FINAL REPORT

BUNKER HILL FACILITY NON-POPULATED AREAS OPERABLE UNIT 2 BIOLOGICAL MONITORING, 2006

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1.0 Background and Objectives

This report summarizes the 2006 activities and results of biological resource monitoring conducted by the U.S. Fish and Wildlife Service (USFWS) at the Bunker Hill Mining and Metallurgical Complex Operable Unit 2 (OU-2). This work was supported through an Interagency Agreement with the U.S. Environmental Protection Agency (USEPA) and follows the framework of the OU-2 Environmental Monitoring Plan (EMP) (USEPA, 2006a).

Phase I of the Comprehensive Cleanup Plan for OU-2 includes the evaluation of remedial actions on ecological conditions at the site. Biological resource monitoring under the EMP was designed to aid in this evaluation and relate the effectiveness of the overall Phase I remedy for OU-2. Biological resource monitoring is based on goals and objectives identified in the OU-2 Record of Decision (ROD) (USEPA, 1992) and subsequent amendments (USEPA, 1996a; USEPA, 2001) and explanations of significant differences (USEPA 1996b; USEPA 1998). Data from the EMP will assist USEPA by evaluating the progress of remedial actions in terms of improving ecological conditions, by providing information supporting the required Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) five-year reviews and by providing information that can be used to guide Phase II of the OU-2 remedy.

As identified in the Environmental Monitoring Plan (EMP) for OU-2 (USEPA, 2006a), USFWS conducted studies in 2006 designed to evaluate two components of remedy with respect to biological resources. The first component investigated the status of aquatic and terrestrial wildlife populations and related habitat quality in remediated areas. These studies included the evaluation of

- waterfowl wetland use within OU-2,
- amphibian use of Smelterville Flats wetlands,
- macroinvertebrate diversity and abundance surveys within the SFCDR, and
- songbird diversity and abundance in OU-2 relative to reference areas.

The second component evaluated exposure of biological resources to contaminants of concern, including arsenic (As), cadmium (Cd), lead (Pb), and zinc (Zn). This study measured heavy metal concentrations in aquatic macroinvertebrates within the SFCDR to determine if remedial activities have reduced ecological receptor exposure to heavy metals.

The selection of study areas within OU-2 was dependent upon a review of past remedial actions (USEPA, 2000), reconnaissance investigations of current habitat conditions, a review of relevant literature, a review of previous studies conducted on site, and sampling site accessibility. Reference areas were chosen based on proximity to the assessment areas, geologic or ecologic similarities to OU-2 sites, and relative lack of mining-related impacts. Biological resource monitoring was conducted in accordance with Upper Columbia Fish and Wildlife Office (UCFWO) Standard Operating Procedures (SOP) and the EMP (USEPA, 2006a), both designed for data continuity and comparability with existing studies.

The following sections discuss the available results from the biological monitoring activities conducted within OU-2 during 2006. Analytical results from macroinvertebrate diversity and abundance surveys were not received in time to incorporate into this report and therefore will be incorporated into the annual report for 2007.

2.0 Breeding Bird Surveys

OU-2 suffered a loss of vegetative diversity and structure from historic mining-related activities (USFWS, 2005). Between 1975 and 2002, approximately 2,541,900 trees were planted on hillsides within OU-2 to help stabilize soils and provide habitat. Some of these plantings, along with hydroseeding and other activities, took place as part of remedial activities within OU-2 (USEPA, 2005). Yet, previous vegetation surveys indicated that vegetation composition within OU-2 exhibited an even-age and single-size class of tree, lack of tree and shrub species diversity, and relatively little ground cover compared to reference areas (USFWS, 2005). While the vegetation composition within OU-2 showed a positive trend in establishment (CH2M Hill, 2003), further tree and ground cover growth would be required to produce vegetation community characteristics comparable to adjacent native habitats (USFWS, 2005).

Bird use of an area has been identified as a useful means for evaluating the performance of restoration activities (Kus, 1998; Gardali, et al., 2006). Previous comparisons of bird species using OU-2 and reference areas indicated songbird community differences driven by habitat requirements of the species of birds observed at those sites (i.e., species typically observed in open habitats vs. those typically found in forests; USFWS, 2005). We conducted the second year of songbird breeding bird surveys outlined in the OU-2 Environmental Monitoring Plan (USEPA, 2006a) to continue to develop the use of OU-2 by songbirds as an indicator of the success of remedial activities in restoring native vegetative habitats at the site.

2.1 Methods

A Breeding Bird Survey (BBS) route was established within and above OU-2 in June 2001 as part of the Bunker Hill Facility non-populated areas OU-2 biological monitoring program, 2001-2004 (USFWS, 2005). We used a slight modification of this route (i.e., modifying exact locations of survey points) to conduct the 2006 breeding bird survey. We established 34 survey points at ½-mile intervals along the route: 29 points within OU-2 (points 1-29) and 5 points in areas above OU-2 (points 30-34) (Fig. 2-1). We conducted the survey on June 16. Survey counts were conducted at each survey point by standing outside a parked vehicle for 3 minutes and counting individual birds seen and heard within approximately 1/4 mile. The observer had extensive knowledge of songs, calls, and visual identification of all species of birds likely to be encountered, as well as the ability to consult bird field guides and call recordings.

We used the route segment established above OU-2 and a previously established Breeding Bird Survey route (Rochat Divide) for comparisons with the OU-2 route. We chose the Rochat Divide route as a reference site due to its geographical and elevation similarities to the OU-2 route. We used only data collected from Rochat Divide observation stops 11 through 50 for comparisons to OU-2 because of similarities in habitat between the routes. Data for the Rochat Divide route from 2006 was not available at the time of this report. We therefore obtained and used data reported for the 2005 Rochat Divide survey (USGS, 2006a). We would not expect general bird use to vary dramatically between subsequent years in these habitats during the sampling period, and therefore would not anticipate year effects when comparing 2006 OU-2 data with Rochat Divide 2005 data.

2.2 Results

We observed 308 birds from 44 species within OU-2 and 25 birds from 13 species above OU-2. Observers recorded 331 birds from 43 species on the Rochat Divide route in 2005 (Table 2-1). Several species were recorded on the Rochat Divide route and not within OU-2, and several were recorded in OU-2 and not on Rochat Divide (Tables 2-2 and 2-3). In addition, we observed two species (ruby-crowned kinglet, *Regulus calendula*, and winter wren, *Troglodytes troglodytes*) above OU-2, but not within OU-2. Species of birds with the highest densities in OU-2 were American robin (*Turdus migratorius*), brown headed cowbird (*Molothrus ater*), Oregon junco (*Junco hyemalis*), spotted towhee (*Pipilo maculatus*), Swainson's thrush (*Catharus ustulatus*), violet green swallow (*Trachycineta thalassina*) and yellow warbler (*Dendroica petechia*). Species with the highest densities observed on Rochat Divide were American robin, Audubon's warbler (*Dendroica coronata)*, cordilleran flycatcher (*Empidonax occidentalis*), Swainson's thrush (*Catharus ustulatus*), Townsend's warbler (*Dendroica townsendi*), varied thrush (*Ixoreus naevius*) and western tanager (*Piranga ludoviciana*) (Table 2-4).

2.3 Discussion

Bird use is an indicator of available habitat, especially when specialist species expected to occur in a specific area are absent (Kus, 1998; Gardali et al., 2006). We recorded marked differences in types of species using the OU-2 and Rochat Divide route areas. Should OU-2 habitat emulate that of the Rochat Divide route, we would expect to record similar songbird species at both sites. Differences in bird species using the OU-2 and Rochat Divide sites exhibit differences in habitat requirements of the species represented (Ehrlich et al., 1988). These trends provide valuable evidence regarding the success of OU-2 remedial activities in restoring habitat within OU-2 to that represented by native habitats adjacent to the site.

Species recorded exclusively on the OU-2 route are well represented by those which inhabit open areas, human-modified and bare ground habitat, fragmented forests with grassy vegetation, sun exposed or open habitat, exposed rocky areas with little or no vegetation, and early successional stage habitat (i.e., European starling, rock wren, sandpiper spp., savannah sparrow, tree swallow, western meadowlark). Several of the species we observed at OU-2 in abundance of >15 individuals (i.e., spotted towhee, American robin, and brown-headed cowbird,) are indicative of habitat generalists, requiring less stringent habitat requirements (Ehrlich et al., 1988).

In contrast, species observed in abundance of >15 individuals during the 2005 Rochat Divide survey or those absent from the OU-2 route (e.g., cordilleran flycatcher, Townsend's warbler, Townsend's solitaire, varied thrush, western tanager, hermit thrush, red-naped sapsucker, red crossbill, and chestnut-backed chickadee) predominantly occupy forest stands or feed on seeds and insects found in conifer and mixed conifer habitats (Ehrlich et al., 1988). Many of these species typically require tree cavities for nesting and brooding (Poole, 2005; Ehrlich et al., 1988). These habitat types typically include decreased temperatures, increased shading and well-established mature upper tree canopies. In general, species observed along the Rochat Divide route represent those requiring more mature forested stands typical of areas dominated by forests in northern Idaho that once dominated OU-2.

The Rochat Divide route is encompassed by a mature forest which has not experienced major anthropogenic disturbances. Areas along the OU-2 route, especially along the lower elevation portion, have been severely impacted by human disturbance which has modified the habitat structure and function. Our data suggests that forested vegetation supporting bird communities has not yet recovered within OU-2 to resemble native forested habitats in this ecoregion. As vegetative diversity and structure improves within OU-2, a corresponding shift in avian communities to more closely represent reference areas is expected to occur.

Figure 2-1. USFWS breeding bird survey route, Operable Unit 2, Coeur d'Alene Basin, Idaho, 2006.

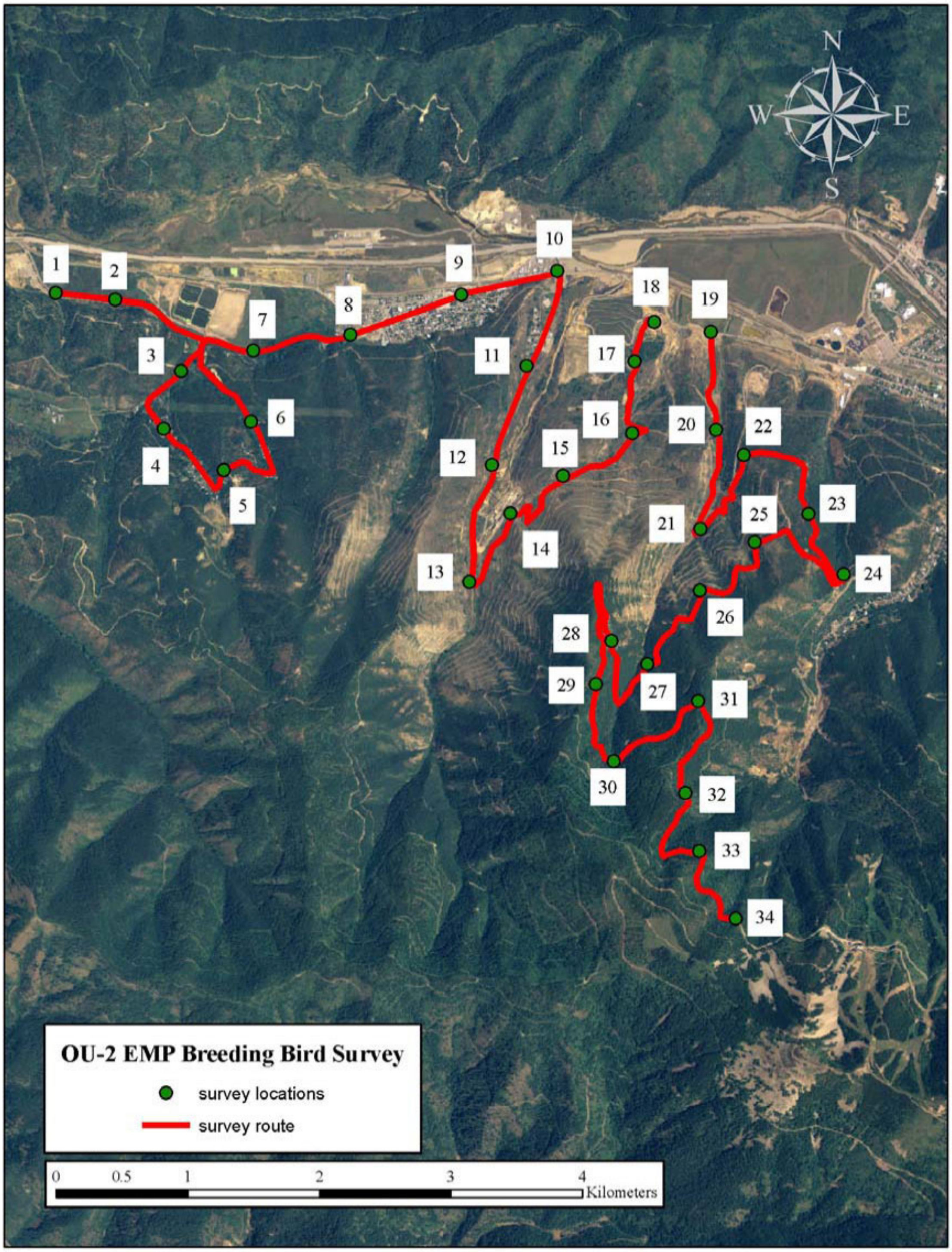


Table 2-1. Bird species observed on Bunker Hill (OU-2) 2006 and Rochat Divide 2005 (stops 11-50) breeding bird survey routes.

Species	Bunker Hill OU-2	Above OU-2	Rochat Divide (2005)
American coot	1		
American crow	2		
American robin	21	1	15
Audubon's warbler	7		17
Belted kingfisher			1
Black-capped chickadee	8	4	
Black-headed grosbeak	11	1	3
Brewer's blackbird	4		
Brown-headed cowbird	15		1
Cassin's vireo	4	1	7
Cedar waxwing	10		2
Chestnut-backed chickadee			14
Chipping sparrow	14		9
Cliff swallow	1		
Common raven	3	1	3
Cordilleran flycatcher			16
Dusky flycatcher			2
European starling	2		
Finch spp.			4
Fox sparrow			2
Golden-crowned kinglet	1	1	8
Hammond’s flycatcher	4		9
Hermit Thrush			1
Hummingbird spp.	1		
Killdeer	1		2
Lazuli Bunting	1		
MacGillivray’s warbler	1		14
Marsh Wren	1		
Mountain chickadee	2		
Mourning dove			
Nashville warbler	2	1	
Olive-sided flycatcher			4
Orange-crowned warbler	6		12
Oregon junco	20	3	9
Pine siskin			3
Red-breasted nuthatch			10
Red crossbill			3
Red-eyed vireo	11		4
Redhead duck	7		
Red-naped Sapsucker			1
Red-shafted flicker			2

Table 2-1 cont.

Species	Bunker Hill OU-2	Above OU-2	Rochat Divide (2005)
Red-winged blackbird	9		
Rock wren	8		
Ruby-crowned kinglet		2	12
Ruffed grouse	1		
Savannah sparrow	1		
Song sparrow	9		6
Spotted sandpiper	2		
Spotted towhee	13	2	
Steller's jay			8
Swainson’s thrush	19	5	34
Townsend’s solitaire			2
Townsend’s warbler			23
Tree swallow	1		
Varied thrush			15
Vaux’s Swift			3
Violet-green swallow	37		
Warbling vireo	2		13
Western meadowlark	11		
Western tanager			23
Western wood-pewee	6		2
Willow flycatcher	7		2
Winter wren		2	8
Woodpecker spp.	1		1
Yellow-headed blackbird	5		
Yellow warbler	15	1	1
Total	**308**	**25**	**331**
Number of Species	**44**	**13**	**43**

Table 2-2. Species of birds observed during the Rochat Divide (2005) breeding bird survey, or above OU-2, but not on the Bunker Hill OU-2(2006) breeding bird survey.

Belted kingfisher	Red-naped sapsucker
Chestnut-backed chickadee	Red-shafted flicker
Cordilleran flycatcher	Steller's jay
Dusky flycatcher	Townsend's solitaire
Fox sparrow	Townsend's warbler
Hermit thrush	Finch spp.
Olive-sided flycatcher	Varied thrush
Pine siskin	Vaux's swift
Red crossbill	Western tanager
Red-breasted nuthatch	Ruby-crowned kinglet
Winter wren	

Table 2-3. Species of birds observed during Bunker Hill (2006) breeding bird survey, but not on the Rochat Divide (2005) breeding bird survey.

American coot *	Red winged blackbird *
American crow	Red head duck *
Black capped chickadee	Rock wren
Brewers blackbird	Ruffed grouse
Cliff swallow	Sandpiper spp.
European starling	Savannah sparrow
Hummingbird spp.	Spotted towhee
Lazuli bunting	Tree swallow
Marsh wren *	Violet-green swallow
Mountain chickadee	Western meadowlark
Nashville warbler	Yellow-headed blackbird *

*These species only observed at stops 1, 2, 7, 8 and 10, which are adjacent to Page Ponds

Table 2-4. Species of birds observed at densities ≥15 (in bold) birds per route at the Bunker Hill (OU-2) and Rochat Divide breeding bird surveys.

Species	**Density (birds per route)**	
	Bunker Hill (OU-2) 2006	Rochat Divide 2005
American robin	**21**	**15**
Audubon's warbler	7	**17**
Brown-headed cowbird	**15**	1
Cordilleran flycatcher	0	**16**
Oregon junco	**20**	9
Swainson's thrush	**19**	**34**
Townsend's warbler	0	**23**
Violet-green swallow	**37**	0
Varied thrush	0	**15**
Western tanager	0	**23**
Yellow warbler	**15**	1

3.0 Page Ponds Wetland Complex and Smelterville Flats Waterfowl Surveys

Thousands of waterfowl use lower Coeur d'Alene Basin (Basin) palustrine habitats during spring migration (Audet et al., 1999; USFWS, 2006). Ingestion of contaminated wetland sediment is the principal exposure pathway of migratory waterfowl to lead in the Basin (Beyer et al., 1998; Audet et al., 1999; Beyer et al., 2000). Lead residues in blood and liver tissues of waterfowl using the Basin exceed both clinical and severe poisoning thresholds (Stratus, 2000; Spears et al., 2007), and lead toxicosis has been shown to be the cause of the majority of waterfowl mortality within the Basin (Stratus, 2000; USEPA, 2002a). Focusing on the goals for the OU-2 remedy identified in the 1992 ROD, the EMP recognizes waterfowl in palustrine environments as key biological indicators of exposure to metals of concern. Because waterfowl habitat in the upper Basin is primarily limited to the Page Ponds and Smelterville Flats wetland complexes, assessment of use and exposure to mining-related metals of concern at these locations is critical in evaluating OU-2 Phase I remedial activities.

We conducted waterfowl surveys at the Page Ponds and Smelterville flats sites within OU-2 to quantify continued waterfowl use and types of use (i.e., feeding, loafing, and resting), and provide a measure of relative waterfowl abundance within OU-2 during the spring migration. Information will be used in conjunction with other exposure monitoring activities (i.e., sediment sampling, waterfowl blood lead concentrations) to help evaluate Phase I remedial actions as they pertain to protection of biological resources at Smelterville Flats and help evaluate biological resource toxicological issues and support future actions at the Page Pond wetland complex.

3.1 Methods

We conducted 12 waterfowl surveys, one/week for 12 weeks, at the Page Ponds Wastewater Treatment Plant (WTP) and associated wetlands (wetland complex) as well as at the Smelterville Flats area from February to May, 2006.

The Page Ponds wetland complex is comprised of two wetlands (East and West Swamp) occurring on the east and west sides of the Page tailings impoundment. The tailings impoundment consists of an inactive flotation tailings pond produced by the Page Mill (USEPA, 1992). Located on top of the tailings impoundment is the Page Ponds Waste Water Treatment Plant (WTP), consisting of four aeration lagoons and a stabilization pond. As of 2006, the East and West swamps and the four aeration lagoons contained open water. The stabilization pond was dewatered in 2003 (USFWS, 2005). Surveys at the Page Ponds wetland complex included observations at the 4 active WTP aeration lagoons, the lower sewage ponds north of the Trail of the Coeur d'Alene's (part of the Smelterville Treatment Plant), and the 2 wetlands occurring on the east and west side of the WTP (i.e., East and West Swamps).

The Smelterville Flats area is located at the west end of OU-2 within the floodplain of the South Fork Coeur d'Alene River. Uncontrolled discharges of jig and flotation tailings into the river, as well as the construction of a plank and pile dam to retain tailings within the floodplain, contributed to heavy metal contamination of soil, sediments and surface waters (USEPA, 2005). Water inputs to the floodplain include the river, the Page Ponds, Smelterville wastewater treatment plants, and groundwater. These water inputs, combined with tailings removal activities, lead to the development of several ponds and wetlands in the Smelterville Flats area. Survey locations at Smelterville Flats included Emerald Pond at the east end of Smelterville Flats, and 4 observation points adjacent to ponds and wetlands located north and west of the Shoshone County Airport.

Survey points were recorded with a hand-held GPS unit (NAD-83, zone 11) and are shown in Figure 3-1. All surveys were conducted following UCFWO SOP #1019.3740. Data collected included species identification, numbers of individual species and waterfowl behavior (i.e., feeding, loafing, and resting).

3.2 Results

We observed 1,944 individual waterfowl and 18 species using the Page Ponds wetland complex. Individual waterfowl averaged 162 per survey (Fig. 3-2). The most common species included common goldeneye (*Bucephala clangula*), mallard (*Anas platyrynchos*) and Barrow's goldeneye (*Bucephala islandica*) (Table 3-1; data from 2005 are included for comparison).

We observed 133 individual waterfowl and 13 species at Smelterville Flats. Individual waterfowl averaged of 11.1 per survey (Fig. 3-3). The most common species included mallard, green-winged teal (*Anas crecca*) and Canada goose (*Branta canadensis*) (Table 3-2).

Waterfowl densities were highest in mid-March and early April at the Page Ponds wetland complex (Fig 3-2) and highest at Smelterville Flats in mid-March.

3.3 Discussion

Lead poisoning has been identified as the cause of death in waterfowl ingesting lead-contaminated sediment during normal feeding behavior in lower Coeur d'Alene Basin habitats (Beyer et al., 2000; USEPA, 2002a). Exposure pathways of waterfowl to contaminants of concern within OU-2 include ingestion of soil-sediment, surface water, and food resources (USEPA, 2005). Both the Page Ponds wetland complex and Smelterville Flats area contain sediment lead concentrations above 530 mg/kg, the level determined to be protective of waterfowl (USEPA, 2002a). Our data demonstrate that waterfowl continue to use the Page Ponds site, as well as newly developed Smelterville Flats wetlands. Exposure to residual soil and sediment metal concentrations at these sites may constitute risks to health of waterfowl.

Actual waterfowl source areas of exposure to metals of concern continues to be a data gap at the Page complex. On the whole, waterfowl appear to primarily use the wastewater treatment ponds for feeding, resting, displaying and other activities during spring migration, with relatively few individuals actually being observed in the East and West Swamp (Audet et al., 1999; this study). Burch et al. (1996) also observed that most of the feeding activity taking place was within treatment lagoons. However, it is probable that waterfowl are feeding and thus being exposed to metals of concern in both the treatment lagoons and swamp areas throughout the year (Mullins and Burch, 1993; Burch et al., 1996). Sediment within the treatment ponds may constitute an exposure source to metals of concern for these waterfowl. Due to issues with the collection system (e.g., inflow/infiltration), contaminated groundwater is entrained in the water entering the treatment plant. While within the Superfund Site, the Page Ponds Waste Water Treatment Plant and ponds are not part of EPA's Superfund cleanup actions.

High numbers of waterfowl continue to use the Page Ponds complex. Average number of waterfowl observed using the Page Ponds wetland complex per survey in 1995, 1997, 2001, and 2003 was 276.5, 57.5, 488.3 and 147.7, respectively (Burch et al., 1996; Audet et al., 1999; USFWS, 2005). We recorded a total of 1,548 individuals in 2005, with an average number per survey of 129.

Previous authors examined ecological exposure and waterfowl injury in the wetland complex. Ingestion of metals-contaminated sediment and food sources within the Page complex likely constitutes a source of exposure to waterfowl. McCulley et al. (1994) reported that sediment in the West and East Swamps contained lead concentrations up to 26,800 mg/kg and 5,990 mg/kg, respectively. A paucity of data exists on sediment concentrations within the treatment ponds. However, these ponds are unlined and occur directly on top of mine tailings. Burch et al. (1996) reported that the estimated sediment ingestion rate for waterfowl captured within the complex was 18%, similar to that reported by Beyer et al. (1998) for waterfowl using lower Coeur d'Alene Basin wetlands. While this sediment ingestion likely constitutes the major waterfowl exposure to metals (Audet et al., 1999), waterfowl food items (i.e., plants and aquatic insects) from this complex have also been reported to contain elevated lead levels. Mullins and Burch (1993) identified elevated levels of lead in all waterfowl food items sampled from the East and West swamps. Burch et al. (1996) reported elevated metals in aquatic invertebrates and plants collected from the East and West swamps and elevated metals in plants collected from the Page sewage ponds. Correspondingly, mean blood lead concentrations in mallards collected from the East swamp in 1993, 1995, and 1997 were 2.0, 0.86, and 2.68 mg/kg, respectively (Mullins and Burch, 1993; Burch et al., 1996; Audet et al., 1999). Mean blood lead concentrations in adult and juvenile males and adult female mallards collected in 2003 were 0.75-1.54 mg/kg (USFWS, 2005). All of these concentrations were within those suggesting clinical and severe clinical poisoning in waterfowl (>0.2 mg/kg) (Pain, 1996). No downward trends have been apparent in overall lead concentrations in mallards using Page Ponds wetlands. The Page complex appears to be a significant and continuing source of waterfowl exposure to metals of concern.

Because the establishment of ponds and wetlands in the Smelterville Flats area has been fairly recent (i.e., Phase I remedial actions were completed in 2001; USEPA, 2005), data on waterfowl use of that area were limited. However, our data show that even these new wetland areas are being used by migratory waterfowl. In addition, while the total number of waterfowl using the Smelterville Flats area appears to be relatively low, we observed a female brooding green-winged teal during another on-site assessment in 2006, suggesting increased use (i.e., waterfowl nesting and brooding) and potential exposure to mining-related metals. Data on exposure and potential effects at the Smelterville Flats site are lacking. Remedial goals for the Smelterville Flats area included 1,000 mg/kg lead south of I-90 and 3,000 mg/kg lead north of I-90 (USEPA, 2005). The top 8 feet of material in Smelterville Flats north of I-90 is estimated to currently contain approximately 400,000 cubic yards of contaminated material >1,000 mg/kg lead (TerraGraphics and Ralston, 2006). Current soil and sediment lead concentrations in the Smelterville Flats area have the potential to adversely impact waterfowl and since this area is in the floodplain of the South Fork it is subject to periodic recontamination from upstream sources. This area is included in the OU2 EMP sediment monitoring program and this data should provide useful on contaminant exposure pathways.

Waterfowl continue to use wetlands within OU-2, including those newly developed at Smelterville Flats. Given the trend in waterfowl blood lead at the Page wastewater treatment plant/wetland complex, we would not anticipate current conditions to improve unless further remedial or management actions are undertaken. This should be considered in evaluating OU-2 Phase II remedial activities. Continued monitoring will provide valuable information regarding the continued use of the Page Pond and Smelterville wetland complexes and trends in ecological receptor exposure to mining-related metals within OU-2. Waterfowl blood lead monitoring at Smelterville Flat wetlands would aid in assessing the exposure status of ecological receptors within OU-2 as it pertains to Phase I remedial actions.

Figure 3-1. Waterfowl survey points and adjacent wetland habitats, Coeur d'Alene Basin Operable Unit 2, 2006.

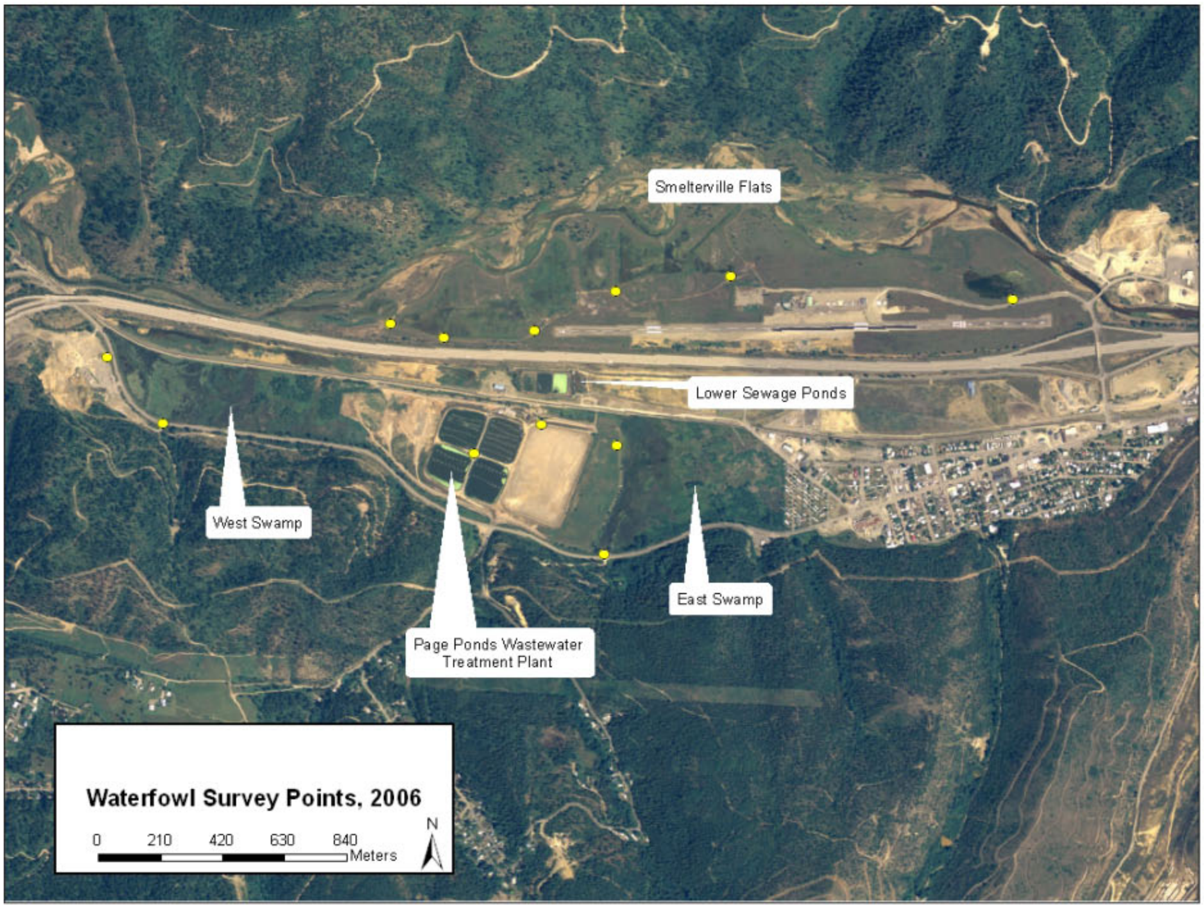


Figure 3-2. Number of waterfowl observed per survey at Page Ponds wetland complex, Coeur d'Alene Basin, Idaho, 2005 (USFWS, 2006; unpublished data) and 2006.

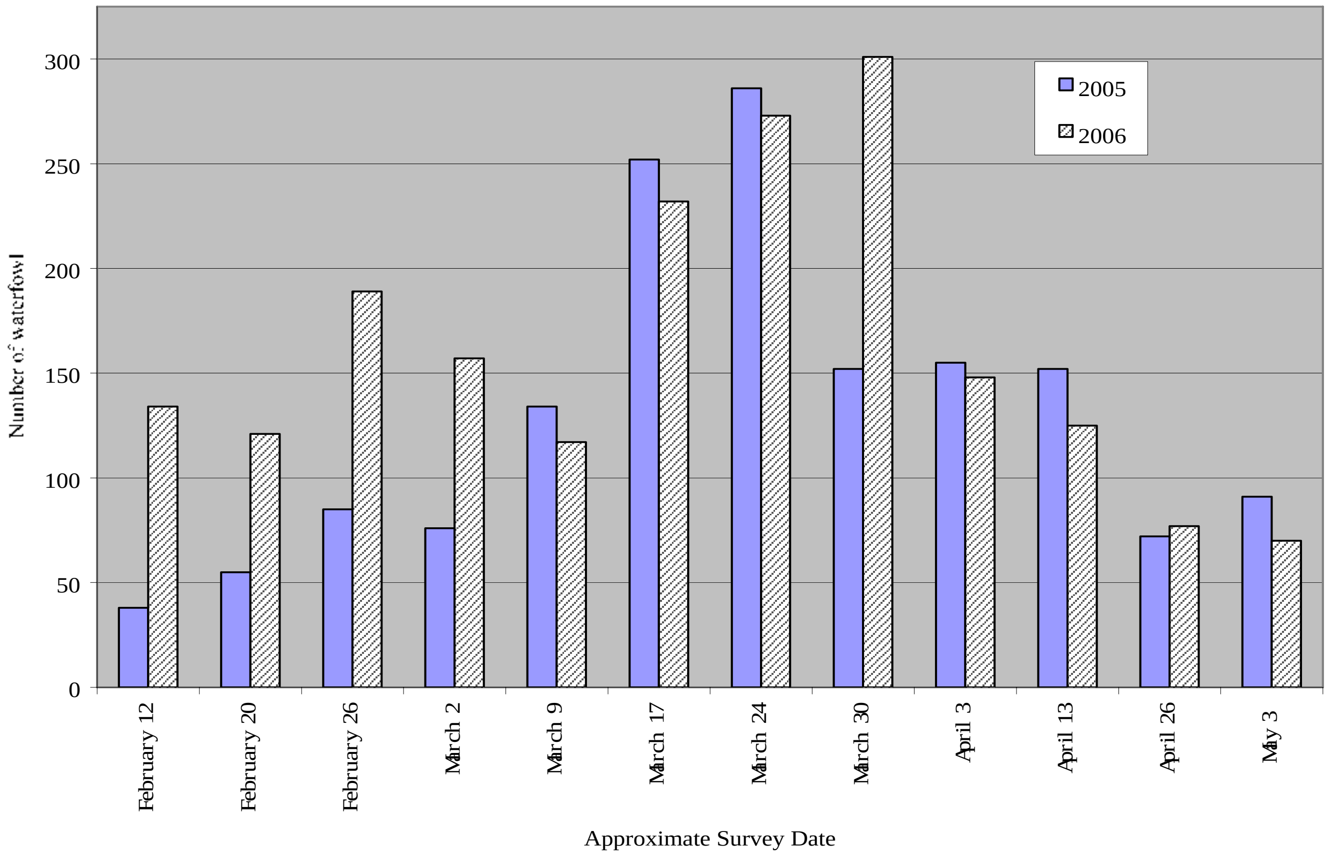


Figure 3-3. Number of waterfowl observed per survey at Page Ponds and Smelterville Flats wetland complexes, Coeur d'Alene Basin, Idaho, 2006.

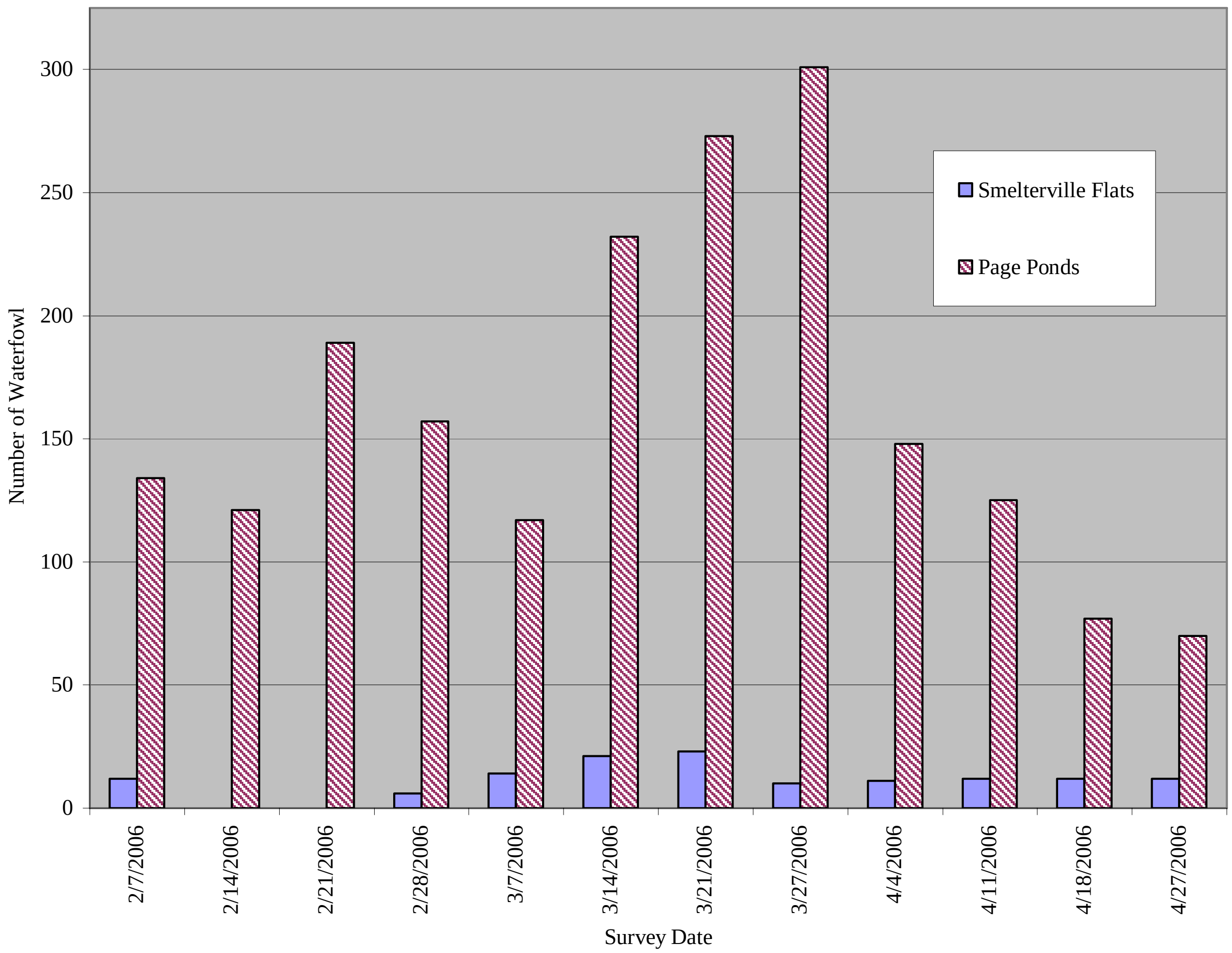


Table 3-1. Number and species of waterfowl observed utilizing Page Ponds wetland complex, Coeur d'Alene Basin, Idaho, 2005 (USFWS, 2006; unpublished data) and 2006.

2005		2006	
Species	**Number**	**Species**	**Number**
American coot	43	American coot	30
		American crow	11
American wigeon	50	American wigeon	39
Barrow's goldeneye	107	Barrow's goldeneye	192
Blue-winged teal	3		
Bufflehead	6	Bufflehead	32
Canada goose	51	Canada goose	44
Canvasback	2		
Cinnamon teal	2		
Common goldeneye	708	Common goldeneye	1087
Common merganser	52	Common merganser	6
		Eurasian wigeon	1
Gadwall	15	Gadwall	6
Great blue heron	3		
Green-winged teal	48	Green-winged teal	64
Hooded merganser	1		
Lesser scaup	45	Lesser scaup	34
Mallard	182	Mallard	247
Northern shoveler	60	Northern shoveler	34
Pied-billed grebe	1		
Redhead	112	Redhead	52
Ring-necked duck	35	Ring-necked duck	41
Ruddy duck	1	Ruddy duck	1
Tundra swan	1		
Wood duck	20	Wood duck	23
Total	**1,548**	**Total**	**1,944**
Average/survey	**129**	**Average/survey**	**162**

Table 3-2. Number and species of waterfowl observed using Smelterville Flats ponds and wetlands, Coeur d'Alene Basin, Idaho, 2006.

Species	**Number**
American coot	2
American wigeon	1
Barrow's goldeneye	5
Bufflehead	4
Canada goose	21
Common goldeneye	2
Common merganser	7
Great blue heron	3
Green-winged teal	24
Hooded merganser	2
Mallard	52
Northern pintail	6
Redhead	4
Total	**133**
Average/survey	**11.1**

4.0 Smelterville Flats Wetlands Amphibian Use

Amphibians are important ecological components of terrestrial and aquatic systems, and are important in biological assessments because of their link between these systems. Amphibians have been described as potential key biological indicators of a wetland's status and a potentially critical component in evaluating wetland communities presumably affected by chemical stressors (Linder and Grillitsch, 2000). USEPA encourages investigators to examine amphibian communities as a possible source of metrics in the development of indices of biological integrity (USEPA, 2002b).

Smelterville Flats is located adjacent to the South Fork Coeur d'Alene River within the floodplain at the west end of OU-2. Soil and sediments at the site have been impacted by a century of uncontrolled discharges of jig and flotation tailings related to Coeur d'Alene Basin mining (USEPA, 2005; TerraGraphics and Ralston, 2006). TerraGraphics and Ralston (2006) estimated that this area included more than 1,488,000 cubic yards of tailings. As of the date of this study, this floodplain area received water from the Coeur d'Alene River, the Page Ponds and Smelterville wastewater treatment plants and groundwater. Elevated metals loadings had been identified for each of these sources at the site (USEPA, 2006b).

Target remedial goals for soil and sediment at the site were 1,000 mg/kg lead south of I-90 and 3,000 mg/kg lead and 3,000 mg/kg zinc north of I-90 (USEPA, 2005). Several phases of remedial activities occurred at Smelterville Flats beginning in 1997 (TerraGraphics and Ralston, 2006). Excavation of contaminated material typically reached depths 4-6 feet, with up to 16 feet of vertical material removed. The final quantity of excavated material transported to the Central Impoundment Area repository was 1,208,448 cubic yards. Backfill and cap consisted of 526,870 cubic yards of borrow pit and topsoil material (Morrison Knudsen Corporation 1999, as cited by TerraGraphics and Ralston, 2006). The top 8 feet of material in Smelterville Flats north of I-90 is estimated to contain approximately 400,000 cubic yards of contaminated material >1,000 mg/kg lead following these remedial activities. The volume of this type of material below 8 feet in depth is unknown (TerraGraphics and Ralston, 2006).

Because of continued water inputs and topography resulting from historic activities, several ponds and wetlands have developed in the Smelterville Flats area. We examined amphibian abundance and species diversity at these wetlands relative to pre-remediation, post remediation and reference locations as an index in evaluating the ecological health of wetlands at the site. This was the first amphibian survey conducted under the OU-2 EMP (USEPA, 2006a). However, survey methods were similar to those used by USFWS (2005) for reptile and amphibian surveys conducted at the site in 2001. Our results can thus be related to previous results at the site. Subsequent surveys are scheduled to take place every 5 years beginning 2012. Results of these surveys will provide a valuable index trend of wetland health as it pertains to the success of remedial activities in protecting ecological receptors from exposure to metals of concern.

4.1 Methods

We conducted amphibian surveys at several Smelterville Flats wetlands April 24-25 and July 9-10, 2006. We conducted surveys within designated periods designed to target both breeding, larval development, and dispersal periods. Surveys followed standardized methods developed by the UCFWO to be used in conducting surveys of amphibian and reptile populations within OU-2 (UCFWO SOP #1019.3762). These methods follow guidance USEPA (2002b) and the USGS North American Amphibian Monitoring Program (USGS 2006b) and are consistent with previous amphibian surveys in the Coeur d'Alene Basin.

We used a variety of amphibian sampling methods designed to maximize collections while minimizing biases caused by observer experience and skill. We used a combination of visual surveys for adults, egg masses and larvae; adult calling censuses; terrestrial cover boards; dipnets; aquatic funnel traps; and terrestrial pitfall traps to survey five Smelterville Flats wetlands (Fig. 4-1). We conducted calling surveys, visual encounters, egg surveys and dipnet surveys once per wetland sampled. We set and opened funnel traps, artificial cover and pitfall traps for 24-hour periods; we observed and captured individuals after approximately 24 hours of trapping effort. We then removed traps and cover boards after each sampling period. Brief descriptions of each method are given below.

Calling surveys
Calling surveys are typically used to determine the presence of calling frogs during the breeding season. We conducted calling surveys at dusk, beginning at least one-half hour after sunset. We conducted calling surveys along a transect on the north side of wetlands encompassing the entirety of wetlands at the western half of the site and the pond at the eastern end. We conducted surveys at listening stations at the start, end, and every 100 m of the transect. Surveyors walked between listening stations and listened for 5 minutes at each station, recording any species heard within approximately 50 meters of the station. The calling survey transect included a total of 12 listening stations. Amphibians observed between listening stations during the route were recorded opportunistically. Ambient temperature may affect calling frequencies, so we recorded ambient temperature during calls.

Visual encounters
Visual encounters were designed to complement other survey methods. We recorded any amphibians observed visually during other surveys.

Egg surveys
The presence of eggs or egg masses confirm amphibian breeding, can provide a repeatable index of relative breeding effort (Richter and Ostergaard, 2001), and can serve as an index of wetland and amphibian population health. We conducted comprehensive egg surveys to the extent possible between the waterline and within approximately 10m of water lines and recorded all egg masses observed.

Dip nets

Dip netting is a common technique used to observe and document frog species in particular. This method followed USFWS survey methods for frog abnormalities on National Wildlife Refuges. Briefly, two surveyors walked along the wetland shoreline perimeter with dip nets. We captured and recorded by species any adult individuals observed, as well as a sample of observed larva/metamorphs (frogs in a state of tadpole-frog transition). We also briefly examined a subset of metamorphs for obvious malformations (i.e., extra legs). We released individuals on site.

Aquatic funnel traps

We chose several wetlands on site for which to sample with submerged funnel traps. We used a pair of standard two-piece minnow traps for each wetland sampled. Traps were held in place with rebar pounded into the wetland bed. We randomly selected funnel trap locations within each wetland. We checked and removed traps after approximately 24 hours of being set. We removed, recorded and released captured individuals on site.

Artificial cover

Artificial cover placed into areas used by amphibians often attracts individuals due to their tendency to seek shelter during the day. Cover boards are especially useful in determining the presence and abundance of salamanders in habitats adjacent to wetlands; vertical piping provides safe and attractive shelter for tree and chorus frogs. Artificial cover used for surveys consisted of flat sheets of plywood laid on the ground surface and/or 1-1.5m sections of 5 cm diameter polyvinyl chloride (PVC) piping pounded into the ground. We placed cover at random locations adjacent to surveyed wetlands and checked it after approximately 24 hours. We recorded species of individuals observed and then released them on site.

Terrestrial pitfall traps

Terrestrial pitfall traps are generally appropriate for surveying for juvenile and adult amphibians which may be migrating or dispersing from a wetland. We used single or double stacked 44 oz coffee cans (with the floor of the upper can cut out) or 5-gallon buckets as pit falls, buried with their upper edge at ground surface level as pitfalls. Pitfall complexes consisted of four pitfalls connected by silt fencing, designed to funnel amphibians into traps. We constructed drift fencing in v-shaped patterns with a pitfall at the center of the “v” on either side and a pitfall at both ends. We checked pitfalls after approximately 24 hours and recorded individuals captured to species and released them on site.

4.2 Results

We conducted call surveys on April 25 between 7:02 and 9:12 pm. Temperatures dropped from 60 to 47º F during the survey. We conducted call surveys on July 10 between 9:44 and 11:57 pm. Temperatures dropped from 64 to 56º F during the survey. No calling frogs were heard during either survey. Vehicles traveling along I-90 were noted as creating an audible distraction.

We observed 1 egg mass in wetland 2 and 1 egg mass in wetland 5 on April 24. We could not identify species based on egg masses. However, they appeared to be different species given differences in size and shape of egg mass and size of eggs. Approximately ½ of the eggs in the wetland 2 mass had hatched with tadpoles swimming within the egg mass material.

We captured 1 adult western toad (*Bufo boreas*) in wetland 5 during April 24 dip net surveys. During July 10 dip net surveys, we captured 1 adult western toad, observed 2 other adult frogs, and observed thousands of juvenile frogs and metamorphs along the shoreline of wetland 1. We collected a sample of 480 of these juvenile frogs, and observed no obvious malformations. We also observed several hundred tadpoles (stage 30-32; Gosner, 1960) in wetland 2 and thousands of tadpoles (stage 30-32) swimming in groups in wetland 3.

We did not capture any amphibians in pitfall traps during the April 24-25 period. We captured 1 adult western toad at wetland 1 during the July 9-10 period. Bycatch included arachnids, beetles and shrews.

We did not capture any amphibians in submerged funnel traps during the April 24-25 period. Bycatch included a speckled dace (*Rhinichthys osculus*) in wetland 3. During the July 9-10 period, we captured approximately 200 frog metamorphs (stage 31) in a funnel trap in wetland 1 and approximately 55 frog metamorphs (stages 32-33) in funnel traps in wetland 3. We identified all metamorphs as western toads. We did not observe any amphibians using cover boards or PVC piping.

4.3 Discussion

Using amphibians as a wetland integrity index may provide the best opportunity to develop bioassessments of the Coeur d'Alene Basin wetland landscape of any vertebrates associated with these habitats (USEPA, 2002b). Amphibians can be key biological indicators of a wetland's status, especially communities presumably affected by chemical stressors (Linder and Grillitsch 2000). Data on several factors, such as landscape ecology, metals exposure and waste water treatment plant input are lacking at Smelterville Flats. However, the lack of amphibians and amphibian species diversity we observed at the site may indicate suboptimal wetland health.

Several amphibian species are known or expected to occupy the Coeur d'Alene Basin (IDFG, 1994; Beck et al., 1997; Jankovsky-Jones, 1999). Jankovsky-Jones (1999) identified the northern leopard frog as "one of the most abundant amphibian species in the (Spokane River) basin." Beck et al. (1997) identified the long-toed salamander (*Ambystoma macrodactylum*), spotted frog (*Rana pretiosa*) and pacific tree frog (*Pseudacris regilla*) as the most widely distributed and abundant pond-breeding amphibians on Coeur d'Alene Basin Bureau of Land Management (BLM) lands. USFWS employees have also made additional observations of amphibians at other Coeur d'Alene Basin locations (i.e., bull frog, *Rana catesbeiana,* in the Coeur d'Alene River, Idaho; giant salamander, *Dicamptodon aterrimus,* in Pine Creek) (Brian Spears, Kate Healy and

Roy Brazzle, USFWS, Spokane, personal observations). We did not observe any of these species at Smelterville Flats. In fact, we identified only 1 species of juvenile or adult (western toad) and possibly 2 species of eggs in the area during all surveys we conducted. A number of potential factors may be affecting amphibian use at this location.

Increases in emergent vegetation may be aiding in Smelterville Flats amphibian breeding opportunities and larval habitat. Beck et al. (1997) found that the majority of pond habitat for breeding amphibians included emergent and sub-emergent vegetation along shorelines and adjacent wet marshy areas. The authors described the Airport Pond in 1995-1996 as “lacking emergent vegetation” (Beck et al. 1997). USFWS (2005) described emergent vegetation in Smelterville Flats ponds and wetlands ponds as “reestablishing”, but “inadequate for amphibian breeding success.” We observed a relative abundance of submerged and emergent vegetation along pond and wetland shorelines and throughout some of the consistently shallow wetlands.

We did not conduct a water quality assessment of the Smelterville Flats wetlands as part of this study. However, we observed large algal growths and a specific odor related to wetlands at the outfall of the Page and Smelterville wastewater treatment plants north of I-90. These characteristics could have potentially been caused by increased nutrient loading of the system from treatment plant outfall. We did not observe amphibians utilizing these wetlands. Ecological receptors such as amphibians may have been precluded from using these habitats due to reduced dissolved oxygen and other required components caused by the apparent eutrophication we observed at this location.

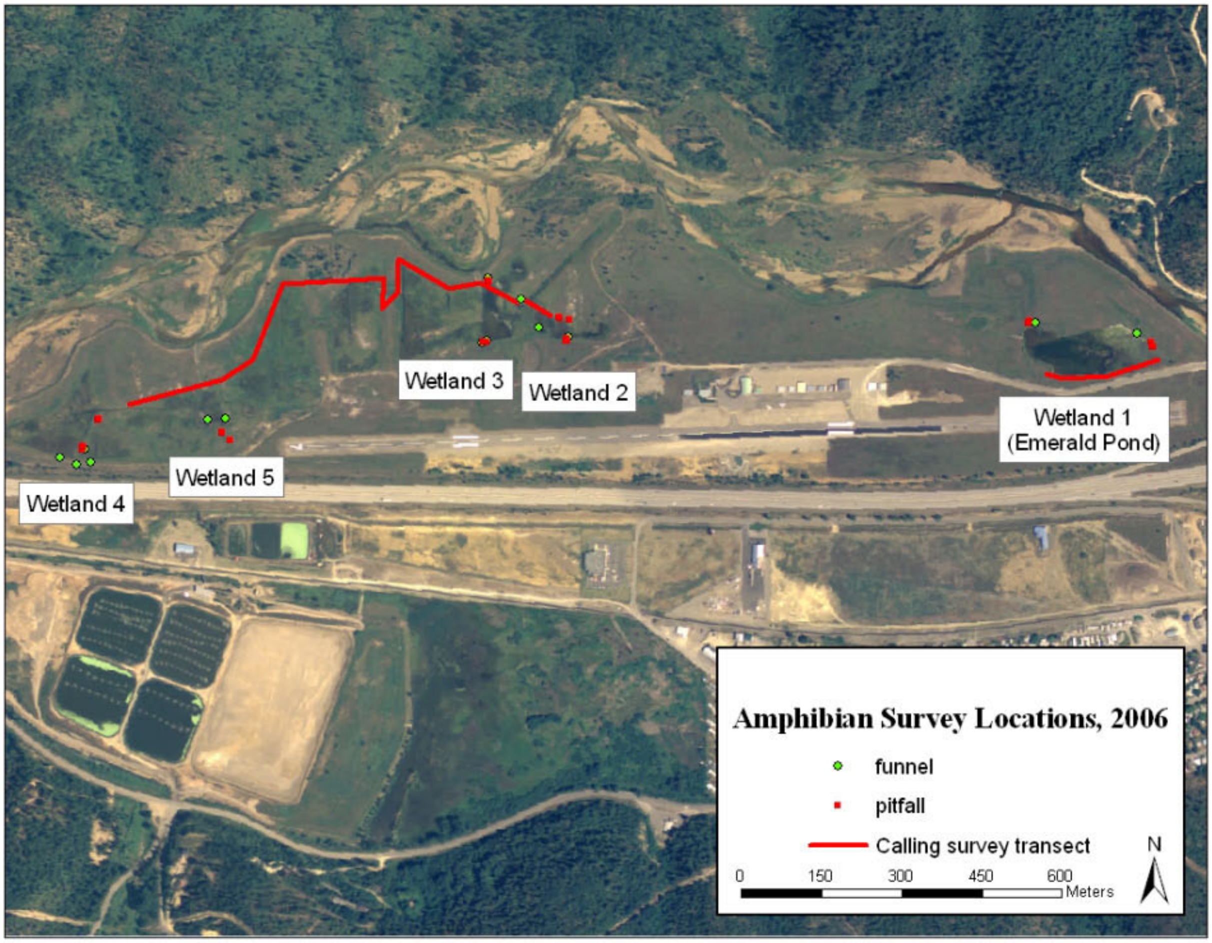
Past remedial activities conducted at Smelterville Flats followed remedial action goals developed for the protection of human health (TerraGraphics and Ralston, 2006). Research suggests that soil and sediment metals concentrations in the Coeur d'Alene Basin below remedial action goals identified for human health (i.e., 1,000 mg/kg lead) can impact the health of ecological receptors (Beyer et al., 2000; USFWS, 2007; Spears et al., 2007). Research suggests that ecological exposure to metals at Smelterville Flats is above toxicity thresholds for wildlife (USFWS, 2007). USFWS (2005) also observed lead concentrations in whole body deer mice collected from Smelterville Flats above those from other OU-2 areas, cadmium and lead in deer mice livers collected from Smelterville Flats above those from a reference area. Cadmium, lead and zinc were higher in Canada goose fecal samples collected at this location than from a reference location. However, it is unknown at this time whether ecological receptors are adversely affected from metal exposures at this location, and limited amphibian use of the Smelterville Flats wetlands due to potential metals exposures have not been explored. Nevertheless, the lack of amphibians, coupled with elevated metals exposure indices, could indicate a potential cause for concern within the Smelterville Flats wetland complex. The sediment monitoring program discussed for this site in the EMP (USEPA, 2006a) should aid in the characterization of potential exposure sources for amphibians to metals of concern.

Despite the apparent lack of amphibian use at Smetlerville Flats, this wetland complex may prove to be a valuable ecological area within OU-2. For example, the western toad was classified in 2003 as an Idaho Department of Fish and Game State Imperiled Species and BLM Sensitive species. However, this species does not appear to be widely distributed throughout the Basin and has declined in portions of its range (Pearl and Bowerman, 2006). Along with long-toed salamander eggs, Beck et al. (1997) documented a western toad tadpole in the pond at the east end of Smelterville Flats (Airport Pond), the only Coeur d'Alene River Valley location they observed this species during 1995-1996 surveys (note: Beck et al. (1997) surveyed “Airport Pond”, which is named “Emerald Pond” in other Superfund documents (i.e., USEPA, 2005)). Subsequent surveys at the site also documented western toads. USFWS (2005) reported 3 western toad adults in Smelterville Flats wetlands during 2001 surveys. In 2006 (this study) we positively identified 2 western toad adults, thousands of metamorphs, and observed thousands of tadpoles we believed to also be western toads. Smelterville Flats wetlands may constitute a source breeding area for this species of concern.

Western toads have been observed to rapidly colonize newly excavated ponds (Pearl and Bowerman, 2006). Western toads will also make relatively large seasonal migrations (>2 km) and travel through both wetland and upland habitats (Bartelt et al., 2004). Without implementing tracking techniques such as mark/recapture or radiotelemetry, it is impossible to ascertain whether adult western toads we captured were repeat breeders at the location or had dispersed from another area. However, wetlands at Smelterville Flats and the Page Pond complex are the last remaining wetlands of significance within OU-2. Given the apparent lack of western toads throughout the rest of the Coeur d'Alene Basin and the isolated nature of remaining OU-2 wetlands from others in the Basin, these individuals could potentially constitute a remnant population historically occurring in the OU-2 area. If so, the recovery of Smelterville Flats wetlands and surrounding habitat would be critical to the local longevity of the species, especially in light of the loss of OU-2 wetland habitat due to development and remedial activities.

In addition to amphibians we observed, we also observed other wildlife using the terrestrial and aquatic portions of Smelterville Flats. While we did not capture or observe amphibians in pitfall traps or artificial cover, pitfall bycatch included arachnids, beetles and shrews, and we observed shrews and a short-tailed weasel (*Mustela erminea*) using cover boards. We also observed 3 small bullheads (*Ameiurus spp*.), a speckled dace and a trout (*Oncorhynchus spp*. or *Salvelinus fontinalis*) in wetland 3 and a female brooding green-winged teal (*Anas crecca*) in wetland 5 during July 10 dip net surveys. We also observed a variety of avian species using the floodplain area. Given the lack of wetland habitat remaining within OU-2, ecological recovery and protection of ecological receptors at Smelterville Flats should continue to be considered in the evaluation of remedial actions on ecological conditions at the site as part of the Phase I Comprehensive Cleanup Plan.

Figure 4-1. Amphibian survey locations, Smelterville Flats, Operable Unit 2, Coeur d'Alene Basin, Idaho, 2006.



5.0 Benthic Macroinvertebrate Metal Residues

Elevated metals have been associated with adverse biological effects on aquatic organisms. Because of their ability to bioaccumulate metals, benthic macroinvertebrates are commonly used as bio-indicators of available heavy metals in the environment (Cain and Luoma, 1998; Goodyear and McNeill, 1999; Cain et al., 2000). Benthic macroinvertebrates also constitute a dietary pathway for exposure to contaminants to some fish species (Woodward et al., 1995; Farag et al., 1999). Metals present in macroinvertebrate tissue are one route through which metals move further up the food chain (Farag et al., 1998).

In 2006, benthic macroinvertebrates were collected from four reaches within Bunker Hill OU-2 for an evaluation of ecological exposure to metals of concern [i.e., arsenic (As), cadmium (Ca), lead (Pb), and zinc (Zn)]. This was the first year benthic macroinvertebrates were sampled as a component of the 2006 OU-2 EMP. As part of the 2000-2004 OU-2 biological monitoring program, benthic macroinvertebrates were also collected in September 2003 and 2004 for metals residue analysis. Results from the 2003 and 2004 sample collections are presented in the 2001-2004 OU-2 Biological Monitoring Final Report (section 4.4 in USFWS, 2005). Together with the 2003 and 2004 benthic macroinvertebrate metals residue data, the 2006 data will provide data for analysis of trends within OU-2 resulting from remedial and management actions. The concentrations of metals in macroinvertebrate tissues will be evaluated to assess mining-related metals exposure over time to aquatic organisms and their prey at specific locations within OU-2. Arsenic, Cd, Pb, and Zn concentrations in benthic macroinvertebrate tissues are presented in this report with comparisons to the 2003 and 2004 macroinvertebrate tissue concentrations.

5.1 Methods

In July 2006, seven macroinvertebrate samples from each of the four river locations in OU-2 were collected (28 samples total) for metal residue analysis. Benthic macroinvertebrates were collected, following methods described in UCFWO SOP # 1020.1006, from the same four OU-2 locations where the 2003 and 2004 macroinvertebrate samples were collected. Benthic macroinvertebrates for diversity and abundance were also collected in 2006; results will be presented in a future report. The sample locations corresponded with sample locations for macroinvertebrate and fish diversity and abundance and fish metals residue assessments in OU-2.

5.1.1 Field Sampling

Macroinvertebrate sampling was conducted downstream (SFR-1) to upstream (SFR-4) using rectangular kick-nets (500 µm mesh) (Figure 5-1). Macroinvertebrates were collected at downstream, midstream, and upstream areas of riffle zones within each sample reach location. The streambed substrate was “kicked” thoroughly and rocks were lifted and any attached particles removed. The entire contents of the kick-net were transferred onto a sorting tray. Macroinvertebrates were collected using stainless steel forceps and were placed in lab-certified chemically clean glass containers. Approximately 5 grams of macroinvertebrates were collected for each sample. The macroinvertebrate samples were not sorted into taxa in the field or laboratory prior to analysis, therefore, the composition of taxa in the sample was not recorded. Samples were stored in a cooler on wet ice and transported to the Upper Columbia Fish and Wildlife Office, Spokane, Washington. Samples were stored in a -20 ºC freezer until being shipped on dry ice to the USEPA Manchester Environmental Laboratory for analysis of As, Cd, Pb, and Zn.

5.1.2 Data Quality Assurance/Quality Control

The macroinvertebrate samples were freeze dried and homogenized at the laboratory prior to digestion. The results were reported on a dry weight basis. All sample preparation was in accordance with laboratory protocols. Samples were analyzed for As, Cd, Pb, and Zn by Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS). Standard calibrations were performed as required and met acceptance criteria. All ICP-MS calibration verification checks met the recovery criteria for As, Cd, Pb, and Zn. Laboratory control samples (spike blanks) and standard reference material samples were digested and analyzed along with the project samples to verify the efficiency of laboratory procedures and accuracy of analysis. All laboratory control sample results met the recovery acceptance criterion (85 - 115% of the standard's true value). The procedural blanks associated with these samples did not contain detectable levels of As, Cd, Pb, and Zn. Matrix spike analysis was performed on samples; however, matrix spike duplicates were not performed due to limited sample volume. Matrix spike recoveries met the specified acceptance limits for As, Cd, and Zn. Matrix spike recoveries for Pb were outside of the acceptance criteria limits (75-125%). Lead was not homogeneous in samples, possibly because of sediment particles containing high lead concentrations that were not distributed evenly throughout the sample.

5.1.3 Data Analysis and Interpretation

Metal residue data were presented in this report as mean and standard deviation, but statistical analysis presented here was based on data from each of seven samples (n=7) collected at each location. Significant differences between locations within year were determined using the Kruskal-Wallis nonparametric analysis with Dunn's multiple comparison test. Significance was based on $\alpha = 0.05$. Data were analyzed using Minitab version 13.32. Multiple comparisons for Kruskal-Wallis nonparametric analysis were by Dunn's multiple comparison test; this procedure used the KrusMC.MAC macro obtained from the Minitab website (www.minitab.com). No statistical analysis was performed between years; future trend analysis will include regression analysis within location between years.

5.2 Results

Arsenic, Cd, Pb, and Zn were detected in all macroinvertebrate samples from all four reaches (Table 5-1). Although not significant, the furthest upstream location (SFR-4) had the lowest mean concentration of As (mean of 6.53 mg/kg dw), and the furthest downstream location had the highest mean concentration of As (mean of 10.0 mg/kg dw). Also not significant, the middle two locations (SFR-2 and SFR-3) had the lowest mean Pb concentrations (230 and 277 mg/kg dw, respectively) compared to the furthest upstream (SFR-4) and furthest downstream (SFR-1) locations (352 and 378 mg/kg dw, respectively; Table 5-1). The middle two locations (SFR-2 and SFR-3) had significantly higher Zn (1403 and 1811 mg/kg dw, respectively) compared to both the furthest upstream (SFR-4, 1077 mg/kg dw) and furthest downstream (SFR-1, 1062 mg/kg dw) locations (Table 5-1). These two middle locations also had significantly higher Cd (24.3 and 20.3 mg/kg dw, respectively) than the furthest upstream location (SFR-4, 15.2 mg/kg dw; Table 5-1). The second location downstream (SFR-2, 24.3 mg/kg dw) had significantly higher Cd compared to the furthest downstream location (SFR-1, 16.9 mg/kg dw; Table 5-1).

5.3 Discussion

Accumulation of metals by aquatic macroinvertebrates can differ by species. For example, the type of functional feeding group and size of macroinvertebrates may influence the concentrations of metals accumulated (Farag et al., 1998; Kiffney and Clements, 1994). The varying species composition in macroinvertebrate samples can also affect the overall concentration of metals in the composite samples. Some macroinvertebrate taxa accumulate metals in proportion to metal concentrations in their environment (Cain et al., 1992). Because the interpretation of metals concentrations in benthic macroinvertebrate samples can be difficult, specific comparisons of metal concentrations between the composite macroinvertebrate samples for this study will be cautiously evaluated.

At all four of the SFCDR sample locations, mean concentrations of As, Pb, and Zn in benthic macroinvertebrate tissues were lower in 2006 than in 2003 and 2004 (Figures 5-2, 5-4, 5-5). Mean concentrations of As and Zn in samples from SFR-2, SFR-3, and SFR-4 have exhibited a noticeable decline in tissue concentrations from 2003 to 2006 (Figures 5-2 and 5-5). Mean concentrations of Cd, Pb, and Zn in the SFR-1 macroinvertebrates were lower in 2006 than the 2004 SFR-1 concentrations. Additionally, the SFR-2 and SFR-3 macroinvertebrate Pb tissue concentrations (Figure 5-4) have decreased over time and the mean Cd concentrations in the SFR-2 and SFR-3 samples have increased over the years (Figure 5-3). Future evaluations of this data from year to year will incorporate formal statistical trend analysis.

The comparison of metals concentrations among locations, and between the years, as part of the OU-2 EMP is most suitably applied as an evaluation of the As, Cd, Pb, and Zn in the dietary exposure pathway to other species such as fish and birds. With the limited number of sampling events and the composition of benthic macroinvertebrates not identified in this study, it is difficult to determine the reasons for declining As, Pb, and Zn concentrations thus far. Macroinvertebrate metal residue samples that are based on representative mixed species serves as an overall integration of metal exposure, metal bioavailability, and community composition. However, as additional data is collected and the benthic macroinvertebrate metals concentrations are paired with the corresponding benthic macroinvertebrate diversity and abundance numbers, a more comprehensive evaluation of the trend in metals concentrations available to aquatic organisms in the OU-2 will be possible.

Figure 5-1. Benthic macroinvertebrate sample locations, South Fork of the Coeur d'Alene River, Operable Unit 2, Coeur d'Alene Basin, Idaho, 2003, 2004 and 2006.

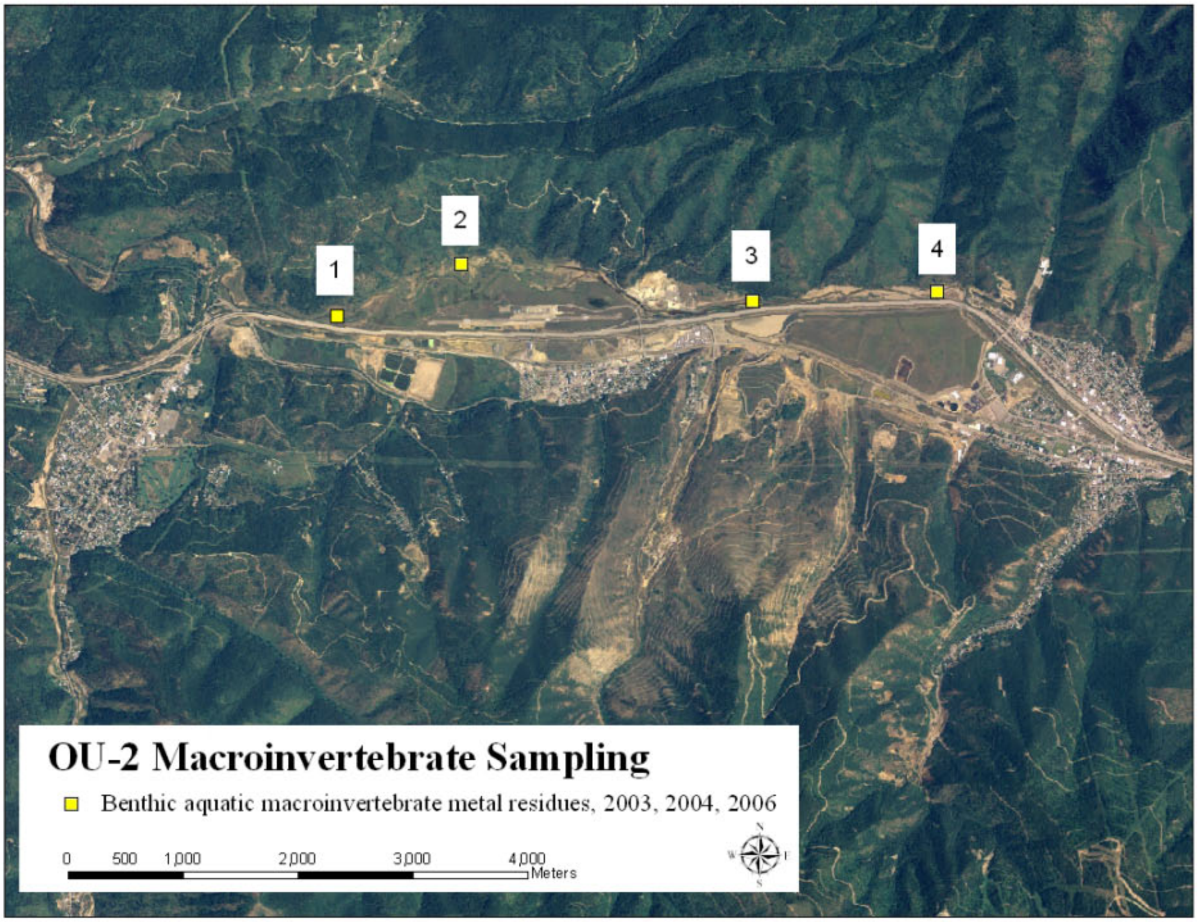


Figure 5-2. Mean concentrations of arsenic (As) in benthic macroinvertebrates by location in the South Fork Coeur d'Alene River, Idaho.

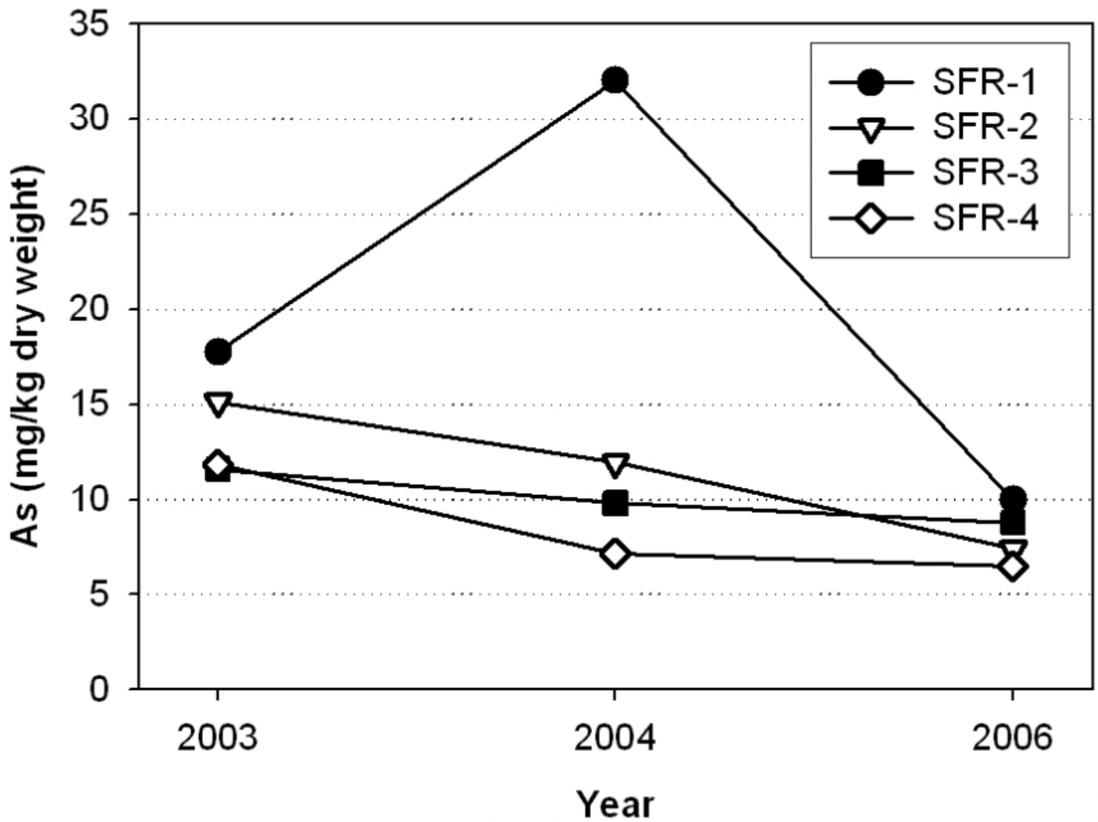


Figure 5-3. Mean concentrations of cadmium (Cd) in benthic macroinvertebrates by location in the South Fork Coeur d'Alene River, Idaho.

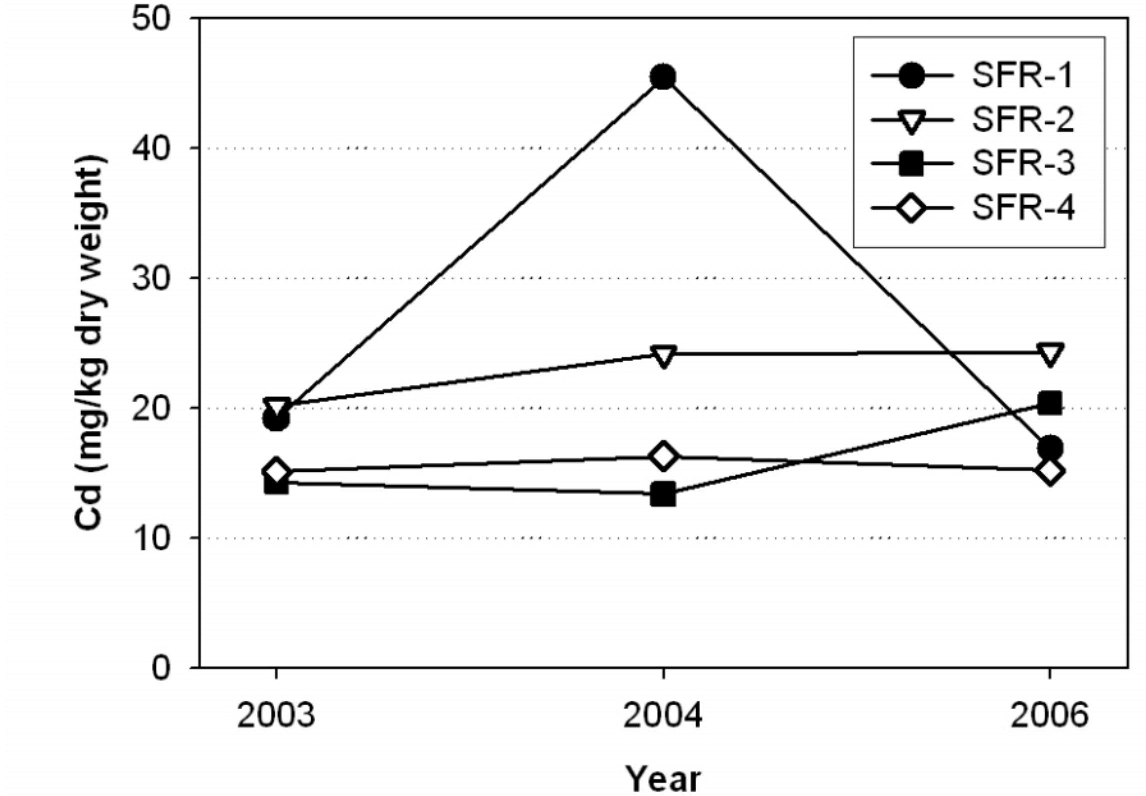


Figure 5-4. Mean concentrations of lead (Pb) in benthic macroinvertebrates by location in the South Fork Coeur d'Alene River, Idaho.

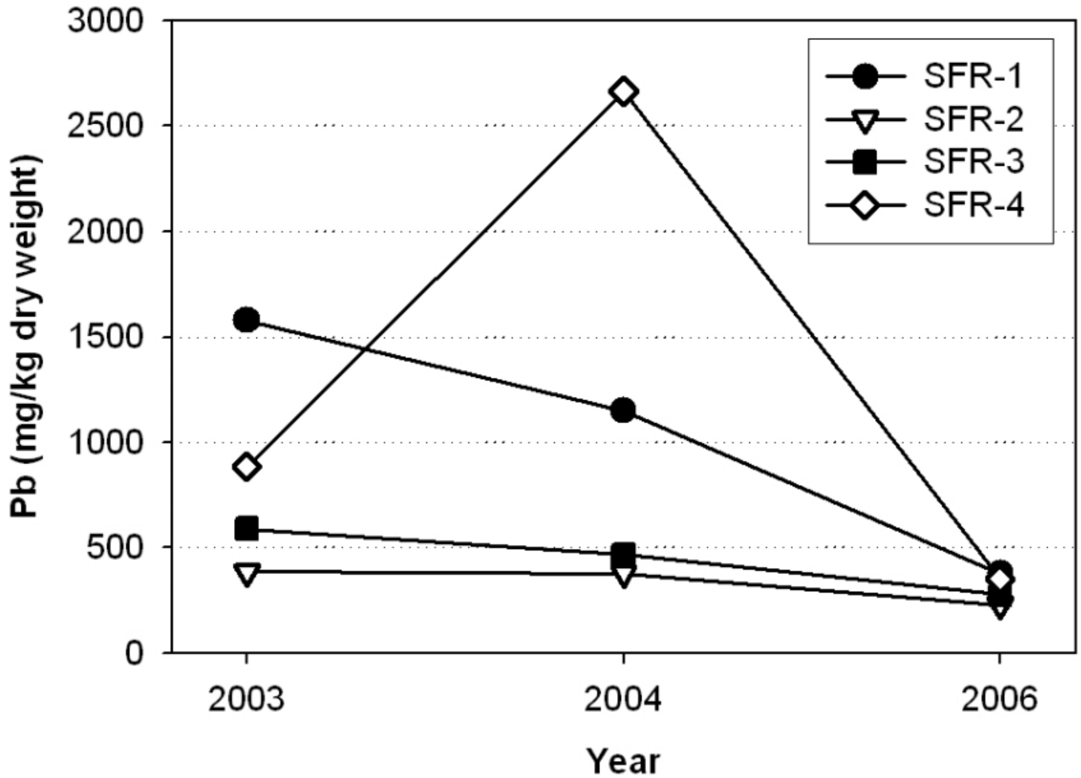


Figure 5-5. Mean concentrations of zinc (Zn) in benthic macroinvertebrates by location in the South Fork Coeur d'Alene River, Idaho.

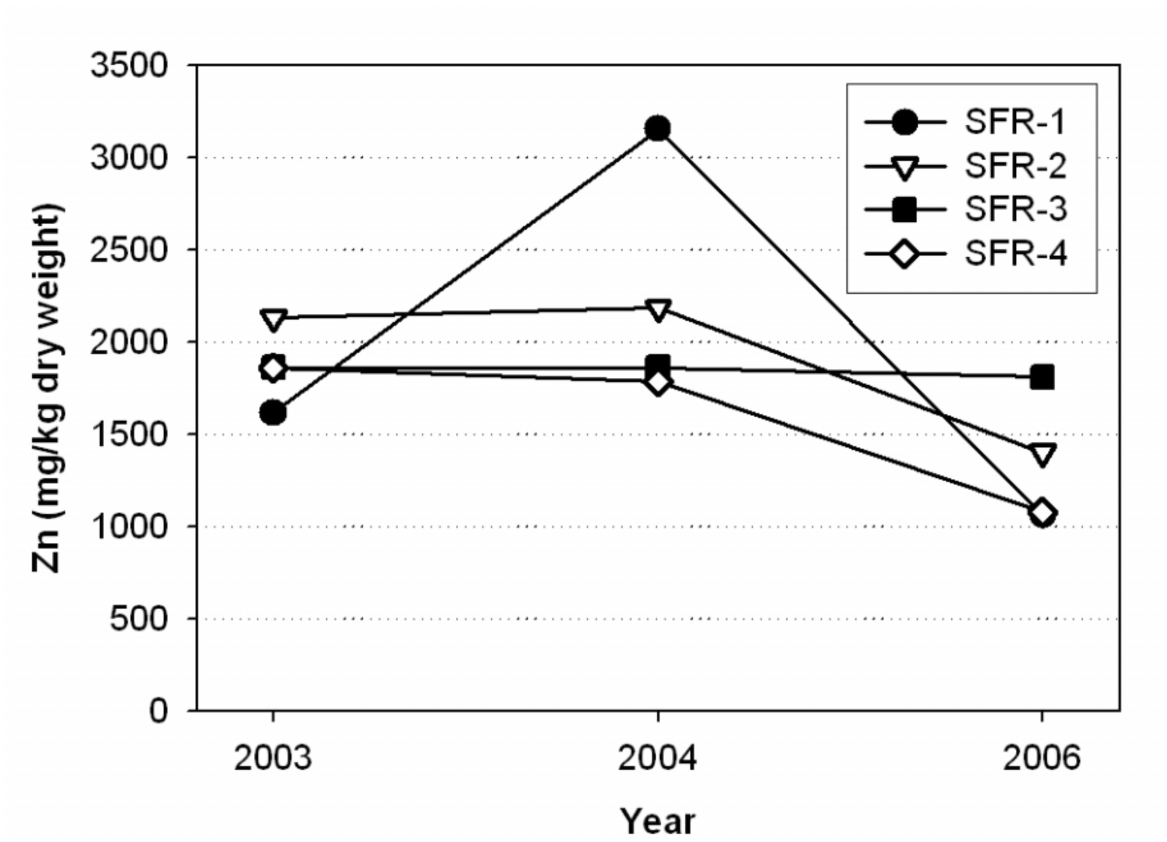


Table 5-1. Mean metals concentrations, standard deviation, and range (mg/kg dry weight) in aquatic macroinvertebrate samples (7 samples / reach) collected in 2006 in the South Fork Coeur d'Alene River. Different letters indicate significant differences at $\alpha = 0.05$.

Location / Year Sampled	**n=7**	**As mg/kg dw**	**Cd mg/kg dw**	**Pb mg/kg dw**	**Zn mg/kg dw**
SFR-1 / 2006	Mean	10.0	16.9 ab	378	1062 a
	SD	4.25	2.56	164	201
	Range	(7.19-17.9)	(11.5-19.2)	(174-624)	(810-1450)
SFR-2 / 2006	Mean	7.41	24.3 c	230	1403 b
	SD	1.35	3.23	48.4	162
	Range	(5.5-9.72)	(20.7-29.5)	(166.5-307)	(1070-1570)
SFR-3 / 2006	Mean	8.79	20.3 bc	277	1811 b
	SD	3.82	4.13	118	389
	Range	(3.5-15.3)	(12.1-24.3)	(128-508)	(1270-2320)
SFR-4 / 2006	Mean	6.53	15.2 a	352	1077 a
	SD	5.10	2.96	79.0	202
	Range	(3.5-18)	(10.2-18.6)	(204-444)	(859-1370)

5.0 References

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