



INFORMATION SHEET

Summary of Kootenai River White Sturgeon Studies

U. S. Fish and Wildlife Service

Upper Columbia Fish and Wildlife Office

Spokane, Washington

2007/2008

Contacts: Julie Campbell or Toni Davidson (509) 891-6839

Why conduct studies on Kootenai River white sturgeon?

Many contributing factors are of concern for the lack of recruitment (addition of individuals via natural reproduction) into the wild Kootenai River white sturgeon population. The evaluation of effects of potential chemical exposures to white sturgeon in the Kootenai River is necessary to support ongoing recovery efforts, and is identified as a research need in the Recovery Plan for the Kootenai River Population of White Sturgeon. Other sturgeon species (Atlantic sturgeon, shortnose sturgeon) have been shown to be very sensitive to chemical exposures relative to other fish species (Dwyer et al. 2005). The studies described herein focus specifically on white sturgeon, and evaluate potential effects to the fish from chlorine and copper in the Kootenai and Columbia Rivers, as well as three herbicides proposed for control of Eurasian watermilfoil in the Kootenai River. At this time we do not know how laboratory results relate to the potential effects to wild Kootenai River and Columbia River white sturgeon populations because of potential dilution, bioavailability, actual river concentrations, or other factors specific to each river system.

The objectives of these studies are to:

- Evaluate toxic effect levels of chlorine, copper and 3 herbicides on sensitive life stages of sturgeon in the laboratory;
- Evaluate actual contributions of municipal discharges into the Kootenai River (i.e., measure concentrations of chlorine and metals in river) and compare to sturgeon toxicity data;
- Compare recommended application rates of herbicides to sturgeon toxicity data.

2007 Laboratory Studies: acute toxicity to early life stage and juvenile white sturgeon from Chlorine and Copper (Tables 1 and 2)

The objectives of the studies are to:

- Identify toxic concentrations of chlorine and copper to sturgeon at 30 days post swim-up (dps) and 5-6 months - complete;
- Identify toxic concentrations of chlorine and copper to rainbow trout (as above) and compare to sturgeon toxicity – complete;
- Compare toxic effect concentrations to measured field concentrations in Kootenai River – planned for spring/summer 2008.

Study Initiated in July 2007

Funding Source: USFWS, USGS partnership

Results:

Table 1. Chlorine LC50^a (96 hr) estimates for Kootenai River (KRWS) and Columbia River white sturgeon (CRWS) and rainbow trout (RBT) at 30 and 160 days post swim-up (dps) (standard deviations for fish weight and length in parentheses and 95% confidence intervals for LC50s in parentheses) (Little 2008a).

Species	Lifestage (dps)	Number of replicates per treatment	Average Fish Weight (gm)	Average Fish Length (cm)	LC50 ^a µg/L, observed
KRWS	30	4	0.07 (0.01)	2.4 (0.14)	42.3 (36.6 – 48.1)
CRWS	160	2	18.1 (5.2)	17.0 (2.3)	34.3 (28.3 – 40.4)
RBT	30	4	0.07 (0.01)	2.4 (0.1)	104 (89.1 – 118)
RBT	160	2	4.8 (2.4)	7.4 (1.2)	287 (152 – 423)

Note: There were five fish per replicate treatment.

^aLC50 – concentration that results in 50% mortality of test population.

Table 2. Copper LC50^a (96 hour) estimates for white sturgeon and rainbow trout at 30 and 160 days post swim-up (dps) (standard deviations for fish weight and length in parentheses and 95% confidence intervals for LC50s in parentheses) (Little 2008b).

Species	Life stage (dps)	Average Fish Weight (gm)	Average Fish Length (cm)	LC50 ^a µg/L, based on measured concentrations	1996 Hardness-dependent acute WQC ^b for Copper (µg/L)
KRWS	30	0.07 (0.01)	2.4 (1.4)	3.1 (2.6 – 3.7)	12
CRWS	30	0.08 (12.7)	2.5 (1.6)	4.9 ^c (3.3 – 6.4)	12
CRWS	160	18.1 (5.2)	17.0 (2.3)	245 (189 – 300)	10
RBT	30	0.17 (0.02)	2.9 (0.84)	71.1 (58.6 – 83.7)	15
RBT	160	4.5 (2.3)	7.2 (12.1)	125 ^d (72.7– 178)	15

^aLC50 – concentration that results in 50% mortality of test population.

^bAcute Water Quality Criteria (WQC) for copper at average water hardness for all tests (90.5 mg/L) is 13 µg/L.

^cLC50 value based copper concentrations measured at the end of the KRWS exposure that immediately preceded the CRWS exposure.

^dCopper concentrations at 96 hours were approximately 50% of that observed at time zero. We are reasonably certain this was caused by an injection pump malfunction that occurred following a power outage after 72 hours of the test. Because mortality was clustered within the first 72 hours of exposure, we consider the time zero concentrations to be most appropriate for the calculation of the 96-h LC50.

2008 Chlorine Field Investigation

The objectives of the study are to:

- Evaluate concentrations of chlorine and copper/metals in Kootenai River (surface water);
- Sample water column at surface and at depth along 3 transects across the Kootenai River (upstream of municipal treatment plant outfalls, between outfalls, downstream of outfalls);
- Two sampling events (May, August);
- Compare concentrations to acute toxicity data for sturgeon from laboratory toxicity studies (above).

Field collection scheduled for Spring/Summer 2008; study will be completed in 2009.

Funding Source: USFWS

2007 Laboratory Studies: acute toxicity to early life stage and juvenile white sturgeon from three herbicides (Tables 3, 4 and 5)

The objectives of the study are to:

- Establish toxic concentrations of triclopyr (trade name Renovate), fluridone (trade name Sonar) and 2,4-D (as DMA-4) to sturgeon at 30 dps and 5-6 months - complete;
- Evaluate acute toxicity of triclopyr, fluridone and 2,4-D to rainbow trout (as above) and compare to sturgeon toxicity - complete;
- Compare toxicity data to proposed application rates for Kootenai River system – complete.

Study Initiated in August 2007

Funding Source: USFWS, USGS, SePRO Corp., 2,4-D Task Force partnership

Results:

Table 3. Observed concentration (mg/L) of **triclopyr** (as acid equivalent) and percent mortality of Kootenai River white sturgeon (KRWS) and rainbow trout (RBT) observed during exposure at 30 and 160 days post swim-up (dps) to Renovate 3 (Little 2008c).

Treatment	Species	Exposure Concentration, mg/L (standard error in parentheses)		Percent Mortality (96 h) (standard error in parentheses) [loss of equilibrium]	
		30 dps	160 dps	30 dps	160 dps
KRWS	Control	<0.03	<0.03	0	0
	Low	0.5 (0.1)	55.0 (1.0)	0	0
	Med-Low	2.0 (0.1)	NC ^b	0	NC ^b
	Med	2.1 (0.1)	107 (0.6)	0	15 (0.96)
	Med-Hi	4.35 (0.5)	NC ^b	0	NC ^b
	Hi	8.0 (0.3)	191 (1.1)	0 [100% LOE ^a]	100
RBT	Control	<0.03	<0.03	0	0
	Low	13.5 (0)	74.7 (1.2)	0	0
	Med-Low	NC ^b	NC ^b	0	NC ^b
	Med	49.2 (0.3)	154 (1.8)	0	0
	Med-Hi	NC ^b	NC ^b	0 [100% LOE ^a]	NC ^b
	Hi	159 (4.6)	264 (23.1)	100	0

^aLOE -Loss of equilibrium (fish could not maintain balance and turned upside down)

^bNC – Not Conducted

Triclopyr data summary:

- No observed KRWS or RBT effects or mortality associated with triclopyr exposure near or within maximum recommended application rate of 2.5 mg/L;
- 30 dps KRWS: Lowest observed effect concentration (LOEC) was 8.0 mg/L based on loss of equilibrium;
- 160 dps KRWS: LC50 calculated at 111 mg/L;
- 30 dps RBT: LOEC observed at nominal concentration of 75 mg/L based on loss of equilibrium;
- 160 dps RBT: LC50 calculated at >264 mg/L.

Table 4. Observed concentration (mg/L) of **fluridone** (as active ingredient) and percent mortality of Kootenai River white sturgeon (KRWS) and rainbow trout (RBT) observed during exposure at 30 and 160 days post swim-up (dps) to Sonar A.S. (Little 2008c).

Treatment	Species	Exposure Concentration, mg/L (standard error in parentheses)		Percent Mortality (96 h) (standard error in parentheses) [loss of equilibrium]	
		30 dps	160 dps	30 dps	160 dps
KRWS	Control	<0.016	<0.016	0	0
	Low	0.07 (0.08)	0.52 (0.42)	5 (0.5)	0[100% LOE ^a]
	Med-Low	0.12 (0.04)	NC ^b	0	NC ^b
	Med	0.22 (0.08)	0.72 (0.59)	5 (0.5)	0[100% LOE ^a]
	Med-Hi	0.47 (0.04)	NC ^b	30 (0.58)	NC ^b
	Hi	0.88 (0.06)	1.34 (1.18)	20 (0.82)	0[100% LOE ^a]
RBT	Control	<0.016	<0.016	0	0
	Low	0.67 (0.27)	1.83 (1.4)	0	0[100% LOE ^a]
	Med-Low	NC ^b	NC ^b	0	NC ^b
	Med	2.7 (1.02)	3.74 (2.8)	0	0[100% LOE ^a]
	Med-Hi	NC ^b	NC ^b	0	NC ^b
	Hi	8.81 (5.1)	7.01 (5.7)	45(2.22) [55% LOE ^a]	5 (0.5) [100% LOE ^a]

^aLOE -Loss of equilibrium

^bNC – Not Conducted

Fluridone data summary:

- Mortality (5%) of KRWS exposed to fluridone was observed below the maximum recommended application rate of 0.150 mg/L;
- No observed RBT mortality was observed associated with fluridone exposure near or within maximum recommended application rate;
- 30 dps KRWS: LC50 calculated at 1.61 mg/L;
- 160 dps KRWS: LOEC observed at 0.52 mg/L based on loss of equilibrium;
- 30 dps RBT: LOEC observed at 8.8 mg/L based on loss of equilibrium;
- 160 dps RBT: LOEC observed at 1.8 mg/L based on loss of equilibrium.

Table 5. Observed concentration (mg/L) of **2,4-D** (as acid equivalent) and percent mortality of Kootenai River white sturgeon (KRWS) and rainbow trout (RBT) observed during exposure at 30 and 160 days post swim-up (dps) to DMA 4 IVM (Little 2008d).

Species	Treatment	Exposure Concentration, mg/L (standard error in parentheses)		Percent Mortality (96 h) (standard error in parentheses) [loss of equilibrium]	
		30 dps	160 dps	30 dps	160 dps
KRWS	Control	< 0.074	2.4 (4.7)	0	0
	Low	1.22 (0.05)	19.8(0.1)	5 (0.5)	0
	Med-Low	2.5 (0)	NC ^b	5 (0.5)	NC ^b
	Med	4.98 (0.4)	38.9 (0.5)	15 (0.5)	0[37.5% LOE ^a]
	Med-Hi	10 (0)	NC ^b	15 (0.96)	NC ^b
	Hi	42.3 (4.5)	85.3 (0.3)	65 (1.7)	0[100% LOE ^a]
RBT	Control	< 0.074	< 0.074	0	0
	Low	54.1 (0.07)	77.2 (0.2)	0	0
	Med-Low	187.5 (1.3)	NC ^b	0	NC ^b
	Med	200 (3.5)	176.7 (0.6)	0	0
	Med-Hi	387 (8.4)	NC ^b	5 (0.5)	NC ^b
	Hi	776 (16.9)	293.7 (2.1)	100	0

^aLOE -Loss of equilibrium

^bNC – Not Conducted

2,4-D data summary:

- Mortality (5%-15%) and behavioral effects of white sturgeon observed with exposure to 2,4-D near or within maximum recommended application rate of 4 mg/L;
- No observed rainbow trout effects or mortality associated with 2,4-D exposure near or within maximum recommended application rate;
- 30 dps KRWS: LC50 calculated at 30.8 mg/L;
- 160 dps KRWS: LOEC observed at 38.9 mg/L based on loss of equilibrium; LC50>85.3 mg/L;
- 30 dps RBT: LC50 >387 mg/L and <776 mg/L;
- 160 dps RBT: LC50>294 mg/L; no significant mortality or loss of equilibrium occurred.

Summary of 2007 Laboratory Herbicide Toxicity Studies to Early Life Stage Juvenile White Sturgeon and Rainbow Trout

Of the three herbicides evaluated, our data indicate that triclopyr has the lowest probability of causing adverse effects to KRWS at the maximum recommended application rate (no observed effects up to 4.35 mg/L). Data from fluridone and 2,4-D toxicity tests show 5% KRWS mortality at concentrations less than the recommended application rates. Given that the KRWS is a critically endangered species, concerns exist regarding any level of mortality of these fish. Additional data addressing sub-lethal and lethal effects to KRWS from exposure to fluridone and 2,4-D within expected application rates and exposure times for anticipated field conditions are warranted prior to their use in the Kootenai River.

Acknowledgements:

Support for these studies was provided by the Kootenai Tribe of Idaho and Washington Department of Fish and Wildlife who provided hatchery white sturgeon eggs and fry for toxicity testing. Additional support was provided by Kurt Getsinger, U.S. Army Corps of Engineers, for herbicide study design and data results review. Juvenile sturgeon illustration by Loucas Raptis.

References:

Dwyer, F.J., F.L. Mayer, L.C. Sappington, D.R. Buckler, C.M. Bridges, I.E. Greer, D.K. Hardesty, C.E. Henke, C.G. Ingersoll, J.L. Kunz, D.W. Whites, T. Augspurger, D.R. Mount, K. Hattala, and G.N. Neuderfer. 2005. Assessing Contaminants Sensitivity of Endangered and Threatened Aquatic Species: Acute Toxicity of Five Chemicals. *Arch. Environ. Contam. Toxicol.* 48:143-154.

Little, E.E. 2008a. Toxicity of chlorine to rainbow trout and white sturgeon from the Kootenai River and Columbia River. Abstract prepared for: Fish and Wildlife Service Spokane Field Office. Prepared by: Edward E. Little, Columbia Environmental Research Center, US Geological Survey, Columbia, MO. February 4.

Little, E.E. 2008b. Acute toxicity of copper to early life stage rainbow trout and white sturgeon from the Kootenai River and two life stages of white sturgeon from the Columbia River. Abstract prepared for: Fish and Wildlife Service Spokane Field Office. Prepared by: Edward E. Little, Columbia Environmental Research Center, US Geological Survey, Columbia, MO. February 4.

Little, E.E. 2008c. Acute toxicity of two herbicides, Renovate 3 and Sonar A.S., to two life stages of white sturgeon from the Kootenai River and to rainbow trout. Abstract prepared by: Edward E. Little, USGS Columbia Environmental Research Center. Submitted to: US Fish and Wildlife Service Region 1 Spokane Field Office. February 12.

Little, E.E. 2008d. Acute toxicity of the herbicide DMA 4 IVM to two life stages of white sturgeon from the Kootenai River and to rainbow trout. Abstract prepared by: Edward E. Little, USGS Columbia Environmental Research Center, Columbia, MO. Submitted to: FWS Region 1 Spokane Field Office. February 11.