# 26th Annual Meeting of the Northern California Regional Chapter of the

Society of
Environmental
Toxicology
And
Chemistry

# *Environmental Justice: Bridging the Gap between Environmental Science and Social Issues*

April 26-27, 2016
Ronald V. Dellums Federal Building
1301 Clay St., North Tower Oakland, CA

## Northern California Regional Chapter

Society of Environmental Toxicology and Chemistry
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# SCHEDULE

# 26th Annual Meeting of the Northern California Regional Chapter of the Society of Environmental Toxicology and Chemistry

## April 26-27, 2016
## Ronald V. Dellums Federal Building, Oakland

## Tuesday, April 26, 2016
## Day One - Short Courses

| Time | Short Course | Instructor | Room |
|---|---|---|---|
| 8:00-9:00 | **REGISTRATION** | | Conference Room H 5th floor |
| 9:00-12:00 | Permutation Tests: Never worry about a normal distribution again! | Dennis Helsel, Practical Stats | Conference Room A 2nd floor |
| 12:00-13:00 | **LUNCH BREAK / REGISTRATION** | | Conference Room H 5th floor |
| 13:00-16:00 | Nondetects and Data Analysis | Dennis Helsel, Practical Stats | Conference Room A 2nd floor |
| 13:00-16:00 | Use of Handheld XRF and LIBS Analyzers for Elemental Analysis | Pete Palmer, San Francisco State University, and Jack Hanson, HMC Analytical | Conference Room C 2nd floor |

# SCHEDULE

## Wednesday, April 27, 2015
## Day Two – Conference

| Time | Description | Speaker | Room |
|---|---|---|---|
| 8:00-13:00 | **REGISTRATION / SILENT AUCTION OPENS** | | Conference Room H, 5th floor |
| 9:00-9:05 | Welcoming Address | Simone Hasenbein, NorCal SETAC, President | Auditorium., 3rd floor |
| 9:05-9:15 | North America SETAC Address | Greg Schiefer, SETAC North America Executive Director | Auditorium., 3rd floor |
| 9:15-9:20 | Introduction of Plenary Speakers | Simone Hasenbein, NorCal SETAC, President | Auditorium., 3rd floor |
| 9:20-9:50 | Plenary Speech | Jonathan London, Associate Professor of Human Ecology/Community and Regional Development, Director of Center for Regional Change, UC Davis | Auditorium., 3rd floor |
| 9:50-10:20 | Plenary Speech | Vanessa Galaviz, Associate Public Health Scientist, Office of the Secretary, California Environmental Protection Agency | Auditorium., 3rd floor |
| 10:20-10:35 | **BREAK** (Refreshments) | | |
| 10:35-11:00 | Plenary Speech | Lauren Ornelas, Founder and Executive Director of "Food Empowerment Project" | Auditorium., 3rd floor |
| 11:00-11:30 | **PANEL DISCUSSION** | Moderator: Simone Hasenbein | Auditorium., 3rd floor |
| 11:30-12:30 | **LUNCH BREAK** (Map of local restaurants provided) | | |
| 11:30-12:30 | Student–Mentor Lunch | | Conference Room H, 5th floor |
| 12:30-13:30 | Session 1: Pesticide Toxicology | Session Chair: David Ostrach | Auditorium., 3rd floor |
| 12:30-13:30 | Session 2: Molecular Toxicology | Session Chair: Simone Hasenbein | Conference Rooms A/B, 2nd floor |
| 13:30-14:30 | **POSTER SESSION / BREAK** (Refreshments) | | Conference Room H, 5th floor |
| 14:30-15:30 | Session 3: Risk Assessment | Session Chair: David Ostrach | Auditorium., 3rd floor |
| 14:30-15:30 | Session 4: Wildlife Toxicology | Session Chair: Simone Hasenbein | Conference Rooms A/B, 2nd floor |
| 15:30-16:00 | **POSTER SESSION** | | Conference Room H, 5th floor |
| 15:50 | **SILENT AUCTION CLOSES** | | |
| 16:00-16:45 | Members Meeting, Student Awards, and Reception | | Conference Room H, 5th floor |

# SCHEDULE

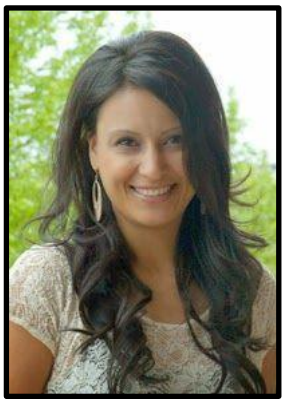
**PLATFORM SESSIONS**

| Time | Session 1: Environmental Occurrence and Effects of Pesticides<br><br>Chair: David Ostrach<br>Room: Auditorium., 3rd floor | Session 2: Contaminant Toxicology I<br><br>Chair: Simone Hasenbein<br>Room: Conference Rooms A/B, 2nd floor |
|---|---|---|
| 12:30-12:50 | **Nowell LH, US Geological Survey, Sacramento, CA:** *Pesticide mixtures in water, sediment, and passive samplers in Midwestern U.S. Streams: Potential effects on invertebrate communities* | **Scanlan LD, California EPA Department of Pesticide Regulation, Sacramento, CA:** *Isotope-dilution GC-MS/MS measurement of DNA damage in C. elegans* |
| 12:50-13:10 | ***Hunt L, University of California, Berkeley, Berkeley, CA:** *Effects of agricultural pesticide use on stream invertebrate communities in the Sacramento River watershed* | ***Frank DF, University of California, Davis, Davis, CA:** *Polychlorinated biphenyl (PCB)-induced neurodevelopmental impairments in zebrafish (Danio rerio)* |
| 13:10-13:30 | **Moschet C, University of California, Davis, Davis, CA:** *Comprehensive chemical assessment and link to effects on invertebrates in the Cache Slough ecosystem* | ***He C, University of California, Berkeley, Berkeley, CA:** *Variation in estrogen sensitivity amongst multiple populations of Xenopus laevis* |
| 13:30-14:30 | **Break** | |
| | **Session 3: Risk Assessment**<br><br>Chair: David Ostrach<br>Room: Auditorium., 3rd floor | **Session 4: Contaminant Toxicology II**<br><br>Chair: Simone Hasenbein<br>Room: Conference Rooms A/B, 2nd floor |
| 14:30-14:50 | **Beckon WN, U. S. Fish and Wildlife Service, Sacramento, CA:** *How long does uptake take?* | **Sun J, San Francisco Estuary Institute, Richmond, CA:** *Selenium in San Francisco Bay White Sturgeon* |
| 14:50-15:10 | **Doherty AC, California Department of Toxic Substances Control, Sacramento, CA:** *The intersection between environmental justice and California's Safer Consumer Products Program* | **Stillway M, University of California, Davis, Davis, CA:** *Toxicity comparison of new and current-use herbicides on early life stages of Delta Smelt (Hypomesus transpacificus) and its prey Eurytemora affinis* |
| 15:10-15:30 | **Bonnar DJ, Blankinship & Associates, Inc. Davis, CA:** *"WHO says so?" Is there rationale for listing glyphosate as a known carcinogen?* | **Peterson MG, University of California, Berkeley, Berkeley, CA:** *Serum POP concentrations are highly predictive of inner blubber concentrations at two extremes of body condition in northern elephant seals* |

*** Student presentation – please remember to fill out an evaluation if you view this presentation**

## Plenary Speakers

**Jonathan K. London, Ph.D.:** Dr. London is an Associate Professor of Human and Community Development and the director of the Center for Regional Change at UC Davis. Dr. London conducts research on rural community development and environmental justice. He has extensive leadership experience in non-profit management, participatory research, and community engagement. He holds a Masters of City and Regional Planning and a Ph.D. in Environmental Science, Policy and Management from UC Berkeley.



**Vanessa Galaviz, Ph.D.:** Dr. Galaviz has ten years of experience in multiple aspects of the environmental public health field, including industrial hygiene/exposure assessment, genetic and molecular susceptibility to environmental pollutants, cumulative impacts, community-based participatory research, environmental justice, and air pollution. She currently works with the CalEPA Assistant Secretary for Environmental Justice and Tribal Affairs and Deputy Secretary for Science and Health on various public health issues that impact environmental justice communities. Dr. Galaviz, who also holds a position as an Associate Toxicologist at OEHHA, is continuing her work on CalEnviroScreen projects, including acting as contract manager for a project with University of Washington to evaluate air quality in San Diego County.

**Lauren Ornelas:** Lauren Ornelas is the founder/director of Food Empowerment Project (F.E.P.), a vegan foodjustice nonprofit seeking to create a more just world by helping consumers recognize the power of their food choices. F.E.P. works in solidarity with farm workers, advocates for chocolate not sourced from the worst forms of child labor, and focuses on access to healthy foods in communities of color and low-income communities. While lauren was the director of Viva!USA, she investigated factory farms and ran consumer campaigns. In cooperation with activists across the country, she persuaded Trader Joe's to stop selling all duck meat and was the spark that got the founder of Whole Foods Market to become a vegan. She also helped halt the construction of an industrial dairy operation in California. She served as campaign director with the Silicon Valley Toxics Coalition for six years. Learn more about F.E.P.'s work at www.foodispower.org and www.veganmexicanfood.com.

# Platform Presentation Abstracts

**Please note: Abstract titles preceded by an "*" indicate student presenters. Student presenters will also be identified at the beginning of their talks by the Session Chair. Please remember to fill out an evaluation if you view this presentation.**

## Session 1: Environmental Occurrence and Effects of Pesticides

**Pesticide mixtures in water, sediment, and passive samplers in Midwestern U.S. Streams: Potential effects on invertebrate communities.** Nowell, L.H.[1]; Van Metre, P.C.[2]; Alvarez, D.A.[3]; Schmidt, T.S.[4]; Rogers, H.A.[4]; Waite, I.R.[5]; Moran, P.W.[6]; Mahler, B.J.[2]; Gellis, A.[7]; Stone, W.W.[8]; Shoda, M.E.[8]; Norman, J.E.[5]; Sandstrom, M.W.[9]; Hladik, M.L.[1]
1 U.S. Geological Survey, California Water Science Center, Sacramento, CA
2 U.S. Geological Survey, Texas Water Science Center, Austin, TX
3 U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO
4 U.S. Geological Survey, Colorado Water Science Center, Fort Collins, CO
5 U.S. Geological Survey, Oregon Water Science Center, Portland, OR
6 U.S. Geological Survey, Washington Water Science Center, Tacoma, WA
7 U.S. Geological Survey, Maryland-Delaware-D.C. Water Science Center, Baltimore, MD
8 U.S. Geological Survey, Indiana Water Science Center, Indianapolis, IN
9 U.S. Geological Survey, National Water Quality Laboratory, Denver, CO

Pesticides were analyzed in water and sediment from 100 wadeable streams in the Midwest by the U.S. Geological Survey National Water-Quality Assessment (NAWQA), in collaboration with the U.S. Environmental Protection Agency. Twelve weekly water samples were collected during May–August, 2013, and analyzed for 227 pesticide compounds. Passive samplers (POCIS) were deployed over 5 weeks, and extracts analyzed for the same pesticide compounds. In early August, bed sediment was sampled and analyzed for 118 pesticides, and benthic invertebrate communities were surveyed. Complex pesticide mixtures were observed in water (median 25 compounds) and POCIS extracts (median 62). Herbicides (including degradates) were detected at >90% of sites. Insecticides (especially imidacloprid) dominated the Pesticide Toxicity Index (PTI) in water for invertebrates, which reflects both concentrations and toxicity of pesticides in a mixture. In bed sediment, the pyrethroid insecticide bifenthrin dominated the Sediment-Pesticide Toxicity Index. Pyrethroid degradates in POCIS (cis-cyhalothric acid, 3-phenoxybenzoic acid) were significant explanatory variables in invertebrate community models. In mesocosms exposed to bifenthrin in suspended sediment, effects on invertebrate communities were observed at concentrations below toxicity values from single-species tests, and at concentrations observed in Midwestern streams.

***Effects of agricultural pesticide use on stream invertebrate communities in the Sacramento River watershed.** L. Hunt, M.C. Chiu, V.H. Resh, University of California at Berkeley, Berkeley, CA.

Although there is ample laboratory data on the toxicity of pesticides to aquatic invertebrates, few field studies have demonstrated effects of pesticides on the structure of stream invertebrate communities. In this study, we used stream macroinvertebrate samples collected by the California Surface Water Ambient Monitoring Program (SWAMP) along with reported agricultural pesticide use data from the California Department of Pesticide Regulation (CDPR) to explore the relationship between macroinvertebrate communities and pesticide dynamics in the Sacramento River watershed of California during 2002 – 2013. We used a hydrological fate and transport model (Soil and Water Assessment Tool) to simulate spatiotemporal dynamics of insecticides and fungicides in streams on a daily time step. Simulated

pesticide concentrations were highest during the rainy season, and pesticide exposure during winter and spring influenced the values of the Species at Risk (SPEAR) pesticide index for macroinvertebrate samples collected in summer. Both maximum and average pesticide toxic units were important in determining impacts on macroinvertebrate communities.

**Comprehensive Chemical Assessment and Link to Effects on Invertebrates in the Cache Slough Ecosystem.** C. Moschet, University of California, Davis CA, B. M. Lew, University of California Davis, CA, S. Hasenbein, University of California Davis, CA, D. Weston, University of California, Berkeley, CA and T. M. Young, University of California Davis, CA.

The Cache Slough complex in the Sacramento–San Joaquin River Delta is an important habitat for endangered fish species. In order to assess toxicity towards important fish prey, the presented study involved deployment of a sensitive amphipod, *Hyalella azteca*, combined with a comprehensive pesticide screening of water samples during storm events. The use of high-resolution mass spectrometry thereby not only allowed detection of target chemicals, but also a broad screening for suspected chemicals without reference standards. Grab samples were taken during two rain events in January and March 2016. Extracted water samples and suspended solids were analyzed by both gas chromatography high-resolution mass spectrometry (GC-TOF-MS) and liquid chromatography high-resolution mass spectrometry(LC-TOF-MS). Nearly 50 target pesticides were evaluated and the samples were screened for additional pesticides and transformation products using two large spectral libraries containing over 2,000 compounds. Data of the first (small) rain event showed low acute toxicity towards *H. azteca*, but more than 30 target pesticides were detected. The second (large) rain event showed high toxicity which suggests a much higher pesticide load. Obtained data are providing crucial information about chemicals that may have been the cause of observed toxicity, which represents a valuable resource for future watershed management.

## Session 2: Contaminant Toxicology I

**Isotope-dilution GC-MS/MS measurement of DNA damage in *C. elegans.*** LD Scanlan[1], P Jaruga, SH Coskun, SK Hanna, C Sims, J Almeida, D Catoe, R Golan, BC Nelson, M Dizdaroglu, National Institute of Standards and Technology, Gaithersburg, MD. [1]Current address: California EPA Department of Pesticide Regulation, Sacramento, CA.

*Caenorhabditis elegans* is used as a medical and systems toxicity model for environmental and developmental assays including high-throughput methodologies that support mode of action and adverse outcome pathway determination for human health risk assessment. However, it is difficult to extract large amounts (>50 μg) of high-quality DNA from the nematode, and little information is available regarding background levels of oxidatively-induced DNA damage. We therefore devised a robust DNA extraction method based on enzymatic digestion and high-salt phase separation and used high-resolution gas chromatography/tandem mass spectrometry (GC-MS/MS) with isotope-dilution to determine native DNA lesion profiles in wild-type *C. elegans*. DNA extracted with this protocol had ideal RNA levels (<10%), PCR functionality and reproducible fragmentation. Lesion levels were significantly lower in high-salt extracts than in phenol/chloroform extracts; phenol caused a significant increase in 8-OH-guanine levels, a known effect, and an increase in 4,6-diamino-5-formamidopyrimidine, 2,6-diamino-4-hydroxy-5-formamidopyrimidine and *R*- and *S*-8,5'-cyclo-2'-deoxyguanosine levels, effects reported here for the first time. Lesion levels in GC-MS/MS controls were comparable to available historical controls, demonstrating sensitivity and robustness across users and time. Our novel DNA extraction method minimizes artefactual DNA damage and is therefore ideal for molecular and toxicological studies where oxidative stress is under investigation.

***Polychlorinated biphenyl (PCB)-induced neurodevelopmental impairments in zebrafish (Danio rerio).** D.F. Frank, G. Miller, R.E. Connon, University of California, Davis, CA, J. Geist, Technische Universität München, Germany, P. Lein, University of California, Davis, CA.

Gene-environment interactions have been identified as important in determining individual risk for neurodevelopmental disorders (NDDs), the incidence of which has increased significantly over recent decades. Dysregulation of $Ca^{2+}$-dependent signaling and mTOR signaling have both been implicated in several NDDs, and PCB 95 has been shown to activate both these pathways in rat hippocampal neurons via ryanodine receptor (RyR)-dependent mechanisms. Therefore, in this study, we evaluated the effects of three PCB congeners (PCB 28, PCB 95 and PCB 153) with differing RyR binding efficacies, on transcript profiles and locomotor behavior in wildtype zebrafish. Zebrafish larvae were exposed for five days to 0.1, 0.3, 1, 3 or 10 µM of each PCB, and endpoints assessed at 72 and 120 days post fertilization (dpf). PCB 95 exposures caused transcriptional changes in several genes of both signaling cascades. The other congeners tested had less impact, which is comparable to results seen in rodent models. Behavioral assessments confirmed altered locomotor behavior at the highest PCB 95 concentration, suggesting altered neurological performance. These findings support the use of zebrafish as model species for gene-environment interactions in vertebrates, helping to identify genetic targets in both investigated pathways.

***Variation in estrogen sensitivity amongst multiple populations of Xenopus laevis.** C.He, University of California, Berkeley, Berkeley, CA, X.Luong, University of California, Berkeley, Berkeley, CA, T. Hayes, University of California, Berkeley, Berkeley, CA.

Endocrine disrupters, especially estrogenic chemicals) in the environment are an emerging concern in environmental toxicology. Endocrine-disrupting contaminants are of special concern in regards to the global amphibian decline. We are exploring how the natural estrogen, estradiol, affects the commonly used lab model, the African clawed frog *(Xenopus laevis)*. When genetically male larval *X. laevis* are exposed to estrogen, they develop into female frogs phenotypically. In addition, the proportion that develops as female varies depending on the population. We have found large variations in these ratios between multiple populations. These findings have implications for reproducibility across laboratories, differential susceptibility between individuals and populations in the wild, and question whether *X. laevis* can be used as a predictor for effects on other species.

## Session 3: Risk Assessment

**How long does uptake take?** W. N. Beckon, U. S. Fish and Wildlife Service, Sacramento, CA.

Depuration times have long been quantified with unambiguous specificity, using the "half-life" concept, which originated in nuclear physics. Yet no such objective measurement of accumulation time has been in general use. Rather, measures and models of the rate of contaminant uptake have been muddled, varied, ambiguous, outright erroneous, or frequently lacking altogether from published studies. To remedy this situation, methodology and terminology are suggested to estimate, from limited data, how long it would take to reach steady state concentration and what that steady state concentration would be. Methods are illustrated, compared, and applied to published accumulation data.

**The Intersection between Environmental Justice and California's Safer Consumer Products Program.** A.C. Doherty, California Department of Toxic Substances Control, Sacramento, CA, J. Gress, California Department of Toxic Substances Control, Sacramento, CA, C. Papagni, California Department of Toxic Substances Control, Sacramento, CA.

The California Department of Toxic Substances Control's (DTSC) Safer Consumer Products (SCP) program evaluates consumer products using a science-based approach to identify Priority Products that include Chemicals of Concern. Following a Priority Product listing, product manufacturers are required to take specific actions, which may include conducting an Alternatives Analysis. This novel regulatory program utilizes a narrative, rather than a prescriptive approach, to prioritize product-chemical combinations, giving DTSC the flexibility to evolve its product evaluation approaches in response to emerging science and tackle issues related to environmental justice in ways not possible with other programs. This presentation will highlight examples where the presence of hazardous chemicals in consumer products disproportionately affects groups of people based on characteristics such as race, income, or culture. The presentation will also address some of the current tools for identifying at-risk communities and how these tools may not be fully capturing risks to disadvantaged communities. Information about the types of data that the SCP program needs to adequately consider environmental justice concerns in its product selection process will also be provided.

**"WHO says so?" Is There Rationale for Listing Glyphosate as a Known Carcinogen?** D. J. Bonnar, Blankinship & Associates, Inc. Davis, CA.

The International Agency for Research on Cancer (IARC) is an intergovernmental agency forming part of the World Health Organization (WHO) and is one of four WHO programs that have reviewed glyphosate. On March 20, 2015, the International Agency for Research on Cancer (IARC) issued a statement that re-classified glyphosate as "probably carcinogenic to humans". According to IARC, there was "limited evidence of carcinogenicity in humans". IARC's conclusions, however, fall in direct contrast with numerous other scientific and regulatory agencies including the USEPA, EFSA, and even three other programs within the WHO. In this presentation, IARC's rationale behind listing glyphosate as a known carcinogen is examined and compared with the findings and conclusions of scientific and regulatory agencies worldwide.

## Session 4: Contaminant Toxicology II

**Selenium in San Francisco Bay White Sturgeon**. J.Sun, A. Robinson, J.Davis, P.Trowbridge, San Francisco Estuary Institute, Richmond, CA, R.Stewart, USGS, Menlo Park, CA, Vince Palace, International Institute for Sustainable Development**,** Winnipeg, Manitoba, Canada, Zachary Jackson, US Fish and Wildlife Service, Lodi, CA.

Selenium is a trace element that may adversely impact reproduction in Bay-Delta sturgeon. To protect this sensitive species, the Selenium (Se) TMDL for North San Francisco Bay established a white sturgeon muscle tissue target concentration of ≤11.3 ug/g dry weight. The Regional Monitoring Program for Water Quality in San Francisco Bay conducted two studies to develop a non-lethal tissue monitoring method to assess attainment of the TMDL target. Se was analyzed in muscle plugs collected from nine live white sturgeon in the North Bay during fall 2014, and also in muscle plug, ovary, liver, fin ray, and otolith samples collected from eight white sturgeon during a fishing derby in the Bay-Delta in 2015.
These studies demonstrated that muscle plug sampling is a viable non-lethal technique for Se monitoring. Muscle plug Se concentrations were within the range of previously measured concentrations. No correlation between Se in different tissues was apparent with the small sample sizes available. A second year of each study was conducted in 2015-2016, and will provide additional data to further evaluate if muscle plugs or other non-lethally collected tissue measurements can be good proxies for Se

accumulation in other tissues.

**Toxicity comparison of new and current-use herbicides on early life stages of Delta Smelt (*Hypomesus transpacificus*) and its prey *Eurytemora affinis.*** M. Stillway, B.G. Hammock, A.F. Cruz, D.I. Hernandez, I. Flores, F.C. Teh, S.J. Teh, University of California, Davis, Davis, CA, and K.C. Hoffmann, California Department of Water Resources, West Sacramento, CA.

Penoxsulam and Imazamox are two herbicides slated for use in the Sacramento-San Joaquin Delta to better control invasive aquatic vegetation. However, health effects of these herbicides on the endangered Delta Smelt and its prey, *Eurytemora affinis*, is unknown. This study compared the toxicity of Penoxsulam and Imazamox, as well as the current-use herbicides glyphosate, 2,4-D and Fluridone to Delta Smelt and *E. affinis* (glyphosate only). Delta Smelt embryos (1-2 days post fertilization) and larvae (1-2 days post hatch) were exposed to chemicals for 96 h with an 80% renewal at 48-hr, then transferred to clean water until hatch (embryo) or up to 4 days (larvae). Endpoints evaluated included embryo hatching success, larval survival, and morphometry. Copepod tests were 96-hr chemical exposure with an 80% renewal at 48-hr and evaluated survival. Results demonstrate that 1) of the two species, *E. affinis* is more sensitive to these herbicides than *H. transpacificus*, as copepod LC50s were generally lower than Delta Smelt; and 2) the current use herbicides elicit more sub-lethal toxic effects on Delta Smelt than Penoxsulam and Imazamox . However, these negative effects were observed at concentrations well above application rates, lending an acceptable margin of safety for use of these herbicides.

**Serum POP concentrations are highly predictive of inner blubber concentrations at two extremes of body condition in northern elephant seals.** M. G. Peterson, University of California, Berkeley, Berkeley, CA, S. H. Peterson, University of California, Santa Cruz, Santa Cruz, CA, C. Debier, Université catholique de Louvain, Louvain-la-Neuve, Belgium, A. Covaci, Universiteit Antwerpen, Wilrijk, Belgium, A. C. Dirtu, “Al. I. Cuza” University of Iasi, Iasi, Romania, Govindan Malarvannan, Universiteit Antwerpen, Wilrijk, Belgium, D. E. Crocker, Sonoma State University, Rohnert Park, CA, D. P. Costa, University of California, Santa Cruz, Santa Cruz, CA.

Long-lived, upper trophic level marine mammals are vulnerable to bioaccumulation of persistent organic pollutants (POPs). Northern elephant seals (*Mirounga angustirostris*) forage for months at a time in the northeastern Pacific Ocean, interspersed with two periods of fasting on land, which results in dramatic seasonal fluctuations in body condition. We examined blood and blubber to describe relationships and determine predictive equations for several POP compounds, including ΣDDTs, ΣPCBs, Σchlordanes, and ΣPBDEs. We collected paired blubber and blood samples from adult female and male seals at Año Nuevo State Reserve (California, USA). For females (N = 24), we sampled the same seals before and after an approximately 7 month foraging trip. For males, we sampled different seals before (N = 14) and after (N = 15) an approximately 4 month foraging trip. Serum POP concentrations were strong predictors of inner blubber POP concentrations for both females and males, while serum was a more consistent predictor of outer blubber for males than females. The ability to estimate POP blubber concentrations from serum, or vice versa, has the potential to enhance toxicological assessment and physiological modeling because access to blood or blubber samples can be a major challenge to studies of free-ranging marine mammals.

# Poster Presentation Abstracts
# (by Poster Number)

**Please note: Abstract titles preceded by an "*" indicate posters by student presenters. Please remember to fill out an evaluation if you view this presentation.**

1. ***Effects of Agricultural Land Use on Stream Habitats, Riparian Zones, Water Quality, and Freshwater Biodiversity in Moorea, French Polynesia**. M. Chang, University of California Berkeley, Berkeley, CA.

Agricultural land use has been shown to negatively impact stream ecosystems. These human-induced disturbances on the stream ecology can be reduced with proper management of riparian zones. This study explored how agricultural land use affects riparian zones, water quality, and stream biodiversity in Moorea, French Polynesia. Furthermore, this study assessed whether riparian management is necessary on a tropical island that is continuously developing in agricultural production. Riparian zones' widths, canopy openness, and predominant species compositions were recorded for ten study sites. Water quality measurements were taken multiple times at each site. Stream biodiversity was examined through sampling benthic macroinvertebrates with the D-net and visually counting fishes. All statistical analyses were performed using R program. This study showed that there were significant differences between land use types and riparian zone width (p-value= 0.0009), canopy openness (p-value= 0.047), temperature (p-value= 0.013), conductivity (p-value= 0.0048), total dissolve solids (p-value= 0.0044), and salinity (p-value= 0.0049). There were also significant positive correlations between canopy openness and total species richness (p-value= 0.0057) and abundance (p-value= 0.0039). Results were suggestive of differences between land use and total richness and abundance. This study provides implications for riparian management as a preventative measure to conserve the existing freshwater biodiversity.

2. **Survey of Pesticide Use by Homeowners in Two California Residential Neighborhoods.** R. Budd & K. Goodell, California Department of Pesticide Regulation, Sacramento, CA.

Both urban residents ("homeowners") and Pesticide Control Operators (PCO) apply pesticides in residential areas. PCO use is reported in the Department of Pesticide Regulation (DPR) Pesticide Use Reporting database, but use by homeowners is not tracked and their practices are not widely known. To better understand current homeowner pesticide use practices, DPR conducted a survey in two single-family neighborhoods located in drainages with current DPR monitoring stations. Homeowners were asked five questions to determine their pesticide use practices. A total of 178 homeowners participated in the survey. Seventy-four percent reported pesticide use on their property. PCOs most frequently made the pesticide applications (39%), closely followed by homeowners applying pesticides themselves (33%). Most reported that pesticide applications occur quarterly or as necessary, and are usually made around the house-foundation perimeter. Homeowners were most concerned about controlling ants (73%) and spiders (44%). Product identification was rare, but the majority (63%) of self-applicators indicated the use of pyrethroid-containing insecticides. Regionally, southern California homeowners used more pesticides and more frequently hired PCOs. This survey confirms that the majority of homeowners use pesticides on their property with pest issues managed by PCOs being the most common strategy.

3. ***Seawater chemistry alters the sensory abilities of intertidal snails and their sea star predators: impacts on indirect effects.** B. Jellison, Bodega Marine Laboratory, University of California Davis, CA, B. Gaylord, Bodega Marine Laboratory, University of California Davis, CA.

Human-induced changes in seawater chemistry ('ocean acidification', OA) are thought to pose a major threat to marine organisms. Although previous research has focused on morphological and physiological consequences of OA, emerging evidence suggests that reduced pH can also disrupt an organism's ability to perceive, integrate, and/or respond appropriately to sensory cues. Such effects may influence not only individual species, but also interactions among species, including those connected across trophic levels. Here, we investigated effects of reduced pH on a three-level food web, including a sea star predator (the six-armed star, *Leptasterias hexactis*), an intermediate consumer (the black turban snail, *Chlorostoma funebralis*), and a common macroalga (*Mazzaella flaccida*). Results indicate that snail anti-predator behavior is impaired under reduced pH. Prey remained below the water line where (regardless of sea star sensory capabilities), predators had a higher chance of encountering and capturing snails, which led to increased consumption of snails in low-pH treatments. The impaired behavior of prey also translated into a diminished trait mediated indirect interaction (TMII). Whereas snails held in ambient seawater consumed a reduced amount of algae in the presence of sea stars (characteristic of a functioning TMII), algal consumption was higher under OA conditions regardless of whether sea stars were present or not (representing a weakened TMII). Although predation has been shown to be an important driver of community structure within the intertidal zone, our work suggests that seawater pH can impact both direct and indirect trophic interactions. As ocean acidification proceeds and conditions of reduced pH become more widespread, alterations in prey behavior could lead to unexpected community level consequences.

4. **The Washoff Potential of Fipronil from Dogs Treated with Fipronil Spot-on Products.** L. Judson, Surface Water Protection Program, Dept. of Pesticide Regulation, Sacramento, CA, R. Budd, Surface Water Protection Program, Dept. of Pesticide Regulation, Sacramento, CA, J. Teerlink, Surface Water Protection Program, Dept. of Pesticide Regulation, Sacramento, CA.

Fipronil and fipronil degradates have been reported in treated wastewater effluent at concentrations that exceed USEPA Aquatic Life Benchmarks, posing a potential risk to the surface waters to which they discharge. Fipronil is a common active ingredient in spot-on flea and tick treatment for pets. The purpose of this study was to determine what fraction of fipronil and fipronil degradates (collectively known as fiproles) from spot-on treatments will wash off during routine bathing of dogs, serving as a potential source of fipronil into the sewershed. We recruited volunteers currently using a fipronil-containing spot-on product on their dogs. A total of 34 dogs were washed either 2, 7, or 28 days after product application, and the rinsate was analyzed. The mass washed off ranged between 0.2−86.0% of total mass applied. Percentage of fiproles detected in rinsate generally decreased with increasing time from initial application. The average mass washed off was 20.6, 15.5, and 3.8% respectively for 2, 7, and 28 days after application. Fipronil was the dominant form and made up approximately 90% of total fiproles detected. Results confirm a direct pathway for the introduction of fipronil and fipronil degradates to wastewater collection systems through the use of spot-on products.

5. ***Hepatic Contribution to Naphthalene-Induced Lung Epithelial Toxicity.** J.S Kelty, UC Davis, Davis, CA, P.C. Edwards, UC Davis, Davis, CA, X. Ding, SUNY Polytechnic Institute, Albany, NY, L.S. Van Winkle, UC Davis, Davis, CA.

*Rationale:* Naphthalene toxicity in the lung requires metabolic activation by cytochrome P450 monooxygenases. We are developing an *ex vivo* approach to determine whether hepatic naphthalene bioactivation contributes to lung toxicity. A source of viable hepatic bioactivation enzymes is provided to replicate metabolism found in whole animal exposures. *Methods:* Cytotoxicity was tested with a human bronchiolar epithelial cell line, HBE1, essentially incapable of bioactivating naphthalene. Naphthalene metabolite formation was catalyzed by mouse liver microsomes, serving as a precursor for future studies using microsomes from humans and genetically modified mice. HBE1 cells were exposed to naphthalene or 1,4-naphthoquinone in a Transwell permeable support system with a basal compartment for liver microsomes. Cell viability was determined by measuring HBE1 membrane permeability. *Results:*

Naphthalene alone did not cause toxicity to HBE1 cells at concentrations ranging from 38 ng/mL to 38 μg/mL. In contrast, significant HBE1 cell death was produced by 1,4-naphthoquinone in the same concentration range. Co-incubation of the cells with mouse liver microsomes doubled the extent of HBE1 cell death resulting from 38 μg/mL naphthalene exposure. *Conclusion:* Liver microsome-generated naphthalene metabolites can cause toxicity to human lung epithelial cells in the *ex vivo* system. Supported by NIEHS grant ES020867 and Schwall Fellowship.

6. ***Measuring Handling Stress at Multiple Time Scales in the Chronically Lead-exposed California Condor.** Z.E. Kuspa, , D.R. Smith, M.E. Finkelstein, UC Santa Cruz, Ca.

Wild California condors (*Gymnogyps californianus*) are frequently lead poisoned from feeding on terrestrial mammal carcasses containing lead ammunition fragments. To monitor and clinically manage these exposures, nearly all condors are trapped and handled at least once/year for blood testing. Elevated lead exposures and stressful events (e.g., handling) can impair the hypothalamic-pituitary-adrenal axis in vertebrate species and produce a heightened and prolonged release of glucocorticoid stress hormones following an acute stressor. Here, we report development of methods for observing glucocorticoid stress responses in wild condors by measuring corticosterone (CORT) concentrations in plasma and feathers, and CORT metabolite concentrations in urates. Results show urate CORT metabolite concentrations increased significantly within 4 hours of a capture/handling stressor ($p<0.01$, $n=7$, paired t-test). CORT concentrations in feather grown during/after a capture/handling stressor were >3-times higher than in feather grown >5 days before the handling stressor. Furthermore, the magnitude of the CORT response to handling stress varied across condors by 2-11-fold over baseline. CORT measurements of wild condor samples will be paired with lead exposure, captivity records, and life history data to investigate relationships with inter-individual variation in CORT stress response, and assess potential effects of observed variation in CORT release on condor reproduction and survival.

7. ***Chemical characterization of indoor dust by comprehensive target screening using GC- and LC-QTOF-MS/MS.** C. Moschet, University of California Davis, Davis, CA, B.M. Lew, University of California Davis, Davis, CA, T. Anumol, Agilent Technologies, Wilmington, DE, and T.M. Young, University of California Davis, Davis, CA.

House dust is frequently contaminated with a broad range of chemicals such as pesticides, plasticizers, constituents from personal care products, and flame retardants, thus acting as a known reservoir through which humans are exposed, especially children. Using a targeted analytical approach, this study aims to characterize the chemical fingerprint in dust samples collected from two groups of households: families with normal developing children and families with children having developmental issues. Methods for sample extraction and time-of-flight (TOF) mass spectrometry were optimized using 145 commonly encountered chemicals. Optimized sample preparation includes sonication extraction with hexane and acetone without subsequent SPE clean-up to enable sensitive non-target screening in a future step. Extracts were halved into an LC fraction for analysis on an LC-QTOF-MS/MS in positive and negative electrospray-ionization mode, and a GC fraction for GC-QTOF-MS/MS analysis in electron-impact mode. The developed method achieved absolute recoveries above 80% for more than 95% of the chemicals, while method detection limits were below 50 ng/g for 70% of the chemicals. Chemical classes most commonly detected include flame retardants, plasticizers, antibacterial agents, and select pesticides. This mixture of chemicals may have an effect on exposed populations that requires further investigation.

8. ***Environmental DNA analysis of cyanobacteria assemblage in the Sacramento-San Joaquin Delta under drought conditions.** M.B. Bolotaolo, University of California, Davis, CA, T. Kurobe, University of California, Davis, CA, P. Lehman, California Department of Water Resources, Sacramento, CA, X. Mary, California Department of Water Resources, Sacramento, CA, S. Teh University of California, Davis, CA.

Harmful cyanobacteria blooms are ubiquitous around the world and are of global concern due to their ability to produce neurotoxins and hepatotoxins. Drought conditions and overall global temperature increases provide favorable growing conditions for toxic cyanobacteria, causing these blooms to become more frequent and intense. However, little is known about the biodiversity and toxicity of cyanobacteria assemblages in drought conditions. To address this gap in knowledge, we evaluated the biodiversity of cyanobacteria as well as other microscopic organisms in the Sacramento-San Joaquin Delta by environmental DNA analysis. Data from this analysis detected over 30 genera of cyanobacteria, *Microcystis spp* being the most dominant genus, and demonstrated the first appearance of *Anabaena circinalis*, a possible neurotoxin producer, in the San Joaquin River. Microcystis and other cyanobacteria were dominant at the three sampling stations in the confluence (Antioch and Collinsville) and Franks Tract while bacteria were dominant at Mildred Island and San Joaquin River. The highest percentage of phytoplankton and zooplankton was observed at Rough 'n Ready, suggesting the site is more productive than the other locations. Our results indicate that eDNA is a powerful tool to understand biodiversity and relative abundances of wide range of aquatic organisms.

9. ***Skeletal Lead: Implications for Exposure Monitoring in California Condors**. G.M. Rizzi, UC Santa Cruz, Santa Cruz, CA, M. Finkelstein, UC Santa Cruz, Santa Cruz, CA, D.R. Smith, UC Santa Cruz, Santa Cruz, CA.

Little is known about how lead concentrations vary by bone or bone type (cortical/trabecular) in avian species. We investigated how lead concentrations vary across California condor bones to determine the utility of bones to indicate a bird's lead poisoning status at time of death. As the lead half-life in trabecular bone is shorter than in cortical bone, we tested if the ratio between trabecular and cortical lead levels is higher for condors that died from lead poisoning versus other causes. Bone samples from condors with known cause of death were cleaned, digested in $HNO_3$ and measured for lead with ICP-MS. Preliminary data on four condors indicate that lead poisoned birds had trabecular to cortical lead concentration ratios of ~5 in tibiotarsus, ~2.5 in humerus, and ~3 in femur, while ratios in a condor that did not die of lead poisoning were ~1.5. We also found significant differences in lead concentrations between proximal and distal bone regions within a bird. Our research addresses a substantial knowledge gap about how lead concentrations differ across avian bone types. Future studies will use bone samples from historic remains to estimate the role of lead poisoning in the condor's decline over the past 200 years.

10. ***Upstream Land Use and Surface Water Pesticide Concentrations in the Salinas River Watershed**. A.N. Patton, University of San Francisco, San Francisco, CA

The Salinas River Watershed is a region within the Central Coast of California that contains agricultural, developed, and park/wild land. The watershed overlaps sections of Monterey County, San Benito County, and San Luis Obispo County, the 4$^{th}$, 29$^{th}$, and 15$^{th}$ most agriculturally productive counties in California. In order to ensure increased agricultural outputs per input, pesticides are often applied to the crops within the watershed. However, it is well known that pesticides can inadvertently enter the environment after their application. This study attempted to quantify the relationship between land use (agricultural, developed, park/wild) and environmental pesticide contamination.
The analysis was conducted using ArcGIS, such that for each individual sampling point, only the land use upstream of that point was considered. Based on four, two year sampling groups, there was no significant difference in land use 1 or 10 miles upstream from each sampling point for either pesticide detect or non-detect samples. It is likely that the physiochemical properties of the pesticides as well as the lack of widespread or diverse sampling areas lead to the lack of clear results. However, further analysis is needed to further quantify the reasons for environmental presence of pesticides.

11. ***Acute exposure to aluminum impairs antioxidant mechanisms in Japanese medaka.** W.F.

Ramirez-Duarte, S.J. Teh, Aquatic Health Program, School of Veterinary Medicine, University of California, Davis, Davis, CA 95616, USA.

The dissolved aluminum concentration is high in both naturally- and anthropogenically-acidified aquatic habitats, which is acutely toxic to fish. This study aimed on potential aluminum-induced oxidative stress in Japanese medaka (*Oryzias latipes*) at pH 5.3. Fish (14-day old) were exposed for 4 days to aluminum (0, 0.025, 0.05 and 0.1 mg/L) at pH 5.3 in soft water. At the end of the exposure period, fish were euthanized and stored at -80°C for eventual whole body enzymatic- (catalase and total glutathione peroxidase) and non-enzymatic- (total glutathione) antioxidants, and lipid peroxidation analyses. Statistical analysis was done by one-way ANOVA with post hoc Dunnett's test. Significant differences in mortality were not found. Aluminum caused a significant reduction in activity of total glutathione peroxidase at 0.05 and 0.1 mg/L ($P<0.01$), and of glutathione reductase at 0.1 mg/L ($P<0.01$). Differences in catalase activity, total glutathione concentration, and lipid peroxidation levels were not found. This study shows that environmentally relevant concentrations of aluminum at low pH affect the defense mechanisms medaka uses to deal with oxidative stressors, which may make fish more susceptible to other pollutant-induced oxidative damage.

12. **Reconnaissance Study of Current-Use Pesticides in 12 Surface Water Sites in California.** C. J. Sanders, J.L. Orlando, M.L. Hladik, US Geological Survey California Water Science Center, Sacramento, CA.

Pesticides are used throughout the state of California in both urban and agricultural settings and are routinely detected in surface water. In 2013 nearly 30 million kilograms of synthetic organic pesticides were applied in California. This ongoing study was designed to characterize the mixtures of current-use pesticides and pesticide degradates in surface water and associated suspended sediment. Samples were collected during baseflow/irrigation runoff and storm runoff conditions from 12 sites located throughout California, over two consecutive years beginning in April 2015, from both urban and agriculturally dominated watersheds. Water samples are being analyzed by GC/MS and LC/MS/MS for a suite of over 150 pesticides and degradates. Suspended sediments associated with these water samples are being analyzed for 125 pesticides and degradates by GC/MS. To date, 80 compounds and/or degradates have been detected in the water, including 30 fungicides, 26 herbicides, 23 insecticides and 1 synergist. In the suspended sediment, 28 compounds have been detected, including 9 fungicides, 9 herbicides, and 10 insecticides. In addition, several compounds (bifenthrin, diuron, fipronil, fipronil sulfone, fluopicolide, metolachlor, and permethrin) have been detected at concentrations that exceed at least one aquatic life benchmark value as defined by the U.S Environmental Protection Agency.

13. **Prevalence of cyanotoxin microcystin-LR detections in California's Stream Pollution Trends (SPoT) Program.** K. Siegler, UC Davis, Dept. of Environmental Toxicology, Monterey, CA, E. Stanfield, California State University, Monterey Bay, Monterey, CA, B. Phillips, UC Davis, Dept. of Environmental Toxicology, Monterey, CA, B. Anderson, UC Davis, Dept. of Environmental Toxicology, Monterey, CA, J. Voorhees, UC Davis, Dept. of Environmental Toxicology, Monterey, CA, R. Tjeerdema, UC Davis, Dept. of Environmental Toxicology, Davis, CA.

Cyanobacterial harmful algal blooms (CHABs) are an emerging threat to drinking water resources in California. *Microcystis* cyanobacteria can release hepatotoxins which affect diverse taxa. Microcystins, stable cyclic heptapeptides, may persist in the environment for weeks to months in water and sediments, but most monitoring efforts in California have focused exclusively on water samples. The Stream Pollution Trends (SPoT) Monitoring Program, in collaboration with California State University Monterey Bay (CSUMB), has identified microcystin-LR presence in sediments monitored statewide using modified extraction methods developed by Chen et al. (2006) and quantified using ELISA. Microcystin-LR was

detected in 31% (n = 108) of the samples in 2014 and 13% (n = 96) in 2015. Microcystins were found in sediments from diverse habitat types and land uses. In both years, a subset of sites were analyzed in an inter-lab method validation study, using ELISA as well as LC-MS. By evaluating sediments at the base of major watersheds throughout the state, SPoT provides a baseline assessment for microcystin-LR prevalence and occurrence statewide. Future research includes an evaluation of the potential for *Chironomus dilutus* (midge) larvae to bioaccumulate microcystin through sediment exposure.

14. ***Evaluation of herbicide and insecticide mixture effects on aquatic invertebrate community dynamics.** Stinson, S.A. Ecology Graduate Group, University of California at Davis CA, Hasenbein, S., School of Veterinary Medicine: Department of Anatomy, Physiology and Cell biology, University of California, Davis, Lawler, S., Department of Entomology and Nematology, University of California, Davis, Connon, R. School of Veterinary Medicine: Department of Anatomy, Physiology and Cell biology, University of California, Davis.

Characterizing risk, exposure and environmental impacts for an increasingly vast number of toxicants requires extensive experimentation with relevance to natural systems. Mesocosms can provide increased environmental relevance while limiting variables within a controlled system. An outdoor mesocosm system was utilized over a period of three months to examine changes in aquatic invertebrate communities following multiple applications of environmentally relevant concentrations of the pyrethroid insecticide, bifenthrin (1 ng $L^{-1}$), in combination with a systemic substituted phenylurea herbicide, diuron (low; 10 and high; 1000 ng $L^{-1}$). Analysis of physicochemical parameters, chlorophyll-a concentration, macrophyte growth, macroinvertebrate and zooplankton diversity and abundance was conducted for four weeks prior to and eight weeks after initial chemical application. Changes in abundance of several sensitive taxa (*Ephemenoptera*, *Chironimidae*, *Ceriodaphnia*) were observed after exposure to bifenthrin as a single stressor. Effects of exposure to bifenthrin in combination with diuron suggest that concurrent herbicide application can further alter invertebrate community composition. Here we present long-term population and community-scale changes occurring in aquatic environments following environmentally realistic pesticide mixture exposures.

15. ***Perfluorinated Compounds in Participants of the Women Firefighters Biomonitoring Collaborative Cohort**. J. Trowbridge, UC Berkeley, Berkeley CA, R. Gerona UCSF, San Francisco, CA., R. Rudel, Silent Spring Institute, Boston, MA., H. Buren, SFFD San Francisco, CA., A. Stefani SFFCPF, San Francisco, CA., Rachel Morello-Frosch, UC Berkeley, Berkeley, CA.

Objective: This is a community based participatory biomonitoring research project looking at occupational exposures to environmental chemicals linked to breast cancer among female firefighters compared to non-firefighter controls.
Methods: Between June 2013 and March 2014 we recruited, interviewed, and collected blood samples from women firefighters with at least 5 years of active service in the San Francisco Fire Department (SFFD) (n=86). and women employed by the City of San Francisco who were not first responders (n=84). Samples were analyzed for perfluorinated compounds (PFCs) using liquid chromatography-tandem mass spectrometry (LC-MS/MS).
Results: Samples were analyzed for 12 PFCs. Five PFCs were detected in 98 to 100% of participants. Four compounds were not detected above LOD. PFNA ($p< 0.1$) and PFHxS ($p <0.05$) were higher for firefighters than controls; PFUnDA levels were higher in controls than firefighters ($p <0.05$). PFC levels were comparable to levels measured in 2011 NHANES and 2011 Firefighters Occupational Exposure (FOX) in Southern California.
Conclusion: This is the first chemical biomonitoring study in a cohort of exclusively women firefighters. Further study is needed to understand the health implications of PFC levels particularly for shorter chain compounds and their potential link breast cancer.

16. **Ambient Air Levels of Sulfuryl Fluoride In and Around Residential Structures During Fumigation.** E.R. Wilson, California Department of Pesticide Regulation (CDPR), Sacramento, CA, J.F. Twining, CDPR, Sacramento, CA, H.R. Fong, CDPR, Sacramento, CA.

Sulfuryl fluoride (SF) is a fumigant pesticide that is most commonly used for structural pest control of wood-destroying insects, and is frequently used in California. To estimate resident and bystander exposure to SF, 19 structures were monitored throughout California between May 2014 and May 2015. Instantaneous concentrations of SF were measured during treatment period, aeration, and post-clearance. A majority of SF was removed from the structure within three hours of initiating aeration. After structures were cleared for re-entry, instantaneous concentrations of SF increased to 6 ppm for termite-rate applications then decreased to less than 1 ppm after an average of 18 hours. In the two applications that targeted beetles, instantaneous concentrations increased to 4 ppm after clearance, but levels greater than 1 ppm lasted until the end of monitoring 24 hours after clearance. The 24-hour concentrations were estimated using instantaneous concentrations and ranged from 0.5–2.1 ppm during treatment adjacent to the tarped structure and 0.6–1.6 ppm inside the structure after it had been cleared for resident reentry. Since current SF pesticide product labels state a limit of 1 ppm after clearance, these results may suggest that residents could potentially be exposed to levels greater than 1 ppm.

17. ***Genetic Architecture of Pollution Resistance Among Convergent Populations of Killifish**. J.T. Miller, Pharmacology and Toxicology Graduate Group, University of California-Davis, B.W. Clark, ORISE fellow at the US EPA Office of Research and Development, D.E. Nacci, US-EPA Office of Research and Development, A.J. Whitehead, Environmental Toxicology, University of California-Davis.

Independent populations of Atlantic Killifish (*Fundulus heteroclitus)* that reside in heavily polluted locations along the East coast have rapidly evolved resistance to some developmentally toxic polychlorinated biphenyls (PCBs). Exposure to PCBs leads to a suite of cardiovascular deformities in fish embryos, but killifish from polluted locations resist the developmentally toxic effects of exposure at concentrations 1000-fold higher than nearby clean-site fish. In common-garden exposures, differences in gene expression profiles between resistant and non-resistant embryos from different populations indicate a largely overlapping mechanism of resistance to PCBs. Despite this overlap, it is unclear if the same genetic architecture has evolved in the convergence of resistance. To associate regions of the genome with resistance, we used RAD-Sequencing to genotype PCB-exposed embryos from 4 different populations of pollution-resistant killifish crossed into a common non-resistant genetic background. RAD markers were tested for their association with resistance and significant loci were compared across the 4 populations. In conjunction with recent population re-sequencing on the same populations, we can infer the evolutionary history of rapidly evolved resistance in killifish, as well as use this system to learn more about the biology of resistance and the toxicity of environmental PCBs.

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# Lunch Options for NorCal SETAC Annual Meeting

There are a number of nearby locations for lunch. Check out the link or the the map below.

[Downtown Oakland Lunch Spots]

1. Rio California
294 reviews
$ · Brazilian, American (New)
Good for Lunch

2. Cafe Gabriela
226 reviews
$ · Coffee & Tea, Filipino, Sandwiches
Good for Lunch

3. The **Lunch** Box
264 reviews
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Good for Lunch

4. Cosecha
405 reviews
$$ · Mexican, Breakfast & Brunch
Good for Lunch

5. Cafe 15
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$$ · American (Traditional), Breakfast & Brunch
Good for Lunch

6. Stag's Lunchette
283 reviews
$$ · Sandwiches, Breakfast &



9. Miss Ollie's
370 reviews
$$ · Caribbean