The origins and definitions of drift

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GUIDELINES ONLY. REFER TO MANUFACTURERS RECOMMENDATIONS AND LOCAL ADVICE

Definitions of drift (1)

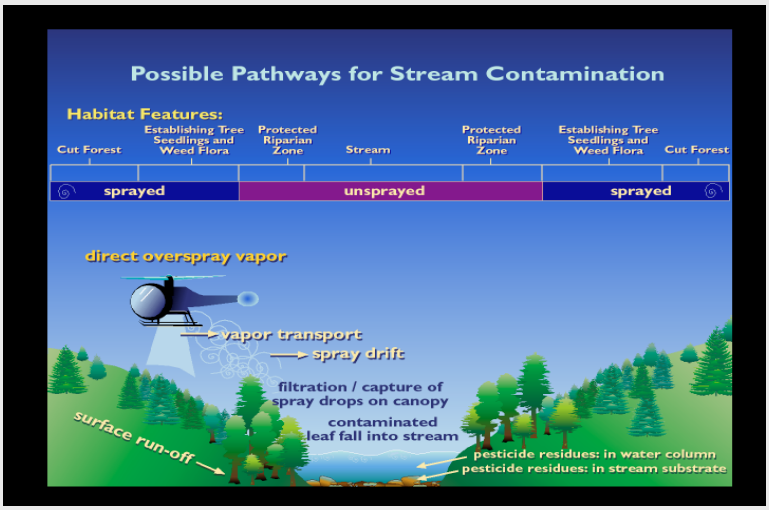
- **Drop/particle drift** (airborne movement of pesticides in a form other than vapor)
  - ***Direct wind drift***: tapering downwind drift deposit, caused by wind capturing small drops, often released too high.
  - ***Thermal drift***: irregular off-target deposition, localized some distance from release, caused by thermal eddies in unstable conditions that carry drops.
  - ***Inversion drift***: also, irregular off-target deposition, localized some distance from release, caused by small drops remaining on top of, or released into, inversion layers, formed in stable conditions.

Why is drift important?

1. A small proportion of the applied pesticide reaches the target organism (Graham-Bryce,)

Pesticide	Application method	Target	Efficiency of utilization
Demeton-S-methyl	**Foliar spray**	**Aphids on sugar beet**	**0.000008%**
Dieldrin	**Seed treatment**	**Wheat bulb fly larvae**	**0.0015%**
Dimethoate	**Foliar spray**	**Aphids on field beans**	**0.03%**
Lindane	**Foliar spray**	**Capsids on Cocoa**	**0.02%**
Dieldrin	**Aerial swarm spray**	**Locusts**	**6.0%**

2. Drift is one of the key processes that takes pesticides away from the intended target.



3. Managing drift can reduce off-target impacts, limit operator risks, improve pesticide use efficiency and thereby reduce costs to the grower

What factors increase the risk of drift?

Ideal conditions for spraying

Local Weather	Application Parameters
Neutral conditions (mild breeze, >3 to <9mph) with considerable mixing of surface air), wind direction away from sensitive areas, cool and humid conditions	Drift-reducing nozzle at mid-operating pressure, moderate volume (>8gpa) boom height <20 in, lower ground speed, with limited wobble. Air blast sprayers with drift reducing technology

Direct Wind Drift

	Local Weather	Application Parameters
Caution	High wind or gusts (particularly > 9mph), towards sensitive areas	Conventional nozzles & sprayers without drift reducing technology
Hazardous	As above, with high temperature and/or low humidity	Ditto, with higher boom height, higher ground speed, low volumes (<4gpa), high pressure

Thermal Drift

	Local Weather	Application Parameters
Caution	Sunny, generating thermals with slight eddies, and falling humidity	Conventional nozzles & sprayers without drift reducing technology
Hazardous	Powerful thermals, with turbulence, and low humidity (<40 %), particularly at high temperatures (70-80F)	Ditto, with higher boom, higher ground speed, or low volumes (<4gpa), high pressure

Inversion Drift

	Local Weather	Application Parameters
Caution	Cool, stable air with low surface mixing	Drift control preferable, but all sprays affected
Hazardous	Cool, cloudless, stable conditions, with slight wind	As above

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Drift Management

Always

Local Weather	Application Parameters
Spray when wind moderate and predictable (3-9mph), cloudy or moderate to high humidity and cool to moderate temperatures. Smoke generator shows gradually expanding plume, downwind, away from sensitive areas	Select a drift reducing nozzle, if target permits. Use low boom height setting, with damping, and operate at mid-pressure rating, moderate volume for nozzle and low to moderate ground speed. Orchard sprayers, minimize off-tree spray, and minimize spraying of outer rows

Direct Wind Drift

Local Weather	Application Parameters
Monitor wind speed to suspend spraying upwind of sensitive areas or in outer rows when >9mph. Plan to spray less sensitive areas in moderate winds and use lower risk products	Use drift-reducing technology, particularly in outer rows, or in down-wind half of crop, when wind direction is towards sensitive area. Employ permeable buffers downwind of windy fields, and consider in-crop (unsprayed) buffers

Thermal Drift

Local Weather	Application Parameters
Smoke generator shows rapid ascent, or high turbulence. Particularly on clear, sunny afternoons. Monitor temperature and humidity and avoid spraying when humidity is low	As above, and consider switching to coarser spray nozzles and lower risk materials in conditions with a high risk of thermal drift

Inversion Drift

Local Weather	Application Parameters
Smoke generator shows limited vertical movement, that acts as a barrier to spray cloud. Caution in mornings after clear nights, and in low winds. Drift can travel long distances.	General drift reduction tactics may help, particularly drop size reduction (i.e. not using very fine (red) or fine (orange) nozzles if the target permits), limiting pressure, and using moderate volumes

NOZZLE SELECTION FOR BOOM SPRAYERS

(FROM WOLF IN 3, 5, 6 & 7)

NOZZLE CATEGORIES	COMMENTS	USE GUIDE
CONVENTIONAL FLAT FAN	Fine spray, reliable, but drift prone	20-60psi, >3gpa
PRE-ORIFICE	50% drift reduction, reliable at low volumes	30-60+psi, >5gpa
LOW-PRESSURE AIR INDUCTION	50-70% drift reduction	30-60+psi, >5gpa
HIGH PRESSURE AIR-INDUCTION	70-90% drift reduction	60-80+psi, >7gpa

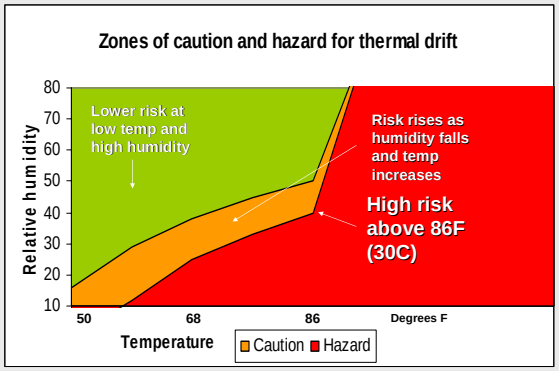


Figure developed from 2, with zones of caution and hazard defined by author

PASQUILL STABILITY CATEGORIES (FROM REFS 3,4)

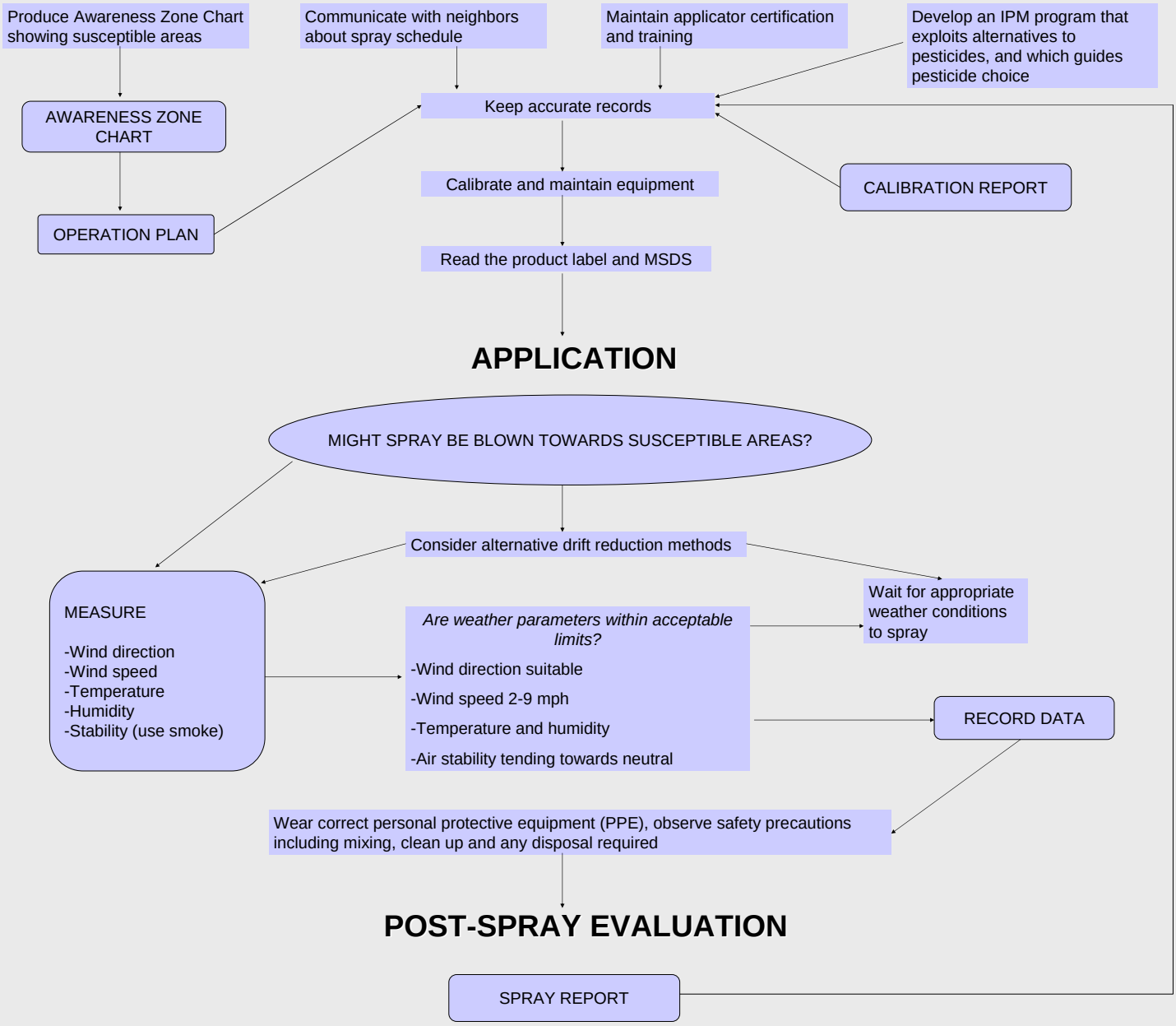
SURFACE WIND SPEED (~MPH) AT 33 FEET	INSOLATION			NIGHT CLOUD	
	H	M	L	THIN/LOW	CLOUD
4.5	A	A-B	B	F	F
4.5-7	A-B	B	C	E	F
7-11	B	B-C	C	D	E
11-13.5	C	C-D	D	D	D
13.5	C	D	D	D	D

A-C (EXTREMELY TO SLIGHTLY UNSTABLE), D NEUTRAL, E-F (SLIGHTLY TO MODERATELY STABLE)

Drift Management Planning

(based on reference 2)

PRE-SPRAY



APPLICATION

POST-SPRAY EVALUATION

CAUTION: The potential for vapor drift must be considered for certain herbicides. Drift management in this case is achieved through product choice, avoidance of ise upwind of sensitive crops and awareness of conditions that promote vapor drift, particularly mist and rain

Drift Management Guidance

All sites and commodities

Plan ahead to protect sensitive sites

- Map each field, including areas to be protected
- Consider climate at the different times you spray (including wind direction)
- Site buffer zones to intercept possible drift, downwind from sprayed sites
- Invest in drift reduction technologies (DRT's)

Develop a strategy for responding to marginal and hazardous conditions

- Use weather forecasts
- Buy equipment to measure wind speed and direction, air temperature and humidity on spray days
- Spray less sensitive areas on marginal days, or only spray part of fields that are upwind of sensitive sites
- Use less hazardous materials, increased drop size, lower boom and ground speed in parts of field near sensitive sites

If the product or target requires fine, or very fine sprays

- Maximize use of IPM alternatives to spraying
- Use thresholds and phenology models to determine optimum spray timing
- Apply least hazardous materials
- Exploit buffer zones and other protective measures
- Only spray in neutral conditions, when wind is not blowing towards sensitive sites

Boom Sprayers

General drift reduction guidance (adapted from 3)

- Consult pesticide label for recommended spray classification/drop sizes and select the nozzle that is least prone to drift from this category
- Aim for minimum boom height, and adjust nozzle spacing to give good coverage
- Adjust pressure to mid-range for nozzle, and moderate ground speed
- Avoid very low volume rates
- Air-assistance may aid canopy penetration and reduce drift

Targets effectively managed by coarser sprays (based on 5)

- Non-selective herbicides; easily-wetted weeds (pigweed, smartweed, thistles etc)
- Cereal canopy penetration
- Outer rows or areas of crop in windy conditions
- Crops adjacent to sensitive crops or non-crop areas

Targets effectively managed by finer sprays (based on 5)

- Insecticides, fungicides and contact herbicides (drift-reducing nozzles need to be tested for efficacy)
- Difficult to wet broad-leaved weeds and grass weeds (lambsquaters, kochia, wild oat, foxtail etc.)
- Open broadleaf canopy penetration
- Many targets in favorable weather conditions

Air Blast Sprayers

General drift reduction guidance (adapted from 3)

- Air-blast sprayers require wider buffers and greater attention to drift mitigation
- Spray outer rows using nozzles on one side, spraying inwards in small tree and bush crops
- Increase drop size in outer rows
- Where spraying from both sides, aim nozzles and air flow at tree, and avoid under and over-spraying, and shut off outward spraying nozzles when treating outer rows
- Shut off spray at row end and in gaps
- Reduce ground speed, which reduces air speed necessary for penetration

Drift-reducing technologies for orchards

- Vertical tower or mast sprayers that direct spray into canopy
- Directional nozzles or air guides
- Cross flow or wrap around sprayers

Particular concerns with air-blast technology

- Spring applications to leafless trees are highly subject to drift, and threatened by inversion conditions
- Upward projection of spray, above or between trees can entrain clouds of drops in above canopy air flows
- High volumes and high pressures create drops of driftable size that are not retained within the canopy

What the Literature on Drift Says

Brief details of some of the key resources that were used to put these posters together

Source literature, with an emphasis on extension sources

1.Broadley, R.H. *et al.* (1986) *Pesticide Drift, Description, Causes and Remedies*: Queensland Department of Primary Industries Q186011, 56pp

1.Terms are clarified and defined, pesticide losses are summarized, drop production and behavior are discussed, and recommendations for drift reductions are given

2.CSIRO (2002) *Spray drift management*. Primary Industries Report no. 82. CSIRO Publishing

1.Guidance concerning drift management for individual operators

3.Proceedings of the International Conference on Pesticide Application for Drift Management, October 27-29, 2004. Washington State University Extension

1.Comprehensive review and analysis of the science, policy and management of spray drift

4.Pasquill, F. (1974) Atmospheric Diffusion (John Wiley) [reported by Thistle in 3]

1.Source for air stability guidance table (cited in 3)

5.Hofman, V., Wilson, J. (2003) Choosing Drift Reducing Nozzles, North Dakota State University Extension Service, FS 919

1.Detailed guidance on the use and application of drift-reducing nozzles for boom sprayers

6.Wolf, R.E., Gardiser, D.R., Slocombe, J., Shaw, B.W. (2002) Nozzle Types for Boom Sprayer Applications of Crop Protection Products. Kansas State University Cooperative Extension Service, Application Technology Series

1.Detailed guidance on the use and application of drift-reducing nozzles for boom sprayers

7.Wolf, T., Making Sense of New Nozzle Choices, Agri-Food Canada, Saskatoon Research Center. Agdex 7441