Aquatic Data Analysis and Database Management

Andrew J. Treble
Aquatic Research Data Analyst

2024 Progress Report

Colorado Parks and Wildlife

Aquatic Research Section

Fort Collins, Colorado

December 2024

STATE OF COLORADO

Jared Polis, Governor

COLORADO DEPARTMENT OF NATURAL RESOURCES

Dan Gibbs, Executive Director

COLORADO PARKS & WILDLIFE

Jeff Davis, Director

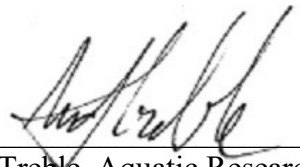
WILDLIFE COMMISSION

Dallas May, Chair
Richard Reading, Vice Chair
Karen Bailey, Secretary
Jessica Beaulieu
Marie Haskett
Jack Murphy
Gabriel Otero
Murphy Robinson
Tai Jacober
James Jay Tutchton
Eden Vardy

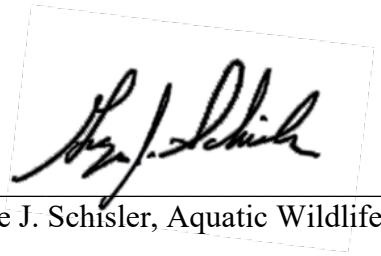
Ex Officio/Non-Voting Members: Kate Greenberg, Dan Gibbs

AQUATIC RESEARCH STAFF

George J. Schisler, Aquatic Research Leader
Brian W. Avila, Aquatic Research Scientist, Population Genetics
Peter J. Cadmus, Aquatic Research Scientist/Toxicologist, Water Pollution Studies
Kelly Carlson, Aquatic Research Program Assistant
Eric R. Fetherman, Aquatic Research Scientist, Salmonid Disease Studies
Tawni B. R. Firestone, Aquatic Research Scientist, Aquatic Toxicology and Disease
Ryan M. Fitzpatrick, Aquatic Research Scientist, Eastern Plains Native Fishes
Adam G. Hansen, Aquatic Research Scientist, Coldwater Lakes and Reservoirs
Zachary Hooley-Underwood, Aquatic Research Scientist, West Slope Three-Species Studies
Matthew C. Kondratieff, Aquatic Research Scientist, Stream Habitat Restoration
Dan A. Kowalski, Aquatic Research Scientist, Stream and River Ecology
Jesse M. Lepak, Aquatic Research Scientist, Warm and Coolwater Lakes and Reservoirs
Eric E. Richer, Aquatic Research Scientist/Hydrologist, Stream Habitat Restoration
Kevin B. Rogers, Aquatic Research Scientist, Cutthroat Trout Studies
Andrew J. Treble, Aquatic Database Manager, Aquatic Data Management and Analysis
Brad Neuschwanger, Hatchery Manager, Fish Research Hatchery
Tracy Davis, Hatchery Technician, Fish Research Hatchery
Troy Meyer, Hatchery Technician, Fish Research Hatchery
Karen Hertel, Librarian

Prepared by: 

Andrew J. Treble, Aquatic Research Data Analyst

Approved by: 

George J. Schisler, Aquatic Wildlife Research Chief

Date: December 2, 2024

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.

Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

The year 2024 was marked by significant achievements across multiple domains, with notable progress on the *Fishes of Colorado* publication serving as a cornerstone of the year's efforts. The submission of the first full draft to the publisher and the return of the initial round of page proofs represent critical milestones in this long-anticipated project. Efforts will continue in 2025, with the goal of completing a final draft and publishing this comprehensive work.

Data management and dissemination remained central to the aquatic data program's mission. Beyond fulfilling routine data management tasks, addressing data requests, and archiving survey records, the program made advancements in analysis and visualization. These included the development of new Tableau Network Dashboards and R scripts, enhancing the program's analytical capabilities. New biologists were trained to use the aquatics data platform, and two interns were brought on board to gain experience with the program's data and software. Additionally, a long-term project was initiated to capture the history of personnel in aquatic positions, preserving institutional knowledge.

In reporting, 2024 saw the completion of the standard Federal Aid Report and Annual Report, along with the co-authoring and publication of a peer-reviewed article. A new initiative was undertaken to estimate fishing revenue losses and their economic impacts using CPW's extensive creel data archives, which was met with favorable reception. An incomplete Standard Operating Procedures (SOP) manual for the aquatic research data analyst position was also revisited, reorganized, and reformatted into a more user-friendly structure in Microsoft Excel.

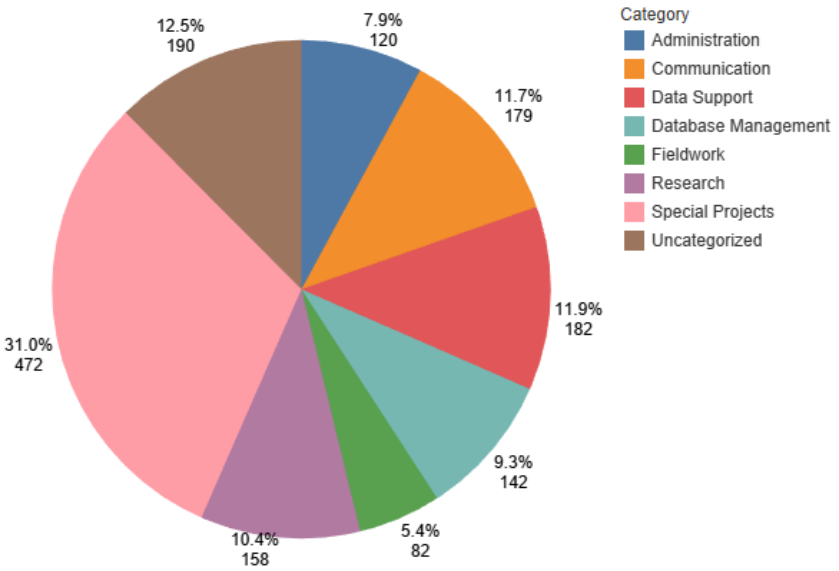
The modernization of aquatics data platforms emerged as a recurring focus throughout the year. Collaboration between aquatic research, hatchery staff, and Portland Webworks facilitated the development of a replacement for the Trans6 platform. Later in the year, attention shifted to drafting a Request for Proposals (RFP) for the simultaneous replacement of ADAMAS and ANS applications, a major step toward streamlining data systems.

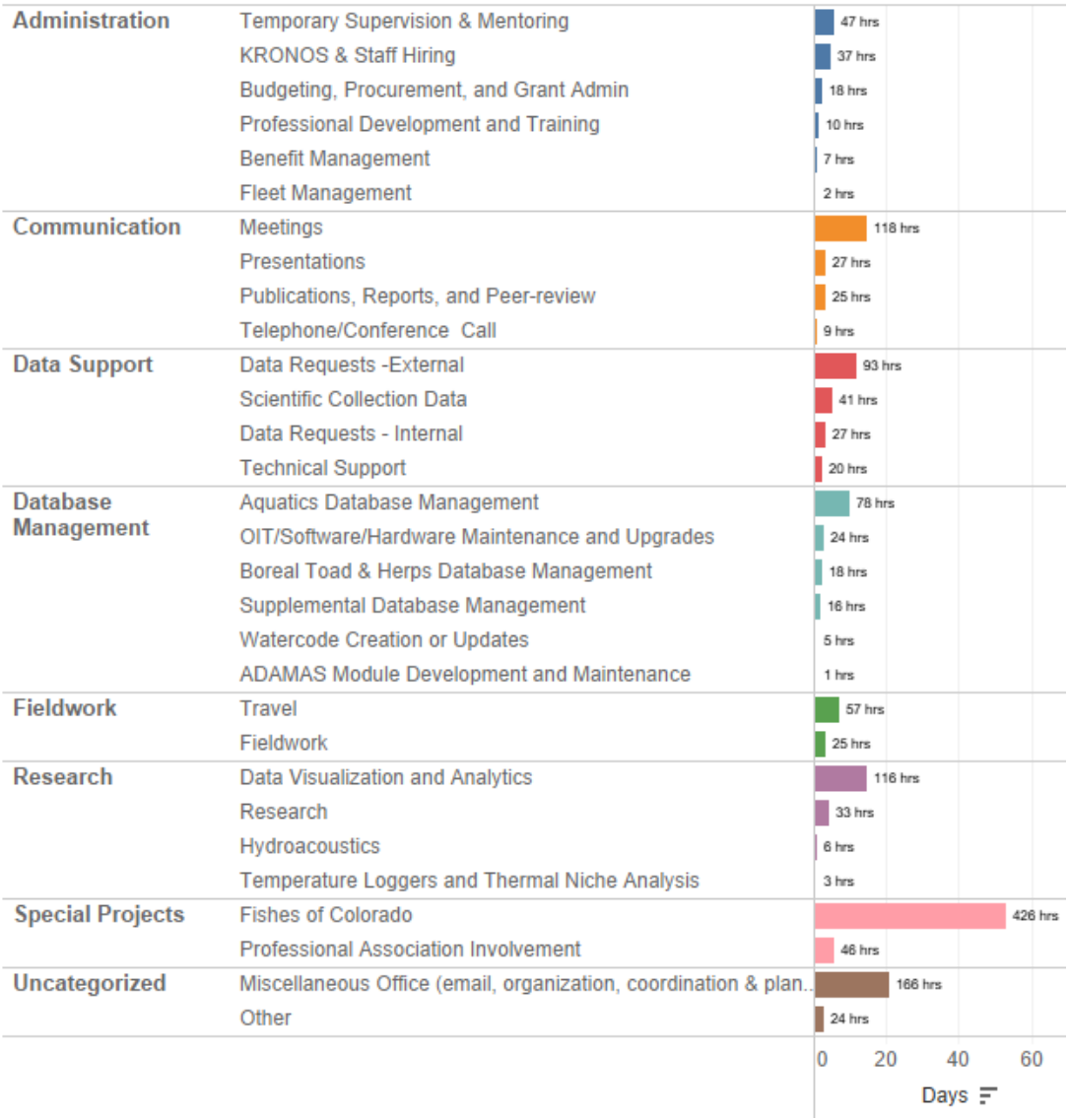
Participation in professional development and networking opportunities was a welcome respite from being in front of a computer. Memorable events included the OFWIM (Organization of Fish and Wildlife Information Managers) conference, the Aquatic Section and Aquatic Research Meetings, the Colorado/Wyoming AFS meeting, and the D'atta Bio Awards. These events are expected to remain on next year's schedule, with the Colorado/Wyoming meeting expanding to include the Western Division AFS (WDAFS). The coordination of the Western Division's listserv and email contacts also continued under the aquatic research data office.

Fieldwork was limited in 2024, focusing on instead on the book and essential operations. Activities included wild spawn collection, a single hydroacoustic survey, and the installation of oxygen sensors under the ice at Zimmerman Lake. These efforts, though minimal, were critical to ongoing research and management initiatives.

In summary, 2024 was a year of meaningful progress, laying the groundwork for continued advancements in the aquatic research unit specifically, and the aquatic section as a whole.

Figure 1. *Allocation of time by the Aquatic Research Data Analyst. January 1st – November 30th, 2024*





ADMINISTRATION

This category includes all staff hiring, KRONOS timekeeping, budgeting and expense tracking, fleet management, and professional development and training (i.e., OIT security modules and software workshops). This category also accounts for any time spent mentoring or supervising temporary personnel. This category accounted for a total of 120 hours (7.9%) in 2024, which is an 81% (90 hours) decrease from the year prior.

I. **Temporary Supervision and Mentoring**

In 2024, three YIP interns and one CSU work-study student were supervised and mentored, emphasizing database training and analytical skills development. Forty-seven hours were spent with temporaries, primarily providing hands-on instruction in the various data packages.

- Alissa Gigliotti (longterm seasonal temporary)
- Matt Bolerjack (23/24 YIP intern)
- Cecilia Huber and Kace Vazquez Del Mercado (24/25 YIP interns)
- Ralph Eberhard is my CSU workstudy student

II. Oversaw data analysis and dashboard development of Raegan Hasselbring, one of Tyler Swarr's temporary employees who was placed on desk work due to knee surgery

III. Hired Riley Dils as Research Associate to work on water temperature projects, in cooperation with Ryan Fitzpatrick and Tawni Firestone

II. Professional Development and Training

Annual mandatory trainings and professional development opportunities accounted for 10 hours (<1% overall) in 2024. These trainings and opportunities included:

- Annual OIT cybersecurity training
- Mandatory HR trainings (Sexual harassment, Workplace Violence, Ethics, Conflict of Interest)
- DNR Equity, Diversity, and Inclusion training
- CPW Identity Manager software training
- DU Daniels Leadership School Alumni Workshops
- Asana online training
- OFWIM conference continuing education on effective presentations

COMMUNICATION

The communication category encompasses meetings, conference calls, presentations (both internal and external), written reports, and publications. During the reporting period, a total of 215 hours, representing 14.1% of overall time, was dedicated to these activities. This level of effort is consistent with previous years, with the largest portion devoted to attending meetings and preparing reports, publications, and presentations, including both authoring and peer-reviewing content. These activities align with annual commitments in these areas.

I. Publications, Reports, and Peer-Review

Approximately 25 hours during this reporting period were allocated to authoring and reviewing various reports, publications, and white papers. This effort resulted in the completion of three reports and one co-authored publication. Among these:

i. Annual Reports:

- **Treble, A. J.** 2024. Statewide Fisheries Assessments and Surveys. Federal Aid Project F-86-R-35. Colorado Parks and Wildlife, Aquatic Wildlife Research Section. Fort Collins, Colorado.
- **Treble, A.J.** 2024. Annual Aquatic Research Data Analysis Report. Colorado Parks and Wildlife, Aquatic Wildlife Research Section. Fort Collins, Colorado.

ii. Specialized Report:

- **Treble, A. J.** 2024. Estimation of fishing effort for Home Lake. Colorado Parks and Wildlife, Aquatic Wildlife Research Section. Fort Collins, Colorado.

iii. Peer-Reviewed Publications:

- Woodling, J., **Treble, A. J.,** Brandt, M., and Lackmann, A. 2024. Otolith analysis reveals long-lived population demographics of Quillback *Carpiodes cyprinus* and River Carpsucker *C. carpio* in Colorado. Environmental Biology of Fishes.

iv. Draft Reviews and Comments:

- In addition to authoring reports and contributing to papers, draft reviews and detailed comments were provided on several reports and documents. These included contributions to CPW's response to various Water Quality Control Commission proposals, ensuring the accuracy and comprehensiveness of the agency's input on critical water quality issues.

Publication-related updates were also logged in key tracking documents within CPW research, including:

i. *Contributions to Management by Aquatic Research*

ii. *Aquatic Research Publications and Presentations*

iii. *Aquatic Research Project List*

II. Meetings

Both formal and informal meetings are essential for maintaining coordination and facilitating the exchange of intra-agency knowledge. They also serve as a platform to highlight how the data management unit can support other teams within the organization. During this reporting period, a total of 152 hours (8.3% of overall time) was spent attending various meetings, underscoring the importance of communication and collaboration in achieving shared goals.

Key meetings attended in 2024 include:

i. Annual Meetings:

- **Annual CPW Aquatic Section Meeting**: Held at Mount Princeton Hot Springs, this meeting brought together aquatic section staff to review progress, set priorities, and discuss statewide aquatic initiatives.
- **Annual CPW Aquatic Research Meeting**: Hosted at State Forest State Park, this gathering focused on updates, collaborations, and strategic planning for aquatic research activities.
- **Annual CPW Coldwater Reservoir Coordination Meeting**: Conducted virtually in 2024, this meeting addressed management strategies and research efforts specific to Colorado's coldwater reservoirs.
- **Annual CPW Aquatic Research Meeting**: An update and teambuilding retreat held at State Forest State Park.
- **CO/WY Chapter of the American Fisheries Society (AFS) Annual Meeting**: Held in Laramie, Wyoming, this event provided an opportunity to network with regional colleagues and share research findings and management practices.
- **Organization of Fish and Wildlife Information Managers (OFWIM) Annual Meeting**: This year's conference in Arcadia, Missouri, focused on advancements in data management and technology within the fish and wildlife management community.
- **Annual Boreal Toad Recovery Program Meeting**: Convened in Colorado Springs, this meeting reviewed progress and challenges in the recovery of boreal toads in the Southern Rocky Mountains.

ii. Monthly Meetings:

- **Project Support Meetings with CPW Researchers**: These meetings facilitated collaboration and provided technical assistance for ongoing research initiatives.
- **Hydroacoustic Planning and Analysis Meetings**: Regular discussions with Pate, Hansen, and Lepak focused on the planning and analysis of hydroacoustic surveys.
- **CPW Data Working Group Meetings**: Held monthly or bimonthly, these meetings included members from terrestrial programs, avian and terrestrial research, and aquatic research to address data management and visualization challenges across the agency.
- **Water Temperature Research Check-In Meetings**: Regular check-ins with Mindi May, Ashley Rust, Tawni Firestone, and Ryan Fitzpatrick ensured continued progress and coordination on water temperature research projects.

In addition to these monthly and annual meetings, specific meetings of interest in **2024** include:

- Attended Data governance meeting with UFWS STReaMS database manager and Recovery Program signatories representing CPW.
- Met with senior staff in August to present public-facing stocking dashboard.
- Met with senior staff in September to present a digitally accessible fisheries summary dashboard to replace PDF fisheries summary reports.
- Met with Battige and Sandersen to discuss hydroacoustics and Horsetooth regulation change.
- Met on multiple occasions with Teklits, Morris, White, and Portland WebWorks to answer data questions concerning replacement of Trans6 application.
- Met with Friebertshauser, Fitzpatrick and Avila to discuss future development of eDNA database.
- Met with Patrick Bachman to discuss his need for a Stream Mitigation Fisheries Dashboard.
- Met with Matt Schulz and Donovan Spaulding to present an overview of how aquatics data platform works and made recommendations on how they should expand their MS Access database.
- Met with Brian Avila frequently to assist him in navigating computer procurement with OIT.
- Met with Michelle Flenner to discuss data needs of Northern Leopard Frog project and how data will flow from Survey123 to SQL and Tableau.

These meetings reflect a consistent commitment to fostering collaboration, improving data management practices, and ensuring alignment across various CPW aquatic programs and initiatives.

III. Presentations

Internal Presentations:

a) **Treble, A. J.** 2024. D'ATTA Bio Awards. Annual CPW aquatic section meeting (Mt. Princeton, CO). February 6th, 2024.

b) **Treble, A. J.** 2024. CPW's Fisheries Creel Program Overview. Annual CPW aquatic section meeting (Mt. Princeton, CO). February 6th, 2024.

c) **Treble, A. J.** and various coauthors. 2024. CPW Aquatic Research Unit. Annual CPW aquatic section meeting (Mt. Princeton, CO). February 6th, 2024.

IV. Telephone/Conference Calls:

While more efficient than traveling to meetings, telephone and conference calls still accounted for almost 9 hours (<1%) of overall time spent in 2024. Most of these calls deal with organizational and coordination issues, technical support, and data requests and are not significant. Some more noteworthy calls over this reporting cycle include:

- Regular update and coordination calls with co-authors regarding Fishes of Colorado
- Monthly conference calls with OFWIM Conference Planning Committee
- Numerous calls with Aquatic Seniors to discuss ongoing data requests
- Regular phone calls from biologists for tech support or specific data analyses

DATA SUPPORT

At the root of the aquatic research data analyst position is data support. This category includes requests for data, whether it be from biologists or researchers, or from external entities. It also involves archiving all of the data that comes into the unit from outside entities as part of their scientific collection permits, as well as assisting CPW biologists and researchers with getting their data uploaded into the database. A total of 182 hours or 12% of total time was invested in data support in 2024. This is how that time can be broken down:

I. Internal/External Data Requests

A total of 64 data requests from external sources were processed over the duration of this report, requiring over 91 hours of work. Additionally, numerous internal requests from CPW staff were addressed promptly during this period, adding 27 hours of effort. Together, internal and external data requests accounted for 7.9% of total time in 2024.

Figures 2 and 3 provide a detailed breakdown of the time and effort allocated to the data request process.

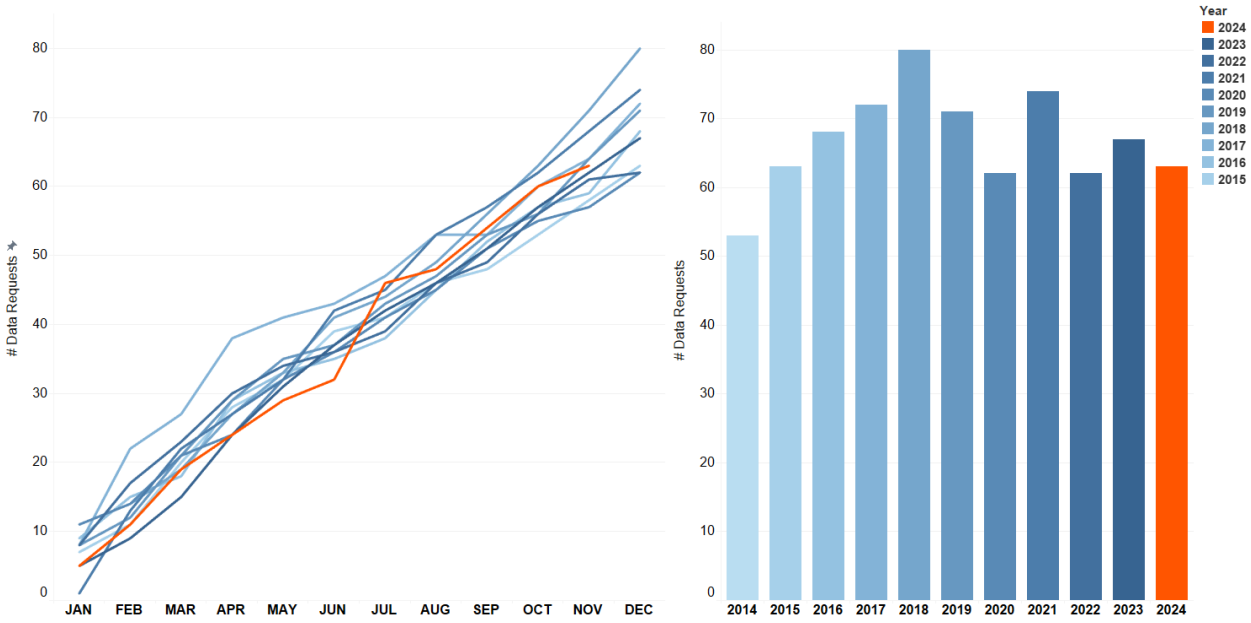


Figure 2. *Summary of external aquatic data requests by month and annual totals for the past ten years.*

Key Highlights of 2024 Data Requests:

- **No CORA Requests**: Notably, the aquatics program did not receive a single CORA (Colorado Open Records Act) request in 2024.
- **Improved Spatial Data Workflow**: New R scripts were developed to handle spatial data requests entirely within R, eliminating the need for the previous cumbersome process of splitting tasks between SQL and ArcGIS.
- **Streamlined Data Sharing Agreements**: The data-sharing agreement process was updated and refined, enabling faster completion and the ability to request e-signatures efficiently.
- **Increased Herpetological Data Requests**: The number of data requests from the Herp Database and Boreal Toad Monitoring Database reached an all-time high, reflecting increased interest in these datasets.
- **Upper Colorado River Recovery Program Contributions**: All CPW Upper Colorado River Recovery Program data were submitted to STReaMS in project-specific uploads, streamlining the process and reducing the need for individual biologists to reformat and upload their data independently.

- **Targeted Data Extracts**: Custom data extracts were created to support research efforts for individuals including Barry Nehring, Jesse Lepak, Adam Hansen, Ryan Fitzpatrick, Brian Avila, and John Woodling.

These efforts reflect ongoing improvements in the efficiency of data handling processes and the ability to meet increasing demands from both internal and external stakeholders. The innovations in workflow and submission practices have significantly enhanced the capacity and responsiveness of the aquatics data management unit.

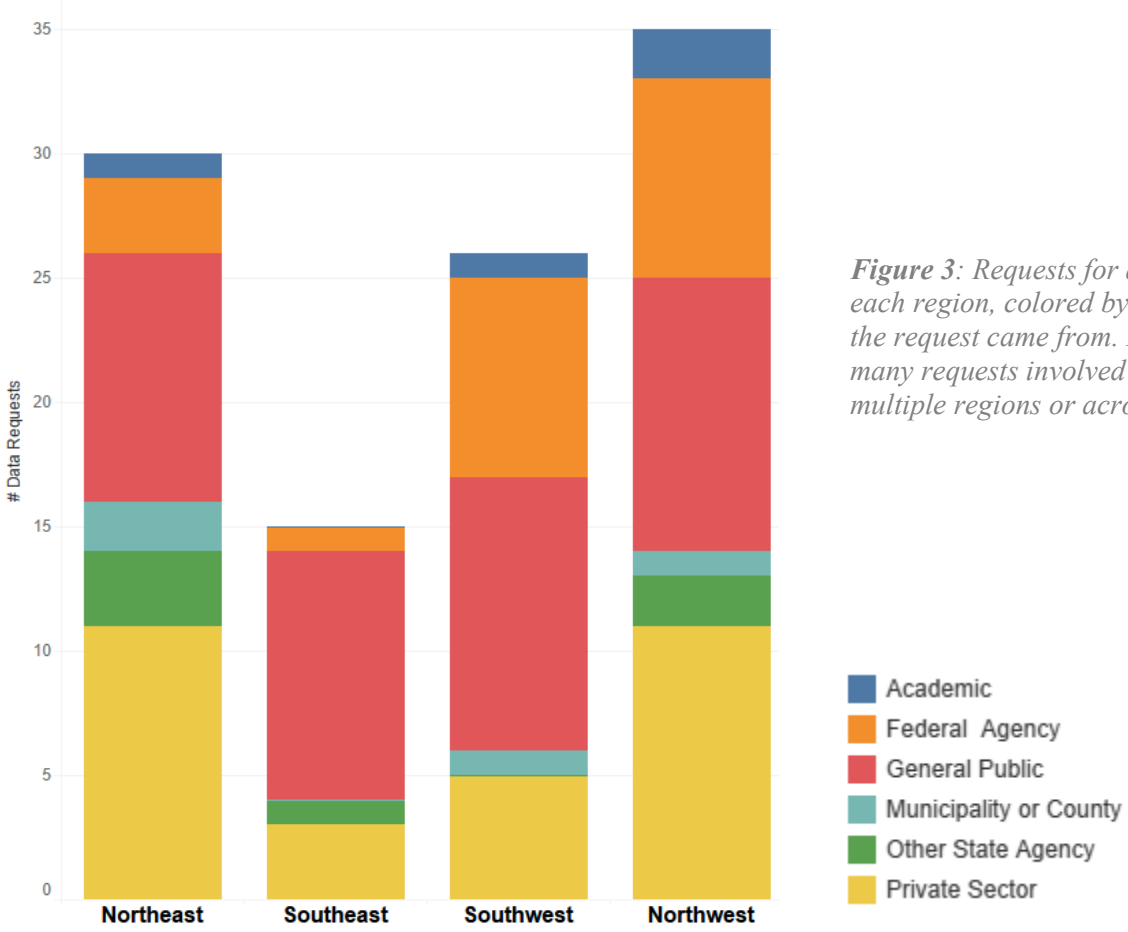
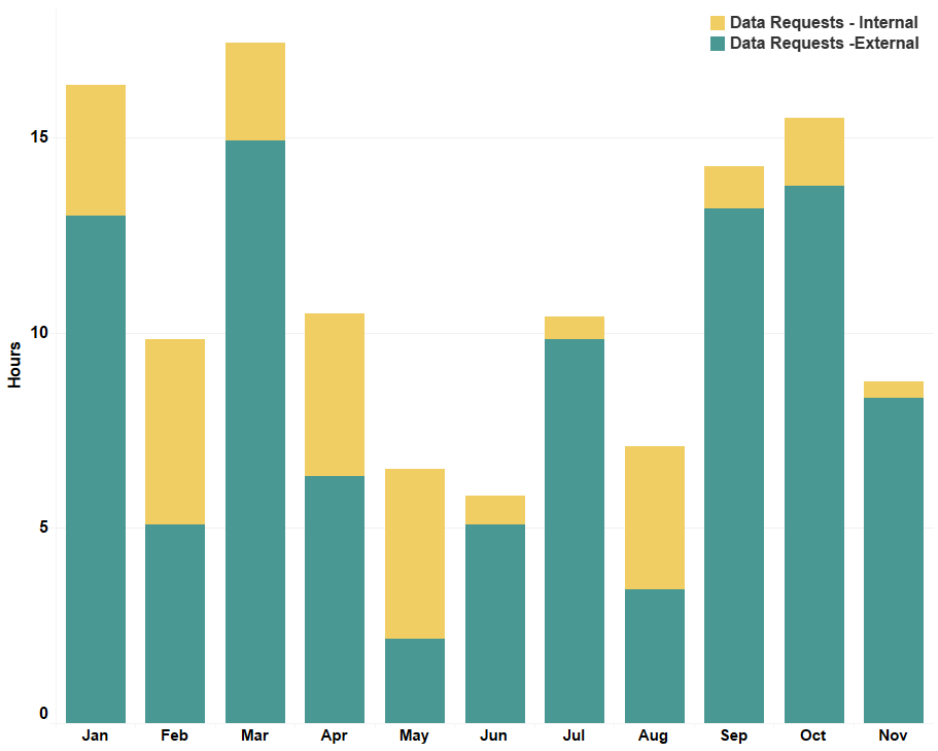


***Figure 3**: Requests for data from each region, colored by what sector the request came from. Note that many requests involved data from multiple regions or across the state.*

Figure 4. Monthly allocation of effort (FTE hours) given to internal and external requests for data in 2024.



II. Scientific Collection Data

A total of 74 Scientific Collection Permits were issued for the 2024 field season. However, as of November 26th, only a handful of these permits have been submitted and uploaded. Despite this, 526 scientific collector survey reports were successfully uploaded in 2024. This task, primarily handled by temporary employees, required significant effort, with 176 total hours devoted to quality assurance/quality control (QA/QC) and uploads, 139 of which were completed by temporary staff.

A significant portion of the data analyst's time was spent on tasks related to permit tracking, downloading and assigning reports, and bulk importing SciColl data from the USFWS's Species Tagging, Research, and Monitoring System (STReaMS).

The effort required to upload and QA/QC SciColl data has increased substantially over the past several years (see Figure 4). Several factors contribute to this trend:

- **Shift in Workforce**: Some of the increased effort can be attributed to a shift in responsibilities from the data analyst to temporary employees and interns, who are less experienced with the available data tools, resulting in slower processing times.
- **Improved QA/QC Tools**: Enhanced QA/QC tools now identify more errors in submitted data, requiring follow-up with permittees to ensure data accuracy and completeness.

- **Reduction in Permits**: The slight decrease in total effort from 2022 to 2024 corresponds with a lower number of reporting permits during the reporting period.

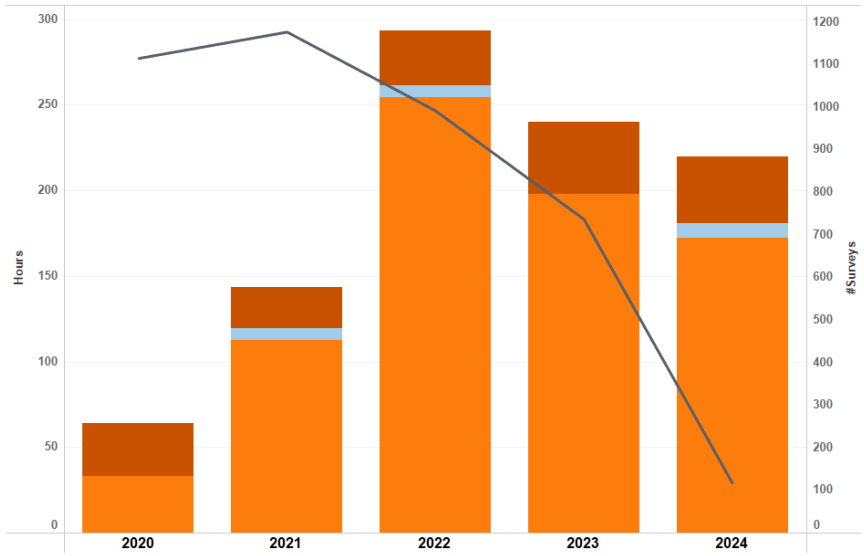
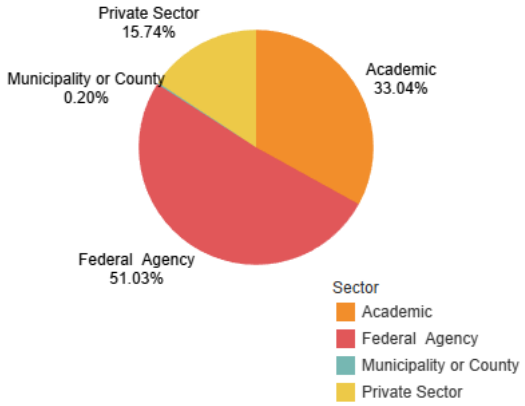


Figure 5. *Comparison of effort devoted to SciColl surveys over the past five years (bars) compared to the number of reports processed (line).*

Note: As the bulk of scicoll permits are uploaded the following year, there is a one-year lag. Almost no 2024 reports had been submitted by the time of this report.

While these improvements in QA/QC processes have enhanced data quality, they have also highlighted the need for additional training and support for temporary staff to improve efficiency. The continued refinement of tools and workflows will be crucial for managing the increasing complexity of data reporting and processing in the coming years.



Sector	Organization	
Academic	Colorado College	10
	Colorado State University	328
	Regis University	0
Federal Agency	Bureau of Land Management	21
	U.S. EPA	1
	U.S. Fish and Wildlife Service	479
	U.S. Forest Service	10
	U.S. Geological Survey	11
Municipality or Cou..	City of Longmont	2
Private Sector	AQUA SIERRA, INC	1
	Battelle	3
	Beavers Fish Farm	4
	Blue Valley Ranch	40
	EcoResource Solutions	6
	GEI Consultants	59
	Jacobs	2
	Metro Wastewater	16
	Northern Water	1
	Owl Ridge	9
	PG Environmental	7
	Rocky Mountain Biological Laboratory	2
	Trinchera Ranch	11
Grand Total		1,023

Figure 6. *N umber and sources of Scientific Collection Reports submitted between January 1st and November 30th, 2024.*

III. Technical Support and Training

The aquatic research data analyst serves as the primary point of contact for biologists, researchers, and other agency staff regarding aquatic data questions and technical support. Due to ongoing contact and availability challenges with OIT, the data analyst often steps in to resolve technical issues beyond their typical responsibilities. These support requests are prioritized and addressed promptly, frequently requiring other tasks to be paused. Between January 1st and November 30th, 2024, 21 hours (1.3% of total effort) were dedicated to providing technical support to biologists and researchers.

Highlights of Technical Support Provided in 2024

1. **Training and Access Support**:
    - Conducted multiple training sessions for new biologists on using ADAMAS and Tableau for data management and visualization.
    - Assisted biologists in securing ADAMAS access and data entry permissions for their seasonal temporary staff.
2. **User and System Maintenance**:
    - Maintained the list of users and data access permissions for CPW's Tableau Network, which includes terrestrial, avian, and aquatic research dashboards. Assisted OIT with troubleshooting dashboard access and system issues.
    - Worked with GIS staff to consolidate station data and address inconsistencies between the Watercode Locator and AquaticsT6.
3. **Database Assistance**:
    - Supported biologists in resolving database issues, including uploading problematic data templates, correcting station assignments, updating survey status columns, creating new species codes, and flagging questionable surveys or species identifications.
    - Frequently assisted with troubleshooting data templates and uploading survey data into ADAMAS.
4. **CREEL Application Troubleshooting**:
    - Fielded numerous calls regarding the operation of the CREEL application, including adding or modifying survey questions and addressing a bug that allows duplicate visits to crash the system. Resolving this issue required deleting specific data entries from the database using SQL Server Management Studio (SSMS).
5. **Custom Tools and Resources**:
    - Provided technical support for biologists using custom Tableau workbooks and data extracts to ensure functionality and accuracy.
    - Maintained and expanded Google Sites for the Boreal Toad and Greenback Cutthroat Recovery Teams to support the efforts of Harry Crockett and Jenn Logan.

The technical support provided by this unit not only ensures seamless operations across various aquatic data systems but also improves biologists' efficiency in using these tools. By addressing immediate challenges and maintaining critical systems, the aquatic research data unit plays a key role in supporting aquatic research and conservation initiatives.

DATABASE MANAGEMENT

Data management represented an investment of about 142 hours, which equates to 9.3% of the total allocation for the year (not including temporaries and work-studies) (Figure 1). This amount of effort is roughly equal to what was spent last year on database management. Approximately 55% of that effort (~78hrs) was directed at the primary aquatic data sources, 13 % (18 hrs) devoted to the Boreal Toad or Herptile databases, with the remaining 32% (~45 hrs) being split between supplemental data sources, linked applications, module development, maintenance, and watercode updates (Figure 1).

I. Aquatics Database Management

Regular maintenance and updates of the aquatics data platform are critical for ensuring smooth system operation and enhancing the analytical capabilities of related applications. The primary data systems, including Trans6 (Hatcheries), ADAMAS (Fisheries Surveys), AAHL (Fish Health Lab), and CREEL (Creel Surveys), as well as several supplemental applications, rely on carefully maintained SQL Server Management Studio (SSMS) tables and views. These activities ensure the seamless functioning of interconnected applications and data workflows.

Key Activities and Accomplishments in 2024:

1. **Data Quality Improvements**:
    - Collaborated with numerous biologists to identify and correct erroneous data, especially in preparation for the annual data bio awards.
    - Performed regular updates to critical database elements, including site elevations, HUC12 designations, area biologist jurisdictions, water and station codes within wilderness boundaries, and station latitude/longitude corrections from UTM coordinates.
2. **System Enhancements**:
    - Undertook major updates by converting live aquatic data sources to hourly refreshed extracts on the Tableau Server. This transition streamlined workflows, improved data accessibility, and enhanced system performance.
    - Continued development and refinement of SQL scripts for reporting to STReaMS and importing data from STReaMS into ADAMAS. This included implementing a new canal salvage summary routine to capture previously missing data.
3. **Optimization of Analytical Tools**:

- Made significant updates to the *CurrentSummary* SQL script, a foundational resource for data requests and linked applications, improving its functionality and reliability.
- Developed R-based monitoring scripts to track all critical data tables across the aquatics data platform. These scripts monitor data input activity and flag instances where data volume unexpectedly decreases.

4. **Data Integration and Updates**:
    - Updated and maintained linkages to RiverWatch and the Water Quality Control Division (WQCD) to ensure accurate and current data integration.
    - Reviewed and corrected area biologist assignments for stations and waters while continuing efforts to document biologist roles over time.
5. **Support for New Modules and Applications**:
    - Advanced the development of the walleye spawn module within AquaticsT6, with plans to expand or replicate the module for other wild-spawn operations, such as Brown Trout.
    - Continued work on the SQL framework feeding the CPW Tableau Server, enabling improved reporting and visualization capabilities for agency stakeholders.
6. **Spatial Data Updates**:
    - Updated geometries and spatial data related to waters and stations to improve spatial accuracy and system utility.

These efforts have strengthened CPW's aquatics data infrastructure, enhancing its capacity to meet increasing analytical demands and improving data reliability across all interconnected systems. The continued development of scripts, monitoring tools, and system enhancements will ensure that CPW’s aquatics data platform remains a robust and dynamic resource for years to come.

II. Current Status of Aquatics Database

The aquatics Database continues to grow as additions from internal and external sources are added to it. A breakdown (by data project) of the surveys that were added to the database over the period of this report is provided in Table 1. The total number of various records added to the database over the period covered by this report, along with the current overall status of records in the database, is provided in Table 2.

Table 1. *The number of surveys, by project, added to the database during 2024.*

Data Project	#Surveys
Aquatic Database Unit	565
Northeast Region Fisheries Management	91
Northwest Region Fisheries Management	143
Scientific Collections Permit	754
Southeast Region Fisheries Management	24
Southwest Region Fisheries Management	41
Species Conservation	73
Upper Colorado River Recovery Program	453

Table 2. *Recent additions and the overall status of the aquatics database (as of 11/30/2024*).

This reporting cycle:	
Number of new surveys entered	2,144
Number of new watercodes added	25
Number of new sampling stations added	154
Number of new fish measured	171,718
Number of new fish enumerated	351,174
Overall:	
Total # of managed waters	13,628
Total # of sampling Stations	19,687
Total # of Surveys	67,890
Total # of measured fish	5,187,987
Total # of enumerated fish	11,893,769

III. Boreal Toad and Statewide Herptile Database Management

In recognition of the increasing time and effort required for managing both the Boreal Toad Monitoring and the Statewide Reptile and Amphibian databases, this work has been designated as its own subcategory for this report, separate from Supplemental Database Management. In 2024, a total of 188 hours were dedicated to these databases, with 170 hours contributed by temporary employees and 18 hours by the data analyst.

Key Highlights of 2024 Work:

1. **Annual Boreal Toad Data Upload and Meeting Preparation**:
    - Completed the annual upload of survey data in preparation for the Boreal Toad Recovery Team meeting.
    - Updated and enhanced the Boreal Toad Database to ensure its readiness for discussions at the annual recovery program meeting.
2. **Northern Leopard Frog Data Module Development**:
    - Advanced the Northern Leopard Frog (NLF) module within the Statewide Reptile and Amphibian database, housed on the SQL test server in Denver.
    - Developed R scripts to automate the process of downloading, formatting, and uploading NLF data into the database, streamlining workflows and reducing manual effort.
3. **Mapping and Conservation Tools**:
    - Collaborated with Harry Crockett and Grant Wilcox to create a Boreal Toad conservation map and a time-series visualization tool, supporting conservation planning efforts.
4. **Database Improvements and Automation**:
    - Updated R scripts used to upload data into the Boreal Toad and Herptile databases, enhancing efficiency and reducing errors.
    - Data-mined citizen science platforms such as iNaturalist and HerpMapper to extract relevant Colorado herpetological data for incorporation into the databases.
5. **Ongoing Data Integration**:
    - Identified the need to incorporate Bd (Batrachochytrium dendrobatidis) swab and eDNA results into the database, ensuring a comprehensive repository for amphibian health and conservation data.

The Boreal Toad and Statewide Herptile databases have become essential tools for Colorado's amphibian and reptile conservation efforts. Continued development, including the integration of Bd and eDNA data and further enhancements to database modules, will ensure these systems remain robust and capable of meeting the growing demands for herpetological research and management.

IV. Supplemental Database Management

In addition to the core aquatics databases and directly linked applications such as Trans6, ADAMAS, AAHL, and Creel, numerous supplemental databases have been developed to support statewide aquatics projects. These supplemental databases are typically updated on an as-needed basis but also require periodic maintenance to ensure compatibility with evolving database schemas. During this reporting period, 16 hours (1% of total effort) were allocated to updating and maintaining these supplemental databases.

List of Supplemental Databases:

1. ADAMAS-Links Microsoft Access front-end
2. Water Temperature Database
3. PIT Tag Database
4. Data Request and SciColl Tracking Database (Oved to Asana)
5. Fishes of Colorado Project Tracking Database
6. Thermal Niche – Logger Placement Database
7. Hydroacoustics Database
8. Data Analyst and Temporaries Time Allocation Databases
9. Walleye Spawn Database (within CPW_AqDatAnalysis)
10. ANS Crayfish Monitoring Database (within CPW_AqDatAnalysis)

Highlights of 2024 supplemental database development:

1. **Hydroacoustics Database**:
    - Recovered lost records and refined SQL-Tableau connections to improve data visualization and reporting.
2. **Water Temperature Database**:
    - Cross-validated HOBO logger files to ensure all data was uploaded into the Water Temperature Database.
    - Created schema maps for a new temperature research associate to enhance understanding and usability of the database.
3. **Time Allocation Databases**:
    - Improved summary routines and dashboards, simplifying processes for KRONOS entry and reporting.
    - Developed secondary database to help monitor daily work progress by all temporary employees.
4. **ANS Crayfish Database**:
    - Developed a new database to track aquatic nuisance species (ANS) crayfish monitoring data.

V. Software and Hardware Maintenance and Upgrades

Approximately 24 hours (1.6%) were required to obtain OIT permissions and installing or to update various hardware unique to the data management unit. This is consistent with the amount of effort expended in years past. A list of these software updates or additions of provided below.

- Connectivity issues in the shared temporary office and dealing with OIT to finally get 4 new LAN network connections added
- Setting up a new desktop in the temp office and outfitting it with all necessary software. Updating software on all three temp workstations.
- Regular updates to Tableau, SQL Server Management Studio, R Studio, EndNote and various R packages
- Tableau Network connection issues with OIT
- Various OIT access requests for aquatics FTEs and temporaries

VI. Aquatic Data Application Development and Maintenance

One hours (<1%) of time was invested in bug fixes to the application and development of SQL code that utilizes the data tables in ADAMAS.

Other activities and accomplishments associated with the various ADAMAS modules is listed below.

- Reviewed proposals and work by Portland Webworks on COFISH, the replacement application for Trans6
- Worked with Julie Orr, Ben Stucky, and Kirk Teklits to develop RFP for the replacement of ADAMAS
- Updating STReaMS-to-ADAMAS templates with Colorado River Recovery Program Team biologists
- Database permissions for new staff and data entry assistants across the state.

VII. Watercode Creation or Updates

The creation of new watercodes for biologists and hatchery managers required about 4.7 hours of time in total (<1%). A total of eight new lakes, three new stream segments, and 14 new coded fish units were added to the growing list of 13,628 managed waterbodies in the state.

A breakdown of all the currently managed waters in the state is provided below in Table 3.

Water Type	# Watercodes	
	New in 2024	Overall
Stream	3	8,820
Lake	8	4,492
Fish unit	14	133
Canal/Ditch	0	55
Wetland	0	125

Table 3. *A summary of newly created and all managed waters held within CPW's Aquatics Database.*

VIII. Data Visualization and Analysis

This category has been moved out from under research and now effectively replaces the old 'ADAMAS-linked Application Creation and Maintenance' since the old MS Access ADAMAS-Links front end has been effectively replaced by the growing Tableau Library of dashboards. Since aquatics was the first unit within CPW to acquire a share on the Tableau Server, the aquatic data analyst is responsible for adding new users and amending user roles for all CPW users of the tableau dashboard.

A total of 112 hrs (7.5%) was devoted to developing summary and analytical dashboards and maintaining the aquatic Tableau network. Highlights of some of the work completed include:

- Created countless new dashboards and insightful data analysis for biologists to access
- Updates and improvements to the Tableau Reader Biologist workbooks
- Developing a Stream Mitigation Dashboard that provides crucial fisheries data to Patrick Backmann
- Development of public-facing (proposed) Stocking and Fisheries Summary Report dashboards and presentation to the seniors
- Addition of new users and controlling permission levels to the Tableau Server
- Development of new analyses and visualizations for biologists outside of biologist-specific workbooks

FIELDWORK

In 2024, a total of 82 hours (~5.4% of overall time) was spent on fieldwork activities, which included hydroacoustics, travel, and other fieldwork. This represents a notable reduction in fieldwork time compared to previous years. It should be noted that this estimate slightly overstates fieldwork time, as it includes travel to meetings and other activities not directly related to fieldwork. Additionally, the hydroacoustics category includes substantial time spent on data management and analysis, alongside fieldwork.

I. Travel:

A total of 57 hours (3.1%) were spent traveling in 2024. This number is not just travel for fieldwork however, but also includes travel to meetings and conferences as well. Travel this year was primarily related to the OFWIM conference in Missouri, CO/WY AFS chapter meeting in Laramie, Aquatic Section meeting at Mt. Princeton, Aquatic Research Meeting at State Forest SP, and a minimal amount of fieldwork.

II. Fisheries- Related Fieldwork:

Hands-on fieldwork experience remains an important component of the data management program, offering insights into data collection processes and fostering efficiency in data analysis. In 2024, 25 hours (~1.4% of total time) were spent assisting other units in the field.

Highlights from the field in 2024 include:

- Conducted a Horsetooth Reservoir smelt hydroacoustic survey in the absence of Bill Pate.
- Assisted Northeast Aquatics with wild spawn take operations for Walleye and Brown Trout.
- Supported Kevin Rogers and Boyd Wright with the installation of oxygen sensors at Zimmerman Lake to investigate survival issues in Greenback Cutthroat broodstock.

RESEARCH & ANALYTICS

The data management subunit primarily supports biologists and researchers, managing both internal and external data. Despite limited resources, meaningful research is conducted when possible. In 2024, 158 hours (~10.4% of total time) were allocated to research.

I. Hydroacoustics:

A total of 12 hours was devoted to hydroacoustic-related activities in 2024, with efforts focused primarily on database and analytical tool development rather than extensive field operations. Key tasks and highlights include:

- Finalized testing and verification of a Tableau analysis dashboard for echo-integration estimates of smelt populations in Horsetooth Reservoir.

- Produced 2024 Horsetooth Estimate, which was the highest number on record since echo integration surveys began in 2017.
- Continued centralization of historical hydroacoustic data and development of SQL-based analyses and Tableau dashboards. These tools expedite the annual sonar population estimates and enable users to examine multiple sonar surveys for a specific waterbody with minimal effort.
- Ongoing development of a dashboard for automated target-tracking calculations.

II. Thermal Niche Analysis

The Thermal Niche Analysis project has experienced delays due to a lack of time and personnel for deploying and retrieving temperature loggers. Less than three hours were devoted to this category in 2024, which consisted of updating the temperature logger placement priority lists

Efforts related to Thermal Niche Analysis in 2024 included:

- Two hours devoted to updating the SCTF progress report and attending meetings with Ryan Fitzpatrick and Mindi May.
- Discussions with Ryan Fitzpatrick, Tawni Firestone, and Dana Winkleman about linking this project with other ongoing efforts and hiring Riley Dils as a Research Associate to take over the bulk of logger and temperature database work.

III. Other Research:

A total of 34 hours (<1% of overall time) was spent on various research activities—more than double the time allocated in 2023. Highlights include:

- Conducted cluster analysis on morphometric characteristics distinguishing Quillback from River Carpsucker as part of a paper with John Woodling, Mandi Brandt, and Alan Lackman.
- Collaborated with Pete Cadmus to consolidate Alex Townsend's Master's data for future analyses and performed initial statistical modeling to prioritize research avenues.
- Developed R-based multivariate model for estimating creel parameters for waters lacking prior creel data.
- Migrated research citation libraries from Mendeley to EndNote, ensuring better organization and access (due to OIT requirement).
- Adopted the use of ChatGPT for generating SQL and R code, as well as a tool for reviewing writing.
- Assisted Jesse Lepak with analyses of Tiger Muskie and White Sucker, as well as investigations into Tiger Muskie-Mountain Whitefish interactions.

- Reviewed current genetics research on Sculpin, Northern Redbelly Dace, Stonerollers, and Carpiodes species.
- Continued expanding an R code library for broader analytical applications.

SPECIAL PROJECTS

This category captures those activities that have recurring but not indefinite investments in time that do not fit neatly in any of the other categories. The subcategories involved may change from year to year depending on the current needs of the research unit or the agency.

A total of 472 hours (31% overall) was devoted to special projects.

I. Fishes of Colorado:

Going into its eighth year, this project to update and publish a new version of the Fishes of Colorado continues to move forward toward completion slowly. The work of John Woodling continues to be an invaluable constant in the project, as involvement by other authors comes and goes with their availability and other commitments. Nicole Vieira was brought on to offer another set of eyes for review and editing. A complete draft has been sent to the publisher, and their first round of page proofs has been returned for further refinement and improvement. A total of 426 hours (23.1% of total hours) were allocated to the book this year, which is more than twice that effort allocated to any other category, reflecting the importance of seeing this project to completion.

II. Professional Association Involvement:

Professional associations remain a vital part of outreach and collaboration. In 2024, 10 hours (~2.7% of total time) were spent on related activities, consistent with 2023. Highlights include:

- Attended CO/WY chapter annual meeting in Laramie
- Attended OFWIM annual meeting in Arcadia, Missouri
- Judging presentations at the CO/WY AFS annual meeting in Laramie.
- Managing the Western Division of AFS listserv and overseeing email communications.
- Continuing participation in OFWIM committees and supporting the organization as a former Excomm member.

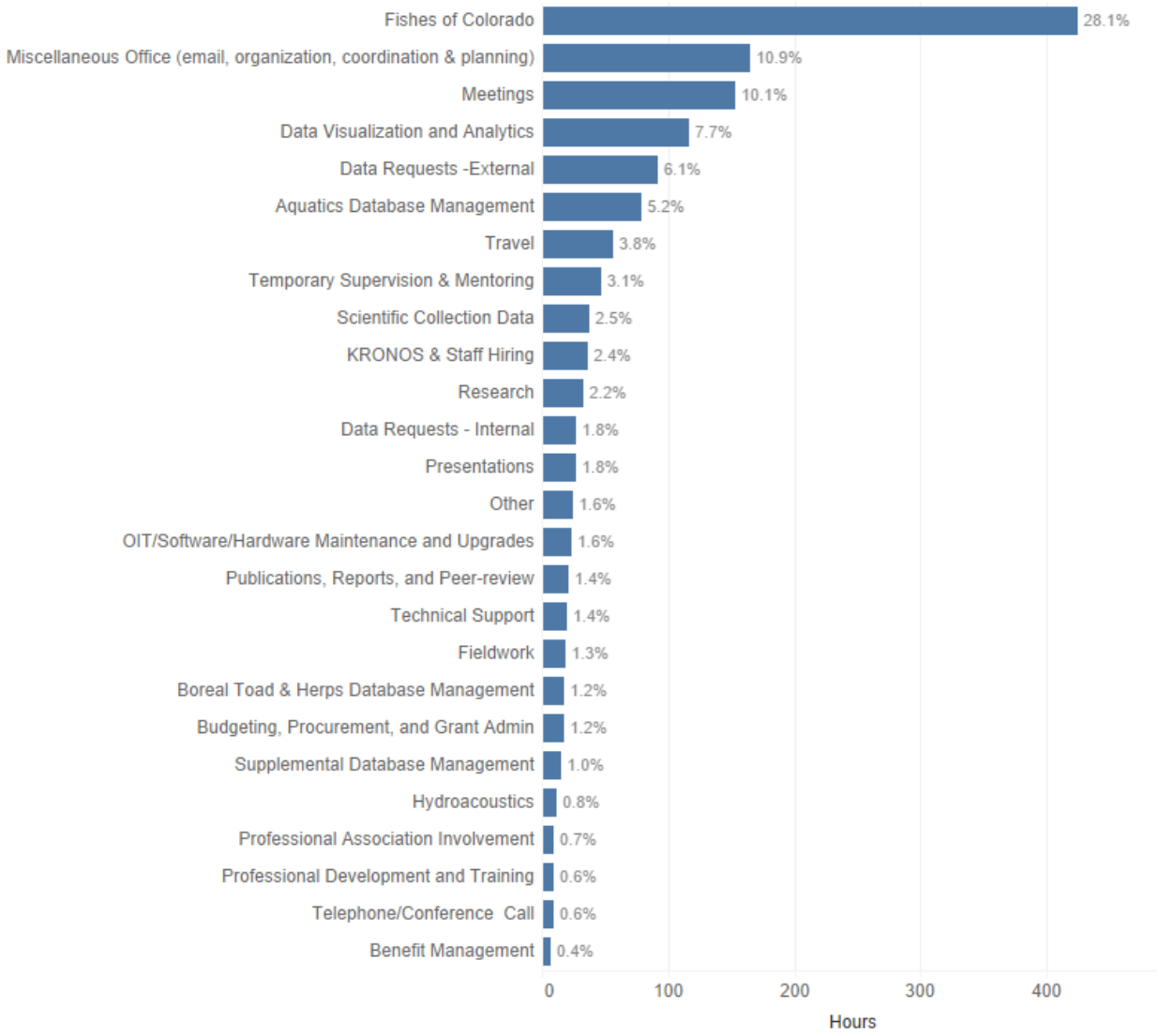
IN THE COMING YEAR

Research and work-related points of interest that are coming up in 2024 include:

- Finish revisions to Fishes of Colorado page proofs and send back to publisher
- Working with aquatic leadership to further detail the new aquatic data position and assist with the hiring process.
- Work with OIT as they move through the RFP process to replace ADAMAS. Meet with Aquatic Senior Staff to discuss options to replace ADAMAS in-house.
- Continue mentoring interns and work studies to further promote good data management skills in the current crop of fish and wildlife students
- Working on additional publications with John Woodling, Jesse Lepak, Adam Hansen, Pete Cadmus, and Bill Pate
- Completion of development and testing of a target-tracking analysis dashboard in Tableau
- Providing ADAMAS and Tableau training to a host of new biologists at the 2025 biologist's summit
- Continued development of the library of Tableau Dashboards available on the network for biologists to use.
- Attending Annual Aquatic Biologist, Coldwater Reservoir, Boreal Toad Recovery Team, and CO/WY AFS meetings in person.

APPENDICES

Appendix A. Bar graph showing the percentage of FTE time spent on individual subcategories in 2024.



Appendix B. Bar graph showing the percentage of Temporary time spent on individual subcategories.