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Bull Trout (*Salvelinus confluentus*) Telemetry and Associated Habitat Data Collected in a Geodatabase from the Upper Boise River, Southwestern Idaho

Data Series 1042

U.S. Department of the Interior
U.S. Geological Survey

Cover: U.S. Geological Survey and Bureau of Reclamation technicians using radio telemetry equipment to document bull trout migration behavior on the North Fork Boise River, southwestern Idaho. Photograph by Justin Schultz, U.S. Geological Survey, September 2013.

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
hectare (ha)	2.471	acre
square hectometer (hm^2)	2.471	acre
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	264.2	gallon (gal)
	Flow rate	
centimeter per year (cm/yr)	0.3937	inch per year (in/yr)
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as

$$°F = (1.8 \times °C) + 32.$$

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

ESRI	Environmental Systems Research Institute
FGDC-CSDGM	Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata
FORT	Fort Collins Science Center
GIS	geographic information system
GPS	Global Positioning System
GUIs	Graphical User Interfaces (GUIs)
IDFG	Idaho Department of Fish and Game
MFB	Middle Fork Boise River
NAD	North American Datum
NRCS	Natural Resources Conservation Service
Reclamation	Bureau of Reclamation
SFB	South Fork Boise River
SNOTEL	Snow Telemetry
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WY	Water Year
XML	Extensible Markup Language

Bull Trout (*Salvelinus confluentus*) Telemetry and Associated Habitat Data Collected in a Geodatabase from the Upper Boise River, Southwestern Idaho

By Dorene E. MacCoy[1], Zachary M. Shephard[1], Joseph R. Benjamin[1], Dmitri T. Vidergar[2], and Anthony F. Prisciandaro[2]

Abstract

Bull trout (*Salvelinus confluentus*), listed as threatened under the Endangered Species Act, are among the more thermally sensitive of coldwater species in North America. The Boise River upstream of Arrowrock Dam in southwestern Idaho (including Arrowrock Reservoir) provides habitat for one of the southernmost populations of bull trout. The presence of the species in Arrowrock Reservoir poses implications for dam and reservoir operations. From 2011 to 2014, the Bureau of Reclamation and the U.S. Geological Survey collected fish telemetry data to improve understanding of bull trout distribution and movement in Arrowrock Reservoir and in the upper Boise River tributaries. The U.S. Geological Survey compiled the telemetry (fish location) data, along with reservoir elevation, river discharge, precipitation, and water-quality data in a geodatabase. The geodatabase includes metadata compliant with Federal Geographic Data Committee content standards. The Bureau of Reclamation plans to incorporate the data in a decision-support tool for reservoir management.

Introduction

Bull trout (*Salvelinus confluentus*) is a coldwater-adapted species that is listed as threatened throughout the contiguous United States under the Endangered Species Act (U.S. Fish and Wildlife Service, 1999). The decline of the species has been linked to habitat degradation and fragmentation, blockage of migratory corridors, water quality parameters such as increase in water temperature, watershed management practices, and the introduction of non-native species (Rieman and McIntyre, 1993; Rieman and others, 1997; Kanda and others, 2002; Dunham and others, 2003; Kiser and others, 2010). The population of bull trout in the upper Boise River watershed (upper Boise River), in southwestern Idaho, is one of the southernmost distributions in the Columbia River watershed, making them particularly susceptible to the effects of climate change (Rieman and others, 1997; Isaak and others, 2012, 2016). Most of the bull trout population is present in the Arrowrock subwatershed that includes Arrowrock Reservoir and its tributaries—the North Fork, Middle Fork, and South Fork Boise Rivers. Despite the fragmentation of the upper Boise River by the Lucky Peak, Arrowrock, and Anderson Ranch Dams, the watersheds upstream of Arrowrock and Anderson Ranch Reservoirs support substantial habitat for migratory bull trout (Flatter, 1998; Salow and Hostettler, 2004). To prevent future loss to the upper Boise River bull trout population, the Bureau of Reclamation (Reclamation) requested a formal consultation with the U.S. Fish and Wildlife Service (FWS) regarding possible effects on bull trout from operation of the Reclamation Arrowrock and Anderson Ranch projects. The resulting biological opinion (U.S. Fish and Wildlife Service, 2005) listed terms and conditions that may minimize harm to bull trout through operation and maintenance of Arrowrock and Anderson Ranch Reservoirs. To address these terms and conditions, Reclamation, in cooperation with the U.S. Geological Survey (USGS), collected telemetry data between 2011 and 2014 to identify the movement and habitat use of bull trout in the upper Boise River (fig. 1). A file geodatabase was created to store the telemetry and associated habitat data to make it available to Reclamation for future management decisions. Other Reclamation investigations outside the scope of this study but pertinent to future management decisions are presented in table 1.

[1]U.S. Geological Survey.

[2]Bureau of Reclamation.

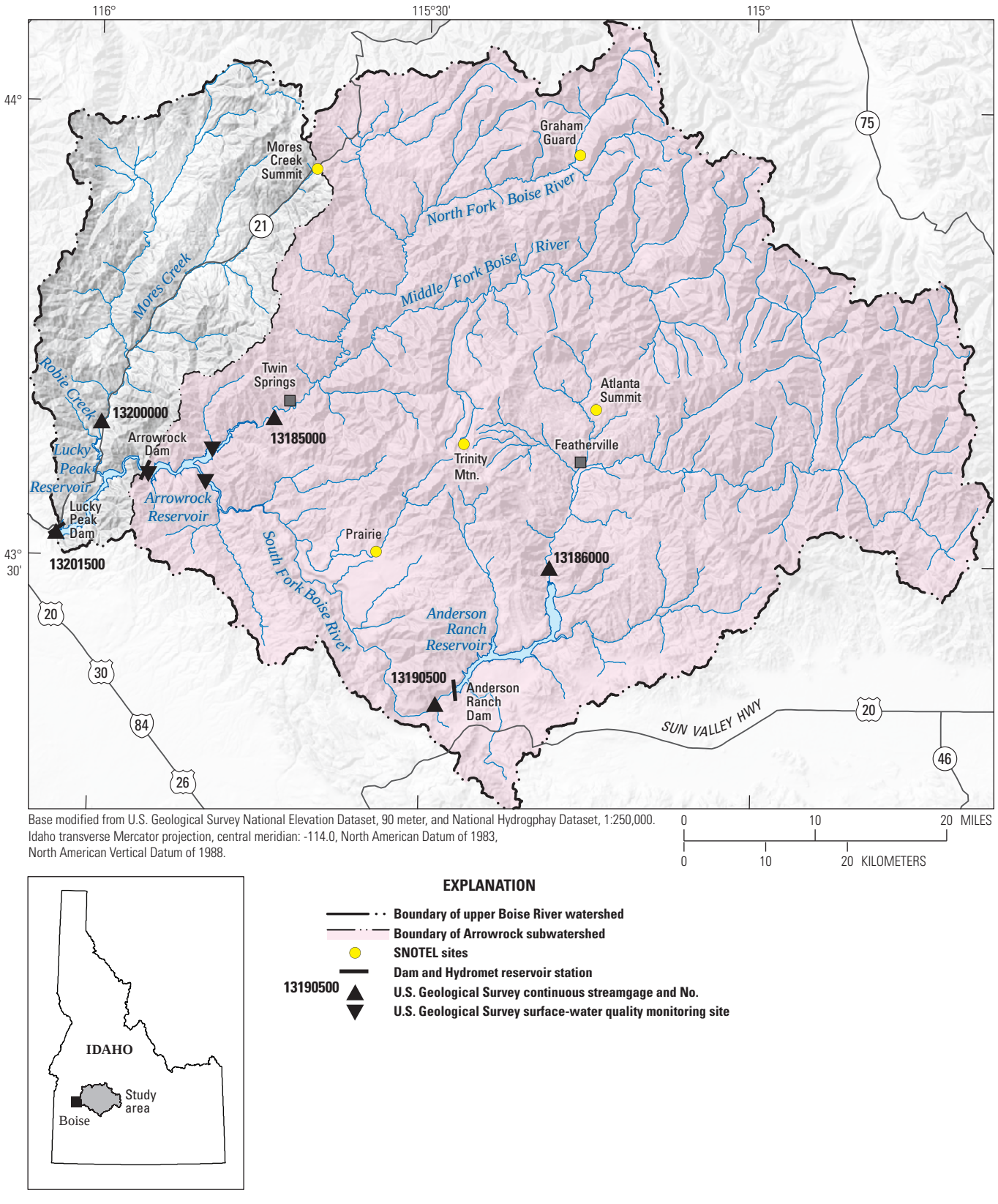

Figure 1. Bull trout telemetry geodatabase study area in the upper Boise River watershed, southwestern Idaho.

Table 1. Additional Bureau of Reclamation investigations of bull trout (*Salvelinus confluentus*) in the upper Boise River, southwestern Idaho.

Report	Study years	Objectives	Findings
Salow (2004)	1999–2000	Present data on bull trout occurrence and movement in the North Fork of the Boise River upstream of Arrowrock Reservoir. Identify bull trout migration patterns and habitat used by differing age classes of fish. Evaluate trapping method efficiency.	Bull trout movement relies heavily on accessibility to migratory corridors and occurs primarily at night. Movement of bull trout was related to discharge and temperature fluctuations. The greatest growth in Bull Trout were in 2–3 year old fish that had greater movement in the river system. North Fork bull trout population was estimated to be 969 (standard deviation of 228).
Monnot and others (2008)	2001–03	Determine the rate of bull trout migration in the North Fork Boise River compared to fish body size, stream temperature, and discharge.	The study concluded that larger bull trout (>30 centimeters) were more likely to migrate into Arrowrock Reservoir after spawning and had faster downstream movement patterns than smaller bull trout in the autumn. Despite predictions to the contrary, downstream migration rates decreased with stream discharge and temperature did not have an effect on migration rates. This study found that fish size and environmental changes have an important influence on bull trout migration.
Salow and Hostettler (2004)	2002, 2003	Monitor the rate of entrainment, migration, dispersal and effects on bull trout that overwinter n Arrowrock Reservoir.	One hundred bull trout were trapped and tagged with radio transmitters at the North Fork Boise River weir. Mortality occurred in 22 percent of the fish in 2002 and 49 percent of the fish in 2003. Of the remaining fish, 4 percent (2 fish) remained in the South Fork Boise River during both years. Almost one-half of the remaining fish (48 percent) migrated upstream into the Middle and North Forks of the Boise River in spring and early-summer, with most of these fish overwintering in Arrowrock Reservoir.
Stiefel and Dare (2006)	2004, 2005	Determine the movement patterns and habitat use of bull trout in Arrowrock Reservoir using acoustic telemetry.	Bull trout arrived in Arrowrock Reservoir between early October and early November, and then began to migrate upstream during early March through May Bull trout remained in the reservoir an average of 173 days. There was no correlation between arrival dates and fish size or between residence time and fish size. A three-stage pattern of bull trout residence in Arrowrock Reservoir was identified. First, in the autumn fish stopped in the upper main stem of the reservoir; second, fish dispersed into the reservoir or the South Fork of the Boise River; and third, fish were found again in the transition zone of the upper main stem before their upstream migration in the spring. The study emphasized the importance of the transition zone as a staging area after downstream migration and before upstream migration.
Prisciandaro (2015)	2015	Identify the habitat characteristics affecting the migration of bull trout at the Arrowrock Reservoir varial zones (area between the reservoir pool and tributaries). Evaluate aquatic habitat created by fluctuating reservoir water levels, migration barriers, and bull trout travel rates through the varial zone. Evaluate bull trout mortality and predator presence in the arial zone.	Varial zone deltas become longer and wider with lowering reservoir elevations. Varial zones also have higher velocities, increased sedimentation, and a lack of riparian vegetation for cover that affect bull trout migration. Mean dates when fish migrated out of Arrowrock Reservoir varied from the end of April to the end of May in this study. Bull trout migrated in and out of the reservoir at multiple times of the year, but usually migrated downstream between September and November. Upstream migration always occurred before water temperatures exceeded 18.6 degrees Celsius. Telemetry and radio tag recovery rates indicated high mortality rates of fish migrating through the varial zone. Fish become more vulnerable to predation while migrating through the varial zone during low reservoir elevations.

Purpose and Scope

This report describes the contents of a geodatabase developed to store bull trout telemetry and associated habitat data collected by Reclamation and USGS from the upper Boise River from 2011 to 2014. These data include individual fish information (such as total length and weight) for tagged fish; fish location information collected using radio and acoustic telemetry techniques; and river discharge, reservoir height, and water-quality data where available. Supplemental data such as long-term discharge and snow levels are included in the geodatabase to help in the development of a decision-support tool (these datasets are preceded by an "S" in the geodatabase).

Description of Study Area

The upper Boise River watershed study area upstream of Lucky Peak Reservoir in southwestern Idaho (fig. 1) is about 5,700 km^2, with altitudes ranging from 930 to 3,230 m. The U.S. Forest Service manages most lands in the upper Boise River watershed, with land uses consisting primarily of grazing, timber harvest, mining, and recreation. Climate in the watershed is characterized by cold, wet winters and hot, dry summers with maximum air temperatures commonly exceeding 30 °C. Precipitation commonly ranges from 60 to 100 cm/yr. High streamflows generally are influenced by snowmelt during spring, with low flows occurring during the rest of the year (McGrath and others, 2001). Three dams on the upper Boise River form Lucky Peak, Arrowrock, and Anderson Ranch Reservoirs in upstream order. These dams and reservoirs are operated collectively as a single system for irrigation, flood control, and recreation. Lucky Peak Dam, at the base of the upper Boise River watershed was constructed by the Corps of Engineers in 1949 and created Lucky Peak Reservoir. Bull trout are seldom found downstream of the Lucky Peak Dam but Reclamation continues to monitor Lucky Peak Reservoir and tributaries to insure bull trout have not passed through the dam. Arrowrock Dam, the oldest of these dams, was constructed in 1915 and is managed by Reclamation. The full pool altitude of Arrowrock Reservoir is 980 m, covering 1,275 ha, with a pool volume of about 3.36×10^8 m^3 and maximum depth of about 60 m. Arrowrock Reservoir, a narrow canyon reservoir, is highly regulated, with about 86 percent of its volume typically released annually, which equates to a low water-level altitude of about 945 m (Bureau of Reclamation, 2016). Two major tributaries, the Middle Fork Boise River (MFB) and South Fork Boise River (SFB), form the two arms of Arrowrock Reservoir. The MFB is unregulated, whereas the SFB is regulated downstream of Anderson Ranch Dam, and is free-flowing for about 43.5 km before it enters Arrowrock Reservoir. Discharge is measured on the MFB at the Boise River near Twin Springs, Idaho (USGS streamgage 13185000) with more than 100 years of record, and on the SFB at South Fork Boise River at Anderson Ranch Dam, Idaho (USGS streamgage 13190500), with more than 70 years of record. Discharge during water years (WYs) 2012–2014 varied between the MFB and SFB. Annual discharge for both MFB and SFB was greater than the long-term median in WY 2012 and less than long-term median in WY 2013 (table 2). Water year 2014 discharge was greater than long-term median for the MFB and less than long-term median for SFB. The transition from these two large tributaries to the lentic waters of Arrowrock Reservoir are where bull trout are commonly found (Stiefel and Dare, 2006). Based on studies by Flatter (1998) and Salow and Hostettler (2004), discharge and water temperatures in these major tributaries are important factors contributing to the migration behavior of bull trout in this system.

Table 2. Annual and median long-term discharge at U.S. Geological Survey streamgages 13185000 and 13190500, upper Boise River watershed, southwestern Idaho, water years 2012–14.

[Discharge data from U.S. Geological Survey (2016). **Abbreviations:** m^3/s, cubic meter per second; MFB, middle fork Boise River; SFB, South Fork Boise River]

Station name	Short name	Station No.	Average annual discharge (m^3/s)			Long-term median discharge (m^3/s)
			2012	2013	2014	
Boise River near Twin Springs	MFB	13185000	42	26	35	33
South Fork Boise River at Anderson Ranch Dam	SFB	13190500	35	21	17	24

Supplemental Data Collection Methods

Reservoir height data were retrieved from the Reclamation Hydromet system from Hydromet reservoir stations Arrowrock Dam and Reservoir (ARK), Anderson Ranch Dam and Reservoir (AND), and Lucky Peak Lake near Boise (LUC) (Bureau of Reclamation, 2016). Hydromet stations collect data at intervals of 15–60 minutes and transmit the data by the Geostationary Operational Environmental Satellite (GOES) network every 4 hours. Data are then processed by the local Reclamation area office and posted on the Hydromet Web site.

Discharge data were retrieved from USGS National Water Information System (NWIS) streamgages (U.S. Geological Survey, 2016) for Boise River near Twin Springs, South Fork Boise River at Anderson Ranch Dam, South Fork Boise River near Featherville (13186000), Mores Creek above Robie Creek, near Arrowrock Dam (13200000), and South Fork Boise River at Neal Bridge, near Arrowrock Dam (13192200). All discharge data included in the geodatabase are provisional and subject to change.

Precipitation and snow level data were retrieved from the Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) database for Mores Creek Summit, Graham Guard, Atlanta Summit, Trinity Mountain, and Prairie. Information on SNOTEL data collection and processing is available at the NRCS Web site (http://www.wcc.nrcs.usda.gov/snow/index.html).

Fish Data Collection Methods, 2011–14

Fish were sampled in Arrowrock Reservoir using a random grid sampling design and mark-recapture methods for estimating fish populations. A 366-m-long gill net with 0.04–0.1 m mesh was used to capture the fish between March 28 and April 20, 2012. Fish species other than bull trout were counted and measured where possible. These data are provided in untagged fish datasets. Captured bull trout were anesthetized using a portable electronacrosis system similar to the one used by Hudson and others (2011). When the fish were immobilized, they were measured for fork and total length (in millimeters) and mass (in grams). Uniquely coded passive integrated transponder (PIT) tags were injected just beneath and behind the dorsal fin of each bull trout. A subset of fish were fitted with radio and (or) archival tags using a modified shielded needle technique described by Ross and Kleiner (1982). Archival tags (fig. 2) were set to record internal temperature of the fish, water temperature at the fish location, and water pressure (depth) at the fish location at 30-minute intervals. Data from archival tags were downloaded when fish were recaptured and the tags were removed. Archival tag data were examined using methods similar to those used in Howell and others (2010).

Radio-tagged fish were tracked between 2011 and 2014 twice a month on the ground using Lotek SRX models 400 and 600 receivers during October–March of 2011–14 while the fish were in the SFB or Arrowrock Reservoir. Additional tracking was completed during reservoir ramping and at more frequent intervals during the study period. When a radio-tagged fish was located, the following data were recorded at that location: (1) date, (2) time, (3) Global Positioning System (GPS) location, (4) pressure (water depth), and (5) water temperature at the location of the fish. Three stationary telemetry stations equipped with Lotek SRX model 600 receivers (operating continuously) were established at USGS streamgage sites, Boise River near Twin Springs and South Fork Boise River at Neal Bridge, near Arrowrock Dam, and a site used by Reclamation for detection of entrained fish downstream of Arrowrock Dam (table 3).

Figure 2. Bull trout (*Salvelinus confluentus*) with an archival tag collected from the upper Boise River watershed, southwestern Idaho. (Photograph by Dimitri Vidergar, Bureau of Reclamation, September 2013.)

Table 3. Stationary telemetry site locations in the upper Boise River watershed, southwestern Idaho, 2011–14.

[**Abbreviation:** USGS, U.S. Geological Survey]

Site description	USGS site ID	Latitude	Longitude
South Fork Boise River at Neal Bridge, near Arrowrock Dam	13192200	43.550	-115.719
Boise River near Twin Springs	13185000	43.668	-115.725
Below Arrowrock Dam in Lucky Peak Reservoir	–	43.597	-115.925

Acoustic tracking in Arrowrock Reservoir was done using a boat mounted GPS device that recorded fish locations. A Lotek MAP 600 RT receiver with two hydrophones mounted at 0.5 m below the water surface on the port and starboard bow of the boat were used to record and detect acoustic signals during tracking events. A stationary LOTEK submersible acoustic receiver (model WHS3250) was placed in each of the three locations in the reservoir (referred to as strata) from May 7 to September 5, 2012, to record fish movements by stationary sites. Mobile and stationary site acoustic telemetry data as well as water-quality profile data collected in Arrowrock Reservoir during 2012 are published in Maret and Schultz (2013).

Geodatabase Design

A file geodatabase was developed using Environmental Systems Research Institute (Esri) geographic information system (GIS) software ArcGIS™ 10.3.1 for storage of bull trout telemetry and associated habitat data. This spatially enabled database allows users to store and manipulate tabular and geospatial datasets. The geodatabase contains nine tabular datasets with geographically referenced discharge, reservoir height, and climatological data; and as many as 20 point, line, and polygon vector datasets stored as feature classes. Feature classes with common themes are grouped and stored together as feature datasets. These themes include the geographic location of fish, basin layers, hydrography, water quality, and continuous data collection site locations. Raster datasets are included that contain bathymetric and topography data. Additionally, relationship classes were established between dataset attribute tables using a common date field to aid in querying the data. Descriptions and sources of datasets contained in the upper Boise River geodatabase are presented in appendix A. The geodatabase and associated metadata are available in MacCoy and others (2017).

Data Input

Data fields were removed or added to the raw data to reduce redundancy or for data clarification. Some of the raw data contained repeating fields that were removed. A unique fish identification number was added to each tagged fish because some radio tags were reused in different fish. Unique identification numbers are a combination of the tag code and the three digits following the decimal point of the tag frequency.

Spatial data were provided by Reclamation, and shapefiles were directly uploaded to the geodatabase. Spatial data were projected from their native coordinate systems into the projected coordinate system North American Datum of 1983 Idaho Transverse Mercator projection (NAD 83 Idaho TM). Some spatial datasets in the geodatabase are partial or clipped versions of their original data source. The content of the original datasets was not modified except to "snap" telemetered fish locations to the Boise River. A detailed description of this technique is discussed in section, "Data Quality." All tabular data were converted to shapefiles prior to uploading to the geodatabase.

Data Quality

The original mobile tracking data points represented the location of the radio receiver at the time a fish was detected. Most mobile tracking efforts occurred along a road next to the reservoir or river. The radio receivers on land were assumed to record detections perpendicular to the actual location of the fish in the stream or reservoir. Therefore, points representing fish detections were snapped to a line feature class in the adjacent waterbody. These snapped points are included in the telemetry data in the geodatabase (appendix A, BoiseArea_Telemetry_2011_2014). However, coordinates listed in the attributes table for this dataset are the original unsnapped coordinates. Furthermore, detections of fish using mobile tracking were done from a motor vehicle and were not confirmed visually.

Metadata

Metadata compliant with the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata (FGDC-CSDGM) were created for each spatial and tabular dataset in the file geodatabase. Associated metadata in this report provide descriptive information about each feature class, raster, and table in the geodatabase and include components such as a title, abstract, purpose, and citation information. Metadata also include information such as the data creation and process steps, geographic settings, and attribute descriptions. A detailed listing of FGDC-CSDGM

content is available at http://www.fgdc.gov/metadata/geospatial-metadata-standards (Federal Geographic Data Committee, 2014).

Metadata were created and validated for FGDC-CSDGM format using Metadata Wizard version: 1.5, a tool developed by the USGS Fort Collins Science Center (FORT), to simplify metadata creation and formatting for GIS users. Two graphical user interfaces (GUIs) were used to enter additional or missing metadata information. Metadata were validated using the Metadata Parser and information exported out of the wizard in an FGDC-CSDGM compliant eXtensible Markup Language (XML) metadata record (Ignizio and others, 2014). The metadata XML files associated with this database often were modified after the Metadata Wizard exported the files; however, all data were validated with the Metadata Parser after editing.

Additional Data

The database structure allows additional data to be incorporated as it becomes available. For example, collection of discharge and temperature data would be ongoing and can be included in the database, as well as updated versions of linked datasets such as the Bull Trout Vulnerability Assessment database (Dunham, 2015). Additional datasets are available that could inform a decision-support modeling effort, but were beyond the scope of this report and database. These existing datasets may include, but are not limited to:

- Fish stocking records that may provide information on available prey for migratory bull trout (Idaho Department of Fish and Game, 2016),
- Infrared flight data to estimate temperature in the upper Boise River (Quantum Spatial, Incorporated, 2014; Dmitri Vidergar, Bureau of Reclamation, written commun., January 3, 2017), and
- Additional studies on bull trout in the Boise River and reservoirs (for example, Flatter, 1998).

Finally, other modeling efforts, such as the Reclamation water-quality model for Arrowrock and Anderson Ranch Reservoirs, may be beneficial to a decision-support model, and can be included upon completion.

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Appendix A. Descriptions and Sources of Datasets in the Geodatabase for the Upper Boise River, Southwestern Idaho

Dataset: S_SNO_Atlanta
Description: Snow Telemetry (SNOTEL) data for Atlanta Summit site, Boise River Basin, Idaho [S_SNO_Atlanta]
Source: Downloaded from Natural Resources Conservation Service (NRCS) Interactive Map. Link: http://www.wcc.nrcs.usda.gov/webmap/help/index.html
SNOTEL site link: http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=306
Data Processing: Data retrieved in tabular format in January 2016. Data formatted as needed including the reordering of various columns. Data exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: S_SNO_GrahamGuard
Description: SNOTEL Data for Graham Guard site, Boise River Basin, Idaho [S_SNO_GrahamGuard]
Source: Downloaded from NRCS Interactive Map. Link: http://www.wcc.nrcs.usda.gov/webmap/help/index.html
SNOTEL site link: http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=496
Data Processing: Data retrieved in tabular format in January 2016. Data formatted as needed including the reordering of various columns. Data exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: S_SNO_Mores
Description: SNOTEL data for Mores Creek Summit site, Boise River Basin, Idaho [S_SNO_Mores]
Source: Downloaded from National Resources Conservation Service (NRCS) Interactive Map. Link: http://www.wcc.nrcs.usda.gov/webmap/help/index.html
SNOTEL site link: http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=637
Data Processing: Data retrieved in tabular format in January 2016. Data formatted as needed including the reordering of various columns. Data exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: S_SNO_Prairie
Description: SNOTEL data for Prairie site, Boise River Basin, Idaho [S_SNO_Prairie]
Source: Downloaded from NRCS Interactive Map. Link: http://www.wcc.nrcs.usda.gov/webmap/help/index.html
SNOTEL site link: http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=704
Data Processing: Data retrieved in tabular format in January 2016. Data formatted as needed including the reordering of various columns. Data exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: S_SNO_TrinityMtn
Description: SNOTEL data for Trinity Mountain site, Boise River Basin, Idaho [S_SNO_TrinityMtn]
Source: Downloaded from NRCS Interactive Map. Link: http://www.wcc.nrcs.usda.gov/webmap/help/index.html
SNOTEL site link: http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=830
Data Processing: Data retrieved in tabular format in January 2016. Data formatted as needed including the reordering of various columns. Data exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: arrowrock_bathy_10ft
Description: 10-foot contour interval bathymetry of Arrowrock Reservoir in Idaho, result of 1987 and 1997 Bureau of Reclamation (Reclamation) surveys [arrowrock_bathy_10ft]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to U.S. Geological Survey (USGS) on an external hard drive in January 2016. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option. Data shifted 90 feet west and 195 feet south, as suggested by the original Reclamation metadata.
Date Range: 10/1987–06/1997

Dataset: arrowrock_bathy_50ft
Description: 50-ft contour interval bathymetry of Arrowrock Reservoir in Idaho, result of 1987 and 1997 Reclamation surveys [arrowrock_bathy_50ft]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to USGS on an external hard drive in January 2016. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option. Data shifted 90 feet west and 195 feet south, as suggested by the original metadata.
Date Range: 10/1987–06/1997

Dataset: Land_Use
Description: Ownership polygon features for Boise National Forest [Land_Use]
Source: Boise National Forest
Data Processing: Data originally created by the U.S. Department of Agriculture Forest Service ALP/GIS Lab. Given to USGS through personal communication from the Bureau of Reclamation. Data were retrieved in January 2016. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: 11/18/2004

Dataset: Stratum_All
Description: All three Reclamation strata in Arrowrock Reservoir near Boise, Idaho, created for Bull Trout Telemetry Studies [Stratum_All]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to USGS on an external hard drive in January 2016. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Current ground condition

Dataset: boiseriver_dams
Description: Current dams of the upper Boise River Basin [boiseriver_dams]
Source: USGS
Data Processing: Relevant dams clipped from larger USGS shapefile containing dams located throughout the US (citation in database metadata), creating layer from selection, and then exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Current ground condition

Dataset: boisearea_SNOTELSites
Description: SNOTEL sites of the upper Boise River Basin, Plotted NRCS data coordinates [boisearea_SNOTELSites]
Source: NRCS
Data Processing: Created by typing the SNOTEL site latitudes and longitudes (collected from NRCS) into Microsoft Excel®, then displaying the X, Y. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Current ground condition

Dataset: boisearea_gages
Description: USGS streamgages of the upper Boise River Basin [boisearea_gages]
Source: USGS
Data Processing: Relevant gaging sites clipped from source file (citation in database metadata) using the ArcMap™ 10.3.1 clip tool. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Current ground condition

Dataset: ANDWatershed
Description: USGS StreamStats - Anderson Ranch Dam pour point drainage basin characteristics [ANDWatershed]
Source: USGS StreamStats (Version 3.0). Link: http://water.usgs.gov/osw/streamstats/
Data Processing: To delineate the watershed, "watershed delineation from a point" tool applied at the desired pour point in USGS StreamStats (Version 3.0). Data downloaded as a shapefile and exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Basin and characteristics are representative of the current ground state

Dataset: ARKWatershed
Description: USGS StreamStats - Arrowrock Dam pour point drainage basin characteristics [ARKWatershed]
Source: USGS StreamStats (Version 3.0). Link: http://water.usgs.gov/osw/streamstats/
Data Processing: Collected and downloaded from USGS StreamStats (Version 3.0) in January 2016. To delineate the watershed, "watershed delineation from a point" tool applied at the desired pour point. Data downloaded as a shapefile and exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Basin and characteristics are representative of the current ground state.

Dataset: BTVA_Boise_Patches
Description: Bull Trout Vulnerability Assessment patches, upper Boise River [BTVA_Boise_Patches]
Source: Stream patches of suitable bull trout habitat and associated patch variables. Link: https://www.sciencebase.gov/catalog/item/54494685e4b0f888a81bb4d9
Data Processing: Data originally created by the USGS Forest and Rangeland Ecosystem Science Center (FRESC). Data received and reformatted in March 2016. Data exported to file geodatabase and projected to coordinate system NAD_1983_Idaho_TM.
Date Range: 1984–2011(range of data used in data model patches)
Note: modeled results are continually updated, refer to FRESC website link for current version.

Dataset: LPWatershed
Description: USGS StreamStats - Lucky Peak Dam pour point drainage basin characteristics [LPWatershed]
Source: USGS StreamStats (Version 3.0). Link: http://water.usgs.gov/osw/streamstats/
Data Processing: Collected and downloaded from USGS StreamStats (Version 3.0) in January 2016. To delineate the watershed, "watershed delineation from a point" tool applied at the desired pour point. Data downloaded as a shapefile and exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Basin and characteristics are representative of the current ground state.

Dataset: boiseriver_reservoirs
Description: 1:250,000 scale reservoir polygons - Lucky Peak, Arrowrock, Anderson Ranch only [boiseriver_reservoirs]
Source: Idaho Department of Water Resources. Link: http://www.idwr.idaho.gov/GIS/NHD/
Data Processing: Reservoirs needed for this dataset selected from the original shapefile using ArcMap™ 10.3.1, and a new layer temporarily created from the selection (however, temporary layer never saved as a layer file). New layer then exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: Represents the ground state in 1996.

Dataset: Initial Capture
Description: Reclamation bull trout telemetry initial capture, 2011–13, Boise River Basin - Arrowrock Reservoir [Initial_Capture]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to USGS on an external hard drive in January 2016. Data retrieved from Microsoft Excel® files and then formatted into a shapefile / GDB from displaying xy coordinates. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: 09/18/2011–10/21/2013

Dataset: Recapture
Description: Reclamation bull trout telemetry recapture, 2011–13, Boise River Basin - Arrowrock Reservoir [Recapture]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to USGS on an external hard drive in January 2016. Data were retrieved from Microsoft Excel® files and then formatted into a shapefile / GDB from displaying xy coordinates. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option.
Date Range: 09/07/2011–10/21/2013

Dataset: bathy10ftdem
Description: Arrowrock Reservoir - Boise River Basin, Idaho —10-m (meter) bathymetry converted from contours to raster [bathy10ftdem]
Source: Reclamation
Data Processing: Data originally created by Reclamation. Data transferred to USGS on an external hard drive in January 2016. Data converted from a polyline vector dataset to a raster dataset using ArcMap™ 10.3.1 Polyline to Raster (Conversion) tool. Data exported to file geodatabase feature dataset with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option. Data shifted 90 feet west and 195 feet south, as suggested by the original metadata.
Date Range: 10/1987–06/1997

Dataset: bathy50ftdem
Description: Arrowrock Reservoir - Boise River Basin, Idaho—50-m bathymetry converted from contours to raster [bathy50ftdem]
Source: Reclamation
Data Processing: Data converted from a polyline vector dataset to a raster dataset using ArcMap™ 10.3.1 Polyline to Raster (Conversion) tool. Data exported to file geodatabase with coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option. Data shifted 90 feet west and 195 feet south, as suggested by the original metadata.
Date Range: 10/1987–06/1997

Dataset: boisebasin90mrelief
Description: 90-m resolution Digital Elevation Map (DEM) of central and southern Idaho, collected from Elevation Derivative for National Applications (EDNA) [boisebasin90mrelief]
Source: EDNA, derived from the National Elevation Dataset (NED).
Data Processing: The 90-m resolution DEM was made from EDNA. Shaded relief was generated using default values, but a z_ factor of 0.01.Data exported to a file geodatabase and projected into coordinate system NAD_1983_Idaho_TM using ArcMap™ 10.3.1 export option. Data was shifted 90 feet west and 195 feet south, as suggested by the original metadata.
Date Range: 2002

Dataset: idaho90rlfclp
Description: Idaho 90-m shaded relief, clipped to the spatial extent of the upper Boise River Basin, derived from EDNA shaded relief [idaho90rlfclp]
Source: EDNA, derived from the NED.
Data Processing: EDNA 90-m shaded relief clipped to Boise Basin extent using ArcMap™ 10.3.1 clip tool. Basin extent determined by delineating the Lucky Peak drainage basin with StreamStats Version 3.0. Exported to file geodatabase with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1.
Date Range: 2002

Dataset: S_Rsvr_Lvls
Description: Boise River Basin Reservoir Hydromet storage data for water years 1998–2000, 2011–14 [S_Rsvr_Lvls]
Source: Reclamation Hydromet. Link: http://www.usbr.gov/pn/hydromet/
Data Processing: Data retrieved in tabular format in January 2016. Data reformatted as needed, including reordering of various columns. Additional columns added with the calculated change in active storage for each reservoir relative to the previous day. Data exported to file geodatabase as a file geodatabase table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: S_Rvr_Q
Description: Discharge data from streamgages in the upper Boise River Basin, for water years 1998–2000, 2011–14 [S_Rvr_Q]
Source: USGS National Water Information System (NWIS) Web Interface. Link: http://waterdata.usgs.gov/id/nwis/current/?agency_cd=usgs&parameter_cd=staname,datetime,00065,00060,00010,median&group_key=basin_cd
Data Processing: Data for individual sites downloaded from USGS NWIS. Data from each site collected individually in tabular form, then compiled in one spreadsheet. Table exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 10/01/1997–9/30/2000 and 10/1/2010–9/30/2014

Dataset: ARK_Acoustic_2012
Description: USGS 2012 bull trout acoustic tag telemetry tracking, Arrowrock fish mobile and stationary receiver telemetry studies [ARK_Acoustic_2012]
Source: USGS (Maret and Schultz, 2013)
Data Processing: Data retrieved in tabular format in February 2016 from Microsoft Excel® file. Data imported to ArcMap™ 10.3.1 and formatted into a shapefile from displaying xy coordinates (latitude and longitude). Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1. Additional columns added to the attribute table, and reorganization of the table occurred as needed.
Date Range: 04/10/2012–08/21/2012

Dataset: S_AND_IDFG_1998_2000
Description: Idaho Department of Fish and Game **(**IDFG) bull trout radio tag telemetry, South Fork Boise River, 1998–99 [S_AND_IDFG_1998_2000]
Source: IDFG (Partridge and others, 2001). Data in this study collected using fixed-winged aircraft. Because of distance of plane above the ground and speed of travel, accuracy recorded probably within 0.5 kilometer. If a fish located near the confluence of two streams, both streams indicated by an overlapping object.
Data Processing: Data received by Reclamation in a shapefile and provided to the USGS. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1
Date Range: 03/19/1998–05/18/2000

Dataset: BoiseArea_Telemetry_2011_2014
Description: Bull trout radio tracking from stationary sites at South Fork Boise River at Neal Bridge near Arrowrock Dam, Boise River near Twin Springs, and Reclamation site below Arrowrock dam in Lucky Peak Reservoir, and mobile tracking.
Source: Reclamation
Data Processing: Data originally created by Reclamation in tabular format Microsoft Excel® file. Data imported to ArcMap™ 10.3.1. Additional field "Unique_ID" added. A subset of the original stationary site data was created to reduce detection redundancy. The original stationary site data contained multiple detections of fish movement within antennae range. The multiple detections of each fish were consolidated into one stationary site detection.
Date Range: 01/03/2012–02/13/2014

Dataset: WQ_LP_Dam_Site
Description: Water-quality profile near Arrowrock Dam, from 2012 USGS telemetry studies [WQ_LP_Dam_Site]
Source: USGS (Maret and Schultz 2013)
Data Processing: Data extracted from appendix A in Maret and Schultz (2013) and then formatted into a shapefile by using ArcGIS™ 10.3.1 Add XY Coordinates tool. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1. Additional columns added (such as latitude and longitude) to the attribute table, and table fields reorganized as needed.
Date Range: 02/19/2012–10/04/2012

Dataset: WQ_Middle_Fork_Arm
Description: Water-quality profile in Arrowrock Reservoir near the Middle Fork Arm, from 2012 USGS telemetry studies [WQ_Middle_Fork_Arm]
Source: USGS (Maret and Schultz 2013)
Data Processing: Data extracted from appendix A in Maret and Schultz (2013) and then formatted into a shapefile by using ArcGIS™ 10.3.1 Add XY Coordinates tool. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1. Additional columns added (such as latitude and longitude) to the attribute table, and table fields reorganized as needed. Water-quality parameters measured with a Hydrolab DS5 meter starting at 1 m below the surface and then at 2-m increments to 21 m below the water surface. Below this depth, measurements taken every 5 m until the bottom reached.
Date Range: 05/19/2012 -10/04/2012

Dataset: WQ_South_Fork_Arm
Description: Water-quality profile in Arrowrock Reservoir near the South Fork Arm, from 2012 USGS telemetry studies [WQ_South_Fork_Arm]
Source: USGS (Maret and Schultz 2013)
Data Processing: Data extracted from appendix A in Maret and Schultz (2013) and then formatted into a shapefile by using ArcGIS™ 10.3.1 Add XY Coordinates tool. Data exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcMap™ version 10.3.1. Additional columns added (such as latitude and longitude) to the attribute table, and table fields reorganized as needed. Water-quality parameters measured with a Hydrolab DS5 meter starting at 1 m below the surface and then at 2-m increments to 21 m below the water surface. Below this depth, measurements taken every 5 m until the bottom reached.
Date Range: 05/19/2012 -10/04/2012

Dataset: untagged_fish
Description: Untagged fish from 2011 to 2014 telemetry sampling efforts, upper Boise River [untagged_fish]
Source: USGS
Data Processing: Developed by Dorene MacCoy of the USGS. Data compiled from several fish capture and telemetry data sources provided by Reclamation in March 2016. Table exported to file geodatabase as a GDB table using ArcMap™ 10.3.1 export option.
Date Range: 08/31/2011–11/02/2012

Dataset: untagged_fish_location
Description: Untagged fish location, upper Boise River telemetry sampling, 2011–14 [untagged_fish_location]
Source: USGS
Data Processing: Developed by Dorene MacCoy of the USGS. Data compiled from several fish capture and telemetry data sources provided by Reclamation in March 2016. Table exported to file geodatabase
Date Range: 10/24/2011–11/02/2012

Dataset: Acoustic stationary sites
Description: Three sites located within Arrowrock Reservoir
Source: USGS as a GDB table using ArcMap™ 10.3.1 export option.
Data Processing: Data table containing site coordinates imported to ArcMap 10.3.1. The Add XY Coordinates tool was used to create temporary spatial layer. Layer then exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcGIS version 10.3.1.
Date Range: 04/10/2012 – 08/21/2012

Dataset: Telemetered stationary sites
Description: USGS streamgage locations at Boise River near Twin Springs and South Fork Boise River at Neal Bridge near Arrowrock Dam, Idaho, and a site used by Reclamation for detection of entrained fish below Arrowrock Dam
Source: Reclamation
Data Processing: Data table containing site coordinates imported to ArcMap 10.3.1. The Add XY Coordinates tool was used to create temporary spatial layer. Layer then exported to file geodatabase feature dataset as a feature class with coordinate system NAD_1983_Idaho_TM using the export option in ArcGIS version 10.3.1.
Date Range: 01/03/2012–02/13/2014

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