**Special Study Proposal: Correlation of Selenium in Sturgeon Tissues - Sturgeon Derby**

**Summary**: The Regional Water Board is currently developing a selenium TMDL for the North San Francisco Bay, which will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. This study proposes the collection of tissues from female sturgeon sacrificed as part of the annual Sturgeon Derby in order to establish relationships between selenium concentrations measured in non-lethally collected tissues (muscle plugs, fin rays) and those more closely tied to, or predictive of, adverse impacts in white sturgeon due to selenium (ovaries, otoliths).

**Estimated Cost**: $37,000

**Oversight Group**: RMP Selenium Strategy Team

**Proposed by**: Jennifer Sun and Jay Davis

## Background

In April 2014, the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that can provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation.

The TMDL will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. White sturgeon is a bottom-feeding species that is considered to be at substantial risk for selenium exposure in the Bay (Beckon and Mauer 2008). White sturgeon are particularly at risk because their diet consists primarily of the overbite clam (*Corbula amurensis*), which are selenium-rich relative to other prey (Stewart et al. 2004). Other increased risk factors for sturgeon include their longevity (they can live over 100 years), their year-round resident status, and long egg maturation times (several years) (Beckon and Mauer 2008). Green sturgeon are also considered to be vulnerable to selenium but their exposure could be limited. Adults and sub-adults spend a large portion of their lives in coastal marine waters outside of the estuary, and are only briefly exposed to high selenium diet during their infrequent spawning migrations through the Bay. In addition, green sturgeon are threatened species and fishing for them is prohibited.

White sturgeon have been routinely sampled (in 1997, 2000, 2003, 2006, 2009, and 2014) as part of RMP sport fish monitoring. The tissue analyzed has been muscle fillets. In recent years, the focus of white sturgeon monitoring has been shifting towards non-lethal sampling methods, which allow for the collection of larger sample numbers.

Sampling of sturgeon ovaries, although logistically more challenging than sampling using non-lethal methods, would provide a more direct metric of the risk to sturgeon reproduction. USEPA recently published draft selenium criteria for freshwater that highlight egg or ovary data as a preferred endpoint most directly tied to adverse effects (USEPA 2014). Data that would allow evaluation of the correlation between concentrations measured in non-lethally collected tissues and ovary concentrations would enhance the application of muscle plugs as an impairment indicator.

The RMP is currently working to establish two non-lethal sampling methods for measuring selenium concentrations in sturgeon tissues. In 2014, the RMP collected muscle plug samples for selenium analysis from 21 white sturgeon, including 12 as part of the sport fish monitoring round and 9 in collaboration with the CDFW during the Selenium in Muscle Plugs Special Study. Similar studies have been approved or are being proposed for future field seasons.

In 2015, the RMP also collaborated with Dr. Vince Palace at Stantec and Dr. Norman Halden with the University of Manitoba, Department of Geological Sciences, to test a second non-lethal sampling method using fin rays using data collected at the annual Sturgeon Derby. In this Sturgeon Derby, held on Super Bowl weekend, anglers attempt to catch sturgeon that come closest to a selected size. Fish that are close to the target size are brought to a central location and sacrificed. For the past several years, the USFWS has collected tissues from these sturgeon and analyzed them for a suite of metals and organics, including selenium, in gonads (including ovaries), liver, and plasma. These data have not yet been published. During the 2015 Sturgeon Derby, the RMP successfully collaborated with USFWS and Stantec to collect muscle plug, fin ray, and otolith samples for selenium analysis as well, for comparison with concentrations measured in ovary samples and other tissues.

Fin rays are taken as a clip and are easy to collect by non-specialists, and fin clips have been shown to be non-harmful to sturgeon (Collins and Smith 1996). Because fin rays have a regular growth pattern similar to growth rings of a tree, a laser ablation MS technique (laser ablation inductively coupled plasma mass spectrometry [LA-ICP-MS]) can be used to allow for the analysis of concentrations of selenium and other elements in each annual ring (i.e., concentrations in the fish tissue over the time). Data showing trends in selenium concentrations in North San Francisco Bay white sturgeon tissue over time will help elucidate the dynamic selenium bioaccumulation patterns in sturgeon, and begin to answer the question of whether or

not changes in selenium water chemistry and prey over time relates to changes in tissue concentrations in sturgeon.

A recent study found that fish otolith selenium measurements are the best predictors of ovary selenium, enhancing data collected from tissues alone (Reash, Friedrich, and Halden 2014). However, otoliths can only be collected from sacrificed fish. Thus, fin ray analysis is being developed as a potential alternative to both muscle plug and otolith sampling. The research team is currently using otolith microchemistry analyses to establish the chemical stability of fin ray samples. Fin ray data will also be compared with muscle and ovary data to develop a model that establishes the relationship between selenium concentrations in these tissues.

The annual sturgeon fishing tournament in the Delta again provides an opportunity to obtain tissue samples from a small number of female sturgeon in 2016. These samples will be used to test the relationships between selenium concentrations measured in tissues collected using lethal and non-lethal methods, and contribute to the development of the fin ray microchemistry analysis technique.

The average number of fish that are sampled during the Derby is about 40, with about half being females. In 2015, sampling conditions were relatively poor during part of the Derby, and only 27 fish were sacrificed, including 8 females. Because sampling conditions and sex ratios may be unpredictable, the proposed target number of female fish sampled during the 2016 Sturgeon Derby will remain at 15. In 2015, the target sample tissues were successfully collected, and the muscle plugs, ovaries, and fin rays have been analyzed for selenium. The full results from the 2015 Sturgeon Derby will be available in August 2015.

This proposal is requesting funds for a second year of sampling at the sturgeon Derby in 2016, which will include measuring selenium in muscle plugs, ovaries, fin rays, and otoliths.

**Study Objectives and Applicable RMP Management Questions**

The objective of this study is to obtain data to evaluate the correlation between muscle and ovary selenium concentrations through a collaboration with USFWS, local fishermen, and USGS. Together with data collected during the 2015 Sturgeon Derby and other selenium studies, data collected during the 2016 Sturgeon Derby would also contribute to the tracking of temporal trends in selenium impairment over time.

Selenium Strategy questions addressed:

2. Are the beneficial uses of San Francisco Bay impaired by selenium?
4. How do selenium concentrations and loadings change over time?

RMP Management Questions addressed:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
   B. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
   B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

**Approach**

This study would be performed in collaboration with USFWS, USGS, and Stantec. RMP staff would plan the study, perform muscle plug sampling, manage the data, and write a brief technical report. USFWS would assist with the collection of ovary samples for the same fish sampled for muscle plugs. USGS (Robin Stewart and her team) would process the muscle plug and ovary samples, perform selenium analyses, and subsequently prepare and ship these samples to UC Davis to perform C, N, and S stable isotope analyses.The stable isotopes will provide information on diet and habitat use by the sturgeon. Stantec would collect fin rays and otoliths and conduct selenium microchemistry analyses.

Tissues would be collected and analyzed from up to 15 female white sturgeon. If fewer than 15 females are euthanized during the Derby, tissues would be collected from all females. The sampling would occur on Super Bowl weekend in 2016.

**Budget**

The proposed budget for this Special Study is $37,000.

**Table 1. Budget for the 2016 Sturgeon Derby Proposal**

| Task | Estimated Cost |
|---|---|
| ***Labor**** | |
| Project Planning & Coordination | $2,500 |
| Field Work | $3,200 |
| Data Management | $9,600 |
| Reporting | $6,000 |
| | |
| ***Subcontracts*** | |
| USGS - sample processing, archiving | $200 |
| USGS - 30 selenium analyses (plugs, ovaries) @ $165/sample | $4,950 |
| UCD - 15 C, N, S analyses (plugs only) @ $25/sample | $375 |
| Stantec - Travel ($3,000), instrument set-up ($2,500), 15 fin ray and 15 otolith selenium microchemistry analyses @ 115/sample | $8,950 |
| | |
| ***Direct Costs*** | |
| Equipment - biopsy plugs, sample containers, etc. | $200 |
| Shipping - 45 samples to lab, 15 samples from USGS to UCD | $200 |
| Travel - 2 days of travel for 2 RMP staff | $350 |
| | |
| ***Contingency*** | $525 |
| ***Grand Total*** | $37,000 |

*Project management, contract management, and archiving costs will be included in the RMP base funding

**Reporting**
A draft technical report describing the results of the study will be prepared by September 30, 2016. The technical report will be reviewed by the Selenium Strategy Team and the TRC and will be finalized by December 31, 2016.

**References**

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