Central Valley Watersheds: OCs Linkage Analysis

Stakeholder Meeting: Module 3 18 October 2010

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Overview

- **Project Status Update**
- **Previous meeting highlights**
- **Linkage analysis**
- **Conclusion**

Project status update

- **Recap of activities to date**
- **NEWS: Staff lead departure**
- **Future activities OC TMDL**
  - **updated overall project schedule (meetings/modules)?**

Previous meeting highlights

- **Verbal Comment: Handling ND data**
- **Comments submitted by MLJ-LLC on behalf of ESJWQC and SJCDWQC**
- **Clarification on Statistical Analysis and Reporting Limits**

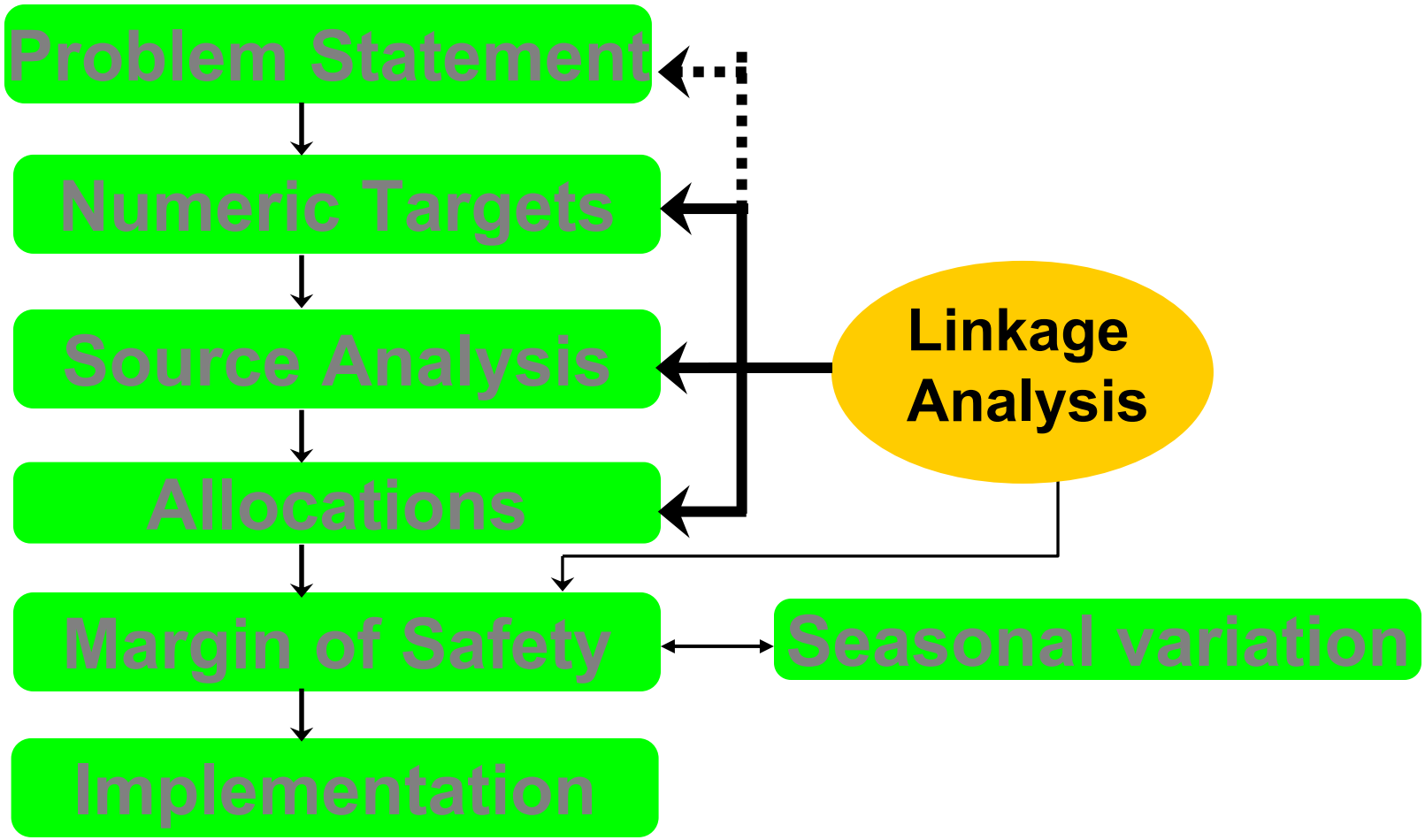
Previous meeting highlights

- **Asiatic Clam tissue concentrations**
- **Declining OC temporal trends**
- **Use of data from Mischke et al 1985**
- **How the WARMF Model was used**

Staff's approach on comments

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

TMDL elements

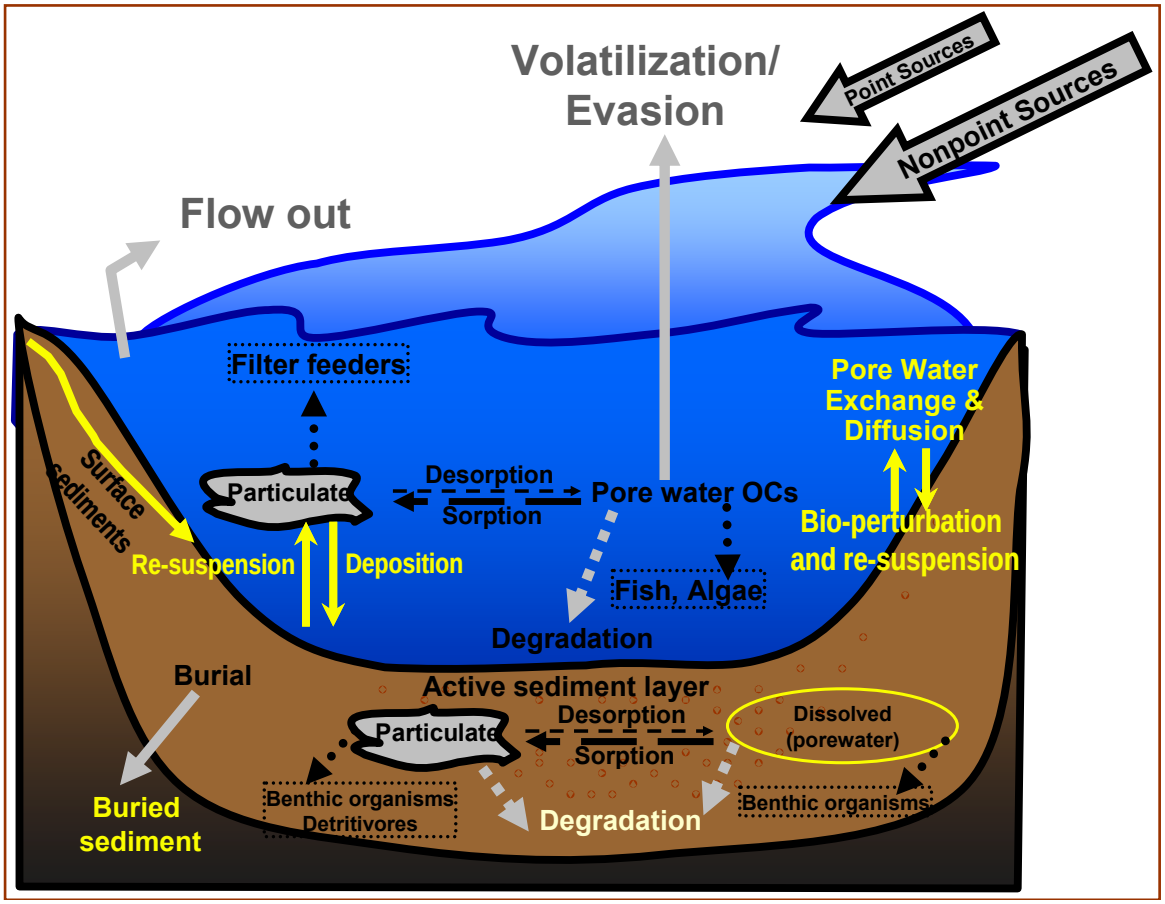


Linkage Analysis

Linkage analysis: Link to BUs

- **Relates OCs to Beneficial uses**
- **See Suppl. Doc. Pg. 5 for BUs**
  - **(Available on OC TMDL website for the 17 June Meeting)**
- **Some of most sensitive BUs:**
  - **Human health: MUN, REC1**
  - **Aquatic life: WARM, COLD, SPWN**

Conceptual model



The linkage of OCs in water and sediment to beneficial uses is uptake by organisms.

Conceptual model

- **For OCs, it Illustrates:**
  - **Key transport and**
  - **Transformation processes (fate)**
  - **Potential sources**
  - **Losses**

Chemical properties of OCs

Excerpt of Table 1

Constituent	Molecular Weight [1]	Water Solubility (mg/L) at 25°C [2]	Henry's Law Constant [2] (atm-m^3/mole)	Log K_{ow} [2]	Log K_{oc} [2]	Log BCF [2]	Half Life in Soil, Low (days) [1]	Half Life in Soil, High (days) [1]
DDT and its isomers								
DDTs (total)*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
p,p'-DDD	320.05	0.090	4.0x10-5	6.02	5.18	0.090	730	2190
p,p'-DDT	354.49	0.025	8.3x10-6	6.91	5.18	0.025	1,460	5,330
p,p'-DDE	318.03	0.120	2.1x10-5	6.51	4.70	0.120	1,000	5,475
Group A Pesticides								
Aldrin	N/A	0.017	1.7x10-4	5.52	4.69	3.500	N/A[3]	N/A[3]
Dieldrin	380.93	0.195	1.5x10-5	4.55	3.92	3.650	109	4,560
Endrin	380.92	0.250	7.5x10-6	4.56	4.06	3.170	60	5,110
Heptachlor	N/A	0.180	1.5x10-3	4.27	3.54	3.980	180	1,200
Heptachlor epoxide	389.20	0.200	9.5x10-4	5.40	1.02	4.160	N/A	N/A
Chlordane (total)**	409.80	0.056	4.9x10-5	N/A	3.09	4.270	350	7,300

Henry's constant

- **Determines volatilization potential**

$$K_H = C_a / C_w$$

Where:

- **K_H = Henry's Constant;**
- **Ca = Concentration in air;**
- **Cw = Concentration in water**

K_{ow} partition coefficient

- **Octanol-water partition coefficient**
  - **Determines lipophilicity**

$$K_{OW} = C_O / C_W$$

Where:

- **Kow = Octanol-water partition coefficient;**
- **Co = Concentration in octanol;**
- **Cw = Concentration in water**

K_d partition coefficient

- **Distribution partition coefficient**

$$K_d \cong f_{oc} * K_{oc}$$

Where:

- **Kd = distribution coefficient;**
- **f_{oc} = fraction of organic carbon in soil or sediment;**
- **KOC = organic carbon-normalized distribution coefficient**

Bioconcentration factors

- **Ratio of a chemical concentration in tissue to that in water**

$$BCF = C_T / C_W$$

Where:

- **BCF = bioconcentration factor;**
- **CT = chemical's concentration in the tissue of an organism;**
- **Cw = chemical's concentration in water**

Gaseous evasion

- **Henry's law constant (K_H) is used as a predictor**

- **Not a major loss mechanism**

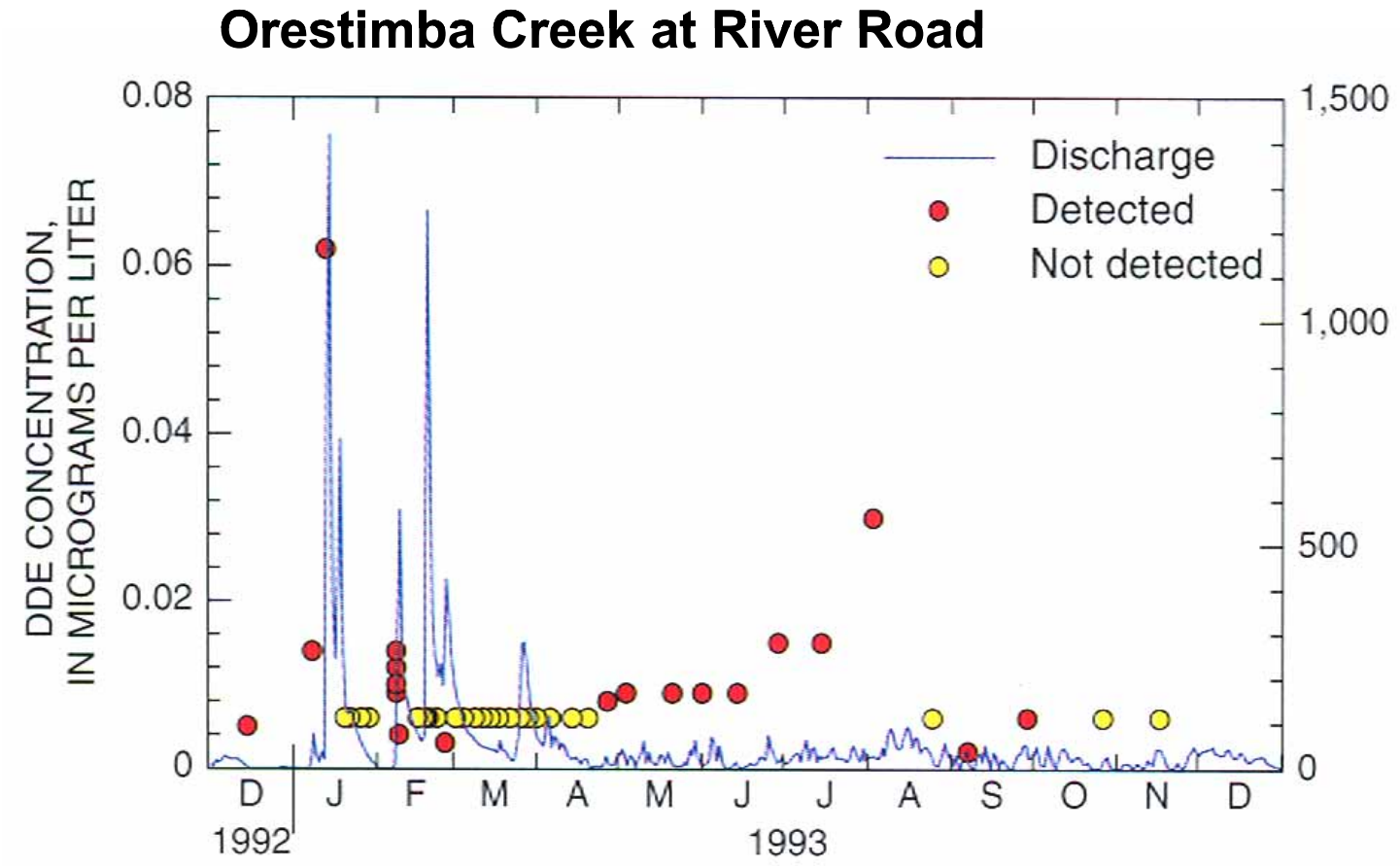
OC degradation

- **Biological processes**
  - **Biotransformation**
- **Abiotic processes**
  - **Photolysis**
  - **Hydrolysis**

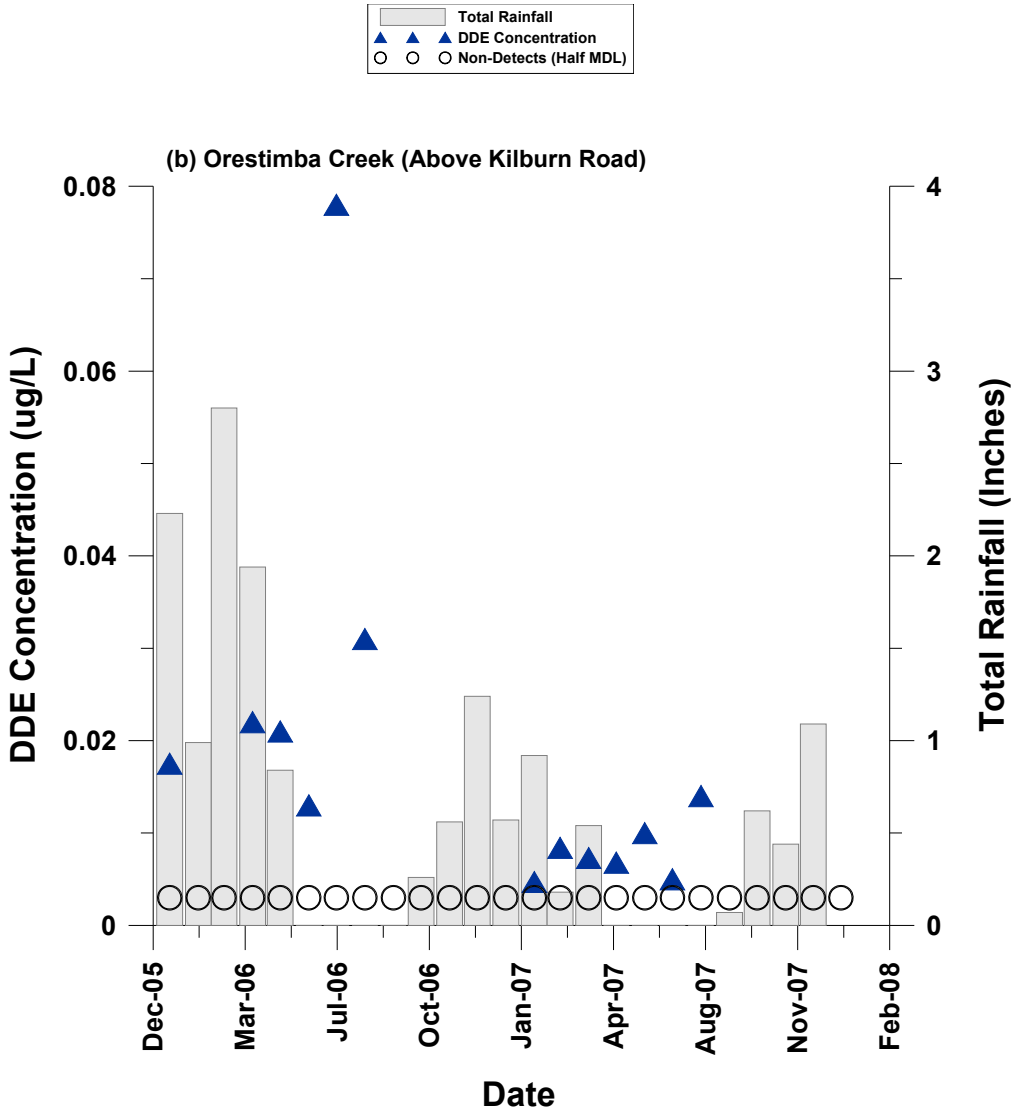
DDE as a representative OC

- **High detection frequency**
- **High persistence**
- **Other OC pesticides used such as chlordane and dieldrin**

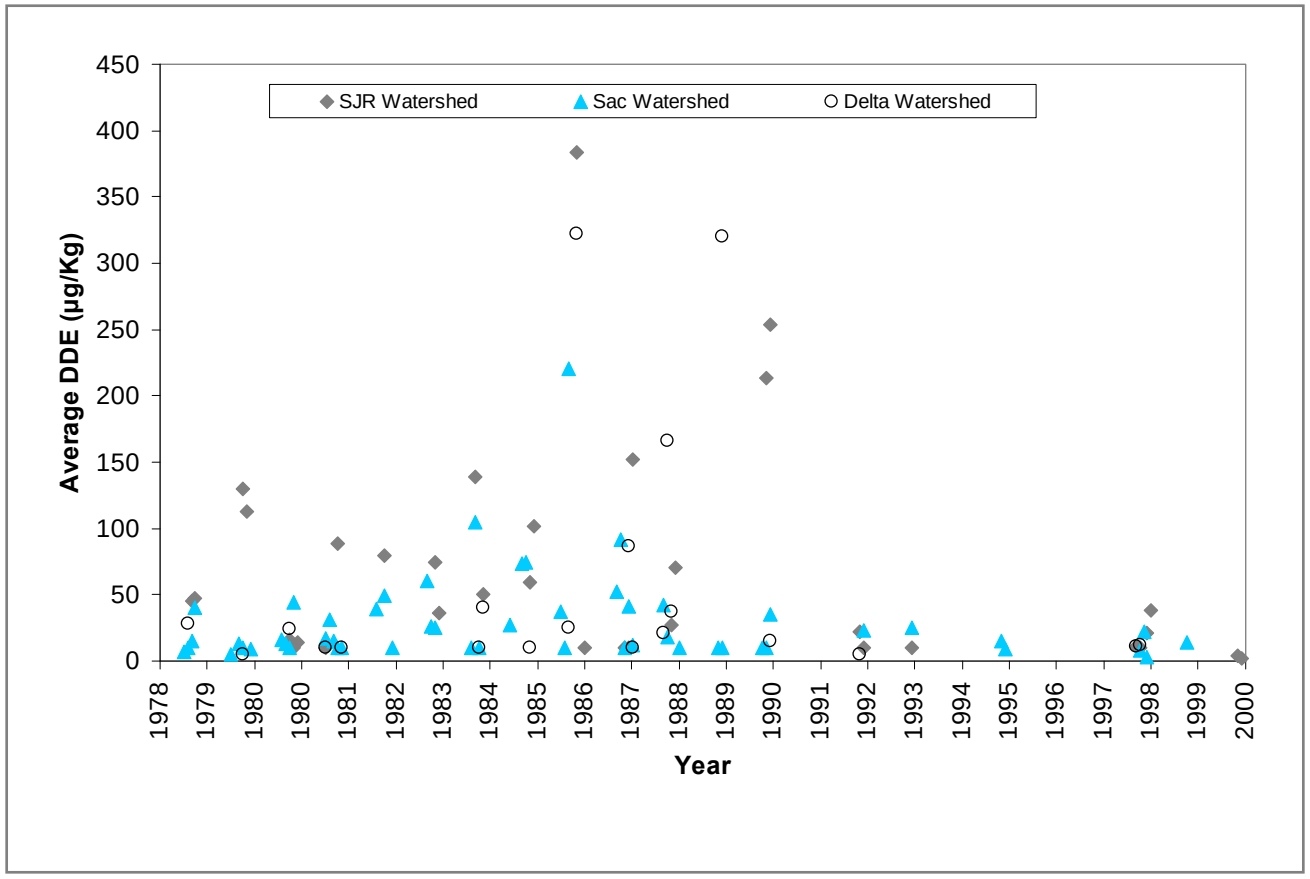
Seasonal variations in DDE



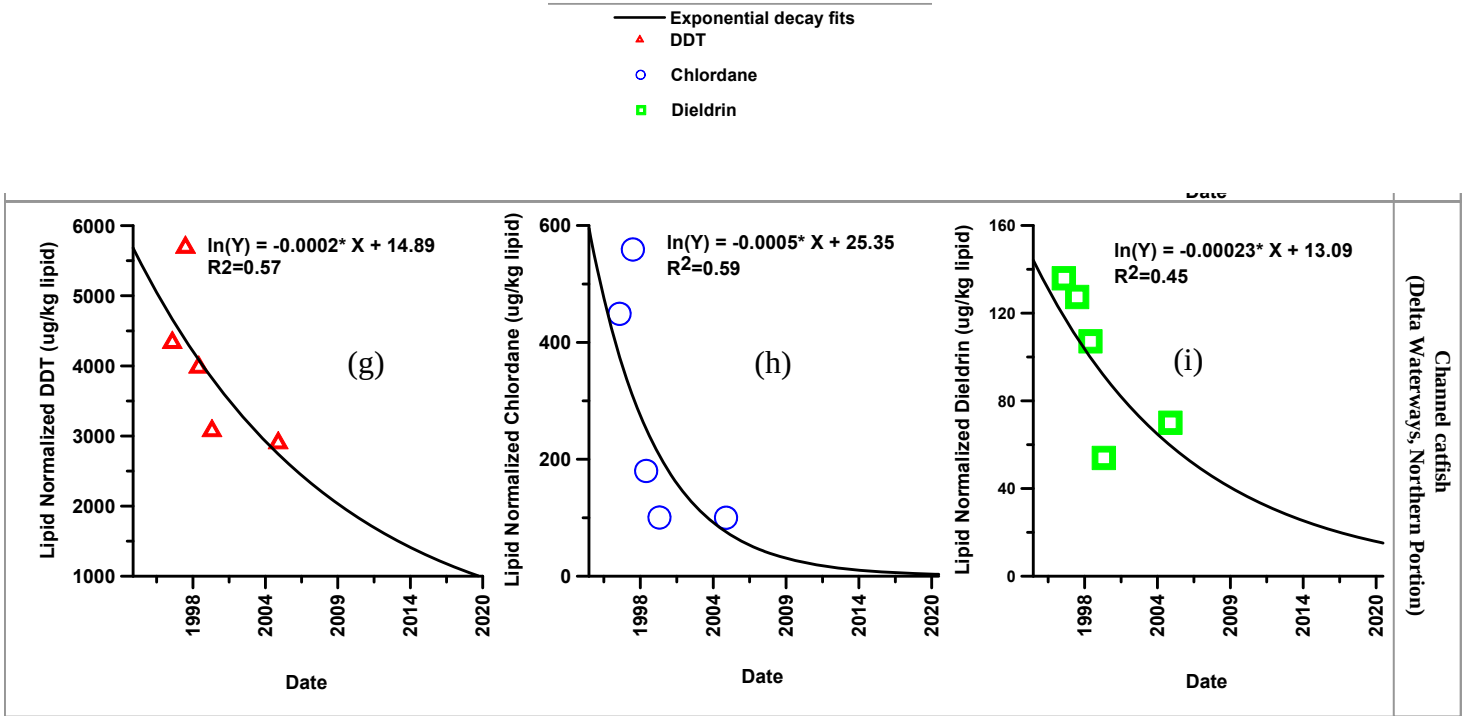
Seasonal variations in DDE



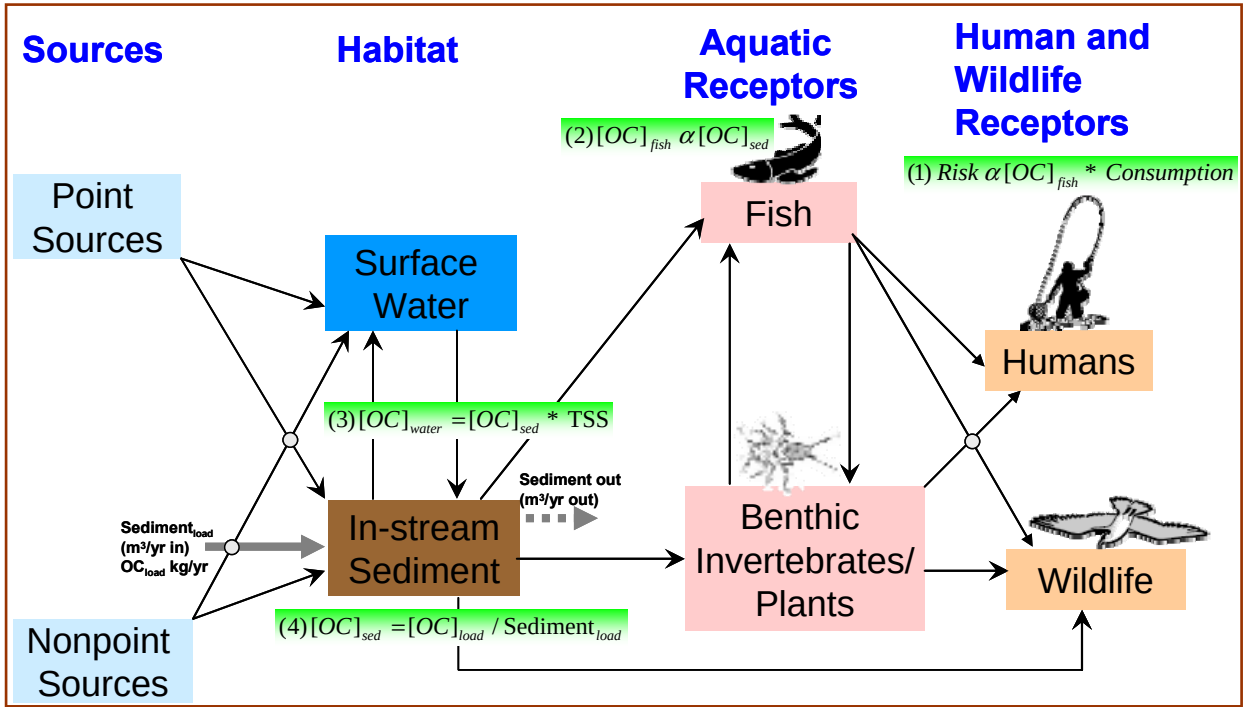
Seasonal variation: Fish tissue



Attenuation of OCs



OC loads, targets and BUs



Four linkages

$$(1)\ Risk\ \alpha\ [OC]_{fish} * Consumption$$

$$(2)\ [OC]_{fish}\ \alpha\ [OC]_{Sed}$$

$$(3)\ [OC]_{water} = [OC]_{sed} * TSS$$

$$(4)\ [OC]_{sed} = [OC]_{load} / Sed_{load}$$

Linkage 1

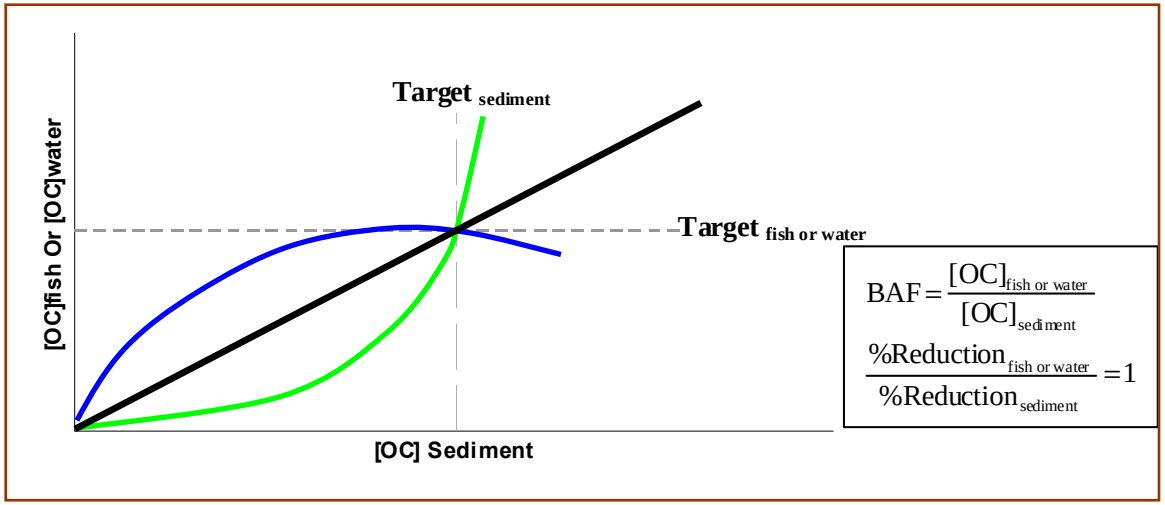
- **Risk is proportional to pollutant concentrations in fish times consumption rates**

$$(1)\ Risk\ \alpha\ [OC]_{fish}\ *\ Consumption$$

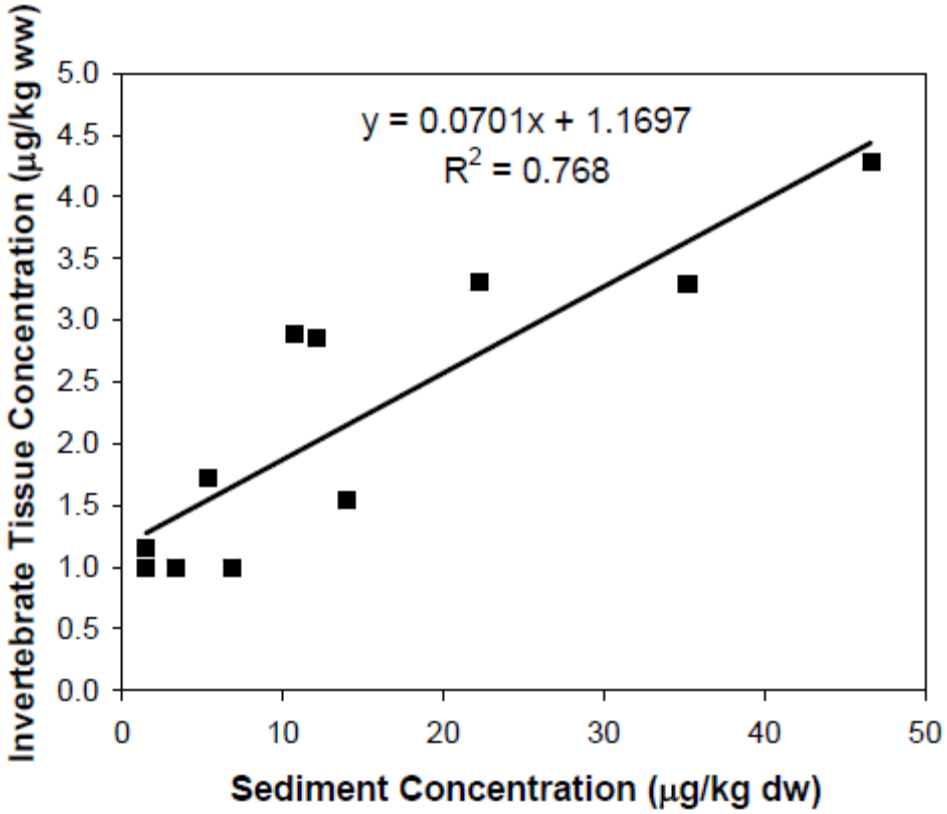
Linkage 2

- **OC concentrations in tissue are proportional to OC concentrations in sediments**

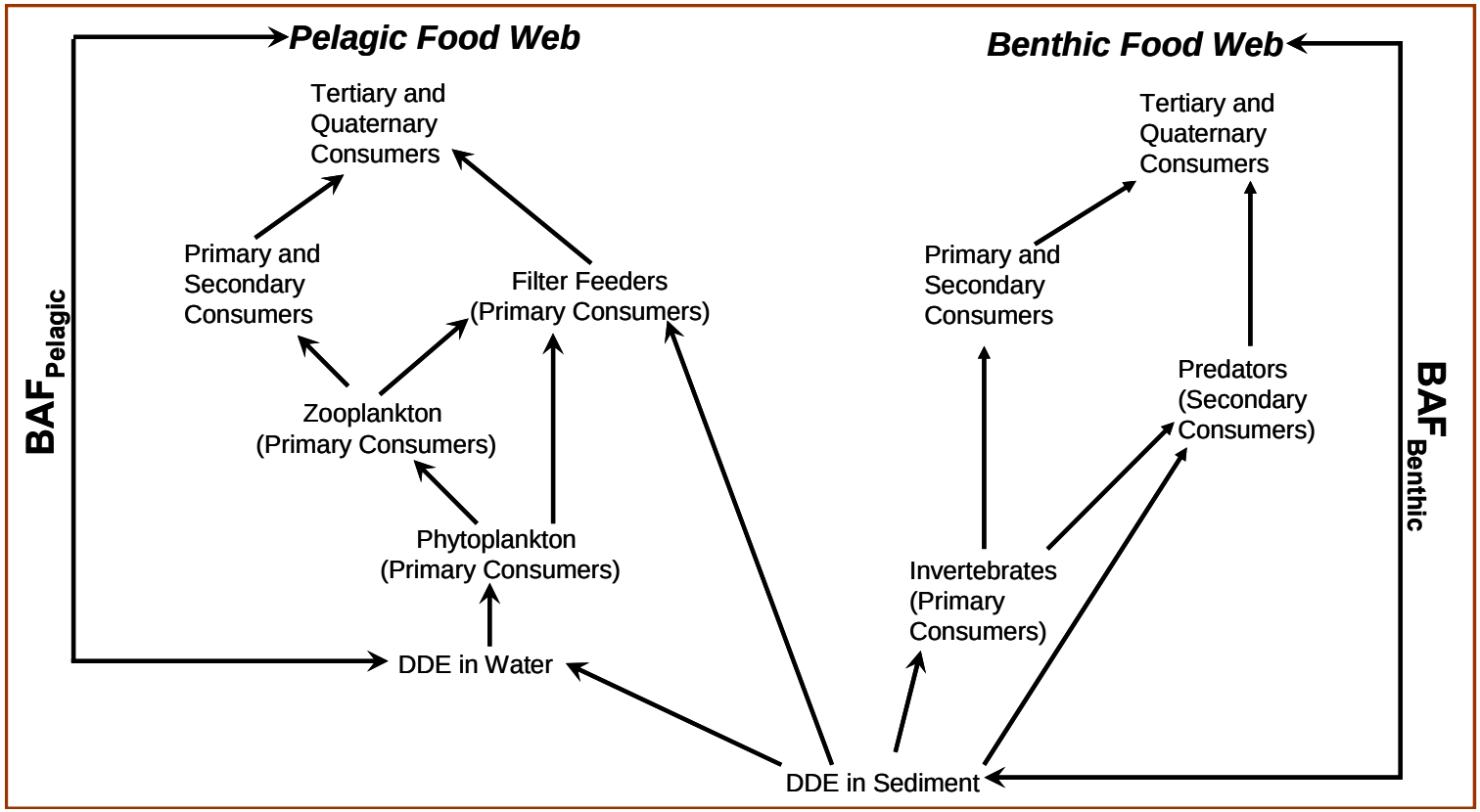
$$(2)\,[OC]_{fish}\ \alpha\ [OC]_{Sed}$$



Tissue and sediment [OC]



Basic food web model



Marine* organisms

Trophic Level	Trophic Level Description	Organism	Genus *(Species)*	n	Mean DDE Concentration (ug/g)	
					Filet/ Muscle	Whole Organism
San Joaquin Watershed (Stanislaus River to Delta Boundary: SJR at Vernalis)						
1	Primary Consumer (Herbivore)	-	-	-	-	-
2	Secondary Consumer (Primary Carnivore)	-	-	-	-	-
3	Tertiary Consumer (Secondary Carnivore)	Crayfish	Pacifastacus *(leniusculus)*	20	N/A	ND
4	Quaternary Consumer (Tertiary Carnivore)	-	-	-	-	-
Sacramento River Watershed (Colusa Basin Drain)						
1	Primary Consumer (Herbivore)	-	-	-	-	-
2	Secondary Consumer (Primary Carnivore)	-	-	-	-	-
3	Tertiary Consumer (Secondary Carnivore)	-	-	-	-	-
4	Quaternary Consumer (Tertiary Carnivore)	-	-	-	-	-
Delta Waterways, Central Portion*						
1	Primary Consumer (Herbivore)	-	-	-	-	-
2	Secondary Consumer (Primary Carnivore)	Golden shiner	Notemigonus *(crysoleucas)*	19	7.8	N/A
3	Tertiary Consumer (Secondary Carnivore)	Redear sunfish	Lepomis *(microlophus)*	17	17	N/A
		Black crappie	Pomoxis *(nigromaculatus)*	6	21	N/A
		Cray fish	Pacifastacus *(leniusculus)*	9	N/A	ND
4	Quaternary Consumer (Tertiary Carnivore)	-	-	-	-	-

Freshwater organisms

Trophic Level	Trophic Level Description	Organism	Genus *(Species)*	n	Mean DDE Concentration (ug/g)	
					Filet/ Muscle	Whole Organism
San Joaquin Watershed (Stanislaus River to Delta Boundary: SJR at Vernalis)						
1	Primary Consumer (Herbivore)	Asiatic clam	Corbicula *(fluminea)*	2	N/A	480
2	Secondary Consumer (Primary Carnivore)	-	-	-	-	-
3	Tertiary Consumer (Secondary Carnivore)	Carp	Cyprinus *(carpio)*	9	580.7	N/A
4	Quaternary Consumer (Tertiary Carnivore)	Red swamp crayfish	Procambarus *(clarki)*	9	N/A	28.5
		White catfish	Ameiurus *(catus)*	46	8,006	N/A
		Channel catfish	Ictalurus *(punctatus)*	44	1,520	N/A
		Large-mouth bass	Micropterus (salmoides)	20	119	N/A
Sacramento River Watershed (Colusa Basin Drain)						
1	Primary Consumer (Herbivore)	Asiatic clam	Corbicula *(fluminea)*	-	N/A	19.5
2	Secondary Consumer (Primary Carnivore)	-	-	-	-	-
3	Tertiary Consumer (Secondary Carnivore)	Carp	Cyprinus *(carpio)*	21	332.5	N/A
		Sacramento sucker	Catostomus *(occidentalis)*	5	ND	N/A
		Sucker	Catostomus spp.	1	39	N/A
		Brown bullhead	Ameiurus *(nebulosus)*	11	450	N/A
4	Quaternary Consumer (Tertiary Carnivore)	White catfish	Ameiurus *(catus)*	12	830	N/A
		Channel catfish	Ictalurus *(punctatus)*	44	1754	N/A
Delta Waterways, Central Portion*						
1	Primary Consumer (Herbivore)	Asiatic clam	Corbicula *(fluminea)*	285	N/A	23.6
2	Secondary Consumer (Primary Carnivore)	Golden shiner	Notemigonus *(crysoleucas)*	-	-	-
3	Tertiary Consumer (Secondary Carnivore)	Carp	Cyprinus *(carpio)*	4	21	N/A
4	Quaternary Consumer (Tertiary Carnivore)	White catfish	Ameiurus *(catus)*	16	70.67	N/A
		Channel catfish	Ictalurus *(punctatus)*	4	190	N/A
		Large-mouth bass	Micropterus (salmoides)	18	25.5	N/A

Linkage 3

- **OC concentrations in water are a function of OC concentrations in sediment**

$$(3)[OC]_{water} = [OC]_{sed} * TSS$$

Site specific data challenges

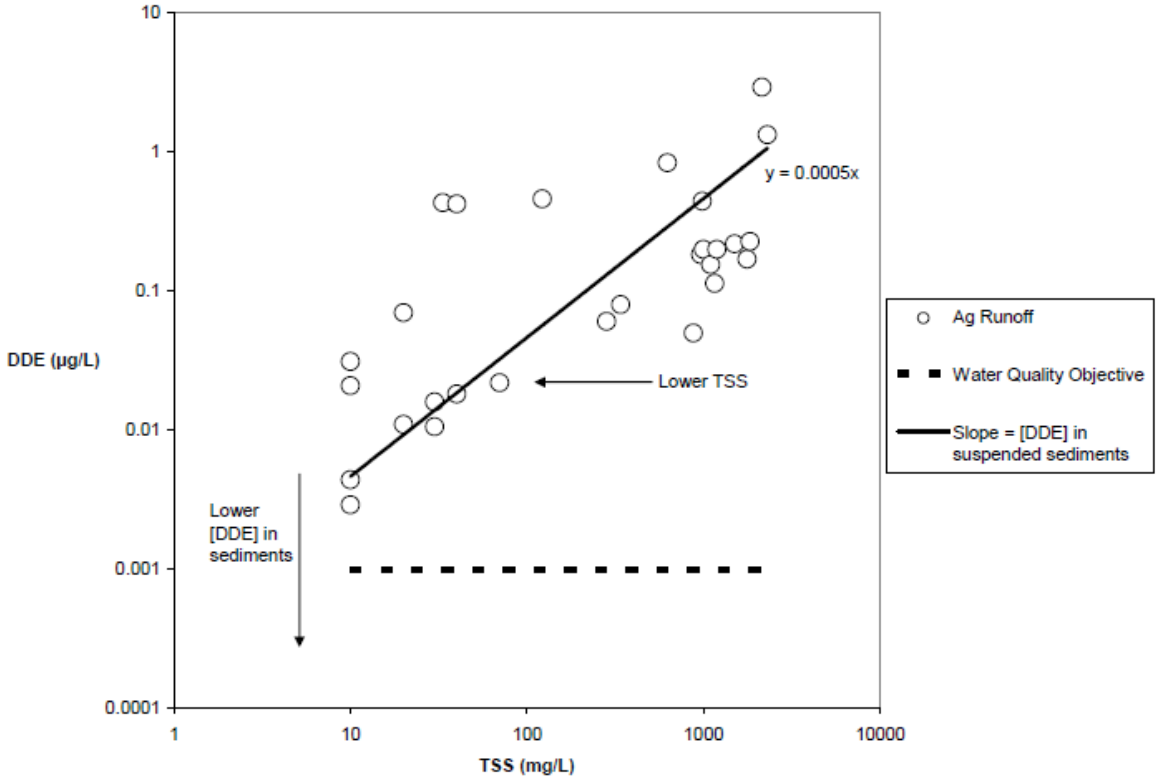
- **Lack of site specific data**
- **Lack of paired data**
- **Comparative studies in other areas relied upon**

Case studies considered

Project	State	Region	Year
Calleguas Creek OC TMDL	California	4	2006
Lower Yakima River TMDL	Washington	8	1997
San Francisco Bay Sediment Study	California	2	2001

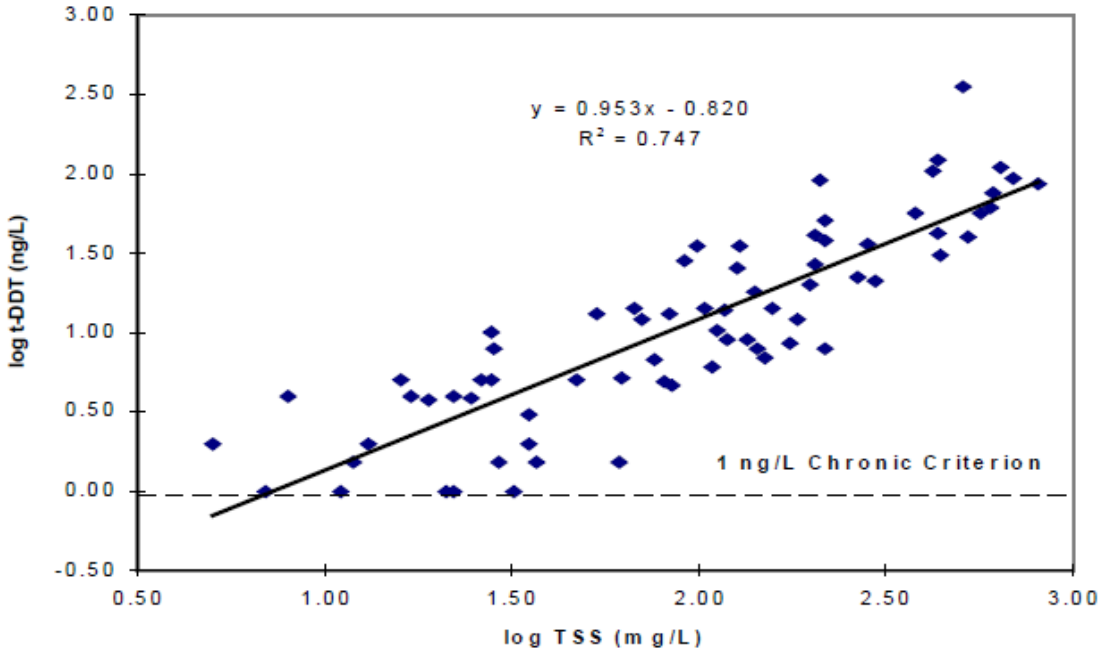
[DDE] and TSS

Calleguas Creek



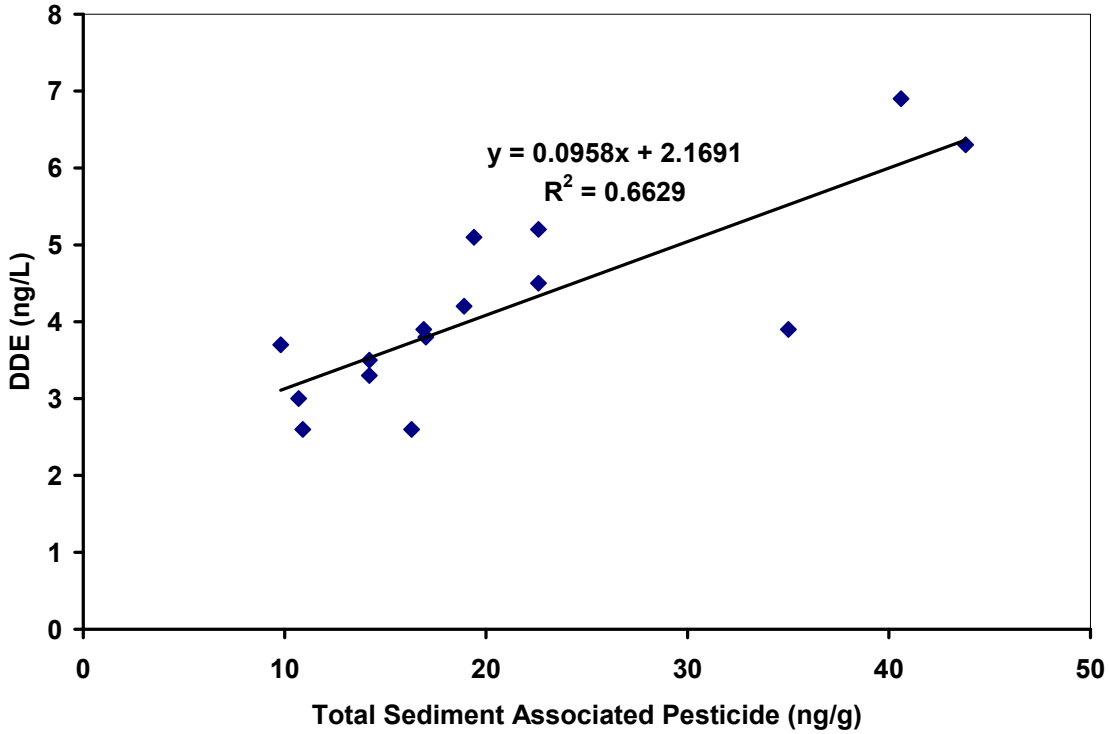
[DDT] and TSS

Lower Yakima River



[DDE] and suspended sediment

San Francisco Bay



Linkage 4

- **OC concentrations in sediment are a function of OC loading and sediment transport.**

$$(4)[OC]_{sed} = [OC]_{load} / Sed_{load}$$

Conclusions

- **Four linkage steps directly relate to implementation actions needed to augment the effects of OC natural attenuation**

- **Linkage analysis presented relates to overall allocations approach**

Next Steps

- **Staff lead departure**

- **Delay of previously scheduled Module meeting dates**

Next Steps

- **When determined, revised project schedule including meetings will be shared via Lyris and website**
  - **Future Modules:**
    - **BPA text for sources and linkage analysis**
    - **Allocations**
    - **Implementation (1) and (2)**
    - **Synthesis of all Modules**

TMDL contact info

- **OC Project Website:**

http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_organochlorine_pesticide/index.shtml

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