

Special Study Proposal: Selenium in Sturgeon Muscle Plugs

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. In 2014, the RMP successfully collaborated with CDFW to non-lethally collect white sturgeon muscle tissue for selenium analysis, and a follow-up study has been approved for 2015. This study proposes a continuation of this sampling in collaboration with CDFW in 2016, with the addition of blood plasma analyses for determination of fish sex and sexual maturity.

Estimated Cost: \$42,000

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 a 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 Status and Trends sport fish monitoring. However, the number of fish collected in

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each round of sampling has been small (12 fish per round), and the collections are currently being performed on a five year cycle. The upper end of the distribution of concentrations measured in North Bay sturgeon exceeds the target under consideration for the TMDL, but this determination is based on a relatively small number of samples. Identifying a means to obtain a larger number of white sturgeon muscle samples on a more frequent basis has been identified as a high priority by the Selenium Strategy Team, both to obtain a more precise understanding of impairment and to track inter-annual trends.

In the 2009 RMP sport fish sampling, an effort began to establish a non-lethal and efficient method of collecting sturgeon muscle through the use of plugs. Concentrations in plugs were found to correlate well with concentrations in muscle fillets for the 12 fish sampled. Another round of evaluation of this correlation will occur with the 12 sturgeon to be collected in the 2014 sport fish monitoring. This correlation has opened the door to an opportunity to obtain a larger number of sturgeon muscle samples, non-lethally, through a collaboration with a California Department of Fish and Wildlife (CDFW) annual tagging program that is tracking population trends (DuBois and Harris 2013; more information at <http://www.dfg.ca.gov/delta/data/sturgeon/bibliography.asp>), and a US Fish and Wildlife Service (USFWS) study on fish movement patterns.

In 2014, RMP staff accompanied CDFW on three sampling dates during their fall sturgeon tagging event. Muscle plugs were successfully collected from nine fish over two days of sampling in Suisun Bay between September and October 2014. All samples were analyzed for selenium, and five samples collected in October will be analyzed for C, N, and S isotopes. This sampling event demonstrated the viability of using muscle plugs to non-lethally sample selenium concentrations in sturgeon tissues. Several improvements to the sample collection and processing methods were identified during the 2014 field season to increase the sample mass collected and optimize sample processing and analysis for low-mass samples. Continued optimization will increase the consistency and reliability of sample results obtained during future studies.

Recent results published in 2015 by Linares-Casenave et al. suggest that selenium concentrations in white sturgeon muscle tissue increases with age, and in particular may be higher in vitellogenic females. Additionally, selenium concentrations in reproductively mature females are the most relevant to understanding the reproductive impacts of selenium in white sturgeon. Sex and sexual maturity data will help both to interpret muscle plug selenium concentrations and to target muscle plug analyses towards reproductively mature females. During future muscle plug sampling events, blood plasma samples can be collected from all fish sampled and tested for testosterone, 17 β -estradiol, and calcium to determine the sex and sexual maturity (Webb et al., 2002).

The reliability of blood plasma sex steroid analyses is highest immediately prior to the spawning season and in sexually mature fish, which can be roughly estimated based on fish length. However, this remains the best method for rapidly and non-invasively determining sex and sexual maturity in live fish; alternative methods require substantial technical expertise as well as

field time and equipment costs (ultrasound, endoscopy) or could potentially cause harm to live fish (laparoscopy).

RMP staff originally planned to train CDFW staff to perform sampling independently in 2014; however, due to initially difficulties with the sampling technique and logistical difficulties of freezing and storing the samples, it is not feasible for the CDFW to sample independently. CDFW staff typically do not return to their office between sampling days, crews change daily, and staff rotate between boats on different days, complicating the storage of samples and restocking of ice and other field supplies.

A follow-up muscle plug study was approved for 2015. In 2015, RMP staff is planning to collaborate with USFWS staff to collect muscle plug samples; however, USFWS staff may not be available during future CDFW cruises to assist with sampling. In 2016, RMP staff plans to be present on the CDFW boats in order to collect tissue samples directly, requiring a significant increase in field work costs.

This proposal outlines a scope and budget for collaborative plug sampling in 2016.

Study Objectives and Applicable RMP Management Questions

This objective of this study is to obtain a relatively large number of sturgeon muscle samples (30 white sturgeon) both to obtain a more precise understanding of impairment and to continue to track inter-annual trends.

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

Up to thirty white sturgeon plugs will be collected and analyzed. Up to another 30 will be collected and archived in case additional samples are needed. Blood plasma samples will be

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collected from all fish sampled for muscle plugs, and tested for testosterone, 17B-estradiol, and calcium to determine fish sex and sexual maturity. Muscle plugs chosen for immediate analysis may be informed by the results of the blood plasma analyses, and potentially targeted towards reproductively mature females

This study would be performed in collaboration with CDFW, USGS, and Bozeman Fish Technology Center. RMP staff would plan the study, perform sampling, ship the samples for laboratory analysis, manage the data, and write a brief technical report. CDFW would provide logistical support through the use of their sampling vessels - the sampling would occur during the course of the CDFW cruise in August through October.

USGS (Robin Stewart and her team) will process the plug samples and perform selenium analyses, and subsequently prepare and ship 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. The Bozeman Fish Technology Center will perform testosterone, 17B-estradiol, and calcium analyses on blood plasma samples.

Budget

The proposed budget for this Special Study is \$42,000.

The increase in the current proposed budget relative to the budgets for the 2014 and 2015 studies primarily reflects an increase in RMP field work for sample collection, as well as an increase in analytical costs to conduct blood plasma analyses to determine fish sex and sexual maturity.

Table 1. Budget for 2016 Selenium in Sturgeon Muscle Plugs Proposal

Task	Estimated Cost
Labor*	
Project Planning & Coordination	\$3,000
Field Work	\$12,000
Data Management	\$8,950
Reporting	\$5,500
Subcontracts	
USGS - sample processing, archiving	\$500
USGS - 30 selenium analyses @ \$165/sample	\$4,950
UCD - 30 C, N, S analyses @ \$25/sample	\$750
Bozeman Fish Technology Lab – 60 T and E2 analyses @ \$40/sample each 60 Ca analyses @ \$4/sample + \$30 for calibration	\$5,070
Direct Costs	
Equipment - biopsy plugs, sample containers, plasma sampling equipment, etc.	\$400
Shipping – 30-60 samples to labs, 30 samples from USGS to UCD	\$430
Travel - 5 days of staff travel to field site	\$200
Contingency	\$250
Grand Total	\$42,000

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

Reporting

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A draft technical report describing the results of the study will be prepared by March 31, 2017. The technical report will be reviewed by the Selenium Strategy Team and the TRC and will be finalized by May 31, 2017.

References

Beckon, W. and T. Mauer. 2008. Species at Risk from Selenium Exposure in San Francisco Estuary. Final report to the USEPA. US Department of the Interior, Fish and Wildlife Service. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/northsfbayselenium/Species_at_risk_FINAL.pdf

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