EXPOSURE AND EFFECTS WORKGROUP MEETING

May 16th

Goals of Meeting

- Update on 2012 Activities
  - Mesohaline Index
  - Hotspot Study
- Check-in on Planned Activities for 2013
  - Part II of Mesohaline Index
  - Part I Bioanalytical Tools
- Prioritize Special Studies for 2014
  - Bioanalytical Tools Part II, LTMS studies, Follow up work on Moderate Toxicity, Additional SQO studies
    - Impacts dredging on benthic assemblages
    - SQO evaluations of other 303 (d) listed sites

Quick Update on Other Deliverables

- Cu and Olfactory Nerve
  - 2012 Report available
    - 30 ppt
    - *"The results of this study indicate that copper-induced inhibition of the olfactory system of seawater-phase Chinook salmon requires an exposure concentration of greater than* ***100 µg copper/L***"
  - Work underway for 2013
    - Intermediate salinity – 10 ppt

Quick Update on Other Deliverables

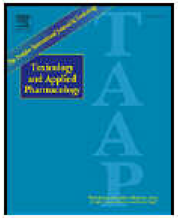
- PAH in Flatfish
  - Study completed
    - High mortality (60 to 80%)
  - Journal article

ELSEVIER

Contents lists available at SciVerse ScienceDirect

Toxicology and Applied Pharmacology

journal homepage: www.elsevier.com/locate/ytaap



Cardiac toxicity of 5-ring polycyclic aromatic hydrocarbons is differentially dependent on the aryl hydrocarbon receptor 2 isoform during zebrafish development

John P. Incardona *, Tiffany L. Linbo, Nathaniel L. Scholz

Ecotoxicology and Environmental Fish Health Program, Environmental Conservation Division, Northwest Fisheries Science Center, 2725 Montlake Blvd E, Seattle, Washington 98112, United States

Budget and Multi-year Plan

			2014	2015	2016
Total Available for Special Studies			$934,743	$719,662	$761,559
Unencumbered/Overencumbered			-$165,257	$259,662	$641,559
			2014	**2015**	**2016**
SPECIAL STUDIES TOTAL			$1,100,000	$460,000	$120,000
Mercury			$0	$0	$0
PCBs			$0	$0	$0
Dioxins			$24,000	$40,000	$0
Emerging Contaminants			$76,000	$100,000	$100,000
Small Tributaries			$430,000	$300,000	$0
Other SPL			$0	$0	$0
Exposure and Effects			$50,000	$0	$0
Forecasting			$200,000	$0	$0
Nutrients			$320,000	$20,000	$20,000

Where is everyone?

- Don Weston resigned
- Jay Davis
- Steve Weisberg

Where is everyone?

- Don Weston resigned
- Jay Davis
- Steve Weisberg

American Airlines Flight 1747

Date: May 15
From: Dallas/Fort Worth, Texas
To: Orange County, California

Flight Status: We apologize - this flight has been canceled.

New Faces

- Meredith Williams – Interim Executive Director. Formerly senior manager of EDIT at SFEI; PhD in Physics from North Carolina State

- Becky Sutton – Senior Scientist. Formerly at EWG; PhD from Cal in Environmental Chemistry (Go Bears!)

- Ellen Willis-Norton – Environmental Analyst. Double major in Environmental Science and Biology from Wellesley College.

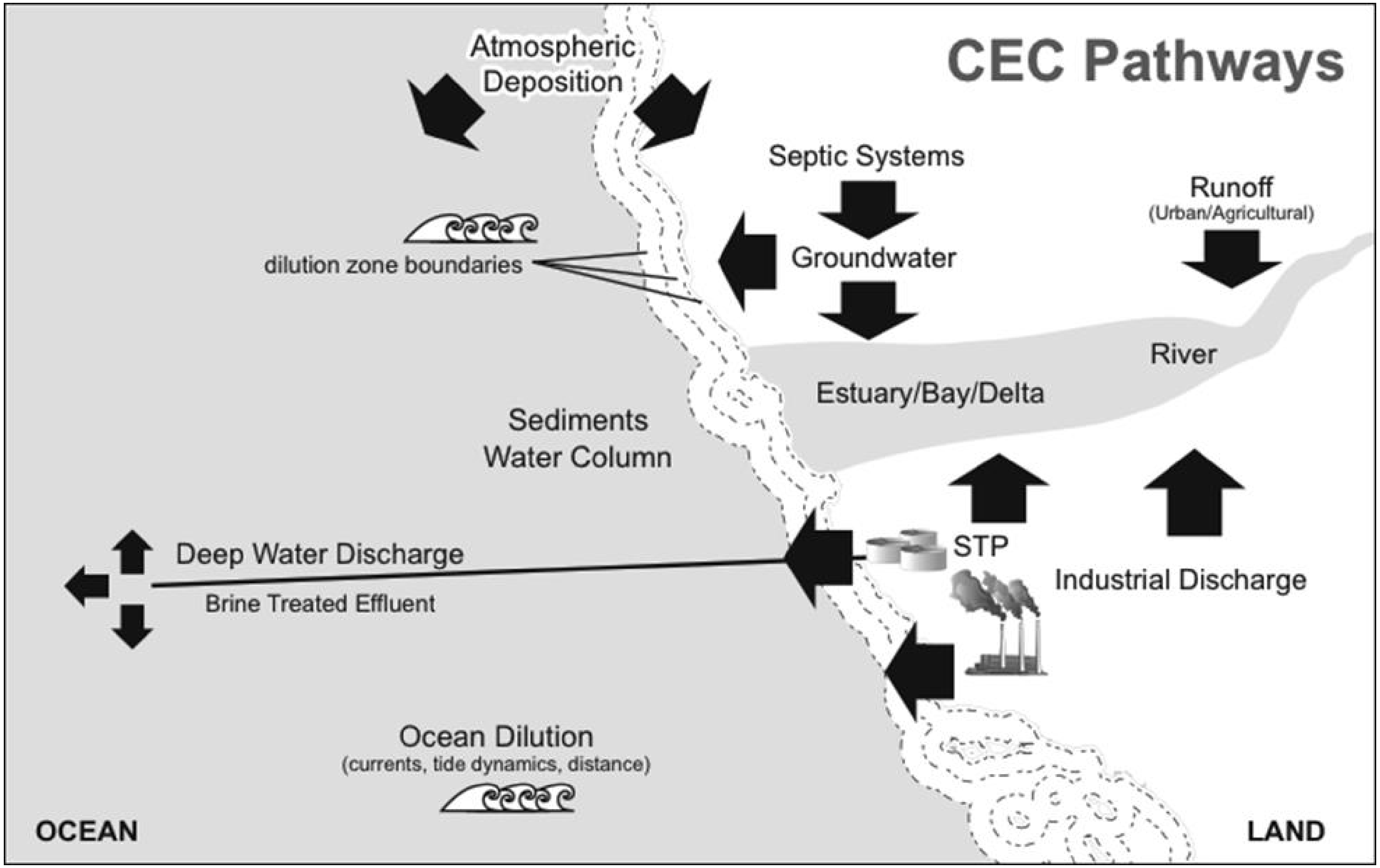
Summary of PAH developmental toxicity

compound or mixture	number of rings	mode of developmental toxicity
naphthalene	2	no effect
fluorene	3	cardiotoxicity, AHR-independent
dibenzothiophene	3	cardiotoxicity, AHR-independent
phenanthrene	3	cardiotoxicity, AHR-independent
alkyl-phenanthrenes	3	cardiotoxicity, AHR-dependent (and independent?)
anthracene	3	no effect
fluoranthene	4	cardiac and vascular toxicity
pyrene	4	late cardiovascular toxicity, AHR- and CYP1A-dependent
benz(a)anthracene	4	cardiotoxicity, AHR-dependent
benz(b)anthracene	4	severe early developmental defects, pathway unknown
chrysene	4	no effect
benzo(e)pyrene	5	no effect
benzo(a)pyrene	5	cardiotoxicity, AHR-dependent
benzo(k)fluoranthene	5	cardiotoxicity, AHR-independent
FL, PY	4,4	cardiotoxicity and vascular malformation, pathway unknown
FL, PY, BEP, BAP, BKF	4,4,5,5,5	cardiotoxicity and vascular malformation, developmental delay, pathway unknown

Linkage of *In Vitro* Assay Results With *In Vivo* End Points

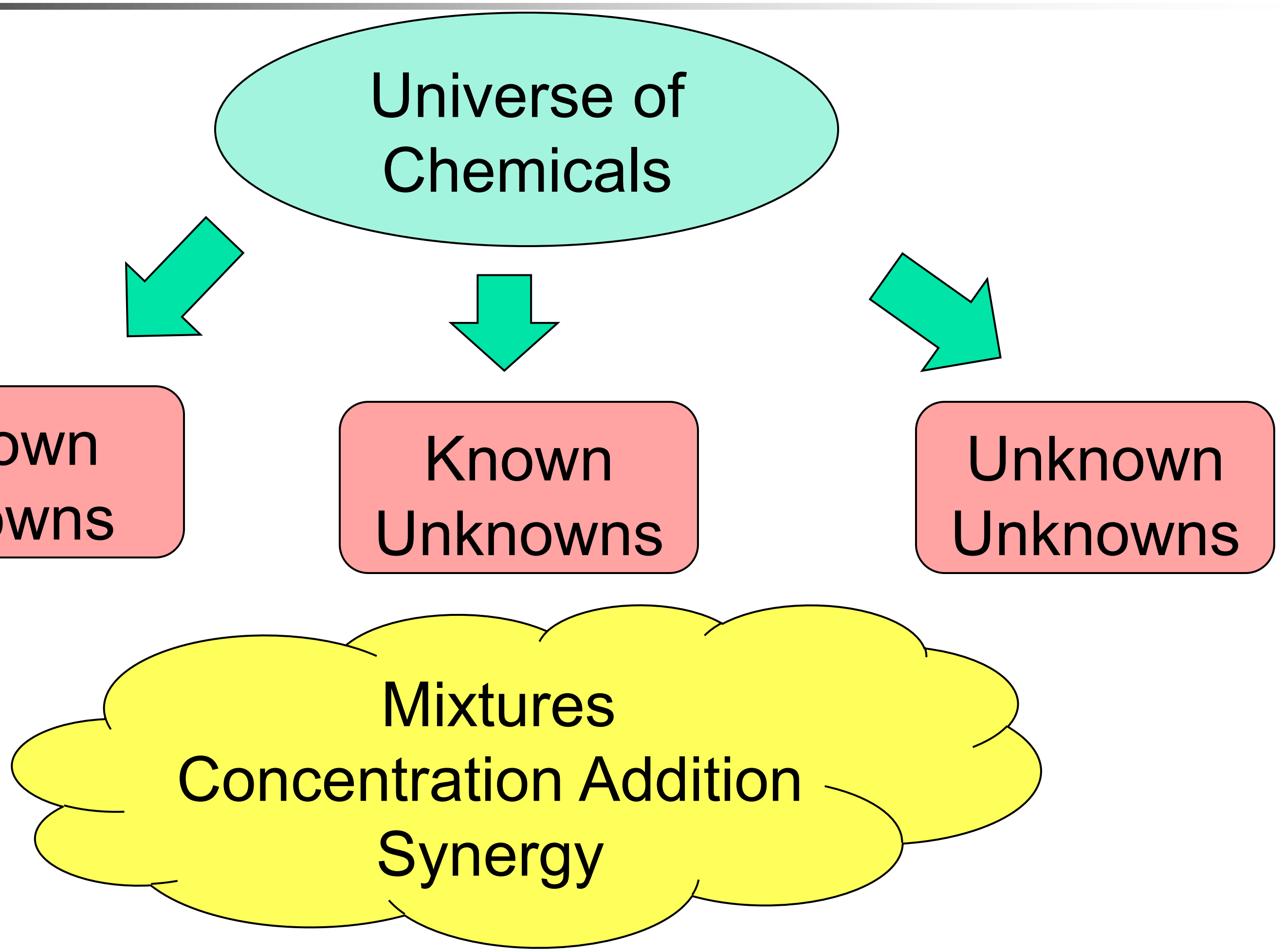
Nancy Denslow, University of Florida
Keith Maruya and Steve Bay, SCCWRP

Fish are exposed to chemicals in discharges to the estuarine & marine environment



(California Water Resources Control Board) Anderson et al., 2012

Contaminants of emerging concern



Chemicals Recommended for Monitoring in CA Receiving Waters

Monitoring trigger quotients

Compound	Scenario 1 Inland Waters Aqueous	Scenario 2 Embayment Aqueous	WWTP Effluent	FW Stream - Storm-water (Aqueous and Sediment)	Scenario 2 Embayment Sediment	Scenario 3 Marine Sediment	All Scenarios Tissue
Bis(2-ethylhexyl) phthalate	NA	NA	M-O	NA	NA	M	NA
Bisphenol A	M	M	M–E/F	M	NA	NA	NA
Bifenthrin	M	M	M-E/F	M	M	NA	NA
Butylbenzyl phthalate	NA	NA	M-O	NA	NA	M	NA
Permethrin	M	M	M-E/F	M	M	NA	NA
Chlorpyrifos	M	M	M-E/F	M	NA	NA	NA
Estrone	M	M	M-E/F	M	NA	NA	NA
Ibuprofen	M	NA	M-F	M	NA	NA	NA
17-beta estradiol	M	M	M-E/F	M	NA	NA	NA
Galaxolide (HHCB)	M	M	M-E/F	M	NA	NA	NA
Diclofenac	M	NA	M-F	M	NA	NA	NA
p-Nonylphenol	NA	NA	M-O	NA	NA	M	NA
PBDE -47 and 99	NA	NA	M-E/F/O	M	M	M	M
PFOS	NA	NA	M-E/F/O	M	M	M	M
Triclosan	M	NA	M-F	M	NA	NA	NA

Risk classification for CECs in San Francisco Bay (Sutton et al. 2013)

Management Tier	Compound(s)	Rationale
Tier III: Moderate Concern	PFOS	Bird egg concentrations greater than PNEC, high concentrations in seal blood, high volume use of precursors
	Fipronil	May be above toxicity thresholds at some sites for calculated porewater concentrations, need better ambient data and/or toxicity thresholds for sediment matrices to better assess risk
	Nonylphenol,	Bay concentrations below most toxicity thresholds, possible impacts on larval barnacle settlement, possible synergistic effects with pyrethroids, high volume use, estrogenic activity
	Nonylphenolethoxylates	
Tier II: Low Concern	PBDEs	Detected in Bay wildlife, toxicity in mammalian models, bird egg concentrations below toxicity threshold, sport fish concentrations below CA fish contaminant goal, possible immune system and behavioral impacts on fish, use declining
	Pyrethroids	Detected infrequently and in low concentrations in Bay sediments, of concern in watersheds, tributary sediment concentrations comparable or higher than toxicity thresholds, toxic at low concentrations, high volume use
	Pharmaceuticals (e.g 17b-estradiol)	Concentrations below toxicity thresholds, toxicity to aquatic species sufficiently characterized
	Personal care products (e.g. galaxolide)	
	HBCD	Concentrations are low; possible reduction in use

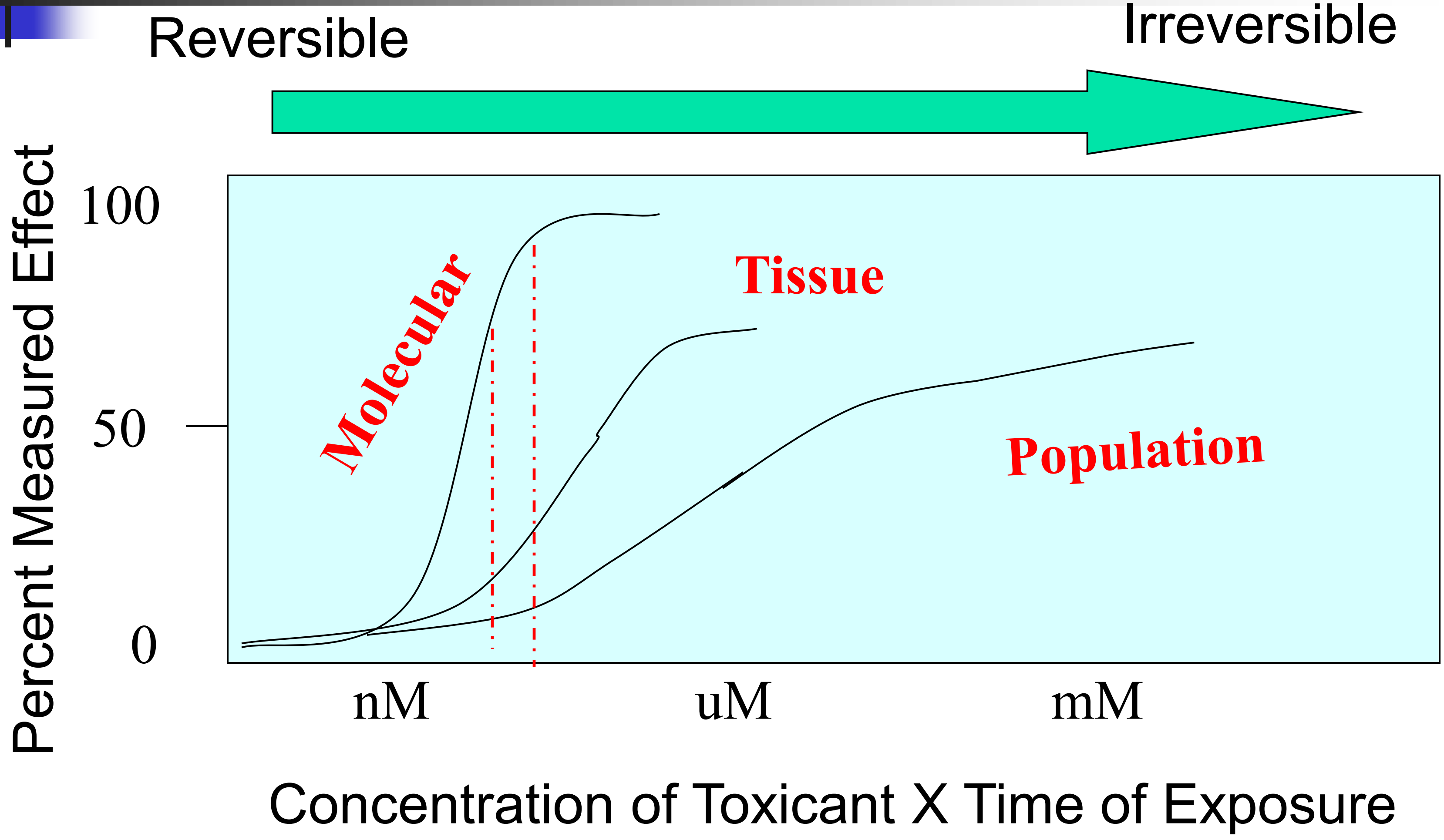
Risk classification for CECs in San Francisco Bay (Sutton et al. 2013)

Management Tier	Compound(s)	Rationale
Tier I: Possible Concern	Alternative Flame Retardants (TBPH, TBB, DBDPE, PBEB, BTBPE, HBB, DP, TDCPP, TCEP, TCPP, TBEP, TPP other organophosphates)	Detection of some in sediments or bird eggs, toxicity for some in mammalian models, limited toxicity data for aquatic species, high volume use or PBDE replacements
	Bisphenol A	Analyzed but not detected in surface waters (<2500 ng/L) or sediments (<2600 ng/g), PNEC=60 ng/L
	Bis(2-ethylhexyl) phthalate (BEHP or DEHP)	Sediment concentrations comparable to high apparent effects threshold (but threshold not directly linked to specific chemicals)
	Butylbenzyl phthalate	Sediment concentrations greater than low apparent effects threshold (but threshold not directly linked to specific chemicals or effects in macrobenthos)
	PFCs other than PFOS	Detection of some compounds, possible impacts to marine mammals from PFOA, toxicity to aquatic species not sufficiently characterized
	Short-chain chlorinated paraffins	Concentrations below toxicity thresholds, uncertainties in toxicity data, high volume use
	Other pesticides**	Concentrations below toxicity thresholds, uncertainty in toxicity to Bay wildlife
	Single-walled carbon nanotubes	Not detected, toxicity information not available, high volume use

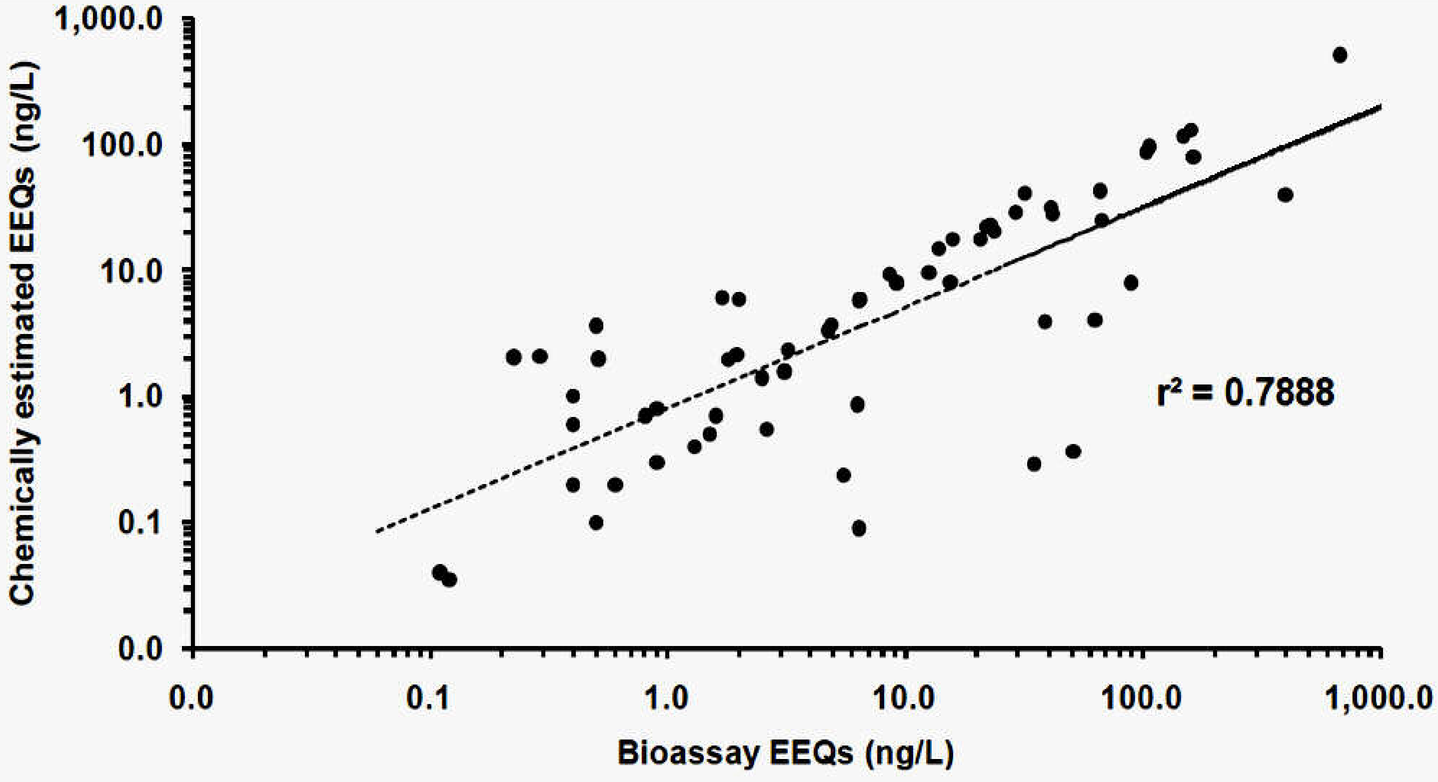
Selected Key Research Needs

- Research and development of bioanalytical research tools
  - High throughput in vitro bioassays with endpoints that respond to CEC exposures
  - Development and application of microarrays and targeted toxicity testing to establish toxicity pathways linked to higher level effects
- Filling data gaps on CEC sources, fate occurrence and toxicity
- Assessing the relative risk of CECs and other monitored chemicals

Biomarker sensitivity



Estrogen equivalency



Correlation between chemically estimated EEQs and bioassay EEQs (Bulloch *et al.*, 2010).

Choice of species: *Menidia beryllina (silverside)*

- Sensitive estuarine fish – similar fish exist in CA
- Related to the topsmelt
- EPA assays used for regulatory purposes: early life stage (ELS) and juvenile stage (JS)

Relevant Molecular Biomarkers

- Illumina sequencing/assembly
- Q-PCR assays for
  - Vtg 1 – vitellogenin
  - ERα – estrogen receptor alpha
  - ERβ – estrogen receptor beta
  - AR – androgen receptor
  - IGF-1 – Insulin like growth factor 1
  - StAR – steroidogenic acute regulatory protein
  - Cyp19a1b – brain aromatase
  - GHR – growth hormone receptor
  - AMH -- anti-Mullerian hormone
  - DMRT1-- doublesex and mab-3 related transcription factor 1

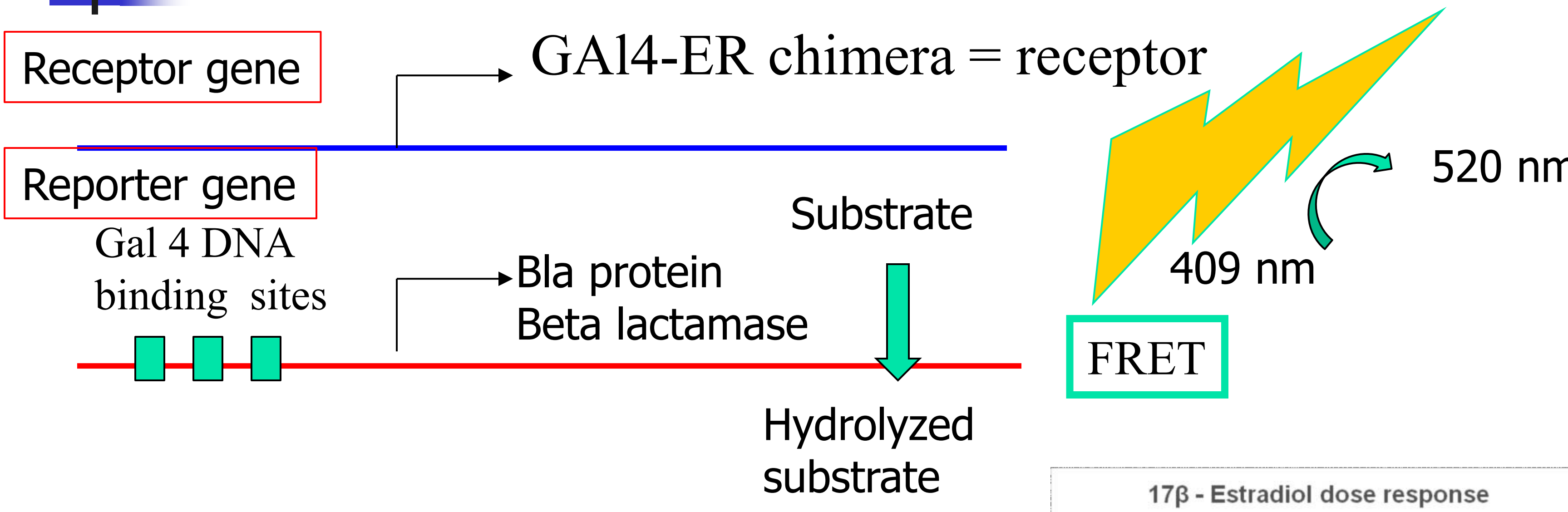
Laboratory exposures (Yr 1)

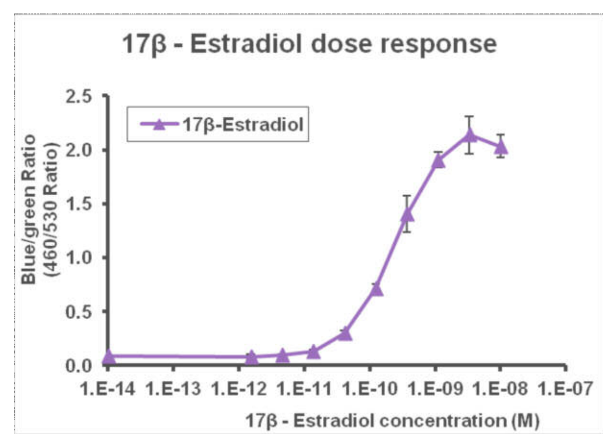
Dr. Alvina Mehinto

Dr. Sumith Balapanage

- Model chemicals: E1, E2, 4-NP, BPA, galaxolide (HHCB)
- ELS – survival, growth, 5 molecular biomarkers
- Juvenile – growth, Vtg, E, T, 5 molecular biomarkers
- High throughput assays – ER, AR

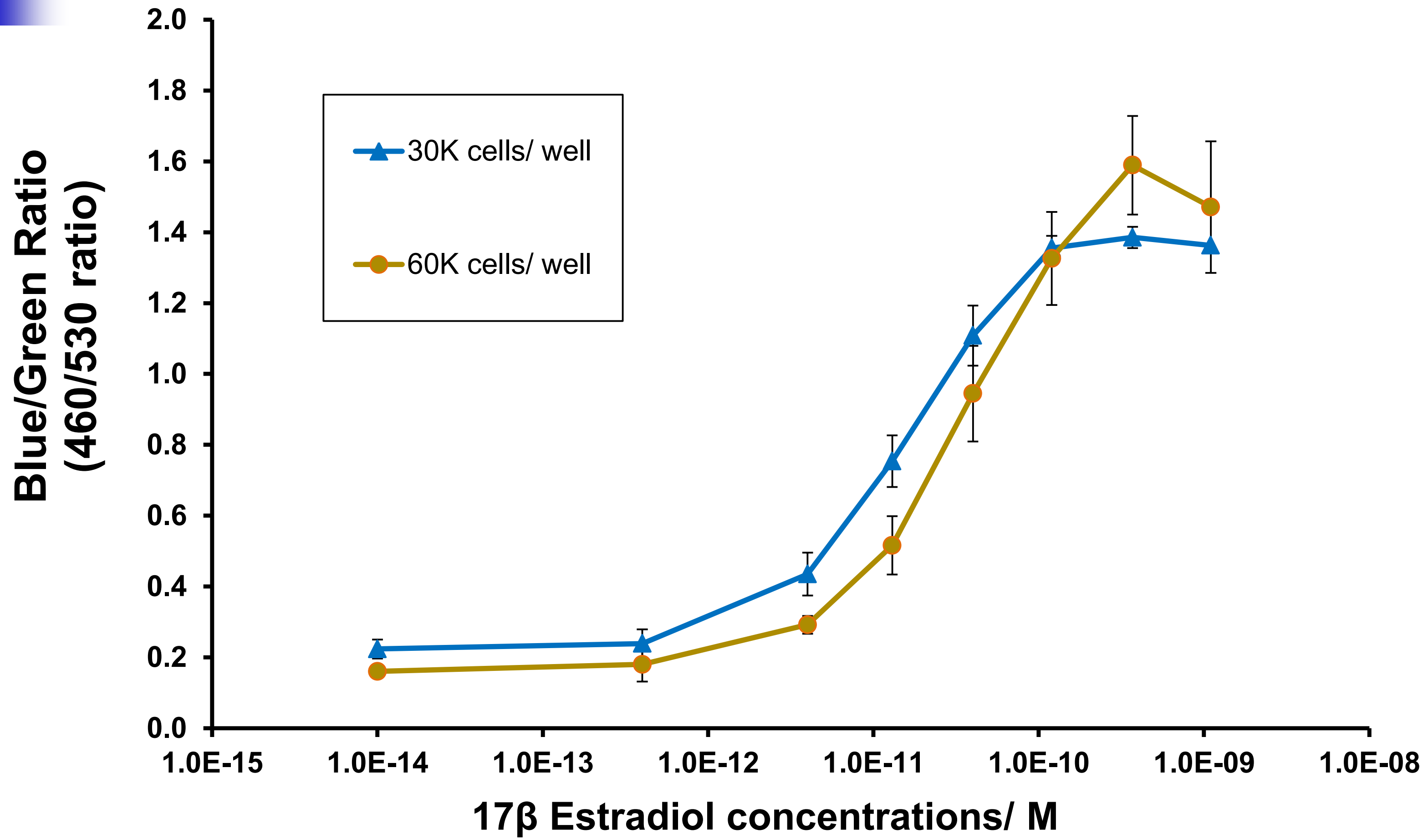
High throughput assays –ER & AR InVitrogen





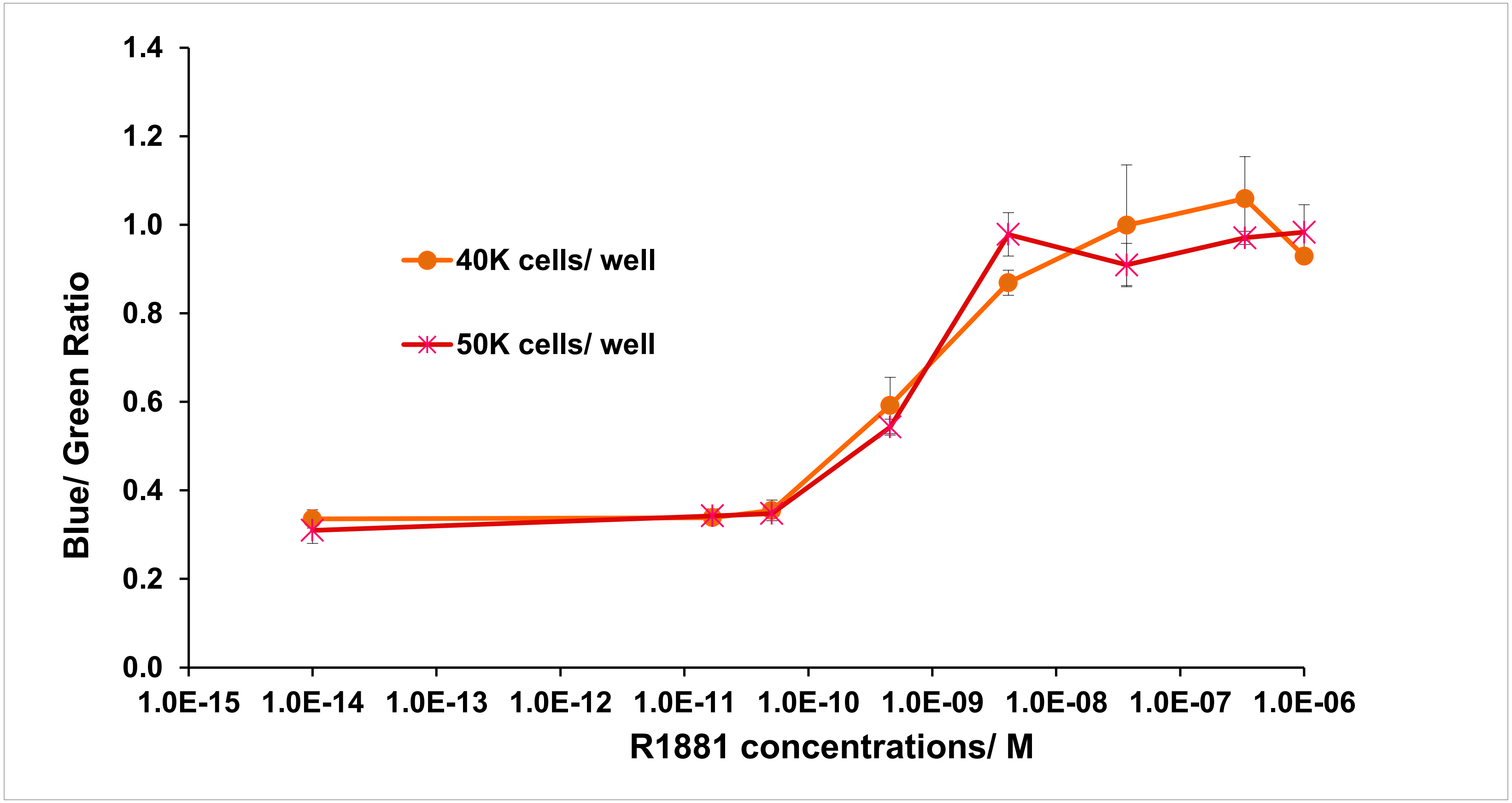
GeneBlazer ERα Assay

E2 dose response curve with 30K and 60 K cells per well



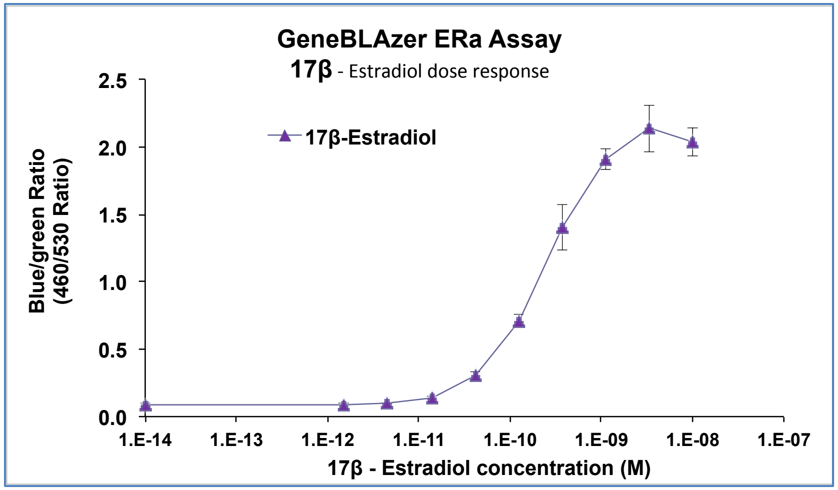
GeneBlazer AR Assay

E2 dose response curve with 40K and 50 K cells per well

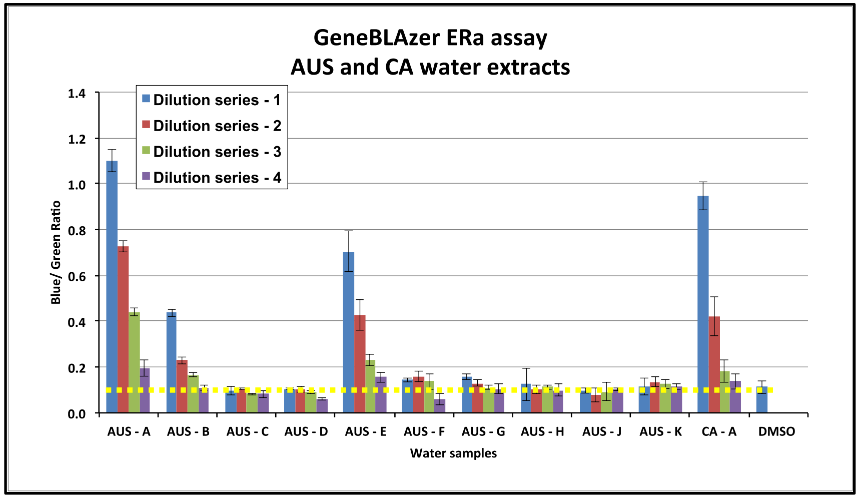


ER assay and evaluation of water

Standard curve



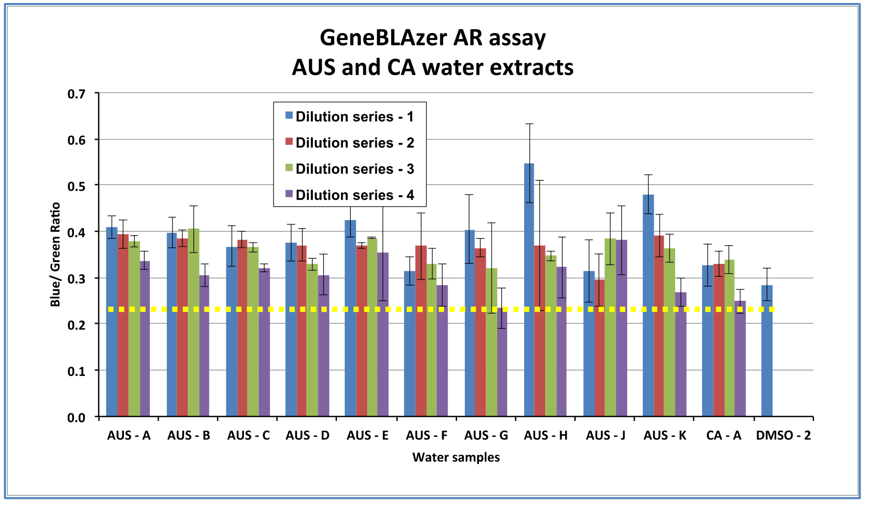
Water samples



Samples A, E, CA-A: Secondary treated effluent

Others: Secondary effluent receiving advanced treatment (e.g. membrane filtration; RO; ozonation & biologically activated carbon filtration; drinking water inlet/outlet stormwater (sample J); blank

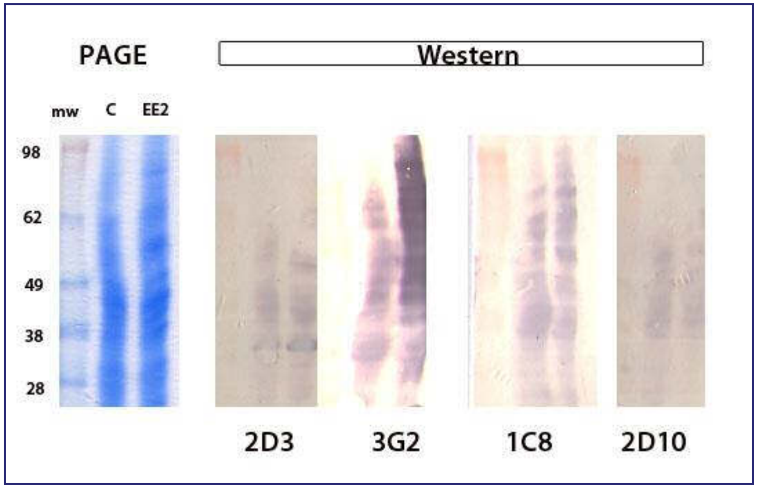
AR assay and water samples



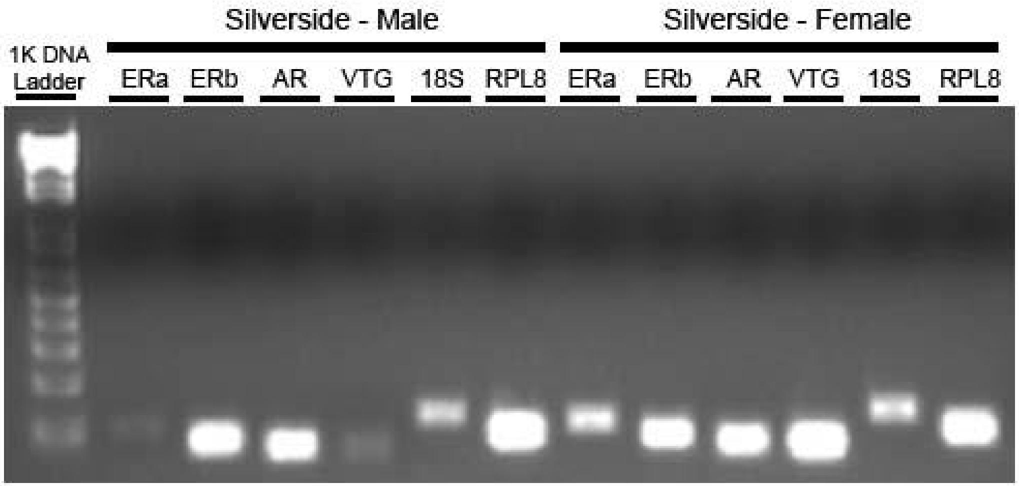
Samples A, E, CA-A: Secondary treated effluent
Others: Secondary effluent receiving advanced treatment (e.g. membrane filtration; RO; ozonation & biologically activated carbon filtration; drinking water inlet/outlet stormwater (sample J); blank

Vtg assay for Menidia – protein and mRNA

Vtg protein
Whole body homogenate



Primers for mRNAs
In liver



Menidia sequencing information

- RNA-Seq experiment with 17 d old fry +/- 5 ng/L EE2 for 7 days.
- One lane of Illumina sequencing using the Illumina-HighSeq, with paired ends = 300 million sequences. Samples will be bar-coded.
- One lane PACBio, for one control sample and one EE2 sample, for long sequences to use as a scaffold.
- Expect to get sequences for genes that we need for the study.
- Bonus, look at other genes that are changing based on the exposure.
- Will add our sequence information to that collected by Richard Connon, UCDavis

Yr 1 Experiments

- Obtain the gene sequences and develop Q-PCR assays
- Perform exposures on ELS for higher level endpoints: growth, survival. Also perform Q-PCR assays
- Perform exposures on Juveniles for higher level endpoints: growth, survival, plasma Vtg, hormone levels, + QPCR
- Perform in vitro assays with the chems

Field Exposures (Yr 2)

- Site 1: marine outfalls in So Cal (4 to choose from)
- Site 2: e.g. San Jose/Santa Clara Water Pollution Control Plant that discharges into south San Francisco Bay.
- Assays:
  - ELS and juvenile assays
  - Molecular biomarkers
  - ER, AR high throughput assays

Relating molecular to organism level responses

- Higher order endpoints
  - Growth
  - Survival
  - Reproduction
  - Susceptibility to disease

- In vitro bioassay
  - EEQs via ER and AR test results

- Molecular biomarkers
  - Plasma Vtg, hormones

  ELS
  - IGF-1, GH, brain aromatase, amh, dmrt1

  Juveniles
  - Vtg, ERα, ERβ, StAR, AR

Schedule, cost & leveraging

- Staged 2 yr project
  - Deliverables: mid-term & final report
  - $168K total; $126K requested ($42K in kind)
- Leverage: In vitro bioassays ($800K; SWB); SoCal Bight ($750K; SCCWRP & partners); Receiving water/linkage study ($75K; SCCWRP)
- Collaboration with Susan Brander (UNC-Wilmington) and Richard Connon (UC Davis) to develop Menidia as a bioindicator species.

Development of Benthic Community Condition Indices for Mesohaline Environments of the San Francisco Bay

Progress Report

May 16th 2013

Ananda Ranasinghe

Eric Stein

SCCWRP

Road Map

1. Project Overview
   - Introduction & Goals
   - Tasks, Progress and Plans

2. Summary of Phase 1 Results

3. Plans for Phase 2 & Next Steps

Sediment Quality Objectives (SQOs)

- Developed by California in the mid-2000's
- SQOs are based on the sediment triad
  - Sediment chemistry, toxicity, & **benthic condition**
- Benthic objectives differ by habitat
  - Species composition varies naturally
  - Biological expectations for reference condition vary
  - Measurements of deviation from reference should also vary
- Need different tools for different habitats

Benthic SQOs

- Were developed only for one SF Bay habitat
  - Sufficient data only in Polyhaline Central Bay

- SF Bay habitat definitions
  - Initially based on west coast-wide gear
    - 0.1m^2 grabs & 1-mm sieves
    - Only 147 samples @ 37 sites; several sites visited multiple times
    - Ranasinghe *et al.* (2012)
  - Subsequently upgraded for San Francisco Bay
    - SFB Traditional 0.05m^2 grabs & 0.5-mm sieves
    - 501 samples @ 328 sites in study; broad spatial coverage; extended into Delta
    - Thompson *et al.* (2013)

- Additional data are now available
  - May enable development in additional low salinity habitats

Project Goals

- Develop benthic assessment tools for additional (low salinity) habitats of SF Bay
  - Mesohaline (San Pablo Bay; Lower South Bay)
  - Possibly Tidal Freshwater and Oligohaline habitats

- Based on improved SF Bay habitat definitions and additional data
  - For SFB traditional 0.05m^2 gear & 0.5-mm sieves
  - Improve spatial definitions
  - Confirm dominant species

Two Phases

- Phase 1
  - Update database (Task 1)
  - Refine habitat definitions (Task 2)
  - Prepare for Index development process

- Phase 2
  - BPJ study to establish reference
  - Develop and calibrate index
  - Validate and refine index
  - Propose thresholds

Tasks, Progress & Plans

Phase	Task No	Task	Progress or Plans
1 (Funded) $50K	1	Update database	In progress. Target: June 15th
	2	Refine Habitat Definitions	Analysis complete
	3	Identify and Withhold Validation Data and conduct BPJ study	Presently identifying data and participants. Target: Commence by end of June
2 (2013?) $76K	4	Develop and Calibrate Benthic Indices	TBD
	5	Assure Independence of Indices and Habitat Factors	TBD
	6	Calculate Benthic Index Values	TBD
	7	Evaluate and Validate Benthic Indices	TBD
	8	Prepare Report/Journal Article	TBD

Task 1 Status

- Standardizing the existing benthic database
  - Benthic data
  - Habitat information
  - Contaminant data
  - Sediment toxicity

Task 2 Refine Habitats: Objective

- Improve SF Bay habitat definitions
  - Spatial
  - Habitat (e.g., salinity, sediment grain size)
  - Species composition

- For benthic index
  - Development, and
  - Benthic community condition assessments for SQOs

Task 2 Refine Habitats: Methods

- Map assemblages
  - Coast-wide study (SFB: 147 samples @ 37 sites)
  - Bay-wide study (SFB: 501 samples @ 328 sites)
- Evaluate assemblage discrepancies
  - Characteristic species
  - Spatial distributions
  - Habitat factors
  - Station revisits

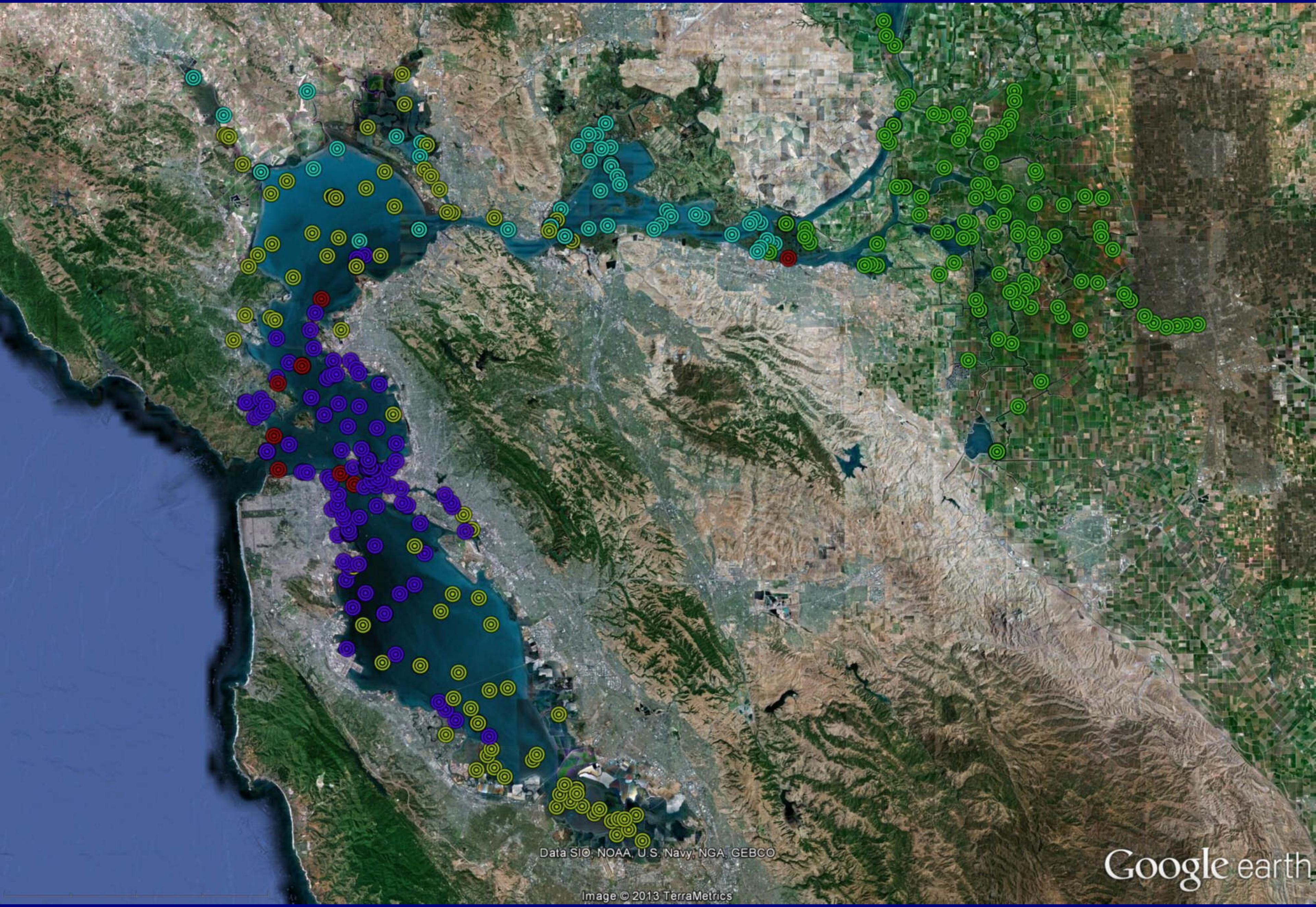
Task 2 Refine Habitats: Assemblage Results

- Coast-wide and bay-wide Polyhaline assemblages are very similar
  - Species with high exclusivity are the same
  - Sites included in both studies classify the same
- Coast-wide Mesohaline splits into bay-wide Mesohaline and Oligohaline
- Coast-wide and bay-wide Tidal freshwater assemblages are very similar

Task 2 Refine Habitats: Spatial Results

- Polyhaline N boundary is the same
  - Richmond San Rafael bridge
- Polyhaline S boundary moves N
  - Shallow areas in S & E Central Bay N of Dumbarton Bridge are mesohaline
- Suisun Bay and N San Pablo Bay tributaries are Oligohaline
- Oligohaline-Tidal Freshwater boundary is at the western tip of West Island


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
Google earth


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
Google earth

Task 2 Refine Habitats: Revisit Results

- Most samples at revisited sites were assigned to the same assemblage
  - SFB Study
    - Only one assemblage at 21 of 29 multiple sample sites
    - Avg. of 77.8% of samples in main assemblage at other 8 sites
  - West Coast Study
    - Only one assemblage at 15 of 20 multiple sample sites
    - Avg. of 76.0% of samples in main assemblage at other 5 sites
- Overall, site assemblages were stable

Phase 2 - Next Steps
Already Funded

- Complete database compilation
- Select experts and samples for BPJ study
- Complete BPJ study to define reference

Phase 2 – Next Steps (Not Yet Funded)

- Developing and calibrate benthic indices
- Assure independence of the indices from environmental variables
- Validate indices and propose thresholds

Thank you

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Applying CA Sediment Quality Objective Assessment Protocols to San Francisco Bay Samples

Using multiple lines of evidence to assess direct exposure of toxic pollutants to San Francisco Bay benthic communities

Ellen Willis-Norton, Ananda Ranasinghe, Darrin Greenstein, Karen Taberski, and Naomi Feger

SQO Assessments in San Francisco Bay

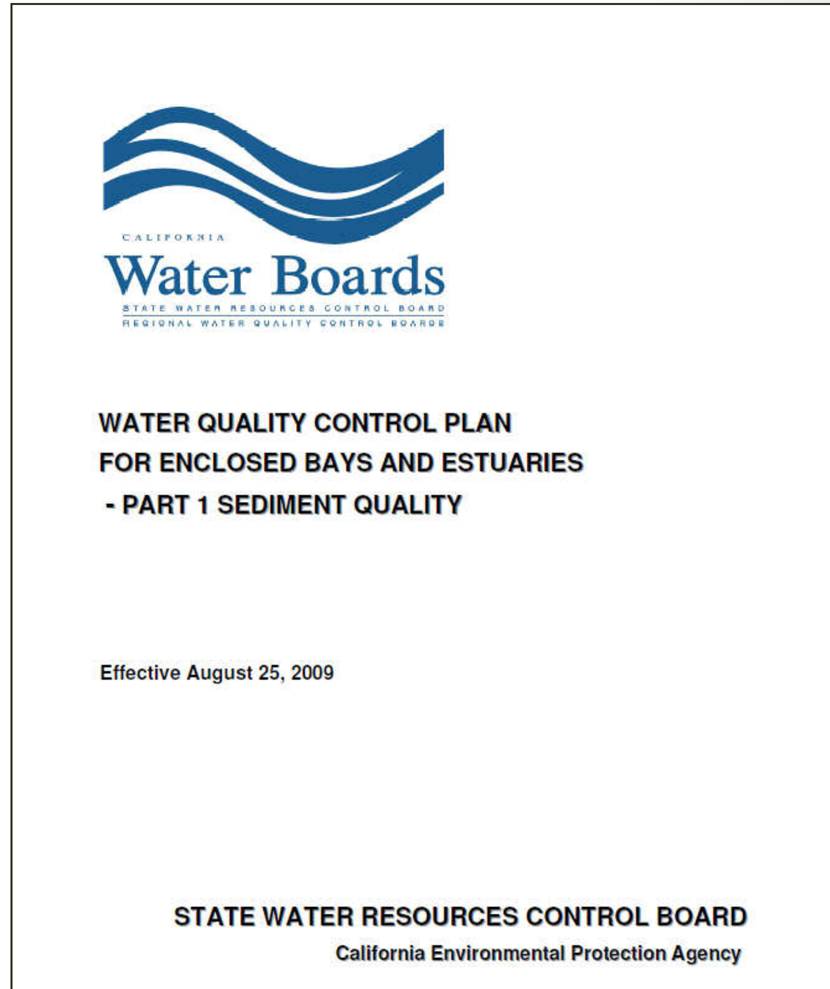
The Regional Monitoring Program for San Francisco Bay applied CA Sediment Quality Objectives to:

1. Two toxic hotspots in Central Bay

2. 50 randomly allocated sites throughout the Bay

Background on SQOs

- 2003: State Board initiated a program to develop SQOs
- 2009: “Water Quality Control Plan for Enclosed Bays and Estuaries” adopted


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

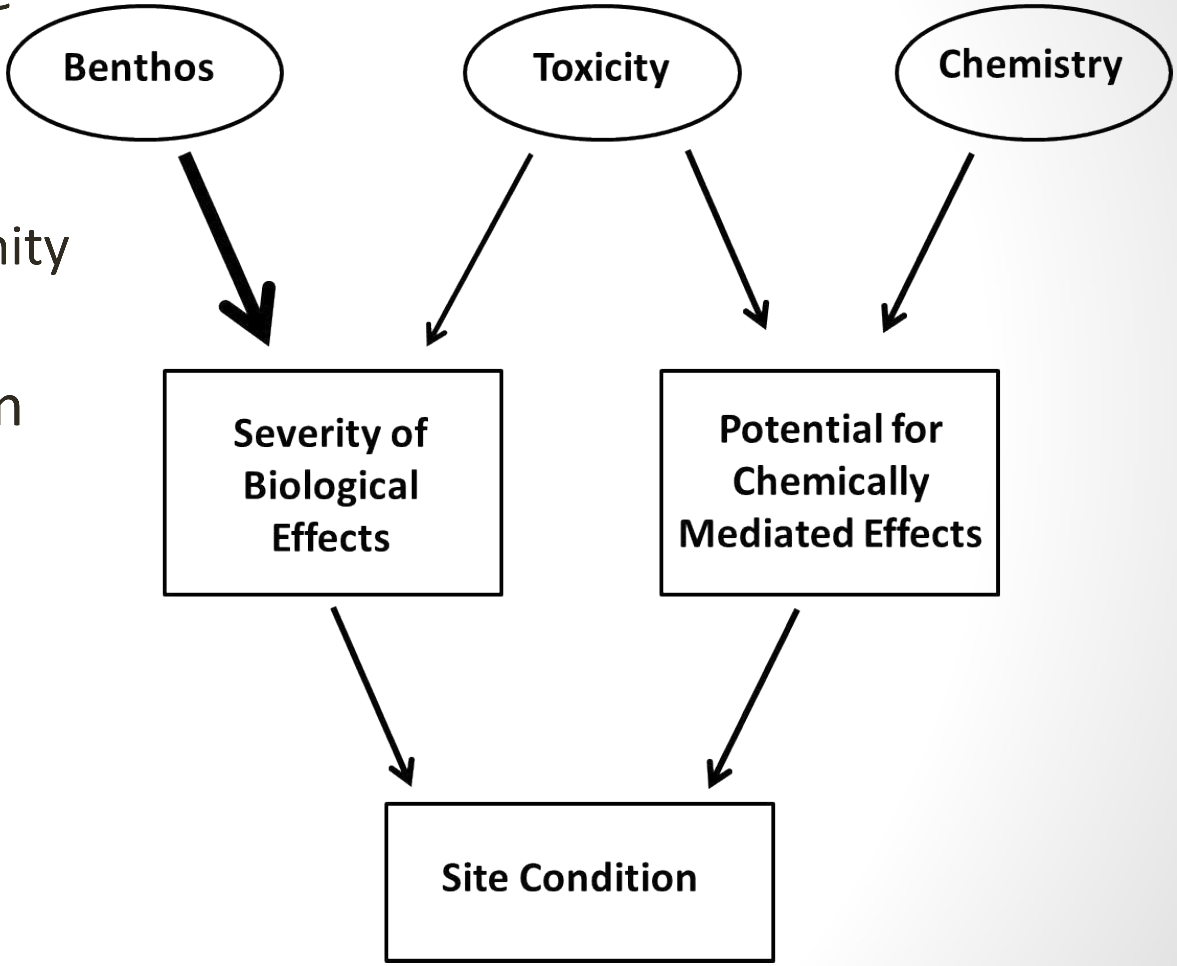
WATER QUALITY CONTROL PLAN
FOR ENCLOSED BAYS AND ESTUARIES
- PART 1 SEDIMENT QUALITY

Effective August 25, 2009

STATE WATER RESOURCES CONTROL BOARD
California Environmental Protection Agency

Multiple Lines of Evidence

- Multiple lines of evidence
  - Sediment Chemistry (2)
  - Sediment Toxicity (2)
  - Benthic Infauna Community Composition (4)
- Six categories for a station assessment
  - ✓ Unimpacted
  - ✓ Likely Unimpacted
  - ✓ Possibly Impacted
  - ✓ Likely Impacted
  - ✓ Clearly Impacted
  - ✓ Inconclusive



Calculation

1) Calculate individual scores for three Lines of Evidence:

Category Score	Chemistry LOE	Benthic LOE	Toxicity LOE
1	Minimal Exposure	Reference	Nontoxic
2	Low Exposure	Low Disturbance	Low Toxicity
3	Moderate Exposure	Moderate Disturbance	Moderate Toxicity
4	High Exposure	High Disturbance	High Toxicity

↓

2) Integrate Benthos & Toxicity Score and Chemistry & Toxicity Score

↓

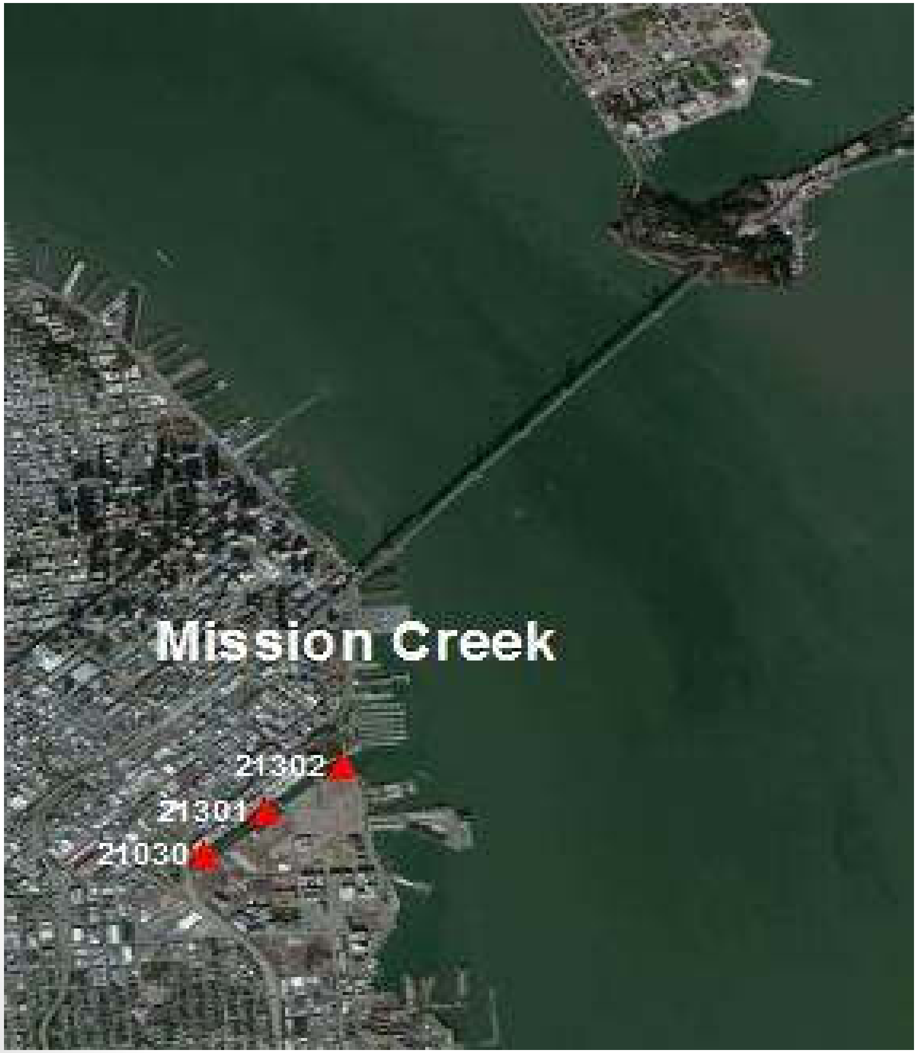
3) Determine Station Assessment scores based on Severity of Biological Effects and Potential for Chemically Mediated Effects:

Potential for Chemically Mediated Effects (Chemistry &Toxicity)	Severity of Effect (Benthos & Toxicity)				
		1	**2**	**3**	**4**
	1	Unimpacted	Likely Unimpacted	Likely Unimpacted	Inconclusive
	2	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
	3	Likely Unimpacted	Possibly Impacted	Likely Impacted	Likely Impacted
	4	Inconclusive	Likely Impacted	Clearly Impacted	Clearly Impacted

2011 RMP Hotspot Study

- Revisited two 303(d) listed creek channels
- Sampled Mission Creek and San Leandro Creek

Hotspot Study Locations



Hotspot Results

Mission Creek (upper-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
High Exposure	High Toxicity	Moderate Disturbance	**Clearly Impacted**
Mission Creek (mid-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
High Exposure	High Toxicity	Moderate Disturbance	**Clearly Impacted**
Mission Creek (end-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
Moderate Exposure	Moderate Toxicity	Moderate Disturbance	**Likely Impacted**

San Leandro (upper-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
High Exposure	Moderate Toxicity	Moderate Disturbance	**Clearly Impacted**
San Leandro (mid-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
Moderate Exposure	Moderate Toxicity	Moderate Disturbance	**Likely Impacted**
San Leandro (end-gradient)			
Chemistry	*Toxicity*	*Benthos*	*Station Assessment*
Moderate Exposure	Moderate Toxicity	Moderate Disturbance	**Likely Impacted**

Contaminants above the ERM

Mission Creek

- ✓ Mercury
- ✓ Chlordanes
- ✓ PCBs
- ✓ Lead
- ✓ Zinc
- ✓ HPAHs

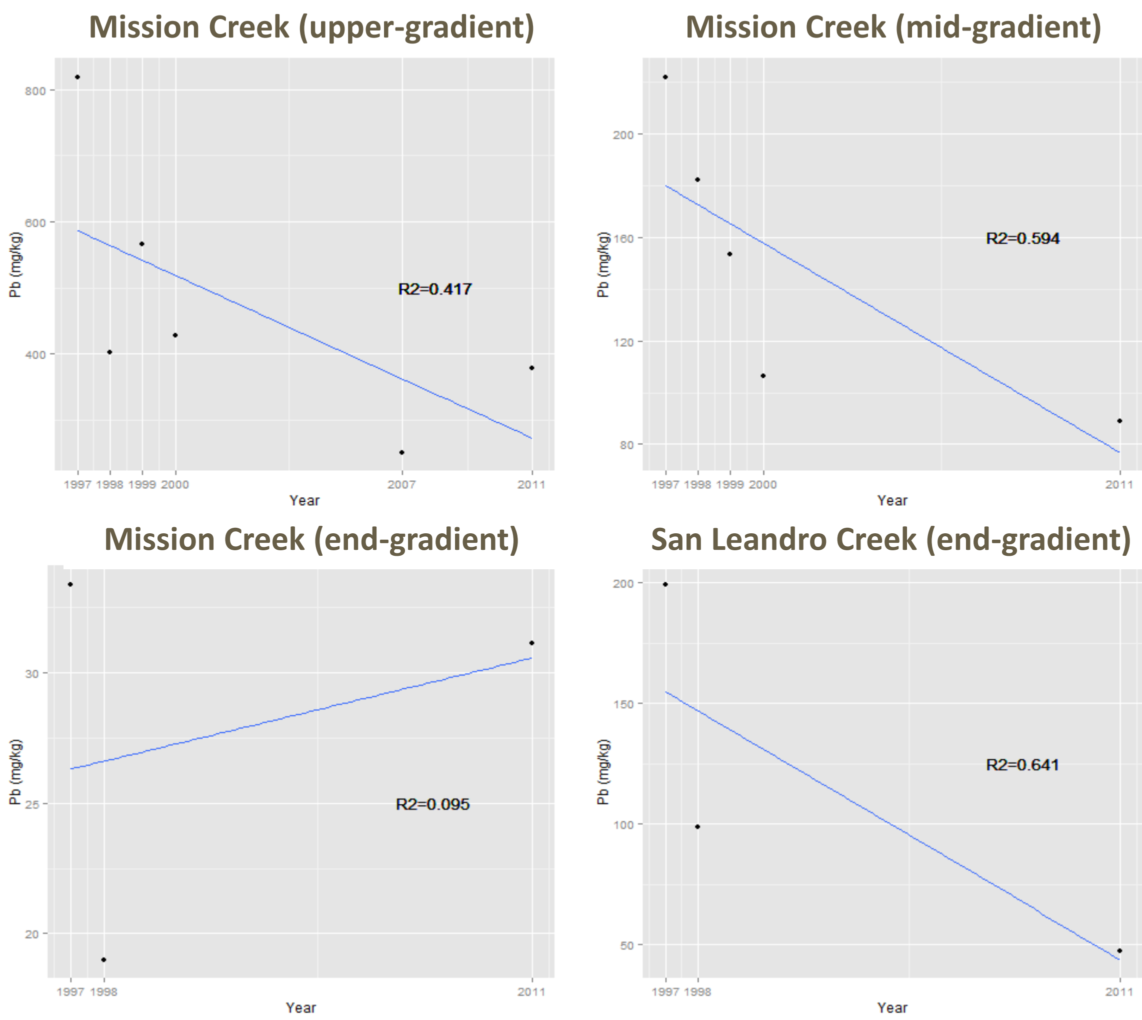
San Leandro Creek

- ✓ Mercury
- ✓ Chlordanes
- ✓ DDEs

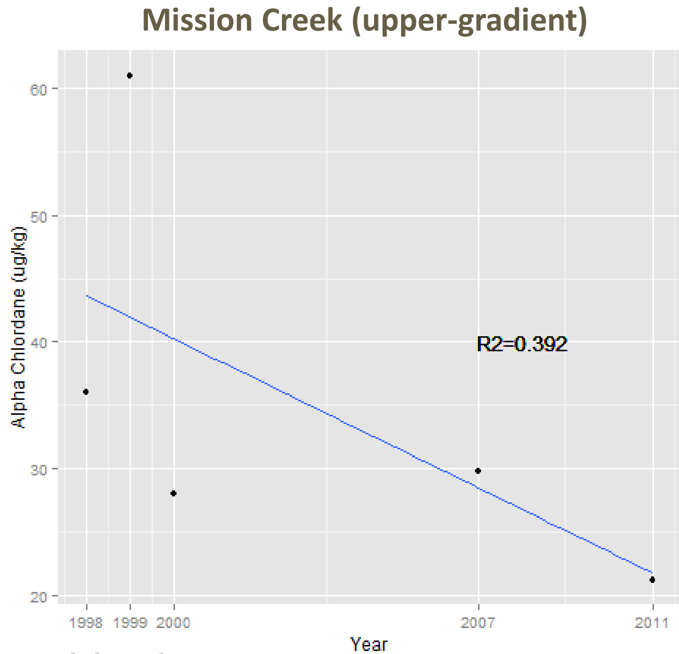
Historical Trends

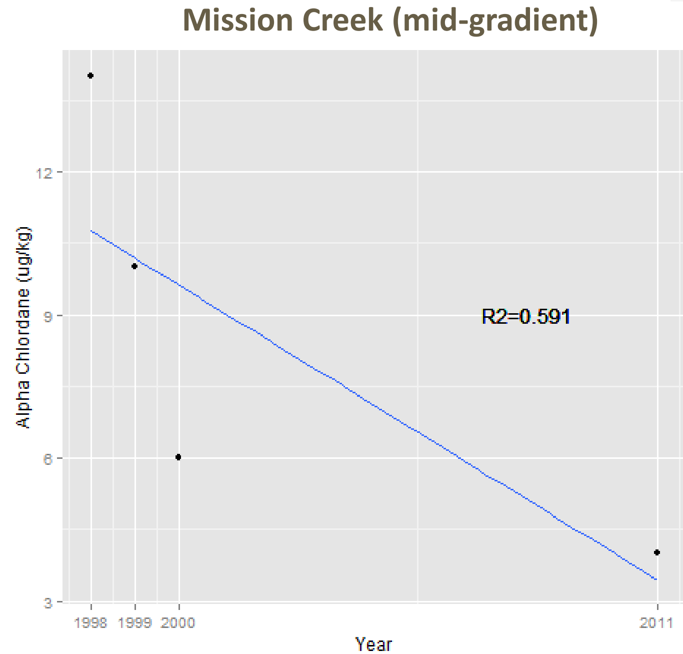
- Amphipod % survival and RBI values exhibited no trend over time
- Chlordanes and Pb were the only two contaminants with a decreasing trend over time

Lead:

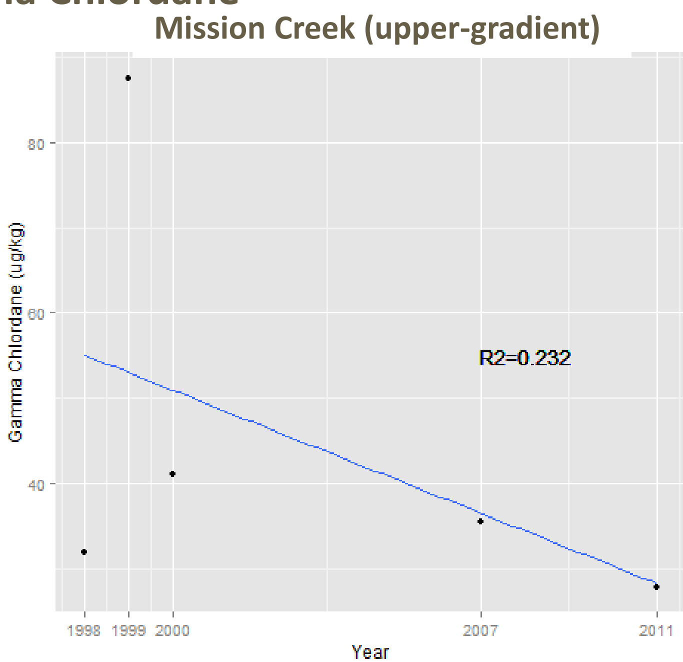


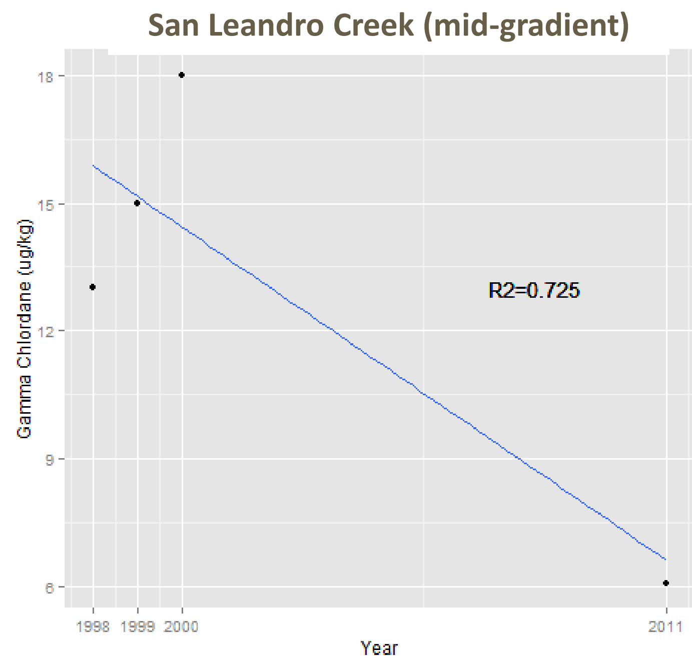
Alpha Chlordane





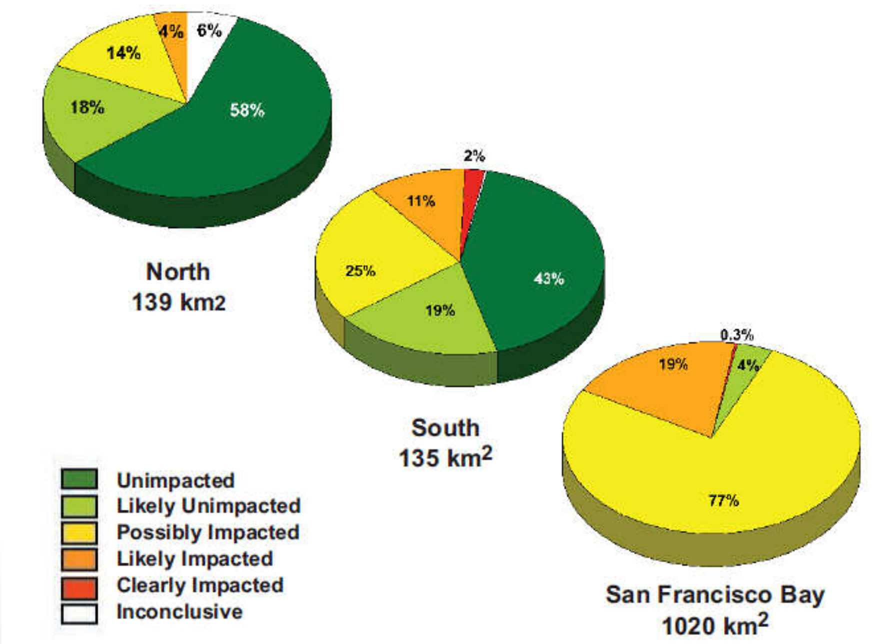
Gamma Chlordane

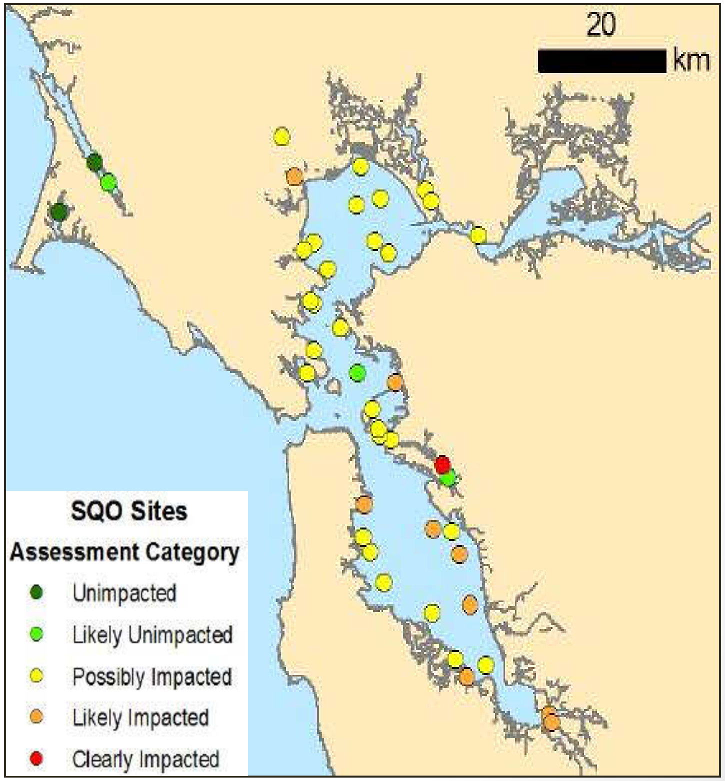




2011 and 2012 RMP Bay sites

- Part of Annual Status and Trends Monitoring
  - Summarizing 2011 and 2012 results



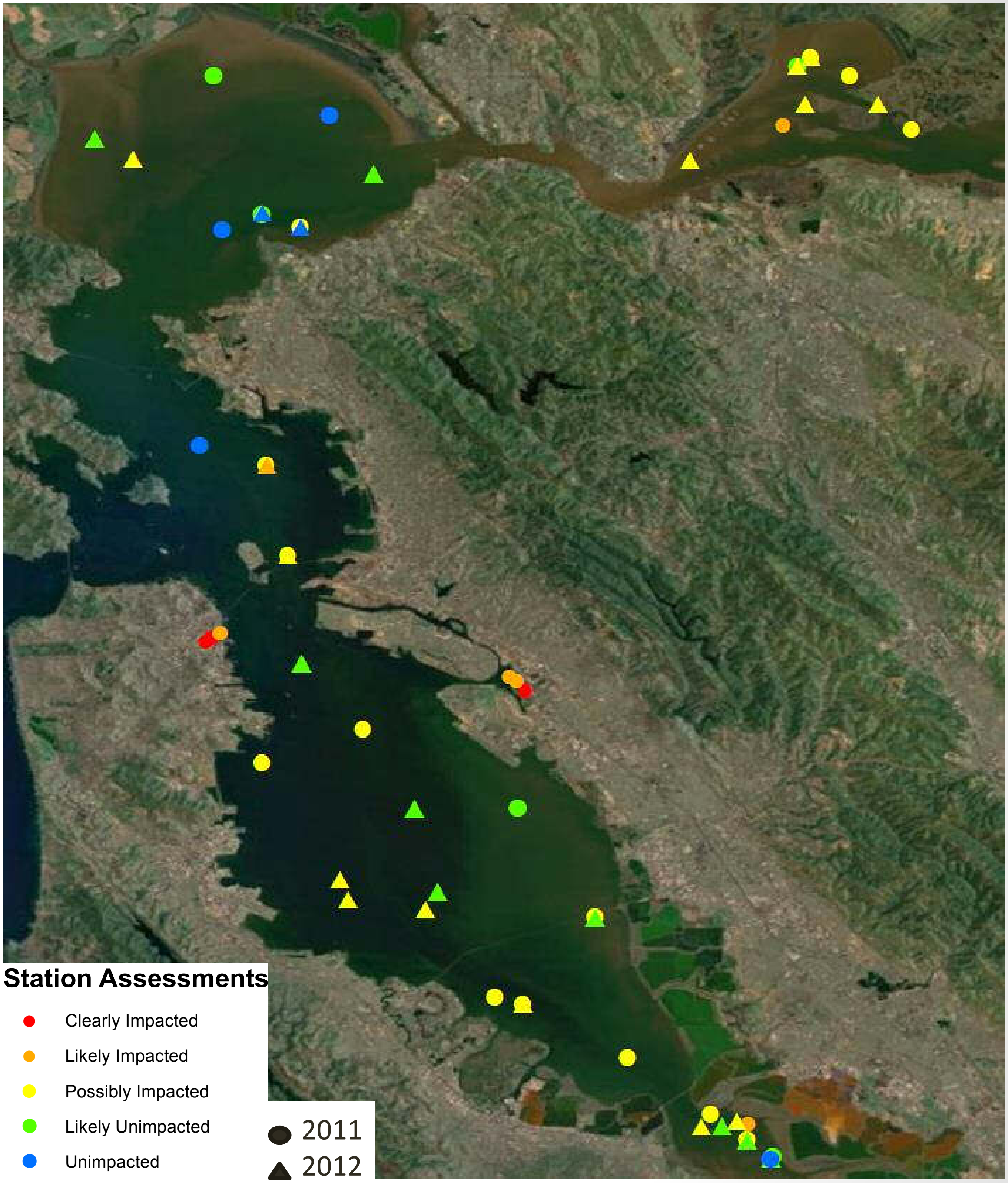


2011 and 2012 RMP S&T Results

SQOs were completed for 50 S&T Sediment sites in 2011 and 2012

Region	Clearly Impacted	Likely Impacted	Possibly Impacted	Likely Unimpacted	Unimpacted
San Pablo Bay			2	4	4
Central Bay		1	6	2	1
South Bay			7	3	
Lower South Bay		1	4	4	1
Suisun Bay		1	8	1	

Contamination in the Open Bay versus Creek Channels



Conclusions

- Mission Creek and San Leandro Creek remain impacted
- The majority of the Bay is “Possibly Impacted” with widespread moderate toxicity
- Pollutant impact greater within creek channels than in open bay sites
- Difficulty with completing SQOs :
  - Causes of moderate toxicity unknown

Thank you!

Special Study to Evaluate the Impacts of Dredging on Benthic Habitats

Korie Schaeffer (NMFS)
Brenda Goeden (BCDC)

May 16, 2013

Rationale

- What are the impacts of dredging on the benthic communities?

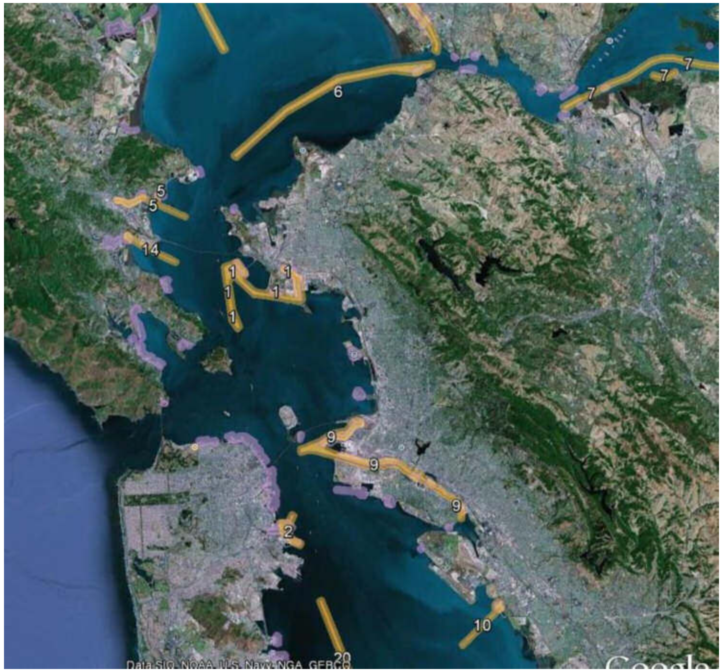
Is the quality of benthic habitat for fish-foraging in areas that are dredged of lesser quality than areas that are not dredged?

3-Phased Approach

- Phase I: Literature review to understand benthic assemblages and fish-feeding
  - *What are fish eating in central San Francisco Bay?*
  - *Can prey and benthos be grouped?*
  - *Leopard Shark; Big Skate; English Sole; Starry Flounder; Brown Rockfish; Green sturgeon; Northern Anchovy; Longfin Smelt; Pacific Sardine; Dungeness crab; California halibut; and White sturgeon*

3-Phased Approach

- Phase II: Statistical study design
  - *Invertebrate functional groups*
  - *Nearshore areas in central San Francisco Bay*
  - *Multiple dredged and undredged sites*



3-Phased Approach

- Phase III: Pilot field study field
  - *Evaluate study design*
  - *Benthic invertebrate sampling*
  - *Working in collaboration with RMP (potentially sediment cruise)*

Schedule

- Jan–Mar 2014: Literature Review
- April–May 2014: Develop statistical design
- July–Aug 2014:   Field sampling
- Jan–Mar 2015: Analyze data and write report

Budget

- RMP $50K
- America's Cup $100K

Detailed budget to be submitted upon selection of study partners

ESTABLISHING A SEDIMENT REFERENCE SITE FOR BAY DREDGING

Brian Ross (USEPA), Beth Christian (SF RWQCB),
Ellen Willis-Norton (SFEI) and Don Yee (SFEI)

Background

- Inland Testing Manual calls for comparison of dredged materials to disposal site sediment
- Multiple disposal sites yield multiple reference sites
- Discharges at the disposal sites impacts the reference condition
- Goal is to adopt a Bay-wide reference site that is unimpacted by previous discharges of dredged material

Courtesy of EPA

Dredging Reference Site Screening

1. Fine-grained sediment (like most dredged material)

2. Unimpacted by previous dumping and nearby industry

3. Relatively easy to access and sample

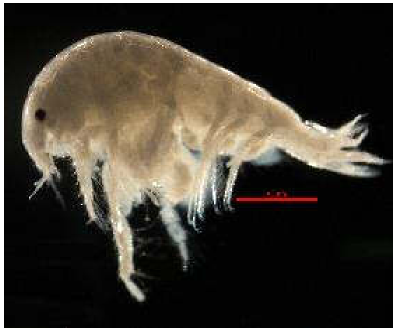
4. Consistently high (> 85%) amphipod survival

5. Does not exceeded ambient sediment chemistry thresholds for dredging projects*

* Different from *Pulse* reporting of Bay averages

Approach

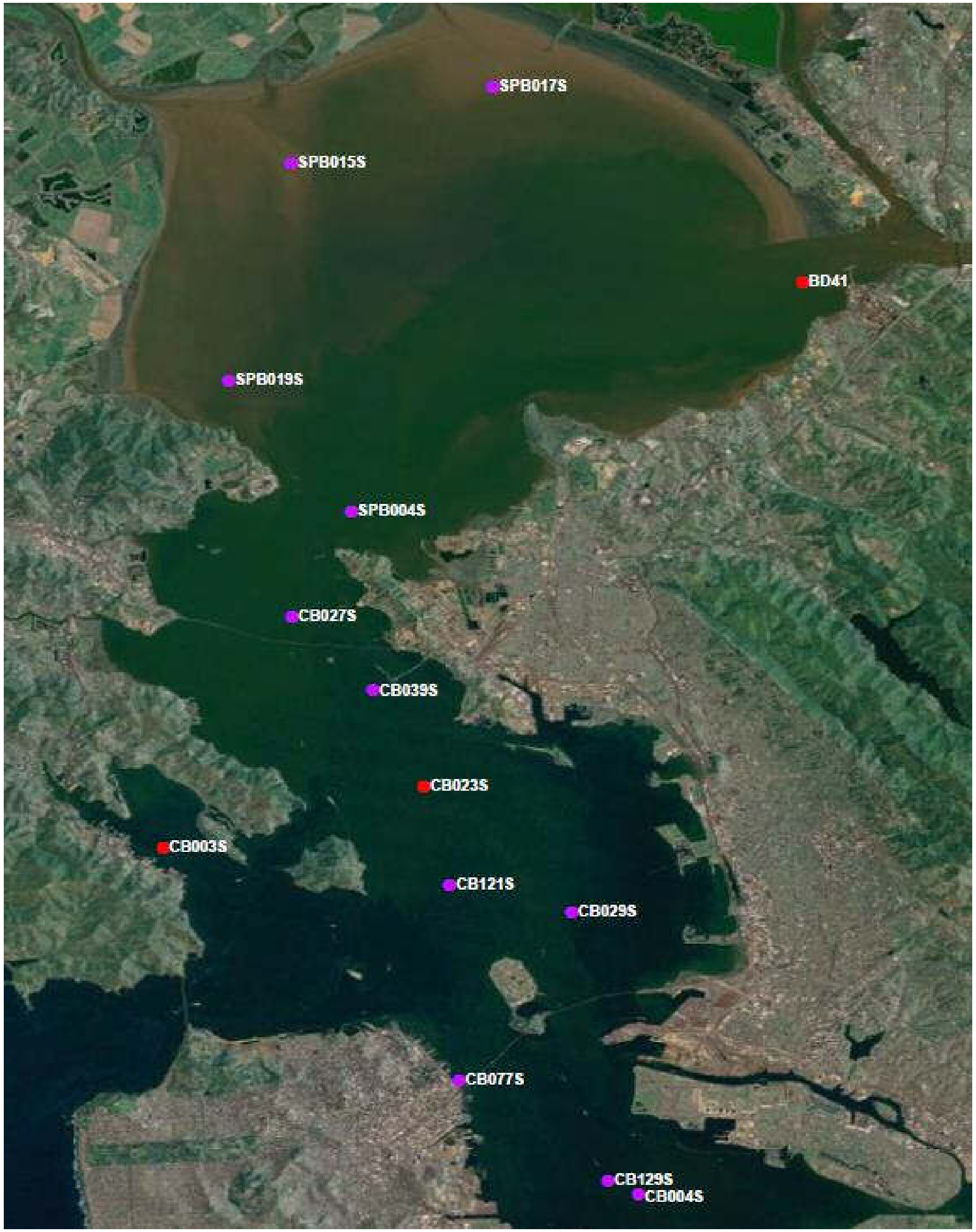
1. Survey previous RMP S&T sites based on screening criteria
2. Choose one or two candidate sites and add to the RMP's biennial sediment cruise
3. Conduct sediment bioassays with additional species used for dredge testing
4. Recommend a reference site as appropriate
5. Maintain an on-line database with adopted site's toxicity and chemistry

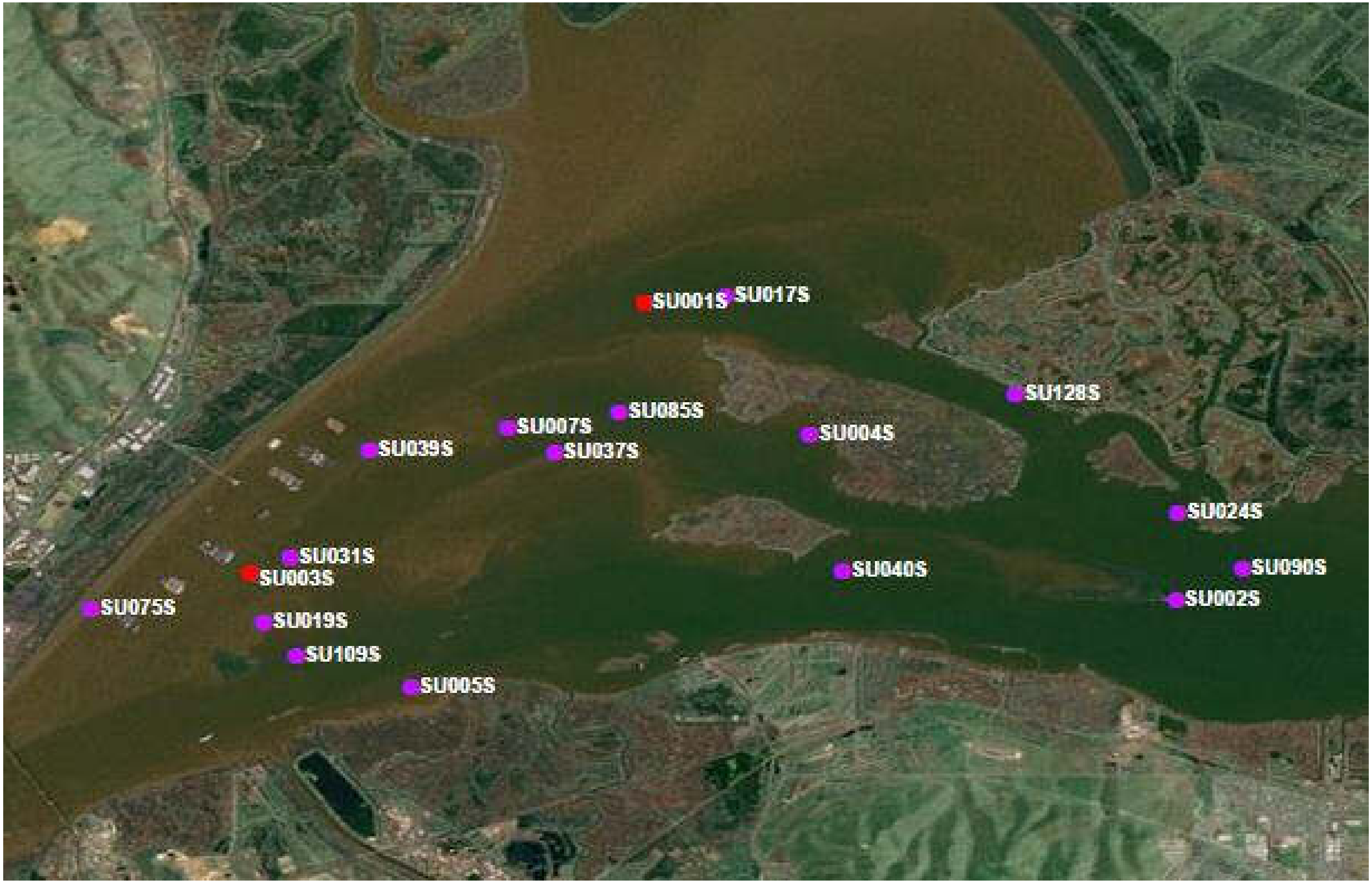
Courtesy of 1) marinespecies.org, 2) boldsystems.org, 3) and 4) SCCWRP

PRELIMINARY INVESTIGATION

San Pablo Bay and Central Bay sites with mean survival of EE amphipods ≥ 85%



Suisun Bay S&T sites with mean survival of E.E. ≥ 85%



Candidate Reference Study Sites For Dredging Projects

Stations	SU001S	SPB004S	CB0023S
n (% survival, fines)	6,9	1,2	2,2
% Survival (range)	88-96	93	88-91
% fines (range)	20-99	70-80	55-76
mean depth (m)	6.2	9.3	7.5

Budget

Fieldwork (assumes conducted in concert w/S&T)	$1,000
Laboratory Analysis	$18,000
Data Formatting and Analysis	$2,500
Report	$5,500
Total	**$27,000**

Causes of Moderate Sediment Toxicity in San Francisco Bay

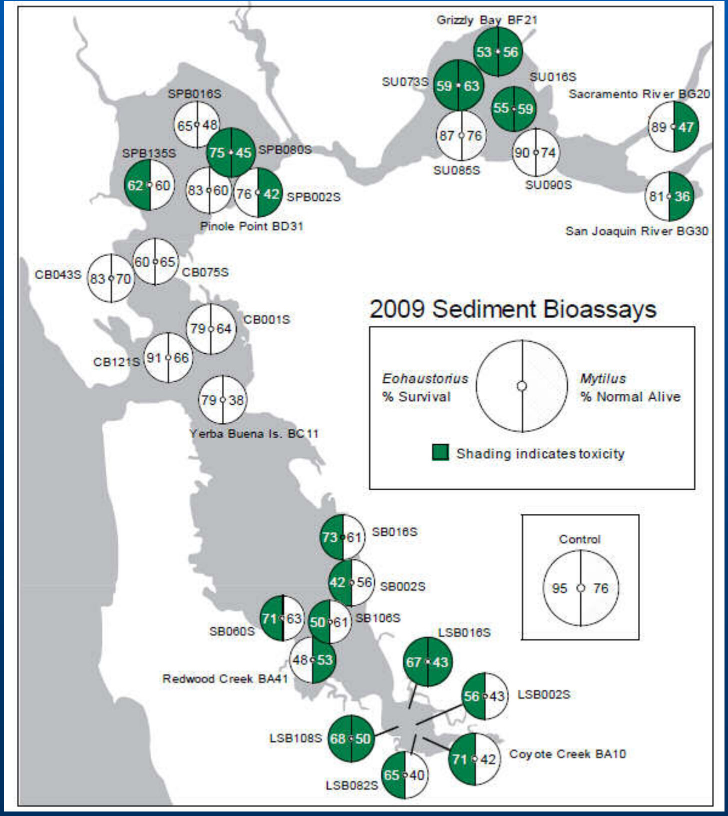
Steven Bay

Southern California Coastal Water Research Project

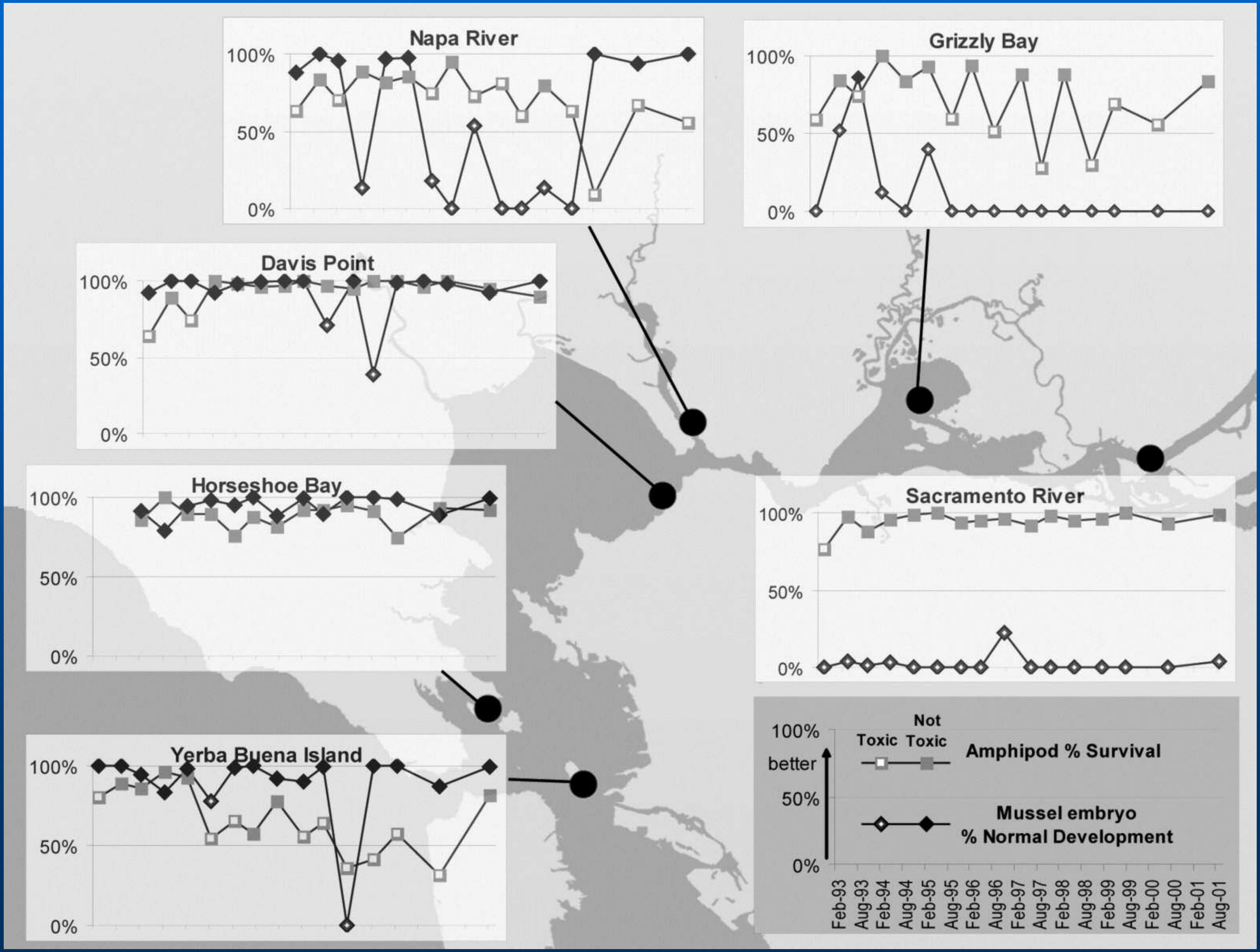
Brian Anderson
Department of Environmental Toxicology, UC Davis –
MPSL Granite Canyon

Background

- Sediment toxicity is an important driver in sediment quality assessment and management nationwide
  - Key component in sediment quality assessment
- Toxicity to multiple species is prevalent in San Francisco Bay and other CA embayments
- Most of the toxicity is at low-moderate levels
- The cause is largely unknown
  - Most efforts have focused on hotspots
- Difficulty and uncertainty in stressor identification are an impediment to management efforts



Seasonal Differences Indicate Environmental Stressors



Workshop I: SFEI Sediment Stressor ID April 2010

- **Attended by regional, state, and national sediment TIE experts**
- **Produced several recommendations**
  - **Define the influence of fine sediments on *Eohaustorius* survival**
  - **Evaluate other non-contaminant factors; e.g., grain shape**
  - **Identify other likely COCs and causal factors**
  - **Continue to develop dose-response information using spiked sediment and water; e.g., chlordane, cyfluthrin, pyrene**
  - **Refine TIE procedures**
  - **Hold follow up workshop and include scientists with additional areas of expertise**

Workshop II: Causes of Sediment Toxicity in CA Marine Waters November 2012

- 22 participants; 12 representing new disciplines/perspectives
- Assess what is known regarding sediment toxicity to amphipods in San Francisco Bay
  - Which contaminant and noncontaminant factors are the most probable cause?
  - Which potential stressors can be excluded?
  - What are key data gaps?
- Develop research designs to improve toxicity identification conclusions
  - Address priority issues
  - Feasible for application to San Francisco Bay

Workshop Accomplishments

- Productive interactions
  - Several new ideas were discussed
  - Workshop Summary Document
- Revised list of stressors of concern
  - Data gaps and uncertainties limit conclusions
- Developed Research Strategy with recommendations
  - Phased approach
  - Three high priority projects

Stressors of Concern

Stressor	Toxicity Potential	Magnitude of Exposure	TIE Method	Workshop I Priority	Workshop II Priority
Sedimentological/Physical Characteristics					
Grain Size **Clay Size** **Shape**	**Uncertain**	**Uncertain**	**No**	**High**	**High**
Shell Debris	**Uncertain**	**Variable**	**Yes**	**Not Discussed**	**High**
Smothering by oils	Uncertain	Unknown	No	Low	Low
Ecological Factors					
Animal Interactions	**Uncertain**	**Uncertain**	**No**	**Not Discussed**	**High**
Eohaustorius **Health & Acclimation**	**Uncertain**	**Uncertain**	**No**	**Not Discussed**	**High**
Metals					
Cations (Cu, Zn, Cd)	Low	Low	Yes	Low	Low
"Other" cations **(Mn, Mg, Fe, Ca)**	**Uncertain**	**Uncertain**	**Unknown**	**Not Discussed**	**High**
Anions (As, Cr)	Low	Low	Yes	Low	Low

Stressors of Concern

Stressor	Toxicity Potential	Magnitude of Exposure	TIE Method	Workshop I Priority	Workshop II Priority
Biological Products					
NH_3	High	Low	Yes	Low	Low
H_2S	High	Low	Yes	Low	Low
Cyanototoxins	**Unknown**	**Unknown**	**No**	**Not Discussed**	**Moderate**
Anenome nematocysts	**Unknown**	**Unknown**	**No**	**Not Discussed**	**Low**

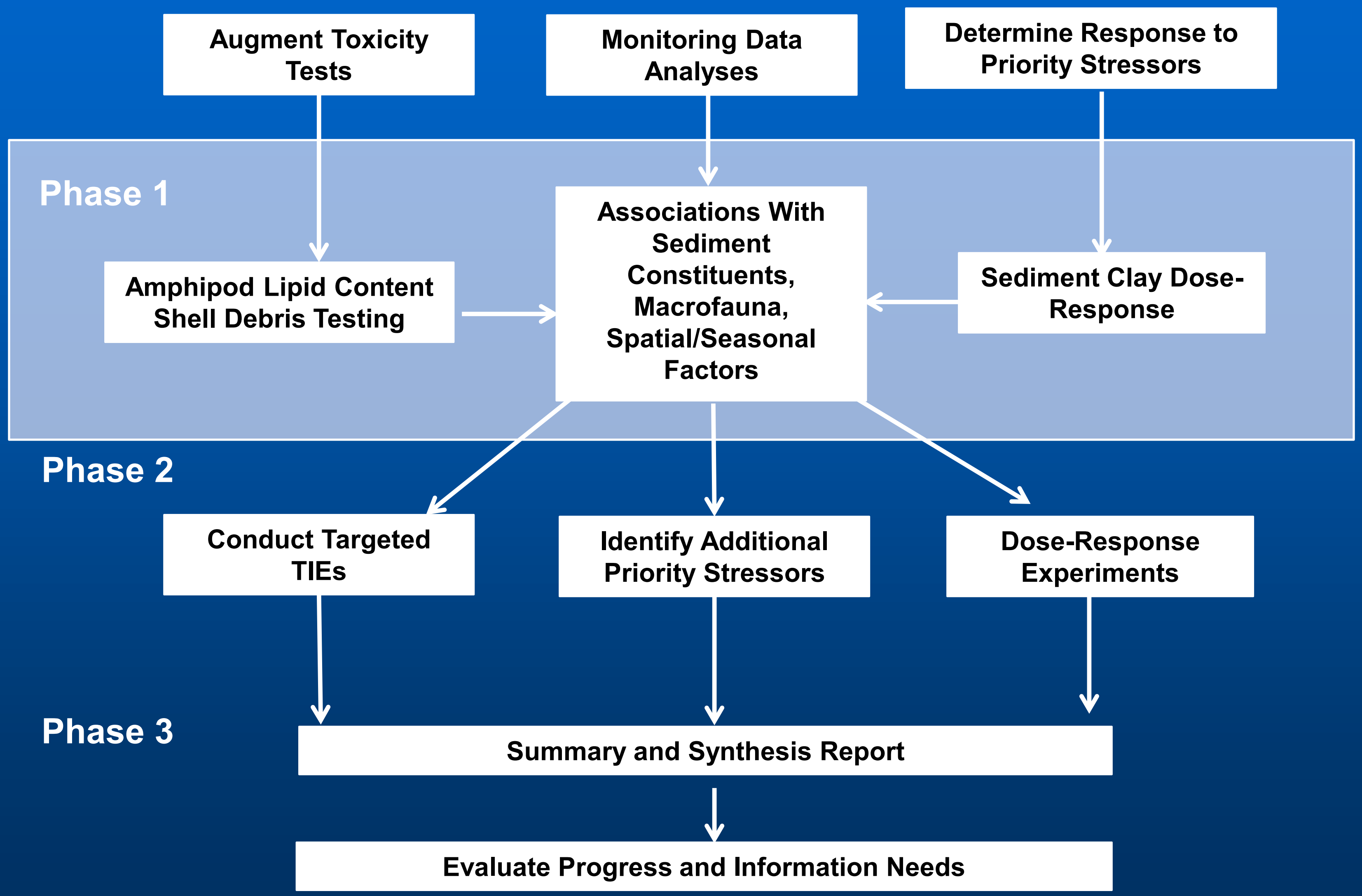
Stressors of Concern

Stressor	Toxicity Potential	Magnitude of Exposure	TIE Method	Workshop I Priority	Workshop II Priority
Organic Compounds					
Organochlorine Pesticides	**High**	**Low**	**Yes**	**High**	**Low**
Organophosphate Pesticides	High	Moderate	Yes	Low	Low
Pyrethroid Pesticides	**High**	**Moderate**	**Yes**	**High**	**Low**
Other Pesticides	High	Uncertain	Yes	High	High
Fungicides & Herbicides	Unknown (low?)	Unknown	Yes	Moderate/Low	Low
PAHs	**High**	**Moderate**	**Yes**	**High**	**Low**
PCBs	Moderate	Low	Yes	Moderate/Low	Low
PBDEs	Unknown	Low	Yes	Low	Low
PPCPs	Unknown	Unknown	No	Low	Low
Mixtures	**Unknown**	**Unknown**	**Some**	**Not Discussed**	**Moderate**

Research Strategy

- Phased approach for new studies
  - Focus on highest priorities first
  - Plan subsequent studies based on results
- Three types of short-term activities needed
  - Augment/refine RMP toxicity testing to provide additional information on potential stressors
  - Develop laboratory effects thresholds for priority stressors
  - Analyze existing RMP data to evaluate hypotheses

Long-Term Vision



Project Proposal 1: Seasonal Variation in Toxicity Test Organisms

- **Objectives**
  - Determine seasonal variation in *Eohaustorius* lipid content as a measure of animal condition
  - Investigate interaction with toxicity test response
- **Tasks**
  - Adapt micro scale lipid assay for use with amphipods
  - Measure changes in test organisms over annual cycle
    - Collaboration with commercial supplier
  - Document interaction with test response
    - Collaboration with proposed clay effect project
- **One-year study**
  - Estimated cost: $30,000

Project Proposal 2: Analysis of RMP Sediment Monitoring Data

- **Objectives**
  - Describe association between potential stressors and sediment toxicity
  - Quantify and compare contaminant-toxicity relationships
- **Tasks**
  - Compile and standardize RMP sediment quality data
  - Select data subsets to focus analyses (e.g., temporal and spatial factors)
  - Develop logistic regressions for specific contaminants
    - Collaboration with NOAA
  - Describe associations with priority chemical, environmental, and ecological factors
- **One-year study**
  - Estimated cost: $50,000

Project Proposal 3: Influence of Fine Sediments on Amphipod Mortality

- Objectives
  - Determine dose-response thresholds for sediment clay
  - Investigate influence of sediment particle shape on E. estuarius mortality
- Tasks
  - Conduct dose-response tests with clay-spiked control sediment
  - Conduct dose-response tests with clay-spike reference sediment from San Francisco Bay
  - Measure sediment particle shape in spiking tests and RMP sediment toxicity monitoring
  - Determine influence of shape and clay content on RMP toxicity results
- One-year study
  - Estimated cost: $84,000

Next Steps

- Does RMP want to move forward on the recommended projects?
  - Seasonal variation in amphipod condition
  - RMP data analyses
  - Effects of clay and particle shape
- Are there opportunities to augment future monitoring to address uncertainties?
  - Shell debris
  - Amphipod condition