



Delta Science Fellows Annual Report  
California Sea Grant College Program

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**Project Information**

ProjectNo\_2C R/SF-27 StartDate\_3a 10/2007 EndDate\_3b 12/2011  
ProjectTitle\_4 Endocrine Disruption in the Delta: Confirming Sites of Known Estrogenicity with Outplants, Histology, and Choriogenin Level Measurements.

**Delta Science Fellow contact information**

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**Research Mentor (for additional please see #8)**

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**Additional Research Mentors and Community Mentors**

**Additional Research Mentors\_8**

Richard Connon, UC Davis  
Michael Denison, UC Davis  
Inge Werner, UC Davis

**Additional Community Mentors\_9**

Stephanie Fong, Central Valley Water Board

**Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.**

**ProjectObjectives\_10**

1. Is a specific physiological response (“biomarker”) indicative of exposure to endocrine disrupting compounds (EDCs) found at sites with confirmed estrogenicity in the Sacramento-San Joaquin Delta.....

2. Do chemicals collected in the field with passive samplers produce effects in laboratory animals that match those seen in the field? Do isolated EDCs collected via passive samplers from Dr. Sedlack’s study (SPMDs) and our passive samplers (POCIS) produce the same or similar results? What EDCs in particular are responsible for these effects?.....

3. What are the effects (i.e. choriogenin induction or gonadal malformations) of environmentally relevant potencies and potential interactive effects of EDC combinations in laboratory testing?.....

4. Do sites with confirmed occurrences of endocrine disruption in *M. beryllina* have a wild fish with similar manifestations? How do our results compare with those of Sedlack and colleagues?.....

**Summary of progress in meeting each of these goals and objectives**

**ProgressSummary\_11**

1. Specific physiological responses in the form of altered gene expression, gonad histology, and altered sex ratio were found at sites with confirmed estrogenic and androgenic activity. These responses are detailed in the dissertation accompanying this report.....

2. Some of the chemicals detected in grab samples from field sites and detected in PEDs (polyethylene devices) used in collaboration with USGS Sacramento produce effects in laboratory animals that match those seen in the field. We conducted a laboratory exposure with 2 pyrethroid pesticides - permethrin and bifenthrin - that induced estrogenic responses in naive *Menidia beryllina*. It is difficult to pinpoint what EDCs in particular are responsible for effects in the wild, as the mixture of EDCs is complex. However, we have determined that specific pyrethroid pesticides are contributing to overall endocrine disruption in fishes. This experiment is detailed in the dissertation accompanying this report.....

3. Both permethrin and bifenthrin induce choriogenin expression in naive silversides exposed to environmentally relevant concentrations. Bifenthrin is of particular concern, as it induced choriogenin at a measured concentration of lower than 1 ng/L. See accompanying dissertation for details.....

4. We were not successful in deploying outplants with *M. beryllina*. However, our results do show that vitellogenin is induced at one of our sites, which supports the findings of Sedlak, Schlenk and colleagues.....

**PROJECT MODIFICATIONS:** Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

**Modifications\_12**

The biggest problem encountered was that we were not successful in deploying outplants with *M. beryllina* due to low survival of outplanted fish. We believe that this was due to periods of low dissolved oxygen concentrations at field sites in Suisun Marsh and the inability of outplanted fish to relocate to deeper, more highly oxygenated, waters during these periods. This problem could not be resolved and outplants were not used.

New directions pursued include the use of polyethylene devices instead of POCIS samplers, due to a successful collaboration with the USGS of Sacramento (Drs. Kiuvila and Smalling). Another successful collaboration was formed with Dr. Richard Connon of UC Davis, leading to the development of qPCR probes to detect changes in the expression of endocrine mediated genes in silversides.

**BENEFITS AND APPLICATIONS:** Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. Delta Science is looking for "management cues" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

**BenefitsApplic\_13**

The findings that are most directly relevant to management are two-fold:

1. Endocrine disruption in the wild cannot be assessed by merely using one biomarker, such as vitellogenin or choriogenin expression (estrogen responsive markers). At one of our sites (Denverton), vitellogenin was expressed in males but no impacts could be seen at other biological scales - such as gonad histology or alterations of sex ratio. At our more highly polluted site (Suisun Slough), vitellogenin expression in males was low but sex ratio was highly skewed towards males and gonadal histology indicated disruption. It is therefore necessary to evaluate responses at multiple scales to determine potential impacts on fish populations.

2. The pyrethroid pesticide bifenthrin is estrogenic at very low environmentally relevant concentrations (1 ng/L). Additionally, it appears from our laboratory experiments that lower concentrations of bifenthrin and permethrin induce a larger estrogenic response in fish than higher concentrations. This falls in line with responses that are typical of chemicals that mimic natural hormones. This adds difficulty to risk assessment as low dose responses are difficult to consider when determining "no effect" concentrations. For details see the accompanying dissertation.

**PUBLICATIONS:** List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and Delta Science Conference during the duration of the fellowship.

**Publications\_14**

Publications:

Brander S.M. Monitoring endocrine disrupting compounds: Considerations in the assessment of risk to aquatic life. In: Monitoring Water Quality. Elsevier (invited contribution). IN REVIEW

Brander S.M., R.E. Connon, G. He, J.A. Hobbs, K.L. Smalling, S.J. Teh, J.W. White, I. Werner, M.S. Denison, G.N. Cherr. From 'omics to otoliths: Correlated responses of an estuarine fish to endocrine disrupting compounds across biological scales. IN PREP

Brander S.M., G. He, K.L. Smalling, M.S. Denison, G.N. Cherr. The in vivo estrogenic and in vitro anti-estrogenic activity of permethrin and bifenthrin. Aquatic Toxicology. IN REVIEW

Brander S.M., B.J. Cole, G.N. Cherr. (2012) An approach to detecting estrogenic endocrine disruption via choriogenin expression in an estuarine model fish species. Ecotoxicology: DOI: 10.1007/s10646-012-0879-2.

Media:

Aquatic Science Center. The Pulse of the Delta: Monitoring and Managing Water Quality in the Sacramento-San Joaquin Delta. Re-thinking Water Quality Monitoring.; Aquatic Science Center, Oakland, CA: 2011

Presentations:

\*Brander, S., He, G., Smalling, K. L., Denison, M. S., Cherr, G. N. Network Biology and Toxicity Pathways, North Carolina Society of Toxicology, Research Triangle Park, NC, "The in vivo estrogenic and in vitro anti-estrogenic activity of permethrin and bifenthrin." (February 23, 2012).

note: I did not participate in the State of the Estuary conference held in 2011 because I had already moved to NC.

**COOPERATING ORGANIZATIONS:** List those agencies and/or persons who provided financial, technical or other assistance to your project since inception. Describe the nature of their collaboration.

**CoopOrganiz\_15**

Technical assistance was provided by Richard Connon and members of the Denison Lab and the Young Lab at UC Davis. Collaboration with Dr. Connon allowed me to develop qPCR probes for endocrine mediated genes in the silverside. This collaboration has led to post-doctoral funding. Assistance from Guochon He and Ben Giudice of the Denison and Young labs, respectively, allowed me to add the use of cell lines to my assessment of EDCs in the Delta.

**AWARDS:** List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

**Awards\_16**

**KEYWORDS:** List keywords that will be useful in indexing your project.

**Keywords\_17**

choriogenin, silverside, estuary, endocrine disruption, estrogenic, androgenic, gene expression, systems biology

**PATENTS:** List any patents associated with your project.

**Patents\_18**

not applicable

