Total Maximum Daily Loads for the San Joaquin River: Organophosphorus Pesticides & Salt and Boron

CVRWQCB
San Joaquin River TMDL Unit
Workshop Agenda

• Morning Session:
  Organophosphorus Pesticide TMDL
  – Welcome and Introductions
  – Overview of Regional Board’s TMDL Development Process and Timelines
  – Organophosphorus Pesticide TMDL
    • Staff presentation
    • Questions and discussion

• Afternoon Session: Salt and Boron TMDL
What Is a TMDL and Why Do One?

- TMDL = Total Maximum Daily Load
- TMDLs are required under section 303(d) of the Federal Clean Water Act
  - TMDLs must be developed for pollutants and waterbodies that have been identified on 303(d) list of impaired waterbodies
What Is a TMDL?

• A total maximum daily load (TMDL) is the amount of a specific pollutant that a waterbody can receive and still maintain a water quality standard

• TMDLs allocate pollutant loads to point and nonpoint sources…
What Is a TMDL?

- TMDL = WLA + LA + MOS + background

  WLA: waste load allocation for point sources
  LA: load allocations for nonpoint sources
  MOS: margin of safety
Components of TMDLs

- TMDL Description (Problem Statement)
- Numeric Targets (will often be new water quality objectives)
- Source Analysis
- Allocations
- Linkage Analysis (relationship between sources, allocations, and targets)
- TMDL Report

*Implementation Plan*
### TMDL Timeline

#### Current Activities

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<tbody>
<tr>
<td>San Joaquin River</td>
<td>Selenium, Salt &amp; boron</td>
<td>Diazinon &amp; chlorpyrifos</td>
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<tr>
<td>Delta</td>
<td></td>
<td></td>
<td>Dissolved oxygen, Diazinon &amp; chlorpyrifos, Mercury</td>
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<td>Sacramento River</td>
<td>Copper, zinc, &amp; cadmium</td>
<td>Diazinon</td>
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<td>Clear Lake</td>
<td>Mercury</td>
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<td>Cache Creek</td>
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<td>Mercury</td>
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San Joaquin River TMDLs
Actual Completion Dates

- Selenium TMDL: August 2001
- Salt and Boron TMDL: January 2002
- Organophosphorus TMDL: on time
San Joaquin River
Organophosphorus (OP) Pesticides TMDL Workshop

Source Analysis

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Emilie Reyes
Matthew McCarthy
Daniel Leva
San Joaquin River TMDL Unit
Topics to be Covered

• TMDL Components & Timeline
• Background Information
• Source Analysis
  – Pesticide Application
  – Mass Loading
  – Sources of OP Pesticide
• Next Steps
Project Area for OP Pesticides TMDL

- Stanislaus River
- Tuolumne River
- Merced River
- Salt Slough
- Mud Slough
- Modesto
- Vernalis
- Patterson
- Mendota Dam
- San Joaquin River
- Orestimba Creek
- Salt Slough
- Modesto
- Patterson
- Stevinson
SJR OP Pesticide TMDL Timeline
July 2000 to July 2001
SJR OP Pesticide TMDL Timeline
July 2001 to June 2002

- In-Season Monitoring
- Draft Source Analysis (workshop)
- Synoptic Study
- Draft Load Allocation (workshop)?
- Dormant Spray Monitoring
- Draft TMDL Report and Implementation Framework (workshop)
- Final TMDL Report

2001

Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun 2002
Components of TMDL

- TMDL Description (Problem Statement)
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL REPORT
- Implementation Plan
Components of TMDL

• TMDL Description (Problem Statement)
• Numeric Target

Completed and available on web:
Components of TMDL

- TMDL Description (Problem Statement)
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL REPORT
- Implementation Plan
### Results of Target Analysis: Recommended Targets

**U.S.EPA Method as used by CDFG**

<table>
<thead>
<tr>
<th></th>
<th>Diazinon (ng/L)</th>
<th>Chlorpyrifos (ng/L)</th>
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<tr>
<td>Acute</td>
<td>80</td>
<td>Acute</td>
</tr>
<tr>
<td>Chronic</td>
<td>50</td>
<td>Chronic</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>14</td>
</tr>
</tbody>
</table>

*Note 80 ng/L = 0.08 ug/L*
Background Information

• Where we are?
  – SJR near Vernalis (10 years – 1991 to 2001):
    • Diazinon acute criteria exceeded 85 times
    • Chlorpyrifos acute criteria exceeded 11 times

• Where do we need to be?
  – EPA guidance for calculating design flows to protect aquatic life: acute water quality objective should not be exceeded more than once every three years
Number of Days Chlorpyrifos Sampled For in San Joaquin River Basin 1991-2001

only samples where detection limit is below the chronic criteria are included
Number of Days ChlorpyrifosObserved to Exceed Acute
Criteria (0.025 ug/L) in SJR Basin

- Stanislaus River
- Tuolumne River
- Del Puerto Creek
- Orestimba Creek
- Merced River
- Mud Slough
- Salt Slough
- SJR @ Paterson
- SJR @ Stevenson

# of Days with Exceedances

- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
only samples where detection limit is below the chronic criteria are included
Number of Days Diazinon Observed To Exceed Acute Criteria (0.08 ug/L) in SJR Basin
Number of Days Chlorpyrifos Observed to Exceed Acute Criteria (0.025 ug/L) in SJR Basin

- SJR @ VERNALIS
- SJR @ PATTERSON
- SJR @ STEVINSON

# of Days with Exceedances

- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
Number of Days Diazinon Observed To Exceed Acute Criteria
(0.08 ug/L) in SJR Basin

- SJR @ VERNALIS
- SJR @ PATTERSON
- SJR @ STEVINSON


# of Days With Exceedances

1991: 1
1992: 1
1993: 1
1994: 2
1995: 1
1996: 1
1997: 1
1998: 1
1999: 1
2000: 1
2001: 45
Number Of Acute Criteria Exceedances Allowed By EPA

- Number Of Days With Exceedances
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001

SJR @ VERNALIS
SJR @ PATTERSON
SJR @ STEVINSON
Source Analysis Study

Objective:
- To identify the sources of OP pesticides so we know where reductions must occur

Approach:
- Divide the watershed into geographic sub-areas
- Use monitoring data to determine loading from sub-areas
Potential Sources of Chlorpyrifos and Diazinon

Agricultural
- *Winter Dormant Spray Storm Runoff*
- *Summer Irrigation Tailwater Runoff*

Urban
- *Urban Storm Runoff*

Atmospheric Deposition
Drift From Different Applications
Improper Mixing and Loading Practices
Data Considered in Source Analysis

- Pesticide Use
- Flow
- Concentration
Pesticide Use

- Agricultural
- Urban
  - Structural Pest Control
  - Landscape Maintenance
  - Private Citizen (unreported)
- Unreported
San Joaquin River Basin
Chlorpyrifos Use (PUR Reported Use)
San Joaquin River Basin
Diazinon Use (PUR Reported Use)

Pesticide Applied (lbs)

Agricultural
Urban

San Joaquin River Basin Chlorpyrifos and Diazinon Agricultural Use

Pesticide Applied (lbs)

- Chlorpyrifos
- Diazinon

Pesticide Use* on Different Crops
Annual Average 1995-1999

Diazinon

- Almond: 58%
- Apricot: 18%
- Peach: 9%
- Prune: 10%
- Other: 11%

Chlorpyrifos

- Almond: 40%
- Apricot: 16%
- Walnut: 17%
- Cotton: 8%
- Other: 19%

* Merced and Stanislaus counties
Replacement Pesticides

• Chlorpyrifos and Diazinon use have declined in recent years
• Market moving to other pesticides
• Potentially problematic:
  – Other organophosphorus pesticides
  – Carbamates
  – Pyrethroids
• Need to avoid creating new problems
## Pesticides of Concern in the SJR Basin

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Family</th>
<th>Main Use</th>
<th>Conc. At Vernalis 1993 (ug/L)</th>
<th>Conc. At Vernalis 2000 (ug/L)</th>
<th>Chronic Criteria for Aquatic Life (ug/L)</th>
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<tbody>
<tr>
<td>Chlorpyrifos</td>
<td>OP</td>
<td>almonds, walnuts</td>
<td>0.04</td>
<td>0.007-0.105</td>
<td>0.014&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Diazinon</td>
<td>OP</td>
<td>almonds</td>
<td>0.6</td>
<td>0.01-0.0947</td>
<td>0.05&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Disulfoton (Disyston)</td>
<td>OP</td>
<td>urban</td>
<td>N/A</td>
<td>N/A</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Dacthal</td>
<td>OC</td>
<td>truck crops</td>
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<td>Carbaryl</td>
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<td>peaches, vineyards</td>
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<td>0.01-0.21</td>
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<td>Eptam</td>
<td>CA</td>
<td>corn, almonds</td>
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<td>0.002-0.009</td>
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<td>Cyanazine</td>
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<tr>
<td>Pyrethroids</td>
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<td>N/A</td>
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<td>Bifenthrin&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
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<td>N/A</td>
<td>N/A</td>
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<td>Esfenvalerate&lt;sup&gt;5&lt;/sup&gt;</td>
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<td>N/A</td>
<td>0.19&lt;sup&gt;5_b&lt;/sup&gt;</td>
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</tbody>
</table>

OP -- organophosphate; OC -- organochlorine; CA -- carbamate; TR -- triazine; UR -- uracil; AM -- amide

(a) Chronic criteria DFG study using EPA method (b) US EPA ECOTOX Database
Pesticide Loading

- Water Column Pesticide Concentration Data
- Flow Data

Load = concentration × flow × conversion factor

Flow data available from USGS, DWR, or direct measurement…

Pesticide concentration data available from…
Pesticide Data Sources

• Studies by DPR, USGS, and Regional Board
• Field studies designed to characterize pesticide occurrence and source
• Since 1990, over 10 major studies in SJR Basin
• Studies collected over 3,000 samples
• Extensive long-term sampling at Vernalis (characterizes basin mass emissions)
Diazinon Concentration and Daily Flow
SJR near Vernalis

![Graph showing Diazinon Concentration and Daily Flow](image-url)
Chlorpyrifos Concentration and Daily Flow
SJR near Vernalis

- Chlorpyrifos Concentration (ug/L)
- Daily Flow (cfs)

Chlorpyrifos Concentration:
- Concentration (ug/L) range: 0.00 to 0.08
- Data points for each year from 1991 to 2000

Chronic Criteria:
- Green line representing the chronic criteria

Flow:
- Flow (cfs) range: 0 to 60,000
- Data points for each year from 1991 to 2000

Graph shows the variation of Chlorpyrifos concentration and daily flow over the years.
Chlorpyrifos Concentration and Daily Flow
SJR near Vernalis
Water Year 1993

Chlorpyrifos
Chronic Criteria
Flow
Calculating Storm Load

- Collect concentration and flow data during storm event
- Compute instantaneous loads
  \[ = \text{concentration} \times \text{flow} \times \text{conversion factor} \]
- Graph instantaneous loads
- Estimate total storm load as area beneath curve
Diazinon – SJR near Vernalis
Instantaneous Flow and Concentration
2000 Storm Season

Concentration (ug/L)

Flow (cfs)

Jan
Feb
Diazinon – SJR near Vernalis
Instantaneous Load
2000 Storm Season

Total Load = 19.6 lbs
Comparison of Single Storm Loads From Major SJR Tributaries Preliminary Results 9-14 Feb 2000

Diazinon
- SJR upstream of Salt Slough: 36%
- Tuolumne River: 6%
- Stanislaus River: 12%
- Merced River: 15%
- Orestimba Creek: 3%
- Other Sources: 7%

Chlorpyrifos
- SJR upstream of Salt Slough: 18%
- Tuolumne River: 14%
- Stanislaus River: 11%
- Merced River: 1%
- Orestimba Creek: 1%
- Other Sources: 7%

2000 Single Storm Load at Vernalis
- Diazinon: 4.9 lbs
- Chlorpyrifos: 1.5 lbs
Dormant Spray Season Summary

- Concentrations of diazinon and chlorpyrifos frequently above criteria
- Occurrence of pesticides and frequency of exceeding WQOs are persistent over time
- Persistent spatial distribution: each sub-area contributes to load
Dormant Spray Season Summary (continued)

• Data suggests that agriculture is primary source:
  – Association of agricultural application to observed loads
  – Sub area sources of loads
  – Consistent with conclusions reached by USGS studies
Irrigation Season Summary

- Similar methods are used to estimate loading during irrigation season
- Available data is more sparse
  - most recent year still being compiled
  - additional information will be obtained this summer
Next Steps (Technical)

- Complete Source Analysis
- Calculate Load Allocations
- Perform Linkage Analysis
- TMDL Report for Diazinon and Chlorpyrifos
Load Allocations

- Review historical flows for SJR main stem sites
- Estimate maximum load allowable to meet acute and chronic criteria with no more than one excursion every three years
- Allocate loads to sources (subarea, crop)
- Margin of Safety
Load Allocations (Considerations)

• Must consider additivity (allowable load based on sum of diazinon and chlorpyrifos)
• Base flows during irrigation season
• Storm flows during dormant spray season
• No more than one excursion (total) every three years for irrigation and dormant spray season
TMDL Equation

\[ \text{TMDL} = (\text{Design Flow}^*) \times (\text{Numeric Target}) \]

*Occurring no more than once every 3 years*
San Joaquin River Near Vernalis
Daily Diazinon Concentration

Diazinon Concentration (µg/L)

- Water Year 1994
- Water Year 2000

Chronic Criteria
San Joaquin River Near Vernalis
Mean Daily Flow

Water Year 1994

Water Year 2000
San Joaquin River Near Vernalis
Daily Diazinon Load

Water Year 1994

Water Year 2000

Daily Diazinon Load (lbs)

Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
Linkage Analysis

• Demonstrate the link between sources, load allocations, and attainment with water quality objectives
Next Steps (Regulatory)

- Complete Draft Basin Plan Amendment
- Staff Report:
  - Beneficial Uses
  - Water Quality Objectives
  - Program of Implementation
  - TMDL Elements (loading capacity, allocations, margin of safety)
  - Surveillance and Monitoring
SJR OP Pesticide TMDL Timeline
July 2001 to June 2002

- In-Season Monitoring
- Synoptic Study
- Dormant Spray Monitoring
- Draft Source Analysis (workshop)
- Draft Load Allocation (workshop)?
- Draft TMDL Report and Implementation Framework (workshop)
- Final TMDL Report
Where You Can Be Most Effective

• Provide feedback on:
  – TMDL Report
  – Draft Program of Implementation
  – Participate in Draft Basin Plan Amendment Workshops
# Staff Contacts

<table>
<thead>
<tr>
<th>Staff</th>
<th>TMDL Topic</th>
<th>Phone</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
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<tr>
<td></td>
<td>Organophosphorus Pesticides</td>
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</tr>
<tr>
<td>Les Grober</td>
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