Promoting Defensible Science in Aquatic Exposure Estimation by Integrating Landscape-Level Data into US Endangered Species Assessments

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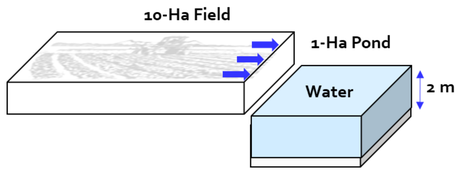
Introduction

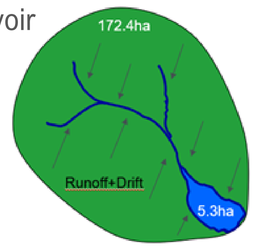
- The 1972 Endangered Species Act (ESA) requires the US Environmental Protection Agency (USEPA) to assess the (re)registration of pesticides for potential **jeopardy** to listed endangered and threatened species and/or **adverse modification** of species habitat (J/AM). Aquatic exposure modeling is a key component of this process.
- As part of its ESA assessment of pesticides, the USEPA prepares a **Biological Evaluation** (BE) (e.g., USEPA 2022) that uses the Pesticide in Water Calculator (PWC) to generate **worst-case aquatic exposure estimates**. If any listed species are determined to be potentially impacted by use of the pesticide, the USEPA submits the BE to the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) for their assessment of potential J/AM at a species level. This further assessment is called a **Biological Opinion** (BO) (e.g., NMFS 2024).
- Based on the BO, **avoidance measures** may be developed to mitigate the estimated effects of a pesticide to listed species. These **mitigations** are conveyed to growers through ESA-specific instructions on the product labels and/or by consulting a website maintained by the USEPA.
- Because the aquatic modeling generated for the BE does not account for **landscape or pesticide usage factors** that can significantly influence the potential for exposure, **further refinement of the baseline modeling** is essential to accurately inform the weight of evidence process used by the BO to determine J/AM.
- We present a **highly efficient, quantitative approach (PWC+)** that builds on the USEPA's baseline PWC aquatic modeling by improving the **spatial / temporal context and resolution** of exposure estimates and generates well-defined and reproducible **species-specific estimated aquatic concentrations** for use in BO J/AM assessments. The results identify sources and locations of potentially significant exposures, allowing for appropriately **targeted mitigations** where needed.

Upper Columbia River Steelhead Trout, Wenatchee Major Population Group (MPG)

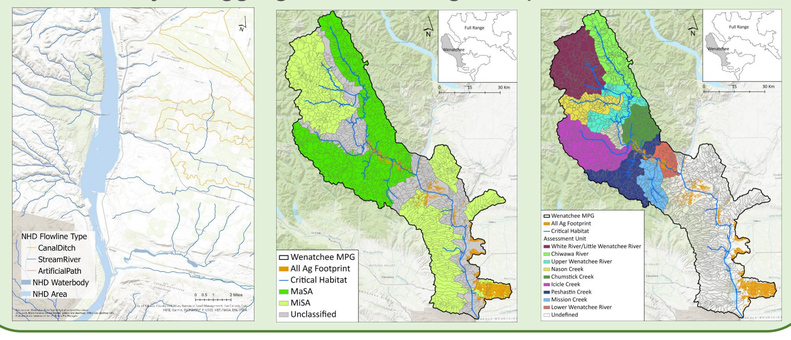
Baseline & Datasets

- The BE uses standard USEPA pesticide fate and transport models to develop conservative Estimated Exposure Concentrations (**EEC**s)
- Modeling represents a standardized set of crop / soil / weather scenarios
- Exposure estimates are based on 30 years of model simulation representing labeled uses of the pesticide
- Surface water scenarios are represented by:
  - Static water: field → pond
  - Flowing water: catchment → reservoir

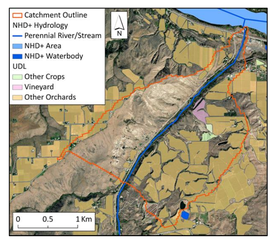


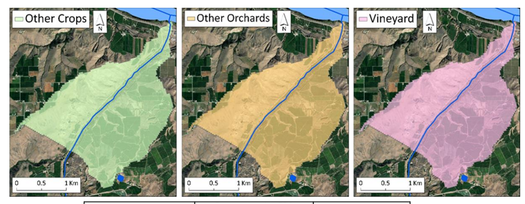


- PWC+ approach uses the National Hydrography Dataset (**NHD+)** for the basic unit of analysis
- NHD+ spatially defines and attributes over 2.6 million stream, ditch, canal, and river segments
- Spatial definition and attributes for ponds, lakes and reservoirs
- Also delineates the immediate land area (*i.e.*, catchments) draining to each flowline or static water body
- Post-analysis aggregation / filtering for species relevant scale



- The BE conservative baseline EECs assume:
  - 100% of the crop is directly adjacent to the water body
  - 100% of the catchment area is cropped
  - 100% of the crop is treated
- Example catchment - assumes catchment is 100% cropped with highest EEC value crop in crop class (Tree Nuts)
- PWC+ approach produces refinements to crop **density**, **proximity** and pesticide **usage** estimates based on actual landscape and crop production information





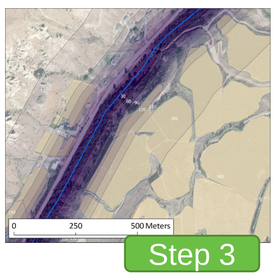
UDL	Representative EPA Scenario	Baseline EEC (µg/L)*
Other Orchards	Tree Nuts	64.6
Other Crops	Clover	18.3
Vineyard	Grapes	24.9

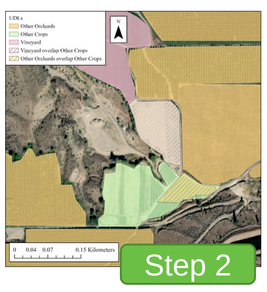
*Carbaryl, HUC 17b, bin 4, 1-day avg, water, 1-in-15 year

Catchment-Level GeoSpatial Assessment

- **Step 1** Baseline EECs from the BO that reflect conservative landscape and cropping factors
- **Step 2** Generate a single EEC that is representative of the pesticide use sites present in the catchment (accounting for crop "overlap")
- **Step 3** Include proximity of crop to aquatic habitats using Proximity Zones (**PZ**s)

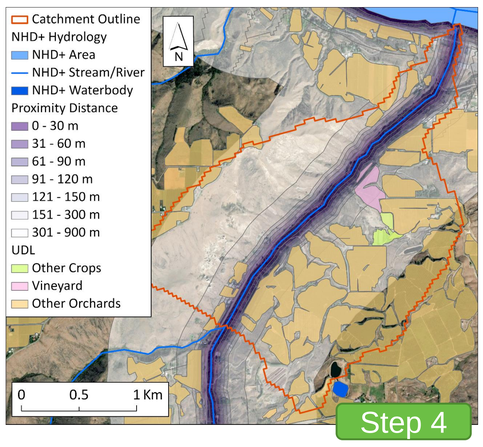
Proximity Zone Distance	Proximity Zone Area (ha)	% Catchment Area	Ag Composite Area (ha)	% Ag Composite Area
0-30m	20	4%	0	0%
31-60m	20	4%	<1	<1%
61-90m	19	4%	1	1%
91-120m	18	4%	4	2%
121-150m	18	4%	6	3%
151-300m	80	17%	28	16%
301-900m	247	51%	94	53%
>900m	61	13%	43	24%
	484	100%	176	100%



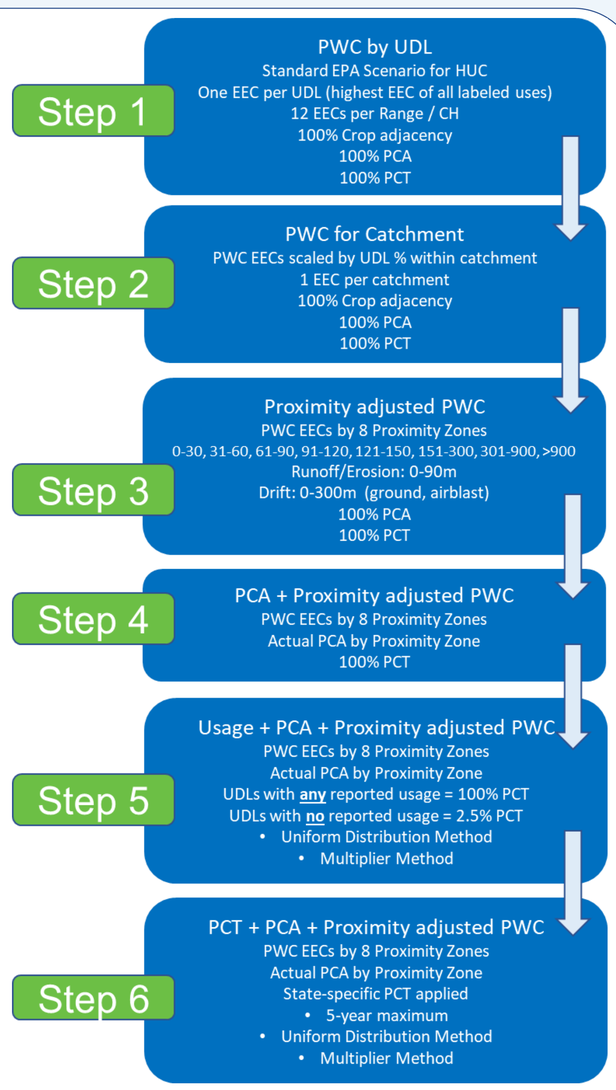


- **Step 4** Address cropping density with Percent Crop Area (**PCA**) in each PZ

Crop Class	Proximity Distance	Baseline EEC (ug/L)	PCA	EEC Contribution (µg/L)
Other Orchards			**38%**	**0.13**
	0-30m	64.6	0%	0
	31-60m	43.5	< 1%	0.00725
	61-90m	42.3	< 1%	0.11
	91-120m	0.334	< 1%	0.003
	121-150m	0.201	1%	0.00246
	151-300m	0.128	6%	0.00733
	301-900m	0	21%	0
	>900m	0	10%	0



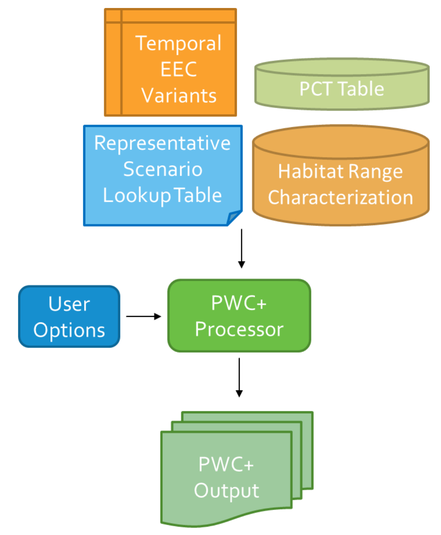
- **Steps 5 & 6** Incorporate state-level pesticide usage (*i.e.*, Percent Crop Treated or **PCT**) as a factor. Two steps (permutations) of PCT are generated that represent varying levels of uncertainty and the level deemed most appropriate for the J/AM assessment used in a BO.



UDL = **Use Data Layer**, a spatial representation of a crop or class of crops (*e.g.*: Corn, Orchards, Row Crops, etc.)

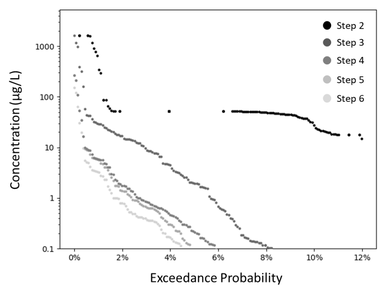
Implementation

- PWC+ implemented as Python scripts
- Uses ArcGIS Pro (ArcPy) for spatial operations
- Uses standard inputs:
  - PWC EEC output (post-processor)
  - Use-site spatial footprints (UDLs)
  - NHDPlus hydrology
- Flexible table-based inputs
- Efficient 2-stage execution: spatial (run once) & tabular (fast case-based runs)

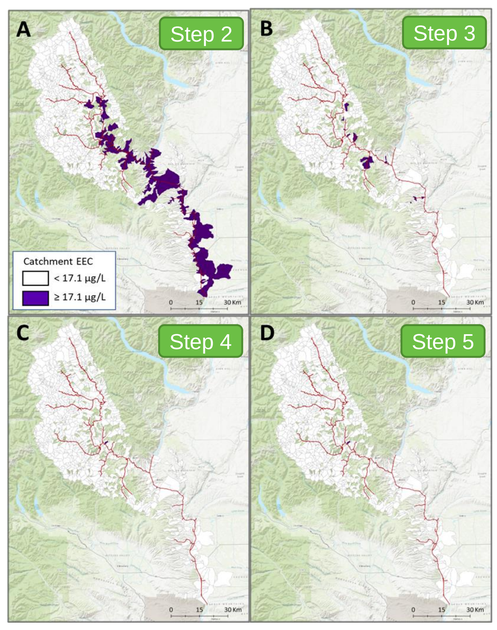


Species-Level Results

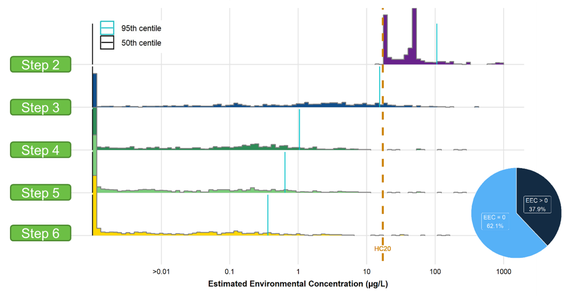
Exceedance probability of 1,353 catchments for the Steelhead Trout, Wenatchee Major Population Group at each PWC+ Step



Spatial distribution of catchments with effects threshold exceedances (invertebrate prey HC_{20} for carbaryl) for PWC+ Steps 2 - 5

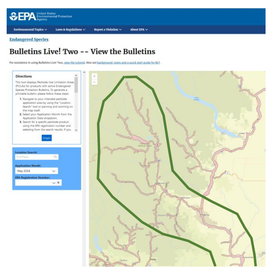


Frequency of effects threshold exceedances (*e.g.*, invertebrate prey HC_{20} for carbaryl) at each PWC+ Step



Concentrations shown are for HUC 17b, bin 2/4, 1-day avg, water, 1-in-15 year EEC

- Spatial definition of Pesticide Limitation Use Area (PULA) by NMFS. 300m buffer around habitat on Bulletins Live! Two EPA website



Portion of PULA on Bulletins Live! Two related to Wenatchee Major Population Group (green outline added for clarity)

- Based on PWC+ refined analysis, spatially-targeted mitigations can be proposed

Conclusions

- PWC+ approach maintains conservative assumptions from BE modeling, uses as a starting point
- Incorporates landscape variability where it can be quantified
- Addresses uncertainty with user options to provide context and customization
- Results show that aquatic concentrations based on screening level assumptions of pesticide use and hypothetical water body scenarios:
  - may occur at some locations at limited times
  - but are far less likely to occur within species range/habitat than is assumed in the baseline (BE) risk assessment

USEPA, 2022. Methomyl Registration Review Docket Folder. Docket ID: EPA-HQ-OPP-2010-0751. Available online at: https://www.regulations.gov/docket?D=EPA-HQ-OPP-2010-0751
NMFS, 2024. Conference and Biological Opinion on the Environmental Protection Agency's Registration Review of Pesticide Products containing Carbaryl and Methomyl. https://doi.org/10.25923/bdng-mp75
USEPA Bulletins Live! Two - https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

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Generic Endangered Species Task Force