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AQUATIC STUDIES AT THE 100-HR-3 AND 100-NR-1 OPERABLE UNITS

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SUMMARY

Pacific Northwest Laboratory initiated a program to characterize selected aquatic biological populations to determine 1) existing levels of inorganic chemical and radionuclide contamination, and 2) the populations' suitability as indicators of chemical releases during cleanup activities at the U.S. Department of Energy's Hanford Site. Following work plans for the ground-water operable units, lower trophic levels in the aquatic habitat (periphyton and caddisfly larvae) were evaluated for contaminants at the 100-HR-3 Operable Unit and 100-NR-1 Operable Unit. The results were evaluated to determine the need for further sampling. If the results showed no significant contamination compared to upriver levels, sampling would be discontinued.

The periphyton community appears to be suitable for determining contamination levels. Baseline concentrations for stable chromium were established and will be useful for comparing samples collected when contaminant release is expected. Concentrations of ^{60}Co, ^{90}Sr, and ^{137}Cs in periphyton were essentially below detectable limits, which will also make this community useful in detecting potential releases of radionuclides during cleanup activities.

Levels for both stable chromium and radionuclides were essentially below detection limits for caddisfly larvae. Thus, these organisms may be used to monitor suspected contaminant releases from cleanup activities; if concentrations exceed detection limits, they may be related to these activities.

Two candidate threatened and endangered species of molluscs occur in the Hanford Reach of the Columbia River. These are the shortface lanx (*Fisherola nuttalli*), which is a Washington State candidate species, and the Columbia pebblesnail (*Fluminicola columbiana*), which is both a state and federal candidate species. Specimens of the shortface lanx were observed in the vicinity of N Springs (100-NR-1 Operable Unit); they likely occur throughout this area. Care will need to be taken in future sampling in this area.

ACKNOWLEDGMENTS

I would like to thank N. A. Cadoret, G. A. Martenson, R. P. Mueller, and B. L. Tiller for their capable assistance in the field and laboratory, and M. E. Almarode and L. L. Belt for assistance with the field sampling. S. Weiss (WHC) provided support and guidance for the program.

CONTENTS

FIGURE

TABLES

INTRODUCTION

The U.S. Department of Energy's (DOE's) Hanford Site in southeastern Washington State has been placed on the National Priorities List. Potentially contaminated sites have been grouped into aggregate areas and operable units. Among the first operable units being remediated are those closest to the Columbia River along the Hanford Reach, where past operations of nuclear reactors released contaminants into the environment. Some releases still occur from riverbank seeps and springs (DOE 1992). Because of this potential contamination, Westinghouse Hanford Company, the current operating contractor for the Hanford Site, requested the Pacific Northwest Laboratory (PNL)(a) to initiate a program to characterize selected biological populations to determine 1) existing levels of chemical and radionuclide contamination, and 2) the populations' suitability as indicators of chemical releases during cleanup activities.

Appendix D2 of the ground-water operable unit work plans for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) past-practice remedial investigations [e.g., 100-HR-3 (DOE 1989)] specifies that lower trophic levels in the aquatic habitat must be evaluated for contaminants at the 100-HR-3 Operable Unit and 100-NR-1 Operable Unit. The results are to be evaluated to determine the need for further sampling. If the results show no significant contamination compared to upriver levels, sampling is to be discontinued.

Discussions among Westinghouse Hanford Company and PNL scientists determined that the two most suitable aquatic populations which could serve these purposes were periphyton and rock-inhabiting caddisfly larvae. The reasons for selecting these populations included:

1. Both are sessile (i.e., they would have remained in place and thus "maximize" their exposure to potential local contaminants).
2. Periphyton is the logical place to start because they are the base of the food web (with phytoplankton) in the Columbia River.
3. Periphyton has a large surface-to-volume ratio and a high capacity to adsorb contaminants.
4. Periphyton has a high reproductive rate.

(a) Pacific Northwest Laboratory is operated for DOE by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

5. Caddisfly larvae are filter-feeding organisms that feed on suspended algae, much of which originates as periphyton, and thus are directly linked with periphyton.

6. Based on previous studies, both would be easy to sample and were suitable for indicating levels of radionuclide contamination.

7. Higher trophic levels, such as fish, are already monitored through the Surface Environmental Surveillance Project.

During the course of the sampling program, however, it became apparent that the diel fluctuations of the river level as a result of operations at Priest Rapids Dam made it impossible to adequately sample either community by wading and retrieving natural substrates. Deep water in the vicinity of two of the sampling stations for the 100-NR-1 Operable Unit also precluded wading. It thus became necessary to use artificial substrates, as will be explained under "Methods."

This report discusses how samples were collected and analyzed; gives results for periphyton and caddisfly larvae; presents historical data on Columbia River water to permit discussion of the present data; and discusses implications of the results.

METHODS

Nine sampling stations were selected and are shown in Figure 1. The rationale for their selection is as follows:

- Station H1, located at the Vernita Bridge, was the control station for both operable unit sites; levels of contamination found at H1 would indicate contamination resulting from upriver, offsite sources, and natural sources. Any increases found in downstream populations could thus be attributed to sources arising within the Hanford Reach.
- Station H2 was selected to provide a site that would separate contaminant releases associated with the 100-D operable unit from those at the 100-HR-3 Operable Unit.
- Station H3 was selected to also separate 100-D effluents, but also to act as the control station for the 100-HR-1 Operable Unit.
- Station H4 was located immediately below the 100-H Area and thus would be the study site where any increased contaminant releases from activities in the 100-HR-3 Operable Unit would most likely be detected.
- Station H5, located further downstream at the White Bluffs ferry landing, was intended to further monitor contamination from activities at the 100-HR-3 Operable Unit.
- Station N1 was an upstream control location for the 100-NR-1 Operable Unit.
- Stations N2, N3, and N4 were located at varying distances downstream from the 100-NR-1 Operable Unit to detect potential contaminant releases.

Irrigation returns entering the Columbia River along the northern and eastern shorelines would not influence the data collected in this study because they do not contain the elements of concern.

The original work plan, based on previous investigations of radionuclide contamination of Columbia River biota (Watson et al. 1970), called for the sampling of periphyton and caddisfly larvae by removing them from rocks retrieved by wading from shore. Thus, stations were placed where suitable-sized rocks could be retrieved by wading. It soon became apparent that both the diel river level fluctuation related to operation of Priest Rapids Dam and the seasonal (spring) increase in river stage and deep water (Stations N2 and N3) prevented waders from reaching and retrieving rocks that supported viable populations of either periphyton or caddisfly larvae. It became obvious that sampling locations with deeper water is needed, where the populations are assured of being covered with water the entire day.

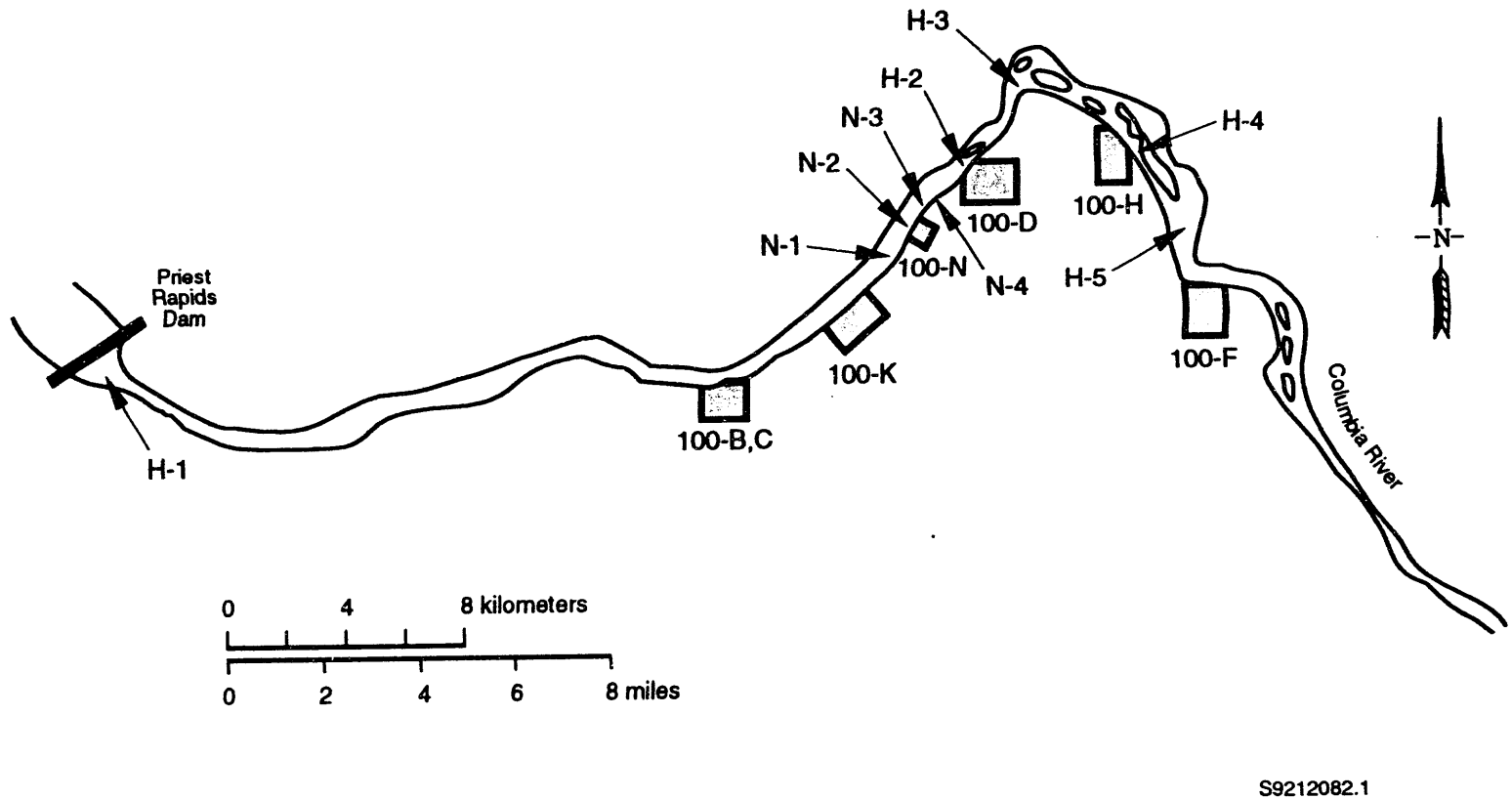

FIGURE 1. Sampling Locations

Two options were considered. The first was to use scuba divers to retrieve rocks for sampling; this was discarded as being inordinately expensive and because it posed unacceptable risks from diving in strong currents. The second was to use artificial substrates for the periphyton and caddisfly larvae to colonize, which could be retrieved by technicians in boats.

For the most part, the artificial substrates proved adequate. However, during certain times of the year, it was difficult to obtain sufficient biomass, especially of caddisfly larvae, for analysis. This was for biological reasons (insect emergence, cold temperatures) and could not be avoided. Samples were collected in September through December 1991 and January 1992.

PERIPHYTON

Ten to fifteen building bricks were tethered together, lowered into water 3 to 4 m deep, and tied to a shoreline stake. The bricks thus became surrogate rocks. Sufficient time (>3 weeks, Cushing 1967) was given for adequate colonization and development of periphyton communities. Field sampling involved the removal of three replicate 4.15-cm^2 samples for analysis of chlorophyll *a* concentrations, after which all periphyton was removed from the bricks by scrubbing into a bucket.

In the laboratory, the chlorophyll *a* content of the samples was determined by fluorometry after acetone extraction (Richards with Thompson 1952). The scrubbed periphyton was blotted, and subsamples were taken for radionuclide, heavy metal, and other trace element analyses. All laboratory preparations were done according to Certified Laboratory Procedures as described in CERCLA protocols. Analytical services were provided by TMA Norcal.

CADDISFLY LARVAE

For caddisfly larvae, several 20-cm-dia by 40-cm-long barbecue baskets were filled with river rocks, tethered together, and placed in water 3 to 4 m deep. As with the periphyton bricks, these were allowed to be colonized naturally by caddisfly larvae. Field sampling was done by using a water jet to wash the larvae from the rocks into a bucket, followed by filtration through a sieve and hand removal of the larvae from the debris.

In the laboratory, subsamples were prepared for radionuclide (^{60}Co, ^{90}Sr, and ^{137}Cs) and heavy metal (chromium) analyses according to Certified Laboratory Procedures as described in CERCLA protocols. Analytical services were provided by TMA Norcal.

QUALITY ASSURANCE

Quality control samples were taken as specified in Section 9 of the Quality Assurance Project Plan (QAPP) in the 100-HR-3 and 100-NR-1 Operable Unit Work Plan (DOE 1990). Applicable procedures, as specified in Section 4 of the QAPP in DOE (1990), were followed.

RESULTS

Concentrations of chromium found in periphyton and caddisfly larvae were similar, and no higher concentrations were found in samples collected adjacent to or below the two operable units than in those at the control station. Concentrations of ^{51}Cr, ^{90}Sr, and ^{137}Cs were usually below detectable levels.

IMPORTANT NOTE: In the data tables (Tables 1 through 4 and 6 through 9), certain values are followed by the letters "J" or "UJ." These are qualifiers and indicate the level of certainty that can be placed on the accompanying numerical values depending upon such things as detection limits and contractual holding times (WHC 1991, 1992). The letter "J" indicates that the sample was held in excess of contractual holding times (six months) for periods averaging about three months. The results are technically accurate for analytes with minimal decay, such as radionuclides with a 30-yr half-life or metals, even though a "J" designation, by definition (WHC 1991), states that it is "estimated." The letters "UJ" indicate the same in terms of contractual holding times and technical accuracy, but is below the detectable limit of the analytical method. ***Thus, values followed by a "J" or "UJ" in the above tables can be interpreted as technically valid, even though the "UJ" values are below analytical detection limits.***

WATER

Water samples were not collected for analysis in this study. However, the historical data presented below will enable the reader to better interpret the results presented.

Stable chromium values in Columbia River water have been reported by Cushing and Rancitelli (1972), who found values of 0.4, <0.1, 0.1, 0.2, and <0.1 ppb in five samples analyzed by neutron activation analyses. This is much less than the mean of 10.8 ppb for rivers of the world reported by Livingstone (1963), although he qualifies this as being "rather high" and further states that the mean for lakes and rivers of the world is probably between 0.1 and 10 ppb.

Some data are available relative to chromium toxicity in freshwaters. The U.S. Environmental Protection Agency (EPA 1986) states that green algae are quite sensitive to Cr^{+6}, that acute toxicity to macroalgae occurs at 1.0 to 5.0 ppm, and that 1,870 ppm had acute toxic effects on a stonefly. For Cr^{+3}, EPA (1986) states that the acute toxic range is from 2.22 ppm for

a mayfly to 71.0 ppm for a caddisfly. Freshwater green algae was affected by 397 ppb in soft water. These concentrations far exceed those reported by Cushing and Rancitelli (1972), the only known values published for the Columbia River.

Several studies have been done at the Hanford Site relative to the toxicity of chromium to the early life stages of fish. Young chinook salmon and rainbow trout were reared from eggs in low concentrations of sodium dichromate; eggs were hatched in the highest concentration (0.18 ppm) of Cr^{+6}. Survival of these fish, however, was adversely affected by 0.08 ppm Cr^{+6}. Growth appeared to be retarded at the lowest concentration of Cr^{+6} (0.013 ppm; Olson and Foster 1956, cited in Becker 1990). Subsequent studies with Cr^{+6} showed that chinook salmon eggs were not affected by concentrations that were lethal to young fish after hatching, effects on young salmon from intermittent exposure were somewhat less than those from constant exposure, and young salmon were less tolerant of Cr^{+6} at 5°C than at 10°C (Olson and Foster 1957, cited in Becker 1990). Olson (1958) found that Cr^{+6} was toxic at 0.02 ppm, but that Cr^{+3} was not. The concentrations reported above that demonstrated deleterious effects on young fish are considerably higher than the concentrations of stable chromium in the Columbia River reported by Cushing and Rancitelli (1972) of 0.0004 ppm.

PERIPHYTON

Stable Chromium Analyses

Table 1 presents the analyses of stable chromium in periphyton. Concentrations apparently remain fairly stable, ranging from low values of around 16 ppb dry-weight (DW) to highs of around 32 ppb DW (ignoring the obvious extraneous value of 73.5 ppb DW at station N3 in October). Although this appears to be a significant range, examination of the data in Table 1 reveals that concentrations are quite stable, with a mean value of 26.1 ppb DW. Converting this to wet-weight, an approximate concentration factor of 28,500 is obtained for chromium in periphyton. Cushing and Rancitelli (1972) report a mean concentration factor for chromium in phytoplankton in the Columbia River to be about 46,000.

There is an indication of higher concentrations at both operable units than at Vernita during September, but values were both lower and higher at the operable units in November and December. Overall, indications are that levels of stable chromium are not significantly higher at either operable unit than at the control station.

TABLE 1. Chromium Content (mg/kg dry weight) in Periphyton

Station	September	October	November	December	January
H1 (control)	24.2 J[a]		28.8 J	27.3 J	
H2	27 J		27.9 J	28.5 J	16.9
H3	27 J		29 J	22.2 J	16.1
H4	29.7 J		28.3 J	24.9 J	16.5
H5	20.5 J		31.6 J	28.2 J	20.6
N1	28.3 J	27.8 J	31.6 J		29.4
N2	34.1 J	21.9 J	30.2 J		23.7
N3		73.5 J	32.7 J		18.7
N4	29.9 J	24.2 J	32.6 J		22

(a) See NOTE, p. 7.

Cushing and Rancitelli (1972) give a mean value of stable chromium in net plankton (essentially the same as periphyton) from the Columbia River of 20.17 ppm DW, a value similar to those found in the present study. For the most part, comparison of concentration data for other elements given in Cushing and Rancitelli (1972) with those of the present study shows that values are similar. However, concentrations of potassium, sodium, and iron found in the present study differed markedly from those reported by Cushing and Rancitelli (1972). Concentrations of potassium in periphyton and caddisfly larvae reported by Cushing and Rancitelli (1972) were 10,700 and 12,600 ppm DW, respectively; corresponding values found in the present study were 1,940 and 2,210 ppm DW, respectively, both considerably lower. For sodium, Cushing and Rancitelli (1972) reported 8,000 and 3,900 ppm DW in phytoplankton and caddisfly larvae, respectively; corresponding values in the present study were 397 and 564 ppm DW, again considerably lower. Iron concentrations in phytoplankton in Cushing and Rancitelli (1972) and periphyton in the current study were comparable, but Cushing and Rancitelli (1972) found 2,000 ppm DW in caddisfly larvae, and the current study found 14,500 ppm DW. It is difficult to explain these differences, although one possibility is differences in methods of analyses; Cushing and Rancitelli (1972) analyzed their samples using neutron activation analyses.

Radionuclide Analyses

Only five of the 93 radionuclide analyses of periphyton for ^{60}Co, ^{90}Sr, and ^{137}Cs (Tables 2, 3, and 4) resulted in measurable values; three were for ^{90}Sr and one each for ^{137}Cs and ^{60}Co. Strontium-90 values were 0.69 and 0.42 pCi/g DW at Stations H1 and H5, respectively, in December, and 0.23 pCi/g DW at station H2 in July. The only measurable value for ^{137}Cs (1.09 pCi/g DW) was found at station H2 in July; the only measurable value for ^{60}Co (2.2 pCi/g DW) was found at N3 in October.

These values indicate that present levels of radionuclide concentrations in periphyton are essentially below detection limits and should provide a good baseline for comparison of values found during or after cleanup activities.

Cushing et al. (1981) report values for ^{60}Co in periphyton in relation to the decrease in radioactivity resulting from closure of the plutonium production reactors. Before closure, periphyton contained approximately 240 ± 480 pCi/g DW ^{60}Co; these levels decreased to around 22 pCi/g DW shortly after closure of the first reactors and eventually declined to about 2 pCi/g DW following closure of all reactors.

TABLE 2. ^{60}Co Content (pCi/g DW) in Periphyton

Station	July	September	October	November	December
H1 (control)	<1.595 UJ[a]	4.6 UJ		4.6 UJ	5.7 UJ
H2	<1.121 UJ	3.4 UJ		3.7 UJ	2.8 UJ
H3	<2.067 UJ	2.8 UJ		2.8 UJ	1.9 UJ
H4	<2.455 UJ	1.1 UJ		3.6 UJ	3.1 UJ
H5	<2.220 UJ	1.6 UJ		2.8 UJ	1.9 UJ
N1		1.5 UJ	2.3 UJ	1.4 UJ	
N2		4.2 UJ	2.3 UJ	1.5 UJ	
N3			2.2 J	1.7 UJ	
N4		1.6 UJ	1.5 UJ	1.7 UJ	

(a) See NOTE, p. 7.

TABLE 3. ^{90}Sr Content (pCi/g DW) in Periphyton

Station	July	September	October	November	December
H1 (control)	-1.5 ± 7.3 E-01 UJ[a]	-0.32 UJ		1.1 UJ	0.69 J
H2	2.3 ± 1.2 E-01 J	-0.13 UJ		0.072 UJ	0.53 UJ
H3	-1.19 ± 0.5 UJ	0.085 UJ		-0.077 UJ	0.016 UJ
H4	0.1 ± 2.0 E-01 UJ	0.89 UJ		-0.16 UJ	0.007 UJ
H5	-0.7 ± 2.8 E-01 UJ	0.081 UJ		-0.28 UJ	0.42 J
N1		0.057 UJ	0.047 UJ	0.059 UJ	
N2		1.3 UJ	-0.13 UJ	0.2 UJ	
N3			0.069 UJ	0.43 UJ	
N4		-0.88 UJ	-0.13 UJ	0.35 UJ	

(a) See NOTE, p. 7.

TABLE 4. ^{137}Cs Content (pCi/g DW) in Periphyton

Station	July	September	October	November	December
H1 (control)	<1.233 UJ[a]	3.5 UJ		3.1 UJ	3.2 UJ
H2	1.092 ± 0.743 J	3.1 UJ		2.2 UJ	1.8 UJ
H3	<1.591 UJ	1.8 UJ		2.4 UJ	1.7 UJ
H4	<2.443 UJ	0.75 UJ		2.1 UJ	2.1 UJ
H5	<1.877 UJ	1.1 UJ		1.7 UJ	2.0 UJ
N1		1.1 UJ	1.5 UJ	1.3 UJ	
N2		2.8 UJ	1.1 UJ	1.1 UJ	
N3			1.8 UJ	1.2 UJ	
N4		1.4 UJ	1.2 UJ	1.5 UJ	

(a) See NOTE, p. 7.

Chlorophyll *a* Analyses

Table 5 presents data for concentrations of chlorophyll *a* in periphyton. These data were collected to establish some measure of biological viability of the community to accompany the measurements of radioactivity and stable metal concentrations.

The low values found in September at the 100-HR-3 Operable Unit were probably the results of the aforementioned problems with fluctuating water levels. These samples had apparently been subjected to dewatering and siltation. For most of the remaining samples collected from the artificial substrates, higher chlorophyll *a* values were found, indicative of healthier periphyton communities. There is no indication of any adverse impacts within the two operable units; in fact, chlorophyll *a* levels within the units usually exceed those at the control station. The mean chlorophyll *a* value at the 100-HR-3 Operable Unit was 0.91 $\mu g/cm^2$, with a range of 0.04 to 2.77 $\mu g/cm^2$; at the 100-NR-1 operable unit, the mean concentration was 1.5 $\mu g/cm^2$ and the range was 0.35 to 8.2 $\mu g/cm^2$. If the two extremely high values found at stations N1 and N2 in January are excluded, the mean value is 0.55 $\mu g/cm^2$ and the range is 0.35 to 2.01 $\mu g/cm^2$. These values can be compared with those reported by Cushing (1967) for periphyton communities grown on artificial substrates near the 100-F Area. Those values ranged from 0.4 to 3.6 $\mu g/cm^2$, and the mean was 2.2 $\mu g/cm^2$. Given the varying circumstances between these two studies, the values are quite comparable and provide a reasonable basis on which to evaluate future perturbations related to cleanup efforts.

CADDISFLY LARVAE

Stable Chromium Analyses

Only four valid analyses of chromium in caddisfly larvae were obtained (Table 6) because sufficient biomass could not be collected at certain times. These levels are comparable to those found in periphyton and indicate no biomagnification of this element by caddisfly larvae from algae, their main food source.

These results differ considerably from those reported by Cushing (1979). Using neutron activation analyses, he reported concentrations of chromium in Columbia River caddisflies of 1.8 ppm DW (= mg/Kg). Further, Davis et al. (1958) reported a stable chromium value of 2.04 ppm DW, a value much closer to Cushing's than to those found in this study. No reason for these discrepancies is apparent. As with the algae (periphyton and phytoplankton), a comparison of the concentrations of other elements given by Cushing (1979) with those of the present study

TABLE 5. Chlorophyll *a* (μ g/cm2) in Periphyton

Station	September	October	November	December	January
H1 (control)	0.07		0.05	0.16	no sample
	0.05		0.02	1.62	no sample
	0.05		0.01	0.5	no sample
H2	0.14		0.16	1.66	2.87
	0.08		0.04	0.32	2.79
	0.08		0.4	1.43	1.27
H3	0.07		0.06	2.15	no sample
	0.27		0.18	1.74	no sample
	0.07		0.35	0.64	no sample
H4	0.04		0.72	2.38	1.84
	0.05		0.91	2.49	2.57
	0.12		0.2	1.06	3.9
H5	0.05		0.49	1.58	0.57
	0.03		0	0.85	2.14
	0.06		0.07	1.13	1.36
Exposure time	natural		3 weeks	4 weeks	5 weeks
N1	1.05	0.05	0.25		2.43
	0.75	0.06	0.2		17.35
	0.23	0.09	0.62		1.99
N2	0.06	0.08	0.42		16.52
	0.09	0.09	0.55		6.54
	0.23	0.02	0.37		1.55
N3	0.45	0.1	0.51		2.06
	0.08	0.07	0.17		1.49
	0.53	0.05	1.76		1.34
N4	1.16	0.05	0.75		0.34
0.52	0.02	0.02	0.43		1.18
0.27	0.27	0.25	0.21		4.52
Exposure time	7 weeks	5 weeks	4 weeks		4 weeks

TABLE 6. Chromium Content (mg/kg) in Caddisfly Larvae. Blanks denote insufficient sample for analysis.

Station	September	October
N2	20.1 J[a]	21.7 J
N3		24.7 J
N4	21.4 J	

(a) See NOTE, p. 7.

reveals general agreement, with exceptions. Concentrations of iron in the present study are nearly an order of magnitude higher, while concentrations of sodium and potassium are lower than those reported by Cushing (1979).

Radionuclide Analyses

Insufficient sample materials prevented an extensive analyses of radionuclide concentrations in caddisfly larvae (Tables 7, 8, and 9). Of the 12 analyses that were accomplished, only one measurable result was obtained. In this analysis, ^{90}Sr concentration was 0.57 pCi/g DW in the sample collected at station N2 in October.

No historical data are available for ^{90}Sr analysis of caddisfly larvae. Cushing et al. (1981) report ^{60}Co values of 66 ± 104 pCi/g DW for caddisfly larvae before closure of the plutonium production reactors; these levels decreased to about 12 pCi/g DW following closure of all reactors.

Cushing (1979) reported concentration factors (the ratio concentration in organism: concentration in food) of 0.1 for chromium in caddisfly larvae feeding on phytoplankton. Periphyton and phytoplankton are both microscopic algae and provide similar food to caddisfly larvae. The data for periphyton and caddisfly larvae from this study produce a concentration factor of about 1.0, an order of magnitude higher than for previous studies of plankton and caddisfly. There is no immediate explanation for this difference.

TABLE 7. ^{90}Sr Content (pCi/g DW) in Caddisfly Larvae. Blanks denote insufficient sample for analysis.

Station	September	October
N1		
N2	0.45 UJ[a]	0.57 J
N3		-0.12 UJ
N4	0 UJ	

(a) See NOTE, p. 7.

TABLE 8. ^{60}Co Content (pCi/g DW) in Caddisfly Larvae. Blanks denote insufficient sample for analysis.

Station	September	October
N1		
N2	2.8 UJ[a]	1.9 UJ
N3		2.2 UJ
N4	5.0 UJ	

(a) See NOTE, p. 7.

TABLE 9. ^{137}Cs Content (pCi/g DW) in Caddisfly Larvae. Blanks denote insufficient sample for analysis.

Station	September	October
N1		
N2	1.5 UJ[a]	1.4 UJ
N3		1.6 J
N4	2.5 UJ	

(a) See NOTE, p. 7.

CONCLUSIONS

Where valid analyses were obtained, there appeared to be no significant differences in concentrations of chromium or radionuclides between samples collected upriver of the operable units and samples collected within the operable units; thus, no additional aquatic sampling is warranted at this time.

WATER

It is highly unlikely that concentrations of chromium present in the Columbia River would prove deleterious to aquatic organisms. Concentrations of chromium near or above drinking water levels are restricted to springs from the 100-B, 100-D, and 100-H Areas (DOE 1992), and elevated chromium levels are present in spring seepage water at the 100-B, 100-D, 100-A, and 100-K (Peterson and Johnson 1992); most of this is in the hexavalent (Cr^{+6}) form. These concentrations, however, are diluted rapidly in the short mixing zone to undetectable concentrations as soon as they enter the Columbia River. The Cr^{+6} would remain in this form unless it encountered reducing conditions (e.g., presence of Fe^{+2}), at which time it would be converted to Cr^{+3}, which is insoluble and would precipitate out of the water.(a) Most studies of toxicity of chromium to aquatic organisms have found that Cr^{+6} is the toxic form of chromium, while Cr^{+3} is not.

PERIPHYTON

Once a suitable sampling method was perfected, this community appears to be suitable for determination of contaminant levels. Baseline concentrations for stable chromium were established and will be useful for comparing samples collected when contaminant release is expected. Concentrations of selected radionuclides (^{60}Co, ^{90}Sr, and ^{137}Cs) were essentially below detection limits, which also makes this community useful for detecting potential releases of radionuclides during cleanup activities. The usefulness of the chlorophyll *a* analyses is mainly to indicate the relative "health" of the community, and this was determined when the artificial substrates were used.

(a) Rai, D., Senior Scientist, Pacific Northwest Laboratory; Personal Communication with C. E. Cushing, February 5, 1993.

CADDISFLY LARVAE

Background levels for stable chromium and radionuclide levels (in this case, below detection limits) were successfully established, albeit from few samples, and will be useful for monitoring suspected contaminant releases as a result of cleanup activities.

THREATENED AND ENDANGERED SPECIES

Two candidate threatened and endangered species of molluscs occur in the Hanford Reach of the Columbia River. These are the shortface lanx (*Fisherola nuttalli*), which is a Washington State candidate species, and the Columbia pebblesnail (*Fluminicola columbiana*), which is both a state and federal candidate species. Specimens of the shortface lanx were observed during the study in the vicinity of N Springs; they likely occur throughout this area. Care will need to be taken to avoid harming these species in future sampling in this area.

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