Coeur d'Alene Basin Biological Monitoring
2010-2012 Annual Report

Bunker Hill Mining and Metallurgical Complex Superfund Site
Operable Units 2 and 3

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Table of Contents

1.0 Introduction- Coeur d'Alene Basin Biological Monitoring 1
Operable Unit 2 2
2.0 Waterfowl Surveys 2
2.1 Methods 3
2.2 Results 5
2.3 Discussion 5
3.0 MAPS, Habitat Structure Assessment and Soil Lead Concentrations 6
3.1 Methods 9
3.2 Results 10
3.3 Discussion 11
Operable Unit 3 13
4.0 Waterfowl Surveys 13
4.1 Results 14
4.2 Discussion 20
5.0 Riparian Songbird Exposure 22
5.1 Methods 22
5.2 Results 24
5.3 Discussion 26
6.0 Data Disposition ..... **Error! Bookmark not defined.**
7.0 References 27
Appendix A 30
Appendix B 31

List of Figures

Figure 1. OU2 Waterfowl Survey Locations 4
Figure 2. MAPS Locations 8
Figure 3. OU3 Waterfowl Survey Locations 13
Figure 4. Weekly Total Waterfowl Observations 16
Figure 5. Annual Total Waterfowl Observations at Highest Use Wetlands 17
Figure 6. 2011 Songbird Exposure Monitoring Locations in OU3 23

List of Tables

Table 1. Weekly Waterfowl Survey Dates 3
Table 2. Potential Breeding Bird Capture Summaries 11
Table 3. Number of Waterfowl Observed per Wetland 15
Table 4. Tundra Swan Observations per Wetland in OU3 (2010-2012) 18
Table 5. Tundra Swan Observations and Mortality in Coeur d'Alene Basin, ID (2005-2012) .. 19
Table 6. 2011 Mean (SD, *n*) Songbird Blood Pb and soil Pb Concentrations (mg/kg Dry Weight) 25

Acronyms

BEMP	Basin Environmental Monitoring Plan
BBL	Bird Banding Laboratory
EMP	Environmental Monitoring Plan
HSA	Habitat Structure Assessment
IBP	Institute of Bird Populations
MAPS	Monitoring Avian Productivity and Survivorship
NIFO	Northern Idaho Field Office
NVCS	National Vegetation Classification Standards
OU2	Operable Unit 2
OU3	Operable Unit 3
Pb	Lead
ROD	Record of Decision
SFCDR	South Fork Coeur d' Alene River
SMFT	Smelterville Flats MAPS station
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WTP	Wastewater Treatment Plant
WQX	Water Quality Exchange
XRF	X-ray Florescence Analyzer

1.0 Introduction- Coeur d'Alene Basin Biological Monitoring

The U.S. Fish and Wildlife Service's (Service) Northern Idaho Field Office (NIFO) conducts biological monitoring in the Bunker Hill Mining and Metallurgical Complex Operable Units 2 (OU2) and 3 (OU3) within the Coeur d'Alene River Basin (Basin), Idaho. This report summarizes three years (2010, 2011, and 2012) of waterfowl and songbird surveys and results of metals concentrations in songbird blood collected in 2011. Riverine Habitat data collected in OU3 in 2012 (fish and benthic macroinvertebrate diversity and abundance and metals tissue concentrations and aquatic habitat assessment) will be analyzed and discussed in the OU3 2012/2013 River Habitat Annual Report. As required by the OU2 and OU3 Records of Decision (ROD)(USEPA 1992, 2002), an OU3 Basin Environmental Monitoring Plan (BEMP)(USEPA 2004) and OU2 Environmental Monitoring Plan (EMP)(USEPA 2006)(Monitoring Plans) were developed to monitor progress of the Selected Remedies in terms of improving ecosystem conditions. The Monitoring Plans implement the environmental monitoring program established as part of the ecological components of the OU2 and OU3 Selected Remedies and are currently being consolidated into a comprehensive revised Basin-wide monitoring plan. The revised plan will continue as a key component of the adaptive management approach to clean up the Basin. As established in the Monitoring Plans, the Service is responsible for conducting the biological resource monitoring component assisting the U.S. Environmental Protection Agency (USEPA) in evaluating the success of Selected Remedies for these OUs. The Service's work is supported through an Interagency Agreement with the USEPA (#DW1495-8302-01).

Objectives of the Monitoring Plans include assessing long-term status and trends of biological resource conditions, evaluation of the Selected Remedy effectiveness and improve understanding of Basin processes and variability to in turn improve the effectiveness and efficiency of subsequent remedial action implementation. The Monitoring Plans identify waterfowl in wetland (palustrine) and lake (lacustrine) environments and songbirds in riparian and upland environments as key indicators change. A major focus of the Selected Remedy for protection of the environment in the OU3 ROD includes the Lower Basin Stream Banks and Beds and Floodplains. Remedial actions will include high-priority floodplain areas with high use by waterfowl and high concentrations of lead in sediments, and reduction of soil toxicity for songbirds and mitigation of risks to riparian receptors (USEPA 2002). Increasing waterfowl feeding areas with sediment lead (Pb) concentrations less than the site-specific cleanup level of 530 mg/kg Pb has been identified as a priority action to achieve the established benchmark of reducing sediment toxicity and waterfowl mortality in palustrine and lacustrine habitats. Waterfowl surveys conducted by the Service have been designed to provide relative measures of waterfowl abundance and wetland use patterns during spring migration. Tundra swan mortality observations recorded during waterfowl surveys augment wetland-specific waterfowl use data; and provide a means to anticipate, evaluate, and report on environmental improvements associated with remedial actions in the Basin. The Service is evaluating the risks to riparian species from exposure to metals in soil by the collection of songbird blood and soil Pb concentrations. Analysis of songbird blood and soil measurements collected in the floodplain habitat provides information relative to potential metals exposure in the riparian environment.

Songbird survival, productivity and recruitment are being measured using the Monitoring Avian Productivity and Survivorship (MAPS) protocols (DeSante et al. 2010) by implementing a five year standardized constant-effort mist netting and banding procedure to examine population dynamics. Data collected using the MAPS protocols can assist in identifying proximate (demographic) and ultimate (environmental) causes of population changes (Nott et al. 2002, Saracco et al. 2008). MAPS stations were established at two locations in OU2 to evaluate changes in avian productivity and survivorship over time and examine differences between a remediated site and an uncontaminated site with similar riparian habitat characteristics.

Given the large area of the Basin, and the pace of remedy implementation, ecosystem changes may occur relatively slowly and not be noticeable for many years. Monitoring and evaluation of the ecological improvements resulting from remedial actions will be used to help guide the continuing and future implementation of cost-effective remedies for the Basin. Waterfowl use and tundra swan mortality survey results, as well as songbird data, will be integrated with water and sediment data to enhance the understanding of Lower Basin environmental processes and variability, and thereby improve the effectiveness and efficiency of cleanup actions. Waterfowl, MAPS, and songbird exposure data will be evaluated and discussed relative to long-term status and trends and how the data are being used to guide remedy protection and restoration in the Lower Basin.

Operable Unit 2

2.0 Waterfowl Surveys

Waterfowl use within the Basin can vary depending on many factors including Pacific Flyway population trends, environmental variables, and episodic events such as flooding. Long-term monitoring of waterfowl use within the Basin is used to understand patterns of relative use and abundance in relation to these variables, as well as, potential exposure to Pb contaminated sediment. Ingestion of contaminated sediment is the principal exposure pathway of migratory waterfowl to Pb in the Basin (Beyer et al. 1998, Audet et al. 1999, Beyer et al. 2000). Approximately 95% of the available waterfowl habitat in the Basin contains Pb concentrations above the remedial action goal of 530 mg/kg Pb (USEPA 2002). Lead residues in blood and liver tissues of waterfowl using the Basin exceed both clinical and severe poisoning thresholds, and lead toxicosis has been shown to be the leading cause of waterfowl mortality within the Basin (Stratus 2000, USEPA 2001). Increasing waterfowl feeding areas with sediment Pb concentrations less than the site-specific cleanup level of 530 mg/kg Pb has been identified as a priority action to achieve the established benchmark of reducing sediment toxicity and waterfowl mortality in palustrine and lacustrine habitats. Understanding Basin processes and variability in terms of waterfowl use, abundance, and mortality within the Basin is crucial to identifying and prioritizing areas for future remedial, restorative, and/or management actions as well as gauging the success of ongoing actions.

Waterfowl survey data were collected during 2010-2012 in OU2 recording relative waterfowl use, abundance, and tundra swan mortality. This three year data set is part of a six year dataset (2006-2012). Waterfowl surveys were not conducted in 2008. Waterfowl Survey data is used in conjunction with ongoing additional (sediment, waterfowl blood) monitoring information within

OU2 to help guide future and ongoing remedial/restorative actions as they pertain to meeting established ecological benchmarks.

2.1 Methods

Twelve weekly waterfowl surveys were conducted between February 7 and May 1, annually, in accordance with NIFO SOP #2010.1013 (Table 1). Survey dates varied each year within the date range of each week. Vehicle-based surveys were conducted along a pre-designated route with observation points situated along the route to maximize wetland visibility. Surveys were conducted with binoculars and/or spotting-scopes and estimates of waterfowl abundance and behavior (i.e., feeding, loafing, resting, and nesting) were recorded for all waterfowl species observed at each survey location. Weather conditions and visibility were also recorded. Waterfowl likely remain within the Basin for more than one week during spring migration and may be counted as individuals during more than one survey, thereby overestimating actual waterfowl abundance.

In addition, unusual dispositions of tundra swans (e.g., isolated, ill and dead individuals) were recorded. Detailed field notes regarding their location (i.e., azimuth/bearing/trip odometer) to avoid double counting carcasses on subsequent survey dates were also recorded.

Table 1. Weekly Waterfowl Survey Dates

Week	Dates
Week 1	February 7-13
Week 2	February 14-20
Week 3	February 21-27
Week 4	February 28-March 6
Week 5	March 7-13
Week 6	March 14-20
Week 7	March 21-27
Week 8	March 28-April 3
Week 9	April 4-10
Week 10	April 11-17
Week 11	April 18-24
Week 12	April 25-May 1

Survey Locations

Although thousands of waterfowl utilize numerous lower Basin wetland habitats during spring migration, waterfowl habitat in the upper Basin is primarily limited to the Smelterville Flats and

Page Ponds wetland complex in OU2. Smelterville Flats is located at the west end of OU2 within the floodplain of the South Fork Coeur d'Alene River (SFCDR). Across I-90 from Smelterville Flats is the Page Ponds wetland complex comprised of two wetlands on the east and west sides (East Swamp and West Swamp). Located just south of the Trail of the Coeur d'Alene's is the Page Ponds Wastewater Treatment Plant (WTP) consisting of four active aeration lagoons and a stabilization pond. In 2010-2012, waterfowl surveys were conducted at Smelterville Flats and the Page Ponds wetland complex. Survey locations at Smelterville Flats included Emerald Pond (Wetland 1) at the east end of Smelterville Flats, and five observation points adjacent to ponds and wetlands (Wetland 2-5) located north and west of the Shoshone County Airport. Surveys at the Page Ponds wetland complex were conducted at the four aeration lagoons, as well as the East and West Swamps (Figure 1).

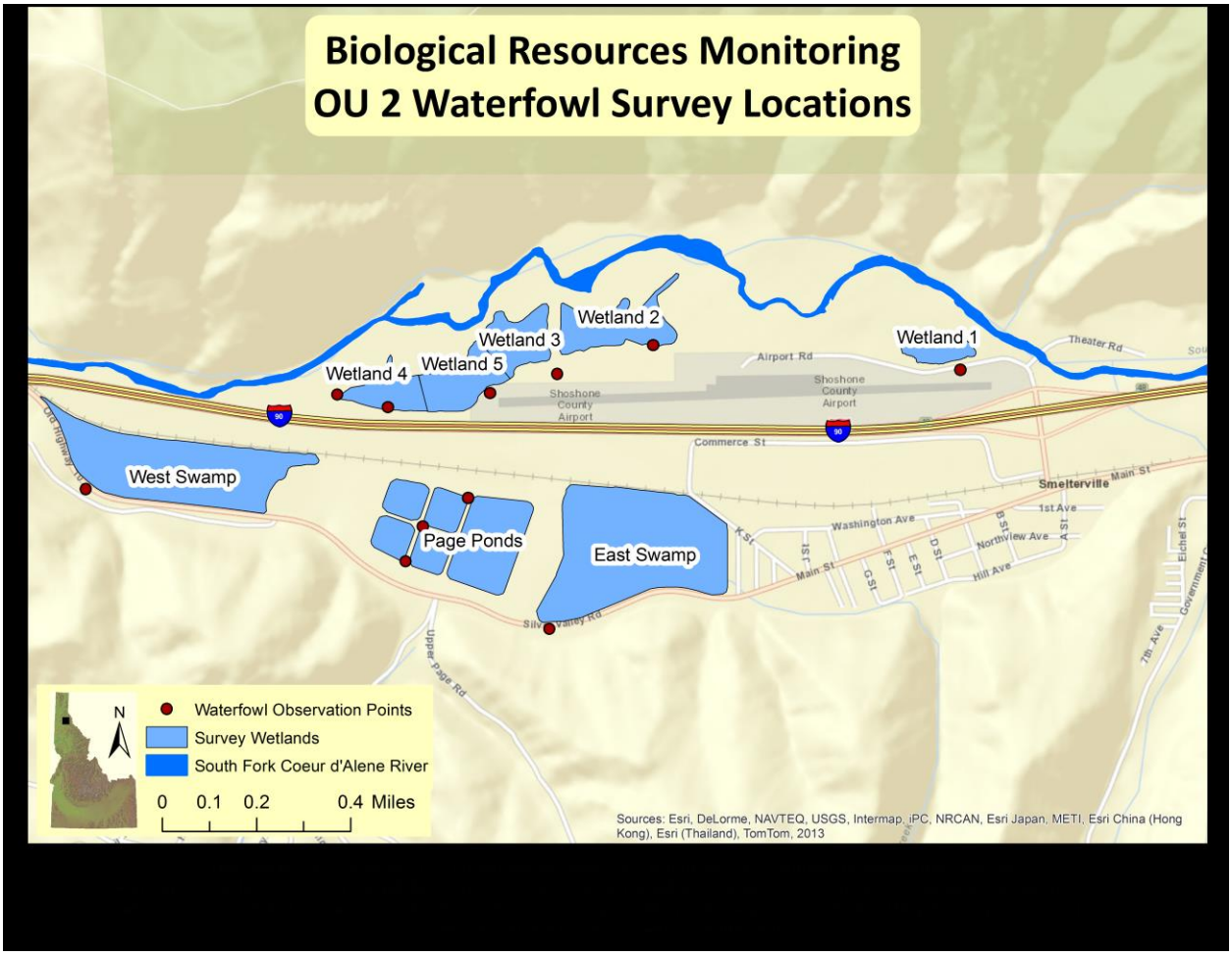

Figure 1. OU2 Waterfowl Survey Locations

2.2 Results

Species lists including both common and scientific names of all waterfowl observed during 2010-2012 can be found in Appendix A.

Weather Conditions

In general, ice cover was typical during February surveys for all three years. In 2010, substantial ice cover occurred during the first two survey dates, the first five survey dates in 2011, and the first four survey dates in 2012. Flood conditions occurred in 2011 and 2012, with 2010 water levels remaining below the long-term average.

Smelterville Flats

Total annual waterfowl observations ranged from 92-283 waterfowl, representing 13 species. The most common species observed among all years included mallard (*Anas platyrynchos*) (47% of observations), followed by green-winged teal (*Anas crecca*) (32%) and Canada goose *(Branta canadensis)* (11%).

Page Ponds Wetland Complex

Total annual waterfowl observations ranged from 2,809-7,006 waterfowl, representing 20 species. The most common species included common goldeneye (*Bucephala clangula*) comprising 72% of observations, followed by mallard (10%) and Barrow's goldeneye (8%) (*Bucephala islandica*). The majority of waterfowl (97%) were observed using the four aeration lagoons at the Page Ponds WTP.

Tundra Swan Mortality

In all three years only four tundra swan were observed using wetland habitats within OU2, whereas an annual average of 11,595 tundra swan were observed in OU3 during 2010-2012. No tundra swan mortalities were observed within OU2 over the past three years.

2.3 Discussion

Waterfowl habitat in OU2 is primarily limited to the Page Ponds and Smelterville Flats wetland complexes. Assessment of waterfowl use and exposure to mining-related metals of concern at these sites is crucial in evaluating OU2 Phase I and guiding Phase II remedial activities as they pertain to improving ecological conditions.

Waterfowl continue to utilize recently established wetlands within the remediated area of Smelterville Flats and monitoring data suggest low, but increasing use. Waterfowl use has increased substantially within the last three years. Since 2009 total waterfowl observations have increased annually and 2012 total observations (251) were a 200% increase over the long-term average (2006-2011).

Up until 2011, data show that mallard and Canada goose have been the most common waterfowl observed within Smelterville Flats wetlands, but a slight change in species abundance may be occurring. In 2012, relatively high numbers (156) of green-winged teal began using flooded wetlands on the west end of Smelterville Flats and were the most common species observed.

Waterfowl use surveys conducted at the Page Ponds wetland complex have shown fluctuating but relatively high use within the WTP portion of the complex, with diving ducks being the dominant waterfowl observed. Counts specific to the West and East Swamps were not differentiated until 2009, but observations within these wetlands comprised only 3% of the observations within the Page Ponds wetland complex over the past three years. The majority (83%) of waterfowl observed using Page Ponds were diving ducks (namely common and Barrow's goldeneye, but also other diving ducks including bufflehead (*Bucephala albeola*), lesser scaup (*Aythya affinis)*, redhead (*Aythya americana*), and ring-necked duck (*Aythya collaris*).

Overall, the number of waterfowl utilizing Smelterville Flats is relatively low when compared to the Page Ponds wetland complex within OU2 and other lower Basin wetlands. Relatively low use is possibly related to the recent establishment of the wetlands. Future monitoring may reveal if a continuing increase in waterfowl abundance and diversity are attributed to various factors such as maturing habitat, flyway population trends, weather conditions, and activities at or near wetlands.

This three year dataset identified no anomalies related to waterfowl use and data will be analyzed further during the 5-year review process.

3.0 MAPS, Habitat Structure Assessment and Soil Lead Concentrations

Migratory birds that use Basin habitats are exposed to Pb through soil and sediment ingestion (Johnson et al. 1999, Beyer et al. 2000, Hansen 2007). Coeur d'Alene Basin ground-feeding songbirds were previously found to be at relatively high risk of reduced survival and adverse health effects from Pb exposure (USEPA 2001). Hansen (2007) confirmed that negative physiological effects in ground-feeding songbirds are associated with exposure to Pb in soil at concentrations found within Basin riparian habitats. However, it is unknown if observed physiological effects are impacting songbird populations and communities utilizing metals-contaminated riparian habitats within the Basin.

As an indicator of riparian habitat conditions, local songbird demographics such as reproduction and recruitment can be indicators of population health, however local songbird populations can fluctuate between years. To evaluate a long-term sampling strategy to provide reliable data for Basin songbird status and trend analyses, methodologies established in the nationwide (MAPS protocol (DeSante et al. 2006) are being implemented to collect a 5-year data set. The Service uses MAPS protocol to evaluate changes in avian productivity and survivorship, examine differences between recovering or remediated riparian areas, and compare OU2 results with a local reference site.

The Service conducted MAPS surveys at two locations (Figure 2) from 2010-2012 (first three years of a 5-year data set) and conducted habitat structure assessments and soil Pb analyses in 2010; Smelterville Flats and a local reference site located on private property (Lambros) adjacent to the North Fork Coeur d' Alene River (hereafter Reference Site). Smelterville Flats is located at the west end of OU2 within the floodplain of the SFCDR. Several phases of remedial activities occurred at Smelterville Flats beginning in 1997 (TerraGraphics and Ralston 2006). Target remedial goals for soil and sediment at the site were 3,000 mg/kg Pb and 3,000 mg/kg Zn, north of I-90 (USEPA 2005). Approximately 1,208,448 cubic yards of tailings were removed and capped with backfill and topsoil (TerraGraphics and Ralston 2006). Also, as part of the Phase I remedial actions, Smelterville Flats was planted with riparian trees and shrubs with the intent of improving habitat. Mean soil Pb concentrations at Smelterville Flats remain elevated above the 530 mg/kg cleanup level that is protective of ground-feeding songbirds. Because Pb concentrations in soil and songbird blood and habitat characteristics alone are difficult measurements for determining songbird exposure, population estimates and species diversity is essential to understanding the status and trends of songbird populations in the Basin.

Exposure to mining-related metals among songbird species is likely influenced by a number of factors including; life history stages and strategies, physiology, and habitat characteristics. Uncertainties regarding these factors emphasize the importance of augmenting songbird population monitoring with data collected on blood and soil Pb concentrations, and habitat condition. At the completion of this five year evaluation, a comprehensive review will include analyses on annual indices of songbird adult population size and post-fledging productivity, annual estimates of adult survivorship, recruitment from mark-recapture data and body conditioning indices, and riparian habitat health.

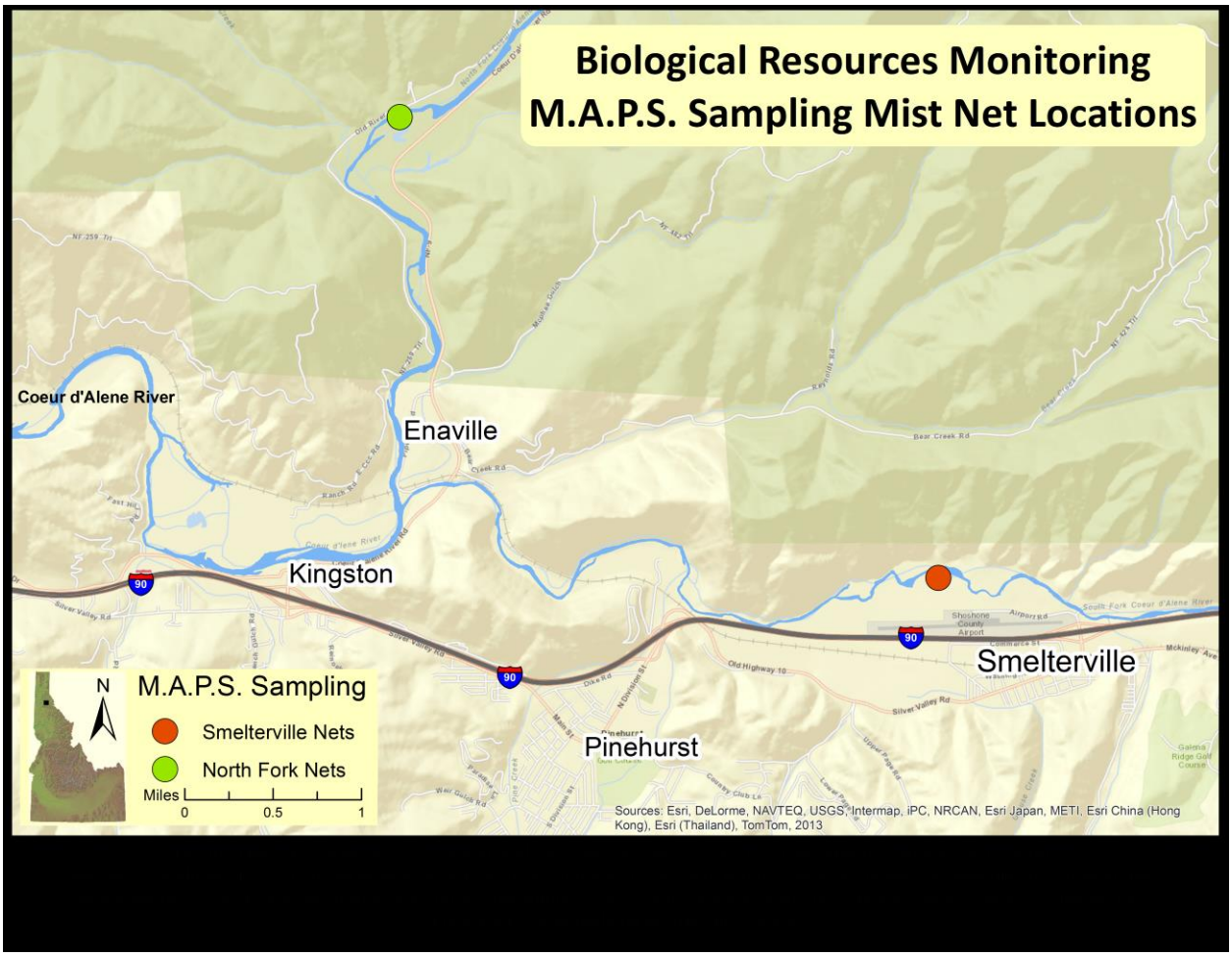

Figure 2. MAPS Locations

3.1 Methods

Survey Locations

The Smelterville Flats MAPS station is located just north of I-90 and the Shoshone County Airport in 25 acres of riparian habitat along the South Fork Coeur d'Alene River. The Reference Site is located approximately three miles upriver of Enaville, Idaho, in 32 acres of riparian habitat along the North Fork Coeur d'Alene River.

Songbird Capture and Data Handling

Standardized guidelines established by the Institute for Bird Populations (IBP; DeSante et al. 2010)(http://www.birdpop.org) and protocols developed by the NIFO (NIFO SOP #2010.1012) were followed while conducting the MAPS program. Nine 12 m long by 2.6 m tall mist nets were placed equidistant apart within the most suitable habitat available at each station. One capture/processing session (session) at each station typically occurred every 6-10 days between May 31, and August 18, (MAPS Periods 4-11). In 2011 and 2012, the starting dates were delayed due to flooding. Also in 2012, a late summer session was added with the intent of banding post-fledging juveniles. To maintain consistent effort between years, only data collected between June 20, and August 8, (MAPS Periods 6-10) are included in analyses.

Sessions consisted of opening mist nets at sunrise and checking each net every 30-45 minutes for approximately six hours. All birds captured were removed from the nets and fitted with a nine-digit aluminum leg band supplied by the U.S. Geological Survey (USGS) Bird Banding Laboratory (BBL). Data collected on each bird included species, age, sex, breeding status, fat content, body feather molt, flight feather molt, flight feather wear, juvenile plumage, wing length, bird weight, injuries observed, the leg band number and if they were newly captured or recaptured birds. All birds were released onsite following processing. In addition, the breeding status of each species observed (i.e., seen, heard, or captured) at each station on each day of operation was also recorded. Breeding status observations are dependent upon bander's ability to detect presence both visually and auditorily, and therefore, was consistent within but not between years. Data were entered and verified using MAPS PROG computer software developed by IBP. All data were submitted electronically to national data repositories at both IBP and the BBL.

Banding data were first summarized as the annual total number of individual birds captured at each station by species and age class. An index of abundance was calculated for potential breeder species (i.e., those species with a regular, usual, or occasional breeding status) as the rate of first captures (including first recapture in a given year of birds originally banded in a previous year) standardized per 100-net hours. Birds recaptured during the field season or birds released unbanded (e.g., birds that escaped without a band and/or hummingbirds, raptors, game birds) were excluded from analyses to prevent counting an individual more than once. For each station, species richness (a measure of bird diversity) was calculated by summing the total number of potential breeder species.

Throughout this report 'target species' are defined as those regular breeder species in common between the two stations with 8 or more individuals captured over the 3 years at each particular station.

Habitat Structure Assessment

As part of the standard MAPS protocol, a Habitat Structure Assessment (HSA) was completed during the first year (2010) of the 5 years of station operations to compare habitat between the Smelterville Flats and Reference Site. Habitat Structure Assessment protocol is designed to describe the type and distribution of the vegetation at each monitoring station, including horizontal pattern, vertical structure, and types of vegetation present. Vegetation types were classified using plant alliances that follow the USGS-NPS National Vegetation Classification Standards (NVCS). These data provide a general classification and characterization of the habitat at each station, allow for comparisons among stations, and documents major changes in the vegetation that may occur as the result of successional changes, new management practices or natural occurrences such as fire or flood.

Soil Lead Concentrations Evaluation

Additionally, in 2010, composite soil samples were collected from net locations to assist with data interpretation and to compare soil Pb concentrations between Smelterville Flats and the Reference Site. A composite of five soil grab samples was collected at each net and placed in sterile plastic containers. Composite samples consisted of surface scoops from each of the two net pole locations, the center of the net, and from either side of the net (~5 m from the center in a direction perpendicular to the net). Samples mixed in the lab using stainless steel bowls and spoons, bench dried and analyzed for Pb concentrations (mg/kg) with a portable X-ray florescence analyzer (XRF) (Innov-X Systems, Inc., Woburn, MA).

3.2 Results

MAPS

Species and breeding statuses of all birds observed (i.e., seen, heard, or captured) at Smelterville Flats and the Reference Site during 2010-2012 are listed in Appendix B.

During 2010-2012, a total of 346 birds from 29 potential breeder species at Smelterville Flats were banded compared to 263 birds from 22 potential breeder species at the Reference Site. The highest (71.91) and lowest (30.37) annual capture rates between sites occurred at Smelterville Flats (Table 2). At Smelterville Flats, a total of 15 birds originally banded in a previous year were recaptured, whereas 20 banded birds returned to the Reference Site. No birds originally banded as juveniles were recaptured at either location. A higher number of species were observed at Smetlerville than the Reference Site.

For all potential breeder species, juvenile mean capture rates were 14.6 and 9.9 for Smelterville Flats and Reference Site, respectively. Mean capture rates for juvenile target songbird species were 9.7 birds at Smelterville Flats and 9.4 birds at the Reference Site.

Table 2. Potential Breeding Bird Capture Summaries

SMFT-Smelterville Flats Ref- Reference Site	2010		2011		2012		2010-2012 Ave	
	SMFT	Ref	SMFT	Ref	SMFT	Ref	SMFT	Ref
Newly Banded Birds	82	86	80	76	184	101	115	88
Returned Birds[a]	NA	NA	7	9	8	11	7.5	10
Capture Rates[b]	30.37	32.15	38.16	32.38	71.91	41.48	46.81	35.38
Species Richness	21	19	23	14	22	19	22	17

[a] First recapture in a given year of a birds originally banded in a previous year
[b] Captures per 100 net-hours

Habitat Structure Assessment

In 2010, Smelterville Flats and the Reference Site were temporarily flooded cottonwood (*Populus trichocarpa*) forests with willow (*Salix spp.*) shrubland, however, these species were taller at the Reference Site. The Reference Site is comprised of 50% canopy cover and trees >15 meters tall on average, compared to 10% canopy cover at Smelterville Flats with trees approximately 5 meters tall. The understory habitat between the two stations differs only in the most abundant grass species. Redtop wheatgrass (*Agrostis stolonifera*) was the dominant grass species at Smelterville Flats, whereas reed canary grass (*Phalaris arundinacea*) was dominant at the Reference Site. The elevation for Smelterville Flats is 2205 feet (672 m) and the Reference Site, 2180 feet (664 m).

Soil Lead Concentrations Evaluation

Composite soil Pb concentrations from each of the nine net locations for both MAPS stations were collected in 2010. Mean composite soil Pb concentrations at Smelterville Flats was 3,474 mg/kg dry weight (range 446 - 10,095 mg/kg) and 94 mg/kg dry weight (range 73 – 124 mg/kg) at the Reference Site.

3.3 Discussion

MAPS data from 2010 through 2012 identified no major anomalies or deviations that need addressing prior to completion of the five-year MAPS data set.

Woody riparian vegetation at the Reference Site was more mature compared to Smelterville Flats. Although there are fewer tall trees at Smelterville Flats, the shrub midstory comprised a larger component of the habitat structure compared to the Reference Site.

Mean Pb soil concentrations of 3,474 mg/kg dry weight from samples collected at Smelterville Flats in 2010 suggest the potential to cause negative adverse physiological effects in songbirds. Previous studies at Smelterville Flats reported severe to subclinical blood Pb levels in song sparrow (*Melospiza melodia*), American robin (*Turdus migratorius*) and Swainson's thrush

(*Catharus ustulatus*) where soil Pb concentrations ranged between 3,320 mg/kg and 4,971 mg/kg (Hansen 2007, USFWS 2008, Franson and Pain 2011).

Since a five-year dataset is optimal for MAPS biomonitoring to distinguish any potential songbird population and community differences between OU2 and the Reference Site, a rigorous analysis will be conducted on songbird demographic variables to determine how riparian habitat and metals contaminated soil may be influencing songbird populations and communities in 2014. However, population level effects such as reduced songbird reproduction, fledgling success and adult survival may be difficult in providing clear relationships between songbird population dynamics and effects of metals exposure due to inherent complexities.

Operable Unit 3

4.0 Waterfowl Surveys

Waterfowl surveys in OU3 were conducted to determine relative waterfowl use, abundance, and tundra swan mortality on the same days as described in Section 2 above for OU2. Methods were also consistent with those described above. This three year data set augments past data and may be used in conjunction with ongoing monitoring information (e.g., Enhanced Conceptual Site Model) within OU3 to help guide future and ongoing remedial/restorative actions as they pertain to meeting established benchmarks. Waterfowl survey locations within OU3 (2010-2012) included 23 major wetlands, marshes, sloughs, and lakes extending from Whiteman's Slough to Coeur d'Alene Lake (Figure 3).

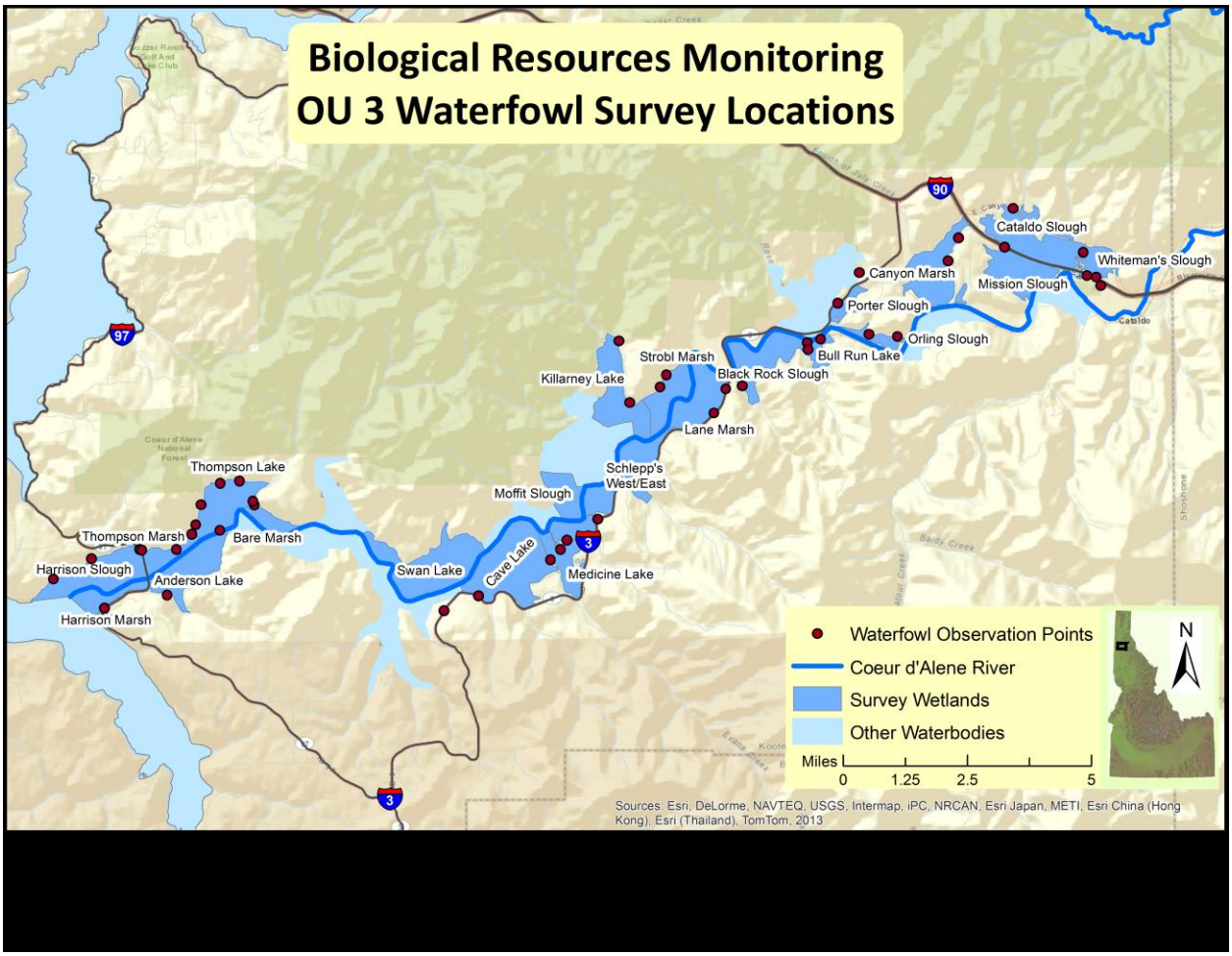

Figure 3. OU3 Waterfowl Survey Locations

4.1 Results

Species lists including both common and scientific names of all waterfowl observed during 2010-2012 can be found in Appendix A.

In 2010, 2011, and 2012 a total of 141,074, 108,212, and 120,882 waterfowl, respectively, representing 32 species were observed using 23 wetlands within OU3. The five most common species observed included Canada goose comprising 42% , northern pintail (*Anas acuta*) (14%), tundra swan (*Cygnus columbianus*) (9%), mallard (8%), and American coot (*Fulica americana*) (7%). The remaining 27 species comprised < 20% of the observations.

During 2010-2012, total numbers of waterfowl observed per wetland ranged between 57 at Bull Run Lake (2011) to 41,095 counts at Canyon Marsh (2010)(Table 3). Highest three-year average waterfowl use occurred at Canyon Marsh (21,257) followed by Schlepp's East Field (20,234), Cave Lake (13,645), Harrison Slough (9,997), and Lane Marsh (9,918). Average species diversity, over the three years, within the highest used wetlands ranged from 13 (Lane Marsh) to 21 (Schlepp's East Field). Waterfowl observations were highest during March and peaked between February 28-March 20, which is consistent with previous years' observations (Figure 4).

The 2010-2012 annual average of 123,389 waterfowl observations was 62% over the long-term average (2005-2009). Observations varied between years among the highest use wetlands with as much as an 80% variation within Lane Marsh between years (Figure 5). Schlepp's East Field had high use among all three years and in 2012 ranked number one out of all 23 wetlands in terms of use, comprising 18% of observations within OU3.

Table 3. Number of Waterfowl Observed per Wetland

Wetland	2010		2011		2012	
	Count	# of species	Count	# of species	Count	# of species
Canyon Marsh	41095	20	8700	18	13977	23
Lane Marsh	3298	12	16495	12	9962	15
Schlepp's East Field	20818	23	18072	16	21812	24
Cave Lake	17209	21	10376	12	13350	25
Harrison Slough	8124	21	14213	16	7654	19
Killarney Lake	6394	9	8638	11	8610	14
Strobl Marsh	9930	10	5147	9	6084	11
Thompson Lake	5589	14	5248	16	7758	19
Swan Lake	2059	6	3525	5	6120	12
Medicine Lake	2997	17	4458	13	2895	16
Thompson Marsh	3631	16	1868	13	3544	19
Black Rock Slough	3580	13	2306	13	2241	14
Mission Slough	2975	14	2427	13	2545	16
Schlepp's West Field	3114	13	1604	16	4808	17
Moffit Slough	2540	8	485	3	1389	9
Orling Slough	2053	13	1557	13	1850	14
Cataldo Slough	1447	14	847	11	1736	17
Anderson Lake	1238	8	946	12	1115	15
Harrison Marsh	1522	7	459	5	1342	14
Bare Marsh	733	7	471	9	1181	11
Porter Slough	354	8	234	7	474	12
Whiteman's Slough	209	12	79	7	151	10
Bull Run Lake	165	7	57	5	284	12
Total	**141,074**	**32**	**108,212**	**22**	**120,882**	**29**

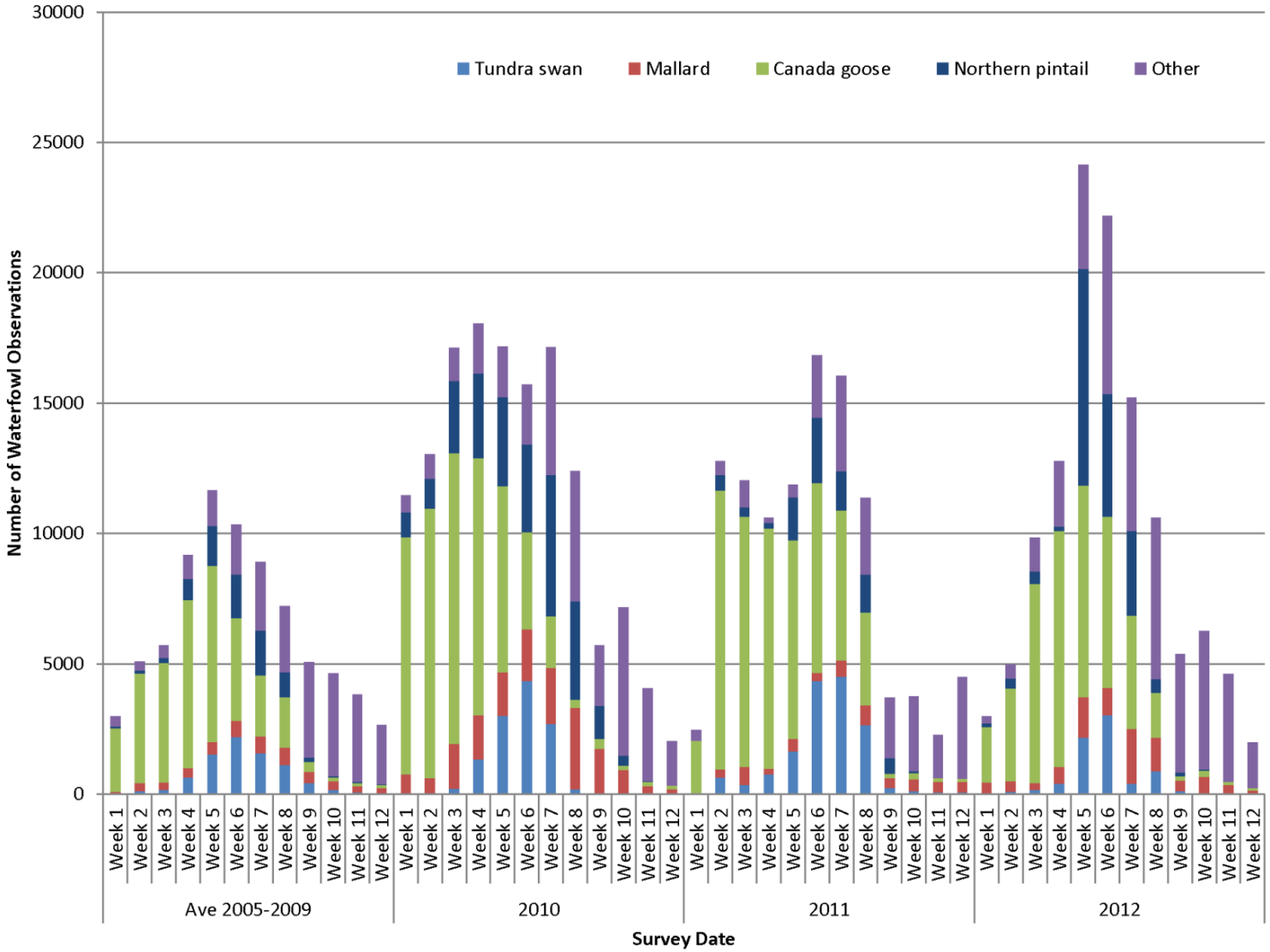

Figure 4. Weekly Total Waterfowl Observations

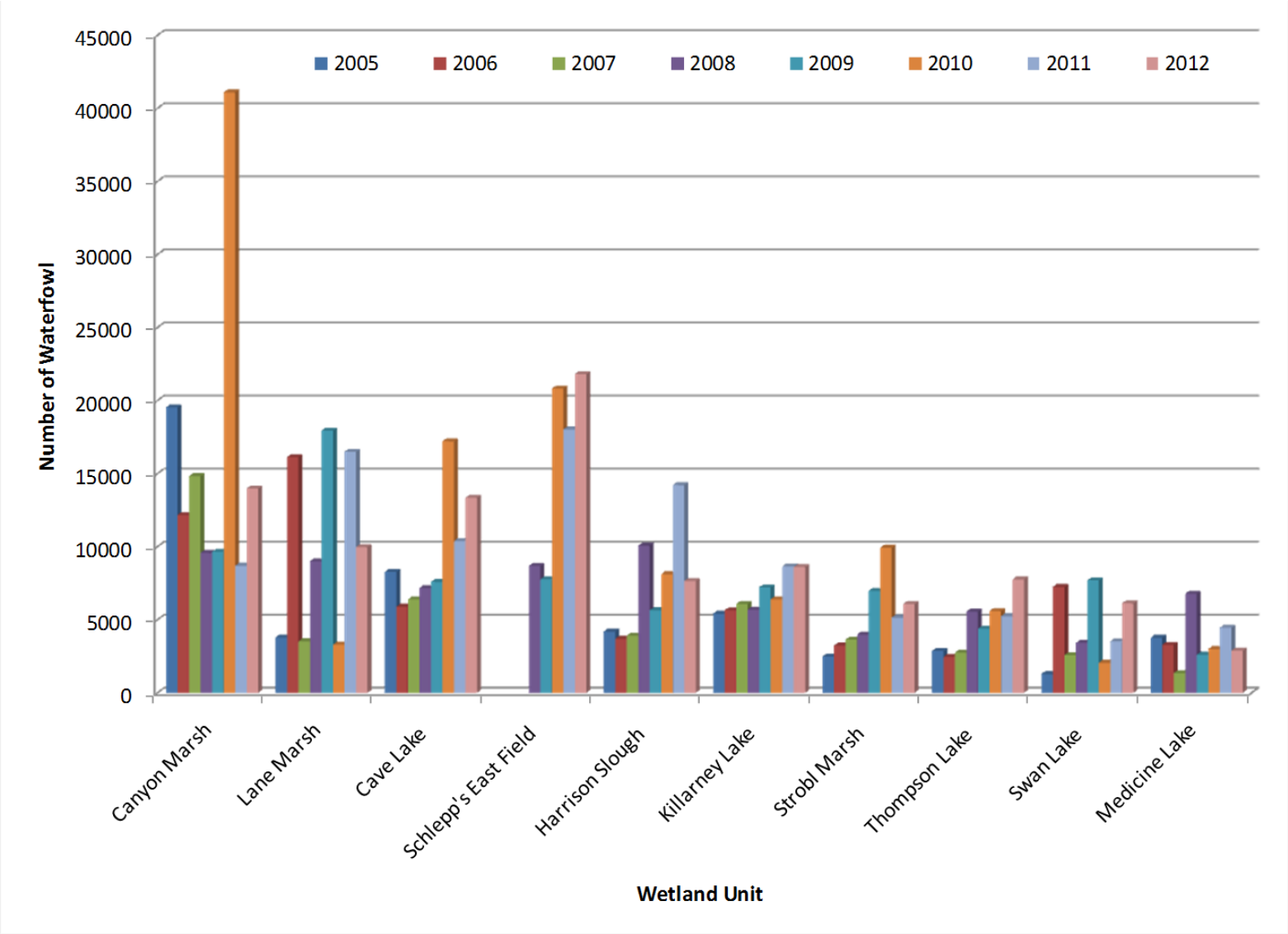

Figure 5. Annual Total Waterfowl Observations at Highest Use Wetlands

Tundra Swan Mortality

During 2010-2012, an annual average of 11,595 tundra swans was observed in OU3. Tundra swan were observed at all 23 wetlands. Based on total number of observations the five highest use areas included Canyon Marsh comprising 27 % of the observations, followed by Strobl Marsh (23%), Lane Marsh (14%), Harrison Slough (11%), and Killarney Lake (6%) (Table 4).

During the three years of observations, annual tundra swan mortalities ranged from 8-116. (Table 5). The highest mortalities were observed in Harrison Slough (40), Thompson Lake (31), and Strobl Marsh (26).

Over the three year period average tundra swan observations were 43% above the previous five year average (2005-2009), and average tundra swan mortalities also increased 25% over the five year average (2005-2009). No major shift in wetland use was observed.

Table 4. Tundra Swan Observations per Wetland in OU3 (2010-2012)

Wetland	**2010**	**2011**	**2012**
Strobl Marsh	3013	2776	2232
Canyon Marsh	7080	1843	642
Lane Marsh	87	2393	2488
Harrison Slough	790	2491	483
Killarney Lake	0	1835	335
Cave Lake	556	805	670
Thompson Lake	66	1344	28
Moffit Slough	94	223	1
Black Rock Slough	0	352	53
Bare Marsh	0	95	2
Anderson Lake	10	42	84
Swan Lake	32	347	124
Harrison Marsh	0	85	133
Schlepp's East Field	122	473	39
Schlepp's West Field	0	21	4
Mission Slough	2	60	35
Thompson Marsh	0	79	30
Medicine Lake	9	20	9
Orling Slough	0	169	26
Whiteman's Slough	0	12	6
Cataldo Slough	0	9	22
Porter Slough	0	5	0
Bull Run Lake	0	1	0
Total	**11,861**	**15,480**	**7,446**

Table 5. Tundra Swan Observations and Mortality in Coeur d'Alene Basin, ID (2005-2012)

Year	Total count	Max daily swan counts	No. weeks ≥ 500	Dead swans
2005	6,617	1,548	5	8
2006	8,039	2,053	6	35
2007	2,461	1,907	1	2
2008	6,116	1,412	5	64
2009	17,339	6,271	6	125
2010	11,861	4,340	4	8
2011	15,480	4,514	6	116
2012	7,446	3,033	3	51

4.2 Discussion

Waterfowl Use

Data from 2012 constitute the eighth year of waterfowl population monitoring within OU3 and demonstrate that thousands of waterfowl continue to utilize lower Basin habitats during spring migration (USEPA 2004). Although timing, magnitude and duration of migration within the Basin may fluctuate annually; Canyon Marsh, Lane Marsh, Cave Lake, Harrison Slough and Schlepp's East have continued to exhibit high waterfowl use (Figure 5). High use of wetlands is likely driven by habitat quality, preferred feeding habitat (e.g., suitable water depths), and the subsequent accessibility to food resources by waterfowl. There continues to be an increase in overall waterfowl use with the Basin since 2008, but at this time it is difficult to determine if this is a long-term trend or related to natural variation attributed to various factors such as flyway population trends or environmental variables.

Several wetlands within OU3 have been prioritized for remedial actions based on high waterfowl use, sediment lead concentrations, and low potential for flooding and subsequent recontamination (USEPA 2002). Lane Marsh has been identified as a potential area for future action based on past waterfowl use and mortality data (Audet et al. 1999), and waterfowl use data collected over the past three years continue to support its identification as a high-priority wetland for remedial, restorative, or manipulative action to reduce waterfowl exposure at this area. In addition to waterfowl use and mortality data, sediment transport and hydrology information will help strengthen decisions in determining the best course of action(s) to reduce waterfowl exposure and/or provide clean waterfowl feeding habitat at this area.

Schlepp's East Field continues to be one of the leading and consistently used wetlands, in terms of waterfowl use and species diversity, within the lower Basin. Waterfowl use within Lane Marsh and Canyon Marsh has varied by nearly 80%, while Schlepp's East has varied by only 17% over the past three years. Schlepp's East Field made up 18% of the total observations in 2012. The past four years of data indicate that Schlepp's East Field continues to consistently provide safe/clean waterfowl feeding habitat for a large number of diverse waterfowl species and this remediation/restoration project is a positive step toward meeting ROD benchmarks. Waterfowl use data at Schlepp's West Field prior to remedial activities, which were completed in 2011, were not collected. Data collected from 2010-2012 are being used to inform and guide restoration activities in the West Field.

Information on waterfowl relative abundance and wetland-specific use and behavior, especially when used in conjunction with waterfowl toxicity trends, will continue to provide valuable data guiding efficient remedial strategies and the success of remedial and restoration activities on the Schlepp Easement. Although, it is early in the biological monitoring program, these data suggest that remedial and restoration activities at the Schlepp Agriculture to Wetland Conversion Project (Schlepp Project) are attracting large numbers of diverse waterfowl species while providing clean waterfowl feeding habitat. As restorative actions continue at this site such as vegetation and hydrologic management, waterfowl monitoring data coupled with restoration monitoring data will be useful to gauge the success of specific actions as well as guide future actions. Weekly waterfowl survey results are being evaluated with habitat conditions to assist in the optimization and protection of remedial and restorative actions. Additional information

regarding remedy protection and restoration at this site can be found in Annual Reports prepared by Ducks Unlimited.

Tundra Swan Mortality

Tundra swan use of wetland habitats from 2010-2012 remained relatively consistent with past observations. Preferred habitats are likely due to suitable hydrologic conditions and subsequent food availability (Audet et al. 1999). Local weather conditions such as temperature, ice cover, snowpack, and rain-on-snow events are prominent predictive factors controlling hydrologic conditions which in turn influence wetland-specific waterfowl/tundra swan use. The Service is exploring the feasibility of using the results from waterfowl use and tundra swan mortality to build a GIS model in conjunction with other relative data (e.g., temperature, hydrology, sediment lead levels, etc.) to help clarify waterfowl trends and prioritize areas for remediation, management and/or restoration.

The Schlepp Project which began remedial activities in 2007, was added to the waterfowl survey in 2008 and remediation was completed in 2011. The project area consists of two portions; the East Field (290 acres) and West Field (105 acres). One of the primary restoration goals of the Schlepp Project is to maximize use by foraging tundra swans and other waterfowl. Although waterfowl use has been high, tundra swan use remains relatively low. From 2010-2012, average tundra swan observations at Schlepp's comprised only 1% of the total observations within OU3. However, nearby areas with elevated sediment lead concentrations such as Strobl Marsh and Lane Marsh continue to be heavily used. As key wetland functional attributes such as vegetation, soils, and hydrologic conditions are continually managed/improved tundra swan use may increase within clean feeding habitat at Schlepp's, thus reducing tundra swan exposure Basin-wide. Continued monitoring will help determine success of restoration/management actions to attract additional tundra swans.

Over the three year period tundra swan mortality increased 25% over the long term average (2005-2009), primarily due to high mortality observed in 2011. In 2007, the Service demonstrated a positive correlation between tundra swan mortality, the maximum number of swans recorded in any one day, and the number of weeks with ≥ 500 swans (USFWS 2007). In 2011, total counts reached 15,480 with six weeks of observations ≥ 500, resulting in 116 tundra swan mortalities. In 2011, the Coeur d'Alene River at Cataldo, ID, crested above flood stage twice during late winter resulting in deposition of contaminated sediment within lower Basin feeding areas. Flood events which mobilize large amounts of lead-contaminated sediments throughout the Basin coincide with high tundra swan mortality (Audet et al. 1999). These trends will likely continue when episodic events such as flooding coincide with years of high tundra swan use and prolonged duration of stay, until exposure to lead-contaminated sediments is reduced and/or additional clean feeding habitat is provided.

These three years of data identified no major deviations from long-term swan mortality trends or anomalies, data will be analyzed further during the five year review process.

5.0 Riparian Songbird Exposure

Riparian songbirds were selected as a key indicator of ecosystem improvement to aid in the evaluation of success in reducing ecological exposure to metals of concern within OU3 riparian habitats. Riparian songbird blood Pb concentrations were examined in 2011 to evaluate ongoing exposure to Pb in soils. Survey methods followed those used by Hansen (2007) for songbird blood Pb collection in the Basin for evaluation of riparian songbird exposure to Pb over time.

Previous surveys evaluating blood Pb concentrations in songbirds from the Basin serve as the baseline condition for the 2011 data set. This was the first songbird blood Pb sampling conducted under the BEMP to evaluate long-term status and trends of exposure to mining-related metals within riparian habitats. Information gathered as part of this effort will inform progress toward ecological improvements within riparian habitats. Subsequent songbird blood collections are scheduled to take place every five years.

5.1 Methods

Based on previous research (Blus et al. 1995, Audet 1997, Johnson et al. 1999, Hansen 2007) and relative abundance in the Basin, song sparrows, American robin and Swainson's thrush were targeted for blood collection. The Ecological Risk Assessment also concluded these three species were at relatively high risk in the Basin (USEPA 2001). In 2011, birds were captured within forested riparian corridor habitat using 12 m by 3 m mist nets placed at four contaminated sites and two reference sites. The contaminated sites included Pine Creek/Highland Creek, Lower Pine Creek, and Springston and Osburn along the SFCDR. The reference sites were located along the Little North Fork Coeur d'Alene River and the North Fork Coeur d'Alene River approximately nine miles upstream from the confluence with the SFCDR (Figure 7).

Once songbirds were captured, target species were removed from nets, placed into cloth bags and processed on site. Non-target species were removed from nets and released on site. Target species were aged, sexed and identified to species. Blood sampling followed a NIFO SOP (#2010.3765) using the following equipment and processes. Blood was sampled from the jugular vein of each bird using a 1ml syringe equipped with a 26-gauge needle. Needles/syringes were prepared with an internal rinse of heparin to help avoid blood clotting in the syringe. The sampling area was wiped with a cotton ball dipped in alcohol, and a target of at least 150 µl of blood was drawn. The outer tail feather of each bird was clipped to identify birds should they be recaptured. Recaptured birds were released at the net site and not resampled. Each bird was offered a sugar water solution for energy replacement and released or placed back into a cloth bag to recover and then released when the bird appeared alert and in good condition. Blood was placed into two separate labeled, chemically cleaned laboratory vials. Blood mass was recorded to 0.001g for each vial. Vials were placed in liquid nitrogen and transported to the NIFO for storage in a -20º C freezer. One vial was shipped on dry ice to the USEPA Region 10 Manchester Laboratory for Pb analysis and the other vial was retained for ALAD analysis. After blood collection at the reference sites an equipment malfunction caused the samples to thaw. This prevented the samples from being analyzed and since reference samples were not able to be

analyzed, the ALAD sampling was discontinued for the rest of the songbird blood sampling in 2011.

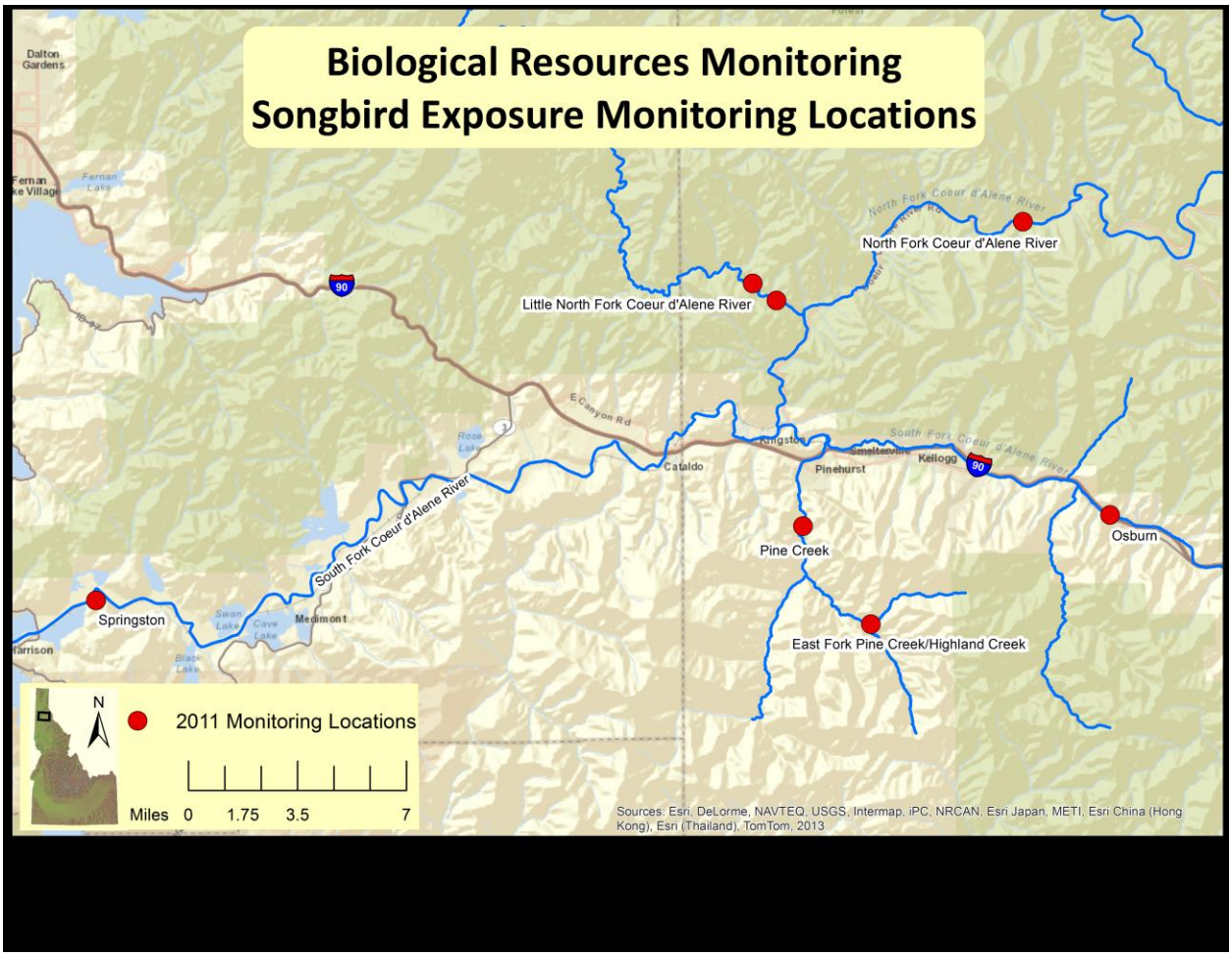

Figure 6. 2011 Songbird Exposure Monitoring Locations in OU3

Laboratory results for blood Pb concentrations were reported as wet weight concentrations, and a songbird blood percent moisture value of 81.4% provided by Hansen (2007) was used to convert results to dry weights (mg/kg).

For statistical analysis Kolmogorov-Smirnov (K-S) tests were used to evaluate normality of blood Pb distributions within species and F-Tests were used to determine if variances were equal. Where sample size permitted Two-Sample T- Tests were used to examine differences between blood Pb concentrations at contaminated sites and reference sites. Due to non-normal distributions, Mann-Whitney tests were used to examine blood Pb differences between species at contaminated sites and between corresponding sites of the same species sampled in 2003 (Hansen 2007). Spearman's Rank Correlation was used to analyze associations between soil Pb and songbird blood Pb concentrations at contaminated sites. Statistical significance in all tests was determined at $\alpha < 0.05$.

Soil samples were also collected at net locations where target birds were captured. Five soil grabs were collected and composited at each net (grabs consisted of surface scoops taken from each of the two net pole locations, the center of the net, and from either side of the net ~5 m from the center in a direction perpendicular to the net). Samples were placed in plastic bags, transported to the NIFO, and thoroughly mixed and bench dried. Samples were analyzed for Pb with XRF (Innov-X Systems, Inc., Woburn, MA).

5.2 Results

A total of 51 American robin, song sparrow, and Swainson's thrush were captured and processed in 2011. Twenty songbirds (five American robin, 10 song sparrow, and five Swainson's thrush) were captured from the two reference sites. Thirty-one songbirds (three American robin, 13 song sparrow, and 15 Swainson's thrush) were captured from four contaminated sites.

Songbird blood Pb concentrations in birds from the reference sites were low with mean concentrations of 0.22 and 0.20 mg/kg at the North Fork and Little North Fork sites, respectively. Mean songbird blood concentrations were highest at Osburn, 3.3 mg/kg (Table 6).

Only song sparrow at Springston, Osburn, and the Little North Fork sites were of sufficient sample size ($n \geq 5$) for comparison. Song sparrow median blood Pb concentrations were significantly greater at Osburn and Springston ($P < 0.05$) compared to the Little North Fork birds.

Blood collected from Little North Fork songbirds and all Swainson's Thrush collected from other sites (North Fork, Pine Creek/Highland Creek, Springston) had background blood Pb toxicity concentrations as categorized by Franson and Pain, 2011, (background (<1.04 mg/kg), subclinical (1.04 to <2.6), clinical (2.6 to <5.2) and severe clinical (>5.2)). All Lower Pine Creek song sparrows had background blood Pb toxicity concentrations as well. Song sparrows collected from Springston showed 80% of the birds had background blood Pb levels and 20% sub-clinical. Forty percent of Osburn song sparrows showed sub-clinical blood Pb levels, 40% clinical levels, and 20% severe clinical levels. And, the three American Robin from Osburn had blood Pb concentrations in the clinical toxicity category.

Blood Pb samples collected from Swainson's thrush at Pine Creek/Highland Creek and song sparrow from Springston were of sufficient sample size to compare to samples collected from these species at these sites in 2003. Mean blood Pb concentrations for Swainson's thrush were not significantly different from those collected in 2003 ($P = 0.38$), but were relatively low in both years. Mean blood Pb concentrations for song sparrow sampled in 2011 were significantly lower ($P = 0.04$) than those sampled in 2003.

Mean soil Pb concentrations at reference sites ranged from 20 to 91 mg/kg. (Table 6). Mean soil Pb concentrations ranged from 339 to 1,260 mg/kg at contaminated sites with the highest mean concentrations at Osburn. Considerable variability in soil Pb concentrations were observed among net locations, particularly at Osburn, as shown by high standard deviations associated

with the means. Concentrations of songbird blood Pb and corresponding soil Pb concentrations from net locations at contaminated sites were not significantly correlated (P = 0.44).

Table 6. 2011 Mean (SD, *n*) Songbird Blood Pb and soil Pb Concentrations (mg/kg Dry Weight)

Site	All songbirds	American robin	Song sparrow	Swainson's thrush	Soil
Reference					
North Fork	0.22 (0.13, 3)	nc	nc	0.22 (0.13, 3)	91 (44, 9)
Little North Fork	0.20 (0.28, 17)	0.59 (0.21, 5)	0.04 (0.02, 10)	< 0.015 (-, 2)	20 (6, 5)
Contaminated					
Pine Creek/ Highland Creek	0.70 (0.69, 9)	nc	1.87 (0.05, 2)	0.37 (0.25, 7)	687 (473, 8)
Lower Pine Creek	0.29 (0, 1)	nc	0.29 (0, 1)	nc	339 (-, 1)
Springston	0.36 (0.36, 13)	nc	0.47 (0.39, 5)	0.29 (0.35, 8)	1229 (306, 8)
Osburn	3.3 (1.2, 8)	3.6 (0.81, 3)	3.1 (1.4, 5)	nc	1260 (2505, 9)

nc- none collected

5.3 Discussion

Hansen (2007) demonstrated that riparian songbirds using the Basin accumulated Pb above suggested toxicological levels. Despite previous remedial activities at locations such as Osburn and Pine Creek, results of the 2011 blood collection demonstrate that representative songbirds using these areas and riparian habitats located further downstream continue to be exposed to and accumulate Pb at concentrations above toxicological thresholds (Franson and Pain 2011).

Although, there was a significant decrease in song sparrow blood Pb concentrations at Springston the results are from only two years of data. These results should be interpreted with caution and do not suggest an overall declining trend in songbird blood at lower Basin locations. In future sampling events, increasing the sample size coupled with other statistical approaches to determine trends such as Mann-Kendall tests will be needed to determine if downward trends are occurring.

Of the three songbird species targeted for blood collection, Swainson's thrush had the lowest blood Pb levels across all sites. These results are consistent with results obtained by Hansen (2007) estimating mean soil-ingestion rates. The soil-ingestion rates were calculated for American robins (20%), song sparrow (17%), and Swainson's thrush (0.7%). Swainsons's thrush primarily inhabit upland areas adjacent to riparian habitat, and generally feed at greater heights than American robin and song sparrow, gleaning insects from foliage, capturing insects from the air, and foraging on berries (Mack and Young 2000, Hansen 2007). Due to preferred habitat selection, feeding habits, and low sediment ingestion it is not surprising Swainson's thrush had the lowest blood Pb levels of the three target species. Based on these results and those by Hansen (2007), Swainson's thrush may not be a suitable bioindicator for evaluating riparian exposure to metals of concern.

Exposure to mining-related metals will continue until further remedial activities are implemented, reducing deposition of contaminated material within riparian habitats. As remedial actions are implemented and other factors such as natural attenuation and habitat changes occur, songbird exposure to Pb should be reduced. The songbird blood collected in 2011 evaluating songbird exposure to mining-related metals within riparian habitats identified no major deviations or anomalies that need addressing prior to the five-year review.

6.0 Data Disposition

The original copies of the data sheets will be retained at the U.S. Fish and Wildlife Service's Northern Idaho Field Office, Spokane, Washington. Original data forms were copied and data was entered into an excel spreadsheets. The USFWS is currently working with the USEPA to store biomonitoring data within USEPA's Water Quality Exchange (WQX) database. This will allow the public to download biological data collected under the EMP and BEMP. Until data is housed within WQZ for public use, electronic copies of the spreadsheets and field data forms can be requested via email (Tim_Kiser@fws.gov), or by phone (509-893-8023).

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Appendix A

Alphabetical list of common and scientific names of waterfowl observed within the Coeur d'Alene Basin (2010-2012).

American coot	*Fulica americana*
American wigeon	*Anas americana*
Barrow's goldeneye	*Bucephala islandica*
Blue-winged teal	*Anas discors*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cinnamon teal	*Anas cyanoptera*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Domestic goose	NA
Eared grebe	*Podiceps nigricollis*
Eurasian wigeon	*Anas penelope*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Hooded merganser	*Lophodytes cucullatus*
Horned grebe	*Podiceps auritus*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Pied-billed grebe	*Podilymbus podiceps*
Redhead	*Aythya americana*
Red-necked grebe	*Podiceps grisegena*
Ring-necked duck	*Aythya collaris*
Ross's goose	*Chen rossii*
Ruddy duck	*Oxyura jamaicensis*
Snow goose	*Chen caerulescens*
Tundra swan	*Cygnus columbianus*
Western grebe	*Aechmophorus occidentalis*
White-fronted goose	*Anser albifrons*
Wood duck	*Aix sponsa*

Appendix B

Table 1. Alphabetical list of common and scientific names of birds observed (i.e., seen, heard, or captured) at **Smelterville Flats station** during MAPS 2010-2012. Breeding status of each species was classified as one of the following: a regular breeder (B); a usual breeder (U); an occasional breeder (O); a transient (T); or a migrant (M).

Common Name	Scientific Name	Breeding Status
American crow	*Corvus brachyrhynchos*	T
American redstart	*Setophaga ruticilla*	O
American robin	*Turdus migratorius*	B
Barn swallow	*Hirundo rustica*	T
Belted kingfisher	*Megaceryle alcyon*	B
Black-capped chickadee	*Poecile atricapillus*	B
Black-chinned hummingbird	*Archilochus alexandri*	T
Black-headed grosbeak	*Pheucticus melanocephalus*	B
Brown-headed cowbird	*Molothrus ater*	B
Bullock's oriole	*Icterus bullockii*	O
California quail	*Callipepla californica*	T
Calliope hummingbird	*Selasphorus calliope*	B
Cassin's vireo	*Vireo cassinii*	T
Cedar waxwing	*Bombycilla cedrorum*	B
Chipping sparrow	*Spizella passerina*	B
Cliff swallow	*Petrochelidon pyrrhonota*	T
Common merganser	*Mergus merganser*	O
Common nighthawk	*Chordeiles minor*	T
Common raven	*Corvus corax*	T
Common yellowthroat	*Geothlypis trichas*	O
Cooper's hawk	*Accipiter cooperii*	T
Dark-eyed junco	*Junco hyemalis*	M
Downy woodpecker	*Picoides pubescens*	U
Eastern kingbird	*Tyrannus tyrannus*	O
European starling	*Sturnus vulgaris*	T
Gray catbird	*Dumetella carolinensis*	B
Great blue heron	*Ardea herodias*	O
House finch	*Haemorhous mexicanus*	T
Killdeer	*Charadrius vociferus*	B
Lazuli bunting	*Passerina amoena*	U
MacGillivray's warbler	*Geothlypis tolmiei*	U
Mallard	*Anas platyrhynchos*	U
Marsh wren	*Cistothorus palustris*	O
Nashville warbler	*Oreothlypis ruficapilla*	T

Northern harrier	*Circus cyaneus*	O
N. rough-winged swallow	*Stelgidopteryx serripennis*	U
Northern waterthrush	*Parkesia noveboracensis*	O
Orange-crowned warbler	*Oreothlypis celata*	T
Osprey	*Pandion haliaetus*	T
Pine siskin	*Spinus pinus*	O
Red-breasted nuthatch	*Sitta canadensis*	T
Red-eyed vireo	*Vireo olivaceus*	B
Red-shafted flicker	*Colaptes a. cafer*	O
Red-tailed hawk	*Buteo jamaicensis*	T
Red-winged blackbird	*Agelaius phoeniceus*	B
Rufous hummingbird	*Selasphorus rufus*	U
Savannah sparrow	*Passerculus sandwichensis*	T
Say's phoebe	*Sayornis saya*	T
Sharp-shinned hawk	*Accipiter striatus*	T
Song sparrow	*Melospiza melodia*	B
Sora	*Porzana carolina*	O
Spotted sandpiper	*Actitis macularius*	B
Spotted towhee	*Pipilo maculatus*	B
Swainson's thrush	*Catharus ustulatus*	B
Townsend's warbler	*Setophaga townsendi*	T
Tree swallow	*Tachycineta bicolor*	O
Turkey vulture	*Cathartes aura*	T
Vesper sparrow	*Pooecetes gramineus*	T
Violet-green swallow	*Tachycineta thalassina*	B
Warbling vireo	*Vireo gilvus*	B
Western flycatcher	*Empidonax difficilis/occid.*	O
Western meadowlark	*Sturnella neglecta*	O
Western tanager	*Piranga ludoviciana*	U
Western wood-peewee	*Contopus sordidulus*	B
White-breasted nuthatch	*Sitta carolinensis*	T
Willow flycatcher	*Empidonax traillii*	B
Wilson's snipe	*Gallinago delicata*	T
Wilson's warbler	*Cardellina pusilla*	M
Yellow warbler	*Setophaga petechia*	B
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	T
Yellow-rumped warbler	*Setophaga coronata*	B

Table 2. Alphabetical list of common and scientific names, and breeding statuses of birds observed (i.e., seen, heard, or captured) at **Lambros reference site** during MAPS 2010-2012. Breeding status of each species was classified as one of the following: a regular breeder (B); a usual breeder (U); an occasional breeder (O); a transient (T); or a migrant (M).

Common Name	Scientific Name	Breeding Status
American goldfinch	*Spinus tristis*	T
American redstart	*Setophaga ruticilla*	B
American robin	*Turdus migratorius*	B
Bald eagle	*Haliaeetus leucocephalus*	T
Barn swallow	*Hirundo rustica*	T
Belted kingfisher	*Megaceryle alcyon*	B
Black-capped chickadee	*Poecile atricapillus*	B
Black-headed grosbeak	*Pheucticus melanocephalus*	B
Brown-headed cowbird	*Molothrus ater*	B
Bullock's oriole	*Icterus bullockii*	U
Calliope hummingbird	*Selasphorus calliope*	B
Canada goose	*Branta canadensis*	T
Cassin's vireo	*Vireo cassinii*	O
Cedar waxwing	*Bombycilla cedrorum*	B
Chestnut-backed chickadee	*Poecile rufescens*	T
Chipping sparrow	*Spizella passerina*	O
Cliff swallow	*Petrochelidon pyrrhonota*	T
Common raven	*Corvus corax*	T
Double-crested cormorant	*Phalacrocorax auritus*	T
Downy woodpecker	*Picoides pubescens*	U
Eastern kingbird	*Tyrannus tyrannus*	O
Evening grosbeak	*Coccothraustes vespertinus*	O
Gray catbird	*Dumetella carolinensis*	B
Great blue heron	*Ardea herodias*	O
Great horned owl	*Bubo virginianus*	T
Hairy woodpecker	*Picoides villosus*	T
Hammond's flycatcher	*Empidonax hammondii*	B
Killdeer	*Charadrius vociferus*	O
Lazuli bunting	*Passerina amoena*	O
MacGillivray's warbler	*Geothlypis tolmiei*	O
Mallard	*Anas platyrhynchos*	O
Mourning dove	*Zenaida macroura*	O
Nashville warbler	*Oreothlypis ruficapilla*	M
N. rough-winged swallow	*Stelgidopteryx serripennis*	U
Northern waterthrush	*Parkesia noveboracensis*	B

Olive-sided flycatcher	*Contopus cooperi*	T
Osprey	*Pandion haliaetus*	T
Pileated woodpecker	*Dryocopus pileatus*	T
Pine siskin	*Spinus pinus*	O
Red crossbill	*Loxia curvirostra*	T
Red-breasted nuthatch	*Sitta canadensis*	T
Red-eyed vireo	*Vireo olivaceus*	B
Red-naped sapsucker	*Sphyrapicus nuchalis*	U
Red-shafted flicker	*Colaptes a. cafer*	B
Red-tailed hawk	*Buteo jamaicensis*	T
Rock pigeon	*Columba livia*	T
Rufous hummingbird	*Selasphorus rufus*	U
Sharp-shinned hawk	*Accipiter striatus*	T
Song sparrow	*Melospiza melodia*	B
Spotted sandpiper	*Actitis macularius*	B
Spotted towhee	*Pipilo maculatus*	T
Swainson's thrush	*Catharus ustulatus*	U
Tree swallow	*Tachycineta bicolor*	O
Varied thrush	*Ixoreus naevius*	T
Vaux's swift	*Chaetura vauxi*	O
Veery	*Catharus fuscescens*	U
Violet-green swallow	*Tachycineta thalassina*	O
Warbling vireo	*Vireo gilvus*	U
Western flycatcher	*Empidonax difficilis/occid.*	U
Western tanager	*Piranga ludoviciana*	O
Western wood-peewee	*Contopus sordidulus*	B
Wild turkey	*Meleagris gallopavo*	T
Willow flycatcher	*Empidonax traillii*	B
Winter wren	*Troglodytes hiemalis*	T
Wood duck	*Aix sponsa*	O
Yellow warbler	*Setophaga petechia*	B
Yellow-rumped warbler	*Setophaga coronata*	B