Appendix F

Aerial Spray Guidelines and Drift Models

AERIAL SPRAY GUIDELINES

These guidelines are intended as a practical field guide for weed managers who may be considering use of aerial herbicide application as part of an integrated pest management program. Some of the terminology and work force, fiscal year, planning references are specific to Forest Service project planning. The information and observations in this guide are specific to large droplet liquid herbicide applications and does not address pellet, insecticide or other fine droplet aerial application projects.

Aerial Sites, Modeling Results and Common Practices

Table F- 1 - Proposed Aerial sites for the Wallowa Whitman Invasive Plant EIS

Inv ID	Species[1]	Proposed Treatment	Alternative Treatment	Acres
06160400070	CESO3	Chemical	Bio-control	9.2
06160400088	CESO3	Chemical	Bio-control	7.4
06160400112	CESO3	Chemical	Bio-control	35.7
06160400130	ONAC	Chemical		7.3
06160400210	CESO3	Chemical	Bio-control	7.9
06160400212	CESO3	Chemical	Bio-control	11.3
06160400213	CESO3	Chemical	Bio-control	12.2
06160400222	CESO3	Chemical	Bio-control	8.6
06160400242	CESO3	Chemical	Bio-control	10.4
06160400297	ONAC	Chemical		18.8
06160400370	CESO3	Chemical	Bio-control	41.8
06160400441	CESO3	Chemical	Bio-control	5.7
06160400442	CESO3	Chemical	Bio-control	51.3
06160400443	CESO3	Chemical	Bio-control	107.8
06160400444	CESO3	Chemical	Bio-control	34.5
06160400445	CESO3	Chemical	Bio-control	259.1
06160400448	CESO3	Chemical	Bio-control	37.3
06160400454	CESO3	Chemical	Bio-control	0.2
06160400536	CESO3	Chemical	Bio-control	19.3
06160400540	ONAC	Chemical		6.3
06160600042	CESO3	Chemical	Bio-control	19.3
06160600162	CESO3	Chemical	Bio-control	3.7
06160600166	CESO3	Chemical	Bio-control	4.0
06160600168	CESO3	Chemical	Bio-control	23.7
06160600169	CESO3	Chemical	Bio-control	38.0
06160600170	CESO3	Chemical	Bio-control	6.5
06160600171	CESO3	Chemical	Bio-control	17.8
06160600172	CESO3	Chemical	Bio-control	5.3
06160600173	CESO3	Chemical	Bio-control	75.1
06160600176	CESO3	Chemical	Bio-control	57.8
06160600177	CESO3	Chemical	Bio-control	15.5
TOTAL = 31				958.5
Total acres treated				875.5

1Note that approximately 83 acres within proposed aerial sites cannot be treated due to riparian buffer restrictions and would need alternative treatments (i.e ground based treatments: chemical, biological, physical).
Aerial spraying is not proposed near listed plant populations; therefore no acreage reductions resulted from plant population buffers (See Chapter 2, PDF I-7).

Aerial Drift Modeling Results for Wallowa Whitman National Forest

Spray Drift Summary. Based on the aerial drift modeling results that depict worst case scenarios allowable under PDFs, the use of picloram and clopyralid for treatment of yellow starthistle and scotch thistle as in the proposed action may cause a short-term impact to non-target native plants that are sensitive to small concentrations of applied herbicides. Picloram and clopyralid are both selective herbicides for use on broadleaved species. Clopyralid is somewhat more selective within the broadleaved species than picloram as described in Appendix D of the BA. Off site drift of these two chemicals could potentially impact broadleaved species especially species particularly sensitive to low concentrations either of these two chemicals and also leaving native and non-native grasses non-impacted. Under worst case scenarios, concentrations of these two herbicides at a distance of 100 feet from the aerial application site are anticipated to be between approximately 18 to 25 times lower in proposed application rates at the treatment site. Although some broadleaved species may be impacted and grasses would remain non-impacted by the off site drift, it is expected that because of the remote locations of these sites, a resident native seedbank is sufficient enough to re-establish a native plant community in the upcoming years. Additionally, PDFs that establish monitoring guidelines and implementation of restoration actions including reseeding of native plants (if necessary) far outweighs the disadvantages of allowing the invasive plant site to continue to grow and spread.

Introduction

AGDISP is a mathematical model used to evaluate the potential for herbicides to move off site. This model was first developed by NASA, improved by the USDA Forest Service, and implemented by the Spray Drift Task Force and the U.S. Environmental Protection Agency into a regulatory version (Teske et. al.2003).

Results from the output of this model that incorporates numerous factors affecting off-site drift is then used to predict possible impacts. A full description of the model can be found at the end of this discussion as well as at http://www.epa.gov/nerl/research/2000/html/g1-12.html. AGDISP Input Data Summary (example for Picloram at release height of 50 feet with swath displacement) can be found in the Botany Report.

Site specific conditions associated with the proposed aerial sites were used as input parameters into the model. Slope, vegetation, and weather conditions were factors in the model, with spray application height, wind speed and droplet size as the three most significant factors impacting drift distance and the potential to affect non-target areas. Numerous iterations of the model were evaluated. Worst case scenarios were evaluated to develop PDFs that protect sensitive resources. In the case of aerial applications, the worst-case scenario is an adverse wind (meaning wind blowing from the point of release toward the resource or area you are trying to avoid). Spray droplet size and wind speed was modeled at the lowest mean droplet size (500µm) and wind speeds of 8mph allowable under PDFs. Three release heights were modeled for the largest aerial site (Table F-2). Clopyralid at 0.35 lb ai/acre and Picloram at 0.25 lb ai/acre are the highest amounts of chemical proposed for treatment of aerial sites.

Conditions

- 8 mile an hour cross winds toward the stream
- median droplet size is approximately 500 microns

- Release height 25, 35 and 50 feet off the ground
- Side slope terrain angle of 40 degrees
- Hiller 12E Solloy Helicopter
- Spray nozzles located no less than ¾ rotor distance (recommended to reduce drift and EPA label restriction for Picloram)
- Vegetation 0.2 to 1 meter in height
- Swath width of 60 feet
- Picloram at 1pt/acre (0.25lb ai/acre), clopyralid at 1.4 pt/acre (0.35lb ai/acre)

Scale: The impacts of weeds on native vegetation, wildlife, soils, fisheries, aesthetics, wilderness and a host of other resources are widely recognized by both the public and land managers. At the same time, the invasive plant problem in the northern Rockies has grown beyond the scale of ground based weed control.

Table F- 2 – Release heights and buffers

	25 ft release height	35 feet release height	50 feet release height
Buffer width at 7-8 mph	Designated buffer – no swath width added	Add 1 swath widths to buffer	Add 2 swath widths to buffer

While ground based and biological weed management practices still are important elements in an IWM program, they have site and species limitations. Ground based application methods such as truck, ATV, horseback, backpack or atomizer applications are generally most effective on:

- New or small infestations or
- Infestations on flat and/or open ground and
- Near a road or trail

Biological control alone, while effective and applicable in certain situations, is:

- Often cyclic,
- Not available for many weed species,
- Not as effective on weed infestations with several weed species and
- Not effective for small or pioneering infestations scattered over a large landscape.
- • Not effective on complex terrain with a wide range of slope, aspect, soil and canopy combinations.

Table F- 3 – Summary of AGDISP output

Measurement	Picloram 25'	Picloram 35' with 1 swath PDF	Picloram 50' with 2 swath PDF
Mean deposition	0.244 lb ai/acre	0.249lb ai/acre	0.245 lb ai/acre
Efficiency	97.2%	98%	97%
Airborne drift	0.32%	0.74%	1.32%
Deposition at a terrestrial point 100' from edge of application	0.01lbs ai/acre	0.01lbs ai/acre	0.017lbs ai/acre
Measurement	**Clopyralid 25'**	**Clopyralid 35' with 1 swath PDF**	**Clopyralid 50' with 2 swath PDF**
Mean deposition	0.341lb ai/acree	0.329lb ai/acre	0.337lb ai/acre
Efficiency	97.3%	98.4%	97.2%

Airborne drift	0.18%	0.451%	0.91%
Deposition at a terrestrial point 100' from edge of application	0.014lb ai/acre	0.015lb ai/acre	0.025 lb ai/acre

Aerial application is an efficient and useful method land mangers can add to their IWM toolboxes for weed infestations involving:

- • Multiple weed species,
- • At landscape scale, and
- • On steep and remote areas

Project Design Features for Wallowa Whitman National Forest

PDFs for protection of resources include swath width set back in wind speeds of 8mph and release heights of 35 feet and 50 feet as well as spray cards that are placed at certain distances around the site to estimate the quantitative deposition of drift during actual applications. The use of drift reduction technology which includes specific nozzle design and or drift reduction additives (approved by the Regional FEIS) can also be used in conjunction or in replacement of swath width adjustments if spray card detection determines spray deposition remains within buffer limits. These PDFs are fully described in Chapter 2 of this EIS.

Monitoring Results from Other Studies

Modeling results have been collected from the Lolo and Bitterroot National Forests in Montana. These results are expected to be similar to the results anticipated from aerial application on sites proposed on the Wallowa-Whitman National Forest. A full description of these modeling results is available in the Botany Report.

AGDISP Model History (derived from users manual)

To predict aerial spray deposition and drift with a computer model, we must first approximate the background atmospheric and aircraft wake behavior, in an effort to determine the effects of the atmosphere and aircraft wake on the released spray material. The approaches considered when aerial spray models were first developed included both Gaussian and Lagrangian formulations. By the late 1960s provision had been made in the U. S. Army's Gaussian modeling techniques to account for the loss of material by gravitational setting of droplets from elevated spray clouds, and to predict the resulting surface deposition patterns. Additional algorithms considered the penetration of droplets into canopies, simple expressions for wake effects of spray aircraft, and droplet evaporation. This work was largely a collaboration by the USDA Forest Service and the U. S. Army with H. E. Cramer and his associates (Cramer et al. 1972; Dumbauld et al. 1977, 1980). The computer code that resulted was called FSCBG (for Forest Service Cramer-Barry-Grim after its developers), detailed in Teske et al. (1993).

In 1979 Continuum Dynamics, Inc. began developing a Lagrangian model for the dispersal of spray material, utilizing the equations for particle motion first suggested by Reed (1953), and culminating in a model for NASA (Bilanin and Teske 1984) known as AGDISP (for AGricultural DISPersal). This approach included models for aircraft wake effects (vortices, propellers, and jet engines) and evaporation (Bilanin et al. 1989), and subsequently became the near-wake model for FSCBG. The AGDISP technology has now become the computational engine of choice in all active near-wake models in the United States, Canada, and New Zealand. Further development and refinement by the Spray Drift Task Force (SDTF) led to its regulatory version AgDRIFT (Teske et al. 2002a), by the New Zealand Forest Research led to its efficacy version SpraySafe Manager (Richardson et al. 1996), by the USDA Forest Service led to its ArcView/GPS version GypsES Spray Advisor (Teske and Curbishley 1998), and now to this, the latest version of AGDISP (Teske et al. 2003a).

FSCBG and AGDISP (as well as all subsequent models) trace their origins to 1981, when the USDA Forest Service contracted with Ketron, Inc. to review the potential for developing and implementing a consistent and inclusive aerial spray model, using as a basis the first released version of FSCBG (Dumbauld et al. 1980). The final report (Weeks et al. 1982) is most impressive for the vision included in its recommendations. Those familiar with the model at that time were perhaps unaware of its potential in the areas suggested, especially as a predictive platform for the development of decision support. Subsequent tasking – funded for the most part by the USDA Forest Service – implemented many of the report’s suggestions, and brought model development to an operational level that permitted subsequent and ongoing model extension. A complete review of scientific research associated with testing this model can be found at:
http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&DbFrom=pubmed&Cmd=Link&LinkName=pubmed_pubmed&LinkReadableName=Related%20Articles&IdsFromResult=11878480&ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVAbstractPlus

Aerial Spray Guidelines

These guidelines are intended as a practical field guide for weed managers who may be considering use of aerial herbicide application as part of an integrated pest management program. Some of the terminology and work force, fiscal year, planning references are specific to Forest Service project planning. The information and observations in this guide are specific to large droplet liquid herbicide applications and does not address pellet, insecticide or other fine droplet aerial application projects.

Why Aerial Spray?

Scale: The impacts of weeds on native vegetation, wildlife, soils, fisheries, aesthetics, wilderness and a host of other resources are widely recognized by both the public and land managers. At the same time, the invasive plant problem in the northern Rockies has grown beyond the scale of ground based weed control.

While ground based and biological weed management practices still are important elements in an IWM program, they have site and species limitations. Ground based application methods such as truck, ATV, horseback, backpack or atomizer applications are generally most effective on:

- New or small infestations or
- Infestations on flat and/or open ground and
- Near a road or trail

Biological control alone, while effective and applicable in certain situations, is:

- Often cyclic,
- Not available for many weed species,
- Not as effective on weed infestations with several weed species and
- Not effective for small or pioneering infestations scattered over a large landscape.
- Not effective on complex terrain with a wide range of slope, aspect, soil and canopy combinations.

Aerial application is an efficient and useful method land mangers can add to their IWM toolboxes for weed infestations involving:

- Multiple weed species,
- At landscape scale, and
- On steep and remote areas

Cost: Aerial application reduces costs in at least two ways. Helicopter aerial application in the area costs around $42 / acre. Ground based applications can range from $100 to $125 / acre for truck based broadcast spraying or backpack applications. The lower application cost combined with the growing scale of the problem puts aerial application in a useful position when we consider that weed infestations are growing faster than any anticipated increases in weed budgets.

Access: Many wildland infestations are occurring in remote and/or very steep topography. Aerial application can quickly (in terms of application time), safely (in regards to applicator and public exposure) and efficiently (in terms of infested area coverage) treat infestations far from roads and trails and in steep or otherwise undrivable terrain.

Safety / Exposure: Aerial application improves safety and reduces worker and public exposure to herbicides. Worker exposure and risk are influenced by the:

- Time a worker is exposed to a product,
- Physical proximity and exposure to a product,
- Personal protective equipment and safe handling practices,
- Toxicity of the product,
- Terrain, hazards, and weather in the treatment area.

Aerial application reduces application time and the time a worker is exposed to a product. It also reduces the number of applicators needed to accomplish a project and the chance of slips, falls and spills associated with ground based treatments in steep, remote or hazardous terrain.

[1] Aerial applications require All aviation activities shall be in accordance with FSM 5700 (Aviation Management), FSH 5709.16 (Flight Operations Handbook)FSM 2150 (Pesticide Use Management and Coordination), , FSH 2109.14, 50 (Quality Control Monitoring and Post-Treatment Evaluation).

Public impacts are influenced by:
• The time it takes to treat an area and the resulting limitations on public use / access,
• Individual physical or philosophical sensitivity to a product, and
• Toxicity of the product.

Aerial application reduces the time that a treatment area is unavailable to the public. It also provides an aerial platform from which an applicator can see people who may have unknowingly entered a treatment area.

Weather and wind patterns also affect worker and public exposure. Aerial application reduces the potential for both worker and public exposure from weather related factors because you can accomplish more acres in less time and thereby capitalize on favorable weather conditions. Worker and public exposure are reduced when it takes less time to treat a larger area.

Efficacy: Aerial application allows a manager to quickly complete projects when the target weed(s) is at the most susceptible phenological stage and weather conditions are most favorable for efficacy. This maximization of efficacy factors can reduce the number and scale of follow up treatments.

Reduced Wildlife Disturbance: The short operational time needed for aerial treatment minimizes wildlife disturbance and use of an area. Aerial applications may typically take only one operational day compared to a week to a month for ground-based treatments.

Visual Quality: Lower application costs that allow treatment of larger areas with a single entry reduce the visual impacts that result from annual treatment of only a portion of the project area. The color and texture of a landscape scale treatment is homogeneous rather than broken up by color, texture and straight lines.

Aerial Spray Control Strategies

Weed management objective: Weed managers should develop realistic and obtainable weed management objectives before beginning a direct weed control program. Even selective herbicides will affect non-target forbs. The effect of invasive weeds on native or desirable vegetation needs to be recognized and considered in relation to the effect of herbicides on non-target vegetation. Aerial application is a general treatment and it can be difficult to avoid small or isolated non-target vegetation. Non-target vegetation can be flagged and smaller sites can be tarped to avoid treatment, but the effect of weed control on individual non-target plant species should be carefully weighed in relation to the effect of unchecked weed spread on the overall population viability of non-target species both on and off the treatment site.

The herbicides and rates used for weed control in the area are generally selective (depending on rate) and many do not generally kill woody vegetation or grasses. While woody vegetation may show short-term effects, widespread mortality or damage is uncommon. Forbs are the non-target plants most at risk from the use of wildland weed herbicides. Whether native forb impacts are long term or short term depends on the rate and frequency of treatment, which is influenced by size of the infestation and whether you have rhizomatous or non-rhizomatous weeds.

While an objective to *"Restore native plant communities"* may be desirable, it may be unrealistic or unobtainable on widespread or rhizomatous weed infestations. More realistic and obtainable objectives may include:

- • Improving or protect existing or adjacent native plant communities,
- • Improving wildlife forage areas,
- • Preventing new weed species from establishing in an area,
- • Containing or reducing the acreage of difficult to control weeds (such as rhizomatous species) and/or
- • Controlling areas of weeds growing in large difficult terrain to access by ground.
- • Controlling widespread weeds on areas with high resource value (such as concentrated public recreation areas, big game winter ranges, or adjacent to neighboring landowners with active weed control programs).

Spring vs. Fall Treatments

Both spring and fall treatments have advantages and disadvantages. Fall treatments have less effect on non-target forbs. Climatologically, the weather is more consistent in the fall, but may be consistently too cold, especially in the morning. A drawback is that there is greater annual variability in the fall treatment window. It is difficult to know (and plan) when the fall treatment window will arrive. On some years there may be no fall treatment window due to warm weather and no rainfall. If it does arrive, it may last only a week or as long as several weeks. The end of the fall window can arrive abruptly with the snowfall and cold windy weather.

The spring treatment window is relatively long and dependable in terms of start and end date and falls at a time when you know and can plan for budget and staff. The days are longer in the spring, which allows more application time (and acres) each day. Late sunset gives application operations the option of shutting down midday if the wind comes up and resuming in the evening when the wind dies down. Both seasons can conflict with aircraft availability as a result of prescribed burning or wildfires.

Re-treatment Considerations

Before beginning an aerial treatment program, re-treatment needs, funding and scheduling should be considered. Keep in mind that the objective is not to simply kill the existing standing weed crop, but to:

- • Restore and/or encourage desirable and competitive vegetation and
- • Deplete the weed seed soil bank.

With these objectives in mind, a single treatment may be insufficient. As with all weed control methods, initial herbicide treatments should include planning for follow up treatments. Follow up treatment frequency should be influenced by the soil seed life of the most abundant and longest-lived weed on the site and the residual control provided by the herbicide selected. Spotted knapweed for example, has a soil seed life of about eight to 10 years. Once a treatment program begins, managers should plan for follow up treatments based on the soil seed life of the weeds present and the residual control of the herbicide selected.

For example, if spotted knapweed is being treated with picloram, a manager may consider follow up treatments every three growing seasons (the approximately residual control period for picloram) for three to four cycles (3 growing seasons x 3 to 4 cycles = 9 to 12 years – the approximately soil seed life for knapweed). Commitment to this program is important because if a cycle is missed and a weed seed crop is allowed to develop, the treatment cycle may have to be extended.

Pre-field Project Preparation

It is helpful to develop a checklist of the protection measures and management requirements. This checklist should clearly identify tasks and provide a place to date and sign off as each task is completed. This checklist should be filed in the project file. Some of the items that can go on the checklist include:

- Protection Measures from NEPA decision.
- Pesticide Use Proposal
- Notification of neighbors (Note: neighboring landowners may want to treat their lands when they learn a project is scheduled next to them)
- Pretreatment monitoring plots (these plots should be established during the growing season prior to the treatment)
- Designation of Aerial Equipment Manager (helicopter manager)
- Recon and selection of a helibase (close to treatment area, good road access, away from waterways, reviewed and OK’d by pilot)
- Posting of the area to be treated
- Establish temporary closure orders, when needed.
- Identification and marking of sensitive areas to be avoided
- TES plant and animal considerations

Field Project Layout

It is difficult to pre-determine the treatment day due to weed phenology, weather, and aircraft availability. It is recommended that aerial spray projects be prepped well in advance (2 to 4 weeks) of the anticipated treatment date.

Ground Truthing: Treatment units should be carefully ground truthed prior to treatment to determine:

- Weed species and distribution •
- Road system and any differences in roadside infestations in relation to off road infestations
- Herbicide prescription considering both weeds and native vegetation
- Live water, wet areas or other sensitive resources you want to avoid
- Overstory canopy closure

This information can be recorded on aerial photographs that include project boundaries and other adjacent or in holding ownerships. Two copies of these aerial photos should be made, one copy for the project manager and one set for the application pilot to have on board the aircraft. When possible, geo-reference the aerial photo information in order to give the pilot GPS location information.

Buffers and No Treatment Areas: Buffer and no treatment areas should be established around any sensitive resource you want to avoid. These areas may include live water, wet areas, other land ownerships, TES plants or occupied areas. Aerial treatment buffer zones may vary depending on site characteristics. Treatments may also be designed to avoid any aerial treatment near sensitive resources. The width of an aerial treatment buffer zone near sensitive resources should consider:

- • Slope (steeper = wider)
- • Vegetation (less overstory vegetation = wider)
- • Wind prescription (applications should be made only with low upslope winds)
- • Overstory vegetation (which determines release height - higher release height = wider buffer)
- • Use of a drift agent (no drift agent = wider buffer- drift reduction agents are recommended near buffer areas)
- • Droplet size (smaller droplet size = wider buffer)
- • Topographic position (narrow deep draws = wider buffer areas)
- • Sensitivity of neighboring landowners (more sensitive = wider buffer)

Buffer Monitoring: Water sensitive "drift cards" can be placed as needed within the buffer zones to document herbicide placement. The number of drift card lines should be determined by the sensitivity of the resource and the size of the area. The number of card lines should be considered carefully because they are time intensive and require additional project staff. Cards should:

• Be placed equidistance within the buffer from the sensitive resource to the beginning of the treatment area.

• Have the Line # and location on the line recorded on each card at the time of placement be placed 10 feet to 10 yards apart depending on the width of the buffer area.
• Be placed on drift cardholders.
• Be placed immediately before application and picked up and stored in waterproof bags immediately after treatment.
• Not be placed the day or evening before early morning applications due to dew, fog or humidity contamination.
• Be laid out in a dry office setting in the order they were placed and interpreted as soon as practical. (Cards often come with interpretation information and sampling square templates.)
• Filed in waterproof bags in the project file.

It is critical that those placing drift cards be briefed on handling, placement, contamination, collection and storage of the cards. Those placing and picking up the cards should carefully check the card condition as they are placed and picked up and note any non-herbicide contamination. Contamination can include fog, high humidity, dew droplets off leaves, moisture on your hands, improper card handling, rodent urine or foot prints, wildlife or insect moisture and/or feeding on the cards.

If drift cards are used, card lines should also be placed in treatment areas under full spray conditions to serve as a reference for determining percentage of full spray on cards in buffer areas that have detection. The purpose of buffers is to protect the resource that is at the end of the buffer area, so detection within the buffer areas may be acceptable as long as the sensitive area itself is protected.

In-stream water sampling has limitations in that it is expensive, should be sterile and automated to avoid contamination, only indicates whether herbicide reached a water way in detectable quantities, does not indicate how close herbicide may have come to the sensitive resource and is subject to dilution depending on stream volume and velocity.

<u>Drift Mitigation Measures</u>: Drift mitigation measures may include:

- • Use of a drift agent
- • Use of buffer areas next to sensitive resources
- • On site weather monitoring
- • Treatment next to sensitive areas when wind is upslope and gentle
- • No treatment during inversions
- • No treatment when winds in the project area are > 6 mph
- • No treatment when weather forecasts predict rain in next 24 hours

<u>Unit Marking Strategies</u>: In agricultural or residential settings treatment area boundaries are clearly defined by fences, roads and / or buildings. Wildland project managers should identify treatment areas on the ground and be sure the application pilots know where treatment and no treatment areas are. Wildland unit marking strategies fall into two general categories:

- • Identification of specific treatment polygons and delineation of where to treat within a larger project area, or

- • Identification of the general project area and delineation of areas not to treat.

Large wildland treatment areas that include many polygons and a mix of timbered and open areas may be difficult to mark and find from the air. If treatment units are large and there are only three to five in the project area it may be practical to mark each individual unit. If there are many units in a large area, it may be more efficient to mark the project area boundary and buffers and instruct the pilot which areas not to treat within the larger project area. The no treatment areas could include marked buffer areas (which would include waterways and wet areas), talus, rock and cliffs and areas with a closed overstory canopy.

<u>On the Ground Unit Marking:</u> Technology is rapidly developing that allows managers to mark treatment units digitally. On the ground block marking is the most expensive part of project layout and through the use of digital marking may be eventually eliminated. Some on the ground features and topography may require some degree of on the ground marking.

When on the ground marking is needed, uniform unit marking is recommended to ensure consistency between treatment blocks, different ranger districts and to reduce pilot workload. Unit marking can be done with high contrast, high strength flagging staked or rocked to the ground or with aerosol survey paint. Markings should be kept as simple as possible. Frequency of marking should depend on the specific site and site features. Some suggested unit markings are:

- • Treatment unit boundary: The vertical line should be on the unit boundary with the perpendicular line pointing into the treatment unit. These markings can also be places were roads enter and leave the treatment units. A unit number can be added for further aerial orientation.
- • A horizontal line to mark the edge of a buffer or area to be avoided. The line should be parallel to the feature inside the buffer area.

All ground marking schemes should be closely coordinated with the application pilot.

<u>Digital Unit and Treatment Marking</u>: GPS guided navigational devices are available that allow an aircraft to develop a digital treatment polygon file from either a recon flight or an on the ground unit layout. These digital shapes appear on a navigational screen in the aircraft and are used to guide the pilot to the units. GPS line files are collected for each spray swath and are displayed on the polygon on the screen during application. These swath lines can be printed after application to provide a digital map record of the treated area. The swath width can be loaded into the program to generate area treated based on swath length and width.

<u>Pretreatment Recon Flight</u>: On or before treatment day, the pilot and project manager should fly the project area with aerial photos in hand to review and discuss treatment area, boundaries, other ownerships, buffer zones and on the ground marking. It is helpful for the project manager to GPS key project locations (such as unit corners or sensitive areas) prior to the flight to allow the pilot and project manager to quickly and efficiently orient from within the aircraft. Things can look different from an aircraft than from the ground and this step can save flight time.

Equipment

Helicopter and fixed wing aircraft are available for aerial application work. Helicopters have been better suited to the steep topography and diverse vegetation.

Aerial applicators typically come with a mix truck equipped with aviation fuel tanks, water tanks, a mix tank and a mix master. Water can be supplied by the Forest Service or by the applicator. Applicator mix trucks are not typically suited to travel over rough or steep forest roads so it is recommended to select a mix site / helibase with relatively easy road and water access. Forest Service rented water tenders can add expense to the project and Forest Service engines may be difficult to schedule during wildfire or prescribed burning season. Pump and hose fitting need to be compatible between Forest Service engines and mix trucks. Water should be clean or potable to avoid plugging up the spray system.

Aerial Spray Recommendations

The treatment block should be marked with flagging to mark the block corners or clearly described and reviewed with applicator. It is be desirable to have a GPS system on board to record helicopter swaths, position, and boom on and off times and location.

In canyon areas, winds should follow the typical diurnal pattern of upslope during the day and down slope during the night. These diurnal winds result from heating and cooling of the surface. Clear skies with solar radiation reaching the surface during the day cause up canyon and upslope winds. Cooling that occurs after sunset generates upslope or drainage winds. Given that waterways/riparian areas are often located in the bottom of canyon areas, it is essential to avoid drift down canyon and downslope. Down canyon and downslope winds will likely occur on clear days following daytime hours. To prevent spray from drifting down canyon/downslope, winds should be up canyon and upslope. Also, inversion can result in spray drifting off site; winds indicate that an inversion is not present.

Avoid spray drift impacting non-target sites by taking the following steps

- When treating next to sensitive areas spray in the morning when up canyon and upslope winds are well established and blowing up canyon (most sensitive areas are down canyon). The specific time will need to be determined by real-time weather monitoring.
- Maintain boom pressure at less than 40psi.
- Monitor spray pressure during flight, since changes in pressure can change the application rates and may change the drop size.
- Use nozzles designed for medium to coarse droplet size (240 to 400 microns)
- Use drift agent to help maintain large droplet size.
- Check nozzles and review calibration with pilot.
- Begin the first swath 300 feet from any sensitive area.

Mark boundaries so they are clearly understood by the pilot. Fly area with pilot prior to treatment to verify location. Use GPS to document boundaries and record treatment flight paths.

- Monitor treatment boundaries next to sensitive areas with spray deposit cards to detect any possible drift. Train people in how to handle the cards, interpret the cards (many things can contaminate the cards such as dew, moisture from hands, insects) and also document results. Card lines should also be placed in treated areas under full spray to serve as a reference.

• Monitor and record weather in the area. The weather should be monitored in real time for operational control and to help with the post-spray analysis. Strive for winds from 3 to 6 miles per hour or per label instruction. Do not treat if rain is predicted within next 24 hours.
• Consider using Forest Service Cramer-Barry-Grim (FSCBG) or AGDISP computer models to evaluate drift potential and to develop operational and drift protection measures prior to treatment.

Post Treatment Considerations and Tasks Post treatment tasks may include:

- • Monitor and document in the project file daily rainfall for up to a week after treatment
- • Schedule reading of monitoring plots between 1 growing season and 1 year after treatment
- • Read drift cards and complete a drift report
- • Compile a treatment project file for reference for the next retreatment
- • Add the project to the retreatment schedule • Pick up ribbon and any other unit markings
- • Complete contract daily diary and submitting original to the Contracting Officer • Completing a Post Treatment Evaluation (FSH 2109.14 Ch 72.1)

Drift Models Currently Available

AgDrift, a new model developed by the Spray Drift Task Force in collaboration with EPA and USDA provides estimates of spray drift deposition under different application and meteorological conditions (see www.Agdrift.com).

USDA Forest Service Cramer-Barry-Grim Spray Dispersion Model analyzes data on aircraft, meteorology, pesticides, and target areas to predict deposition and drift (see www.fs.fed.us/foresthealth/technology).