OpenGIS® Simple Features Specifications⁵ must also be satisfied:

- Check basic topology;
- Disallow repeated consecutive points;
- Check Polygon Orientation;
- Check minimum segment length (.001 m);
- Check minimum angle (1 degree);
- Check minimum polygon area (.001 m²);
- Check that geometries are simple (e.g. do not self-intersect).

Data Transfer

Providing Data to FLNRORD:

The attribute database and digitized map data prepared by contractors for regions or districts may be transferred by ftp, flash, portable hard drive or CD/DVD to the administrating office for review for errors and omissions. Hard copy maps may be required to facilitate the data review process. Once the data quality has been checked against the original overview maps, map files are transferred to the Resource Practices Branch or directly to the Provincial GIS contractor.

The preferred method of digital data to the Resource Practices Branch is through the MFLRNORD FTP site at: <ftp://ftp.for.gov.bc.ca/HFP/external/incoming/>

The output from the digital roll-up of all provincial data will be in the form of:

1. Two provincial scale shapefiles, one for polygonal data and one for spot data;
2. Attributes summarized in an MS Excel spreadsheet (fhsurvey.xls) (template posted on the ftp site at:
ftp://ftp.for.gov.bc.ca/branches/forest_practices/external/!publish/Aerial_Overview/);
3. Adobe Acrobat portable document format (pdf) versions of each of the following documents:
Provincial (4), Regional (3 x 4 = 12) summary maps for:

⁵ <http://www.opengeospatial.org/standards/sfa>

1. Mountain pine beetle (IBM),
2. Spruce beetle (IBS),
3. Douglas-fir beetle and western balsam bark beetle (IBD and IBB),
4. All defoliators and other disturbances (other IB, diseases, abiotics and animal damage).

Each document will have a title, legend, and points and polygons with appropriate annotation and/or color theme depicting pest code as needed for interpretation. Hard copies are not required.

Output will be distributed via the Province's ftp site at:

https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/

or ftp://ftp.for.gov.bc.ca/HFP/external/!publish/Aerial_Overview/

Data Upload to the BC Geographic Warehouse:

Resource Practices Branch and the Information, Innovation and Technology Division annually uploads the final spatial data files into the BC Geographic Warehouse that is administered by GeoBC. The data upload is initiated once the spatial data has been reviewed and finalized. The spatial data is uploaded from the ministry aerial overview survey FTP site and then processed through an application called the "Standard Object Loader" that checks for errors and, if acceptable, will be uploaded into a test environment in the BC Geographic Warehouse. Following a review by database administrators, it is then uploaded to the production database and available for public access. This database is linked to various web mapping applications and is downloaded by various users. The data upload process is usually completed before the end of the fiscal year (March).

ACCURACY AND CONSISTENCY

Obtaining credible data

Aerial surveying is not an exact science, but an observer should do everything possible to ensure the best information is collected. Credibility comes from following established criteria:

- Ensuring disturbance mapping consistency between different survey areas, and between both surveyors in the plane;
- Not missing areas of significant damage;
- Not ignoring unknown disturbances;
- Placing the polygon or spot in the right geographic location;
- Drawing polygons to accurately reflect infested areas on the ground: draw to the finest detail possible (e.g., favour "splitting" rather than "lumping");
- Correctly identifying the tree (host) species;

- Knowing and identifying the correct damage agent or promptly following up on identifying unknown damage factors;
- Accurately estimating damage intensity or numbers of trees in a spot; and,
- If resources and weather permit, flying your entire area of responsibility even if damage was not previously recorded.

Check flights

Annual check flights are conducted by the provincial survey monitor. Ideally, checks of at least 10% of the survey work conducted by each surveyor throughout different stand types in the province are completed near the beginning of the survey to help maintain a high standard of survey quality and consistency. This audit includes all facets of mapping such as pest and host identification, damage intensity levels and accuracy of disturbance sketching. Any suggested corrections are made on the working maps and the results are reviewed with the surveyors.

If a significant issue is found during a check flight or if a survey crew is relatively inexperienced, the provincial survey monitor will spend time mentoring the surveyors in question by flying with them until any issues are deemed resolved.

Data review

Once all data digitizing is complete the data is reviewed by various provincial forest health experts. Checks are made on accuracy of digitizing of the data from the composite maps as well as investigation of any inconsistencies (e.g., damage by a given forest health agent in an area never previously recorded, host tree species that don't match the given damage agent, defoliation recorded as spot infestations, unusually large new disturbances, etc.). The database is then revised as necessary.

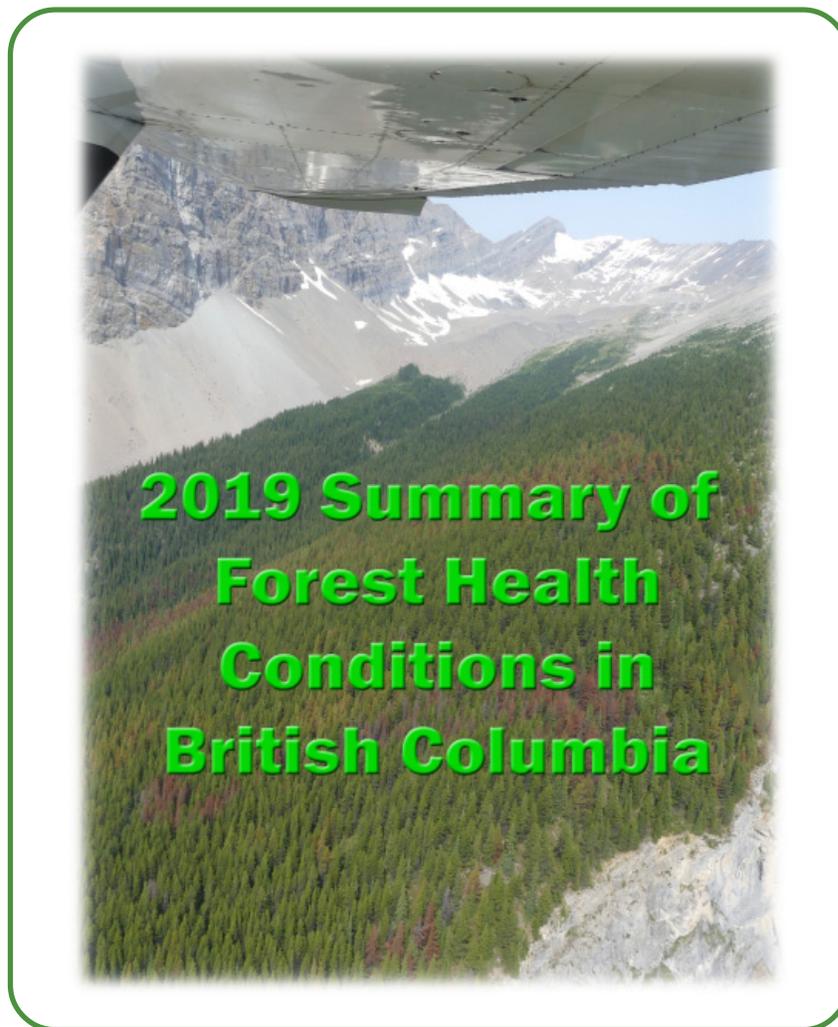
Continued improvement

Annual aerial overview surveys are the cornerstone of the forest health program in British Columbia, and the resulting data is recognized as a valuable asset for many interest groups. Although the current AOS method and surveyor experience is considered to be of a high standard, continued improvement will always be sought. This occurs automatically in the present standards framework through the annual review meeting, continued technology reviews, the surveyor training program, mentoring and check flights.

ANNUAL FOREST HEALTH CONDITIONS REPORT

Once the data has been vetted, an annual (since 2001) *Summary of Forest Health Conditions in British Columbia* report is written by the provincial survey monitor and the FLNRORD provincial forest health officer. The AOS data is the primary source for reporting on damaging agents in this report, but this material is augmented by some detailed helicopter surveys, insect population assessments, forest health surveys and ground observations by trained personnel. Summaries of special projects, meetings, presentations and publications conducted by FLNRORD entomologists, pathologists, and their associates over the given year are also included in the final sections.

A draft of the report is sent to the FLNRORD entomologists and pathologists for review, then the final version is published online at: <http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/aerial-overview-surveys/summary-reports>



Cover of the 2019 Forest Health Conditions in BC report

Appendix A. The biological window for aerial survey mapping of primary forest health agents in British Columbia.

Tree Species	Pest Code	Pest	Peak Period
Bark Beetles			
Pine	IBM	mountain pine beetle	early July -early Sept.
Spruce	IBS	spruce beetle	mid-June - early Sept.
Douglas-fir	IBD	Douglas-fir beetle	mid-June - late Aug.
True firs	IBB	western balsam bark beetle	anytime
Defoliators			
Douglas-fir	IDW	western spruce budworm	late June - mid-Aug.
	IDT	Douglas-fir tussock moth	mid-July - late Aug.
Hemlock:	IDH	western blackheaded budworm	mid-Aug - early Sept.
	IDL	western hemlock looper	mid-Aug. - early Sept.
	IDG	green-striped forest looper	mid-July - early Sept.
True firs	IDE	2-year-cycle spruce budworm	mid-July - mid-Aug.
Pine	IDI	pine needle sheathminer	late June - mid-Aug.
	IDS	conifer sawflies	mid-July - late Aug.
Spruce	IAS	Spruce aphid	March through June
Larch	IDC	larch casebearer	mid-May - mid-June
	IDP	larch sawfly	late July - early Sept.
Deciduous	IDF	tent caterpillar	early June - early July
	IDU	satin moth	early June - mid-July
	ID6	aspen leafminer	early June - mid-July
	IDX	large aspen tortrix	early June-mid-July
	IDN	birch leafminer	early-June - mid-July
Diseases			
Pine	DFL	pine needle cast	May through June
	DFS	Dothistroma needle blight	May through July
Douglas-fir	DFW	Swiss needle cast	April-mid May (special low level flight required)
Larch	DFH	larch needle blight	July - mid Sept.
Deciduous	DLV	Venturia blight	August - mid Sept.

Appendix B. Aerial Overview Surveyor Pre-Flight Check List

Items to bring:

- Fire resistant, layered clothing
- Boots (bring if not wearing them)
- Hand held radio with communication guide and survey area repeater map
- SPOT or satellite phone
- GPS unit (previous track cleared) and extra batteries
- Mini first aid kit
- Leatherman type tool
- Flashing light/flashlight
- Seat belt cutting/window breaking tool
- Matches
- Bug repellent
- Food and water for a minimum 24 hrs
- Any required medication
- Personal ear protection (if you have it)
- Lots of map choices
- Hard cover mapping surface
- FHF and tree species codes
- Lots of pen choices
- Camera (preferably SLR) with zoom lens
- Warm tinted and polarized sun glasses

Actions prior to and while in flight:

- If pilot doesn't give safety briefing, ask for it
- Discuss route with pilot including fuel and lunch break
- Maintain cockpit silence for 5 minutes prior to and during takeoff and landing
- Actively exercise legs at least once per hour to avoid deep vein thrombosis issues
- Ensure ear protection is adequate
- Drink a bit of water to stay hydrated
- If uncomfortable with weather conditions or pilot's flying, say so!

Appendix C. Survey Resource Links

Weather and Visibility Sites:

USDA Forest Service Live Fire Data-KML creator: <https://fsapps.nwcg.gov/afm/googleearth.php?sensor=modis&extent=canada>

Blue Sky Canada smoke forecasts:

<http://firesmoke.ca/forecasts/viewer/run/ops/BSC-WC-01/current/>

Weather models used by the Fire Center: <https://spotwx.com/>

NASA GOES West satellite picture:

<https://flightplanning.navcanada.ca/cgi-bin/Fore-obs/sat.cgi>

<https://weather.msfc.nasa.gov/goes/abi/goesWestfullDiskband02.html>

UNBC: http://weather.unbc.ca/cgi-bin/cgi-bin2/loops/SATELLITE_IR_Goes-W_W-Canada

NAV Canada Aviation Weather Forecasts by Region: https://flightplanning.navcanada.ca/cgi-bin/CreePage.pl?Langue=anglais&NoSession=NS_Inconnu&Page=Fore-obs%2Fgfacn31-metar-taf&TypeDoc=html

Environment Canada BC weather conditions and forecasts: https://weather.gc.ca/forecast/canada/index_e.html?id=bc

The Weather Network: <https://www.theweathernetwork.com/ca/hourly-weather-forecast/british-columbia/kamloops>

Weather Underground: <https://www.wunderground.com/weather/ca/vancouver>

Highway/Weather Cams:

BC Highway Cams: <http://images.drivebc.ca/bchighwaycam/pub/html/www/index-Northern.html>

BC and Yukon Webcams: <http://www3.telus.net/ruping/webcams/pyrwebcams.html>

NAV Canada Webcams: <http://www.metcam.navcanada.ca/hb/index.jsp?lang=e>

Appendix D. Forest Health Factor (FHF) Code Listing⁶

Code Value	Code Description
A	Animal Damage
AB	Bear
AC	Cattle
AD	Deer
AE	Elk
AH	Hare or Rabbit
AM	Moose
AO	Pika (<i>Ochotona</i> spp.)
AP	Porcupine
AS	Squirrel
AV	Vole
AX	Birds
AZ	Beaver
C	Cone and Seed Insects
CAH	Cone Resin Midge (<i>Asynapta hopkinsi</i>)
CBC	Fir (Fd) Cone Moth (<i>Barbara colfaxiana</i>)
CBX	Fir Cone Moth (<i>Barbara</i> spp.)
CCP	Douglas-fir Cone Scale Midge (<i>Camptomyia pseudotsugae</i>)
CDC	Spruce (Sx) Cone Gall Midge (<i>Kaltenbachiola (Dasineura) canadensis</i>)
CDD	Fir Seed Midge (<i>Kaltenbachiola (Dasineura) abiesemia</i>)
CDR	Spruce (Sx) Cone Axis Midge (<i>Kaltenbachiola (Dasineura) rachiphaga</i>)
CDX	<i>Kaltenbachiola (Dasineura)</i> Midges (<i>Kaltenbachiola (Dasineura) spp.</i>)
CEA	Fir Seed Maggot (<i>Earomyia abietum</i>)
CEB	Spruce Cone Maggot (<i>Earomyia barbara</i>)
CEQ	(<i>Earomyia aquilonia</i>)
CEX	<i>Earomyia</i> Maggots (<i>Earomyia</i> spp.)
CFP	Fir (Fd) Cone Beetle (<i>Ernobius punctulatus</i>)
CHX	Budworms (<i>Choristoneura</i> spp.)
CIA	Fir Coneworm (<i>Dioryctria abietivorella</i>)
CIP	Fir (Fd) Coneworm (<i>Dioryctria pseudotsugella</i>)
CIR	Spruce (Sx) Coneworm (<i>Dioryctria reniculelloides</i>)
CIS	Pine (Py) Coneworm (<i>Dioryctria rossi</i>)
CIV	Ponderosa pine (Py) Coneworm (<i>Dioryctria auranticella</i>)
CIX	Coneworms (<i>Dioryctria</i> spp.)
CLO	Western Conifer Seed Bug (<i>Leptoglossus occidentalis</i>)
CMA	Ponderosa pine (Py) Seed Chalcid (<i>Megastigmus albifrons</i>)
CMC	Spruce (Sx) Seed Chalcid (<i>Megastigmus piceae</i>)

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
CML	Subalpine fir (Bl) Seed Chalcid (<i>Megastigmus lasiocarpae</i>)
CMP	Fir Seed Chalcid (<i>Megastigmus pinus</i>)
CMR	(<i>Megastigmus rafni</i>)
CMS	Fir (Fd) Seed Chalcid (<i>Megastigmus spermotrophus</i>)
CMT	Hemlock Seed Chalcid (<i>Megastigmus tsugae</i>)
CMX	Seed Chalcids (<i>Megastigmus</i> spp.)
CNP	Pine Cone Beetle (<i>Conophthorus ponderosae</i>)
CPS	Spruce Gall Adelgid (<i>Pineus similis</i>)
CRX	Cone Scale Midges (<i>Resseliella</i> spp.)
CSN	Spiral Spruce Cone Borer (<i>Strobilomyia neanthracina</i>)
CTO	Fir (Fd) Cone Gall Midge (<i>Contarinia oregonensis</i>)
CTW	Fir (Fd) Cone Scale Midge (<i>Contarinia washingtonensis</i>)
CVP	White pine (Pw) Cone Borer (<i>Eucosma ponderosa</i>)
CVR	Lodgepole pine (Pl) Cone Borer (<i>Eucosma recissoriana</i>)
CYC	Spruce (Sx) Seed Midge (<i>Mayetiola carpophaga</i>)
CYP	Ponderosa pine (Py) Seedworm (<i>Cydia piperana</i>)
CYS	Spruce (Sx) Seedworm (<i>Cydia strobilella</i>)
CYT	Cedar (Cw) Cone Midge (<i>Mayetiola thujae</i>)
CYX	Seedworms (<i>Cydia</i> spp.)
D	Diseases
DB	Broom Rusts
DBF	Fir Broom Rust (<i>Melampsorella caryophyllacearum</i>)
DBS	Spruce Broom Rust (<i>Chrysomyxa arctostaphyli</i>)
DD	Stem Decay
DDA	White Mottled Rot (<i>Ganoderma applanatum</i>)
DDB	Birch Trunk Rot (<i>Fomes fomentarius</i>)
DDC	Brown Cubical Rot of Birch (<i>Piptoporus betulinus</i>)
DDD	Sulfur Fungus (<i>Laetiporus sulphureus</i>)
DDE	Rust Red Stringy Rot (<i>Echindontium tinctorium</i>)
DDF	Brown Crumbly Rot (<i>Fomitopsis pinicola</i>)
DDG	Sterile Conk Trunk Rot of Birch (<i>Inonotus obliquus</i>)
DDH	Hardwood Trunk Rot (<i>Phellinus ignarius</i>)
DDO	Cedar Brown Pocket Rot (<i>Poria sericeomollis</i>)
DDP	Red Ring Rot (<i>Phellinus pini</i>)
DDQ	Quinine Conk Rot (<i>Fomitopsis officinalis</i>)
DDR	Red Heart Rot (<i>Stereum sanguinolentum</i>)
DDS	Schweinitzii Butt Rot (<i>Phaeolus schweinitzii</i>)
DDT	Aspen Trunk Rot (<i>Phellinus tremulae</i>)

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
DDU	Stringy Butt Rot (<i>Perenniporia subacida</i>)
DF	Foliage Diseases
DFA	Western pine Aster Rust (<i>Coleosporium asterum</i>)
DFB	Delphinella Tip Blight (<i>Delphinella</i> spp.)
DFC	Large-spored Spruce-Labrador tea Rust (<i>Chrysomyxa ledicola</i>)
DFD	Spruce Needle Cast (<i>Lirula macrospora</i>)
DFE	Elytroderma Needle Cast (<i>Elytroderma deformans</i>)
DFF	Marssonina Leaf Blights (<i>Marssonina</i> spp.)
DFG	Cottonwood Leaf Rust (<i>Melampsora occidentalis</i>)
DFH	Larch Needle Blight (<i>Hypodermella laricis</i>)
DFI	Linospora Leaf Blotch (<i>Linospora tetraspora</i>)
DFJ	Phaeoseptoria Needle Cast (<i>Phaeoseptoria contortae</i>)
DFK	Septoria Leaf Spot (<i>Septoria populicola</i>)
DFL	Pine Needle Cast (<i>Lophodermella concolor</i>)
DFM	Larch Needle Cast (<i>Meria laricis</i>)
DFN	Leptomelanconium Needle Blight (<i>Leptomelanconium pinicola</i>)
DFO	Lophodermium Needle Cast (<i>Lophodermium seditiosum</i>)
DFP	Fir Fireweed Rust (<i>Pucciniastrum epilobi</i>)
DFQ	Alpine Fir Needle Cast (<i>Isthmiella quadrispora</i>)
DFR	Douglas-fir Needle Cast (<i>Rhabdocline pseudotsugae</i>)
DFS	Dothistroma Needle Blight (<i>Dothistroma septosporum</i>)
DFT	Sirococcus Tip Blight (<i>Sirococcus conigenus</i>)
DFU	Cedar Leaf Blight (<i>Didymascella thujina</i>)
DFW	Swiss Needle Cast (<i>Phaeocryptopus gaumanni</i>)
DFX	Brown Felt Blight (<i>Herpotrichia</i> spp.)
DFY	Hendersonia Needle Cast (<i>Hendersonia pinicola</i>)
DFZ	Rhizosphaera Needle Cast (<i>Rhizosphaera kalkhoffii</i>)
DL	Disease Caused Dieback
DLD	Dermea Canker (<i>Dermea pseudotsugae</i>)
DLF	Red Flag Disease (<i>Potebniamyces balsamicola</i>)
DLK	Conifer Cytospora Canker (<i>Leucostoma kunzei</i>)
DLP	Phomopsis Canker (<i>Phomopsis lokoyae</i>)
DLS	Sydowia (<i>Sclerophoma</i>) Tip Dieback (<i>Sclerophoma pithyophila</i>)
DLV	Aspen-Poplar Twig Blight (<i>Venturia</i> spp.)
DM	Dwarf Mistletoe
DMF	Douglas-fir Dwarf Mistletoe (<i>Arceuthobium douglasii</i>)
DMH	Hemlock Dwarf Mistletoe (<i>Arceuthobium tsugense</i>)
DML	Larch Dwarf Mistletoe (<i>Arceuthobium laricis</i>)

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
DMP	Lodgepole pine Dwarf Mistletoe (<i>Arceuthobium americanum</i>)
DR	Root Disease
DRA	Armillaria Root Disease (<i>Armillaria ostoyae</i>)
DRB	Black Stain Root Disease (<i>Leptographium wageneri</i>)
DRC	Laminated Root Rot (cedar strain) (<i>Phellinus weirii</i>)
DRL	Laminated Root Rot (Fd form) (<i>Inonotus sulphurascens</i>)
DRN	Annosus Root Disease (<i>Heterobasidion annosum</i>)
DRR	Rhizina Root Disease (<i>Rhizina undulata</i>)
DRS	Schweinitzii Butt Rot (<i>Phaeolus schweinitzii</i>)
DRT	Tomentosus Root Rot (<i>Inonotus tomentosus</i>)
DS	Stem Diseases (Cankers and Rusts)
DSA	Atropellis Canker (Lodgepole pine) (<i>Atropellis piniphila</i>)
DSB	White pine Blister Rust (<i>Cronartium ribicola</i>)
DSC	Comandra Blister Rust (<i>Cronartium comandrae</i>)
DSE	Sooty Bark Canker (<i>Encoelia pruinosa</i>)
DSG	Western Gall Rust (<i>Endocronartium harknessii</i>)
DSH	Hypoxyton Canker (<i>Entoleuca (Hypoxyton) mammatum</i>)
DSP	Cryptosphaeria Canker (<i>Cryptosphaeria populina</i>)
DSR	Ceratocystis Canker (<i>Ceratocystis fimbriata</i>)
DSS	Stalactiform Blister Rust (<i>Cronartium coleosporioides</i>)
DST	Target Canker (<i>Nectria galligena</i>)
DSY	Cytospora Canker (<i>Cytospora chrysosperma</i>)
I	Insects
IA	Aphids
IAB	Balsam Woolly Adelgid (<i>Adelges piceae</i>)
IAC	Giant Conifer Aphid (<i>Cinara</i> spp.)
IAG	Cooley Spruce Gall Adelgid (<i>Adelges cooleyi</i>)
IAL	Larch (Lw) Cone Woolly Aphid (<i>Adelges lariciatus</i>)
IAP	Pine Needle Scale (<i>Chionaspis (Phenacaspis) pinifoliae</i>)
IAS	Green Spruce Aphid (<i>Elatobium abietinum</i>)
IB	Bark Beetles
IBB	Western Balsam Bark Beetle (<i>Dryocoetes confusus</i>)
IBD	Douglas-fir Beetle (<i>Dendroctonus pseudotsugae</i>)
IBE	Silver Fir Beetle (<i>Pseudohylesinus sericeus</i>)
IBF	Fir Engraver Beetle (<i>Scolytus ventralis</i>)
IBH	Hylurgops Beetle (<i>Hylurgops rugipennis</i>)
IBI	Engraver Beetles (<i>Ips</i> spp.)

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
IBL	Lodgepole Pine Beetle (<i>Dendroctonus murryanae</i>)
IBM	Mountain Pine Beetle (<i>Dendroctonus ponderosae</i>)
IBP	Twig Beetles (<i>Pityogenes</i> , <i>Pityophthorus</i> spp.)
IBR	Fir Root Bark Beetle (<i>Pseudohylesinus granulatus</i>)
IBS	Spruce Beetle (<i>Dendroctonus rufipennis</i>)
IBT	Red Turpentine Beetle (<i>Dendroctonus valens</i>)
IBW	Western Pine Beetle (<i>Dendroctonus brevicomis</i>)
ID	Defoliators
ID1	Leaf Beetles (<i>Chrysomela</i> spp.)
ID2	Bruce Spanworm (<i>Operophtera bruceata</i>)
ID3	Winter Moth (<i>Operophtera brumata</i>)
ID4	Cottonwood Sawfly (<i>Nematus currani</i>)
ID5	Fall Webworm (<i>Hyphantria cunea</i>)
ID6	Aspen Leafminer (<i>Phyllocristis populiella</i>)
ID7	Woolly Alder Sawfly (<i>Eriocampa ovata</i>)
ID8	Aspen Leaf Roller (<i>Pseudexentera oregonana</i>)
ID9	Birch Leaf Skeletonizer (<i>Buccalatrix</i> spp.)
IDA	Black Army Cutworm (<i>Actebia fennica</i>)
IDB	Two-year Budworm (<i>Choristoneura biennis</i>)
IDC	Larch Casebearer (<i>Coleophora laricella</i>)
IDD	Western Winter Moth (<i>Erranis tiliaria vancouverensis</i>)
IDE	Eastern Spruce Budworm (<i>Choristoneura fumiferana</i>)
IDF	Forest Tent Caterpillar (<i>Malacosoma disstria</i>)
IDG	Greenstriped Forest Looper (<i>Melanolophia imitata</i>)
IDH	Western Blackheaded Budworm (<i>Acleris gloverana</i>)
IDI	Pine Needle Sheathminer (<i>Zellaria haimbachi</i>)
IDJ	Gray Forest Looper (<i>Caripeta divista</i>)
IDK	Northern Tent Caterpillar (<i>Malacosoma californicum</i>)
IDL	Western Hemlock Looper (<i>Lambdina fiscellaria lugubrosa</i>)
IDM	Gypsy Moth (<i>Lymantria dispar</i>)
IDN	Birch Leafminers (<i>Fenusa pusilla</i> and <i>Profenusa thomsoni</i>)
IDO	Filament Bearer (<i>Nematocampa filamentaria</i>)
IDP	Larch Sawfly (<i>Pristophora erichsoni</i>)
IDQ	Hemlock Needleminer (<i>Epinotia tsugana</i>)
IDR	Alder Sawfly (<i>Eriocampa ovata</i>)
IDS	Balsam Fir Sawfly (<i>Neodiprion abietis</i>)
IDT	Douglas-fir Tussock Moth (<i>Orgyia pseudotsugata</i>)

⁶Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
IDU	Satin Moth (<i>Leucoma salicis</i>)
IDV	Variiegated Cutworm (<i>Peridroma saucia</i>)
IDW	Western Spruce Budworm (<i>Choristoneura occidentalis</i>)
IDX	Large Aspen Tortrix (<i>Choristoneura conflictana</i>)
IDY	Birch-Aspen Leafroller (<i>Epinotia solandriana</i> (Linnaeus))
IDZ	Western False Hemlock Looper (<i>Nepytia freemani</i>)
IEA	Unidentified Aspen Defoliation
IEB	Hemlock Sawfly (<i>Neodiprion tsugae</i>)
IEC	Larch Budmoth (<i>Zairaphera improbana</i>)
IED	Larch Looper (<i>Semiothis sexmaculata</i>)
IEF	Cottonwood Leaf Skeletonizer (<i>Phyllonoryctes apparella</i>)
IEG	Lodgepole pine Sawfly (<i>Neodiprion nanulus contortae</i>)
IEH	Phantom Hemlock Looper (<i>Nepytia phantasmaria</i>)
IEI	Saddleback Looper (<i>Ectropis crepuscularia</i>)
IEJ	Willow Leafminer (<i>Micrurapteryx salicifoliella</i>)
IEK	Rusty Tussock Moth (<i>Orgyia antiqua</i>)
IEL	Pine Needleminer (<i>Coletechnites</i> spp.)
IS	Shoot Insects
ISA	Bronze Birch Borer (<i>Agrilus anxius</i>)
ISB	Western Cedar Borer (<i>Trachykele blondeli</i>)
ISC	Poplar Borer (<i>Saperda calcarata</i>)
ISE	European Pine Shoot Moth (<i>Rhyacionia buoliana</i>)
ISG	Gouty Pitch Midge (<i>Cecidomyia piniinopsis</i>)
ISP	Pitch Nodule Moths (<i>Petrova</i> species)
ISQ	Sequoia Pitch Moth (<i>Vespamima sequoiae</i>)
ISS	Western Pine Shoot Borer (<i>Eucosma sonomana</i>)
ISW	Poplar and Willow Borer (<i>Cryptorhynchus lapathi</i>)
IW	Weevils
IWC	Conifer Seedling Weevil (<i>Steremnius carinatus</i>)
IWM	Magdalis Species (<i>Magdalis</i> spp.)
IWP	Lodgepole pine Terminal Weevil (<i>Pissodes terminalis</i>)
IWS	White pine Weevil (on Spruce) (<i>Pissodes strobi</i>)
IWW	Warrens Root Collar Weevil (<i>Hylobius warreni</i>)

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

Code Value	Code Description
IWY	Cylindrocopturus Weevil (Cylindrocopturus spp.)
IWZ	Yosemite Bark Weevil (Pissodes schwartzii)
M	Mite Damage (Trisetacus spp.)
N	Non-Biological (Abiotic) Injuries
NAV	Avalanche or Snow Slide
NB	Fire
NBP	Post-burn Mortality
NCA	Aspen Decline
NCB	Birch Decline
NCF	Douglas-fir Decline
NCY	Yellow cedar (Yc) Decline
NDM	Drought, mortality
NDF	Drought, foliage affected
NE	Cedar Flagging
NF	Flooding
NG	Frost
NGC	Frost Crack
NGH	Frost Heaved
NGK	Shoot/Bud Frost Kill
NH	Hail
NI	Redheart
NK	Fumekill
NL	Lightning
NN	Road Salt
NR	Redbelt
NS	Slide
NW	Windthrow
NWS	Windthrow - Soil Failure
NWT	Windthrow - Treatment or Harvest-related
NX	Wind Scarring or Rubbing
NY	Snow or Ice (includes snow press)
NZ	Sunscald
P	Cone and Seedling Fungal Pathogens

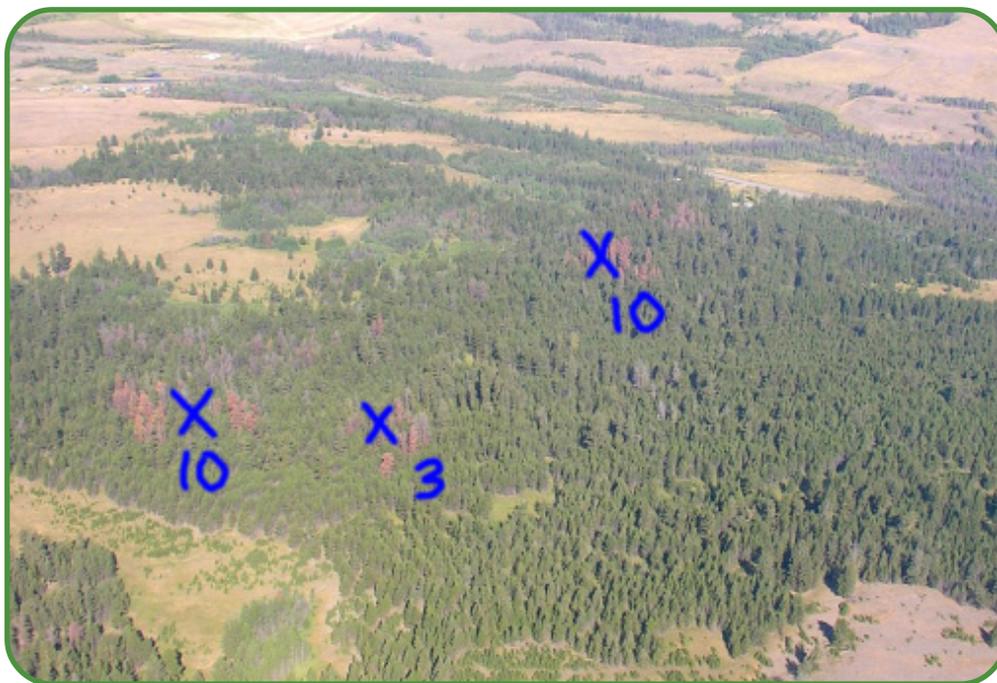
⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix D. Forest Health Factor (FHF) Code Listing⁶ (Continued)

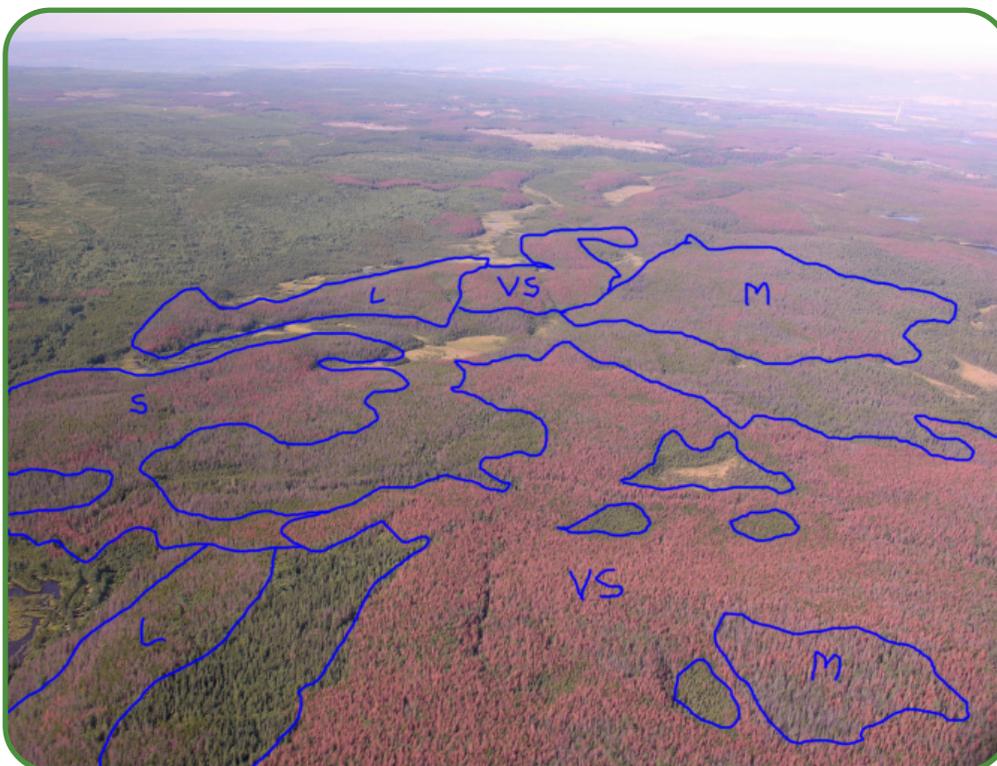
Code Value	Code Description
PAX	(<i>Alternaria</i> spp.)
PBC	Gray Mould (<i>Botrytis cinerea</i>)
PCD	(<i>Neonectria radicicola</i>)
PCF	Seed or Cold Fungus (<i>Caloscypha fulgens</i>)
PCP	Inland Spruce Cone Rust (<i>Chrysomyxa pirolata</i>)
PDT	Cedar Leaf Blight (<i>Didymascella thujina</i>)
PFX	(<i>Fusarium</i> spp.)
PPG	Damping-off Disease (<i>Phoma glomerata</i>)
PPX	(<i>Penicillium</i> spp.)
PSS	Sirococcus Blight (<i>Sirococcus strobilinus</i>)
PTX	(<i>Trichothecium</i> spp.)
T	Treatment Injuries
TC	Chemical Injury
TL	Logging Wounds
TM	Other Mechanical Damage (non-logging)
TP	Planting (incorrectly planted)
TPM	Planting (poor microsite)
TR	Pruning Wound
TI	Thinning or Spacing Wound
U	Damage (cause unknown)
UBT	Unknown Broken Top
UCR	Unknown Crook
UF	Unknown Fork Damage
USW	Unknown Sweep
V	Problem Vegetation
VH	Herbaceous Competition
VP	Vegetation Press
VS	Shrub Competition
VT	Tree Competition

⁶ Greyed out forest health factors are not visible from the elevation at which the AOS survey is flown. For the most current Pest Codes, please use the following hyperlink: https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=PEST_SPECIES_CODE

Appendix E. Examples of Forest Disturbances and Intensity of Damage



Spot mortality caused by Douglas-fir beetle near 100 Mile House. This method is used for discrete clusters of up to 50 trees, which can be estimated. Note that only current (fading, or bright red foliage) mortality is mapped.

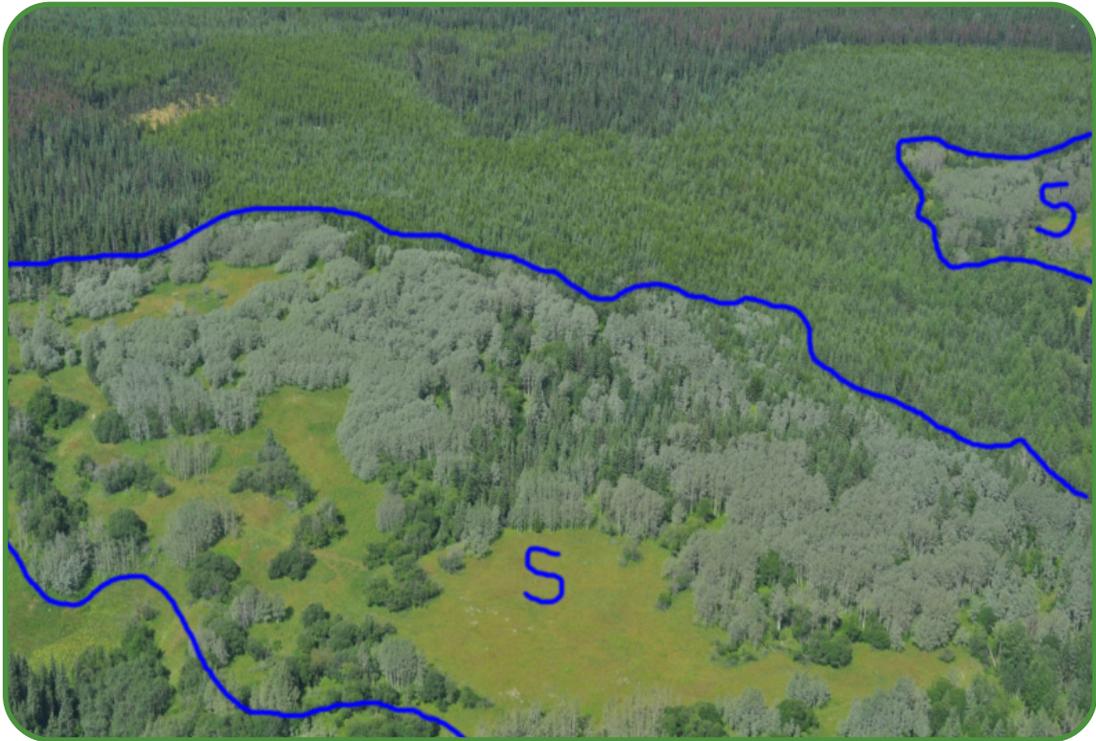


Mountain pine beetle caused mortality north of Prince George, by polygons of varying severity. Note infestations continue further at the top of the photograph, but this attack would be mapped on the next survey line. Intensity and size of polygons can vary depending on several factors: map to the best detail possible, without missing disturbances.

Appendix E. Examples of Forest Disturbances and Intensity of Damage (Continued)



Scattered balsam bark beetle caused mortality near Smithers – only the brightest orange is mapped. Attack is too scattered to be mapped as spots, hence a large, low intensity (most likely trace) polygon would be drawn (larger than the photographed area).

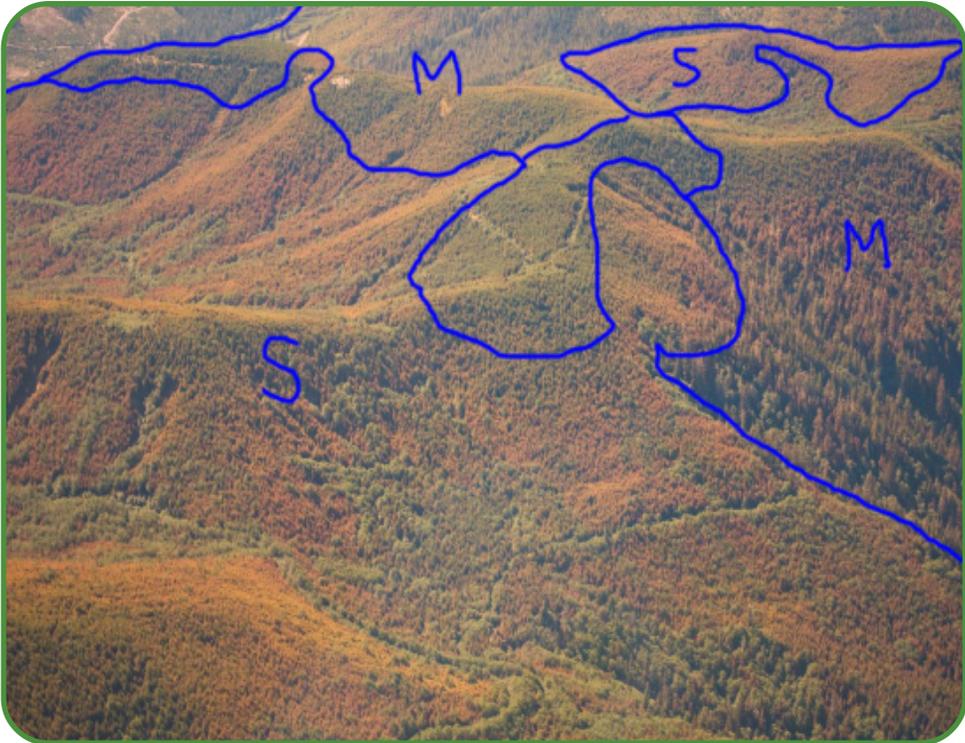


Severe aspen leafminer defoliation near Smithers – note that damage intensity ratings for this defoliator are calculated according to the percentage of stems affected in a drawn polygon, similar to bark beetle severity ratings, as opposed to the proportion of the foliage affected, like other defoliator damage.

Appendix E. Examples of Forest Disturbances and Intensity of Damage (Continued)



Two-year-cycle budworm defoliation northeast of Smithers - note that damage intensities tend to fade into each other, and that the polygons continue onto the next survey line.



Western blackheaded budworm defoliation on Haida Gwaii. Note that severity refers to level of damage to host tree species.

Appendix E. Examples of Forest Disturbances and Intensity of Damage (Continued)



Pine needle sheathminer defoliation west of Quesnel, by host species damage intensity. Note that aspen leafminer damage is also present, which would require a separate, overlapping polygon.

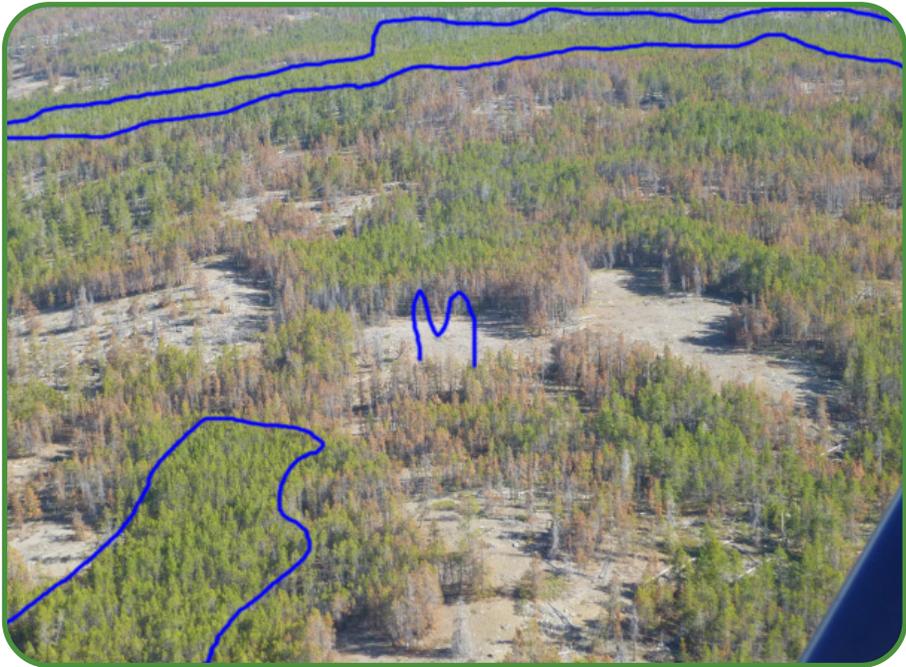


Post burn fire damage near Vanderhoof. Note that severity is somewhat subjective in this case, as mortality appears to be occurring gradually with some trees very recently killed (chlorotic), others bright red and others more faded red, making it difficult to tell which year damage occurred in. It is important with abiotic damage to note tree species affected (in this case lodgepole pine) and comment if other agents are suspected to be a factor too, such as secondary beetles.

Appendix E. Examples of Forest Disturbances and Intensity of Damage (Continued)

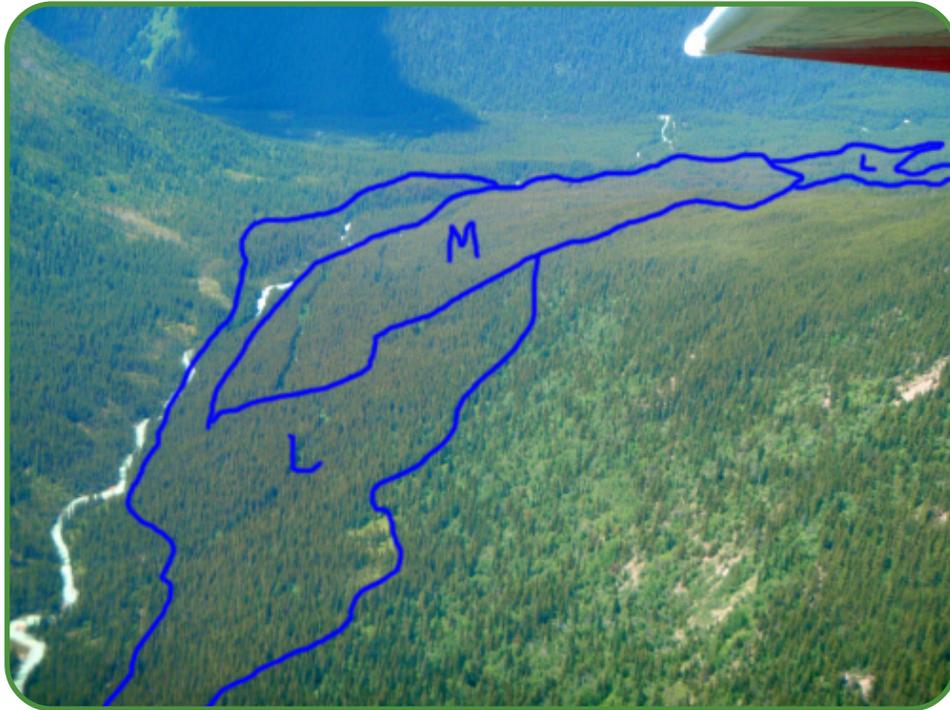


Yellow cedar decline on the northern BC coast. This would be a large disturbance polygon (extending past the picture borders) of light intensity mortality.



Drought damage in lodgepole pine in the Chilcotin; disturbance polygon extends past the boundaries of the picture. Note that if enough undamaged areas are excluded, severity of damage would rise.

Appendix E. Examples of Forest Disturbances and Intensity of Damage (Continued)

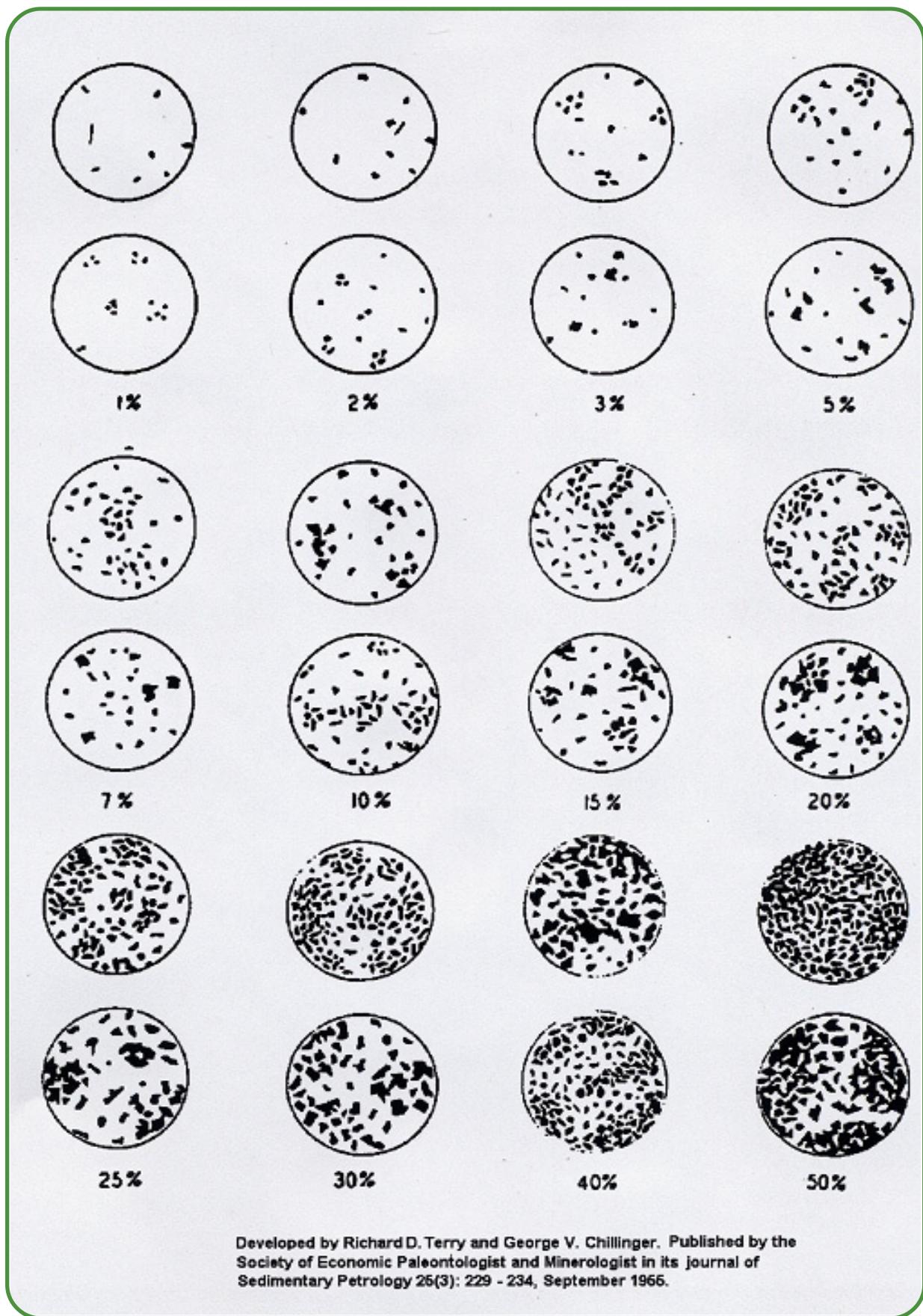


Red belt foliage damage near Invermere in lodgepole pine: note intensity of damage categories fades into each other and is somewhat subjective.



Windthrow damage north of Lac La Hache. It is very important to note the tree species affected (spruce/balsam in this example). Note that windthrow is often under-represented from the aerial overview survey, as scattered understory damage is not visible.

Appendix F. Guide for estimating intensity of mortality



Appendix G. Provincial Tree Code Listing⁷

Code Value	Code Description
A	Aspen, Cottonwood or Poplar
AC	poplar
ACB	balsam poplar
ACT	black cottonwood
AD	southern cottonwood
AT	trembling aspen
AX	hybrid poplars
B	Fir (Balsam)
BA	amabilis fir
BB	balsam fir
BC	white fir
BG	grand fir
BL	subalpine fir
BM	Shasta red fir
BN	Noble fir (code replaced by Bp)
BP	noble fir
C	Cedar
CW	western redcedar
D	Alder
DG	green/Sitka alder
DM	mountain alder
DR	red alder
E	Birch
EA	Alaska paper birch
EB	scrub birch
EE	European birch
EP	paper birch
ES	silver birch
EW	water birch
EX	birch hybrid
EXP	Alaska x paper birch hybrid
EXW	Water x paper birch
EY	yellow birch

⁷ Greyed out tree species are not commercial BC species, hence forest damage is not mapped. For the most current Tree Species Codes, please use the following hyperlink:
https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=TREE_SPECIES

Appendix G. Provincial Tree Code Listing⁷ (Continued)

Code Value	Code Description
F	Douglas-fir
FD	Douglas-fir
FDC	coastal Douglas-fir
FDI	interior Douglas-fir
G	Dogwood
GP	Pacific dogwood
GR	red-osier dogwood
H	Hemlock
HM	mountain hemlock
HW	western hemlock
HX	hemlock hybrid
HXM	mountain x western hemlock hybrid
J	Juniper
JD	common juniper
JH	creeping juniper
JR	Rocky Mtn. juniper
JS	seaside juniper
K	Cascara
KC	cascara
L	Larch
LA	alpine larch
LD	Dahurian larch
LS	Siberian larch
LT	tamarack
LW	western larch
M	Maple
MB	bigleaf maple
ME	box elder
MN	Norway maple
MR	Douglas maple
MS	Sycamore maple
MV	vine maple

⁷ Greyed out tree species are not commercial BC species, hence forest damage is not mapped. For the most current Tree Species Codes, please use the following hyperlink:
https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=TREE_SPECIES

Appendix G. Provincial Tree Code Listing⁷ (Continued)

Code Value	Code Description
OA	incense-cedar
OB	giant sequoia
OC	coast redwood
OD	European mountain-ash
OE	Siberian elm
OF	common pear
OG	Oregon ash
OH	white ash
OI	shagbark hickory
OJ	tree-of-heaven
OK	Japanese walnut
P	Pine
PA	whitebark pine
PF	limber pine
PJ	jack pine
PL	lodgepole pine
PLC	shore pine
PLI	lodgepole pine
PM	Monterey pine
PR	red pine
PS	sugar pine
PW	western white pine
PX	pine hybrid
PXJ	lodgepole x jack pine hybrid
PY	ponderosa pine
Q	Oak
QE	English oak
QG	Garry oak
QW	white oak
R	Arbutus
RA	Arbutus
S	Spruce
SA	Norway spruce (code replaced by Sn)

⁷ Greyed out tree species are not commercial BC species, hence forest damage is not mapped.

For the most current Tree Species Codes, please use the following hyperlink:

https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=TREE_SPECIES

Appendix G. Provincial Tree Code Listing⁷ (Continued)

Code Value	Code Description
SB	black spruce
SE	Engelmann spruce
SN	Norway spruce
SS	Sitka spruce
SW	white spruce
SX	spruce hybrid
SXB	white x black spruce
SXE	engelmann x sitka spruce
SXL	Sitka x white
SXS	Sitka x unknown hybrid
SXW	Engelmann x white
SXX	white x engelmann x sitka spruce
T	Yew
TW	western yew
U	Apple
UA	apple
UP	Pacific crab apple
V	Cherry
VB	bitter cherry
VP	pin cherry
VS	sweet cherry
VV	choke cherry
VW	choke cherry (code replaced by Vv)
W	Willow
WA	peachleaf willow
WB	Bebb's willow
WD	pussy willow
WP	Pacific willow
WS	Scouler's willow
WT	Sitka willow
Y	Cypress
YC	yellow-cedar
YP	Port Orford-cedar

⁷ Greyed out tree species are not commercial BC species, hence forest damage is not mapped. For the most current Tree Species Codes, please use the following hyperlink:
https://www.for.gov.bc.ca/pscripts/isb/idd/ValidationCode.asp?Codename=TREE_SPECIES

Appendix H. Ground Confirmation Assessment Record

British Columbia Aerial Overview Survey - Ground Confirmation/Assessment Record			
Location Summary			
Forest District:		TSA:	
100K NTS mapsheet tile:		General location:	
Location Information: (Use either decimal degrees or UTM)		Longitude:	Latitude:
UTM zone:	UTM Easting:	UTM Northing:	
BEC Zone:		BEC Subzone:	
Access Directions and Conditions/Other Information:			
Aerial Survey Summary			
Aerial survey or name(s) and company name:			
Aerial survey date:			
Original suspected FHF Code:			
Infestation Type:	tree species affected:		
severity code:			
Stand age:	Photographs taken?		
Damage symptoms/pattern:			
Additional notes/observations made at time of aerial survey:			
Ground Confirmation/Assessment Summary			
Ground Confirmation Date:		Ground confirmation completed by:	
Stand Composition/Description:			
Sample(s) collected?		Photographs taken?	
Sample Description:			
Sample(s) submitted to specialist?		Specialist name and affiliation:	
Specialists sample assessment/identification notes:			
Notes/observations made at time of ground confirmation:			
Final Assessment Summary			
Final FHF Code:			
Infestation Type:	tree species affected:		
Severity Code:	Stand age:		
Comments:			

insert aerial survey photos, ground survey photos, and descriptions here:

Appendix I. District/Region Lookup Table

District Code	Region Code	District Name	Region Name
DSI	RWC	South Island Natural Resource District	West Coast Natural Resource Region
DCK	RSC	Chilliwack Natural Resource District	South Coast Natural Resource Region
DSQ	RSC	Sea to Sky Natural Resource District	South Coast Natural Resource Region
DCR	RWC	Campbell River Natural Resource District	West Coast Natural Resource Region
DSC	RSC	Sunshine Coast Natural Resource District	South Coast Natural Resource Region
DCS	RTO	Cascades Natural Resource District	Thompson-Okanagan Natural Resource Region
DRM	RKB	Rocky Mountain Natural Resource District	Kootenay-Boundary Natural Resource Region
DOS	RTO	Okanagan Shuswap Natural Resource District	Thompson-Okanagan Natural Resource Region
DMH	RCB	100 Mile House Natural Resource District	Cariboo Natural Resource Region
DSE	RKB	Selkirk Natural Resource District	Kootenay-Boundary Natural Resource Region
DKA	RTO	Thompson Rivers Natural Resource District	Thompson-Okanagan Natural Resource Region
DCC	RCB	Cariboo-Chilcotin Natural Resource District	Cariboo Natural Resource Region
DNI	RWC	North Island - Central Coast Natural Resource District	West Coast Natural Resource Region
DQU	RCB	Quesnel Natural Resource District	Cariboo Natural Resource Region
DVA	ROM	Vanderhoof Natural Resource District	Omineca Natural Resource Region
DQC	RWC	Haida Gwaii Natural Resource District	West Coast Natural Resource Region
DPG	ROM	Prince George Natural Resource District	Omineca Natural Resource Region
DND	RSK	Nadina Natural Resource District	Skeena Natural Resource Region
DKM	RSK	Coast Mountains Natural Resource District	Skeena Natural Resource Region
DJA	ROM	Fort St. James Natural Resource District	Omineca Natural Resource Region
DMK	ROM	Mackenzie Natural Resource District	Omineca Natural Resource Region
DPC	RNO	Peace Natural Resource District	Northeast Natural Resource Region
DFN	RNO	Fort Nelson Natural Resource District	Northeast Natural Resource Region
DSS	RSK	Skeena Stikine Natural Resource District	Skeena Natural Resource Region

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