

- I. Project Title: Assessment and prediction of effects of selenium exposure to larval razorback sucker.
- II. Principal Investigator(s): Daniel W. Beyers, Ph.D., Larval Fish Laboratory, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523; 970-491-5475; Fax: 970-491-5091; Email: danb@lamar.colostate.edu
- III. Project Summary: Many potential nursery habitats have elevated selenium levels in water and food organisms that may be toxic to fish. Concern exists about potential effects on larval razorback sucker that may reside in these habitats. To quantify the potential for adverse effects, standard early life-stage toxicity tests were conducted in which razorback sucker larvae were exposed to gradients of selenium-contaminated water and food organisms. Growth and survival of larvae were monitored over a 28-day period and the resulting data were represented as concentration-response relationships.  
A separate study was conducted to compare the sensitivity of razorback sucker and fathead minnow to selenium. Both species were studied simultaneously using standard 96-hour acute toxicity tests.  
A final report describing the research was approved by the Biology Committee on 23 November 1999. Copies of the report are currently being prepared for distribution.
- IV. Study Schedule: Initial year: FY99; final year: FY99. Project is complete.
- V. Relationship to RIPRAP: General Recovery Program Action Plan
  - II. restore habitat
    - II.A. restore flooded bottom land habitats
      - II.A.2. screen high-priority sites for restoration
    - II.B. support actions to reduce contaminant impacts
      - II.B.1. evaluate effects of... ..agriculture, and municipal... ..sources of potential contaminants throughout the Upper Basin
      - II.C.1. identify what restoration and protection are needed
  - Green River Action Plan
    - II. restore habitat
      - II.A. restore flooded bottom land habitats
        - II.A.2.a. identify and evaluate sites
      - II.D. support actions to reduce contaminant impacts at Ashley Creek and Stewart Drain
  - Colorado River Action Plan-Mainstem
    - II. restore habitat
      - II.A. restore and manage flooded bottom land habitat
        - II.A.1. 29-1/2 Road gravel pit

- II.A.1.e. monitor and evaluate success
  - II.A.2. Adobe Creek
    - II.A.2.e. monitor and evaluate success
  - II.A.3. Walter Walker
    - II.A.3.e. monitor and evaluate success
  - II.A.4. develop and implement levee removal
    - II.A.4.a. preconstruction contaminants screening
- Colorado River Action Plan-Gunnison
- II. restore habitat
    - II.A. restore flooded bottom land habitat
      - II.A.2.a. preconstruction contaminants screening
      - II.A.2.d. evaluation

VI. Accomplishment of FY 99 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

**Deliverables:** Results of the research were presented at the 17<sup>th</sup> Annual Upper Colorado River Endangered Fishes Researchers Meeting, Grand Junction, CO, and at the annual National Irrigation Water Quality Program, Albuquerque, NM. A final report describing the research was approved by the Biology Committee on 23 November 1999. Copies of the report are currently being prepared for distribution. Over 50 requests for copies have been received to date.

**Findings:** We did not observe changes in survival or growth of larval razorback sucker in response to food-chain exposure. Other investigators have suggested that exposure to dietary selenium concentrations greater than 3 g/g dry weight will produce adverse effects in fish. In our study, the highest concentrations of selenium in rotifer were about half of this value (1.40 g/g). This magnitude of bioaccumulation in food organisms was less than anticipated and is the most likely explanation for lack of adverse effects on razorback sucker. Because of low dietary exposure we were not able to estimate a relationship that describes adverse effects as a function of selenium concentration in diet. Results of this study do confirm that exposure to dietary selenium concentrations below 1.4 g/g dry weight do not adversely effect survival and growth of larval razorback sucker.

A separate study was conducted to compare the relative sensitivity of razorback sucker and fathead minnow using standard 96-hour acute toxicity tests. Exposure concentrations in acute toxicity tests were over 1000 times higher than in the dietary study. The 96-hour median lethal concentrations and 95% confidence limits (in parentheses) for razorback sucker and fathead minnow exposed to dissolved selenium were 40.8 (37.0, 44.9) and 33.3 mg/L (29.8, 37.1), respectively.

Ongoing investigations will expand this research and allow evaluation of its predictive accuracy. The new data will be combined with findings of this report to provide a description of effects over a broad range of environmental and dietary concentrations that can be used to compare predicted and observed toxicity of water collected from potential razorback sucker nursery habitats in the Colorado River basin.

**Shortcomings:** A shortcoming of this investigation was that bioaccumulation in the experimental food chain was lower than expected. The experimental food chain was based on a published design presented by Dobbs et al. (1996) and used identical species of algae, rotifer, and type of selenium. The time required for exchange of algae growth media (turnover rate) in the system described by Dobbs et al. was 2 days. In our investigation, we attempted to maximize bioaccumulation by increasing residence time of algae and growth media using a longer exchange time of approximately 10 days. The slower exchange rate may have reduced bioavailability of selenium in cultures as a result of sedimentation of algae. Selenium may have been retained in dead algae that accumulated over time on the bottom of culture vessels. Thus, dissolved selenium may not have been available for incorporation into living algae, rotifers and fish. In subsequent investigations (CAP-6 SE-2; CAP-6 SE-NF), exchange rate was increased to approximately once every 3 days. This change combined with a broader range of exposure concentrations should produce dietary exposure concentrations that exceed predicted thresholds for toxic effects in fish.

## VII. Recommendations:

- 1. Recommend that the program guidance be modified to include an investigation to describe the time course of selenium bioaccumulation in fish food organisms in backwaters.** Data that describe the time-dependent relationship between selenium concentrations in backwaters and tissue concentrations in food organisms are needed in order to estimate dietary exposure of fish (adults and larvae) in the field. Because backwaters may fill and drain annually, selenium concentrations in resident food organisms probably change over time and this is a major source of uncertainty for evaluating the influence of dietary exposure on wild fish.
- 2. Recommend that the program guidance be modified to include further evaluation of selenium effects on reproductively active razorback sucker.** Current research will thoroughly describe effects of selenium exposure on larval razorback sucker, but additional studies are needed to evaluate effects of selenium exposure on reproductively-active adults. Future investigations should emphasize bioaccumulation of selenium in adult fish prior to spawning and monitor survival of resulting embryos and larvae. This research should be conducted under controlled conditions so that selenium exposure is well known and confounding influences are minimized.
- 3. Recommend that the program guidance be modified to include evaluation of influence of fish movement on selenium bioaccumulation.** Existing or new radio telemetry investigations of movements of razorback sucker adults could be linked with selenium investigations. Adult fish may move in and out of selenium contaminated areas. Assessments that do not account for this behavior will over estimate effects of selenium on adult fish. Radio telemetry data can be linked to bioaccumulation results using a computer model. The model could simulate accumulation of selenium given fish movements in and out of contaminated areas and estimate reproductive effects.

VIII. Project Status: Project is complete.

IX. FY 99 Budget Status

Note: The following are FY 98 funds from the Recovery Program and from NIWQP. The work carried over into FY 99 and FY 00 at no additional cost. The final report has been approved by the Recovery Program.

- A. Funds Provided: \$62,076
- B. Funds Expended: \$61,576
- C. Difference: \$500: \$65 indirect cost; \$435 to cover printing and mailing costs.
- D. Percent of the FY 99 work completed, and projected costs to complete: Complete.
- E. Recovery Program funds spent for publication charges: \$0.00

X. Status of Data Submission (Where applicable): NA

XI. Signed: Daniel W. Beyers, Ph.D.      3 December 1999  
Principal Investigator                      Date