Herbicide Buffer Zones for Protection of Sensitive Species

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Food Quality Protection Act (FQPA)
- Includes exposure through drinking water
- Re-registration process includes ecological effects

Clean Water Act
- Extension to aquatic pesticide applications
- Will use of forestry pesticides need an NPDES?

Endangered Species Act (ESA)
- Will the 4d rule swamp pesticide use??
Irrigation district to pay for fish kill

MEDFORD — The Talent Irrigation District has agreed to pay $200,000 to settle a lawsuit over a 1996 herbicide spill that killed 92,000 young salmon and steelhead in a nearby creek.
Earth Justice/NCAP sued under the pretense of a violation of the Clean Water Act

- Premise: NPDES (National Pollution Discharge Elimination System) Permit needed for aquatic pesticide applications

Judge agreed with EJ/NCAP

- Despite the conflict with FIFRA

All aquatic applications need an NPDES permit
A looming issue is whether forestry pesticide applications will require an NPDES issued under authority of the CWA.

EPA declares that it doesn’t believe the law (CWA) was intended to consider pesticide applications as point sources.

The 9th Circuit U.S. Court of Appeals disagreed in a consent decree based on a lawsuit filed in California.

The future is open to litigation!
Threatened or Endangered Species Listings in Salmon Recovery Regions
Section 4 (Factors for Listing Determination)

- Present or threatened destruction, modification, or curtailment of its habitat or range;
- Over-utilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- Inadequacy of existing regulatory mechanisms;
- Other natural or manmade factors affecting its continued existence.
Salmon backers push Corps to choose breaching dams

By Mike Lee
Herald staff writer

Salmon advocates are increasing legal pressure to breach the lower Snake River dams by demanding the Corps of Engineers tally the cost of making the dams comply with environmental laws.

Hydro woes:

Hydroelectric situation worsening.

Page A4.

About how the Corps can comply with the Clean Water Act, especially in a year when salmon friendly operations are being sacri-
EPA was successfully sued by EarthJustice and WA Toxics Coalition for failing to implement the Endangered Species Act in its re-registration of pesticides.
According to EarthJustice

Pesticides have profound effects on northwest salmon and may be a serious factor in their decline.
Section 7(a)(2) of the ESA requires any entity engaging in an activity that may affect listed species to consult with agencies administering the ESA (includes National Marine Fisheries Service and Fish & Wildlife Service)
- A single registration of a single pesticide is considered a single agency action that could affect salmon
EarthJustice argued the case successfully before the US District Court of Western WA
The ESA Consent Decree

- EPA will consult with NMFS on 54 targeted pesticides
- Mitigation needed if deemed harmful to salmon
- Court received new petition from WA Toxics Coalition (represented by Earth Justice League) for injunctive relief (11/26/02)
  - Prohibit use of listed pesticides unless 300 ft buffer around salmon-bearing streams is established for aerial application or 60 feet for ground application
EPA must consult with NMFS for each of the designated 54 pesticides under re-registration review

- NMFS will issue biological opinion as to “safety” of pesticide to salmon population (an ESU) and what action should be taken to protect salmon

Salmon in danger in interim until consultation and biological opinion finished, thus need protection

- No-spray buffer zones of 60 and 300 ft for ground & aerial application, respectively

- Only certified applicators have access to 13 urban use pesticides
What EPA Is Doing

- EPA issuing endangered species findings
- First Victim(s)?
  - EPA proposing a 300 foot buffer zone around water sources for applications of propargite (OMITE)
  - Registration in WA State cancelled until buffer issue resolved
- Thus, far EPA has made ESA determinations for 29 pesticides
EPA Determination: No Effect

<table>
<thead>
<tr>
<th>Alachlor</th>
<th>Norflurazon</th>
<th>Thiobencarb</th>
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<tbody>
<tr>
<td>Atrazine</td>
<td>Paraquat</td>
<td>Thiodicarb</td>
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<tr>
<td>Bentazon</td>
<td>Pebulate</td>
<td>Triallate</td>
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<td>Dicamba</td>
<td>Simazine</td>
<td>Triclopyr</td>
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<tr>
<td>Molinate</td>
<td>Terbacil</td>
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<tr>
<td>Acrolein</td>
<td>Diazinon</td>
<td>Metolachlor</td>
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<tr>
<td>---------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td><strong>Azinphos-methyl</strong></td>
<td>Dichlobenil</td>
<td>Oryzalin</td>
</tr>
<tr>
<td>Bensulide</td>
<td>Diuron</td>
<td><strong>Phorate</strong></td>
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<tr>
<td><strong>Carbaryl</strong></td>
<td><strong>Fenbutatin Oxide</strong></td>
<td>Prometryne</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Methomyl</td>
<td><strong>Propargite</strong></td>
</tr>
</tbody>
</table>
In a letter to the NMFS requesting consultation, EPA declared that triclopyr, imazapyr, and sulfometuron-methyl are not likely to adversely affect salmon, steelhead, or their habitat.

In the same letter, EPA stated that there was a remote chance that imazapyr and sulfometuron-methyl could have indirect effects on salmon by adversely affecting their cover (a critical habitat effect).
Western WA District Court Judge issued a tentative ruling.

Indicated evidence of harm shown by plaintiffs, although they had no burden to prove so.

Defendants (EPA) & intervenor (Crop Life America) showed no information to contrary.

Buffers likely to stand as proposed unless EPA makes a determination of no effect.

Industry frantically gathering data.
Any Science Behind Those No-Spray Buffer Zone Proposals?

Two Issues

– Does a one-size fit all buffer make sense?
– How do the pesticide residues move into water?
Is a One-Size-Fits-All No Spray Buffer Scientifically Logical?
Any Science Behind Those No-Spray Buffer Zone Proposals?

- In eastern WA & OR, spray drift, not runoff is likely to be the route of concern for pesticide movement into water.
- In western WA & OR, depending on time of year, runoff could be the main pathway.
  - However, minimizing off-target movement into riparian zones will mitigate runoff concentrations.
  - Also, if an NPDES permit is applicable in forestry operations, will need to avoid direct entry into water.
- Thus, minimizing spray drift makes sense.
But.....

Emphasis should be on BMPs for spray drift first, before worrying about no spray buffer zones
Get Real About Drift

The Facts of Life

What Goes Up--
Must Come Down
All Sprays Drift!!!!

- But, we want to minimize the amount of drift.
- Thus, we need to understand the mechanics of drift, the factors affecting drift, and how we can manage those factors.
Avoidable & Unavoidable Factors

What You Can & Cannot Control
Size Matters

- The one factor that you have some control over is aerosol/particle size.
The Bigger They Are the Faster They Fall

<table>
<thead>
<tr>
<th>Diameter (µm)</th>
<th>Appearance</th>
<th>Time to Fall 10 Feet in Still Air</th>
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<tbody>
<tr>
<td>1</td>
<td>Fog</td>
<td>28 hours</td>
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<tr>
<td>10</td>
<td>Fog</td>
<td>17 minutes</td>
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<tr>
<td>100</td>
<td>Mist</td>
<td>11 seconds</td>
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<tr>
<td>200</td>
<td>Fine Spray</td>
<td>4 seconds</td>
</tr>
<tr>
<td>400</td>
<td>Coarse Spray</td>
<td>2 seconds</td>
</tr>
<tr>
<td>1000</td>
<td>Coarse Spray</td>
<td>1 second</td>
</tr>
</tbody>
</table>
Particle Control

- Nozzle type
- Pressure
- Volume (proportion of AI to Carrier)
- Others
  - Nozzle orientation
  - Speed
  - Boom height
  - Drift retardants??
Volume Median Diameter
Effect of Droplet Size on Drift Distance

Distance (ft.) in 10 ft. fall with 3 mph wind

Droplet Diameter (microns)

1000 500 200 150 100 50 20 10 5

Bode & Butler ‘81
Effect of Boom Height on Spray Drift Deposition

% of Application Rate Deposited

Distance from Edge of Swath (ft.)

2 ft boom ht.

4 ft boom ht.
A Hard, Cold Reality

- All pesticide sprays drift!!!!
- Drift cannot be eliminated;
- Drift can be minimized
  - Best Management Practices (BMPS)
BMP Objectives for Pesticide Use

- Minimize transport out of targeted area
- Maintain efficacy
BMPs for Sprayer Operation

- Nozzles producing coarser droplets
- Lower pressure
- Lower boom height
- Increase spray volume
- Drift control additive
- Protective shields
BMPs for Spraying Operations

- Spray when wind <10 mph
- Do not spray when air is calm (inversion)
- Know what is next door
- Use buffer zones
Inversions

Be Aware of Inversions

Solar energy from the sun is blocked by the stationary, warm air.
What To Do About Inversions?
EPA is considering requiring no spray zones, defined as

- An area in which application of the pesticide is prohibited;
- This area is specified in distance between the closest point of direct pesticide application and the nearest boundary of a site to be protected, unless otherwise specified on a product label.
How Big Is Big Enough?

- No set formula for determining how large an effective buffer zone should be

- Idealized Objectives
  - Maximal reduction of pesticide transport
  - Minimal removal of productive land
  - Meet all water quality criteria
  - Do no harm to your neighbors
Strategy for Setting Reasonable Buffer Zones

- Determine toxicological (or regulatory) criteria to be met
- Determine relationship between spray drift deposition and distance
- Overlay the two to obtain buffer zone
A protective buffer zone for purposes of this risk management strategy is defined as the downwind distance between the outer edge of the last swath and the point beyond which exposure to a nontarget receptor is reasonably certain to pose no harm.
Establishing Buffer Zones

- Compile toxicological data
  - Endpoints for Aquatic Nontarget Organisms
    - LC50
    - NOAEC—dose at which no effect observed
    - EPA Risk Quotient for Endangered Species
    - Aquatic Criteria (Federal Clean Water Act Criteria or State Criteria)

- Information Sources
  - Registration Eligibility Decision Documents
  - EPA Acquire Database
    - Information is now linked to Pesticide Action Network Database!!
What Pesticides Are Used

- Identify pesticides to be used
- Need to know toxicological parameters
  - Most hazardous compound drives the hazard assessment
  - Want to know the equivalent dose, concentration, or deposit level that provides a reasonable certainty of no harm
Beware the Hazard Narrative

Need Well-Defined Toxicological Endpoints
The Shallow Depths of Hazard Narratives

- “Effect of Sulfometuron Methyl and Nicosulfuron on Development and Metamorphosis in Xenopus laevis: Impact of Purity”
  - Fort et al. 1999, Environ. Tox. & Chem. 18:2934
  - “In the present study, tail resorption rates (thyroid dysfunction) and limb development were most significantly impacted by the sulfonylurea herbicides.”
  - “Thus, based on this study, longer-term developmental processes seemingly are more likely to be affected by sulfonylurea herbicides”
  - “The impact of sulfonylurea herbicides on frog populations in the field remains unclear.”
Effect of Sulfometuron-Methyl on Development of *Xenopus*

% Limb Malformations (30-Day Test)

Fort et al. 1999
Effect of Sulfometuron-Methyl on Tail Resorption in *Xenopus*

Fort et al. 1999

![Graph showing the effect of Sulfometuron-Methyl on tail resorption in Xenopus.](image-url)
Reality Check

- There is a clearly defined NOEC of 1000 ppb (µg/L)
- Sulfometuron-methyl detections in water are at levels of ppt (ng/L)
- Note that amphibian endocrine disruption may not be the most sensitive endpoint
  - However, it may be for sulfometuron-methyl
A Rose By Any Other Name

- glyphosate ➢ Roundup
- hexazinone ➢ Velpar
- sulfometuron ➢ Oust
- triclopyr ➢ Garlon
- azinphos-methyl ➢ Guthion
- chlorpyrifos ➢ Lorsban/Dursban
Increased Predation
Sockeye Salmon (fry/smolts)

Impaired Swimming
Rainbow Trout (yearlings)

Schooling Behavior
Fathead Minnow

Impaired Swimming
Rainbow Trout (juveniles)

Sublethal Effects of Pesticides on Fish

2,4-DBE
chlorpyrifos
chlorpyrifos

LC50
Sublethal EC

µg/L (ppb)

1  10  100  1000  10000
glyphosate
hexazinone
triclopyr
2,4-D
sulfometuron
diazinon
chlorpyrifos

$Daphnia\; LC_{50}$
µg/L (ppb)

Direct Overspray Concentration

1 lb AI/Acre Stream, 1 m deep
## Estimating “Safe” Aquatic Concentrations

Divide LC50 for *Daphnia* by 100

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Daphnia LC&lt;sub&gt;50&lt;/sub&gt;</th>
<th>Aquatic Criteria</th>
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<tr>
<td>glyphosate</td>
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<td>hexazinone</td>
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<td>triclopyr</td>
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<td>2,4-D</td>
<td>250000</td>
<td>250</td>
</tr>
<tr>
<td>sulfometuron</td>
<td>125000</td>
<td>125</td>
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</table>
Establishing Buffer Zones

- Compile Distance-Deposition Function
  - AgDrift Model
    - Developed by Spray Drift Task Force--an industry consortium
    - Based on a combination of empirical studies and theoretical models of particle movement
    - Sanctioned by EPA
Is Spray Drift Predictable?

It’s All About Physics of Particles

% of Spray Deposit

Drift Off-Target
0.5% of Applied Spray

Spray Swath
99.5% on target area

% of Spray Deposit

Downwind Distance (feet)
About AgDRIFT

AgDRIFT®
Spray Drift Task Force Spray Software
Version 2.03

The computer model AgDRIFT® and its companion drop size distribution model DropKick® describe a proposed overall method for evaluating off-site deposition of pesticides applied by aerial, ground, and orchard airblast spraying means, and for evaluating the potential of buffer zones to protect sensitive aquatic and terrestrial habitats from undesired exposures.

These models are provided to the U.S. Environmental Protection Agency's (EPA) Office of Pesticide Programs (OPP) as a product of the Cooperative Research and Development Agreement (CRADA) between the EPA's Office of Research and Development, USDA Agricultural Research Service (ARS), USDA Forest Service, and the Spray Drift Task Force (SDTF), a coalition of 39 pesticide registrants formed to develop a comprehensive database of off-target drift information in support of pesticide registration requirements. The protective assessment methodology represents the joint work of industry and EPA researchers working under this agreement as the modeling subcommittee of the SDTF.

AgDRIFT® and DropKick® are protected by copyright laws and international copyright treaties, other intellectual laws and treaties, and the end-user licence agreement under the Help Menu.

OK
AgDRIFT - [AgCat Run 1.agd]

Title:
- Tier I Ground (Agricultural)
- Tier I Orchard/Airblast (Agricultural)
- Tier III Aerial (Agricultural)
- Tier III Aerial (Forestry)

Aircraft:
- Ag Husky

Nozzles and DSD:
- Boom Height: 8 ft
- Flight Lines: 20

Swath:
- Swath Width Definition: Fixed Width
  - Swath Width: 60 ft
- Swath Displacement Definition: Fraction of Swath Width
  - Fraction: 0.0313

Material:
- Type: User-defined (Water)

Transport:
- Flux Plane: 0 ft

Meteorology:
- Wind Speed: 4 mph
- Wind Direction: -90 deg
- Temperature: 70 deg F
- Rel. Humidity: 75 %

Terrain:
- Surface Roughness: 0.1 ft

Advanced Settings:
- Half Boom Effect

AgDRIFT® Tier III Aerial Agricultural
Getting The Units Straight

- Drift deposition function yield data with units of proportion of application depositing at distance $x$ from swath.
- Toxicological parameters are in units of $\mu g/L$ water.
Surface Area to Volume Translation
Graph Transformation

- Determine dimensions of water body trying to protect
- Change proportional deposition (fraction of applied) to surface area deposition (mg/m$^2$) and then factor in a depth (m)
  - $m^2 \times m = m^3$;
  - $1000 \text{ L} = m^3$
  - Transform mg to $\mu$g
- Transform axes to log-log scale
Concentration of Herbicide in Water At Various Downwind Distances from Spray Swath

AgDrift Model Simulation
Helicopter, 10 ft boom ht
10 mph wind, 86°F, 50% RH
25 ft wide stream, 1 ft deep

0.25 lb  1 lb AI/acre
Estimated Buffer Zone
Sulfometuron (OUST)
(Based on 0.01 x LC$_{50}$, Daphnia)
Case Study Showing Use of Risk Quotient Approach

Propargite

EPA Determined It “May Effect Salmon”
Simulated Aerial Application-- Propargite

(Stream ~9.8 ft wide x 1.6 ft deep)

Propargite (Comite) Parts Per Billion (ppb) in Water

Proposed 300 ft Buffer

Rainbow Trout LC50 = 118 ppb

Fathead Minnow NOAEC = 16 ppb

Daphnia NOAEC = 9 ppb

Distance from Last Spray Swath

@ RQ = 0.05

Buffer Zone

RQ = 0.1

(Stream ~9.8 ft wide x 1.6 ft deep)
Stream Assessment

Geometry

Spray Block
Spray Line Length: 328.08 ft
Turn-Around Time: 0 sec

Spray Block

Stream
Width: 9.84 ft
Depth: 1.64 ft
Flow Rate: 396.3 gal/s
Flow Speed: 2.24 mph

Distance from edge of application area to center of stream: 164.04 ft

Riparian Interception Factor: 0
Instream Chemical Decay Rate: 0 1/day
Recharge Rate: 0 gal/s/mi

Control
Calculate results at: a single point.

Provide one value and the others will be calculated.
Time: 0 sec  Distance: _______ ft  Peak Conc.: _______ ng/L (ppt)

Tier I Settings
Active Rate: 0.2505 lb/ac

Plot  Export  EXAMS  Calc  Close
Comite Residues in Flowing Water Following Simulated Aerial Application Using a 300-ft No-Spray Buffer
Fall chinook numbers highest ever

Largest numbers of adult salmon passing Bonneville Dam since counting started

By John Stang
Herald staff writer

The largest numbers of adult fall chinook since counting began have passed by the Bonneville Dam this year in their journey up the Columbia River to spawn.

The tally is about 474,000 salmon, the National Marine Fisheries Service announced Monday. NMFS began counting fish passing Bonneville in 1958.

That number does not include about 90,000 fall chinook estimated to be caught by sport and commercial fishermen in the Columbia River below Bonneville Dam, NMFS said.

Numbers were unavailable Monday for adult fall chinook passing Bonneville Dam last year. However, the annual average for the past 10 years has been about 203,000 fall chinook salmon.

This year's return includes about 40,000 jackels — adult fall chinook that return from the Pacific Ocean after one year instead of the normal three or four years. NMFS sees that number as an early indicator that a huge fall chinook return can be expected for 2003, said agency spokesman Brian Gorman.

About 80 percent of the returning fall chinook are hatchery fish that will return to the streams from which they were released as smolts.

Between 50 percent and 80 percent of the wild returning fall chinook are expected to try to return to the Hanford Reach to spawn. That translates to about 47,000 to 76,000 fish returning to the Reach if all survive the trip upriver past dams, fishermen and predators.

While various inland salmon revival efforts contributed, the main reason for the increased fall chinook numbers is naturally occurring favorable conditions in the Pacific Ocean, Gorman said.

The cyclical changes in air currents and temperatures over the Pacific have drawn deep water — laden with food for salmon — toward the surface for the fish to eat. Also, ocean temperatures have been more salmon friendly in recent years, he said.

Other anadromous fish species have made good showings this year as they pass Bonneville Dam to go upstream. The dam recorded 296,000 spring chinook, 127,000 summer chinook and 480,000 steelhead in 2002.

This year's steelhead count is the second largest ever, NMFS said, surpassed only by last year's total of 65,000.

Reporter John Stang can be reached at 582-1517 or via e-mail at jstang@tricityherald.com.
October flooding could take toll on salmon runs

By The Associated Press

Mount Vernon — Biologists and fish experts say last week's flooding and record rainfall in Western Washington might take a toll on future salmon runs.

That's because the rapid rush of floodwaters can churn up the nests salmon leave on the river bottom, destroying fragile eggs or leaving them open to predators.

"A week after eggs are laid in gravel, if you run a feather through them, you could kill a lot of eggs," said Curt Kraemer, a biologist with the state Department of Fish and Wildlife.

The actual impact won't be known until spring, when the state counts hatched fish, or possibly years later, when the fish return to spawn.

"We're pretty sure that it was not a good thing," Kraemer said. "How bad it will be remains to be seen."

About a million pink salmon — also known as humpies — made their way up the Skagit River this year, an exemplary run on one of the region's most critical rivers for the salmon.

The Skagit got hit with some of the area's worst flooding, which means many of the hundreds of millions of eggs in the river probably didn't survive the muddy, rapidly moving water.

"For a wild fish, I think the Skagit is overall the most important river in the state," said Fred Pelleman, an activist with the environmental group Ocean Advocates.

"We had buckets of fish returning this year.... All their progeny just got washed out to sea."
For More Information

- http://feql.wsu.edu
  - Food & Environmental Quality Lab
- http://wsprs.wsu.edu/
  - WA State Pest Management Resource Ctr.
- http://aenews.wsu.edu
  - Agrichemical & Environmental News
- afelsot@tricity.wsu.edu