Building the Center for Habitat and Wildlife Analyses:

Connecting Wildlife and Habitat Data to Governments and Business Interests to Improve Decision-Making and Natural Resource Conservation Outcomes

A Report Commissioned by the AFWA Science and Research Committee and the AFWA Technology and Data Committee

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Executive Summary and Recommendations

State, territorial, and provincial fish and wildlife agencies and their state, federal, and private-sector partners are actively engaged in the development of innovative tools for managing and analyzing wildlife and natural resource data. These tools are increasingly incorporating novel data sources such as satellite and remote sensing imagery, advanced geospatial data, web-based databases, and live data feeds, in addition to traditional point and polygon data. The development of large aggregated databases by AFWA members such as NatureServe (currently with data for 22,984 rare or at-risk species) and the USGS BISON platform (currently with 375 million records) is providing states with significant new data resources for wildlife management and biodiversity conservation.

This report highlights innovative tools for wildlife data management which have been developed by state and provincial governments, the regional associations, as well as AFWA members such as NatureServe, USGS, and the Canadian Wildlife Service. These tools are presented according to four thematic areas:

- Examples of integrated data management platforms and approaches that enable state agencies to integrate multiple, complex data sources/data streams in order to inform the management of fish and wildlife populations.

- Examples of major data discovery, data archiving and data storage activities at state wildlife agencies, particularly in circumstances where agencies have undergone a process to: discover all existing data sources within the agency, translate those data sources into compatible formats, and archive or store these data in comprehensive or integrated data management system(s) at the departmental or agency level.

- Examples of data analysis tools that states are already using to combine data from multiple complex data sources (including large databases, external and internal data sources, and frequently updated external data sources), in order to perform analyses that directly inform management.

- Examples of data security management tools that are being used by state agencies, particularly to control access to sensitive data on species and habitats and to uphold state privacy laws.

We also make the following recommendations for AFWA staff and membership in order to further the development of fish and wildlife informatics systems in North America, based on our discussions with state wildlife and data managers and state agency leadership:

- We commend the Western Association of Fish and Wildlife Agencies (WAFWA) for their leadership role in managing and updating the WAFWA Crucial Habitat Assessment Tool (CHAT), originally developed by the Western Governors' Association (WGA). We note that technology and data sources currently exist that would permit expansion of CHAT to encompass the entire United States and potentially to Canada and México as well. Accordingly, we recommend that AFWA work with WAFWA, the U.S. states, and the relevant Canadian and Mexican authorities, as well as key partners and AFWA members such

as NatureServe and USGS, to explore options for expanding coverage of the WAFWA CHAT to continental scale.

- We commend the Arizona Game and Fish Department for the development of HabiMap™, an online data visualization platform that can also be used for geospatial data analysis and conservation planning. We support efforts currently underway at Arizona Game and Fish Department to build a version of HabiMap™ that would be capable of integrating data from multiple states, and can be used as a data visualization tool by states currently lacking this capacity. We encourage AFWA staff to work with Arizona and other states to identify resources and opportunities to facilitate adoption of this tool by other states and in a way that more easily integrates states' data across species' ranges and habitats to more effectively and efficiently inform management decisions.

- We commend the U. S. Geological Survey for its development and active management of the "BISON" (Biodiversity Information Serving the Nation) web data portal, which currently includes over 375 million species observation records (https://bison.usgs.gov). BISON scientists regularly review and integrate research-level data from such varied and disparate sources as USFWS, USGS, USDA, BLM, NPS, the state universities, major natural history museums, NatureServe, eBird, and iNaturalist, among many others (see https://bison.usgs.gov/#providers for a complete list). The BISON platform also provides significant resources for possible use by states, including the possibility of geospatial mapping of species occurrence data in a secure data environment, as well as analytical tools for combining state data with other existing high-quality data on wildlife species distributions at state and regional scales.

- We commend NatureServe and the state, provincial, and territorial Natural Heritage Programs for the development of integrated databases and related data visualization tools that currently provide information on 987,238 occurrences of 22,984 rare or potentially at-risk species. We support further development of this platform, and particularly its "Observation Data Standard," in order to help meet the broader data management and analysis needs of state, territorial, and provincial fish and wildlife agencies.

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Introduction

State fish and wildlife agencies have broad trustee powers and statutory authority over the management of fish and wildlife within their borders, with concurrent management authority with the federal government for migratory birds, interjurisdictional fishes, and species listed under the Endangered Species Act. Most often the States have the best available science on species, their distribution, and habitat needs and challenges. Every year state and federal agencies, governors, and legislatures make decisions about infrastructure, environmental, and fish and wildlife management. These include decisions about transportation needs, energy and water infrastructure development, land use policy, or other land use decisions that affect water, habitat, wetlands, fish and wildlife species, migration corridors and other natural resources, many of which can affect businesses and industries. Information needed to inform these decisions often crosses state and political boundaries, and is held by multiple agencies, non-governmental, and commercial organizations. Pulling these disparate data sources together, covering everything from weather and migration patterns to flood and drought data, can give state agencies and other decision-makers a better understanding of how their decision will impact not only their own state's natural resources, but also those of other states, and identify opportunities for improving decision outcomes and mitigating or reducing risks.

States and regional associations of fish and wildlife agencies are increasingly working across political boundaries for the management of species of mutual interest and for which they share responsibility. Every state fish and wildlife agency does not have a sophisticated data management and analysis system that integrates information from all agency divisions to populate a common management decision-support system, much less have the ability through which their data and analyses, at the discretion of the agency, can be pooled or shared with other state fish and wildlife agencies' information to strengthen analytical power and better inform multistate species conservation efforts. Successful multistate conservation processes take many forms through state and regional initiatives, and several of these efforts have been successful in precluding the federalization of species as well as recovering listed species. Unfortunately, a nationally coordinated infrastructure that can more easily facilitate states' individual and collective sharing of information does not currently exist, and some States' technological infrastructure, data requirements, and state privacy and private property rights laws make it difficult to share data directly with their peers. A private entity can work with all of the states to overcome these challenges and create an environment that makes range-wide conservation of fish and wildlife easier, more efficient, and possibly more effective by creating capacity within every State to meet its individual needs and, at the state's discretion, enable sharing of information with other states.

Government agencies, industries and businesses across the country would benefit from having access to a single robust and comprehensive data source that brings all of this disparate data together to better inform decisions about growth, land use management, development, expansion opportunities, and natural resource resiliency. This information could be used to help business and industries avoid, minimize, and mitigate impacts to fish, wildlife, and their habitats while also providing opportunities to proactively enhance voluntary conservation actions. Through a consolidated and comprehensive data source decision-makers will be able to optimize public trust resources as well as business functions, reduce risks, better manage regulatory considerations, and improve profit margins.

Vision

The vision is to develop a state-led, state-based and nationally coordinated integrated fish, wildlife and habitat data system. The system will be supported by a non-regulatory pre-planning support center that better informs states' range-wide conservation efforts and government and business decisions affected by fish, wildlife, habitat, climatological and other natural resource conditions. This Center for Habitat and Wildlife Analyses (CHWA) would help identify strategic species and habitat conservation actions that can be deployed to reduce identified wildlife, habitat, and natural resource and business risks; manage adverse conditions and resolve challenges; and guide government and business decisions that lead to desired outcomes for fish, wildlife, and their habitats and provide additive societal benefits.

Building on Success

Three out of four regional associations of fish and wildlife agencies are working on different approaches to enhance management efforts across the region and for select species. The Western Governors Association (WGA), through their respective state fish and wildlife agencies, developed a common database of information regarding wildlife habitat across the western states: the Crucial Habitat Assessment Tool (CHAT), now known as the Western Association of Fish and Wildlife Agencies (WAFWA) CHAT. These data provide agencies, developers, governors, businesses, industries, and other external interests with detailed, non-regulatory geographical information (maps) of crucial wildlife habitat. It is a pre-interpreted map accessible by the public that depicts how important each square mile across the west is to the sustainability of the state's fish, wildlife, and crucial habitat. It is not designed as a project approval tool; rather, it is a pre-planning tool that helps inform decisions and is a common starting point for discussions about habitat, infrastructure, and development. Some western states also have a state level version of the CHAT. These regional and state data allow the agencies, governors, businesses and industries to see where and how crucial fish, wildlife, and habitat patterns are changing not only within their state borders, but across the region. Through this system decision-makers can anticipate and try to avoid conflicts with development, understand impacts across state borders, and see how land use decisions affecting fish, wildlife, and their habitats can be minimized or avoided. It also allows companies and businesses to utilize results from wildlife and habitat analyses to identify the optimal or strategic opportunities for growth, expansion, risk mitigation and enhanced profitability with the least amount of wildlife and habitat challenges.

The Directors of the Southeastern Association of Fish & Wildlife Agencies (SEAFWA) have been constructing the Southeastern Conservation Adaption Strategy (SECAS) since 2011, which was initiated because of ongoing landscape level changes occurring across the southeastern United States which they expect to continue and accelerate during this century. SECAS is built through a collaboration of dozens of partners and focuses on incorporating large landscapes and ecosystems as primary units for conservation planning, increasing the understanding of these complex ecological systems, and creating a robust analytical framework for informing public and private decisions likely to impact the sustainability of southeastern species and ecosystems into the year 2060 (Wathen 2013). It is a planning tool for the future and includes predictive modeling capabilities for the interactions of population growth, climate change, timber markets, and invasive species across the region which will likely be the key drivers of change.

The Northeastern Association of Fish and Wildlife Agencies has built a region-wide habitat map for its multistate conservation use and is working on more multistate conservation tools. Finally, the University of Montana is working in partnership with some western states to create powerful analytical tools to inform state management decisions on select species. States upload their data into a university supported web tool with predetermined analyses options that agency staff can perform and share at their discretion. Clearly the states and their regional associations see great value in working across political borders and leveraging their collective expertise and resources to improve conservation outcomes for species, but these regional efforts stand-alone with no national networking ability to deliver much needed information to their peers, government agencies, businesses and industries across the country.

The Future: Nationally Organized, State-based, State-Led Land Use Pre-Planning and Natural Resources Conservation

Current CHAT data sources include habitat and species information, and SECAS provides a plethora of state and public data sets for public consumption and individual analyses. Networked with other data such as distribution of invasive species, spread of fish and wildlife diseases, habitat risks and resiliency, risk of wildfire, changes in surface water flows, migratory data, climate data, energy potential, satellite imagery and data, and state and local regulatory information such as zoning could enhance analyses and more fully inform appropriate management actions, strategic habitat restoration activities, and business decisions across the country.

By developing an integrated analytical system that brings these data together, we can provide a tool for the states that can be used individually and collectively to better assess, project, and answer land-use, energy, development, business and natural resource questions across the US and to improve natural resource influenced decision outcomes. This requires working closely with the state data owners, experience and expertise in database development, data validation and verification, and the development of back-end analytical tools to understand and display the data. There is also a need to conduct objective, independent, data-centered analyses on wildlife and land use issues in support of states' and stakeholders' interests.

States must maintain ownership and access to all of their data, which must be protected to meet all state privacy and private property laws, and reserve the right to determine the level of specificity that an external user or other government agency may access or view information. By developing an analytical research tool that is closely tied to state and stakeholder needs, and shaping academic research to help support those needs and gaps, government decision-makers and businesses will be better able to base their decisions in the scientific, natural resource, and governmental realities that exist. This could add another dimension to the relevancy of state fish and wildlife agencies and American wildlife management in the 21st century. Thus, we propose developing a center for analysis of habitat and wildlife issues.

The Center for Habitat and Wildlife Analyses

The Center for Habitat and Wildlife Analyses (CHWA) could begin as a Memorandum of Understanding or Agreement between the Association of Fish and Wildlife Agencies' AWARE 501c3

entity, regional associations, and other partners, and other data systems and management experts such as the CNA Corporation (who handle data and analytical requirements for the military and the FAA).

AFWA, in consultation with the MOU partners, would be responsible for structuring the center's functions and ensuring that analytics objectives are consistent with the needs and requirements of the state fish and wildlife agencies first and their user communities second. The Center has several, complementary objectives:

- Maintain existing CHAT and SECAS capabilities, work with all state fish and wildlife agencies to develop a common vision and framework, and extend current datasets and capabilities to all 50 states' habitat and natural resources databases, and expand to Canada.
- Maintain ability for state, local, federal, and public users to access and use CHAT, SECAS, and other regional association functions at the appropriate level of accessibility and security.
- Over time, incorporate data about water and floodplains, wildfire, energy potential, invasive species, fish and wildlife disease, state conservation plans, climatological variables, climate change effects, land-use policies, satellite data and imagery, predictive modeling capacity, critical legacy data, and other data relevant to natural resources analyses and management into a fully integrated and expanded national state-based data system that includes the ability to integrate federal data sources.
- Develop and integrate common applications and modernized web-based and satellite-based data entry processes that seamlessly integrate across states, maintain critical legacy data collected that is unique to each state, and are capable of uploading data in real time through any internet connected device.
- Enable states and regions to conduct enhanced analyses of issues that affect the habitat, ecology, maintenance, and sustainability of fish and wildlife resources across landscapes and geopolitical boundaries to more fully inform their individual agency and collective fish and wildlife management decisions as well as the federal government's land stewardship and management regimes.
- Provide natural resources data to inform business decisions on a national (and international through our Canadian partnerships) land-use pre-planning scale and create new partnerships opportunities for achieving corporate sustainability goals, managing business risks, increasing community resiliency, and maintaining regulatory flexibility before a listing under the federal Endangered Species Act (ESA) is contemplated.
- Supervise and structure academic research requests for specific data needed to support and appropriately fill identified gaps in important natural resource datasets and cross-walk state data sets, as appropriate.
- Collaborate with academic institutions and professors on integrating critical and proprietary data that would beneficially inform state management analyses and decisions without compromising the author's publication capabilities.
- Communicate with diverse audiences about CHWA and recent state research; facilitate dialogue among state agencies, industry, businesses and other decision-makers; incorporate stakeholder feedback into regular improvements to CHWA and the regional components.

We anticipate the CHWA will be organized around three functions:

- *Database development, management, and data visualization.* Responsible for maintaining, enhancing, and expanding the CHAT, SECAS, and enhanced national system, including data validation. States would control their data, use permissions, and all accessibility.

- *Analytical and scientific*. Provide objective, scientifically-based analyses using statistically and analytically valid models for fish, wildlife and habitats that are based on state-driven analyses and produce unbiased interpretations.
- *Management, communications, and funding*. Responsible for policy and scientific analyses in support of state and stakeholder decision-making, soliciting and incorporating stakeholder input, and scientific research using the database and other sources that support decision-making.

Benefits to States and AFWA

AFWA has a long history and extensive experience of working with state fish and wildlife agencies since 1902. AFWA believes it is critical that the CHAT, SECAS and the proposed CHWA continue to be directed and maintained by the state fish and wildlife agencies that established the tools, have broad trustee powers and statutory authority over the management of fish and wildlife within their borders, and most often have the best available science on species, their distribution and habitat needs and challenges. Defending the aforementioned roles of the state fish and wildlife agencies are AFWA's most important and central mission components. State fish and wildlife agencies are one of the most trusted sources for fish, wildlife, and habitat information, and this stature elevates the prominence and reliability of the CHWA's science-based data and analysis potential.

Furthermore, Congress continues affirm its full support of use of states' data: "The Committee is concerned that the Department of the Interior, its bureaus, and the Forest Service are not maximizing the opportunity to save funds and leverage States' on-the-ground wildlife expertise. State wildlife agencies often have the best available science on species and retain primary jurisdiction over most wildlife on Federal, State, and private lands. The Federal government should recognize and fully utilize State resources, including scientific information about species population numbers, conservation status, and habitat availability, among other data. The Committee directs Federal agencies to cooperatively engage with State wildlife agencies and to use State fish and wildlife data and analyses as a primary source to inform Federal land use, land planning, and related natural resource decisions. The agencies should not duplicate analysis of raw data previously prepared by the States. Federal agencies should also provide their data to State wildlife managers to ensure that the most complete data is available to be incorporated into all decision support systems." (House of Representatives Department of the Interior, Environment, and Related Agencies Appropriations Bill, 2017).

There is great value and utility in merging and expanding, with support from the states, the current benefits of CHAT, SECAS, and their capabilities to all 50 states as well as the Canadian provinces to create provincial and state-based management decision support systems and state-led, nationally coordinated non-regulatory pre-planning tools focused on fish, wildlife and habitat that will better inform state, local and federal government and business decisions. This vision is consistent with the views expressed by the WGA. Under this concept and structure, the state fish and wildlife agencies could develop the most comprehensive internal management decision support systems and the best external non-regulatory, pre-planning tool available in the country to help drive and direct how, when, and where land-use pre-planning and development occurs while protecting the fish, wildlife and habitat they are entrusted to manage in trust for the public. This allows states to strategically utilize their "soft power," as opposed to the regulatory "hard power," to emphasize and guide others' actions

on the ground in ways that benefit the agency's mission, conservation priorities and objectives. Businesses that rely on or are greatly impacted by the health of our fish, wildlife, habitats and natural resources need strategies to mitigate risks and maintain profitability, have regulatory certainty and reach their corporate sustainability objectives which are a growing part of stockholders' expectations. The assimilated information that businesses could derive through the CHWA could create new public-private partnership opportunities for mutually beneficial conservation projects such as: strategic restoration of wetlands and barrier islands that create community resiliency, reduce flooding and damage, protect against property losses, and save everyone money; manage forests, forest pests and invasive species that contribute to the spread and severity of wildfires by targeting forest health and restoration efforts that protect private property and infrastructure investments and restore important wildlife habitat; and reduce threats and risks to imperiled species to maintain regulatory and operational flexibility before species' population declines warrant listing under the federal Endangered Species Act (ESA).

The need for states to participate in and lead enhanced range-wide species conservation efforts is likely going to accelerate in the future. Therefore, expanding these efforts nationally, and eventually to Canadian provinces, could facilitate easier range-wide conservation collaboration among states and across international boundaries. Data will be more readily accessible and usable when the agencies need it for various range-wide decision-making, landscape level conservation plans and actions, and when confronted with short deadlines to inform decisions such as whether to list a species under the ESA.

Moreover, incorporating states' Best Practices and other types of proactive conservation documents could increase their use by external audiences that could improve natural resource related outcomes. All states could greatly benefit from a flexible but cohesive and connected data management system like the CHWA that leverages states' data, knowledge, and expertise to maintain authority for fish and wildlife within their borders and create a new era of agency relevancy for fish and wildlife management in the 21st century.

This capability increases the relevancy of state fish and wildlife agencies in their responsibilities for fish, wildlife, and natural resources management as well as for informing and directing infrastructure and energy development, modernized water management, strategic restoration of habitat that provides societal benefits and long term resiliency, and other landscape level efforts that directly and indirectly impact natural resources. Finally, the CHWA increases AFWA's member services and membership value to our state fish and wildlife agency members specifically, and to our affiliate and associate members more generally by enhancing state coordination to better harness the power of state data and to beneficially shape our nation's future.

We will work with fish and wildlife agencies of all 50 states (and hopefully Canadian provincial partners) on a voluntary basis to ensure the internal agencies' and external non-regulatory pre-planning tools address the unique circumstances and needs of individual states and addresses issues of multistate and regional significance. To maintain CHAT and SECAS and expand CHWA, AFWA anticipates utilizing state fish and wildlife agency expertise found on its Science and Research Committee and its Technology and Data Committee, as appropriate, in conjunction with state experts of regional associations, and outside data management systems experts like The CNA Corporation,

technology amalgamation experts, and others.

Potential Costs

Fully funding the CHAT expansion to all 50 states with the additional data layers and enhanced analytical capabilities described above is estimated to cost between $2-4 million per year. Knitting together all state and regional efforts to create the CHWA will cost more. These funds must come from sources outside of AFWA that are supportive of and consistent with the missions of state fish and wildlife agencies. Industries and non-profit organizations interested in these types of landscape level analyses may provide the revenue streams needed to fully populate and expand a nationwide and/or international CWHA.

Resources and Funding Requirements

AFWA's Government Affairs Director and Science Advisor will lead the initiative and coordination efforts with the regional association Partner States of CHAT, SECAS and others. Additional AFWA staff including legal counsel, accounting manager and others may assist, as appropriate. It is possible that AFWA may need to hire a part-time contractor to help coordinate the creation and launch of the CHWA and necessary discussions with Partner States' staff that are currently responsible for managing individual state CHATs, the west-wide CHAT, SECAS, and other regional association efforts.

At one point, The CNA Corporation agreed to provide the services of their Director of Strategic Development to help find outside funding sources in support of the annual hosting and maintenance costs of the CHAT as well as the expansion and enhancement costs. Once funding is secured, The CNA Corporation may still be interested in dedicating staff to manage the database, design, and web developer services. Other conservation-minded business interests have expressed an interest in assisting with funding strategies, and other conservation NGOs may be interested as well. Additionally, initial conversations with NASA's Office of Earth Science indicate a great interest in facilitating the transfer and utilization of NASA's satellite technology and information to states, local communities, businesses and others. Specifically, a commitment from AFWA and the states to create the CHWA will provide an opportunity to pursue a new collaborative partnership with and possibly obtain funding from NASA to build the CHWA. Finally, Mr. Gary Taylor, former AFWA Legislative Director, may be interested in assisting with state relationships, transitions, and future expansion. Mrs. Connie Parker with Bankers Financial remains interested in realizing the vision of the CHWA for the mutual benefits that may be derived for conservation-minded and natural resource affected businesses.

Citation:

Wathen, Greg; Bill Bartush, Tim Breault, Ed Carter, Cindy Dohner, William Gould, Ken McDermond, Gerard McMahon, Bill Uihlein. 2013. The Southeastern Conservation Adaptation Strategy: A Conservation Landscape for the Future. Southeastern Association of Fish and Wildlife Agencies Proceedings.

Elements in Place: Examples of Integrated Data Management Platforms and Approaches

This section of the report highlights examples of **integrated data management platforms and approaches** that enable state and provincial agencies to integrate multiple, complex data sources/data streams in order to inform the management of fish and wildlife populations.

Arizona HabiMap™

Joyce Francis, Arizona Game and Fish Department

The Arizona Game and Fish Department (Department) recently revised its State Wildlife Action Plan that provides a framework and information to assist in setting conservation priorities for the state's wildlife and habitats. Data gathered for Arizona's State Wildlife Action Plan represents myriad sources and extensive public comment, and is used to support the Department's efforts to develop proactive conservation goals and objectives. Much of that data (more than 300 data layers) is compiled into a single model of wildlife conservation potential, the Species and Habitat Conservation Guide.

To ensure the State Wildlife Action Plan information is accessible and useful to everyone, the Arizona Game and Fish Department developed HabiMap™ Arizona. This user-friendly, web-based tool allows users to visually explore the distribution of Arizona's wildlife, potential stressors to wildlife, the Species and Habitat Conservation Guide, and other relevant data.

The Species and Habitat Conservation Guide provides non-regulatory information compiled from the best available data and is meant to identify Arizona's wildlife conservation potential at a statewide scale, regardless of ownership. It does not replace or supersede consultation with the Arizona Game and Fish Department. HabiMap™ Arizona is intended to be used as an early planning tool for landscape-level analysis and should be used in concert with all available data and expertise to ensure project plans address wildlife and habitat conservation at all levels. Site-specific analysis will require additional wildlife information and on-the-ground expertise from the Arizona Game and Fish Department biologists. For more information on environmental compliance issues and special status species (including plants), please use the Online Environmental Review Tool at https://azhgis2.esri.com.

The Arizona Game and Fish Department recognizes the need to continually update and refine HabiMap™ Arizona. As new or additional data becomes available to the Department, the team will make appropriate revisions and adaptations to the tool. Likewise, they encourage feedback and questions, which can be submitted through the HabiMap™ Arizona tool or by the webgis@azgfd.gov email address.

California Department of Fish and Wildlife BIOS Map Viewer

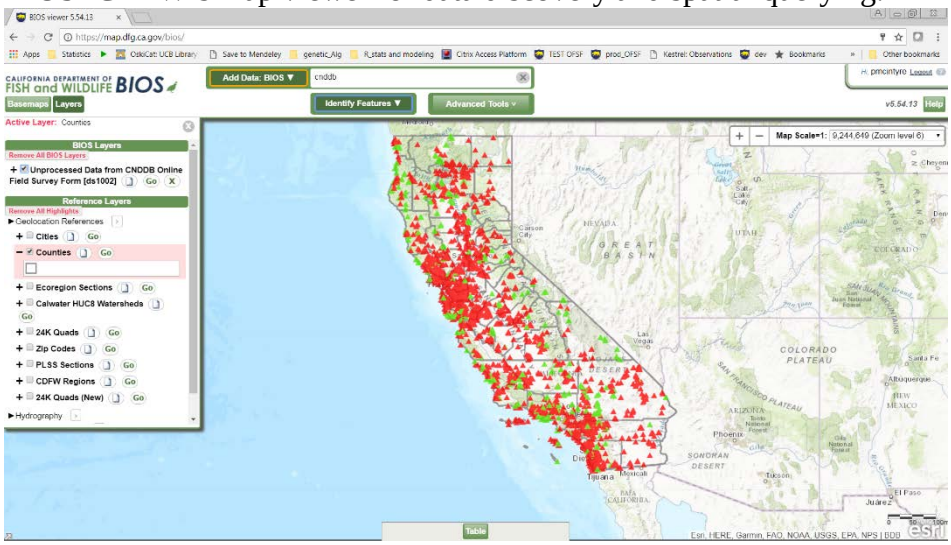
Patrick McIntyre, California Department of Fish and Wildlife

The California Department of Fish and Wildlife's Biogeographic Data Branch supports a number of data discovery and analysis tools used in conservation planning and environmental review.

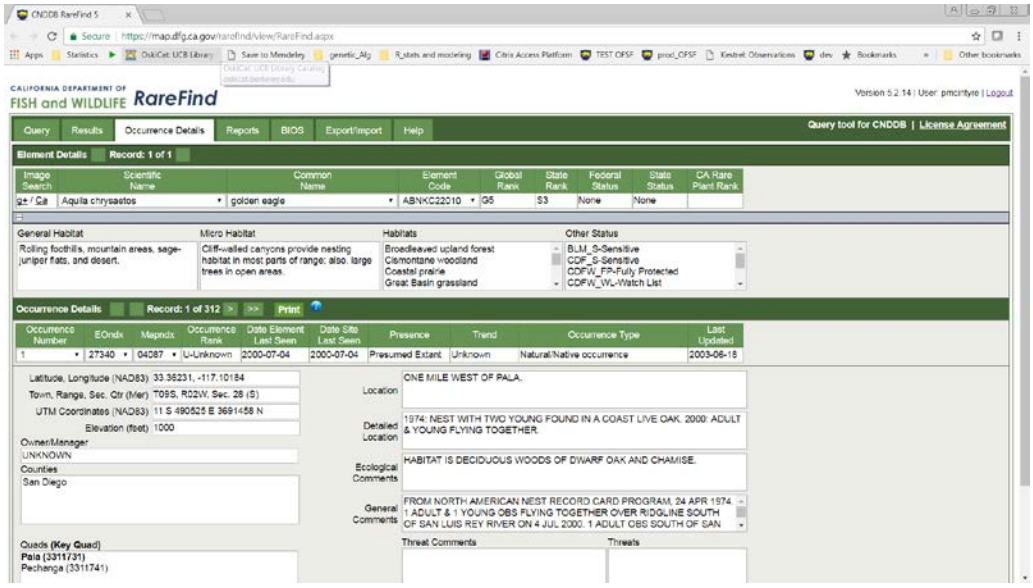
CDFW provides a BIOS map viewer that hosts over 2,000 datasets with variable access (public, government, subscriber). BIOS is a system designed to enable the management, visualization, and analysis of biogeographic data collected by the California Department of Fish and Wildlife and its Partner Organizations. In addition, BIOS facilitates the sharing of those data within the BIOS community. BIOS integrates GIS, relational database management, and ESRI's ArcGIS Server technology to create a statewide, integrated information management tool that can be used on any computer with access to the Internet. BIOS also hosts data from the California Natural Diversity Database (CNDDB) on rare and special status species distributions, and is integrated into RareFind5 a web based tool that queries detailed tabular information on rare species occurrences.

Links:
BIOS: https://www.wildlife.ca.gov/Data/BIOS
CNDDB: https://www.wildlife.ca.gov/Data/CNDDB
VegCAMP: https://www.wildlife.ca.gov/Data/VegCAMP
Conservation Analysis Unit: https://www.wildlife.ca.gov/Data/Analysis

Screen Shots:
BIOS- CDFW's map viewer for data discovery and spatial querying:



CNDDB- RareFind5: Reports and detailed text information on special status species occurrences, for CNDDB Commercial and Government (including restricted datasets) subscribers.



CNDDB- QuickView Tool: Publically available information at the USGS 7.5 minute quad level on special status species data reported to CDFW. Hosted in BIOS.

Florida Fish and Wildlife Conservation Commission Long Term Monitoring Project

Jason Dotson, Florida Fish and Wildlife Conservation Commission

The Freshwater Fisheries Research Section and the Division of Freshwater Fisheries Management of the Florida Fish and Wildlife Conservation Commission (FWC) implemented a Freshwater Fisheries Long Term Monitoring (LTM) Project in 2006 with the objective of obtaining standardized data that can be used by managers to determine trends in aquatic plant coverage, sportfish relative abundance, species composition, mortality, growth, size structure, and angler directed effort and harvest for Florida's important freshwater fisheries. The major sampling components of the LTM Project include habitat monitoring (aquatic plants), fishery-independent monitoring (electrofishing, trawl, gillnet, and fykenet sampling), and fishery-dependent Monitoring (angler creel surveys). Currently, sampling is focused on priority waterbodies (29 lakes, 1 canal, and 8 rivers), however, standardized sampling methods have been applied to numerous non-priority waterbodies (176) across the state. A critical component of the LTM Project is the data application (web application and database), which consists of:

- A SharePoint portal that provides links to the web-based data entry form, report queries, and tools for data analysis. The portal also holds data documents, tracking/schedule information, and documentation.
- A web based data entry form. The data entry form uses Microsoft Office InfoPath which is being replaced in Fall 2017 with an ASP/browser based form. The form captures sampling data based on a standardized FWC protocol, as well as, several non-standard protocol options. The data entry form captures data related to sampling type, location, time, crew, habitat, environment, and gear. Data field objects are date/time, text, numeric, and dropdown. Date/time, text, and numeric objects have range validation. The dropdown objects provide

standardized values to reduce data entry errors and insure consistency with the data being stored. The dropdown or lookup values are associated with the primary key values of standardized reference information; such as, Geographic Names Information System (GNIS) for location identification and Integrated Taxonomic Information System (ITIS) for species identification.

- A SqlServer 2014 database. The database holds sampling data and standardized lookup information for location, species, and instrument values. Captured LTM data spans 10 years of sampling and consists of 38,000 sampling sites from 216 waterbodies within Florida. Over 1.3 million rows of fish data (species, count, length, weight, notes) have been captured. The design of the LTM database eliminates the need to build a cross-reference table when joining with other databases that incorporate the key values used in GNIS and ITIS.
- A SqlServer Reporting Services database (SSRS). Reporting Services allows biologists and managers to access event, fish, environmental, and habitat data through standard reports or ad-hoc queries. Data from the priority waterbodies are used to compose summary statements, tables, and data snapshot reports on an annual basis. These reports provide data on fish community (percent composition and richness/diversity), creel (fishing effort and harvest), and sportfish (catch rate, stock density, length/age frequency, and condition) metrics over time and enables comparisons between waterbodies and statewide averages.

The data application component of the LTM Project provides an integrated data management platform that enables the agency to integrate freshwater fisheries data from all over the state to inform management decisions, access management actions, direct research projects, and allow for the establishment and maintenance of long-term datasets. The LTM data feeds into a FWC geodata application (MRGIS) that is available to the public and an interactive ArcGIS Online map application that resides on the LTM SharePoint portal for internal use. The LTM sampling data has been provided, in a spreadsheet format, to Florida universities, water management districts within Florida, other Florida agencies, and organizations outside of Florida.

The habitat monitoring component of the LTM Project began in 2015. The objective of this component was to implement sampling protocols that would provide accurate lake-wide estimates of the percent area covered (PAC) and percent volume infested (PVI) of submersed and emergent vegetation in lakes that are part of the LTM Project. The justifications for the implementation of the habitat monitoring were that these data could help explain changes in sportfish or fish community data, would provide a baseline dataset of habitat conditions that could be monitored through time, and could focus future research and/or management actions. To monitor lake-wide vegetation PAC and PVI, we are using remote sensing methods (hydro-acoustic sensing and satellite imagery) in combination with the BioBase Company's subscription based EcoSound and EcoSat data analysis products. These BioBase products provide an interactive web based platform for the analysis and viewing of remote sensed vegetation data collected from Lowrance sonar units and commercial satellite imagery. With the EcoSound product, a Lowrance sonar is used to map submersed aquatic vegetation (SAV), in which recorded acoustic sonar signals are interpreted by algorithms on BioBase's website, these sonar data are then used to interpolate and extrapolate data into un-sampled areas to create a lake-wide map of SAV coverage and density. We are using EcoSound to map established submersed vegetation communities in LTM Project lakes on an annual basis during the summer months when peak vegetation growth occurs. With the EcoSat product, a user can order imagery from various commercial satellites, in which imagery is interpreted by algorithms on

BioBase's website to pick out and map the coverage of different vegetation species based on their light reflectance characteristics using vegetation species training points provided by the user. We are using EcoSat to map emergent vegetation in a subset of LTM Project lakes on a rotational basis during spring months when water levels are lower and greater vegetation growth is exposed. BioBase also allows for the viewing of all vegetation maps and summary data for non-subscription holders within FWC so that biologists and managers can access these data to aide in research and management actions. BioBase vegetation maps can also be transferred into ArcGIS maps, which has allow us to add these maps to the interactive ArcGIS Online map on the LTM Project's SharePoint web portal for FWC staff to view.

Florida Fish and Wildlife Conservation Commission Wildlife Incident Management System

Ignacio Sanchez, Rene Baumstark, Sherry Lake, Florida Fish and Wildlife Conservation Commission

Our Wildlife Incident Management System (WIMS), started in 2014 as a multi-species cloud-based database system to track agency-wide activities related to human-wildlife interactions, reducing staff time involved with data entry and subsequent analysis and allowing a more holistic view of multiple species involved in conflicts. It maintains caller contact information, mapping capabilities, and external portals for contractors to add incident information. This flexible system can grow as new species programs are incorporated, and it is also being considered for other non-wildlife initiatives such as derelict vessels tracking, and as a component of an enterprise call center (CRM).

Through our Fish and Wildlife Research Institute (FWRI), we maximize the utility of scientific data and expertise with analytical tools and technologies. FWRI's Center for Spatial Analysis, for example, hosts agency level GIS services that support innovative web and application development, producing decision support tools, interactive web maps, data discovery/download web sites and other targeted tools and services.

These services are used to plan land acquisition and management, promote wildlife viewing, and provide public education in the form of maps and mobile applications. Our Law Enforcement staff currently use these services to identify derelict vessels and to monitor captive wildlife. Additionally, several disparate law enforcement-related databases and systems are being integrated into a complex data source, to help isolate and protect criminal justice data, while facilitating analytics, and data-sharing between multiple law enforcement agencies.

Idaho Fish and Game's Integrated Information System

Bart Butterfield, Idaho Department of Fish and Game

The Idaho Department of Fish and Game (IDFG) historically maintained data about fish, wildlife and plants in a decentralized fashion, scattered across the agency in individual biologist's computers. Compiling and synthesizing data across regions and the state was time-consuming, error prone and sometimes resulted in duplicative and disparate data. To rectify this problem, IDFG has been working to build a central, integrated data management system called the Idaho Fish and Wildlife Information System (IFWIS).

A staff of 14 developers, GIS analysts and data managers work with biologists to develop applications and manage data for fishery and wildlife surveys and research. Current development is focused on Web and mobile applications. Custom applications are built on top of in-house database and GIS software, as well as cloud-based solutions, such as ArcGIS Online and Google Map interfaces. It is all tied together with databases and GIS data that use common coding schemes, such as species IDs and geo-referencing schemas. In this way, previously disparate datasets can be combined or compared.

IFWIS products are made available via a "one-stop shopping" web portal at https://idfg.idaho.gov/data.
A public section makes data, typically in summary form, available to the public. Two of our most popular applications are the Idaho Hunt Planner and the Idaho Fishing planner. Another section of the IFWIS portal requires an IDFG authentication login and provides technical, data entry and reporting applications to biologists.

IFWIS has proven to be effective at improving the quality and accessibility of data used by IDFG for management and conservation, while delivering useful information to the public in easy-to-use tools. But much work remains and IDFG will continue to use technology to improve their data collection, management, and analysis needs to support sound decision-making for our fish and wildlife.

Idaho Statewide Animal Marking Master

Mark Hurley, Idaho Department of Fish and Game

Idaho Department of Fish and Game has developed a comprehensive data management system (Statewide Animal Marking Master; SAMM) to standardize data entry, storage, and extraction for all captured ungulates. The database has recently been expanded to include large carnivores and will eventually include all animals processed in Idaho. The data management system includes interfaces to enter survival monitoring and mortality data, results of biological sampling, and animal location data. The system automatically sweeps remotely downloaded locations from GPS collars into the database. The database can be queried in multiple fashions to provide data such as live animals to monitor and mortality cause. We have produced a web application integrated with the SAMM system that combines GPS collar locations, capture and mortality data from collared animals in SAMM, and spatial layers to display animal locations according to user defined areas, species and/or age class. It is used daily by biologist for mortality investigation, commenting on proposed actions, and public information.

Louisiana Department of Wildlife and Fisheries Office of Fisheries Data Management System

Ty Medlen and Kenny Ribbeck, Louisiana Department of Wildlife and Fisheries

Over the past several years the Office of Fisheries has migrated most of their data management needs into one unified system. As a division, this has enhanced their abilities to control data inputs, speed up the data entry process, quickly and efficiently evaluate data sets, interface with the departments licensing database, find relations and run data analysis across different programs in ways never before

possible, properly and securely store data, and increase the ability and mechanisms to share data with outside entities. Currently, the Office of Wildlife is working towards unifying data management for the entire department by migrating into the same system. Utilizing the knowledge that the Office of Fisheries has gained throughout their development experience is an invaluable resource available to the Office of Wildlife that will result in a robust, reliable, and multifunctional system right out of the gate by reducing the need for input and relational data repairs down the road. Furthermore, the consolidation of all Louisiana State IT services has resulted in a new organization called the Office of Technology Services (OTS) which has put in place an Enterprise Architecture (EA) project. One of the main objective of EA is to develop an integrating framework for data management for each state agency. This has resulted in the dedication of well abled IT staff and a plethora of resources to our department that will bring application development and maintenance in-house, ultimately reduce the departments dependency on contractors.

The following is a technical breakdown of the system that our department is adopting:

System: The Data Management System (DMS) platform that was initially selected by the Office of Fisheries is Microsoft's .Net framework with a MS-SQL backend database that follows industry standards. This system has proven to be a powerhouse in managing data as a whole for the Office of Fisheries because of its customizability to meet data input and management needs as well as its broad interfacing capabilities for analytics and reporting.

Data Entry: Web application driven. This allows our department to migrate from traditional paper/manual entry to real-time web-based data entry by biologists and the public when feasible.

Data Storage and Sharing: Relational Database. The data will be stored in a relational database which in most cases will be the MS-SQL environment to maximize our ability to store, protect, and analyze all aspects. Two core components of OTS's EA are Master Data Management (MDM) and Data Warehouse (DWH). Through MDM, the State is establishing "golden record" or "Single Source of Truth (SSOT)" repositories for people and entities which agencies can leverage and share.

Data Analytics: Multiple. The agency uses MS-SQL Server Business Intelligence features such as Analysis Services and Reporting Services for formal standardized data analysis and reporting. This allows analysis and reporting services that focusing on a centralized structure that allows for a one-stop-shop where biologist can query data to suit requesters needs and output datasets in multiple common use formats (SAS/Excel/Access/Text(CSV)). However, since no one tool fits all, SAS, "R", and a handful of other analytical tools are used for more unique data dives. Additionally, OTS has setup a data governance group to oversee the State's data management strategy.

Security: Due to the Personally Identifiable Information (PII) data and data that agencies have deemed sensitive and confidential, security is of the upmost importance. There are many checks and balances to ensure the appropriate persons have access to the exact data they need to do their jobs. Identity Management identifies an individual and user access rights and restrictions are tied to the identity of each person. Access Controls are put in place to give or restrict access to data depending on the user's identity. Security patches and vulnerability scans occur often along with corrective actions. Audits are conducted on three different levels: Project Manager, Internal I.T. audits, and agency internal audit sections to maintain a heightened level of security.

Data migration and development implementation for the Office of Wildlife status:

Phase 1—Data Discovery
Completed: The Office of Wildlife has taken the necessary steps to migrate all data sets into one single network location. All programs and related data sets have been analyzed to determine the best approach in developing the high-level relational database elements. All programs have been evaluated individually to create a program priority list.

Phase 2—Development of Dashboard and Relational Elements:
In production: The Office of Wildlife Dashboard is being developed keeping user friendly aspects and quick access in the forefront. Analysis of all programs is under way to identify relational elements to create standard data inputs where necessary.

Phase 3—Individual Program Development—repeated for each program:
In production: Development teams have been working with program managers following the program priority list to begin evaluating, enhancing, and developing program applications. Testing, testing testing. Program staff have been informed of the value of testing all aspects of their developing applications to address any concerns before pushing to a live environment. Reporting opportunities are being evaluated to determine the best platform(s).

Phase 4—Implementation—repeated for each program:
Not complete: As each program application is developed it will be pushed to a live site in an active environment.

Michigan DNR Wildlife Division's Disease Surveillance System

Sarah Mayhew, Michigan Department of Natural Resources

The Michigan DNR Wildlife Division's Disease Surveillance System is an example of the integrated data management approach because it integrates data from the Disease Lab (positive/negative test results), the WildMobile application (harvest location, biological data, and hunter ID collected at check stations), and our electronic licensing system (hunter name and contact information). Multiple database links and queries integrate several data streams to provide a more efficient sample collection process and faster response times to hunters looking for disease testing results.

The Wildlife Division's Bear database and the Deer Data Reporting Program (DDRP) are examples of data analysis tools because they pull together data from a variety of sources. For the DDRP, biological data from check stations and hunter success data from mail surveys are combined and summarized to describe characteristics of the harvest. For the Bear database, registration data, mail survey data, and electronic licensing system data are combined to describe characteristics of the harvest. Both systems provide user-friendly analysis tools for all DNR staff to use. They allow staff the ability to conduct customized data searches and queries from a variety of sources at one time using simple tools in a point-and-click environment.

Missouri Department of Conservation Integrated Wildlife Databases

Julie Fleming, Missouri Department of Conservation

Natural Heritage Program

The Missouri Natural Heritage Program uses NatureServe Biotics to track locations and condition of rare plants, animals and natural communities. Biotics is a web-based software program with structure maintained by NatureServe staff. For more information on Biotics structure, please contact NatureServe.

POS (Point of Sale System):

The Online Point of Sale Permit Distribution System developed a web based platform to be used to administer a statewide automated system of distribution and revenue collection for hunting and fishing permits for the state of Missouri. The web based platform provided hunters and anglers, permit vendors and the Missouri Department of Conservation (MDC) with increased flexibility, oversight and distribution options using technology that is now commonplace in society.

Hunters and anglers are able to purchase permits using our online sales site, or by visiting one of 700+ retail vendor locations located statewide. Customers are also able to download the MO Hunting Mobile Application which allows them to carry the permits they purchased on their smartphone or tablet while in the field.

The POS system includes a control center module which is used to administer and track sales generated by the system in real time. The Department is now able to update the availability of permits immediately following regulation updates and season changes, as well as communicating directly with permit vendors by using the event notification process.

IAMS (Infrastructure Asset Management System)

MDC began implementation of an Enterprise Geographic Information Systems (EGIS) Program. That EGIS Program initially consisted of three projects:

1. EGIS Repository – (described below) Design and build a centralized EGIS Repository capable of storing and providing easy access to the Department's GIS data.
2. Lands Management System - Procure and implement a comprehensive Lands Management System to replace the aging set of disparate applications that fulfill some of the Department's realty functions such as land acquisition and easement tracking.
3. Infrastructure Asset Management System - Procure and implement a new comprehensive Infrastructure Asset Management System that would become the Department's primary solution for tracking and managing Infrastructure Assets.

Over the past 80 years, the MDC has accumulated 1,192 properties, with 1,700 buildings on them. MDC has nearly 1,000 miles of roads with over 500 acres of parking lots, and 50 vehicular bridges. Most of these assets are to provide public access but some are critical to delivering resource management services at hatcheries and wetlands. At wetlands, there are almost 50 pump stations and nearly 1,000 water control structures that help biologists manage wetland resources. The individual components which make up the infrastructure assets are included in the infrastructure portfolio, such as compressors, back flow preventers, valves, electric motors, boilers, hydraulic actuators, flow

meters, submersible pumps, vertical turbines, variable frequency drives, diesel power units and transfer switches.

EGIS (Enterprise Geographic Information System) Repository

Missouri's centralized Enterprise Geographic Information System (EGIS streamlines data management workflows and processes, improves security and increases data integrity. The system currently houses over 100 GIS data layers accessible for use in various maps, analyses and applications used by both Department staff and the public. Examples include; the "MO Fishing Interactive Map," "Confirmed Mountain Lion Sightings Interactive Map," the "Stream Team Interactive Map," the "Hydrilla Reporting App, and the "MDC Cadastral Viewer" to name a few. The EGIS also provides solutions to assist with the management of invasive and endangered species, the distribution of disease, tracking of accomplishments, and provides the ability to monitor species behavior. The implementation of the EGIS system has improved resource communication with the public and has provided solutions to staff to more efficiently manage the fish, forest and wildlife of Missouri.

Integrated Data Management at Montana Department of Fish, Wildlife and Parks

Dawn Anderson, Montana Department of Fish, Wildlife and Parks

Wildlife Division staff has considerable experience with integrated data management at all levels. At the local level, this is accomplished by research and management biologists. Management biologists keep track of data on specific metrics they monitor to inform season and habitat project proposals. Research biologists each keep integrated databases of similar data types across several different projects, which is necessary to achieve the objectives of each research project (e.g., we maintain databases of elk telemetry relocations, elk detection/ non-detection on cameras, elk forage, elk harvest, etc. in order to efficiently address the objectives of several elk research projects). These databases are kept in various software formats, including Arc geodatabases, Access databases, and Excel spreadsheets.

At the enterprise level, in 2007, MFWP began creating centralized databases for all wildlife mandatory reporting, harvest estimate, hunting effort estimate, and survey & inventory data. These databases have been constructed so they can be integrated with each other and with the Automated Licensing Database (i.e., the fields and structure are common enough that joint queries can be used to produce common data tables). These databases have also been integrated into a Regulations database. This database is used to create the annual season proposals for the Fish and Wildlife Commission, create the printed hunting regulations, store annual regulations for the long-term, and control the work flow of the season-setting process. For example, biologists use this database to construct season proposals (based on integrating data trends and analyses from the harvest and S&I databases), then the approval process for these proposals is tracked through the internal chain of command all the way through final Commission decisions to printing of the hunting regulations.

Similar enterprise databases that store data, enable analyses, and control work flows have been created for the scientific collector permits, wildlife immobilization drug tracking, wildlife health and disease sampling, and several other applications.

A couple of primary lessons the Wildlife Division has learned during the course of creating enterprise data management systems are:

(1) We can improve the efficiency of process in terms of timely service to our constituents, but not in terms of financial cost. These systems require skilled technical staff to create, and they require constant improvements and maintenance, which is a lot of work and staff time. Any savings from antiquated, paper-based sort of systems are spent on staff time, technical equipment, and maintenance.

(2) A lot of collaboration and time is required to create these systems, which is a significant investment for both technical and biological staff. If projects like this are undertaken, they fail if there is not sufficient staff time devoted by the primary users to help create the systems. This is difficult because this is often not the staff's primary responsibility. A lot of energy is expended trying to get core work processes to function in enterprise database systems. These systems never reach the point of complete functionality for, or satisfaction by, the end users however, we strive to make them work sufficiently to get core work done.

The Fisheries Division has also embarked on a centralized database to enter, house and report fisheries data. The system is available to staff via the web and resides in our internal website for data entry, data uploads and reporting. The system houses survey and inventory information for streams and lakes as well as hatchery stocking information, fish tagging data, distribution, temperature logger, habitat data and associated references and photos. Plans are underway to include fish genetics, conservation projects and fishing and boating regulations in the near future. The system offers biologists and managers a suite of analysis tools that employ R statistical tools. Reporting functionality is also incorporated and includes the ability to report by species, biologist, surveypurpose and survey type. Maps are incorporated into the system at many different levels including the ability report by area with the inclusion of spatial filters. Currently this system holds over 2.5 million individual fish records.

MFWP's spatial data management is an enterprise geographic information system (GIS). GIS data is a component of the listed data management systems and ongoing work is being done to directly relate complex geometries to those systems in a way that facilitates a more seamless experience for agency staff. The products from agency systems and GIS data from outside entities is distributed to staff for use as spatial data resources in desktop GIS, on the web via ArcGIS Online, and as components of in-house spatial data applications. These resources allow users to compare locational data, conduct analytics, evaluate management actions (Energy Development Review Application) and visualize products collaboratively on the web (MFWP and MT Dept Of Transportation planning of highway projects). Many foundational GIS data layers (Cadastral, Landcover, Infrastructure) are managed with the MT Natural Resource Information Service as part of the state and national Spatial Data Infrastructure layers.

MFWP has a Technical Services Division, consisting of employees in Application Development, Database Administration, Geographic Data Services, and other Bureaus, that work closely with technical staff from other divisions to create these data systems.

New Mexico Game and Fish Department's State Wildlife Action Plan Web Information Portal

Matt Wunder, New Mexico Game and Fish Department

The Department is preparing to develop a web based information portal based on the recently approved State Wildlife Action Plan (SWAP). Although still in its formative stage, the desire is to database and interlink the information in the SWAP so that it can be readily accessed from multiple starting points. So for example, one could be looking at a key habitat and go directly to lists of species found in that habitat, ecoregions where the habitat is found, threats that impact that habitat and conservation actions appropriate for threats to the habitat. There will be a strong geospatial component so that one could also access this information through maps. Clicking on a point in the state would take you to information on the ecoregion, habitat, associated species, threats, and/or Conservation Opportunity Areas. In addition to enhanced access to information within the SWAP, there will also be linkages to other information management systems and relevant sources of background information.

We anticipate that the web based SWAP portal will link up with the WAFWA CHAT and the evolving Environmental Review Tool. Someone who clicks on a hexagon while looking at the CHAT could be taken to the SWAP where they would be presented with multiple levels of information about that hexagon. Information on the ecoregion where the hex is located, what habitats are found in the hex, what species are associated with the ecoregion and habitat, and what are the threats and associated conservation actions related to that hex. For project proponents utilizing the Environmental Review Tool, defining a project footprint would then link to the SWAP where you could be presented with the same information as with the CHAT. This feature will help the proponents to have a better understanding of the ecological conditions in the area where they are planning to implement a project. It will also assist the Department habitat specialists when they are reviewing project submissions.

Finally, in addition to enhanced interoperability, the SWAP portal will let users readily access much more detailed information on the subjects presented in the SWAP. For example, by clicking on a point in the map of New Mexico, one would learn about the ecoregion and have ready linkages to the website with much more detailed and up-to-date information on the ecoregion. Likewise, by clicking on a particular habitat, one could be directed to the National Vegetation Classification System where you could review the latest peer reviewed description of the habitat and associated plant species. When linked to a habitat, one could see all the SGCN that are associated with the habitat and then follow a link to the Biota Information System of New Mexico (BISON-M) and Natural Heritage New Mexico where one could find the most up-to-date information on the species including peer reviewed reference materials. Likewise with threats, you could easily go to the IUCN site where specific threats to species and habitats are found.

North Carolina's Shorebird and Colonial Waterbird Web-based Applications for Data Storage, Sharing, and Assessment

Sara H. Schweitzer, Carol Anne Feehan, Annika G. Andersson, Mary E. Kornegay, North Carolina Wildlife Resources Commission

The North Carolina Wildlife Resources Commission has created two web-based applications that live within an integrated wildlife portal and provide both internal and external access to the Shorebird and Colonial Waterbird datasets. External access is by permission, which is granted to certain state and federal agency and non-governmental staff with whom NCWRC biologists work. These applications allow for the collection, editing, searching, and reporting of the data, which include information such as sites, survey details, GPS coordinates, species, populations, habitat conditions, activities observed, nests, bird banding, and photos. An Administration module allows the business team to set user access and role level without needing to contact IT for assistance. These applications are built using the .NET framework against a SQL Server database.

The biologist team using these applications has compiled and integrated both current data as well as legacy data dating back to the 1960s. These datasets provide critical and timely information to decision-making project teams, especially those involved with coastal engineering activities that have the potential to affect species of greatest conservation need and their habitats. Datasets also enable comparative analyses within adaptive management processes.

Ohio Division of Wildlife and the Great Lakes GLATOS Database

Scott Hale, Ohio Division of Wildlife

One example of a very useful integrated data management platform might be GLATOS, used by the Great Lakes states to house telemetry data throughout the Great Lakes for a variety of species and studies. More details can be found by following the link http://glatos.glos.us/ which also provides the contact information for Chuck Kruger for further information assistance. Chuck is the best individual to provide insights about the system. It is truly remarkable.

Otherwise, in Ohio, we essentially have standard databases, GIS systems, tools for constituent reporting, and applications for management similar to other states. Most of these systems and the associated development of tools and security are developed and maintained by the State IT staff at ODNR, which operate outside of the Division of Wildlife.

Vermont Department of Fish and Wildlife Integrated Databases

Everett Marshall, Vermont Department of Fish and Wildlife

Vermont Natural Resources Atlas

http://anrmaps.vermont.gov/websites/anra5/

The Vermont Department of Fish and Wildlife provides the public and its partners with many of its data layers through the online Vermont Natural Resources Atlas (Atlas). The Atlas delivers geographic information about environmental features and sites that the Vermont Agency of Natural

Resources manages, monitors, permits, or regulates. In addition to standard map navigation tools, this site allows you to link from sites to documents where available, generate reports, export search results, import data, search, measure, mark-up, query map features, and print PDF maps.

The integrated online atlas includes natural resources layers from the Department of Fish and Wildlife; Department of Forest Parks and Recreation; and Department of Environmental Conservation. There are approximately 30 Department of Fish and Wildlife data layers related to fish and wildlife management; as well as additional 100 layers from the two sister Departments.

Vermont Fish and Wildlife Database

The Vermont Fish And Wildlife Department working with our Agency's Information Technology staff have developed a suite of integrated systems that allow for the sharing, manipulation and reporting of the department's data. Some of the Department's datasets include the following: Deer; moose; bat; bear; turkey; lotteries; rare species reporting; bird collection; Green Mountain Conservation Camp data; hunter education; trapping; furbearer; land administration; fish and fish tagging; commercial bait dealer data; and enforcement data. Some of the datasets contain geospatial information when possible for graphical representation.

The Department also has many project specific databases, such as vernal pools, spiny softshell, and wood turtle that are in Access, Excel, or an older database format and have yet to be incorporated into the Department's database. The Vermont Cooperative Fish and Wildlife Research Unit has worked with the Department in integrating some of these standalone databases and spreadsheets into a comprehensive species and project management system called 'ROVER'. However, some of data originally earmarked in this database system has been moved to our Department's Fish and Wildlife Database because of our Information Technology group uses a different database server and security concerns.

Natural Heritage Database

The Vermont Department of Fish and Wildlife (Department) has incorporated natural heritage methodology to rank species and natural community elements as to their rarity in the state. Ranking has been completed for all vertebrate species, selected invertebrate groups, bryophytes, rare vascular plants, and all natural community types. State ranks are housed in NatureServe's central Biotics database and is used to inform national and global ranks. Global and state element information is made available through NatureServe Explorer. The Department uses Biotics to map, rank viability and summarize information on the occurrences of rare species and significant natural communities in the state. We have nearly 8,000 field verified occurrences in our Natural Heritage Database. This information is used to inform the Endangered Species Committee and various Scientific Advisory Groups in deciding which species should be listed or delisted as Threatened or endangered.

GIS files created from the Natural Heritage Database depict the location of rare, threatened and endangered species are widely used by government biologists and planners and by landowners, consultants, and the public. These files are also made available through the online Natural Resource Atlas and GIS files. Detailed information, including the name, is available from the Department through data-use agreements.

The Department's Vermont Wildlife Action Plan was informed extensively by the Natural Heritage

Database, which provided integrated taxonomy, state and global ranking and distribution, field verified occurrence data, and a consistent methodology. The Department actively participated in the North Atlantic LCC regionwide "habitat classification," which drew heavily on data from NatureServe and Natural Heritage network.

In the long-term, the Department believes that open and efficient sharing of fish and wildlife data between state agencies and the natural heritage network is critical. This does not negate necessary institutional support needed by heritage programs from state and federal partners.

Virginia Department of Game and Inland Fisheries Aquatic Comprehensive Database Initiative

Cale Godfrey, Virginia Department of Game and Inland Fisheries

The Virginia Department of Game and Inland Fisheries (DGIF) is implementing an Aquatic Comprehensive Database Initiative that seeks to centralize aquatic data storage and improve data sharing. Data from DGIF aquatic surveys are currently stored in Microsoft Access databases (for Coldwater Streams, Warmwater Streams, and Nongame Aquatics data) or in Excel spreadsheets and notebooks (for Creel, Aquatic Wildlife Conservation Center, and Fish Production and Stocking data). In most cases, multiple regional copies of each MS Access database exist and extensive effort is required to regularly compile a complete "master" copy. To achieve the goal of the Comprehensive Database Initiative, DGIF will acquire data from biologists and make a SQL based database for each of the aquatic data types. These databases will be accessed thought a portal on the internet. DGIF biologists will be able to log in and enter, query, analyze and export data and reports. They will also be able to query data across all five databases and conduct more complex and integrated analyses to better inform the management of fish populations and stocking efforts in Virginia. Approved external constituents will be granted regulated access to view and export data.

DGIF staff members from the Information Management System (IMS) and Fish and Wildlife Information Services (FWIS) sections are currently collaborating on the development of the new centralized Coldwater Streams database, which is the first of the five aquatic databases to be created. DGIF biologists were consulted about required data fields, queries and reporting abilities and provided data from their current MS Access Coldwater Streams databases. IMS and FWIS staff are using the Agile software development process to compile and standardize the data and create the user interface necessary to allow for data entry, import, querying, reporting and exporting. Once the centralized Coldwater Streams database has been created, tested, and released, this team will follow the same process to develop the other identified aquatic database until all five databases are completed.

Northeast Association of Fish and Wildlife Agencies State Wildlife Action Plan Database

Karen Terwilliger and Elizabeth Crisfield, Northeast Association of Fish and Wildlife Agencies

The Northeast SWAP Database Tool was developed to facilitate collaborative regional attention and action on shared priorities identified in northeast (NE) state wildlife action plans (SWAPs) by

compiling key information from the 14 NE SWAPS in a database with simple query and report functions.

The project began in 2012 as a proof of concept database framework and evolved to produce a Lexicon with consistent terms for all SWAP Elements that enabled comparison across state lines. It also produced a NE database template, a data entry and edit tool for states to provide their data in consistent compatible format. After the 2-year timeframe, the final condensed database version 1.0 "datalite" contains all available key data fields from Northeast SWAP Elements 1-4.

This database tool allows users to access and explore the priority species, habitats, threats, and actions that were cited in Northeast SWAPS. It is designed to allow users to search for a species by taxa and to review its status in each state. Threats specific to that species and their key habitats can also be reviewed along with any proposed conservation actions. This allows state fish and wildlife managers, their partners, and stakeholders a convenient method to share their Wildlife Action Plan data. This will lead to increased coordination of efforts to monitor species populations and address threats to those species. State fish and wildlife agency programs and their partners can query all NE SWAPS in one easily accessible database to find and compare priority species, habitat, threats and actions with those listed in their state. States can work together on these identified priority actions and share them with partners for further implementation through partnerships at both the state and regional levels.

The Regional SWAP Database Tool was supported by State Wildlife Grant funding awarded through the Northeast Regional Conservation Needs (RCN) Program administered by the Northeast Fish and Wildlife Diversity Technical Committee of the Northeast Association of Fish and Wildlife Agencies. The RCN Program joins thirteen northeast states, the District of Columbia, and the U.S. Fish and Wildlife Service in a partnership to address landscape-scale, regional wildlife conservation issues. Progress on these regional issues is achieved through combining resources, leveraging funds, and prioritizing conservation actions identified in the SWAPs. See RCNGrants.org for more information.

WAFWA Mule Deer Working Group Data Collection, Integration, and Analysis

Jim Heffelfinger, Arizona Game and Fish Department

The WAFWA's Mule Deer Working Group, chaired by Arizona Game and Fish's Jim Heffelfinger, continues to work with Paul Lukacs and Josh Nowak at University of Montana on a mule deer survival analysis using existing telemetry data across the West (potentially 23 western states and provinces). We have finalized and distributed a request for existing data to WAFWA member agencies. This effort will evaluate variation in mule deer survival across space and time and in relation to other variables. This analysis will allow us to: 1) improve management decisions agencies make when they measure survival in a few key areas and extrapolate that to larger areas, 2) to predict population response to environmental conditions, and 3) improve population models. Survival estimation on this scale is complicated, but we are working on accumulating the data and raising funds for the analysis. A technician is on board to begin formatting and organizing data. Josh Nowak and Paul Lukacs began developing analysis software for the project by building off methods used in similar collaborative work with Mark Hurley (ID) and expand those methods to the entire study area.

Approximately 90% of the estimated funding costs have been secured through the Southern Rockies Landscape Conservation Cooperative.

Canadian Wildlife Service Bird Conservation Region National Database

Judith Kennedy, Canadian Wildlife Service

The Canadian Wildlife Service led an initiative to complete Bird Conservation Region (BCR) strategies, and created a national database to house the information compiled for each of the strategy documents.

The BCR national database houses information used to complete the six standard elements of BCR plans (see *Kennedy et al., 2012* attached) for each of the 25 BCR planning units (subregions) across Canada. These elements include information both within Canada and internationally (for threats). Every effort was made to standardize the approach taken to BCR planning, including adopting the Open Standards for the Practice of Conservation where possible. The BCR national database provides a central repository of data that promotes consistency of data storage across regions, and provides useful data management features that facilitate data entry and updating.

Introducing a consistent structure for information made it possible to share methods of analysis and promote collaboration among regions, thereby saving time and effort. The database facilitates national analyses and provides the flexibility to query by species, habitat, threat and action. This flexibility supports connection with datasets for other programs, such as Species at Risk, enabling further integration.

The database provides automatic roll-ups of threats and objectives, pre-designed queries that produce standard output for use in written plans, and metadata. It also provides quality control tools that can make regional tasks easier and more efficient.

Another type of data management initiative that would be of great interest to the North American Bird Conservation Initiatve Canada Council is any conservation tracking system that practitioners have developed to record partner actions undertaken and the resulting progress towards conservation objectives. That type of tracking system would be a useful tool for supporting an Adaptive Management approach, but seems like a daunting prospect to develop. It would be great to benefit from any similar work undertaken by AFWA members.

U. S. Geological Survey's BISON (Biodiversity Information Serving Our Nation)

Gerald Guala, U. S. Geological Survey

USGS Biodiversity Information Serving Our Nation (BISON) is a unique, web-based Federal mapping resource for species occurrence data in the United States and its Territories. Researchers collect species occurrence data, records of an organism at a particular time in a particular place, as a primary or ancillary function of many biological field investigations. Presently, these data reside in

numerous distributed systems and formats (including publications) and are consequently not being used to their full potential. As a step toward addressing this challenge, the Core Science Analytics, Synthesis, and Libraries (CSAS&L) program of the U.S. Geological Survey (USGS) is developing Biodiversity Information Serving Our Nation (BISON), an integrated and permanent resource for biological occurrence data from the United States. BISON will leverage the accumulated human and infrastructural resources of the long-term USGS investment in research and information management and delivery. Read the DOI Official Press Release in which BISON's public debut was announced.

The USGS CSAS&L program is also the U.S. Node of the Global Biodiversity Information Facility (GBIF), an international, government-initiated and funded effort focused on making biodiversity data freely available for scientific research, conservation and sustainable development. USGS CSAS&L hosts a full mirror of the hundreds of millions of global records to which GBIF provides access. BISON was first released in April 2013 and included 110 million records made available through GBIF from the U.S. and U.S. Territories. In November, 2015 BISON passed the 260 million record count and is continuing to integrate millions more records from other sources each year.

NatureServe Integrated Databases

Lori Scott and Don Kent, NatureServe

Biotics 5, http://www.natureserve.org/conservation-tools/biotics-5, is the primary biodiversity data management system used by state natural heritage programs and provincial conservation data centers. Biotics 5 is a web-enabled platform for tabular and spatial data management, delivered via software as a service from a centralized application hosting environment maintained by NatureServe. Biotics 5 is currently used by 43 US states, 8 Canadian provinces and territories, as well as NatureServe central staff. Biotics facilitates adherence to Network taxonomic and data standards and includes mechanisms for automating bi-directional exchange and reconciliation of data between the central and local databases.

Missouri Natural Heritage Program uses NatureServe Biotics to track locations and condition of rare plants, animals and natural communities. Biotics is a web-based software program with structure maintained by NatureServe staff. For more information on Biotics structure, please contact NatureServe.

Observation Data Management Systems. NatureServe has an existing solution known as Kestrel, http://www.natureserve.org/conservation-tools/kestrel, that is used by a few states and provinces and by the Parks Canada Agency. In 2017 NatureServe expects to launch a major new development effort to build a more modern, robust and highly scalable online observation solution that would support hundreds of millions of observations and would continue to support variable data models, as Kestrel does now. The completion date for the proposed system is December 2018, and it would work in conjunction with Biotics 5 for states using that system or as a standalone option for states and other organizations who do not adopt Biotics 5 or natural heritage methodology.

There are numerous state developed observation databases, which will be assessed before undertaking a NatureServe Network solution outlined above to ensure we are building on existing capabilities to the extent possible.

Elements in Place: Data Discovery, Data Archiving, and Data Storage Activities

This section of the report highlights examples of **major data discovery, data archiving and data storage activities** at state and provincial wildlife agencies, particularly in circumstances where agencies have undergone a process to: discover all existing data sources within the agency, translate some or all those data sources into compatible formats, and archive or store these data in integrated data management system(s) at the departmental or agency level.

Florida Fish and Wildlife Conservation Commission Metadata Repository

*Ignacio Sanchez, Rene Baumstark, Sherry Lake, Florida Fish and Wildlife Conservation Commissio*n

An internal metadata repository (MetaRep) is nearing completion, has a great search tool, but currently only searches metadata records entered into the system. After this tool is complete, we are planning enhancements to add links to data sources, websites, network resources, etc.

Missouri Department of Conservation Data Mining

Julie Fleming, Missouri Department of Conservation

Natural Heritage Program

The Missouri Natural Heritage Program mines data from other Missouri Department of Conservation staff databases by exporting targeted species into Excel spreadsheet and adding the data to the Missouri Natural Heritage Database. Information is also obtained from staff: research projects, monitoring, and surveys for incorporation into the Database.

Telecheck

The Telecheck harvest reporting system provides a simple and efficient way for the public to enter harvest information for deer and turkey, using a voice recognition system. In addition to permit number, species, sex and county of harvest, biological data is gathered to determine the age of the animal. These measurements include beard and spur length for turkey and the number of antler points for deer. Since the animals have to be checked on the date of harvest, date information is simply recorded automatically by the system. This allows management staff to stay abreast of harvest information by species, county, time of harvest, etc.

Once the information is received at the department it is linked to the hunting/fishing permit system. This allows law enforcement personnel the ability to check on individual permit and harvest records, and provides real-time harvest reports to the public via the agency website.

FINS (Fisheries Information Network System)

The Fisheries Information Network System (FINS) is a centralized information system that the Missouri Department of Conservation fisheries management biologists and aquatic researchers use for storing, analyzing, and reporting. The system allows users to track sampling locations, fish data (i.e.

length, weight, etc.), water quality, and tag information. The system can generate reports to determine age/growth, length frequencies, and population estimates to name a few. FINS solved many issues for users including; providing access to others' data (centralized), ensuring data accessibility when employees leave/retire, quality control and assurance, common data structure, and standardized reports. The system has improved workflows, data integrity, and reporting consistency.

EGIS (Enterprise Geographic Information System) Repository

Missouri's centralized Enterprise Geographic Information System (EGIS) streamlines data management workflows and processes, improves security and increases data integrity. The system currently houses over 100 GIS data layers accessible for use in various maps, analyses and applications used by both Department staff and the public. Examples include, the "MO Fishing Interactive Map," "Confirmed Mountain Lion Sightings Interactive Map," the "Stream Team Interactive Map," the "Hydrilla Reporting App, and the "MDC Cadastral Viewer" to name a few. The EGIS also provides solutions to assist with the management of invasive and endangered species, the distribution of disease, tracking of accomplishments, and provides the ability to monitor species behavior. The implementation of the EGIS system has improved resource communication with the public and has provided solutions to staff to more efficiently manage the fish, forest and wildlife of Missouri.

Montana Fish, Wildlife and Parks Historical Data Inventory and Archiving

Dawn Anderson, Montana Fish, Wildlife and Parks

The Wildlife Division has experience with this for several different species, including all of the mandatory check species, historical big game survey and harvest data, and several carnivore species. Additionally, several research projects (e.g., grizzly bear trend estimation) have necessitated locating all the relevant historical research project data and archiving them in project databases. Finally, recently we have embarked on data discovery and synthesis efforts for some data-deficient species, in order to help plan future courses of management and research action, for example moose (http://fwp.mt.gov/fwpDoc.html?id=70357) and mountain goats (http://fwp.mt.gov/fwpDoc.html?id=81144).

Each of these projects has taken a full-time person dedicated to the task as a primary (or even sole) job responsibility. These are huge tasks that require very good people skills and an incredible amount of interaction with other people. They almost always take longer than expected. At the national level an effort of this magnitude would likely require a significant amount of time and effort. A person would need to be hired for the task within each state agency and probably within each major office (region?) of each federal agency. Otherwise, if there is not a good reason for each agency to do it, they will not be able to justify dedicating staff to do it for an AFWA project.

At the local level, each biologist archives the information they collect as part of the area and species managed and passes those data onto their successor. At the state level, MFWP's enterprise data management systems are built for current and near future perceived requirements. This can make archiving all data difficult as often historical data is not in the same format. While ideally all data would fit one data "model" the reality is that data inconsistencies negate the ability to fully use

existing data management applications to go back and store historical data effectively. This means that long term evaluations cannot, at this time, be done effectively within enterprise systems. Historical GIS data is somewhat analogous to the local level management, where statewide or local GIS resources are end-dated and archived as part of the respective process (e.g. management unit boundaries).

The Fisheries Division centralized system (FIS) made a large effort to first handle current data, but also asked that historic information be incorporated as time and resources allowed. Tools were developed in house to assist biologists in uploading historic information stored in various locations. Many biologists have used the tools, allowing for historic data to be incorporated into the system much more quickly than what was expected. Financial resources have been allocated in the next biennium to address historical data entry as well.

The Fisheries Division has also embarked upon a new public web presence that ties directly into the FIS to replace existing web systems that have become technically obsolete. The web interface will improve service to the public by providing more up-to-date and comprehensive data and ensuring that data collected with state dollars is more accessible to the public.

MFWP closely collaborates with the MT Natural Heritage Program (NHP) to facilitate the management of native species and species of concern data for plants and animals. NHP is not part of MFWP, however, we share data closely and work to facilitate their ability to discover, compile and archive species location data.

New Mexico Game and Fish Department Data Mining

Matt Wunder, New Mexico Game and Fish Department

The Department has developed a website for consolidating data from Scientific, Educational, and Commercial Collecting Permits issued by the Department. We have developed the website, and are mining data from past permit reports. The data retrieved from these reports will augment the location records of species and help better define species ranges in NM. This information will be incorporated into Natural Heritage New Mexico. Once the Data mining is complete, the Law Enforcement Division will be able to record and manage collecting permits more easily and effectively. Other divisions within the Department will have access to the data on species collected, numbers, locations, and over time, trends. This will help the Department better manage more species and where necessary, and better understand the potential impacts of collection.

Virginia Department of Game and Inland Fisheries Aquatic Comprehensive Database Initiative

Cale Godfrey, Virginia Department of Game and Inland Fisheries

The Virginia Department of Game and Inland Fisheries (DGIF) is implementing an Aquatic Comprehensive Database Initiative that seeks to centralize aquatic data storage and improve data sharing. Data from DGIF aquatic surveys are currently stored in Microsoft Access databases (for Coldwater Streams, Warmwater Streams, and Nongame Aquatics data) or in Excel spreadsheets and

notebooks (for Creel, Aquatic Wildlife Conservation Center, and Fish Production and Stocking data). In most cases, multiple regional copies of each MS Access database exist and extensive effort is required to regularly compile a complete "master" copy. To achieve the goal of the Comprehensive Database Initiative, DGIF will acquire data from biologists and make a SQL based database for each of the aquatic data types. These databases will be accessed thought a portal on the internet. DGIF biologists will be able to log in and enter, query, analyze and export data and reports. They will also be able to query data across all five databases and conduct more complex and integrated analyses to better inform the management of fish populations and stocking efforts in Virginia. Approved external constituents will be granted regulated access to view and export data.

Elements in Place: Data Analysis Tools

This section of the report highlights examples of **data analysis tools** that states and provinces are already using to combine data from multiple complex data sources (including large databases, external and internal data sources, and frequently updated external data sources such as web data feeds), in order to perform analyses that directly inform management.

Florida Fish and Wildlife Conservation Commission Data Analysis Tools

Ignacio Sanchez, Rene Baumstark, and Sherry Lake, Florida Fish and Wildlife Conservation Commission

We commonly use SAS tools, with some implementations of "R" and Microsoft SQL Server integration Studio.

Idaho Department of Fish and Game PopR Data Analysis Tools

Mark Hurley, Idaho Department of Fish and Game

The Idaho Department of Fish and Game has collaborated with the University of Montana to develop population models for both deer and elk, integrating all demographic data collected in Idaho. The model is housed within a web application, PopR, a data analysis tool providing a single platform for demographic analysis of populations. PopR was developed to combine and analyze multiple complex data sourced directly from our statewide databases through an API. The data is manipulated as needed within the application to standardize the analyses and reduce this most time consuming step of data analysis. The software provides data entry and analysis of our aerial sightablity surveys for both deer and elk, replacing Idaho's old Aerial Survey software. The application combines survival estimates of different ages, 5-year interval population estimates, young of the year ratios, and harvest data to produce annual estimates of survival by age and sex class, male ratios, population growth rates, and population estimates for each Population Management Unit. We have recently added a module to estimate winter fawn survival from remotely sensed weather data. The application automates the process of downloading the weather data layers and generates the covariates needed for the hierarchical survival models. The estimates can then be fed back into the integrated population model to account for missing survival data. The website is http://www.popr.cfc.umt.edu/.

Missouri Department of Conservation Natural Heritage Review Website

Julie Fleming, Missouri Department of Conservation

Missouri Department of Conservation has made various spatial datasets available through a GIS framework for use with the Natural Heritage data. MDC has worked with NatureServe to develop our Natural Heritage Review Website. The website is a tool used to examine potential development locations for sensitive species locations, combining other data layers from partners (e.g., Sensitive

Fish Spawning Layer, which is a U.S. Army Corps of Engineers Clean Water Act Missouri Regional Condition for Nationwide Permits). A tool was developed using the Missouri Natural Heritage Database and other datasets to identify priority areas within Missouri for our State Wildlife Action Plan.

Montana Fish, Wildlife and Parks Integrated Population Modeling

Dawn Anderson, Montana Fish, Wildlife and Parks

The Wildlife Division's primary exposure to this task has been related to development and use of Integrated Population Models. Division staff work closely with faculty and staff at the University of Montana on these kinds of projects. You can see the Application Programing Interfaces (API) for these models at http://www.popr.cfc.umt.edu/.

MFWP currently has an operational, enterprise model developed for mountain lions. The API that runs on the UM server is linked with MFWP central databases real-time, so that all analyses are always updated. We are currently developing enterprise models for sage-grouse, black bears, and bobcats as well. These models are used directly for season proposals, to direct resources to the most efficient monitoring methods, and to generate population estimates as required by law.

Additionally, MFWP Wildlife staff are currently working in a research capacity (with UM staff) to develop Integrated Population Models for elk, mule deer, moose, and grizzly bears. These models are being developed with all the available data streams (telemetry, occupancy, genetics, surveys, harvest, etc. etc.), but not in a manner connected to central databases. We first plan to evaluate their utility, and if they are useful we suspect they will be constructed using the same PopR API on the UM platform at some point in the future.

The Fisheries system offers biologists and managers a suite of analysis tools that employ R statistical tools. These tools leverage existing code from the R community and are available at no cost.

Nebraska Game and Parks Commission's Conservation and Environmental Review Tool

Rachel Simpson, Nebraska Game and Parks Commission

The Nebraska Game and Parks Commission's Conservation and Environmental Review Tool is an online, interactive system for conservation planning and environmental review of proposed development projects. The system is built on an application framework maintained by NatureServe, the umbrella organization for natural heritage programs. That framework, the 'Environmental Review Tool' (ERT), is flexible and can be configured to meet a range of agency objectives. ERTs have been deployed in 7 states (Arizona, Louisiana, Missouri, Nebraska, North Carolina, Pennsylvania, Virginia) with further deployments in development.

Nebraska's Conservation and Environmental Review Tool provides an automated review of submitted projects and generates formatted PDF reports that include embedded maps, tables, and guidance. The guidance is the result of a complex synthesis of multiple spatial data sets, decision rules, and user-

provided information. For example the report provides guidance on avoiding impacts to Pallid Sturgeon only if the project's activities could potentially adversely affect the species and only if the project location is one at which Pallid Sturgeon may occur (based on documented occurrences of the species and the modeled distribution).

Tables in the report show information about features that intersect the project area, such as agency properties and other protected areas, documented occurrences of at-risk species and natural communities, and distribution models of at-risk species.

One of the data sets provided via the map interface is Nebraska's CHAT (Crucial Habitat Assessment Tool), which itself is a synthesis of multiple complex data sources. The report does not currently include statistics pulled from the CHAT data, e.g., percent of project area falling in different CHAT categories, but it could potentially be modified to do so.

Links:

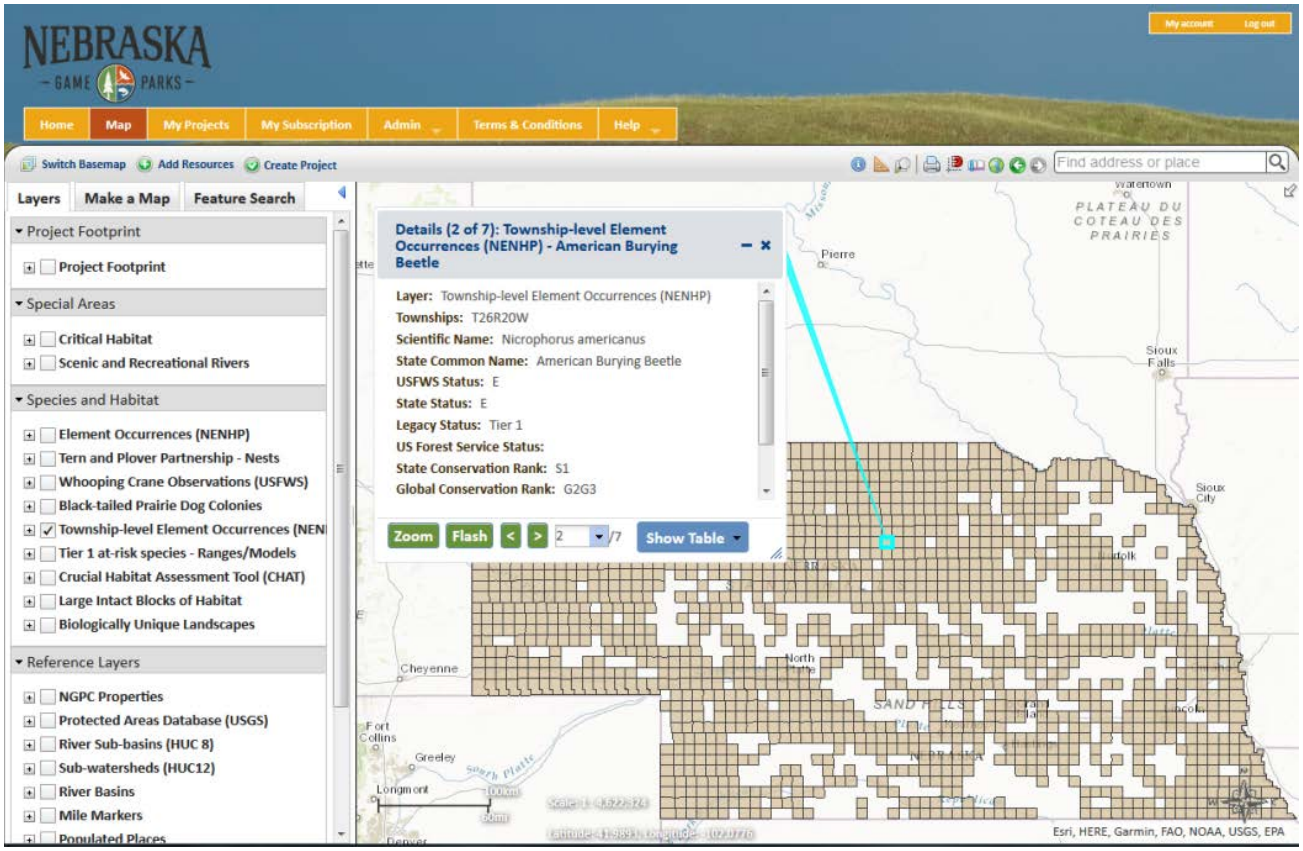
Nebraska Conservation and Environmental Review Tool:
https://cert.outdoornebraska.gov

ERT information:
http://www.natureserve.org/conservation-tools/environmental-review-tool

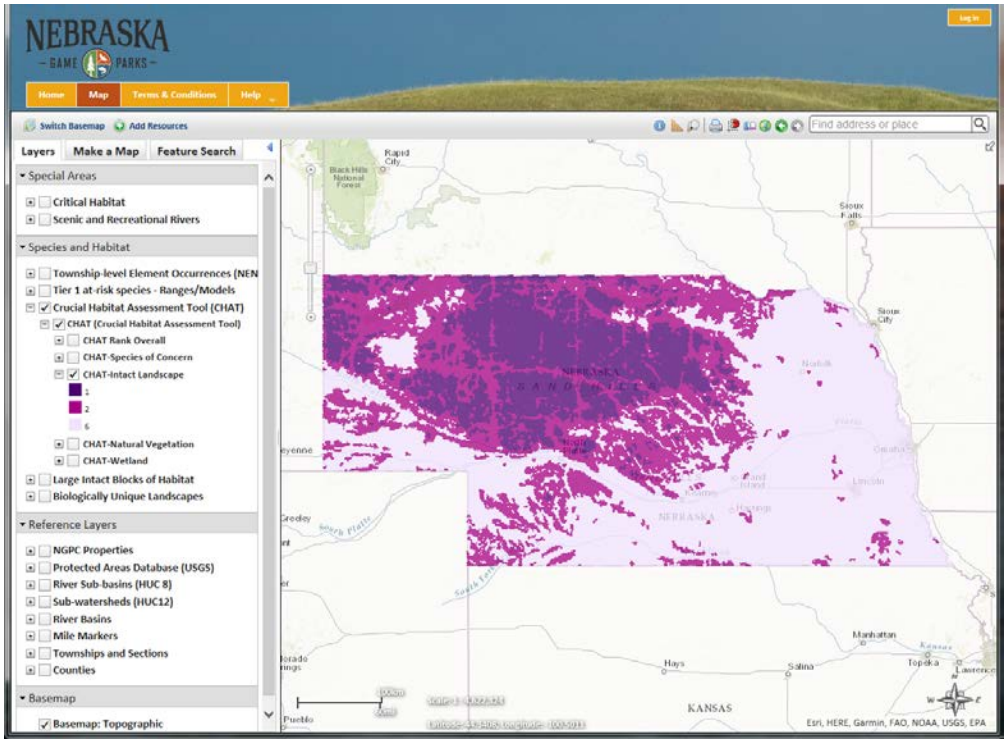
ERT implementation examples from other states:
AZ: https://azhgis2.esri.com/
MO: https://naturalheritagereview.mdc.mo.gov/
NC: https://ncnhde.natureserve.org/
PA: https://conservationexplorer.dcnr.pa.gov/
VA: https://vanhde.org/

Images:

Map interface for the Nebraska Conservation and Environmental Review Tool, built using NatureServe's Environmental Review Tool platform, showing township-level documented occurrences from the Nebraska Natural Heritage Program's database:



Map interface for the Nebraska Conservation and Environmental Review Tool, built using NatureServe's Environmental Review Tool platform, showing a Nebraska CHAT data layer:



Examples of state agency sites using NatureServe's Environmental Review Tool platform:

South Dakota Game, Fish and Parks Department PopR Data Analysis Tools

Andy Lindbloom, South Dakota Game, Fish and Parks Department

Through a collaborative effort with the University of Montana (Josh Nowak and Paul Lukacs), a deer modeling software package currently known as PopR was developed for South Dakota Game, Fish, and Parks (SDGFP). This server-based software system merges wildlife agency survey databases with state-of-the-art statistical software for real-time data analysis, population modeling, and reporting. The interface to PopR is a secure website, connecting to remote data sources through an application program interface (API) and thus allowing access from any location with internet access and from any platform (personal computer, smartphone, tablet). PopR includes summary data and statistics for all deer surveys completed by SDGFP to include harvest, herd composition, reproduction, aerial, and distance sampling surveys. All field survey data are collected on mobile recording devices (e.g., cell phones, tablets), uploaded to a SQL server database via cell or wifi service, time and location stamped, and available instantly on PopR for summary statistics or population modeling. All department staff have access to the same data and analyses tools, thus improving data interpretation and message consistency.

In addition, PopR provides data and analyses to support and develop Data Analysis Units in South Dakota, which are aggregates of management units that serve as the geographic extent of a biological population. DAUs were quantitatively defined through hierarchical cluster analyses, and were based on the biological potential of the area as defined by fall snow, spring snow, precipitation, temperature, net primary productivity, and agricultural coverage datasets. Furthermore, PopR includes population estimation functions using Bayesian integrated population models (IPMs) combining multiple sources of data into a single population projection model simultaneously fit to all data across time. Using previous 3-5 year average harvest rates specific to licenses in each management unit, PopR allows wildlife managers to manipulate future harvest strategies to assess potential population-level effects and impacts to growth rates. PopR enables the seamless workflow from data to analysis to reporting and generates reports and figures for rapid dissemination and incorporation of results into decision processes.

Vermont's Data Analysis Tools

Everett Marshall, Vermont Department of Fish and Wildlife

BioFinder

http://biofinder.vermont.gov/
http://anrmaps.vermont.gov/websites/BioFinder2016/

BioFinder was developed by the Vermont Department of Fish and Wildlife along with other Departments in the Agency of Natural Resources Departments and partners to further our collective stewardship and conservation efforts. BioFinder Is a database, mapping, and data analysis tool for identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. It is the most comprehensive assessment of its kind in Vermont. Updated in 2016, BioFinder highlights the interconnected network of forests, streams and physical landscape features that are at the heart of Vermont's landscape.

Vermont Conservation Design
http://www.vtfishandwildlife.com/conserve/conservation_planning/vermont_conservation_design
The Department took the lead in developing the Vermont Conservation Design, a landscape-level approach to protecting and enhancing ecological function into the future. The lands and waters identified in this project are the areas that are a priority for maintaining ecological integrity and comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend.

USGS BISON Platform for Data Mapping and Analysis

Gerald Guala, Core Science Systems, USGS

USGS Biodiversity Information Serving Our Nation (BISON) is a unique, web-based Federal mapping resource for species occurrence data in the United States and its Territories. Researchers collect species occurrence data, records of an organism at a particular time in a particular place, as a primary or ancillary function of many biological field investigations. Presently, these data reside in numerous distributed systems and formats (including publications) and are consequently not being used to their full potential. As a step toward addressing this challenge, the Core Science Analytics, Synthesis, and Libraries (CSAS&L) program of the U.S. Geological Survey (USGS) is developing Biodiversity Information Serving Our Nation (BISON), an integrated and permanent resource for biological occurrence data from the United States. BISON will leverage the accumulated human and infrastructural resources of the long-term USGS investment in research and information management and delivery. Read the DOI Official Press Release in which BISON's public debut was announced.

NatureServe Data Analysis Tools

Lori Scott and Don Kent, NatureServe

iMap Invasives, http://www.imapinvasives.org/, is an online tool for managing invasive species data. It supports early detection and citizen observation reports as well as robust survey and treatment management options for natural resource agencies. In 2017, a next generation system will begin development and is expected to be ready within two years.

LandScope America, www.landscope.org, is an online platform that provides curated content from many state, federal, and NGO partners to support conservation planning. The system includes about 400 map layers from hundreds of sources. LandScope supports directly accessing data from the provider via map services, which facilitates keeping the content up to date. This summer several noteworthy changes are coming to LandScope:

- In coordination with USGS, the map layer that aggregates SWAP conservation opportunity areas is being updated to reflect the latest mapped plans from states, and state content pages will also be updated to point to the most current state SWAPs.
- The Conservation Registry, www.conservationregistry.org, contents and functionality will be integrated into LandScope. With these changes, LandScope will have the capability to support more advanced, custom state portal functionality.

NatureServe Vista, http://www.natureserve.org/conservation-tools/natureserve-vista, is a free downloadable Esri ArcGIS Desktop extension for land use planning and assessment.

There is a NatureServe Network species distribution modeling initiative which is coordinating efforts among network modeling experts to develop a nationally consistent, verifiable, multi-jurisdictional library of modeled distributions for all listed, candidate, and petitioned species. For this initiative we are partnering with industry reps, USGS, and USFWS to bring together expertise, input predictor layers, and information technology infrastructure for a cost effective and efficient process.

NatureServe has developed an online platform for data sharing, conservation planning and environmental review. Implemented in 8 states so far, the platform combines a Drupal content management system with Esri ArcGIS Server (Javascript) mapping. Each state system shares core application components that are configured/customized to meet the state's unique business rules and workflow for environmental review. The system includes support for online fee collection and credit card payment via a subscription or pay per survey model. http://www.natureserve.org/conservation-tools/environmental-review-tool

Links to state implementations of the NatureServe Environmental Review Tool:

- Virginia - https://vanhde.org/
- Arizona - https://azhgis2.esri.com/
- Pennsylvania - https://conservationexplorer.dcnr.pa.gov/
- Missouri - https://naturalheritagereview.mdc.mo.gov/
- North Carolina - https://ncnhde.natureserve.org/
- Louisiana - https://laert.natureserve.org/
- Nebraska and New Mexico systems are in final testing stages now

Elements in Place: Data Security Management Tools

This section of the report highlights examples of **data security management tools** that are being used by state and provincial agencies, particularly to control access to sensitive data on species and habitats.

California Department of Fish and Wildlife Data Security Efforts

Patrick McIntyre, California Department of Fish and Wildlife

The BIOS map viewer and CNDDB data are managed by a combination of monthly password distribution list and CDFW logins. Access to BIOS datasets is at four levels: 1) fully public data visible to all, 2) data on rare species restricted to CNDDB commercial subscribers (typically consulting biologists and environmental consulting firms) and 3) data restricted to government agency CNDDB subscribers on particularly sensitive data (e.g. eagle nesting locations), and 4) data restricted entirely to CDFW. CDFW is moving to enable security related to individual logins, but currently manages access by sending a monthly password.

Maine Data Management and Security

Amanda Shearin, Maine Department of Inland Fisheries and Wildlife

Maine provides natural resource information to the public and willing partners through several mechanisms. Information for non-regulatory planning purposes at the town and regional scale can be obtained through our Beginning with Habitat (BwH) partnership (http://www.beginningwithhabitat.org/) among state, federal, and non-profit conservation partners. We also provide this information through the online Habitat MapViewer (http://webapps2.cgis-solutions.com/beginningwithhabitat/). Wildlife and plant species sensitive to collection are masked in our maps as 'rare species'. Users also can obtain fish and wildlife spatial data upon request; however, we do not currently allow users to directly download this information from our website. We do not routinely provide information for non-incorporated towns. Fish and wildlife information for regulatory or project-specific purposes (e.g., development proposals) is directed through our Environmental Review program. Wherever possible, we try to make a clear distinction between appropriate regulatory and non-regulatory uses of our information.

Missouri Department of Conservation Data Protection and Security

Julie Fleming, Missouri Department of Conservation

Natural Heritage Program

Biotics is password-protected software. The Natural Heritage Database Manager assigns logins for staff. Partner agencies sign a Memorandum of Understanding before receiving Natural Heritage data. The Natural Heritage Review Website requires users to create a login and they do not receive exact data or species name without specifically contacting Program staff.

Montana Department of Fish, Wildlife and Parks Data Security and Access

Dawn Anderson, Montana Department of Fish, Wildlife and Parks

Security and access is a central component that is a primary consideration during the construction of each database and application. This includes every database and API developed by MFWP as well as with partners such as UM. User access, data visibility, read/write capability, and many other things are explicitly considered in each database and software application we develop.

Nebraska Game and Parks Commission User Management

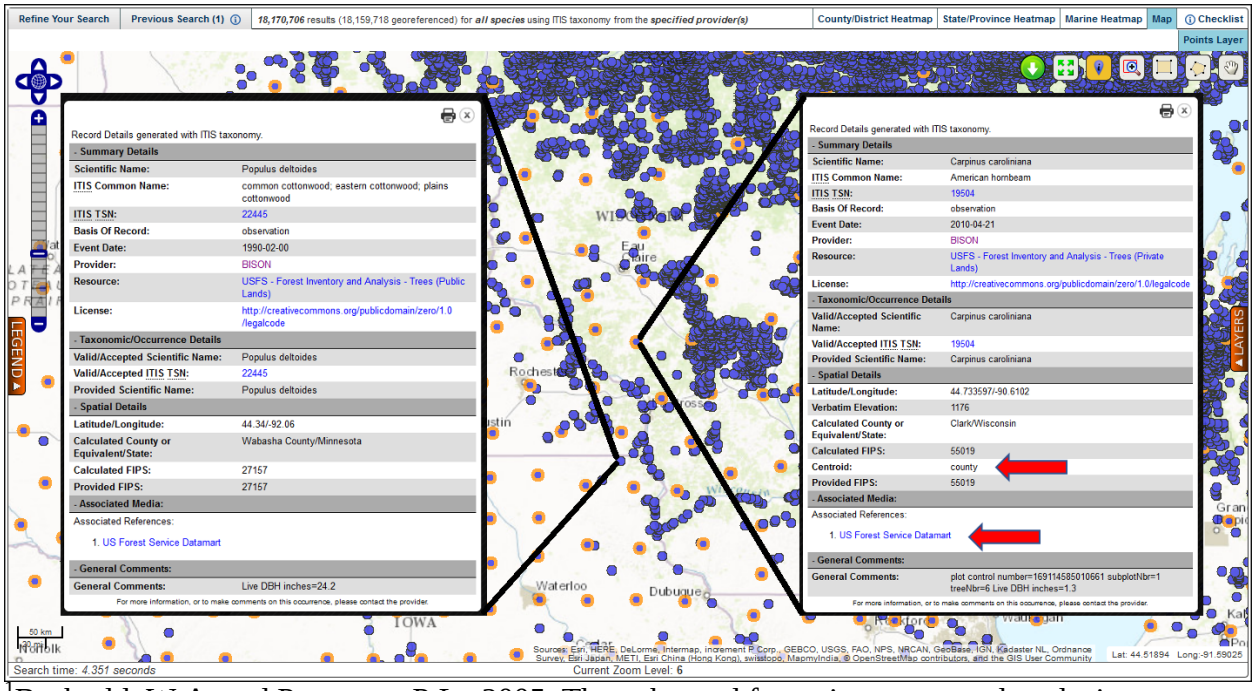
Rachel Simpson, Nebraska Game and Parks Commission

Nebraska's Conservation and Environmental Review Tool permits access to information according to the user type. Users without an account can explore and query map layers for conservation planning and educational purposes. For example data on species generalized to a township (56 square miles) is available to all users, including the public. Registered users can submit project areas and receive a report back. Access to sensitive data by registered users is controlled by the type of account that is assigned to the user. For example, precise location data for at-risk species is not displayed to the standard account type but it is visible to 'privileged' users. Similarly, a list of at-risk species documented at a project site is not included in the standard report but is included in the report for privileged users.

Resolution-protected records and provider-controlled access to exact locations in USGS BISON

Gerald Guala, U. S. Geological Survey

There are numerous reasons for data providers to want to protect the exact locations of species in their data from full public access. Common use cases involve protected species and those that are subject to local exploitation. Privacy concerns about the ownership and the exact nature of resources on privately held land are also an issue. In the case of the USDA Forest Service Forest Inventory and Analysis (FIA) Program[1], the latter concern is addressed by intentionally switching plot locations in public data when they occur on private land[2]. In BISON[3] while FIA data from public lands are delivered with exact locations[4], broad integration and use of data across many data sets is the common usage scenario, so rather than delivering FIA data from private lands with intentionally incorrect exact locations, the standard method of de-resolution is used, and the data from private lands are delivered de-resolved to county centroids[5]. Centroids in BISON are designated in both text and graphics in each record. A link to the original provider in each record gives users the option to contact the original provider directly for exact locations, and the provider then maintains direct control over who sees sensitive data.



[1]Bechtold, W.A. and Patterson, P.L., 2005. The enhanced forest inventory and analysis program-national sampling design and estimation procedures.

[2]Coulston, J. W.; Reams, Greg A. 2004. The effect of blurred plot coordinates on interpolating forest biomass: a case study. In: Proceedings of the joint meeting of the 15th annual conference of the International Environmetrics Society and the 6th international symposium on spatial accuracy assessment in natural resources and environmental sciences. (https://www.srs.fs.usda.gov/pubs/ja/ja_coulston005.pdf)

[3]https://bison.usgs.gov/

[4]https://bison.usgs.gov/?providerID=440&resourceID=100028#home

[5]https://bison.usgs.gov/?providerID=440&resourceID=100042#home

Conclusions and Recommendations

State, federal, provincial, and territorial fish and wildlife agencies are all facing similar challenges related to the management and analysis of data on fish and wildlife populations and habitats. Some of the common challenges that we have documented in this report include:

- The discovery, compilation and (in some cases) digitization of legacy data from past data collection activities. The management of legacy data appears to be a common concern across many of the agencies in the Association. We note the existence of a variety of solutions for the problems associated with legacy data management, ranging from low-tech human data entry to high-tech digital scanning. These solutions have been implemented in various combinations by various agencies and organizations in the Association, as documented in this report.
- The development of integrated databases or data platforms that combine data from multiple data sources into a single data management environment. We note that many of the individual states or agencies have already developed their own integrated data management systems, tailored to their individual agency needs. These tools often utilize web or desktop user interfaces which are modeled on or utilize Geographic Information Systems technology in order to display, analyze, and manage information from disparate data sources, but they do not always "speak" to platforms in other states in order to inform range-wide fish and wildlife conservation and management decisions.
- The development of sophisticated new data analytic tools that can address complex management questions by integrating data from multiple complex data sources, including various satellite, climatic, remotely sensed, and predictive modeling data. This is an area of active research and development both within the state and federal agencies and at major partners such as the land-grant universities and the Cooperative Fish and Wildlife Research Units. We note in particular the ongoing efforts by multiple Association members to develop web-based data analysis tools using statistical languages such as R.
- Data security and access management. This is a primary concern of state agency leadership in any discussions regarding the management and analysis of potentially sensitive fish, wildlife, or habitat data. The problem of access to sensitive data is a general topic of concern for data management professionals and has received extensive discussion in other fields with sensitive data issues such as health care and human resources. A wide range of solutions to problems of data security and data access are already available and many of these solutions have already been implemented by individual Association members in order to protect access to sensitive data.

Based on these common concerns and findings, we recommend a series of initial steps that can be taken by AFWA, the regional associations, the state and provincial fish and wildlife agencies, and other AFWA members, in order to promote and realize the vision of the Center for Habitat and Wildlife Analyses. These steps include:

- Expand the WAFWA CHAT to continental scale as an important external user tool.
- Develop an expanded version of the Arizona HabiMap^{TM}, as a potential common platform for data visualization and spatial data analysis for the state fish and wildlife agencies individual and collective conservation and management decision-making processes, and ensure data from

other sources such as NASA, NOAA and USGS BISON can readily integrate into the states' data system to inform management scenarios .

- Promote the continued development of USGS BISON as an integrated data source and data repository for a broad range of publicly-available species and habitat data, which can be accessed by a wide range of partners include state, federal, territorial, and provincial fish and wildlife agencies.
- Promote the continued development of the NatureServe Observation Data Standard as a common data standard which could be applied to a broad range of data associated with fish and wildlife species and their habitats.
- Work with other conservation and business interests who would benefit from utilizing such collections of state data and information to reduce operating costs, increase return on investments, protect property and reduce risks, identify strategic conservation investments, fulfill corporate sustainability goals and objectives, and save money.

Individual steps and recommendations are discussed in more detail in the sections that follow.

Expanding the CHAT: Potential for a Continental-scale Crucial Habitat Assessment Tool

Mike Houts, WAFWA Information Systems Director

The current Western Association of Fish and Wildlife Agencies' Crucial Habitat Assessment Tool (CHAT) provides useful information at larger spatial scales (1 square mile or greater) about the presence of crucial habitats and species of conservation interest across the entire western United States. The current CHAT data system is based around a 1 square mile hexagon grid. Each grid cell summarizes information from a suite of "raw" data sets using criteria identified by the states to create a ranking on a scale of 1-6 that describes how "crucial" that cell is for the conservation of wildlife species and habitats of interest. The hexagon layer now extends seamlessly across the United States, Mexico, and most of Canada, allowing for geospatial data sets to be combined/related even if they were collected at different times, dates, scales. The hexagons also provide a way to combine and summarize point/line/polygon data so a single query can indicate the presence of features from many different data layers in a spatially generalized way.

One new tool that we are working on is a mechanism to ingest external data sets so that key attributes of the source layer are related to a hexagon ID. Once related, the query of a hexagon could show a range of attributes from the source layer and also reference back to the source layer it came from. In this way the general information of a feature of interest can be shared and made useful to users while the specific spatial location and detailed attribute data (and the raw data itself) stay secure.

WAFWA has created a consistent 1-sq. mile hexagon / 7-sq. mile cog grid covering the entire United States (including Alaska and Hawaii), México, and 5 Canadian providences. Cells also cover the 250 mile Economic Exclusivity Zone (EEZ) around the coasts. The 1 sq. mile hexagons are in turn nested in a 7 sq. mile cog which allows users to map data at either scale, depending on the spatial sensitivity of the data or the particular needs of the audience it is being shared with. The hex/Cog matrix provide consistent mapping units for data from state/federal agencies and other sources. Units flow seamlessly across political boundaries and do not reflect landowner or landscape features so they are neutral for

mapping regions or priority areas (where to draw the line) and they are also useful for conducting random sampling.

Mapping of data on a uniform grid can provide increased opportunities for data sharing and coordination. Key attributes of data can be tied to a hexagon to convey what is in an area, while the precise spatial location is obscured. This allows general information to be shared, while respecting the spatial sensitivity of some datasets or restrictions related to landowner privacy. Hexagons allow data from point/line/polygon formats, different spatial scales, years, methods, or regions to all be combined in a common framework for comprehensive assessments. Data layers referenced to the hexagons make them easier to share and incorporate into CHAT based rankings and tools so more people can utilize the data. With many data sets referenced to the hexagons, a simple query on a cell can return results from all layers. Hexagon attributes can include a citation back to the source layer if more detail/access is needed.

The Arizona Conservation Strategy: A Model for State Agency Data Management

Joyce Francis, Arizona Game and Fish Department

The Arizona Conservation Strategy (ACS) is intended to be an umbrella support framework that will inform multiple-use actions of the landscape with science and data so that management of, or impacts to wildlife, is influenced and directed in order to reduce impacts and create a streamlined and predictable process for permitting and mitigation, while maximizing conservation. The Strategy itself is a multifaceted operating framework which includes financial, organizational, social, political and legal aspects as well as the geospatial wildlife data that is core to AGFD decision making. On the technical side, the ACS is conceptualized as decision support system that informs a voluntary conservation partnership system that can be used to minimize and advise impacts to wildlife on the landscape while facilitating development and industry. In this context, the ACS will rely on continuous data collection so that decisions are made based on the most current and complete data available. This data will be housed, along with all of the Arizona Game and Fish Department's (AGFD) data in a Data Warehouse (Warehouse). The Warehouse, which is currently in the early stages of development, will be a data storage system which allows the user to develop their own data entry scheme from a library of available data types, fields and look up tables. The Warehouse will allow individual biologists control over their study design while maximizing standardized data collection. In addition, real time streaming of data will be enabled from mobile device based applications as data is collected opportunistically or targeted by biologists in the field. There will also be options for bulk uploads of partner and or archived data. The purpose of the Warehouse is to concentrate all of the AGFD data in one easily accessible location.

The ACS is an interface into the Data Warehouse that will convert all spatially explicit information in the Warehouse into native Geographic Information System files that can be used in geospatial analysis. In essence, this will create a layer after layer of the most current and complete wildlife data for the State of Arizona. As an evolution of the current CHAT efforts, this data will remain in its original state and not transformed into a "mash up" model. The ACS will act like a cookie cutter slicing through the data and performing a number of analyses to determine actual impacts to wildlife from actions on the landscape. Each of those analyses will have individual parameters set that will

generate a list of concerns with each project. Questions asked will include things such as what percentage of available habitat for each species will be impacted by the project? What will be the effect on fragmentation? What is the impact to recreational access? Perhaps, most importantly, what is the most effective mitigation for this project at this site? The ACS will provided scientific, data driven answers to these questions, and many more, in a way that is both defensible and repeatable. Those answers will inform management decisions, provide partners with data up front to make informed decisions and form the basis for conservation partnerships that will incentivize voluntary partner investments into wildlife conservation and change the future of wildlife management into the future.

USGS BISON as a comprehensive, integrated data platform for wildlife and biodiversity data

Gerald Guala, U. S. Geological Survey

USGS Biodiversity Information Serving Our Nation (BISON) is a unique, web-based Federal mapping resource for species occurrence data in the United States and its Territories. Researchers collect species occurrence data, records of an organism at a particular time in a particular place, as a primary or ancillary function of many biological field investigations. Presently, these data reside in numerous distributed systems and formats (including publications) and are consequently not being used to their full potential. As a step toward addressing this challenge, the Core Science Analytics, Synthesis, and Libraries (CSAS&L) program of the U.S. Geological Survey (USGS) is developing Biodiversity Information Serving Our Nation (BISON), an integrated and permanent resource for biological occurrence data from the United States. BISON will leverage the accumulated human and infrastructural resources of the long-term USGS investment in research and information management and delivery. Read the DOI Official Press Release in which BISON's public debut was announced.

The USGS CSAS&L program is also the U.S. Node of the Global Biodiversity Information Facility (GBIF), an international, government-initiated and funded effort focused on making biodiversity data freely available for scientific research, conservation and sustainable development. USGS CSAS&L hosts a full mirror of the hundreds of millions of global records to which GBIF provides access. BISON was first released in April 2013 and included 110 million records made available through GBIF from the U.S. and U.S. Territories. In November, 2015 BISON passed the 260 million record count and is continuing to integrate millions more records from other sources each year.

Biodiversity Information Serving Our Nation (BISON) is committed to providing free and open access to primary species occurrence data. Data currently available through BISON are contributed by various U.S. Federal and State agencies, universities, and non-profit organizations, either directly to BISON or indirectly through their participation in the Global Biodiversity Information Facility (GBIF). GBIF Participants who have signed the GBIF Memorandum of Understanding have expressed their willingness to make biodiversity data available through their nodes to foster scientific research development internationally and to support the public use of these data. GBIF data sharing should take place within a framework of due attribution. Therefore, using data available through BISON requires agreement with the BISON Data Use Agreement that is displayed prior to a data download.

The NatureServe Observation Data Standard

Information Derived from NatureServe Website

Common data standards are important tools and building blocks for the development of integrated data management systems. NatureServe has initiated the development of an Observation Data Standard (http://www.natureserve.org/conservation-tools/standards-methods/natureserve-observation-data-standard) which promises to be broadly applicable to wildlife and biodiversity data management needs of state, federal, territorial, and provincial fish and wildlife agencies. Observational data are recognized to be fundamental for scientific inventory and monitoring, conservation planning, habitat management, invasive-species assessments, predictive distribution modeling, and much more. The observation data standard is intended to benefit the research and conservation communities by facilitating data aggregation and sharing within and among organizations, such as data discovery through global search portals, and by fostering interoperability and collaboration. An observation is a set of information that describes the presence or absence of an organism or assemblage of organisms through a data collection event at a location. The NatureServe observation data standard is designed to be broadly applicable regardless of data or survey type. Initial work on this data standard was completed in 2006 but further refinement and development is needed in order to meet the data needs of state and federal fish and wildlife agencies. Further development of this standard could be of broad and significant benefits to state, federal, territorial, and provincial fish and wildlife management agencies.