Potential designated chemicals: Organophosphorus pesticides

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Presentation to the Scientific Guidance Panel
July 20, 2017

OEHHA

BIOMONITORING CALIFORNIA

Designated chemicals

- Chemicals that can be considered for biomonitoring by the Program

- Chemicals are designated based on:
  - Inclusion in CDC's National Reports on Human Exposure to Environmental Chemicals program
  - Recommendations by the Scientific Guidance Panel (SGP) for Biomonitoring California

Organophosphate insecticides on designated list

- Some organophosphate insecticides are already on the list
  - Based on inclusion in CDC's National Reports on Human Exposure to Environmental Chemicals program

- Examples currently used in California include:
  - Acephate
  - Chlorpyrifos
  - Diazinon
  - Dimethoate
  - Malathion
  - Naled

Organophosphorus pesticides

- Structure-based definition of class:
  Phosphorus-containing organic compounds used as pesticides*

- Class encompasses:
  - All organophosphates already on the designated list
  - Other sub-classes, such as organophosphinates and organophosphonates
  - Any organophosphorus pesticide in current use, or introduced in the future

*The term “pesticides” includes herbicides, insecticides, fungicides, plant growth regulators, and other types of chemicals intended to control, destroy, repel, or attract a pest.

SGP actions on organophosphorus pesticides

- March 2009: SGP recommended that all organophosphate insecticides that were already designated be added to the list of priority chemicals

- July 2016: Preliminary screening of three pesticide classes reviewed by SGP
  - Panel recommended that OEHHA prepare a potential designated chemical document on organophosphorus pesticides

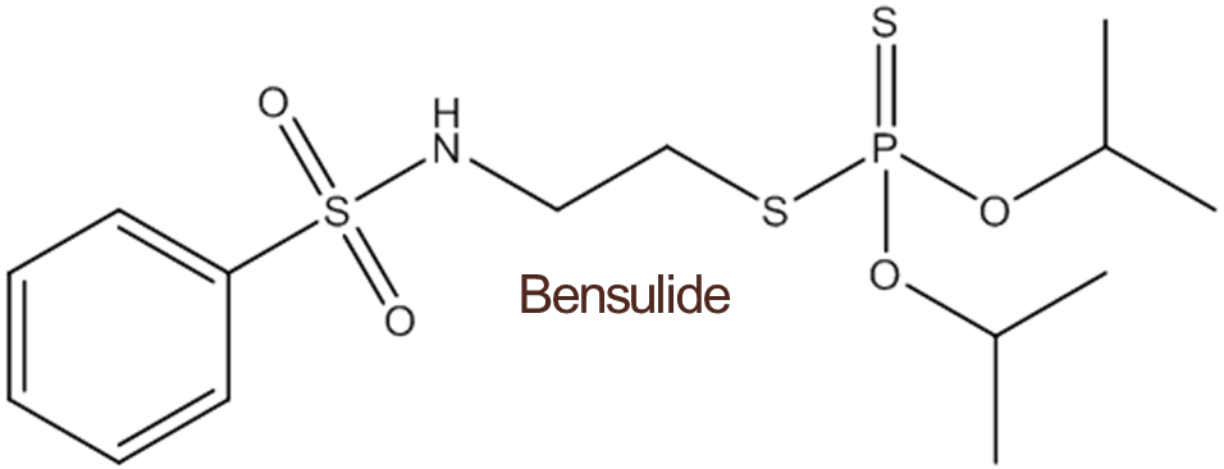
Criteria for recommending designated chemicals

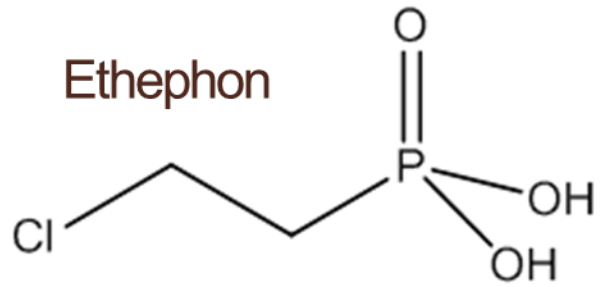
- ***Exposure or potential exposure*** to the public or specific subgroups
- The ***known or suspected health effects*** resulting from some level of exposure based on peer-reviewed scientific studies
- The ***need to assess the efficacy of public health actions*** to reduce exposure to a chemical
- The ***availability of a biomonitoring analytical method*** with adequate accuracy, precision, sensitivity, specificity, and speed
- The ***availability of adequate biospecimen samples***
- The ***incremental analytical cost*** to perform the biomonitoring analysis for the chemical

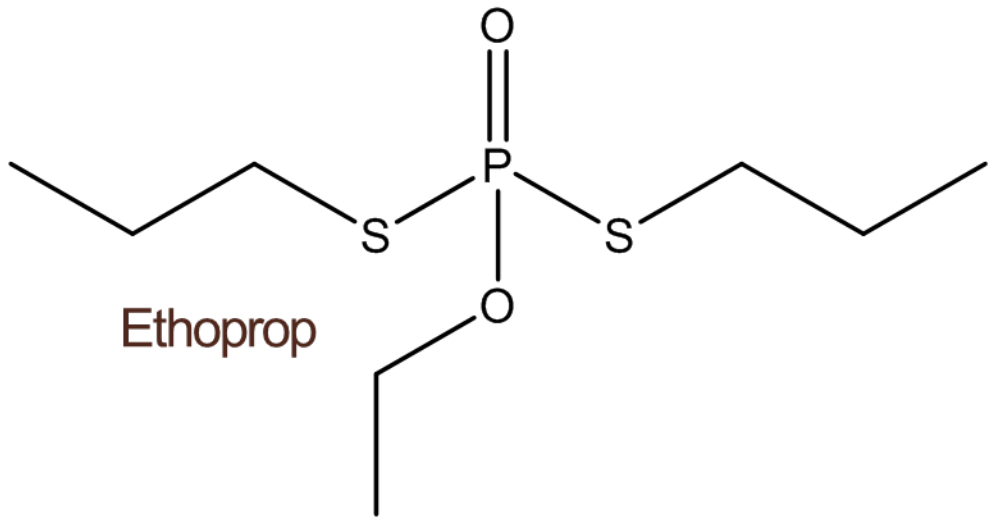
Highlighted organophosphorus pesticides

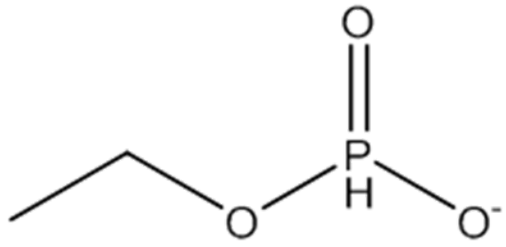
- Reviewed seven organophosphorus pesticides currently in use in California:
  - Bensulide
  - Ethephon
  - Ethoprop
  - Fosetyl-aluminum
  - Glufosinate-ammonium
  - Glyphosate
  - S,S,S-Tributyl phosphorotrithioate (tribufos)

Highlighted organophosphorus pesticides

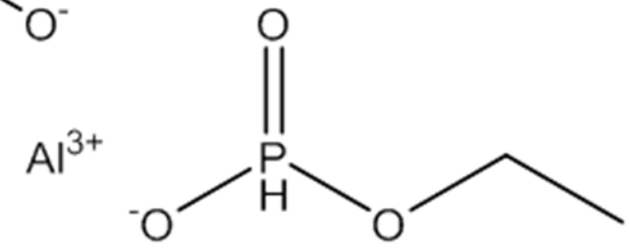


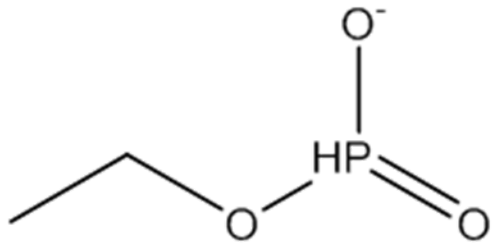




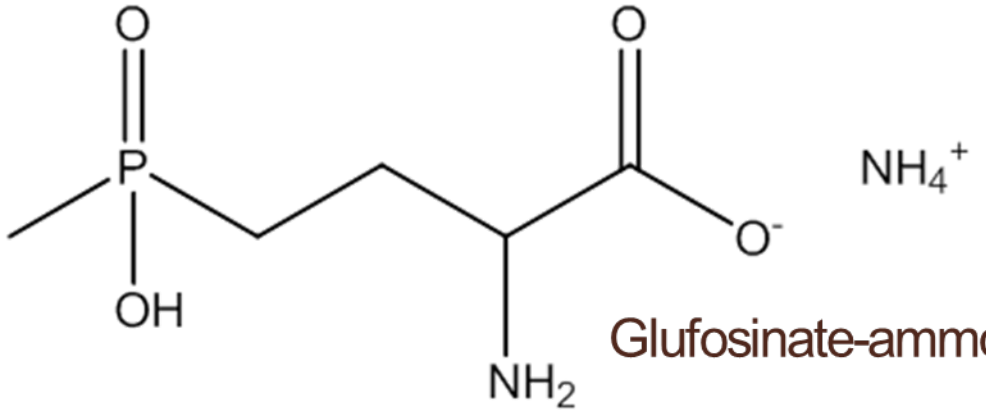


Fosetyl-aluminum

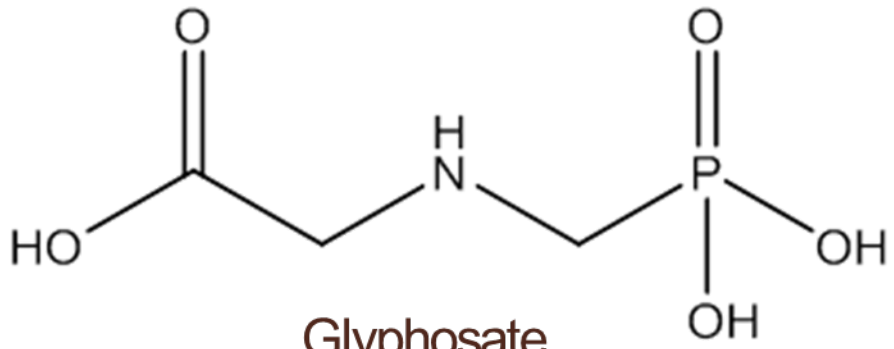




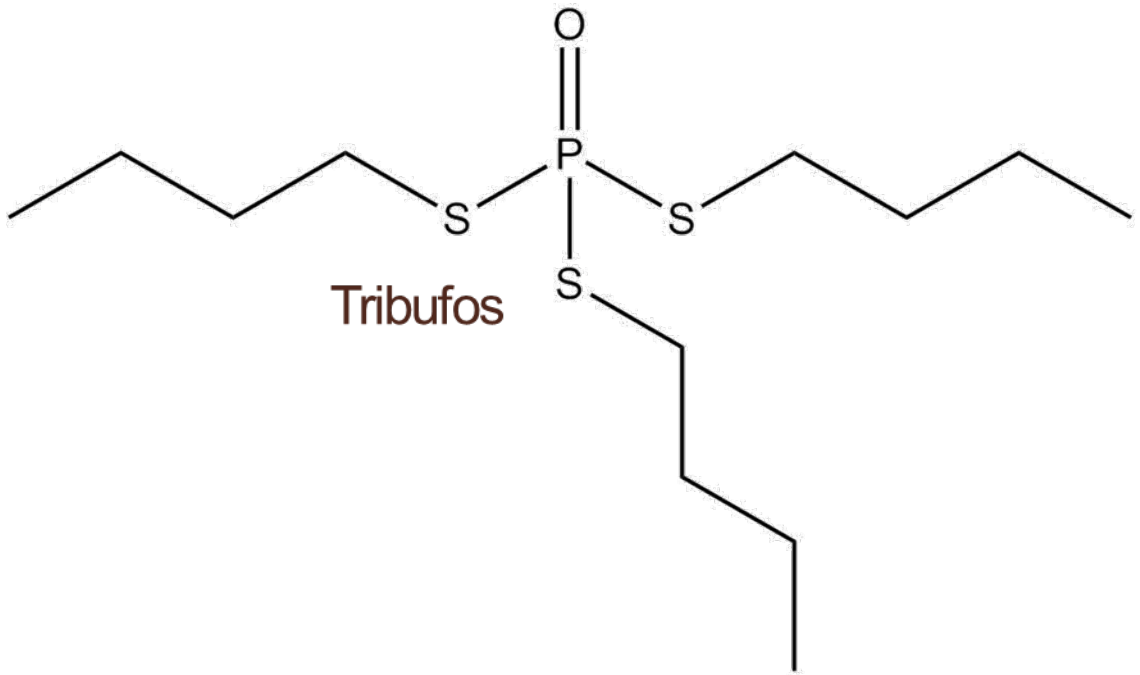
Highlighted organophosphorus pesticides



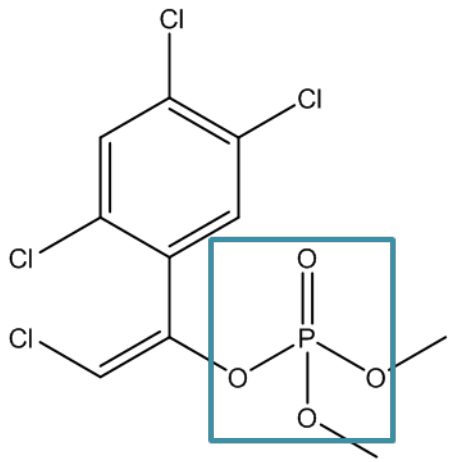
Glufosinate-ammonium



Glyphosate



Tribufos



Tetrachlorvinphos
-Organophosphate structure for reference-

Agricultural pesticide use* in California

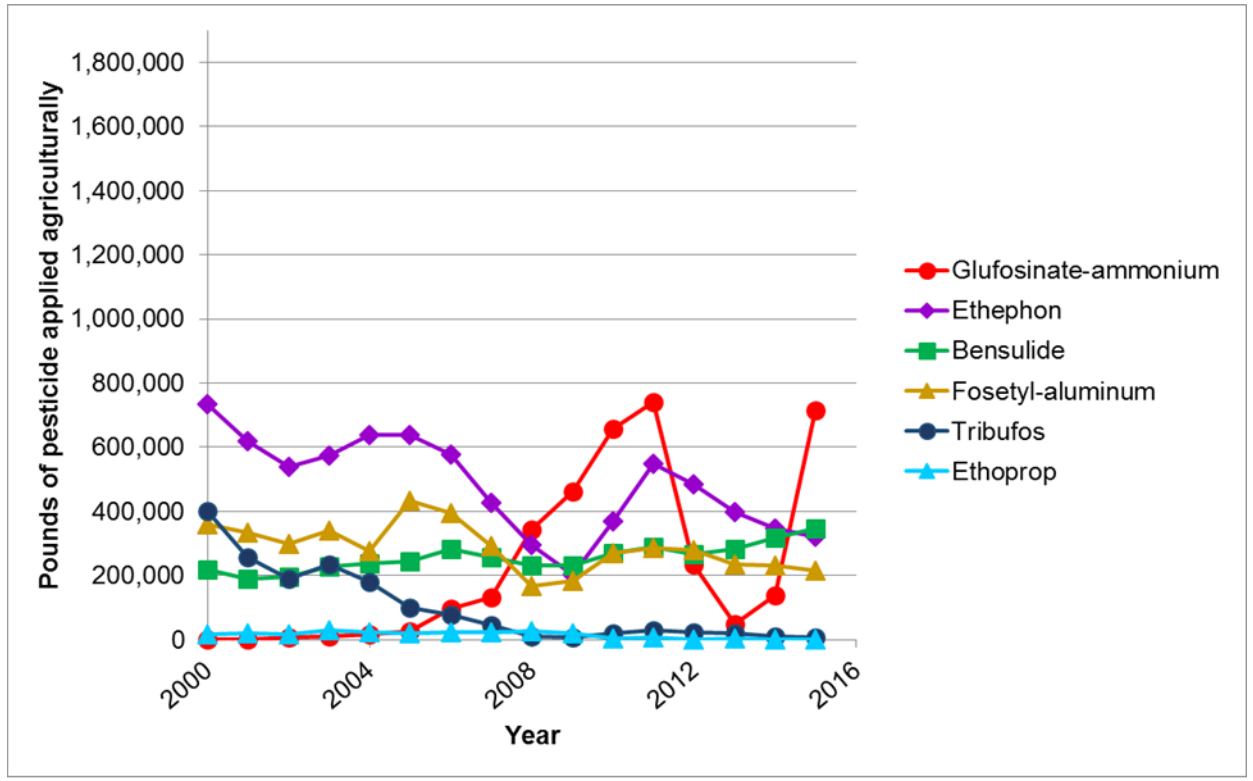
Highlighted organophosphorus pesticide -Not yet designated-	Rank in top 100 pesticides used agriculturally in 2015
Glyphosate, potassium salt	7
Glyphosate, isopropylamine salt	8
Glufosinate-ammonium	33
Bensulide	57
Ethephon	58
Fosetyl-aluminum	77
Ethoprop	--
Tribufos	--

A double dash (--) indicates pesticide does not rank in top 100.

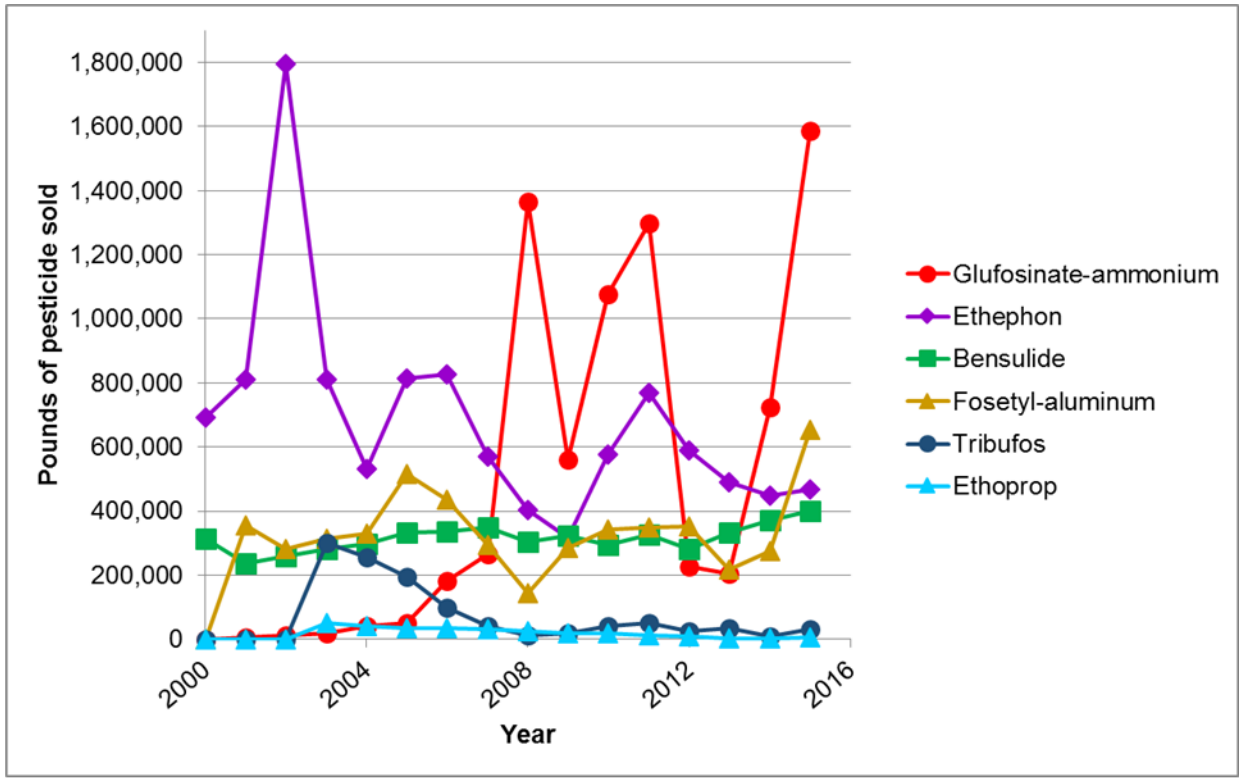
*From reports compiled annually by the California Department of Pesticide Regulation (DPR)

Time trends: Agricultural use and pounds sold in California

Agricultural pesticide use



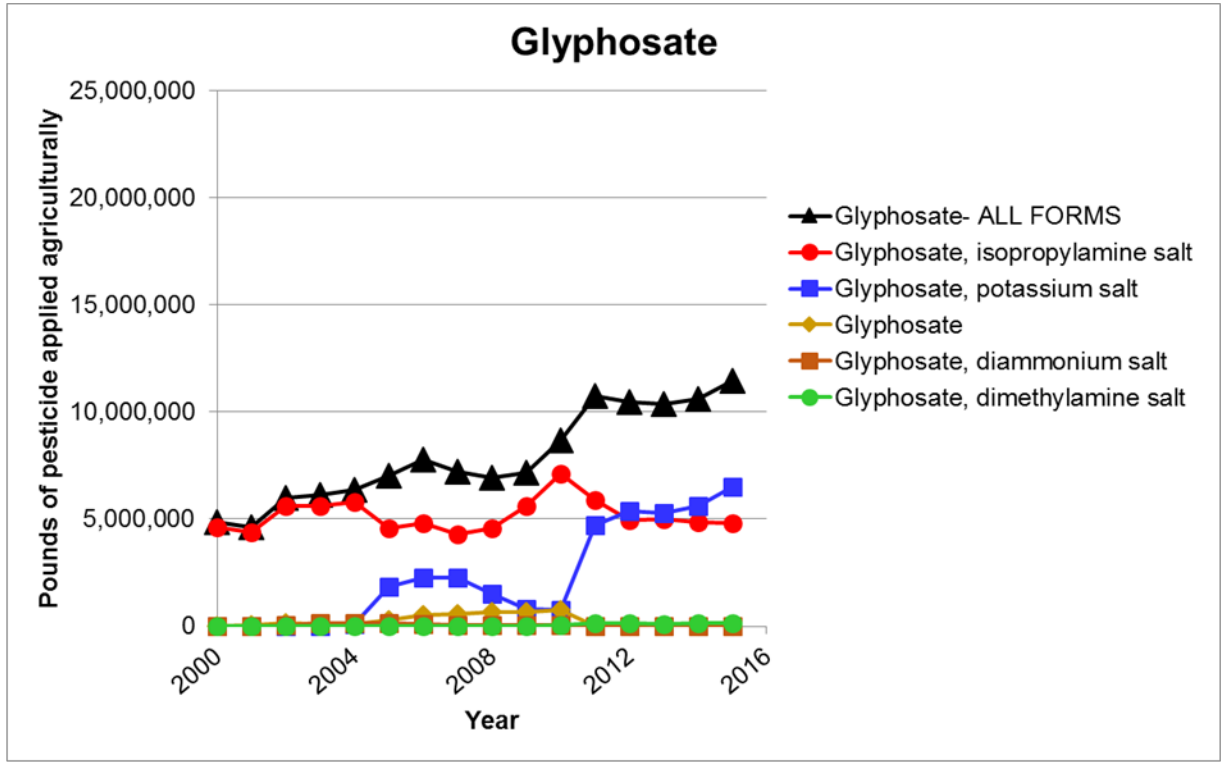
Pesticide pounds sold



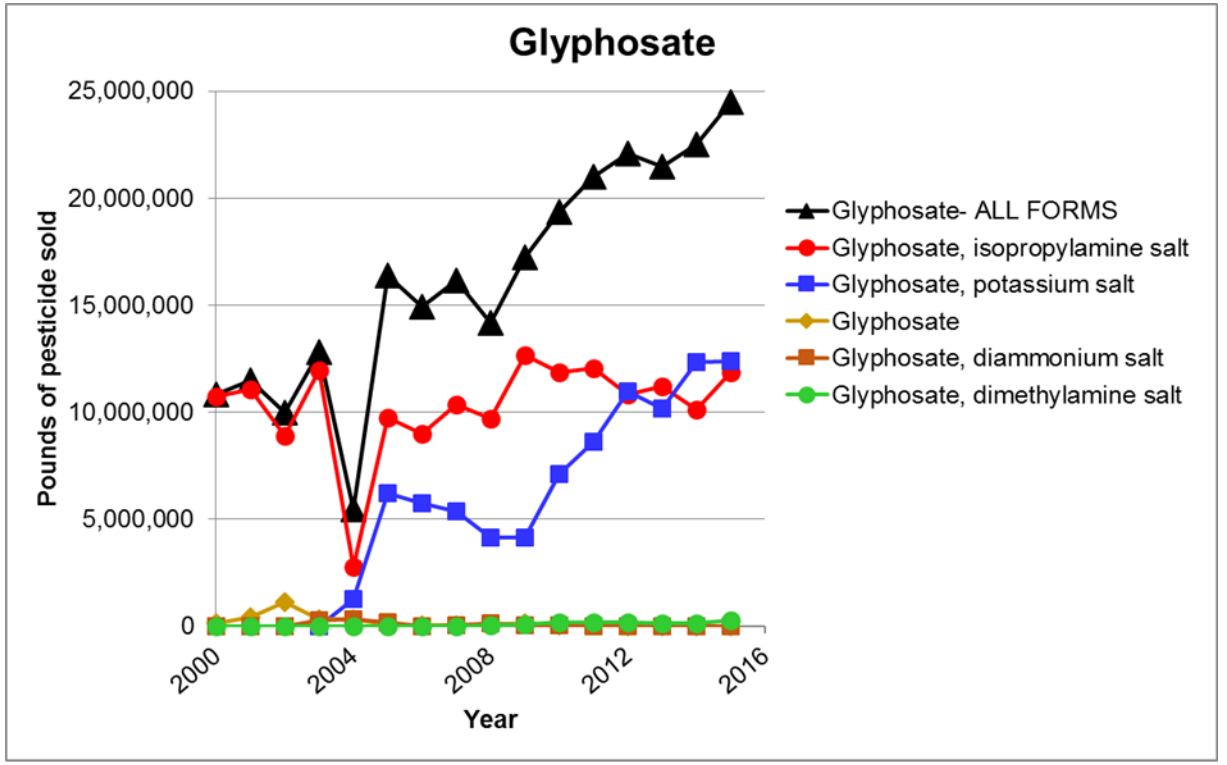
Use and sales information from reports compiled annually by DPR

Glyphosate time trends

Agricultural pesticide use



Pesticide pounds sold



Use and sales information from reports compiled annually by DPR

Organophosphorus pesticides: Retail products/home use

- Herbicides for gardens and lawns – glufosinate-ammonium and glyphosate
- Herbicide for turf – bensulide
- Plant growth regulator – ethephon
- Fungicide for plants and lawns – fosetyl-aluminum

- *No retail products with ethoprop or tribufos due to restrictions*

Detections in environmental media in California

- Air: one detection of bensulide
  - Salinas – < LOQ, 2015
- Drinking water: two detections of glyphosate
  - Imperial Irrigation District – 16.5 µg/L, 2005
  - City of Bakersfield – 32 µg/L, 2006
- Groundwater: two detections of glyphosate
  - Los Angeles County – 1.3 µg/L, 2009
  - Santa Barbara County – 20 µg/L, 2013

Organophosphorus pesticides: Known or suspected health effects

- Potential toxicity concerns include:
  - Neurotoxicity
  - Carcinogenicity
  - Developmental effects
  - Endocrine effects
  - Respiratory effects

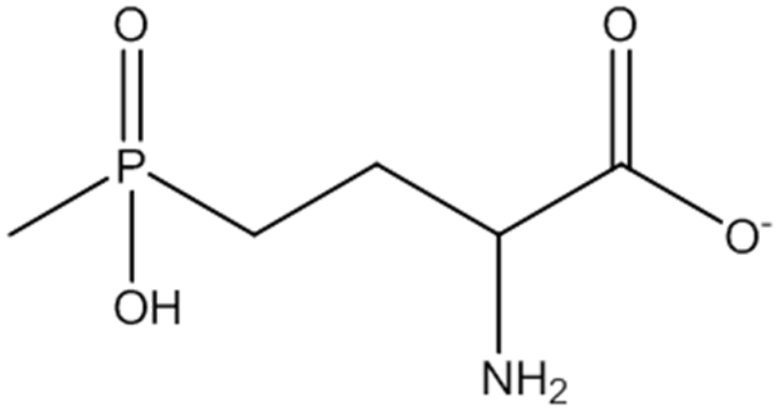
Proposition 65 and IARC classifications for organophosphorus pesticides

	Organophosphorus pesticide	Proposition 65		IARC classification*
		Carcinogen	Reproductive toxicant	
Highlighted pesticide not on designated list	Ethoprop	✓	--	Not classified
	Glyphosate	✓	--	Group 2A
	Tribufos	✓	--	Not classified
Pesticide already on designated list	Diazinon	--	--	Group 2A
	Dichlorvos (DDVP)	✓	--	Group 2B
	Malathion	✓	--	Group 2A
	Oxydemeton-methyl	--	Reproductive – female, male	Not classified
	Parathion	✓	--	Group 2B
	Tetrachlorvinphos	✓	--	Group 2B

*Group 2A – "probably carcinogenic to humans"
Group 2B – "possibly carcinogenic to humans"

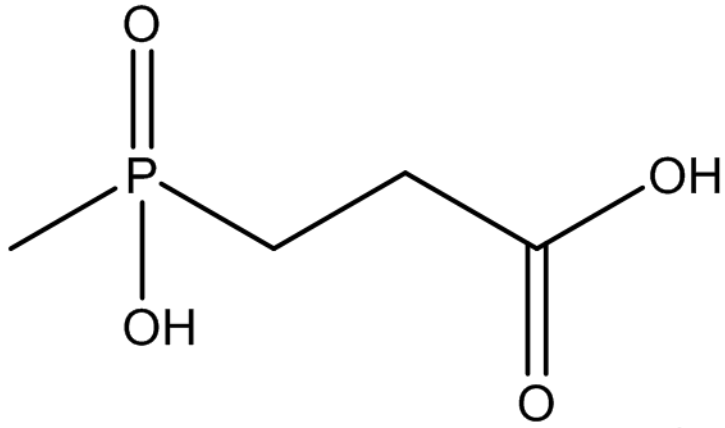
Potential to biomonitor

Structures of selected metabolites/breakdown products

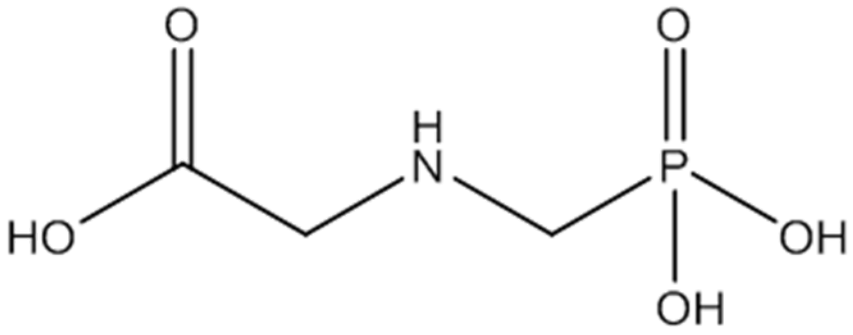


Glufosinate-ammonium

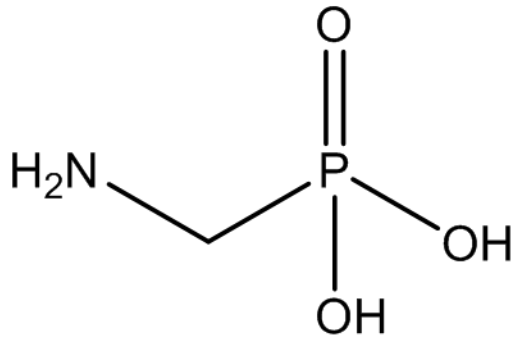
NH_4^+



3-Methylphosphinicopropionic acid (3-MPPA)
-Major human metabolite and breakdown product-

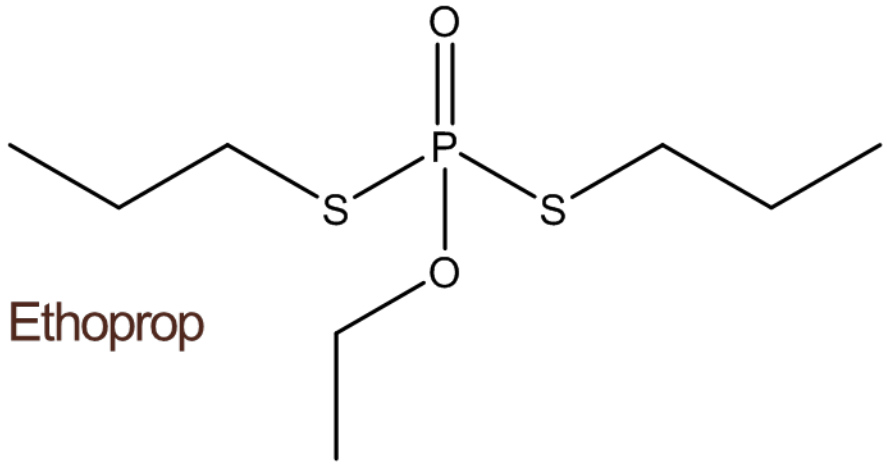


Glyphosate

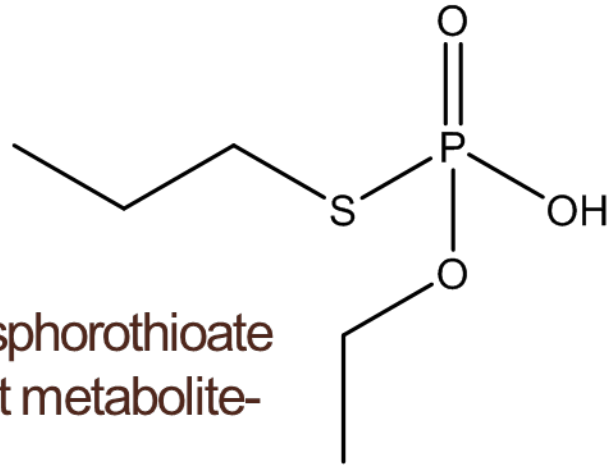


Aminomethylphosphonic acid (AMPA)
-Human and plant metabolite, and breakdown product-

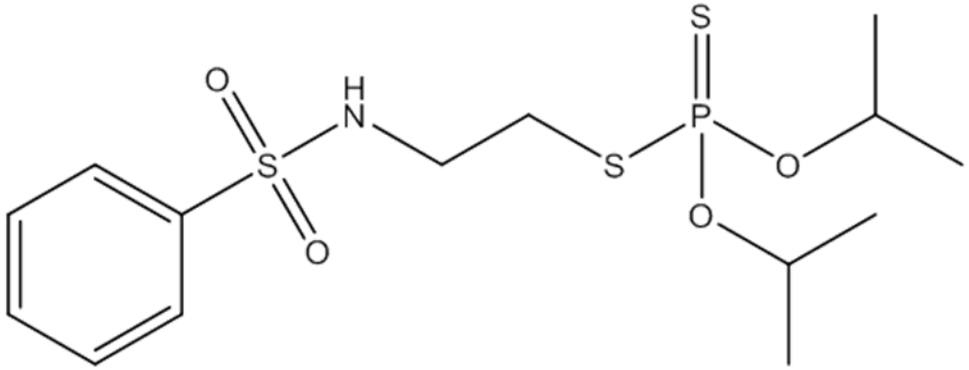
Structures of selected metabolites/breakdown products



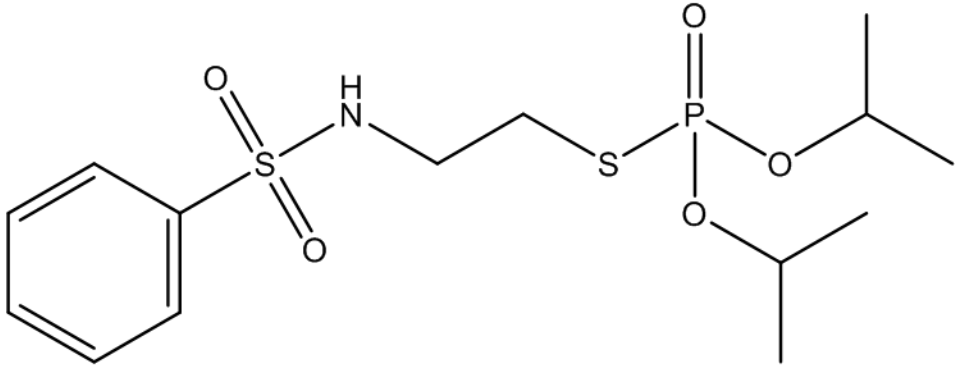
Ethoprop



O-Ethyl-S-propyl phosphorothioate
-Major human and rat metabolite-



Bensulide



Bensulide oxon
-Rat metabolite and breakdown product-

Past biomonitoring studies

Organophosphorus pesticide	Detected in serum	Detected in urine
Bensulide	✓	--
Ethoprop	✓	--
O-Ethyl-S-propyl phosphorothioate	--	✓
Glufosinate-ammonium	✓	--
3-MPPA	✓	--
Glyphosate	✓	✓
AMPA	NF	✓
Tribufos	✓	--

Double dash (--) means that no biomonitoring studies were located
NF: Looked for and not found in one study

Bioaccumulation on selected pesticides

Organophosphorus pesticide	Log K_{ow}	Additional comments
Bensulide	4.2	Does not appear to have the potential to significantly bioaccumulate in fish (BCF of 550 in fish).
Tribufos	5.7	May accumulate in exposed aquatic (BCF in fish of 730) or terrestrial organisms. Metabolism and rapid elimination are expected to mitigate the bioaccumulation concern.

Potential concern for bioaccumulation indicated by:

- Log K_{ow} (log octanol-water partition coefficient) of ≥ 4
- BCF (bioconcentration factor) of >1000

Environmental persistence

Organophosphorus pesticide	Soil half-lives*	Additional comments
Bensulide	• 27-44 days • 1 year	• Predicted to be extremely persistent in terrestrial ecosystems
Ethoprop	• 100 days	• Dissipation rates in soil faster than expected given the long soil half-life • Moderately to strongly persistent in the environment
Glufosinate-ammonium	• ~8-23 days	• Degrades in soil to 3-MPPA • Residues may persist in aquatic environments
Glyphosate	• ~2-5 days	• Persists longer in soil under cool and dry conditions, compared to warm and wet conditions • Degrades in soil to AMPA, which persists longer in soil than glyphosate
Tribufos	• ≥ 60 days • 745 days	• Appears to be more persistent than is typical for other chemicals in this class

*Each bullet shows results from one study

Analytical considerations

- CDPH's Environmental Health Laboratory currently measures:
  - Two specific urinary metabolites of organophosphate pesticides:
    - 3,5,6-Trichloro-2-pyridinol (metabolite of chlorpyrifos and chlorpyrifos-methyl)
    - 2-Isopropyl-6-methyl-4-pyrimidinol (metabolite of diazinon)
  - Four non-specific dialkyl phosphate (DAP) metabolites

- Additional method development would be required for Biomonitoring California to measure any of the highlighted organophosphorus pesticides

Assessing efficacy of public health actions to reduce exposure

- Adding the class of organophosphorus pesticides as designated chemicals would allow the Program to:
  - Select any member of the class to be included in a future study
  - Have the flexibility to choose analytes appropriate to the particular scenario of interest
  - Track the levels of exposure and how they change over time and by region
- The results of biomonitoring studies can inform ongoing state efforts to reduce pesticide exposures of concern

Options for the Panel

- Recommend adding “organophosphorus pesticides” as a class to the list of designated chemicals
- Defer, pending more information
- Recommend against adding organophosphorus pesticides as a class to the list of designated chemicals