Tracking Pesticide Impacts Over Time Using San Francisco's Hazard Tier System

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INTRODUCTION

Municipalities with IPM ordinances need a way to track progress in reducing pesticide impact over time. The metric chosen must be easy to use and understand. Ideally, it should be:

- Representative of actual impacts on human health and the environment
- Usable even with limited data
- Transparent and easy to understand

One option is to assign a rating to each pesticide product used. Other systems exist for agricultural use products (Pesticide Risk Mitigation Engine, and Environmental Impact Quotient), but there is a dearth of options for urban and suburban IPM.

We leveraged Pesticide Research Institute's pesticide databases and the San Francisco Hazard Tier Rating system to create the Pesticide Impact Index (PII) for the City of San Francisco.

DATA SOURCES

Environmental and Human Acute Scores

The Environmental Score and Human Acute Score are based on key phrases on the product label, and endpoints on the product MSDS (if available). For example, the Environmental Score **(ES)** for Fish is defined as follows:

Score	Label Statement		MSDS LD_{50} for product impacts (mg/L)
3	"highly toxic to fish"	or	LC_{50} <1
2	"toxic to fish"	or	LC_{50} > 1 and < 10
1	no fish toxicity warning	or	LC_{50} >10

The Human Chronic Score

The Human Chronic Score is based on the long-term risks, such as cancer, developmental, and reproductive toxicity.

Cancer risk is based on lists published by the IARC, NIH, EPA, and California Proposition 65.

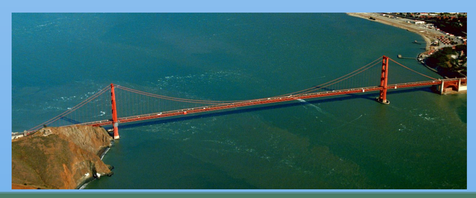
Developmental and reproductive risks are based on the California Prop 65 list, the EPA Toxic Release Inventory list, and the data published in EPA's risk assessments.

Score	Value for Cancer Rating	Value for Dev/Rep Rating
3	known or probable carcinogen	reproductive or developmental toxin
1	not likely or not listed	no data have been published indicating dev/repro toxicity

Water Pollution Potential Score

Water Pollution Potential is based on the aerobic half life and Koc of the chemical (which represents soil mobility), and the percent of the ingredient in the product. The calculation applies the maximum of the values for all ingredients, including active and inert ingredients.

See Methods for the **Water Pollution Potential** calculation.



METHODS

The Impact Index for a single pesticide application is the product of the Impact Score and the pounds of product applied.

Impact Index = Impact Score * Pounds Applied

The Impact Score is the sum of four component scores, divided by a factor of 100 for **low-toxicity** pesticide products.

$$\textbf{Impact Score} = \frac{(ES + HCS + HAS + WPPS)}{\text{Low Toxicity Factor}}$$

The Environmental Score and Human Acute Score are based on component scores, which are determined by examining the product label and MSDS. See **Data Sources.**

The scores are the average of their components:

- Environmental Score **(ES)**: ∑ (Fish + AqInvert + AqOrgs + Birds + Bees)/5
- Human Acute Score **(HAS)** = ∑ (Skin + Eye + Dermal + Oral + Inhalation + Sensitization)/6

The Human Chronic Score is based on cancer, developmental, and reproductive toxicity. **See Data Sources.**

- Human Chronic Score **(HCS)** = ∑ (Cancer + DevRep)/2

The Water Pollution Potential (WPP) score is based on the Groundwater Ubiquity Score (GUS) and the percent of the ingredient:

WPP Value = log (% ingredient in formulation) + GUS,
where GUS = log (aerobic half-life) + 4 - log (Koc)

Water Pollution Potential Score (**WPPS**):

1: WPP Value ≤0.8
2: 1.8 ≥ WPP Value > 0.8
3: WPP Value >1.8 or CA DPR classifies as a potential water pollutant

Low Toxicity Factor: A factor of 100 is applied to products for which every ingredient is considered low toxicity. Low toxicity ingredients are those for which EPA waived data requirements because of low toxicity.

RESULTS AND DISCUSSION

In order to assess the Pesticide Impact Index, we compared our results to the Environmental Impact Quotient (EIQ). To most accurately model risk, we also selected representative hazard quotients from risk assessments and summed them to create a ranking for the pesticide products. We chose five herbicides to compare using the PII and these two methods.

Advantages of PII over EIQ

The Environmental Impact Quotient (EIQ) is a common index used to assess impact and track impact over time. Pesticide Impact Index:

- Is product-specific, rather than active ingredient-based
- Encompasses indoor-use products and other non-agricultural-use products
- Accounts for low toxicity products
- Is easily reproducible; inputs are publicly available
- Produces similar results with agricultural-use herbicides
- Includes all pesticide chemicals, rather than a limited set

Comparison with Risk Assessments

The best possible estimate of impact comes from quantitative risk assessments, because they provide accurate estimates of actual exposure. The risk assessments featured were developed by the US Forest Service.

This set of risk assessments is **more accurate** than EIQ and PII when ranking relative impacts associated with Savana and Roundup Ultra Herbicide.

An index based on scores and summed across criteria (environmental impacts, human health impacts), such as PII and EIQ, may fail to capture large differences in relative risk. A score of 3 is not very different from a score of 1 in an index that sums 4 scores. The Pesticide Impact Index balances accuracy and administrative simplicity.

When should I use PII and when should I use EIQ to assess impact?

PII

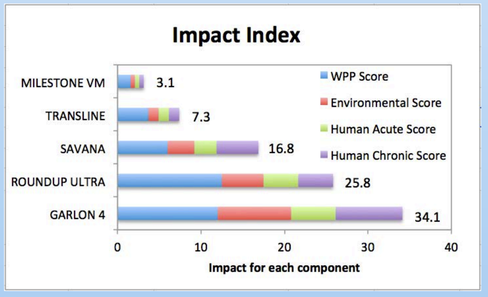
- Tracking pesticide use over time
- Urban settings
- Include the effects of "inert" ingredients
- Pesticide **product** use in **pounds** is available

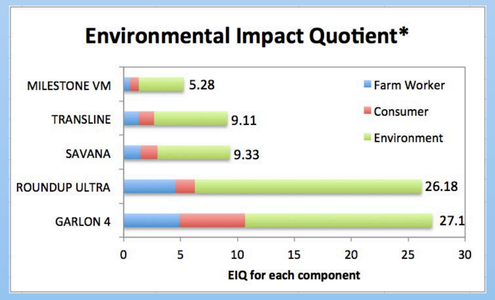
EIQ

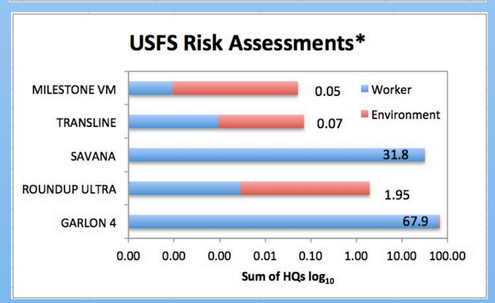
- Comparing pesticide chemicals in known conditions
- Agricultural use
- Pesticide **chemical** use in **pounds per acre** is available

Use the Pesticide Risk Mitigation Engine to assess risk in agricultural systems.

Comparison of Relative Impact/Risk For Selected Herbicides



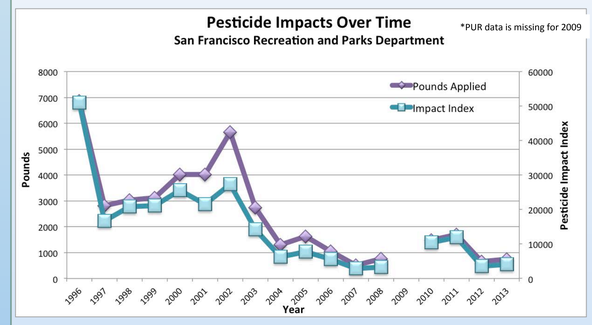




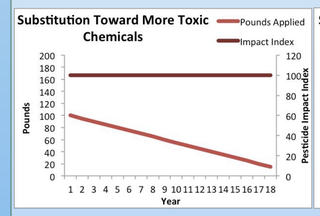
*Water Pollution Potential is accounted for through estimates of runoff as it may affect aquatic life (EIQ and USFS) and groundwater contamination (EIQ).

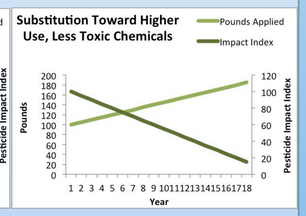
IMPACT INDEX IN ACTION

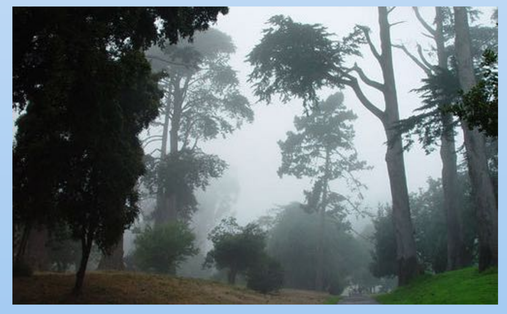
The Impact Index is calculated for each pesticide application, and then summed over the year to create a representation of the change in impact over time.



These data show that San Francisco Recreation and Park Department is reducing pesticide use over time, and selecting lower toxicity products. This scenario can be compared with two hypothetical scenarios, below.







NEXT STEPS

- Refine the index to optimize correspondence with quantitative risk assessments
- Compare PII to PRiME
- Gather data for low toxicity pesticide products and inert ingredients
- Develop graphics to effectively communicate trends in pesticide impacts over time to diverse audiences

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