

Aquatic Data Analysis

Federal Aid Project F-239R-23

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Federal Aid in Fish and Wildlife Restoration

Job Progress Report

Colorado Parks & Wildlife

Aquatic Research Section

Fort Collins, Colorado

August 2016

STATE OF COLORADO

John W. Hickenlooper, Governor

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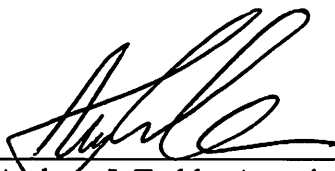
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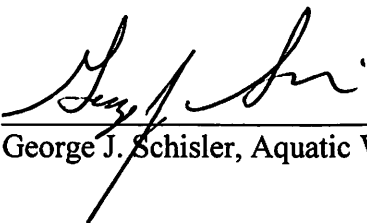
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Date: 08/26/16

The results of the research investigations contained in this report represent work of the authors and may or may not have been implemented as Colorado Parks & Wildlife policy by the Director or the Wildlife Commission.

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State:Colorado

Project No. F-239R-19

Project Title: Aquatic Data Management

Period Covered: July 1, 2015 through June 30, 2016

Project Objective:

To develop and maintain a centralized depository of aquatic biological data from across the state and to provide the expertise and single point-of-contact for requests relating to data, data application development and data analysis. The overall goal of the project is the development of statistical models and analyses that accurately describe and/or predict the status of fish communities and/or the results of management actions on these communities.

Relationship with Other Grants:

This project is also strongly tied to Federal Aid Grant F-86 – Statewide Fishery Inventory. While F-86 provides the funding for the field work and data entry to be completed, the data collected from those efforts are stored in the ADAMAS database and the reporting numbers for the F-86 annual report are generated from within ADAMAS.

Job No. 1. Aquatic Data Management System (ADAMAS)

Job Objective: Develop and maintain a computer based, statewide aquatic data management application that facilitates the standardized entry and analysis of survey data across the state, as well as providing centralized access to information from all sources of aquatic data including CPW stream and lake inventories, Scientific Collection (SCICOLL) reports and CPW creel surveys.

Need: Management of the state’s vast aquatic resources requires standardized data collection and analysis procedures, as well as centralized data source that is easily accessible to biologists, managers and researchers.

Specific Objectives:

1. Maintain Microsoft SQL database and Access front ends, as well as proprietary ADAMAS application
2. Oversee the upload and verification of aquatic survey data by CPW biologists and researchers
3. Upload and verify aquatic survey data from external scientific collection permit holders

Approach:

Action #1- Maintain current and accurate data from aquatic biological surveys statewide

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Research, Survey or monitoring-fish & wildlife populations
- Level 3 Action Activity – N/A

The effort to collect and enter both current and historic fisheries data from field survey sheets stored at various CPW offices continues. At the beginning of this reporting period, the database held 43,448 surveys at 15,035 locations across the state, with 2,934,421 fish sample records, representing 7,565,813 fish.

During the reporting period (July 1st, 2015 to June 30th, 2016), we've added 6,460 new surveys, 2,821 new sampling sites, and 717K new fish records to the database. This brings the total holdings of CPW's ADAMAS database to 49,972 surveys, 17,841 unique sampling sites, and 8.23 M fish records. Of those, 868 surveys were performed by CPW biologists, with another 1,260 surveys from SCICOLL reports. A summary of the surveys added to the database over the course of this reporting period is provided in Table 1.

Table 1. Source and content of surveys performed and added to the database during this reporting period. Note that the number of samples refers to the number of fish that were actually measured or groups of fish that were enumerated, whereas the number of fish represents the total number of fish encountered.

Project	#Surveys	#Samples	#Fish
Aquatic Database	1,551	41,978	139,106
Aquatic Research	182	13,362	33,341
CDO Water Quality	2,599	6,931	46,606
Northeast Region Fisheries Management	248	43,303	64,630
Northwest Region Fisheries Management	214	32,325	39,014
Scientific Collections Permit	1,260	84,454	170,065
Southeast Region Fisheries Management	113	14,401	27,327
Southwest Region Fisheries Management	152	36,888	45,243
Species Conservation	141	39,206	108,135
Total For 2015-16	6,460	312,848	673,467

We continue to bring surveys into the system from a variety of sources. Initially, the database was comprised of records from the (former) Colorado Division of Wildlife's Stream and Lake Databank (the predecessor to ADAMAS) compiled by David Weber. Since 1993 there have been annual reports of surveys submitted by CPW biologists and SCICOLL permit holders. The original ADAMAS database was designed around basic parameters collected in the field with enough flexibility to support the variety of inventory sampling protocols used by aquatic biologists, researchers and consultants across the state. We continue to standardize field data reporting formats based on that design, allowing for expansion to accommodate new methods and projects.

We continue with the effort we began several years ago to systematically review area office hardcopy files, scanning field data sheets to PDF for entry by database staff. As surveys are processed, sampling information is verified and compared to data from previously entered surveys. From time to time, historic survey reports with more detail and individual fish data are found to replace previously recorded, summary information.

The following table shows the total database holdings, including the number of surveys, fish samples, and fish counts, summarized by reporting cycle (July 1st – June 30th). Note that these numbers are adjusted annually as erroneous or duplicate surveys are removed and new surveys are added.

Table 2. Current data holdings of CPW aquatic database

Year	#Surveys	#Samples	#Fish
Pre-2003	12,522	338,513	1,593,632
2003-2004	1,302	24,553	43,123
2004-2005	1,610	91,740	116,283
2005-2006	1,989	167,602	333,550
2006-2007	1,147	44,471	92,054
2007-2008	1,286	142,948	216,319
2008-2009	2,568	265,376	653,660
2009-2010	2,665	344,383	716,816
2010-2011	1,493	193,237	391,265
2011-2012	1,091	136,300	219,526
2012-2013	2,001	132,186	339,856
2013-2014	6,057	366,470	1,233,384
2014-2015	7,717	666,002	1,449,887
2015-2016	6,460	312,848	673,467
Totals at end of FY-2016	49,908	3,226,629	8,072,822

Action #2- Ongoing development and Maintenance of aquatic SQL database(s)

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management
- Level 3 Action Activity – Database Development

Several related efforts affecting the ADAMAS database and CPW aquatic data as a whole took place during this reporting period:

- i. The production server that houses all of the aquatic data was upgraded from a 2003 SQL server to a 2014 SQL server to improve stability, speed, and capitalize on added geo-spatial data capabilities.
- ii. Development of new data entry templates and applications compatible with updated versions of the ADAMAS application, for use by CPW biologists in the field and Scientific Collector Permit reports.

- iii. Presented a discussion of schema and application development, as well as lessons learned in fisheries data management, during Fisheries Information Technology Section (FITS) Symposium at annual American Fisheries Society Conference in Portland, OR.

Action #3 – Management and support of ADAMAS data application

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management
- Level 3 Action Activity – Information systems operations & maintenance

Standardization of inventory sampling data entry, analysis and reporting continues to be the primary target of the Aquatic Data Management System (ADAMAS) within the aquatics data umbrella. As we have described in previous reports, the applications' designs and implementation were set up to take place at a rate of one application per year, with the Hatcheries production application to be implemented first, followed by ADAMAS, a network-accessible version of C-SAP (creel survey analysis) and then a network-accessible application for the AAHL (disease inspections and certifications).

At the time of this report, the ADAMAS and TRANS6 (Hatcheries) applications have been utilized for about three years. An upgrade to both ADAMAS and Trans6 applications, as well as a redesigned AAHL module has been completed and installed and work continues to deal with any remaining bugs that are discovered. Funding has been obtained and development has commenced on a new Creel data application.

Specific efforts related specifically to the ADAMAS application that occurred during this reporting period include:

- i. Updates and bug fixes for our aquatic data application, ADAMAS, were installed on the main database server to address bugs and enhance capabilities. This system allows biologists across the state to directly link to the SQL database, query the database, upload or directly enter data and analyze individual surveys.
- ii. Funding and the necessary approvals were obtained to start development on a new Creel data application that will be replace the old C-SAP program and complete the centralized CPW aquatics data application portfolio. This will be a two-year development project, with a rough operating front end, database schema and data import routines being delivered at the beginning of this fiscal year and a fully functional data management and analysis application being delivered at the beginning of FY 2017-18.
- iii. Training of new biologists and researchers in the use of the ADAMAS application and serving as the primary contact for any questions regarding data collection, entry and analysis.

Action #4 – Ancillary Front Ends

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management

- Level 3 Action Activity – Database Development

Development of need-specific front-ends for other CPW users to access the data within the database, while controlling what data they have access to or how it is summarized, is another continuing aspect of this project. Currently an ADAMAS-Links (MS Access) database has been developed for biologists to summarize and analyze data across multiple surveys and continues to be improved and updated. A separate Access front end that allows the CPW water quality coordinator to identify species assemblages for specific water segments is also being maintained. In addition, level one data (stream/lake/station name, location, sampling dates) and some basic survey information are accessible internally through a web-based GIS application (the CPW Watercode and Station locator). The general public may also access fisheries data through the Colorado Fishing Atlas web-GIS portal.

Job No. 2. Supplemental Database Development

Job Objective: Development and maintenance of additional computer based, aquatic data management systems to facilitate the management and analysis of data that is not readily incorporated into the ADAMAS database. Examples include: CPW Passive Integrated Transponder (PIT) tag study data, and bulk water temperature data.

Need: There are aquatic projects whose data needs to not fit the ADAMAS schema, so supplemental databases need to be developed to accommodate data storage and analysis. Often these databases may be linked through primary tables (i.e. waters and species) to the ADAMAS system.

Specific Objectives:

1. Identify data management needs that do not conform to ADAMAS schema
2. Work with biologists/researchers to develop a customized solution in Microsoft SQL server or Access

Approach:

Action #1- Ongoing development and Maintenance of aquatic SQL database(s)

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management
- Level 3 Action Activity – Database Development

As the expert in data management and database development for the aquatic section, the data analyst is often called upon to develop databases that are linked or completely separate from the main aquatics data application. Development of new database products may include stand alone MS Access databases or SQL linked Access front ends residing on external servers.

Supplemental database development activities that relate to this reporting period were:

- i. Serving as the coordinator for the development of the various database applications. Acting as the primary contact between CPW and the software vendor(s), compiling a list of bugs from users, testing new beta versions and monitoring system performance.
- ii. Continued development and improvements to a CPW Statewide Passive Integrated Transponder (PIT) tagging database.
- iii. Participate on the development team for Species Tagging Research and Monitoring System (STReAMS), led by Colorado Natural Heritage Program/US Fish and Wildlife Service, Bureau of Land Management.
- iv. Continue to gather temperature data and develop a centralized database for temperature logger data from across Colorado. Shared data with USGS's NorWeST temperature modeling project.
- v. Database development and support to other CPW units outside of aquatics.

Job No. 3. Data Requests

Job Objective: To facilitate the review, consolidation, and delivery of aquatic data requests from individuals and agencies both internal and external to CPW. Develop data request and data sharing documents, serve as the main point of contact for internal/external data requests and coordinate the review of each external request with the review committee. Consolidate data requests, obtain signed data sharing agreements, and maintain records of all requests and outgoing data.

Need: Under the Colorado Open Records Act (CORA) (24-72-201-24-72-309, C.R.S.), virtually all data collected by CPW is open to public request, with the exception of data relating to private lands (Section 204(3)(a)(XXI), C.R.S) and ongoing research (Section 204(2)(a)(III), C.R.S. A coordinator is needed to be the single point-of-contact for all aquatic data and ensure that Colorado Statutes concerning open access to data and protection of privacy/ongoing research are adhered to.

Specific Objectives:

1. Provide a single point-of-contact for both internal and external requests for aquatic data.
2. Provide timely and accurate data summaries to internal and external sources as needed
3. Ensure data sharing agreements are in place and that Colorado Statute () is adhered to.
4. Maintain log of data requests and data sets that were sent out for future reference

Approach:

Action #1- Ongoing development and Maintenance of aquatic SQL database(s)

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management
- Level 3 Action Activity – Information Systems Operations & Maintenance

Requests for CPW aquatic data continue to be filled in a timely manner, with priority given to support CPW research and management needs. Federal, state and local government agencies, consultants, contractors and educational researchers are accommodated as expeditiously as possible. Requests from the general public are generally referred to Aquatic Area biologists and the Colorado Fishing Atlas. A total of 59 data requests were received during the timeframe of this report, which is on par with the number from last year.

Table 3. Number of Data Request received annually since 2012.

Fiscal Year	# Requests
FY 2012-13	23
FY 2013-14	47
FY 2014-15	62
FY 2015-16	59

The source and number of external data requests handle in FY2015-16 is provided below.

Table 4. Source of external data requests in 2015-16 for CPW aquatic data

Organization Type	# Requests
Private Consultant	22
Federal Agency	13
Academic Institution	10
Other	5
State-external to CPW	2
NGO	2
Law Firm	2
General Public	2
Municipality	1
Total	59

A centralized process for review of requests by CPW’s biologists prior to release of data has been formally adopted. A formal request for data is made via email to the data analyst with a completed CPW Aquatic Data Request Form (Appendix A). The form allows the requestor to declare their intended use for the data, define the specific waters or geographic area of interest, and identify the final user of this data (i.e. their client). The second page allows the requestor to further define the resolution (both temporal and spatial) required and the justification for the level of detail requested.

The request, and often the data requested, is distributed to the Aquatic Data Request Group via email for review and comment. The members include the Aquatic Research Leader, the regional Senior Aquatic Biologists, the Water Unit Manager, the regional Senior Wildlife Species Conservation biologists, the regional Aquatic or Water Quality Wildlife Species Conservation biologists, the Aquatic Toxicologist, the Aquatic GIS Specialist and the Aquatic Database Manager. The members of this group are aware of

aquatic issues statewide and are all in contact with Aquatic Area biologists responsible for the management of waters in the requestor's area of interest. Discussions take place among the members via email to determine how the request is to be filled. Once everyone is in agreement, or has deferred decision-making on the request to other members of the group, a data sharing agreement is sent to the requestor for signature (See Appendix B). This form simply states that the data is provisional, will not be passed to a third party and that raw data, when distributed, will not be displayed or published in its raw form. Once this signed agreement is on file, the request is filled electronically via email. The requested deliverable, the request form, signed agreements and a copy of the email discussion are archived for future reference.

Job No. 4. Technical Assistance and Data Mining

Job Objective: To provide technical and statistical assistance to researchers, field biologists, and staff on a variety of aquatic data analysis topics, as well as attempting to answer questions pertinent to the management of aquatic resources in Colorado by analyzing current and historical data. Topics include creel survey, inventory survey, management categorization, fishery trends, spatial data analysis, hardware and software review and upgrades, application and supplemental database development, as well as other computer related data analysis needs.

Need: The complexity of the aquatic data management system and its many relationships with other aquatic applications (hatcheries, aquatic animal health lab, creel) requires that someone knowledgeable in these relationships and the functioning of the system as a whole be available to provide technical support to users when needed. In addition, senior aquatic managers and researchers require the ability to pool and analyze data from across the state to identify trends and develop models concerning fishery populations. As the person responsible for all of the aquatic data, the data analyst is in a unique position to leverage their knowledge of the database to answer questions and develop novel research hypothesis relating to the over 100 years of aquatic data that now resides in the database.

Specific Objectives:

1. Provide technical assistance to biologists and researchers in application functioning, data extraction/manipulation and data analysis
2. Identify trends and patterns in long-term fishery data, utilizing both spatial and temporal data sets
3. Collaborate with internal and external researchers to answer research hypothesis
4. Publish significant results in peer-reviewed literature or as management briefs

Approach:

Action #1- Ongoing development and Maintenance of aquatic SQL database(s)

- Level 1 Action Category – Data Collection and Analysis
- Level 2 Action Strategy – Database Development & Management
- Level 3 Action Activity – Information Systems Operations & Maintenance

The data analyst is also responsible for providing technical support relating to all of the data applications in the aquatics program, as well as assisting biologists and researchers with specific data questions and data summaries. This includes working with CPW GIS staff in support of numerous inter-and intra-net aquatic geo-spatial applications. Finally, utilizing various database and data mining software, the data analyst develops new research questions and identifies informational gaps in the data.

Specific topics of investigation undertaken during this reporting period include:

- i. Investigations into mobile data gathering applications stalled in 2015-16 due to other data development requirements, but will continue in 2016-17 as time permits (ongoing).
- ii. Development of various Tableau dashboards for internal use and monitoring of aquatic data and evaluation of the potential benefits of adding a Tableau network license for report generating (ongoing).
- iii. Collaborate with researchers at US Geological Survey to investigate factors that influence brook trout displacement of cutthroat trout, as well as brown trout displacement of brook trout related to temperature/climate change (ongoing).
- iv. Collaborate with researchers at Colorado State University to assess factors that may influence the magnitude of climate change on high elevation lakes in Colorado (ongoing).
- v. Assisted CPW biologists in identifying the effects of the 2012 floods along the CO Front Range on the fish community of St. Vrain, Boulder Creek, Big Thompson, and Cache La Poudre watersheds.
- vi. Enhanced analysis and visuals for 2012 CPW Angler Survey

Appendix A: CPW Data Request Form



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Request for Aquatic Data

1. (a) Name (s) of persons requesting data: _____

1. (b) Organization/Company/Agency Name (s): _____

1. (c) Organization/Company Agency Contact Information:

PHONE: _____ FAX: _____ email: _____
(Email address is where electronic data files would be sent)

1. (d) Ultimate person/organization asking for the data (i.e. if a consultant is making this request, who is the client?):

2. (a) We are requesting data for the following water bodies/geographic area:

(Note that CPW does not typically distribute point-sample locations or generate GIS maps)

2. (b) Describe the data you are requesting (fish species distributions? Water quality parameters?):

3. Please describe your intended use for this data:

4. You are advised of the following regarding the requested data:

- (a) the data may be exempt from the Colorado Open Records Act, in which case, CPW may deny your request (refer to CORA for exemptions)
- (b) the data may be in provisional status (i.e., error check still in progress)
- (c) raw data values should not be changed. If you have original or copies of data sheets or previous exports with differences in the data you receive, please call or email for possible corrections.
- (d) Do not redistribute this data to parties not listed above. Other parties must submit a formal request to CPW to insure that they receive the most updated version of the data available.

5. Resolution:

In order to speed up the approval and data distribution process, please further define you data needs. While we will strive to give you the data you have requested in a timely manner, keep in mind that the lower the resolution of your data request, the less scrutiny (and thus time) required by the data request



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review committee, and also the more likely that your request will be approved. Note that requests for raw data will need to demonstrate this need to the committee before approval will be granted.

- (a) What level of fish data are you requesting (Species Resolution):
- i. Species Occurrence (For all species? For specific species?)
 - ii. Species numbers, size ranges, population estimates, and biomass
 - iii. Data on individual fish collections
 - iv. Creel Survey Data?
 - v. Fish Stocking Data
- (b) At what scale do you want this data summarized (Spatial Resolution):
- i. (i) Basin (6 digit HUC)
 - ii. Sub basin (8 Digit HUC)
 - iii. Watershed (10 Digit HUC)
 - iv. Sub-Watershed (12 digit HUC)
 - v. Catchment
 - vi. Individual water body/Survey Sample points
- (c) How far back do you want to go (Temporal Resolution):
- i. Only the most recent surveys
 - ii. Back to a specific year? Please specify: _____
 - iii. All data in the CPW Aquatics Database

Additional Explanation or requirements:

Please provide as much information as possible and return to:

Andrew J. Treble
Aquatic Research Data Analyst
Aquatic Research Section, Research, Policy & Planning Branch



COLORADO
Parks and Wildlife
Department of Natural Resources

P: (970) 472-4372 | F: (970) 472-4458/4457 | C: (517) 420-4588
317 West Prospect, Fort Collins, CO 80526
AndrewTreble@state.co.us | www.cpw.state.co.us

Appendix B: CPW Electronic Data Sharing Agreement



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317 W. Prospect Rd, Fort Collins, CO 80526
 970-472-4300 • 970-472-4457
 wildlife.state.co.us • parks.state.co.us

Non-disclosure Agreement for the Use of Colorado Parks and Wildlife Electronic Information

- 1) Colorado Parks and Wildlife (CPW) will provide information on aquatic species, statewide, as requested by XXXXXXX of XXXX for the purposes of providing a baseline for the National Rivers and Stream Assessment Survey. These data will be used solely by XXXXXXX for the purpose of this project.
- 2) CPW, for management and conservation reasons, considers this information confidential and sensitive due to the elements' vulnerability to intentional and unintentional disturbance, interpretation, and due to agreements made with, and statutory requirements for, the protection of individual landowners' privacy.
- 3) We, the undersigned, acknowledge that the information noted above is considered sensitive and confidential, and agree to the following stipulations:

For Raw Data

- i. Raw data will only be accessible to XXXXXXXXXX and to no other individual or entity, nor will it be published or made available for public viewing in its raw state. It may be used in analysis and summaries that are then published or reported to clients without issue.
- ii. The information may not be transcribed or reproduced in any manner, unless authorized in writing by the CPW representative and signatory identified below. Locations may be displayed spatially if necessary to their stated purpose, but only in a manner and at a scale where specific locations of individual points cannot be derived.
- iii. The information will be used for the requested purpose described above and for no other purpose. The information will be destroyed upon completion of the project and may not be kept for future use. Any future requirements for the data will involve a new data request to ensure the most up-to-date data is used.
- iv. Requests involving biological interpretation or use of the information beyond the stated purposes will be referred to CPW aquatic biologists.
- v. CPW does approve the passing of summary reports, based on this data, to the reported end-user (XXXXXXXXXX) at the end of this project.

For Summarized Data

- i. The information will be used for the requested purpose described above and for no other purpose.
- ii. The information will be destroyed upon completion of the project and may not be kept for future use. Any future requirements for the data will involve a new data request to ensure the most up-to-date data is used.
- iii. Requests involving biological interpretation or use of the information beyond the state purposes will be referred to CPW.

Signed by:

 Colorado Parks & Wildlife (signature)

 Data Requested By (signature)

 (Please Print)

 (Please Print)

 Date

 Date

STATE OF COLORADO
 John W. Hickenlooper, Governor • Mike King, Executive Director, Department of Natural Resources
 Bob D. Broscheld, Director, Colorado Parks and Wildlife
 Parks and Wildlife Commission: Robert W. Bray • Chris Castilan, Secretary • Jeanne Home
 Bill Kane, Chair • Gaspar Perricone • James Pribyl • John Singletary
 Mark Smith, Vice-Chair • James Vigil • Dean Wingfield • Michelle Zimmerman
 Ex Officio Members: Mike King and John Salazar



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317 W. Prospect Rd, Fort Collins, CO 80526
970-472-4300 • 970-472-4457
wildlife.state.co.us • parks.state.co.us

Colorado Parks and Wildlife Data Request Disclaimer

Colorado Parks and Wildlife (“CPW”) collects aquatic data from both internal sources and a variety of external governmental and non-governmental agencies. CPW provides this data, upon request, solely as a public service. As a significant proportion of this data comes from an outside agency, over which CPW lacks the ability to verify the protocols and data collection procedures, CPW makes no warranty, representation, or guarantee as to the content, accuracy or completeness of any of the data provided. CPW makes this data available on an “as is” basis and explicitly disclaims any representations and warranties, including, without limitation, the implied warranties of merchantability and fitness for a particular purpose. The CPW assumes no liability and the user assumes all liability for: 1. any errors, omissions, or inaccuracies in the data provided, regardless how it was caused; or, 2. any decision made or action taken or not taken by anyone using or relying upon data provided.

Use of Data

CPW may require a user of this data to terminate any and all display, distribution or other use of any or all of the data for any reason including, without limitation, violation of these Terms of Use.

Signed by:

Name (signature)

Name (Please Print)

Date

STATE OF COLORADO
John W. Hickenlooper, Governor • Mike King, Executive Director, Department of Natural Resources
Bob D. Broscheid, Director, Colorado Parks and Wildlife
Parks and Wildlife Commission: Robert W. Bray • Chris Castellan, Secretary • Jeanne Home
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