# Central Valley Watersheds: OCs Source Analysis

**Stakeholder Meeting:**
**Module 2**
**19 August 2010**

## Overview

- Opening Remarks
- Previous Meeting Highlights
- Source Analysis
- Conclusion



## Opening remarks

- Revised Schedule for Modules
- Module 2: Attachment 1
- Module 3 will include
  - Source Analysis BPA text
  - Linkage analysis
  - Allocations

## Previous meeting highlights Comments:

- Duration between modules
  - Allow for more time
- Target development
  - Consider appropriate averaging periods



## Previous meeting highlights Comments:

- Basin Plan Objective
  - Consider revising Non-detect objective
- Concern on SQOs
- Assumptions for proportional reductions in sediment and fish



## Previous meeting highlights

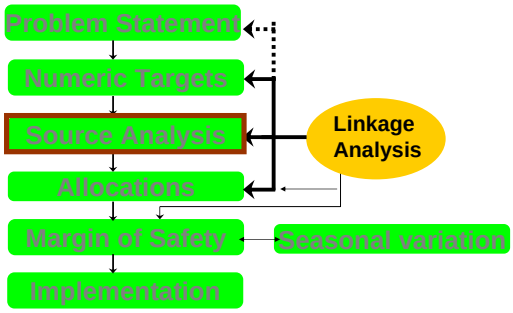
- Fish Tissue targets
  - FCGs Vs SVs
  - TTRLs
- Clarification regarding:
  - Background terminology
  - Bio-concentration factors

## Staff's Approach on comments

- Submitted comments
- When will Choices or Decisions be made?
- Response to comments



## TMDL Elements






# Source Analysis

## Current Conditions Assessment

- Pollutant categorization
  - Similar to Region 4's approach
- Data time span
  - Fish Tissue: 1978 – 2002
  - Sediment/Water Column: 1990s- 2009



## Sources of Monitoring Data

- Data was used to asses current conditions
- Data sources presented in:
  - Section 2.1.1
  - Tables 1, 2 and 3



## Sources of Monitoring Data

- TSMP
- DPR
- USGS
- SRWP
- USACE
- SWAMP1
- SWAMP2
- ILRP
- NPDES
- CDEC
- WARMF
- DWR

Also see Tables 1-3

# Data Analysis

- **Statistical analysis: STATISTICA 6.2**
- **STATISTICA was used to run parametric power analysis**
  - **Determines sample size required to achieve significant differences at p<0.05**



# Water Column Data

- **CTR criteria**
- **Averaging periods**
  - **DDT, Chlordane and Lindane**
- **Tables 4 and 5 in Attachment 2**



# Water Column: SJR

| Station Name | Constituent | Mean result | Number (n)1 | Significant at level for the above CTR | Power Analysis sample size | % Above CTR Criteria (n) | % Detection (#) | % Non-Detect (n) | % with High Reporting Limits (#) |
|---|---|---|---|---|---|---|---|---|---|
| Bear Creek to Mud Slough | DDE | 0.004±0.002 | 49 | NS | 3 | 4 (2) | 96 (47) | - | 96 (47) |
| | Lindane | 0.004 | 66 | S | Achieved | 8 (5) | 92 (61) | - | 45 (30) |
| | Alpha-HCH | 0.004±0.001 | 47 | NS | 4 | 5 (3) | 67 (44) | - | 45 (30) |

# Water Column: Sacramento River Basin

| Station Name | Constituent | Mean result | Number (n)1 | Significant at P=0.05 for above CTR | Power Analysis sample size | % Above CTR Criteria (n) | % Detection (n) | % Non-Detect (n) | % with High Reporting Limits (#) |
|---|---|---|---|---|---|---|---|---|---|
| Feather River | Dieldrin | 0.0029±0.002 | 3 | No | - | - | - | - | 100 (3) |
| | Lindane | 0.004±0.001 | 3 | No | - | - | 100 (3) | - | 100 (3) |
| | DDE | 0.005 | 3 | No | - | - | - | - | 100 (3) |



# Water Column: Sacramento-San Joaquin Delta

| Station Name | Constituent | Mean result | Number | Significant at P=0.05 for above CTR | Power Analysis sample size | % Above CTR Criteria (n) | % Detection (n) | % Non-Detect (n) | % with High Reporting Limits (#) |
|---|---|---|---|---|---|---|---|---|---|
| Delta Waterways-Eastern Portion | DDD(p,p') | 0.356±0.271 | 266 | Yes | Achieved | 6 (16) | - | 94 (250) | - |
| | DDE(p,p') | 0.320±0.287 | 254 | Yes | Achieved | 5 (14) | 1 (1) | 94 (239) | - |
| | DDT(p,p') | 0.339±0.311 | 272 | Yes | Achieved | 6 (16) | 1 (1) | 93 (255) | - |
| | DDD(o,p') | 0.028±0.010 | 129 | Yes | Achieved | 5 (6) | - | 95 (123) | - |
| | DDE(o,p') | 0.025±0.009 | 129 | Yes | Achieved | 5 (6) | - | 95 (123) | - |
| | DDT(o,p') | 0.089±0.160 | 129 | Yes | Achieved | 5 (6) | - | 95 (123) | - |
| | Dieldrin | 0.286±0.301 | 254 | Yes | Achieved | 6 (16) | 1 (1) | 93 (237) | - |
| | Endrin | 0.369±0.311 | 255 | Yes | Achieved | 5 (14) | - | 95 (241) | - |



# Sediment Data

| Station Name | Pollutant | Mean result | Number | Significant at P=0.05? | Power Analysis sample size | # Detection | # Non-Detect | High Reporting Limits |
|---|---|---|---|---|---|---|---|---|
| Delta Waterways-Eastern Portion | DDD(p,p') | 1.23 | 7 | Yes | Achieved | 14 (1) | 86 (6) | - |
| | DDE(p,p') | 6.95±5.72 | 6 | Yes | Achieved | 17 (1) | 66 (4) | - |
| | DDT(p,p') | 3.88±1.39 | 7 | Yes | Achieved | 14 (1) | 14 (1) | - |
| | Dieldrin | 1.38 | 6 | Yes | Achieved | 17 (1) | 83 (5) | - |
| | Endrin | - | 18 | Yes | Achieved | - | 100 (18) | - |
| | Chlordane | - | 5 | Yes | Achieved | - | 100 (5) | - |

## Sediment Data

- Table 6
- Frequent detections of DDT
- Data limitations
  - Non-detects
  - Insufficient # of samples



## Brown 1997 study

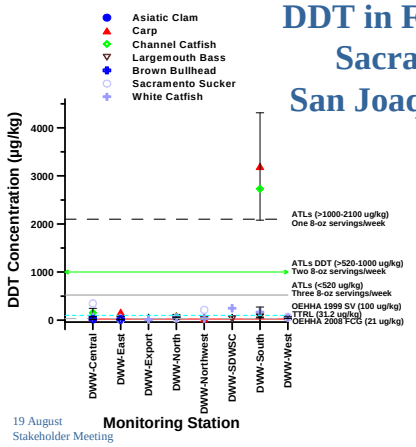
- Conducted in SJR Basin
- Sampled Biota and Sediment
- DDT was frequently detected
- Declining concentrations



## Fish Tissue Data

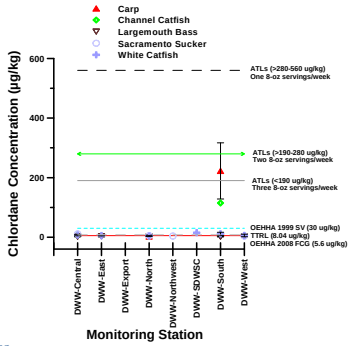
- Data handling: Isomers
- Lipid normalization
- Figures 1, 2, 3 and 4

# DDT in Fish Tissue Sacramento-San Joaquin Delta



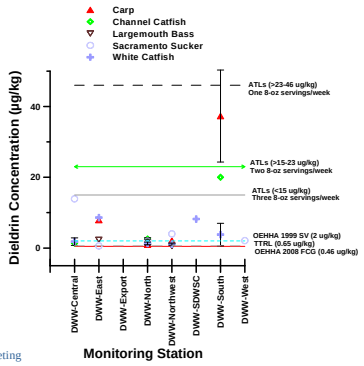



# Chlordane in Fish Tissue Sacramento-San Joaquin Delta

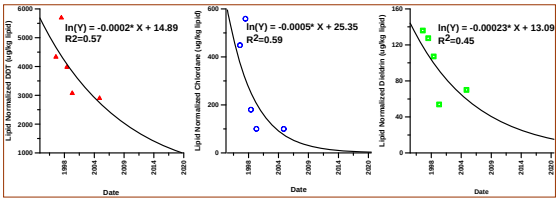





# Dieldrin in Fish Tissue Sacramento-San Joaquin Delta

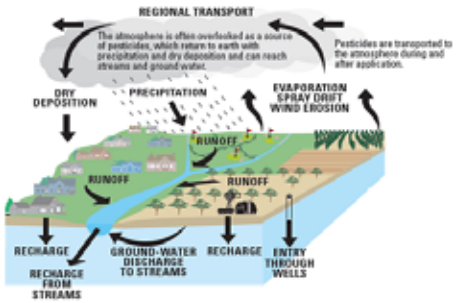


## Temporal variation of OCs for Channel catfish






## Fate and Transport (Fig. 5)






## Sources Discussion points

- **Background**
- **Atmospheric deposition**
- **Recent Uses and Land uses analysis**
- **Groundwater**
- **Open channel**
- **NPDES facilities**
- **Load estimation**

# Background



## Background

- No background sources
- OCs are manmade



# Atmospheric Deposition

## Atmospheric deposition

- **Atmospheric deposition is a minor OC contributor**
- **Implicitly captured in monitoring**



## Atmospheric deposition

Table 9. Atmospheric deposition rates for OC constituents upon total land and water surface area in the Central Valley Watersheds using estimates from the NJADN studies, normalized according to Central Valley watersheds $PM_{10}$ data.

| Constituent | Atmospheric Deposition Fluxes (ng $m^{-2}$ $d^{-1}$) | | Estimated Atmsopheric Input (lb/yr) | | Total (lb/yr) |
|---|---|---|---|---|---|
| | **Wet** | **Dry** | **Wet** | **Dry** | |
| ΣDDT | 0.61 | 1.15 | 1.69 | 5.52 | 7.21 |
| Dieldrin | - | 1.2 | - | 5.76 | 5.76 |
| Aldrin | - | 0.1 | - | 0.48 | 0.48 |
| Endosulfan I | 0.35 | 0.45 | 0.97 | 2.16 | 3.13 |
| Endosulfan II | 1.38 | 1.07 | 3.82 | 5.13 | 8.96 |
| Endosulfan Sulfate | 1.02 | 0.51 | 2.83 | 2.45 | 5.27 |
| Chlordane | 0.42 | 1.64 | 1.16 | 7.87 | 9.03 |



# Recent Uses and Land Use

# Recent Uses of OCs

Table 10. Select crops in three counties applied with Dicofol, Endosulfan and Lindane in 1991 from PUR data

| | Madera (lbs of chemical applied) | | |
|---|---|---|---|
| Crop | Dicofol | Endosulfan | Lindane |
| Beans | 30 | X | X |
| Cotton | 10300 | 465 | X |
| Grapes | 676 | X | X |
| Grapes (Wine) | 1862 | X | X |
| Almond | 1293 | X | X |
| | **Stanislaus (lbs of chemical applied)** | | |
| | Dicofol | Endosulfan | Lindane |
| Beans | 1744 | X | 212 |
| Cotton | X | X | X |
| Grapes | X | 4 | X |
| Grapes (Wine) | 51 | 49577 | X |
| Almond | X | 196 | X |
| | **Merced (lbs of chemical applied)** | | |
| | Dicofol | Endosulfan | Lindane |
| Beans | 5376 | 177 | X |
| Cotton | 13139 | X | X |
| Grapes | X | 201 | X |
| Grapes (Wine) | X | 2652 | X |
| Almond | X | 240 | X |



# Land Use Analysis

- **Comparison of Land Use systems**
  - **Categorization**
- **Land Use changes in watershed**
- **Agricultural Land Uses**



# Comparison: Land Use Systems

Table 11. Comparison of three land use classification systems for Central Valley watersheds

| Land Use Type | 1977-1980 GIRAS (%) | 2007 NASS (%) | USGS-WARMF 2000 (%) |
|---|---|---|---|
| Urban | 3.78 | 9.14 | 4.05 |
| Native* | 13.87 | 10.87 | 3.61 |
| Agriculture | 59.54 | 52.60 | 56.51 |
| Rangeland/Grassland | 21.14 | 25.66 | 29.52 |
| Forests | 0.83 | 0.33 | 5.11 |
| Open water | 0.84 | 1.40 | 1.20 |

# Land Use Categories

Table 12. Land use categories and subcategories for Central Valley Watersheds

| Land Use Category | Sub-categories | % Watershed Area |
|---|---|---|
| Urban | Built-up areas, Residential, Industrial, Commercial, POTWs, confined feeding lots | 4.05 |
| Native | Barren, forested wetland, non-forested wetland | 3.61 |
| Agriculture | Cropland, pasture, orchards and managed wetlands | 56.51 |
| Rangeland/Grassland | Rangeland and grassland | 29.52 |
| Forests | Deciduous, coniferous and mixed forests | 5.11 |
| Open Water | Rivers, streams, open channels | 1.20 |



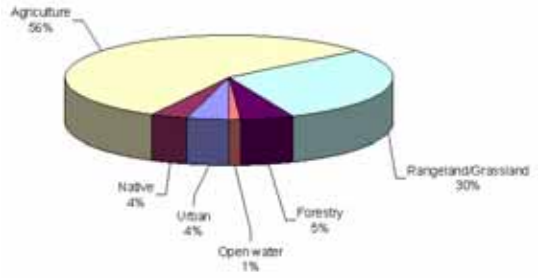
# Land Use Estimates by Reach

Table 13. Land Use Estimates by Reach

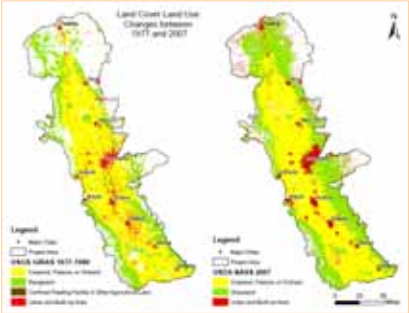
| Land Use Type (%) | SJR Merced/Bda Pool to Bear Creek | SJR Bear Creek to Mud Sl | SJR Mud Slough (N) to Merced R. | SJR Merced R. to Tuolumne R. | SJR Tuolumne R. to Stanislaus | SJR Stanislaus to Delta (SJR) | Merced R. Lower (SJR) | Tuolumne R. Lower | Orestimba Creek (Westside) | Lower Stanislaus R. | Colusa Basin Drain | Feather River | Delta watersheds (Eastside) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Urban | 1.54 | 0.60 | 1.33 | 2.59 | 4.06 | 5.16 | 0.83 | 7.06 | 1.09 | 5.41 | 5.00 | 9.00 | 8.92 |
| Native | 3.39 | 10.78 | 8.02 | 2.62 | 2.16 | 1.59 | 4.94 | 0.21 | 0.90 | 4.76 | 1.09 | 5.20 | 1.31 |
| Agriculture | 64.32 | 37.99 | 49.88 | 75.84 | 40.99 | 68.18 | 58.20 | 36.59 | 51.72 | 61.40 | 74.90 | 52.80 | 61.77 |
| Rangeland /Grassland | 28.04 | 49.98 | 38.87 | 18.31 | 36.82 | 13.39 | 30.97 | 37.33 | 42.94 | 19.10 | 19.00 | 30.00 | 19.00 |
| Forests | 1.95 | 0.00 | 0.29 | 0.60 | 15.77 | 11.26 | 4.92 | 18.41 | 3.35 | 8.94 | 0.00 | 1.00 | 0.00 |
| Open water | 0.76 | 0.65 | 1.61 | 0.04 | 0.20 | 0.42 | 0.14 | 0.40 | 0.00 | 0.39 | 0.01 | 2.00 | 9.00 |
| **Total by reach** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |



# Land Use Categorization



## Land Use Changes Over Three Decades





## Current Agricultural Land Use

| County | Major Ag Land Use |
|---|---|
| Shasta and Tehama | Pastures and Deciduous Trees |
| Stanislaus, Sutter, Madera, San Joaquin, Butte | Almond, Pistacio, Deciduous Trees, Sub-tropical Trees and Vineyards |
| San Joaquin | Corn and Alfalfa |
| Merced | Cotton |
| Merced, Sacramento, San Joaquin, Colusa, Stanislaus, Yolo | Grain, Pasture, Tomato |



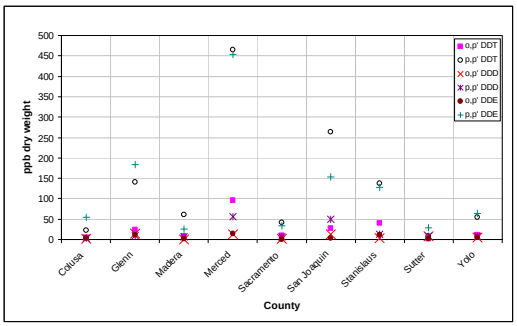
# Historical Assessment of OCs

# DDT

- Insecticide in agriculture
- Control of Malaria
- High residue levels in 1970s
- Banned in 1972



# DDT






# Historical Uses

Table 15. DDT Use in California from 1970 to 1980a (Mischke et al, 1985)

| Year | Pounds Used | Main Use |
|---|---|---|
| 1970 | 1,164,699 | agricultural |
| 1971 | 111,058 | agricultural |
| 1972 | 80,800 | agricultural |
| 1973b | No use reported | -- |
| 1974 | 160 | Residential pest control (special local need) |
| 1975-1980 | <200 lbs per year | Vector control (special local need) |

a. 1970 was the first year in which the amount of restricted pesticides used in California was reported. In 1980, the introduction of new pesticides replaced the need to use DDT for vector control.

b. Year all use banned except for special local needs (SLN)

# Potential DDT input from Dicofol

Table 16. Annual Dicofol Use in Select Counties within Project Area during the Years of 2001-2006 (Pounds of Active Ingredient)

| County/Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Total by County |
|---|---|---|---|---|---|---|---|
| **Merced** | 19746 | 17070 | 18552 | 27707 | 19666 | 22032 | 124773 |
| **Stanislaus** | 14536 | 13948 | 11925 | 13822 | 7120 | 5330 | 66681 |
| **San Joaquin** | 3379 | 4895 | 3527 | 5582 | 4839 | 5924 | 28146 |
| **Butte** | 4846 | 1278 | 4196 | 2255 | 3797 | 1102 | 17474 |
| **Sutter** | 3071 | 4067 | 2500 | 1846 | 1580 | 2905 | 15969 |
| **Yolo** | 1511 | 2466 | 1771 | 403 | 431 | 341 | 6924 |
| **Colusa** | 233 | 770 | 403 | 1775 | 756 | 479 | 4415 |
| **Madera** | 4369 | 3019 | 2037 | 2454 | 5358 | 4938 | 22173 |
| **Glenn** | 1066 | 1273 | 980 | 618 | 1226 | 1170 | 6333 |
| **Tehama** | 1128 | 2356 | 2159 | 42 | 277 | 29 | 5991 |
| **Contra Costa** | 1282 | 33 | 301 | 334 | | 10 | 1960 |
| **Total by year** | 55167 | 51175 | 48351 | 56838 | 45050 | 44260 | |
| **Statewide use** | 212809 | 183014 | 186112 | 216836 | 193791 | 101501 | 1094061 |



# Chlordane

- **First used in 1948**
- **Used on crops:**
  - **Corn, citrus, homelawns, gardens, termites**
- **Cancelled in 1978 on all food crops**
  - **All used banned in 1988**



# Dieldrin

- **Aldrin rapidly degrades to form Dieldrin**
- **Uses: Control termites and in agriculture**
- **Banned in 1970 and all used cancelled in 1987**

## Toxaphene

- First used in the 1940s
- Used mainly in Southern States
- Used to control insects on cotton, livestock and eliminate unwanted fish
- EPA canceled registration in 1982
  - All uses banned in 1990



# GROUNDWATER



## Groundwater

- Annual Well Inventory findings:
  - Presence of OCs in GW
  - Various Counties affected

## Groundwater

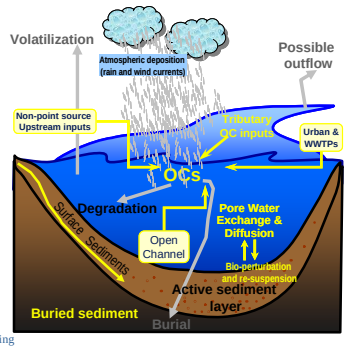
- Quantification of GW discharge
- Present mitigation measures
- Implications on GW contribution



# Open Channel Contributions



## Open Space, Channel and Streambed contributions



## Estimation of open channel and streambed sediment loads

- Methodology
- Equation (8):
  - Volume Sediment = Depth Active Sediment x Stream Surface Area
- Equation (9):
  - Existing Sediment Pollutant Load = Volume Sediment x Observed Pollutant Conc.



# NPDES Facilities



## NPDES Facilities in the Central Valley

- Potential OC sources in POTW effluent
  - Stormwater
  - Imported produce
  - Residual amounts in clothing
- Tables 18, 19, 20

## NPDES Facilities in the SJR Basin

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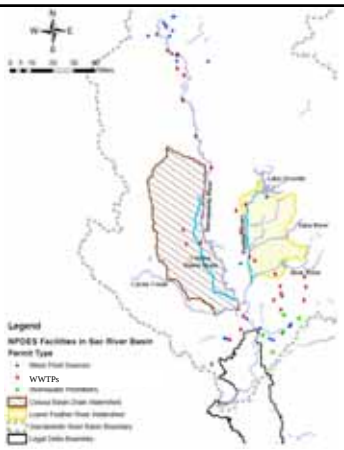
## NPDES Facilities in the Sacramento River Basin

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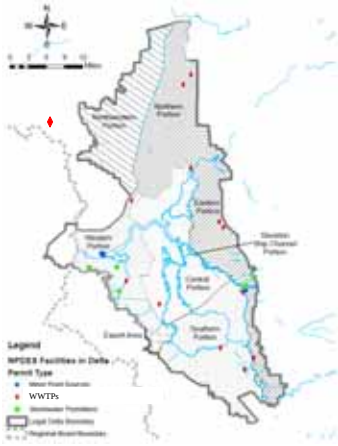
## NPDES Facilities in the Sacramento-San Joaquin Delta

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# OC Loads in Water By Source

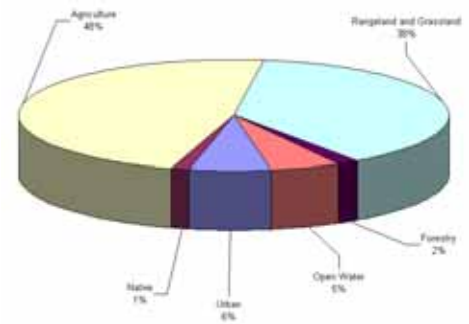
## Estimation of OC Loads in Water by Source

- **Concentration data from monitoring**
- **Flow data from WARMF**
- **Equation (10):**

  **L = C * Q.**

  **Where: L = Load (mass per time)**
  **C = product of concentration**
  **Q = flow rate**

## Load By Land Use Category






## Conclusion

- **Significant progress on source analysis**
- **Next steps**
- **Comments will be used in Staff Report Development**



## Comments

- **Informal comments submitted 3 weeks after meeting**
- **Comments due 9 September**