RECLAMATION

Managing Water in the West

2011 Annual Report

Bureau of Reclamation

Report on Monitoring and Implementation Activities Associated with the USFWS 2005 Biological Opinion For Operation and Maintenance of the Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Snake River Area Office
Boise, Idaho

March 2012

MISSION OF THE U.S. DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

MISSION OF THE BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Photograph on front cover: Captured fish being measured during a population estimate effort at Arrowrock Reservoir.

RECLAMATION

Managing Water in the West

2011 Annual Report

Bureau of Reclamation

Report on Monitoring and Implementation Activities Associated with the USFWS 2005 Biological Opinion

For

Operation and Maintenance of the Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Snake River Area Office
Boise, Idaho

March 2012

Table of Contents

1 Introduction 1

2 Summary of 2011 Operations 3

2.1 Idaho 3

2.2 Oregon 4

3 Bull Trout 5

3.1 Introduction and Background 5

3.2 Bull Trout Monitoring 7

3.2.1 Boise River Basin Operational Indicators 7

1.1.1 Payette River Basin Operational Indicators 13

1.1.1 Malheur River Basin Operational Indicators 16

4 Implementation of Reasonable and Prudent Measures and Associated Terms and Conditions for Bull Trout 19

4.1 Boise River Basin 19

4.1.1 South Fork Boise River Data Collection 21

4.1.2 Fish Sampling 21

4.1.2.1 Picket Migration Weirs 23

4.1.2.2 Fyke Netting 24

4.1.2.3 Beach Seining 25

4.1.2.4 Gill Netting 26

4.1.2.5 Radio Telemetry 28

4.1.3 Hydrology and Water Chemistry 28

4.1.4 Trap-and-Transport Efforts 29

4.1.5 Other Activities 29

4.1.5.1 Arrowrock Dam Hydroelectric Project – Boise Board of Control 29

4.1.5.2 Fish Management in Arrowrock Reservoir – Idaho Department of Fish and Game 29

4.2 Payette River Basin – Deadwood River System 30

4.2.1 Data Collection in the Reservoir and Tributaries above the Dam 31

4.2.1.1 Fish Sampling 31

4.2.1.2 Fyke Netting 33
4.2.1.3 Beach Seine 34
4.2.1.4 Hook-and-Line Sampling 35
4.2.1.5 Picket Weirs 35
4.2.1.6 Backpack Electroshocking 37
4.2.1.7 Radio Telemetry 37
4.2.2 Hydrology and Water Chemistry 38
4.2.3 Other Activities 42
4.2.4 Data Collection in the Deadwood River Reach Downstream of Deadwood Dam 43
4.2.4.1 Fish Sampling 43
4.2.4.2 Backpack Electroshocking 44
4.2.4.3 Stranding Pool Survey 45
4.2.4.4 Radio Telemetry 46
4.2.5 Hydrology and Water Chemistry 46
4.2.6 Deadwood River Productivity 48
4.3 Malheur River Basin - Beulah Reservoir and the North Fork Malheur River 50
4.3.1 Beulah Reservoir and Tributary Data Collection 51
4.3.1.1 Fish Sampling 51
4.3.1.2 Results 52
4.3.1.3 Temporary Water Lease 56
4.3.1.4 Trap-and-Transport Efforts 56
4.3.1.5 Redd Counts 56

5 Other Activities 58
5.1 Water Quality 58

6 Literature Cited 60

List of Figures

Figure 1. Known distribution of bull trout populations associated with Reclamation facilities in the upper Snake River basin. 6
Figure 2. Arrowrock Reservoir elevation for Water Year 2011 11
Figure 3. Arrowrock Reservoir discharge in cubic feet per second for Water Year 2011. 11
Figure 4. Anderson Ranch Reservoir elevations for Water Year 2011. 12

Figure 5. Anderson Ranch Reservoir storage volumes for Water Year 2011e. 12
Figure 6. Deadwood Reservoir storage volumes (acre-feet) for Water Year 2011. 16
Figure 7. Beulah Reservoir storage volumes (acre-feet) for Water Year 2011 18
Figure 8. Limnologic and hydrologic sampling locations in the Boise River basin, 2011. 20
Figure 9. Limnologic and hydrologic sampling locations in the Deadwood study area, 2011. 36
Figure 10. Water quality sampling locations in the Deadwood Reservoir, tributaries and the Deadwood River Reach study sections 39
Figure 11. Deadwood River productivity sample sites on the Deadwood and South Fork Payette rivers and Clear Creek for prey base portion of Deadwood Reservoir Flexibility Study Proposal. 49
Figure 12. Locations of experimental gill net and fyke net sets and bull trout capture locations during the spring 2011 sampling in Beulah Reservoir. 54
Figure 13. Locations and numbers of experimental gill net and fyke net sets locations during the fall 2011 sampling in Beulah Reservoir 55
Figure 14. Bull trout redds observed in the North Fork Malheur River watershed between 1992 and 2011 and carryover storage in Beulah Reservoir 57

List of Tables

Table 1. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Arrowrock Dam and Reservoir facility operations during the 2011 reporting period..... 8
Table 2. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Anderson Ranch Dam and Reservoir facility operations during the 2011 reporting period. 10
Table 3. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Deadwood Dam and Reservoir facility operations during the 2011 reporting period..... 14
Table 4. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Beulah Dam and Reservoir facility operations during the 2011 reporting period..... 17
Table 5. Total catch summary for Boise River basin in 2011, including numbers of each species captured and percent of total catch from weirs, fyke nets, beach seine hauls, and gill netting. 22
Table 6. Weir sampling summary for North Fork Boise and Middle Fork Boise rivers in 2011, including species, total count, and percent of total catch. 24
Table 7. Fyke net sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort, and percent of total catch. 25

Table 8. Beach seine sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort, and percent of total catch. 26
Table 9. Gill net sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort, and percent of total catch. 27
Table 10. Total catch summary for 2011 including numbers of each species captured and percent of total catch. 32
Table 11. Fyke net sampling summary for Deadwood Reservoir in 2011, including species, total catch, catch per unit of effort, and percent of total catch. 34
Table 12. Beach seine sampling summary for Deadwood Reservoir in 2011, including species, total catch, catch per unit of effort, and percent of total catch. 35
Table 13. Numbers of each species captured, fish per 100 meters of stream shocked, and percent of total catch for all 2011 electrofishing sampling efforts above Deadwood Dam 37
Table 14. Water quality parameters measured in the field and laboratory processed for Deadwood River and Reservoir, 2011. 40
Table 15. Reservoir sampling locations and frequency of sampling for Deadwood River and Reservoir, 2007-2011. 41
Table 16. Total catch summary for 2011, including numbers of each species captured and percent of total catch 44
Table 17. Combined 2011 total catch summary for Wilson, No Man, and South Fork Scott creeks, including numbers of each species captured, fish per 100 meters of stream, and percent of total catch. 45
Table 18. Summary of fish species captured and percent of total catch for all 2011 stranding pool salvage efforts along the mainstem Deadwood River below Deadwood Dam. 46

1 INTRODUCTION

The Bureau of Reclamation (Reclamation) consulted with the U.S. Fish and Wildlife Service (USFWS) on 12 proposed actions involving the effects of future operations and routine maintenance at 12 federal projects in the upper Snake River basin. In March 2005, USFWS completed a non-jeopardy Biological Opinion (2005 Opinion) for Reclamation operations and maintenance activities in the Snake River basin above Brownlee Reservoir. The 2005 Opinion contains a 30-year incidental take statement (ITS) and corresponding reasonable and prudent measures (RPMs) that outline nondiscretionary actions to minimize take for bull trout (*Salvelinus confluentus*) (USFWS 2005).

Section 9 of the Endangered Species Act (ESA) defines take as any action that can harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in such conduct toward an ESA-listed species. Under the terms of Section 7(b)(4) and Section 7(o)(2), take that is incidental to and not intended as part of the agency action is not considered to be a prohibited take under the ESA, provided that such take is in compliance with the terms and conditions of the ITS. The ITS has two main components: 1) a monitoring component to ensure the action agency does not exceed the amount or extent of incidental take described in the ITS, and 2) RPMs to minimize the amount or extent of take without altering the basic design, location, scope, duration, or timing of the action. The 2005 Opinion requires Reclamation to provide an annual report to the USFWS by March 31 of each year reporting incidental take monitoring efforts and implementation status of all RPMs and terms and conditions. The submittal date was changed from December 31 to March 31 after USFWS agreed to a request by Reclamation for a permanent change (letter dated November 13, 2007).

This document is submitted as Reclamation's annual report for Water Year (WY) 2011 (October 1, 2010, to September 30, 2011). This is an appropriate reporting period, but presents a challenge because annual minimum reservoir contents occur near the end of the reporting period. For 2011, the minimum contents of several reservoirs occurred in the first few days of the reporting period in October 2010 and are the result of 2010 operations that were reported last year. Generally, the relevant 2011 minima are reported in this report and their relationship to the initial conditions is described when needed to enhance clarity.

Also referenced in this report is a Biological Opinion from the National Oceanic Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries Service), dated May 2008 for the continued operation and maintenance of Reclamation projects in the Snake River basin above Brownlee Reservoir (NOAA Fisheries Service 2008). The ITS included RPMs and associated terms and conditions to minimize incidental take to 13 ESA-listed salmon and steelhead evolutionarily significant units (ESUs) or adversely modify or destroy critical habitat that is designated for three of the ESUs. The annual progress report for the NOAA Fisheries Service Biological Opinion is reported under a different cover (Reclamation 2010).

In addition to bull trout, previous annual reports to the USFWS reported on two species of snails in the Snake River basin: Utah valvata and Snake River physa. The USFWS determined that Utah valvata did not meet the definition of an endangered or threatened species under the Act. The Utah valvata was removed from the List, thereby removing all protections, and subsequent monitoring and reporting requirements, provided by the Act (75 FR 52272). Accordingly 2010 was the last year Reclamation monitored the Utah valvata. A final report on Snake River physa status was completed in 2010 (Gates and Kerans 2010). No field collection activities for Snake River physa were conducted in this reporting period.

2 SUMMARY OF 2011 OPERATIONS

2.1 Idaho

November carryover storage from 2010 was near average in the Payette River basin (99 percent) and in the Boise River basin (99 percent), and slightly below average in the upper Snake River basin above Milner Dam (86 percent). After a wet fall, snowpacks accumulated at a fairly average rate during the winter, although a dry period from mid-January to mid-February threatened that trend. March, however, was very snow-laden and made up for the lag, so that by April 1, snowpacks in these three basins were 105 percent, 99 percent, and 119 percent of average, respectively. April was significantly wet (over 200 percent of average in places) and cold and added substantially to the snowpack, with May 1 values well exceeding the normal April 1 peaks, especially in the upper Snake River basin above Milner Dam where the May 1 snowpack was 160 percent of average for the date, and 142 percent of its average April 1 value. Cool temperatures continued throughout the remainder of spring and early summer, allowing for a drawn out, but high, runoff season. Observed unregulated runoff for the April through July period was 130 percent for the Payette River at Horseshoe Bend, 130 percent for the Boise River near Boise, and 150 percent of average for the Snake River at Heise. While the seasonal volume at Heise was not a record, the amount of runoff in the June through July period set a new record going back over 100 years. The unprecedented late runoff, along with the fact no major flooding occurred, was the most notable feature of the 2011 water year.

The Upper Snake reservoir system refilled completely in 2011. The Boise and Payette reservoir systems had sufficient water to refill completely, but were deliberately held slightly below full (39,900 acre-feet on the Boise system and 2,900 acre-feet on the Payette) in order to move the flow augmentation release to an earlier timeframe as outlined in the 2008 Biological Opinion (NOAA Fisheries Service 2008). Sufficient water was available in 2011 to provide 487,000 acre-feet for Reclamation's flow augmentation program for salmonid species below Brownlee Reservoir. This amount is the upper limit of flow augmentation to be provided in any given year. Contributions to the flow augmentation included 207,500 acre-feet from the upper Snake River above Milner Dam, 160,000 acre-feet from the Payette River basin, 41,851 acre-feet from the Boise River basin, and 77,649 acre-feet of natural flows, 17,649 acre-feet of which originated in Oregon.

2.2 Oregon

Carryover storage going into WY 2011 was much improved over the previous year for the Malheur River basin. The watershed above Beulah Reservoir represents approximately 20 percent of the Malheur River basin. At the beginning of the 2011 WY, carryover storage in Beulah Reservoir was about 6,860 acre-feet, or 113 percent of the 2000-2010 average due to near average runoff in 2010. WY 2011 was an extremely wet year in the Malheur River basin, and unregulated runoff for the April through July period was 214 percent of the 1971-2000 average for Beulah Reservoir, thanks primarily to a cool and wet spring. Beulah Reservoir filled to capacity (59,212 acre-feet) in 2011 and was drafted to 31 percent of reservoir capacity (18,359 acre-feet) on September 30. The Malheur River basin does not contribute to Reclamation's flow augmentation program.

Flow information for the 2011 WY (October 1, 2010, to September 30, 2011) can be found at Reclamation's Hydromet website (Reclamation 2012a). Reservoir water operations including daily average reservoir elevations, acre-feet contents, storage, and outflow for the following sites are discussed in detail later in this report:

- American Falls Reservoir and Lake Walcott
- Anderson Ranch Reservoir
- Arrowrock Reservoir
- Deadwood Reservoir
- Beulah Reservoir

3 BULL TROUT

3.1 Introduction and Background

Bull trout are present in four of Reclamation's facilities in the upper Snake River basin (Figure 1). This chapter describes the bull trout ITS including monitoring efforts and RPMs during WY 2011. Operational thresholds, population monitoring, and other relevant bull trout work managed by Reclamation and work associated with research projects that addresses specific RPMs are described in this report. In addition, other relevant bull trout work not managed by Reclamation may be discussed in this report if directly relevant to bull trout or bull trout critical habitat within Reclamation's projects.

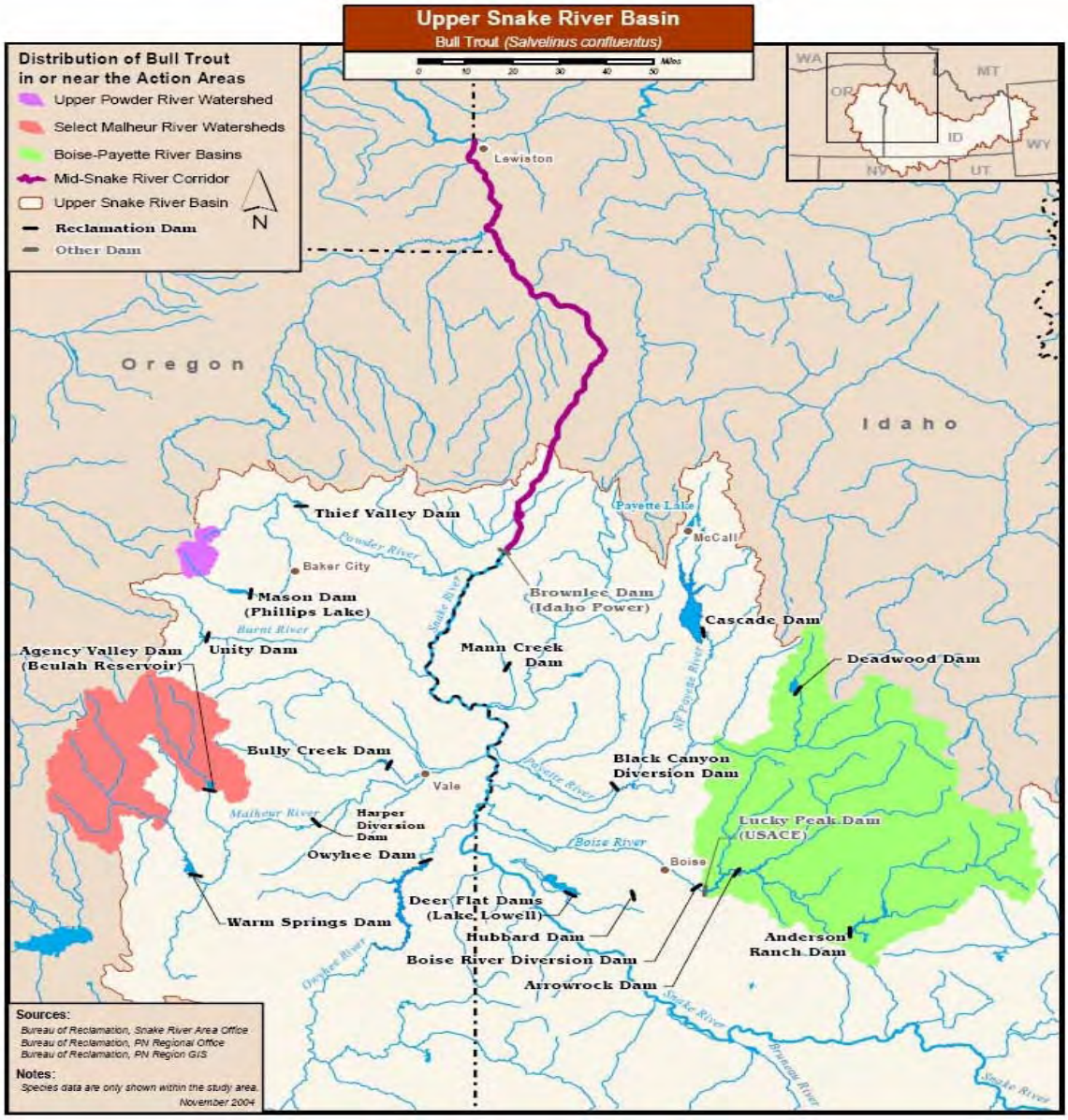

Figure 1. Known distribution of bull trout populations (shaded areas on map) associated with Reclamation facilities in the upper Snake River basin (Reclamation 2004).

The USFWS determined incidental take by correlating frequencies and magnitudes of streamflow and reservoir conditions at specific facilities with an estimate of population effects during critical seasonal time periods in the bull trout's life history. The USFWS then described the amount or extent of incidental take at each facility based on operational thresholds as stated in Table 1 through Table 4 (USFWS 2005).

3.2 Bull Trout Monitoring

The Monitoring and Implementation Plan identifies how Reclamation will monitor bull trout throughout the duration of the 2005 Opinion (Reclamation 2006). Monitoring elements include evaluating operational indicators and tracking population trends. To monitor compliance with the operational thresholds defined in the ITS, operations for WY 2011 were monitored, evaluated, and summarized using Reclamation's Hydromet system (Reclamation 2012b). Operational thresholds affecting the amount or extent of anticipated take are described in the following sections. Monitoring population trends do not occur annually at each of the four facilities.

3.2.1 Boise River Basin Operational Indicators

Two operational indicators were exceeded during the 2011 reporting period in the Boise River basin. Anderson Ranch Reservoir stored and released water (Table 1); however, Reclamation has an exemption for this action 30 of the 30 years in the 2005 Opinion. Also, the reservoir volume in Arrowrock Reservoir was less than 200,000 acre-feet by the end of June. Reclamation has an exemption for this action 3 of 30 years. Figure 2 through Figure 5 illustrate how water was stored and released at Anderson Ranch Dam and Arrowrock dams during WY 2011.

Boise River basin bull trout population trend monitoring activities occurred during WY 2011. Migration weirs were operated on the Middle and North Fork Boise rivers to enumerate the migratory portion of the Arrowrock Reservoir adfluvial bull trout population. A data summary is provided in Section 4 of this report.

Table 1. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Arrowrock Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Arrowrock Dam and Reservoir	Up to 50 percent of the Middle and North Fork populations are affected by low reservoir productivity and decreased prey.	Reservoir volume of less than 200,000 acre-feet by the end of June.	June 30	3 of 30 years	Reservoir volume fell below 240,439 for 14 days during June in 2011 (June 1-14, 2011).	3 of 3 years 2007: yes 2008: 0 2009: 0 2010: yes 2011: yes
	Up to 8 percent of bull trout in the reservoir are entrained into Lucky Peak Reservoir, as averaged over any consecutive 5-year period.	Water is discharged over the spillway.	March through June	15 of 30 years	Spillway use did not occur during the reporting period.	1 of 15 years 2007: 0 2008: 0 2009: 0 2010: 0 2011: 0
	Up to 2 percent of bull trout in the reservoir are entrained into Lucky Peak Reservoir.	Discharge exceeds 695 cfs while the reservoir water surface elevation is less than 3,111 feet (Figure 3).	July through September	30 of 30 years	Res. surface elevation did not drop below 3,111 during the 2011 Water Year (Figure 2).	4 of 30 years 2007: 48 days 2008: 1 day 2009: 3 days 2010: 0 days 2011: 0 days

Table 1 continued. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Arrowrock Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Arrowrock Dam and Reservoir	Up to 20 percent of bull trout in the reservoir, as averaged over any 5 consecutive years, experience habitat degradation and predation.	Mean daily reservoir elevation falls below 3,100 feet.	September 15 through October 31	18 of 30 years	Res. surface elevation did not drop below 3,111 during the 2011 Water Year (Figure 2).	0 of 18 years 2007: 0 2008: 0 2009: 0 2010: 0 2011: 0
	Up to 5 percent of bull trout in the reservoir are entrained into Lucky Peak Reservoir, as averaged over any consecutive 5-year period.	Discharge exceeds 695 cfs while the reservoir water surface elevation is less than 3,111 feet (Figure 3).	winter	20 of 30 years	Reservoir elevations did not drop below 3,111 in the winter months of 2011 (Figure 2).	0 of 20 years 2007: 0 2008: 0 2009: 0 2010: 0 2011: 0

Table 2. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Anderson Ranch Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Anderson Ranch Dam	Up to 50 percent of the North and Middle Fork Boise Rivers' spawning population are affected by spillway discharges that disrupt timing of migration and spawning and that alter metabolic rates and up to 10 percent of bull trout in the reservoir are entrained into the SF Boise River.	Water is discharged over the spillway.	spring	6 of 30 years	Spillway use did not occur during the reporting period.	1 of 6 years 2007: 0 2008: 0 2009: 0 2010: 0 2011: 0
	Up to 50 percent of the North and Middle Fork Boise Rivers' spawning population are affected by the altered flow and temperature regime that disrupts migration and spawning and that increases metabolic rates.	Water is stored and released at Anderson Ranch Dam.	spring through fall	30 of 30 years	Anderson Ranch Reservoir elevations for WY 2011 are shown in Figure 4.	5 of 30 years 2007:spring/fall 2008: spring/fall 2009: spring/fall 2010: spring/fall 2011: spring/fall
	Up to 4 percent of bull trout in reservoir experience degraded water quality.	Reservoir storage volume falls below 62,000 acre-feet.	summer	2 of 30 years	Reservoir storage volume was maintained above 62,000 acre-feet (Figure 4).	0 of 2 years 2007: 0 2008: 0 2009: 0 2010: 0 2011:0

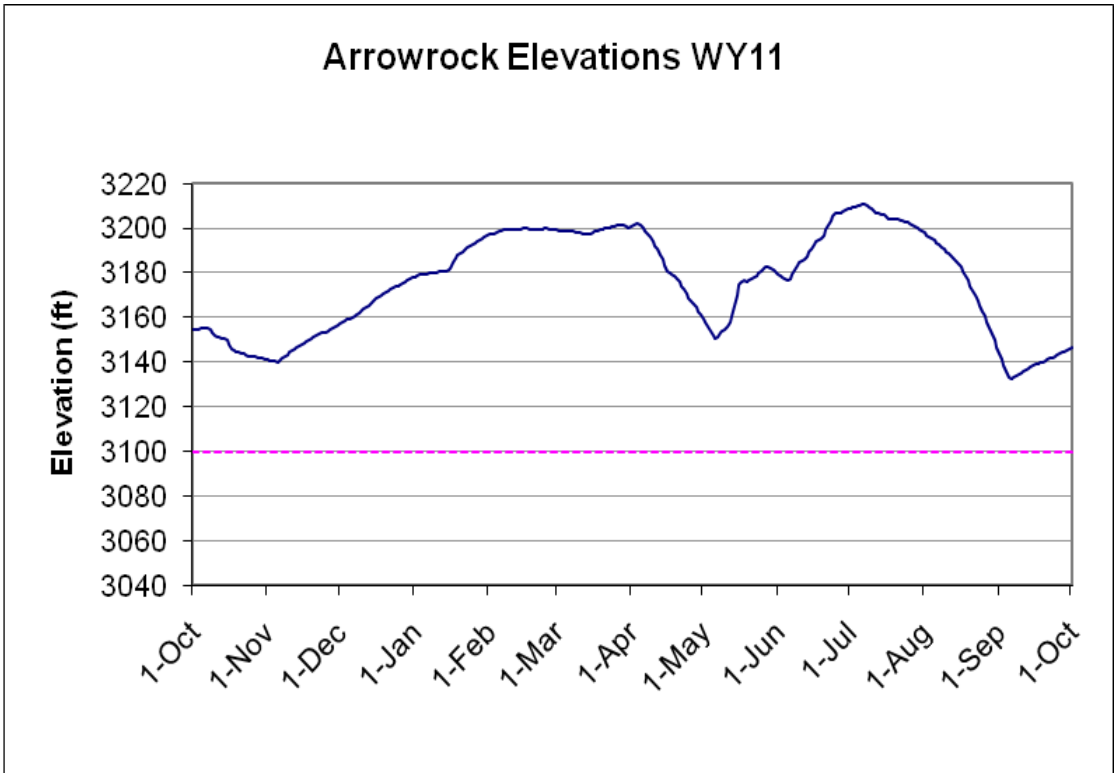

Figure 2. Arrowrock Reservoir elevation (feet above sea level) for Water Year 2011 (WY11). Bottom dotted line represents Reclamation's fall minimum threshold at elevation 3100 feet.

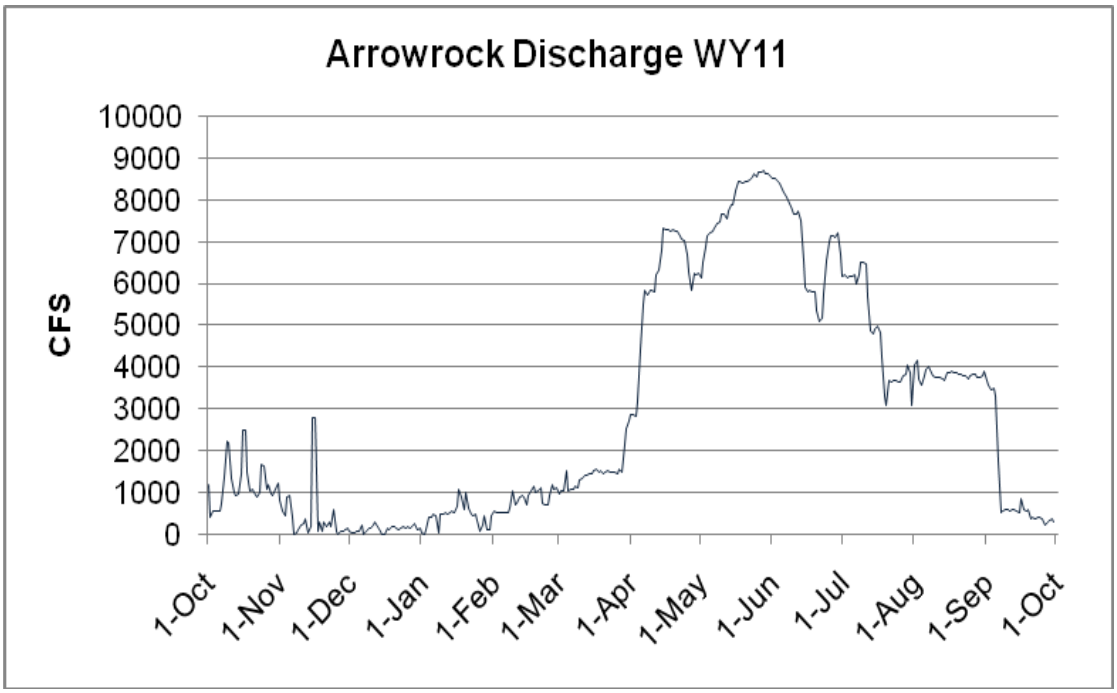

Figure 3. Arrowrock Reservoir discharge in cubic feet per second (cfs) for Water Year 2011 (WY11).

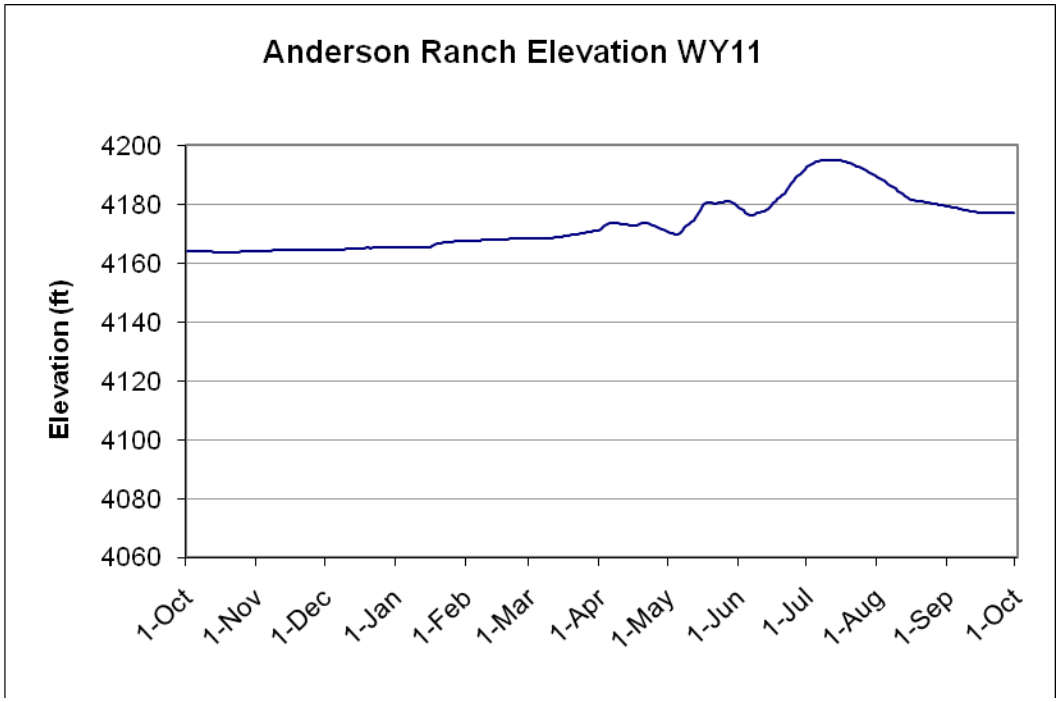

Figure 4. Anderson Ranch Reservoir elevations (feet above sea level) for Water Year 2011 (WY11).

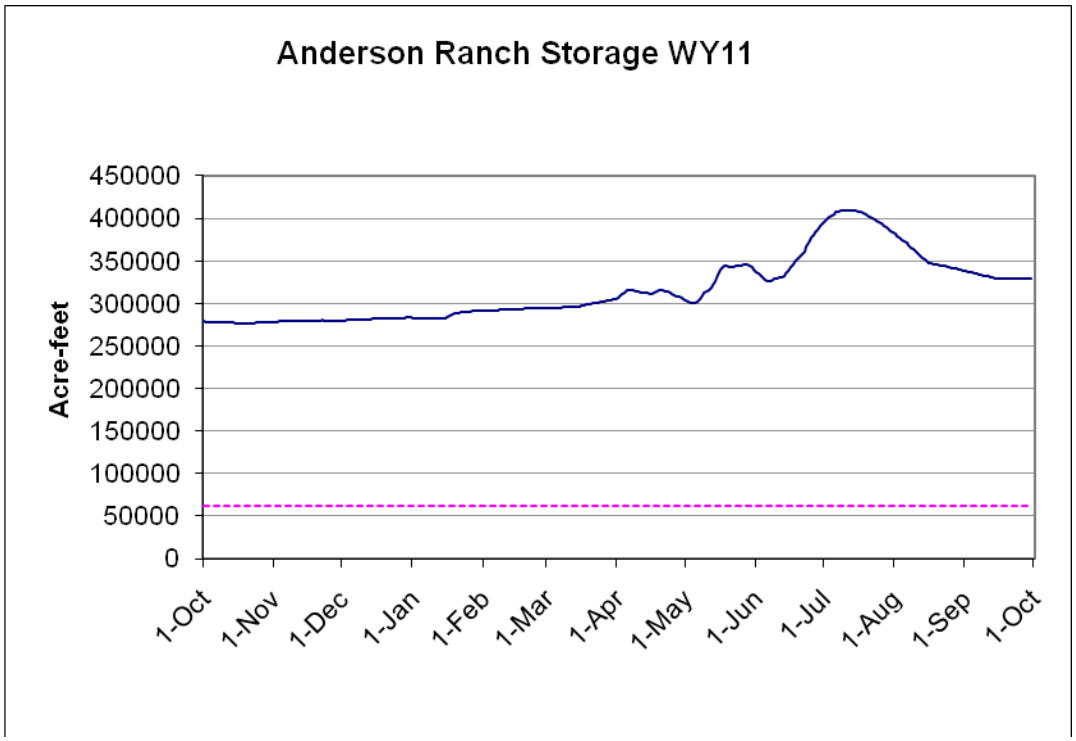

Figure 5. Anderson Ranch Reservoir storage volumes (acre-feet) for Water Year 2011 (WY11). The bottom dotted line represents Reclamation's minimum threshold of 62,000 acre-feet of storage.

1.1.1 Payette River Basin Operational Indicators

One operational indicator was exceeded during the 2011 reporting period in the Payette River basin with deep water releases occurring throughout the year at Deadwood Dam (Table 3). Reclamation has an exemption for this action 30 of the 30 years. Figure 6 illustrates Deadwood Reservoir storage volume in WY 2011.

Payette River basin bull trout population trend monitoring activities did not occur during the WY 2011.

Table 3. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Deadwood Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Deadwood Dam	Up to 2 to 4 percent of bull trout in Deadwood Reservoir are entrained into the Deadwood River below the dam.	Water discharged over the spillway.	spring	11 of 30 years	Water was discharged over the spillway for 0 days during WY11.	4 of 12 years 2007: 33 days 2008: 33 days 2009: 0 days 2010: 15 days 2011: 0 days
	Up to 2 to 4 percent of bull trout in Deadwood Reservoir are affected by degraded water quality.	Reservoir storage volume falls below 50,000 acre-feet.	August through October	2 of 30 years	Reservoir storage volumes were maintained between 86,473 and 153,276 acre-feet during WY11 (Figure 6).	0 of 2 years 2007: 0 2008: 0 2009: 0 2010:0 2011: 0
	All bull trout in the Deadwood River downstream from the dam are affected by spillway discharges that disrupt timing of migration and spawning and that alter metabolic rates.	Water is discharged over the spillway.	May through July	11 of 30 years	Water was discharged over the spillway for 0 days during WY11.	4 of 11 years 2007: 33 days 2008: 33 days 2009: 0 days 2010: 15 days 2011: 0 days

Table 3 continued. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Deadwood Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Deadwood Dam	All bull trout in the Deadwood River downstream from the dam are affected by low winter stream flows and temperatures that affect bull trout movement and growth and reproduction of bull trout and the prey base.	Deep water releases at Deadwood Dam and low flows below the dam.	Spring - temperature increases and flow decreases. Summer - temperature decreases and flow increases. Fall -temperature increases and flow reductions. Winter - temperature increases and flow reductions.	30 of 30 years	All releases are deep water releases except for water discharged over the spillway.	5 of 30 years 2007: all year 2008: all year 2009: all year 2010: all year 2011: all year

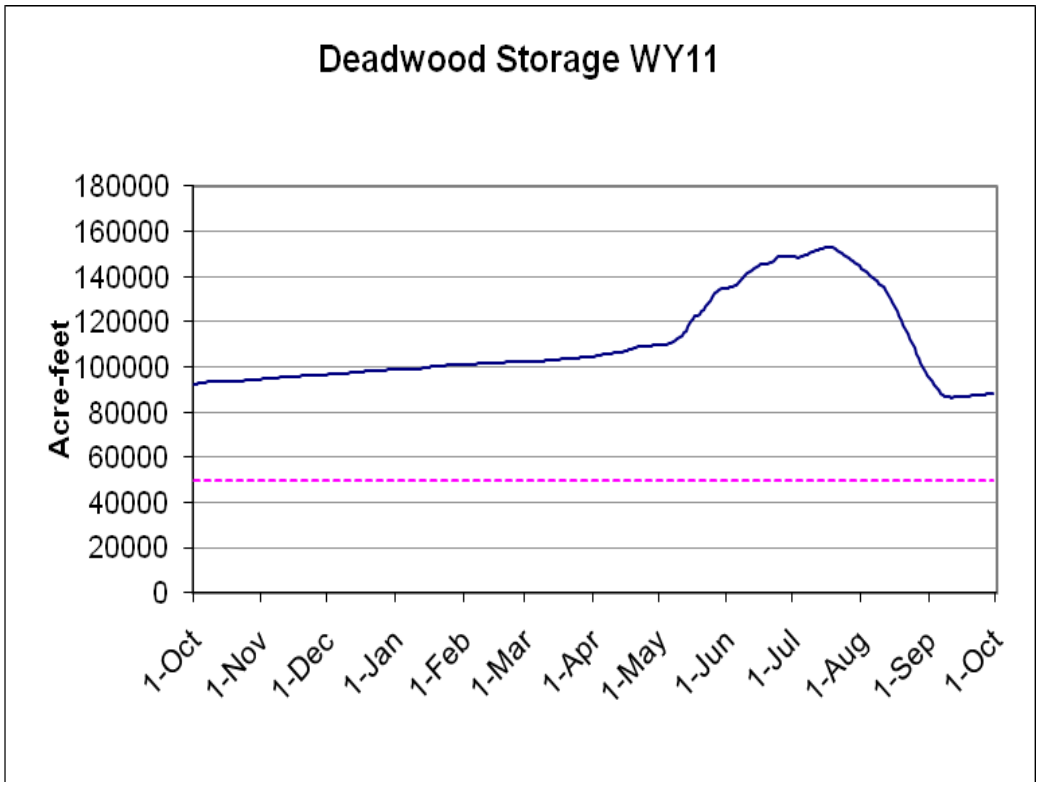

Figure 6. Deadwood Reservoir storage volumes (acre-feet) for Water Year 2011 (WY11). The bottom dotted line represents Reclamation's minimum threshold of 50,000 acre-feet of storage.

1.1.1 Malheur River Basin Operational Indicators

One operational indicator was exceeded during the 2011 reporting period in the Malheur River basin (Table 4). Water was released over the spillway in May, resulting in a trap-and-transport effort in the stilling basin to sample bull trout and relocate them upstream of the dam. Reclamation has an exemption for this action for 3 of the 30 years in the Opinion. Figure 7 illustrates the water storage volume in Beulah Reservoir during WY 2011.

Table 4. Summary of amount or extent of anticipated take of bull trout associated with Reclamation's Beulah Dam and Reservoir facility operations during the 2011 reporting period.

Facility	Anticipated Take	Operational Indicators	Critical Season	Frequency of Exemptions	2011 Operations (October 2010 to September 2011)	Quick reference: Times threshold was exceeded
Beulah Dam	Up to 10 percent of bull trout in Beulah Reservoir are entrained into the NF Malheur River below the dam.	Water is discharged over the spillway.	May through June	3 of 30 years	Spillway was used May 15-19, 2011.	2 of 3 years 2007: 0 2008: 0 2009: 0 2010: 0 2011: yes
	All bull trout that return to Beulah Reservoir to over winter are affected by a reduced prey base.	Reservoir storage volume falls below 2,000 acre-feet.	August through October	10 of 30 years	Reservoir storage volume did not fall below 2,000 acre-feet in this reporting period (Figure 7).	4 of 11 years 2007: 60 days 2008: 34 days 2009: 53 days 2010: 28 days 2011: 0 days

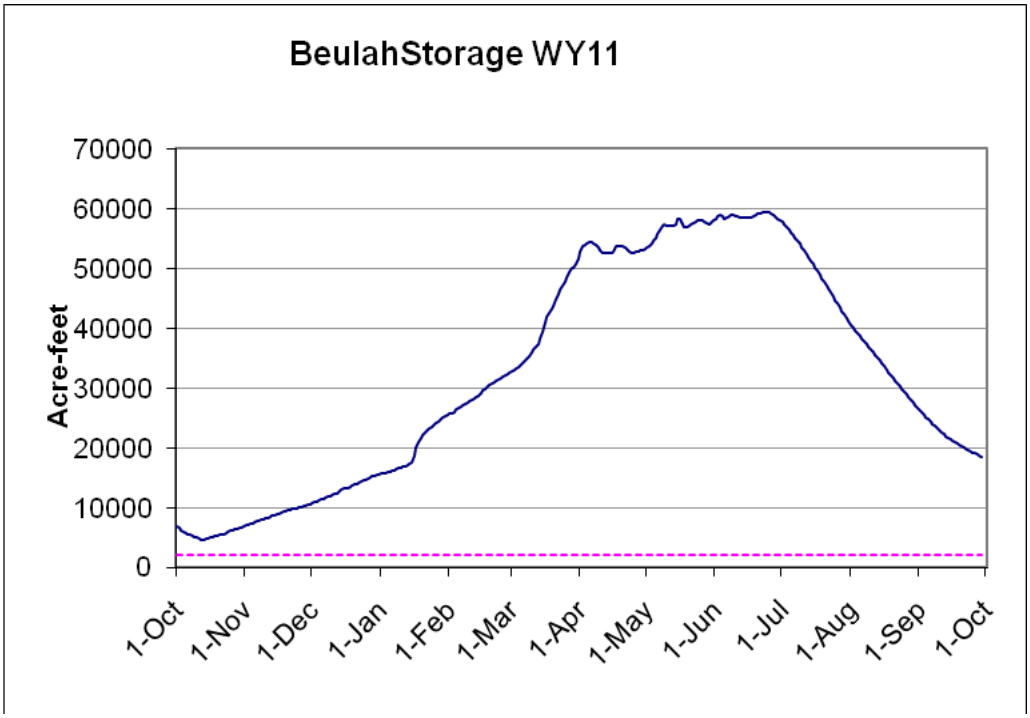

Figure 7. Beulah Reservoir storage volumes (acre-feet) for Water Year 2011 (WY11). The bottom dotted line represents Reclamation's minimum threshold of 2,000 acre-feet of storage.

4 IMPLEMENTATION OF REASONABLE AND PRUDENT MEASURES AND ASSOCIATED TERMS AND CONDITIONS FOR BULL TROUT

The ITS includes four RPMs and associated terms and conditions to minimize incidental take of bull trout related to operations at Reclamation's facilities in the identified action areas where bull trout are present: Arrowrock, Anderson Ranch, Deadwood, and Agency Valley dams and associated reservoirs. Data collected to address these efforts may be used to satisfy terms and conditions and/or monitoring requirements. For example, data collected during a fish sampling activity, may be used to help monitor population trends.

Since the 2005 Opinion was completed, Reclamation has concentrated its data collection efforts in the Deadwood Project area to address the five associated terms and conditions (Section 4.2). Focusing resources at a single project has proven a more efficient way to address the RPMs. Field efforts are concluding at the Deadwood Project and have begun to focus on the Boise River basin starting in 2011. In 2011, Reclamation was involved with RPM activities and/or monitoring at Deadwood, Arrowrock, and Beulah reservoirs.

4.1 Boise River Basin

The USFWS 2005 Opinion identifies five terms and conditions for Reclamation to address in order to minimize the effect and/or amount of take associated with the operation of Arrowrock Dam and two terms and conditions for Anderson Ranch Dam. Each of the terms and conditions addresses a different aspect of the effects of operations on bull trout. Most data collection efforts described in the following sections will be used to assess terms and conditions for both Arrowrock and Anderson reservoirs because the influence of both projects overlap.

Data collection efforts discussed for the Boise River basin during this reporting period include fish sampling, tracking radio-tagged bull trout, hydrologic and water chemistry sampling, trap and transport, a review of 2011 Arrowrock Hydroelectric Project operations, and fisheries management activities performed by the Idaho Department of Fish and Game (IDFG) in Arrowrock Reservoir. For the purpose of this report, the Boise River basin study area includes Arrowrock Reservoir, South Fork Boise River below Anderson Ranch Dam, Middle and North Fork Boise rivers, and Grouse and Cottonwood creeks.

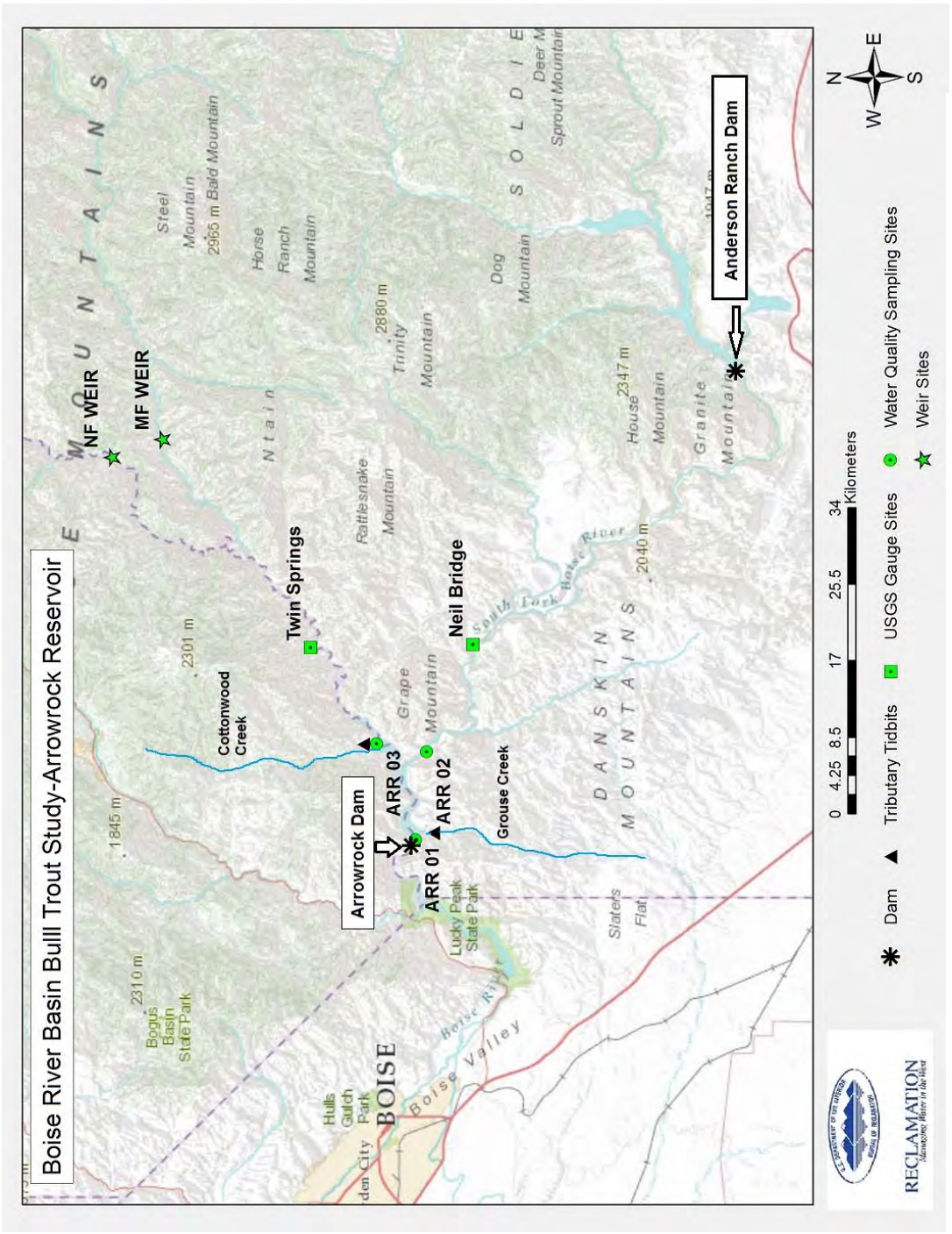

Figure 8. Limnologic and hydrologic sampling locations in the Boise River basin, Idaho 2011. Equipment used to record data varied between locations and included temperature loggers, Hydrolab, and a U.S. Geological Survey water gage (USGS gage). Weir locations on Middle Fork Boise River (River Mile 107) and North Fork Boise River (River Mile 10), Boise County, Idaho.

4.1.1 South Fork Boise River Data Collection

South Fork Boise River data collection included both hydrology and fisheries efforts. Radio-tagged bull trout were tracked in the South Fork Boise River (Term and Condition 2.a. and 2.b.) and are described in Subsection 4.1.2.5. Stream flow and temperature were monitored on the South Fork Boise River and selected tributaries. Bull trout migration behavior and river hydrology conditions will be coupled to assess how operations at Anderson Ranch Dam influence bull trout (Term and Condition 2.a. and 2.b.).

In 2011, Reclamation funded the U.S. Geological Survey (USGS) to establish flow/temperature gages at Neal Bridge on the South Fork Boise River and two tributaries to the South Fork Boise River, Pierce Creek and Dixie Creek, for the purpose of monitoring flow below Anderson Ranch Dam. Data from these gages will be used in conjunction with the bull trout migration work and water quality monitoring for Arrowrock Reservoir.

4.1.2 Fish Sampling

Two separate fish sampling efforts were conducted during this reporting period: migration weirs on the Middle and North Fork Boise rivers and netting on Arrowrock Reservoir (fyke, beach seine and gill netting). Migration weir fish sampling was performed to meet the following objectives: 1) adfluvial bull trout population monitoring and 2) radio tag fish to observe migration behavior. Radio tagged fish will be tracked to monitor behavior during downstream migration (Term and Conditions 1.a.) and prior to spring migration from Arrowrock Reservoir and the South Fork Boise River (Term and Conditions 2.a. and 2.b.). Arrowrock Reservoir fish sampling was performed to meet the following objectives: 1) radio tag fish to observe migration behavior and 2) document the condition of bull trout prey abundance to assist in identifying the affects of Term and Conditions 1.b. By monitoring the behavior of radio-tagged bull trout, Reclamation will also be able to monitor entrainment risk of bull trout through clamshells outlet conduits (Term and Conditions 1.c.). Sampling efforts are first summarized by total effort in the Boise River basin and secondly by individual projects.

A total of 12,372 fish, including 203 bull trout, were sampled in the Boise River basin between August and November 2011. As shown in Table 5, large scale sucker *(Castostomus platyrhynchus)* and northern pikeminnow (*Ptychocheilus oregonensis*) made up over 80 percent of the total catch. Bull trout made up 1.64 percent of the total sample.

Table 5. Total catch summary for Boise River basin in 2011, including numbers of each species captured (total catch) and percent of total catch from weirs, fyke nets, beach seine hauls, and gill netting.

2011 Boise River Basin Total Catch Summary		
Species	**Total Catch**	**Percent**
Bull trout (*Salvelinus confluentus*)	203	1.64
Rainbow trout (*Oncorhynchus mykiss*)	145	1.17
Mountain whitefish (*Prosopium williamsoni*)	297	2.40
Westslope cutthroat (*Oncorhynchus clarki lewisi)*	3	0.02
Rainbow trout/Cutthroat Hybrid	1	0.01
Brook trout *(Salvelinus fontinalis*)	2	0.02
Largescale sucker (*Catostomus macrocheilus*)	6,159	49.78
Mountain sucker (*Castostomus platyrhynchus*)	144	1.16
Northern pikeminnow (*Ptychocheilus oregonensis*)	4,095	33.10
Longnosed dace (*Rhinichthys cataractae*)	3	0.02
49.78+Kokanee salmon (*Oncorhynchus nerka kennerlyi*)	146	1.18
Yellow perch *(Perca flavescens)*	971	7.85
Chiselmouth *(Acrocheilus alutaceus)*	70	0.57
Smallmouth bass *(Micropterus dolomieui)*	133	1.08
Total	**12,372**	**100**

All captured fish were identified by species and enumerated; total length (millimeter [mm]) was recorded for all game species. All bull trout were scanned for a Passive Integrated Transponder (PIT) tag from Biomark Incorporated, Boise, Idaho for individual identification; those without had one installed. Newly captured bull trout that met weight requirements were implanted with radio telemetry transmitters (radio tags; Lotek models MCFT2-3BM, MCFT2-3EM, MCFT2-3FM, SR-TP11-25, and SR-TP11-35) and archival temperature recording tags (archival tags; Lotek Internal model 1410 and external model 1100). The radio tags and internal archival tags were implanted with the modified shielded needle technique described by Ross and Kleiner (1982). The external archival tags were attached with the method described by Howell et al. (2010). The 12 mm PIT tags were inserted into the dorsal sinsus of all bull trout greater than 125 mm in total length. Fish were anesthetized by electronarcosis, a method described by Hudson et al. (2011), or with anesthesia of 100 mg of Tricaine

Methanesulfonate (MS-222) mixed with one liter (L) of water buffered with 100 milligrams per L (mg/L) sodium bicarbonate.

Biological samples collected from bull trout included fin clips (n=191) and scales (n=192) while the bull trout were anesthetized. None of the methods for taking these biological samples were lethal to the fish. Fin clips were sent to the USFWS Genetics Lab in Abernathy, Washington for storage and potential future genetic analysis. Genetic analysis may be used for population assignment within the Boise River basin. Bull trout scales are being analyzed by Reclamation staff to determine general age and growth patterns in the population. A digital image of each scale sample was created and multiple readers will assign ages to each fish by identifying growth annuli. Aging techniques and backcalculating length at age measurements for scales are described by Devries and Frie (1996). Scale samples are being housed at Reclamation's Snake River Area Office in Boise, Idaho.

4.1.2.1 Picket Migration Weirs

Two picket migration weirs were operated by Bureau of Reclamation in 2011. One weir was operated on the North Fork Boise River near Barber Flat between August 30 and October 28, with the exception of October 11 when it was temporarily washed out by a rain event (Figure 8). At this weir, 91 bull trout, ranging from 165 mm to 820 mm in total length, were caught while in operation. Twenty of the bull trout captured at the North Fork Boise weir were tagged with radio tags and/or archival tags; six bull trout surgically implanted with a radio tag only, seven with an archival tag only, and seven with both radio and archival tags.

The second weir was operated on the Middle Fork Boise River near Alexander Flats between August 31 and October 16; however, it was temporarily inoperable from October 5 to October 12 when the weir was partially washed out by a rain event (Figure 8). Sixteen bull trout ranging from 196 mm to 685 mm in total length were caught during this effort. Five radio tags and archival tags were deployed in three bull trout; one bull trout was surgically implanted with an archival tag only, and two with both radio and archival tags. The behavior of radio-tagged bull trout will be summarized upon completion of this project.

A total of 376 fish, including 107 bull trout, were sampled at the Boise River weirs between August 30 and October 28, 2011 (Table 6). The most abundant fish sampled at the weirs were Kokanee salmon (38.83 percent of the total catch) and bull trout (28.46 percent).

Table 6. Weir sampling summary for North Fork Boise and Middle Fork Boise rivers in 2011, including species, total count, and percent of total catch.

2011 North Fork Boise and Middle Fork Boise Rivers Weir Sampling Summary				
Species	**North Fork Weir**	**Middle Fork Weir**	**Total Count**	**Percent**
Bull trout (*Salvelinus confluentus*)	91	16	107	28.46
Rainbow trout (*Oncorhynchus mykiss*)	21	10	31	8.24
Mountain whitefish (*Prosopium williamsoni*)	52	11	63	16.76
Westslope cutthroat (*Oncorhynchus clarki lewisi)*	0	2	2	0.53
Rainbow trout/cutthroat hybrid	1	0	1	0.27
Brook trout *(Salvelinus fontinalis*)	2	0	2	0.53
Largescale sucker (*Catostomus macrocheilus*)	0	3	3	0.80
Chiselmouth (*Acrocheilus alutaceus*)	0	3	3	0.80
Northern pikeminnow (*Ptychocheilus oregonensis*)	3	13	16	4.26
Longnosed dace (*Rhinichthys cataractae*)	3	0	3	0.80
Kokanee salmon (*Oncorhynchus nerka kennerlyi*)	71	75	146	38.83
Total	**243**	**133**	**376**	**100.28**

4.1.2.2 Fyke Netting

A total of 2,869 fish, including 3 bull trout, were sampled using fyke nets in Arrowrock Reservoir for a total of 1,215.21 hours from October 24 to November 10, 2011 (Table 7). Northern pikeminnow and yellow perch were the most abundant fish sampled (cumulatively 91.9 percent of the total catch) and bull trout represented 0.10 percent of the total catch. The total catch per unit (hours) of effort (CPUE) was 2.36 fish per hour.

Table 7. Fyke net sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort (CPUE), and percent of total catch.

2011 Arrowrock Reservoir Fyke Net Summary			
		Hours = 1,215.21	
Species	**Total Count**	**CPUE**	**Percent**
Bull trout (*Salvelinus confluentus*)	3	0.0025	0.10
Bridgelip sucker *(Catostomus columbianus)*	2	0.0016	0.07
Chiselmouth (*Acrocheilus alutaceus*)	5	0.0041	0.17
Hatchery rainbow trout (*Oncorhynchus mykiss*)	22	0.0181	0.77
Wild rainbow trout (*Oncorhynchus mykiss*)	4	0.0033	0.14
Large scale sucker *(Catostomus macrocheilus)*	194	0.1596	6.76
Northern pikeminnow *(Ptychocheilus oregonensis)*	1,970	1.6211	68.67
Yellow perch *(Perca flavescens)*	669	0.5505	23.32
Total	**2,869**	**2.36**	**100**

Newly captured bull trout were implanted via dorsal sinus with a 12 mm PIT tag (n=3). These bull trout ranged from 455 mm to 471 mm in total length. Bull trout were surgically implanted with radio (n=2) and/or archival tags (n=1) as long as the tag weight did not exceed 3 percent of the host fish weight. Behavior of radio and archival tagged bull trout will be summarized upon completion of this project.

4.1.2.3 Beach Seining

A total of 127 fish representing 8 species, including 3 bull trout, were sampled in 13 hauls using beach seine nets in Arrowrock Reservoir from October 24 to November 10, 2011 (Table 8). The most abundant fish sampled were northern pikeminnow, accounting for 48.82 percent of the total catch, followed by hatchery rainbow trout (25.2 percent). Bull trout represented 2.36 percent of the total captures.

Table 8. Beach seine sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort (CPUE), and percent of total catch.

2011 Arrowrock Reservoir Beach Seine Summary			
	Number of Hauls: 13.00		
Species	**Total Count**	**CPUE**	**Percent**
Bull Trout (*Salvelinus confluentus*)	3	0.2308	2.36
Bridgelip Sucker *(Catostomus columbianus)*	4	0.3077	3.15
Chiselmouth (*Acrocheilus alutaceus*)	1	0.0769	0.79
Hatchery Rainbow Trout (*Oncorhynchus mykiss*)	32	2.4615	25.20
Large Scale Sucker *(Catostomus macrocheilus)*	10	0.7692	7.87
Northern Pikeminnow *(Ptychocheilus oregonensis)*	62	4.7692	48.82
Mountain Whitefish (*Prosopium williamsoni*)	5	0.3846	3.94
Yellow Perch *(Perca flavescens)*	10	0.7692	7.87
Total	**127**	**9.77**	**100**

Newly captured bull trout were implanted via dorsal sinus with a 12 mm PIT tag (n=3). These bull trout ranged in total length from 275 mm to 350 mm. None of the bull trout met the 3 percent weight requirement needed to apply a radio or archival tag

4.1.2.4 Gill Netting

A total of 9,015 fish representing 12 species, including 85 bull trout, were sampled using gill nets for a total of 74.28 soak hours in Arrowrock Reservoir from October 24 to November 10, 2011 (Table 9). Largescale sucker and northern pikeminnow comprised 89 percent of the total catch while bull trout represented only 0.94 percent of the total catch.

Table 9. Gill net sampling summary for Arrowrock Reservoir in 2011, including species, total count, catch per unit of effort (CPUE), and percent of total catch.

2011 Arrowrock Reservoir Gill Netting Summary			
	Soak Time(hrs): 74.28		
Species	**Total Count**	**CPUE**	**Percent**
Bull trout (*Salvelinus confluentus*)	85	1.1443	0.94
Bridgelip sucker *(Catostomus columbianus)*	135	1.8174	1.50
Chiselmouth (*Acrocheilus alutaceus*)	66	0.8885	0.73
Cutthroat trout *(Oncorhynchus clarki)*	2	0.0269	0.02
Hatchery rainbow trout (*Oncorhynchus mykiss*)	42	0.5654	0.47
Wild rainbow trout (Oncorhynchus mykiss)	14	0.1885	0.16
Kokanee salmon *(Oncorhynchus nerka)*	5	0.0673	0.06
Large scale sucker *(Catostomus macrocheilus)*	5,952	80.1292	66.02
Northern pikeminnow *(Ptychocheilus oregonensis)*	2,044	27.5175	22.67
Small mouth bass *(Micropterus dolomieui)*	133	1.7905	1.48
Mountain whitefish (*Prosopium williamsoni*)	228	3.0695	2.53
Yellow perch *(Perca flavescens)*	309	4.1599	3.43
Total	**9,015**	**121.37**	**100**

Newly captured bull trout were implanted via dorsal sinus with a 12 mm PIT tag (n=62). These bull trout ranged from 243 mm to 781 mm in total length. Bull trout were surgically implanted with radio tags (n=30) and/or archival tags (n=17) as long as the tag weight did not exceed 3 percent of the host fish weight. Behavior of radio and archival tagged bull trout will be summarized upon completion of this project.

A total of 28 bull trout expired in the Boise River basin in the 2011 field season. This level of mortality was expected based on previous sampling efforts using similar methods in Glacier National Park, Montana; Lake Pend Oreille, Idaho; and Priest Lake, Idaho. Gill nets overall resulted in the lowest survival; however, mesh sizes and soak times were adjusted early during the sampling period which reduced mortality rates substantially. A 1-hour soak time during the first 2 days of sampling resulted in an average of 5.5 bull trout mortalities per day. Reducing soak time by ½-hour resulted in an average fish mortality of 0.85 bull trout mortalities per day for the remainder of the project. Weir mortalities accounted for 14 percent (n=4) of the mortalities. Seven percent (n=2) of the bull trout mortalities were found washed up against the weir and cause of mortality is unknown for these fishes. Three and a half percent (n=1) were captured in poor condition and were found expired at a later date. An

additional 3.5 percent (n=1) expired shortly after surgically implanting a radio tag. Otoliths were extracted from all mortalities and will be analyzed at a later date.

4.1.2.5 Radio Telemetry

The use of radio and archival tag technology is necessary to address the terms and conditions outlined in the 2005 Opinion. Bull trout spatial and temporal use of Arrowrock Reservoir and South Fork Boise, North Fork Boise, and Middle Fork Boise rivers can be documented with these technologies. Information collected on bull trout movement patterns coupled with continuous measurements of water temperature and discharge will be used to identify migratory cues for bull trout migration. Ultimately, this will provide information to implement ramping rates that minimize harassment and/or harm of bull trout in the South Fork Boise River below Anderson Ranch Reservoir.

As part of this investigation, 47 bull trout were surgically implanted with radio tags during the 2011 field season. Of those 47 radio-tagged fishes, 25 were also tagged with either an internal or external archival tags. Ten bull trout were surgically implanted with archival tags only. Data from the radio and archival tags will be summarized upon completion of this project.

The movements of radio-tagged fish were monitored using fixed telemetry sites, mobile tracking, and boat tracking. Fixed telemetry sites were located with the USGS flow monitoring equipment at Neil Bridge and Twin Springs and mobile tracking occurred once a week during the fall 2011 and biweekly during the winter 2011. Mobile telemetry will continue biweekly until the bull trout migration occurs and then will occur at a minimum of once a week on both the North Fork Boise and Middle Fork Boise rivers. Mobile telemetry will be conducted in South Fork Boise River weekly beginning in 2012.

4.1.3 Hydrology and Water Chemistry

Hydrology and water chemistry data were collected in Arrowrock Reservoir and selected tributaries during this reporting period. These data are being used to assess Term and Condition 1.b., and coupled with bull trout migration behavior to assess Term and Condition 2.b.

Reservoir vertical profiles were collected monthly from May through August and in November. Seven water quality parameters were measured at three locations on the reservoir: water temperature, dissolved oxygen concentration, pH, conductivity, turbidity, florescence, and barometric pressure. Hydrology and water quality samples will continue to be sampled through the 2012 field season.

Onset TidbiT temperature thermographs were deployed in Grouse Creek and Cottonwood Creek on May 12, 2011, and were set to record water temperature hourly (Figure 8). Data are manually downloaded a minimum of two times a year. Water temperatures will continue to be collected in Grouse Creek and Cottonwood Creek through the 2012 field season.

4.1.4 Trap-and-Transport Efforts

Bull trout work associated with the 2005 Opinion includes a trap-and-transport effort every 2 years to relocate bull trout from Lucky Peak Reservoir to Arrowrock Reservoir. A trap-and-transport effort was conducted during the spring of 2010; therefore, no trap-and-transport effort was required for the 2011 field season. A trap-and-transport effort is scheduled for the spring 2012 field season.

4.1.5 Other Activities

4.1.5.1 Arrowrock Dam Hydroelectric Project – Boise Project Board of Control

Arrowrock Dam Hydroelectric Project (Project), FERC licensee 4656-020, started operations in 2010. Among the requirements of the FERC license the licensee is obligated to:

1. Monitor water temperature and dissolved oxygen of the water that exits the project
2. Conduct a fish salvage effort in the project tailrace if a shutdown occurs for more than 24 hours when the Lucky Peak Reservoir pool elevation is below elevation 3022 feet
3. Meet with the Arrowrock Hydro Team (IDFG, Reclamation, Army Corps of Engineers, and the USFWS) annually to report operations of the project

During calendar year 2011, the Project operated for 252 days. The lowest dissolved oxygen readings and highest water temperatures occurred during the last week of August and first week of September when the Lucky Peak Reservoir pool was full. Fish salvage and recovery protocols were completed and equipment was obtained; however, the conditions did not arise during 2011 that required a fish salvage-and-recovery effort to take place (BBC 2012).

4.1.5.2 Fish Management in Arrowrock Reservoir – Idaho Department of Fish and Game

The IDFG assisted with fish sampling efforts conducted by Reclamation in the fall 2011. A total of 6,297 suckers (largescale and bridgelip), 72 chiselmouth, and 4,076 pikeminnow were removed from Arrowrock Reservoir during this effort (Butts et al. in press). These fish are known to compete with bull trout for the same prey items (macroinvertebrates and

zooplankton) and are not desired sport fish. A total of 195,396 rainbow trout were also stocked into Arrowrock reservoir between March and November (IDFG 2012).

4.2 Payette River Basin – Deadwood River System

The 2005 Opinion identified five terms and conditions for Reclamation to address in order to minimize the effect and/or amount of take of bull trout associated with the operation of Deadwood Dam. Each term and condition addressed a different aspect of the effects of operations on bull trout and made assumptions regarding the reservoir operation effects on bull trout. Addressing each aspect individually limited Reclamation's understanding of how much flexibility it has in the operation of the system as a whole and the systemic impacts of individual changes in operations; therefore, before an evaluation of the operational flexibility could be done, those impacts needed to be understood and quantified. By addressing the terms and conditions jointly and looking at the system in its entirety, Reclamation can evaluate operational flexibility to minimize biological impacts.

The Deadwood Reservoir Flexibility Study (Flexibility Study) was initiated in 2006 to collectively address all five terms and conditions and their relative tradeoffs and balances when looking for system flexibility in minimizing impacts. The Flexibility Study Proposal outlined the terms and conditions, hypotheses, assumptions, and assessments and identified the data needed to test the hypotheses. Study objectives were described in the Flexibility Study Proposal and encompassed both the Deadwood Reservoir and the Deadwood River reach located below the dam and extending to the confluence with the South Fork of the Payette River (Reclamation 2008).

The year 2011 was the final year of an intensive data collection process to establish a comprehensive understanding of physical and biological factors limiting bull trout productivity as well as understanding bull trout movement in the reservoir and in the river below the dam. A detailed description of the methods can be found in the Flexibility Study Proposal and detailed fish sampling results can be found in Reclamation's 2011 fish sampling report to IDFG (Reclamation 2011). The Flexibility Study involves data collection methods for fish population dynamics, productivity, hydrology, and water chemistry monitoring (Reclamation 2008) and these data are being used in physical, hydrodynamic, and bioenergetic modeling. Instruments in Deadwood Reservoir and the Deadwood River above and below the dam recorded hydrology and water quality data such as temperature, river channel morphology, inflow and outflow quantities, water quality, and reservoir profile characteristics. The information collected from the reservoir is key to understanding how the releases from the dam affect the habitat conditions below the dam under varying operational conditions.

Evaluating the flexibility of the operational effects of Deadwood Dam on aquatic fauna requires an understanding of the potential overall ecosystem response to an operational

change over time. Using modeling and physical and biological parameters measured over the course of this project will allow for an ecosystem analysis of the terms and conditions for Deadwood Reservoir operations and its influence on bull trout populations. The results of the Flexibility Study will be provided at the completion of the project and reported under a different cover.

These efforts involve collaboration between multiple agencies and include annual activities not detailed in this report.

4.2.1 Data Collection in the Reservoir and Tributaries above the Dam

In the Deadwood River system above Deadwood Dam, four methods of fish sampling were used in 2011: fyke netting and beach seining in Deadwood Reservoir; picket weirs in the Deadwood River and Trail Creek; and backpack electrofishing in South Fork Beaver Creek, a tributary to the reservoir, and the upper mainstem Deadwood River. All fishes, including bull trout, were released at the point of capture. Captured bull trout that were of proper size (large enough so the tag weight did not exceed 3 percent of the fish's body weight) were surgically fitted with radio or acoustic transmitters (acoustic tags) and/or archival tags before being released. In addition to sampling bull trout, physical, hydrologic, and water quality data were collected in the river, reservoir, and selected tributaries as outlined in the Flexibility Study Proposal (Reclamation 2008).

4.2.1.1 Fish Sampling

A total of 1,647 fish, including 105 bull trout, were sampled between July and November 2011 in Deadwood Reservoir and tributaries to the reservoir (Table 10; Reclamation 2011). Longnose dace (*Rhinichthys cataractae*) and Westslope cutthrout trout (*Oncorhynchus clarki lewisi*) accounted for about 60 percent of the total catch. Sculpin cottus spps, Chinook salmon (*Oncorhynchus tshawytscha*), and redside shiners (*Richardsonius balteatus*) were the least abundant of the sampled species all, collectively accounting for less than 1 percent of the total catch. Bull trout were 6.38 percent of the total catch.

Table 10. Total catch summary for 2011 including numbers of each species captured (total catch) and percent of total catch. Includes catches from fyke nets and beach seine hauls in Deadwood Reservoir and backpack electroshocking in the tributaries to the reservoir.

2011 Deadwood Reservoir and tributaries total catch summary		
Species	**Total Catch**	**Percent of total**
Bull trout (*Salvelinus confluentus*)	105	6.38
Westslope cutthroat trout (*Oncorhynchus clarki lewisi*)	337	20.46
Cutthroat/Rainbow hybrid	21	1.28
Rainbow trout (*Oncorhynchus mykiss*)	192	11.66
Redside shiner (*Richardsonius balteatus*)	2	0.12
Sculpin (*Cottus spps*.)	7	0.43
Longnose dace (*Rhinichthys cataractae)*	661	40.13
Mountain whitefish (*Prosopium williamsoni*)	294	17.85
Kokanee salmon (*Oncorhynchus nerka)*	22	1.34
Chinook salmon (*Oncorhynchus tshawytscha*)	6	0.36
Total	**1,647**	**100**

All captured fish were identified by species and enumerated; total length was recorded for all game species. Some newly captured bull trout were implanted with radio tags (Lotek models SR-TP11-25, SR-TM11-25, and SR-TP16-25), acoustic tags (Lotek model MM-M-8-SO), or archival tags (Lotek Internal model 1410 and external model 1100). A total of 12 mm PIT tags were inserted into the dorsal sinsus of all new bull trout greater than 125 mm in total length. Fish were anesthetized using either 100 mg MS-222 to 1 L of water buffered with sodium bicarbonate (also 100 mg/L) or electronarcosis as described by Hudson et al. (2011). MS-222 was the primary method of anesthesia used for electrofishing. Surgery methods used to implant radio, acoustic, and internal archival tags followed a modified shielded needle technique described by Ross and Kleiner (1982). The method for attaching external archival tags is described by Howell et al. (2010).

In 2011, a total of nine radio tags (seven of which were paired with archival tags) and five acoustic tags were deployed. Of these 14 bull trout, 12 were tracked through the end of the season. Two radio tags were recovered. There were also 16 radio tags from previous years (11 from 2010, 3 from 2009, and 1 each from 2008 and 2007) that were sporadically located during the 2011 project season. Of those 16 fish, only 3 were known mortalities.

Biological samples collected from bull trout included fin clips (n=71), scales (n=71), and gut samples (n=15). Fin clips were sent to the USFWS Genetics Lab in Abernathy, Washington. Genetic analysis may be used for population assignment within the South Fork Payette River basin using methods described in DeHann and Ardren (2008). Bull trout scales are being analyzed by Reclamation staff to determine general age and growth patterns in the population. Digital images of scales from each fish are created and multiple readers assign ages by identifying growth annuli. Aging techniques and backcalculating length at age measurements from scales are described by Devries and Frie (1996). Scale samples are being housed at Reclamation's Snake River Area Office in Boise, Idaho. Gut samples are being analyzed by the USFS Rocky Mountain Research Station in Boise, Idaho and afterward will be housed at Reclamation's Snake River Area Office. The collection of fin clips, scales, and gut samples occurred while bull trout were anesthetized. None of the methods for taking these biological samples were lethal to the fish. Bioenergetic modeling, scheduled to occur after field studies are complete, will utilize data from age, growth, and diet analyses.

4.2.1.2 Fyke Netting

A total of 1,387 fish, including 57 bull trout (29 of which were recaptures), were sampled using fyke nets in Deadwood Reservoir from July 6 to August 25, 2011, for a total of 691.25 hours (Table 11; Reclamation 2011). Species composition was similar to previous accounts for littoral fish assemblages in the reservoir. Mountain whitefish and longnose dace were the most abundant fish sampled (cumulatively 65.97 percent of the total catch) while bull trout represented 4.11 percent of the total catch. The total CPUE increased in 2011 to 2.01 from 0.49 fish per hour in 2010.

Table 11. Fyke net sampling summary for Deadwood Reservoir in 2011, including species, total catch, catch per unit of effort (CPUE), and percent of total catch.

2011 Deadwood Reservoir fyke net summary			
	Hours = 691.25		
Species	**Total Catch**	**CPUE (fish/hour)**	**Percent of total**
Bull Trout (*Salvelinus confluentus*)	57	0.08	4.11
Cutthroat Trout (*Oncorhynchus clarki lewisi*)	231	0.33	16.65
Cutthroat/Rainbow hybrid	9	0.01	0.65
Rainbow Trout (*Oncorhynchus mykiss*)	166	0.24	11.97
Redside Shiner (*Richardsonius balteatus)*	2	0.00	0.14
Sculpin *Cottus spps.*	7	0.01	0.50
Longnose Dace (*Rhinichthys cataractae)*	655	0.95	47.22
Mountain Whitefish (*Prosopium williamsoni*)	260	0.38	18.75
Total	**1387**	**2.01**	**100**

All newly captured bull trout were fitted with a 12 mm PIT tags (n=29). PIT tags were inserted via dorsal sinus for all bull trout greater than 125 mm. Bull trout captured ranged from 125 mm to 480 mm in total length. Bull trout were surgically implanted with either an acoustic (n=5) or a radio tag (n=7) as long as the tag weight did not exceed 3 percent of the body weight of that fish. Four bull trout were also fitted with either an internal or external archival tag. Five of the seven radio-tagged bull trout were tracked through the end of the reporting period; the two remaining tags were recovered. Behavior of radio-tagged bull trout will be summarized upon completion of this project.

4.2.1.3 Beach Seine

A total of 108 fish, including 3 bull trout (all of which were recaptures), were sampled using beach seine nets in Deadwood Reservoir for a total of 1.75 hours between August 30 and September 7, 2011 (Table 12; Reclamation 2011). The most abundant fish sampled were cutthroat trout, which accounted for 43.52 percent of total catch, and bull trout were the least abundant, being 2.78 percent of total catch. The total CPUE using this method is 61.71 fish per 1.75 hours.

Table 12. Beach seine sampling summary for Deadwood Reservoir in 2011, including species, total catch, catch per unit of effort (CPUE), and percent of total catch.

2011 Deadwood Reservoir Beach Seine Summary			
	Hours = 1.75		
Species	Total Catch	CPUE (fish/hour)	Percent of total
Bull Trout (*Salvelinus confluentus*)	3	1.71	2.78
Cutthroat Trout (*Oncorhynchus clarki lewisi*)	47	26.86	43.52
Cutthroat/Rainbow hybrid	12	6.86	11.11
Kokanee salmon (*Oncorhynchus nerka*)	5	2.86	4.63
Rainbow Trout (*Oncorhynchus mykiss*)	18	10.29	16.67
Mountain Whitefish (*Prosopium williamsoni*)	23	13.14	21.30
Total	**108**	61.71	100

4.2.1.4 Hook-and-Line Sampling

Hook-and-line sampling was not conducted as a method for capturing bull trout in 2011, but occurred on several occasions during off-duty hours. Although other fish species were not noted, one bull trout (total length of 447 mm) was captured twice during these efforts. This previously uncaptured bull trout was fitted with a PIT tag, a radio tag, and an external archival tag. It was tracked through the end of the season and on October 27, 2011, was recaptured near the dam with a gill net and data from its archival tag were retrieved.

4.2.1.5 Picket Weirs

In 2011, two picket migration weirs were operated by IDFG, one at the mainstem inflow of the Deadwood River into the Deadwood Reservoir and the other in Trail Creek just above the AquaRod water level gauge (AquaRod) and the Onset TidbiT temperature logger (TidbiT) location (Figure 9). The mainstem weir was operated from August 15 to September 13, 2011, but no bull trout were captured. Reclamation aided in the operation of the Trail Creek weir from August 15 to October 13, 2011, during which nine bull trout were captured (five recaptures) ranging in length from 148 mm to 510 mm in total length (Alsager et al. in press). The four newly captured bull trout were fitted with a PIT tag and one was also surgically implanted with a radio and an internal archival tag. This fish was tracked through the end of the reporting period. One of the recaptured bull trout was also fitted with an external archival tag. Behavior of radio-tagged bull trout will be summarized upon completion of this project.

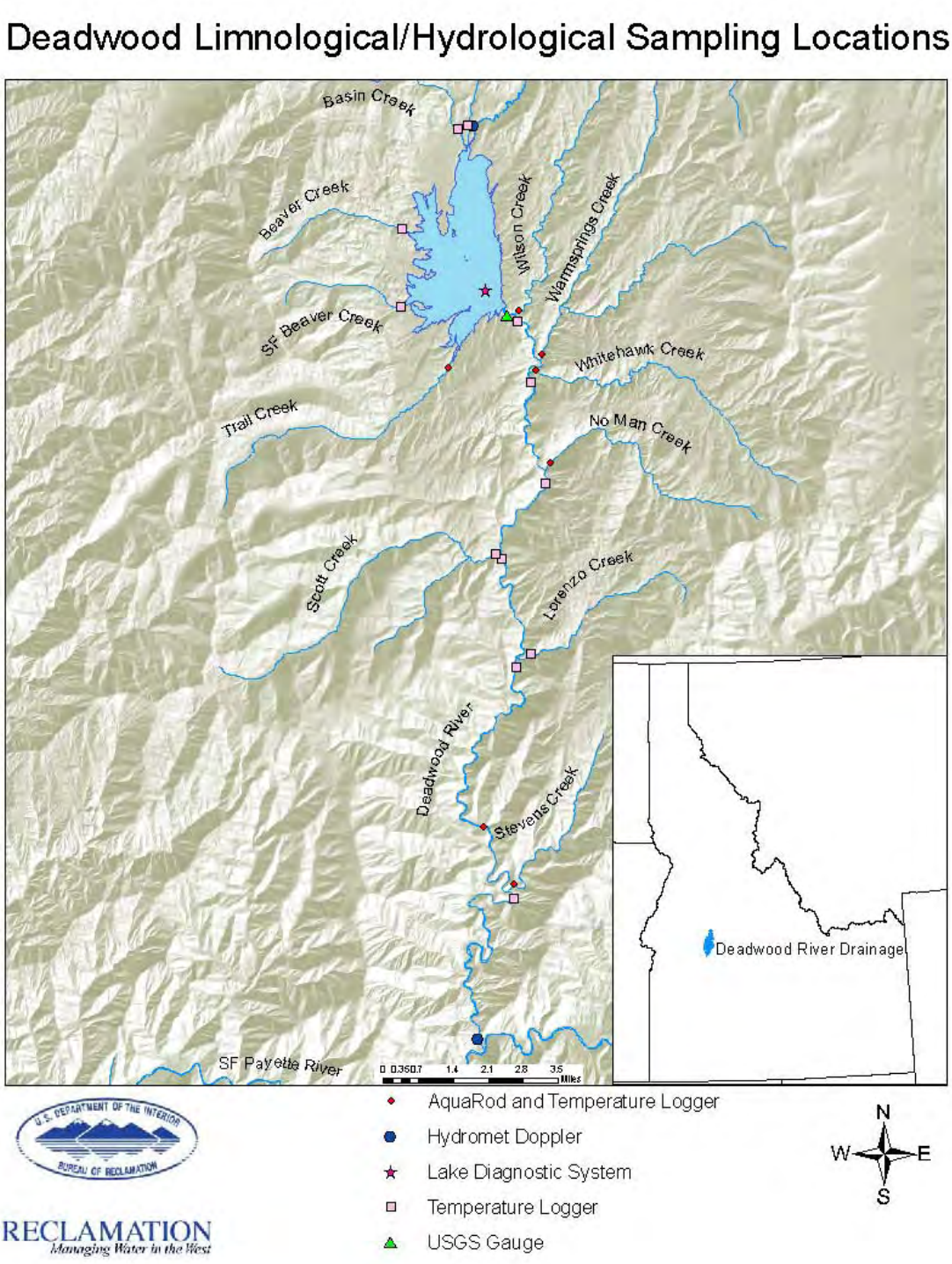

Figure 9. Limnologic and hydrologic sampling locations in the Deadwood study area, Idaho 2011. Equipment used to record data varied between locations and included AquaRods and TidbiTs, a lake diagnostic system, an Acoustic Doppler Current Meter, and a U.S. Geological Survey water gage (USGS gage).

4.2.1.6 Backpack Electroshocking

From early July through early August 2011, South Fork Beaver Creek, which flows directly into the reservoir and the upper mainstem Deadwood River were sampled with Smith-Root backpack electroshockers. The two main goals of this effort were to collect bull trout for genetic samples to determine natal origin and radio tag bull trout for monitoring of their migration habits. From these two tributaries, 101 fish were collected representing 4 species (Table 13: Reclamation 2011). The most abundant fish sampled were cutthroat trout, which accounted for 56.44 percent of total catch, followed by bull trout at 33.66 percent.

Table 13. Numbers of each species captured (total catch), fish per 100 meters of stream shocked, and percent of total catch for all 2011 electrofishing sampling efforts above Deadwood Dam. A total of 816.1 meters of stream was sampled.

Deadwood Basin Tributary Electroshocking Summary			
Species	**Length (m) shocked = 816.1**		
	Total Catch	**Fish/100m**	**Percent of total**
Bull Trout (*Salvelinus confluentus*)	34	4.17	33.66
Cutthroat Trout (*Oncorhynchus clarki lewisi*)	57	6.98	56.44
Rainbow Trout (*Oncorhynchus mykiss*)	1	0.12	0.99
Mountain Whitefish (*Prosopium williamsoni*)	9	1.10	8.91
Total	**101**		**100.00**

All newly captured bull trout were fitted with a PIT tag (n=33) and total lengths ranged from 104 mm to 557 mm. Due to a lack of radio tag availability, none of the bull trout captured using this method received a radio tag in 2011.

4.2.1.7 Radio Telemetry

Behavior of radio-tagged bull trout has varied since the radio telemetry work started in 2006 and will be summarized upon completion of this project. In general, tributary inflow (timing and extent of spring runoff) as well as reservoir and tributary water temperatures appear to influence the behavior and migration timing of bull trout in the reservoir.

In 2011, annual mortality of radio tagged bull trout above the dam was lower than the average (36.7 percent) of all six study years. Two of the nine bull trout that were radio tagged in 2011, died in 2011 (22 percent), compared to 38 percent in 2006, 78 percent in 2007, 34 percent in 2008, 20 percent in 2009, and 17 percent in 2010. None of the 2011 mortalities were directly related to the surgery process. Bull trout that were fitted with acoustic tags were

not included in the mortality rate for 2011 because there was a minimal amount of data collected from these tags due to difficulties with tracking instrumentation.

4.2.2 Hydrology and Water Chemistry

Evaluation of the 2007 hydrology and water chemistry data indicated a need for some modifications to the sampling program. Analyses of silica concentrations and low-level detection analyses for nitrogen and phosphorus were initiated in 2008 and continued in 2011. The trichromatic spectrophotometric method used in 2007 for chlorophyll-a analyses was changed in 2008 through 2011 to an acid-corrected spectrophotometric one that yields values for both chlorophyll-a and pheophytin-a. Chlorophyll sampling from 2008 through 2011 was modified to collect samples at the 1-meter depth as well as at the depth of the fluorescence maxima at most of the reservoir stations.

Hydrology and water chemistry samples were collected at eight locations on the reservoir as well as Trail Creek, Deadwood River inflow (to the reservoir), and Deadwood River outflow from the reservoir (Figure 10). Sampling frequency and locations in 2011 were similar to the 2010 field season. In-reservoir sampling locations included the same seven sites and the same frequency as 2010. The frequency was reduced from biweekly in 2008 to monthly from 2009 through 2011, due to funding reductions and the evaluation of the 2008 data which lead to refined data needs for the last 3 years. Reservoir and tributary samples were collected almost monthly during 2011, with sampling beginning in early July and ending in mid-October. Similar to the 2010 protocols, eight water quality parameters were measured in the field and another eleven were processed in the lab; all of the parameters are listed in Table 14 and Table 15.

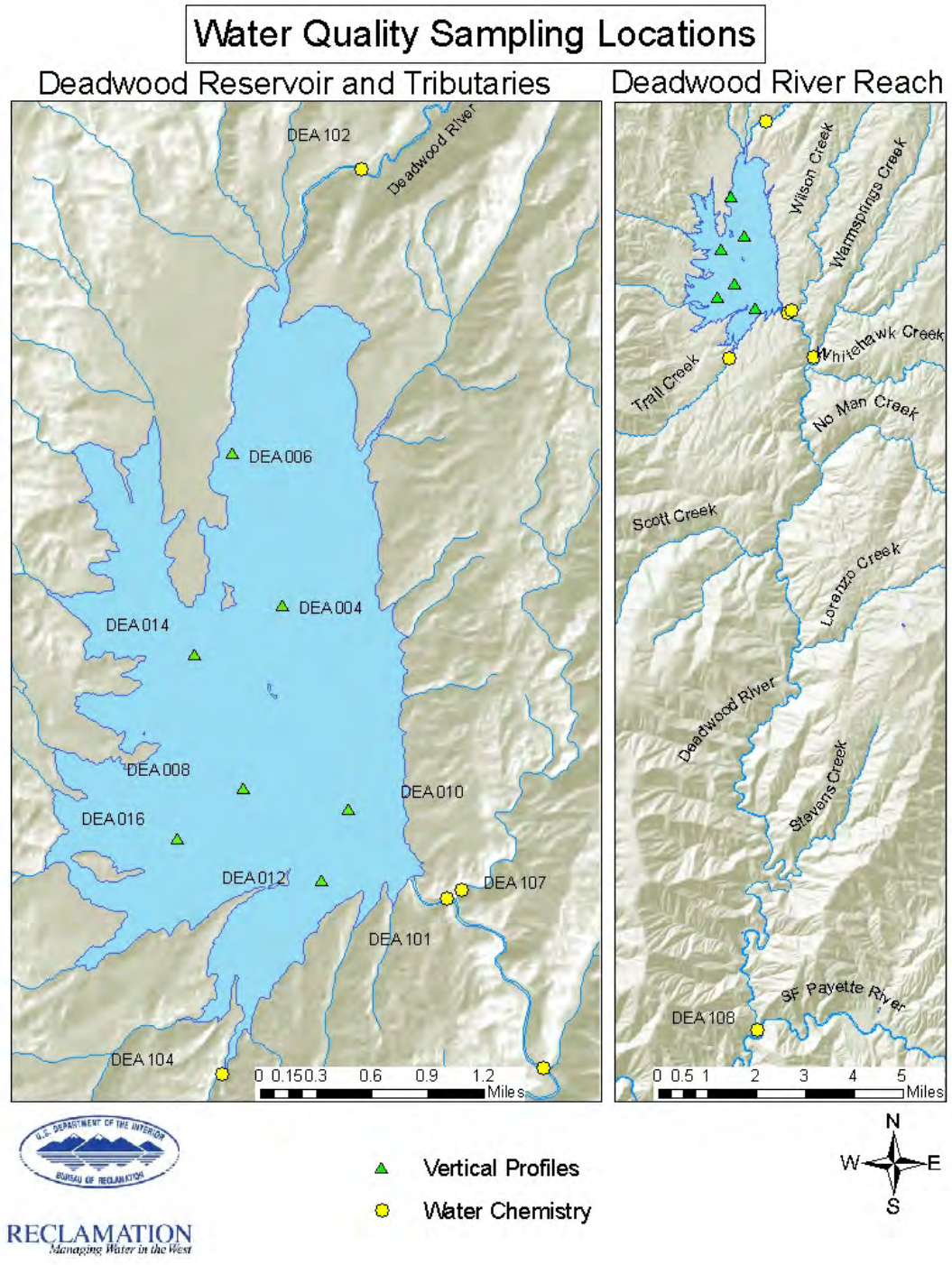

Figure 10. Water quality sampling locations in the Deadwood Reservoir (DEA), tributaries and the Deadwood River Reach study sections. Vertical profiles and water chemistry samples were collected in all areas. Sample frequencies are described in Table 15.

Table 14. Water quality parameters measured in the field and laboratory processed for Deadwood River and Reservoir, 2011.

Field Measured	Laboratory Processed
Water Temperature	Nitrate + Nitrite, dissolved
Dissolved Oxygen concentration	Orthophosphate, dissolved
pH	Total phosphorus
Conductivity	Ammonia, dissolved
Turbidity	Total Kjeldahl nitrogen
Florescence (reservoir only)	Total Organic Carbon
Barometric Pressure	Dissolved Organic Carbon
Secchi depth (reservoir only)	Turbidity
	Chlorophyll-a
	Pheophytin-a
	Silica, dissolved

Table 15. Reservoir sampling locations and frequency of sampling for Deadwood River and Reservoir, 2007-2011.

Sampling Site	2007 Sampling Duration	2007 Sampling Frequency	2008 Sampling Duration	2008 Sampling Frequency	2009 Sampling Duration	2009 Sampling Frequency	2010 Sampling Duration	2010 Sampling Frequency	2011 Sampling Duration	2011 Sampling Frequency
DEA004	5/23-10/9	weekly	6/16-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA006	5/23-10/9	weekly	6/16-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA008	4/30-10/9	weekly	---	---	---	---		---		---
DEA010	4/30-10/9	weekly	6/5-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	Weekly (mid-June to late-July) monthly (all other times)	07/7-10/17	Weekly (early-July to early-August) monthly (all other times)
DEA012	5/29-9/10	biweekly	---	---	---	---		---		---
DEA014	5/29-9/10	biweekly	6/30-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA016	5/29-9/10	biweekly	6/16-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA101	4/26-10/9	weekly	6/5-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA102	4/26-10/9	weekly	6/5-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly
DEA104	5/10-10/9	weekly	6/5-10/6	biweekly	6/29-9/28	monthly	06/3-11/4	monthly	07/7-10/17	monthly

In 2010, the lake diagnostic system (LDS) meteorological sensors were moved onshore during the winter months to protect the frame structure from damage by winter ice cover on the lake, but the LDS temperature and oxygen chain remained in the reservoir year-round. The LDS meteorological sensors and the temperature and oxygen chain were removed from their winter locations on July 7, 2011, for calibration and minor repairs. Both were redeployed on the reservoir August 25 and were again removed October 28. Reclamation collected a sufficient amount of data to calibrate the lake model ELCOM, which allowed for this final removal of the LDS. Data obtained by the LDS were transmitted via satellite communication to Boise, Idaho and subsequently uploaded onto the Online Lake and Reservoir Information System (OLARIS) website daily. These data can be viewed on the Centre for Water Research, University of Western Australia's website (CWR 2011).

The collection of water temperature data continued in five tributaries to the reservoir (Trail, South Fork Beaver, Beaver, Basin, and Wildbuck creeks) using TidbiTs. TidbiTs recorded hourly water temperature data that were manually downloaded a minimum of two times per year. The Deadwood River inflow was monitored with a Sontek Acoustic Doppler Current Meter (ADCM) which collected water temperatures at 15-minute intervals. Manual downloading of the ADCM started on July 7 due to interference during satellite transmission and was completed on August 1 and September 6. In the reservoir, a LDS temperature and oxygen chain recorded data every minute at 1-meter intervals while it was deployed (Figure 9).

Flow stage was collected at the Deadwood River inflow using an ADCM which also recorded water velocity and water temperature. An AquaRod in Trail Creek recorded flow stage every 30 minutes from July through October and hourly during the rest of the year. Data was downloaded three times from the AquaRod during the 2011 field season. On three occasions, manual flow measurements were made at the same location as the AquaRod for the purposes of developing stage/discharge relationships to quantify flow and water quality constituent concentrations entering the reservoir. All temperature, flow, and stage data is stored on Reclamation's Hydromet database and is being used for the biological and hydrology modeling (Reclamation 2012b).

Hydrology and water quality data collection for the Flexibility Study was completed in 2011. Use of these data in the modeling efforts, as well as additional study background information, is described in the Flexibility Study Proposal (Reclamation 2008).

4.2.3 Other Activities

The IDFG operated a picket weir on the mainstem of the Deadwood River just above the reservoir; however, no bull trout were caught moving upstream or downstream of the weir. Trawling and hydroacoustic surveys were conducted on August 1 and 2, 2011, to provide

estimates of kokanee recruitment. The IDFG also stocked 10,552 catchable (6 inches or greater) Chinook salmon and 20,410 fingerling (6 inches or less) Hayspur Triploid rainbow trout into Deadwood Reservoir as a measure to control kokanee salmon and provide a sport fishery. All work performed by the IDFG is summarized in the IDFG Regional Fisheries Management Investigations; Southwest Region Report (Butts et al. in press).

4.2.4 Data Collection in the Deadwood River Reach Downstream of Deadwood Dam

Prior to 2007, no bull trout had been sampled in the Deadwood River below the dam using a combination of gill nets, fyke nets, tributary weirs, hook-and-line, and electrofishing methods. Since 2007, 42 bull trout have been sampled in the mainstem Deadwood River and 182 bull trout in tributaries below the dam. Movement of radio-tagged fish has varied between years and seasons. During the 2011 reporting period, no bull trout were captured in the mainstem river below Deadwood Dam and 15 were sampled from tributaries, but none of these bull trout received radio tags. Eighteen radio tags that were deployed in 2010 were tracked throughout 2011, all in Scott Creek. Mortality information for these bull trout is unknown.

In 2011, backpack electroshocking was the only method used for sampling fish in the Deadwood River system below Deadwood Dam and all fishes were released in close proximity to their capture location. In addition to sampling bull trout, physical, hydrologic, and water chemistry data were also collected throughout the year as outlined in the Flexibility Study Proposal (Reclamation 2008).

4.2.4.1 Fish Sampling

A total of 411 fish, including 15 bull trout, were sampled in the Deadwood River system below Deadwood Dam (Table 16). The most abundant fish sampled were rainbow trout, accounting for 92.21 percent of the total catch; bull trout accounted for 3.65 percent. All 15 bull trout were captured in South Fork Scott Creek, a tributary to the mainstem Deadwood River below the dam (Reclamation 2011).

Table 16. Total catch summary for 2011, including numbers of each species captured (total catch) and percent of total catch. Includes all fish captured in the Deadwood River system below Deadwood Dam.

Deadwood River and Tributaries below the dam summary		
Species	**Total Catch**	**Percent of Total**
Bull Trout (*Salvelinus confluentus*)	15	3.65
Rainbow Trout (*Oncorhynchus mykiss*)	379	92.21
Sculpin *Cottus spps.*	9	2.19
Longnose Dace (*Rhinichthys cataractae)*	7	1.7
Mountain Whitefish (*Prosopium williamsoni*)	1	0.24
Total	**411**	**100**

All captured fish were identified by species and enumerated; total length was recorded for all game species. When a bull trout was captured, it was anesthetized using MS-222, measured (total length and fork length in mm), and scanned for PIT tags. All previously untagged bull trout over 100 mm were implanted with PIT tags (n=12). Biological samples collected from bull trout included fin clips (n=15) and scales (n=15). The collection of fin clips and scale samples occurred while bull trout were anesthetized. None of the methods for taking these biological samples were lethal to the fish.

Fin clips were sent to the USFWS Genetics Lab in Abernathy, Washington where genetic analysis may be used for population assignment within the South Fork Payette River basin using methods described in DeHann and Ardren (2008). Bull trout scales are being analyzed by Reclamation staff to determine general age and growth patterns in the population. A digital image of each scale sample is created and multiple readers assign an age to each fish by identifying growth annuli. Aging techniques and backcalculating length at age measurements using scales are described by Devries and Frie (1996). Scale samples are being housed at Reclamation's Snake River Area Office in Boise, Idaho.

4.2.4.2 Backpack Electroshocking

Smith-Root backpack electroshockers were used on July 19-20, July 27, and August 8, 2011, in No Man, Wilson, and South Fork Scott creeks to collect bull trout for genetic samples to determine natal origin and to insert radio and PIT tags for telemetry purposes. There were 387 fish collected from all 3 creeks that represented 3 species. The most abundant were rainbow trout, accounting for 94.32 percent of the total catch, followed by bull trout at 3.88 percent (Reclamation 2011). A total of 1,464.9 meters were surveyed in these creeks with 26.42 total fish per 100 meters of stream.

Table 17. Combined 2011 total catch summary for Wilson, No Man, and South Fork Scott creeks, including numbers of each species captured (total catch), fish per 100 meters of stream, and percent of total catch.

Combined Fish Summary for Wilson Creek, No Man Creek, and South Fork Scott Creek			
	Length (m) shocked =1,464.9		
Species	**Total Count**	**Fish/100m**	**Percent**
Bull Trout (*Salvelinus confluentus*)	15	1.02	3.88
Rainbow Trout (*Oncorhynchus mykiss*)	365	24.92	94.32
Longnose Dace (*Rhinichthys cataractae)*	7	0.48	1.81
Total	**387**	**26.42**	**100**

The 15 bull trout captured below Deadwood Dam were all sampled from South Fork Scott Creek and ranged from109 mm to 177 mm in total length. Of those, 12 bull trout were PIT tagged, but none received radio tags. There were no other fish species captured in South Fork Scott Creek. A total of 135.7 meters of this stream was surveyed with 11.05 total fish per 100 meters of this stream.

4.2.4.3 Stranding Pool Survey

A stranding pool survey effort was conducted in the Deadwood River below the dam as a continued effort from work performed in 2010. A continued stranding pool effort was conducted from September 12-15, 2011, when flows from the dam were reduced to 50 cfs.

Reclamation used green LiDAR data to delineate the 24 miles of the Deadwood River from the dam to the South Fork Payette River into 16 separate reaches based on geomorphological features. In 2011, Reclamation assessed 9 reaches and conducted surveys on 11 stranding pools. A summary of stranding pool survey results are shown in Table 18. A final summary and comparison between years will be provided upon completion of the Flexibility Study report.

A total of 24 fish were captured from the 11 surveyed stranding pools (Table 18; Reclamation 2011). The most abundant species captured was rainbow trout representing 58.33 percent of the total catch; no bull trout were found in the survey. All fishes were released into the closest mainstem pool habitat.

Table 18. Summary of fish species captured (total catch) and percent of total catch for all 2011 stranding pool salvage efforts along the mainstem Deadwood River below Deadwood Dam.

Stranding Pool Summary		
	Area (m^2) = 236.145	
Species	**Total Catch**	**Percent of total**
Rainbow Trout (*Oncorhynchus mykiss*)	14	58.33
Mountain Whitefish (*Prosopium williamsoni*)	1	4.17
Sculpin Cottus spps.	9	37.50
Total	**24**	**100**

4.2.4.4 Radio Telemetry

Three remote stations track radio-tagged bull trout in the Deadwood River system below the dam. The uppermost of the three is positioned on Deadwood Dam and records fish movement both below and above the dam. The middle station is located at the confluence of Scott Creek with the Deadwood River and the third is located in the Deadwood River just above its confluence with the South Fork Payette River. Tracking activities will continue through the summer of 2012.

4.2.5 Hydrology and Water Chemistry

Water chemistry sampling frequency and locations during 2011 were similar to the 2010 field season, with the same three sites and the same frequency as 2010. The frequency was reduced from biweekly in 2008 to monthly from 2009 through 2011, due to funding reductions and the evaluation of the 2008 data which lead to refined data needs for the last 3 years.

Water quality data were collected during the 2011 reporting period for the purpose of riverine and habitat modeling efforts (Reclamation 2008). Eight water quality parameters were measured in the field and another eleven processed in the lab (Table 14). Water quality sampling sites included three locations on the Deadwood River (one above the reservoir, one below the dam and one near the confluence with the South Fork Payette River), multiple reservoir sites, one at the Trail Creek confluence with Deadwood Reservoir and one in Wilson Creek, a tributary to the river below Deadwood Dam (Figure 9 and Figure 10). Sample locations and frequencies are listed in Table 15.

Onset TidbiT temperature thermographs continue monitoring water temperatures downstream of Deadwood Dam in the mainstem Deadwood River and in seven tributaries to the Deadwood River: Wilson, Whitehawk, No-Man, Scott, Lorenzo, Julie, and Stevens creeks

(Figure 9). Thermographs recorded water temperature hourly throughout the year and were manually downloaded a minimum of once per year. Locations of all temperature thermographs in the Deadwood River basin are illustrated in Figure 9.

An ADCM located near the confluence of the Deadwood River with the South Fork Payette River was maintained and continued to record water temperature, water velocity, and water depth data until late fall 2010 when it was replaced by USGS with a pressure transducer. The new pressure transducer records water temperature and depth. Data from this location are transmitted via satellite to Reclamation's Hydromet website, listed as site DRMI (Reclamation 2012b).

AquaRods were maintained in Wilson, Warmsprings, Whitehawk, and Stevens creeks and in the Deadwood River near Julie Creek. The AquaRods recorded flow stage every 30 minutes from July through September and hourly during the rest of the year. Data were downloaded several times during the field season. On several occasions, manual flow measurements were made at these locations for the purpose of developing stage/discharge relationships in order to quantify flow and water quality constituent concentrations entering the river.

In 2011, flows were measured at various times in different locations to aid in the completion of developing stage-discharge relationships at the gages and to verify discharge measurements from the automated sensors. The first recorded flow measurement in 2011 was for Stevens Creek in February. Flows for Nellys Basin, Josie, Deadwood Jim, Slim, Slaughterhouse, and Scott creeks were completed in April. Stevens and Whitehawk creeks flows were recorded in May and flows for Trail Creek were recorded in both June and July. The final flow measurements took place in Wilson Creek and Whitehawk Creek in August.

Two additional data collection efforts are underway in the Deadwood River system in order to further understand two noteworthy observations. First, at the mouth of Warmsprings Creek, but within the Deadwood River, a network of TidbiTs were deployed in 2010 to track the thermal "plume" or "regime" of Warmsprings Creek (the creek is geothermally influenced). The goal of this data collection effort is to characterize the thermal signature, determine whether it provides a thermal refuge for bull trout, and/or how a different operation of the dam may affect the warm water entering the river from Warmsprings Creek. The second data collection effort is investigating the ice formation and snow in the Trail Creek drainage. In past winters, very large spikes in Trail Creek's flow stage have been observed and were discovered to coincide with large snow events tracked at Deadwood Summit. To better understand and help identify what may be occurring at Trail Creek, three Moultrie (brand) game cameras were deployed facing the Trail Creek AquaRod and TidbiT to take time lapse photos from three different angles. If photos of significant snow or ice events are captured, they may provide insight into winter habitat for bull trout.

Hydrology and water quality data collection will be completed in the 2012 field season. All temperature, flow, and stage data is stored on Reclamation's Hydromet database and is being used for the biological and hydrologic modeling. Results will be available in the final report upon completion of the project following the outline described in the Flexibility Study Proposal (Reclamation 2008).

4.2.6 Deadwood River Productivity

The 2005 Opinion describes factors that potentially limit bull trout in the Deadwood River below Deadwood Dam, including low winter flow and low water temperatures that limit invertebrate production. Aquatic macroinvertebrates make up an important part of the prey base for bull trout, both directly for bull trout and indirectly as food for fish that bull trout prey upon. The objective of this portion of the Flexibility Study Proposal is to determine if macroinvertebrate abundance and biovolume below the bottom-release dam on the Deadwood River is adequate to provide a sufficient prey base for bull trout and their forage (Reclamation 2008). Another goal is to describe effects of dam regulation on periphyton abundance and macroinvertebrate communities in the Deadwood River. The aquatic macroinvertebrate communities are being described for three locations in the study area: the regulated portion of the Deadwood River, unregulated sections of the Deadwood River, and similar nearby rivers (e.g., Clear Creek, Middle Fork Payette River). Unregulated sites serve as references to describe background conditions without dam influence. A comparison of macroinvertebrate communities using community-level metrics (density, community composition) and population-level metrics (productivity, phenology) for select indicator taxa was developed.

Two study sites were located upstream of Deadwood Dam, four were located downstream of the dam, two sites were in unregulated Clear Creek, and two sites were in the upper South Fork Payette River (Figure 11). The selected study sites are accessible and most likely to support maximum benthic macroinvertebrate densities. Riffles dominated by cobble are commonly the richest-targeted habitat in streams for macroinvertebrates (Buffagni and Comin 2000, Moulton et al. 2002) and so were selected as the target habitat to sample in this study.

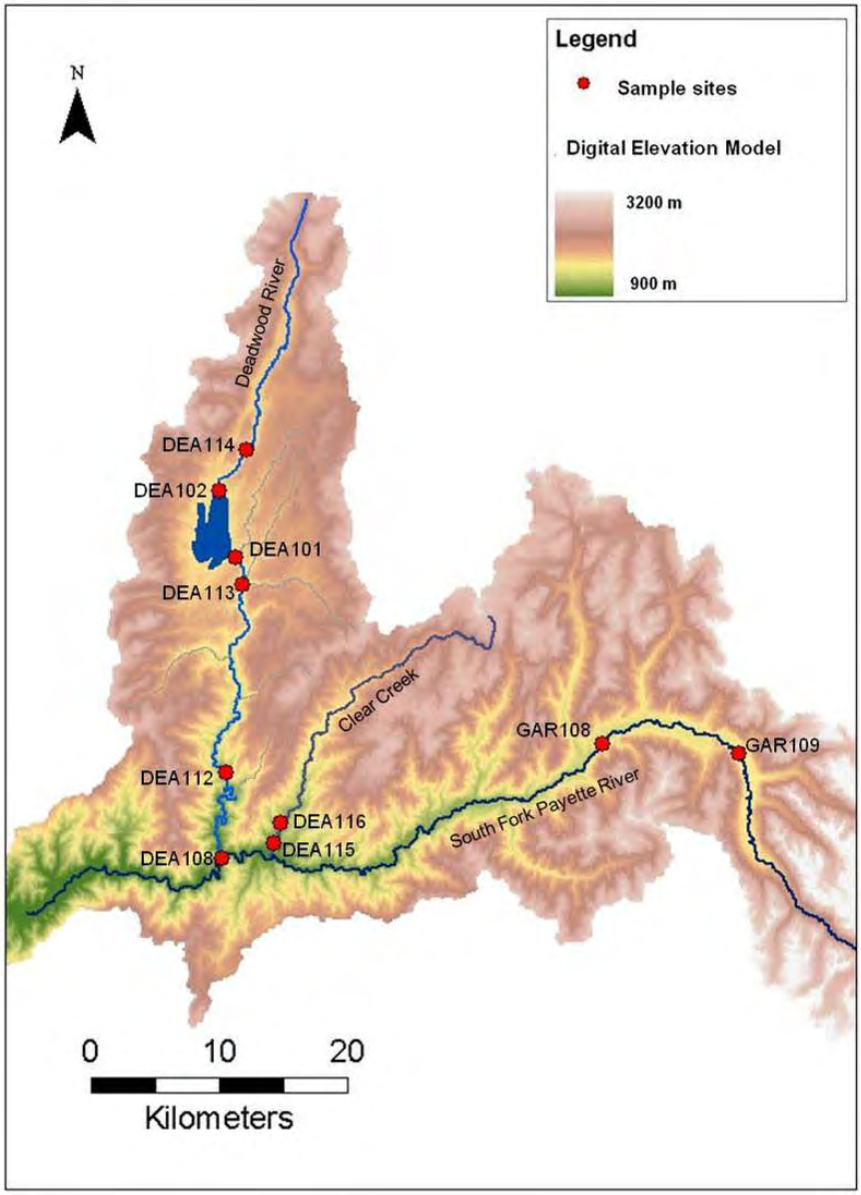

Figure 11. Deadwood River productivity sample sites on the Deadwood and South Fork Payette rivers and Clear Creek for prey base portion of Deadwood Reservoir Flexibility Study Proposal (Reclamation 2008).

Field data were collected from July through October 2011. Temperature data were collected hourly using TidBits and discharge data were collected at varying intervals, depending on the method used. Water quality, periphyton, macroinvertebrate data, and some physical habitat data were collected monthly at each site. Other physical habitat data were collected once during low water. At each site, a 100-meter sample reach was established along a cobble-dominated riffle and during each sampling date, three transects were selected randomly (without replacement) within the reach. Benthic macroinvertebrate samples were collected at

two depths along each transect. Detailed methodology of this study is described in the Flexibility Study Proposal (Reclamation 2008). Data collection results will be provided in a final report at the completion of the project.

4.3 Malheur River Basin - Beulah Reservoir and the North Fork Malheur River

The 2005 Opinion identifies four terms and conditions for Reclamation to address in order to minimize the effect and/or amount of take associated with the operation of Agency Valley Dam (Beulah Reservoir). Each of the terms and conditions addresses a different aspect of the effects of operations on bull trout. Reclamation is working to develop recommendations for a minimum pool level for Beulah Reservoir that would maintain a prey base for bull trout returning to the reservoir to overwinter (Terms and Conditions 4.a. and 4.c.).

In 2010, USFWS approved a time extension to allow Reclamation to collect additional data at Beulah Reservoir and tributaries. A 4-year study was initiated in 2010 to extend fish, invertebrate, zooplankton, and water quality sampling to lower drawdown levels and to complete bioenergetics modeling. Prey base and bull trout studies (Term and Condition 4.a.) will be conducted during the first 3 years; in the last year, the collected data will be combined with previous sampling efforts to conduct bioenergetics modeling and to develop a defensible minimum pool recommendation for Beulah Reservoir and the efficacy of prey supplementation (Term and Condition 4.b).

Bull trout marking and tagging will be used to determine bull trout population levels; seasonal use of Beulah Reservoir; and the timing and extent of migration. A migration weir fish trap will be installed in the North Fork Malheur River near the inlet to Beulah Reservoir during spring and fall periods of 2011 through 2013. A PIT-tagging program was instituted in 2011 with the installation of a PIT-tag antenna array on the North Fork Malheur River near the inlet to Beulah Reservoir to record bull trout migration to and from the reservoir. Hydroacoustic surveys will be conducted to estimate fish numbers and distribution in the deeper portions of the reservoir where other sampling methods are not effective.

The reservoir pool elevation will be kept at or above 2,000 acre-feet until minimum pool recommendations are presented to the USFWS (April 2015 deadline). New work will build from past prey base studies by increasing the sampling effort for prey fish and benthic invertebrates and adding sampling for zooplankton. Basic limnology data will also provide information on primary and secondary productivity. A final summary report for the prey base, bioenergetic modeling, and fish salvage work will be prepared by the April 30, 2015, deadline.

Other bull trout work performed during this reporting period included bull trout trap-and-transport efforts, population monitoring, and limnologic and macroinvertebrate surveys in the reservoir. The spillway at Agency Valley Dam was used during this reporting period, thereby requiring a trap-and-transport effort for bull trout in the tailrace below the dam (Term and Condition 4.d.). Bull trout spawning nest surveys (redd counts) have been conducted annually since 1993. Reclamation assisted with this effort during the fall 2011.

4.3.1 Beulah Reservoir and Tributary Data Collection

In the tributaries, high flows hampered spring sampling in 2011 and no bull trout were caught in the fall sampling. Only 17 bull trout were caught in the reservoir during sampling during the year.

In the North Fork Malheur River system, four methods of fish sampling were used in 2011: fyke netting and gill nets in Beulah Reservoir, a migration weir in the North Fork Malheur River and hook-and-line with backpack electrofishing in tributaries to the reservoir. All fishes, including bull trout, were released at the point of capture. Most captured bull trout were fitted with PIT tags (half duplex) and floy tags before being released.

4.3.1.1 Fish Sampling

Fish sampling efforts conducted during this reporting period included reservoir fish sampling (fyke and gill netting), a pilot hydroacoustics survey on the reservoir, a migration weir on the North Fork Malheur River, and tributary backpack electroshocking and hook-and-line sampling. Fish sampling efforts were conducted to meet the following objectives:

1. Pit tag bull trout to monitor migration to and from the reservoir
2. Estimate population of adfluvial bull trout using Beulah Reservoir
3. Estimate and describe the bull trout prey base in Beulah Reservoir seasonally (spring and fall).

By tagging adfluvial bull trout in the reservoir and tributaries, Reclamation will also be able to monitor the entrainment risk of bull trout through Agency Valley Dam (Term and Condition 4.d.).

Reservoir sampling was done with fyke nets and experimental gill nets for fish capture. Fyke nets were usually set in the afternoon to fish overnight and pulled the following day. Experimental gill nets were generally fished on the bottom during daylight hours for 30 minutes or less. All bull trout captured during the sampling were anesthetized in a solution of one tablet of Alka Seltzer Gold in 2.5 L of water. Bull trout were then tagged with a floy and

a 23 mm half-duplex PIT tag was inserted into the dorsal sinus if the fish was over 300 mm in total length. The fork length (mm) and weight (g) were also recorded for each fish. Stomach samples were collected on all bull trout captured in the reservoir. Recaptured bull trout were not subjected to repeat stomach pumping to minimize negative effects.

Hydroacoustic surveys and limnological and aquatic macroinvertebrate samples were also collected during the spring and fall survey periods. The lab and data analysis of these was not completed in time for this report.

A migration weir was installed on the North Fork Malheur River adjacent to the existing gaging station in the inlet to Beulah Reservoir and field tested during October 2010. When it was found to be functioning properly, it was removed from the river and stored. In 2011, extremely high flows (1,480 cfs) in the North Fork Malheur River made installation and sampling impossible during the April-May sample period, but the weir was successfully installed during the fall sampling period. Bull trout appeared to stack up behind the weir, but would not enter the trap so no bull trout were captured during the fall sampling period. Some design modifications will be implemented during the spring 2012 to reduce this effect.

Tributary sampling took place in July using hook-and-line surveys with a single barbless hook and a backpack electroshocker (LR-24 Electrofisher, Smith Root Inc., Vancouver, Washington) to capture bull trout. During the July tributary sampling, 12 mm half duplex tags allowed tagging of fish down to 100 mm. A description of the 2011 field season is described in more detail in the Fish and Wildlife Service Annual Sampling Permit report (Best 2012).

4.3.1.2 Results

In 2011, spring reservoir sampling was conducted twice: between April 19 and May 5, then between May 24 and June 2. Seventeen bull trout were collected in fyke nets; six of these were recaptured during the spring sampling (Table 1; Figure 12). Total lengths of the bull trout averaged 298 mm and ranged between 236 and 447 mm and weights averaged 329 grams, ranging between 169 and 993 grams. Fall reservoir sampling with a picket weir was conducted from September 22 to October 11, but no bull trout were captured during this period (Figure 13).

Backpack electrofishing and hook-and-line sampling took place in the North Fork of the Malheur River from July 27-29. A single bull trout was captured by angling on July 27 and an additional 14 were captured with a backpack electroshocker on the July 28-29. The bull trout averaged 279 mm in total length, ranging between 157 mm and 436 mm; weights averaged 265 grams and ranged from 50g to 720 g.

One bull trout was captured in the North Fork Malheur River canyon upstream of the Bear Creek confluence. In spite of intensive angling efforts throughout the North Fork Malheur River, no other bull trout were captured using this method. The rest of the bull trout were captured by using backpack electrofishing in the upper North Fork Malheur River and associated tributaries including Elk Creek, Sheep Creek, Swamp Creek, and several others (Figure 12). These adult bull trout were located in very small flows associated with cold springs and/or large woody debris.

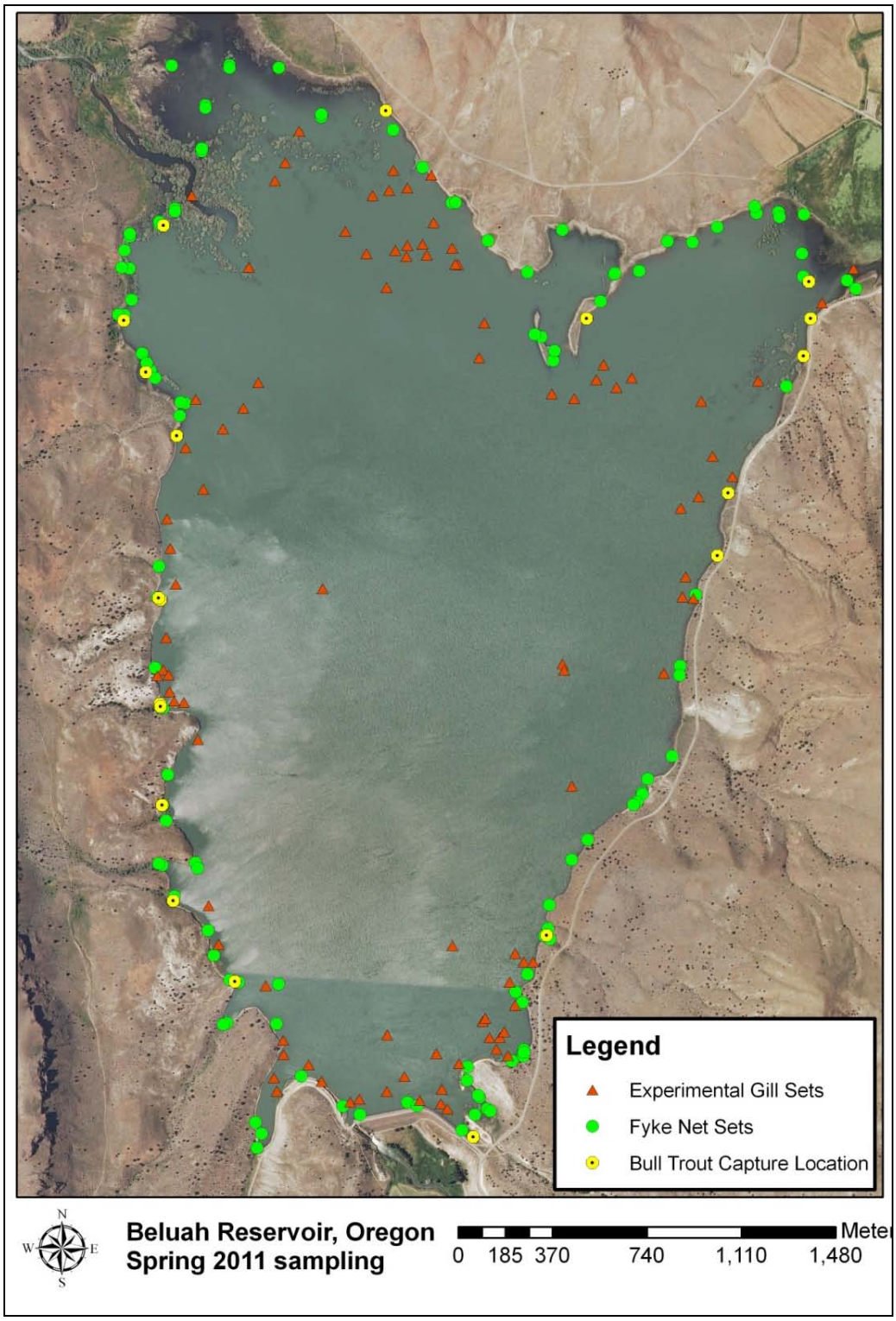

Figure 12. Locations of experimental gill net and fyke net sets and bull trout capture locations during the spring 2011 sampling in Beulah Reservoir.

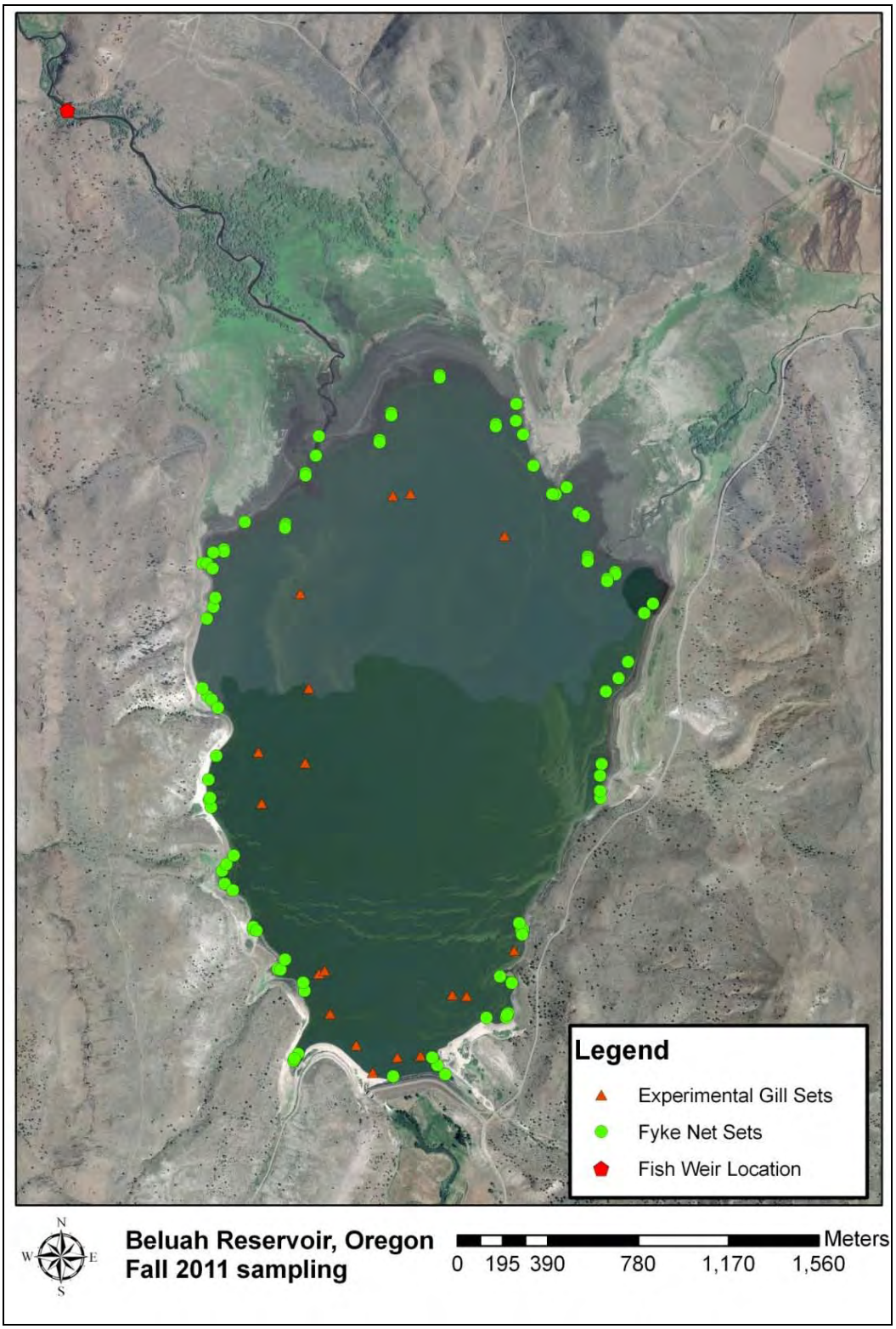

Figure 13. Locations and numbers of experimental gill net and fyke net sets locations during the fall 2011 sampling in Beulah Reservoir. No bull trout were captured.

4.3.1.3 Temporary Water Lease

In 2011, Reclamation entered into a 4-year temporary water lease to maintain reservoir pool elevation above 2,000 acre-feet until minimum pool recommendations are presented to the USFWS (April 2015 deadline). Due to near average moisture in WY2010 and above average moisture and a cool spring in WY2011, the pool elevation at Beulah Reservoir stayed above 2,000 acre-feet throughout the year. Minimum pool elevation (4,559 acre-feet) occurred on October 12, 2010, while the 2011 carryover was 18,559 acre-feet.

4.3.1.4 Trap-and-Transport Efforts

During 2011, trap-and-transport efforts were conducted because the spillway was used to release water from the reservoir (Term and Condition 4d). In 2010, Reclamation and the Burns Paiute Tribe signed a contract for the Tribe to conduct trap-and-transport efforts from 2011 through 2014 if the Agency Valley spillway is used to release water from the reservoir. The Burns Paiute Tribe spent a total of 144.5 hours sampling in the tailrace immediately below Agency Valley Dam between May 19 and June 16 using hook-and-line methods. A total of 124 fish were counted during this sampling effort, including rainbow trout, largescale sucker, mountain whitefish, and northern pike minnow (Poole 2011).

4.3.1.5 Redd Counts

Malheur River Basin bull trout population trend monitoring activities included bull trout redd counts in the North Fork Malheur River through interagency cooperation organized by the Oregon Department of Fish and Wildlife.

In 2011, a total of 53 bull trout redds were counted in the North Fork Malheur River basin; however, the survey area was reduced from past surveys (Perkins 2009). Assuming 2.68 bull trout per redd (Al-Chokhachy et al. 2005), an estimated 142 adfluvial adult bull trout were present in 2011. Figure 14 depicts the number of redds observed in the North Fork Malheur River Basin and the carryover of reservoir storage in Beulah Reservoir. Carryover storage in Beulah Reservoir has been shown to affect the bull trout prey base (Rose and Mesa 2009); however, a direct link between carryover pool elevations and bull trout redd counts remains speculative.

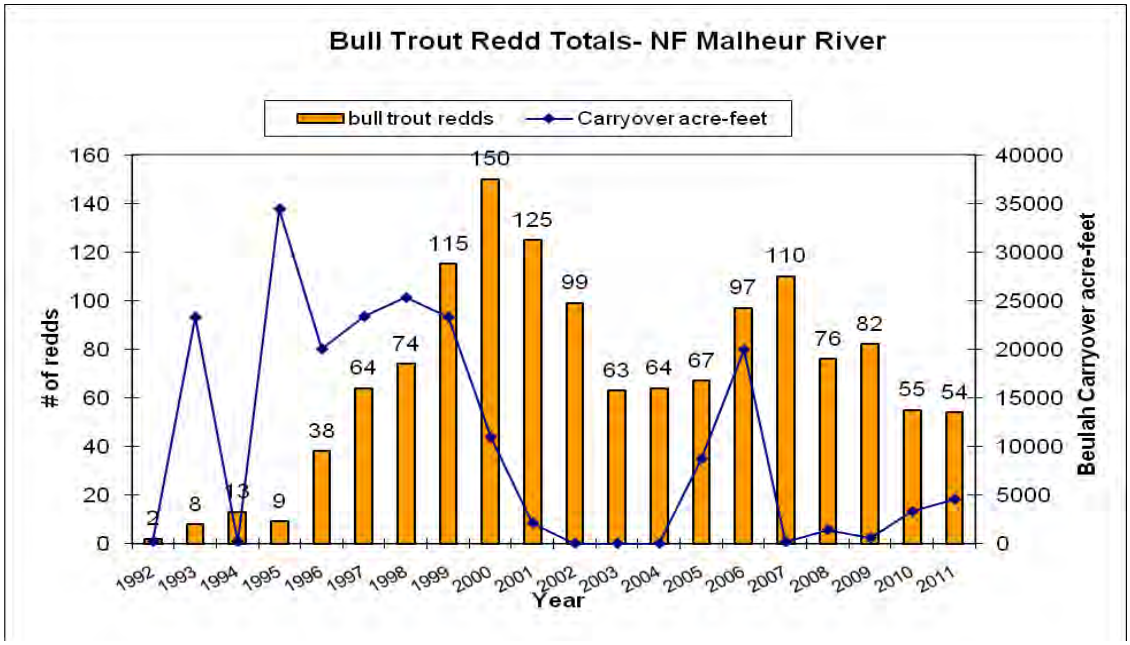

Figure 14. Bull trout redds observed in the North Fork Malheur River watershed (NF Malheur River) between 1992 and 2011 and carryover storage in Beulah Reservoir. The number of redds observed in 2008 and after is adjusted to reflect the area no longer surveyed. The adjusted value in each year is 1 redd.

5 OTHER ACTIVITIES

5.1 Water Quality

Reclamation participated in several water quality related activities in the upper Snake River basin during 2011. As part of Idaho and Oregon's ongoing Total Maximum Daily Load development and implementation activities, Reclamation staffs from the Snake River Area Office and/or Pacific Northwest Regional Office participated in all appropriate watershed advisory group and watershed council meetings in the upper Snake River basin. These included activities in the North Fork Payette River, Lower Payette River, Middle Snake River, Lake Walcott, and American Falls Reservoir Watershed Advisory Groups, as well as the Malheur Watershed Council.

Reclamation also provided technical assistance to irrigation system operators and other appropriate entities throughout its project areas in the upper Snake River basin. Reclamation's Pacific Northwest Region Laboratory provided analytical laboratory services to several entities in the basin, including:

- Idaho Department of Environmental Quality
- Aberdeen Springfield Irrigation District
- Burley Irrigation District
- Lower Boise River Watershed Advisory Group
- A & B Irrigation District
- Minidoka Irrigation District
- Lake Walcott Watershed Advisory Group
- University of Idaho (Kimberly Field Office)
- Oregon Stream Restoration Monitoring
- Malheur Soil & Water Conservation District

In addition, Reclamation has developed and implemented a basin-wide temperature monitoring study for the upper Snake River basin. In 2011, Reclamation and the USGS maintained a total of 52 stream temperature loggers throughout the basin. The intent of the on-going study is to describe temperature regimes in the Snake River relative to Reclamation's management activities; this work will continue through 2012. The information from this study was reported in Reclamation's 2010 Annual Report to the NOAA Fisheries Service.

Reclamation also performed routine water sampling across the region. Reclamation performed nutrient monitoring on drains that return water to Lake Lowell; this monitoring is aimed at identifying the affects of added nutrients on the water quality in Lake Lowell. In 2011, Reclamation performed routine water quality sampling at Jackson Lake, Island Park, Little Wood, American Falls, Deadwood, Arrowrock, Anderson Ranch, Beulah, Ririe, Palisades, Owyhee, Lake Lowell, Cascade, Mann Creek and Walcott reservoirs in 2011. This sampling was performed as part of an ongoing regional reservoir sampling regime and invasive species monitoring (zebra/quagga mussels). Similar sampling is scheduled for 2012 field season. The conditions at American Falls Reservoir did not trigger sediment and nutrient monitoring in 2011. When threshold conditions are met, monitoring is performed to track the effects of low pool elevations on water quality below the reservoir.

6 LITERATURE CITED

Parenthetical Reference	Bibliographic Citation
75 FR 52272	Federal Register. 2010. "Endangered and Threatened Wildlife and Plants; Removal of the Utah (Desert) Valvata Snail from the Federal List of Endangered and Threatened Wildlife." *Federal Register*, August 25, 2010. Vol. 75, Number 164. pp. 52272 - 52282.
Al-Chokhachy et al. 2005	Al-Chikhachy R, P. Budy, H. Schaller. 2005. "Understanding the significance of redd counts: a comparison between two methods for estimating the abundance of and monitoring bull trout populations." *NAJFM* vol: 25 (4), p. 1505 – 1512. 2005.
Alsager et al. in press	Alsager, R., B. Turik, B. Becker. 2012. *Idaho Department of Fish and Game Annual Report, Nampa Fish Hatchery 2011*. Idaho Department of Fish and Game, Nampa, Idaho.
BBC 2012	Boise Board of Control. 2012. *2011 Annual Report Article 404 Dissolved Oxygen Monitoring Plan*. Arrowrock Dam Hydroelectric Project – FERC No. 4656-020. Submitted by Boise Project Board of Control, Boise, Idaho.
Best 2012	Best, E. 2012. *2011 Beulah Reservoir Prey Base/Minimum Pool Studies Annual Report for Federal Fish & Wildlife Permit Number TE28745A-0*. U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
Buffagni and Comin 2000	Buffagni, A., and E. Comin. 2000. "Secondary production of benthic communities at the habitat scale as a tool to assess ecological integrity in mountain streams." *Hydrobiologia* 422: 183-195.
Butts et al. in press	A. Butts, Kozfkay, J., and J. Dillion. 2012, in press. *2011 Annual Report, Regional Fisheries Management Investigations; Southwest Region*. State of Idaho Department of Fish and Game, Boise, Idaho.
CWR 2011	The Centre for Water Research. 2011. University of Western Australia. Website: http://rtm.cwr.uwa.edu.au/olaris/olaris/index.php
DeHaan and Ardren 2008	DeHaan, P. and W. Ardren. 2007. *Genetic analysis of bull trout in the Deadwood and Payette rivers, Idaho; Phase II Final genetics report*. Abernathy Fish Technology Center, U.S. Department of the Interior, Fish and Wildlife Service, Longview, Washington.

Parenthetical Reference	Bibliographic Citation
Devries and Frie 1996	Devries, D. R. and R. V. Frie. 1996. "Determination of Age and Growth." *Fisheries techniques*, 2nd edition. Edited by B. R. Murphy and D. W. Willis. American Fisheries Society, Bethesda, Maryland. Pp. 483-512.
Gates and Kerans 2010	Gates, K.K and Kerans, B.L. 2010. Snake River *Physa, Physa (Haitia) Natricina, Survey and Study. Final Report*. Department of Ecology, Montana State University, Bozeman, Montana.
Howell et al. 2010	P.J. Howell, J.B. Dunham, P.M. Sankovich. 2010. "Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA." *Ecology of Freshwater Fish*, Vol. 19, p. 98-99.
Hudson et al. 2011	Hudson, J.M., J.R. Johnson, and B. Kynard. 2011. "A portable electronarcosis system for anesthetizing salmonids and other fish." *North American Journal of Fisheries Management, Vol.* 31, pg 335-339
IDFG 2012	Idaho Department of Fish and Game. 2012. http://fishandgame.idaho.gov/public/fish/stocking/stockingDataDisplay.cfm accessed on March 21, 2012.
Moulton et al. 2002	Moulton, S. II, J. Kennen, R. Goldstein, J. Hambrook. 2002. *Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program*. U.S. Geological Survey Open-File Report 02-150; http://pubs.usgs.gov/of/2002/ofr-02-150/index.html.
NOAA Fisheries Service 2008	NOAA Fisheries Service. 2008. *Biological Opinion and Magnuson-Stevens Fisher Conservation and Management Act Essential Fish Habitat Consultation; Consultation for the Operation and Maintenance of 10 U.S. Bureau of Reclamation Projects and 2 Related Actions in the Upper Snake River Basin Above Brownlee Reservoir*, 5 May 2008, NOAA Fisheries Service, Northwest Region. NMFS Log Number: F/NWR/2006/07518
Perkins 2009	Perkins, R. 2009. *Bull Trout Spawning Survey Report, 2009*. Oregon Department of Fish and Wildlife, Malheur Fish District, Ontario, Oregon.
Poole 2011	Poole, A. 2011. *Evaluate the Life History of Native Salmonids in the Malheur Subbasin*. Burns Paiute Tribe, Natural Resources Department – Fisheries Division, Burns, Oregon (in draft)

Parenthetical Reference	Bibliographic Citation
Reclamation 2004	Bureau of Reclamation. 2004. *Biological assessment for the Bureau of Reclamation Operations and Maintenance Activities in the Snake River Basin above Brownlee Reservoir.* U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
Reclamation 2006	Bureau of Reclamation. 2006. *Utah Valvata and Bull Trout Monitoring and Implementation Plan. Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir.* U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho. March 2006
Reclamation 2008	Bureau of Reclamation. 2008. *Deadwood Reservoir Flexibility Study Proposal* (note: study results and methodology will be detailed and distributed at the end of this project. Annual updates and progress results for internal use only.) U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
Reclamation 2010	Bureau of Reclamation. 2010. *Bureau of Reclamation 2010 Salmon Flow Augmentation Program and Other Activities Associated with the National Marine Fisheries Service 2008 Biological Opinion and Incidental Take Statement for Operations and Maintenance of Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir, Annual Progress Report.* U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho. December 1, 2010.
Reclamation 2011	Bureau of Reclamation. 2011. Boise River and Deadwood River Bull Trout monitoring and mitigation activities. Permit # F-02-07-10. U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
Reclamation 2012a	Bureau of Reclamation. 2010. Hydromet data for 2010. Website: http://www.usbr.gov/pn/Hydromet/ U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
Reclamation 2012b	Bureau of Reclamation. 2010. Hydromet data for 2010. Website: http://www.usbr.gov/pn-bin/rtindex.pl?cfg=payette U.S. Department of the Interior, Bureau of Reclamation, Snake River Area Office, Boise, Idaho.

Parenthetical Reference	Bibliographic Citation
Rose and Mesa 2009	Rose, B. and M. Mesa. 2009. *Minimum pool and bull trout prey base investigations at Beulah Reservoir. Final Report for 2008*. Submitted to: United States Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho as Final Report for the Study Agreement #29-RO184. January 2009.
Ross and Kleiner 1982	Ross, M.J. & Kleiner, C.F. 1982. "Shielded-needle technique for surgically implanting radio-frequency transmitters in fish." *Progressive Fish-Culturalist*, Vol. 44, p 41–43
USFWS 2005	U.S. Fish and Wildlife Service. 2005. *Biological Opinion for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir*. U.S. Department of the Interior, Fish and Wildlife Service. March 31, 2005.